EIS2016

Clare County Council

Comhairle Chontae an Chlair

N18 Road Improvements Dromoland to Crusheen (including the Ennis Bypass)

Environmental Impact Statement

Volume 3: Appendices

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EIS No: 2016

LA 00/4

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Comhairle Chontae an Chlair

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Environmental Impact Statement

VOLUME II

Environmental Impact Statement

Babtie Pettit Ltd.
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Ireland.

March 2000

Babtie

Pettit
Project Design & Management

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APPENDIX I – PART A

PROPOSED ROUTE LAYOUT MAPS

EIS NO: 2016

Any of the larger maps unable to be included in this EIS may be viewed on hardcopy if necessary.

Contact ENFO for details on how to view these files.

Email: info@enfo.ie
Phone: 01 888 3910

MAP

SEE ENCLOSED

APPENDIX I – PART B

DESIGN REPORT (CLARE COUNTY COUNCIL SEPTEMBER 1999)

COMHAIRLE CHONTAE AN CHLÁIR

CLARE COUNTY COUNCIL

N18 ROAD IMPROVEMENTS
DROMOLAND TO CRUSHEEN
(INCLUDING THE ENNIS BYPASS)

DESIGN REPORT

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Co Clare

September 1999

3/61/REP-0128

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SECTION 1

PROJECT DESCRIPTION

N18 ROAD IMPROVEMENTS SCHEME
DROMOLAND TO CRUSHEEN
(INCLUDING THE ENNIS BY-PASS)

1. PROJECT DESCRIPTION

1.1 Brief Description of the Proposed Works

The project involves the construction of a new section of road to relieve the existing N18 between Dromoland and Cragard which is about 3km south of Crusheen, with a short section of tie-in along the existing road at Cragard. It also includes the construction of a new N85 Western relief road from the N18 at Killow to the existing N85 Ennistimon road to facilitate the national and regional traffic from south and west Clare.

The main lengths of road to be constructed are:

- 5.6 km of N18 standard dual carriageway
- 2.5 km of N85 Western relief reduced dual carriageway
- 8.5 km of N18 wide 2 lane carriageway(with shoulders)
- 4.6 km of N85 Western relief wide 2 lane carriageway(without shoulders)
- 5.0 km of Slip roads\link roads\county road realignment

The route is shown on Site Layout Map 300-61-67 with this report.

Access to and from the road will be restricted to key junction locations. International experience has shown that such a policy leads to a greatly reduced number of accidents and preserves the capacity of the road to cater for the expected volumes of traffic.

The estimated cost of the scheme is £57.3 million at 1998 prices.

1.2 The Position of The Project in a Local and National context

The N18 National Primary Route runs from Limerick City to Galway City. It travels through the centre of County Clare via Newmarket on Fergus, Clarecastle, and Ennis. It is connected to Shannon Town, its Airport, and its Industrial Districts by the N19 National Primary Route. The N18 and N19 routes form part of the Western and Southwest Road Corridors identified as two of the four strategic Corridors both in the current National Development Plan and in the Operational Programme for Transport 1994-1999.

The N18, itself, is part of the Trans-European Road Network (TERN). ***(see figure 1.1).*** It provides access from the Northwest, West, and Midwest regions to the southern sea corridor ports of Waterford, Rosslare and Cork. It also links the west and northwest regions to Shannon Airport and to the University cities of Galway and Limerick, as well as providing links to the Regional Airports at Sligo, Knock and Galway, the regional port at Galway and the Shannon Estuary ports.

This project is part of an overall strategy to improve the road network through County Clare. In previous developments, 5.5 km of new dual carriageway was provided on the Bunratty Bypass opened in 1992 and 6.9 km of the existing dual carriageway was recently improved from the Limerick border to the Bunratty Bypass. The Newmarket on Fergus by-pass (N18\N19 Ballycasey To Dromoland Road Improvements -Phase 1) is under construction at present and Contract No. 1 is expected to be complete by 2002, thus providing dual carriageway from Carrigoran to Dromoland before the Dromoland to Crusheen scheme commences.

Shannon Airport and its Industrial District are located close to the section of road under consideration. They provide employment for a large workforce from many parts of the region. This important area is expected to continue growing at a fast pace. To encourage this growth to continue, it is important that the supporting infrastructure be in place. The road network to Shannon is a major part of the facilitating network needed to provide easy access for the workforce and for the efficient movement of raw materials and manufactured goods. The Airport, with its obvious advantage of being located close to several major tourist routes, is the gateway for a large volume of the tourist traffic visiting Ireland and access to the Airport has to reflect this demand.

Frequent delays are experienced in Clarecastle because the traffic is delayed due to right-turning vehicles or heavy commercial vehicles obstructing the flow. There are no outer link roads which allow through-traffic to easily avoid the town. Significant conflicts between traffic and pedestrians occur, thereby reducing the attractiveness of the town. The streets in Ennis through which the heavy goods vehicles travel are narrow and these larger vehicles are easily hindered in their passage. The main N18 passes to the west of the town centre resulting in a high level of turning movement from the main thoroughfare into and out of the town centre.

From the overall traffic viewpoint, studies indicate that the volume of traffic on the N18 national route exceeds the present capacity of this road and consequently is detrimental to the local economy due to the resulting congestion and delay. Diversion of bypassable traffic from Clarecastle and Ennis, would bring benefits to the local community and to national users while the removal of such traffic would enhance the quality of urban living in the town. Having an efficient national road network convenient to Shannon will enhance the attractiveness of the area to industrial and commercial interests already located there and for potential businesses looking for a base.

This is in accordance with the strategic objectives of the Ireland, National Development Plan 1994-1999 (Ref 23) which include:

"...improving internal and access transport infrastructure and facilities on an integrated basis, thereby reducing transport costs and offsetting the negative effects of peripherality;

....improving the reliability of the transport system by removing bottlenecks, remedying capacity deficiencies and reducing absolute journey times and journey time variance."

1.3 The Road Network in County Clare

The road network in County Clare (ref 27) amounts to ***4,142 km*** of road comprising of:-

(1) ***54.5 km*** of ***National Primary Roads*** accounting for 1.3% of the total Clare road network.
   - (a) N18 Limerick to Galway
   - (b) N19 Ballycasey to Shannon

(2) ***184 km*** of ***National Secondary Roads*** accounting for 4.4% of the total Clare road network.
   - (a) N67 Kilcolgan to Kilrush
   - (b) N68 Ennis to Kilrush
   - (c) N85 Ennis to Ennistymon

(3) ***598 km*** of ***Regional Roads*** (14.5% of Clare network).

(4) ***3,307 km*** of ***Local Roads*** (79.8% of Clare network).

1.4 Local and National Policies

The proposed roads are to be seen in relation to national policy as outlined in:

(a) "Ireland - Road Development 1989 to 1993" (Ref. 23)
This is the Operational Programme submitted by the government to the European Community

(b) "Operational Programme on Peripherality; Roads and Other Transport Infrastructure; Ireland 1989 - 1993" (Ref 24),
This is the programme agreed by the Government with the E.C..

(c) "Ireland, National Development Plan 1994 - 1999" (Ref 22)
This was the Development Plan submitted by the Government to the E.C. It contains an Infrastructure sub-plan extending the development programme initiated in the preceding period.

(d) "National Road Needs Study" 1998 (Ref 3)
This is the National Roads Authority guidance document.

The fundamental aim of the policy may be summarised as the development of a modern, highly efficient, internal and access transportation system in order to aid the economic development of the country.

Having regard to national objectives and to the need to promote the economic development of the county and the need to preserve the safety and capacity of the road network in County Clare, the Clare County Council County Development Plan, 1988,

(Ref 1) states that: "The Council recognises the importance of providing a safe and efficient road system in the county, to contribute to the development of the local and national economics, to ensure the safety of users of the public roads and to protect the investment of public resources in the provision, improvement, and maintenance of the public road system."

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3. ROUTE SELECTION

Clare County Council is engaged in a continuous process of forward road planning.

This present road scheme is part of a broader network of road improvement objectives contained in the County Development Plan (Ref 1). Due regard is taken of the broader network of road improvements when selecting the route of any individual link.

The process of route selection consisted of two main phases:

1. The initial broad route corridor selection.
2. The more particular route selection within the broad route corridor.

3.1 Broad Route Corridor Selection

3.1.1. The considerations which affected the broad corridor selection included:

(a) Keeping the route as short as possible while maintaining safe operating speeds and low travel times;

(b) Matching the traffic desire lines;

(c) Economic viability;

(d) Minimising major severance to properties;

(e) Minimising effect on existing development as much as possible;

(f) Minimising community severance;

(g) Avoidance (or at least keeping to a minimum) road construction through areas which present engineering problems or which would increase construction costs,

(h) Minimising the impact on, and if possible avoidance of, known archaeological sites or areas of scientific interest;

(i) Taking advantage of scenic landscape features and pleasant new views.

3.1.2. Description of Alternatives

The broad route corridor alternatives considered may be summarised as follows:-

Option A (FIG 3.1)

Utilises western by-pass corridor proposed in the 1968 and 1985 McCarthy & Partners reports for Clare County Council. (11.0 km)

Option B (FIG 3.1)

The eastern route using the most direct line from Latoon to south of Crusheen. This makes no provision for traffic west and south of Ennis.
(9.9km)

Option C (FIG 3.1)

This option is similar to Option A but located further west, though acting more as a straight through route (i.e. not acting as a collector for local traffic).
(13.5 km)

Option D (FIG 3.1)

A combination of Option B and Option A, incorporating a ring road type solution with the national traffic using the eastern alignment to by-pass Ennis in the most direct manner, and the western corridor acting as a collector for local traffic as well as south and west traffic .
(Eastern leg - 9.9 km, Western relief road - 7.3 km)

SECTION 2

THE NEED FOR THE ROAD

2. THE NEED FOR THE ROAD

2.1 Need for the Project

The project is needed for the following reasons:

(a) The present road network is inadequate in regard to safety, capacity and pavement strength;

(b) Greater capacity is required to cater for the projected increases in traffic flows;

(c) To minimise the negative environmental impacts of forcing the future traffic volumes to use the existing network;

(d) As a modern transport network is required in order to compliment the continued economic development of the area;

(e) To eliminate holdups caused by the bottlenecks in Clarecastle and Ennis;

(f) Reducing the traffic volumes through the community's of Clarecastle and Ennis will increase the quality of urban life in both locations;

In addressing these outlined needs, the project is conforming with stated national and local policy on Road Transport.

2.2 Traffic Flow

A separate report on the traffic flow and recommendations is contained in this study (Ref 25)

2.3 Cost Benefit Analysis

During the route corridor selection process in 1993 a cost benefit analysis was carried out which showed the preferred route corridor (Option D) to have an internal rate of return of 15.2%.

This analysis showed that the proposal exhibited a positive net benefit to the economy and was a suitable project for the investment of public money. More recent analyses of the proposed scheme have confirmed this to be the case.

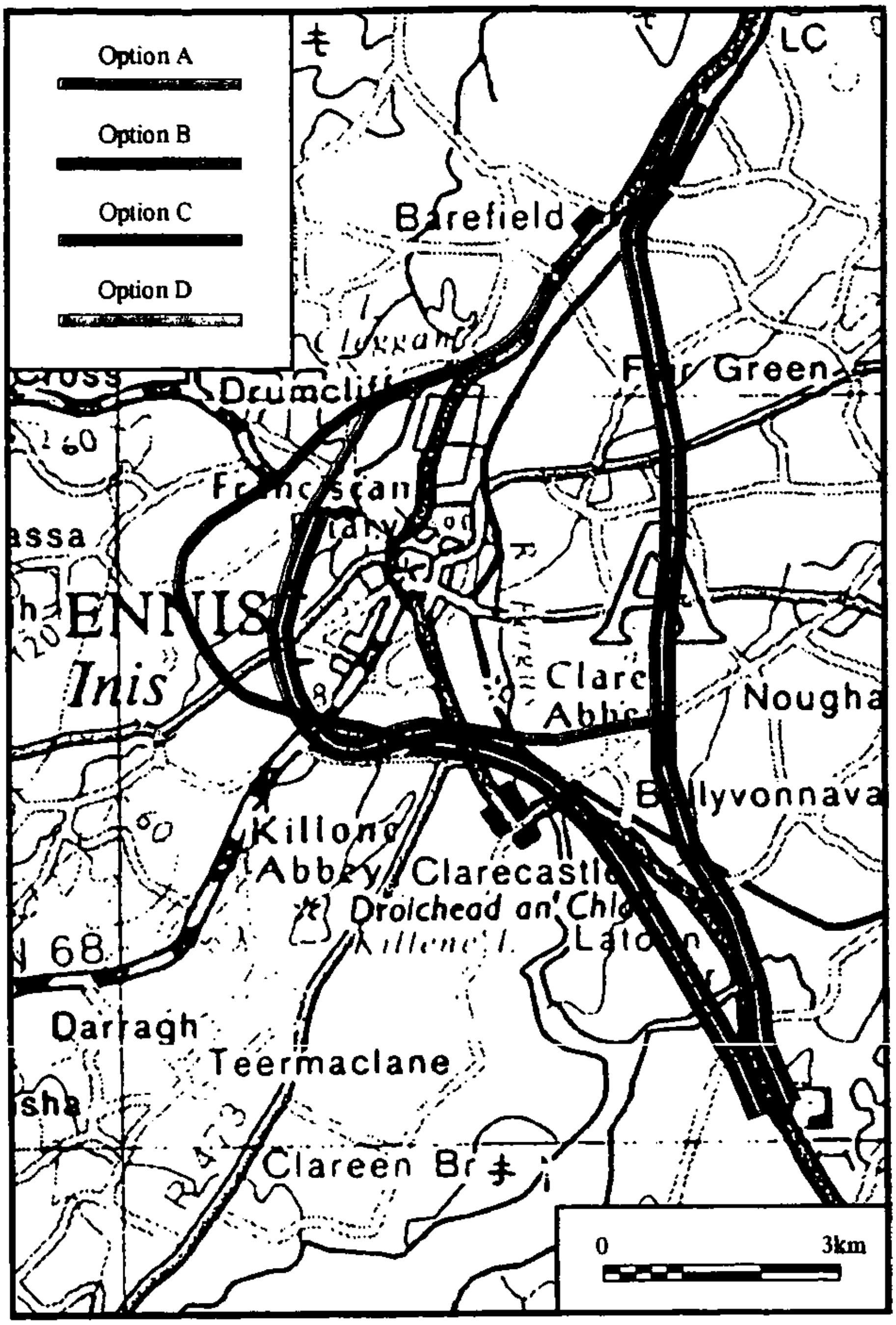

Fig 3.1 Four options (A, B, C, D) were considered in the Broad Route Corridor Selection Report (November 1993 – Clare County Council)

3.1.3. Option A was discarded for the following reasons -

The increased travel distance for the N18 (national) traffic around Ennis.
The increased nose and visual intrusion in facilitating grade separated junctions.

3.1.4. Option B was rejected because -

This option was not suitable due primarily to the failure of the route to cater for the large proportion of traffic going to and from West Clare. The location of the route would not improve the overall traffic management problems existing there at present, thus would not act as a stimulant to growth in the Ennis area.

3.1.5. Option C was rejected because -

It is too long to facilitate the N18 (national) traffic and too far out from the town to facilitate distribution of local traffic.

3.1.6. Option D was proposed because -

It meets the need to cater for national and local traffic.
The impacts on homes and buildings are low.
It facilitates the shortest route for N18 (national) traffic.
By providing at-grade junctions over the western relief road it facilitates local traffic with minimal effect on the locality.
It is less intrusive in terms of noise and visual effects on the area as a whole.

3.1.7. Choice of Broad Route Corridor

In summary, having examined the Corridors available and the considerations set out in Section 3.1.1, Corridor Option D clearly showed itself to be the most suitable.

3.2. Particular Route Selection

Within the broad route corridor of Option D, various sub-options were examined. These are described below.

3.2.1. The factors which influenced the more detailed route selection included:

(a) Alignment beneficial to safety and capacity;

(b) Effects on dwelling houses & proximity to urban development;

(c) Construction of junctions and accommodation roads;

(d) Environmental Considerations (ref 19)

(e) Engineering considerations and construction costs.

(f) Property severance;

3.2.2. Sub-Options

Within corridor D certain physical constraints, such as existing developments and the need to provide for junctions, serve to restrict the freedom of movement of the route. Four main sub-options were considered and these are summarised in the following clauses.

3.2.2.1. Sub-options D1 and D2 at Manusmore Townland

Two sub-options were considered at Manusmore Townland (Figure 3.2).
Option D1 uses the most direct route between Latoon bridge (River Rine) and Killow Junction.
Option D2 follows a more easterly alignment, more curved and slightly longer with less cut than Option D1.
Following examination of the design implications, assessment of the ground conditions and environmental considerations, and consultations with the landowners concerned, Option D2 was deemed to be the more favourable option with consideration given in particular to:

(i) Minimising land severance;
(ii) Minimising impact on existing development
(iii) Utilising the best ground conditions available.
(iv) Physical constraints
    a) County road L714(2)
    b) The railway
    c) Other physical contraints (ESB lines, impact on development)

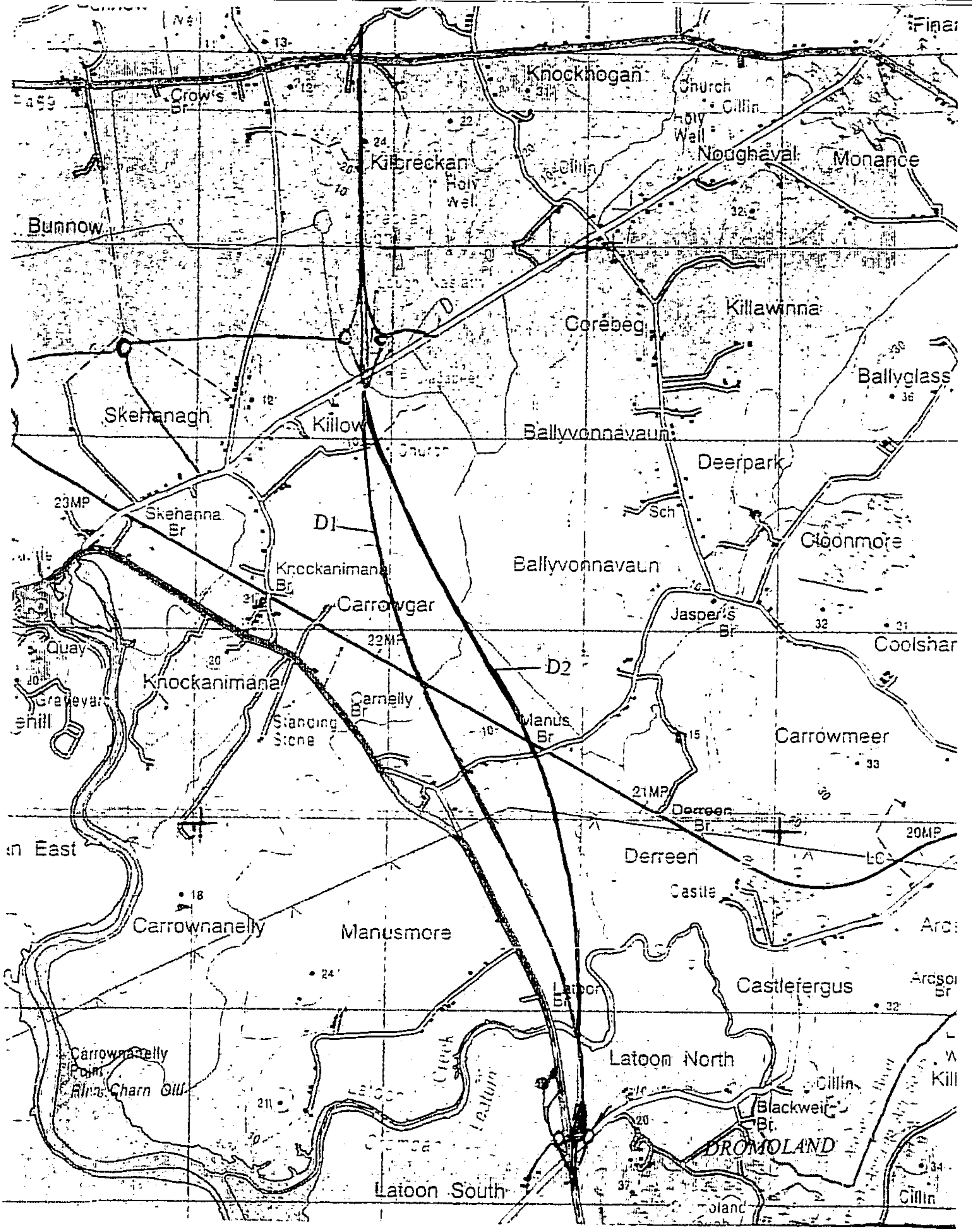

Fig 3.2 Sub-Options at Manusmore (D1 and D2)

3.2.2.2. Sub-options D3 and D4 at Knockaskibbole/Knockanean

The deciding factor in choosing Sub-Option D3 over Sub-Option D4 at Knockaskibbole (Fig. 3.3) occurs in the geometric alignment. Sub-Option D3 follows a significantly preferable alignment in terms of safety, road standard, economy and visual aesthetics.

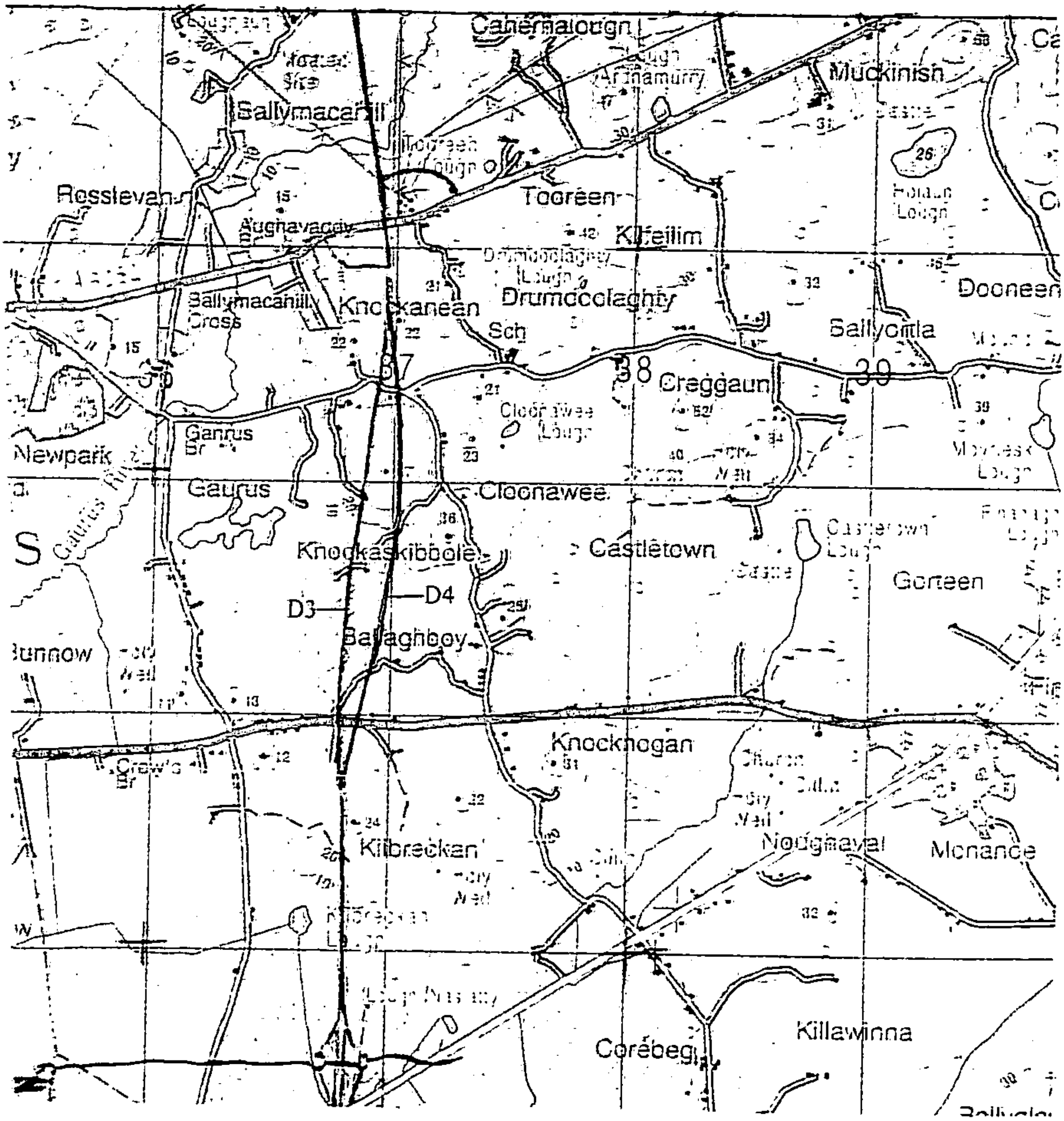

Fig. 3.3 Sub-Options at Knockaskibbole (D3 and D4)

3.2.2.3. Sub-options D5 and D6 at Cahircalla

The main differences between the Sub-Options at Cahircalla (Fig 3.4) occur in geotechnical difficulties and geometric alignment. Sub-Option D5 follows a substantially preferable alignment in terms of construction feasibility, and visual aesthetics. Sub-Option D6, although a more desirable alignment in terms of capacity, would pose aesthetic problems and involves cutting into the limestone bedrock which makes up most of this section. This could prove economically unviable as well as posing extreme difficulty in construction relating to removal of the rock. Taking into account the predicted traffic flow on this section of the scheme and the spare capacity likely to be available with either option it was decided to pursue Sub-Option D5.

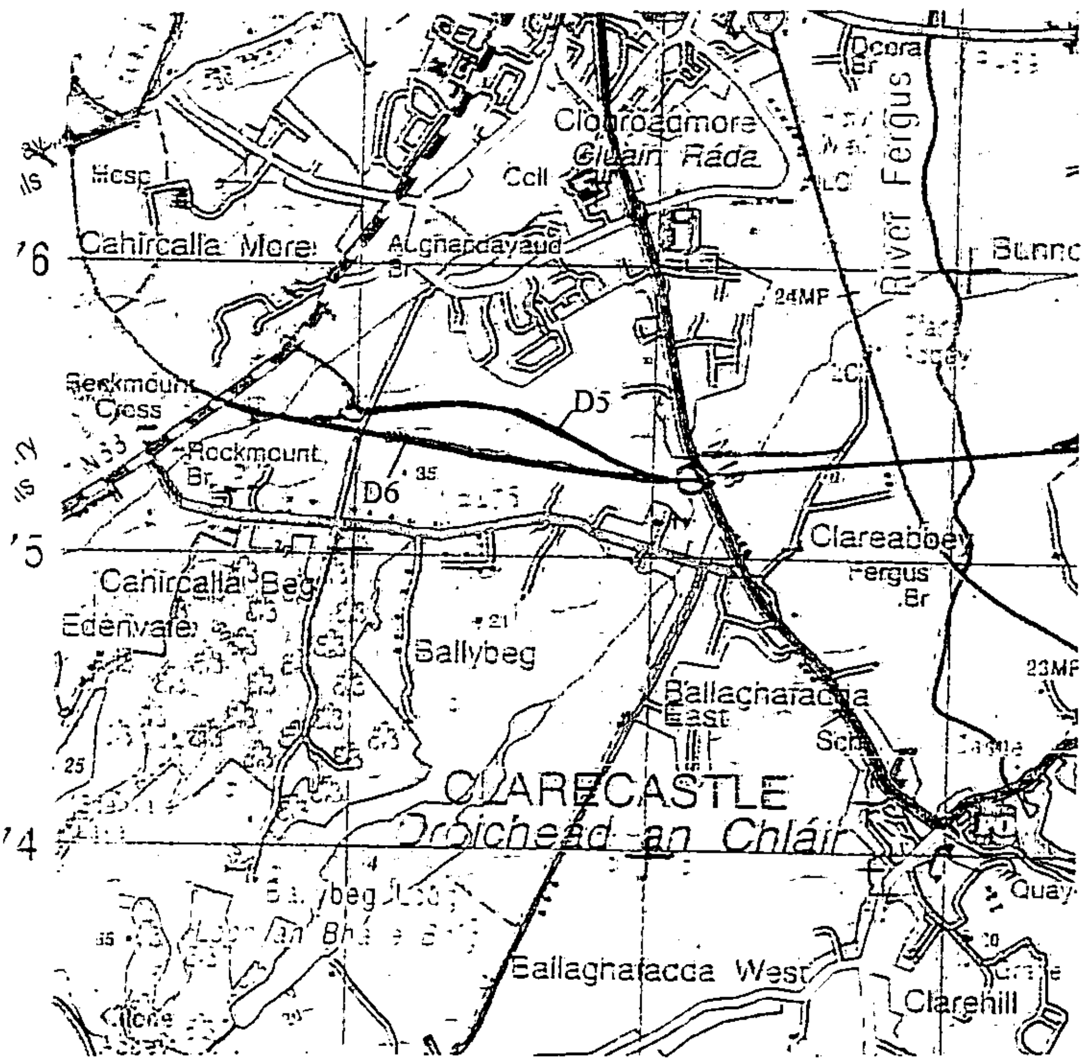

Fig. 3.4 Sub-Options at Cahircalla (D5 and D6)

3.2.2.4. Sub-options D7 and D8 at Skehanagh

The critical difference between the Sub-Options at Skehanagh (Fig 3.5) occurs in geometry. Sub-Option D7 follows more closely the desire line of the traffic flow. It is the shorter route between the junctions at Clareabbey and Killow and provides desirable alignment for good junction design in terms of safety and aesthetics. Another factor is the comparative ground conditions. Whilst Sub-Option D8 is passing through wetlands the depth of soft material is deemed to be sufficiently shallow so as to accommodate construction on the underlying bedrock.

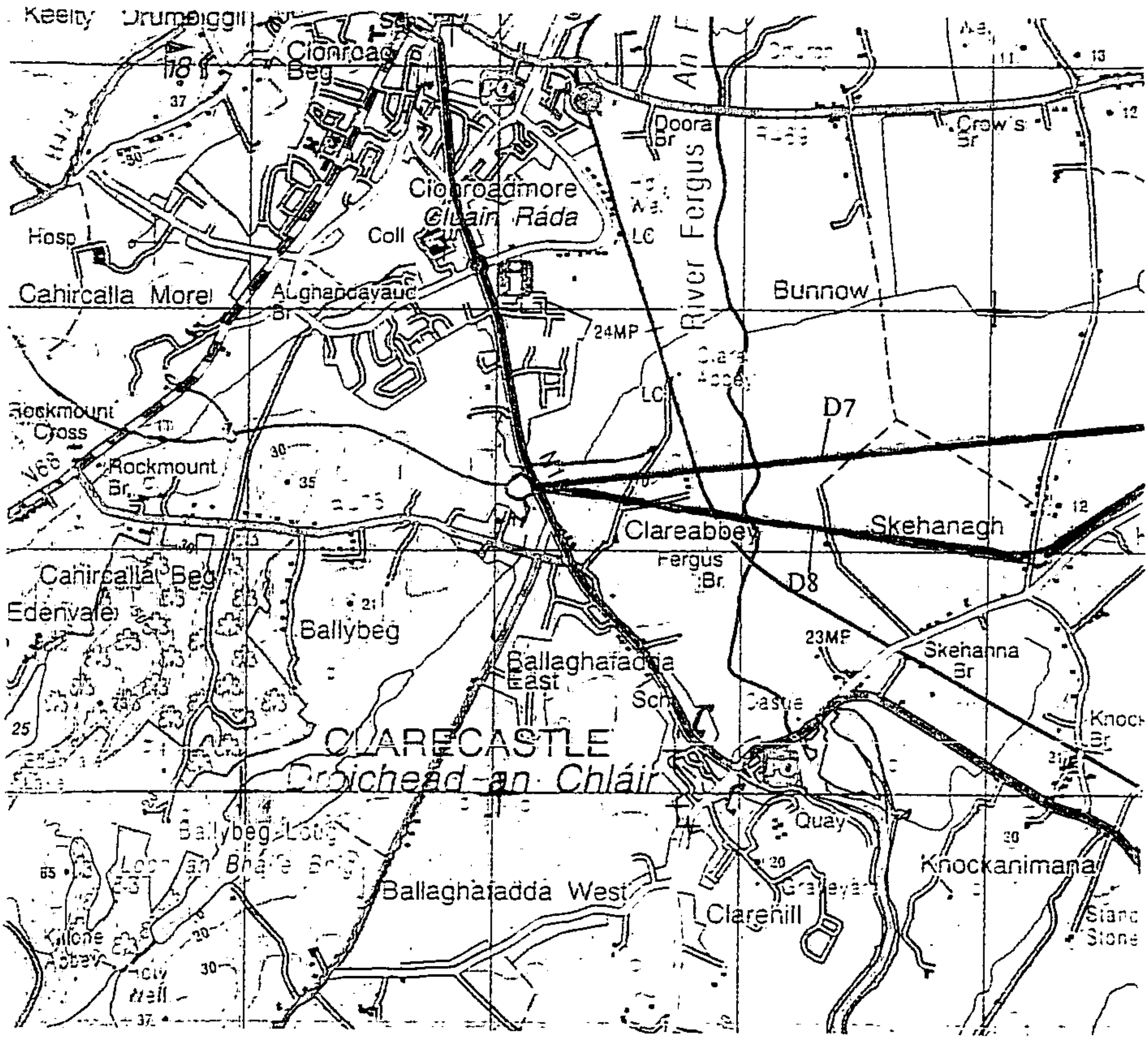

Fig. 3.5 Sub-Options at Skehanagh (D7 and D8)

SECTION 4

ENVIRONMENTAL CONSIDERATIONS

4.1 General Comments

An Environmental Impact Statement has been prepared in accordance with
Section 50 of The Roads Act 1993
S.I. 119 of 1994 (Roads Regulations)
S.I. No. 93 of 1999 (Environmental Impact Assessment) and
S.I. No. 92 of 1999 (Planning and Development)

The Environmental Impact Statement is contained in a separate report (ref 19).

Roads by their nature have an impact on the environment. Severance of land, noise, air pollution, and visual amenity all have to be considered in conjunction with social and cultural aspects as well as ecological impacts. The proposed road will pass through an environment that consists, in the main, of agricultural farms and will only come in close proximity to housing where it will cross or run alongside the existing road network apart from a few isolated farmhouses the natural terrain through which it will pass. In open countryside some interesting new views will also be seen from the proposed roadway embankments. And also every effort has been made to keep severance of land to a minimum. The geometric result of these considerations is covered in detail in Section 5, entitled "Alignment Details".

4.2 Considered impacts of the Proposed Scheme

4.2.1 Road Users, Drainage and Ecology considerations

The proposed road scheme will have beneficial impacts on road users in terms of time savings and accident reduction.

The proposed road will be drained by a system of piped drainage. Use will be made of existing channels and streams to receive the run-off from these drains.

None of the wildlife habitats impacted by the scheme have been recognised or are considered to merit recognition as areas of significant scientific importance.

The landscaping which will take place will include plantations of native species at suitable locations to replace vegetation lost due to the construction of the road and to counterbalance any loss of natural habitats.

4.2.2 Noise

Noise is expected to have a significant impact at approximately 30 houses along the Eastern By Pass with anticipated levels of 50 to 70 db (A).

Along the Western Relief road the predicted range is in the region of 50 to 65 (no significant impact is anticipated). The noise reduction in Clarecastle and Ennis will be significant when the through-traffic is removed. Of the 30 houses predicted to experience as significant noise impact 10 may exceed the 68 db (n) noise level at which mitigation measures are required by UK noise Regulations 1975. It is intended to ameliorate any such areas.

4.2.3 Air Quality

A study of the existing air quality was carried out at 12 locations and estimates were mad of air pollution at these sites near the proposed route. These measurements are tabulated in a separate report (Ref 6). Conclusions were that there is not a problem with air pollution at present and that the proposed route will not lead to any future problem with air pollution. Furthermore, in the cases of Clarecastle and Ennis the it is anticipated that the air pollution levels will be reduced significantly.

4.2.4 Archaeological Considerations

As part of the design for the road scheme archaeological records were consulted and field surveys were carried out (Ref. 11 & 26).
The aim of the road design, from an archaeological viewpoint, has been to avoid where possible major archaeological sites, and the scheme has largely been successful in this regard.
Where the route crosses locations of possible archaeological interest, construction work will be so arranged that it will be possible to ascertain whether a site does exist and its significance.
3 sites have been identified as meriting investigation before construction begins. In the cases of significant sites further controlled excavation will take place (under the supervision of a suitable qualified person) in order to retrieve and record such information and artefacts as may be archaeologically important.

Further mitigation is to be identified in relation to the sites of potential impact identified in the Archaeological report.

4.2.5 Water Quality

Much of the greater Ennis area is supplied by either private wells or group water schemes. Thus care is needed to protect these and Council supplied water.
Because of this and the highly karstic nature of the terrain a closed drainage system is to be designed for the scheme, thus eliminating any possible contamination of water supply due to run-off or spillages associated with the new proposed scheme.
Also, at sensitive locations it is intended to provide artificial wetlands to filter out impurities from the runoff before it enters the watercourse. Interceptors will be considered in areas of critical concern to fisheries.

4.2.6 Landscape and visual consideration

Where possible the road follows closely the existing ground. At bridges over the rivers at Latoon and Skehanagh as well as the three railway crossings this is not possible, thus due care will be paid to the need for the road to blend into the landscape where possible. Panoramic views of the town of Ennis will be possible at several points along the scheme.

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SECTION 5

ALIGNMENT DETAILS

5.0 Design Criteria

The realigned N18 (Eastern Bypass leg) from Dromoland Interchange to Barefield is designed for a speed of a minimum 100kph.
(The dual-carriageway sections may be to 120 kph)
It is designed to dual-carriageway cross-section from Ch11300 to Ch17000 and wide-2-lane carriageway from Ch17000 to Ch25300.
The N85 Western relief section is to be designed to a design speed of 100kph although it may be necessary to ~~restrict the speed over portions of the scheme to 40kph.~~

5.1 Alignment Details

This section deals with a number of the physical aspects of the design of the road e.g. horizontal and vertical curvature, sight distances, land holdings affected, items of note in relation to the design, outline proposals for drainage outfalls and land acquisition. The section is broken down into sub-sections based on chainage ranges and a brief commentary is included in each sub-section. Junctions are dealt with more fully in Section 7.

In designing a wide-2-lane carriageway a benefit is gained in safety and capacity by keeping the radii above 3500m where possible. This increases the opportunities for passing and thus the restriction is governed by vertical curvature only if a 3500m radius or higher is used. For this reason 3500m is the desirable minimum radius for the Eastern Bypass section of this scheme.

N18 - EASTERN BY-PASS (DROMOLAND TO CRAGARD) 12.7 KM

AREA 1.1 CHAINAGE RANGE 11432 - 13712 (2.3 KM)

STANDARD DUAL-CARRIAGEWAY

5.1.1 Dromoland To Manusmore

IP	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
1	St chn= 11432.060	137916.359E 171309.694N				
2	TS chn= 11537.088 ST chn= 12683.471	137970.000E 172000.000N	50	2000	0.030	31deg 24min 32sec
3	TS chn= 13712.009 ST chn= 15562.726	136810.000E 174280.000N	0	4000	-0.030	26deg 30min 34sec

5.1.1.1 Horizontal Curvature (Series of large radii 2000,4000 & 7200)

The first radius in this dual carriageway area is the curve which follows closely in parallel the existing N18 to Manusmore.
The connecting straight from the Interchange at Dromoland carries through from the Ballycasey to Dromoland scheme currently under construction.
The road follows an alignment to the east of the existing N18 by means of a 2000m radius which could be described as a moderately large radius facilitating a gentle left hand bend from the interchange. Radii of this size do not require a transition as the change is crossfall to facilitate superelevation is gradual and not extreme.
The curve exits to a short straight of 130m before the next radius is applied

5.1.1.2 Vertical Profile

The road falls gently (-0.2%) following the lie of the land from the interchange at Dromoland passing over Latoon Creek (River Rine) at 5.0m AOD minimum clearance from flood level to a low point in McInerney's land Manusmore.
The profile stays relatively low through the south of McInerneys land to maintain clearance under the 400kv cables before changing direction of grade (+0.8%) to gently rise upwards under the overbridge of side road L7142.

5.1.1.3 Affected Property

Landowners	Townlands
Various	Latoon South
Reps of Patrick Power (Land)	Manusmore
Mr. Christopher Power (Land)	Manusmore
~~Mr. Patrick McInerney (Land)~~	Manusmore
Reps of Gerard McCarthy (Land)	Manusmore
Mr. Gerard Costello (Land)	Manusmore

5.1.1.4 Drainage

Drainage Outlets proposed at

1. Manusmore - Chainage 12900
2. Carrowgar - Chainages 14900

5.1.1.5 Others

Tie-in to N18 Ballycasey-Dromoland scheme at Dromoland Interchange.(Ch 11332)
Bridge over River Rine (Ch 12000)
Farm service road from river Rine to county road at Carrowcar east of mainline (Ch 12000 - Ch 13450) .
Overbridge for county rd (L-714) at Manusmore (Ch 13450)

AREA 1.2 CHAINAGE RANGE 13712 - 17225 (3.5 KM)

STANDARD DUAL-CARRIAGEWAY

5.1.2. Manusmore to Kilbreckan

IP	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
2	TS chn= 11537.088 ST chn= 12683.471	137970.000E 172000.000N	50	2000	0.030	31deg 24min 32sec
3	TS chn= 13712.009 ST chn= 15562.726	136810.000E 174280.000N	0	4000	-0.030	26deg 30min 34sec
4	TS chn= 17225.678 ST chn= 18293.558	136785.000E 177420.000N	0	7200	-0.030	8deg 29min 52sec

5.1.2.1 Horizontal Curvature

From McCarthys land in Manusmore a large radius of 4000m leaves the short 130m straight easing in right hand bend to Casey's in Killow. This size radius does not require a transition or a change in crossfall direction as the radius is so gradual it has tan effect similar to a straight at design speed.
The curve exits to a straight of 170m before the next radius is applied Following the grade separated junction at Killow (Ch 16200) the cross-section changes from standard dual-carriageway to wide-2-lane over the end of this section. in which provision is made in the design for upgrade to reduced standard dual carriageway at a future date.

5.1.2.2 Vertical Profile

The grade up (+0.8%) to gently rise upwards passing under the overbridge of side road L7142 and over the railway line bordering Costello's & Cannys land in Carrowgar before cutting into the high land to the east of Canny's the ground and following an easy downgrade (-0.5%) towards the old Doora road L4114 to connect to the interchange proposed directly north of this side road at O'Meara's land in Killow.

5.1.2.3 Property Affected

Landowners	Townlands
Mr. Gerard McCarthy (Land)	Manusmore
Mr. Gerard Costello (Land)	Manusmore
C.I.E. ~~(Railway reservation)~~	~~Manusmore~~
Mr. John Canny (Land)	Carrowgar
Mrs. Thomas McCabe (Land)	Carrowgar
Mrs. Bridget Keane (Land)	Carrowgar
Mr. Gerard Casey (Land)	Killow
Mr. Micheal O'Meara (Land)	Killow
Mr. Patrick Hegarty (Land)	Kilbreckan
Mr. Shane Bridgedale (Land)	Kilbreckan

5.1.2.4 Drainage

Drainage outlets proposed at:-

1. Canny's Chainage 14900
2. Doora road Killow, Chainage 15640

5.1.2.5 Others

Sight Distance over section > 300m throughout.
Overbridge for railway at Manusmore (Ch 14100)
Access road to farms(P.Power & Power), Killow church & graveyard (Ch 15300-Ch 15640)
Grade separated (dumbell type) Interchange at Killow.
Realigned county road (L4114) at Killow.

AREA 2 CHAINAGE RANGE 17225 - 19800 (2.6 KM)

WIDE-2 LANE CARRIAGEWAY

5.2.1 Kilbreckan to Knockanean (Ch17225 to Ch19800)

Pt	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
3	TS chn= 13712.009 ST chn= 15562.726	136810.000E 174280.000N	0	4000	-0.030	26deg 30min 34sec
4	TS chn= 17225.678 ST chn= 18293.558	136785.000E 177420.000N	0	7200	-0.030	8deg 29min 52sec
5	TS chn= 18619.199 ST chn= 19743.112	136984.685E 178833.360N	0	3500	-0.030	18deg 23min 55sec
6	TS = 20494.001 ST = 21409.368	136665.400E 180580.400N	0	7500	-0.030	6deg 59min 34sec

5.2.1.1 Horizontal Curvature

This section is virtually straight consisting of a very large 7200m radius curve which eases left to right to Knockanean. This size of radius needs no change in crossfall as the extent of the curvature is negligible considering design speed.

5.2.1.2 Vertical Profile

The alignment dips to a low point at the R469 (12.0m) mainly due to the terrain of the ground and the need to drain nearby at Knockaskibbole (Possible carrier to Gaurus). The road grades up from the R469 through the hill at Knockanean and cresting at the natural valley that is the Knockanean road (L8172) to 20.5m. This crest is quite flat (K=280) thus retaining a high percentage of sight distance. The road then falls close following the terrain towards the R352 but remaining 2 to 3 meters

5.2.1.3 Affected Property

Landowners	Townland
Mr. Oliver Plunkett (Land)	Kilbreckan
Mrs. Mary P. Moroney (Land)	Ballaghboy
Mr. & Mrs. Vincent Coffey (Land)	Ballaghboy
Mr. Micheal Hogan (Land)	Ballaghboy
Mrs. Margaret Clune (Land)	Knockaskibbnole
Mr. Patrick Moloney (Land)	Knockaskibbnole
Mr. John O'Malley (Land)	Knockanean
Mr. James Hayes (Land)	Knockanean
Mr. Martin Killeen (Land)	Knockanean
Mr. Stephen Killeen (Land)	Knockanean
Mr. Michael Murphy (Land)	Knockanean
Mr. James Carolan (Land)	Knockanean
Mr. Joseph Keary (Land)	Knockanean

5.2.1.4 Drainage

Drainage outlets proposed at

1. Knockaskibbole Chainage 17780

5.2.1.5 Others

Vertical realignment of Regional road R469 at Ballaghboy Chainage 17300
(to pass under the mainline)
Horizontal & Vertical realignment of county road L410 (Knockanean road)
(to pass under the mainline)
Half-Clover leaf grade separate interchange at regional road R352 (Tulla road)
(Slip ramps at South-west and North-east quadrants)
500m length of cut through Knockanean hill

AREA 3.1 CHAINAGE RANGE 19800 - 22500 (2.7 KM)

WIDE-2-LANE CARRIAGEWAY

5.3.1 Ballymacahill to Barefield Interchange

Pt	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
6	TS = 20494.001 ST = 21409.368	136665.400E 180580.400N	0	7500	-0.030	6deg 59min 34sec
7	TS =21498.851 ST =22780.764	136300.000E 181749.981N	0	1600	0.030	45deg 54min 18sec
8	TS = 21794.446 ST = 23629.878	136831.059E 182725.825N	0	3500	0.030	13deg 40min 34sec

5.3.1.1 Horizontal Curvature

A long straight from the river at Ballymacahill in at the south end of Clune's extends over the Ballymacahill road before easing in a right to left curve (1600m) to lead into a similar size curve in the opposite, left to right, direction to approach Barefield railway and junction at a favourable angle as well as minimising severance to properties. An existing underpass on the railway serves as an ideal location to cross the railway as it is in a valley and the clearance over the railway is less conspicuous.

5.3.1.2 Vertical Profile

The road rises with the land up through Ballymacahill with a few meters extra required to clear the Ballymacahill . The lake nearby is a critical guiding criteria as the flood level means that either road is at a minimum grade of about 13.7m AOD. The prospect of taking the side road under the mainline was deemed the best option (See Sub-option comparisons) Thus the alignment returns closer to ground level as the ground is rising north of the county road and the vertical profile crests. The profile then changes with the ground to fall in a slight (0.5%) grade with the land. before climbing away from the existing ground at chainage 21800 to cross the railway and the Cappagh road at Barefield Interchange. This grade up is in the order of 1.85 % to a crest at the Interchange. The mainline crosses the side road (Cappagh) with little change to the profile of the side road at this junction (22.5m AOD)

5.3.1.3 Affected Property

Landowners	Townland
Mrs. Katherine Clune (Land)	Ballymacahill
Mr. Oliver Clune (Land	Ballymacahill
~~Mr. Joseph Clune (Land)~~	~~Ballymacahill~~
Mr. Michael O'Connell	Ballymacahill
Mr. Michael Flanagan (Land)	Ballymacahill
Mr. Francis Clune (Land)	Ballymacahill
Mr. & Mrs. John McGovern (Land)	Ballyduff
Mr. Michael Purcell (Land)	Ballyduff
Mr. Brendan Hassett (Land)	Ballyduff
Reps of Mr. Christopher Cahir (Land)	Ballyduff
Mr. John Mulcreevy (Land	Ballyduff
Patrick Doolaghty (Land)	Ballyduff
Mr. John P. Hogan (Land)	Barefield
Mr. James Whelan (Land)	Barefield
Mr. Patrick Hassett (Land)	Barefield

5.3.1.4 Drainage

Drainage outlets proposed at:-

1. Ballymacahill, Gaurus river Chainage 19800
2. Ballyduff Chainage 21950

5.3.1.5 Others

Lake at Ballymacahill dictates vertical profile Chainage 20320
Bridge over county road (L-410) Ballymacahill road Chainage 20480
Railway bridge (under) at Barefield south Chainage 20140
Barefield Interchange at Cappagh road (L-407) Chainage 22480
300m stretch of cut through hill at Barefield.
Crosses Ballyogan road (L-812) at-grade (no ingress permitted)
Ring fort to be avoided at Drumquin.

AREA 3.2 CHAINAGE RANGE 22500 - 24100 (1.6 KM)

WIDE-2 LANE CARRIAGEWAY

5.3.2 Drumquin to Cragard

Pt	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
8	TS = 21794.446 ST = 23629.878	136831.059E 182725.825N	0	3500	0.030	13deg 40min 34sec
9	TS chn= 23732.730 ST chn= 24789.712	137106.300E 183761.780N	81	1400	-0.030	39deg 56min 33sec
10	TS chn= 24852.267 ST chn= 25089.759	137703.570E 184182.770N	79	1400	0.031	6deg 29min 11sec
11		137944.090E 184396.800N				

5.3.2.1 Horizontal Curvature

Ties back to the existing road via back to back curves to weave through the various obstacles taken into consideration for design such as the houses the ring fort and proximity. Exiting the 1600m radius from the Interchange the road bends left via a 3500m radius to pass through the corridor at Barefield school and tie in to the existing N18 at Cragard via a 1000m bend to connect to the existing bend in the N18.

5.3.2.2 Vertical Profile

The road grades down (1.8%) towards the existing ground north of the school to a low point before gradually grading up (0.5%) cutting through the hill at Carrowdotia and flattening out in a long crest before grading down with the existing N18 (1.0%).

5.3.2.3 Affected Property

Landowners	Townland
Benster Ltd. (Land)	Drumquin
Mr. George Hayes (Land)	Drumquin
Mr. & Mrs. John Howard (Land)	Carrowdotia
Mr. Mrs. Seamus O'Halloran (Land)	Carrowdotia
Mr. Donal Moloney (Land)	Carrowdotia
Mr. Denis Sheedy (Land)	Carrowdotia
Mr. Michael Carmody (Land)	Carrowdotia
Mrs. Bernadette Callinan (Land)	Carrowdotia
Reps of Daniel Fahy (Land)	Carrowdotia
Mr. Joseph Whyte (Land)	Carrowdotia
Mr. James Carmody (Land)	Carrowdotia
Mr. Micheal Purcell (Land)	Cragard
Mr. Thomas Meaney	Cragard

5.3.2.4 Drainage

Drainage outlets are proposed at:-

1. Drumquin Chainage 23300

5.3.2.5 Others

Link road for interchange to connect via T's at county roads L-407 & L-812

N85 - WESTERN RELIEF ROAD (CLAUREEN TO KILLOW) 7.1 KM

AREA 4 CHAINAGE RANGE 4700 - 7100 (2.4 KM)

REDUCED DUAL CARRIAGEWAY (1.0M SHOULDERS &4.5M MEDIAN)

5.4.1 Clareabbey to Killow

Clareabbey Roundabout

Pt	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
1	4570.000	134152.600E 175306.300N				
2	6000.000	135592.523E 175456.300N				

Skehanagh Roundabout

Pt	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
1	6100.000	135647.670E 175490.000N				
2	TS=6703.837 ST=6886.235	136341.332E 175534.302N	79	1200		
3	7100.000	136880.592E 175522.229N				

Killow Interchange

5.4.1.1 Horizontal Curvature

Exiting the roundabout at Clareabbey the road is to go in an easterly direction to a the Skehanagh roundabout. The road exits this roundabout in a similar direction towards the Killow Interchange with a gentle 1200m radius curve aligning the road to meet the eastern by-pass at right angles.

5.4.1.2 Vertical Profile

Leaving the existing N18 road level at Clareabbey roundabout (6.1m AOD) the road rises (1.4%) to cross the railway at Clareabbey (design level = 12.4m AOD)and crests at this point to cross over the river Fergus and grade down (1.4%) to the Skehanagh roundabout (4.3m AOD)

5.4.1.3 Property Affected

Landowners	Townland
Mr. James Flynn (Land)	Clareabbey
Mr. James Hickey (Land)	Clareabbey
Mr. James Liddy	Clareabbey
Mrs. Mona Costello	Clareabbey
Mr. Michael Lyons	Skehanagh
Mr. James Kelly	Skehanagh
Mr. John Joe McCabe	Skehanagh
Commonage	Skehanagh
Reps of Bridget Clune	Skehanagh
Reps of Timothy Sweeney	Skehanagh
Mr. Paschal Brooks	Skehanagh
Mr. Micheal O'Meara	Killow

5.4.1.4 Drainage

Drainage Outlets are proposed at:-

1. Clareabbey Chainage 5000
2. Skehanagh (R. Fergus) Chainage 6000 (via land drain)

5.4.1.5 Others

Link road at Clareabbey to serve abbey and access to lands
Farm access road at Skehanagh roundabout.
Link road at Skehanagh to serve realigned Doora road (L-411)
Bridges over railway at Clareabbey and River Fergus.
Access from 'Bog' road for left-turn only on and off from north.
No access from south of 'Bog' road to new road.
Access to be provided at Skehanagh for JJ McCabe to lands north of road.
Site boundary line conceded to garage at Clareabbey

AREA 5 CHAINAGE RANGE 1900 - 4700 (2.8 KM)

WIDE-2-LANE CARRIAGEWAY (WITHOUT SHOULDERS)

5.5.1 Ballymacaula to Clareabbey Alignment

Ballymacaula Roundabout

Pt	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
1	1960.000	132051.755E 176352.511N				
2	TS chn= 2210.695 ST chn= 3471.238	132281.044E 175354.271N	110	760	0.041	86deg 44min 18sec
3		133032.071E 175482.302N				

CAHIRCALLA ROUNDABOUT

Pt	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
1	3500.00	133065.532 E175502.453N				
2	TS chn= 3609.563 ST chn= 4299.637	133526.210 E175589.560N	123	760	0.041	42deg 45min 04sec
3	TS chn= 4301.458 ST chn= 4684.795	133997.485 E175294.573N	144	460	0.063	29 deg 48 min 39 sec
4		134212.186 E175286.201N				

CLAREABBEY INTERCHANGE

5.5.1.1 Horizontal Curvature

The roundabout location on the R474 is governed by the proximity to development and alignment through from north to south. Heading almost due south and about 200m from the Hospital the road bends towards the east via a 760m radius along the protected corridor of the old 'Ennis Bypass' route. Passing over the N68 to a roundabout at Cahircalla Beg to serve same. The road then snakes in the opposite direction (760m) to avoid the main peak of the limestone at Cahircalla More and heads towards the roundabout at Clareabbey.

5.5.1.2 Vertical Profile

The road falls roughly with the ground (0.8%) or slightly above it for the first 450m.
It then continues at this grade (0.8%) through the cutting at Cahircalla (400m) and crosses the N68 (design level 19.5m AOD) before grading up gently (1.4%) to the roundabout at Cahircalla Beg. The road the follows the level of the ground approximately (1.3%) down to the roundabout at Clareabbey.

5.5.1.3 Property Affected

Landowners	Townland
St. Flannans College (Land)	Cahircalla More
Cahircalla Hospital (Land)	Cahircalla More
Harnett Homes (Land)	Cahircalla More
Mr. Brendan Dillon (Land	Cahicalla Beg
Mr. George Gallery (Land)	Cahicalla Beg
Construction Co.	Clonroad More
Mr. Patrick McInerney (Land)	Clonroad More
Mr. & Mrs Patrick Hynes &	Clonroad More
Mr. & Mrs O'Connell (Land)	
John McCarthy (Land)	Ballybeg
Mr. James Flynn (Land	Clareabbey
Mr. James Hickey (Land)	Clareabbey

5.5.1.4 Drainage

Drainage Outlets are proposed at:-

1. Cahircalla Beg Chainage 3200

5.5.1.5 Others

Hospital to be kept 200m from road minimum for Noise & Air quality
Rock deemed to difficult to rip to consider a straighter alignment through Cahircalla More\Ballybeg.
Farm access to lands of Hynes in Cahircalla More to be maintained.
Access to 'Rocky road' to be maintained for pedestrians.
Link road no. N68 at Cahircalla Beg.

AREA 6 CHAINAGE RANGE 0 - 1900 - (1.9 KM)

WIDE-2-LANE CARRIAGEWAY (WITHOUT SHOULDERS)

5.6.1 Claureen to Ballymacaula Alignment Details

Claureen Roundabout

Pt	Chainage	IP Coords	Trans	Radius	Cant	Deflection Angle
1	50.000	132566.470E 178163.840N				
2	TS chn= 625.815 ST chn= 821.301	132347.450E 177526.850N		3000	0.030	3deg 44min 01sec
3	TS chn= 1446.487 ST chn= 1911.752	131964.069E 176610.721N	115	550	0.057	42deg 28min 42sec
4	1950.00	132037.739 E176405.759N				

BALLYMACAULA ROUNDABOUT

5.6.1.1 Horizontal Curvature

The. Road follows a southerly direction towards the river Claureen at the boundary of Pyne's and Howards with a gentle 3000m radius. It then weaves in a left-hand 550m radius to tie in to the roundabout at Ballymacaula.

5.6.1.2 Vertical Profile

The road dips (0.5%) to a low point at the river Claureen (Ch 780) before grading up (2.0%) towards the roundabout at Ballymacaula.

5.5.1.3 Property Affected

Landowners	Townland
Mr Michael Howard	Claureen
Mr Tom Pyne	Keelty
Mr Pk. Barry	Ballymacaula
Mrs Quinn	Ballymacaula
St. Flannans College (Land)	Cahircalla More

5.5.1.4 Drainage

Drainage Outlets are proposed at:-

1. Cahircalla Beg Chainage 3200

5.5.1.5 Others

Culvert to be designed for crossing of River Claureen
Farm access to lands of Tom Pyne

SECTION 6

DESIGN STANDARDS

6. DESIGN STANDARDS

6.1 Design Speed

A design speed of 120 kph has been used for all rural sections of the dual carriageway. This is in accordance with the design speeds used in the design of other recently constructed rural dual-carriageway national routes in the Region and conforms with practice nationally.

The use of lower design speeds than the above on the rural sections of dual carriageway national roads is not recommended and in the case of the present alignment would not result in any significant savings in construction costs.

A minimum design speed of 100 kph has been used for the design of the Western Relief road from the junction at Killow to the Ennistimon road (N85) and on the proposed new N18 from Kilbreckan to Cragard.

6.2 Carriageway Standard

Analysis of available traffic counts and future projections in conjunction with national guidelines (ref 3) has been used by Clare County Council to establish that a standard dual-carriageway will be the required cross-section standard for the proposed N18 route between Dromoland and Killow and a reduced standard dual-carriageway from Killow to Clareabbey on the N85 Western Relief road . In addition, a wide single lane carriageway is detailed for the section of road from north of the junction at Killow to the existing N18 single carriageway at Cragard. The proposed carriageway standards are shown in figure 6.1 and figure 6.2. The carriageway from Cragard to the start of the Crusheen by-pass at Ballyline, is to be upgraded along the existing horizontal alignment to a Wide (10.0m) single carriageway from the present 7.5m carriageway. The N85 Western Relief road from Clareabbey to Claureen is also to be wide lane single carriageway.

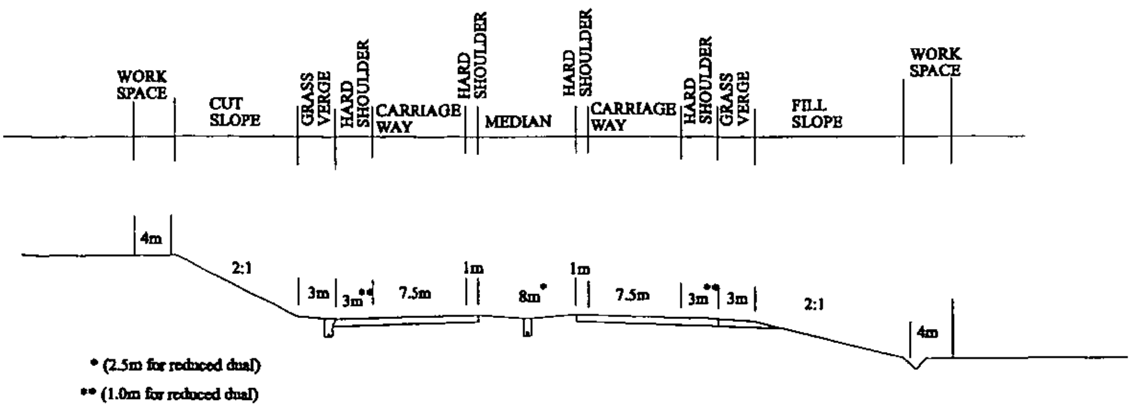

FIG 6.1 TYPICAL DUAL CARRIAGEWAY CROSS SECTION

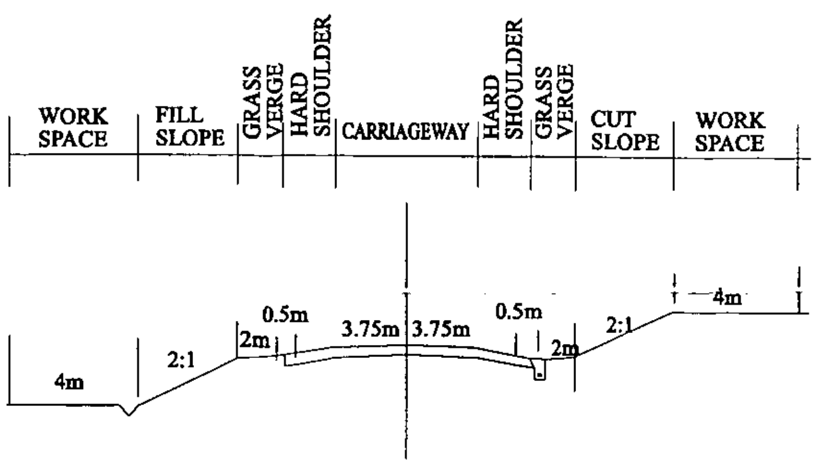

FIG 6.2 TYPICAL CROSS SECTION OF REGIONAL ROADS

6.3 Junctions and Accesses

The N18 dual carriageway from Dromoland to Kilbreckan, and the N18 single carriageway from Killow to Cragard will be a limited access roadway, which means that access will only be permitted at the planned junction locations.

Access will also be restricted on the N85 Western Relief road from Killow to Claureen in accordance with the current general planning guidelines and considerations of safety.

All junctions on the N18 Dromoland to Cragard section will be grade-separated. The Western Relief road will have a series of 'at-grade' roundabout type of junctions.

Roads with limited access and grade-separated junctions have the following advantages:

(i) Accidents are significantly reduced.

(ii) The capacity is preserved for a greater number of years.

(iii) Vehicle running costs are reduced due to the lack of side interference.

(iv) Reduction in travel time for road users.

In view of the above advantages and taking into account that most of the new route is away from existing roads it was decided that a limited access roadway would be the best option for design purposes.

6.4 Cross-Section Elements

The typical cross-sections of the dual carriageway consists of:-

2 No. 7.5m carriageways;

2 No. 3.0m outer hard shoulders (1.0m strip instead for reduced dual);

2 No. 1.0m inner hard shoulders (run-on strips);

2 No. 3.0m grass verges;

A 10.0m median including inner shoulders (4.5m for reduced dual);

Side slopes are generally 2:1 in fill and 2:1 in cut. A 4.0m workspace is allowed inside the permanent fence line to provide for drainage and maintenance. (See Fig. 6.1)

The typical cross-section of the proposed new wide lane single carriageway Western Relief from the Clareabbey roundabout (existing N18) to the Ennistimon road (N85) at Claureen is:-

2 No. 5.00m lanes;

2 No. 2.5m hard shoulders

2 No. 3.0m grass verges

The side slopes will be constructed at a slope of 2:1. In addition, a 4.0m workspace is provided for drainage and maintenance. (See Fig. 6.2).

6.5 Ramps

In general one-way ramps have a 4.0m carriageway with a 1.5m left-hand hard shoulder, a 0.5m right-hand hard shoulder and two 2.0m wide verges. See Fig 6.3. Two-way ramps (or junction link roads) have an 8.0m carriageway with two 1.5m wide hard shoulders and two 2.0m grass verges.

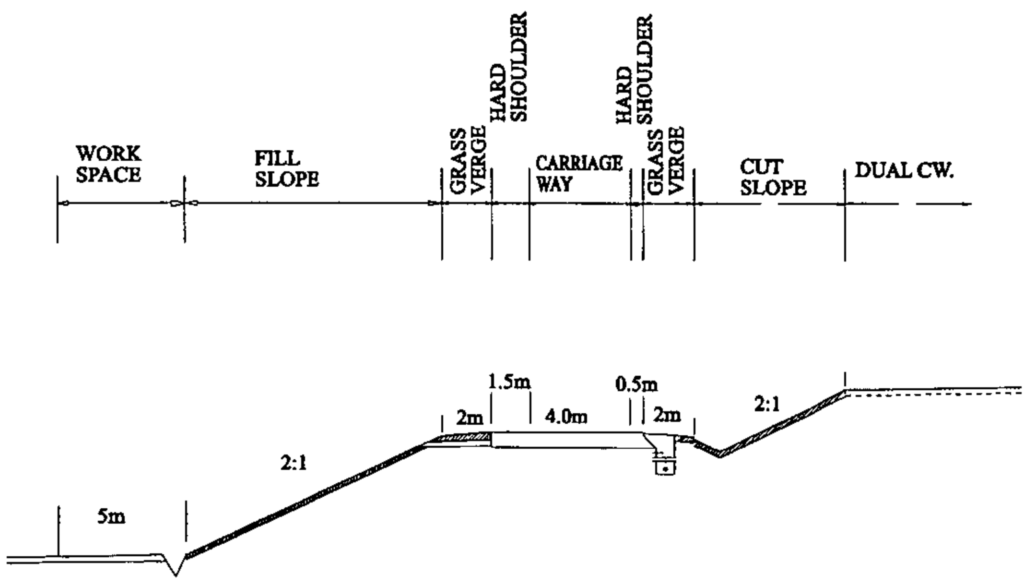

FIG 6.3 TYPICAL SECTION OF ONE-WAY INTERCHANGE RAMP

6.6 Minor Roads\Access Roads

The cross-sections of the minor roads vary to suit the standard of the road. Generally a minimum pavement width of 6.0m (5.0m carriageway with 0.5m strips either side) combined with 2m grass verges either side is typical.

Table 6.1 - Proposed Carriageway Standards

National roads	Class\ Carriageway Type	Carriageway Width	Median	Hard shoulders	Verge	*Length of* Section
Eastern Bypass N18 *Dromoland- Killow*	RND 120 Standard Dual	2 x 7.5m	10m	3.0m (outer) 1.0m (inner)	3m	5.600 km
Eastern Bypass N18 *Killow-Caheraphuca*	RNU 100 Wide 2-Lane	10.0m	0	2.5m	3m	11.000 km (4km on existing)
Existing N18 *Ballyallia-Drumquin*	RNU 100 Wide-2-Lane	10.0m	0	2.5m	3m	1.200 km (0.4 +0.8)
Western Relief-N85 *Killow- Clareabbey*	RND 120 Reduced Dual	2 x 7.5m	4.5m	3.0m (outer) 1.0m (inner)	3m	2.500 km
Western Relief-N85 *Clareabbey-Claureen*	UNU 100 Wide 2-Lane	10.0m	0	2.5m	3m	4.600 km
				National roads	***Length***	***24.900 km***
Regional roads						
Quin road *R469*	RRU-100 Single C\way	7.0m	0	0.5m	2m	0.650 km
Tulla rd *R352*	RRU-100 Single C\way	7.0m	0	0.5m	2m	1.250 km
Tulla rd *Southwest ramp(2-way)*	RRU-80 Single C\way	7.5m	0	0.5m	2m	0.350 km
Tulla rd *Northeast ramp(2-way)*	RRU-80 Single C\way	7.5m	0	0.5m	2m	0.400 km
				Regional roads	***Length***	***2.650 km***

Local (County) roads	Class\ Carriageway Type	Carriageway Width	Median	Hard shoulders	Verge	Length of Section
Manus rd L714(2)	RCU-60 Single C\way	5.0m	0	0.5m	2m	0.100 km
Doora rd L411(4)	RCU-60 Single C\way	5.0m	0	0.5m	2m	1.200 km (0.8 + 0.4)
Knockanean rd L410(6)	RCU-60 Single C\way	5.0m	0	0.5m	2m	0.600 km
Ballymacahill rd L410(2)	RCU-60 Single C\way	5.0m	0	0.5m	2m	0.750 km
Cappagh road L407(6)	RCU-60 Single C\way	5.0m	0	0.5m	2m	0.050 km
Ballyogan road L812(2)	RCU-60 Single C\way	5.0m	0	0.5m	2m	0.300 km (0.25 +0.5)
Cahircalla road New	RRU-60 Single C\way	7.0m	0	0.5m	2m	0.300 km
Clareabbey road L832(8)	ULU-60 Single C\way	8.0m	0	0	2m	0.550 km
				County roads	***Length***	***3.850 km***
				ALL ROADS	***TOTAL***	**31.400km**

6.7 Traffic Lanes

6.7.1. Dual Carriageway - N18 Dromoland to Killow & Western Relief Killow to Clareabbey

The predicted traffic figures (ref 17) indicate that a divided roadway with two traffic lanes in each direction is required from Dromoland to Killow on the N18 and from Killow to Clareabbey on the Western Relief. Accordingly, 2 no. 3.75m carriageways are proposed in each direction in accordance with national standards.

6.7.2. Single carriageway N18 Killow to Cragard & Western Relief Claureen to Clareabbey

The predicted traffic figures .(ref 17) indicate that a 10.0 metre (wide lane) carriageway is adequate for the traffic volumes projected for the design year (2020) in these sections.

6.8 Hard Shoulders

6.8.1. Outer hard shoulders are provided on roadways for numerous reasons which include safety measures, additional benefit to capacity, ease of maintenance, structural support, and amenity.

6.8.2. The inner hard shoulder (or run-on strip) incorporates the advantages of the outer shoulder, however its principal use, in addition to definition and delineation, is to provide lateral structural support to the pavement of the travelled section as well as a safety buffer for vehicles between the carriageway and the grass verge.

6.8.3. Based on considerations of safety, capacity and taking into account the high standard of the proposed road, and conforming with current practice in National road construction widths (ref 3) of 2.5 metres were selected for the wide single lane outer shoulders and 3.0 metres in the case of the dual carriageway. For the dual carriageway a 1.0 m inner shoulder at the edge of the median was selected.

6.9 Median

Medians are provided on roads with a high volume of traffic for several reasons including reduction of the incidence of head-on collisions, reduced glare from oncoming headlights at night, and the ease and freedom of operation in the sense of physical and psychological separation from opposing traffic. A width of 10 metres between travelled lanes was chosen. This is to ensure a balance between safety and economy.

6.10 Side Slopes

Side slopes of 2 horizontal to 1 vertical are provided in situations of cut and fill. This side slope is sufficient to ensure the structural stability of the cutting and is flat enough to maintain a satisfactory appearance. Steeper side slopes could lead to an undesirable tunnel effect, loss of stability, and difficult maintenance. In cases where the additional cost is not prohibitive flatter sideslopes may be used.

6.11 Verges

The provision of a verge provides an extra zone of safety should a vehicle veer off the paved carriageway and hard shoulder. Verges add to the appearance of a road by creating a feeling of "openness" and space. Verge space is also used for the erection of Advance Direction and other road signs. A verge width of 3m is used for the main-line sections of the proposed route.

6.12 Pavement

The road pavement will be designed in accordance with recognised pavement design standards.

The initial pavement design life is 20 years from the year of opening.

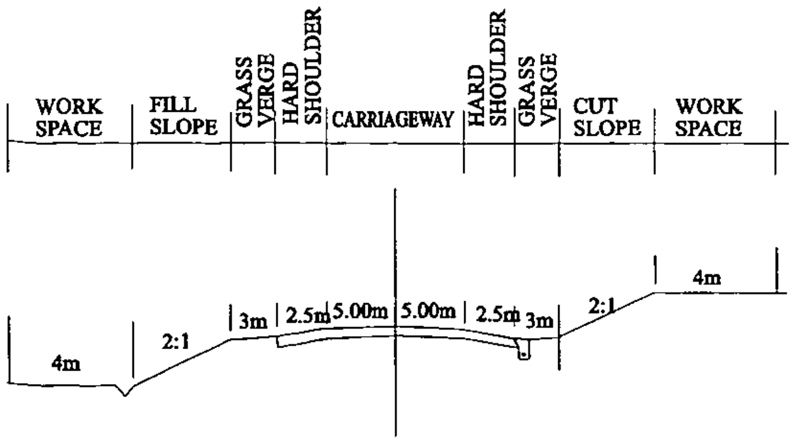

FIG 6.2 TYPICAL CROSS SECTION
WIDE-2-LANE SINGLE C\WAY

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SECTION 7

JUNCTIONS

7. JUNCTIONS

Access to the N18 Dromoland to Crusheen and Western Relief road will only be permitted at recognised junction locations .Minor roads, will be carried over or under the new road by means of bridges.

7.1. Junction No. 1 Killow Interchange (Drg. No. 361-04-62)

This is the main junction serving Ennis. At this junction 65% of the traffic movement is in the Western Relief road\Limerick corridor. Due to the high volume of traffic predicted for this movement two-lane ramps are required on and off the N18. The layout is of the "dumbell" type with slip roads from each direction meeting at two grade separated roundabouts.

Several options were examined before the present layout was decided on. The necessity for safety was the paramount aim in design of the junction.

The junction layout chosen will involve all traffic leaving or entering the N18 at Killow negotiating a roundabout.

7.2.1 Junction No. 2 Tulla Road Junction (Half-Clover Leaf)

(Drg. No. 361-04-65)

This junction will serve east Clare and west Ennis town The layout is to be a half-cloverleaf type with two staggered T-junctions. The treatment of the junction of the slip roads with the N18 will be such that right turning movements off the N18 will not be possible.

7.2.1 Junction No. 2a Tulla road junction (south-west) (Drg. No. 361-04-65)

This junction will serve northbound traffic to the N18-north from east Clare and west Ennis and traffic from the N18-south to east Clare and west Ennis by means of T-junctions.

7.2.2 Junction No. 2b Tulla road junction (north-east) (Drg. No. 361-04-65)

This junction will serve southbound traffic from the N18-north to east Clare and Ennis and traffic to the N18-south from east Clare and Ennis by means of T-junctions.

7.3. Junction 3 N18 Barefield Interchange (Drg. No. 3\61-04-67)

Barefield link road (realigned from the existing N18 south of Barefield) serves traffic from the north of Ennis, Barefield and the adjoining local roads L812(2), L407(6), and L415(8) providing access to the new N18 to Galway and Limerick.

7.3.1 Junction 3a N18 Southbound to Barefield link road

Serves southbound traffic to and from the new Interchange.

7.3.2 Junction 3b L812(2) to Barefield link road

The Ballyogan road L812(2) is to be closed at the point it meets the proposed new N18 and thus provision is made for this mainly local traffic by realigning the road and connecting to the new link road via a T-junction.

7.3.3 Junction 3c L407(6) to Barefield link road

This connects the Cappagh road L407(6) to the new link road, N18 south via junction 3a and ultimately via an underbridge to Barefield and the N18 northbound and Ennis.

7.3.4 Junction 3d Roundabout connecting the N18 northbound, the L407(6) and the new Barefield link road

This will be the primary junction to the north of Ennis facilitating access for traffic from north and central Ennis to the N18-northbound as well as traffic accessing Barefield and its surround.

7.4 Junction 4 N18 Clareabbey Roundabout (Drg. No. 3\61-04-62)

This junction is to be an at-grade roundabout to connect the Western Relief road with the existing N18 and the access road to Clareabbey and the surrounding land.

7.4a Junction 4a L411 Skehanagh Roundabout (Drg. No. 3\61-04-62)

This junction is to be an at-grade roundabout to connect the N85 Western Relief road with the 'Bog' road-L411(6) and the realigned Doora church road L411(4) and farm access from south to north Skehanagh and the 'Green' road.

7.5 Junction 5 N68 Kilrush Road Roundabout (Drg. No. 3\61\04-64)

This junction is to be an at-grade roundabout to connect the N85 Western Relief road with the existing N68 Kilrush Road via a link road connecting two roundabouts, with the N68 passing under the N85 via underbridge (Structure No. 11)

7.6 Junction 6 R474 Miltown-Malbay Roundabout (Drg. No. 3\61\04-65)

This junction is to be an at-grade roundabout to connect the N85 Western Relief road with the R474 Miltown-Malbay road.

7.7 Junction 7 N85 Ennistimon Roundabout (Drg. No. 3\61\04-65)

This junction is to be an at-grade roundabout to connect the western relief road with the N85 to Ennistimon.

SECTION 8

MINOR ROADS

8. MINOR ROADS

The new N18 route crosses the line of the following roads:

(a) L714(2) Local Road at Manusmore.
(b) L411(4) Local Road at Killow\Kilbreckan (Doora Church road).
(c) R469 Quin Road at Kilbreckan\Ballaghboy.
(d) L410(6) Local Road at Knockanean.
(e) R352 Tulla Road at Knockanean\Tooreen.
(f) L410(2) Local Road at Ballymacahill\Cappagh More.
(g) L407(6) Local Road (Cappagh) at Barefield\Drumquin.
(h) L312(2) Local Road (Ballyogan) at Drumquin

8.1. Local Road L714(2) Manusmore Drg. No. 3\61-04-60

In this location it is planned to cross the new dual carriageway with a bridge carrying Co. Rd. L714. The profile of the county road will not alter significantly from the existing although the some minor realignment will be necessary to facilitate the most suitable bridging of the dual carriageway.

8.2 Local Road L411(4) Killow\Kilbreckan Drg. No. 3\61-04-62

L411(4)- east

The realignment of this road to the east in the vicinity of Patrick Hegartys land facilitates the new junction layout. Access along the existing local road at the new N18 will not be allowed. The existing road will however act as an access road to farms and Killow graveyard.

L411(4)- west

Access along the existing local road at the new N18 will not be allowed. The existing road will however act as an access road to private dwellings and farms but will cul-de-sac at the new N18. The through traffic wanting access to the east of the proposed N18 will travel by means of a new link road to Skehanagh roundabout (Junction 4a) and Killow Interchange to the realigned L411-east and back to the existing road.

8.3. R469 Kilbreckan\Ballaghboy Drg. No. 3\61-04-65

This road will require some realignment most noticeably in vertical profile to direct the side road under the N18 at this point.

8.4. Local L410(6) Knockanean Drg. No. 3\61-04-65

This local road will need total realignment over a section of the existing road to facilitate the side road under the N18. The access roads connecting onto the Knockanean road at present will require minor realignment so as to achieve safety and design standards for the rearranged junction at this location.

8.5. R352 Knockanean\Tooreen Drg. No. 3\61-04-66

This road will require some realignment most noticeably in vertical profile to direct the side road over the N18 at this point. There will be access provided to the N18 from the R352 by means of two T-junctions to facilitate all turning movements at this location (Junction No. 2). The realigned R352 will need to be widened to facilitate right turn movements with storage sufficient to provide for uninterrupted movement on the regional road.

8.6. L410(2) Ballymacahill\Cappagh More Drg. No. 3\61-04-66

This local road will need total realignment over a section of the existing road to facilitate directing the L410(2) under the N18.

8.7. L407(6) Barefield\Drumquin Drg. No. 3\61-04-67

This local road will need total realignment over a small section of the existing road to facilitate the side road under the N18 and Barefield Junction (Junction No. 3)

8.8. L312(2) Drumquin Drg. No. 3\61-04-67

This local road will need total realignment over section from the existing road to tie into the Barefield link road. The existing road will be closed at the point where it meets the proposed N18 and realigned south as detailed.

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SECTION 9

BRIDGES

9. BRIDGES

9.1. General

The proposed road scheme will require the construction of fifteen bridges;
These include:-

Three Railway bridges
Three River Bridges
Nine road bridges

Table 9.1 summarises the proposals.

There will also be several culverts of various size.

9.2. Standards

The bridges will be designed to the latest relevant standards. The visual appearance of each bridge will be a factor in the final choice of bridge design at each site.

TABLE 9.1 - BRIDGES

STRUCTURE	TOWNLAND	DRGS. REF.	ROAD\RIVER\RAIL UNDER\OVER	DESCRIPTION	BRIDGE DECK WIDTH (m)	BRIDGE DECK LENGTH (m)
1	Latoon South Manusmore	300-61-60	River Under	Skew Dual-carriageway bridge over river at Latoon	32	150
2	Manusmore	300-61-60	Road Over	County road bridge over mainline	10	32
3	Manusmore Carrowgar	300-61-60	Rail Under	Skew Dual-carriageway bridge over Single track railway	32	8
4	Killow & Kilbreckan	300-61-61	Road Over	Reduced Dual-carriageway bridge over Dual-carriageway mainline	21.5	32
5	Kilbreckan & Ballaghboy	300-61-61	Road Under	Reduced Dual-carriageway bridge over regional road R469 (Quin rd	21.5	12
6	Knockanean	300-61-64	Road Under	Reduced Dual-carriageway bridge over county road	21.5	10
7	Knockanean & Tooreen	300-61-64	Road Over	R352 (Tulla rd) regional road over Reduced Dual-carriageway	12	21.5
8	Ballymacahill & Cappagh More	300-61-65	Road Under	Reduced Dual-carriageway bridge over county road	21.5	10
9	Barefield	300-61-66	Rail Under	Skew Reduced Dual-carriageway bridge over Single track railway	21.5	8
10	Barefield & Drumquin	300-61-66	Road Under	County road bridge under Dual-carriageway	10	21.5
11	Cahircalla	300-61-63	Road Under	Single-carriageway bridge under western relief road	13.5	16
12	Clareabbey	300-61-62	Rail Under	Reduced Dual-carriageway bridge over Single track railway	21.5	8
13	Clareabbey	300-61-62	River Under	Reduced Dual-carriageway bridge over River Fergus	21.5	130
14	Claureen	300-61-63	River Under	Single-carriageway bridge under western relief road	13.5	16

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SECTION 10

DRAINAGE

10. DRAINAGE

10.1. General

The road will use a closed (piped) drainage to deal with surface water run-off.

Because of the karstic nature of the bedrock in this region the drainage design will need to minimise the effects on groundwater and existing subterranean drainage systems. Additional experience in this regard can be drawn from the N18\N19 Ballycasey to Dromoland scheme currently under construction

In situations of cut, piped French drains will generally be used which have the added advantage of localised controlling of the water-table under the adjacent road pavement.

Because of the sensitivity of the Ennis region to flooding particular care will be needed in designing the scheme so as to account for any effect on such. Areas of particular concern include the Claureen catchment as well as the Fergus catchment at Doora and Skehanagh.

10.2. Design Parameters

All major culverts under the proposed new road will be designed for a storm return period of fifty years.

The road drainage system will be designed to cater for a storm with a return period of five years.

The piped drainage will be designed using the Modified Rational Method which is accepted as being applicable to the pipe sizes involved.

10.3. Existing Land Drains

Where existing land drainage pipes are severed by the road construction they will be diverted into the road drainage system or otherwise alternative drainage outfalls will be provided.

10.4. Existing Drainage Channels

Existing streams, where they cross the line of the proposed new road, will be redirected as little as possible.

10.5. Drainage Outfalls

The main outfall watercourses crossed by the road and which may be used for the discharge of surface water run-off from the road are:

(1) Latoon creek (Rine river)

(2) Manus river (McCarthy's\Costello's land)

(3) Kilbreckan lough

(4) Gaurus river (Ballymacahill).

(5) River at Mulcreevys land (Cappagh).

(6) Stream at Drumquin.

(7) Claureen river (tributary of the R. Fergus)

(8) Cahircalla river (tributary of the R. Fergus)

(9) Ballybeg river (tributary from Ballybeg Lough to R. Fergus)

(10) Fergus river (Via existing land drain from Kilbreckan Lough)

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SECTION 11

ECONOMIC ASSESSMENT

11. ECONOMIC ASSESSMENT

11.1. Budget Estimate

The preliminary budget estimate for the proposed scheme is £57.3 million at 1998 prices.

11.2. Cost Benefit Analysis

During the route corridor selection process in 1993 a cost benefit analysis was carried out which showed the preferred route corridor (Option D) to have an internal rate of return of 15.2%.

That analysis showed that the proposal exhibited a positive net benefit to the economy and was a suitable project for the investment of public money. More recent analyses of the proposed scheme have confirmed this to be the case.

SECTION 12

CONCLUSIONS AND RECOMMENDATIONS

12. CONCLUSIONS AND RECOMMENDATIONS

This report sets out to establish -

(i) the need for the proposed scheme;

(ii) that the route selected is suitable and economical;

(iii) that the project is value for money and of benefit to the economy;

(iv) that the road has been designed to appropriate standards.

Having considered all the above factors Clare County Council is satisfied that these proposals for the improvement of the National Primary Route N18 and the N85 Ennis Western Relief road represents the optimum solution in terms of cost-benefit, minimisation of environmental impact and disruption to the locality.

It is recommended that the scheme contained in this report and accompanying drawings and details be approved without modification.

REFERENCES

REFERENCES

1. County Development Plan 1988
Clare County Council

2. N18 Road Improvements Dromoland To Crusheen
(including The Ennis By-Pass)
Broad Route Corridor Selection Report
Clare County Council, November, 1993

3 National Road Needs Study
The National Roads Authority 1998

4 Operational Programme for Transport 1994 - 1999
The Stationery Office, November 1990

5. Environmental Impact Study, N18 Road Improvements Dromoland to Crusheen (including the Ennis bypass) , Noise Aspects
ANV Technology, 1999

6. Environmental Impact Study, N18 Road Improvements Dromoland to Crusheen (including the Ennis bypass) , Air Quality Aspects
K.T. Cullen & Associates 1999

7. A study on the Impact of the Proposed N18 Road Improvements Dromoland to Crusheen (including the Ennis bypass) on Water Quality.
RPS Cairns Ltd, 1999

8. A study on the Impact of the Proposed N18 Road Improvements Dromoland to Crusheen (including the Ennis bypass) on Flora & Fauna
RPS Cairns Ltd, 1998

9. Socio-Economics Aspects of the Environmental Impact Study for the N18 Road Improvements Dromoland to Crusheen (including the Ennis bypass).
Jonathan Blackwell & Associates , 1999

10. Environmental Impact Study
N18 Road Improvements Dromoland to Crusheen (including the Ennis bypass)
Landscape, Aesthetic and Visual Impact Report.
Brady Shipman Martin Ltd, 1999

11. N18 Road Improvements Dromoland to Crusheen (including the Ennis bypass).
Environmental Impact Study - Archaeological Report
ADS, 1999

13. RT165 Geometric Design Guidelines
(Motorway Interchanges)
An Foras Forbartha, 1982

14. RT 180 Geometric Design Guidelines
(Classification, Alignment, Cross-Section)
An Foras Forbartha, Revised 1986

15. RT181 Geometric Design Guidelines
(Intersections at Grade)
An Foras Forbartha, Revised 1986

16. RT182 Guidelines on Road Design Aesthetics
An Foras Forbartha, 1981

17. Traffic Report - N18 Road Improvements Dromoland To Crusheen
(including The Ennis By-Pass)
Clare County Council, 1999

19. N18 Road Improvements Dromoland to Crusheen (including the Ennis bypass)
Environmental Impact Statement
Clare County Council, February 1999

22. Ireland, National Development Plan 1994-1999
Stationery Office, 1993

23. Ireland - Road Development 1989 to 1993
Stationery Office, 1989

24. Operational Programme on Peripherality; Roads and Other Transport Infrastructure; Ireland 1989 - 1993
Stationery Office, 1990

25. N18 Dromoland to Crusheen Road Improvements(includes the Ennis Bypass)
Report on Projected Traffic and Route Capacities
Clare County Council, April 1999

26. N18 Dromoland to Crusheen Road Improvements(includes the Ennis Bypass)
Preliminary Archaeological Survey
Celie Rahilly, 1985

27. Clare County Council Draft Development Plan
Clare County Council, 1999

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ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

This report has been prepared by the staff of the Clare County Council Road Design Team.

We are indebted to the following people for their help, contributions, and comments:

The Land Owners

The N.R.A. Engineering Inspectorate

MAPS

MAPS

The following drawings are bound with this report:

Drg. No. 300 - 72 - 13	Route Corridor Options
Drg. No. 300 - 61 - 55B	Site Layout Map

The report must be read in conjunction with the following drawings:

DRAWING NUMBER	TITLE	SCALE
300 - 61- 60	GL A1a Plan Ch 11400 - Ch 13800	1:2500
300 - 61- 61	GL A1b Plan Ch 13800 - Ch 16450	1:2500
300 - 61- 62	GL A5 Plan Ch 1900- Ch 5240	1:2500
300 - 61- 63	GL A6 Plan Ch 0000 - Ch 1900	1:2500
300 - 61- 64	GL A2 Plan Ch 16450 - Ch 19080	1:2500
300 - 61- 65	GL A3a Plan Ch 19080 - Ch 21900	1:2500
300 - 61- 66	GL A3b Plan Ch 21900 - Ch 24100	1:2500
300 - 61- 67	General Layout - Total Scheme	1:10,000
300 - 61- 68	LP A1 Ch 11440 - Ch 17000	1:2500H 1:250V
300 - 61- 69	LP A2 Ch 17000 - Ch 20680	1:2500H 1:250V
300 - 61- 70	LP A3 Ch 20680 - Ch 24100	1:2500H 1:250V
300 - 61- 71	LP Western relief Ch000 - Ch7100	1:2500H 1:250V

Clare County Council
Comhairle Chontae an Chláir

N18 Road Improvements Dromoland to Crusheen (including the Ennis Bypass)

Design Report Addendum

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March 2000

BTI 020344

Contents

1.0 Introduction

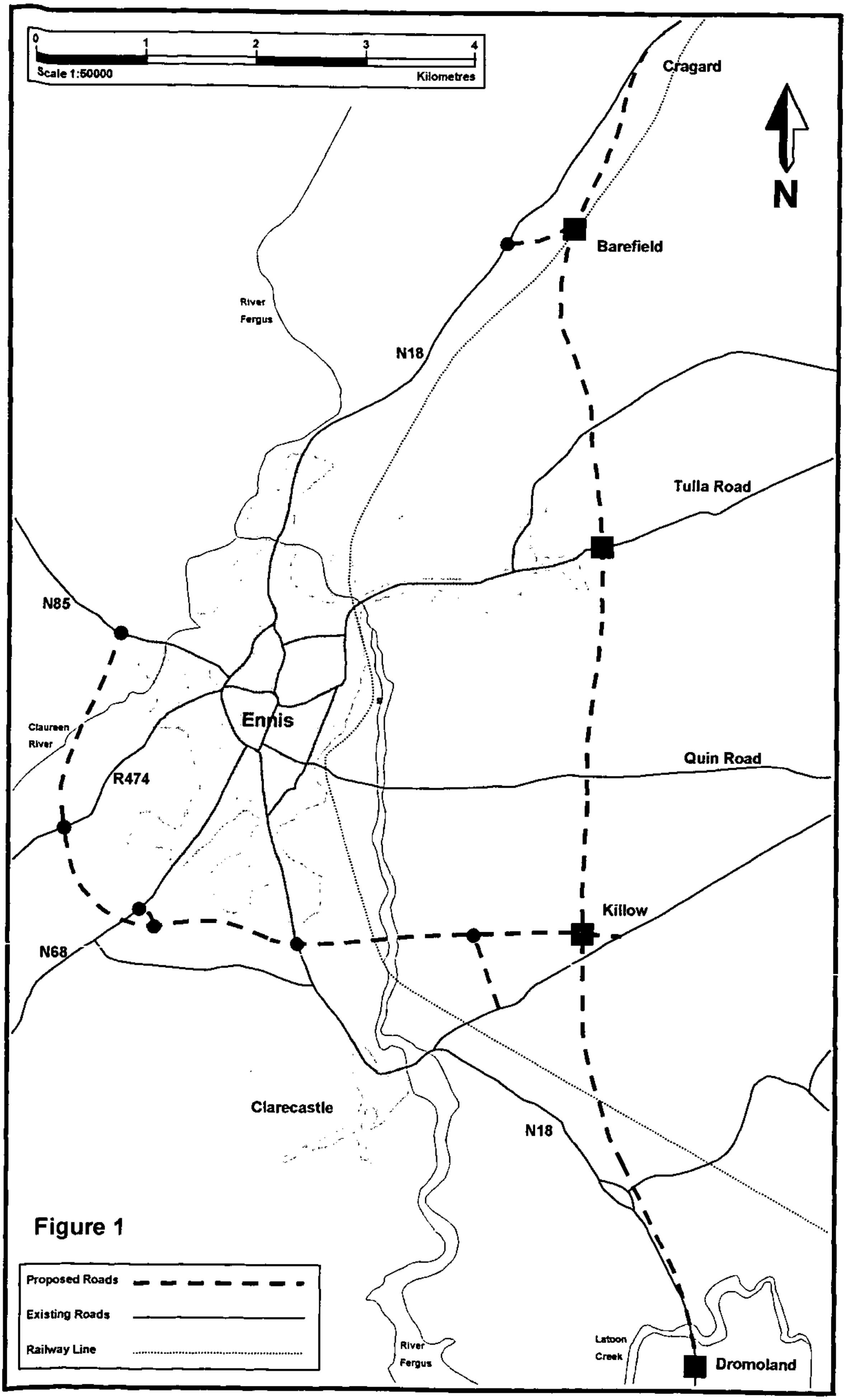
1.1 This document has been prepared by Babtie Pettit consultants on behalf of Clare County Council as an addendum to the N18 Road Improvements Dromoland to Crusheen (including the Ennis Bypass) Design Report prepared by Clare County Council September 1999.

1.2 The purpose of this report is to provide an update to the information contained in the earlier Design Report and only includes those aspects of the design which been modified through the development of the scheme.

2.0 Description of the Development

2.1 The proposed N18 Road Improvements Dromoland to Crusheen (including the Ennis Bypass) forms part of the National Roads Authority programme for upgrading the N18 Limerick to Galway road. The N18 route is part of the Trans-European Road Network (TERN). It provides access from the northwest, west and mid-west regions to the southern sea corridor ports of Waterford, Rosslare and Cork. It also links the west and northwest regions to Shannon International Airport and to the University cities of Galway and Limerick.

2.2 The project involves the construction of major sections of the N18 National Primary Route from Dromoland, where the Newmarket on Fergus bypass terminates, to a point on the existing N18 south of Crusheen. The N85 Western Relief Road will be constructed from Claureen bridge on the existing N85 Ennistymon Road. It will extend southwards, crossing the N68 at Cahircalla, and the existing N18 north of Killadysert Cross to connect with the new N18 Eastern Bypass route at Killow. A plan of the proposed road layout is shown as Figure 1. A schedule of the engineering drawings prepared for the scheme, which will be available for public viewing, are listed in Appendix A of this report.



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Scale 1:50000
Kilometres
N
Cragard
Barefield
River Fergus
N18
Tulla Road
N85
Ennis
Claureen River
R474
Quin Road
Killow
N68
Clarecastle
N18
Proposed Roads
Existing Roads
Railway Line
River Fergus
Latoon Creek
Dromoland

Figure 1

3.0 Layout and Design

3.1 The main lengths of road to be constructed are detailed below;

N18 Eastern Bypass

Latoon to Killow;	5.6 km new standard dual carriageway
Killow to Barefield;	7.0 km new reduced dual carriageway
Barefield to Cragard;	1.2 km upgrade to wide 2-lane carriageway

N85 Western Relief Road

Killow to Clareabbey;	2.5 km new reduced dual carriageway
Clareabbey to Claureen;	4.6 km new 10m wide 2-lane carriageway (no hardshoulders)

3.2 The existing N18 south of Barefield will be linked to the realigned N18 at a new junction to the east of the village. Other consequential works include junctions, slip roads and the realignment of Regional and Local (County) roads crossing the new routes.

3.3 The scheme will involve 14 major new structures, including 3 river crossings and 3 railway crossings, designed in keeping with local sensitivity at each location. A complete list of the main structures proposed as part of the scheme is provided in Appendix B of this report.

3.4 Access to and from the proposed N18 will be restricted to key junction areas. International experience has shown that such a policy leads to a greatly reduced number of accidents and preserves the capacity of the road to cater for larger volumes of traffic. A design speed of 100 kph has been adopted throughout for the proposed N18 and N85 routes. This will ensure that a consistently high standard of alignment is maintained between both dual and single carriageway sections of routes. A list of the proposed carriageway standards is given in Appendix C of this report.

Appendix A

Drawing Schedule

Clare County Council
N18 Road Improvements Dromoland to Crusheen (including the Ennis Bypass)
Design Report Addendum

Drawing Schedule

Drawing No.	Title	Scale
BTI 020344/LP/01	Location Plan	1/ 10,000
BTI 020344/R1/01	General Plan and Longitudinal Section (Sheet 1)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/02	General Plan and Longitudinal Section (Sheet 2)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/03	General Plan and Longitudinal Section (Sheet 3)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/04	General Plan and Longitudinal Section (Sheet 4)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/05	General Plan and Longitudinal Section (Sheet 5)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/06	General Plan and Longitudinal Section (Sheet 6)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/07	General Plan and Longitudinal Section (Sheet 7)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/08	General Plan and Longitudinal Section (Sheet 8)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/09	General Plan and Longitudinal Section (Sheet 9)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/10	General Plan and Longitudinal Section (Sheet 10)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/11	General Plan and Longitudinal Section (Sheet 11)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/12	General Plan and Longitudinal Section (Sheet 12)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/13	General Plan and Longitudinal Section (Sheet 13)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/14	General Plan and Longitudinal Section (Sheet 14)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/15	General Plan and Longitudinal Section (Sheet 15)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/16	General Plan and Longitudinal Section (Sheet 16)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R1/17	General Plan and Longitudinal Section (Sheet 17)	1/ 2500 horz, 1/ 250 vert.
BTI 020344/R15/01	Side Road Long Sections (Sheet 1)	1/ 1000 horz, 1/ 250 vert.
BTI 020344/R15/02	Side Road Long Sections (Sheet 2)	1/ 1000 horz, 1/ 250 vert.
BTI 020344/R15/03	Side Road Long Sections (Sheet 3)	1/ 1000 horz, 1/ 250 vert.
BTI 020344/R15/04	Side Road Long Sections (Sheet 4)	1/ 1000 horz, 1/ 250 vert.
BTI 020344/R15/05	Side Road Long Sections (Sheet 5)	1/ 1000 horz, 1/ 250 vert.
BTI 020344/R15/06	Side Road Long Sections (Sheet 6)	1/ 1000 horz, 1/ 250 vert.
BTI 020344/R15/07	Side Road Long Sections (Sheet 7)	1/ 1000 horz, 1/ 250 vert.

Appendix B

Structures

Structure No.	Name/ Location	Drawing No.	Description	Bridge deck width (m)	Bridge deck length (m)
1	Latoon Creek Underbridge	**BTI 20344/ST01/01**	Dual-carriageway bridge over river at Latoon	**35**	**56**
2	L-7142 Overbridge	**BTI 20344/ST02/01**	County road bridge over proposed N18	**10**	**87.5**
3	Manusmore Railway Underbridge	**BTI 20344/ST03/01**	Dual- carriageway bridge over single track railway	**35**	**18.5**
4	Killow Junction Overbridge	**BTI 20344/ST04/01**	Reduced dual carriageway bridge over proposed N18	**25.5**	**72**
5	R469 Underbridge	**BTI 20344/ST05/01**	Reduced dual carriageway bridge over regional road R469	**25.5**	**24**
6	Knockanean Road Underbridge	**BTI 20344/ST06/01**	Reduced dual carriageway bridge over county road	**25.5**	**24.5**
7	R352 Overbridge	**BTI 20344/ST07/01**	Regional Road R352 over proposed N18	**13**	**62.5**
8	Ballymacahill Road Underbridge	**BTI 20344/ST08/01**	Reduced dual carriageway bridge over county road	**25.5**	**25.5**
9	Barefield Railway Underbridge	**BTI 20344/ST09/01**	Reduced dual carriageway bridge over single track railway	**25.5**	**18.5**
10	Barefield Interchange Underbridge	**BTI 20344/ST10/01**	Reduced dual carriageway bridge over county road	**25.5**	**28.5**
11	N68 Underbridge	**BTI 20344/ST11/01**	Single carriageway bridge over N68 Kilrush Road	**14**	**36.5**
12	Clareabbey Railway Underbridge	**BTI 20344/ST12/01**	Reduced dual carriageway bridge over single track railway	**28.0**	**12.5**
13	River Fergus Underbridge	**BTI 20344/ST13/01**	Reduced dual carriageway bridge over River Fergus	**25.5**	**110**
14	Claureen River Underbridge	**BTI 20344/ST14/01**	Single carriageway bridge over River Claureen	**14**	**62**

Appendix C

Proposed Carriageway Standards

N18 Eastern Bypass

Master String	Road Name	Proposed Road Type/ Design Speed	Proposed CW	Proposed Med.	Proposed HS	Proposed Ver.
M001	N18 Eastern Bypass	Std. Dual	2 x 7.5	10.0	3.0	3.0
	Dromoland - Killow	RND 120			1.0	
M001	N18 Eastern Bypass	Red. Dual	2 x 7.5	4.5	1.0	3.0
	Killow - Tulla	RND100				
M001	N18 Eastern Bypass	Red. Dual	2 x 7.5	4.5	1.0	3.0
	Tulla - Barefield	RND 100				
M001	N18 Eastern Bypass	Wide 2-lane	10.0	-	2.5	3.0
	Barefield - Caheraphuca					

N85 Western Relief Road

Master String	Road Name	Proposed Road Type/ Design Speed	Proposed CW	Proposed Med.	Proposed HS	Proposed Ver.
M002	N85 Western Relief	Red. Dual	2 x 7.5	4.5	1.0	3.0
	Killow - Skehanagh	RND 120				
M003	N85 Western Relief	Red. Dual	2 x 7.5	4.5	1.0	3.0
	Skehanagh - Clareabbey	RND 120				
M004	N85 Western Relief	Wide 2-lane	10.0	-	-	3.0
	Clareabbey - Ballybeg	UNU 100				
M005	N85 Western Relief	Wide 2-lane	10.0	-	-	3.0
	Ballybeg - Ballymacaula	UNU 100				
M006	N85 Western Relief	Wide 2-lane	10.0	-	-	3.0
	Ballymacaula - Claureen	UNU 100				

Master String	Road Name	Proposed Road Type/ Design Speed	Proposed CW	Med.	HS	Ver.
M007	Link to Old N18		7.5	-	-	2.0
	Dromoland Interchange					
M008	N/B Merge		4.0		1.5	2.0
	Dromoland Interchange				0.5	
M009	S/B Diverge		4.0		1.5	2.0
	Dromoland Interchange				0.5	
M010	Manus Rd	RCU 60	5.0	-	0.5	2.0
	L7142	Single c/way				
M011	N/B Diverge	Slip Road	2 x 3.0	-	1.0	2.0
	Killow Junction	70.0				
M012	S/B Merge	Slip Road	2 x 3.65	-	1.0	2.5
	Killow Junction	70.0			0.7	2.8
M013	N/B Merge	Slip Road	3.70	-	2.3	2.0
	Killow Junction	70.0			1.0	
M014	S/B Diverge	Slip Road	3.70	-	2.3	2.0
	Killow Junction	70.0			1.0	
M015	Overbridge		2 x 7.5	4.5	1.0	3.0
	Killow Junction				1.0	
M016	Doora Rd (part 2)	RCU 60	5.0	-	0.5	2.0
	Killow East R'about - L4114	Single c/way				
M017	Quin Rd	RCU 100	7.0	-	0.5	2.0
	R469	Single c/way				
M018	Knockanean Rd	RCU 60	5.0	-	0.5	2.0
	L4106	Single c/way				
M019	Tulla Rd	RRU 60	7.5	-	0.5	2.0
	N/B 2-way slip	Single c/way				
M020	Tulla Rd	RRU 100	7.0	-	0.5	2.0
	R352	Single c/way				
M021	Tulla Rd	RRU 60	7.5	-	0.5	5.0
	S/B 2-way slip	Single c/way				
M022	Ballymacahill Rd	RCU 60	5.0	-	0.5	2.0
	L4102	Single c/way				
M023	N/B 2-way slip	Compact	7.5	-	0.5	2.0
	Barefield Junction	60.0				
M024	Barefield Village South Link	RNU 60	7.5	-	2.0	2.0
		Single c/way				
M025	Cappagh Rd	RCU 60	5.0	-	0.5	2.0
	Barefield Village R'about - Old N18	Single c/way				
M026	N18 Link (part 2)	RCU 60	7.5	-	0.5	2.0
	Barefield S/B 2-way slip	Single c/way				
M027	Cappagh Rd	RCU 60	5.0	-	0.5	2.0
	L4076	Single c/way				
M028	Ballyogan Rd	RCU 60	5.0	-	0.5	2.0
	L8122	Single c/way				
M029	Skehanagh/Killow Access Rd	RCU 60	5.0	-	0.5	2.0
	L4116	Single c/way				
M030	Doora Rd (part 1)	RCU 60	5.0	-	0.5	2.0
	Skehanagh R'about - L4114	Single c/way				

Note 1: Offside H/S only applies if carriageway falls to right. A 3m verge shall be used if H/S not included.

APPENDIX I – PART C

REPORT ON PROJECTED TRAFFIC & ROUTE CAPACITIES
CLARE COUNTY COUNCIL SEPTEMBER 1999)

COMHAIRLE CHONTAE AN CHLÁIR

CLARE COUNTY COUNCIL

N18 ROAD IMPROVEMENTS
DROMOLAND TO CRUSHEEN
(INCLUDING THE ENNIS BYPASS)

REPORT ON PROJECTED TRAFFIC
AND ROUTE CAPACITIES

Mr Tom Carey B.E., C. Eng., F.I.E.I.
County Engineer
New Road
Ennis
Co Clare

September 1999

3/61/Rep-0116

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SECTION 1

INTRODUCTION

1. INTRODUCTION

1.1 Background To Scheme

The N18 is identified as a priority route in recently published documentation on road priority strategy.
In The National Roads Needs Study published by the NRA last year (1998) the N18 is categorised as backlog.
The N18 has been identified as worthy of particular priority and is included as part of the Trans European Network (TEN). It is seen as a vital cog in what is described as the Strategic Western Road Corridor which connects the North-West of the country (Sligo) to the Southern and Eastern passenger and freight ports (Cork, Waterford, & Rosslare). It also links the University cities of Galway and Limerick.(ref National Development Plan 1994-1999)

1.2 Justification for the road - Traffic

In November 1993 Clare County Council published as part of the design process a report titled "N18 Road Improvements Dromoland To Crusheen (including the Ennis By-Pass) Broad Route Corridor Selection Report"
This report recommended an eastern by-pass of Ennis combined with a western relief road to connect the N85, N68 and R473 & R474 roads to the new bypass as the optimal solution to serve both the National through traffic as well as the local access traffic to Ennis and its hinterland.
The existing N18 , in particular through and to the south of Ennis is struggling to deal with the increasing volume of traffic and is in an urban context for over half of the existing N18 corridor. Speed limits of 40 mph and 30 mph are in place over more than half the existing N18 road to be realigned from Dromoland to the townland of Cragard, north of Barefield village.
The realigned section of the proposed new road will cover the journey from Dromoland Interchange to Cragard in 13.2km via a freeflow grade-separated road. The existing N18 involves 17.0km of road for the same journey. The positive impact on journey times and road safety will be significant.(*)
A more extensive breakdown of the needs is described in Section 2 of the Design Report contained in Volume IIIa of the Environmental Impact Study.

* Journey - Time survey by RDO\BP yet to be carried out

SECTION 2

TRAFFIC GROWTH

2. TRAFFIC GROWTH

2.1 Traffic Records

Clare County Council in co-operation with An Foras Forbartha and latterly the National Roads Authority (NRA) have been keeping records of traffic counts for many years.
Table 2.1 shows the manually measured A.A.D.T. traffic volumes for various national routes in the Ennis Area over the 20 years 1977 to 1997. These figures are derived from counts traditionally taken in late July which are then factored according to expansion from the guidance manual RT201 published by An Foras Forbartha.
Clare County Council have more accurate estimations for AADT conversion based on a continuous count on an annual basis from past records (up to 1987)
Thus the following are the accepted conversion figures for the five main arteries for Ennis:

N18-Skehanagh AADT = July count x 0.90 (8% HGV)
N18-Ballycoree AADT = July count x 0.90 (7% HGV)
N68-Darragh AADT = July count x 0.85 (9% HGV)
N85-Fountain X) AADT = July count x 0.99 (R476-8% HGV)
= July count x 0.84 (N85-9% HGV)
R352-Corrovorin AADT = July count x 0.98 (4% HGV) RT201

In addition to these figures the NRA maintain permanent traffic counters at Ballycasey Junction and Gort. The figures from these have been used in collaborating the manually measured figures.
From hourly patterns observed the route from Dromoland to Ennis is treated as Intertown and all other sections are being treated as Tourist for the purpose of grouping for design hourly volumes (RT180 Table C4.4)

Clare County Council		ANNUAL TRAFFIC GROWTH RATES ENNIS AREA												
Year		1979	1984	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N18 (South)	AADT's	6980	8254	9455	-	-	11536	12041	12503	14846	13826	16247	16556	19103
Skehanagh Cross	% G.R.		3.65	2.90	6.53	6.53	6.53	4.38	3.83	18.74	-6.87	18.81	1.9	15.34
		<-------	-3.5%	--><---					10.2%					--->
N18(North)	AADT's	2996	3866	3983	5109	-	5543	5011	6134	5731	5968	6550	7058	8492
Ballycoree	% G.R.		5.8	0.6	28.29	6.30	6.30	-14.59	22.45	-6.6	4.13	9.75	7.75	20.32
		<-------	-3.3%	---><---		-			11.3%					--->
N85	AADT's	3123	4577	5203	6918	6392	6635	7138	7884	6930	8097	7799	9352	9078
to Ennistimon	% G.R.		9.30	2.73	32.96	-7.60	3.80	7.58	10.45	-12.1	16.84	-3.7	19.9	-2.9
		<------	6.66%	---><---					7.4%					--->
N68	AADT's	1873	2358	2569	2817	2820	2846	2799	3097	3052	3960	3760	3823	4569
to Kilrush	% G.R.		5.18	1.8	9.66	0.12	0.84	0.89	10.6	-1.40	29.75	-5.10	1.68	19.51
		<-------	-3.7%	---><---		-			7.79%					--->
R352	AADT's.	2343	2282	2521	-	2958	2901	3497	3252	4337	4578	4566	5176	6094
to Tulla	% G.R.		-2.59	2.1	8.67	8.67	-1.92	20.54	-7.0	33.39	5.54	-2.0	13.36	17.74
		<-------	0.8%	---><---					14.2%					--->

AADT = Annual Average Daily Traffic
% G.R. = Annual Growth Rate

TABLE 2.1 ANNUAL TRAFFIC GROWTH RATES - ENNIS AREA

2.2 Growth Rates

From Table 2.1 the annual rate of increase in traffic on the N18 (south) has been in excess of 10% per annum for the 10-year period 1989 - 1999. The N18 (north) has had an average increase of 11% annually over the same period.

The traffic stream through Ennis has a Heavy Goods Vehicle (HGV) content of between 8 and 10 % from south to north. For the purpose of traffic projections a growth rate of 3% per annum has been assumed for future years (Ref National Roads Needs Study).
The 1997 A.A.D.T.'s for the existing route, is derived from these counts and are shown in Table 3.1 and projected forward to the year 2020 in addition to Design Hour Volumes (D.H.V.) for these routes.

2.3 Origin and Destination Surveys

In September 1992 Clare County Council carried out an Origin and Destination (O/D) Traffic Survey on the N18 National Primary road at two locations, one to the north at Barefield and one to the south of Ennis at Latoon.
In May 1999 Clare County Council carried out a further Origin and Destination (O/D) Traffic Survey at two locations on the N18 National Primary road, one to the north at Barefield and one to the south of Ennis at Latoon as per the 1992 study as well as additional locations on the three other major roads into the town, namely the N68, N85 and R352.

2.4 Traffic Designation

Using the splits derived from the 1999 O/D survey combined with the measured traffic figures at the major legs described above the traffic was assigned to the new and old network.

SECTION 3

DESIGN TRAFFIC CAPACITY

3.1 Capacity on the Existing Road Network

The geometric alignment of the existing road is sub-standard in many respects. The existing N18 from Dromoland to Crusheen through Ennis has poor horizontal and vertical sight distance. Passing opportunities are virtually non existent. The length of N18 being considered has a deficient alignment relative to the traffic volumes which it carries. A large proportion of this section of this road has speed restrictions and is urban in categorisation. Opportunities for overtaking are restricted and consequently operating speed is constrained by the alignment deficiencies as well as the urban environment. Also, there is a high number of access points on and off the road contributing to difficult driving conditions with a resulting high level of cross movement

Delays experienced at Clarecastle and Ennis currently arise directly from the mismatch of current national route traffic with a road struggling to cope with modern volumes of traffic combined with restrictive road space and poor alignment. This situation through Clarecastle and Ennis is expected to worsen without a by-pass of with the advent of the Newmarket-on-Fergus by-pass combined with continuing traffic growth.

At present national traffic is passing through the heart of Ennis thus mingling with town and local traffic thus creating a wide degree of conflicting traffic movements, resulting in severe congestion at peak hours and in high tourist season. Ennis serves as the focal point for tourist journeys for West Clare and the Aran islands as well as being an obvious stop for the Galway to Limerick tourist and commercial traffic. (The town has a large tourist information office).

The 1999 Origin-Destination study by Clare County Council indicates that :

- 68% of N18 traffic entering Ennis from the North (through Barefield) at present of has no purpose in the town and would use the new road network..
- 61% of N18 traffic entering Ennis from the South (through Clarecastle) at present of has no purpose in the town and would use the new road network.

This traffic is a hindrance to those using the town.

3.2 Capacity on the Proposed New Road Network

With the creation of a new network the existing N18 will revert to a road operating within capacity again .
The section of existing N18 from Clarecastle will benefit from the reduction of traffic from the present volumes (capacity) to substantially lower volumes on opening the new scheme.
(22663 veh\day to 127veh\day in year of opening 2005)

The section of existing N18 from Ballycoree to Barefield will benefit from the fact that more than two-thirds of the traffic existing traffic are likely to use the new scheme thus preserving the capacity of the existing N18 for a greater period of time. (A reduction from 10139 veh\day to 3376veh\day in year of opening 2005)

Most sections of the proposed new road will operate within design capacity for the design life of the road (up to 2020). However, the proposed wide-2-lane single carriageway from Kilbreckan to Crusheen may need to be upgraded to reduced dual carriageway as the Northern section (Area 3b) in particular will be operating at close to or above design capacity by design year 2020.(Table 3.1)

TABLE 3.1

TRAFFIC FIGURES (AADT Vehicles/day & Design Hourly Volumes DHV pcu\hour) FOR THE N18\N85*

	1999 AADT	1999 *DHV*	2005 AADT	2005 *DHV*	2020 AADT	2020 *DHV*
+Area 1a Dromoland-Killow	18238	*2371*	21776	*2813*	33923	*4831*
Area 2a(EB) Killow-R352	9362	*1404*	11178	*1677*	17413	*2612*
Area 3a(EB) R352-Barefield	7086	*1063*	8461	*1269*	13180	*1977*
Area 3b(EB) Barefield-Cragard	8492	*1274*	10139	*1521*	15795	*2369*
Area 3c Existing N18 Barefield (sth)	2828	*424*	3377	*507*	5260	*789*
+Area 4(WR) Killow-Existing N18	11356	*1476*	13559	*1633*	21122	*2746*
Area 5a(WR) Existing N18 - N68	7039	*1056*	8405	*1261*	13093	*1964*
Area 5b(WR) N68- R474	4534	*680*	5414	*812*	8433	*1265*
Area 6(WR) R474 -N85	3945	*592*	4710	*707*	7338	*1101*

* This table shows the projected traffic volumes at 3% annual growth rate distributed over the proposed network using Clare Co Co measured figures projected from 1997.
EB = N18 Eastern Bypass(of Ennis)
WR = N85 Western Relief Road
\+ Intertown group (RT 180) all others are tourist group

At 1999 figures the existing N18 between Dromoland and its junction with the R473 at Clarecastle carries an A.A.D.T. of *18238 veh/day*. This volume exceeds the rated 'Mid D' capacity of *13800 veh/day* of the 'National Roads Needs Study' 1996\2019 (Ref 1) The capacity of the existing N18 road is therefore already exceeded.

The traffic figures designation as they would break down for the year 1999 on the proposed network are shown schematically in Figure 2.1.

3.3 Cost Benefit Analysis

During the broad route corridor selection process in 1993 a cost benefit analysis was carried out which showed the preferred route corridor (Option D) to have an internal rate of return of 15.2%.

This analysis showed that the proposal exhibited a positive net benefit to the economy and was a suitable project for the investment of public money. More recent analyses of the proposed scheme have confirmed this to be the case.

(NRA CBA awaited from Michael Kennedy - NRA)

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SECTION 4

PROJECTED TRAFFIC FLOWS CROSS-SECTION

TABLE 4.1 CROSS-SECTION DESIGN

	PROPOSED CROSS-SECTION	AADT IN DESIGN YEAR 2020	DESIGN CAPACITY AT LOS D (AADT)	LOS D DESIGN CAPACITY in 2020	DESIGN CAPACITY AT LOS C (AADT)	LOS C DESIGN CAPACITY in 2020
Area 1(N18) Dromoland-Killow	Standard Dual Carriageway	33923	44100	73.9 %	34,600	98.0 %
Area 2(N18) Kilbreckan-R352	Wide 2 Lane Reduced Dual	17413 17413	13800 26500	126 % 65.7 %	7,700 20,800	226 % 83.7 %
Area 3a(N18) R352-Barefield	Wide 2 Lane Reduced Dual	13180 13180	13800 26500	95.5% 49.7%	7,700 20,800	171 % 63.4%
Area 3b(N18) Barefield-Cragard	Wide 2 Lane Reduced Dual	15795 15795	13800 26500	114 % 59.6%	7,700 20,800	205 % 75.9%
Area 3c(N18) Existing N18 Barefield (sth)	Wide 2 Lane	5260	8600	61.2 %	4,800	110%
Area 4(N85) Killow-Existing N18	Reduced Dual Carriageway	21122	26500	79.7 %	20,800	102%
Area 5a(N85) Existing N18 -N68	Wide 2 Lane (with shoulder)	13093	13800	94.9 %	7,700	170 %
Area 5b(N85) N68- R474	Wide 2 Lane (no shoulder)	8433	8600	98.0 %	4,800	206 %
Area 6(N85) R474 -N85	Wide 2 Lane (no shoulder)	7338	8600	85.3 %	4,800	153 %

At 1999 figures the existing N18 between Dromoland and its junction with the R473 at Clarecastle carries an A.A.D.T. of 18238 veh/day.
At 1999 figures the existing N18 between Barefield and the tie-in at Cragard carries an A.A.D.T. of 8492 veh/day.
The National Roads Needs Study rates the design capacity of the existing road at 8600 veh/day to provide a level of service D (LOS D).
The capacity of the existing N18 road is therefore already exceeded.
The projected traffic figures for the design year 2020 on the proposed network are shown schematically in Figure 4.2

Clare County Council
Comhairle Chontae an Chlair

N18 Road Improvements Dromoland to Crusheen (including the Ennis Bypass)

Traffic Assessment
Position Paper

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March 2000

BTI 020344

Clare County Council
N18 Road Improvements Dromoland to Crusheen (including the Ennis Bypass)
Traffic Assessment
Draft Position Paper

1. Introduction

1.1 This paper details the traffic levels, which will be used for the purpose of link and junction design, produced as part of the above study. Within the previous paper, December 1999, an estimate of carriageway provision was provided based on levels calculated within the initial traffic model.

1.2 We have now produced an enhanced traffic model and undertaken a series of traffic growth sensitivity tests which now accurately represent traffic volume on the design scheme links.

1.3 Re-assessment of carriageway provision, using this final set of traffic levels, confirms the findings of the previous study.

2. 1999 Model Production

2.1 The current model is the product of traffic and network information received from Messrs Atkins McCarthy. From the computer files received we were unable to reproduce the traffic levels published within the Draft Final Report published by McCarthy & Partners, however we were assured that the 1995 pcu pm peak matrix supplied to us is accurate. This 1995 matrix was therefore used in the production of a 1999 matrix. The new matrix represents the average annual weekday pm vehicle level in and adjacent to Ennis.

2.2 The make–up of the new matrix remains similar to that supplied by Atkins McCarthy, in that the majority of trips travel to and from the centre of Ennis, with a smaller proportion of through traffic. As this is consistent with the 1999 origin-destination survey data, undertaken by Clare Council, we are confident that the strategic traffic and trips to/from Ennis are accurately modelled.

2.3 Although it is not possible to use this matrix for detailed modelling within the centre of Ennis, it can be used to produce traffic volumes on the proposed links.

2.4 With regard to the existing highway network this has been updated from the 1995 base using information received from Clare County Council in order to model current conditions.

3. Traffic Levels

3.1 There is some concern in the production of the average annual traffic level (AADT) due to the lack of available data. AADT has been produced by applying a factor of 11.46 to the pm peak hour. This is based on the relationship between pm peak and AADT at the automatic counter site north of Ennis. This assumes that the origin-destination pairs throughout the day are similar to that found in the evening peak and that the peak to AADT north of Ennis is similar on all other links in the area.

3.2 From experience the factor obtained is realistic and therefore will be used in the production of AADT levels.

4. Ennis Congestion, Growth & Development

4.1 Currently Ennis is an extremely congested town. By applying growth at a rate of approximately 3% per annum (as stipulated in Table 6.1 of the Road Needs Study for National Primary Routes), the town will remain congested even under design conditions. Therefore traffic routing on the network will be strongly influenced by traffic growth and development in the town. Also, as the majority of planned and anticipated future development sites are located adjacent to the Western Relief Road, it is expected that a higher level of growth will be experienced southwest of Ennis rather than in the centre or north of the town.

5. Sensitivity Tests

5.1 In order to take cognisance of growth and development and as it is unrealistic that all areas of Ennis will experience growth of approximately 3% per annum, a series of sensitivity tests have been undertaken. These include various growth assumptions to and from different areas within Ennis.

5.2 The effect of a change in growth is demonstrated within Figure 1 attached. This figure shows the level of carriageway provision required, under three of the test scenarios for the proposed link between Killow and Tulla junctions of the Eastern Bypass.

5.3 The first column, Test 1, is based on full 3% growth applied to all areas of Ennis, Test 2 on 1% growth in traffic to and from the Town Centre and the full 3% elsewhere. The last column, Test 3, is based on zero growth to the centre, full growth to all other zones and the development traffic.

5.4 The area encompassed by the Town Centre and all development sites is shown within Figure 2.

5.5 From Figure 1 it is clear that, by the design year of 2020, a reduced dual carriageway is required under each scenario. However, when assessing the exact year that this carriageway type is required, the effect of growth is shown. Within Test 1 and 3 it is anticipated that this level of provision is required by year 2011 and 2010 respectively, while the carriageway type is not required until 2017 under Test 2.

5.6 This is as expected as Test 2 has significantly lower growth predictions between year 1999 and 2020. The difference in options 1 and 2 is due to the higher prediction of growth in Test 3, which includes 3 % and development traffic.

5.7 All assessments will be undertaken based on the development scenario, as this includes both the strategic growth and planned development within Ennis, therefore producing the most realistic set of traffic levels within the design year of 2020.

5.8 The attached schematics (Figures 4 to 6) show the AADT levels on the base within year 1999 and both the base and design network in year 2020. As the majority of development sites will not go ahead without the proposed improvements, the projected traffic levels on the base network exclude development traffic.

6. Carriageway Provision

6.1 Figure 3 attached lists the level of carriageway provision required between each of the design junctions for a design year of 2020. In addition the requirement for the N18 north of this study is also provided.

6.2 The carriageway classification is based on Table 4.3 of the National Road Needs Study, Final Report. For this assessment the capacities are based on level of service D and for the N18 Eastern Bypass, rural limits apply, while the commuter limits apply for the Western Relief Road.

6.3 Figure 3 also includes the AADT levels within year 1999 and 2005 for comparison. In addition the theoretical year that a reduced dual carriageway type is required is provided.

6.4 The flows on the N18 between Killow and Tulla are such that we would recommend construction of reduced dual carriageway at the outset for this section of the route.

7. Junction Assessment

7.1 An initial assessment of design roundabouts has been undertaken based on traffic turning levels extracted from the development scenario. As present there are no capacity problems at any location.

7.2 With regard to the priority junctions at Tulla and Barefield design checks have also been undertaken.

7.3 Based on the traffic flows used in the production of the previous Position Paper, it was found that one quadrant link at Barefield and Tulla junction would provide adequate capacity. However undertaking the same assessment using the new traffic levels demonstrates this would not be the case.

7.4 When assigning the traffic matrix in year 2020 more vehicles will use these junctions due to congestion levels elsewhere on the network. Including the development traffic also forces more trips through these junction locations. Figure 7 and 8 show the turning movements at each site, showing the average pm peak and also the two-way AADT level. All figures are at year 2020.

7.5 Assessment of Tulla junction shows that one arm is likely to be sufficient at the time of opening. However shortly after opening junction capacity will be exceeded and the second quadrant link will be required. As the mainline is now proposed as dual carriageway through the junction, this will allow the safe adoption of two arms which would be included in the scheme at the outset.

7.6 With regard to Barefield junction, one arm may be sufficient for some five or six years after opening. A second quadrant link will then be required and we have concerns about the provision of two quadrant links on a single carriageway. Our recommendations would be to extend the reduced dual carriageway to Barefield junction, where the median would prevent incorrect use of the two left in – left out quadrant links. Considering that such a situation would arise shortly after opening, we would suggest constructing the dual carriageway to Barefield at the outset.

8. Sensitivity Tests at Barefield & Tulla Junctions

8.1 On Tulla Road within the 1999 base model, the AADT level approaching Ennis Centre is approximately 14,000 vehicles. However the level increases to approximately 19,000 vehicles in the design model. This design level is considered to exceed the capacity of the existing link. We have therefore undertaken a test, which limits the level on Tulla Road. This results in higher traffic levels at both the Tulla junction and at Barefleld than the design levels discussed above, as shown in Figure 9.

8.2 The increase in traffic level on the links to the mainline at Tulla junction is due to trips from Tulla now using the proposed bypass south towards Killow junction in order to get to their destination, as opposed to using Tulla Road through Ennis. At Barefield the increase is due to traffic to and from the N18 North using the old N18 to access Ennis instead of via Tulla Road.

9. Conclusion

9.1 The above traffic assessment report was presented to the National Roads Authority on the 15th of February 2000. At this meeting the recommendations above were discussed and the following confirmed as adopted within the N18 Dromoland to Crusheen Road Improvement (including the Ennis Bypass) project;

- N18 Killow to Barefield to be designed as reduced dual carriageway from year of opening,
- Local grade separation at Tulla and Barefield with both quadrant links included.

Growth Case			
	Test 1	**Test 2**	**Test3**
Year	**3% all traffic**	**1% town centre 3% elsewhere**	**0% town centre 3% elsewhere and development included**
2000	9000	9000	9000
2005	11200	10400	11400
2020	17900	14700	18700
Year reduced D2AP required	2011	2017	2010

Figure 1 – D2AP Provision
Killow – Tulla Road

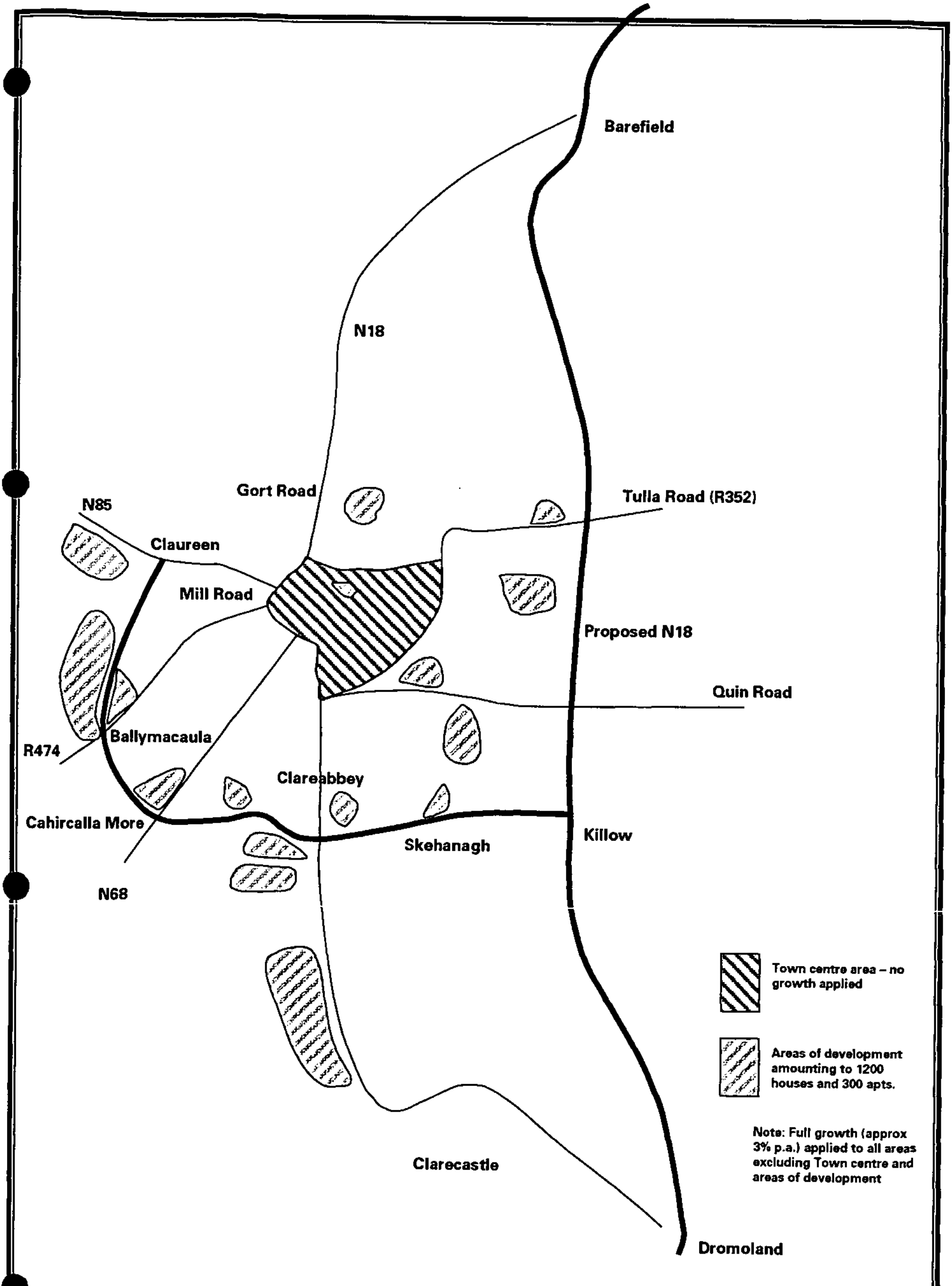


Figure 2 – Traffic Growth and Development Scenario

	PROPOSED N18			EXISTING N18	PROPOSED WESTERN RELIEF ROAD			
YEAR	**Dromoland To Killow**	**Killow To Tulla**	**Tulla To Barefield**	**North Of Barefield**	**Killow To Clareabbey**	**Clareabbey To Cahircalla**	**Cahircalla To Balleymacaula**	**Balleymacaula To Claureen**
1999	18900	8700	7200	9000	14100	8000	6100	5300
2005	22700	11400	9100	10600	17200	10700	8500	7500
2020	32100	18700	13700	14500	24800	17600	14600	12900
C/Way at Year 2020	Standard Dual	Reduced Dual	Wide 2 Lane	Reduced Dual	Reduced Dual	Wide 2 Lane	Standard 2 Lane	Standard 2 Lane
Year Reduced D2AP Required	Year 2010 (Standard D2AP)	Year 2010	Year 2022	Year 2018	Year 2007	Year 2024	*	*

* Outside growth projection range, (i.e. greater than year 2035)

Carriageway classification for proposed N18 and existing N18 based on rural conditions.
Carriageway classifications for the proposed western relief road based on commuter conditions.
Traffic levels in year 2020 include development traffic

Figure 3: Design Links Average Annual Daily Traffic Flows

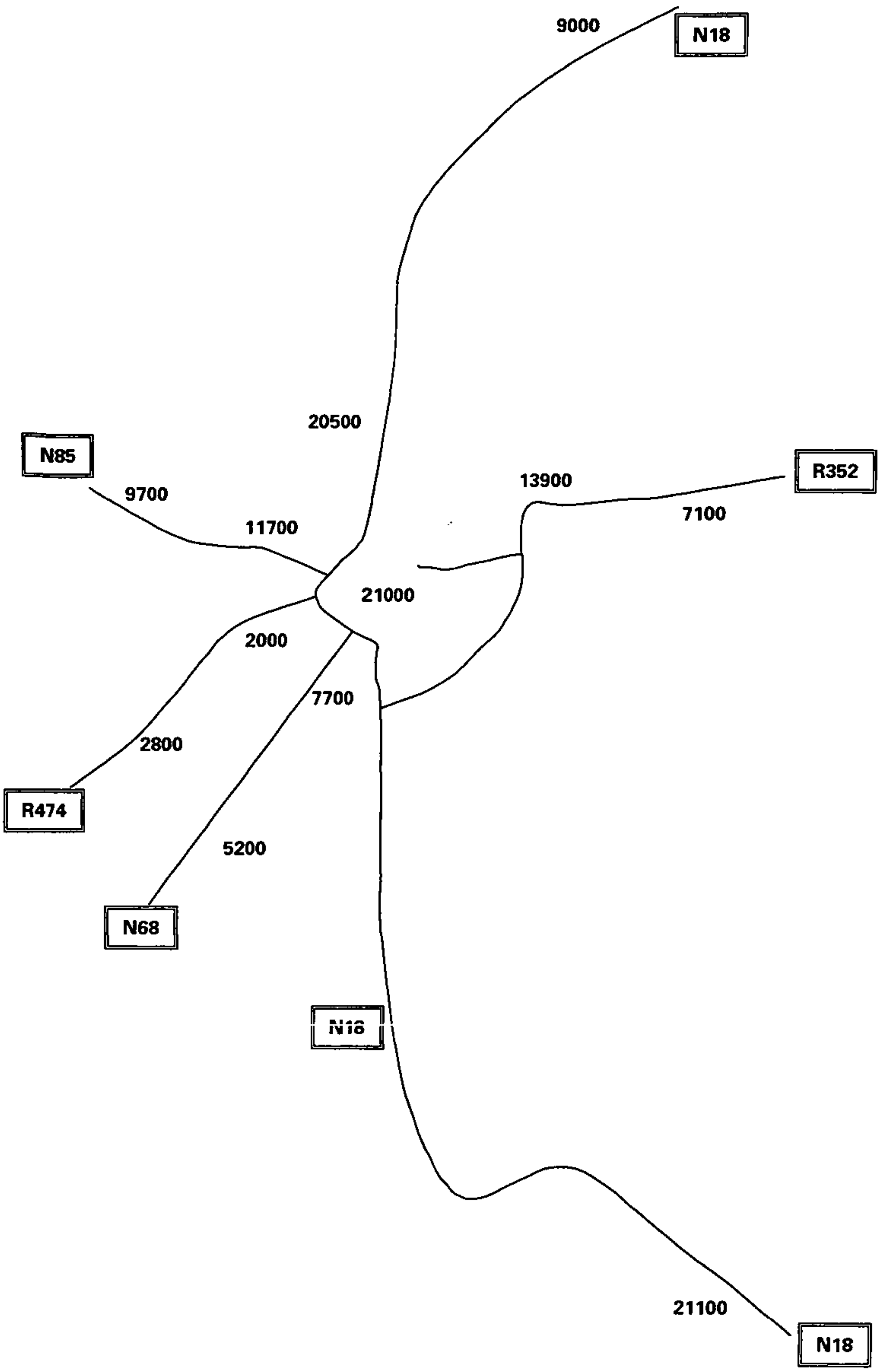


Figure 4
Ennis Traffic Model – Estimated BASE AADT 1999

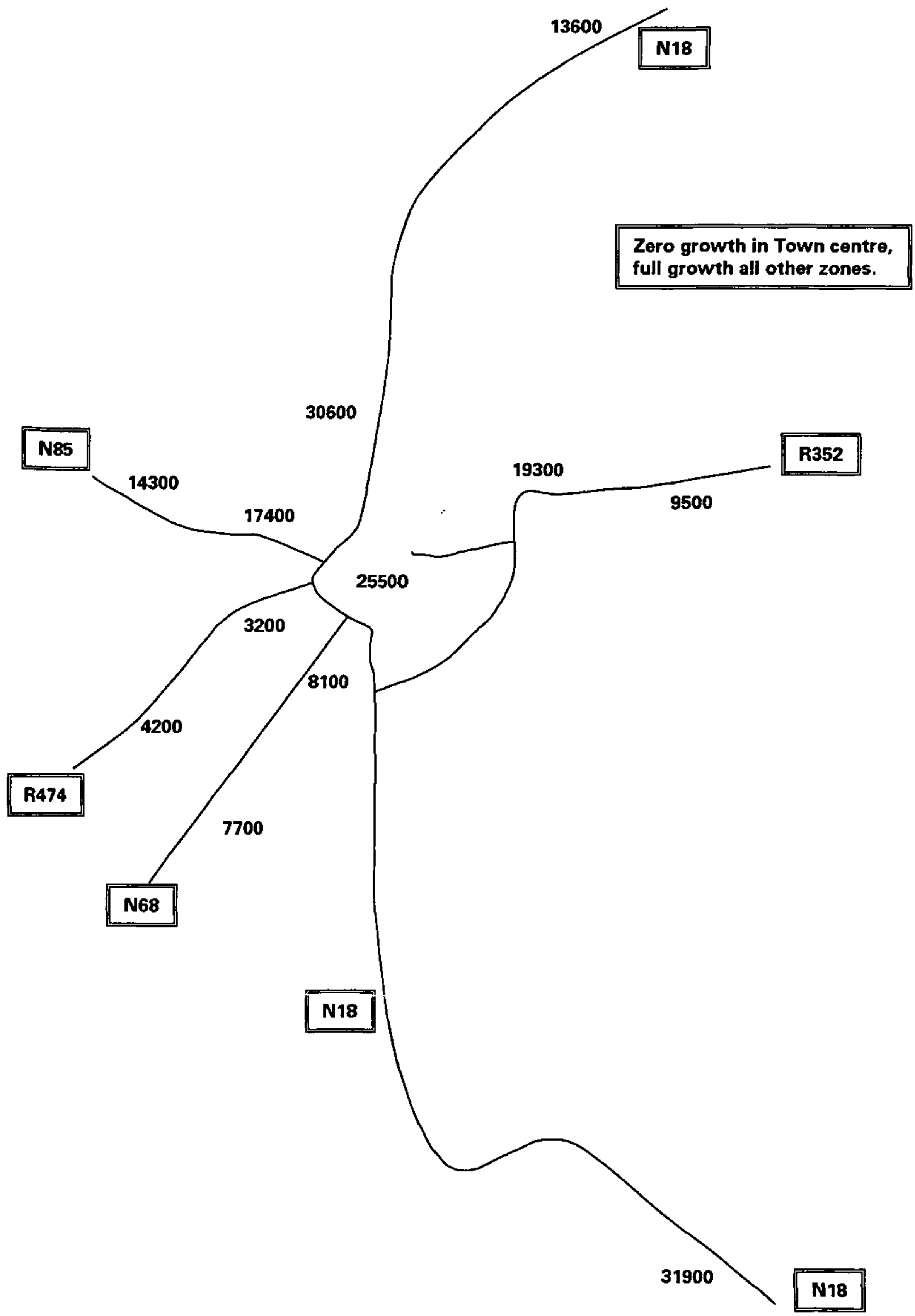


Figure 5
Ennis Traffic Model – Estimated BASE AADT 2020
Assigned Matrix Year 2020 Reduced Growth

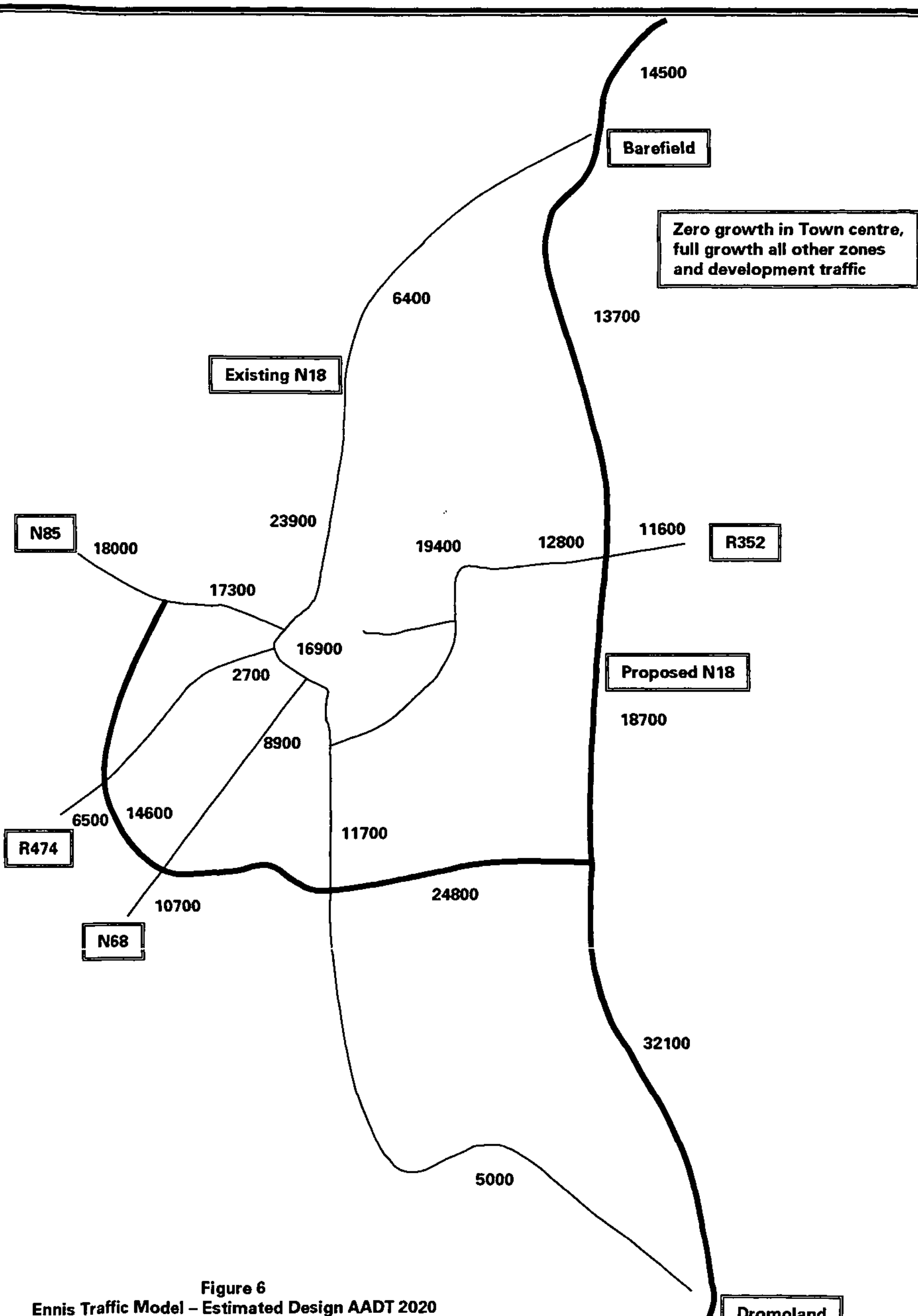
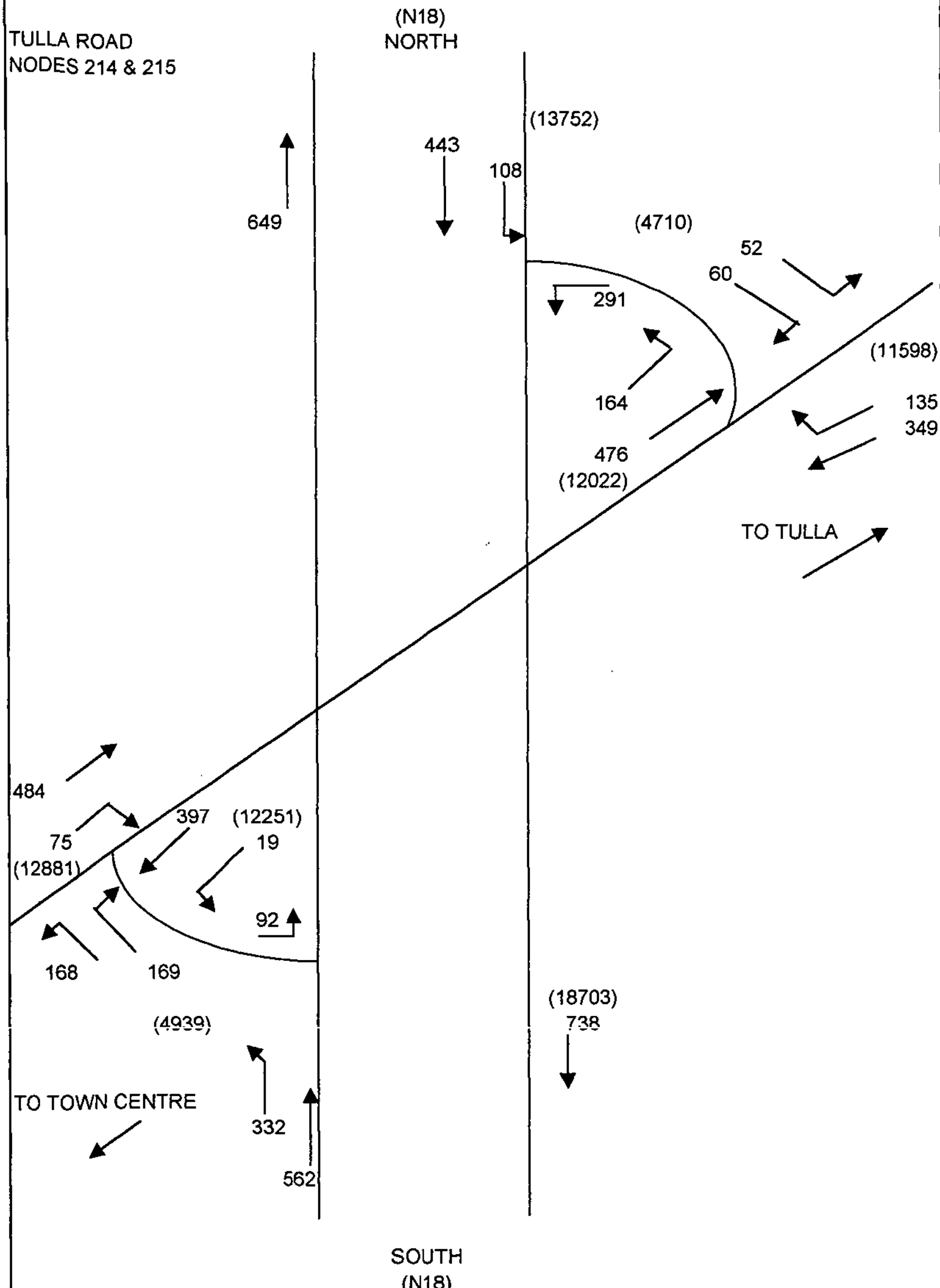
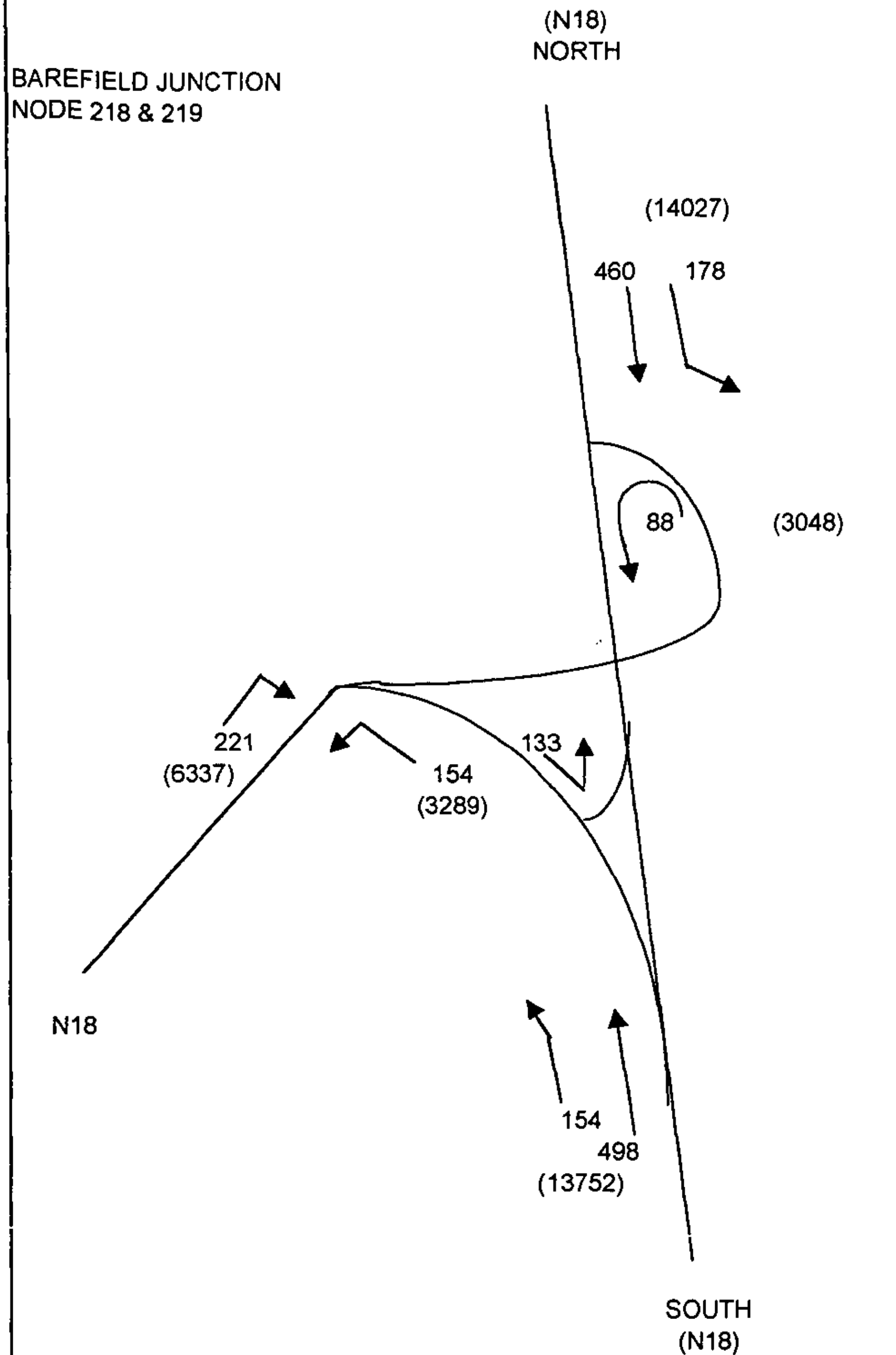


Figure 6
Ennis Traffic Model – Estimated Design AADT 2020
Assigned Matrix Year 2020 - Development



2020 Full Growth + Development
PM Peak 1 Hour turning flows
Figures in brackets are AADT two way

Babtie	**BABTIE GROUP** 95 Bothwell Street Glasgow G2 7HX	Job Numb Figure No Drawn By Date	BTI20344 **7** MS FEB 2000



2020 Full Growth + Development
PM Peak 1 Hour turning flows
Figures in brackets are AADT two way

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		Figure No	**8**
		Drawn By	MS
		Date	FEB 2000

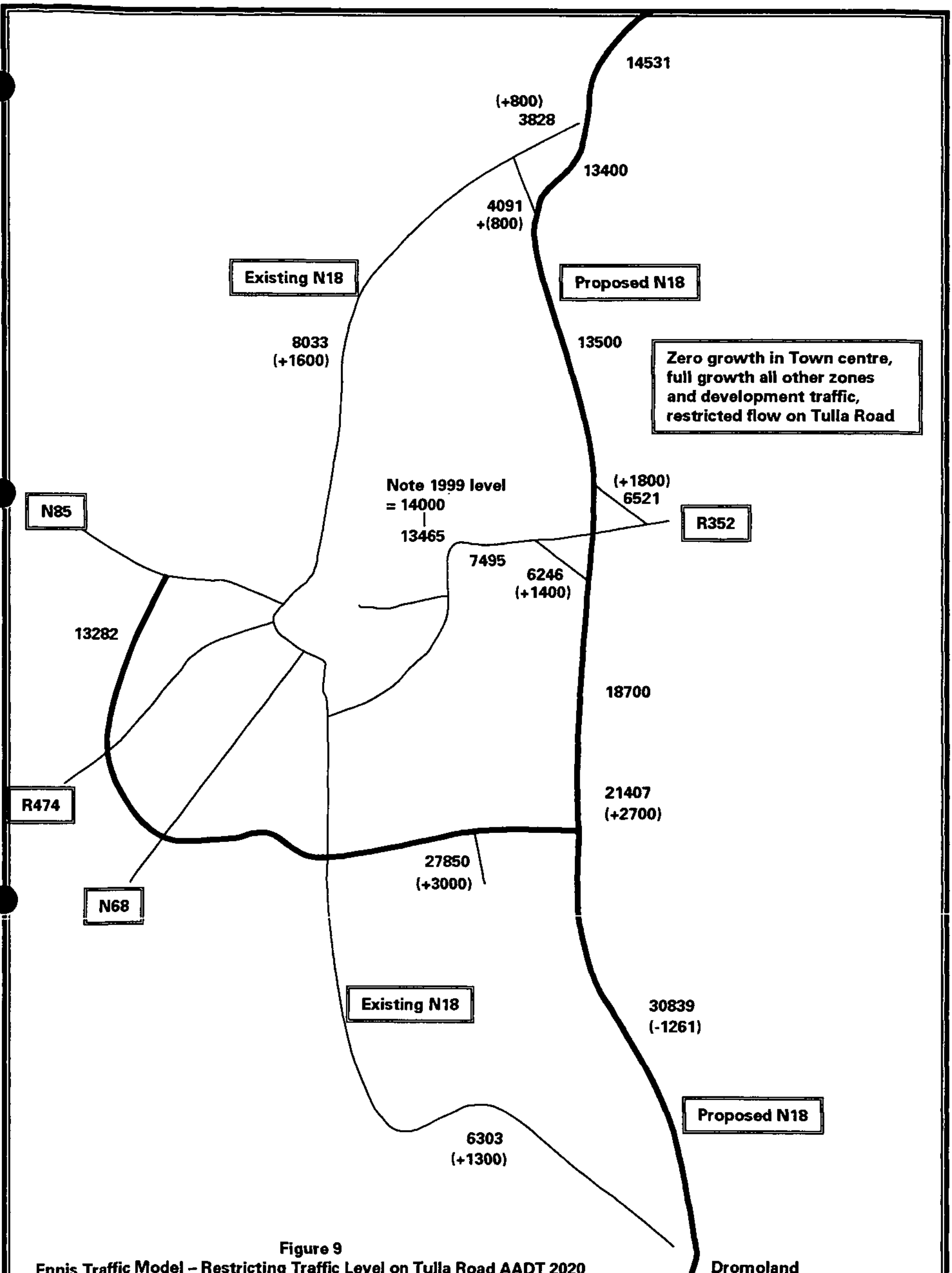
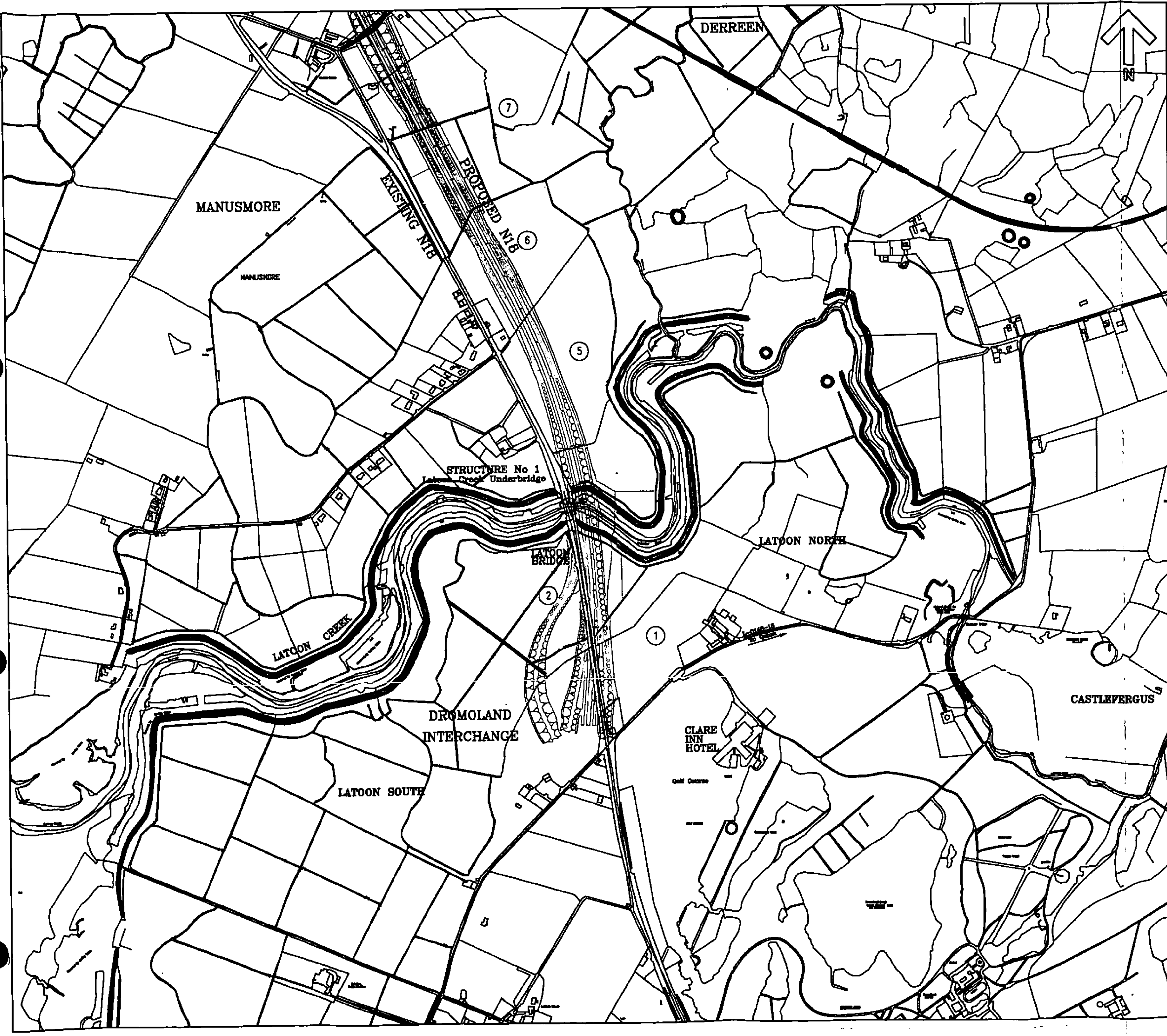


Figure 9
Ennis Traffic Model – Restricting Traffic Level on Tulla Road AADT 2020
Assigned Matrix Year 2020 - Development

APPENDIX I – PART D

LANDOWNERSHIP MAPS



Drawing Number

K5650–NK100

Notes

LEGEND

(115) OWNERSHIP REFERENCE

Do not scale this drawing

Rev	Date			Checked

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Client

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CLARE COUNTY COUNCIL
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an Chlair

COUNTY ENGINEER
MR TOM CAREY,
B.E., C.Eng., F.I.E.I.
Co. Clare

ROAD DESIGN OFFICE
Limerick

Project

N18 DROMOLAND TO CRUSHEEN
(Including The Ennis By-Pass)
ENVIRONMENTAL IMPACT STATEMENT

Title

LANDOWNERSHIP & PROPOSED ROUTE LAYOUT
SHEET 1 OF 8

Drawing No.	K5650–NK100		
Scale	1:10000		Date
	Drawn	Checked	Approved

Drawing Number

K5650–NK101

Notes

LEGEND

(115) OWNERSHIP REFERENCE

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(including The Ennis By-Pass)
ENVIRONMENTAL IMPACT STATEMENT

Title

LANDOWNERSHIP & PROPOSED ROUTE LAYOUT
SHEET 2 OF 8

Drawing No.	K5650–NK101		
Scale	1:10000		Date
	Drawn	Checked	Approved

Drawing Number

K5650–NK102

Notes

LEGEND

(115) OWNERSHIP REFERENCE

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Project

N18 DROMOLAND TO CRUSHEEN
(Including The Ennis By–Pass)
ENVIRONMENTAL IMPACT STATEMENT

Title

LANDOWNERSHIP & PROPOSED ROUTE LAYOUT
SHEET 3 OF 8

Drawing No.	K5650–NK102		
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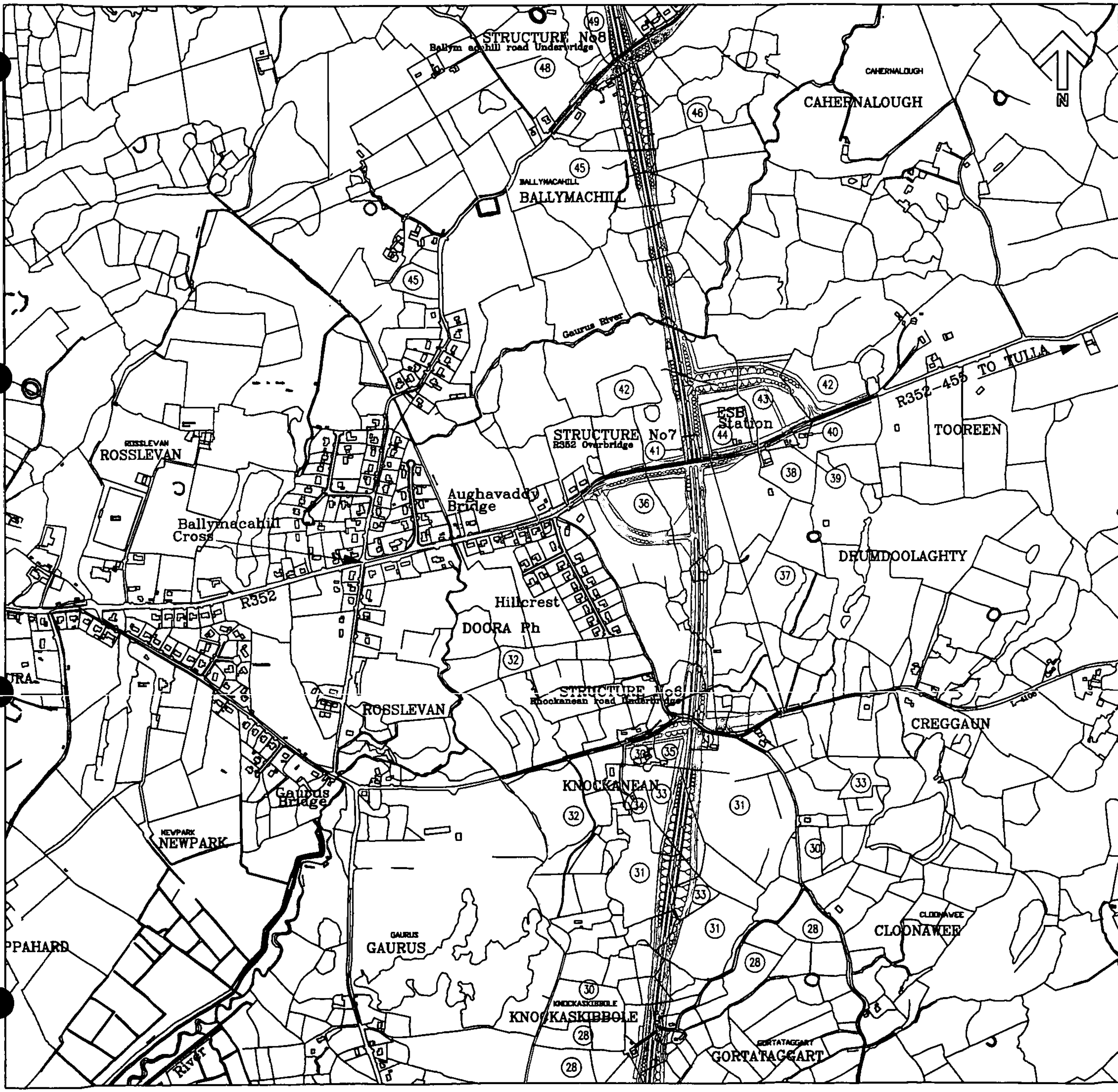

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LEGEND

(115) OWNERSHIP REFERENCE

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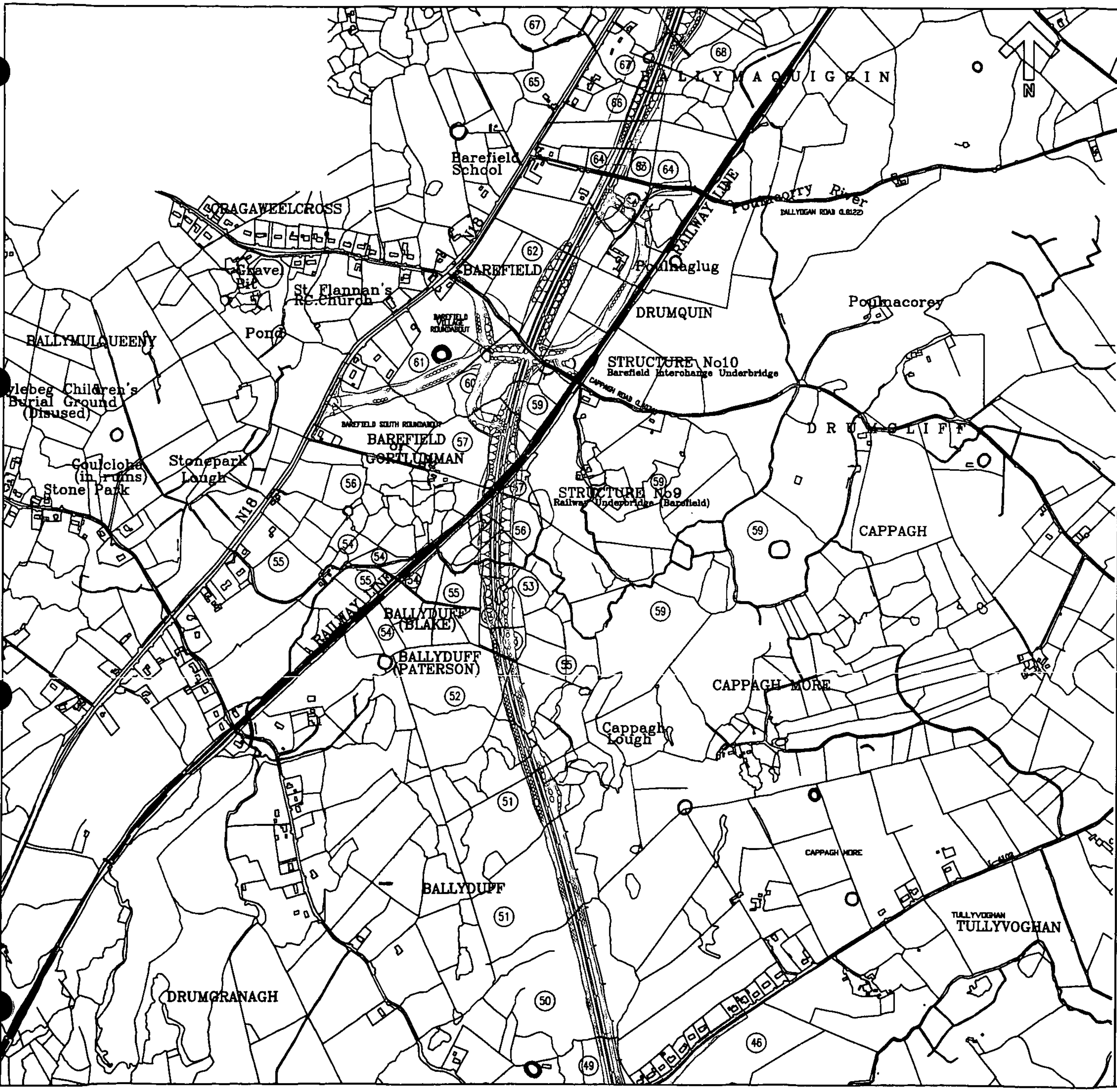
N18 DROMOLAND TO CRUSHEEN
(Including The Ennis By-Pass)
ENVIRONMENTAL IMPACT STATEMENT

Title

LANDOWNERSHIP & PROPOSED ROUTE LAYOUT
SHEET 4 OF 8

Drawing No.	K5650-NK103		
Scale	1:10000	Date	
Drawn	Checked	Approved	



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Rev	Date		Checked

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Project

N18 DROMOLAND TO CRUSHEEN
(Including The Ennis By-Pass)
ENVIRONMENTAL IMPACT STATEMENT

Title

LANDOWNERSHIP & PROPOSED ROUTE LAYOUT
SHEET 5 OF 8

Drawing No.	K5650-NK104
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Drawing Number

K5650-NK105

Notes

LEGEND

(115) OWNERSHIP REFERENCE

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Rev	Date		Checked

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N18 DROMOLAND TO CRUSHEEN
(Including The Ennis By-Pass)
ENVIRONMENTAL IMPACT STATEMENT

Title

LANDOWNERSHIP & PROPOSED ROUTE LAYOUT
SHEET 6 OF 8

Drawing No.	K5650-NK105		
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	Drawn ADW	Checked FR	Approved

Drawing Number

K5650-NK106

Notes

LEGEND

(115) OWNERSHIP REFERENCE

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Rev	Date		Checked

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Project

N18 DROMOLAND TO CRUSHEEN
(including The Ennis By-Pass)
ENVIRONMENTAL IMPACT STATEMENT

Title

LANDOWNERSHIP & PROPOSED ROUTE LAYOUT
SHEET 7 OF 8

Drawing No.	K5650-NK106		
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	Drawn ABW	Checked PR	Approved

Drawing Number

K5650–NK107

Notes

LEGEND

(115) OWNERSHIP REFERENCE

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Rev	Date			Checked

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N18 DROMOLAND TO CRUSHEEN
(Including The Ennis By-Pass)
ENVIRONMENTAL IMPACT STATEMENT

Title

LANDOWNERSHIP & PROPOSED ROUTE LAYOUT
SHEET 8 OF 8

Drawing No.	K5650–NK107		
Scale	1:10000		Date
	Drawn	Checked	Approved

APPENDIX II

HUMAN ENVIRONMENT

PART A **REPORT ON SOCIO-ECONOMIC ELEMENTS OF THE EIS (Jonathan Blackwell & Associates)**

APPENDIX II – PART A

REPORT ON SOCIO-ECONOMIC ELEMENTS OF THE EIS
(Jonathan Blackwell & Associates)

SOCIO-ECONOMIC ELEMENTS OF THE EIS FOR THE N18 NATIONAL PRIMARY ROUTE FROM DROMOLAND TO CRUSHEEN AND THE ENNIS WESTERN RELIEF ROUTE

FINAL Draft

Jonathan Blackwell and Associates

January 1999

Table of Contents

1. PRELIMINARY

1.1. Commissioning and Terms of Reference

This report forms part of an Environmental Impact Statement (EIS) relating to the realignment of the N18 national primary route from Dromoland to Crusheen (a distance of approximately 14 kilometres), together with the construction of a new Western Relief Route which will connect with the National Primary Route, the N85, into Ennistymon (a distance of 12 kilometres).

The new roads are referred to hereafter as the N18 by-pass route and the new Western Relief route, respectively. This report describes the impacts on the environment caused by socio-economic factors arising out of the project.

As well as identifying and assessing the development likely to be facilitated by the new roads and the consequent environmental impact of the development, attention is given in the report to a consideration of commercial loss which will arise from the reassignment of traffic flows. Environmental impacts will flow from each of these socio-economic factors.

The terms of reference for the study specifically exclude the following elements:

- Severance of economic holdings (though other types of severance are included and individual cases of severe economic severance have been dealt with)
- Traffic impacts in terms of noise, visual intrusion, congestion and air pollution. The economic cost of congestion caused or relieved is part of the cost-benefit analysis carried out in respect of the development, and noise and air pollution are the subject of separate reports within the present EIS, based on the projected traffic growth.

Also included in this report is a preliminary assessment of the impact of road realignment of the N18 between the present scheme and the proposed Crusheen By-pass. For the purposes of analysis under in this report, this section is included under the heading 'N18 by-pass route'.

1.2. Application of the EC Directive

According to Article 3 of EC Directive 85/337, an EIS must identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect effects of a project on (inter alia) **human beings, material assets and cultural heritage**. Annex III of the directive makes it clear that there must be a description of the likely significant effects of the proposed project on the environment resulting (*inter alia*) from the existence of the project. Section 50 (2)(c) of the Roads Act (1993) also requires the Road Authority to make this assessment.

It is the understanding of the Consultant that the effects to which reference is made in the foregoing paragraphs are effects on the physical environment. Changes in income, consumption and employment are therefore relevant only insofar as they give rise to further, or associated, environmental impacts.

The requirements of the Directive pose particular problems in the context of the present study because the development is part of a programme of road development in the region and the impact of this section cannot easily be divorced from the impact of other elements of the system and the impact of the system as a whole when it is completed.

In the following section, the background to the current proposal is set out in the context of the overall road network development, and the associated land-use planning policies which are being pursued by Clare County Council and Ennis Urban District Council. *Nevertheless, the impacts which are considered in this study are the incremental impacts arising from the construction of this element of the overall system.*

1.3. The Scope of the Report

The impact on **human beings** arising from traffic movement in terms of noise, air quality and visual impact is being dealt with in other sections of the EIS. The impacts on human beings considered here relate to direct physical impacts of the construction work (including demolition) and impacts on the quality of life arising from changed traffic flows, as well as social severance.

This report also seeks to isolate the land-use changes and changes in economic activity which are directly attributable, or attributable in part, to the development of the new routes, with resultant impacts on **material assets and cultural heritage** (but excluding archaeology). These include direct physical impacts through construction work, or impacts mediated through the economic system.

In addition to examination of published reports and discussion with Local Authority planners, the Consultants have surveyed existing commercial activity in the impacted areas, held discussions with representatives of local business interests and assessed development opportunities and constraints.

The structure of this report is as follows:-

In *Section 2* the proposed development is set in the context of the sub-regional planning framework for settlement and communications. The expected shifts in traffic flow are outlined and the cost benefit calculations arising from these shifts reviewed.

In *Section 3* the existing environments along both the existing and proposed routes are described, in terms of economic activity and land use.

In *Section 4*, the anticipated development impact is set out, including the impact of loss of business and enhanced residential amenities, on routes where traffic has been reduced. This section also deals with the anticipated construction impact.

In *Section 5*, the broader shifts in land-use development patterns likely to arise from the developments, are discussed, with implications for human beings and material assets.

In *Section 6*, the impacts from construction activity are discussed.

Section 7 states the likely significant direct and/or indirect interactions

In *Section 8*, mitigation proposals are set out, where these are required.

A *non-technical summary* is appended as *Section 9*

2. THE PROPOSED DEVELOPMENT

2.1. Planning Context

NATIONAL CONTEXT

Operational Programme for Transport 1994-99

The route forms part of the Strategic Western Corridor, identified in the 1994-1999 Operational Programme for Transport. The purpose of this corridor is to counteract the radial (ex Dublin) nature of the other corridors defined for investment purposes, and to provide access from the Northwest, West and Midwest regions to the Southern Sea Corridor ports of Waterford, Rosslare and (via the N20 link route) Cork. Rosslare and Cork are important both as freight and passenger access points while Waterford is a key lo-lo port. The corridor also links the West and the North-West regions to Shannon Airport and to university cities of Galway and Limerick. It also provides links to the regional airports at Sligo, Knock and Galway, the regional port at Galway and the Shannon Estuary ports.

Priority is being given, in road development programmes, to strategic corridors.

Road Needs Study

This stretch of the N18 is included in the Backlog Phase Needs section of the study. The term backlog refers to those routes not included in the current OPT which by the end of 1999, with projected traffic growth between 1995 and 1999, will not be capable of delivering 80 kph average inter-urban journey speed at that date.

SUB-REGIONAL CONTEXT

A number of regional and sub-regional plans have been completed in the last 25 years of relevance to the Limerick-Shannon-Ennis triangle. Sub-regional plans for the Mid west region have emphasised the link between Limerick, Shannon and Ennis. This was perceived by the Buchanan Report in the late 1960s as a growth triangle and was subsequently underpinned by more detailed sub-regional strategies and their associated transport plans.

The growth of Ennis town has been substantial in the last 25 years, as illustrated in Table 1 below. Growth in the last inter-censal period averaged 2 per cent per annum.

Table 1 Growth in the Population of Ennis since 1971

Year	Popn	Growth	Annual Percent Growth
1971	11,203		
1981	14,640	3,437	2.7
1991	16,058	1,418	0.9
1996	17,726	1,668	2.0

Source: Census of Population

Growth in the number of households has been substantially faster, as Table 2 illustrates:

Table 2 Housing permissions in Ennis UDC

Year	Houses granted
1991	403
1992	346
1993	203
1994	303
1995	717
Total	1,972

Source: Ennis UDC

2.2. *Expected shifts in traffic flow*

Table 3 below sets out the expected shifts in traffic flow with and without the proposed N18 by-pass development and associated Western Relief Road.

Table 3 *Expected shifts in traffic flow with and without the proposed N18 by-pass development and associated Western Relief Road*

Route Section	1992 AADT (veh/day)	2015 AADT (no bypass) (veh/day)	2020 AADT with bypass and New W.R.R. (veh/day)	2015 flows as % of 1992 flows, with by-pass
N18 at Latoon to Ennis	11844	23434	334	
N18 Ennis to Barefield	6350	12532	18628	
N68 Ennis to Kilrush	2811	5548		
N85 Ennis to Ennistymon	6142	12122		
R473 Ennis to Labasheeda	1509	2978		
R474 Ennis to Milltown Malbay	1597	3152		
R352 Ennis to Tulla	2486	4906		
R469 Ennis to Quin	1390	2743		

Source: Limerick County Council Road Design Office - data subject to final revision

The following conclusions may be drawn from this data:

- The volume of traffic entering and leaving Ennis on the existing N18 through Clarecastle will be reduced from an expected 23,434 in the year 2015 to 10,405 with the new N18 Eastern Bypass and the Western Relief Road. The absolute numbers in 2015 will be 88 per cent of the 1992 flows.
- ~~The volume of traffic entering and leaving Ennis on the N18 through Barefield~~ **(Data suspect: to be checked)**
- The volume of traffic on the N85 to Ennistymon and Corrofin within the line of the proposed Western Relief Road will be reduced from 12,122 in the year 2015 to 10,580 with the construction of the new route. This is a reduction of 13 per cent, though the volume of traffic in 2015 with the new route will still represent an increase of 72 per cent on the 1992 total.
- The N68 from Ennis town to Kilrush will also experience a reduction from 5,548 to 4,474 within the line of the proposed Western Relief Road due to the new route. The absolute numbers will decrease by 20 per cent, though the volume of traffic in 2015 with the new route will still represent an increase of 59 per cent on the 1992 total.
- The R474 from Ennis to Miltown Malbay within the relief road will be reduced from 3,152 to 2840 in the year 2015, this is a total reduction of 10 per cent, though traffic will still be increased by three quarters on the 1992 total.
- The R473 from Ennis to Labasheeda within the relief road will be reduced from 2,978 to 2,798 in the year 2015, this is a total reduction of 6 per cent, but still represents nearly a doubling from the 1992 total.
- Traffic on the R469 Quin Road will be unaffected by the proposed developments
- Traffic on the R352 Tulla road, west of the N18 by-pass, will be significantly increased as a result of this road now being used as an entrance point to Ennis. Traffic in 2015 will be two-and-a-half times the 1992 levels.

2.3. *Cost-benefit analysis*

A cost-benefit analysis has been carried out for the proposed development. It should be noted that these studies relate to the development of the N18 by-pass from Dromoland to Crusheen, and the Ennis Western Relief Route, in isolation, and may not therefore reflect the impact of the improved road network in the region as a whole. This analysis forms part of the Broad Route Corridor Selection Report.

The quantifiable benefits (i.e. time savings, fuel savings and accident reduction) which accrue to the community over the design life of the scheme have been set against its capital cost to estimate the Internal Rate of Return (IRR) of the scheme. Traffic growth was assumed to be at the rate of three per cent per annum over the period for which the return was calculated (twenty years). The preferred option resulted in an IRR of 15.2 per cent which is well above the 5 per cent minimum or threshold sought by the Department of the Environment.

2.4. *Broad Route Corridor Selection Process and Socio-economic elements*

A Broad Route Corridor Selection Report has been prepared which deals for the most part with engineering and cost-benefit issues.

Four routes were considered:

Option A: Inner Western By-pass
Option B: Eastern By-pass
Option C: Outer Western By-pass
Option D: Combination of Eastern By-pass and Western Relief Road

Each of these options may be examined under the following headings:

Site specific impacts

- Impact on residential amenity, including social severance and the level of required demolitions, on new routes and the existing road system
- Impact on economic activity on new routes and the existing road systems

Broad impacts

- Impact on balanced development of the town of Ennis
- Impact on commercial activity within Ennis
- Impact on sub-regional settlement patterns

As the routes being considered are broad corridors only, it is not possible to be definitive with regard to site specific impacts.

Table 4 sets out in more detail the impact types and examines each option in relation to its impact under each type.

Specifically, the impact of Option D, under each of the specified impact types, is set as the baseline. All other options are then examined in terms of the magnitude of the impact in relation to that of Option D.

Under site specific impacts, it is generally the case that site specific impacts are equal or less than Option D. Much of the explanation for this under the new routes heading lies in the greater absolute length of road to be constructed under Option D, which embraces elements of both the Eastern and the Western by-pass.

Under broad impacts, the picture is much more mixed.

Table 4: Impacts of Options relative to Option D

Type of Impact	Option Choice and impact			
	Option A	Option B	Option C	Option D
Site specific impacts				
General residential amenity				
• New Routes	less	less	less	Baseline
• Existing road systems	greater	greater	less	Baseline
Demolitions				
• New Routes	Less	Equal	Less	Baseline
• Existing road systems	Equal	Equal	Equal	Baseline
Social severance				
• New Routes	Greater	Less	Unclear	Baseline
• Existing road systems	Unclear	Greater	Less	Baseline
Impact on economic activity				
• New Routes	Equal	Less	Equal	Baseline
• Existing road systems	Equal	Less	Equal	Baseline
Broad impacts				
• Threat to balanced development of the town of Ennis	Greater	Greater	Greater	Baseline
• Impact on commercial activity within Ennis (reduction)	Unclear	Less	Unclear	Baseline
• Impact on sub-regional settlement patterns	Equal	Equal	Equal	Baseline

Table 5 formalises the scoring system, with a baseline score attached to Option D and other options scored 1 where impact is less, 2 where it is equal and 3 where it is greater.

Table 5: Scoring of Options relative to Option D

Site specific impacts	A	B	C	D
General residential amenity				
· New Routes	1	1	1	2
· Existing road systems	3	3	1	2
SUB-TOTAL	4	4	2	4
Demolitions				
· New Routes	1	2	1	2
· Existing road systems	2	2	2	2
SUB-TOTAL	3	4	3	4
Social severance				
· New Routes	3	1	2	2
· Existing road systems	2	3	1	2
SUB-TOTAL	5	4	3	4
Impact on economic activity				
· New Routes	2	1	2	2
· Existing road systems	2	1	2	2
SUB-TOTAL	4	2	4	4
Broad impacts				
· Threat to balanced development of the town of Ennis	3	3	3	2
· Impact on commercial activity within Ennis (reduction)	2	1	2	2
· Impact on sub-regional settlement patterns	2	2	2	2
SUB-TOTAL	7	6	7	6
Grand Total	23	20	19	22
Number of lowest or equal lowest scores	4	7	6	3
Number of highest or equal highest scores	8	6	6	7

Commentary on the results

Of the four options presented, option D is third. It comes equal first in terms of broad impacts, but equal last in terms of site specific impacts. *However, if the impacts of the new route development are isolated, it scores second in both specific impacts and broad impacts, just one point above Option C.*

In addition to the point that there is a greater length of road to be constructed under Option D, and therefore the impact of this option is likely to be greater for this reason alone, the following comments may be made:

- Though the negative impact on economic activity will be greater when more roads are constructed, because more traffic will be diverted, the impact on the town centre cannot be computed. This may have the impact of offsetting this tendency
- Option C, because it takes a wider route, is likely to be less disruptive in general
- Because the main line is to be built to the East, and a distributor road is to be built to the West, Option D provides the best chance of balanced development for the town.

In summary, in socio-economic terms, routes B and C are the most favourable, since they are furthest from built form and therefore site specific impacts are likely to be less. However, if the level of specific impact is acceptable on foot of the detailed examination which is contained in this report, then Option D provides the best opportunity or balanced development and quality of life in Ennis.

Caution should be exercised in interpreting results set out above, since they are the results of a desk study only.

3. THE EXISTING ENVIRONMENT

Examination of existing land use and economic activity relates both to the route of the new roads and also the existing road network insofar as traffic patterns are changed on them as a result of the proposed development.

3.1. The route of the realigned N18

Existing landuse and economic activity along the proposed new line of the N18 is for the most part agricultural. Other uses are present where the new line crosses existing roads. There are a total of six such intersections, excluding Latoon and Barefield junctions

3.2. The route of the Ennis Western Relief Road

Existing landuse and economic activity along the proposed new line of the N18 is for the most part agricultural. Other uses are present where the new line crosses existing roads. There are a total of 7 such intersections.

3.3. The route of the existing N18

3.3.1. On the Existing N18 from Latoon Cross to Clarecastle

Economic activity along this section is restricted to a small number of commercial enterprises, mostly locally oriented. These include a boutique, beauty salon and hairdressers.

There is also a total of three Bed and Breakfast establishments along this stretch of the N18.

In addition to these economic activities which front directly onto the route, there are a number of Bed and Breakfast establishments signed at existing junctions on the N18, particularly at Latoon cross.

Land use along this section of this route is for the most agricultural, with scattered single dwellings.

3.3.2. On the Existing N18 within Clarecastle

The settlement of Clarecastle is located some three miles South of the centre of Ennis on the N 18, but is effectively part of the commercial and social entity of Ennis. There is a strip of practically continuous development linking Clarecastle with the suburbs of Ennis.

The exact population of Clarecastle cannot be assessed, since it is not separately recorded in the Census of Population. From a house count conducted by the consultants there are some 350 dwellings within the village core.

Tabulations exist for the DED of Clareabbey lying within the environs of Ennis.

This is the closest that the census comes to the settlement of Clarecastle in definitional terms. The area is recorded as having a population of 1,874 persons in 1996.

Because of its location, Clarecastle experiences significant quantities of through traffic. In terms of **economic activity**, it caters principally for tourists with two Antique stores located within a short distance of each other. There are also two butcher shops and three public houses established within the town. A small village shop caters for local necessities, in addition to a hairdressers and a boutique. There is only one registered Bed and Breakfast establishment within the town.

Land use within Clarecastle with the exception of the commercial outlets outlined above is for the most part residential. Clarecastle is slowly becoming a popular destination for first time buyers as house prices have escalated within Ennis.

3.3.3. On the Existing N18 from Clarecastle to Ennis

Examination of **Economic activity** along this section is restricted to commercial enterprises which may obtain a significant quantity of their trade from passing tourist and commuter traffic. This is reflected in the presence of five petrol garages within a relatively short distance, these are Maxol, Shell, Texaco and two Statoil stations. The West County Hotel on the N18 from Limerick, is located adjacent to the Halfway Public house with Michael Lynch Joiners Ltd. situated opposite. Garvello's restaurant is located near to Clarecastle. There is also a total of seven Bed and Breakfast establishments along this stretch of the N18.

In addition to these economic activities which front directly onto the route, there are a number of Bed and Breakfast establishments signed at existing junctions on the N18 from Clarecastle to the outskirts of Ennis town. There is also a sign for the Auburn Lodge Hotel and the Temple Gate Hotel.

Land use along this section of this route comprises, for the most part, residential accommodation with agricultural land to the rear.

3.3.4. On the Existing N18 within Ennis Town

In terms of **economic activity** within Ennis, there is a wide range of commercial and recreational establishments situated along the N18. There are two service stations. There are also five public houses in close proximity to one another. Other economic activities include a tile centre, a tyre shop and an exhaust and windscreen centre, an estate agent and a youth hostel. There are also a number of Bed and Breakfast establishments fronting onto the N18. In addition, there are a number of signs advertising other Bed and Breakfast establishments.

The predominant **land use** is commercial with residential estates located to the rear.

Table 6 Inventory of establishments along the N18 in Ennis Town Centre.

Type of establishment	Number of outlets present
Financial institutions	1
Food shops and supermarkets	8
Pharmacies, jewellers/gift shops etc.	1
Newsagents	1
Petrol stations	7
Motor services	3
Public houses	5
Estate Agents	1
Hardware stores	3
Accommodation	12

3.4. On the Existing N18 from Ennis to Barefield

Economic activity along this stretch of the N18, the main Galway/Gort Road comprises Our Lady's Hospital, Sandfield Retail Centre, Ennis Supply Company Ltd., and the Gort Road Industrial Estate. In addition to these activities fronting directly onto the route, there are a number of smaller enterprises such as Hogan's newsagent and the adjoining plant hire centre and Pat Cooke's showroom (fitted kitchens). There are also two car sales garages which sell petrol. There are a considerable number of Bed and Breakfast establishments located on the Gort Road. There is also considerable signage on the approaches to the outskirts of Ennis town. These advertisements relate for the most part to accommodation for Bed and Breakfast establishments situated off the main road and also for two Hotels within the town of Ennis.

Existing **land use** is mainly residential approaching Ennis town. Further from the urban centre, the land use is predominantly agricultural. The current demand for housing has encouraged two new housing developments to be initiated in this area.

3.5. On the existing N18 North of Barefield to PJ's Lounge

This section of the N18 is likely not to change in terms of its alignment, but may require widening.

Land use along the N18 north of the point at which the proposed new line rejoins the existing alignment, is for the most part agricultural, with a number of single dwellings and commercial premises fronting the road.

For the most part, dwellings are set well back and the impact of road widening would be limited and would not require the demolition of these dwellings.

Nine dwellings are set forward on sites along the road, including one which fronts the road directly.

The impact of any widening proposals on these dwellings cannot be assessed until a more precise alignment has been established.

There are five Bed and Breakfast establishments situated on this section of the route, three of which are set forward on their sites.

There are three dwellings located immediately to the West of the proposed new line as it merges with the existing line of the N18. The residential amenity of one of these dwellings, in particular, may be seriously impacted by the development proposals, depending on the exact line and the vertical alignment as the road passes the dwellings.

PJs Lounge Bar fronts onto the existing N18 and would be impacted in the event of land being required on the western side of the road at this point. Since it is close to a cottage on the opposite side of the road which also fronts onto the road, and a property impact seems unavoidable at this point, whatever design is selected.

3.6. On Radial Routes from Ennis, inside the line of the proposed new road construction

3.6.1. On the Existing N68 from Kilrush to Ennis

In terms of **economic activity,** there are three car sales showrooms located within a relatively short distance of one another, two of which also sell petrol. There is a third filling station - Estuary. Auto World Business Park is also located here, selling car parts.

Other economic uses located on the N68 include a number of Government departments including a Social Welfare Office and a Driving Tester's Centre. There are also two small foodstores located opposite the relatively large residential estates on the main Kilrush road. There are two Bed and Breakfast establishments on this route.

Existing **land use** is predominately residential due to the presence of four relatively large residential estates in close proximity to the town, and a significant number of single dwellings further from the urban centre of Ennis.

3.6.2. On the Existing N85 from Ennis to Ennistymon

The only **economic activity** along this stretch is a filling station and a Bed and Breakfast establishment.

In terms of **land use**, two housing estates are sited alongside this road close to Ennis. Further from the town, land use is mainly agricultural with some single dwellings.

3.6.3. On the Existing R474 from Ennis to Miltown Malbay

There are a number of **economic activities** along this route in close proximity to Ennis town. These include an auctioneers, three public houses, a filling station, a car repair centre, a fast food outlet and a convenience store. Also located on the R474 are the Ennis Urban District Council offices and the County Clare Showgrounds. There is one Bed and Breakfast establishment located on this road with signage advertising another on a side road.

The predominant **land use** is agriculture. There is also an official halting site located on the boundary of Ennis Urban District's jurisdiction.

3.6.4. On the R352 between the intersection with the realigned N18 and Corravarrin bridge

Land use along this route is low density urban in type, and dominated by single houses fronting onto the road

Economic activity includes the following (from East to West)

1. Signpost for Bed and Breakfast establishment at junction with Four Seasons Drive
2. Shell filling station and supermarket east of Ballymacahill Cross
3. Garden Centre
4. Roslevan Arms Hotel
5. Joinery works
6. Bakery
7. Maxoil filling station and supermarket
8. Commercial units mostly building industry related

4. DEVELOPMENT IMPACT

Impacts which may be found on the new route will broadly be as follows:

- ~~Severance of a social nature~~ (agricultural severance is dealt with in the agronomy report)
- Demolition of dwellings
- Loss of residential amenity (this may be linked to visual impact and noise and may have impacts on house prices)
- Interruption, reduction or increase in trade

Impacts along existing routes will relate for the most part to

- Loss of residential amenity (this may be linked to visual impact and noise and may have impacts on house prices)
- Interruption, reduction or increase in trade

4.1. Along the N18 By-pass Route

As indicated above, existing landuse and economic activity along the proposed N18 by-pass route is for the most part agricultural. Other uses are present where the new line crosses existing roads. There are a total of six such intersections, excluding Latoon and Barefield junctions

County Road L7144 - Overbridge

Two dwellings (one to the East and one to the West) are located within 50 metres of the proposed carriageway and will suffer some loss of residential amenity.

No demolition will be required, there will be no social severance and no impact on economic activity

County Road L 4114 - Overbridge

Existing land use is agricultural with single dwellings fronting the road.

County road L 4114 will be severed and traffic re-routed via the new Killow Junction to the North.

The most serious impact of this severance will be felt by dwellings on the L 4114 between the intersection of this road with the realigned N18 and Skehanna Bridge. Access to and from these dwellings in a westerly direction will involve an extra distance of one kilometre, on average (check). There will be an element of social severance insofar as residents use the Catholic church at Doora.

There will be a loss of residential amenity to the dwelling located on the L4114 some 200 metres East of the point of severance, since this will now have the Eastern access road to the new junction, at its rere. This, however, will be compensated for in some measure by the closure of the L4114 to through traffic.

No demolition will be required and no impact on economic activity

Regional Road R469 - Underbridge

A single dwelling located within 40 metres of the carriageway will suffer a loss of residential amenity.

No demolition will be required and there will be no impact on economic activity

Regional Road R352 - overbridge

There will be no impacts at this intersection. There will be no significant loss of residential amenity, no demolition will be required and there will be no impact on economic activity.

Impacts on the R352 between this junction and Corravarrin Bridge are dealt with elsewhere in this report.

Balymacahill Road - underbridge

A farm dwelling and associated outbuilings will be demolished at this intersection.

There will be no impact on economic activity other than any impact on agricultural activity as a result of the demolition. These impacts are dealt with in the agronomy report.

4.2. Along the new route of the Western Relief Road

Impacts will relate to junctions with existing routes, which are discussed below in Section 4.4.

4.3. On the Route of the existing N18

4.3.1. On the Existing N18 from Latoon Cross to Clarecastle

Human Beings

The major impact on this stretch of the existing N18 will be an increase in the residential amenity of existing dwellings, as a result of the reduction of traffic flows.

Material Assets

Local services will be unaffected by the reduction in traffic flow.

Bed and Breakfast establishments on the route or signed from it may suffer a reduction in passing trade.

4.3.2. On the Existing N18 within Clarecastle

Human Beings

At present Clarecastle is suffering from excessive through traffic. The construction of the bypass and the Western Relief Road will create a safer environment for the local population. The atmosphere for shopping and other social activity in the centre of town will also be improved by the reduction in the overall flow of traffic and the virtual elimination of the heavy goods traffic on this section of the route.

Material Assets

There are currently two antique shops in Clarecastle which is a reflection of the passing tourist trade. It is most likely that these commercial premises will experience a reduction in trade.

There is now a significant body of evidence available on the impact of by-passes on trading in towns. In general, this evidence indicates:

- The smaller the town, the more significant the impact
- Trade typically diminishes in the short run but then recovers, as the benefits of an enhanced shopping environment outweigh the loss of passing traffic
- There are always winners and losers: the principal losers will be filling stations and possibly restaurants, though the latter is dependent on the type of trade. Winners are likely to be outlets where visits are planned, as well as those where access and parking had previously presented a problem.

Studies in the United States indicate that in towns by-passed, there is a 2:1 chance of trade increasing as a result of the bypass being put in place. Studies in the UK of 32 towns by-passed in the period 1970 to 1980 showed that 23 reported an increase in trade during the period, with 19 claiming that the by-pass had been a major contributory factor.

4.3.3. On the Existing N18 from Clarecastle to Ennis

Human Beings

The principle impact of the proposed bypass and the Western Relief Road is the significant reduction in vehicle traffic using the existing N18. In absolute terms the reduction in traffic may be as high as 44 per cent. This will create a safer environment both for pedestrians and children in general. The residential amenity of the area will be enhanced as a result of the reduction in traffic.

Material Assets

There will be three main impacts along this section of the route.

1. While there may be initial concerns about the effects of reduced through traffic on commercial trade, it is believed that the reduction in through traffic and congestion will encourage visitors going to Ennis to stop and avail of the facilities along this stretch of the N18.

2. There is a Bed and Breakfast establishment and a service station in close proximity to the interchange between the Western Relief Road and the existing N18. This could suffer a reduction in business, though signing would be possible.
3. The third impact relates to the Bed and Breakfast accommodation either fronting directly onto this route or signed from it. In both cases trade it is likely to be impacted. The extent of the impact will depend on the policy adopted with regard to the signing of Bed and Breakfast accommodation from the realigned route. Signage also exists for the Temple Gate Hotel and the West County Hotel.

4.3.4. On the Existing N18 within Ennis Town

Human Beings

The residential amenity of the N18 through Ennis will be enhanced with the construction of the proposed by-pass.

Material Assets

The West County Hotel and numerous Bed and Breakfast establishments along this stretch gain considerable custom from passing traffic. While there may be initial concerns about the effect of the by-pass on the local trade, it is believed that the reduction in traffic congestion may encourage tourists and visitors to linger and avail of the facilities in the town. The extent of this impact will also depend upon the arrangements for signage on the proposed by-pass.

The six petrol garages within a short distance on the N18 may be most severely impacted due to an estimated reduction of 36 per cent in vehicle traffic.

4.3.5. On the Existing N18 from Ennis to Barefield

Human Beings

The residential amenity of dwellings both in Barefield and on the N18 between Barefield and Ennis, will be enhanced due to the diversion of through traffic to the by-pass.

Material Assets

The following impacts on material assets may result from the proposed construction of the N18 by-pass and the necessary link roads.

1. Bed and Breakfast activity on the existing N18 may be adversely affected. This will depend upon the signage permitted along the new route.
2. Commercial activity in Barefield will be particularly adversely impacted as a result of the link road from the existing N18 to the new route, passing south of the village itself. Traffic passing through Barefield will be restricted to terminating traffic and traffic to and from County Roads L4158 and L 4076.

4.3.6. On the existing N18 North of Barefield to PJ's Lounge

Local road L 4076 running east from Barefield National School will be severed. Access to the junction with the N18 at the school, approaching from the East, will now be via the ~~underbridge at the Barefield junction to the South.~~

A total of 10 pupils currently use this road, four of whom either walk or cycle. The remainder are transported by car. Although the main line as it intersects the route of local road L4076 will be at grade, pedestrian crossing of this route by younger children will be unacceptable from a safety perspective. Alternative arrangements will therefore have to be made to ensure that these students can reach the school.

A further element of social severance will occur for the same reason, as two nearby dwellings occupied by different generations of the same extended family will be severed from each other.

4.4. On Radial Routes from Ennis

4.4.1. On the Existing N68 from Kilrush to Ennis within the Relief Road

Human Beings

There will be two major impacts on human beings along this section of the route.

- Residential amenity will be enhanced with the reduction in noise and vehicle traffic.
- The Rocky Road which is a local amenity walking route will be intersected by the proposed Western Relief Road.

It is proposed to carry out a pedestrian survey in order to establish the usage of the Rocky Road as an amenity.

Material Assets

The trade of two petrol garages and three car showrooms may be adversely affected due to a decrease in passing traffic. The impact on these commercial outlets may also depend upon the signage permitted on the new route. The petrol stations are close to the proposed new roundabout and may be visible from it and could be signed from it.

4.4.2. On the Existing N85 from Ennis to Ennistymon within the Relief Road

Human Beings

Traffic volumes on this route will be reduced as through traffic to Ennistymon and Corrofin uses the Western Relief Road. There will be a countervailing increase insofar as Ennis terminating traffic uses the relief road as access from the N18 to the North western quadrant of the town, as an alternative to the existing N18 and the R352 Tulla Road. Projections for the year 2015 estimate a net reduction of 13 per cent of traffic volumes along the route, if the proposed by-pass is constructed.

Material Assets

There are no commercial activities likely to be significantly impacted.

4.4.3. On the Existing R474 from Ennis to Miltown Malbay

Human Beings

Besides a reduction in vehicle traffic, the principal impact along this route will relate to the required relocation of the settled halting site near the intersection with the proposed Western Relief Road.

Material Assets

As economic uses along this stretch of the R474 gain most of their custom from local residents, the effect on trade is likely to be minimal. However, Bed and Breakfast establishments fronting onto the Miltown Malbay Road may suffer a decrease in custom. The extent of the impact of the proposed by-pass depends upon the arrangements for signage along the new route.

4.4.4. Along the R352 between the intersection with the realigned N18 and Corravarrin bridge

Both filling stations and shops will be positively impacted by the projected increase in traffic along this route.

The Roslevan Hotel may also be impacted positively by the increase in passing traffic.

Although the road is well aligned along most of its route, six houses fronting directly onto or very close to the road will suffer a decrease in residential amenity as a result of increased traffic volume.

There will be no demolitions along this route, and no negative economic impacts.

5. POSSIBLE SHIFTS IN LAND-USE AND DEVELOPMENT PATTERNS WITH RESULTANT IMPACTS ON HUMAN BEINGS AND MATERIAL ASSETS.

5.1. Pattern of residential development within Ennis and the surrounding settlements

The railway line running to the east of the N18 currently forms the boundary of residential development on this side of Ennis town. In the light of the present demand for houses it is postulated that the new by-pass, which is positioned to the east of the railway line, will form a new natural boundary for future residential development around Ennis. Current trends in house prices have already forced first time buyers to move further from Ennis town in the search for affordable houses. In particular, it is thought that the Bog Road, which runs parallel to the N18, will experience pressure for development. There is already a considerable number of single dwellings along this and other roads in the vicinity.

The new by-pass may also encourage commuters to locate in Clarecastle due to the ease of access onto the new route via the Western Relief Road. The shortage of developable land within Ennis will further exacerbate the pressure upon Clarecastle. According to the 1988 Clare County Council Development Plan, Clarecastle is classified as an area experiencing a high threshold of development pressure.

Other high accessibility areas located on link roads to the proposed by-pass such as the R352 which is the Tulla Road and the R469 which is the Quin Road will also experience pressure for residential development. Commuters will be drawn to these locations due to the reduction in travel times which the new route will offer. However, the extent of development will be constrained in these areas due to the propensity to local flooding.

5.2. Pattern of industrial development within Ennis town and the surrounding settlements

There is currently a large industrial estate on the N18 North of Ennis and a smaller business park which caters for the repair of motor vehicles located on the R474. When the Ennis Urban District Plan was published in 1992 the industrial sector utilised a total of 17 hectares out of a total of 517 hectares in the urban area as a whole. However, the 1992 Plan rezoned an extra 74 hectares of land to encourage further industrial development. While these industrial zones are already in highly accessible areas in County Clare beside the N18 and a national freight and passenger rail line, the advent of the proposed by-pass will undoubtedly become a focus for future industrial development. For many industries the visibility of the company logo from a national primary route is a form of advertisement.

The current demand for an office park in Ennis will receive an additional injection if the proposed by-pass is constructed. The junctions of motorways often act as a focal point for this type of land use as it is an attractive location in terms of access to a large consumer market.

The construction of the by-pass will exert pressure on Ennis Urban District Council to rezone land beside the new route for industry and offices uses. The intersection near the N68 to Kilrush on the Western Relief Road is a suitable location for such land uses as heavy goods traffic will not need to pass through Ennis.

5.3. Growth of Ennis

Ennis will be the settlement most impacted in the long term by the new road construction and consequent traffic reassignments. Commuting currently takes place from Ennis to Newmarket-on-Fergus, Limerick and Shannon, and as the residential amenity of the town is enhanced by the removal of through traffic, it is likely to be an increasingly favoured location for new residential development. According to the 1992 origin and destination survey, one fifth of the daily traffic wishes to by-pass the town.

According to the Ennis Urban District Plan 1992, the aim of the council is to cater for the most efficient traffic movement possible, while not imposing an undue pressure on the environment nor losing the scale and character of the town. It is critical, in order to ensure that the town's central role in the region is maintained, that the issue of congestion is tackled. The construction of the proposed by-pass will eradicate unnecessary through traffic and will thereby transform the town into a pedestrian friendly and pollution free environment. Though there may be concerns about the impacts on local trade, research illustrates that the business of commercial and retail outlets is significantly improved as tourists and shoppers are encouraged to linger in an attractive and highly accessible town.

5.4. Changes in sub-regional shopping patterns

Typically the construction of a by-pass increases the attractiveness of an area to the large shopping multiples. Unfortunately, they often draw trade from the core of the town by locating at an interchange on the new route. However, this is unlikely to occur in Ennis for a number of reasons. The presence of a number of high quality goods outlets in the town ensure that the consumer market will remain. Furthermore, the strength of the commercial centre of Ennis will deter large shopping developments from locating at interchanges along the by-pass, rather it is likely that such enterprises would wish to operate close to the core, where outlets currently include Dunnes Stores (65,000 sq.ft.), Quinnsworth (35,000 sq.ft.) and Pennys. This is reflected in the objective of Quinnsworth who aim to expand and extend on their current premises in the foreseeable future. In addition, the policy of Ennis Urban District Council is to prohibit new development from locating in a manner that would cause undue damage to the existing commercial shopping areas of the town. Such developments will be encouraged to locate within the commercial core of the town.

5.5. Changes in the recreational facilities of Ennis

Ennis is currently lacking in adequate leisure and recreational facilities. The construction of the proposed by-pass will inevitably encourage the development of such facilities as the new route will broaden the market base of the town. Customers will be attracted to Ennis from settlements as far as six to ten miles away as the distance time will be reduced due to the by-pass, therefore encouraging them to avail of the town's range of activities.

5.6. *Justification for the mid-route junction with the R352*

The socio-economic factors which justify the construction of a third junction on the N18 to serve Ennis, may be set out as follows:

- The road gives direct access to Ennis shopping centres from East Clare, with a resultant considerable reduction in traffic congestion
- The access road to the centre of town is well aligned and is capable of taking a considerable increase in the volume of traffic
- It is less intensively developed and better aligned than some other radials: impacts on residences on the route will be limited in scope and intensity
- Access from Limerick to the Northern portion of the town will be considerably enhanced: without it, there would be over-use of the old bog road and/or congestion in the centre of Ennis
- It gives further general access to the east of the town, which, as a result of the realignment of the N18, is now an area suitable for development in support of the balanced development of Ennis
- It gives direct access to the industrial estate on the Northern fringes of the town, as well as to Our Lady's Hospital and the GAA stadium

6. Construction Impact

The cost of the scheme is £57.3 million.

The major direct environmental impacts of construction activity relate to air, noise, light and traffic. These are dealt with in the relevant sections of the EIS.

Other environmental impacts may be mediated through the economic system, in particular the impact on the extraction of aggregates and impacts arising from recruitment of labour and associated infrastructural requirements such as housing and schools.

Given the limited duration of the work programme and the proximity of Limerick city, all such impacts are likely not to be significant in the context of ongoing construction and other economic activity in the region.

7. Likely significant direct and/or indirect interactions

In accordance with Section 50(2) (c)(iii) of the Roads Act, 1993, the matrix below sets out the interaction between the relevant environmental matters listed in Sections 50(2) (c)(i) and (ii).

Interaction between human beings and:	
Human Beings	
Fauna	None
Flora	None
Soil	None
Water	None
Air	Changed air quality likely to influence settlement patterns along the route of the road
Climate	None
Landscape	Changed landscape patterns likely to influence settlement patterns along the route of the road
Material Assets	Changed residential amenity may impact on house values in either direction

8. MITIGATION

The following actions should be taken by way of mitigation:

Control of housing developments outside of Ennis town

It is already the policy of Clare County Council to restrict development outside of the Development Centres with certain specified exceptions relating to the accommodation of farmers and their sons, in-fill sites and subdivision of dwelling plots, as well as the redeveloping the existing sites. Specifically it is a policy to prohibit development which would be likely to give rise to ribbon development in rural areas whether in itself or by the effect of it being added to existing development.

A number of national and regional roads are likely to experience increased pressure for the development of single houses as a result either of a reduction of flows along them or their enhanced access to Ennis, Limerick and Shannon arising from their location in proximity to proposed junctions with the by-pass and the Western Relief Road. These roads are as follows:

- Clarecastle and the surrounding area.
- Regional routes in the vicinity of the R469 junction and the R352 interchange.

Existing planning control policies in relation to these vulnerable areas, should be maintained.

While Ennis U.D.C. currently have no policy in relation to access points for housing developments or in relation to single dwellings, this will be reviewed in the compilation of information for the next development plan.

Signage of Bed and Breakfast and Hotel facilities from the new route

A considerable number of Bed and Breakfast establishments and the accompanying signage will now find themselves divorced from the main flow of through-traffic with the construction of the new route. Origin and destination surveys have illustrated that only one fifth of the vehicle traffic in the town wish to bypass Ennis. Therefore the other four-fifths of the visitor traffic is likely to continue to use Ennis as a tourist base or destination. In addition, discussion will be entered in to with local interest groups in order to establish an acceptable form of generic signage on the by-pass which will divert traffic that is seeking overnight accommodation-but without specifying the names of the establishments. Such signage should be in the vicinity of existing junctions.

Retaining the Rocky Road Public Amenity Walk

The construction of an overpass pedestrian bridge for the Western Relief Road will ensure that the locals and visitors alike can continue to use this natural amenity. The requirement for this cannot be established until proposed pedestrian surveys have been completed.

Development at Junctions

A set of guidelines should be issued by both Ennis U.D.C. and Clare County Council as to the type of development which will be permitted at the junctions of both the by-pass and the Western Relief Road. This would be helpful particularly in the case of petrol stations who may have to relocate due to the decrease in passing trade.

9. Non-technical summary

Route Corridor Selection

This EIS has examined in detail, Option D of four options originally chosen. Of the four options presented, option D is third on socio-economic grounds, based on a scoring scheme adopted in this report. It comes equal first in terms of broad impacts, but equal last in terms of site specific impacts. *However, if the impacts of the new route development are isolated, it scores second in both specific impacts and broad impacts, just one point above Option C.*

The following comments may be made:

- There is a greater length of road to be constructed under Option D, and therefore the impact of this option is likely to be greater for this reason alone,
- Though the negative impact on economic activity will be greater when more roads are constructed, because more traffic will be diverted, the impact on the town centre cannot be computed. This may have the impact of offsetting this tendency
- Option C, because it takes a wider route, is likely to be less disruptive in general
- Because the main line is to be built to the East, and a distributor road is to be built to the West, Option D provides the best chance of balanced development for the town.

In summary, in socio-economic terms, routes B and C are the most favourable, since they are furthest from built form and therefore site specific impacts are likely to be less. However, if the level of specific impact is acceptable on foot of the detailed examination which is contained in this report, then Option D provides the best opportunity or balanced development and quality of life in Ennis.

Caution should be exercised in interpreting results set out above, since they are the results of a desk study only.

Impacts of the chosen route: site specific

Along the N18 by-pass route the following dwellings L7144 will suffer some loss of residential amenity

- At the crossing point with the L7144 (two)
- East of the crossing of the L4114, as a result of the construction of an access road (one)
- On the R469, about 40 m from the new line (one)

Some households in dwellings on the L4114 will be severed from the church at Doora.

A farm dwelling and associated outbuildings will be demolished at the intersection with the Balymacahill Road.

Along the route of the Ennis Western Relief Road, impacts will relate to junctions with existing routes, which are discussed below.

On the route of the existing N18, there will be an increase in the residential amenity of existing dwellings, as a result of the reduction of traffic flows. Local services will be unaffected by the reduction in traffic flow and bed and breakfast establishments on the route or signed from it may suffer a reduction in passing trade.

On the existing N18 within Clarecastle, two antique shops may suffer a reduction in trade, but in general the trading environment will improve in the long run.

On the existing N18 from Clarecastle to Ennis, one filling station and several B & B establishment may suffer some loss of business.

Within Ennis, residential amenity and the trading environment will both improve, though filling stations are likely to experience some reduction in trade.

On the existing N18 between Ennis and Barefield, and within Barefield itself, residential amenity will be enhanced, though B & B establishments along the route will be negatively impactsed, as will a shop in Barefield itself.

Some pupils attending Barefield National School and walking or cycling, will be severed from the school by the rerouting of the L4076. A further element of social severance will occur for the same reason, as two nearby dwellings occupied by different generations of the same extended family will be severed from each other.

On the existing N68 from Kilrush to Ennis within the Relief Road, residential amenity will be enhanced with the reduction in noise and vehicle traffic, but a local amenity walking route (the Rocky Road) will be severed. Two filling stations may have trade impacted.

On the Existing N85 from Ennis to Ennistymon within the Relief Road, residential amenity will be improved as a result of a net reduction of traffic. No commercial activities are likely to be significantly impacted.

On the Existing R474 from Ennis to Miltown Malbay, besides a reduction in vehicle traffic, the principal impact along this route will relate to the required relocation of the settled halting site near the intersection with the proposed Western Relief Road.

As economic uses along this stretch of the R474 gain most of their custom from local residents, the effect on trade is likely to be minimal. However, Bed and Breakfast establishments fronting onto the Miltown Malbay Road may suffer a decrease in custom.

Along the R352 between the intersection with the realigned N18 and Corravarrin bridge, both filling stations and shops will be positively impacted by the projected increase in traffic. The Roslevan Hotel may also be impacted positively by the increase in passing traffic.

Six houses fronting directly onto or very close to the road will suffer a decrease in residential amenity as a result of increased traffic volume.

Impacts of the chosen route: broader impacts

Examining the broader impacts, the N18 by-pass is likely to replace the railway line as the eastern boundary of development of the town. The Bog Road, in particular, may experience pressure for development. There may be additional pressure for development in Clarecastle as well as other high accessibility areas on link roads to the proposed by-pass.

The by-pass may become a focus for future industrial development and possibly an office park, with consequent pressure to rezone land for this purpose.

The growth of Ennis town will be facilitated by enhancing access and reducing congestion.

Examination of zoning policies and existing market conditions suggests that the by-pass is unlikely of itself to result in the development of out of town shopping. It may increase the draw of Ennis as a centre for shopping recreation.

The mid-route junction with the R352 may be justified on the grounds that it gives direct access to existing shopping facilities from East Clare. The road is relatively well aligned and is less developed than some other radial routes. It will also facilitate access to housing and industry in North Ennis, as well as hospitals and sports facilities. Finally, it enhances access to development land to the East of Ennis, which is required for the balanced development of the town.

Construction Impact

There will be no significant identifiable impact on human beings or material assets as a result of the required construction work.

The following mitigation measures are recommended:

Retention of existing planning control policies on vulnerable roads in proximity to national route junctions and elsewhere, where additional development pressure is likely to be experienced.

Signage scheme from national routes to B&B and other accommodation. Discussion should be entered in to with local interest groups in order to establish an acceptable form of generic signage on the by-pass which will divert traffic that is seeking overnight accommodation-but without specifying the names of the establishments. Such signage should be in the vicinity of existing junctions.

Retaining the Rocky Road Public Amenity Walk: consideration should be given to the construction of an overpass pedestrian bridge for the Western Relief Road. However, the requirement for this cannot be established until proposed pedestrian surveys have been completed.

Development at Junctions: A set of guidelines should be issued by both Ennis U.D.C. and Clare County Council as to the type of development which will be permitted at the junctions of both the by-pass and the Western Relief Road. This would be helpful particularly in the case of petrol stations who may have to relocate due to the decrease in passing trade.

APPENDIX III

FLORA & FAUNA

PART A	**FLORA & FAUNA ASSESSMENT (RPS Cairns Ltd.)**
PART B	**BAT SURVEY (Brian Keeley and Donna Mullen)**
PART C	**SURVEY OF FEN BEDSTRAW POPULATION AT KILLOW, ENNIS, CO. CLARE (RPS Consultants Ltd.)**

APPENDIX III – PART A

FLORA & FAUNA ASSESSMENT (RPS Cairns Ltd.)

ENNIS BYPASS

ENVIRONMENTAL IMPACT STATEMENT

FLORA AND FAUNA ASSESSMENT

SEPTEMBER 1999

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This report has been prepared by RPS Cairns Ltd

REPORT NUMBER	**IR527/4**
STATUS OF REPORT:	**Revision 2**
DATE OF REPORT:	**07 September 1999**
PROJECT MANAGER:	**Tom Gittings**

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NON-TECHNICAL SUMMARY

The route corridor of the Ennis Bypass contains a high proportion of semi-natural habitat, some of which is of very high quality. The proposed route will not directly affect any proposed Natural Heritage Areas, proposed Special Areas of Conservation, designated Special Protection Areas, or known populations of protected plant species. The scheme will, however, have a number of significant ecological impacts. These will result from both direct removal of habitat, and indirect impacts such as hydrological changes, air pollution and habitat fragmentation/barrier effects. While there is considerable uncertainty involved in the prediction of some of these impacts, the most significant likely impacts are:

- impacts to fen habitat, limestone pavement, notable plant and invertebrate species in a large complex of wetland and calcareous habitats at Kilbreckan/Skehanagh/Killow.
- impacts to species-rich calcareous grassland with notable plant and invertebrate species in an old quarry at Ballybeg.
- removal of one maternity roost and three night roosts for Lesser Horseshoe bats.

A number of mitigation measures can be adopted which may reduce, but eliminate these impacts. These include:

- preserving, as far as possible, the existing hydrological regime where the road crosses important wetland sites.
- planting dense scrub along road embankments to screen sensitive habitats from air pollution impacts.
- using native-origin plant species in any landscape planting in the vicinity of areas of ecological constraint.
- providing wildlife underpasses for Otters and Pine Martens.
- construction of purpose-built bat roosts.
- translocation of affected populations of nationally scarce plant species.

1. INTRODUCTION

1.1. BRIEF

RPS Cairns have been commissioned by Clare County Council to prepare the flora, fauna and water quality sections of the Environmental Impact Statement (EIS) for the proposed Ennis Bypass. This report presents the results of the flora and fauna assessment. The water quality and fisheries assessment is presented in a separate report.

1.2. STUDY TEAM

This report was prepared by Dr Tom Gittings of RPS Cairns. Specialist contributions to this assessment were made as follows:

Botany	Tony O'Mahony (BSBI Recorder for Co. Cork), with assistance from Dr Tom Gittings (RPS Cairns)
Entomology	Ken Bond (Department of Zoology and Animal Ecology)
Birds	Dr Tom Gittings and Dr Paul O'Donoghue (RPS Cairns)
Terrestrial Mammals	Dr Liam O'Sullivan (Mammalogist)
Bats	Brian Keeley (Mammalogist) and Dr Paul O'Donoghue (RPS Cairns)

2. METHODOLOGY

2.1. INTRODUCTION

The scope and methodology used for this assessment are based upon the recommendations of the Institute of Environmental Assessment's *Guidelines for Baseline Ecological Assessment* (IEA, 1995). The assessments satisfy the requirements of the Environmental Protection Agency's *Draft Guidelines on the Information to be Contained in Environmental Impact Statements* and *Advice Notes on Current Practise (in the preparation of Environmental Impact Statements)* (EPA, 1995a, b).

The basis for the assessment was a habitat survey of the entire route corridor. This allowed identification of areas of potential ecological value (areas of ecological constraint). These areas were then targeted for more detailed surveys of specific groups of flora and fauna.

Additional information was also obtained by review of the relevant technical literature and consultations with relevant organisations and specialists.

Details of the specific methodologies used for individual sections of this assessment are provided below.

Scientific names of plants and animals mentioned in the text are listed in Appendices 1, 2 and 4.

2.2. FIELD SURVEY

2.2.1. Habitats

The study corridor was defined as a 500 m wide band centred on the line of the proposed route. This width was chosen to allow for some assessment of indirect impacts such as habitat fragmentation (Kirby, 1995) and noise impacts (Reijnen *et al.*, 1995). This width should also be sufficient to allow for any modifications to the proposed route. However, where the 500 m corridor extends across an existing main road, the study corridor boundary was taken as the centreline of the main road, as the main road will already have effectively fragmented any semi-natural habitat across it.

A phase 1 habitat survey was carried out within this study corridor using the methodology of JNCC (1993). The survey was carried out between 22 and 30 April 1998. Where associated link roads extend outside the 500 m corridor, the habitat survey was extended to cover areas directly impacted by these link roads.

2.2.2. Vegetation

Following evaluation of the results of the habitat surveys, a number of sites were selected for more detailed botanical surveys. These comprised sections of Areas of Ecological Constraint (AECs) numbers 3, 4, 6, 7, 10, 11, 13, 14, 15 and 17. AECs 2, 9 and 12 were not surveyed as they are outside the line of the proposed route. AECs 1, 5, 8 and 16 were not surveyed as they represent locally common habitat types of low botanical potential. These surveys were carried out between July and September 1998.

A specific survey of the Fen Bedstraw population in sub-site 3/6 was carried out on 27 August 1999 in order to map the distribution of the plant in relation to the alignment of the proposed route (see RPS Consultants Report No. IR527/6).

2.2.3. Lepidoptera

Based on the results of the habitat survey, eight sites along the proposed route of the Ennis by-pass and the link road through Clareabbey were selected for entomological survey. These sites were located in three of the areas of ecological constraint (AECs 3, 10 and 14) which were considered to have the greatest potential for lepidoptera. Observations from some additional sites which are close to the study area, are also included for completeness.

The details of sites, dates, etc. are provided in Appendix 2. The sites were visited on several occasions between late May and the end of August 1998. Light-trapping using a mercury-vapour trap was used twice in AEC 3, and once at AEC 10. Daytime recording included netting of specimens and observations of adults and larvae. Fieldwork was adversely affected by unfavourable weather, especially during June and July, and the total number of species recorded is therefore an inadequate reflection of the true number present.

2.2.4. Birds

Notes were made of all birds observed during the course of habitat surveys of the entire route corridor during 22 to 30 April 1998. Additional observations were made during survey work in May, July, August, September and November 1998. A general assessment of the habitat potential for birds was also made.

2.2.5. Terrestrial Mammals

For the purposes of the survey a total of 18 representative sites along the routes were selected for examination, ten sites on the main bypass route (east of Ennis) and eight sites on the southern/western bypass (south of Ennis). These sites are shown in Fig. 3. The survey included:

- A field survey of mammal signs.
- An assessment of the existing habitat value to mammals.
- An assessment of the existing level of habitat management and proposed development impact.
- Consultation with the National Parks and Wildlife.

2.2.6. Bats

The assessment was carried out in two stages:

1. a general assessment of the route corridor in August 1998.
2. a more detailed survey of the Lesser Horseshoe bat population using roost sites in the Knockanean and Knockaskibbole area in July 1999.

1998 Survey

The assessment focused on trying to identify the significance for bats of buildings which may be demolished for the route of the Ennis Bypass. A general assessment of effects on feeding (or commuting to feed) was also made.

The survey used the following equipment:

- Eco-Tranquility time expansion and heterodyne bat detector
- Batbox III heterodyne bat detector
- Petzl headlamp
- Cassette Recorder and lead
- PC with sound analysis software (Cool and Gram-shareware)

The study was undertaken on 19-22 August 1998 and involved observations made in and around buildings proposed for demolition throughout the night and also daytime examinations for signs of bat usage (where access was possible). Some observations on feeding within the area and nearby roost sites were made. Bats were identified by flight pattern in conjunction with ultrasonic signals. PC sound analysis was used where a need for further clarification of identification was required. In some situations, bats were seen at rest within buildings. Weather conditions ranged from mild and dry (19 August) to heavy rains clearing to dryness by dawn (20 to 21 August). Bat activity was noted during dry conditions and to a lesser extent during light rain.

Follow-up visits were made in November 1998 and January 1999 to check buildings for hibernating bats.

July 1999 Survey

The aim of this survey was to identify the species present at Knockanean and at nearby buildings at Knockaskibbole, to identify the flight paths of the lesser horseshoes and to establish their likely feeding range. It also sought to estimate the numbers of bats utilising each site.

The roosts were observed from July 1st to July 31st and from August 1st to August 2nd, 1999 by two trained batworkers. Counts were made on the roost-sites for the Lesser horseshoes only and by one individual. This was done on July 1st and 2nd and on July 29th and 30th to account for any increase due to reproduction. Identification of other species present was made but no overall numbers were deemed necessary.

Determination of feeding routes was only possible by a laborious attempt to follow the bats from the time that they emerged from the roost to the point where feeding was noted. This was done by two batworkers on July 3rd and 4th and from July 21st to August 2nd.

Full details of this survey are provided in a separate report (RPS Consultants Report No. IR527/5).

2.3. EVALUATION

The results of the baseline surveys were evaluated to determine the significance of the features located in the route corridor on an importance scale ranging from international-national-county-district importance to local value to insignificant. District importance relates, approximately, to a scale of one 10 km square.

It should be noted that there are no standard criteria for evaluating the importance of ecological features in Ireland and any evaluation of the type presented below has to be considered provisional. Furthermore, this evaluation may be biased by the fact that some groups of flora and fauna have been studied in more detail than other groups.

2.4. ASSESSMENT OF IMPACTS

The impact of direct physical land-take was quantified by overlaying the proposed route on the habitat plan. Indirect impacts such as those relating to habitat fragmentation, water quality and disturbance, were assessed in a qualitative manner based upon available information from relevant technical literature, in particular PAA (1993), DoT (1994), ERM (1996), Forman and Alexander (1998), Spellerberg (1998) and Treweek (1999).

The significance of impacts was assessed on a combined basis of the value of the feature being affected (see Section 2.3 above) and the magnitude of the impact. Impacts on features of less than local value are not considered to be potentially significant. The terminology used to define impact significance is defined in Appendix 5.

3. EXISTING ENVIRONMENT

3.1. REVIEW OF EXISTING INFORMATION

The Regional Manager of the National Parks and Wildlife (Duchas The Heritage Service; NPW), the BSBI Recorder for County Clare and Birdwatch Ireland were all consulted, but did not express any specific concerns in relation to the proposed scheme (with the exception of the bat roosts discovered during the course of the survey work for the EIS).

No designated sites occur in the line of the proposed route. However, several proposed Natural Heritage Areas (pNHAs) occur closely adjoining the route (see Table 3.1) and include one site which has been designated as a Special Protection Area under the Birds Directive (79/409/EEC). One of these pNHAs (Cahircalla Wood) just extends into the route corridor.

TABLE 3.1 Proposed Natural Heritage Areas within two kilometres of the proposed route of the Ennis Bypass. The descriptions are based on the information in the NHA site synopses.

Site Code	Site Name	Description	Distance from proposed route
0014	Ballyiallia Lake	Base-rich lakes and fen; nationally important for wildfowl	2 km
0061	Newpark House (Ennis)	Nationally important nursery roost for Lesser Horseshoe bats	1.3 km
1001	Cahircalla Wood	Ash woodland with scrub, wet woodland and limestone pavement	0.2 km
0037	Pouladatig Cave (Ennis)	Internationally important hibernation roost for Lesser Horseshoe bats	1.3 km
2091	Newhall and Edenvale Complex	Internationally important nursery and hibernation roosts for Lesser Horseshoe bats, with surrounding mixed woodlands, parkland and lakes	1 km
2048	Fergus Estuary & Inner Shannon, North Shore	Estuarine complex (mudflats, reedbeds, swamps, salt marsh and wet marsh); internationally important for wildfowl; rare plant species. **Designated SPA**	0.04 km
1008	Dromoland Lough	Lake and marsh with diverse flora	0.6 km

In addition to the bat roost at Newpark House, several other bat roosts were known from the Ennis area, prior to the start of survey work for this EIS. However, based on information available to date (C. McGuire, NPW, and K. McAney, Vincent Wildlife Trust, personal communications), none of these roosts will be directly affected by the proposed route.

3.2. HABITAT DESCRIPTIONS

The study corridor contains a varied mix of habitats, including a good range of semi-natural habitats. Figure 1 shows the distribution of semi-natural habitat (excluding hedgerows) in the study corridor; these have been identified as sites of ecological constraint (see Section 2.4 below).

3.2.1. Rivers and watercourses

Three rivers occur in the study corridor: Latoon Creek (AEC 1), the River Fergus (AEC 4) and the Inch or Claureen River (AEC 16). Latoon Creek and the River Fergus are tidal creeks within the study corridor with the adjoining flood plains being protected from tidal flooding by flood embankments. Narrow strips of floodplain within these embankments hold species-poor saltmarsh along Latoon Creek and marginal strips of Common Reed and Greater Pond-sedge swamp along

the River Fergus. The Inch or Claureen River within the study corridor is a slow-flowing, deep river with heavily shaded banks.

Numerous small streams and field drains also occur within the study corridor. These have generally been modified for field drainage and are slow-flowing with heavy growth of aquatic plants. Some of the drains through the wet modified bog and marshy grasslands in the floodplain of the River Fergus hold rich assemblages of aquatic plants.

3.2.2. Lakes and ponds

Several small loughs occur within the study corridor: Cappagh Lough, an unnamed lough to the north of Cappagh Lough, Ballymachill Lough and Kilbreckan Lough. These loughs vary in size from 0.4 to 3 ha. They are generally fringed by small areas of reed or sedge swamp usually comprising Common Reed and/or Great Fen-sedge. None of these loughs are directly affected by the proposed route.

Six field ponds occur within the study corridor. These differ from the loughs in that they have steeply sloping banks and lack marginal marsh or fen. Therefore, they are accessible to grazing stock and consequently have heavily poached margins and usually very limited aquatic flora. Three of these ponds will be affected by the proposed route.

3.2.3. Wetlands

A number of different types of wetland habitat occur within the study corridor. As discussed above, the loughs are fringed by reed or sedge swamp. At the unnamed lough in AEC 10, the Common Reed swamp gives way to a swamp with Bottle Sedge and Water Horsetail dominated vegetation. Areas of fen or transitional fen vegetation occur in AECs 3, 6, 7 and 11. The fens are generally backed by species-rich marshy grassland often characterised by high cover of small sedges and/or Purple Moor-grass. This latter habitat-type is quite widespread within the study corridor, with the most extensive areas occurring on peaty soils along the floodplain of the River Fergus (see below). As the pastures become drier and/or more heavily grazed with mineral soils, unimproved or semi-improved wet neutral grassland becomes frequent, this habitat being characterised by the dominance of Soft Rush/Hard Rush and lower overall species diversity with sedges becoming rare.

Extensive areas of wet modified bog occur on deep peat along the floodplain of the River Fergus (AEC 3). These are characterised by Purple Moor-grass dominated vegetation with patches of Bog Myrtle creating a distinctive appearance. Some of these bogs have been recently planted up with conifers or broadleaves. The wet modified bog is intermixed with marshy grasslands with variable mixtures of Purple Moor-grass, sedges and rushes on peaty mineral soils (fen meadows).

3.2.4. Dry grassland

The study corridor lies over limestone bedrock. Consequently, the grassland flora often shows calcareous influences. Unimproved calcareous grassland occurs in small patches widely scattered through the route corridor. These grasslands are very rocky with a diverse flora including many herbs such as Cowslip, Carline Thistle, Lady's Bedstraw, Common Milkwort and Early Purple Orchid. Some of these grasslands also hold numerous anthills. Other unimproved dry grasslands in the route corridor lack obvious calcareous species and are classified as unimproved neutral grassland (e.g. sub-site 6/2). Where the pastures have been improved, the fields have been cleared

of rocks. Some of these fields which have not been intensively grazed or fertilised retain elements of the unimproved flora, with Cowslip being a visually prominent indicator of such semi-improved grasslands. However, the majority of dry grasslands in the study corridor comprise improved grassland which have been subject to intensive grazing, fertilising and/or reseeding. These grasslands have a species-poor flora dominated by agricultural species.

3.2.5. Limestone pavement

This habitat, which is a typical feature of the Burren region, comprises very distinctive outcrops of near horizontal bare limestone, cut by deep, semi-regular, fissures (grikes). A diverse flora occurs within the grikes including Juniper, Bloody Cranesbill, Burnet Rose and Mountain Everlasting. While limestone outcrops are widespread within the study corridor, the vast majority are covered by Hazel scrubwood (see below) with open limestone pavement being restricted to a few small patches in AECs 3, 10 and 14.

3.2.6. Scrub and woodland

The predominant form of wooded vegetation within the study corridor is Hazel scrubwood. This covers extensive areas, particularly in Ballyduff, Knockanean and Ballybeg townlands, with smaller fragments scattered throughout the route corridor. This habitat comprises a canopy of mature Hazel around five metres tall with a scattering of Ash. At the western end of scrubwood in Ballybeg townland (AEC 14) the Ash becomes semi-dominant, while mature Ash woods occur on the fringes of the study corridor in this area. Mixed scrubwood with Hawthorn, Blackthorn and Hazel co-dominant occurs at the eastern end of the Ballybeg scrubwood while a Hawthorn dominated scrubwood occurs in Kilbreckan townland (AEC 5).

3.2.7. Field boundaries

Hedgerows comprise the dominant form of field boundary but with drystone walls frequent, especially in the drier areas. Typically the hedgerows comprise tall, bushy Hawthorn dominated hedgerows. Hazel dominated hedgerows occur in places where fields have been cleared of Hazel scrubwood. Ash is the commonest hedgerow tree species, with a little Beech, Sycamore and Horse-chestnut, and with other species very scarce.

3.3. AREAS OF ECOLOGICAL CONSTRAINT

3.3.1. Criteria for identification of ecological constraints

In Section 3.2, individual habitat types were described in isolation. However, in practise, the semi-natural habitats generally occur in mosaics and/or transitions reflecting varying conditions of topography, drainage, soils and human interference. In this section areas of ecological constraint (AECs) are identified which include both habitats of high individual value and habitat complexes whose value is enhanced by the presence of several different semi-natural habitat types in close proximity. These ecological constraints are shown on Figure 2 and are the focus for the more detailed survey work in Sections 3.4-3.8 of this report.

The areas of ecological constraint include all areas of semi-natural habitat in the route corridor, with the following exceptions:

- small patches of Hazel scrubwood, and other scrub types.

- *Holco-Juncetum* wet neutral grasslands (Rodwell, 1992) - this vegetation type is generally considered to be of low conservation importance (JNCC, 1995).
- hedgerows and other field boundary vegetation.
- field ponds.
- wet modified bog which has been planted with conifers.

The sites are briefly described below under their respective provisional grades. The sites are generally named by townland; this only intended to give an approximate indication of their locations (which are shown more accurately in Figure 2).

3.3.2. Site Descriptions

AEC 1: Latoon Creek

This AEC is a tidal creek which runs off the upper Fergus Estuary to eventually become the Ardsollus River. The section of the creek to the west of the existing N18 forms part of the Shannon and Fergus Estuary Special Protection Area (SPA), but the SPA does not extend into the study area. Within the study area, the creek is approximately 30 m wide, with narrow, steeply shelving mudbanks and a narrow, patchy fringe of *Phragmites*. The banks of the creek hold narrow strips of species-poor saltmarsh, enclosed by tall embankments.

AEC 2: Carrowgar

This AEC lies at the upper end of a shallow valley and consists of sedge-rich marshy grassland along the narrow gently sloping valley floor, which extends up to a small patch of Alder woodland just outside the study area. The valley widens and levels out to the east holding extensive areas of *Holco-Juncetum* wet neutral grassland, which are not included in this AEC (see above).

AEC 3: Kilbreckan/Skehanagh/Killow

This AEC comprises an extensive and diverse area of continuous semi-natural habitat. It occupies around 80 ha within the study area, with extensive contiguous areas outside. The habitats present include limestone pavement, unimproved calcareous grassland, marshy grassland, wet modified bog and fen. The AEC is divided by a number of roads and tracks into sections which are described below.

AEC 3a: Kilbreckan/Skehanagh/Killow South

This section comprises sedge-rich, marshy grassland and wet modified bog. The latter extends for a considerable distance to the east of the study area.

AEC 3b: Kilbreckan/Skehanagh/Killow East

This is the largest of the sections (at around 32 ha) and includes the most diverse range of habitats. Much of the sub-site is low-lying and occupied by a complex mixture of wet modified bog, fen and sedge-rich marshy grassland. The steep hillside along the eastern boundary of the sub-site holds a few remnant areas of limestone pavement, although most of the fields on this hillside have been cleared and reseeded. The gentle undulating ground in the southern part of the site holds quite an extensive area of unimproved calcareous grassland. Kilbreckan Lough, a small lake (approx. 0.85 ha) surrounded by marginal Great Fen-sedge, occurs in the northern part of the sub-site.

AEC 3c: Kilbreckan/Skehanagh/Killow Central

This section is separated from the previous section by a minor road on a raised embankment, and comprises part of an extensive area of drained bog. It is divided into a number of compartments by drainage ditches. The western part of this section comprises wet modified bog, dominated by Purple Moor-grass with frequent patches of Bog Myrtle. Old peat cuttings add variety in the form of bog pool habitats. In the eastern part of this section the dominant habitat is sedge-rich marshy grassland.

AEC 3d: Kilbreckan/Skehanagh/Killow West

This section is separated from the previous section by a dirt track on a raised embankment, and comprises mainly marshy grassland. An area of Hawthorn scrub and calcareous grassland occurs on a rock outcrop in the southern part of the sub-site. To the north and south of this section, extensive areas of drained bog occur. These have recently been planted with conifers and are, therefore, excluded from the AEC.

AEC 4: River Fergus

This AEC is a tidal section of the River Fergus around 1 km upstream of the existing N18. In this section, the river is around 20-30 m wide. The banks hold a 20 m wide strip of marginal Common Reed and Greater Pond-sedge, enclosed by tall embankments. The immediately adjoining fields on either bank are improved grassland: on the eastern side, the AEC is separated from AEC 3d by a c. 100 m wide strip of improved grassland.

AEC 5: Kilbreckan North

This AEC comprises around 2.5 ha of Hawthorn dominated scrubwood and an adjoining 0.5 ha pond. The pond is heavily cattle poached around its margins and lacks any significant marginal vegetation; it is included within this AEC because of its proximity to the scrubwood.

AEC 6: Knockaskibbole

This AEC contains a number of different habitats. The eastern part of the AEC comprises a small valley with fen and marshy grassland along its narrow floor and patches of unimproved dry neutral grassland on its sides. This valley feeds into an extensive area of wet modified bog, most of which, however, is outside the study corridor, extending up to Gaurus lake to the north-west. The south-western portion of the AEC is an old quarry which contains numerous marshy pools and patches of calcareous grassland.

AEC 7: Knockanean

Despite evidence of considerable recent habitat clearance, this AEC still contains an extensive area of Hazel scrubwood and unimproved calcareous grassland. The southern part of the AEC holds some marshy grassland and fen which is also being degraded by agricultural improvement.

AEC 8: Ballymacahill South

This AEC lies in a narrow steep-sided stream valley surrounded by large fields of improved grassland. Some patches of marshy grassland remain along the valley floor, with belts of Hazel scrubwood along the valley sides.

AEC 9: Ballymacahill Lough

This AEC comprises part of a 3 ha lough and associated marginal swamp (Great Fen-sedge and Common Reed) and adjoining marshy grassland. The majority of the lough lies outside the study corridor.

AEC 10: Cappagh/Ballyduff

This is another large AEC with a varied mix of habitats. The western part of the AEC comprises an extensive area of Hazel scrubwood which includes a section of limestone pavement along its western side. Parts of the scrubwood have, however, been recently cleared. The eastern part of the AEC contains a varied mix of wetland habitats along a narrow valley. These include two loughs: the 2.9 ha Cappagh Lough to the south and an un-named 0.4 ha lough to the north. The two loughs are quite contrasting in terms of their habitats. Cappagh Lough has open shorelines with an obvious draw-down zone and displays some features reminiscent of a turlough. In contrast, the northern lough has dense reedswamp around its margins. The two loughs are linked by a narrow stream which runs through marshy grassland, before entering an area of impeded drainage to the west of the northern lough where the vegetation changes to Water Horsetail-Bottle Sedge swamp.

AEC 11: Barefield

This AEC comprises a small (2 ha) patch of fen dominated by Water Horsetail, Bogbean and sedges with a small area of open water. Some reclamation has been carried out along its margins.

AEC 12: Ballymaconna

This AEC comprises an area of Hazel scrubwood and marshy grassland.

AEC 13: Clareabbey

This AEC comprises an area of marshy grassland intersected by several drainage ditches which is separated from the nearby River Fergus by a narrow ridge of higher ground.

AEC 14: Ballybeg/Cahircalla Beg

This is another large, complex AEC with a diverse mix of habitats. The dominant habitat is Hazel-dominated scrubwood. Towards, the east of the AEC, the Hawthorn and Blackthorn become co-dominant with Hazel, while towards the west of the AEC Ash becomes semi-dominant. Intermixed among the scrubwood are a few small patches of limestone pavement, and more extensive areas of unimproved calcareous grassland. The latter is especially associated with an old quarry site near the eastern end of the AEC. This quarry is sheltered by the surrounding scrubwood, with south-facing slopes, and, consequently, is of high entomological potential. Another quarry to the west has been abandoned more recently and, consequently, has a less species-rich calcareous flora. The western end of the AEC is formed by a small stream valley. The

eastern side of the stream holds a strip of marshy grassland; on the western side the grassland is a more species-poor *Holco-Juncetum* and is excluded from the AEC.

AEC 15: Cahircalla

This AEC comprises mainly Hazel and mixed-species scrubwood. However, its principal interest is formed by a small patch of Greater Tussock Sedge swamp and marshy grassland in the south-western part of the AEC.

AEC 16: Inch or Claureen River

This AEC comprises a small non-tidal river which is a tributary of the River Fergus. Within the study corridor, this river is c. 10 m wide, slow-flowing and deep. Its banks are generally heavily shaded by Alder-dominated treelines. The adjoining fields have been improved, so the river lacks a semi-natural riparian strip.

AEC 17: Claureen

This AEC contains two distinct, narrowly linked habitats. The western arm comprises Ash-dominated, semi-natural broadleaved woodland. This is linked, via a patch of willow carr, to a remnant area of species-rich marshy grassland. There has been recent habitat losses in this area to house building and the future of the remaining area of marshy grassland must be doubtful.

3.4. VEGETATION

Plant species lists for the sites surveyed are included in Appendix 1. English names used in the text follow Stace (1991). The sub-site locations are shown in Figure 1.

3.4.1. Survey Results

AEC 3 Kilbreckan/Skehanagh/Killow

The range of ecological habitats encompassed within the survey area were quite diverse, and included: fen-meadow, meadow/bog transition, flood-meadow, circum-neutral rushy pasture, drainage ditches, calcareous grassland, and Burren-type limestone pavement. As a consequence, the flora was rich and boasted a number of regionally/nationally rare species, such as: Dogwood, Juniper, Short-styled Field Rose (apparently new to the flora of Co. Clare), Fen Bedstraw, Frogbit and Great Water Dock, etc. Moreover, the minor road from Skehanagh to Gaurus held an 8 m stand of the nationally rare Spiked Sedge; this was located around 100 m to the south of the landtake of the western bypass.

Sub-site 3/1 Fen-meadow transition

Lying to the east of the byroad, this wetland grades from circum-neutral pasture on its margins, to rich fen-meadow, while beyond the ditch which bisects the meadow occur tiny outcroppings of limestone, which alternate with hummocky pockets of bog-type vegetation, making for an overall diverse floral assemblage.

Typical circum-neutral meadow species present in abundance are: Yorkshire Fog, Sweet Vernal Grass, Crested Dog's-tail, False Oat-Grass, Perennial Rye Grass, Red Fescue, Self-Heal, Cat's-ear,

White Clover, Red Clover, Ribwort Plantain, Meadow Buttercup and Lesser Knapweed, while paludal species include: Marsh Bedstraw, Marsh Bird's-foot-trefoil, Marsh Horsetail, together with taller species such as: Purple-loosestrife, Wild Angelica, Compact Rush, Hard Rush and Meadowsweet, which give way to sedge communities on the margins of the transverse ditch which bisects the site. Here occur Carnation Sedge, Glaucous Sedge, Oval Sedge, Tawny Sedge, Lesser Tussock Sedge and Slender Sedge, associated with: Blunt-flowered Rush, Meadow Thistle, Water Horsetail, Quaking Grass, etc. The ditch itself is carpeted with floating mats of Creeping Bent, while Reed Canary-grass flanks the margins. Beyond the ditch, a striking mix of calcicole/calcifuge species cohabit, with tiny calcareous outcrops supporting Wild Thyme, Common Milkwort and Common Spotted Orchid, while the adjoining acid hummocks hold: Heath Spotted Orchid, Bog Myrtle and Cross-leaved Heath. Associated species occurring commonly here are: Tawny Sedge, Carnation Sedge, Fragrant Orchid, Lesser Butterfly Orchid, Tormentil and Devil's-bit Scabious, etc. Some small stands of Great Fen-sedge also occur.

Sub-site 3/2 Calcareous grassland

In sub-site 3/2, shallow outcropping of limestone on more elevated ground produce a limestone turf with a rather depauperate calcicole flora which includes: Carline Thistle, Wild Thyme, Common Spotted Orchid, Fragrant Orchid Common Milkwort and Quaking Grass, associated with circum-neutral grass-land species such as: Yarrow, Lessser Hawkbit, Purging Flax, Red Clover, White Clover, Perennial Rye-Grass, Self-Heal, Common Bird's-foot-trefoil, and Red Fescue, etc. Weed species such as Creeping Thistle and Spear Thistle are frequent here, reflecting the use of the land for cattle grazing.

The same calcicole flora is present on the larger rock outcroppings, where Blue Moor-grass occurs abundantly, and where shattered limestone provides an additional habitat for Blackthorn scrub, Hawthorn, Bramble, Wood Sage and Common Male Fern. Occasional plants of Pyramidal Orchid are also present here.

Sub-site 3/3 Neutral meadow

This small, low-lying, circum-neutral meadow has impeded drainage and holds an abundance (co-dominance) of Soft Rush and Blunt-flowered Rush - an unusual alliance, as the former is usually associated with mildly acidic soils, while the latter is most characteristic of neutral/highly calcareous fen habitats. (Such anomalous species-associations are of widespread occurrence in western Ireland). The co-habiting flora is meagre, and typical of circum-neutral, damp meadow habitats throughout Ireland, viz: Sweet Vernal Grass, Marsh Bedstraw, Marsh Thistle, Creeping Buttercup, Yorkshire Fog, Heath Grass, Red Fescue and Carnation Grass. Meadow Thistle and Flea Sedge also occur.

The adjacent ditch habitat also yielded: Creeping Bent, Fool's Water-cress, Hard Rush, Bottle Sedge, and a few tussocks of the very distinctive Tufted Sedge.

Sub-site 3/4 Limestone pavement

The limestone pavement habitat is separated from the adjacent pastures by boulder-walls, which are locally fortified by the development of scrubwood. Two discrete patches of limestone pavement occur, separated by more or less levelled ground, which has been cleared of its boulder cover and is now grazed by cattle. The massive residue of removed boulders forms a high barrier

around the northern section of limestone pavement. The flora is essentially a 'watered-down' Burren Flora, minus most of the Burren rarities.

The flora of the limestone pavement is very varied - a heterogeneous mix of calcicoles/circum-neutral pasture species, weed introductions, and some naturalised aliens. A suite of widespread Burren species are present: Blue Moor-grass, Bloody Cranesbill, Wild Madder, Fragrant Orchid, Burnet Rose, Mountain Everlasting and Quaking Grass, etc. The interstices between the boulders provide an ideal microhabitat for small, calcicolous fern species such as: Rusty Fern, Wall-Rue, Maidenhair Spleenwort and Hart's-tongue, all of which are common. Orchid species are surprisingly few here, consisting only of Common Spotted Orchid, Fragrant Orchid, and occasional Early Purple Orchid. Once again, shattered sections of block-limestone provide an ideal habitat for Wood Sage and Burnet Rose, the only other rose species seen being Common Dog Rose, though the area looked ideal for rarer species of this genus. Small, herbaceous species present included: Lady's Bedstraw, Herb Robert, Bulbous Buttercup, Eyebright, Common Bird's-foot-trefoil, Common Milkwort, Lesser Yellow Trefoil, Hop Trefoil, Glaucous Sedge, Wild Thyme, Mouse-ear Hawkweed and Elegant St John's Wort. These were accompanied by taller perennials such as: Ragwort, Imperforate St John's Wort, Lesser Knapweed and Ox-eye Daisy. The elegant Wall Lettuce, a long-naturalized species, is common here, as on the Burren limestone. The range of tree/shrub species includes: Ash, Sycamore, Blackthorn, Hawthorn, Hazel, Mountain Ash, Bramble, Honeysuckle, Common Ivy, Wild Roses and Traveller's Joy - a pernicious, rampagious alien which is well established, and poses an ongoing threat to the flora of the region.

Lastly, weed adventives (associated with disturbance of the habitat by grazing cattle) include: Spear Thistle, Rough Sow-Thistle, Smooth Sow-Thistle, Short-fruited Willowherb, Hoary Willowherb and Lesser Swine-cress.

This northern section of limestone pavement is cattle-free, but is rapidly becoming scrub-covered, chiefly by expanding thickets of Blackthorn. Two Burren arboreal specialities, Juniper and Dogwood, occur, both in very small quantities, in the northern section

Sub-site 3/5 Fen meadow

The boundary hedgebank separating along the eastern margin of this field held a single vegetative bush of Short-styled Field-rose.

This fen-meadow is very picturesque, with a markedly fluctuating water-level as indicated but the frequency of Bogbean, Brown Sedge, Bottle Sedge and Marsh Cinquefoil in the marginal ditches. These ditches provide an ecological niche for local sedge species such as Lesser Tussock Sedge and Tufted Sedge, in addition to Greater Tussock Sedge, Bottle Sedge, Common Sedge and Water Horsetail, etc.

Typical paludal meadow species such as Greater Bird's-foot-trefoil, Red Fescue, Marsh Bedstraw, Marsh Thistle, Meadowsweet, Wild Angelica, Purple-loosestrife, Hard Rush, Common Sedge and Common Spotted Orchid are augmented by a more calcareous floral assemblage which includes: Twayblade, Lesser Butterfly Orchid, Early Marsh Orchid, Marsh Horsetail, and Fragrant Orchid, other associates including: Meadow Thistle, Jointed Rush, Purple Moor-grass (subdominant locally), and Sharp-flowered Rush, etc.

Sub-Site 3/6 Bog Transition

This site is essentially as extension of sub-site 3/5, and is wedged between this and the roadway. The acidic nature of the habitat is exemplified by the ditch flora, which includes: Bogbean, Marsh Cinquefoil, Bog Asphodel, Round-leaved Sundew, White Water-lily, Cross-leaved Heath and Bottle Sedge. Associates include: Purple Moor-grass, Gorse and a narrow-leaved variant of Greater Tussock Sedge, which is probably showing the effects of nutrient deficiency. Tormentil occurs abundantly, while a most unexpected find was Fen Bedstraw - a very slender, graceful species that is rare in Co. Clare and Ireland generally, and is more usually found in calcareous/base-rich sites.

A more detailed survey of this sub-site was carried out in August 1999 to map the distribution of Fen Bedstraw. A total of 12 distinct patches of Fen Bedstraw were located. The patches varied in size from approximately 1 m^2 to 8 m^2. The three largest patches were 5-8 m^2, the remaining patches were 1-4 m^2 in size. The detailed results are presented in a separate report (RPS Consultants Report No. IR527/6).

Sub-Site 3/7 Bog west of roadway

This massive, species-rich site actually consists of a range of habitats; dryish, acid heath predominating westwards to a boundary ditch, but with neutral, damp meadow occurring at the eastern margin of the site, where it is associated with a circum-neutral ditch habitat. Purple Moor-grass is subdominant throughout most of this site.

The meadow flora includes: Glaucous Sedge, Brown Sedge, Tawny Sedge, Common Bent, Red Fescue, Yorkshire Fog, Crested Dog's-tail, Cock's-foot, Purging Flax, Meadow Buttercup and Imperforate St John's Wort, together with a range of common paludals such as: Marsh Bedstraw, Yellow Iris, Meadowsweet, Hard Rush, Soft Rush, Marsh Thistle, Greater Bird's-foot-trefoil, and the more localised Meadow Thistle.

The above assemblage is augmented by the ditch-flora, which includes: Water Horsetail, Marsh Horsetail, Lesser Water Parsnip, Fool's Water-cress, Water Mint, Tufted Sedge (a few clumps), Greater Tussock Sedge, Great Fen-sedge, Common Valerian, Greater Reedmace, Purple-loosetrife, Great Water Dock (a few plants), Lesser Spearwort, and an understorey of Creeping Bent and Amphibious Bistort, etc.

The dry-heath/bog-pool association is considerably larger in area yet, by comparison, its flora is sparser numerically. The dry-heath holds: Bell Heather, Brown Bent, Tormentil, Devil's-bit Scabious, Sheep's Sorrel, Black Bog-rush, Bog Myrtle, Lousewort, Eared Willow, Creeping Willow, Rusty Willow, and Gorse, etc.

The bog-pool habitat (and margins) contains: Bog Asphodel, Round-leaved Sundew, Bulbous Rush, Heath Rush, Carnation Sedge, Yellow-sedge (*oedocarpa* sub-species), Glaucous Sedge, Star Sedge, Greater Tussock Sedge, Great Fen-sedge and aquatics such as Bladderwort, etc. Bog mosses (*Sphagnum* sp.) were restricted to the bog pool habitat.

Throughout the heathland, Fragrant Orchid, Lesser Butterfly Orchid and Heath Spotted Orchid are of common occurrence. Of particular interest is the frequent co-occurrence of Heath Spotted Orchid and Common Spotted Orchid (this latter species of common occurrence), which are normally mutually exclusive, as Common Spotted Orchid is essentially a species of calcareous or

circum-neutral soils. This fact highlights the fascinating mosaic of contrasting micro-habitats present on-site. Indeed such anomalies are of common occurrence throughout Co. Clare and Galway and the west of Ireland in general, and the Burren area in particular.

Lastly, a deep ditch along the western edge of this sub-site separates it from sub-site 3/8, and, like the eastern ditch, it holds an abundance of the base-demanding emergents, Lesser Water Parsnip, together with tall, stately clumps of Great Water Dock.

Sub-Site 3/8 Paludal Meadow with surrounding ditches

This rectangular, paludal meadow (surrounded by deep, freshwater ditches) bears a typical circum-neutral marsh flora, which is very varied, with: Creeping Bent, Fool's Watercress, Meadow Foxtail, Marsh Foxtail, Oval Sedge, Brown Sedge, Common Sedge, Carnation Sedge, Wild Angelica, Marsh Horsetail, Mouse-ear Chickweed, Yellow Rattle, Hard Rush, Common Knapweed, Marsh Thistle, Common Spotted Orchid, etc. Species such as Amphibious Bistort, Marsh Ragwort, Silverweed, Clustered Dock, Tufted Water Forget-me-not and Brown Sedge attest to considerable fluctuation of the water-level on-site throughout the year, doubtless with sporadic periods of submergence of the habitat.

The ditch flora is of considerable interest, large stretchs of water being totally covered with the leaves of Frogbit (which was in flower at the time of our visit) co-habiting with the much smaller-leaved, part submerged rafts of Ivy-leaved Duckweed. Other sections of ditch habitat in which Frogbit and Ivy-leaved Duckweed are localised or absent, are inhabited by small emergents such as: Water-plantain, Lesser Water Parsnip and Mare's-tail associated with tall emergents such as Greater Reedmace and Great Water Dock.

Sub-site 3/9 Poached, paludal meadows

These peripheral meadow lies at the western extremity of the survey area, and are tightly grazed and considerably poached by cattle. The flora is quite limited, consisting mainly of: Hard Rush, Soft Rush, Jointed-Rush, Greater Bird's-foot-trefoil, Marsh Bedstraw, Tufted Water Forget-me-not and Self-Heal, while Bog Pimpernel is frequent here in its only recorded site during the present survey, though it surely occurs elsewhere.

Site 3/10 Killow Meadow 1

A large, circum-neutral, poached marshy-meadow, with a wide selection of common paludal species. Widely fluctuating water-levels on-site are indicated by the presence of: Bogbean, Marsh Cinquefoil, Brown Sedge and Floating Sweet-grass. Shallow areas of water hold an abundance of small-sedge species, such as Glaucous Sedge, Carnation Sedge, Yellow-sedge (*oedocarpa* sub-species) and Common Sedge, associated with an equal abundance of; Hard Rush, Soft Rush, Sharp-flowered Rush and mat-forming, ground-hugging perennials such as: Creeping Bent, Silverweed, White Clover, Creeping Buttercup and Water Mint. Other common paludals scattered throughout the site are: Purple Moor-grass, Devil's-bit Scabious, Purple-loosestrife, Meadowsweet, Lesser Spearwort, Sweet Vernal Grass, Yorkshire Fog, etc. Localised clumps of Common Cottongrass indicate acid water-pockets.

The calcareous deep ditch which forms the boundary between this site and a large reedbed, holds a few marginal clumps of Lesser Pond-sedge (a rare Clare species), small stands of Blunt-flowered Rush, plenty of Bottle Sedge and submerged plants of Yellow Water-lily.

Sub-site 3/11 Killow Meadow 2

This small marshy-meadow is separated from the previous sub-site by a byroad. The species composition of its flora is similar, but there is a much greater frequency of Purple Moor-grass compared to rushes. This sub-site also contains small populations of Badder Sedge and Blunt-flowered Rush.

Sub-site 3/12 Killow Meadow 3

Essentially similar to sub-site 3/11, additional species being: Hoary Willowherb, Marsh Willowherb, Oval Sedge in plenty, Water-pepper and Tufted Hair-grass, while the boundary ditch wedged between the meadow and the main road holds an abundance of Least Bur-reed, and a little White Water-lily.

AEC 4 River Fergus at Clareabbey

The steep embankment flanking the muddy bank of the River Fergus between Clareabbey and the Railway Bridge is severely poached and degraded by horses. As a consequence, the perennial embankment grass species have largely been lost, being replaced by vast quantities of the crucifier, Charlock, an annual weed of disturbed ground and arable land.

However, the low-lying riverbank is notable for holding a localised abundance of Greater Pond-sedge and Reed Sweet-grass, together with small populations of Flowering-rush and Great Water Dock - all four species of varying degrees of rarity in Co. Clare (see below). Other interesting species present are: Pink Water Speedwell, English Scurvygrass, and Celery-leaved Buttercup. Common Reed is sub-dominant here, with localised stands of Grey Club-rush.

The saline ditch on the landward side of the river embankment holds populations of: Water-plantain, Greater Reedmace, Grey Club-rush, Sea Club-rush and Branched Bur-reed, etc.

AEC 6 Knockaskibbole

Sub-site 6/1 Knockaskibbole fen

The damp margins of the paludal meadow bordering this mire-type habitat hold a wide mix of paludal and meadow species, viz: Cuckooflower, Glaucous Sedge, Carnation Sedge, Yellow-sedge (*oedocarpa* sub-species), Jointed Rush, Bulbous Rush, Soft Rush, Hard Rush, Clustered Rush, Silverweed, Purple Moor-grass, White Clover, Common Bent, Crested Dog's-tail, Yorkshire Fog, Meadowsweet, Marsh Thistle, Marsh Pennywort, Marsh Bedstraw, Devil's-bit Scabious and Tufted Forget-me-not, etc.

In deeper water, these give way to an additional range of species, such as: Brown Sedge, Bottle Sedge, Common Sedge (sub-dominant), Sharp-flowered Rush, Blunt-flowered Rush, Water Horsetail, Purple-loosestrife, Creeping Bent, Floating Sweet-grass, Marsh Arrowgrass, Marsh Speedwell, Water-cress, Common Spike-rush, and rafts of Floating Club-rush, Various-leaved Water-starwort, and a Pondweed species.

Particularly notable is the occurrence of one massive stand of Hybrid Hard Rush, a nationally-rare hybrid, that appears to be new to the flora of Co. Clare.

Sub-site 6/2 Dry meadow

This small, grazed, rough-meadow adjoins sub-site 6/1, from which it is separated by hedgerow boundaries dominated by suckering Blackthorn scrub and Bramble. Scattered bushes of Common Dog Rose and the nationally-scarce Short-styled Field-rose, also occur in these hedgebanks. The dry-pasture flora is depauperate, consisting of only a handful of common, circum-neutral species Ragwort, Common Knapweed, Meadow Buttercup, Common Bent, Crested Dog's-tail, Self-Heal and White Clover, together with scattered clumps of Marsh Thistle and Soft Rush in pockets of damp ground.

Sub-site 6/3 Transition meadow

This site is a large, saucer-shaped, still-intact old meadow, with the substrate grading from dry on the higher peripheral ground, to permanently waterlogged at its centre, where wet scrubwood ('carr') is developing. An interesting feature is the absence of invading Bramble thickets - a phenomenon that runs counter to the ubiquitous occurrence of Bramble in neglected meadows and pastures.

This attractive site holds a complex mosaic of interwoven ecological habitats, part-determined by gradient and edaphic factors, and part by the water-chemistry of the substrate. As a consequence, the dryish, elevated, peripheral ground holds a range of circum-neutral meadow species such as: Timothy, Quaking Grass, Wild Carrot, Common Knapweed, Cock's-foot, Yorkshire Fog, Crested Dog's-tail, Tufted Vetch, Meadow Vetchling, Common Bird's-foot-trefoil, Common Spotted Orchid, Ribwort Plantain and White Clover, etc. By contrast, acid sections of lower ground hold Ling-heath, with Tormentil, Trailing Tormentil, and Purple Moor-grass, while adjoining acid-ditch habitats contain: Common Cottongrass, Marsh St John's Wort, Bottle Sedge, Carnation Sedge, Glaucous Sedge and Star Sedge, etc. More neutral paludal/aquatic species include: Jointed Rush, Sharp-flowered Rush, Soft Rush, Clustered Rush, Lesser Spearwort and Creeping Buttercup.

The central area of the site holds a circular belt of wetland scrub ('carr') consisting of Common Alder and a small, distinctive willow taxon, which may well be Grey Willow. This very local Irish shrub may be new to the flora of Co. Care. Other arboreal taxa present in this community are Bog Myrtle and naturalised Rhododendron - the latter posing a future threat to this otherwise native community. Greater Tussock Sedge is quite frequent here.

On one section of the wetland periphery, a more base-rich community occurs, with a local abundance of Blunt-flowered rush, Great Willowherb, Marsh Willowherb and Hoary Willowherb, associated with: Greater Tussock Sedge, Hairy Sedge and plenty of Hard Rush and Soft Rush.

A tiny thicket on the marsh periphery holds at least one bush of Short-styled Field Rose.

AEC 7 Knockanean

Sub-site 7/1 Disturbed meadow

This tiny wetland site has been grubbed-up on its margins, and consists of a deep drain and surrounding marshy pasture, with a little scrub. The ditch flora is interesting, with co-habiting stands of Water-plantain and Lesser Water-plantain, accompanied by such emergents as: Mare's-

tail, Water Horsetail, Bottle Sedge, Common Sedge, Brown Sedge and Bogbean, with submerged rafts of a Water-starwort.

The paludal meadow flora is very varied, the more interesting species being: Small Sweet-grass, Lesser Hawkbit, Marsh Arrow-grass, Corn Mint and Tall Fescue, associated with: Marsh Horsetail, Water Mint, Marsh Speedwell, Lesser Spearwort, Yellow Iris, Hard Rush, Soft Rush, Jointed Rush, Meadowsweet and Purple Moor-grass, etc. Marginal species of note were: Cowslip, Wild Carrot, and Hairy Dog Rose in an adjacent hedgebank - a rose of seemingly local occurrence in Co. Clare (see below).

Sub-site 7/2 Fen-swamp transition

This small, clearly demarcated habitat is part-encompassed by hedgebanks, and by two ditches, one of which separates it from sub-site 7/1. This site is obviously subject to considerable fluctuation in water-levels, and the dominant vegetation is, accordingly, tall and coarse. At least six sedge species are present, of which three are of particular interest: Tufted Sedge (a few tussocks only), Lesser Tussock Sedge (locally abundant) and what seems to be a rather peculiar etiolated from of the *brachyrryncha* sub-species of Yellow-sedge. The latter occurs as scattered plants here, in the only habitat recorded for it during this survey.

Associated tall paludals of frequent occurrence are: Wild Angelica, Hemp Agrimony, Great Fen-sedge, Clustered Rush, Hard Rush, Blunt-flowered Rush, Purple-loosestrife, Common Valerian, Yellow Iris, Purple Moor-grass, etc., while near the ditch separating sub-site 7/1 occur Greater Reedmace, Branched Bur-Reed, Marsh Willowherb, Hoary Willowherb, Water Mint, Tufted Forget-me-not, Lesser Spearwort, Black Bog-rush, Clustered Dock, Silverweed and Greater Bird's-foot-trefoil. Around the periphery of the fen, these are supplemented with: Quaking Grass, Common Knapweed, Fragrant Orchid, Common Spotted Orchid, Tufted Vetch and Yellow-Rattle, etc., with a few specimens of Guelder-rose in the damp hedgerow. The ditch/ditch-margins hold: Blue Water-speedwell, Pink Water-speedwell, Water-starwort, Mare's-tail, Broad-leaved Pondweed, Creeping Bent and Fool's Water-cress, etc.

Sub-site 7/3 Calcareous grassland

A large area of rough, abandoned calcareous rocky pastureland, which is rapidly reverting to scrub. The dominant scrub species is Blackthorn, which forms dense thickets here, common associates being: Hazel, Hawthorn, Bramble, Common Dog-rose, with occasional Elder, Spindle, Ash and Rowan. Of note was the occasional occurrence of Field-rose and Short-styled Field-rose. The former is of very local occurrence in Co. Clare, while the latter species was apparently added to the county flora during the present survey.

Calcicolous species are widespread on-site, (yet all of the Burren limestone specialities seem to be absent) and include: Fragrant Orchid, Imperforate St John's Wort, Carline Thistle, Wild Thyme, Quaking Grass, Blue Moor-grass, Thale Cress, Lady's Mantle, Lady's Bedstraw, Common Milkwort, and a trio of small fern species - Rusty-Back, Wall-Rue and Maidenhair Spleenwort. The only naturalised species is Wall Lettuce, which is widespread and common. The predominant floral assemblage, however, consists of circum-neutral pasture species, such as: Yarrow, Common Bird's-foot-trefoil, Self-heal, Daisy, White Clover, Red Clover, Lesser Yellow Trefoil, Common Sorrel, Ribwort Plantain, Fairy Flax, Wild Carrot, Common Knapweed, Perennial Rye-grass, Yorkshire Fog, Red Fescue, Cock's-foot, Sweet Vernal Grass and Crested Dog's-tail, etc.

The scrubwood flora is meagre and mundane, consisting of: Wood Sorrel, Primrose, Wood False-brome, Ground-ivy, Ivy, Wood Avens, Herb Robert, Barren Strawberry, Wild Strawberry, Common Dog Violet, together with local populations of: Bugle, Wood Anemone and Early Purple Orchid.

AEC 10 Cappagh/Ballyduff

Sub-site 10/1 Swamp

This small, base-rich quaking mire habitat bears a typical swamp flora, the following species occurring commonly: Common Sedge, Bottle Sedge, Marsh Bedstraw, Fool's Water-cress, Water-cress, Common Spike-rush, Water Mint, Water Horsetail, Marsh Ragwort, Lesser Spearwort, Jointed-rush, Water Forget-me-not and Marsh Pennywort, etc.

Species indicative of markedly fluctuating water-levels on-site include: Bogbean, Marsh Marigold, Brown Sedge, Silverweed, Clustered Dock, Creeping Bent and Water-plantain. Tall emergents include: Hard Rush, Soft Rush, Purple-loosestrife, Meadowsweet, Wild Angelica, Common Valerian, Branched Bur-reed, Tall Fescue (rare) and scattered stands of Common Club-rush and Reed Canary-grass.

The base-rich nature of the habitat is indicated by the presence of Lesser Water-parsnip, Hard Rush, together with a few tussocks of Tufted Sedge. The landward margin of the mire holds populations of: Brookline, Carnation Sedge, Yellow-sedge (*oedecarpa* sub-species), Marsh Speedwell and Self-heal, etc.

The ecotone of ground separating the mire from a deep ditch holds a mono-culture of Common Reed, while Blue Water-speedwell occurs with it in small quantity. Bordering the limestone boundary wall which separated sub-sites 10/1 and 10/2, small populations of Hemp-agrimony occur.

Sub-site 10/2 Cappagh Lough and environs

Sub-site 10/2 holds a fascinating mosaic of paludal/calcareous damp grassland habitats, plus Lough Cappagh itself. The area adjoining the boundary-wall with sub-site 10/1 bears an identical mire-flora to that of 10/1, yet this abruptly gives way to firm, damp, calcareous grassland which is low-growing and species-rich. This very attractive habitat supports an abundance of: Carnation Sedge, Glaucous Sedge, Tawny Sedge, Yellow Sedge (*oedecarpa* sub-species), Common Bird's-foot-trefoil, Lesser Hawkbit, White Clover, Bog Pimpernel, Ribwort Plantain, Trailing Tormentil, Red Fescue, Lady's Bedstraw, Devil's-bit Scabious, Fragrant Orchid, Lesser Stitchwort, Ox-eye Daisy and Common Spotted Orchid, etc.

Bordering areas of damp, rough grassland hold: Quaking Grass, Common Knapweed, Purple Moor-grass, Sweet Vernal Grass, Crested Dog's-tail, Heath Grass, Marsh Thistle, Wild Angelica, Clustered Rush, Hard Rush, Water Horsetail and Marsh Horsetail etc. Throughout the more calcareous parts of this meadow, Grass of Parnassus occurs frequently. The paludal ecotone of marshy ground fringing the Lough holds additional species, such as: Bottle Sedge, Common Sedge (occurring in large, sub-dominant stands), Creeping Bent, Bogbean, Water Horsetail, Black Bog-rush, Lesser Water-plantain, Common Club-rush (rare), Water Forget-me-not, Tufted Forget-me-not and floating mats of Broad-leaved Pondweed. Some large, sub-marginal stands of a sedge occur in one section of the Lough, but the deep water and quaking, precarious nature of the lough-

margin, prevented collection of this sedge. On balance, it would seem to be Tufted Sedge, yet the growth is mat-forming rather than tussocky (thus uncharacteristic), while what seems to be long, pioneering rhizomes occur adjacent to the stands - yet such long-spreading rhizomes are stated to be absent in Tufted Sedge. This anomalous taxon deserves further research (if it can be collected): it may be the inter-specific hybrid, Tufted Sedge x Common Sedge (= *C.* x *turfosa*), but it seems more likely that at least some of the material is only Bottle Sedge, which does have long-spreading rhizomes.

The marginal vegetation of Cappagh Lough suggests that the pH of its water is low (? 5.5-6.5) and thus slightly acidic rather than calcareous in reaction.

Sub-site 10/3 Calcareous pasture, scrubwood and scrubby limestone pavement

This area has a devastated appearance as a consequence of considerable scrub-removal, combined with cattle-grazing, resulting in a widespread weed-flora of: Common Nettle, Spear Thistle, Prickly Sow-thistle, Smooth Sow-thistle, Common Chickweed, Shepherd's-purse, etc. The dominant scrub is Blackthorn thicket, associated with: Hazel, Hawthorn, Bramble, Honeysuckle and Ivy, together with Common Dog-rose and a little Ash, Rowan and Spindle.

The scrubwood ground-flora is mundane and meagre, consisting mainly of: Wood False-brome, Ground-ivy, Wood Avens, Herb Robert, Wild Strawberry, Barren Strawberry, Elegant St John's Wort, Wood Sorrel, Primrose, Common Dog Violet, with localised populations of Bugle, Early Purple Orchid and Bracken.

The limestone pavement bears a more or less similar flora, with the addition of: Hart's-tongue, Rusty-back, Wall-rue and Maidenhair Spleenwort ferns - calcareous ferns for a calcareous habitat. The characteristic Burren calcicoles seem to be totally lacking on-site, save for an abundance of Blue Moor-grass. The delicate, naturalised Wall Lettuce occurs here commonly.

AEC 11 Barefield

A relatively recently constructed farm-access pathway bisects a section of the site, effectively separating the lightly-grazed damp-meadow/mire transition from a small, remnant lakelet community, which latter bears a distinctly different floral assemblage.

The firm but dampish margins of the flood-meadow hold a range of typical circum-neutral pasture and paludal species such as: Meadow Buttercup, Meadow Vetchling, Red Clover, White Clover, Sweet Vernal Grass, Yorkshire Fog, Common Spotted Orchid, Quaking Grass and Hairy Sedge (local in the general area?). Seepage areas on the margin of the swamp community hold: Yellow-sedge (*oedecarpa* sub-species), Carnation Sedge, Glaucous Sedge, Brown Sedge, Bristle Club-rush, Hard Rush, Soft Rush, Sharp-flowered Rush, Jointed-Rush, associated with: Silverweed, Creeping Buttercup, Purple Moor-grass, Black Bog-rush, Meadowsweet and Purple-loosestrife, etc.

In deeper water these give way to stands of Common Sedge, Bottle Sedge, Brown Sedge, Water Horsetail, Water Mint, Marsh Speedwell, Creeping Bent, Common Spike-rush, Lesser Spearwort, and a suite of willowherbs, viz: Great Willowherb, Hoary Willowherb and Marsh Willowherb, with isolated stands of Greater Reedmace and Tall Fescue.

The lakelet community appears depauperate, but holds large stands of Great Fen-sedge, Broad-leaved Pondweed and Least Bur-reed, small amounts of Common Cottongrass, and plenty of Yellow-sedge (*oedocarpa* sub-species) and Fool's Water-cress on the margins.

AEC 13 Clareabbey Inundation Meadow

This site consists of a very large, low-lying, flood-meadow, together with vegetation-choked ditches and quaking mires bordering the central stream. Sub-dominants are Hard Rush and Soft Rush, other tall, common associates being: Sharp-flowered Rush, Compact Rush, Blunt-flowered Rush, Brown Sedge, Meadowsweet, Purple-loosestrife, Yellow Iris, Devil's-bit Scabious, Hoary Willowherb, Marsh Ragwort, and Common Reed bordering the stream/ditch banks. Tall Fescue occurs as scattered clumps. One of two very localised large stands of Greater Pond-sedge (rather rare in Co. Clare) borders the stream which part-bisects the meadow.

The ground-flora of the site is dominated by creeping perennials such as: Creeping Bent, Creeping Buttercup, Silverweed, Jointed Rush, Greater Bird's-foot-trefoil, Water Mint and Water Forget-me-not, etc. Other common associates are: Red Fescue, Yorkshire Fog, Perennial Rye-grass, Crested Dog's-tail, White Clover, Red Clover, Marsh Thistle etc., with populations of Creeping Thistle and Common Nettle on the meadow margin, near a hedgebank.

The quaking mire habitat bordering the stream holds dense beds of Water-cress and Fool's Water-cress, associated with: Water Forget-me-not, Water Pepper, Clustered Dock and Marsh Ragwort, etc. The stream itself holds submerged stands of Various-leaved Water-starwort.

The ditch near Clareabbey (very deep in parts) holds localised stands of Lesser Water-Parsnip, together with the second population of Greater Pond-sedge, associated with a range of common paludals such as: Common Reed, Hoary Willowherb, Creeping Bent, Creeping Buttercup and Lesser Spearwort, etc.

AEC 14 Ballybeg/Cahircalla Beg

Sub-site 14/1 Limestone quarry

Occurring to the north west of Clarecastle, this two-tiered limestone quarry holds a rich flora, and is very attractive in appearance. A small quarry-pool adds a paludal element to an otherwise terrestrial flora.

Six orchid species are present, of which Common Spotted Orchid, Fragrant Orchid and Lesser Butterfly Orchid are of very common occurrence. Only a few plants of Common Twayblade and Pyramidal Orchid were seen, however, while Greater Butterfly Orchid is only very locally frequent. Other calcicoles associated with the orchids are: Yellow-wort, Wall-rue, Rustyback, Quaking Grass, Perforate St John's Wort, Kidney Vetch, Common Agrimony, Wild Strawberry and Blue Moor-grass.

A wide range of species requiring free-draining conditions, but largely indifferent to soil pH levels are common here, and include: Wild Carrot, Bulbous Buttercup, Ox-eye Daisy, Weld, Common Bird's-foot-trefoil, Lady's Bedstraw, Goldenrod, Wild Thyme and Wood Sage.

The paludal/aquatic element associated with the quarry-pool and its environs includes: Remote Sedge, False Fox-Sedge, Water-crowfoot, Water Milfoil, Marshwort, Fool's Water-cress, Water Mint, Water Horsetail, Pink Water-speedwell and Mare's-tail.

Three, common hemi-parasitic species present are: Red Bartsia, Eyebright and Yellow-Rattle. Among the rarest species present on-site are: Knotted Pearlwort, Goat's-beard and Vervain, this last generally regarded as only a naturalised medicinal herb in Ireland, but showing a preference for calcareous habitats.

The major natural threat to this beautiful site is the rampant spread of Blackthorn thickets.

Sub-site 14/2 Limestone pavement and scrubwood

This site is reached by a long boreen, which holds a few bushes of the nationally-scarce, Short-styled Field-rose. The limestone pavement is species-poor, lacks all of the Burren rarities, and is predominantly covered with Hazel scrub. The ground-flora consists of just a handful of species, viz: Soft Shield-fern, Ground-ivy, Hart's-tongue, Wood False-brome, Common Dog Violet, Primrose, Wild Strawberry, Barren Strawberry, Germander Speedwell, Wood Speedwell and Ivy, etc.

Occasional pockets of open limestone pavement hold an abundance of just a few species: Blue Moor-grass, Wood Sage, Wall-Rue, Rustyback, Maidenhair Spleenwort, Herb Robert, and the abundantly naturalised Wall Lettuce. Most regrettably, the area is considerably degraded by the invasive spread of the naturalised woody liana, Traveller's Joy which forms an almost impenetrable, interlacing network of prone stems on the pavement surface, as well as cascading canopy-fashion, over the Hazel scrubwood. This pestilential plant is likely to spread widely in this area in future years.

Sub-site 14/3 Mire-Meadow

A distinctive hummocky-type mire habitat, with a rather tenaciously-clingling muddy substrate. Botanizing on-site was greatly hampered by rain, which occurred as a torrential, prolonged downpour throughout the survey period. One quite unusual feature of the site was the apparent total absence of sedge species - a genus which is characteristically well represented in this type of paludal habitat. The following species were noted to occur commonly: Meadowsweet, Meadow Buttercup, Wild Angelica, Soft Rush, Hard Rush, Lesser Spearwort, Lady's Smock, Fool's Water-cress, Creeping Buttercup, Lesser Water-Parsnip (local in Clare) and Tufted Forget-me-not. Various-leaved Water-Starwort occurred locally in pools of water and drains.

AEC 15 Cahircalla

A small area of mire-type habitat and adjoining Greater Tussock Sedge/Alder swamp provide the only significant botanical interest in this AEC.

The frequency of Lesser Water-Parsnip in the mire habitat points to a base-rich substrate. A range of moderately tall species occur commonly, such as: Hoary Willowherb, Soft Rush, Hard Rush, Lesser Spearwort, Meadow Buttercup and Devil's-bit Scabious, etc. The ground-flora consists mainly of creeping perennials, such as: White Clover, Creeping Buttercup, Creeping Bent, Floating Sweet-grass, Jointed Rush, Water Horsetail, Brooklime, Bogbean and Brown Sedge - the latter two species being characteristic of sites with widely fluctuating water-levels throughout the

year. These coarse-growing species are associated with a range of more delicate species, such as: Marsh Arrowgrass, Cuckooflower, Short-fruited Willowherb, Star Sedge, Carnation Sedge, Glaucous Sedge, Common Sedge, Yellow-sedge (*oedocarpa* sub-species), Bog Pimpernel and Square-stemmed St John's Wort, etc.

The adjoining Alder/Greater Tussock Sedge swamp is a very distinctive and fascinating habitat, though unfortunately it could not be examined in detail as the deep ditch bisecting both habitats prevented access. Greater Tussock Sedge occurs here in abundance, and at least one fern species - Broad Buckler Fern occurs as an epiphyte here, growing on the sedge-pedestals, and thus elevated above the water-level. The expanse of quaking mire intervening between a paludal pasture and this swamp, holds a small population of Mare's-tail, while the ditch itself holds populations of Various-leaved Water-starwort.

AEC 17 Claureen

This low-lying, firm-of-foot flood-meadow fronts a small, new housing estate. The flora is very meagre, with just a handful of sub-dominants. The only notable species is Bladder Sedge, which is locally frequent and was not recorded elsewhere during these surveys. It is frequently accompanied by False Fox-sedge - a species of mainly coastal occurrence in Co. Clare and Galway.

Common Sedge is locally abundant, being associated with other creeping perennial species, such as: Creeping Bent, Creeping Buttercup, Amphibious Bistort, Marsh Woundwort, Floating Sweet-Grass, Common Spike-rush, Marsh Bedstraw, Water Mint, Whorled Mint and localised Copper-leaved Water-cress. Taller paludals frequent throughout the site include: Wild Angelica, Meadowsweet, Purple-loosestrife, Marsh Ragwort, Meadow Buttercup, Great Willowherb, Ragged Robin, Curled Dock and Hard Rush, etc.

Locally, this species-rich community gives way to low-growing, circular stands of Jointed Rush and Common Spike-rush, while these in turn are superseded by a dense monoculture of Reed Canary-grass. The part re-seeded ecotone of ground wedged between the flood-meadow and housing estate still holds a range of native paludal species, while Hairy Sedge also occurs here, though it was not seen in the flood-meadow itself.

3.4.2. Evaluation

Floristics

No plant species protected under the Flora Protection Order 1999, listed in the Irish Red Data Book (Curtis and McGough, 1988) or listed on Annex 2 of the Habitats Directive (92/43/EEC) were recorded. By and large, the flora of the study corridor represents a 'diluted' version of that occurring to the north/north-west, in the botanically renowned Connemara-Burren Region of Clare-Galway, but with the notable absence of the specialities of that region, such as: Spring Gentian, Mountain Avens, Dense-flowered Orchid and Shrubby Cinquefoil, etc. Nevertheless, some nationally rare species occur within the study corridor as well as outliers for a range of species which are of local occurrence in the Clare-Galway Region.

Detailed information on the status of Irish plants is limited. Perring and Walters (1990) provide distribution maps for all Irish species, but these are based on surveywork in the 1950s. Nevertheless, this source does provide a basis for a comparative evaluation of the national status of

species recorded in this survey. For aquatic plants, more recent information on Irish distribution is provided by Preston and Croft (1997). Webb and Scannell (1993) is the only flora dealing with any part of Co. Clare. Eight regional 'Districts' are recognised in this flora, of which only Districts 1 and 3 impinge on the route corridor, their southern limit being just to the north of Ennis, where they each border one side of the Ennis-Gort road. More recent work on the plants of the Burren-Connemara region include McGough (1988) and Mooney and O'Connell (1990). However, the information sources that deal specifically with the route corridor are extremely few, and largely out-of-date (Colgan and Scully, 1889; Praeger, 1901; Praeger, 1934). As a consequence, the current status of many species in the Clare flora south of Ennis is not known with accuracy.

The more notable plant species recorded are listed in Table 3.2. They have been classified, in descending order of importance, as either 'Nationally Scarce', 'Nationally Local', 'Regionally Scarce/Local' or 'Regionally Local but Frequent', based on the information in the above sources.

A suite of rose species of Local/Regional rarity also occur (see Table 3.2). One of these, Short-styled Field Rose, was previously unrecorded in County Clare, but was found to be of widespread but scattered occurrence in the study corridor. Large areas of suitable habitat for wild roses (i.e. hedgerows and scrubwood) exist within the route corridor and it was not possible to survey all this potential habitat. Therefore, the occurrence of notable rose species has not been used as a major factor in the critical evaluation of sites. Similarly, the occurrence of one notable hybrid has also not been a major factor in this evaluation, because hybrids are not generally used in conservation evaluation.

On the basis of this evaluation, and the overall diversity of the sites, the following sites are considered to be the most important, in terms of floristics: 3/4, 3/6, 3/8, 4, 6/3, 7/2 and 14/1.

TABLE 3.2 Notable plant species.

Species	Irish status[1]	Recent Irish status[2]	Status in Burren[3]	Occurrence in route corridor
		Nationally scarce		
Flowering-rush	29	50	Very rare	Site 4
Dogwood	33	-	Rare	Site 3/4
Frogbit	35	32	Not seen recently	Site 3/8
Fen Bedstraw	40	-	Not recorded	Site 3/6
Grey Willow	-	-	Not recorded	? Site 6/3
		Nationally local		
Reed Sweet-grass	55	97	Not recorded	Site 4
Goat's-beard	60	-	Very rare (probably introduced)	Site 14/1
English Scurvygrass	66	-	Probably not recorded	Site 4
Greater Pond-sedge	75	57	Very rare	Site 4, 13
Slender Sedge	75	89	Frequent except in the extreme south and west	Site 3/1
Bladder Sedge	77	115	Local	Sites 3/11, 17
Juniper	77	-	Occasional to frequent, but irregularly distributed	Site 3/4
Vervain	82	-	Occasional on the limestone, but tending to decrease (introduced)	Site 14/1
Lesser Pond-sedge	84	80	Rare	Site 3/10
Tufted Sedge	89	116	Frequent and locally abundant on the limestone; rare elsewhere	Sites 3/1, 3/3, 3/7, 7/2, 10/1, 10/2
Great Water Dock	91	102	Frequent in the area N. of Ennis; very rare elsewhere	Sites 3/7, 3/8, 4
Small Sweet-grass	93	165	Occasional in the West; rather rare in the East	Site 7/1

Various-leaved Water-starwort	-	84	Occasional	Site 14/3, 15
Brown Bent	-	-		Site 3/7
		Regionally scarce/local		
Greater Butterfly Orchid	126	-	Rare in the Burren; occasional elsewhere	Site 14/1
Lesser Tussock Sedge	133	-	Local	Sites 3/1, 3/5, 7/2
Least Bur-reed	135	129	Occasional	Sites 3/8, 3/11, 11
Brown Sedge	194	-	Local	Sites 7/1, 7/2, 10/1, 10/2, 11
Hairy Sedge	246	-	Occasional in the Burren and adjacent areas; very rare in Connemara	Site 11
		Regionally local but frequent		
Lesser Water Parsnip	110	136	Very local, but abundant in places	Site 3/7, 3/8, 10/1, 13, 14/3, 15
Yellow-sedge (*brachrhyncha* subspecies)	115	-	Abundant on the limestone; very rare elsewhere	Site 7/2
Floating Club-rush	138	159	Very frequent in acid waters; very rare on the limestone	Site 6/1
Lesser Water-plantain	154	202	Frequent, but local	Sites 7/2, 10/2
Grass of Parnassus	172	-	Frequent, though local on the limestone; rare elsewhere	Site 10/2
Mare's-tail	188	268	Frequent on the limestone; rather rare elsewhere, and absent from markedly oligotrophic waters	Site 3/8, 7/2
Guelder Rose	196	-	Occasional and locally frequent	Site 7/2
Pink Water-speedwell	50	134	Frequent on the limestone; elsewhere only in the extreme west of Connemara	Site 4, 7/2
Blue Water-speedwell	200	276	Frequent on the low-lying limestone; rather rare elsewhere	Site 7/2, 10/1
		Roses		
Field-rose	110	-	Rather rare, and only on the limestone	Site 7/3
Hairy-leaved Dog-rose		-	Not recorded	Site 7/1
Harsh Downy-rose		-	Not recorded	near Site 10
Short-styled Field-rose		-	Not recorded	Site 6/2, 6/3, 7/3, 14/2
		Hybrids		
Hybrid Hard Rush		-	Not recorded	Site 6/1

[1] no. of 10 km squares from Perring and Walters (1990), all records, excluding recorded introductions.
[2] no. of 10 km squares from Preston and Croft (1997), post-1950 records, excluding recorded introductions.
[3] from Webb and Scannell (1983)

Habitats Directive Plant Communities

A number of plant communities occur in the route corridor which show some correspondence to habitat types listed on Annex 1 of the Habitats Directive (92/43/EEC).

Calcareous grasslands

Calcareous grasslands occur in AECs 3, 7 and 14, and, in small patches, elsewhere. These grasslands show a mixture of typical neutral grassland species and calcareous species. They appear correspond to the community described by Ivimey-Cook and Proctor (1966) from the Burren as a transition or mosaic between *Centaureo-Cynosuretum* and the true limestone grasslands. This type

of grassland was described by these authors as widespread in the Burren. Whether this grassland falls within the Annex 1 type 6210 (Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)) is not clear. Most of the calcareous grassland within the route corridor was species-poor. The absence of the Burren specialities and the widespread occurrence, locally and regionally, of this habitat makes it of limited interest. However, the calcareous grassland in sub-site 14/1 was species-rich and of significant botanical interest.

Purple Moor-grass communities

While Purple Moor-grass is widespread within the route corridor, habitats where it is dominant or subdominant are limited to Site 4, where they occur extensively. They can be divided into two types:

- fen meadows (marshy grassland) where Purple Moor-grass occurs in association with rushes, sedges and wet meadow species (sites 3/1, 3/5, 3/11 and 3/12).
- wet modified bog where Purple Moor-grass occurs in association with acid heath species such as heathers and Bog Myrtle.

'Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caerulae*)' are an Annex 1 habitat-type. From the information in EC DGXI (1996) it would appear, however, that the wet modified bog is excluded from this category. The wet modified bog shows a close correspondence to the UK NVC community M25 (*Molinia caerulae-Potentilla erecta* mire) (Rodwell, 1991), and this latter community is specifically listed as excluded from the Annex 1 type (EC DGXI, 1996). Of the *Molinia* fen meadows, sites 3/1 and 3/5 represent the better, more species-rich examples.

Fens

Four examples of fen-type habitat occur within the route corridor. The assessment of fen vegetation is based on Ó Críodáin and Doyle's (1994) classification. However, accurately assigning fen vegetation to recognised community types would require quadrat samples and identification of the bryophyte flora. The following comments should, therefore, be regarded as provisional.

At site 3/1, around the transverse ditch and to its east, a transitional small sedge fen habitat occurs. The combination of calcareous fen and acid indicator species show some correspondence to the Campylio-Caicetum-dioicae association of Ó Críodáin and Doyle (1994), although several typical species of this association were not recorded; these authors describe this association as corresponding to the Annex 1 type 7230 (Alkaline fens). The stands of Great Fen-sedge which occur within this habitat, show correspondence with another Annex 1 habitat: 7210 Calcareous fens with *Cladium mariscus* and *Carex davallianae*. This latter type is a priority habitat type. It is, however, described as being of frequent occurrence in Ireland (Ó Críodáin and Doyle, 1994); the example in Site 3/1 contains very small stands of Great Fen-sedge and is, probably, therefore, one of the poorer examples.

At site 6/1, a flooded valley bottom holds fen vegetation dominated by Common Sedge and Jointed Rush. This shows a close correspondence to the Carici nigrae-Juncetum articulati association of Ó Críodáin and Doyle (1994); it is not described by these authors as corresponding to any Annex 1 type, and is probably quite widespread in Ireland.

At site 7/2, a tall sedge fen has, so far, survived amid drainage of surrounding land. It shows some correspondence to the Calliergo-Caricetum diandrae association of Ó Críodáin and Doyle (1994),

with the exception of the absence of Slender Sedge. These authors describe this association as corresponding to the Annex 1 type 7140 (Transition mires and quaking bogs). Again, the occurrence of Great Fen-sedge also brings in the priority Annex 1 type 7210, but the stands are very small.

At site 11, the southern section again shows some correspondence to the Carici nigrae-Juncetum articulati association of Ó Críodáin and Doyle (1994) but here, this community essentially occurs as a transition between the marginal fen meadow and the deep swamp community.

Limestone pavement

Small patches of this habitat occur in the route corridor at sites 3/4, 10/3 and 14/2. This is a priority Annex 1 habitat type (8240: Limestone pavements). It is, however, widespread within the Burren region and the present examples represent depauperate outliers. The examples at site 3/4 do, however, contain a good range of limestone species and may be of value as a geographical limit for some species. The limestone pavements in the other two sites hold a very mundane flora.

Other plant communities

Other plant communities of particular interest within the study corridor included:

- the ditch flora in Site 3/8.
- the transition meadow in Site 6/3.
- the calcareous damp grassland and adjoining Cappagh Lough in Site 10/2.
- the Greater Tussock-sedge swamp in Site 15.

3.5. INVERTEBRATES

3.5.1. Results of Fieldwork

During this survey, total numbers of Lepidoptera and Odonata species recorded were 100 and seven respectively. Full details of all species recorded are provided in Appendix 2.

3.5.2. Evaluation

Species

The sites visited contain habitats of considerable entomological interest, as illustrated by the high number of scarce and local Lepidoptera recorded (13% of the total). Unfortunately the weather of the summer was very unfavourable for insect recording. In particular the important June-July period was very badly affected, and many species were, as a result, under-recorded or completely missed. This is strikingly shown by the absence of such ubiquitous species as the White Ermine (*Spilosoma lubricipeda*) and the Buff Ermine (*S. lutea*), which must certainly be present, but have their flight periods from mid-June to mid-July.

Of the one hundred species of moth and butterfly recorded, the species listed in Table 3.3 call for special mention.

TABLE 3.3 Noteworthy Lepidoptera recorded during this survey. Micro-lepidoptera are shown under their scientific names. Scientific names of macro-lepidoptera are given in Appendix 2.

Species name	sub-sites recorded at	Irish status	Foodplants (Emmet, 1991)

Agonopterix yeatiana	3/7	scarce	Unbelliferae, esp. Wild Carrot
Elachista subnigrella	14/1	scarce (calcareous grasslands)	Upright Brome
Aethes piercei	3/7	local (calcicole species)	Devil's-bit Scabious
Dichrorampha plumbana	14/1	local	Oxeye Daisy, Yarrow (rootstock & roots)
Donacaula mucronella	3/7	local (wetlands)	Greater Pond-sedge, Common Reed, Reed Sweet-grass, ?other *Carex* spp.
Anania funebris	3/4	very local (mainly Burren)	Goldenrod
Dingy Skipper	3/4, 14/1	almost confined to limestone outcrops	Common Bird's-foot-trefoil, occ. Greater Bird's-foot-trefoil
Marsh Fritillary	3/7	local and declining	Devil's-bit Scabious (occasionally other species)
Barred Rivulet	3/7	local	Red Bartsia (seeds)
Latticed Heath	3/7	local and declining	Lucerne, Clovers
Bee Hawk-moth	3/7	very local and declining	Devil's-bit Scabious, Field Scabious
Scarce Silver-Y	3/7	very local	Heather, Bilberry
Small Rufuos	3/7	local (fens and marshes)	Jointed Rush, Sharp-flowered Rush, Soft Rush (stems)

The details of the Irish distribution of these species are summarised in Appendix 2. One of these species, the Marsh Fritillary, is listed on Annex 2 of the Habitats Directive (92/43/EEC). While it is declining and threatened in most European countries, its Irish status is not clear. Lavery (1993) described it as not threatened in Ireland but Warren (1994) suggests that the species may be declining in Ireland. Its apparent metapopulation structure (Warren 1994) makes it particularly vulnerable to habitat fragmentation as it probably requires networks of inter-connected habitat patches. The *Molinia caerulae-Potentilla erecta* mire habitat in which the species was found in sub-site 3/7 is a typical habitat for the species (Warren, 1994). During the present survey, the species was only found in a small area of sub-site 3/7. However, only a small proportion of the total extent of this habitat in the area was searched. The habitat extends over a large area in, and surrounding, AEC 3, with at least 35 ha of similar habitat contiguous with sub-site 3/7 and an equal area around 0.7 km to the south-east adjoining sub-site 3/10. Moreover, some of the other habitats (i.e. fen meadow and calcareous grasslands) in AEC 3 may also be suitable for this species. By contrast Lavery (1993) found that 20 out of 23 colonies in County Kerry occurred on sites of less than 0.1 ha in size, while Warren (1994) found that only 18 out of 108 colonies surveyed in Britain occupied habitat patches larger than 10 ha, with the maximum patch size being 40 ha. The extent of suitable habitat in the Kilbreckan/Skehanagh/Killow area, therefore, has the potential to support an important population of this species, although further surveys would be required to confirm this.

Habitats

The areas surveyed during this survey fall into three main categories, viz. 1) limestone pavement and scrub, such as the area around Kilbreckan Lough (sub-site 3/4); 2) small calcareous lakes with rich emergent vegetation, exemplified by Cappagh Lough (sub-site 10/2); and, 3) fen and associated wetland habitat such as found in the Bunnow area (sub-site 3/1, 3/6 and 3/7). Each of these areas are of entomological and conservational interest.

The limestone pavement area around Kilbreckan Lough, which has already been affected by scrub clearance and other disturbances, can be looked on as a southern outlier of the Burren habitat type. Species such as the Pyralid moth *Anania funebris* appear to be very scarce and local south of here,

while they are common a short distance to the north. The area therefore represents a geographical limit for such species, and its loss could lead to a decline in their distributional areas.

The area around Cappagh Lough resembles in many ways the habitat found further north in the turlough area of Co. Clare and south-east Galway, and could also be looked upon as a southern limit for the associated species.

The wetlands around Bunnow and Kilbreckan Lough contains a highly interesting range of biotopes and ecotones. While fen vegetaion is well represented, extensive areas of Common Heather indicate the local presence of acidic conditions, resulting in a rich mix of Lepidoptera associated with calcicole or calcifuge plants. The extensive occurrence of Devil's-bit Scabious here, and the presence of two important and declining species (Bee Hawk-moth and Marsh Fritillary) which feed on it indicate that this is a site of high conservation value. It should also be pointed out the Marsh Fritillary was found only in a very small and restricted area of the wetland habitat searched, indicating the sensitivity of the species to subtle local differences within an area where the foodplant was common and widespread. Indeed it is the loss and decrease in size and diversity of such wetland sites that is the most significant factor in the decline of such species. The preservation of this site is therefore probably the most important requirement highlighted by this survey.

3.6. AMPHIBIANS AND REPTILES

No specific surveys were carried out for amphibians and reptiles but observations were made during the course of other surveys. Common Frogs were recorded commonly in most of the wetland sites visited. Common Lizards were recorded in the limestone pavement in AEC 10 and the old quarry in AEC 14, and probably occur more widely in the route corridor. Neither species is considered to be threatened in Ireland (Whilde, 1993).

3.7. BIRDS

3.7.1. Survey Results

The route corridor holds a typical assemblage of common Irish farmland and hedgerow birds. Some additional species also occur as a result of the various semi-natural habitats in the route corridor and its geographical location.

The open fields hold few birds, mainly Meadow Pipits and Skylarks. The wetter fields held good numbers of Snipe in October but probably dry out too much in summer to be suitable for breeding Snipe.

The hedgerows and scrub held a good variety of common species such as Woodpigeon, Wren, Dunnock, Stonechat, Robin, Blackbird, Song Thrush, Willow Warbler, Blue Tit, Great Tit, Coal Tit, Goldcrest, Chaffinch, Linnet, Bullfinch, Reed Bunting, etc. Whitethroat and Cuckoo also occur commonly; these species are common in this region but scarce in some other parts of Ireland. Blackcaps were recorded from the extensive scrubwoods at Cappagh/Ballyduff (AEC 10) and Ballybeg North/Cahircalla Beg North (AEC 14).

The tall wetland vegetation (dry modified bog, swamp and fen) held Sedge Warbler and Reed Bunting in addition to many of the scrub species listed above. Grasshopper Warblers were quite numerous in this habitat at Kilbreckan/Skehanagh/Killow (AEC 3) and may also occur in some of

the other wetlands. Snipe were widespread in this habitat in April; while some of these birds would have been non-breeders, they are likely to breed in Kilbreckan/Skehanagh/Killow (AEC 3) and Cappagh/Ballyduff (AEC 10), and, possibly, some of the other sites. Water Rail was recorded from the tall sedge swamp at Cappagh/Ballyduff in April and may breed here

The small loughs and field ponds hold breeding Moorhen and Mallard. These are generally too small to attract many wintering wildfowl but small numbers of Grey Heron, Teal and Mute Swan are likely to occur.

The River Fergus, within the study corridor, held a few Grey Heron, Cormorant and Mute Swans on some visits, but none of these were nesting. In April, a flock of 80 Black-tailed Godwits were recorded from a field adjoining the Fergus; these would have been birds passing through on spring migration. Similarly, a few Whimbrel seen in various locations were spring migrants.

3.7.2. Evaluation

The more notable species recorded, or likely to occur, within the study corridor are listed in Table 3.4. Of these, Water Rail and Grasshopper Warbler are probably the most significant.

TABLE 3.4 Notable bird species recorded in the study corridor

Species	Irish Status	Occurrence in route corridor
Water Rail	Scarce and very locally distributed breeding species (850-1700 pairs)	Possibly breeding in AEC 10; suitable habitat elsewhere
Snipe	Scarce breeding species (10,000 pairs); widespread and common in winter	Probably breeds in AECs 3 and 10, at least
Cuckoo	Scarce breeding species (3000-6000 pairs) but widespread along the western seaboard	Widespread; presumed breeds
Grasshopper Warbler	Scarce and locally distributed breeding species (5,500 pairs	Presumed breeding in AEC 3 and suitable habitat elsewhere
Blackcap	Local breeding species (40,000 pairs)	Presumed breeding in AECs 10 and 14

3.8. TERRESTRIAL MAMMALS

3.8.1. Survey Results

Mammal Species

In general, it is considered that the majority of habitats traversed by the proposed bypass routes are likely to be utilised by both a low to moderate number of mammals. However there are some sites likely to be of high importance to local mammals. The field survey recorded the presence of at least three unprotected species utilising the habitats on the road routes namely, Fox, Rabbit and Brown Rat. Other small protected species that may utilise the habitats in part are: Wood Mouse, Pygmy Shrew and Hedgehog. The habitat requirements of larger protected mammals such as Badgers, Stoat and Hare are partially met in places and these may be visitors. Pine Marten are resident in the area. Otter, also protected, were confirmed utilising some of the watercourses traversed by the road routes.

Pine Martens

The Pine Marten distribution in Ireland is limited and Co Clare is a stronghold for the mammal. The species is virtually to be found in every 10 km square in the county (Paddy O'Sullivan, National Parks and Wildlife, personal communication). The scrub type habitats common in Co. Clare are favoured by the species though it is also found in relatively open ground with marginal vegetation cover. The population is considered overall to be in a healthy state. In recent years the semi-urban habitat has been an attractant for the species where it can productively forage. A area of some 30-40 acres of scrub habitat would be an average home range for an individual female. This area would be almost double for an individual male. Thus, a significant land area of suitable habitat is required for a few individuals. Pine Martens are known to inhabit the scrub habitats in the semi-urban setting of Ennis that are to be traversed by the southern and eastern by-pass routes (Paddy Sullivan, National Parks and Wildlife, personal communication). However, these scrub habitats are patchy in nature and are relatively small compared to scrub habitat elsewhere. Accordingly, the carrying capacity for martens is likely to be low and no more than a few individual Pine Martens are likely to be significantly affected by this habitat loss, removal or fragmentation caused by the proposed bypass in these areas.

Mammal Habitat

A total of 18 representative sites were surveyed (see Figure 3). These are fully described in Appendix 3. The sites were generally evaluated as being of low to moderate local importance to mammals, with the better quality sites being associated with the presence of scrubwood for general mammal fauna and/or wetland habitat suitable for Otters. The scrubwood in AEC 14 was considered to be of high local importance for mammals.

3.8.2. Evaluation

All the terrestrial mammal species recorded, or likely to occur, within the study corridor are widespread in the region; none are considered to be threatened in Ireland (Whilde, 1993). Otters are listed on Annex 2 of the Habitats Directive (92/43/EEC) but are considered to be common in Ireland. Generally, terrestrial mammal species have a dispersed distribution in Ireland and as such, their conservation is more dependent on landscape-scale measures rather than protection of individual sites. Individual sites are, usually, not more than of local importance to terrestrial mammals.

3.9. BATS

3.9.1. Survey Results

Six species of bats were recorded: Lesser Horseshoe, Whiskered, Natterer's, Daubenton's, Brown Long-eared, Leisler's, Pipistrelle (45 kHz) and Pipistrelle (55 kHz).

Knockanean/Knockaskibbole

Details of the roosts recorded in the Knockanean/Kockaskibbole area are presented in Table 3.5 below, and are shown in Figure 4a. The results of the 1999 survey of Lesser Horseshoes commuting routes and feeding areas are also shown in Figure 4a. Full details of the results of the 1999 survey are included in RPS Consultants Report No. IR527/5.

TABLE 3.5 Bat roosts in the Knockanean/Knockaskibbole area (see Figure 4a for locations)

Location of roost	Species present 1998	1999	Number of bats 1999	Nature of roost (maternity, night, etc.)
Knockanean Old Schoolhouse (KnA)	Lesser Horseshoe	Lesser Horseshoe	6	Maternity
	Brown Long-eared		-	
	? Whiskered		-	
Knockanean B (KnB)	Lesser Horseshoe	Unoccupied in 1999	-	?
Knockanean C (KnC)	not surveyed	Lesser Horseshoe	1	Night
Knockaskibbole A (KsA)	Lesser Horseshoe		-	Night
		Brown Long-eared	>10	Maternity, Night
Knockaskibbole B (KsB)	Lesser Horseshoe	Lesser Horseshoe	1	Night
		Brown Long-eared	-	Night
Knockaskibbole C (KsC)		Lesser Horseshoe	2	Night
Knockaskibbole D (KsD)	Pipistrelle (55kHz)			Mating roost
Gaurus old mill (GaA)	Lesser Horseshoe	Lesser Horseshoe,	2	Night
	? Natterers		-	
		Brown Long-eared	1	Daytime

Knockanean Old Schoolhouse is an uninhabited building used primarily for agricultural storage. In August 1998, it held roosts of Lesser Horseshoe, Brown Long-eared and possibly Whiskered bats. Six Lesser Horseshoe were seen in the building and one Brown Long-eared. Whiskered fed outside the building throughout the night and performed swarming behaviour at one end of it. One room, the attic area and the rear of the building are not open to public access. The ceiling was sagging and urine-stained and may contain large numbers of bats.

When re-surveyed in July 1999, however, Knockanean Old Schoolhouse had been considerably altered from the time of the first survey. The two windows and front door that had been open to access had been sealed up. Some bats would have been excluded by the process. This must certainly have prevented the subsequent usage of many bats. The opening which the bats were using to enter and leave was a 35 cm x 20 cm hole to the rear of the building which had been made to run a length of "hydrodare" containing an electric fence wire to the electric fence below. As Lesser Horseshoes leave and return to the roost in flight, this is not a significant clearance for wings. It may hamper entry enough to render the roost less attractive. Equally, two barns (KnB) north of the Knockanean Old Schoolhouse, that also appeared to be used by Lesser Horseshoes in 1998, had been rendered unsuitable for use by July 1999.

The survey of commuting routes and feeding areas used by the Lesser Horseshoes in this area (see Figure 4a), showed that the Lesser Horseshoes from the Knockanean Old Schoolhouse roost commuted westwards along the Knockanean Road towards Gaurus Bridge keeping very close to cover. Feeding Lesser Horseshoes were noted along the Ballaghboy road from the corner surrounding the former mill at Gaurus Bridge to a point north of the newest housing along the Ballaghboy road. Two Lesser Horseshoes routinely night-roosted in the Gaurus mill building.

An alternative commuting route for the Lesser Horseshoes was a detour south along a small lane running south from the Knockanean road and down to Knockaskibbole (see Figure 4a). Dense hedgerow surrounding fields of varying size (often very small) and corners of mature hazel provided feeding areas for the Lesser Horseshoes. Farm buildings at Knockaskibbole (KsA-C) were noted to be night roosts for Lesser Horseshoe in both years, although occupancy of the individual buildings varied between years. While discussions with the owner raised the possibility that these buildings may be hibernaculum for Lesser Horseshoes, no evidence of hibernating bats was observed during visits in November 1998 and January 1999 and the buildings do not appear to

be suitable for hibernating Lesser Horseshoes. A maternity roost of Brown Brown Long-eared bats was discovered in one of the buildings (KsA) in 1999. This species also used these buildings as a night perch for grooming, etc. A Pipistrelle (55kHz) mating roost was recorded in another farm building (KsD) in 1998.

Ballymacahill

A barn was noted to be used by a Leisler's bat as a mating roost in August 1998 (see Figure 4b). While the possibility exists that it is a maternity roost during early summer, this study cannot confirm this.

Ballybeg Quarry (North Of R475 Road)

In 1998, a Pipistrelle bat returned to a crevice in the limestone quarry (see Figure 4b) while a *Myotis* performed return behaviour but may have been disturbed by the observer and was not seen to enter the quarry. It is reasonable to predict that the quarry serves as a variety of roost sites throughout the year as possibilities exist for bats within crevices and under stone piles. A Lesser Horseshoe did pass by at the smaller adjacent quarry but no roosts were located. An internationally important site for Lesser Horseshoes is found south of this area in Edenvale (outside the study corridor).

Castlefergus

Pipistrelles (55kHz) were noted to be roosting in a Bed and Breakfast (Castlefergus farm) and one Daubenton's bat was seen roosting in a railway under-pass on Castlefergus farm (see Figure 4b).

3.9.2. Evaluation

Of the bat species recorded during this survey, Lesser Horseshoes are considered to be globally threatened (Vulnerable) while Leislers are classified as near-threatened (Bailie and Groombridge, 1997). Lesser Horseshoes are listed on Annex 2 of the Habitats Directive (92/43/EEC). Whiskered and Natterer's bats are listed as 'Indeterminate' in the Irish Red Data Book (Whilde, 1993).

There is an estimated population of 12,000 Lesser Horseshoes in Ireland. Limestone-rich areas form an important element in the habitat within which they are found. Within this area, Edenvale is a site of international importance (pSAC). Another roost, Newpark House, has also been designated a roost of national importance (pNHA). Counts in July 1999 have, however, indicated that this latter roost is in decline. It is considered that this decline is due to suitable roosting sites for successful rearing of young being a limiting factor (see RPS Consultants Report No. IR527/5).

Knockanean Old Schoolhouse may serve as a "reservoir" for replenishment of the roost in Newpark House. There are at present few Lesser Horseshoe bats at Knockanean Old Schoolhouse. In the light of the reduced access to the building, this is not surprising. Historical use of this site (in the past 25 years or more) is unclear. It was shown to be used by Brown Long-eared bats and Whiskered bats during 1998. These are no longer present. It is very possible that, should the building be opened up to greater access for bats, it would become a more important roost again.

Consequently, while the present numbers of bats known to be using the Knockanean Old Schoolhouse roost are not of international or national importance, this roost site is probably still of

significant value. It may be a "reservoir" roost for the Newpark House roost (a proposed NHA). It is also likely that untill very recently it held larger numbers of Lesser Horseshoes.

3.10. EVALUATION OVERVIEW

The best sites are listed with their key features in Table 3.6. The key site is AEC 3 which forms part of a large habitat complex of value for an array of flora and fauna. Some nationally scarce species occur and, while many of the other features of interest in this site are frequent in the Burren region, the site may represent a geographical limit for these species. The occurrence of Lesser Horseshoe bat roosts at Knockanean and Knockaskibbole is also particularly notable.

TABLE 3.6 Summary of key areas of ecological constraint and their key features.

AEC	Key sub-sites	Key features		Importance
3	3/1, 3/4, 3/5, 3/6, 3/7, 3/8	Plant communities:	Alkaline fen (3/1)	County(/National?)
			Limestone pavement (3/4)	
			Molinia meadow (3/1 and 3/5)	
		Plants:	3 nationally scarce species	
			7 nationally local species	
			2 regionally scarce/local species	
			Anania funebris (3/4)	
		Lepidoptera:	Marsh Fritillary (3/7)	
			8 other notable lepidoptera	
		Birds:	Grasshopper warbler (throughout)	
4		Plants:	1 nationally scarce species	County
			3 nationally local species	
7	7/1, 7/2	Plant community:	Transition mire (7/2)	District/County
		Plants:	1 nationally scarce species	
			2 nationally local species	
10	10/2	Plant community:	Wet calcareous meadow (10/2)	District/County
		Plants:	1 nationally local species	
			1 regionally local/scarce species	
		Birds:	Water Rail (10/1)	
14	14/1	Plant community:	Calcareous grassland (14/1)	District/County
		Plants:	3 nationally local species	
			1 regionally local/scarce species	
		Lepidoptera:	3 notable species	
6	6/1, 6/3	Plant community:	*Carici nigrae* fen (6/1)	District
			Marshy grassland/Fen transition (6/3)	
		Plants:	1 nationally scarce species	
11		Plant community:	*Carici nigrae* fen	District
			Cladium swamp	
		Plants:	1 regionally scarce/local species	
15		Plant community:	Greater Tussock Sedge swamp	District
17		Plants:	1 nationally local species	District

4. IMPACT

4.1. INTRODUCTION

Impacts on water quality affecting aquatic flora and fauna are discussed in the Water Quality and Fisheries Report (RPS Cairns Report No. IR527/2).

Ecological impacts can occur by several different mechanisms. The main types of impacts are discussed in a general context below while impacts specific to particular sites or features of ecological value are discussed in detail in Section 4.2

The terminology used to describe impact significance is defined in Appendix 5.

4.2. TYPES OF IMPACTS

4.2.1. Direct Habitat Loss

The direct loss of semi-natural habitats along the road corridor is summarised in Table 4.1.

TABLE 4.1 Habitat loss to proposed route (only semi-natural habitats of potential conservation interest, excluding hedgerows, are listed)

Habitat-type	Amount affected	No. of discrete parcels affected
River	0.71 ha	4
Field Pond	0.07 ha	2
Swamp	1.32 ha	5
Wet modified bog	2.94 ha	6
Fen	1.75 ha	5
Fen/marshy grassland complex	0.12 ha	1
Marshy grassland	9.99 ha	21
Unimproved calcareous grassland	1.61 ha	5
Scrubwood/calcareous grassland complex	1.77 ha	1
Saltmarsh	0.21 ha	2
Scrub	0.58 ha	5
Scrubwood	10.86 ha	12
Semi-natural broad-leaved woodland	0.10 ha	2
Quarry complex	0.33 ha	1
Limestone pavement	0.73 ha	2
Limestone cliff	117 m	2

4.2.2. Indirect habitat changes

As well as direct loss, habitats outside the land-take of the road may change as a result of indirect impacts. If these changes significantly alter the type and/or quality of the habitat, then such changes are effectively additional habitat losses. In the case of the Ennis Bypass, indirect impacts could include hydrological impacts and air pollution impacts.

Hydrological Impacts

Hydrological impacts to habitats could result from changes to patterns of surface water and/or ground water drainage. While it may be relatively straightforward to prevent changes to surface water drainage patterns, changes to ground water drainage may be much more difficult to predict at a scale relevant to potential ecological impacts. Habitats such as fen, swamp, wet modified bog

and marshy grassland are potentially susceptible to hydrological impacts, and even quite subtle and localised hydrological changes may have significant habitat impacts (PAA, 1993).

Air Pollution

Air pollution from road traffic could potentially cause a number of types of ecological impacts but the actual likelihood and significance of many of these are not known (PAA, 1993). There is, however, good evidence that increased aerial deposition of nitrogen can have significant impacts on a variety of plant communities typical of nutient-poor conditions (Bobbink *et al.*, 1998). The link between vehicle emissions and impacts on heathland plant communities has been demonstrated by Angold (1997). The latter study showed that increased cover of Purple Moor-grass relative to Heather and *Cladonia* lichens occurred close to roads. This effect was correlated with traffic numbers, with an edge effect of up to 200 m along busy roads (c. 35,000 axle pairs per 12 h). Based on the information in Bobbink *et al.* (1998), it would appear that the marshy grassland, unimproved calcareous grassland, fen, wet modified bog and scrubwood habitats could all be vulnerable to these type of impacts. Swamp-type habitats are probably not vulnerable due to the large nitrogen inputs via surface water. The vulnerability of limestone pavement habitat is not specifically discussed by these authors. However, the vulnerability of individual sites may differ from the general vulnerability of their habitat-type, due to site specific factors.

In Section 4.3, the potential for air quality impacts is only discussed where the habitats involved are of botanical interest and are potentially vulnerable.

4.2.3. Habitat Fragmentation

Habitat fragmentation will occur when a contiguous patch of habitat is crossed by the road creating one or more smaller habitat patches. Reducing the size of the habitat patches may cause declines in species numbers if the patches become too small to support viable populations. The increased proportion of 'edge' to 'interior' in these smaller patches can cause changes to the species composition due to increased invasion or predation by 'edge' species. Habitat fragmentation may have significant impacts in AEC 3.

4.2.4. Barrier Effects

Roads may act as barriers to movements by many types of animals (e.g. Mader, 1984; Richardson *et al.*, 1997). The Ennis Bypass may have significant barrier effects on Common Frogs and Common Lizards in several areas. In addition, the road will cause barrier effects on small mammals and invertebrates throughout the route but especially where it crosses an existing hedgerow or patch of wooded habitat. Barrier effects may have significant impacts in AEC 3, where a number of notable invertebrate species were recorded (see Section 4.3.3).

4.2.5. Disturbance

Roads can cause significant disturbance impacts to birds through the effect of traffic noise on breeding bird populations (Reijnen *et al.*, 1995). This impact will occur throughout the route corridor wherever the level of traffic noise rises significantly. While farmland bird populations will be affected over much of the route, the impact will be more significant when woodland or wetland bird populations are affected due to the relative scarcity of such habitat in the area. These impacts would, potentially, be of most significance in AECs 3, 10 and 14 which held notable breeding species.

4.2.6. Wildlife Road Casualties

Direct mortality of animals due to collisions with traffic often occur. While many different groups of animals can be subject to such mortality, the impact of this mortality on the animal populations may often be insignificant (e.g. Munguira and Thomas, 1992). Road casualties may have significant impacts when deaths are concentrated in certain locations and result in the near loss of a local population (PAA, 1993). In the context of the Ennis Bypass, potential road casualties of Common Frogs, birds and mammals (especially Otters and Pine Martens) are issues to be considered.

Road casualties can result in loss rates of 20-40% of an amphibian breeding population (Langton, 1989). Common Frogs were commonly observed in wetland habitats within the route corridor. Based on habitat suitability, breeding populations of Common Frogs are likely to occur in most of the AECs within the route corridor, and in additional ditch and field pond habitats outside the AECs.

While large numbers of birds and mammals are reported as road casualties (Mead, 1997) many of these are common species and the number of deaths may simply reflect their abundance (Slater, 1994). Some of the highest bird road death rates are for owls (Mead, 1997). Both Barn Owls and Long-Eared Owls are scarce breeding species in County Clare but have been recorded from the vicinity of Ennis (Gibbons *et al.*, 1993); no specific surveys for owls were carried out for this EIS.

The mammals in the study area for which road deaths could be of concern are Pine Martens and Otters. Pine Martens may be particularly vulnerable in AECs 10 and 14, where the proposed route bisects large areas of scrubwood habitat. Otters could be affected where the road crosses wetland corridors. This applies to most AECs as well as watercourses outside AECs, but may be particularly significant in AECs 3, 4 and 16.

In Section 4.3, only the potential risk to Pine Martens is highlighted for individual sites; it can be assumed that Common Frogs and Otters are potentially at risk over the majority of the proposed route.

4.3. PREDICTED IMPACTS

4.3.1. AEC 1 Latoon Creek

The proposed crossing of this creek will be adjacent to the existing road. The marginal saltmarsh at this point is species-poor and of low ecological interest. Therefore, the impact is considered to be imperceptible.

4.3.2. AEC 2 Carrowgar

This AEC is not directly affected by the proposed route. The marshy grassland habitat could, however, be negatively affected by air quality impacts

4.3.3. AEC 3 Kilbreckan/Skehanagh/Killow

This is the largest and most important AEC in the route corridor and the proposed route will have a number of significant ecological impacts here.

Habitat Loss

Habitat loss to the proposed route is summarised in Table 4.2. Of particular significance are the loss of limestone pavement and fen habitats, as a large proportion of the total extent of these habitats within the AEC will be lost. The fen habitat may be completely lost, as it is likely that road construction will affect the hydrological conditions (e.g. by changes to groundwater drainage patterns) in the small remnants outside the direct land-take. The larger of the two parcels of limestone pavement in this AEC will also be almost completely lost. The smaller, northern parcel of limestone pavement will probably not be directly affected (the qualification 'probably' is required because it was not possible to precisely map the limits of this habitat as the habitat boundaries do not correspond to mapped features on the OS base map). This section was the more notable, botanically, with one nationally scarce plant species (Dogwood).

TABLE 4.2 Direct habitat loss to the proposed route in AEC 3. Only habitats of conservation interest are listed.

Habitat type	Sub-site number	Habitat loss
Marshy grassland	3/10	0.83 ha
Marshy grassland	3/12	0.28 ha
Marshy grassland	3/11	0.48 ha
Marshy grassland	3/5	1.73ha
Limestone pavement	3/4	0.72 ha
Calcareous grassland	3/2	1.13 ha
Fen	3/1	0.76 ha
Marshy grassland	3/1	0.55 ha
Unimproved neutral grassland	3/1	0.08 ha
Wet modified bog	3/6	0.08 ha
Wet modified bog	3/7	2.67 ha
Marshy grassland	3/8	0.64 ha
Marshy grassland	3/9	2.52 ha

The marshy grassland habitat lost comprises sections of sub-sites 3/1, 3/3, 3/8, 3/9, 3/10, 3/11 and 3/12. Of these sub-sites, 3/1 was perhaps the most interesting with a species-rich community transitional from the adjoining neutral grassland to fen habitats and held three locally notable sedges. Sub-site 3/11 held one nationally local plant species (Bladder Sedge). This sub-site will be completely removed by the proposed route. The remaining marshy grassland sub-sites did not hold any outstanding features. However, each sub-site is different in terms of its plant community composition, and all contribute toward the overall diversity of the marshy grassland habitat in this AEC.

The wet modified bog habitat loss is only a small proportion of the total extent of this habitat in the area. However, the sections being affected by the road include the only location where Marsh Fritillary butterflies were observed. It should be noted, however, that only a small proportion of the wet modified bog habitat was searched. The extent of suitable habitat in, and adjoining this AEC, and the suspected metapopulation structure of Marsh Fritillary populations (see Section 3.5.2), makes it unlikely that Marsh Fritillaries are restricted to this location.

The wet modified bog in sub-site 3/6 held a population of the nationally scarce plant species, Fen Bedstraw. Of the twelve patches recorded in August 1999, one is within the land-take of the road and three are within 10 m of the land-take (see RPS Consultants Report No. IR527/6). Therefore, depending upon the extent of disturbance during construction, up to one-third of the known population of this species could be removed. In this worst-case scenario, the overall viability of the local population could be affected. It is likely, however, that additional patches of this plant could

occur outside the landtake of the road (see RPS Consultants Report No. IR527/6). If care is taken during construction to avoid any impacts outside the road landtake, then the loss of a single patch is probably unlikely to affect the viability of the local population.

The numerous wet ditches in this AEC held, in places, an interesting aquatic flora. Of particular interest was the community occurring in the ditches which bound the southern meadow of sub-site 3/8. These held populations of the nationally scarce Frogbit as well as several locally notable species (Lesser Water Parsnip, Mare's-tail and Great Water Dock). The proposed route will remove around 50% of the lengths of ditches holding this community.

The section of ditch holding the nationally local Lesser Pond-sedge in sub-site 3/10 will not be directly affected by the proposed route.

The unimproved calcareous grassland in this AEC was not considered to be of high botanical or entomological interest.

Hydrological Impacts

Hydrological impacts could cause changes in any of the wetland habitats crossed by the proposed route, but are most likely to be significant in sub-site 3/1. This sub-site was considered to be of high botanical interest with a complex range of transitional plant communities which are likely to be particularly susceptible to any hydrological changes. The proposed route will bisect the sub-site and must be likely to cause significant changes to the remnant sections outside the direct land-take of the road.

The Fen Bedstraw population in sub-site 3/6 outside the road landtake could potentially be affected by hydrological impacts. However, the depth of the drainage ditches surrounding this sub-site suggest that if the existing surface drainage patterns are maintained, such impacts are unlikely to occur. Similarly, the important aquatic plant flora in the ditches surrounding sub-site 3/8 could be affected by hydrological changes but this should be preventable if culverts are provided to maintain the existing drainage patterns.

Air Pollution Impacts

Most of the habitats within this AEC are potentially vulnerable to air pollution impacts. In particular, there could be an increase in the relative abundance of Purple Moor-grass compared to ericoids and forbs in the fen meadow and wet modified bog habitats. This could affect a substantial area of habitat.

Habitat Fragmentation and Barrier Effects

While it is difficult to predict specific ecological impacts from habitat fragmentation, the proposed route will clearly cause a high amount of physical habitat fragmentation. The loss of over 50% of the limestone pavement in this AEC may be particularly significant, given the small total extent of this habitat: local extinctions of specialist lepidoptera and other invertebrates could occur as a result.

The proposed route may also cause significant barrier effects, preventing or limiting movements by sensitive species between the remaining sections of habitat. This is probably most likely where the western bypass crosses sub-sites 3/3, 3/2, 3/1, 3/7 and 3/8 on high embankment. Butterflies

and large moths may not be affected (see Munguira and Thomas, 1992); in particular, Marsh Fritillaries are probably good dispersers (cf. Warren, 1994). However, smaller and/or less mobile invertebrates may be affected. This could include some of the notable species of micro-lepidoptera recorded in sub-sites 3/4 and 3/7.

Disturbance

The proposed roads will, presumably, cause a large increase in traffic noise in this area. This may cause noise impacts to breeding birds (including Snipe and Grasshopper Warblers).

Impact Significance

The overall significance of the potential impacts to this AEC is considered to be substantial - profound. This is based upon the extent of direct habitat loss to areas of high ecological importance, and the number of potential indirect impacts which could occur.

4.3.4. AEC 4 River Fergus at Clareabbey

Depending upon the bridge design, the road will result in the removal of up to up to 0.38 ha of marginal habitat. This habitat in this AEC held a number of notable plant species. Flowering Rush, the rarest of these, however, occurred outside the land-take of the road, as did Great Water Dock. The other two species, Greater Pond-sedge and Reed Sweet-grass occurred extensively throughout this AEC, and also occur upstream.

The potential for impacts from habitat fragmentation/barrier effects will depend upon the bridge design. If the bridge abutments extend right up to margins of the tidal channel, then movement by riverine fauna along the river corridor may be impeded and Otters may be at high risk of road mortalities. Suitable mitigation will, probably, largely eliminate the potential for these impacts.

Impact Significance

The significance of habitat loss is slight given the extent of similar habitat upstream and downstream, and the fact that localised plant species do not occur in the affected stretch. The significance of indirect impacts depend upon the bridge design.

4.3.5. AEC 5 Kilbreckan North

The proposed route will not directly impinge upon this site. Traffic noise could cause disturbance to breeding bird populations in the site, but these populations are not likely to be of particular significance. The impact is, therefore, likely to be imperceptible.

4.3.6. AEC 6 Knockaskibbole

The direct habitat loss in this AEC is shown in Table 4.3. The road will pass through the middle of the fen habitat in sub-site 6/1 and will probably result in the loss of this entire habitat through associated disturbance and hydrological impacts. This type of fen habitat is apparently not of high scientific interest, but this site is of at least local value. This site holds a population of a nationally-rare hybrid (Hybrid Hard Rush) which will be removed by the proposed route.

TABLE 4.3 Direct habitat loss to the proposed route in AEC 6. Only habitats of conservation interest are listed.

Habitat type	Sub-site number	Habitat loss
Marshy grassland/fen transition	6/3	0.12 ha
Fen	6/1	0.89 ha

While land-take in sub-site 6/3 will be minor, this habitat may be affected by hydrological impacts. This sub-site contains a range of transitional vegetation which is likely to be susceptible to even subtle changes in hydrological conditions. This sub-site may also be vulnerable to air quality impacts.

The unimproved neutral grassland which the proposed route will affect is of low ecological interest.

Impact Significance

The direct habitat loss is only a moderate impact as sub-site 6/1 is not of high conservation importance. If indirect impacts cause large changes to sub-site 6/3, then the overall impact significance could rise to moderate-substantial.

4.3.7. AEC 7 Knockanean

The direct habitat loss in this AEC is shown in Table 4.4. The road will result in the complete removal of sub-site 7/1, a small area of marshy grassland with some notable plant species, including one nationally local species (Small Sweet-grass). Part of this habitat has, however, already been lost (to agricultural improvement) and the long-term future of the remainder of this sub-site is probably questionable. The scrubwood/calcareous grassland complex (sub-site 7/3) is of local importance for mammals. This site held two notable rose species; however, as discussed above (Section 3.4.2), the occurrence of notable rose species is not being used as an important factor in this assessment.

TABLE 4.4 Direct habitat loss to the proposed route in AEC 7. Only habitats of conservation interest are listed.

Habitat type	Sub-site number	Habitat loss
Marshy grassland	7/1	0.33 ha
Fen	7/2	0.09 ha
Scrubwood/calcareous grassland	7/3	1.77 ha

The road may cause hydrological and air quality impacts to the fen habitat in sub-site 7/2. This sub-site was the best example of fen habitat recorded in the route corridor and held several notable plant species. It should be noted, however, that even in the absence of road construction the surrounding agricultural improvement, which is ongoing, is likely to affect this site.

The road will cause fragmentation of the large block of scrubwood and calcareous grassland in sub-site 7/3. This may be particularly significant for Pine Martens, who will also be at risk from road mortalities here.

Impact Significance

The overall significance of impacts in this AEC will be moderate-substantial given that a population of a nationally local plant species will be lost, and that an important fen habitat may be affected.

4.3.8. AEC 8 Ballymacahill South

The proposed route will cause loss of Hazel scrubwood, marshy grassland and unimproved neutral grassland in this AEC. The examples of these habitats occurring in this AEC were not, however, considered to be of particular significance. The impact is, therefore, considered to be imperceptible-slight.

4.3.9. AEC 9 Ballymacahill Lough

While there will be no significant direct habitat loss in this AEC, indirect habitat impacts could occur through hydrological and/or air pollution impacts.

4.3.10. AEC 10 Cappagh/Ballyduff

The direct habitat loss in this AEC is shown in Table 4.5. The road will result in the direct removal of most of the swamp habitat in sub-site 10/1 and it is likely that major hydrological impacts will occur to the remainder. This sub-site held one nationally local plant species (Tufted Sedge). This species was, however, quite widely recorded during the present surveys. Overall, this sub-site is not considered to be of very high botanical value.

TABLE 4.5 Direct habitat loss to the proposed route in AEC 10. Only habitats of conservation interest are listed.

Habitat type	Sub-site number	Habitat loss
Scrubwood	10/3	1.90 ha
Swamp	10/1	0.84 ha

The road may cause hydrological and/or air quality impacts to sub-site 10/2. This sub-site is of high botanical interest and is likely to be sensitive to even small changes in the hydrological regime.

The road may cause water quality impacts to Cappagh Lough (see Water Quality and Fisheries Report (RPS Cairns Report No. IR527/2)).

The road will cause fragmentation of the large block of scrubwood in sub-site 10/3. This may be particularly significant for Pine Martens, who will also be at risk from road mortalities here.

The proposed roads will, presumably, cause a large increase in traffic noise in this area. This may cause noise impacts to breeding birds (including Water Rail, Snipe and Blackcap).

Impact Significance

The overall significance of the predicted impacts is moderate-substantial, depending upon the extent of any impacts to sub-site 10/2.

4.3.11. AEC 11 Barefield

While the direct habitat loss in this AEC is minimal (0.08 ha), there is potential for significant hydrological impacts. There is no obvious source of surface water inflow to this fen. It is presumably fed by sub-surface drainage from the higher ground to the east of the site. There is an obvious potential for this drainage to be interfered with by the road construction.

Impact significance

This site held three regionally scarce/local plant species (Least Bur-reed, Brown Sedge and Hairy Sedge) but is not considered to be of exceptional ecological interest. It has already suffered, to some extent, from habitat disturbance. The significance of the predicted impact is, therefore, considered to be probably no more than moderate.

4.3.12. AEC 12 Ballymaconna

The proposed route follows the line of the existing N18 in the vicinity of this site. Any direct habitat loss will be very minor and confined to the margins of the site which are already disturbed. Indirect impacts should not change significantly from those arising from the existing road. The impact, therefore, is likely to be imperceptible.

4.3.13. AEC 13 Clareabbey Inundation Meadow

The proposed route will cause the direct removal of 0.64 ha of marshy grassland. This marshy grassland is a rather mundane flood meadow. While two notable plant species occurred, associated with the ditch habitat, these will not be affected by the proposed route.

The location of the proposed route at the upper corner of the meadow may limit any potential hydrological impacts, providing the existing surface water inflows are maintained.

Impact Significance

This AEC is not of high ecological value, so the overall impact significance is considered to be slight-moderate.

4.3.14. AEC 14 Ballybeg/Cahircalla Beg

The direct habitat loss in this AEC is shown in Table 4.6. The road will result in the direct removal of much of the unimproved calcareous grassland habitat in sub-site 10/1. This sub-site is considered to be of high botanical and entomological value. It was the best example of calcareous grassland encountered within the route corridor. The remainder of this sub-site will be vulnerable to air quality impacts. Invertebrates occurring in this sub-site may be affected by habitat fragmentation and/or barrier effects.

TABLE 4.6 Direct habitat loss to the proposed route in AEC 14. Only habitats of conservation interest are listed.

Habitat type	Sub-site number	Habitat loss
Scrubwood	14/2	6.66 ha
Unimproved calcareous grassland	14/1	0.48 ha
Limestone Cliff	14/1	117 m
Pond	14/1	0.06 ha
Limestone Pavement	14/2	0.01 ha
Marshy grassland	14/3	0.37 ha

The road will cause significant fragmentation of the large block of scrubwood in this AEC. This is the largest area of scrubwood in the route corridor and is semi-contiguous with Cahircalla Wood pNHA which lies to the south of the R475 road. This scrubwood is of high local importance for mammals and the proposed road may have significant impacts on mammal utilisation of this area

in terms of habitat fragmentation, barrier effects and road traffic casualties. These effects would be of particular significance in terms of their impacts on Pine Martens.

Impact Significance

The predicted impact on the calcareous grassland habitat is a substantial impact. The remaining impacts are of no more than moderate significance.

4.3.15. AEC 15 Cahircalla

The proposed route will cause the direct removal of an area of scrub habitat. It will not directly affect the marshy grassland or the swamp. These wetland habitats appear to be fed by drainage from the west; this will not be interfered with by the proposed route. The impact is likely, therefore, to be imperceptible at this site.

4.3.16. AEC 16 Inch or Claureen River

Impacts on water quality affecting aquatic flora and fauna are discussed in the Water Quality and Fisheries Report (RPS Cairns Report No. IR527/2). The proposed route may cause increased risk of Otter road mortalities. Suitable mitigation will, probably, largely eliminate this risk. The short stretches of bankside habitat which may be removed by the road construction are not of particular significance. Therefore, assuming, appropriate measures are taken to reduce the risk of Otter road mortalities, the impact should be imperceptible-slight.

4.3.17. AEC 17 Claureen

The proposed route will cause the direct removal of 0.51 ha of marshy grassland in this AEC and may have hydrological impacts to the remainder. This site held one nationally local plant species (Bladder Sedge) but was not considered to be of exceptional botanical interest. In any case, the main populations of this species within the site will not be directly affected.

Impact Significance

Depending upon the extent of any indirect hydrological impacts, the overall impact significance is considered to be slight-moderate.

4.3.18. Bats

The known bat roosts which will, or may, be removed by the proposed route are listed in Table 4.7. In the case of the quarry at Ballybeg, the proposed route crosses the northernmost end of the quarry face but leaves the remainder unaffected.

TABLE 4.7 Known bat roosts in the line of the proposed route

Chainage	Townland	Description
		Definitely to be removed
18,000	Knockaskibbole (KsA and KsB)	Two barns: Lesser Horseshoe night roost and Brown Long-eared maternity and night roost
18,400	Knockanean (KnC)	Barn: Lesser Horseshoe night roost
18,720	Knockaknean Old Schoolhouse (KnA)	Lesser Horseshoe maternity roost, Brown Long-eared and, possibly, Whiskered in in 1998
		May be removed

20,450	Ballymacahill	Barn: Leisler's mating roost
4,200[1]	Ballybeg	Pipistrelle and (?) *Myotis* roost in quarry

[1] western bypass

The loss of roost sites, as well as causing direct mortality of bats, can affect the capacity of an area to support bats, as the availability of roost sites may often be quite limited. In particular, Lesser Horseshoes have very specific requirements for roost sites and the results of the 1999 survey (see RPS Consultants Report No. IR527/5) indicate that suitable roost sites may already be limiting the population in this area. Bat populations may also require a number of alternative roost sites for use at different times of the year.

As well as direct loss of roost sites, the proposed route is likely to cause impacts to bat populations through loss of feeding habitat and interruptions to commuting routes. This is clearly demonstrated by the survey results for the Knockanean/Knockaskibbole area (see Figure 4a) and is likely to occur elsewhere along the route.

Bats generally use corridors of tall vegetation, such as hedgerows and treelines, to commute between their feeding habitat and roost sites. In particular, Lesser Horseshoes are known to be very dependent on the existence of such corridors for their commuting routes, and even small breaks in these corridors may create barriers. There appears to be no specific evidence available as to the potential role of major roads as barriers to commuting bats. However, based on knowledge of their general ecology, it is very likely that a dual carriageway would be a significant barrier to commuting Lesser Horseshoes. Thus, in the Knockanean/Knockaskibbole area, the proposed route may isolate Lesser Horseshoe roosts on either side of the road, and could affect the overall viability of the local population.

Significance

Lesser Horseshoes are listed on Annex 2 of the Habitats Directive and are globally threatened. Any impacts on this species are of potential significance. The removal of a maternity roost and three night roosts, interruption to commuting routes and loss of feeding habitat could potentially affect the viability of the local population. This would be a substantial-profound negative impact.

5. MITIGATION

5.1. INTRODUCTION

This section provides recommendations for measures which can mitigate or compensate some of the predicted ecological impacts of the proposed route. General mitigation measures which can be applied throughout the length of the roadway are discussed in Section 5.2. Mitigation measures specific to particular sites are discussed in Section 5.3.

5.2. GENERAL MITIGATION MEASURES

5.2.1. Construction

Habitat disturbance in areas of ecological constraint during construction work should be strictly confined to within the direct land-take of the proposed route.

5.2.2. Mitigation of hydrological impacts

The requirement for mitigation of hydrological impacts is difficult to assess due to the considerable uncertainty as to the nature and extent of any such impacts that are likely to occur. However, as a precautionary measure, the existing surface drainage patterns should be maintained through appropriate provision of culverts, wherever the road passes through, or adjoins, an important wetland habitat. Sites where this is particularly important are identified in Section 5.3.

5.2.3. Mitigation of air quality impacts

Where the road passes through, or close to, habitats which may be sensitive to air quality impacts, dense planting of scrub on the road embankments may significantly reduce any such impacts by filtering pollutants from the air (PAA, 1993). Some species of trees and shrubs are more efficient at filtering pollutants, than others (Madders and Lawrence, 1981).

These requirements may, in some cases, conflict with requirements for mitigating fragmentation/barrier effects (see Section 5.2.4)

5.2.4. Mitigation of habitat fragmentation/barrier effects

Many of the impacts of habitat fragmentation/barrier effects are not practicably mitigatable. However, underpasses/tunnels installed for mitigation of wildlife road casualties (see Section 5.2.6) will also mitigate against habitat fragmentation/barrier effects for the species concerned. Continuation of a similar habitat type/structure onto the road embankments may also provide some mitigation, by reducing the effective barrier width. However, this may conflict with requirements for mitigation of air pollution impacts (see Section 5.2.3).

5.2.5. Landscape Planting

Where the proposed route passes through areas of ecological constraint, the landscape planting of the road embankment should use predominantly Irish native-origin species which reflect the existing vegetation of the area. These should be derived from locally indigenous genetic stock following the principles of the *Flora Locale Draft Technical Guidance Notes* (see

http://www.naturebureau.co.uk/pages/floraloc/guidenot.htm). An indicative list of appropriate native species is provided in Table 5.1.

TABLE 5.1 Indicative list of appropriate native species for landscape planting on road embankments in areas of ecological constraint.

Habitat type	Core species	Additional species
Hedgerows and scrub	Hawthorn, Blackthorn, Hazel,	Elder, Common Dog-rose, Spindle, Rowan, Guelder-rose, Holly
Hedgerow trees	Ash	Sessile/Pedunculate Oak
Wetland scrub	Rusty Willow, Alder	

While wildfower seed mixes are often used for planting road embankments as an ecological 'mitigation' measure, the value of this is uncertain. Use of inappropriate seed mixes can, in certain cases, cause ecological damage. Where it is desired to create a semi-natural grassland, a better approach may be to allow natural colonisation of the road embankment, following appropriate preparation of the substrate. This would involve using an appropriate soil (a sub-soil may be the most suitable) and creating irregularities (such as ledges and variation in slope) in the grading of the embankments. This approach is particularly suitable where there is existing semi-natural grassland adjacent which can act as a source for colonisation (see Gilbert and Anderson, 1998).

5.2.6. Wildlife tunnels/underpasses

Wildlife tunnels/underpasses can be used to mitigate against both habitat fragmentation/barrier effects and the risk of wildlife road casualties.

Where the proposed route crosses an existing watercourse, Otter pipe underpasses should be installed to minimise the risk of mortalities from collision with traffic. These underpasses should be above, but within one metre of, the high water level of the watercourse. The underpasses should be screened by scrub planting and fencing for three metres either side of the entrance. This will encourage Otters to use the underpass and prevent them from travelling over the roadway. These underpasses will probably also be suitable for use by Common Frogs. Where specifically recommended in Section 5.3, similar types of underpasses should be installed for Pine Martens. These should be located at habitat boundaries, and at intervals in long sections of continuous scrubwood. These underpasses may also be suitable for use by Common Lizards.

5.2.7. Mitigation of impacts to bats

A number of specific impacts to known roost sites have been identified and specific recommendations to mitigate against these impacts are provided in Section 5.3.9 below. However, there are also a number of general recommendations that can be made which can be applied throughout the route.

Timing of Road-works

The demolition of bat roosts during summer (May to mid-August) when bats are present should be avoided to prevent unnecessary mortalities. Similarly, where it is evident that bats are present at other times when work is due to commence, efforts should be made by an expert to exclude the bats before demolition.

Creation of Vegetation Corridors

Bats usually follow landmarks to their feeding sites, i.e. hedgerows, tree cover or for larger species, free-standing trees. Planting blackthorn, or other native shrubs attractive to insect fauna, along road routes increases the available insect prey and may connect areas that have been severed by the road. This is especially true where bridges and under-passes exist or are incorporated. Lesser Horseshoe and other species will often fly several kilometres to feeding sites.

Erection of Bat Boxes

Bat boxes may provide alternative roosts for tree roosts or building roosts not identified in this study. Various designs exist for roosting boxes for bats, from the standard design to a design that can be incorporated into bridges or free-standing (the "Belfry Box" and Scwegler boxes). These boxes (especially the latter) have been successful throughout Europe in providing new roosts for bats.

Adaptations to Bridges to Attract Bats

Incorporation of timber elements into bridges may provide new roosts for bats. Equally, creation of a suitable cavity at a southerly aspect may serve as a roost. One bridge in the Dun Laoghaire-Rathdown Borough has been adapted for bats. The "Belfry Box" or the Type 27 box from Alana Ecology are other options, even for present bridges.

Provision of accessible cavities in new walls

Such cavities should be open to the outside via 4-6 cm gaps. Holes need only be approximately 2 cm in height. Cavities could be 3-5 cm in depth with variations in the depths to allow for choice. Equally, the Type 27 box is suitable for this purpose.

5.3. SPECIFIC MITIGATION MEASURES

5.3.1. AEC 3 Kilbreckan/Skehanagh/Killow

Culverts should be used to maintain the existing drainage patterns, as far as possible, so as to reduce the potential for indirect hydrological impacts to wetland habitats outside the direct line of the proposed route. In particular, the existing surface water drainage around sub-site 3/8 should be maintained to retain suitable conditions for the nationally scarce plant, Frogbit, which occurs in these drainage ditches. In order to compensate for the loss of habitat for this species, sections of unoccupied ditch habitat adjoining existing populations could be managed to create suitable conditions for this species. These areas of additional habitat could be 'seeded' by translocating material from the areas being affected by the proposed route.

The existing surface water drainage around sub-site 3/6 should be maintained to retain suitable conditions for the nationally scarce plant, Fen Bedstraw (the preferred water table conditions for this species are 5-20 cms below ground level; Newbold and Mountford, 1997). The patch of Fen Bedstraw within the road landtake should be translocated to an appropriate receptor site. Care should be taken during construction to avoid any interference to the patches of Fen Bedstraw outside the road landtake. If disturbance to the three patches within 10 m of the road landtake is considered inevitable, then these should also be translocated.

The population of Marsh Fritillary butterflies in sub-site 3/7 should also be translocated away from the line of the road. This will involve searching the landtake area of the proposed route in early spring for the caterpillars before they leave their distinctive communal webs. These should then be transferred to a suitable receptor site away from the line of the route, i.e., a site with Devil's-bit Scabious exhibiting a similar growth form and growing in similar habitat conditions to the donor site. To prevent adult butterflies from ovipositing in the landtake area of the proposed route, the vegetation in this area should be cut back in mid-May, with repeat cuts, as necessary, to maintain a low vegetation height up to the end of the flight season (early July).

Translocation will require specialist ecological advice (see Birkinshaw, 1991; Bullock *et al.*, 1997).

Planting of dense scrub along the road embankments would mitigate against potential air quality impacts. However, this may exacerbate fragmentation/barrier effects against invertebrates in, for example, the wet modified bog. There is no definitive advice that can be given as to the best treatment of the road embankments, given the uncertainties attached to prediction of both air pollution impacts and fragmentation/barrier effects. However a strategy of dense scrub planting interspersed with narrow corridors of grassland may be an appropriate compromise between these conflicting requirements.

In the vicinity of Killow Junction, shattered limestone could be used to create limestone outcrop-type habitats along the road embankments and in the severed areas inside the interchange. While it will not be possible to re-create limestone pavement, this may provide suitable habitat for some of the characteristic species, particularly if it is linked up to the remaining area of limestone pavement to the north.

In view of the extent and significance of the predicted impacts in this AEC, consideration could be given to some form of habitat creation, as a compensatory measure.

5.3.2. AEC 4 River Fergus at Clareabbey

In order to minimise potential habitat fragmentation/barrier effect impacts, the bridge abutments should be kept close to the existing embankments. This will allow retention of corridors of marginal wetland habitat under the bridge.

It is also important that Otter underpasses (see Section 5.2.6 above) should be provided along the ditches that run outside the river embankments (i.e., it should not be assumed that the wetland corridors underneath the bridge will be, by themselves, sufficient mitigation for the risk of Otter road mortalities).

5.3.3. AEC 6 Knockaskibbole

The western road embankment adjoining sub-site 6/2 should be planted with dense scrub in order to buffer potential air quality impacts to this sub-site.

5.3.4. AEC 7 Knockanean

The eastern road embankment adjoining sub-site 7/2 should be planted with dense scrub in order to buffer potential air quality impacts to this sub-site.

Pine Marten underpasses should be installed in sub-site 10/3 (see section 5.2.6)

5.3.5. AEC 9 Ballymacahill Lough

The eastern road embankment adjoining this AEC should be planted with dense scrub in order to buffer potential air quality impacts to this site.

5.3.6. AEC 10 Cappagh/Ballyduff

The road embankments should be planted with a scrub mixture of predominantly Hazel where the road passes through the existing scrubwood.

The eastern road embankment should be planted with dense scrub where it crosses sub-site 10/1, in order to buffer potential air quality impacts to sub-site 10/2.

Pine Marten underpasses should be installed in sub-site 7/3 (see section 5.2.6)

5.3.7. AEC11 Barefield

An effort should be made to maintain the existing sub-surface drainage which appears to feed this site from the east.

5.3.8. AEC14 Ballybeg/Cahircalla Beg

The unimproved calcareous grassland associated with the two quarries is potentially vulnerable to air pollution impacts. Planting of dense scrub along the road embankments would mitigate against such impacts. However, this may exacerbate fragmentation/barrier effects against invertebrates in this habitat. There is no definitive advice that can be given as to the best treatment of the road embankments, given the uncertainties attached to prediction of both air pollution impacts and fragmentation/barrier effects. However a strategy of dense scrub planting interspersed with narrow corridors of grassland may be an appropriate compromise between these conflicting requirements.

Pine Marten underpasses should be installed along this section of the route (see section 5.2.6)

In view of the extent and significance of the predicted impacts in this AEC, consideration could be given to some form of habitat creation, as a compensatory measure.

5.3.9. Mitigation for impacts to bats at Knockanean and Knockaskibbole

Avoidance

If possible, direct impacts to the Knockanean Old Schoolhouse Lesser Horseshoe roost should be avoided.

Creation of replacement roost sites

That Lesser Horseshoe bats are persisting in roosting in Knockanean Old Schoolhouse, despite the recent changes to the building that have rendered it significantly less suitable, implies a scarcity of alternatives. Therefore, in the likely absence of suitable alternative roost sites, provision of a replacement roost is required to mitigate the loss of the Knockanean Old Schoolhouse.

For many species of bat, mitigation can be achieved by the provision of bat boxes (similar to bird boxes). However, such an option is not possible for Lesser Horseshoes because their roosting habits demand a greater roost volume. Erection of an alternative roost is the only means of mitigating the loss of the daytime roost at Knockanean Old Schoolhouse.

Little work has been done on assessment of the features of night roosts that are of greatest benefit to Lesser Horseshoe bats. The sheds used in the area of study were warm and dark. It is difficult to propose a night roost design with the limited knowledge to hand. Were the replacement daytime roost to be sited closer to the Knockaskibbole feeding area (e.g., at the location suggested in Figure 4a), it is possible that it would also be usable as a night roost. Bats feeding in the Gaurus area would still have the disused mill and other structures at their disposal. Securing the sheds that already exist within the area (i.e. preventing further collapse) may provide further suitable roosts for night purposes.

Location

As the Lesser Horseshoes were noted to travel west and south-west of the current roost at Knockanean Old Schoolhouse, it is suggested that an alternative roost be located south-west of the proposed road widening. This is in order that the bypass does not separate the roost from the primary feeding sites. A site close to the small lane leading south towards two farmhouses would give the bats access to Gaurus and to Knockaskibbole. A guide location has been indicated on Figure 4a.

Design

This involves the construction of a building to specifications meeting the roost requirements of Lesser Horseshoes. This has been successfully achieved in Britain and is in progress at one site in Ireland. The designs of The Vincent Wildlife Trust purpose-built roosts are estimated to cost £10,000 to complete. Summer roosts should maintain a daytime temperature of 30°C. This may require the installation of heaters if temperatures do not stabilise at this level. It is recommended that the replacement roost follows the Office of Public Works design included in RPS Consultants Report No. IR527/5. Some important features to incorporate into a Lesser Horseshoe roost would be the following:

- an entrance greater than 0.5 metres in width near to the ground floor level.
- 2 metre vertical clearance within the building.
- Unshaded roof with an east-west orientation of the ridge-line.
- 30° pitch on the south facing slope of roof.
- Thin, scored battens fixed to the ceiling joists.
- Vegetation leading from the building to nearby hedgerows. This proximity of vegetation is quite critical to lesser horseshoe roosts and it is also a feature of Brown long-eared bat roosts.

With the following minor adaptations other species may also be accommodated by such a roost:

- Bat bricks.
- Bat slates.
- ½" to ¾" gaps between timber joists within the building in the warmest areas of the building. Timber should only be treated with low toxicity chemicals (e.g. cypermethrin based products).
- Black timber fascia around the building (appears to be of benefit to species like Pipistrelle and Leisler's).

- Additional heating or solar panels at roof level for raising the temperature to as high as 28°C in summer months.

The replacement roost should be erected before the destruction of the present roosts. This is to ensure that there is an immediate alternative for the bats whenever the buildings are removed. Timber treatment should be avoided as it is lethal to resident bats. Ventilation and damp-proofing should make this step unnecessary.

Timing of Road-works

The demolition of bat roosts during summer (May to mid-August) when bats are present should be avoided to prevent unnecessary mortalities. Similarly, where it is evident that bats are present at other times when work is due to commence, efforts should be made by an expert to exclude the bats before demolition.

Creation of Vegetation Corridors

A continuous corridor of scrub should be created along the western side of the bypass route where it crosses the existing Lesser Horseshoe feeding area (approximately ch 18,000-ch 18,400; see Figure 4a).

The bats may also use other feeding sites (possibly including sites on the eastern side of the bypass route) at different times of year, depending on local insect abundance. Therefore, a vegetation corridor (hedgerow orscrub) should connect to the Knockanean road underbridge and to the R352 overbridge. At these bridges, the corridors should be linked to similar corridors along the eastern side of the bypass route. These latter corridors should, in turn, be linked to adjoining areas of scrub and/or bushy hedgerows.

5.4. MONITORING

The results of any translocations attempted in AEC 3 should be monitored.

The use of any purpose-built bat roosts should be monitored.

It would also be of value to monitor the vegetation in AEC 3 and or 14 to establish whether any significant air pollution impacts occur. The proposed landscape planting of the road embankments (see Section 5.3.1 and 5.3.8) would allow comparison of vegetation changes in screened versus unscreened sections of adjacent vegetation.

Guidelines for monitoring techniques in wet grassland are provided in RSPB *et al.* (1997).

REFERENCES

Angold, P.G. (1997). The impact of a road upon adjacent heathland vegetation: effects on plant species composition. *Journal of Applied Ecology* 34, 409-417.

Bailie, J. and Groombridge, B. (1997). *1996 IUCN Red List of Threatened Animals.* IUCN.

Birkinshaw, C.D. (1991). *Guidance notes for translocating plants as part of recovery plans.* CSD Report No. 12225, Nature Conservancy Council, Peterborough, UK.

Bobbink, R., Hornung, M. and Roelofs, G.M. (1998). The effects of air-borne nitrogen pollutants on species diversity in natural and semi-natural European vegetation. *Journal of Ecology* 86, 717-738.

Bullock, J.M., Hodder, K.H., Manchester, S.J. and Stevenson, M.J. (1997). *Review of information, policy and legislation on species translocation.* JNCC Report No. 261, Joint Nature Conservation Committee, Peterborough, UK.

Colgan, N. and Scully, R.W. (1898). *Cybele Hibernica,* ed. 2. Ponsonby, Dublin.

Curtis, T.G.F. and McGough, H.N. (1988). *The Irish Red Data Book. 1 Vascular Plants.* The Stationery Office, Dublin.

DOT (Department of Transport) (1994). *Design Manual for Roads and Bridges Volume 11: Environmental Assessment.* Amendment No. 1, HMSO, London.

EC DG XI (European Commission DGXI) (1996). *Interpretation Manual of European Union Habitats (Version EUR 15).* European Commission DGXI, Brussels.

Emmet, A. M. (1991). Life History and Habits of the British Lepidoptera. In: Emmet, A. M. & Heath, J. (Eds) *The Moths and Butterflies of Great Britain and Ireland 7(2).* (pp 61-303) Harley Books, Colchester, UK.

EPA (Environmental Protection Agency) (1995a). *Draft Guidelines on the Information to be Contained in Environmental Impact Statements.* Environmental Protection Agency, Wexford.

EPA (Environmental Protection Agency) (1995b). *Advice Notes on Current Practise (in the preparation of Environmental Impact Statements).* Environmental Protection Agency, Wexford.

ERM (Environmental Resources Management) (1996). *The Significance of Secondary Effects from Roads and Road Transport on Nature Conservation.* English Nature Research Report No. 178, English Nature, Peterborough, UK.

Forman, R.T.T. and Alexander, L.E. (1998). Roads and their major ecological effects. *Annual Review of Ecology and Systematics* 29, 207-231.

Gibbons, D.W., Reid, J.B. and Chapman, R.A. (1993). *The New atlas of Breeding Birds in Britain and Ireland: 1988-1991.* T & AD Poyser, London, UK.

Gilbert, O.L. and Anderson, P. (1998). *Habitat Creation and Repair.* Oxford University Press, Oxford, UK.

IEA (Institute of Environmental Assessment) (1995). *Guidelines for baseline ecological assessment.* E & FN Spon, London.

Ivimey-Cook, R.B. and Proctor, M.C.F. (1966). The plant communities of the Burren, Co. Clare *Proc. R. Ir. Acad.,* 64B, 211-301.

JNCC (Joint Nature Conservation Committee) (1993). *Handbook for Phase 1 Habitat Survey.* Joint Nature Conservation Committee, Peterborough, UK.

JNCC (Joint Nature Conservation Committee) (1995). *Guidelines for the selection of biological SSSIs.* Joint Nature Conservation Committee, Peterborough, UK.

Kirby, K. (1995). *Rebuilding the English Countryside: habitat fragmentation and wildlife corridors as issues in practical conservation (English Nature Science No. 10).* English Nature, Peterborough, UK.

Langton, T.E.S. (ed.) (1989). *Amphibians and Roads.* ACO Polymer Products Ltd.

Lavery, T.A. (1993). A review of the distribution, ecology and status of the marsh fritillary *Euphydryas aurinia* Rottemburg, 1775 (Lepidoptera: Nymphalidae) in Ireland. *Irish Naturalists Journal* 24, 192-199.

Madders, M. and Lawrence, M. (1981). Techniques No. 39, air pollution control by vegetation buffer zones. *Landscape Design,* August 1989.

Mader, H.-J. (1984). Animal habitat isolation by roads and agricultural fields. *Biological Conservation* 29, 81-96.

McGough, H.N. (1988). Additional to and notes on the flora of Clare (H9), Galway (*H 15-17*), Longford (*H 24*) and Leitrim (*H 29*). *Ir. Nat. J.,* 22(9), 411-413.

Mead, C. (1997). Pathetic bundles of feathers - birds and roads. *British Wildlife* 229-232.

Mooney, E.O. and O'Connell, M. (1990). The phytosociology and ecology of the aquatic and wetland plant communities of the Lower Corrib Basin, Co. Galway. *Proc. R. Ir. Acad.,* 90B, 57-97

Munguira, M.L. and Thomas, J.A. (1992). Use of road verges by butterfly and burnet populations, and the effects of roads on adult dispersal and mortality. *Journal of Applied Ecology* 29, 316-329.

Newbold, C. and Mountford, O. (1997). *Water level requirements of wetland plants and animals.* English Nature Freshwater Series No. 5, English Nature, Peterborough, UK.

Ó Críodáin, C. and Doyle, G.J. (1994). An overview of Irish small-sedge vegetation: syntaxonomy and a key to communities belonging to the Scheuchzerio-Caricetea nigrae (Nordh. 1936) Tx. 1937. *Biology and Environment* 94B, 127-144.

PAA (Penny Anderson Associates) (1993). *Roads and Nature Conservation: Guidance on Impacts, Mitigation and Enhancement*. English Nature, Peterborough.

Perring, F.H. and Walters, S.M. (1990). *Atlas of the British Flora*. (1990 reprint), Botanical Society of the British Isles.

Praeger, R. Ll. (1901). *Irish Topograpical Botany. Proc. R. Ir. Acad.*, 23(3rd series, 7), 1-410.

Praeger, R. Ll. (1934). *The Botanist in Ireland*. Hodges & Foggis, Dublin.

Preston, C.D. and Croft, J.M. (1997). *Aquatic Plants in Britain and Ireland*. Harley Books, Colchester, UK.

Reijnen, M.J.S.M., Veenbaas, G. and Foppen, R.P.B. (1995). *Predicting the effects of motorway traffic on breeding bird populations*. Road and Hydraulic Engineering Division, DLO-Institute for Forestry and Nature Research, The Netherlands.

Richardson, J.H., Shore, R.F., Treweek, J.R. and Larkin, S.B.C. (1997). Are major roads a barrier to small animals? *Journal of Zoology, London* 243, 840-846.

Rodwell, J.S. (ed.) (1992). *British Plant Communities Volume 2: Grasslands and montane communities*. Cambridge University Press, Cambridge, UK.

Rodwell, J.S. (ed.) (1992). *British Plant Communities Volume 3: Mires and Heaths*. Cambridge University Press, Cambridge, UK.

RSPB *et al.* (Royal Society for the Protection of Birds, English Nature and Institute of Terrestrial Ecology) (1997). *The Wet Grassland Guide: Managing floodplain and coastal wet grasslands for wildlife*. Royal Society for the Protection of Birds, Sandy, Bedfordshire, UK.

Slater, F. (1994). Wildlife road casualties. *British Wildlife* 214-221.

Spellerberg, I.F. (1998). Ecological effects of roads and traffic: a literature review. *Global Ecology and Biogeography Letters* 7, 317-333.

Stace, C. (1991). *New Flora of the British Isles*. Cambridge University Press, Cambridge, UK.

Treweek, J. (1999). *Ecological Impact Assessment*. Blackwell Science, Oxford, UK.

Warren, M.S. (1994). The UK status and suspected metapopulation structure of a threatened European butterfly, *Euphydryas aurinia* (the marsh fritillary). *Biological Conservation* 67, 239-249.

Webb, D.A. and Scannell, M.J.P. (1983). *Flora of Connemara and the Burren*. Cambridge University Press and Royal Dublin Society.

Whilde, A. (1993). *Threatened Mammals, Birds, Amphibians and Fish in Ireland. Irish Red Data Book 2: Vertebrates*. HMSO, Belfast.

APPENDICES

APPENDIX 1

Vegetation

This appendix provides species lists for the sites surveyed. In interpreting these species lists it should be noted that

1. sites were surveyed on different dates; and
2. the survey effort varied between sites, generally reflecting the perceived botanical potential of the site.

Non-Wetland Sites

		3/2	3/4	6/2	7/3	10/3	14/1
Acer pseudoplantanus	Sycamore		√				
Achillea millefolium	Yarrow	√	√			√	√
Agrimonia eupatoria	Hemp-agrimony				√		√
Agrostis capillaris	Common Bent		√	√			√
Agrostis stolonifera	Creeping Bent						√
Agrostis vinealis	Brown Bent					√	
Ajuga reptans	Bugle					√	
Alchemilla vulgaris AGG	Lady's-mantle					√	
Anacamptis pyramidalis	Pyramidal Orchid	√					√
Anemone nemorosa	Wood Anemone				√	√	
Angelica sylvestris	Wild Angelica				√		
Antennaria dioica	Mountain Everlasting		√				
Anthoxanthum odoratum	Sweet Vernal Grass	√			√	√	
Anthylis vulneraria	Kidney Vetch						√
Apium inundatum	Lesser Marshwort						√
Apium nodiflorum	Fool's Water-cress						√
Arabidosis thaliana	Thale-cress					√	
Arrhenatherum elatius	False Oat-grass	√			√		
Arum maculatum	Lords-and-Ladies		√				
Asplenium adiatum-nigrum	Black Spleenwort		√				
Asplenium ruta-muraria	Wall-rue					√	√
Asplenium trichomanes	Maidenhair Spleenwort					√	
Asplenium trichomanes spp. *quadrivalens*			√				√
Blackstonia perfoliata	Yellow-wort						√
Brachypodium sylvaticum	Wood False-brome		√		√	√	√
Briza media	Quaking Grass	√	√		√	√	√
Calluna vulgaris	Heather				√	√	
Cardamine pratensis	Cuckooflower						√
Carex caryophyllea	Spring Sedge					√	
Carex flacca	Glaucous Sedge	√	√		√	√	√
Carex hostiana	Tawny Sedge	√					
Carex otrubae	False Fox-sedge						√
Carex panicea	Carnation Sedge					√	√
Carex remota	Remote Sedge						√
Carlina vulgaris	Carline Thistle	√	√			√	
Centaurea nigra	Common Knapweed	√		√	√	√	√
Centaurium erythraea	Common Centaury	√	√		√	√	√
Cerastium fontanum	Common Mouse-ear	√	√			√	√
Ceterach officinarum	Rustyback		√				√
Chamerion angustifolium	Rosebay Willowherb				√		
Cirsium arvense	Creeping Thistle	√	w				
Cirsium palustre	Marsh Thistle			√		√	
Cirsium vulgare	Spear Thistle	√	w				
Clematis vitalba	Travellers-joy		√				
Cornus sanguinea	Dogwood		√				
Corylus avellana	Hazel		√		√	√	
Crataegus monogyna	Hawthorn	√			√	√	

		3/2	3/4	6/2	7/3	10/3	14/1
Crepis capillaris	Smooth Hawk's-beard						√
Cynosorus cristatus	Crested Dog's-tail	√		√	√	√	√
Dactylis glomerata	Cock's-foot	√	√		√		√
Dactylorhiza fuchsii	Common Spotted Orchid	√	√		√		√
Danthonia decumbens	Heath Grass		√				
Daucus carota	Wild Carrot				√	√	√
Deschampsia cespotosa	Tufted Hair-grass				√		
Epilobium hirsutum	Great Willowherb				√		
Epilobium obscurum	Short-fruited Willowherb		√				
Epilobium parviflorum	Hoary Willowherb		√				
Equisetum fluviatile	Water Horsetail						√
Euonoymus europaeus	Spindle					√	
Euphrasia spp.	Eyebright		√		√	√	T
Festuca rubra	Red Fescue	√	√			√	√
Filipendula ulmaria	Meadowsweet						√
Fragaria vesca	Wild Strawberry				√	√	√
Fraxinus excelsior	Ash		√		√	√	
Galium aparine	Clevers		√				
Galium palustre	Marsh Bedstraw						√
Galium verum	Lady's Bedstraw	√			√	√	√
Geranium dissectum	Cut-leaved Crane's-bill		√				
Geranium robertianum	Herb-robert		√		√	√	
Geranium sanguineum	Bloody Cranesbill		√				
Geum urbanum	Wood Avens				√	√	
Gymnadenia conopsea	Fragrant Orchid	√	√			√	√
Hedera helix	Ivy		√		√	√	
Holcus lanatus	Yorshire Fog	√					√
Hypericum maculatum	Imperforate St John's-wort		√		√		
Hypericum perforatum	Perforate St John's-wort		√				√
Hypericum pulchrum	Slender St John's-wort		√			√	√
Hypochaeris radicata	Cat's-ear				√		
Ilex aquifolium	Holly				√		
Juncus bufonius	Toad Rush						√
Juncus effusus	Soft Rush			√			
Juncus inflexus	Hard Rush						√/√
Juniperus communis	Juniper		√				
Leontodon saxatilis	Lesser Hawkbit	√					
Leucantheum vulgare	Oxeye Daisy		√		√	√	√
Linum catharticum	Fairy Flax	√				√	
Lolium perenne	Perennial Rye-grass		√				√
Lonicera periclymenum	Honeysuckle				√	√	
Lotus corniculatus	Common Bird's-foot-trefoil	√	√		√	√	√
Medicago lupulina	Black Medick		√		√		√
Mentha aquatica	Water Mint						√
Mycelis muralis	Wall Lettuce		√			√	
Myriophyllum sp.	Water-milfoil						√
Orchis mascula	Early Purple Orchid		√			√	√
Oxalis acetosa	Wood-sorrel				√	√	
Phleum pratense	Timothy				√		√
Phyllitis scolopendrium	Hart-tongue		√		√	√	√
Pilosella officinarum	Mouse-ear -hawkweed		√				
Plantago lanceolata	Ribwort Plantain		√		√	√	
Plantago major	Greater Plantain		√				
Platanthera bifolia	Lesser Butterfly Orchidd						√
Platanthera chlorantha	Greater Butterfly Orchide						√
Poa humilis	Spreading Meadow-grass		√				
Polygala vulgaris	Common Milkwort	√	√			√	√
Polystichum setiferum	Soft Shield-fern		√				
Potamogeton natans	Broad-leaved Pondweed						√
Potentilla anglica	Trailing Tormentil				√	√	
Potentilla anserina	Silverweed						√
Potentilla erecta ssp. *erecta*	Tormentil	√					
Potentilla reptans	Creeping Cinquefoil						√
Potentilla sterilis	Barren Strawberry					√	√

Primula veris	Cowslip	√			√	√	√
Primula vulgaris	Primrose					√	√
		3/2	3/4	6/2	7/3	10/3	14/1
Prunella vulgraris	Self-heal	√		√	√		
Prunus spinosa	Blackthorn	√	√	√	√	√	√
Pteridium aquilinum	Bracken		√	√	√	√	
Ranunculus acris	Meadow Buttercup	√	√	√			√
Ranunculus bulbosus	Bulbous Buttercup	√	√				√
Ranunculus flammula	Lesser Spearwort						√
Ranunculus repens	Creeping Buttercup						√
Ranunculus Sect. *Batrachium*	Water-crowfoot						√
Reseda luteola	Weld						√
Rhianthus minor	Yellow-rattle						√
Rosa (canina) corymbifera	Hairy Dog-rose						√
Rosa arvensis	Field-rose				√		
Rosa canina	Dog-rose		√		√	√	√
Rosa pimpinellifolia	Burnet Rose		√				
Rosa stylosa	Short-styled Field-rose			√	√		
Rubia peregrina	Wild Madder		√				
Rubus fruticosus AGG.	Bramble		√	√	√	√	
Rumex acetosa	Common Sorrel			√	√	√	
Sagina nodosa	Knotted Pearlwort						√
Sagina procumbens	Procumbent Pearlwort		√				√
Salix caprea	Goat Willow				√		
Salix cinerea ssp *oleifolia*	Rusty Willow						√
Sambucus nigra	Elder					√	
Senecio jacobaea	Common Ragwort		√	√	√	√	√
Sesleria caerulea	Blue Moor-grass	√	√			√	
Solidage viguarea	Goldenrod				√	√	√
Sonchus arvensis	Perennial Sow-thistle				√	√	
Sorbus aucuparia	Rowan		√		√	√	
Stachys sylvatica	Hedge Woundwort				√		
Stellaria graminea	Lesser Stitchwort					√	
Succsia pratensis	Devil's-bit Scabious	√			√	√	√
Teucrium scorodonia	Wood Sage	√	√		√	√	√
Thymus polytrichus	Wild Thyme	√	√			√	√
Tragopogon pratensis	Goat's-beard						√
Trifolium campestre	Hop Trefoil		√				√
Trifolium dubium	Lesser Trefoil		√			√	√
Trifolium pratense	Red Clover	√	√			√	√
Trifolium repens	White Clover	√	√	√			√
Urtica dioica	Common Nettle	√	w				
Verbena officinalis	Vervain						√
Veronica arvensis	Wall Speedwell		√				
Veronica catenata	Pink Water-speedwell						√
Veronica chamaedrys	Germander Speedwell	√	√				√
Veronica officinalis	Heath Speedwell					√	
Veronica persica	Common Field-speedwell		w				
Veronica serpyllifolia	Thyme-leaved Speedwell		√				
Viburnum opulus	Guelder-rose				√		
Vicia cracca	Tufted Vetch		√		√	√	
Vicia sepium	Bush Vetch	√	√				
Viola riviniana	Common Dog-violet		√		√	√	

Wetland Sites

		3/1	3/3	3/5	3/6	3/7	3/8	3/10	3/11	3/12	6/1	6/3	7/1	7/2	10/1	10/2	11	13	15	17
Achillea millefolium	Yarrow	√																		
Agrostis capillaris	Common Bent		√			√				√	√	√		√						
Agrostis stolonifera	Creeping Bent	√	√			√	√	√			√	√	√	√	√	√	√	√	√	√
Agrostis vinealis	Brown Bent					√														
Alchemilla vulgaris AGG	Lady's-mantle															√				
Alisma plantago-aquatica	Water-plantain						√						√	√	√					
Alnus glutinosa	Alder																		√	
Alopecurus pratensis	Meadow Foxtail						√													
Anagallis tenella	Bog Pimpernel															√	√		√	
Angelica sylvestris	Wild Angelica	√					√		√					√	√	√				√
Anthoxanthum odoratum	Sweet Vernal Grass	√	√	√		√	√	√		√		√	√	√		√	√			√
Apium nodiflorum	Fool's Water-cress	√		√		√	√					√		√	√					
Arrhenatherum elatius	False Oat-grass					√														
Baldellia ranunculoides	Lesser Water-plantain	√									√		√			√				
Berula erecta	Lesser Water-parsnip					√	√								√			√		
Briza media	Quaking Grass	√										√	√	√		√	√			
Callitriche platycarpa	Various-leaved Water-starwort										√							√	√	
Callitriche sp.	Water-starwort												√	√						
Callitriche stagnalis	Common Water-starwort																	√		
Calluna vulgaris	Heather											√								
Caltha palustris	Marsh Marigold														√					
Cardamine pratensis	Cuckooflower	√									√	√								
Carex acutiformis	Lesser Pond-sedge							√												
Carex diandra	Lesser Tussock-sedge	√		d										√						
Carex disticha	Brown Sedge	√		√			√	√	√	√	√		√	√	√	√	√	√		
Carex echinata	Star Sedge	√						√				√					√		√	
Carex elata	Tufted Sedge		√	√		√								√	√	√				
Carex elata hybrid																√				
Carex flacca	Glaucous Sedge	√		√		√		√	√		√	√	√			√	√	√		
Carex hirta	Hairy Sedge											√					√			
Carex hostiana	Tawny Sedge	√		√		√						?				√				
Carex lasiocarpa	Slender Sedge	√																		
Carex nigra	Common Sedge	√		√		√	√	√	√	√	√	√	√	√	√	√	√	√		√
Carex otrubae	False Fox-sedge																			√
Carex ovalis	Oval Sedge	√					√			√		√								
Carex panicea	Carnation Sedge	√	√	√	√	√	√	√	√	√	√	√			√	√	√	√	√	
Carex paniculata	Greater Tussock-sedge			d	√	√	√					√							√	
Carex pulicaris	Flea Sedge	√	√													√				

		3/1	3/3	3/5	3/6	3/7	3/8	3/10	3/11	3/12	6/1	6/3	7/1	7/2	10/1	10/2	11	13	15	17
Carex riparia	Greater Pond-sedge																	√		
Carex rostrata	Bottle Sedge	√	d	d	√	√		√		√	√	√	√	√	√	√	√			
Carex versicaia	Bladder Sedge								√											√
Carex viridula ssp. *lepidocarpa*	Yellow-sedge													√						
Carex viridula ssp. oedocarpa	Yellow-sedge	√			√	√		√	√	√	√		√		√	√	√		√	
Centaurea nigra	Common Knpaweed	√				√	√					√	√	√		√		√		
Cerastium fontanum	Common Mouse-ear						√									√				
Chara spp.	Stonewort													√		√	√			
Cirsium arvense	Creeping Thistle																	√		
Cirsium dissectum	Meadow Thistle	√	√	√		√					√	√								
Cirsium palustre	Marsh Thistle	√	√	√		√	√		√		√	√				√	√			
Cladium mariscus	Great Fen-sedge	√				√		√						√			√			
Cynosorus cristatus	Crested Dog's-tail						√	√			√	√	√			√		√	√	
Dactylis glomerata	Cock's-foot	√				√						√								
Dactylorhiza fuchsii	Common Spotted Orhid	√		√		√	√					√				√	√			
Dactylorhiza incarnata	Early Marsh-orchid			√																
Dactylorhiza maculata	Heath Spotted Orchid	√				√														
Danthonia decumbens	Heath-grass		√			√										√				
Daucus carota	Wild Carrot											√	√							
Deschampsia cespotosa	Tufted Hair-grass									√						√				√
Drosera rotundifolia	Round-leaved Sundew				√															
Eleocharis palustris	Common Spike-rush										√			√	√	√	√			
Eleogiton fluitans	Floating Club-rush										√									
Epilobium hirsutum	Great Willowherb											√					√			√
Epilobium obscurum	Short-fruited Willowherb																		√	
Epilobium palustre	Marsh Willowherb									√		√		√			√			
Epilobium parviflorum	Hoary Willowherb									√		√		√		√	√	√		
Epilobium tetragonum	Square-stemmed Willowherb																			√
Equisetum arvense	Field Horsetail															√				
Equisetum fluviatile	Water Horsetail	√		√		√					√		√	√	√	√	√		√	√
Equisetum palustre	Marsh Horsetail	√		√								√	√	√						
Erica cinerea	Bell Heather					√														
Erica tetralix	Cross-leaved Heath	√			√	√						√								
Eriophorum angustifolium	Common Cottongrass					√		√		√		√					√			
Eupatorium cannabinum	Hemp Agrimony													√	√					
Euphrasia spp.	Eyebright															√				
Fectuca pratensis	Meadow Fescue	√																		
Festuca aurundinacea	Tall Fescue												√		√		√	√		
Festuca rubra	Red Fescue	√	√	√		√				√		√		√		√		√		
Filipendula ulmaria	Meadowsweet	√		√		√	√	√	√	√	√	√	√	√	√	√	√	√		√
Fraxinus excelsior	Ash													√						

Galium palustre	Marsh Bedstraw	√	√	√		√	√				√		√	√	√		√			√
Galium saxatile	Heath Bedstraw					√														
		3/1	3/3	3/5	3/6	3/7	3/8	3/10	3/11	3/12	6/1	6/3	7/1	7/2	10/1	10/2	11	13	15	17
Galium uliginosum	Fen Bedstraw				√															
Galium verum	Lady's Bedstraw															√				
Glyceria declinata	Small Sweet-grass												√							
Glyceria fluitans	Floating Sweet-grass							√	√	√	√				√	√	√		√	√
Gymnadenia conopsea	Fragrant Orchid	√				√								√		√				
Rosa (canina) corymbifera	Hairy Dog Rose												√							
Hippuris vulgaris	Mare's-tail						√						√	√			√		√	
Holcus lanatus	Yorkshire Fog	√	√	√	√	√	√	√		√	√	√	√	√		√	√	√	√	√
Hydrocharis morsus-ranae	Frogbit						d													
Hydrocotyle vulgaris	Marsh Pennywort										√			√	√	√	√			
Hypericum elodes	Marsh St John's-wort											√							√	
Hypericum maculatum	Imperforate St John's-wort					√							√							
Hypericum pulchrum	Slender St John's-wort					√														
Hypericum tetrapterum	Square-stemmed St John's-wort															√	√			
Hypochaeris radicata	Cat's-ear	√							√						√					√
Iris psuedacorus	Yellow Iris					√				√			√	√				√		
Isolepis setacea	Bristle Club-rush																√			
Juncus acutiflorus	Sharp-flowered Rush	√		√		√	√		√		√	√	√	√	√	√	√	√	√	√
Juncus articulatus	Jointed Rush							√		√	√	√					√			
Juncus bufonius	Toad Rush																√			
Juncus bulbosus	Bulbous Rush	√			√	√				√	√									
Juncus conglomeratus	Clustered Rush	√									√	√		√		√		√		√
Juncus effusus	Soft Rush	√	√			√	√	√		√	√	√	√		√		√	√	√	√
Juncus inflexus	Hard Rush	√	√	√		√		√	√	√	√	√	√	√	√	√		√		√
Juncus squarrosus	Heath Rush					√														
Juncus subnodulosos	Blunt-flowered Rush	√						√	√		√	√		√				√		
Juncus x diffusus	Hybrid Hard Rush										√									
Lathyrus pratensis	Meadow Vetchling											√	√	√			√			
Lemna minor	Common Duckweed					√					√						√	√		
Lemna triscula	Ivy-leaved Duckweed						√													
Leontodon autumnalis	Autumn Hawkbit						√				√									
Leontodon saxatilis	Lesser Hawkbit						√									√				
Leucantheum vulgare	Oxeye Daisy										√		√			√				
Linum catharticum	Fairy Flax					√														
Listera ovata	Common Twayblade			√																
Lolium perenne	Perennial Rye-grass	√																√		√
Lotus corniculatus	Common Bird's-foot-trefoil	√				√						√				√				
Lotus pendunculatus	Greater Bird's-foot-trefoil	√		√		√								√				√		√
Lychnis flos-cuculi	Ragged Robin																		√	√

Lythrum salicaria	Purple-loosestrife	√		√		√	√	√	√	√	√	√	√	√	√			√		√
Mentha aquatica	Water Mint	√	√			√	√	√	√		√	√	√	√	√	√	√	√		√
Mentha arvensis	Corn Mint												√							
		3/1	3/3	3/5	3/6	3/7	3/8	3/10	3/11	3/12	6/1	6/3	7/1	7/2	10/1	10/2	11	13	15	17
Mentha x *verticillata*	Whorled Mint																			√
Menyanthes trifoliata	Bogbean	√		√	√	√		√	√		√		√	√	√	√	√		√	
Molinia caerulea	Purple Moor-grass	√		√	√	√		√	√	√	√	√	√	√		√	√	√		
Myosotis laxa	Tufted Forget-me-not						√				√			√		√				
Myosotis scorpioides	Water Forget-me-not														√	√		√		√
Myrica gale	Bog Myrtle	√			√	√														
Narthecium ossifragum	Bog Asphodel				√															
Nuphar lutea	Yellow Water-lily							√												
Nymphaea alba	White Water-lily				√	√				√										
Odontites verna	Red Bartsia						√													
Osmunda regalis	Royal Fern					√														
Parnassia palustris	Grass of Parnassus	√					√									√				
Pedicularis palustris	Marsh Lousewort	√									√									
Pedicularis sylvatica	Lousewort					√														
Persicaria amphibia	Amphibius Bistort					√	√													
Persicaria hydropiper	Water-pepper																	√		
Phalaris aurundinacea	Reed Canary-grass	√				√					√				√					√
Phleum bertolonii	Small Timothy												√							
Phleum pratense	Timothy	√					√					√								
Phragmites australis	Common Reed				√	√		√	√						√			√		
Plantago lanceolata	Ribwort Plantain	√										√				√				√
Platanthera bifolia	Lesser Butterfly Orchid	√		√		√														
Poa sp.	Meadow-grass											√								
Poa trivalis	Rough Meadow-grass						√													
Polygala serphyllifolia	Heath Milkwort					√														
Polygala vulgaris	Common Milkwort	√																		
Persicaria bistorta	Common Bistort																√			√
Potamogeton natans	Broad-leaved Pondweed													?		√	√			
Potamogeton polygonifolius	Bog Pondweed	√				√														
Potamogeton sp.	Pondweed										√									
Potentila anglica	Trailing Tormentil										√	√	√	√		√				
Potentilla anserina	Silverweed	√					√	√	√	√	√	√	√	√	√		√	√		
Potentilla erecta ssp. *erecta*	Tormentil	√			√	√														
Potentilla palustris	Marsh Cinquefoil	√		√	√	√		√		√				√			√			
Primula veris	Cowslip												√							
Prunella vulgraris	Self-heal	√					√	√				√	√	√	√	√		√		√
Pteridium aquilinum	Bracken										√									
Ranunculus acris	Meadow Buttercup	√	√			√	√	√			√	√	√			√	√	√	√	√

Ranunculus ficaria	Lesser Celandine													√						
Ranunculus flammula	Lesser Spearwort	√				d	√	√	√	√	√	√	√	√	√	√	√		√	√
Ranunculus repens	Creeping Buttercup	√	√			√	√	√			√	√			√	√	√	√	√	√
Ranunculus tricophyllus	Thread-leaved Water-crowfoot													√						
		3/1	3/3	3/5	3/6	3/7	3/8	3/10	3/11	3/12	6/1	6/3	7/1	7/2	10/1	10/2	11	13	15	17
Rhianthus minor	Yellow-rattle						√							√						
Rorippa microphylla	Narrow-fruited Water-cress														√					√
Rorippa nasurtium-aquaticum	Water-cress										√							√		
Rosa stylosa	Short-styled Field-rose											√								
Rumex acetosa	Common Sorrel					√						√								
Rumex acetosella	Sheep's Sorrel					√														
Rumex conglomeratus	Clustered Dock					√	√							√	√			√		
Rumex crispus	Curled Dock											√								√
Rumex hydrolapathum	Great Water Dock					√	√													
Salix aurita	Eared Willow					√														
Salix cinerea ssp. *cinerea*	Grey Willow										√?									
Salix cinerea ssp. *oleifolia*	Rusty Willow					√														
Salix repens	Creeping Willow					√														
Salix vinealis	Osier										√									
Samolus valerandi	Brookweed															√				
Schoenoplectus lacustris	Common Club-rush										√				√	√				
Schoenus nigricans	Black Bog-rush	√			√	√								√		√	√			
Senecio aquaticus	Marsh Ragwort						√								√		√	√		√
Senecio jacobaea	Common Ragwort											√								
Sparganium erectum	Branched Bur-reed													√	√					
Sparganium natans	Least Bur-reed						√													
Sparganium sp.	Bur-reed									√							√			
Stachys palustris	Marsh Woundwort																			√
Stellaria graminea	Lesser Stitchwort															√				
Succsia pratensis	Devil's-bit Scabious	√	√	√		√	√	√	√	√	√	√		√		√		√	√	
Thymus polytrichus	Wild Thyme	√																		
Trifolium pratense	Red Clover	√					√			√		√	√				√	√		√
Trifolium repens	White Clover	√					√	√			√	√				√	√		√	
Triglochin palustris	Marsh Arrowgrass								√		√	√	√		√		√		√	
Typha latifolia	Greater Reedmace					√	√							√			√			
Ulex europaeus	Common Gorse				√	√														
Ulex gallii	Western Gorse					√														
Urtica dioica	Common Nettle																	√		
Utricularia sp.	Bladderwort																√			
Valeriana officinalis	Valerian					√								√	√					
Veronica anagallis-aquatica	Blue Water-speedwell													√	√					
Veronica beccabunga	Brooklime					√					√				√		√		√	

Veronica catenata	Pink Water-speedwell													√						
Veronica chamaedrys	Germander Speedwell	√				√														
Veronica scutellata	Marsh Speedwell										√		√		√		√			
Viburnum opulus	Guelder-rose													√						
Vicia cracca	Tufted Vetch										√	√	√	√		√	√			√

APPENDIX 2

Entomology

Areas Surveyed

Note site numbers refer to the botanical survey sites, as shown in Figure 1.

Area of Ecological Constraint 3: Kilbreckan/Skehanagh/Killow

Site 3/1, 3/3, 3/5-6	wetland E. of road south of Gaurus and S. of Kilbreckan Lough, "R364755 Bunnow marsh (east)", 22.05.98
Site 3/4	limestone pavement (and hazel scrub) SE of Kilbreckan Lough, R368755, 22.05.98
Site 3/7	wetland (fen & bog) W. of road south of Gaurus, R362755/R362756, referred to as "Bunnow marsh", 22.05.98, light-trapping 02.08.98 & 28.08.98

Area of Ecological Constraint 10: Cappagh/Ballyduff

Site 10/2	Cappagh Lough, S. of Barefield and east of Ballyduff, around north shore, R367813, 22.05.98
Site 10/3	Ballyduff limestone pavement and hazel, etc. scrub, R365817, 22.05.98
Site 10/4	field near end of lane leading east from Ballyduff, NW of Cappagh Lough, R365815, light-trapping and daytime observations, 06.08.98
Site 10/5	unnamed lough S. of Barefield and W. of Ballyduff, R365817, 22.05.98

Area of Ecological Constraint 14: Ballybeg /Cahircalla Beg

Site 14/1	disused limestone quarry at Clareabbey, R339753, 22.05.98

Additional Sites

Gaurus, R362773 (small area of limestone grassland), 12.06.98
Ballymacahill cross, R362789, specimens attracted to light, 27/28.08.98
Ennis (east), R341776, species attracted to light, 27.08.98

Irish Distribution of Notable Lepidoptera Recorded

Donacaula mucronella
A very local wetland species. Recent records are from bog sites such as Mongan Bog, Co. Offaly, and fens such as Ballyvergan and Kilcolman, Co. Cork.

Elachista subnigrella
A very local species of calcareous grassland, also recorded from coastal sand-dunes in Co. Dublin (Bond, unpublished), and from Pollardstown Fen, Co. Kildare (Bond, 1991).

Agonopterix yeatiana
Although Beirne (1941) described this species as "generally distributed", there are very few records since that time, and the species was not recorded during the extensive surveys of the Burren Lepidoptera summarised by Bradley and Pelham-Clinton (1967). The only recent records appear to be Achill Island, West Mayo (Langmaid, 1989) and Ballyconneely, West Galway (Emmet, 1971).

Aethes piercei
Local in areas with a good growth of Devil's-bit Scabious. It has not been recorded from Eastern Ireland in recent decades and therefore seems to be in decline.

Dichrorampha plumbana
A local species of calcareous grassland, also found on sandy coasts. As with the preceding species, its range seems to have contracted in recent years.

Anania funebris
Nearly all the records of this species are from the Burren and the adjacent limestone country of SE Galway;. There are also isolated old records from West Galway and Kerry, and a 1977 record from near Watergrasshill, East Cork (Bond, unpublished).

Erynnis tages
This local and easily overlooked butterfly is almost totally confined to limestone pavement and quarries in Ireland, although it has recently been found twice on the granite coastline of West Galway (Bond, unpublished). There are only very few scattered colonies south of Ennis (Heath *et al.*, 1984).

Euphydryas aurinia
Although common and widespread in the past, this butterfly is becoming increasingly scarce and local in Ireland, due to loss of habitat. In Britain and much of continental Europe it is in serious decline, and has become extinct over large areas. It occurs in small discrete colonies, and is very dependent on certain biotopes. Heath *et al.* (1984) state that it is found mainly where Devil's-bit Scabious occurs in boggy fields and moorland, where the plant produces leaves large enough to support the larvae, and that these sites have suffered severely from agricultural improvements such as drainage, etc.

Perizoma bifaciata
A local, but possibly overlooked species, absent from many apparently suitable areas where its foodplant, Red Bartsia, is common. Baynes (1964) describes its Irish status as "scarce and sporadically distributed".

Chiasmia clathrata
Although not scarce, the Latticed Heath appears to have declined considerably in recent years, in common with many other Lepidoptera which are associated with unimproved grassland.

Hemaris tityus
Like the Marsh Fritillary, this species also feeds on Devil's-bit Scabious, and also appears to be undergoing a serious decline. It has been recorded from only twelve recent (post-1960) Irish 10km quadrats (Heath,1979).

Syngrapha interrogationis
Heath (1983) records the Scarce Silver-Y from only five Irish post-1960 quadrats. It appears to be confined to bogs and heaths which have remained fairly intact.

SPECIES LIST OF **LEPIDOPTERA** (100 species)

(Nomenclature based on Schnack (1985), with more recent modifications)

HEPIALIDAE
Hepialus humuli (Linnaeus, 1758) [GHOST MOTH]. Male at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Hepialus fusconebulosa (DeGeer, 1778) [MAP-WINGED SWIFT]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.

GRACILLARIIDAE
Phyllonorycter salicicolella (Sircom, 1848). Mine on *Salix* sp. (det. from pupa), Bunnow marsh, R362755, 28.viii.1998.

GLYPHIPTERIGIDAE
Glyphipterix thrasonella (Scopoli. 1763). One, Bunnow marsh, R364755, 22.v.1998; two, Cappagh Lough (N. shore), R367813, 22.v.1998.

OECOPHORIDAE
Agonopterix yeatiana (Fabricius, 1801). Female (genitalia checked), Bunnow marsh, R363756, 1.viii.1998; one at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.

ELACHISTIDAE
Elachista subnigrella Douglas, 1853. Male taken (genitalia checked), Clareabbey, R339753, 22.v.1998.
Elachista argentella (Clerck, 1759). One, Gaurus, R362773, 12.vi.1998.

COLEOPHORIDAE
Coleophora taeniipennella Herrich-Schäffer, 1854. Female at m. v. trap (genitalia checked), Bunnow marsh, R362756, 2.viii.1998.

GELECHIIDAE
Mirificarma mulinella (Zeller, 1839). One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.

TORTRICIDAE
Aphelia paleana (Hübner, 1793). One, Bunnow, R355772, 10.vi.1998.
Acleris variegana (Denis & Schiffermüller, 1775). One at light, Ennis, R341776, 27.viii.1998; one dead, Ballymacahill Cross, R362789, 28.viii.1998.
Cochylimorpha straminea (Haworth, 1811). Four at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.
Agapeta hamana (Linnaeus, 1758). One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Aethes piercei Obraztsov, 1952. One, Bunnow marsh (west), R362755, 22.v.1998.
Olethreutes lacunana (Denis & Schiffermüller, 1775). One, Clareabbey, R339753, 22.v.1998; one, Bunnow (East), R362755, 12.vi.1998.
Bactra lancealana (Hübner, 1799). Two, Clareabbey, R339753, 22.v.1998; one, Bunnow marsh, R364755, 22.v.1998; one, Bunnow (East), R362755, 12.vi.1998; one, Bunnow marsh (east), R366756, 28.viii.1998.
Epiblema costipunctana (Haworth, 1811). Two, Clareabbey, R339753, 22.v.1998.
Eucosma cana (Haworth, 1811). Four at m. v. trap, Bunnow marsh, R362756, 2.viii.1998; one at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Cydia succedana (Denis & Schiffermüller, 1775). Five, Bunnow marsh (west), R362755, 22.v.1998.
Dichrorampha plumbana (Scopoli, 1763). Male taken (genitalia checked), Clareabbey, R339753, 22.v.1998.

CHOREUTIDAE
Anthophila fabriciana (Linnaeus, 1767). One, Bunnow, R355772, 11.vi.1998; two, Gaurus, R362773, 12.vi.1998.

ALUCITIDAE
Alucita hexadactyla (Linnaeus, 1758) [MANY-PLUMED MOTH]. One, Ballymacahill Cross, R362789, 28.viii.1998.

PTEROPHORIDAE
Stenoptilia bipunctidactyla (Scopoli, 1763). Male (genitalia checked), Bunnow marsh, R362756, 1.viii.1998; one at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.

PYRALIDAE
Elophila nymphaeata (Linnaeus, 1758). Larvae under cut-out leaf sections of *Potamogeton* sp. and *Nuphar lutea* (L.) Smith, Cappagh Lough (N. shore), R367813, 22.v.1998.

Donacaula mucronella (Denis & Schiffermüller, 1775). Male at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Chrysoteuchia culmella (Linnaeus, 1758). One, Gaurus, R362773, 12.vi.1998; two, Bunnow (East), R362755, 12.vi.1998.
Crambus pascuella (Linnaeus, 1758). Four, Bunnow (East), R362755, 12.vi.1998; one, Bunnow marsh, R362756, 1.viii.1998; one at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Crambus lathoniellus (Zincken, 1817). Four, Bunnow marsh, R364755, 22.v.1998; two, Scrub & pavement W. of Cappagh Lough, R365810, 22.v.1998; one, Bunnow (East), R362755, 12.vi.1998.
Crambus perlella (Scopoli. 1763). One at light, Gaurus, R362773, 11.vi.1998.
Agriphila tristella (Denis & Schiffermüller, 1775). One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998; one at m. v. trap, Ballyduff, R365815, 6.viii.1998; four, Bunnow marsh (east), R366756, 28.viii.1998.
Agriphila straminella (Denis & Schiffermüller, 1775). C10, Bunnow marsh, R362756, 1.viii.1998; one at m. v. trap, Bunnow marsh, R362756, 2.viii.1998; three, Bunnow marsh, R362755, 28.viii.1998; one, Bunnow marsh (east), R366756, 28.viii.1998.
Eudonia mercurella (Linnaeus, 1758). One at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Pyrausta purpuralis (Linnaeus, 1758). Male taken at m. v. trap (genitalia checked), Ballyduff, R365815, 6.viii.1998.
Pyrausta despicata (Scopoli, 1763). One, Cappagh Lough (N. shore), R367813, 22.v.1998.
Anania funebris (Ström, 1768). One, Kilbreckan Lough limestone pavement, R368755, 22.v.1998.
Udea lutealis (Hübner, 1809). One, Bunnow marsh (east), R366756, 28.viii.1998.

HESPERIIDAE
Erynnis tages (Linnaeus, 1758). Two, Clareabbey, R339753, 22.v.1998.

PIERIDAE
Leptidea sinapis (Linnaeus, 1758) [WOOD WHITE]. One, Clareabbey, R339753, 22.v.1998; four, Kilbreckan Lough limestone pavement, R368755, 22.v.1998.
Pieris brassicae (Linnaeus, 1758) [LARGE WHITE]. One, Gaurus, R362773, 12.vi.1998; one, Kilbreckan Lough limestone pavement, R368757, 28.viii.1998.
Pieris napi (Linnaeus, 1758) [GREEN-VEINED WHITE]. One, Bunnow marsh, R364755, 22.v.1998; one, Lough near Ballyduff, R365817, 22.v.1998; two, Bunnow, R355772, 11.vi.1998.
Anthocharis cardamines (Linnaeus, 1758) [ORANGE-TIP]. Ova & larva on *Cardamine pratensis* L., Clareabbey, R339753, 22.v.1998; male, Bunnow marsh, R364755, 22.v.1998; female & ova on *Cardamine pratensis* L.Lough near Ballyduff, R365817, 22.v.1998.
Colias crocea (Fourcroy, 1785) [CLOUDED YELLOW]. One, Kilbreckan Lough limestone pavement, R368757, 28.viii.1998.

NYMPHALIDAE
Inachis io (Linnaus, 1758) [PEACOCK]. One, Bunnow marsh, R362755, 28.viii.1998; one, Kilbreckan Lough limestone pavement, R368757, 28.viii.1998.
Euphydryas aurinia (Rottemburg, 1775) [MARSH FRITILLARY]. Six, Bunnow (East), R362755, 12.vi.1998.
Hipparchia semele (Linnaeus, 1758) [GRAYLING]. Two, Kilbreckan Lough limestone pavement, R368757, 28.viii.1998.
Maniola jurtina (Linnaeus, 1758) [MEADOW BROWN]. One, Bunnow marsh, R362756, 2.viii.1998; two, Ballyduff, R365815, 6.viii.1998; five, Bunnow marsh (east), R366756, 28.viii.1998.
Pararge aegeria (Linnaeus, 1758) [SPECKLED WOOD]. Two, Clareabbey, R339753, 22.v.1998; two, Bunnow marsh, R364755, 22.v.1998; one, Kilbreckan Lough limestone pavement, R368755, 22.v.1998; one, Ballyduff, R365815, 6.viii.1998; one, Kilbreckan Lough limestone pavement, R368757, 28.viii.1998.
Lasiommata megera (Linnaeus, 1767) [WALL]. One, Kilbreckan Lough limestone pavement, R368755, 22.v.1998; one, Cappagh Lough (N. shore), R367813, 22.v.1998.

LYCAENIDAE
Polyommatus icarus (Rottemburg, 1775) [COMMON BLUE]. Two males & female, Clareabbey, R339753, 22.v.1998; male, Kilbreckan Lough limestone pavement, R368755, 22.v.1998; two males, Gaurus, R362773, 11.vi.1998; male, Bunnow (East), R362755, 12.vi.1998; three males, Kilbreckan Lough limestone pavement, R368757, 28.viii.1998.

GEOMETRIDAE
Scopula immutata (Linnaeus, 1758) [LESSER CREAM WAVE]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Idaea dimidiata (Hufnagel, 1767) [SINGLE-DOTTED WAVE]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Scotopteryx chenopodiata (Linnaeus, 1758) [SHADED BROAD-BAR]. One at m. v. trap, Ballyduff, R365815, 6.viii.1998; one at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Orthonama vittata (Borkhausen, 1794) [OBLIQUE CARPET]. Five at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.

Xanthorhoe designata (Hufnagel, 1767) [FLAME CARPET]. One, Cappagh Lough (N. shore), R367813, 22.v.1998; one at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Xanthorhoe ferrugata (Clerck, 1759) [DARK-BARRED TWIN-SPOT CARPET]. Two at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Xanthorhoe fluctuata (Linnaeus, 1758) [GARDEN CARPET]. One at light, Ballymacahill Cross, R362789, 27.viii.1998; one at light, Ennis, R341776, 27.viii.1998.
Epirrhoe alternata (Müller, 1764) [COMMON CARPET]. One, Bunnow (East), R362755, 12.vi.1998; one, Clareabbey, R339753, 22.v.1998; three at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Camptogramma bilineata (Linnaeus, 1758) [YELLOW SHELL]. One, Ballyduff, R365815, 6.viii.1998.
Eulithis populata (Linnaeus, 1758) [NORTHERN SPINACH]. Two at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Chloroclysta truncata (Hufnagel, 1767) [COMMON MARBLED CARPET]. One at light, Ennis, R341776, 27.viii.1998.
Colostygia pectinataria (Knoch, 1781) [GREEN CARPET]. One at m. v. trap, Bunnow marsh, R362755, 28.viii.1998; one at m. v. trap, Bunnow marsh, R362756, 2.viii.1998; one, Bunnow marsh, R364755, 22.v.1998.
Perizoma bifaciata (Haworth, 1809) [BARRED RIVULET]. One taken at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Eupithecia absinthiata (Clerck, 1759) [WORMWOOD PUG]. Five at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Abraxas grossulariata (Linnaeus, 1758) [MAGPIE MOTH]. One at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Chiasmia clathrata (Linnaeus, 1758) [LATTICED HEATH]. One, Bunnow (East), R362755, 12.vi.1998.
Opisthograptis luteolata (Linnaeus,1758) [BRIMSTONE MOTH]. One at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.
Epione repandaria (Hufnagel, 1767) [BORDERED BEAUTY]. One, Bunnow marsh, R362756, 1.viii.1998.
Ourapteryx sambucaria (Linnaeus, 1758) [SWALLOW-TAILED MOTH]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Peribatodes rhomboidaria (Denis & Schiffermüller, 1775) [WILLOW BEAUTY]. One at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Ematurga atomaria (Linnaeus, 1758) [COMMON HEATH]. *C*20, Bunnow marsh (west), R362755, 22.v.1998; four, Bunnow (East), R362755, 12.vi.1998.
Cabera exanthemata (Scopoli. 1763) [COMMON WAVE]. One at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.

LASIOCAMPIDAE
Euthrix potatoria (Linnaeus, 1758) [DRINKER]. Larva, Bunnow marsh, R364755, 22.v.1998; larva, Bunnow, R363755, 7.vii.1998; nine at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.

SPHINGIDAE
Hemaris tityus (Linnaeus, 1758) [BEE HAWK-MOTH]. One, Bunnow marsh (west), R362755, 22.v.1998.

ARCTIIDAE
Arctia caja (Linnaeus, 1758) [GARDEN TIGER]. Six at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Phragmatobia fuliginosa (Linnaeus, 1758) [RUBY TIGER]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.

NOCTUIDAE
Rivula sericealis (Scopoli, 1763) [STRAW DOT]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Hypena proboscidalis (Linnaeus, 1758) [THE SNOUT]. Two at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Euclidia glyphica (Linnaeus, 1758) [BURNET COMPANION]. One, Clareabbey, R339753, 22.v.1998.
Dichrysia chrysitis (Linnaeus, 1758) [BURNISHED BRASS]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998; six at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Plusia festucae (Linnaeus, 1758) [GOLD SPOT] . Three at m. v. trap (genitalia of male checked), Bunnow marsh, R362755, 28.viii.1998.
Autographa bractea (Denis & Schiffermüller, 1775) [GOLD SPANGLE]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Syngrapha interrogationis (Linnaeus, 1758) [SCARCE SILVER-Y]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Apamea monoglypha (Hufnagel, 1766) [DARK ARCHES]. Three at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Apamea crenata (Hufnagel, 1766) [CLOUDED BORDERED-BRINDLE]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Mesapamea secalis (Linnaeus, 1758) [COMMON RUSTIC]. Two at m. v. trap (genitalia of female checked), Ballyduff, R365815, 6.viii.1998.
Mesapamea didyma (Esper, 1788) [REMM'S COMMON RUSTIC]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998; two at m. v. trap (genitalia of male checked), Ballyduff, R365815, 6.viii.1998.
Photedes pygmina (Haworth, 1809) [SMALL WAINSCOT]. Nine at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.

Amphipoea lucens (Freyer, 1845) [LARGE EAR]. Male at m. v. trap (genitalia checked), Bunnow marsh, R362755, 28.viii.1998.
Hydraecia micacea (Esper, 1789) [ROSY RUSTIC]. Six at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.
Celaena leucostigma (Hübner, 1808) [THE CRESCENT]. Thee at m. v. trap, Bunnow marsh, R362756, 2.viii.1998; five at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.
Coenobia rufa (Haworth, 1809) [SMALL RUFOUS]. Male taken at m. v. trap (genitalia checked), Bunnow marsh, R362756, 2.viii.1998.
Mythimna impura (Hübner, 1808) [SMOKY WAINSCOT]. 18 at m. v. trap, Bunnow marsh, R362756, 2.viii.1998; one at m. v. trap, Ballyduff, R365815, 6.viii.1998; three at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.
Agrotis exclamationis (Linnaeus, 1758) [HEART AND DART]. One at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Ochropleura plecta (Linnaeus, 1761) [FLAME SHOULDER]. One at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.
Noctua pronuba (Linnaeus, 1758) [LARGE YELLOW UNDERWING]. One at m. v. trap, Bunnow marsh, R362756, 2.viii.1998; two at m. v. trap, Ballyduff, R365815, 6.viii.1998; three at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.
Noctua comes Hübner, 1813 [LESSER YELLOW UNDERWING]. One at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.
Noctua janthe (Borkhausen, 1792) [LESSER BROAD-BORDERED YELLOW UNDERWING]. One at m. v. trap, Ballyduff, R365815, 6.viii.1998.
Lycophotia porphyrea (Denis & Schiffermüller, 1775) [TRUE-LOVER'S KNOT]. Two at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.
Diarsia rubi (Vieweg, 1790) [SMALL SQUARE-SPOT]. Three at m. v. trap, Bunnow marsh, R362755, 28.viii.1998.
Xestia baja (Denis & Schiffermüller, 1775) [DOTTED CLAY]. Two at m. v. trap, Bunnow marsh, R362756, 2.viii.1998.

SPECIES LIST OF **ODONATA**
(7 species)

COENAGRIIDAE
Coenagrion puella.(Linnaeus, 1758) [AZURE DAMSELFLY]. *C*10, Clareabbey, R339753, 22.v.1998; one, Bunnow marsh, R364755, 22.v.1998; *c*5, Bunnow marsh (west), R362755, 22.v.1998; *c*10, Cappagh Lough (N. shore), R367813, 22.v.1998; male, Bunnow, R355772, 10.vi.1998; one, Bunnow, R355772, 11.vi.1998.
Ischnura elegans (Vander Linden, 1823) [BLUE-TAILED DAMSELFLY]. Male, Clareabbey, R339753, 22.v.1998; one, Cappagh Lough (N. shore), R367813, 22.v.1998.
Pyrrhosoma nymphula (Sulzer, 1776) [LARGE RED DAMSELFLY]. Three, Bunnow marsh, R364755, 22.v.1998; four, Cappagh Lough (N. shore), R367813, 22.v.1998; four, Bunnow (East), R362755, 12.vi.1998.

AESHNIDAE
Brachytron pratense (Müller, 1764) [HAIRY DRAGONFLY]. Male & female, Cappagh Lough (N. shore), R367813, 22.v.1998; male, Bunnow, R355772, 11.vi.1998.
Aeshna grandis (Linnaeus, 1758) [BROWN HAWKER] One, Ballyduff, R365815, 6.viii.1998; one, Bunnow marsh, R362755, 27.viii.1998; one, Bunnow marsh, R362755, 28.viii.1998.

LIBELLULIDAE
Libellula quadrimaculata Linnaeus, 1758 [FOUR-SPOTTED CHASER]. One, Bunnow marsh, R364755, 22.v.1998; one, Bunnow marsh (west), R362755, 22.v.1998.
Sympetrum striolatum. (Charpentier, 1840) [COMMON DARTER]. *C*10, Bunnow marsh (east), R366756, 28.viii.1998.

References

Baynes, E. S. A. (1964). A revised catalogue of the Irish Macrolepidoptera (butterflies and moths). Classey, Middlesex, UK.

Bond, K.G.M., (1991). A preliminary survey of the Lepidoptera of Pollardstown Fen, Co Kildare, including a record of Cosmopterix lienigiella (Lienig & Zeller, 1839) (COSMOPTERIGIDAE), a species new to Ireland. *Bull. Ir. biogeog. Soc.* 14(1), 24-47.

Bradley, J. D. & Pelham-Clinton, E. C. (1967). The Lepidoptera of the Burren, Co. Clare, W. Ireland. *Entomologist's Gaz.* 18, 115-153.

Emmet, A. M. (1971). More Lepidoptera in West Galway. *Entomologist's Gaz.* 22, 3-18.

Emmet, A. M. (1991). Life History and Habits of the British Lepidoptera. In: Emmet, A. M. & Heath, J. (Eds) *The Moths and Butterflies of Great Britain and Ireland 7(2).* (pp 61-303) Harley Books, Colchester, UK.

Heath, J. & Emmet, A. Maitland (1983). *The moths and butterflies of Great Britain and Ireland 10 Noctuidae (Part II) and Agaristidae.* Harley Books, Colchester, UK.

Heath, J. (Ed.) (1979). *The moths and butterflies of Great Britain and Ireland 9 Sphingidae-Noctuidae (Noctuiinae and Hadeninae)* Harley Books, Colchester, UK.
Heath, J., Pollard, E. and Thomas, J. (1984). *Atlas of butterflies in Britain and Ireland.* Viking. Middlesex, UK.
Langmaid, J. R. (1989). Lepidoptera in Ireland, August 1986. *Entomologist's Gaz.* 40, 307-313.
Schnack, K. (Ed.) (1985). Katalog over de danske sommerfugle. *Ent. Meddr* 52, 1-163.

APPENDIX 4

Mammal Survey

For the purposes of the survey a total of 18 representative sites along the routes were selected for examination, ten sites on the main bypass (east of Ennis) and eight sites on the western bypass (south and west of Ennis). The symbol thus * indicates impact levels of some moderate/high significance at the particular site in question. In these instances, mitigation measures of replanting pockets of scrub/tree species lost or reduced in the development is recommended. However, the removal of hedgerows will have wider implications in so far as hedgerows are used by mammals as 'corridors' between other habitat types. Thus, the overall movements of mammals in the area is likely to be moderately affected particularly during the construction phase. It is recommended that rather than just clear fencing along the realigned roadway that supplementary tree/scrub planting of Ash, Hawthorn/Blackthorn be undertaken as a mitigation measure along the removed field hedgerow lines.

Site M 1 Latoon creek river crossing.

There are two existing bridges located at this site (one old, one modern), crossing a tidal stretch of the river. The riverine habitat has been previously drained and the large artificial embankments are remnants of past drainage spoil. The bankside vegetation includes tall grasses and reeds and there is very little tree cover. There is a small clump of bramble/nettles near the old bridge. The only tree line in the area borders the existing road. Overall the area has a low habitat diversity, is generally exposed and already highly disturbed. No recent signs of otters were found and the area is likely to be of low importance to mammals. The impact of the proposed bridge crossing and new roadway will not be significant.

Site M 2 Small road crossing north of Latoon creek.

The habitat in the vicinity of this site is primarily that of semi-improved or improved pasture and is of little importance to mammals. The hedgerows and deciduous tree lines are of moderate importance. There is no significant scrub or woodland of importance to mammals. Overall habitat diversity is low and disturbance moderate. Locally, there is broadly similar habitat in the vicinity. The development impact of the roadway is likely to be low and can be minimised further by planting of tree/scrub to replace sections of lost hedgerow.

*Site M 3 Small road crossing south of Kilbreckan Lough**

This area is generally low-lying incorporating rough pasture north of the existing road and rough pasture/wetland south of the road. The drainage stream/canal from Kilbreckan lough is < 2 m wide and joins a drainage canal running parallel to the road. The bankside vegetation incorporates reeds, rushes and emergent macrophytes. The area north of the road is exposed, damp and subject to low-moderate disturbance. It is suitable for rabbit, fox, hare and otter. The wetland/willow scrub south of the road can be considered of moderate importance to otters but of little importance to other mammals. The existing crossing for otters following the watercourse at the site appears to be over the existing road as there is a drainage pipe under the road taking the existing water flow. The impact of the proposed road/any culverting of the watercourses may disrupt the movement of

otters to and from Kilbreckan Lough and increase the possibility of otter road mortalities but is likely to be of little impact on other mammals.

Site M 4 Kilbreckan Lough

The stream outflow from the west of the lough is 2-3 m wide, had a low flow during the survey and is clogged with emergent macrophyte growth. Bankside vegetation include Hawthorn and Bramble. The lough itself is surrounded by rush/reed dominated wetland. It is stocked with coarse fish. To the south there is some scrub habitat and a small copse of likely moderate importance to mammals. The area surrounding the lough offers a potential rest area/haven for otters though no recent signs of the species were found during the survey. The overall area has a moderate habitat diversity and low levels of disturbance. The site will not be directly affected by the development though disturbance levels to the east of the lough will rise.

Site M 5 Road crossing north of Kilbreckan Lough *

The habitat north of the existing road, is generally one of small fields of semi-improved pasture, rough ground, small scrub thickets and relatively small hedgerows. There is a ribbon strip development of houses nearby. Habitat diversity is low to moderate and the area is subject to moderate disturbance. The impact of the development is likely to be low to moderate on local mammals.

South of the road are pasture fields, degraded/semi-developed ground and a relatively good sized scrub habitat likely to be of moderate importance to mammals. Whilst the area is already highly disturbed, the scrub habitat is intact. It is likely that the impact of the development on this habitat will be significant.

Site M 6 Road/bridge crossing on the Knockanean road

North of the existing road, habitats consist of semi-improved pasture (thistles common), uneven ground, small water bodies, tree-lined hedgerow bordering the road (vegetation including semi-mature ash, hawthorn, ivy, bramble, fern). The area has moderate habitat diversity and moderate levels of disturbance. To the north east of the site, there is scrub/copse of likely moderate importance to mammals and this is likely to be marginally affected by the development. South of the road, there is improved pasture and occasional tree copses/scrub. Habitat diversity low-moderate and disturbance is low. The hedge rows in the area are generally of moderate importance to mammals and impact of the development can be minimised by compensatory scrub planting parallel to the road margins.

Site M 7 Road crossing west of ESB station

North of the existing road, habitats are semi-improved pasture (thistles common), uneven ground, low diversity hedgerows, small water body surrounded in part by relatively good scrub. The overall habitat diversity is low and the area is subject to moderate disturbance. The water body on site is not important to otters and the area generally is of low importance to mammals. There is plenty of similar type habitat in the vicinity and the overall impact will not be significant.

South of the road the habitat includes an old quarry site recolonised/surrounded by significant scrub vegetation (bramble and hawthorn are common). Overall the area provides relatively good

habitat diversity and is likely to be of moderate importance to mammals. Impact accordingly will likely be moderate on local mammals.

*Site M 8 Ballymacahill road**

North of the existing road, the habitat is primarily one of semi-improved pasture (thistles are common), uneven ground, small rock outcrop with surrounding scrub of moderate importance. There are relatively narrow hedgerows including hawthorn and bramble. The habitat is generally one of low diversity and low disturbance. Overall it is of little importance to mammals.

South of the road, there are small fields of semi-improved pasture. Approximately two fields south of the road, there is a strong belt of scrub likely to be of at least moderate importance to mammals. It appears that the road development will traverse through this scrub causing local habitat fragmentation and significant local impact.

Site M 9 Barefield Road Crossing

South-west of the existing road, the habitat is primarily improved pasture, with relatively narrow hedgerows. The latter includes hawthorn and bramble with very few semi-mature trees. North-east of the road, the habitat is again dominated by pasture fields, stonewalls and relatively narrow hedgerows (the latter including hawthorn, bramble and nettles).

The overall area has a low habitat diversity and relatively low levels of disturbance. In general it is of low importance to mammals and there will be no significant development impact.

Site M 10 Drumquin Road crossing

South-west of the road, habitats consist of rough pasture fields (thistles are common), uneven ground, occasional thickets of bramble, stonewall and hedgerow (including hawthorn) bordering a small pond. There are few semi-mature deciduous trees. Gardens of dwelling houses are also present. Excepting the bramble thickets, the area is of marginal importance to local mammals.

North-east of the road, the habitat is dominated by rough pasture, small stonewalls and very marginal hedgerows. The habitat diversity in the area is low and the levels of disturbance are also low. Overall, the general area is of very little importance to mammals and the development impact will not be significant.

Site M 11 Ennistymon Road crossing

South of the proposed roundabout site, there are a number of moderate sized fields of semi-improved pasture (thistles are common). The surrounding boundaries are of stonewall and hedgerows of variable ecological quality (poor to moderate). The overall area has relatively low habitat diversity, moderate levels of disturbance and can be considered of low importance to mammals. The development impact is likely to be low. To the west of the proposed roadway route is an extensive wood likely to be of local significant importance to mammals. However this wood will not be affected by the development.

Site M 12 Claureen River crossing

There is dense vegetation cover along the southern bank of the Claureen river at the proposed crossing point. The scrub includes hawthorn, willow, young ash, bramble and nettles. There is somewhat similar though less abundant cover along the northern bank. The area has a moderate habitat diversity and low disturbance levels. While no recent signs of otters were found during the survey, the area is most probably used as a temporary area on a regular basis. There were no signs of permanent underground resting sites (holts).

The impact of the development is likely to be significant on otters during the construction phase. In the medium-long term otters will adjust to the modified habitat. There is likely to be an attendant increase in the likelihood of otter mortalities on the new road. However depending on the design of the proposed bridge, otters underpasses if necessary should reduce this risk. The impact on other mammals is likely to be low to moderate.

Site M 13 Miltown Malbay Road crossing

To the west of the existing road, habitats consist of semi-improved pasture, rough ground, some spoil spreading, a small young ash copse and a small thicket of bramble. The overall area has a low habitat diversity and high disturbance levels. It is of marginal importance to mammals and development impact will not be significant.

To the east of the existing road, the area incorporates a caravan park and adjacent scrub habitat of a relatively good size. The latter has a moderate habitat diversity and is subject to moderate/high levels of disturbance. Overall the development impact is likely to be low to moderate on local mammals.

*Site M 14 Kilrush Road and stream crossing**

To the west of the existing road, the area is uneven/hilly ground with small pasture fields and moderate hedgerows. It has a moderate habitat diversity and is subject to moderate/high levels of disturbance. Overall the development impact is likely to be low to moderate on local mammals.

To the east of the existing road, are low-lying fields of poor/rough pasture dominated by rushes and thistles. The area is damp underfoot and exposed. During the survey the land was semi-flooded. The small drainage canal/stream may be used by otters but no recent signs of the species were found. Overall this section of habitat is of low importance to mammals. However, to the east of the drainage canal, there is an extensive scrub/woodland of mixed deciduous trees. The area has a high vegetation diversity, is dense and subject to low disturbance levels. Overall this habitat can be considered of high importance to local mammals. The development impact in this case is likely to be significant with habitat loss, fragmentation, disturbance and likely increase in road traffic mortalities.

*Site M 15 Main Ennis Road crossing**

West of the existing road, there is a dense scrub belt (including hawthorn, bramble, nettles, fern) with a moderate/high species diversity. The area is likely to be of increasing importance to mammals further away from the urban habitat to the west. The area is highly disturbed close to the road. The overall development impact is likely to be moderate to significant.

To the east of the existing road, the habitat is one of small fields (mixed grasses and fern are common), stonewalls, occasional scrub thickets and a conifer belt. The area has a moderate habitat diversity and is subject to low-moderate disturbance levels. Overall the area provides relatively good cover especially for small mammals and the development impact is likely to be moderate-significant.

Site M 16 Clareabbey road crossing

To the west of the existing small road to Clareabbey, the habitat is low-lying and one of rough pasture/marsh/wetland, occasional thickets of bramble and a nettle belt following a stonewall. Overall the habitat diversity is low-moderate and is subject to low disturbance. The thicket areas are of moderate importance to mammals whilst other habitat is of low importance. Overall, the development impact is likely to be low.

To the east of the existing road, there is a large pasture/arable field with no significant vegetation or hedgerows. The area is open and exposed with very low habitat diversity. Overall development impact will not be significant.

Site M 17 River Fergus crossing

At the site of the proposed crossing, the River Fergus is bordered by both banks by steep embankments/drainage spoil and drainage ditches. The bankside vegetation includes reeds, nettles, meadowsweet and occasional scrub hawthorn. The habitats in the area are relatively uniform. To the east of the crossing, the small pasture fields and extensive wetland area is of little importance to mammals. Overall impact of the development is likely to be low for most mammals. However, recent signs of otters were located at the proposed river crossing during the survey and the overall river length is likely to be of moderate importance to the species. Notwithstanding, it is more important to allow continued movement of otters up and down the Fergus after bridge construction. During the construction phase, there will be significant disturbance. Otter underpasses should be developed under the main bridge and both drainage channels to allow unhindered otter movement. In the absence of same, otter road mortalities are a possibility.

Site M 18 Skehanagh Road crossing

To the west of the existing small road there is an extensive marsh/wetland type habitat (vegetation includes, fern, nettles, meadowsweet, willow scrub). The general area is quite damp underfoot with isolated patches of drier ground that are likely to be of low to moderate importance to mammals. The overall area has low-moderate habitat diversity, existing low development impact and low disturbance levels. Nothwithstanding, the proposed development impact is also likely to be low on mammals.

To the east of the existing road the habitat is one of small semi-improved/rough pasture fields, hedgerows including hawthorn and marsh/wetland. Overall, the area is considered to be of low, if of marginally moderate importance to mammals and development impact will not be significant.

APPENDIX 4

Scientific names of other species mentioned in the text

Plants (not listed in Appendix 1)

Beech	*Fagus sylvatica*
Broad Buckler-fern	*Dryopteris dilatata*
Celery-leaved Buttercup	*Ranunculus scleratus*
Charlock	*Sinapsis arvensis*
Dense-flowered Orchid	*Neotinea maculata*
English Scurvygrass	*Cochlearia anglica*
Flowering-rush	*Butomus umbellatus*
Grey Club-rush	*Schoenoplectus tabernaemontani*
Horse-chestnut	*Aesculus hippocastanum*
Mountain Avens	*Dryas octopetala*
Pedunculate Oak	*Quercus frobur*
Reed Sweet-grass	*Glyceria maxima*
Sea Club-rush	*Bolboschoenus maritimus*
Sessile Oak	*Quercus petraea*
Shrubby Cinquefoil	*Potentilla fruticosa*
Spiked Sedge	*Carex spicata*
Spring Gentian	*Gentiana verna*

Amphibians and Reptiles

Common Frog	*Rana temporaria*
Common Lizard	*Lacerta vivipara*

Birds

Blackbird	*Turdus merula*
Blackcap	*Sylvia atricapilla*
Black-tailed Godwit	*Limosa limosa*
Blue Tit	*Parus caeruleus*
Bullfinch	*Pyrrhula pyrrhula*
Chaffinch	*Fringilla coelebs*
Coal Tit	*Parus ater*
Cormorant	*Phacrocorax carbo*
Cuckoo	*Cuculus canorus*
Dunnock	*Prunella modularis*
Goldcrest	*Regulus regulus*
Grasshopper Warbler	*Locustella naevia*
Great Tit	*Parus major*
Grey Heron	*Ardea cinerea*
Linnet	*Carduelis cannabina*
Mallard	*Anas platyrhynchos*
Meadow Pipit	*Anthus pratensis*
Moorhen	*Gallinula chloropus*
Mute Swan	*Cygnus olor*
Reed Bunting	*Emberiza schoeniclus*
Robin	*Erithacus rubecula*
Sedge Warbler	*Acrocephalus schoeniclus*
Skylark	*Alauda arvensis*
Snipe	*Gallinago gallinago*
Song Thrush	*Turdus philomelos*
Stonechat	*Saxicola torquata*
Teal	*Anas crecca*
Water Rail	*Rallus aquaticus*
Whimbrel	*Numenius phaeopus*
Whitethroat	*Sylvia collybita*
Willow Warbler	*Phylloscopous trochilus*
Woodpigeon	*Columba palumbus*
Wren	*Troglodytes troglodytes*

Mammals

Badger	*Meles meles*
Brown Rat	*Rattus norvegicus*
Daunenton's Bat	*Myotis daubentoni*
Fox	*Vulpes vulpes*
Hare	*Lepus timidus*
Hedgehog	*Erinaceus europaeus*
Leisler's Bat	*Nyctalus leisleri*
Lesser Horseshoe Bat	*Rhinolophus hipposideros*
Natterer's Bat	*Myotis natteri*
Otter	*Lutra lutra*
Pine Maretn	*Martes martes*
Pipistrelle (45 kHz)	*Pipistrellus pipistrellus*
Pipistrelle (55 kHz)	*Pipistrellus pygmaeus*
Pygmy Shrew	*Sorex minutus*
Rabbit	*Oryctolagus cuniculus*
Stoat	*Mustela erminea*
Whiskered Bat	*Myotis mystacinus*
Wood Mouse	*Apodemus sylvaticus*

APPENDIX 5

Impact Terminology

While the EPA *Guidelines* (EPA, 1995) provide a defined terminology for describing impact significance, this terminology has not proved to have been of much use in practise: a review of 28 recent Environmental Impact Statements found that only one of these used this terminology (Gittings, 1998). In fact, a terminology specifically defined with reference to ecology is required for description of ecological impact significance. The following terminology has been devised on this basis and is used to describe impact significance in this EIS:

Type of Impact

Positive impact:	A change to the ecology of the affected site which enhances the ecological value of the area.
Negative impact:	A change to the ecology of the affected site which reduces the ecological value of the area.

All impacts referred to in the text are negative, unless otherwise stated.

Magnitude of Impact

No change:	No discernible change in the ecology of the affected site.
Imperceptible Impact:	A change in the ecology of the affected site, the consequences of which are strictly limited to within the development boundaries.
Slight Impact:	A change in the ecology of the affected site which has noticeable ecological consequences outside the development boundary, but these consequences are not considered to significantly affect species or habitats of conservation importance.
Moderate Impact:	A change in the ecology of the affected site which has noticeable ecological consequences outside the development boundary and these consequences are considered to significantly affect species or habitats of conservation importance.
Substantial Impact:	A change in the ecology of the affected site which has noticeable ecological consequences outside the development boundary. These consequences are considered to significantly affect species or habitats of high conservation importance and to potentially affect the overall viability of those species or habitats in the wider area.

Profound Impact: A change in the ecology of the affected site which has noticeable ecological consequences outside the development boundary. These consequences are considered to be such that the overall viability of species or habitats of high conservation importance in the wider area is under a very high degree of threat (negative impact) or is likely to increase markedly (positive impact).

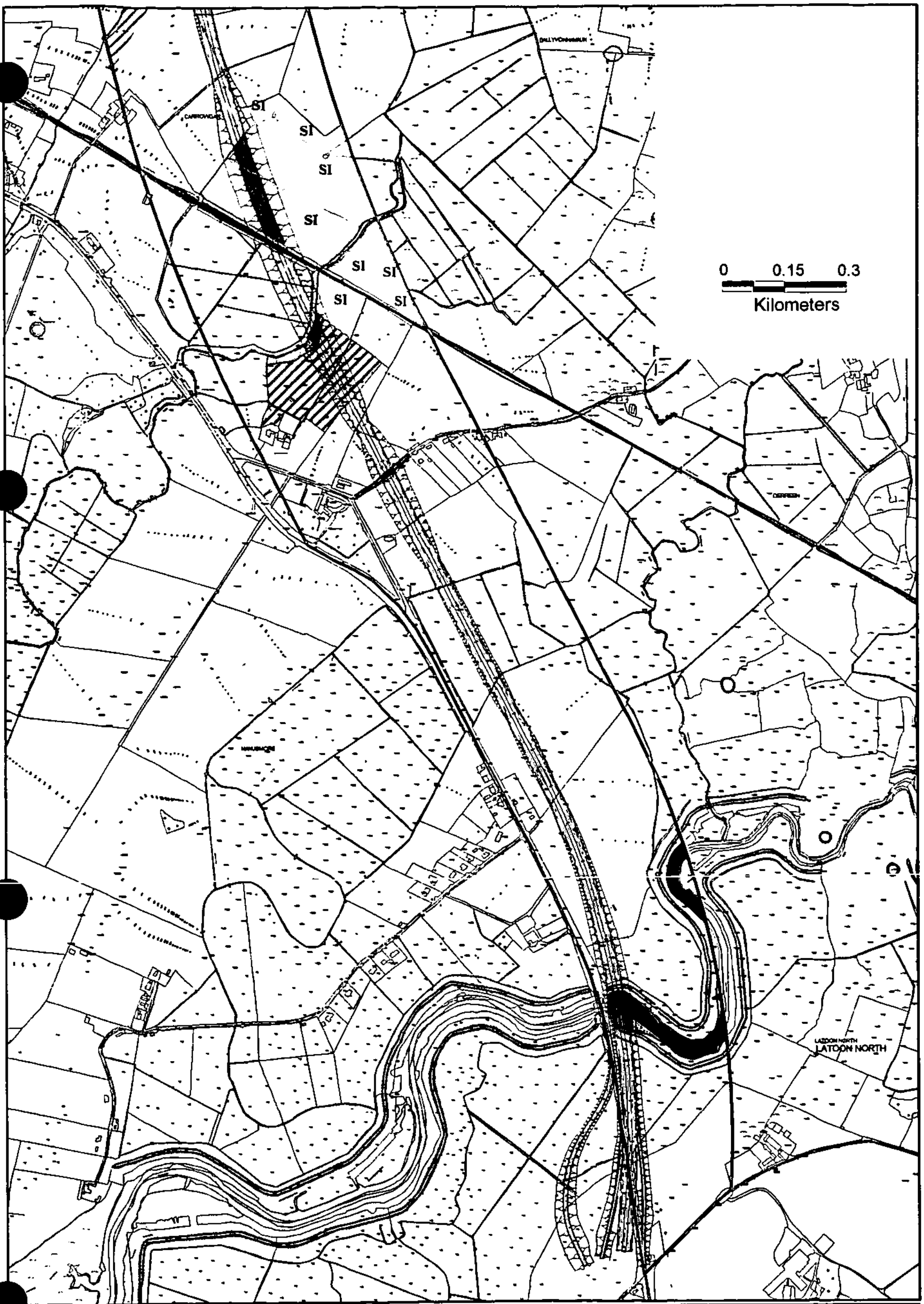
References

EPA (Environmental Protection Agency) (1995). *Draft Guidelines on the Information to be Contained in Environmental Impact Statements*. Environmental Protection Agency, Wexford.

Gittings, T. (1998). Assessing the significance of ecological impacts: a proposed framework and terminology. *8th Environmental Researchers Colloquium, RTC Sligo, 30th January to 1st February 1998, Book of Abstracts*, p. 26.

This report has been prepared by RPS Cairns Ltd

REPORT NUMBER	**IR527/4**
STATUS OF REPORT:	**Revision 2**
DATE OF REPORT:	**02 March 2000**
PROJECT MANAGER:	**Tom Gittings**



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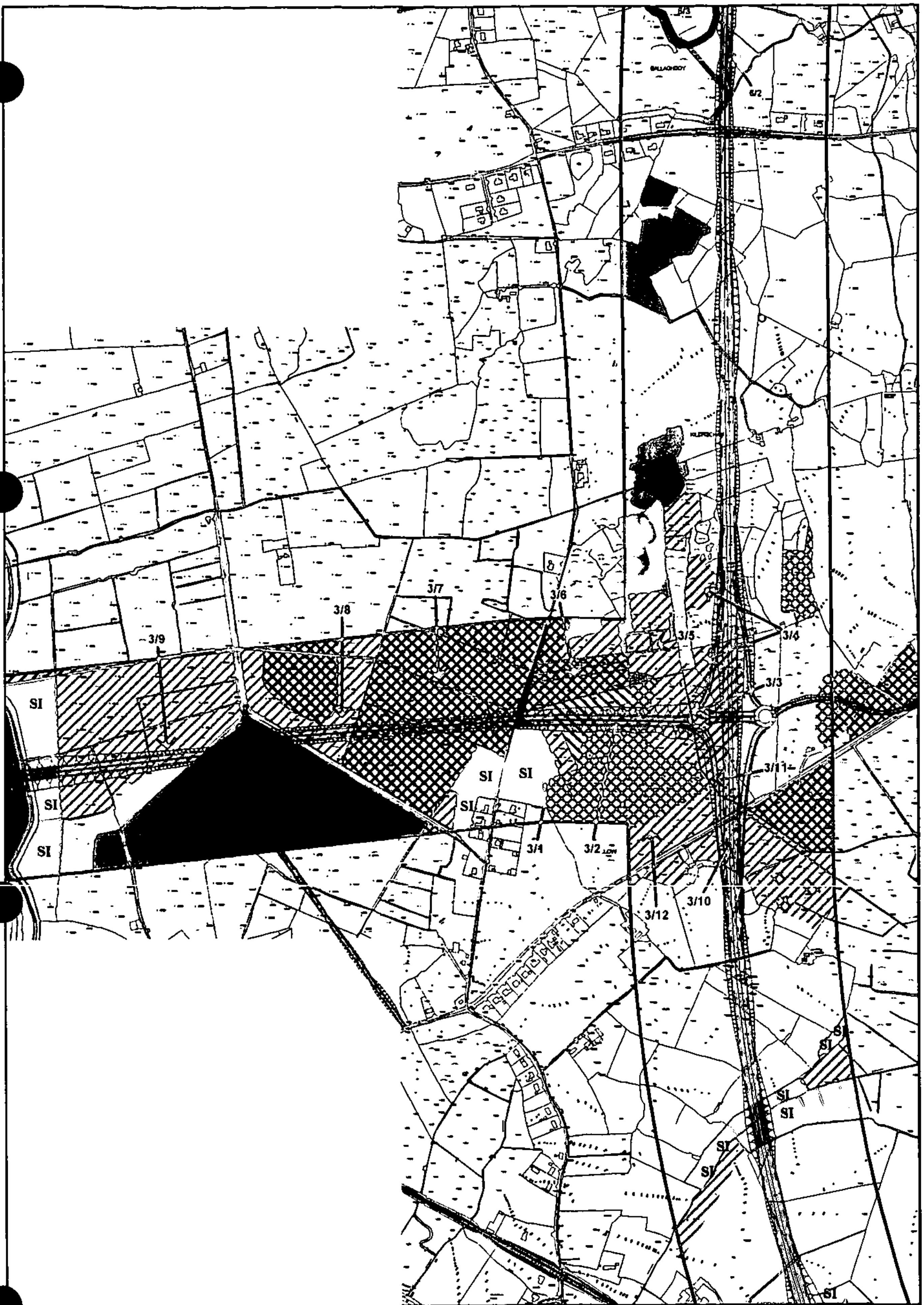
Habitat Plan - section 1

Figure 1a



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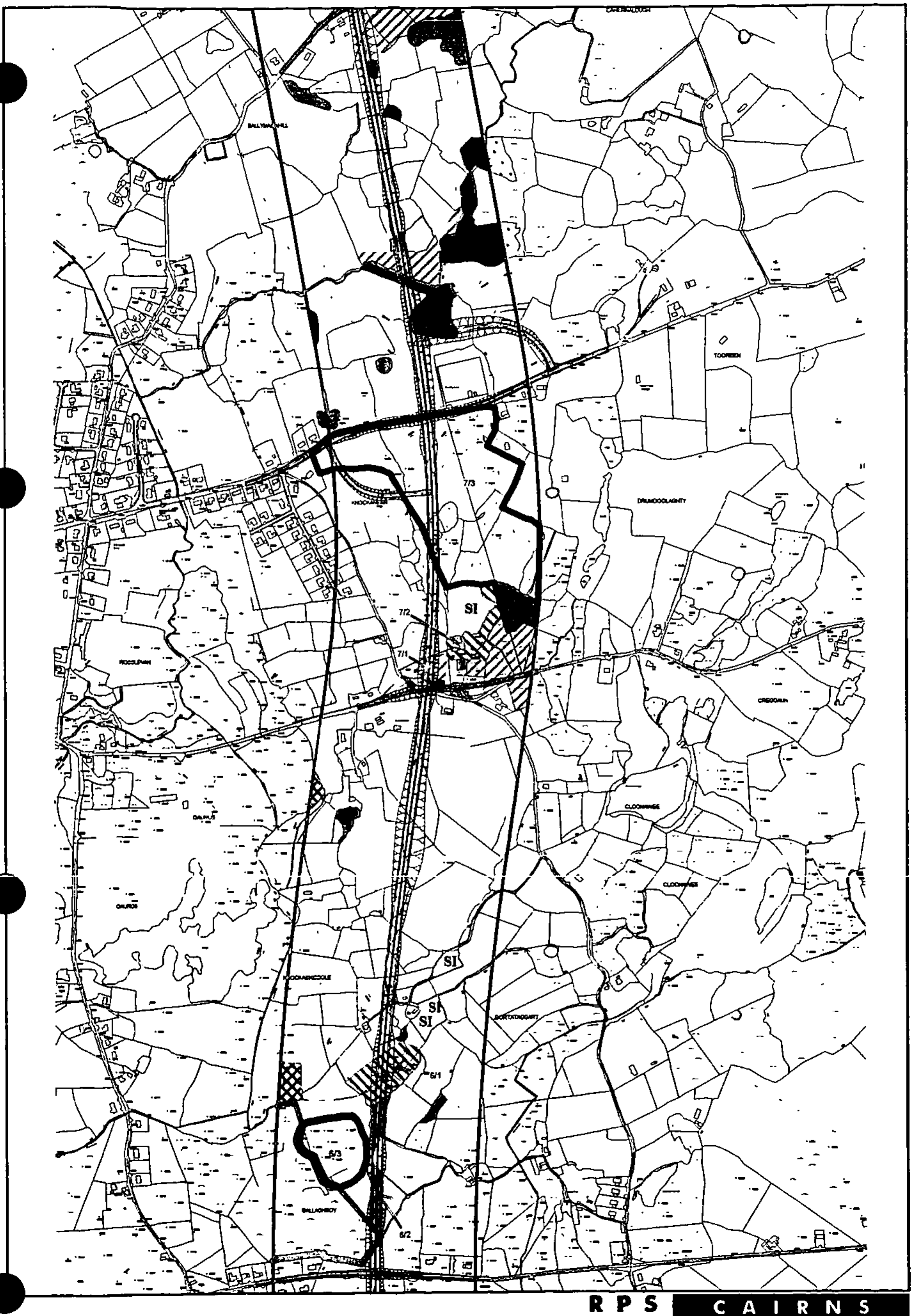
Habitat Plan - section 2

Figure 1b



Habitat Plan - section 3

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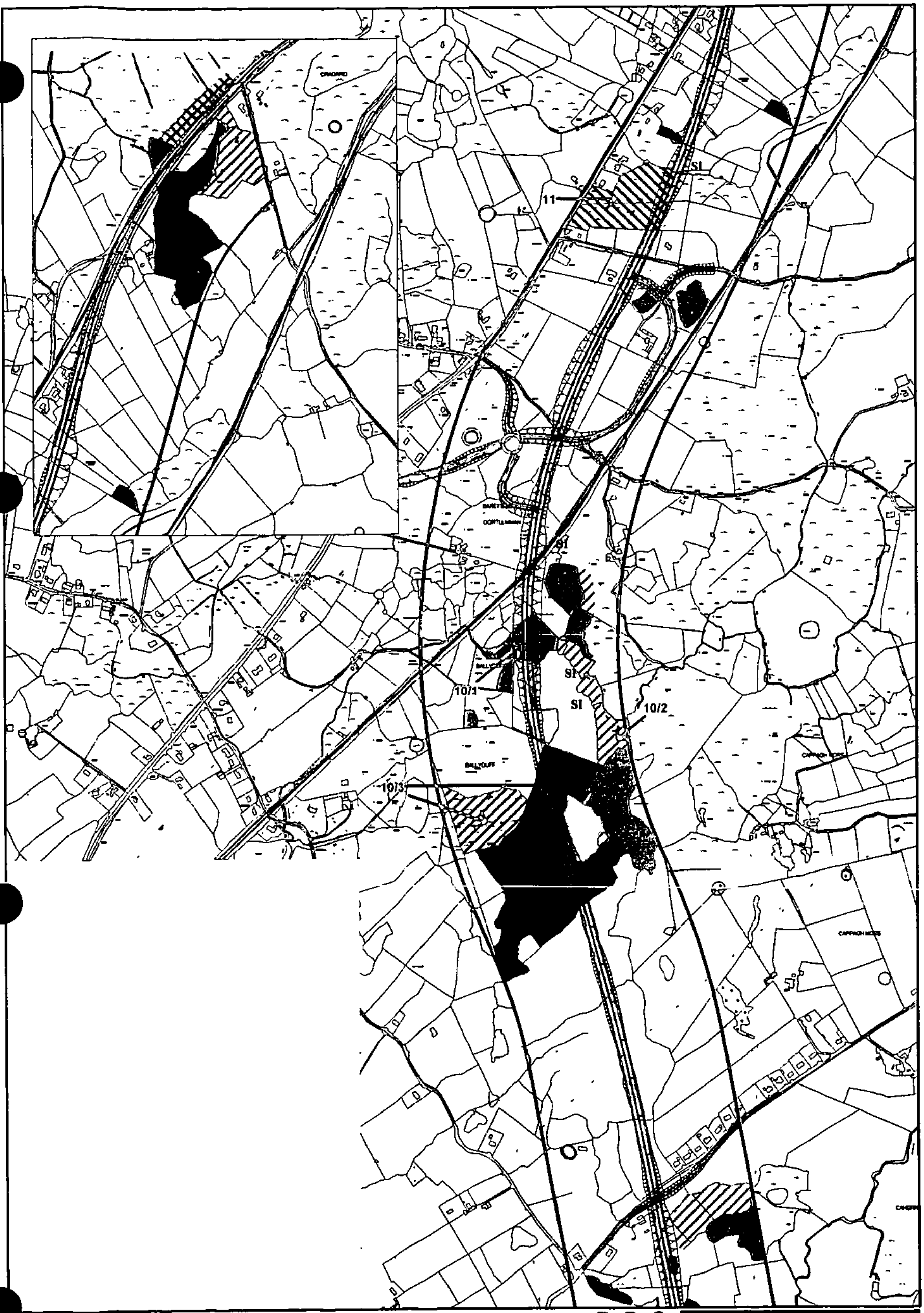
Figure 1c



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Habitat Plan - section 4

Figure 1d

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Habitat Plan - section 5

Fiqure 1e

	River / standing water		Unimproved calcareous grassland
	Swamp		Wet modified bog
	Saltmarsh		Fen
SI	Semi-improved neutral grassland		Scrub
	Plantation broad-leaved woodland		Limestone pavement
	Plantation coniferous woodland		Unimproved neutral grassland
	Marshy grassland		Fen/marshy grassland complex
	Quarry		Semi-natural broad-leaved woodland
	Limestone cliff		Hazel scrubwood/calcareous grassland complex
	Scrubwood	14/1	Botanical survey sites

Key for habitat plans

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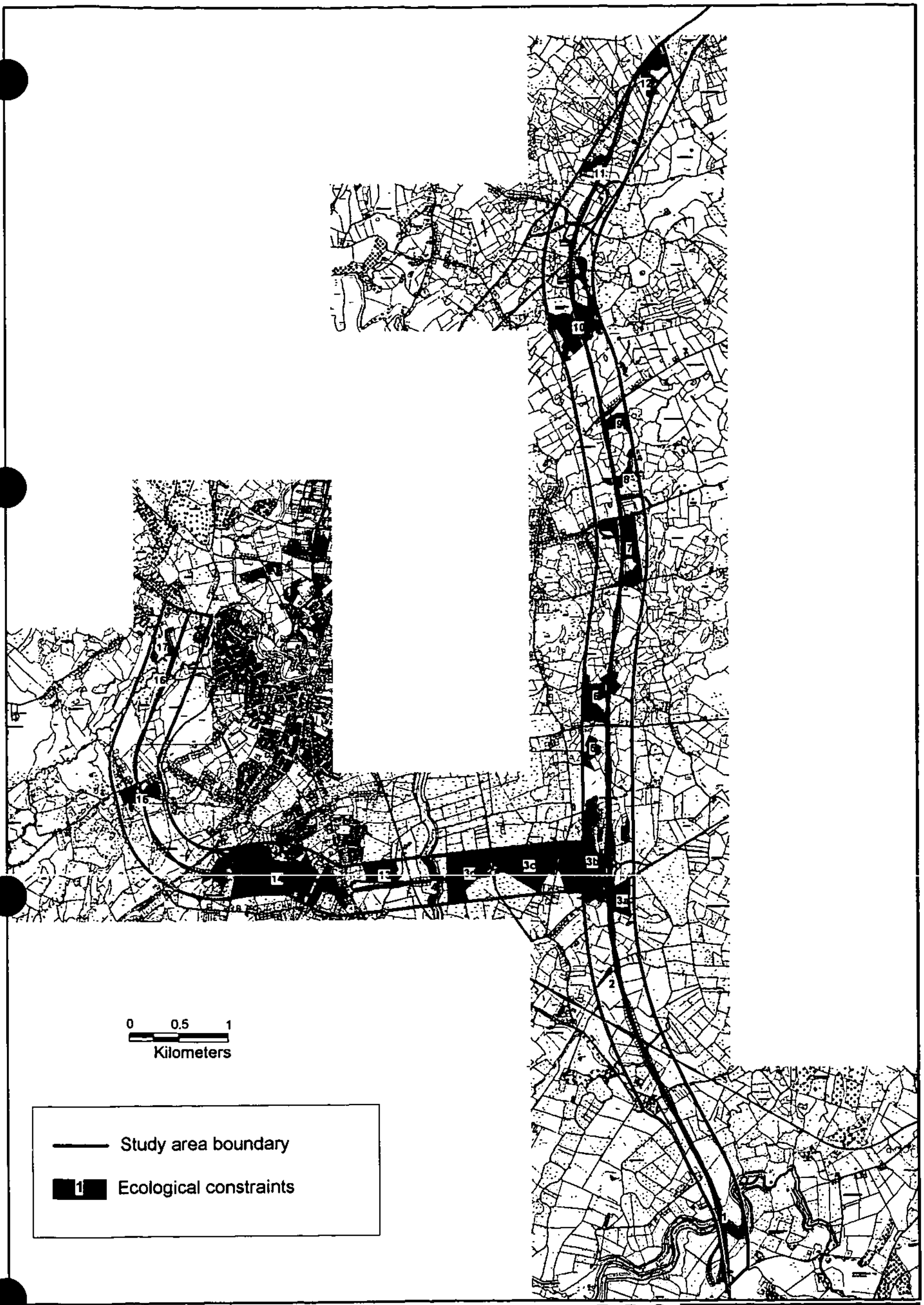
Figure 1f



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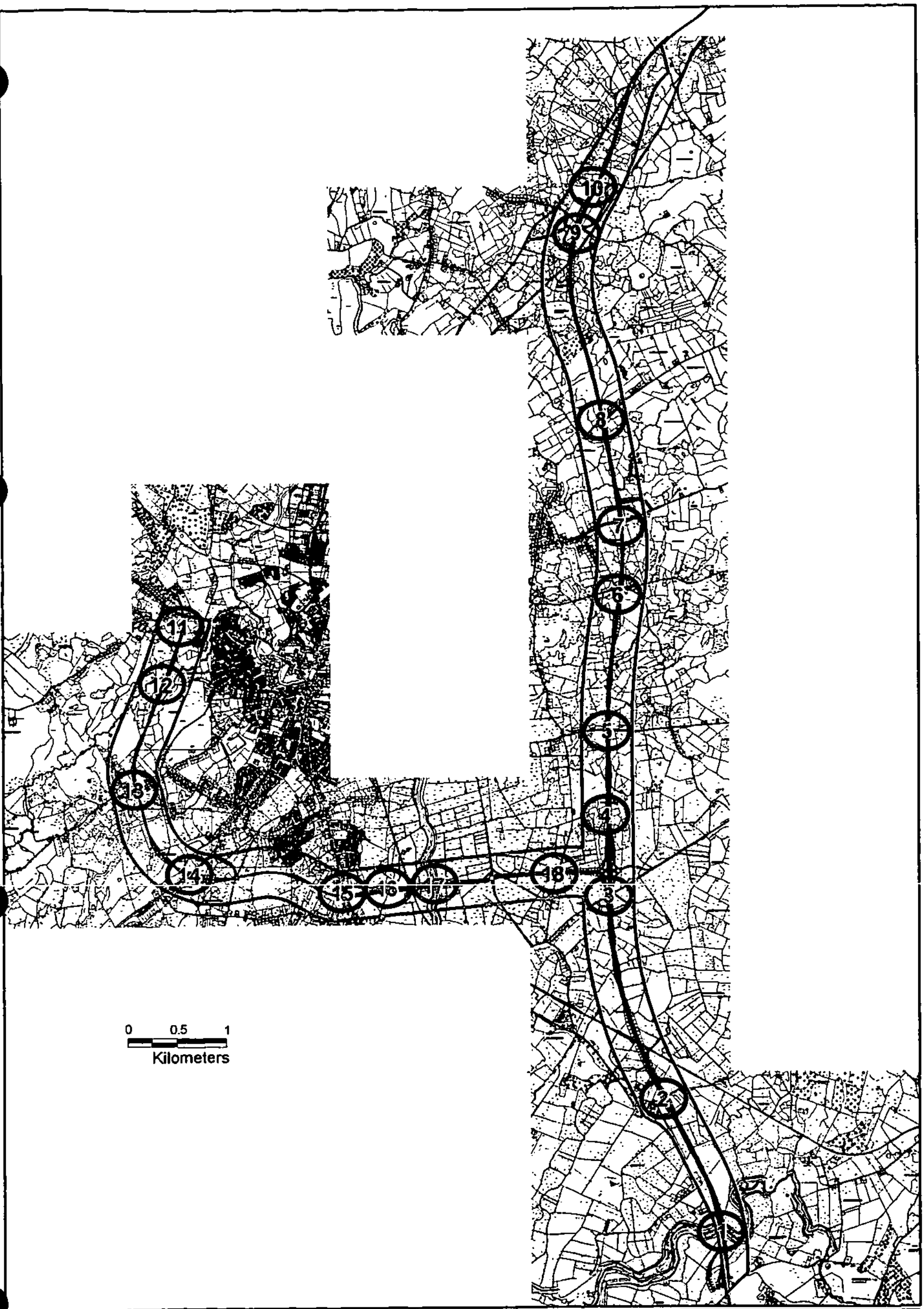
Ecological Constraints Map

Figure 2



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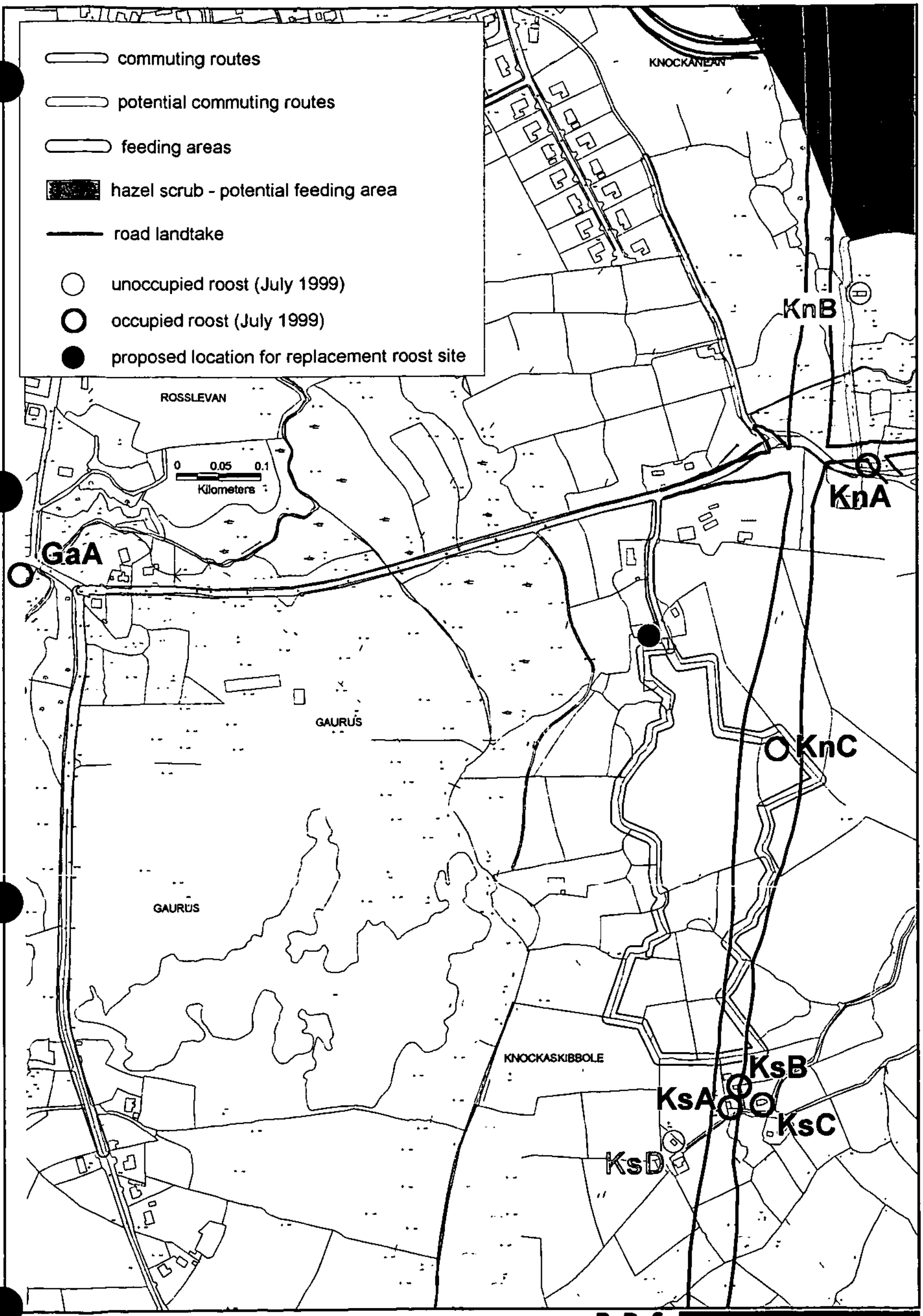
Mammal survey sites

Figure 3



Bat roosts, commuting routes and feeding areas

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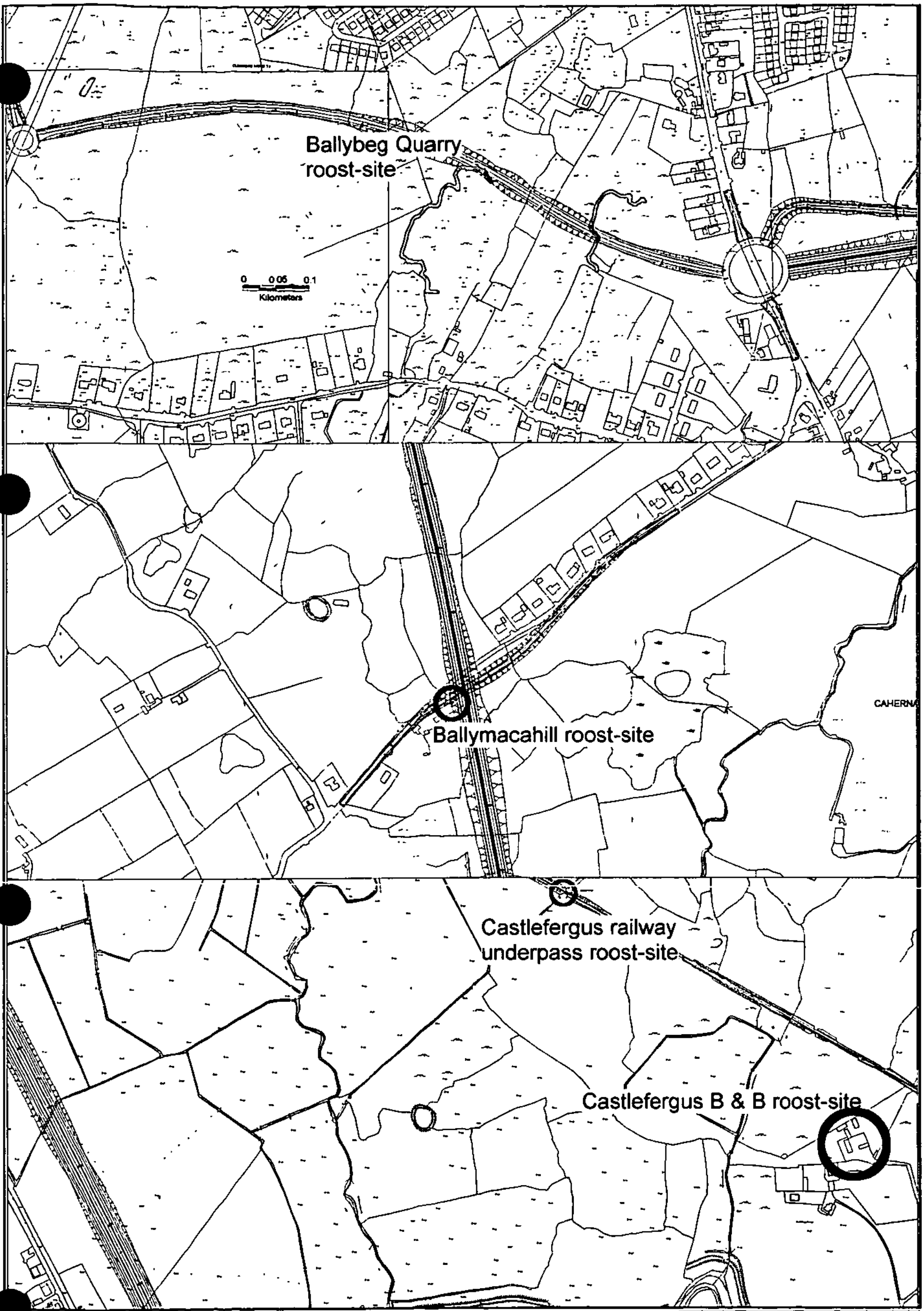
Figure 4a



Bat roost sites

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Figure 4b

APPENDIX III – PART B

BAT SURVEY (Brian Keeley and Donna Mullen)

24 - 9 - 99
3/61/REP-0133

Ennis Bypass Environmental Assessment

Commuting routes and feeding range of Lesser Horseshoe bats (*Rhinolophus hipposideros*) at Knockanean Old Schoolhouse

SEPTEMBER 1999

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REPORT NUMBER:	**IR527/5**
STATUS OF REPORT:	**Revision 3**
DATE OF REPORT:	**27 September 1999**
PROJECT MANAGER:	**Tom Gittings**

CONTENTS

ENCLOSURES

1. Plans for Lesser Horseshoe roost (courtesy of Dr. K. McAney)
2. Countryside Council for Wales Contract Science report No. 250, including plans for artificial maternity roost (courtesy of CCW)
3. Bat access adaptations (courtesy of Joint Nature Conservation Committee)

difficult for this species due to the directionality and relative weakness of the signal. (It is given the title a "whispering bat").

This study took a far greater effort than was originally envisaged (see Table 1). This was mainly due to the smaller number of bats in the roost than expected (see below) and the directionality of the signal of this bat.

Observations were made throughout the night but were most concentrated at dusk and dawn as these are the times when commuting is most in evidence.

Examination of the buildings proposed for demolition for bat usage and examination of nearby buildings that were considered suitable was also carried out to account for night roosts.

A count was made at Newpark House, further west on the same road to ascertain any trends in Lesser Horseshoe numbers in the area. This house is a proposed Natural Heritage Area that will receive full legal status under the Wildlife (Amendment) Bill scheduled for later this year.

TABLE 1 Dates of observations and fieldwork in assessing feeding area and roost usage in the Knockanean and Knockaskibbole townlands

Activity	Number of people	Number of nights	Dates
Observation of roosts at: Knockanean Knockaskibbole	1	4	1/7/99, 30/7/99, 2/7/99, 29/7/99
Examination of roost sites during daytime and visits to roost-owners	1	4 (days)	1/7/99, 2/7/99, 29/7/99, 30/7/99
Determination of feeding route and feeding areas	2	10	3/7/99, 4/7/99, 21/7/99 - 2/8/99 (excluding 29/7/99 and 30/7/99)

Assessment dates for two nearby Lesser Horseshoe roosts have not been included in this summary

3. RESULTS

A summary of the roosts located in this study is presented in Table 2 and the location of the roosts are shown in Figure 1.

TABLE 2 Bat roosts in the vicinity of the Ennis Bypass scheme

Location of roost	Species present	Number of bats	Nature of roost (maternity, night, etc.)
Knockanean A (KnA)	Lesser Horseshoe	6	Maternity
Knockanean B (KnB)	Unoccupied in 1999	-	-
Knockanean C (KnC)	Lesser Horseshoe	1	Night
Knockaskibbole A (KsA)	Brown Long-eared	>10	Maternity, Night
Knockaskibbole B (KsB)	Lesser Horseshoe Brown Long-eared	1	Night Night
Knockaskibbole C (KsC)	Lesser Horseshoe	2	Night
Gaurus old mill (GaA)	Lesser Horseshoe, Brown Long-eared	2 1	Night Daytime

3.1. Alterations to buildings in study area since August 1998

An initial comment is necessary to qualify the results as made during this study. The roost site at Knockanean Old Schoolhouse (KnA) had been considerably altered from the time of the first survey. The two windows and front door that had been open to access had been sealed up. Some

bats would have been excluded by the process. This must certainly have prevented the subsequent usage of many bats. The opening which the bats were using to enter and leave was a 35 cm x 20 cm hole to the rear of the building which had been made to run a length of "hydrodare" containing an electric fence wire to the electric fence below. As Lesser Horseshoes leave and return to the roost in flight, this is not a significant clearance for wings. It may hamper entry enough to render the roost less attractive. Equally, two barns (KnB) north of the Knockanean Old Schoolhouse that also appeared to be used by Lesser Horseshoes in 1998 have had one end wall removed from each. This renders both structures unsuitable for use.

Despite numerous attempts, it proved impossible to contact the owner of Knockanean Old Schoolhouse, Mr. Michael Murphy. This has prevented any assessment of the use of the building historically and to some extent, currently. The house has been uninhabited for c. 25 years and would have provided roosting capacity throughout this time.

While Lesser Horseshoes are very site faithful, these changes may have had a short-term effect on the use of this building. Studies of other roosts have shown that this species will attempt to continue roosting and breeding in buildings that are undergoing collapse.

3.2. Knockanean Old Schoolhouse roost

Emergence of Lesser Horseshoe bats was observed from July 1st onwards from a hole to the rear of the building (west corner of the north-facing wall). Four bats emerged between 10.05 p.m. and 10.40 p.m. on July 1st. A subsequent count on July 30th yielded a total of six bats. All bats flew into the western hedgerow. Some individuals flew around the outside of the roost before disappearing into vegetation. Bats flew down low at a height of 1 metre up to 2 metres. Bats returned to the roost from 4 a.m. to 5.10 a.m. and on some nights also returned to the roost during the night at around 1 a.m.

One injured Lesser Horseshoe was recovered from the study area. This proved to be a post-lactational female. In addition to this, from observations of the size of bats emerging from Knockanean Old Schoolhouse it is clear that the building is indeed a maternity roost.

3.3. Knockaskibbole roosts

Observations on the Knockaskibbole sites (KsA-C) on July 2nd and July 29th proved that no Lesser Horseshoes were roosting there during the daytime. Lesser Horseshoes do use these sites as night roosts (see Section 3.4.2, below).

A maternity roost of Brown Long-eared bats and a night roost of this species were located at Knockaskibbole (KsA). As it was difficult to count the bats on emergence, an estimate of greater than 10 bats is the closest approximation that can be derived.

3.4. Commuting routes from Knockanean Old Schoolhouse and night roosts

3.4.1. Knockanean to Ballaghboy

Observations on the commuting flight-paths and feeding as recorded during this work are shown on Figure 1. In addition to this, a likely area for bat feeding is also marked in. This is an area that

would appear suitable for feeding but in which no feeding was noted. Bats may select alternative feeding areas at different times of year. More evidence is emerging of Lesser Horseshoe winter feeding activity.

The bats were found to commute from the roost immediately into the nearest vegetation, a small copse that continued as a hedgerow in a westerly and northerly direction. This allows the bats to travel towards the Gaurus direction and towards a large area of hazel scrub to the north of the roost, reaching up towards the Tulla road.

However, the bats were never encountered commuting to the hazel scrub. This is despite the fact that there is a body of slow-moving water, bracken and gorse that would potentially be rich in insects and other invertebrates. Instead, the bats travelled west to Gaurus Bridge and south towards Ballaghboy; a distance of 1.6 km in total. Bats used the hedgerow as a commuting corridor, keeping very close to cover. The bats crossed to the south side of the road in advance of reaching a row of well-lit modern housing, flying along the hedgerow of the disused quarry.

The bats proved difficult to pursue on arrival at the Gaurus Bridge - Ballaghboy junction. Feeding Lesser Horseshoes were noted along this road from the corner surrounding the former mill to a point north of the newest housing along the Ballaghboy road. On occasion, the bats were visible flying into the road when backlit by moonlight.

Two Lesser Horseshoes routinely night-roosted in the Gaurus mill building. This normally took place from two hours after emergence, which began c. 10 p.m. each night. Other buildings in this complex served as a roost for Brown Long-eared bats.

3.4.2. Knockanean to Knockaskibbole

An alternative commuting route for the Lesser Horseshoes was a detour south across the road and down to Knockaskibbole. Dense hedgerow surrounding fields of varying size (often very small) and corners of mature hazel are a feature of this townland. The flooded Gaurus quarry was located behind this site but it was not a feeding area for species other than soprano (55kHz) pipistrelles (*Pipistrellus pygmaeus*).

The farm buildings at Knockaskibbole were noted to be night roosts for Lesser Horseshoe (only one bat in the previously recorded roost site, KsB). A maternity roost of Brown Long-eared bats was discovered in another of the buildings (KsA). This species also used these buildings as a night perch for grooming, etc. A further Lesser Horseshoe night roost was noted in a used barn adjacent to this site. Two bats were present at the time of this study, in this roost (KsC).

An old farm building on the proposed route halfway between the Knockanean roost and the Knockaskibbole night roosts, which had not previously been identified for assessment, was located and turned out to be another Lesser Horseshoe night roost (KnC). Only one bat was present.

One bat was noted flying in this night roost (KnC) ½ hour after emergence. Similarly, Lesser Horseshoes were noted to fly around the Knockanean Old Schoolhouse roost at various points in the night. On a number of occasions, this was *prior* to the emergence of bats from this roost. This suggests that other bats routinely examine the building for suitability.

These may be bats in small satellite roosts formed as a result of the restriction of access to Knockanean. Equally, they may also be bats from Newpark House (see Section 3.6, below) assessing it. The third alternative would be that there are roosts in the area that have not been located to date.

3.5. Other species previously in Knockanean Old Schoolhouse

One whiskered bat was noted feeding in an area south of the Schoolhouse behind a farmhouse and upon a lane to the west of the Schoolhouse, but at no stage was it noted to leave or enter the Schoolhouse. This species was believed to be roosting here during the survey in 1998. Closure of entry points may have prevented entry. Similarly, no Long-eared bats were noted around this building despite their presence last year. It is possible that these bats are now in the roost at Knockaskibbole (KsA).

In light of the current situation, one maternity roost and two night roosts of Lesser Horseshoes are due to be demolished. Another night roost may also be rendered unsuitable by its proximity to the proposed road. One maternity roost of Brown Long-eared bats and two night roosts are also upon the proposed route. Whiskered bats were not found to be using the Knockanean building during this study. However, a future return is not an unlikely occurrence.

3.6. Observations of alternative Lesser Horseshoe roosts in the Ennis area

In order to assess in a very preliminary manner, the significance of the roosts in the Knockanean/Knockaskibbole area in the context of bats in the Ennis area, it was decided to observe the nearest known Lesser Horseshoe roost, Newpark House (a proposed NHA). Previous records by Wildlife Rangers of Duchas place a total of 40 to 50 Lesser Horseshoes for this house. Mature woodland, hazel scrub, gorse, bramble, and areas of marsh in addition to grassland surround the house. It would appear to have ideal conditions for bats and the proprietors are aware of the importance of the resident bats and have not taken any intentionally adverse measures.

A count of the roost in July 1999 yielded a total of 10 bats. This is in keeping with the figure that the owners had determined and counted by Wildlife Ranger, Congella Maguire. This is a substantial decline from the earlier counts and must lead to concerns for the survival of the roost. One incident in recent years may have some bearing on the roost's lack of success. A pine marten nested in the attic of the house.and may have been responsible for disturbing the roost (or even eating the bats). If there have been similar incursions of this nature into the house, it may explain the decline. Likewise, should such events occur at a future date, the bats may require an alternative roost. The Knockanean roost may well have arisen from such a history.

No such decline has occurred in another Lesser Horseshoe roost visited during this study, Clifden House, Corofin. Nor is this the case a site at Ruan, under the protection of the Vincent Wildlife Trust and the Heritage Council.

4. DISCUSSION

4.1. The significance of the affected roosts

The Lesser Horseshoe has a particularly important status in Ireland's fauna. The 12,000 individuals that have been found here are a significant proportion of the European population. It is believed that only England and Wales (taken as a continuous geographical entity) are host to a greater national population. European legislation introduced into Irish law by statutory instrument, gives a high degree of protection to this species, its habitat and its roosts.

A decline may be in evidence in the number of Lesser Horseshoe bats in this eastern region of Ennis. The number of bats at the only previously known roost in this area (Newpark House) has certainly undergone a dramatic decrease. There may be a number of factors involved in this. Certainly the increasing urbanisation must affect the habitat for bats. Loss of suitable feeding areas or roosts may be two of the more likely reasons.

Decline has not been noted as a feature of the internationally important roosts at Ruan and Corofin. While it would be true of both sites that loss of feeding habitat is not a threat at present at these roosts, it is also true that roost protection has been almost uniquely strong, in the Irish context.

The Lesser Horseshoe bat has more specialised requirements for roost characteristics than most other Irish species. It is reasonable to speculate that undisturbed maternity roosts are limited in their abundance. When one also includes the requirement for a network of roosts for different purpose (i.e. hibernation, night roosting, and transition between summer and winter sites), this becomes increasingly restrictive. The specialised nature of the Lesser Horseshoe's life history (type of roost, accessibility, proximity of caves or their equivalent) may contribute to a distinct difficulty for this species in finding secure, suitable roosts. These considerations would place roost availability high on the list of limiting factors.

Hedgerows in the Kockanean/Knockaskibbole area are frequently very dense. A number of shrub and tree species are found in such hedgerow and on many farms there still survive large tracts of untreated hazel scrub. While no attempt was made to assess the insect availability throughout the area, it was evident that bats were abundant. Insectivorous bird species were also regularly encountered.

Having considered the restrictions that are invoked upon Lesser Horseshoe bats by their roosting requirements and no obvious dearth of insects, we, the authors believe that food availability is not the cause of any decline in bat numbers at Newpark House. It would seem reasonable to assume that suitable roosting for successful rearing of young is more limiting. Hence, the loss of a roost, regardless of the low numbers at present, may have great significance in the future.

Knockanean Old Schoolhouse may serve as a "reservoir" for replenishment of the roost in Newpark House. An incident, such as the nesting of a pine marten may have drastic effects in the absence of outlying roosts. Previous reports that the bats may be located in outbuildings of Newpark House proved incorrect; no suitable buildings are located on the surrounding farm.

There are at present few Lesser Horseshoe bats at Knockanean. In the light of the reduced access to the building, this is not surprising. Historical use of the Old Schoolhouse (in the past 25 years or more) still remains unclear. It was shown to be used by Brown Long-eared bats and whiskered bats during last year's study. These are no longer present. It is very possible that should the building be opened up to greater access for bats, then it would become a more important roost again. Such a scenario is quite likely, given the poor state of repair of the house and human incursions (i.e. access to the building for bats may be increased by forced entry by humans).

The loss of a number of night roosts may have greatest significance for pregnant females. The increased weight and subsequent raised wing loading reduces these bats' capacity to fly throughout the night and such roosts may serve to allow them to feed further afield without returning to the day roost.

The removal of two types of roost within the area by the proposed bypass route will have an effect on the potential for this species to expand, were conditions favourable enough to allow this. Bats must have secure roosts in order to breed. It is likely that the individuals in this area undergo a local migration to a hibernaculum within a cave or cellar. Loss of summer roosts may also impede feeding to such an extent that fat deposition for winter survival may be lessened.

4.2. Need for replacement roosts

That Lesser Horseshoe bats persist in roosting in buildings that have suffered a degree of collapse, or in this case, closure implies a scarcity of alternatives. This is likely to be the case in the Knockanean area also. Therefore, in the likely absence of suitable alternative roost sites, provision of a replacement roost is required to mitigate the loss of the Knockanean Old Schoolhouse.

While for many species of bat mitigation can be achieved by the provision of bat boxes (similar to bird boxes), such an option is not possible for Lesser Horseshoes. As explained, their roosting habits demand a greater roost volume. Erection of an alternative roost as described in Section 5.1 below is the only means of mitigating the loss of the daytime roost at Knockanean Old Schoolhouse. In its absence, then no effort at mitigation has been attempted.

Little work has been done on assessment of the features of night roosts that are of greatest benefit to Lesser Horseshoe bats. The sheds used in the area of study were warm and dark. It is difficult to propose a night roost design with the limited knowledge to hand. Were the alternative daytime roost to be sited closer to the Knockaskibbole feeding area (e.g., at the location suggested in Figure 1), it is possible that it would also be usable as a night roost. Bats feeding in the Gaurus area would still have the disused mill and other structures at their disposal. Securing the sheds that already exist within the area (i.e. preventing further collapse) may provide suitable roosts for night purposes.

5. RECOMMENDATIONS

5.1. Provision of an alternative roost in the Knockanean area

"We cannot stress too heavily that the most desirable course of action to protect a colony is preservation of its existing roost(s). Lesser Horseshoes are extremely faithful to their roost sites,

and will continue to use seriously decayed buildings." This extract from a Countryside Council for Wales report (1998) is in keeping with the opinion of the authors of this report.

Two plans are included herein to provide roosts primarily for Lesser Horseshoes: the OPW plan and that proposed in a Countryside Council for Wales report. In our opinion, the OPW plans are most appropriate in an Irish development. This would principally be advisable to adhere to local (or national) building norms and requirements. The OPW plan would also appear to be considerably cheaper to provide. Some important features to incorporate into a Lesser Horseshoe roost would be the following:

- 2 metre vertical clearance within the building
- Unshaded roof with an east-west orientation of the ridge-line
- 30° pitch on the south facing slope of roof
- Thin, scored battens fixed to the ceiling joists
- Vegetation leading from the building to hedgerow. This proximity of vegetation is quite critical to Lesser Horseshoe roosts and it is also a feature of Brown Long-eared bat roosts. As described earlier in this report, Lesser Horseshoe bats fly to cover immediately following emergence.

With minor adaptations other species may also be accommodated by such a roost. The following are some of our recommendations:

- Bat bricks
- Bat slates
- ½" to ¾" gaps between timber joists within the building in the warmest areas of the building. Timber should only be treated with low toxicity chemicals (e.g. cypermethrin based products)
- Black timber fascia around the building (appears to be of benefit to species like pipistrelle and Leisler's) (uPVC listed in the plans but timber appears to be of greater benefit to bats. We have observed that uPVC fascia is only of use to bats where the original timber fascia has been left in place and has been covered)
- Additional heating or solar panels at roof level for raising the temperature to as high as 28°C in summer months

The recommendations included in the Flora and Fauna report (RPS Cairns Report no. IR527/4) upon the timing of work and the timing of the erection of a new roost should be adhered to. For such a roost to be successful, bats should be given ample time to assess it and there should be an alternative immediately available to the bats, should they attempt to return to their original roost. Alternative roosts should be erected prior to the removal of current roosts. Such demolition should only take place when bats are known to have left the roost. Examination of the structures to ensure this or to remove any unexpected bats should also be done.

5.2. Location of an alternative roost

As the bats were noted to travel west and south-west of the current roost, it is suggested by the authors that an alternative roost be located southwest of the proposed road widening. This is in order that the bypass does not separate the building from the primary feeding sites. However, as earlier stated, the bats may use other feeding sites at different times of year, depending on local

insect abundance. If possible, a vegetation corridor (hedgerow or other plant cover) should also connect to any road underpasses to allow for a greater access to neighbouring sites. A site close to the small lane leading south towards two farmhouses would give the bats access to Gaurus and to Knockaskibbole. A guide location has been indicated on Figure 1.

While not relevant to the assessment of the Ennis Bypass scheme, it is speculated that up to 100 houses are due to be built in the area previously quarried at Gaurus. If this is the case, it is important that some continuous vegetation is provided to allow commuting from roost to feeding areas. Hedgerow currently provides this corridor. Re-planting with native (preferably local) hawthorn, blackthorn etc. would suffice.

Acknowledgments

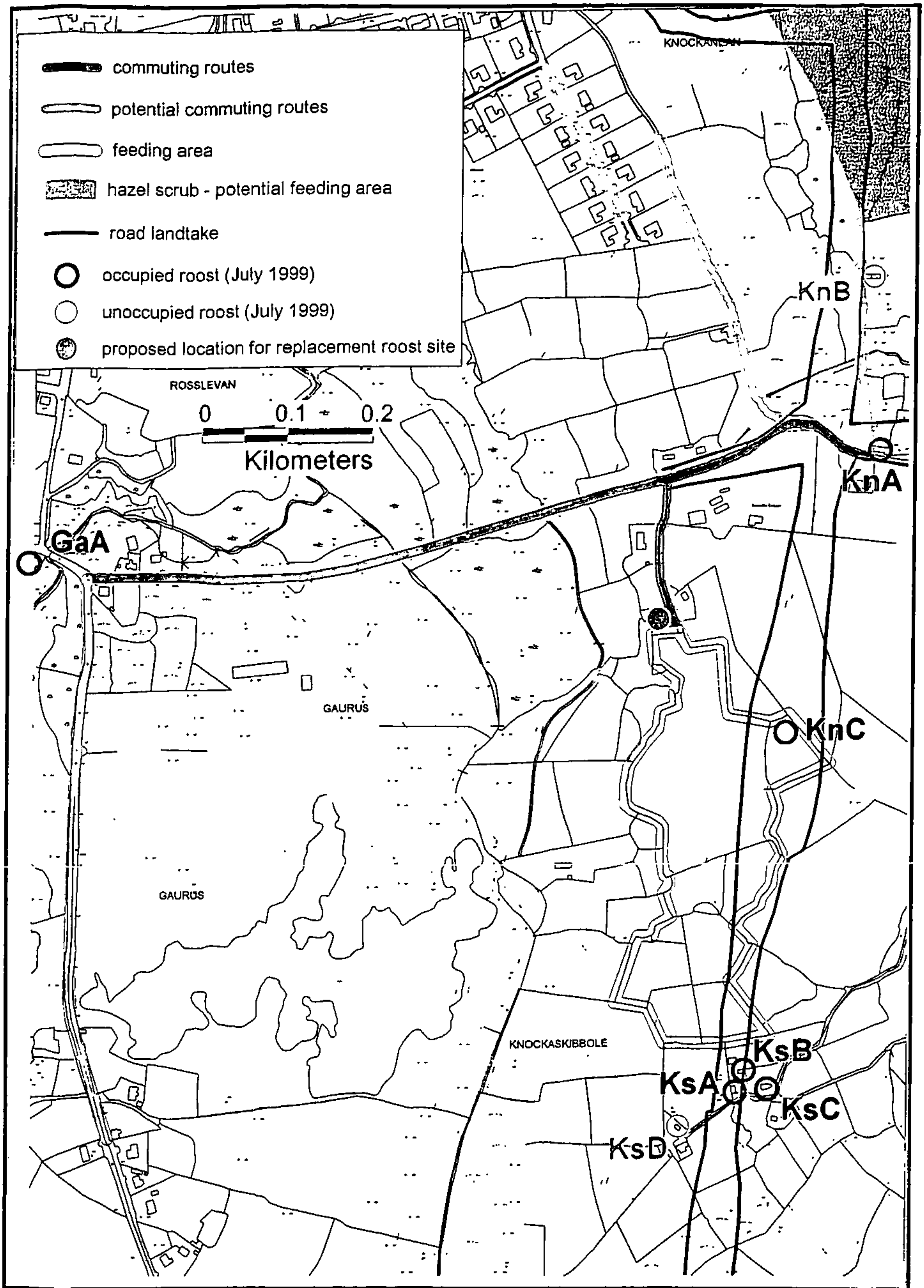
We would like to thank the following for their advice in this matter:

Dr. Kate McAney, Lesser Horseshoe conservation officer,Vincent Wildlife Trust (Ireland) for observations

Jean Matthews, Species Officer (Lesser Horseshoe), Countryside Council for Wales

R.A. Freer, D.A. Waters and J.D. Altringham authors, "Artificial maternity roosts for *Rhinolophus hipposideros*, the Lesser Horseshoe bat. CCW Contract Science report No. 250 February 1998

A.J. Mitchell Jones, "The Batworker's Manual", Joint Nature Conservation Committee, 1999



Bat roosts, commuting routes and feeding areas

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Figure 1

ENCLOSURE 1

Plans for Lesser Horseshoe roost (courtesy of Dr. K. McAney)

ENCLOSURE 2

Countryside Council for Wales Contract Science report No. 250, including plans for artificial maternity roost (courtesy of CCW)

Artificial maternity roosts for *Rhinolophus hipposideros*, the lesser horseshoe bat

A feasibility study

A report prepared for the Countryside Council for Wales

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February 1998

Clwydi mamolaeth artiffisial ar gyfer *Rhinolophus hipposideros*, yr ystlum pedol lleiaf

Crynodeb di-dechnegol

Prif amcan y prosiect oedd asesu gwerth creu clwydi pwrpasol gogyfer ystlum pedol lleiaf dros gyfnod mamolaeth, ac i ddarparu cynllun dylunio syml i'r clwydi hyn.

Adolygir y defnydd a wneir gan ystlumod o glwydi artiffisial "eang". Mae clwyd fach yn anaddas, gan fod rhaid i'r ystlum pedol lleiaf allu hedfan yn syth i'w man clwydo mewn mannau clwydo gwag enfawr. Prin iawn yw'r wybodaeth yn y Deyrnas Unedig a gweddill Ewrop, sydd wedi neu heb ei gyhoeddi, ac ychydig iawn o gasgliadau a ellir ei dynnu o'r wybodaeth yma. Mae'n ymddangos mai ychydig iawn o fannau clwydo mawr sydd wedi eu gwneud. Mewn dwy enghraifft yn yr Almaen, perswadiwyd yr ystlum mawr (*Nyctalus noctula*) i fabwysiadu man clwydo artiffisial, yn y ddau achos defnyddiwyd ystlumod "rhyddhau meddal" dof i ddenu ystlumod gwyllt. Dim ond dau achos sydd wedi ei nodi lle'r oedd yr ystlum pedol lleiaf yn defnyddio mannau clwydo wedi eu creu'n bwrpasol. Yn yr Almaen, fe symudwyd nythfa i ofod to 150 m i ffwrdd wedi ei addasu yn ofalus i ddynwared y man glwyd wreiddiol a oedd i'w ddymchwel. Cyflawnwyd hyn trwy "hau" y glwyd newydd gydag ystlumod swrth o'r glwyd gwreiddiol. Yn y D U, mae man clwydo artiffisial yn Gwlad-yr-Haf (wedi ei adeiladu i ddenu ystlumod pedol mawr) wedi cael ei fabwysiadu gan ystlumod pedol lleiaf. Defnyddir y man clwydo yma fel patrymlun i'n cynllun dylunio ni.

Trwy adolygu mannau clwydo ystlumod pedol lleiaf sy'n bodoli yn barod, gwelir fod ganddynt amryw o nodweddion arbennig. Yn gyffredinol, mae'r mannau clwydo yn rhai mawr, gyda'r gwagle yn fwy na 200 m^3, a'r uchder fel arfer yn >2 m. Galluoga'r nodweddion yma i'r ystlumod hedfan yn rhwydd i'w mannau clwydo. Rhaid i dymheredd rhannau o'r glwyd gadw'n gyson uchel (>27°C) trwy'r haf, ond fel arfer mae tymheredd amrywiol ar gael, yn aml mor isel â thymheredd gaeafgwsg sydd rhwng 5-11°C. Gellir cael pocedi o dymheredd isel yn yr un adeilad neu gerllaw. Mae hyn yn bodloni gofynion egnïol ystlumod magu benyw, neu rai heb fod yn magu, yr ystlum gwryw a rhai ifanc. Mae'r ystlumod yn mynd i mewn i'r glwyd trwy agoriad mawr dirwystr. Fel arfer, ceir gorchudd allanol dros agoriad y fynedfa, sy'n caniatáu mynediad diogel i mewn ac allan , ac yn eu gwarchod rhag creaduriaid ysglyfaethus. Sefydlir y glwyd fel arfer mewn cynefin gyda digonedd o fwyd da: dyffrynnoedd cysgodol gyda choetir collddail eang neu brysg trwchus. Fel arfer, mae'r llwybr hedfan o'r glwyd yn dilyn gwrychoedd, ffensys, waliau a'u tebyg. Yn aml, mae'r ystlumod yn hedfan yn agos i'r llawr/ddaear.

Fe anogir astudiaethau o niferoedd ac arferion clwydo'r ystlumod yma, yn enwedig ar ôl aflonyddu neu/a newid y glwyd, gyda chofnodi gofalus ac arolwg I ddilyn o unrhyw glwydi artiffisial. Mae'r adroddiad yma wedi dibynnu yn helaeth ar nifer fechan o astudiaethau, ac mae gennym lawer i ddysgu eto. Hyd nes mwy o wybodaeth ar gael, dylid ond trosglwyddo nythfa i glwyd artiffisial fel y cam olaf. Y ffordd orau o warchod nythfa yw trwy gadwraeth y clwydi presennol. Os oes rhaid creu clwyd newydd, dylid ei sefydlu yn agos i'r glwyd gwreiddiol.

Yn yr adroddiad, fe roddir canllawiau a chostau manwl ar gyfer clwydi artiffisial. Mae'r rhain yn cynnwys y defnyddiau a'r gwaith adeiladu sylfaenol, sy'n dangos lle gellir gwneud newidiadau. Yn ychwanegol, fe ddarperir cynigion a chostau tuag at offer gwresogi a monitro.

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Artificial maternity roosts for *Rhinolophus hipposideros*, the lesser horseshoe bat.

By R.A.Freer, D.A. Waters
and J.D.Altringham.

February 1998

CCW Contract Science report No 250

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COUNTRYSIDE COUNCIL FOR WALES

CCW CONTRACT SCIENCE REPORT DISTRIBUTION

Report number:	250
Publication Date:	FEBRUARY 1998
Contract number:	FC 73-01-190
Nominated Officer:	M. ELLIS R. WARREN
Title:	Artificial maternity roosts for *Rhinopolophus hipposideros* the lesser horseshoe bat.
Author:	R. A. Freer, D.A.Waters and J.D. Altringham
Restrictions:	None

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Artificial maternity roosts for *Rhinolophus hipposideros*, the lesser horseshoe bat

Non-technical summary

The principle aim of this project was to assess the potential value to lesser horseshoe bats of purpose-built, artificial maternity roosts, and to provide a basic design brief for such a structure.

The use by bats of 'large-scale' artificial roosts is reviewed. Small structures are inappropriate, since lesser horseshoe bats must be able to fly directly into their roosting positions in large roost voids. Published and unpublished information from the U.K. and the rest of Europe is scarce, and few conclusions can be drawn from it. Relatively few large roosts appear to have been made. In two instances in Germany noctule bats (*Nyctalus noctula*) were persuaded to adopt an artificial roost, but in both cases 'soft-release' captive bats were used to attract wild bats. Only two documented cases were found of lesser horseshoe bats using purpose-built roosts. In Germany a small colony was translocated 150 m to a roof space carefully adapted to mimic the original roost, which was to be demolished. This was achieved by 'seeding' the new roost with torpid bats from the original roost. In the U.K., an artificial roost in Somerset (built to attract greater horseshoe bats) has been adopted by lesser horseshoe bats. This roost has been used as the template for our own design.

A review of existing lesser horseshoe bat roosts shows that they have several characteristic features. Roosts are typically large, occupying spaces in excess of 200 m^3. The roost void is typically >2 m high. These features allow the bats to fly freely in the roost. Some parts of the roost must maintain high temperatures (>27°C) throughout the summer, but a wide range of temperatures is usually available, often down to the hibernating temperature range of 5-11°C. Low temperature sites may be in the same building or nearby. This is to satisfy the different energetic demands of breeding and non-breeding females, males and juveniles. Bats enter roosts through large, unimpeded apertures. Access points usually have some external cover, which allow exit and entry without exposing the bats to potential predators. Roost sites are usually situated in good quality foraging habitat: sheltered valleys with extensive deciduous woodland cover or dense scrub. Flight paths to and from the roost typically follow hedges, fences, walls and similar structures, and bats will often fly close to the ground.

Quantitative studies of the roosting habits of these bats, particularly after roost disturbance and/or modification is to be encouraged, as is careful documentation and subsequent survey of any artificial roosts. This report has relied heavily on a very small number of studies, and we still have much to learn. Until more information is available, translocation of a colony to an artificial roost should be seen as a last resort. The most desirable course of action to protect a colony is preservation of its existing roost(s). If a new roost must be built, it should be situated close to the original roost.

Guideline plans and costing for an artificial roost are detailed in the report. These cover the basic materials and construction, indicating where modifications may be made. Suggestions and costing are also provided for heating and monitoring equipment.

Artificial maternity roosts for *Rhinolophus hipposideros*, the lesser horseshoe bat

Introduction

Policy regarding the conservation of any bat species must address three issues: maintenance of adequate foraging habitat, preservation of maternity and summer roosts, and preservation of hibernacula. Habitat conservation is legally and practically complex, but for a given situation, a range of possible solutions and compromises is possible: negative changes can be ameliorated by positive ones to some extent. In the case of roost sites there is a clear legal framework, and the practical solution is less flexible: preservation of the colony demands that certain criteria are met. In order to ensure continued suitability, the roost must remain accessible to bats, disturbance must be minimised, and existing temperature and humidity regimes must be maintained. However, in some situations, destruction or alteration of the roost, or exclusion of the bats from a roost cannot be prevented. In such cases, it has been suggested that the construction of alternative roosts will allow bats to exploit their traditional and familiar foraging areas, centred on a new or alternative roost. This report first reviews the available information on the success or otherwise of translocation schemes, reviews the roosting ecology of *R. hipposideros*, and suggests a possible design for an artificial maternity roost.

The use of artificial roosts by bats

Instances where existing bat colonies have been moved, or encouraged to move, to purpose-built structures are poorly catalogued. This is a consequence of the fact that most are undertaken on a small, case-by-case basis, and published records are simply not kept or made available. Many cases of artificial roost creation involve hibernacula, often as a result of mitigation measures in local development. These constructions provide high profile media attention (e.g. Symonds, 1995), but few of them have attracted bats to date. Information on artificial summer or maternity roosts is restricted mainly to data on bat boxes (e.g. Taake and Hildenhagen, 1988, Park *et al.*, 1998), which could be considered artificial tree-roosts, rather than artificial building roosts with which this review is concerned.

As an illustration of the paucity of information, in one study in Germany, a maternity roost of 400 *Myotis myotis* was under threat from a road development. After consultation with various ecologists it was decided that there was insufficient information to assess whether a translocation would be successful or not, and the route of the road was changed (Fuhrman and Kiefer, 1996).

Where new roosts are constructed to provide additional or replacement roosts, varying degrees of success are reported. In North America, artificial 'bat-houses' are actively promoted by Bat Conservation International. Although frequently no bigger than bat boxes in the U.K., these may be large wooden boxes with multiple chambers, usually attached to buildings. Where these bat houses are erected as additional roosts, occupancy rates as high as 52% are reported (e.g. Tuttle and Hensley, 1993). Occupation often occurs in the first year, and two *Myotis* species are recorded as using the boxes as maternity roosts. Two large, American style bat-houses erected in forest in the North York Moors were adopted by small numbers of *P. pipistrellus* in their first year, and have higher occupancy rates than nearby conventional, small bat boxes (Altringham, 1998). They have not yet been used as maternity roosts, but they have been in place for just two summers. No information appears to be available on their use in the rest of the U.K. In the same forest small numbers of bats were known to roost in a 'high seat' constructed for deer control - effectively a strong wooden hide four meters above the ground. Substantial modifications to the structure were made to provide more and more varied roosting opportunities, including the provision of thick-walled hibernation boxes

(Palmer, 1991). However regular inspection over the last seven years has seen no significant increase in its utilisation by bats (J.D. Altringham, unpub. obs.).

Gebhard (1986) managed to encourage *Nyctalus noctula* to move into a temporary roost by breeding bats in captivity which were subject to a soft-release from the roost. This method was also used by Devrient *et al.* (1997) where an injured female noctule gave birth to two pups. The female and pups were stationed in a specially constructed roost on the roof of an apartment. As the pups became volant, they began to make short excursions and return to the roost and their mother. In the first winter, the pups left to hibernate elsewhere, but returned the following spring. Three years after the initial release, up to nine *N. noctula* were using the roost as a maternity roost. It would appear that the presence of bats in this artificial roost attracted others.

A notable successful translocation was performed on *R. hipposideros* in Bavaria (Richarz, 1988). In this case study, a maternity roost of 15 *R. hipposideros* in the loft of a hotel was under threat from development. A loft in a similar building 150 m away was converted to act as a replacement roost. The replacement roost had a number of partitions installed to create similar structural conditions to the original roost. As the replacement roost was partially in the shade, and the original was exposed to the sun, artificial heating (floor heating and small radiant heaters) was installed to maintain parts of the roost at 28°C. Bats would enter and leave via a 40 cm x 40 cm window. Six torpid animals were transported from the original roost in May. The following day, four animals had left. The day after this, all bats had left and all returned to their original roost site several days later. Twelve days after the translocation, bats began to visit the new roost site and occasionally remained there during the day. The following year, up to 13 individuals were found to be occupying the new roost, some months after the destruction of the original roost. Richarz (1988) suggests that the success of this project was due to the substitute roost having the same characteristics of the original roost, that the bats were transported in torpor, and the substitute roost was within the home range of the colony.

An artificial roost constructed in Somerset for greater horseshoe bats has attracted a colony of *R. hipposideros* (D. Cottle and C. Hancock, pers. comm.). The roost was built as a replacement for a roost of *R. ferrumequinum* (which also had a few *R. hipposideros*) which burnt down. Built in 1989, bats of unknown species were present in 1990, smaller numbers of *R. hipposideros* were in residence in 1991, and for the last five years the colony has been stable at about 40 bats. In 1997, six bats were found hibernating in the roost. A colony of over 200 *R. hipposideros* is known to occupy a building close by, and the surrounding habitat is ideal for the species.

Ecology of *R. hipposideros*

Current status

The range of *R. hipposideros* in the U.K. has shrunk by as much as 50% over the last 50 years and the current population, concentrated in Wales and SW England, has been estimated at 12,000-15,000 individuals (Stebbings, 1992; Hutson, 1993; Harris *et al.*, 1995; Schofield *et al.*, 1997). Wales holds a significant proportion of the NW European population (Stebbings, 1988; Hutson, 1993). A major threat to the species is the loss of roost sites, particularly those in old buildings. Roosts are typically lost during renovation or demolition of buildings. The treatment of timbers against insect pests and fugal infection has also been a major factor in the decline of bats (Shore, *et al.* 1991). A reluctance to travel long distances limits roost availability, further increasing vulnerability of this species (Ransome, 1991).

Habitat
The highest densities are found in valleys with extensive deciduous woodland cover, or dense scrub. These sites must be close to a variety of suitable roost sites (Ransome, 1991; Schofield, 1996). In W Ireland McAney and Fairley (1988a) recorded the highest densities over open water close to woodland, and in farmyards, with tree and hedgerows yielding lower levels of activity.

Roosting requirements
Choice of roost site changes seasonally. Hibernacula are typically underground sites such as caves, mines, tunnels and cellars, with winter temperatures of 5-11°C (Ransome, 1991). Maternity roosts are occupied as early as April, and are found predominantly in the roof voids of 19th century buildings with stone walls and slate roofs: either occupied houses or out-buildings (Ransome, 1991; Schofield, 1992). Maternity colonies vary greatly in size, from fewer than 20 individuals to several hundred (e.g. Warren *et al.*, 1997). Colonies frequently fragment, with groups occupying different parts of the same building, or even nearby buildings. Bats will frequently move backwards and forwards between winter and summer roost sites, depending upon the weather. This is particularly common when the two roosts are close together. Many summer roost sites have a wide range of microclimates within them, including cold basements, and bats move around the roost as part of their thermoregulatory strategy. In the summer roost they typically hang from the roof timbers or lining and frequently have a favoured clustering area. This is often far from the roost entrance (Schofield, 1992), but is presumably constrained by roost temperature gradients. Summer roosts are typically occupied through to September, but again, the use of cold site in the same roost, or alternative cooler roosts, becomes increasingly common from the end of summer.

Roost microclimate
Although these bats are facultative heterotherms, pregnant females must maintain a high body temperature in order to sustain foetal growth (Racey, 1973) and homeothermy must also be maintained during lactation. High temperatures facilitate foetal development, rapid attainment of thermal independence in the young, and rapid fat deposition for hibernation. To minimise energy expenditure roost sites are chosen with high ambient temperatures, such as roof spaces or cellars with central heating boilers. Females may also cluster to conserve metabolic heat. Non-breeding females, males, and juveniles do not have the same energetic constraints as breeding females and will often select cooler locations within the roost, using torpor to minimise energy expenditure.

On the basis of temperature measurements made in known maternity roosts Schofield (1996) suggested that a minimum temperature of 30°C is required by homeothermic females. Richarz (1988) reported the successful adoption of a modified roost by *R. hipposideros*, in which artificial heating maintained temperature above 28°C in specific locations in the roost. R. Ransome suggests a preferred temperature of 27°C (pers. comm.). Suggestions for raising or maintaining the temperature in otherwise suitable roosts include the removal of tree branches which shade the roof, the repair of roofs which are in poor condition to retain warm air, the insulation of areas of the roof space to produce hot-spots, or the installation of thermostatically controlled heaters. All have been applied with varying degrees of success (e.g. Richarz, 1988; Schofield *et al.*, 1997). Non-breeding bats will benefit from lower temperatures, perhaps all the way down to 5°C. Certainly a wide thermal gradient appears to be a characteristic of roosts occupied by large and stable colonies (R. Ransome, pers. comm.).

Roost entrances
R. hipposideros prefer to enter their roosts through holes large enough for unimpeded flight, such as broken windows, holes in flooring and open doorways (e.g. Richarz, 1988; Schofield *et al.*, 1997). Ideally, access holes should be about 300 mm high x 400 to 500 mm wide (Schofield, 1992; Stebbings, 1992), although Bemment (1995) reports that a 200 mm x 200 mm aperture was used by

one colony. The best holes are permanent features within a door, window frame or wall, that have some cover from adjacent vegetation. *R. hipposideros* may enter roosts via louvres when no other access point is available providing the gaps between the slats are greater than 10 cm high (Schofield, 1992). The flight paths to and from the roost typically follow hedges, fences, walls and similar structures, and bats will often fly close to the ground. There is also some preference for a low level roost entrance, with a subsequent flight up into the main roost area. Bats leaving a roost with exposed exit routes frequently leave later than those leaving from a sheltered site, reducing the available foraging time (McAney and Fairley, 1988b). Many roosts have several entrances.

Roost dimensions
R. hipposideros requires particularly large roosts spaces, for several reasons. They prefer to fly directly into the roost and into their roosting position: their hind limbs are not adapted to clambering about on surfaces in the way vesper bats do. They hang vertically, in the open, from horizontal or inclined surfaces. Bats frequently spread out in the roost space for thermoregulatory or social reasons, or to groom and exercise their wing muscles before flight. The available internal surface of the roost must be large enough to accommodate these activities. From the age of three weeks juveniles start wing flapping exercises and begin to make short practice flights within the roost, before extending their flights to excursions away from the roost. A large roost volume will facilitate entry and exit of adults, and practice flights of juveniles. Even adults make extensive flights within the roost when 'light sampling': short flights are made in and around the roost before finally leaving to forage. It is believed that this activity allows the bats to check light intensity and climatic conditions (e.g. McAney and Fairley, 1988b). A large internal volume of still air will have a high thermal inertia, smoothing out diurnal temperature fluctuations. A characteristic of many large maternity roosts is the presence of a series of linked 'rooms' with few entrances, or entrances which are misaligned, all of which limit airflow. Stebbings (1992) suggests that there is a relationship between roost volume and colony size, with large colonies of 200-300 bats requiring several hundred cubic metres. Schofield (1992) found no such relationship, but noted that roosts of low volume were almost inevitably secondary roosts, containing few bats, or damaged roosts with declining colonies. He suggested a viable volume for a healthy maternity roost of 300 m^3 in a conventional pitched roof space. Others have suggested that a significantly smaller space is adequate (T. Hodnet, D. Villis and D. Cottle, pers. comm.).

R. hipposideros will occasionally use roosts that have very little vertical clearance. Gaisler (1963) found *R. hipposideros* using underfloor spaces in Czechoslovakia. However, this appears to be very rare, and in the U.K. the vertical dimensions of roosts used by large colonies is rarely less than 2 m (Schofield, 1992). There may be several underlying reasons. There will be a substantial thermal gradient from top to bottom, and therefore a range of temperature niches for individuals to exploit. Flights within the roost will be easier, particularly for inexperienced juveniles. Finally, the bats will be safer from predators such as stoats and weasels, and particularly domestic cats.

There have been several reports of colony decline or loss following reduction in roost volume (Stebbings 1992). There is a considerable variation between sites and between years at the same site, and factors such as roost shape, solar exposure, microclimate, proximity to cover outside the roost, and proximity to good feeding habitat will all be contributing factors. Despite the existence of substantial colonies occupying much smaller roosts, a conservative strategy would support the view that roost volume should be at least 200 m^3 and the vertical height should be 2 m or more.

Disturbance

It has been suggested that *R. hipposideros* are susceptible to disturbance, although evidence is anecdotal. A colony stuued by Bemment (1995) appeared relatively unperturbed by limited disturbance. However, as a precautionary measure the roost must be secure from unwanted guests, and visited only when necessary.

Viability of an artificial roost - recommendations

Quantitative studies of the roosting habits of these bats, particularly after roost disturbance and/or modification are essential, as is careful documentation and subsequent survey of any artificial roosts. This report has relied heavily on a very small number of studies, and we still have much to learn.

We cannot stress too heavily that the most desirable course of action to protect a colony is preservation of its existing roost(s). *R. hipposideros* are extremely faithful to their roost sites, and will continue to use seriously decayed buildings. When the Vincent Wildlife Trust purchased Hendre Cottage a colony of 60 bats occupied the stairwell - the only part of the building providing sufficient cover. Over the six years following extensive renovation, the colony has increased steadily to almost 200 bats, which make use of the restored parts of the building (Schofield *et al.*, 1997). To what extent this represents the return of previous members of the colony is unknown.

The construction of a new roost should be undertaken only as a last resort, when the existing roost is to be destroyed, or drastically modified to the detriment of the colony. If a new roost must be built, it should be placed in close proximity to the existing roost. Monitoring of such a roost should be carefully planned and executed.

Roost Design

Detailed drawings are given in the appendix.

The architect's estimate for building the roost is £23,000 to £28,000, excluding VAT, fees, planning permission, etc. Cost will vary depending upon location and the nature of the foundations.

The design is based partly on the Mells Valley artificial roost commissioned by the Somerset Wildlife Trust. Although the roost was designed for *R. ferrumequinum*, it was occupied by *R. hipposideros* soon after construction. About 40 bats use the roost, including the cellar and ground floor. Modifications are based on discussions with D. Cottle, C. Hancock, R. Ransome and D. Villis and P. Dickeson (architect).

Size / Volume

Although a smaller space may well be adequate, we recommend a cautionary approach, and an internal volume of 200 to 300 m^3. This is achieved in a building 6000 mm x 7000 mm x 6950 mm high, with a roof void 2000 mm high: internal volume is approx. 260 m^3. A smaller volume would not lead to a major saving in building materials.

Walls and Floors

The external wall is either a double skinned cavity wall made of concrete blockwork with a rendered exterior, or a blockwork inner and local stone outer wall (this may be more desirable from an

architectural point of view, but will be much more expensive). The concrete skin and cavity will provide thermal stability in the main body of the building, with most thermal variation in the roof space.

The internal wall (ground floor) is made of Thermolite (highly insulating) to keep the 'cool' room cool, and buffer diurnal temperature changes.

The ground floor ceiling must be capable of supporting the weight of humans to allow inspection of the roof space. It has joists at 600 mm centres, off a plywood web centre beam. Exterior ply boarding is used for the floor. The ceiling above the 'cool' room is insulated with 100 mm thick polystyrene. 'Dummy' timbers on the first floor ceiling provide additional roosting space. Two permanent voids are included in the ceiling (1000 mm x 1000 mm), one to each of the lower floors. The void that leads to the main entrance/exit needs to be grilled for security, the gaps between the bars at 100 to 150 mm. The intruder grill leading from 'Area A' and the more secure door between Area A and the cool room are optional security measures.

Roof

Since the roof needs plenty of exposure to the sun, the aspect and pitch of the roof space are very important, and the roof must not be heavily shaded by overhanging vegetation. An east-west orientation of the roof ridge line, with a 30° pitch on the south-facing slope, will maximise solar heating. The addition of a gable mid-way along the south facing-slope provides a change of angle to the sun. The side that faces east will receive solar energy earlier in the day than the main body of the roof, and the west side will catch the early evening sun, providing warm locations throughout the day.

The roof is timber framed and either slate or tiled, depending on which best fits the surrounding architecture. Rafters are placed at 600 mm intervals: *R. hipposideros* appear to prefer hanging from timber. The sarking felt underside can be covered by 'greenhouse screening', a 0.5 cm^2 gauge semi-rigid plastic mesh to facilitate roosting. This is less likely to sag or trap bats than Netlon if firmly secured (D. Cottle pers. comm.). However thin, scored, wooden battens fixed horizontally between the ceiling joists would serve equally well (C. McAney, H. Schofield, pers. comm.). The westernmost end of the roof space is heavily insulated. This is achieved by securing 100 mm polysyrene boards between the roof beams using 6 mm untreated plywood boards. The insulation should extend approximately two thirds the way down the roof slope. A triangular plywood board at the east end forms a tent-shaped insulated structure. A rough mesh carpet weave or greenhouse screening secured by scored cross battens (approx. 15 cm apart) will aid roosting (R. Ransome pers. comm.). Elsewhere the roof is not insulated.

A false floor extends from the base of the roof apex on the west wall to the central gable. This will create an additional compartment and reduce air movement. This can be hung from the roof using timber/galvanised wire or supported off the floor. Provision should be made for an electricity supply to any heaters positioned either on the false floor or at the base of the insulated alcove, and for monitoring equipment. The provision of a ceiling along part of roof space also offers a more varied microclimate.

A letter box entrance (500 mm x 250 mm) in the roof gable of the east wall (to avoid the sunset on emergence, D. Villis and R. Ransome, pers. comm.) provides alternative access, allowing uninterrupted passage to the main roost space. An internal plywood cowl reduces the amount of sunlight entering the roof space (R. Ransome, pers. comm.) and doesn't have the problems of eddies associated with external dormer-type access points (T. Hodnet, pers. comm.). The roof structure includes roof vents and air bricks, and the letterbox entrance also helps to ventilate the roof.

Additional roof features

In existing roosts, central heating boiler rooms/cupboards retain heat and are frequently used as night perches. Alcoves and multiple voids in the roof space increase the range of microclimates available. Chimneys are another favourite site for day roosting and they retain residual heat from fires/solar radiation. The mock chimney in the design will retain any heat absorbed during the day. Additional partitions can easily be fitted.

For artificial heating, R. Ransome recommends 120w, 2 ft long horticultural incubators, set to 28°C with a thermostat, suggesting higher temperatures may lead to dehydration. Perforated screening around the heaters will prevent bats from burning themselves A heater with thermostat would cost <£30.

Access

The ground floor room facilitates low level entry into the roost, light sampling behaviour and the training flights of the juveniles. Human access is through a secure door, raised above the ground for increased security. Behind the door is a platform and staircase to ease authorised access, and repair. Bats enter the ground floor via the aperture in the 'chimney' on the N wall, below the level of the smaller entrance on the E gable. Inside the ground floor room a grilled void gives the bats access to the roof cavity. The cool room has an ungrilled void into the roof, but no other entrance: bats can therefore only enter this room via the roof space.

Ground Floor Cool Room and Cellar

The ground floor and cellar may be used by non-breeding bats in cool summer weather, for hibernation, or as a transition roost in spring and autumn. Timbers on the ceiling facilitate roosting. The design must minimise air movement: the access point to the outside, and to the roof are positioned with this in mind. The 'chimney' on the north wall will restrict airflow at the entrance. The cool room must be well insulated to minimise temperature variation. Leading off the cool room is a cellar constructed of concrete beams partially buried in the ground floor. Access to the cellar is through a permanently open hole (750 mm x 1000 mm) in the ceiling. If the cool room and cellar are to be used as a hibernaculum or transition roost, the humidity needs to be high, so an earth floor has been chosen. A deeper cellar (1500 mm) should help maintain high humidity levels, but will push construction costs up. Where suitable hibernation sites are known to exist locally, the cellar can be eliminated from the design. Winter roost temperatures should ideally be 5-11°C. Humidity is important in determining evaporative water loss, which may be especially important during hibernation (Thomas and Cloutier, 1992). Humidity is largely correlated with temperature during the summer but little is known of the importance of humidity to *R. hipposideros* during the breeding season. If the air is too humid it may lead to condensation at higher levels in the roost.

Services

A 240 v/13 A mains electrical supply and a small number of power points are required for the possible use of heaters and monitoring equipment. Weatherproof sockets are preferred. Few sockets are needed, since it will be difficult to predict where they will be required, and extension cables can be used. Monitoring equipment (even CCD cameras) is compact, and may be successfully concealed in the structure. A secure area may be needed for larger, remote items of recording equipment e.g. video recorders and data loggers. In the absence of a mains electrical supply, monitoring equipment can be run off batteries.

General considerations

Planning permission is simplified if the design is vernacular and/or in sympathy with the environment.

The design must be flexible to allow alterations according to the site, and interior changes will probably be necessary in the light of experience.
A slate roof and local stone will blend in with other rural buildings in North Wales.
Much more flexibility of location is allowed if the planners are satisfied that the building will not have an alternative use if it fails as a bat roost.

Monitoring

Monitoring should be non-intrusive, potentially comprehensive and require minimum maintenance and expertise once in place. The most important variables are temperature, humidity, bat movement in and out of the roost, and roosting positions within the roost.

Temperature Temperature is perhaps the single most important environmental determinant of whether or not the roost is used. Temperature can be monitored in three ways.
Minimum/maximum thermometers: low cost and maintenance, but require regular inspection which is intrusive.
Cost: <£20 each
Miniature, archival loggers: e.g. TinyTalk Dataloggers (Orion, available from RS). These small loggers fit inside 35 mm film canisters, and can store temperature and other information at intervals of 1 s to 4.5 h for periods of 30 min to 1 year. Data can be down-loaded to pc computer or Psion, and displayed/analysed with Windows-based software. Relatively inexpensive, accurate, reliable and very flexible - they can be fixed almost anywhere, and are easily relocated. We have rigorously tested them in caves and bat boxes. Down-loading may be intrusive if loggers are placed near the bats - it depends upon how often information must be gathered.
Cost: Single channel TinyTalk £60 (internal sensor), £100 (external sensor), software and cable £50.
Multi-channel fixed logger: e.g. Enviromon (Pico Technology, available from RS). Data from a series of fixed sensors is fed to a remote central logger (total cabling can be up to 400 m). The system is flexible, with up to 30 sensors being routed to the logger. This can store 15,000 data points, taking readings every 1-60 min. The logger can be down-loaded to a pc with DOS/Windows software, or direct to a printer. Comparable cost to TinyTalks if many are needed, accurate and reliable, and can be down-loaded without entering the roost.
Cost: Enviromon logger (with 3 channel converter unit, three sensors, software, printer and pc cables) £380, additional 3 channel converters £80, additional sensors (with 5 m cable) £54.

Humidity Both the TinyTalk and Enviromon systems have relative humidity (RH) sensors.
Cost: TinyTalk with RH sensor £76, Enviromon 3 channel converter with one combined RH/temperature probe £147.

Bat emergence and return The passage of bats into and out of the roost can be monitored in several ways. An array of infra-red LEDs and photodiodes can be placed across the access hole, and linked to a data logger or pc computer. When a bat breaks the beam, a signal is sent to the data logger. A modified burglar alarm may also be used. The design will be determined by the access hole. Rapidly changing technology has made published designs obsolete - a local university, college, or electronics company can advise. The components, minus the pc computer will cost £50-100. To determine the direction of travel, a double beam system will be required. An alternative method is to trigger a data logger from the echolocation calls. *R. hipposideros* are particularly well suited to this approach, since no other species has a similar call. The system must be designed to limit the range and receiving angle of the bat detector/microphone. This system should also be inexpensive. Neither are likely to give a very reliable estimate of the number of bats, since they are likely to enter and

leave the roost repeatedly when light sampling. However, with careful placing of the sensors, a good estimate can be made.

Roosting behaviour The location of large clusters of roosting bats can be most cheaply determined using temperature probes in favoured roosting sites. However, the most reliable and informative method uses small CCD cameras linked to a time lapse video recorder, in conjunction with low intensity or infra-red lights. CCD cameras are ~~small and can be cheap~~ (<£100, but for reasonable resolution ~£250+). A time lapse video-recorder will cost £500+.

Environment around the roost

The management of core habitat adjacent to the roost is supported by the Bonn Bat Agreement. Horseshoe bats are rarely observed crossing wide open spaces. They rely on structures such as hedges, fences and tree-lines to commute between roosts and their foraging areas. They may also forage amongst this vegetation. It is recommend that existing linear habitat is preserved and derelict/removed hedges are replanted and managed. Preservation and enhancement of these and other key habitat features within approx. 1-2 km of the roost (e.g. ponds) is encouraged, to cater for the limited foraging ability of juveniles. Undulating countryside with hedgerows, tree-lines and woodland are the preferred foraging habitats. In *R. hipposideros* surveys, roosts were most frequently located close to stands of woodland and access to such woodland was along continuous linear landscape features such as hedgerows or tree-lines. Roosts did not occur in upland areas, urban areas or flat open areas that were intensively farmed. Where there is little or no cover, vegetation (possibly laurel or another evergreen species) should be planted linking access points to the roost with the nearest woodland or hedgerow. Cover provided close to roost entrances should encourage bats to emerge and feed as soon as possible after sunset.

Acknowledgements

The paucity of published information has meant that we have had to rely very heavily on the help of those few individuals with practical experience in this field. All gave their time and knowledge freely and enthusiastically. For all their help, we would like to thank Kate McAney and Henry Schofield (Vincent Wildlife Trust), Tim Hodnet, Jean Matthews and Ruth Warren (Countryside Council for Wales), David Cottle and Christopher Hancock (Somerset Wildlife Trust), Tony Mitchell-Jones and Dave Villis (English Nature), David Priddis and Roger Ransome. Special thanks to the architect, Pete Dickeson of *Peter Dickeson Associates* for his help, and for drawing up the plans at a considerable discount.

References

Altringham, J.D. (1998) Bat houses and Forestry in England, *Bats* **16**, in press.

Bemment, G.E. (1995) Case study: the lesser horseshoe bat on the Killerton Estate, Devon. *Biol. J. Linn. Soc.* 56, 127-129.

Devrient, I., Wohlgemuth, R. and Jasper, A. (1997) The noctules new home. *Bats* 15, 16-17

Furhman, M. and Kiefer, A. (1996) Fledermausschutz bei einer Straßenneubauplanung: Ergebnisse einer zweijährigen Untersuchung an einem Wochenstubenquartier von Großen Mausohren (*Myotis myotis* Borkhausen, 1797). - In: Kiefer, A. & M. Veith (Hrsg.): Beiträge zum Fledermausschutz in Rheinland-Pfalz. Fauna und Flora in Rheinland-Pfalz, Beiheft 21: -. Landau.

Gaisler, J. (1963) The Ecology of lesser horseshoe bats (*Rhinolophus hipposideros*, Bechstein 1800) *in* Czechoslovakia, Part 1. *Vestnik Ceskoslovenske Spolecnostic Zoologicke* 27, 211-233.

Gebhard, J. (1986) Erste Erfahrungen mit freifliegenden *Nyctalus noctula*, die in Gefangenschaft geboren und aufgewachsen sind. 60. Hauptvers. Deut. Gessell. f. Saugetierkunde. Kurzfass. der Vortrage und Posetrdemonstrationen: 19-20. verlag. Paul parey, hamburg u. Berlin

Harris, S., Morris, P., Wray, S. and Yalden, D.W. (1995) *A review of British mammals: population estimates and conservation status of British mammals other than cetaceans*. JNCC, Peterborough.

Heaver, S. (1987) The status of the lesser horseshoe bat. *Bat News* **10**, 5-7.

Hutson, A.M. (1993) Action plan for the conservation of bats in the United Kingdom. BCT, London.

McAney C.M. and Fairley, J.S. (1988a) Habitat preference and overnight seasonal variation in the foraging activity of lesser horseshoe bats. *Acta Theriol.* **33**, 393-402.

McAney C.M. and Fairley, J.S. (1988b) Activity patterns of the lesser horseshoe bat *Rhinolophus hipposideros* at summer roosts. *J. Zool. Lond.* **216**, 325-338.

Palmer, S. (1991) High rise flats for bats. *Bat News* **21**, 3.

Park, K.J., Masters, E. and Altringham, J.D. (1998) Social structure in three sympatric species of temperate bat. *J. Zool.*, in press, March issue.

Racey, P.A. (1973) Environmental factors affecting the length of gestation in heterothermic bats. *J. Reprod. Fertil.*, Supplement 19, 175-189.

Ransome, R.D. (1991) The lesser horseshoe bat. In: *The Handbook of British Mammals*, ed. G.B. Corbet and S. Harris. Blackwell, Oxford.

Richarz, K. (1988) Report of the successful transplantation of a nursery colony of the lesser horseshoe bat (*Rhinolophus hipposideros*) and remarks about the actual status of this species in Bavaria. In: *European Bat Research 1987*, ed. V. Hanek, I. Horacek and J. Gaisler. Charles Univ. Press. Praha.

Schofield, H.W. (1992) The physical parameters of lesser horseshoe bat roosts in relation to colony size. Paper to The Vincent Wildlife Trust.

Schofield, H.W. (1996) The ecology and conservation biology of *Rhinolophus hipposideros*, the lesser horseshoe bat. PhD thesis, Aberdeen University.

Schofield, H.W., McAney, C.H. and Messenger, J.E. (1997) Research and conservation work on the lesser horseshoe bat. In: *The Vincent Wildlife Trust Review of 1996*, pp58-68.

Shore, R.F., Myhill, D.G., French, M.C., Leache, D.V. and Stebbings, R.E. (1991) Toxicity and tissue distribution of pentachlorophenol and permethrin in pipistrelle bats experimentally exposed to treated timber. *Environmental Pollution* 73, 101-118

Stebbings, R.E. (1988) Conservation of European bats. Christopher Helm, London.

Stebbings, R.E. (1992) Accommodating lesser horseshoe bats in the redevelopment of various buildings. Report for the Countryside Council for Wales, North Wales Region.

Stebbings, R.E. and Griffith, F. (1986) *Distribution and Status of Bats in Europe*. ITE, Abbots Ripton.

Symonds, D. (1995) Blackwater Valley bat cave - a landscape architect's perspective. *Bat News* 37, 2-3.

Taake, K-H. and Hildenhagen, U. (1989) Nine years inspections of different artificial roosts for forest-dwelling bats in Northern Westfalia: some results. In: *European Bat Research 1987*, ed. V. Hanek, I. Horacek and J. Gaisler. Charles Univ. Press. Praha. pp487-498

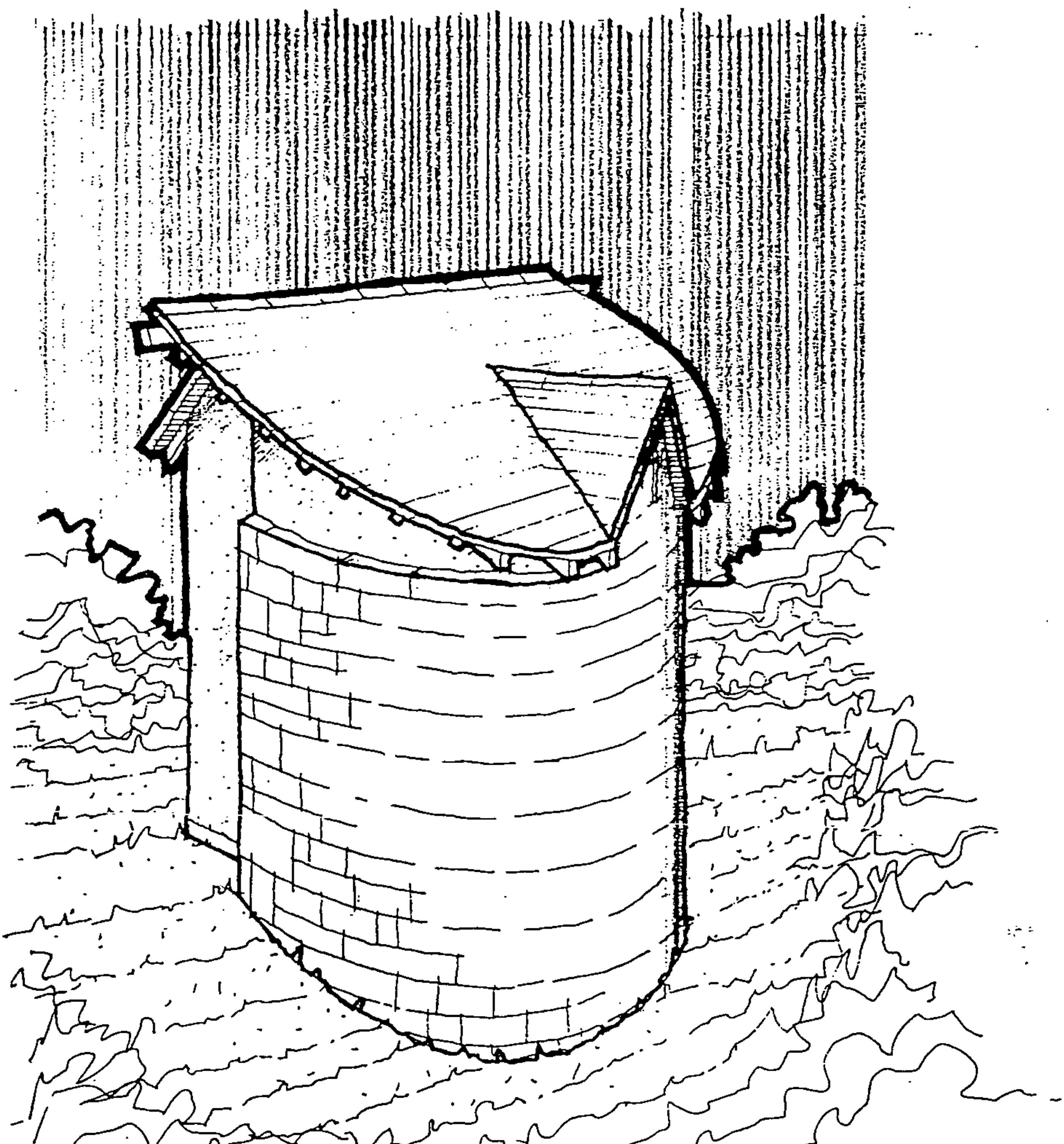
Thomas, D.W. and Cloutier, D. (1992) Evaporative water loss by hibernating little brown bats, *Myotis lucifugus*. *Physiol. Zool.* 65, 443-45.

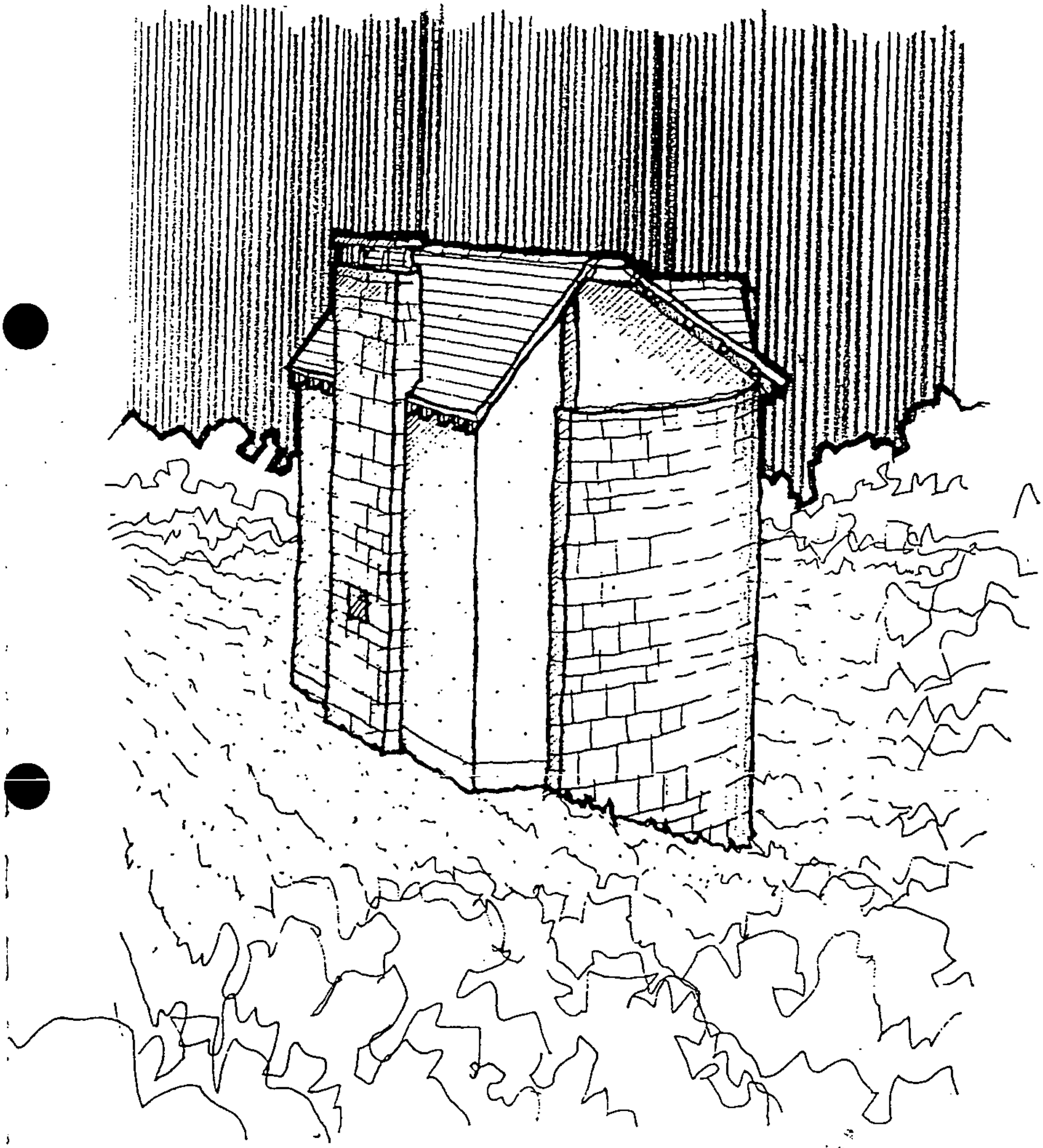
Tuttle, M.D. and Hensley, D. (1993) Bat houses: the secrets of success. *Bats* 11, 3-19.

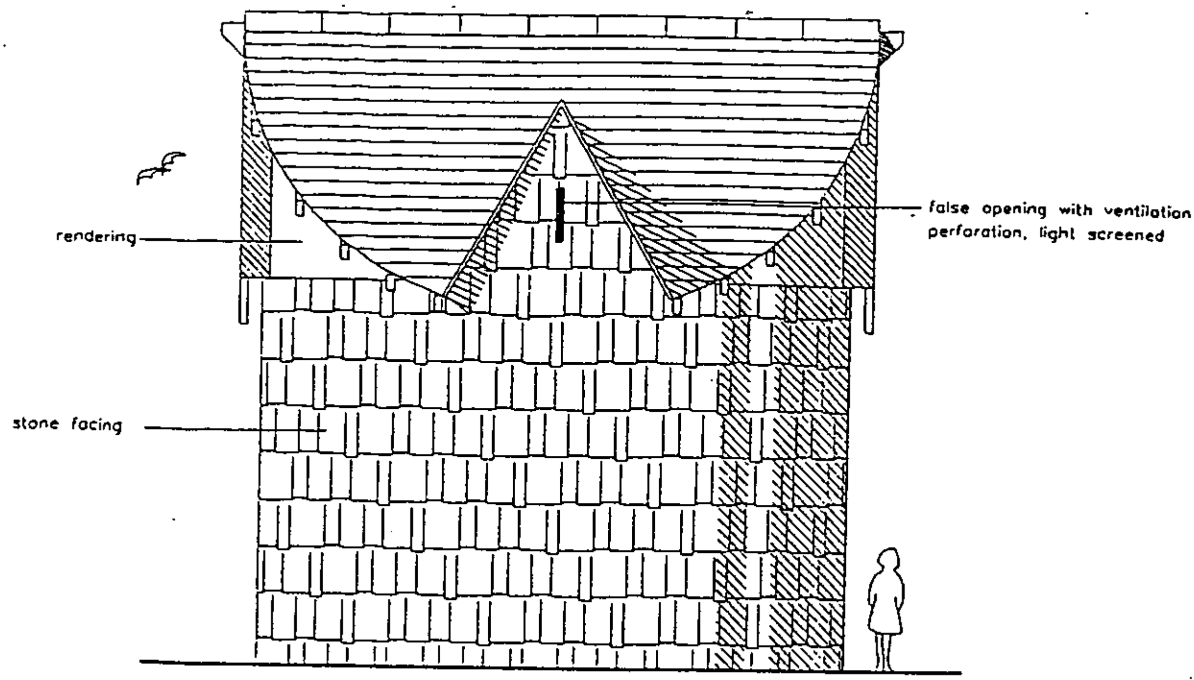
Warren, R.D., Matthews, J.E. and Howe, M.A. (1997) Lesser horseshoe bat summer roost monitoring 21 May to 17 June 1996. *CCW Science Report 164*.

APPENDIX

ARCHITECT'S DRAWINGS AND PLANS







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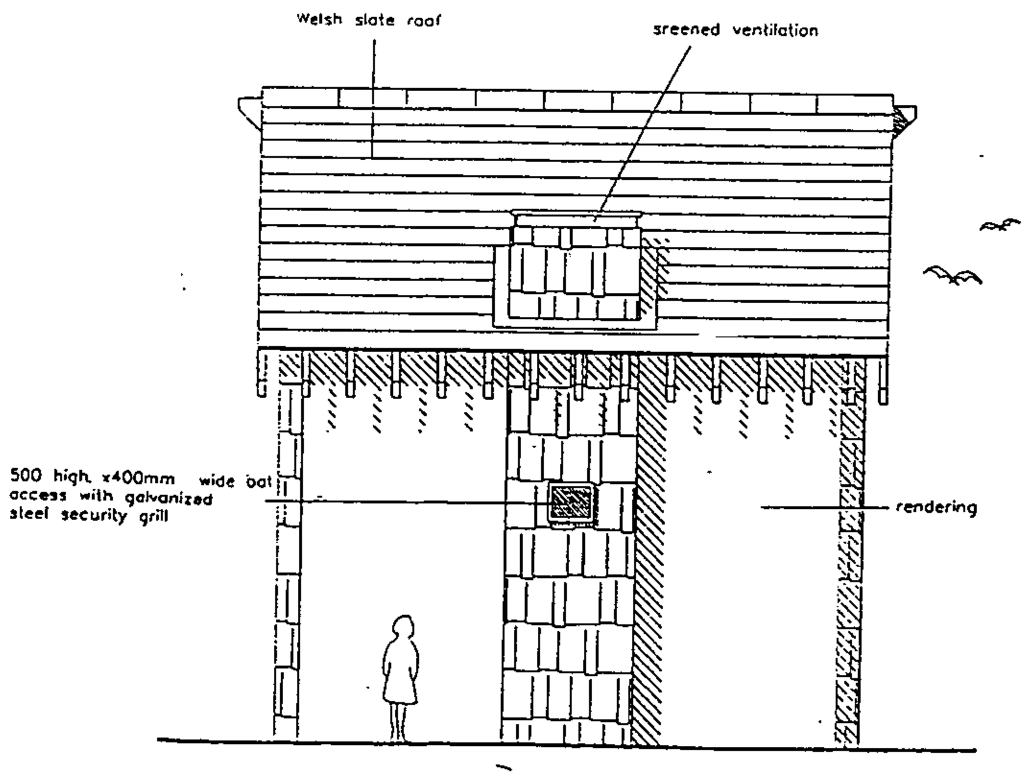

North elevation
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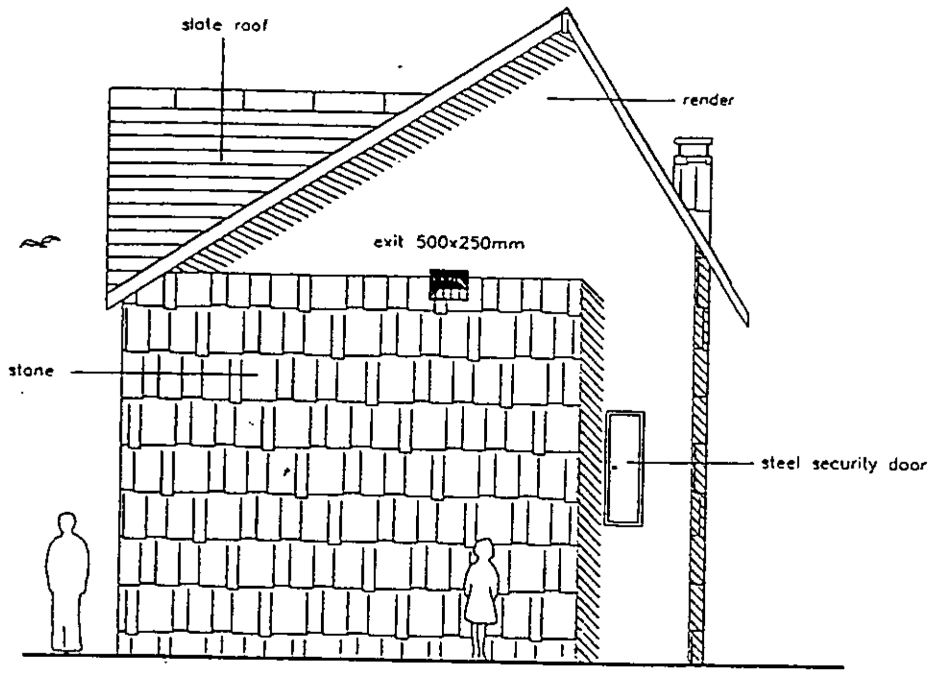

East elevation
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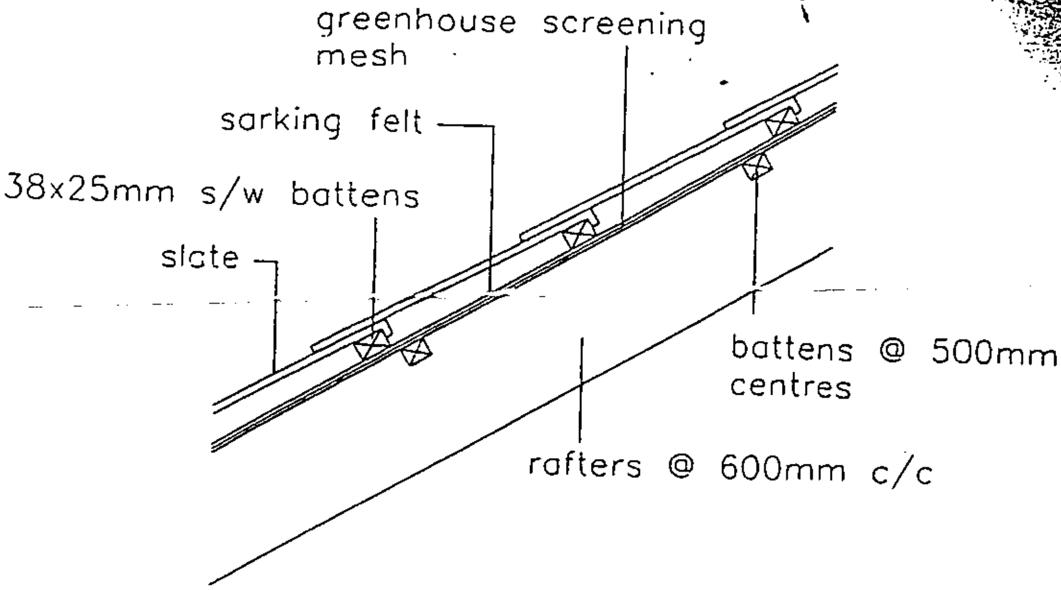

ROOF DETAIL
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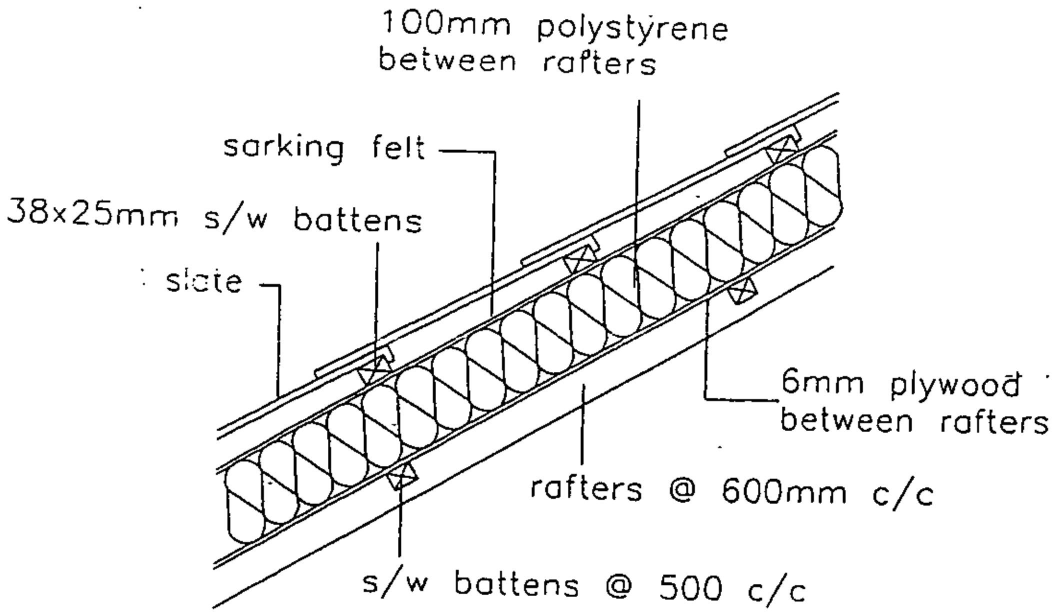

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INSULATED
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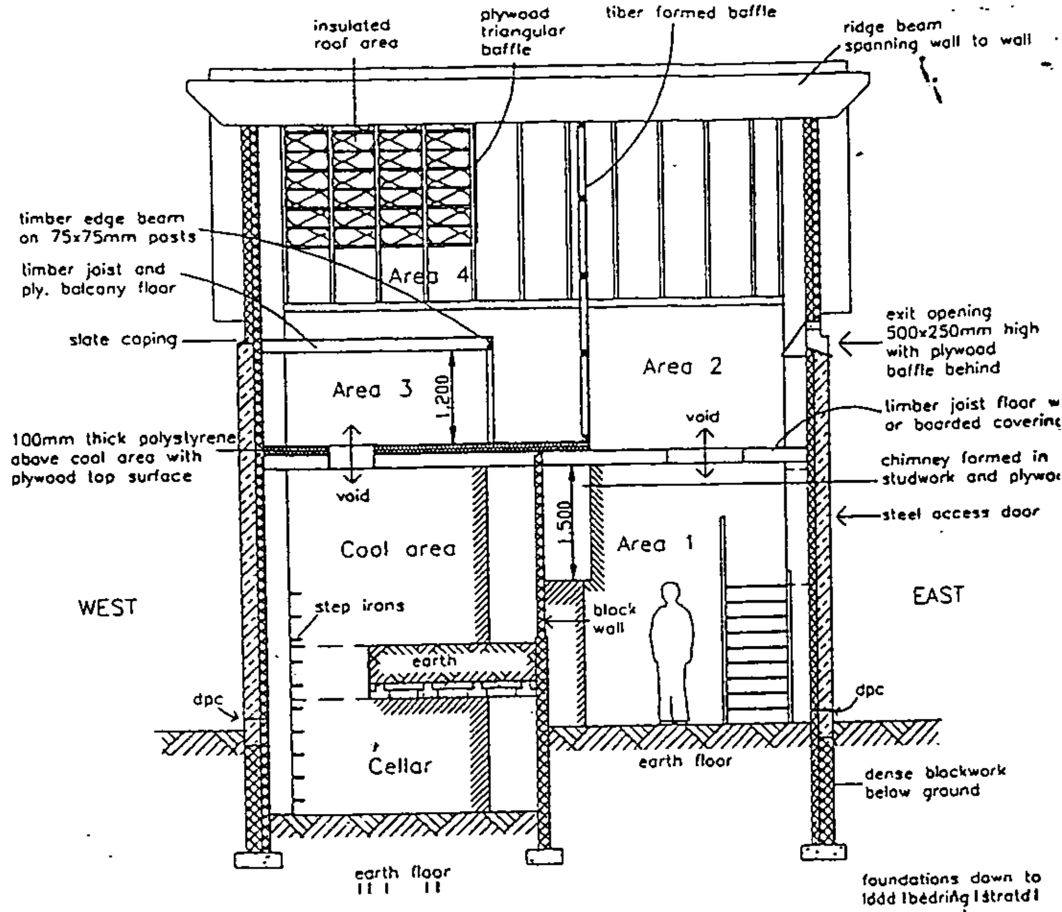
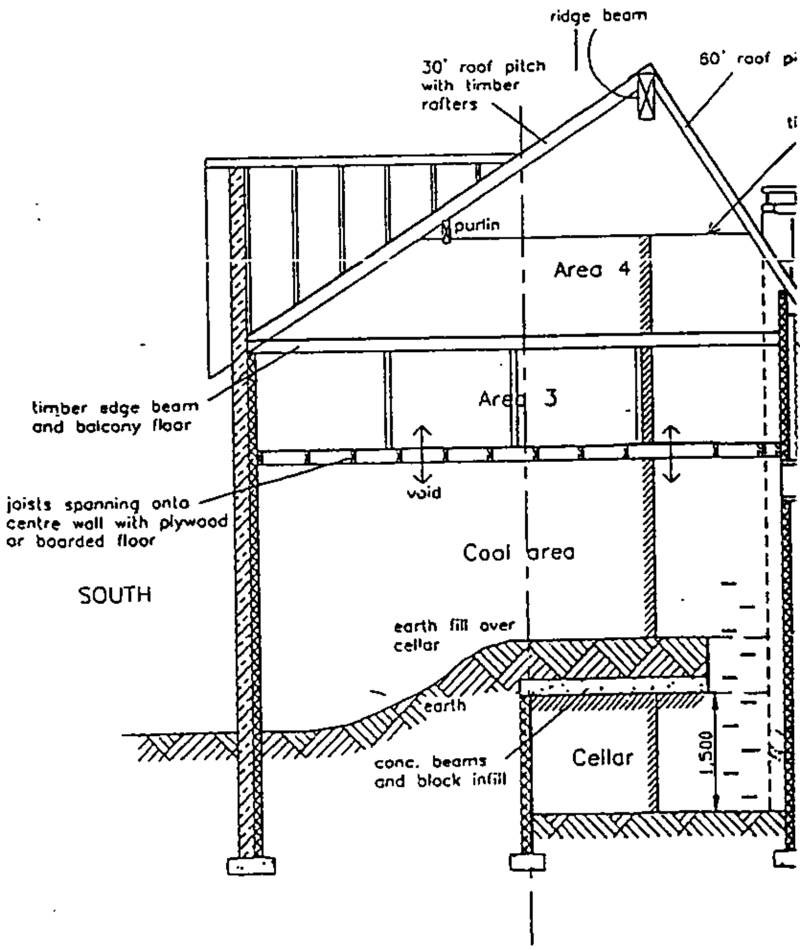


Section A–A

(scale 1:100)



Section B–B

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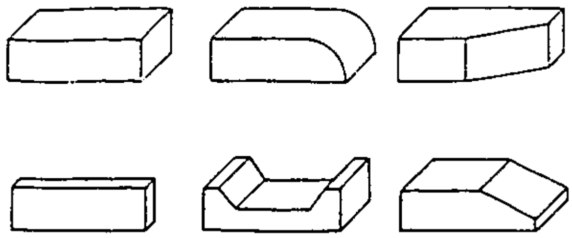
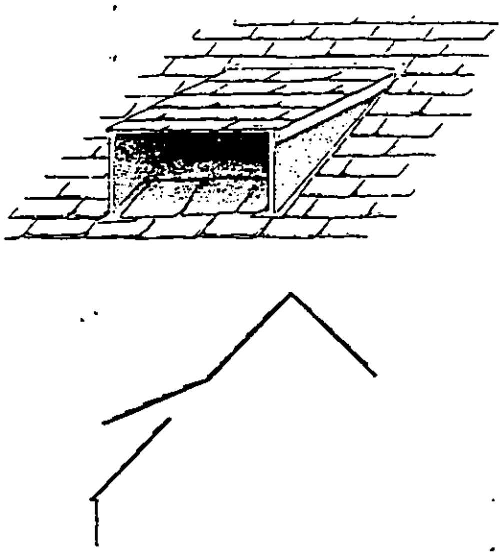
ENCLOSURE 3

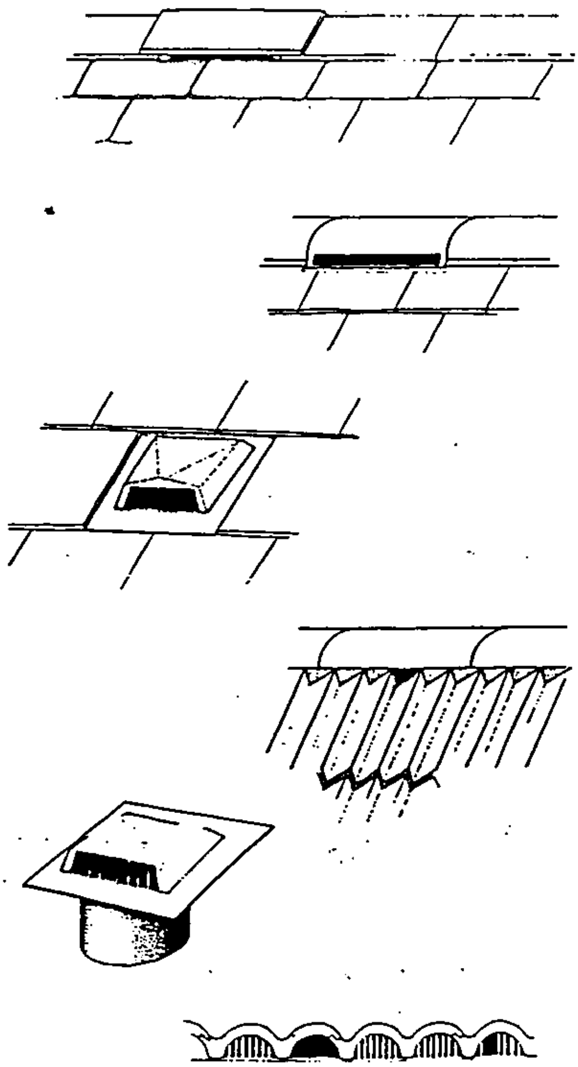
Bat access adaptations (courtesy of Joint Nature Conservation Committee)



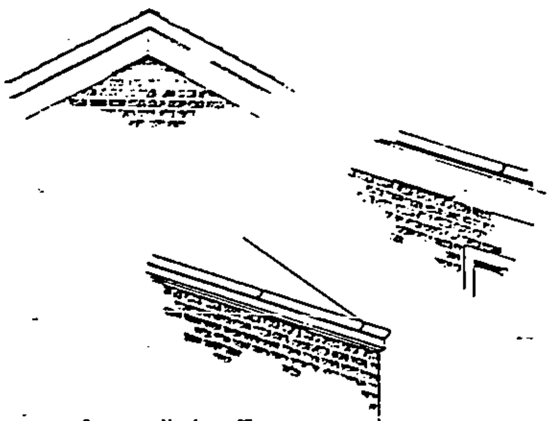
Walling bricks for creating bat access points. A standard brick is shown top left.



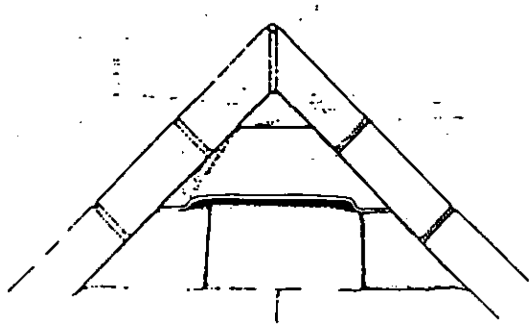
Dormer entrance, particularly suitable for horseshoe bats.



Ridge ventilators can be adapted as bat access points. It may be necessary to remove internal mesh or plastic moulding.



Access slits in soffits.



Lead saddle in place of a slate to allow bats access to ridge or roof void

Figure 9.4 Bat access holes. Horseshoe bats prefer to fly into their roosts, but only small holes or slots are needed for other species and this also helps to deter colonisation by birds.

APPENDIX III – PART C

SURVEY OF FEN BEDSTRAW POPULATION AT KILLOW, ENNIS, CO. CLARE (RPS Consultants Ltd.)

Ennis Bypass Environmental Assessment

Survey of Fen Bedstraw (*Galium uliginosum*)
Population at Killow, Ennis, Co. Clare

AUGUST 1999

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This report has been prepared by RPS Consultants Ltd

REPORT NUMBER:	**IR527/6**
STATUS OF REPORT:	**Revision 1**
DATE OF REPORT:	**06 September 1999**
PROJECT MANAGER:	**Tom Gittings**

CONTENTS

LIST OF FIGURES

1. INTRODUCTION

During botanical survey work for the Ennis Bypass EIS in July 1998, a population of the nationally scarce plant species Fen Bedstraw (*Galium uliginosum*) was recorded at Killow (botanical survey sub-site 3/6 in RPS Consultants Report No. IR527/4). At the time of the survey, the final alignment of the bypass route had not been decided, and it was not clear whether the Fen Bedstraw was directly in the line of the route. Following finalisation of the bypass alignment, it has been necessary to resurvey this Fen Bedstraw population and determine whether it will be directly affected by the bypass route. This report presents the results of the survey.

2. METHODS

The approximate extent of the area surveyed is shown in Figure 1. This area included adjoining areas outside the landtake of the route in an attempt to ascertain the general distribution of the species in the area. A period of five hours was spent searching this area on 27 August 1999. Initially, the surveying was focused on the wet modified bog habitat in, and adjoining, the landtake of the proposed route and on the margins of the ditches away from the proposed route (as the initial discovery was made adjoining a ditch). Subsequently, the survey was expanded to include other areas away from ditches. However, these areas were not so thoroughly searched.

3. SURVEY RESULTS

A total of 12 distinct patches of Fen Bedstraw were located (see Figure 1). The patches varied in size from approximately 1 m^2 to 8 m^2 (Table 1). The three largest patches (5-8 m^2) were located around 60 m north of the landtake of the proposed route (see Figure 1). Note, however, that these patches did not represent continuous cover of Fen Bedstraw but, rather, dispersed plants, so that the overall cover of Fen Bedstraw within a patch would be less than 10%.

TABLE 1 Approximate size of Fen Bedstraw patches

Patch number	Patch size(approx)/m^2	Distance from proposed route(approx)/m
1	2	0
2	4	2
3	2	5
4	1	5
5	4	20
6	3	27
7	4	45
8	2	55
9	5	60
10	8	60
11	6	60
12	2	65

see Figure 1 for the location of the patches

The general habitat within which these patches occur is wet modified bog (JNCC, 1993) dominated by Purple Moor-grass (*Molinia caerulea*) and Tormentil (*Potentilla erecta*) with dense patches of Bog Myrtle (*Myrica gale*). However, the marginal ditch vegetation was more species-rich and typical species associated with the Fen Bedstraw included, in addition to the three aforementioned species, Sharp-flowered Rush (*Juncus acutiflorus*), Yorkshire Fog (*Holcus lanatus*), Meadow Thistle (*Cirsium dissectum*), Water Mint (*Mentha aquatica*), Meadowsweet (*Filipendula ulmaria*), Purple-loosestrife (*Lythrum salicaria*), Common Knapweed (*Centaurea nigra*), Bramble (*Rubus fruticosus* AGG.), Devil's-bit Scabious (*Succsia pratensis*) and Sweet

Vernal Grass (*Anthoxanthum odoratum*). The closely-related Marsh Bedstraw (*Galium palustre*) was also recorded sparsely in this habitat but never in association with Fen Bedstraw.

The majority (9 out of 12) of the patches of Fen Bedstraw were found close to ditches. This may reflect, however, the more intensive search effort focused in the vicinity of the ditches. One patch of Fen Bedstraw was found in a patch of Bog Myrtle and this latter vegetation was very difficult to search thoroughly. It is likely, therefore, that some patches away from the ditches were missed.

The area of grazed fen meadow to the south of the first ditch was also searched. While Marsh Bedstraw was common here, no Fen Bedstraw was located. The area had been recently grazed by cattle which would have made locating an unobtrusive plant like Fen Bedstraw more difficult. However, the habitat conditions here are probably unsuitable for Fen Bedstraw. The fen meadow was level with the ditch and, therefore, was waterlogged unlike the wet modified bog which is raised above the level of the ditch; the preferred water table conditions of Fen Bedstraw are 5-20 cms below ground level (Newbold and Mountford, 1997).

4. IMPACT

One patch of Fen Bedstraw is within the landtake of the bypass while another three patches are within a few metres of the landtake. The impact of the bypass will, therefore remove at least 8% of the known population (in terms of patches) and possibly up to one-third. It is likely, however, that further, as yet, undiscovered patches occur outside the line of the bypass route.

The Fen Bedstraw population in sub-site 3/6 outside the road landtake could potentially be affected by hydrological impacts. However, the depth of the drainage ditches surrounding this sub-site suggest that if the existing surface drainage patterns are maintained, such impacts are unlikely to occur.

In the short term, the bypass is unlikely to cause local extinction of the Fen Bedstraw population, providing the bypass does not have significant indirect effects on the remaining habitat outside its landtake. Reduction in patch numbers could, in theory, affect the long-term viability of the population. In the absence of detailed modelling of the population dynamics of the population, it is not possible to predict with certainty whether or not this will occur. However, as the bypass only affects what appears to be a marginal part of the population, it appears quite likely that it will not have any long-term effects.

It should be noted, however, that patchy plant populations are likely to exhibit spatio-temporal fluctuations. It is quite likely, therefore, that the size of the individual patches of Fen Bedstraw may vary from year to year, and that some patches may disappear while new patches may be founded.

5. MITIGATION

In order to prevent indirect impacts on the Fen Bedstraw population, the existing hydrological regime should be maintained, if possible (the preferred water table conditions are 5-20 cms below ground level; Newbold and Mountford, 1997). This will probably include constructing a ditch along the northern edge of the bypass landtake to link up the exiting ditches which are severed by the route. This is, probably, the most crucial requirement to secure the future of this population.

The patch of Fen Bedstraw within the road landtake should be translocated to an appropriate receptor site. Care should be taken during construction to avoid any interference to the patches of Fen Bedstraw outside the road landtake. If disturbance to the three patches within 10 m of the road landtake is considered inevitable, then these should also be translocated.

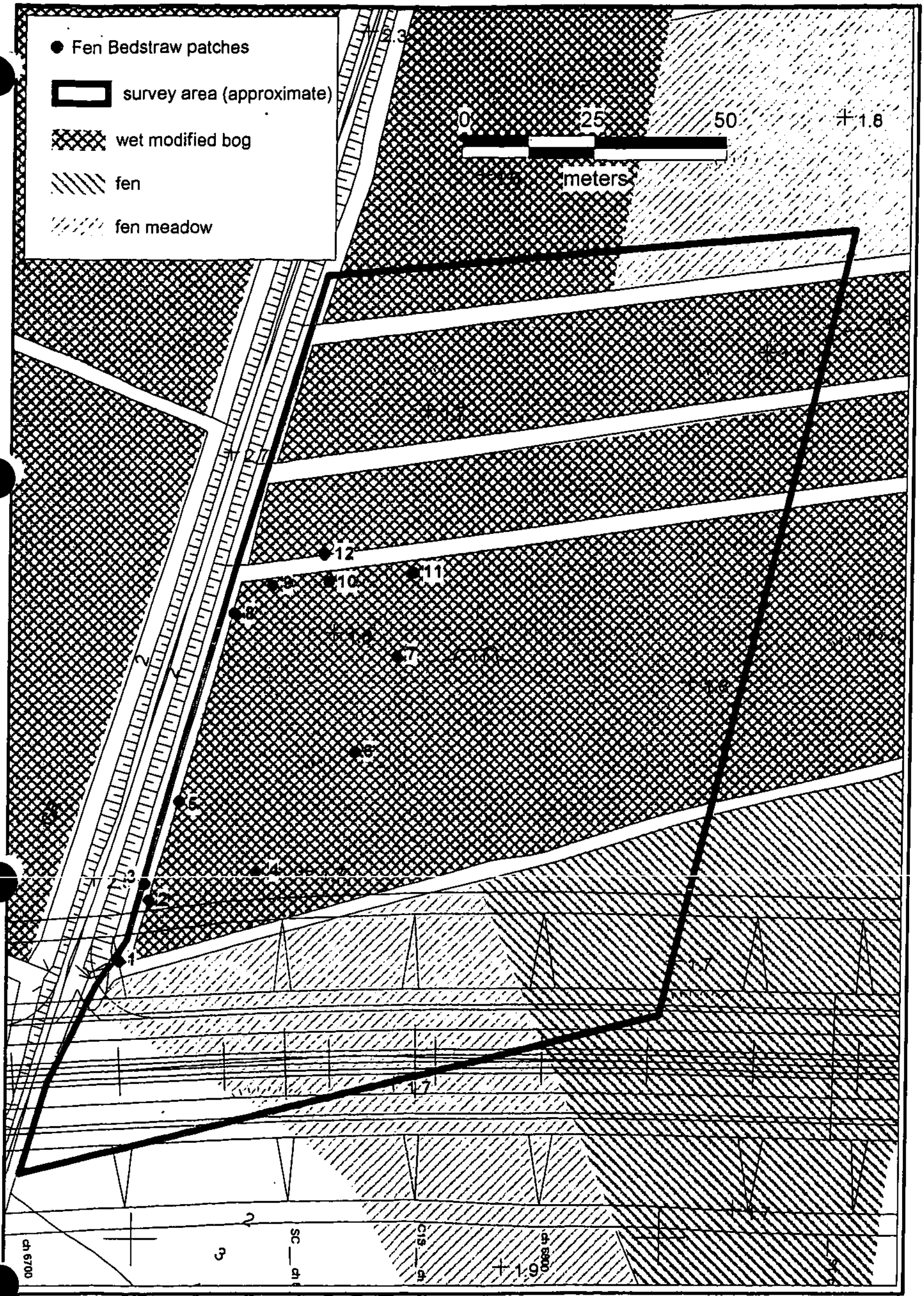
Translocation will require specialist ecological advice (see Birkinshaw, 1991; Bullock *et al.*, 1997).

REFERENCES

Birkinshaw, C.D. (1991). *Guidance notes for translocating plants as part of recovery plans*. CSD Report No. 12225, Nature Conservancy Council, Peterborough, UK.

Bullock, J.M., Hodder, K.H., Manchester, S.J. and Stevenson, M.J. (1997). *Review of information, policy and legislation on species translocation*. JNCC Report No. 261, Joint Nature Conservation Committee, Peterborough, UK.

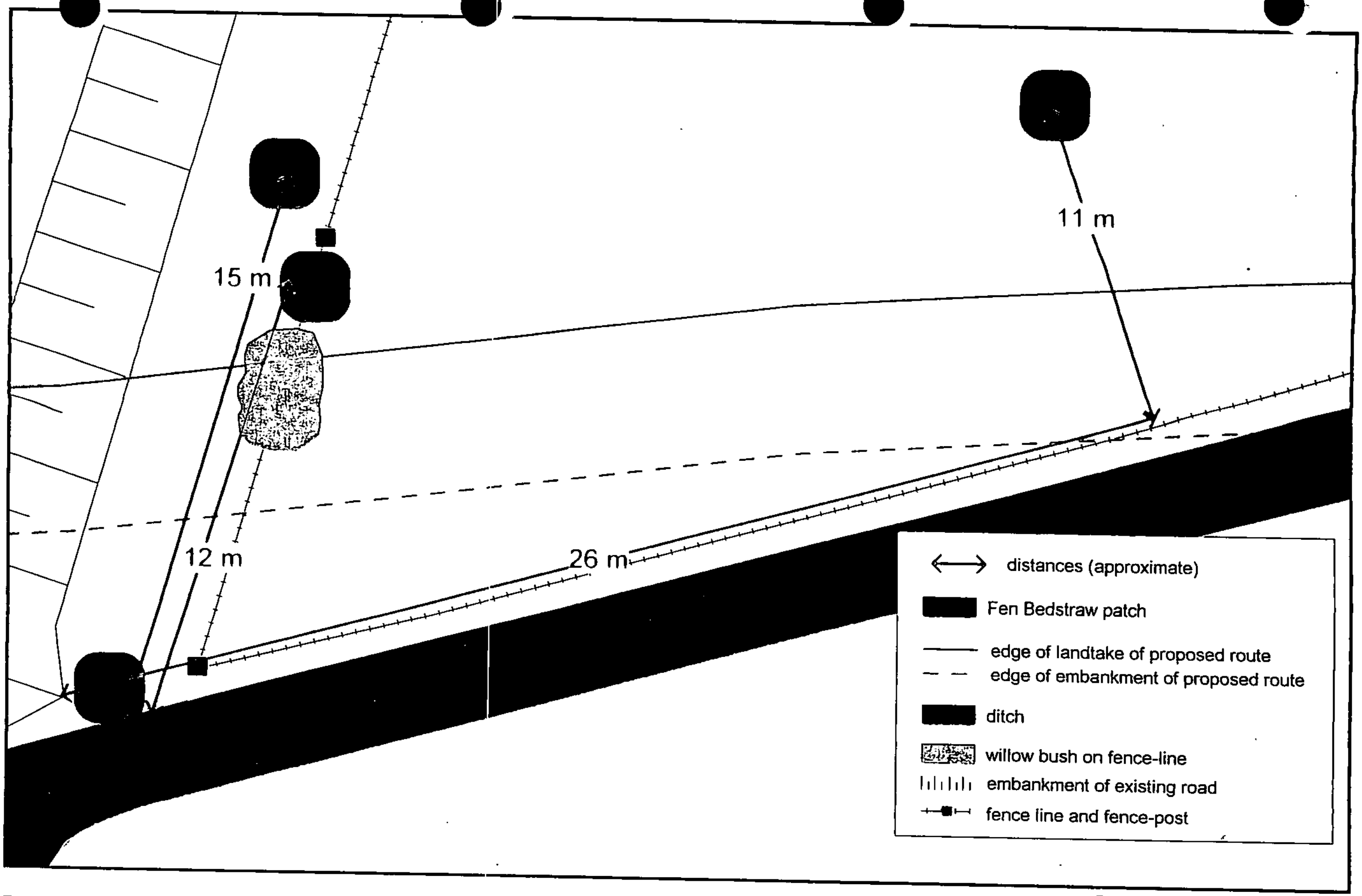
Newbold, C. and Mountford, O. (1997). *Water level requirements of wetland plants and animals*. English Nature Freshwater Series No. 5, English Nature, Peterborough, UK.



Distribution of Fen Bedstraw in relation to the proposed route

RPS CONSULTANTS
THE ENVIRONMENTAL CONSULTANCY

Figure 1



Detail of location of Fen Bedstraw patches near proposed route

RPS CONSULTANTS THE ENVIRONMENTAL CONSULTANCY

Figure 2

iv

APPENDIX IV

SOIL, GEOLOGY & HYDROGEOLOGY

PART A **Geology & Hydrogeological Aspects of the Proposed Improvements to the N18 between Dromoland to Crusheen (K.T Cullen & Co. Ltd.)**

APPENDIX IV – PART A

Geology & Hydrogeological Aspects of the Proposed Improvements to the N18 between Dromoland to Crusheen (K.T Cullen & Co. Ltd.)

GEOLOGY & HYDROGEOLOGICAL ASPECTS OF THE PROPOSED IMPROVEMENTS TO THE N18 BETWEEN DROMOLAND TO CRUSHEEN ENVIRONMENTAL IMPACT STATEMENT

April 1999

K.T. Cullen & Company Limited
Bracken Business Park
Bracken Road
Sandyford Industrial Estate
Dublin 18

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APPENDIX

Geological & Hydrogeological Aspects of the Proposed Improvements to the N18 between Dromoland to Crusheen Environmental Impact Statement

Introduction

At the request of Clare County Council, K.T. Cullen & Co. Ltd. have undertaken the geological and hydrogeological aspects of an environmental impact study for the proposed improvements to the N18 between Dromoland to Crusheen. Figure 1 presents the location of the proposed route. These works are an extension of the road improvements undertaken on the N18 and N19 between Ballycasey to Dromoland. The geological and hydrogeological aspects of that route were reviewed in a report entitled "Geological and hydrogeological aspects of the proposed improvements to the N18/N19 between Ballycasey and Dromoland" (January 1996).

This report describes the geological setting of the proposed route and the likely significant impacts of this route on the underlying soils, geology and hydrogeological regime in the surrounding area. Areas where potential impacts may occur are highlighted and recommendations are made with regard to minimising the impact on the receiving environment.

1.0 OVERBURDEN & BEDROCK GEOLOGY

RECEIVING ENVIRONMENT

1.1 Regional Setting

The proposed route runs along the drainage catchment of the River Fergus which discharges to the Shannon Estuary in the south, (Figures 1 and 2). The route is generally underlain by glacial deposits except where bedrock is exposed at surface. The topography of the region consists of undulating glacial deposits with bedrock rising to the west, east and south of the route.

1.2. Sources of Information

The geological maps and sections included in this report are based on the known regional distribution of bedrock types together with a detailed analysis of the trial pit logs undertaken during the site investigation programme along the proposed route. Regional overburden information was provided by the Geological Survey of Ireland (Mr O. Bloejet).

In the absence of full site investigation boreholes along the route, depth to bedrock information and evidence of karst features were derived from outcrop distribution determined from maps provided by the Geological Survey of Ireland, field mapping by a hydrogeologist along the proposed route and the interpretation of features from aerial photographs.

1.3 Bedrock Geology

Figure 3 presents the regional geology for County Clare and parts of neighbouring counties. The position of the proposed road improvement scheme has been superimposed on the bedrock geology for reference.

The eastern part of the county is underlain by Silurian and Devonian (Old Red Sandstone) sandstones and greywackes, typified by the Slieve Aughty Mountains. The rest of the county is underlain by Carboniferous age deposits; shales and sandstones (Namurian age) in the west and by limestones (Courceyan- Brigantian age) in the central and northern parts.

As shown in Figure 3, the proposed route is underlain for the most part by Chadian-Brigantian age limestones, and in the north (around Barefield) by Waulsortian reef limestones.

The Waulsortian reef limestones are the oldest of these units and are light grey in colour and usually devoid of bedding structures. These are overlain by Chadian-Brigantian age limestones which are the uppermost limestone unit and consist of well bedded, light grey coloured limestones which are usually devoid of significant shale horizons. These limestones are typical of the Burren landscape of Clare and South Galway and impart the unique topographic and drainage characteristics of this region which is referred to as Karst. In this report these limestones are referred to as the "Burren Limestones".

1.3.1 Karst and Hydrogeology

The limestones which underly most of the proposed route are part of the Burren Limestones which are typified in the Burren Plateau to the northwest of Clare. These limestones form a karst topography where surface drainage is replaced or interlinked with a subterranean drainage network in the limestone aquifer. Karstification is where pre-existing fractures in limestone slowly enlarge by groundwater dissolution. As these develop, underground drainage networks can mature increasing groundwater movement through the aquifer. Karstification can develop in saturated zones or in unsaturated zones where previously the groundwater table was higher. The primary topographic features associated with karst are; enclosed depressions (dolines), sinking streams (swallow holes), intermittent streams, bare rock exposures, collapse features, dry valleys, caves and large springs.

The Burren Plateau is elevated and essentially devoid of surface drainage and it is a modern karst where limestone bedrock continues to be dissolved by infiltrating acid rainfall. Further south, along the Fergus Catchment, the Burren upland karst is replaced by a lowland karst with surface drainage interlinking with turloughs, swallow holes and springs. Although covered by a blanket of glacial sediments, the limestone in this area has undergone similar dissolution to that presently seen in the Burren plateau.

In general the Waulsortian limestones, display a much lower level of karstification than the overlying Burren limestones. This is due to the composition and less bedded nature of the former.

Applying this regional picture to the proposed route, it is clear that karst features can be expected along the entire route, decreasing in risk around the Barefield area which is underlain by less karstified Waulsortian limestones.

1.4 Overburden (Soils)

1.4.1 Regional Overburden

The topography of the region is defined by undulating glacial deposits with some peat and alluvium, which cover for the most part, the bedrock described above. Figure 4 presents the regional overburden cover. The glacial deposits can be described as unconsolidated deposits whose composition reflects the depositional environments that occurred during the last ice age.

Till (Boulder Clay) is a generic term describing sediments deposited by ice usually at the margin of an ice sheet. Tills can be broadly subdivided into Lodgement Tills (deposited subglacially, giving rise to features such as Drumlins) and Ablation Tills (deposited proglacially, giving rise to features such as Terminal Morraines). As till is deposited directly from the glacial ice, there is no significant sorting by running water and particles of any size can occur.

Drumlins are formed during a glacial advance. They can form around a nucleus of outcrop

or hard sediment, or by meltwaters flushing under the ice-sheet, streamlining the basal sediments. Movement of the ice and/or meltwaters mould the drumlin into a teardrop shape, with a long axis in the direction of ice movement.

Sands and gravels are deposited by glacial meltwaters, either subglacially (e.g. Eskers, channelled deposits), englacially (e.g. Kames, crack infill deposits) or proglacially (e.g. Saunders, outwash plain deposits). These deposits are typically clean and well-sorted.

Peats are post-glacial deposits formed during the Holocene period, in waterlogged areas where plants and mossy material decayed and accumulated over time.

As the glacial deposits were laid down on the older bedrock framework, the thickness of these deposits reflect the bedrock surface. Where bedrock troughs exist, thick deposits can occur and are sometimes exploited in sand and gravel quarries. No maps showing thickness of overburden are currently available for this area. However, inference of overburden thickness can be derived from Figure 4 as bedrock outcrop is highlighted. Along the proposed route trial pits were excavated which give thickness of overburden information. The logs of these trial pits are discussed in Section 1.4.2. Overburden is absent in areas of bedrock outcrop and thick (approximately 10 metres to 40 metes) in areas of drumlins.

1.4.2 Range of Overburden Deposits

The exiting soil and bedrock conditions along the proposed route corridors are indicated in two cross sections Figure 6 Claureen to Skenagh (A-A') and Figure 7 Latoon Bridge to Carrodotia (B-B'). These cross sections are derived from an interpretation of the trial pit data completed as part of the site investigation programme and the surface topography. The location and thickness of overburden encountered are shown on Figure 5. This data and outcrop information (from 6 inch sheets) was derived from the Geological Survey of Ireland maps. The combination of this data allows the probable bedrock surface to be interpreted. Where the trial pits did not encounter bedrock, the bedrock surface is interpreted from nearby outcrops. These are indicated as "interpreted" on the sections.

Reference to the 86 trial pit logs and 16 borehole logs shows the most common overburden deposits along the route are soft grey/brown sandy/silty clay, gravelly clayey silt with boulders (0.4m) and very silty very sandy gravel with cobbles and boulders (0.4m). Soft grey organic silt, soft white calcareous silt (shell marl) and soft brown/black fibrous peat are less commonly encountered. These deposits are seen to overlie grey limestone bedrock.

1.5 Potential Impacts & Mitigation

The proposed route is designed to rest on bedrock or for the most part be contained within the overburden deposits. This should have no significant impact on the soils or geology underlying the route or in the surrounding area.

As the bedrock underlying most of the route is karstic in nature, this lends a certain degree of unpredictability to the road design. Incorporation of the karstic nature of the bedrock (where necessary) into the road design will allow construction of the route with no significant impact on either the road itself, or any underlying subterranean drainage networks. The potential impacts on the hydrogeology are further discussed in section 2.0.

Removal of soil in the cutting areas (Figure 13) will result in a reduction in protective cover to the underlying aquifer. Mitigation for this is discussed in section 2.0. Removal and compaction of the soil itself will not have any significant effect due to the abundance of such soil type in the area. No soils or bedrock of intrinsic scientific importance are to be effected by this development.

2.0 GROUNDWATER

RECEIVING ENVIRONMENT

2.1 Regional Drainage

This region is drained by the River Fergus, its tributaries and a subterranean network. The limited soil cover combined with the limited amount of storage in the subterranean system results in a hydrological regime that responds quickly to rainfall events. Therefore while flows may be high during wet conditions they can fall off rapidly in dry conditions. Interruption of this drainage pattern can result in flooding in extreme conditions.

The drainage presented in Figures 1 & 2 shows the proposed road realignments running north from Latoon Bridge and paralleling the River Fergus to some 5 kilometres north of Ennis Town. The Ennis By-Pass leaves the N18 route at Skehanagh and passes south and west of the town to link up with the N85 at Claureen. The planned N18 route runs directly across the main east-west drainage pattern and separates the south east corner of the Fergus Catchment from the main channel. As much of this area is devoid of surface drainage features the planned route overlies the subterranean drainage network that drains the corner of the catchment. Similarly, though not as dramatic, the Ennis By-Pass crosses the drainage into the River Fergus around Ennis town with most, though not all of the drainage here being above ground. The rivers and permanent lakes in the area are shown in Fig. 1. The outstanding feature is the Northeast-Southwest trend to drainage. This is due to preferred solution weathering along structural weaknesses in the underlying karst limestones, either along joints or a fracture cleavage. The resulting river catchments and subcatchments show this same Northeast-Southwest elongated shape.

A number of springs, turloughs, sink holes and elongate collapse features are seen in the area. In particular to the east and west of the proposed route around Knockanean, a series of "lakes" appear unconnected on the surface. Based on the direction of flow in the surrounding catchment these are expected to discharge to the west into the River Fergus

or tributary by a system of underground channels. The locations of these subterranean channels are currently undetermined.

To the south of the proposed Ennis Town By-pass a surface stream discharging from Ballybeg Lough (a water supply source) sinks and rises again directly north of the proposed route prior to discharging to the River Fergus. It is expected that drainage to the south of the By-Pass will flow in a southwest-northeast direction mirroring the adjacent Claureen River discharging to the Fergus River.

Ennis Town receives its potable water supply from a karst spring at Drumcliff located immediately north of the town. Pouladower spring further north is another significant potential source of water supply. The relationship of these major springs and the Fergus catchment is not well understood. However, both of these springs are at a distance from the proposed route and flows are not expected to be affected by the proposed development.

Based on the regional drainage catchment, it is clear that any interference with the subterranean flows or addition of pollutants will have direct implications for the quantity and quality of water in the River Fergus and its surface tributaries.

2.1.1 Bedrock & Drainage along the Proposed Route.

Where the proposed profile is contained either above or within the overburden deposits the bedrock plays only a limited role in the structural design of the road improvements. However where the overburden cover is shallow or in particular where bedrock is exposed there is a higher risk of impact on the subterranean drainage system. This is particularly important in the route area underlain by Burren limestones, i.e most of the proposed route apart from the very north of the section (Barefield area). As discussed in section 1.2 Burren limestones are karstic in nature resulting in a subterranean drainage network.

The proposed By-Pass around Ennis town is entirely underlain by Burren Limestones. Figure 6 presents a section along this route (Section A-A'). The overburden was found to

be quite thin along the entire section apart from where drumlins were encountered. Very thin cover or exposed bedrock was evident around Cahircalla More (TP 36 –TP32), to the north of Ballybeg and Edenvale loughs (TP 31 and TP24) and again at the intersection of the routes near Skehanagh (TP 42 – TP 43). The absence of overburden (natural or resulting from excavation for cuts) results in the underlying aquifer being particularly vulnerable to contamination and at risk of development of karstic collapses.

Figure 8 presents a larger scale (1:15,000) drawing of the Ennis area from the Claureen river in the north west to the Ballybeg lough sink near ClareAbbey in the south of the town. The proposed road is also marked on the drawing. Linear depressions identified during field walking are superimposed from aerial photographs of this area. These depressions mirror the flow directions of surface drainage systems i.e southwest to northeast and are likely to indicate karstic collapses. These are indicative of preferential migration paths by subterranean groundwater systems. Also indicated on this drawing is a significant depression between the sink from Ballybeg lough (to the south of the proposed route) and the rise located to the north of the proposed route. Similar linear depressions are seen torun in a south west to north east direction to the west of Ballybeg lough and may indicate subterranean drainage paths from Edenvale Lough to the Fergus River. Deep solution weathering was noted at outcrops along probable jointing planes with this trend (010^0 - 025^0) . This information indicates that a substantial part of the drainage to the south and south west of the By-Pass route may be flowing along preferential underground channels and eventually discharging to the River Fergus.

Figure 7 presents a section along the proposed route from Latoon bridge in the south to Carrowdotia in the north (Section B-B'). Overburden thickness in the trial pits excavated along this route are indicated in Figure 5. Unlike the Ennis Town By-Pass route, most of this route is covered by glacial deposits in the form of undulating drumlins. However bedrock is exposed to the south of Kilbreckan (TP 41 - TP 46) and again to the south and north of the River Gaurus (Ballymacahill to Knockanean TP 54 - TP 56).

Figure 9 presents a larger scale drawing (1:10,560) drawing of the area around Ballymacahill to Knockanean. Again karstic features identified during the field

investigation were mapped by means of aerial photographs. The upper part of the Gaurus river is seen to lie in a karstic depression and probably depicts the joining of an over ground river with a now exposed subterranean river. Depressions to the north and south of this may indicate subterranean drainage/collapse features. In addition drainage from a number of turloughs (such as Tooreen Lough) to the east of the proposed road (see Figure 5) is likely to be through subterranean drainage systems in a similar north east - south west line towards the River Fergus and its tributary, the River Gaurus.

2.2 Wetland Areas

The Special Protection Areas (SPAs), Proposed Special Areas of Protection (pCSPAs) and Proposed National Heritage Areas (pNHAs) located in this area are presented in Figure 12. A brief site synopsis of pNHAs (supplied by Duchas) is included in the Appendix A. Of the pNHAs identified, those where impact need to be considered in terms of any effects by the development on flow quantity or quality are:

The Fergus Estuary (Duchas code 002048);

The Lough Cleggan & Ballyallia Lough (Duchas code 001331 & 000014)

The Newhall & Edenvale Complex (Duchas code 002091)

As groundwater flows from the Newhall and Edenvale complex north easterly to the River Fergus, road run-off is not likely to have an impact. However, potential blockage of the suspected underground channels which would appear to cross directly beneath the proposed route south of Ennis town could have implications on the current water level in these lakes and the discharge to the Fergus Estuary.

The proposed route is not expected to have any direct effect on the Lough Cleggan & Ballyallia Lough. However, the field study indicates that groundwater from the east of the route may discharge by underground channel into these systems. Again blockages of the underground channel network during road building or run-off into these karst conduits could indirectly impact on the water levels and water quality of these lake systems.

As all groundwater in this area drains to the River Fergus and its tributaries, any reduction in flow or impact on groundwater quality could have a effect on the water levels and quality of the water discharging to the Fergus estuary.

2.3 Existing Flood Areas

Monitoring of flood waters in the area is carried out by the OPW and Clare County Council. The OPW monitor river levels on the Fergus at Ballycorey and at Ennis Bridge, above the barrier, and on the Claureen River at Inch Bridge. Clare County Council monitor river levels on the Fergus at Doora Bridge and at the Cappahard landfill. There are also river level gauges at Clarecastle, one above and one below the barrier.

Based on historical photographs and records, aerial photographs and a field survey during the early spring of 1999, the major areas of flooding along the route of the planned by-pass are considered to be:

River Fergus floodplain from Clareabbey to Gaurus
Claureen River floodplain
Wetlands of Killow
Lowland at Ballyduff

Minor local flooding or ponding occurs in lowlands east of Cahircalla More, Clareabbey, Killow, Ballaghboy, Knockaskibbole, Gaurus, Knockanean, Rosslevan, Drumgranagh, Drumquin and Ballymaconna.

Each of these existing flood areas are discussed below with reference to photographs, the location of which are shown on Figure 10. Figure 11 presents the subcatchments of the River Fergus through which the By-pass is proposed.

River Fergus Floodplain from Clareabbey to Gaurus

Both sides of the river Fergus flood from Clarecastle to Doora Bridge, with the most extensive flooding occurring on the east side of the river. The mix of grasslands and marshlands are drained by ditches that drain to the Fergus (Photo 1). The area is very flat and very wide. Severe flooding of the grasslands and marshlands north of the Gaurus

River and south of Doora landfill site in the Newpark to Bunnow area occurs during prolonged wet periods. Drainage in the Doora to Bunnow area is poor (Photos 2–5).

Claureen River Floodplain

In the area north of Keelty extensive flooding occurs on both sides of the river Claureen where the land is flat and wide. Flooding in the Hermitage area has been recorded to an approximate height of 7mOD (County Council complaint). Ponding occurs in wide shallow depressions in grasslands (Photos 6–8). Two small rises just south of Claureen Bridge in the wetlands also contribute to the flooding of the area (Photo 9). Less flooding occurs higher up on the river to the southwest.

Wetlands of Killow

This area of overgrown marshland is drained by deep ditches on either side of the road and by other ditches but still remains very saturated (Photo 10). This area is flat and wide and ultimately drains to the Fergus. The wetland extends north as far as Kilbreckan Lough (Photos 11-12) and as far south as Carrowgar.

Lowland at Ballyduff

The lake in the wide topographic depression at Ballyduff floods extensively, as far northeast as the Ballyallia road (Photo 12). There is no obvious surface drainage from the lake.

East of Cahircalla More

The small stream flowing north-east to Ennis Town is liable to flood its banks during the winter in the area east of Cahircalla More (Photo 14). Flooding is not extensive.

Clareabbey

The stream draining Ballybeg Lough to the west of Clareabbey sinks before a junction of three roads and rises again in marshland on the other side. A linear depression in the ground, probably the surface expression of a subsurface collapse feature, northeast of this junction and before the rise is normally dry but during prolonged rain floods to a shallow

level (Photos 15-16). The peat-marshlands north of Clareabbey flood during prolonged wet periods (Photo 17).

Killow

A small pond of accumulated water in marshland occurs northeast of the crossroads at Killow, to the right of the cottage entrance (Photo 18).

Ballaghboy

Several small ponds occur northeast of the crossraods at Ballaghboy in low-lying marshlands, and one small pond south of the crossroads on the east side of the road.

Knockaskibbole

Shallow ponding occurs in low-lying grasslands and marshlands in Knockaskibbole.

Gaurus

A small pond in a depression in grasslands occurs west of the Gaurus road in the vicinity of the Gaurus river (Photo 19). Ponded water is visible in the marshlands around the Gaurus lake with no obvious drainage (Photos 20-21).

Knockanean

Shallow ponding occurs in grassland north of the sharp bend in the road, close to a private house, north of Knockanean (Photo 22). To the north-east of this, a pond set in a deep topographic depression behind the electricity station floods to larger extent with prolonged rainfall (Photo 23). Flooding of the Gaurus River in the Knockanean area can be extensive (Photo 33).

Rosslevan

The upper reaches of the Gaurus river in Rosslevan flood adjacent lowland grasslands and marshlands. Flooding is patchy and not extensive. Low-lying fields south of Rosslevan are subject to flooding north of the Tulla Road (Photo 34).

Drumgranagh

Local ponding occurs beside the road heading northwest from Ballymacahill to Ballyduff in poorly drained low-lying grasslands and marshlands (Photo 24).

Drumquin

East of Barefield school near the railway tracks large permanent ponds occur in grasslands (Photo 25). A permanent marsh with ponded water occurs just north of the school at the base of the hill (Photo 26).

Ballymaconna

Flooding of low-lying fields and ponding occurs in Ballymaconna on the west side of the road (Photos 27-28), and south of Ballymaconna on either side of the road to Drumquin during wet periods (Photos 29-32).

2.4 Potential Impacts & Mitigation

Consideration of the karstic nature of the bedrock (where necessary) in the road design will allow construction of a route with no significant impact on either the road itself, or any underlying subterranean drainage networks. Numerous routes have been developed in karst areas with no significant impact on the underlying environment.

The proposed route is not considered to have any impact on the Drumcliff or Ballybeg, or Poulduff spring supplies to Ennis Town due to their distance from the proposed development and the drainage direction.

Where the route is underlain directly by bedrock or thin soil cover, this must be taken into account in the road design to ensure that any subterranean drainage paths are not affected in terms of flow or water quality. Equally impacts can arise in karst areas due to surface run off flowing preferentially into weaker (more permeable) karst areas leading to cavity development and ultimately in its worst state, karst collapses. To mitigate against this, road drainage (particularly in areas of thin cover) will be designed to discharge to well

defined surface water bodies. A record of pollution events prior to road construction is given in Table 1.

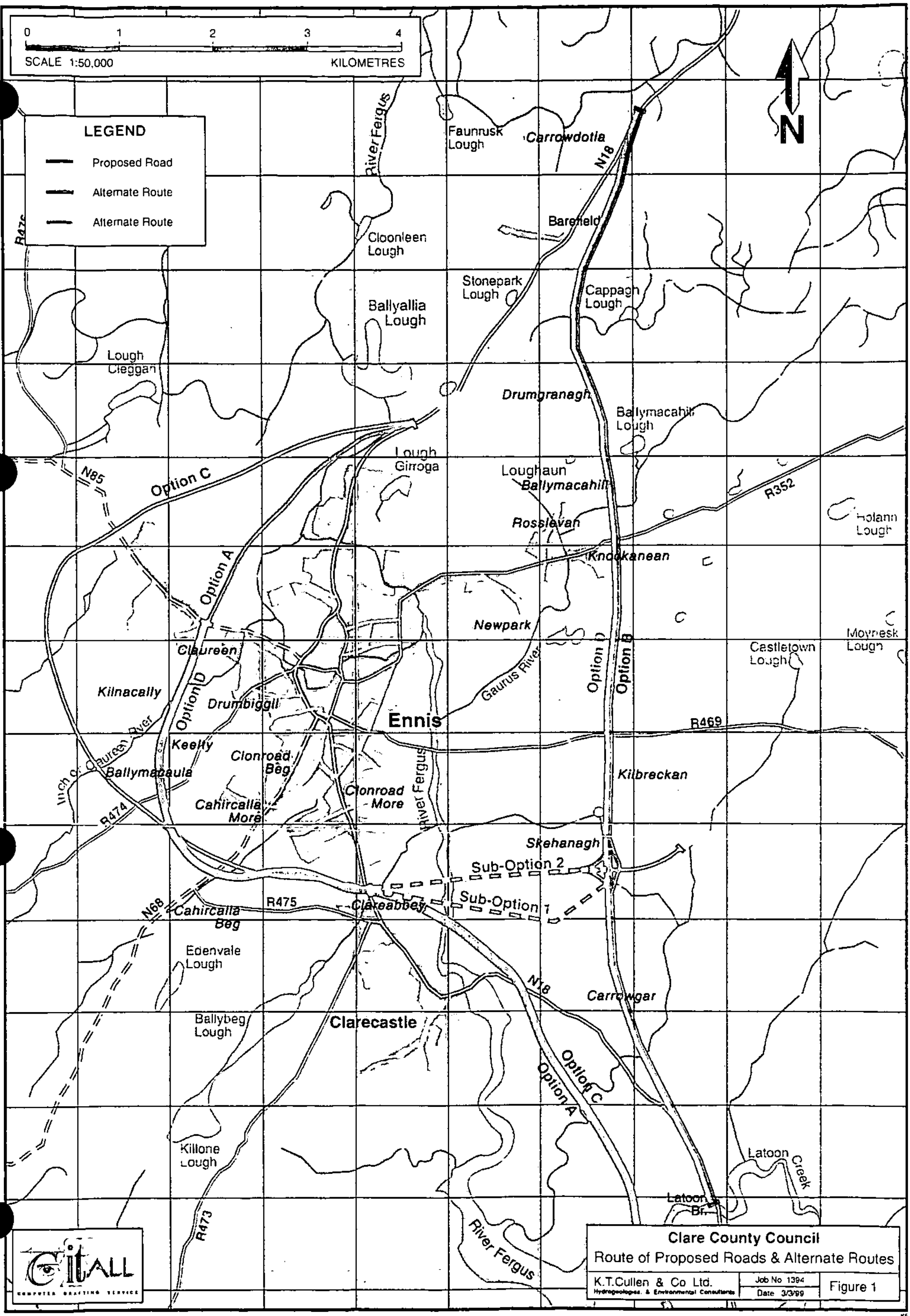
In relation to subterranean flow, a number of possible preferential pathways beneath the proposed route way have been identified. These are located where bedrock outcrops; south and south west of Ennis town; (i) to the north of Ballybeg and Edenvale loughs, and; (ii) at Cahircalla draining to Cahircalla Lough and, on the northern route north of Knockanean, near the intersection of the R352. Prior to construction, further geophysical and/or subsurface investigations will be undertaken to identify underground conduits and thereby minimise disruption to the subsurface discharges. When underground channels are identified adequate features should be incorporated into the design to avoid blocking the subsurface flow during road construction and to cover for possible longterm changes in the subterranean flow regime. To avoid increased karstification resulting in road failure or deterioration in groundwater quality, discharge of surface runoff away from these areas to adjacent surface water bodies is to be incorporated into the road design.

Removal of overburden deposits in cut areas will result in an increase in vulnerability of the underlying aquifer. This will be mitigated against by incorporating enclosed drainage in these areas discharging to well defined surface water bodies. Shallow wells abstracting groundwater adjacent to proposed cuttings could be impacted in terms of quality and/or yield. Enclosed drainage as outlined above will minimise any significant impact in terms of quality. As excavations for the cutting will not extend to the water table in the bedrock there is only potential for impacting on yields of shallow overburden wells within 200 metres (maximum) of the route. According to the GSI database most private wells are installed into bedrock and therefore should not experience any significant effect. Monitoring of water levels in any wells within 200 metres of the cuttings will be undertaken prior to construction works. Where wells are proven to be adversely impacted they will be deepened to allow abstraction from the bedrock aquifer. No County Council groundwater supply schemes will be effected by this development.

As blockages of any subterranean karst channels will be mitigated agains during road construction, the road design is not expected to add to the flooding which currently occurs

along the proposed routeway (Figure 10). Road run–off will discharge to well defined surface water bodies (see surface water section Volume IIID) and the peak discharges will ~~be mitigated by buffering lagoons where~~ appropriate.

APPENDIX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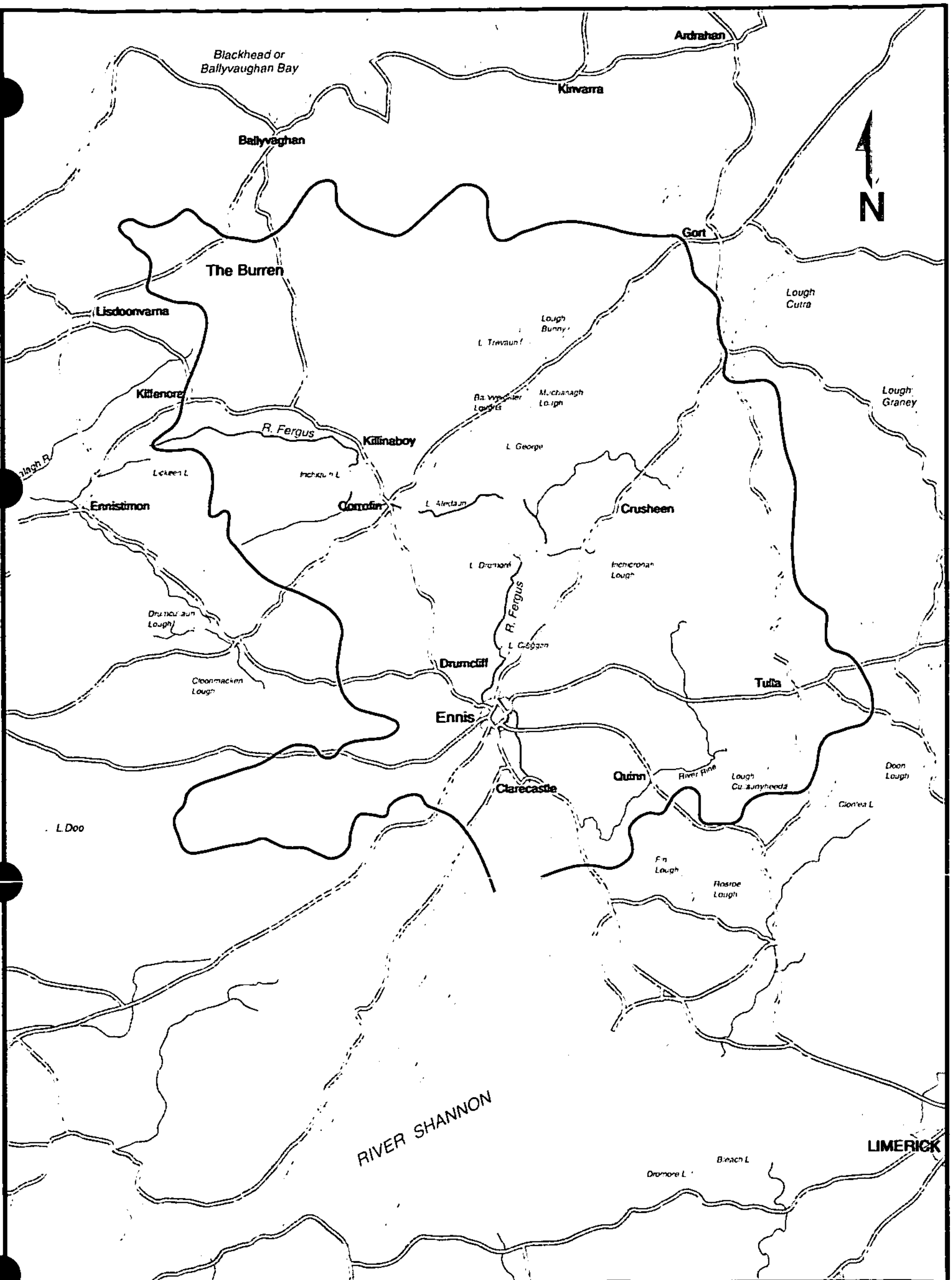
KILOMETRES
N
LEGEND
Proposed Road
Alternate Route
Alternate Route
Faunrusk Lough
Carrowdotia
N18
River Fergus
Barefield
Cloonleen Lough
Stonepark Lough
Cappagh Lough
Ballyallia Lough
Lough Cleggan
Drumgranagh
Ballymacahill Lough
Lough Girroga
Loughaun
Ballymacahill
N85
Option C
R352
Holann Lough
Rossievan
Knockanean
Option A
Newpark
Moyriesk Lough
Castletown Lough
Claureen
Option D
Option B
Kilnacally
Drumbiggil
Gaurus River
Ennis
R469
Keelty
Inch or Claureen River
Clonroad Beg
Ballymacaula
Kilbreckan
Clonroad More
R474
Cahircalla More
Skehanagh
Sub-Option 2
Sub-Option 1
N68
Cahircalla Beg
R475
Clareabbey
Edenvale Lough
N18
Carrowgar
Ballybeg Lough
Clarecastle
Option C
Option A
Killone Lough
Latoon Creek
Latoon Br.
R473
River Fergus
Clare County Council
Route of Proposed Roads & Alternate Routes
K.T.Cullen & Co Ltd.
Hydrogeologists & Environmental Consultants
Job No 1394
Date 3/3/99
Figure 1
CitALL
COMPUTER DRAFTING SERVICE



Clare County Council

River Fergus/River Rhine Catchment Area

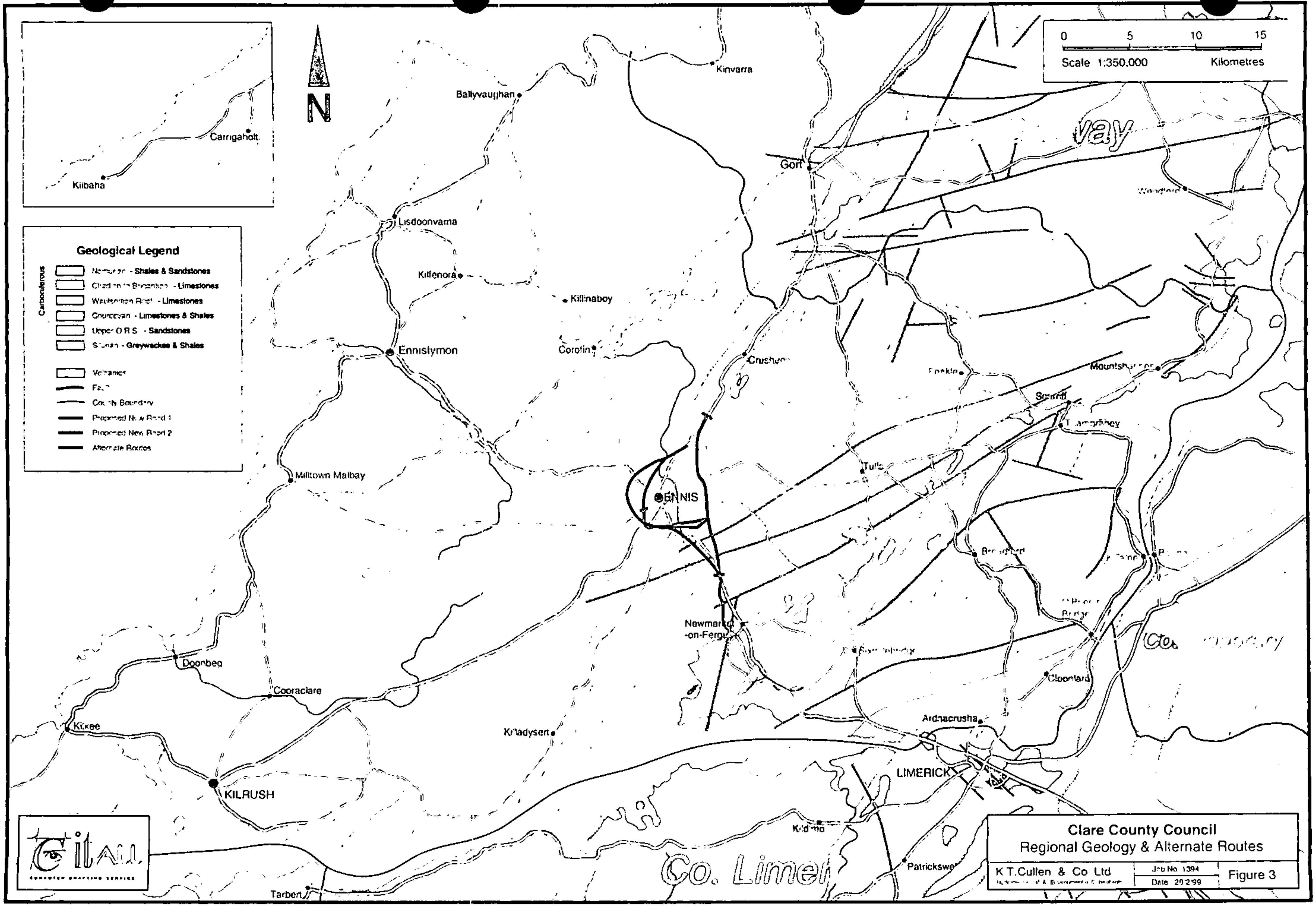
K.T Cullen & Co Ltd.

Hydrogeological & Environmental Consultants

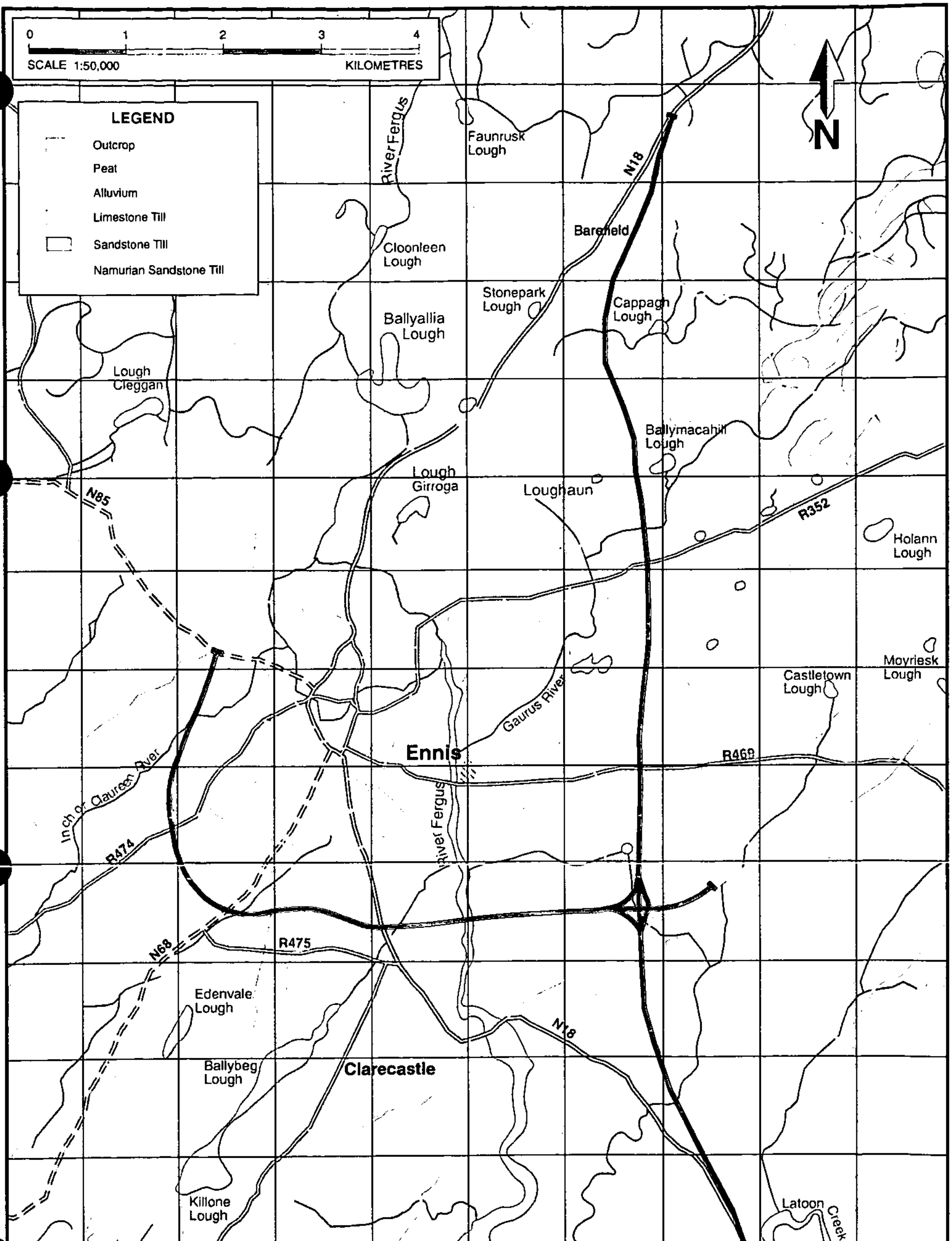
Job No. 1280

Date 20/7/99

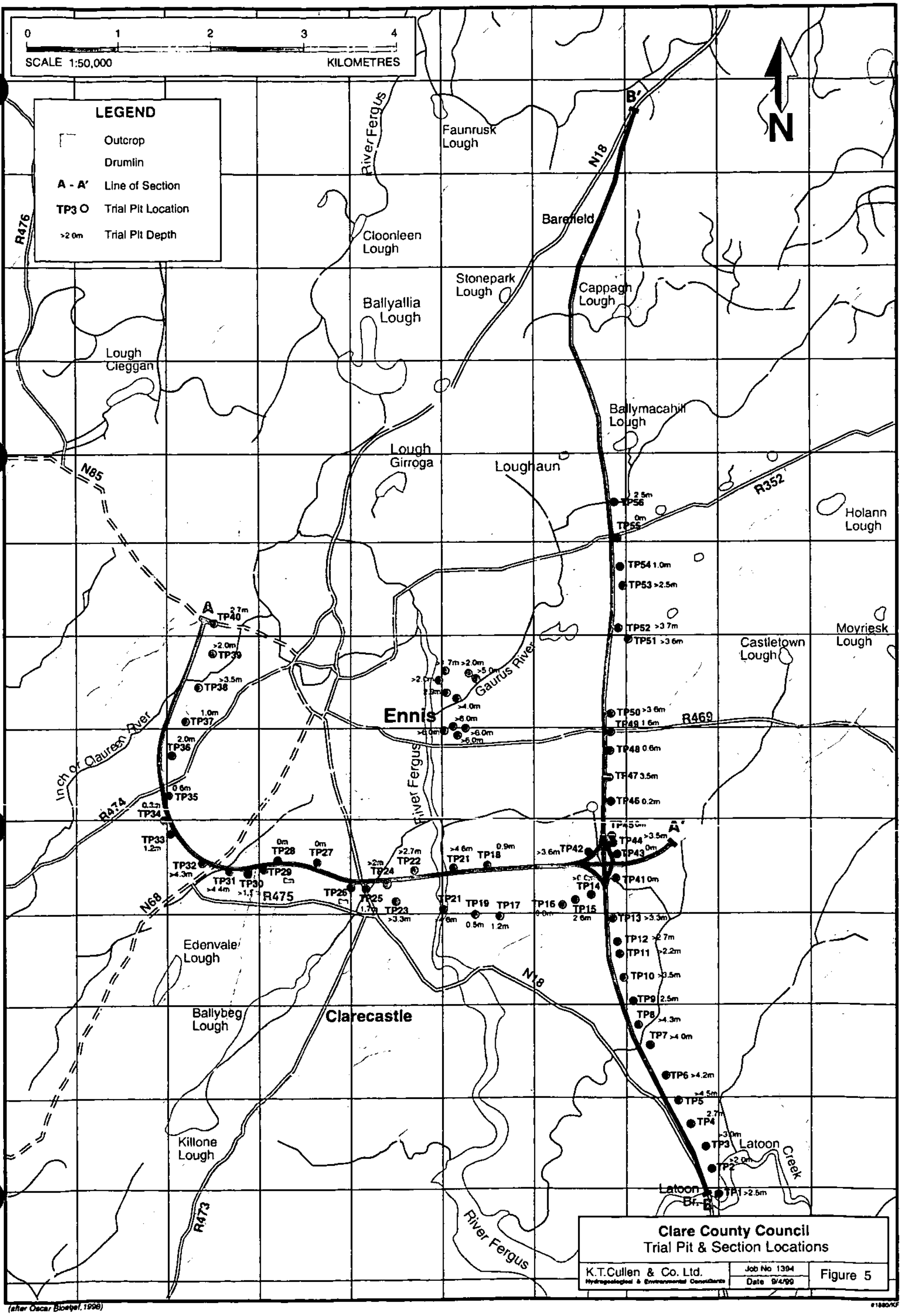
Figure 2



Scale 1:350,000
0 5 10 15
Kilometres
N
Carrigaholt
Kilbaha
Geological Legend
Carboniferous
Shales & Sandstones
Limestones
Limestones
Limestones & Shales
Sandstones
Greywackes & Shales
Kinvarra
Ballyvaughan
Gort
Lisdoonvarna
Kilfenora
Killinaboy
Ennistymon
Corofin
Crusheen
Milltown Malbay
ENNIS
Tulla
Mountshannon
Scariff
Newmarket -on-Fergus
Doonbeg
Cooraclare
Kilkee
Kiladysert
KILRUSH
Ardnacrusha
Cloonlara
LIMERICK
Tarbert
Patrickswell
Co. Limer
Co.
Clare County Council
Regional Geology & Alternate Routes
K.T.Cullen & Co Ltd
Job No 1394
Date 20.2.99
Figure 3



Clare County Council
Overburden *(after Oscar Bloetjef, 1998)*
K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants
Job No 1394
Date 9/4/99
Figure 4



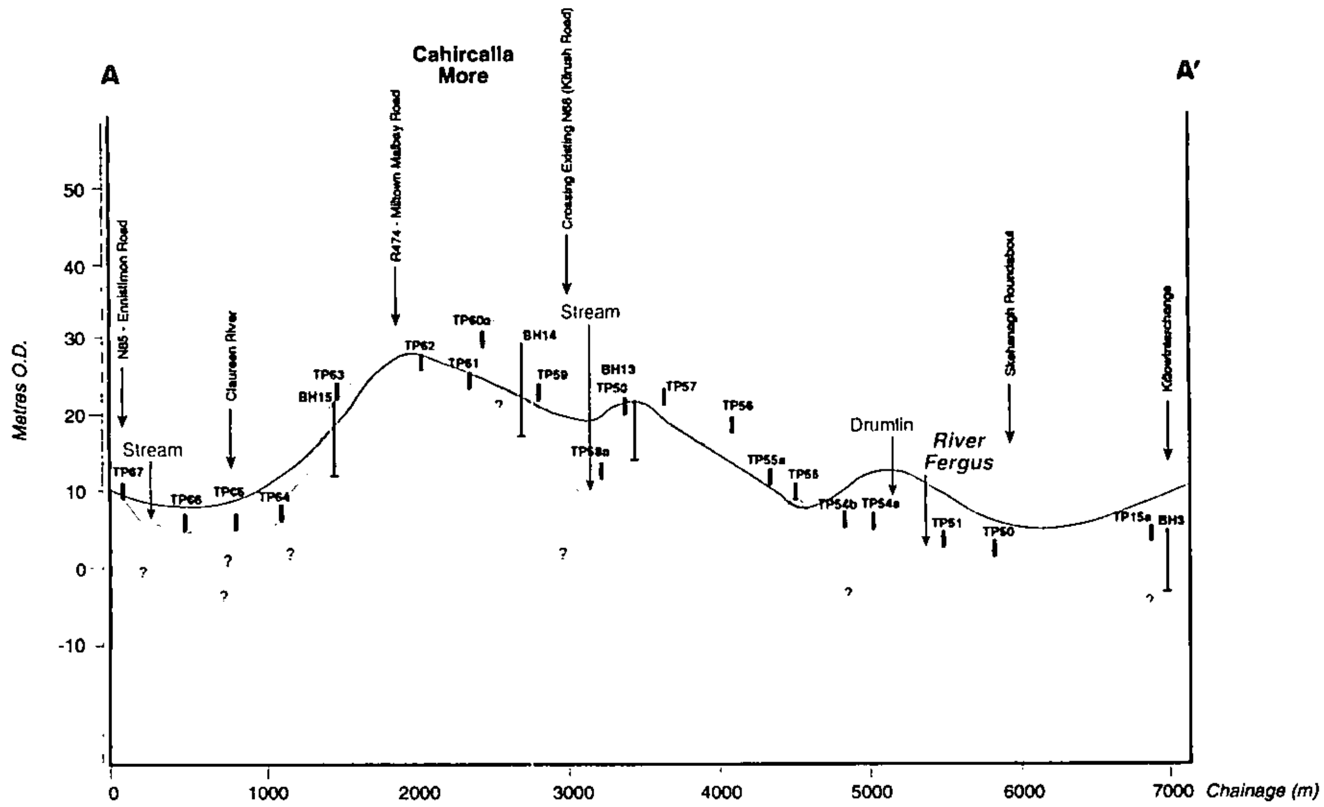
Clare County Council
Trial Pit & Section Locations

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

Job No 1394
Date 9/4/99

Figure 5

(after Oscar Bloetjel, 1998)



LEGEND

TP36	Trial Pit Location
BH13	Borehole Location
——	Proposed Road Elevation
	Till with Peat
	Alluvium
	Limestone Till
	Karst Limestone Bedrock

Vertical Scale Exaggerated 1/1000
Horizontal Sacle 1/50000

Citall
COMPUTER DRAFTING SERVICE

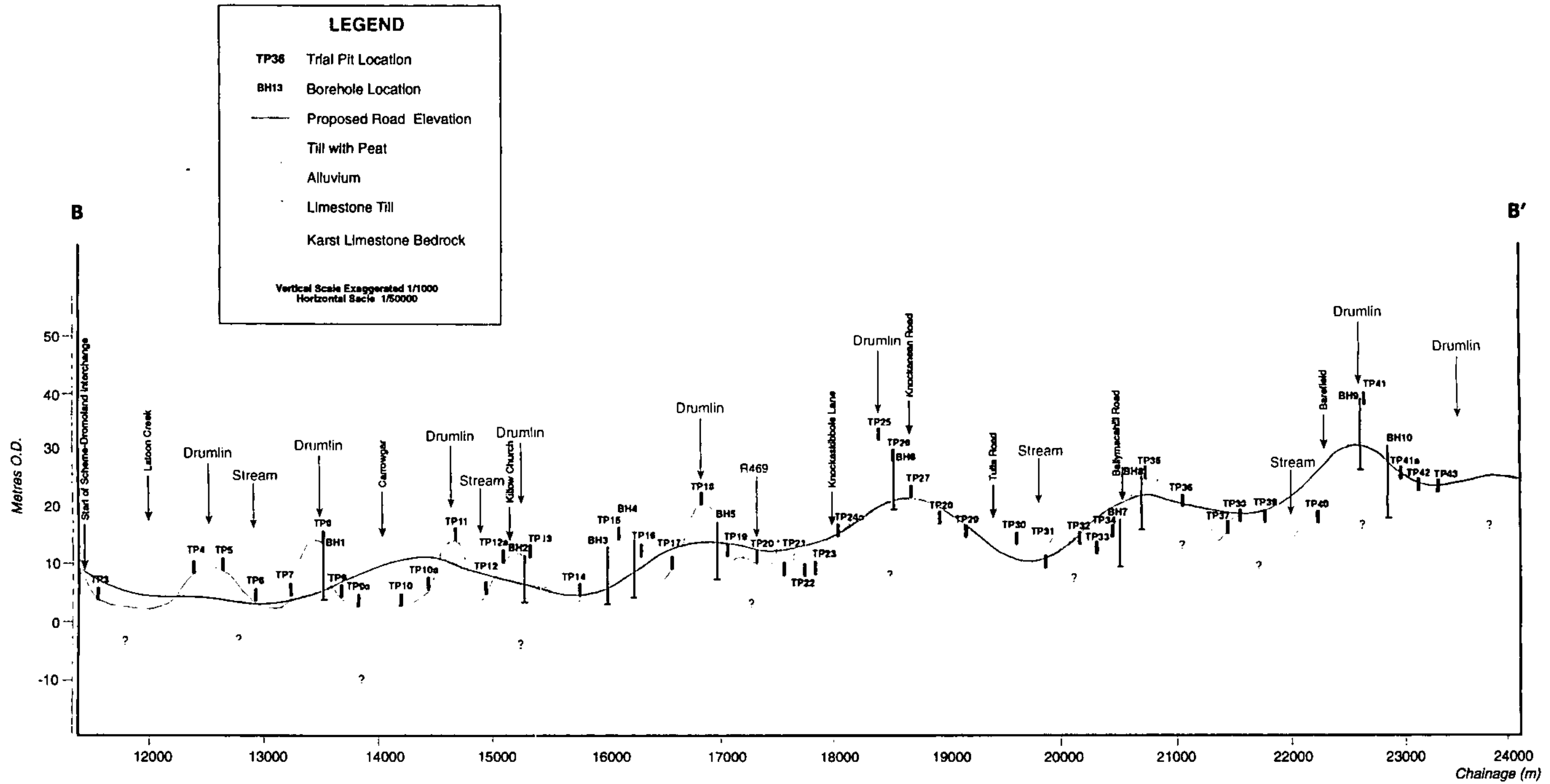
Clare County Council
Cross Section A - A'

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

Job No 1394
Date . 11/10/99

Figure 6

KF



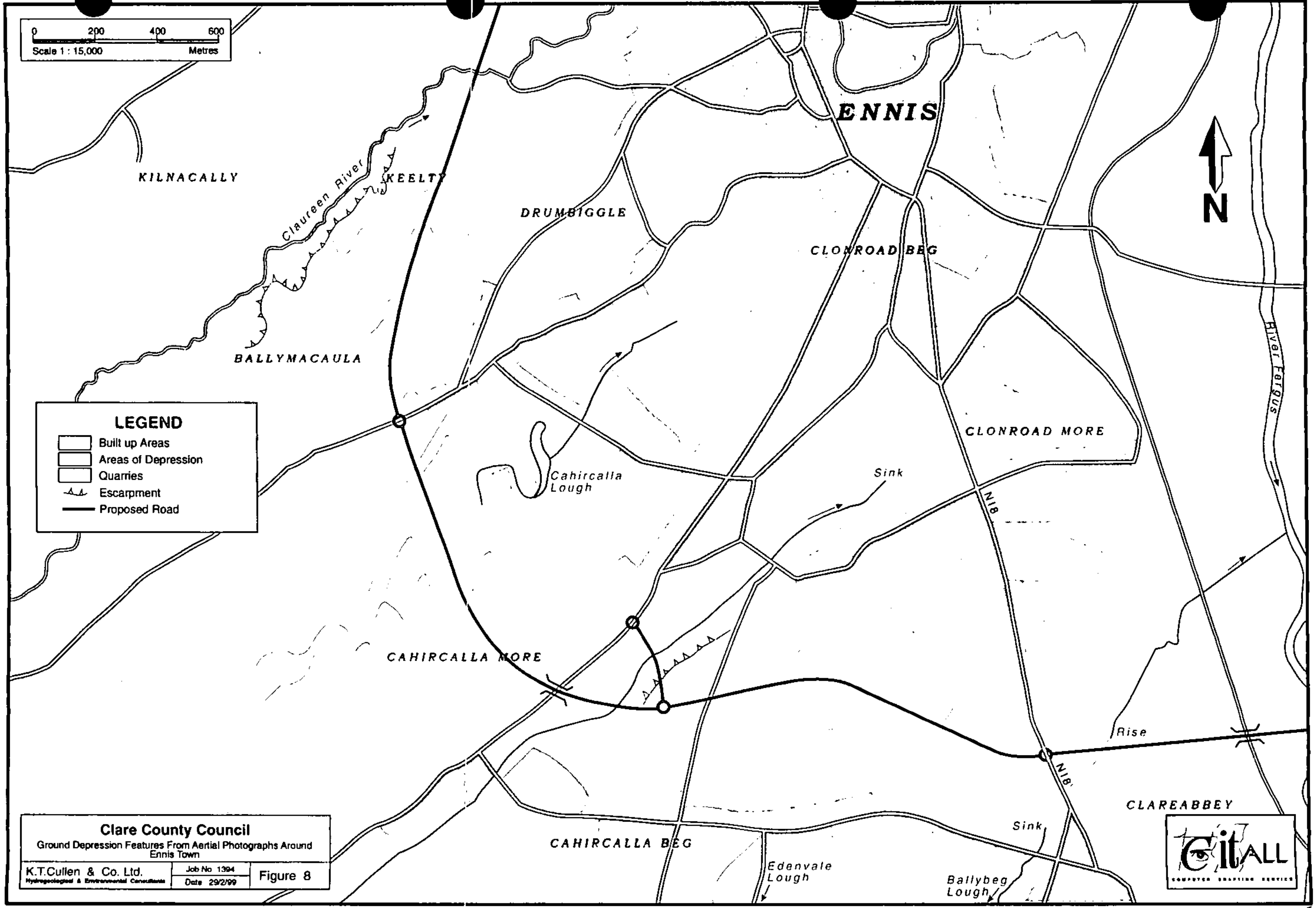
Clare County Council
Cross Section B - B'

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

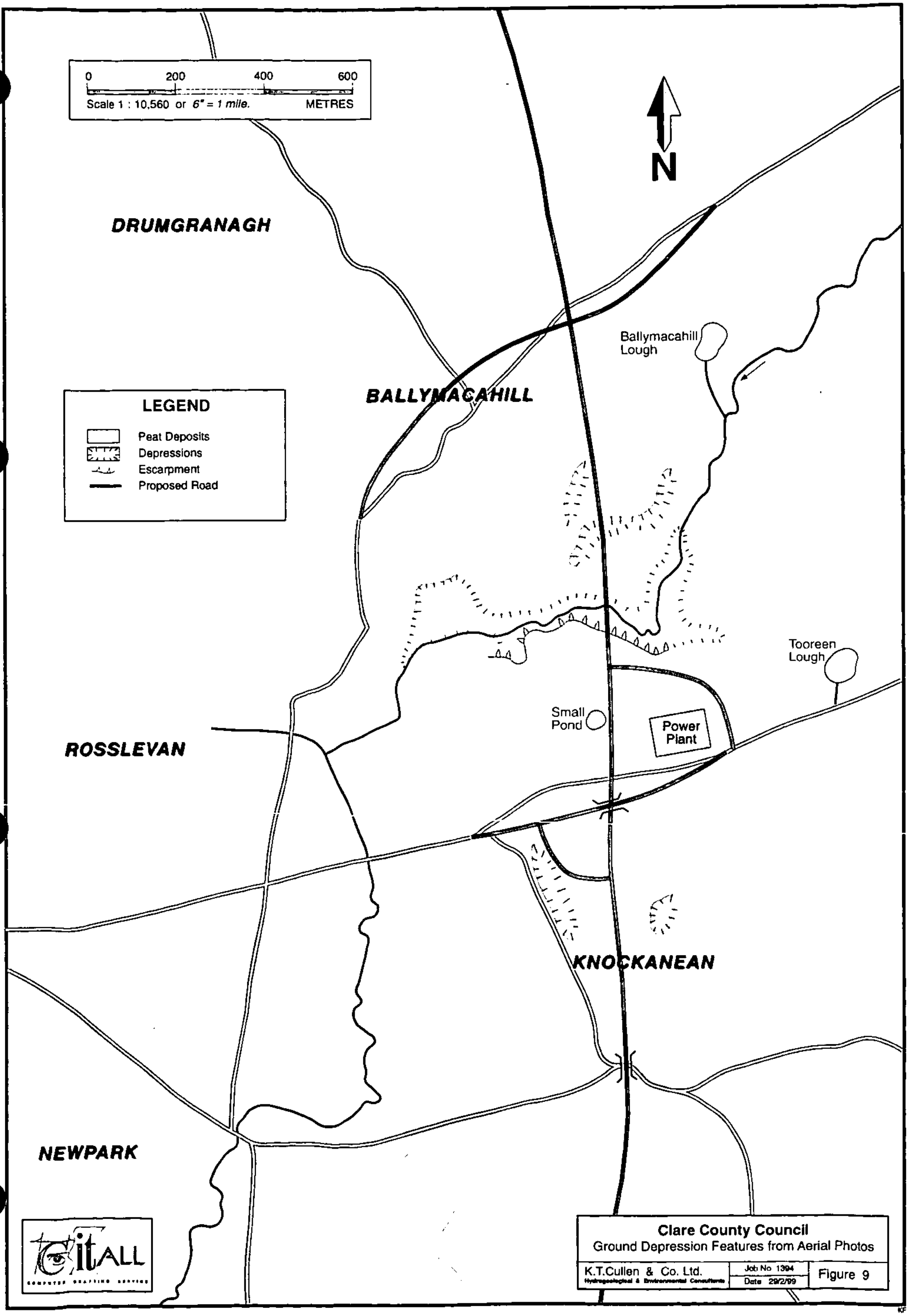
Job No. 1394
Date 11/10/99

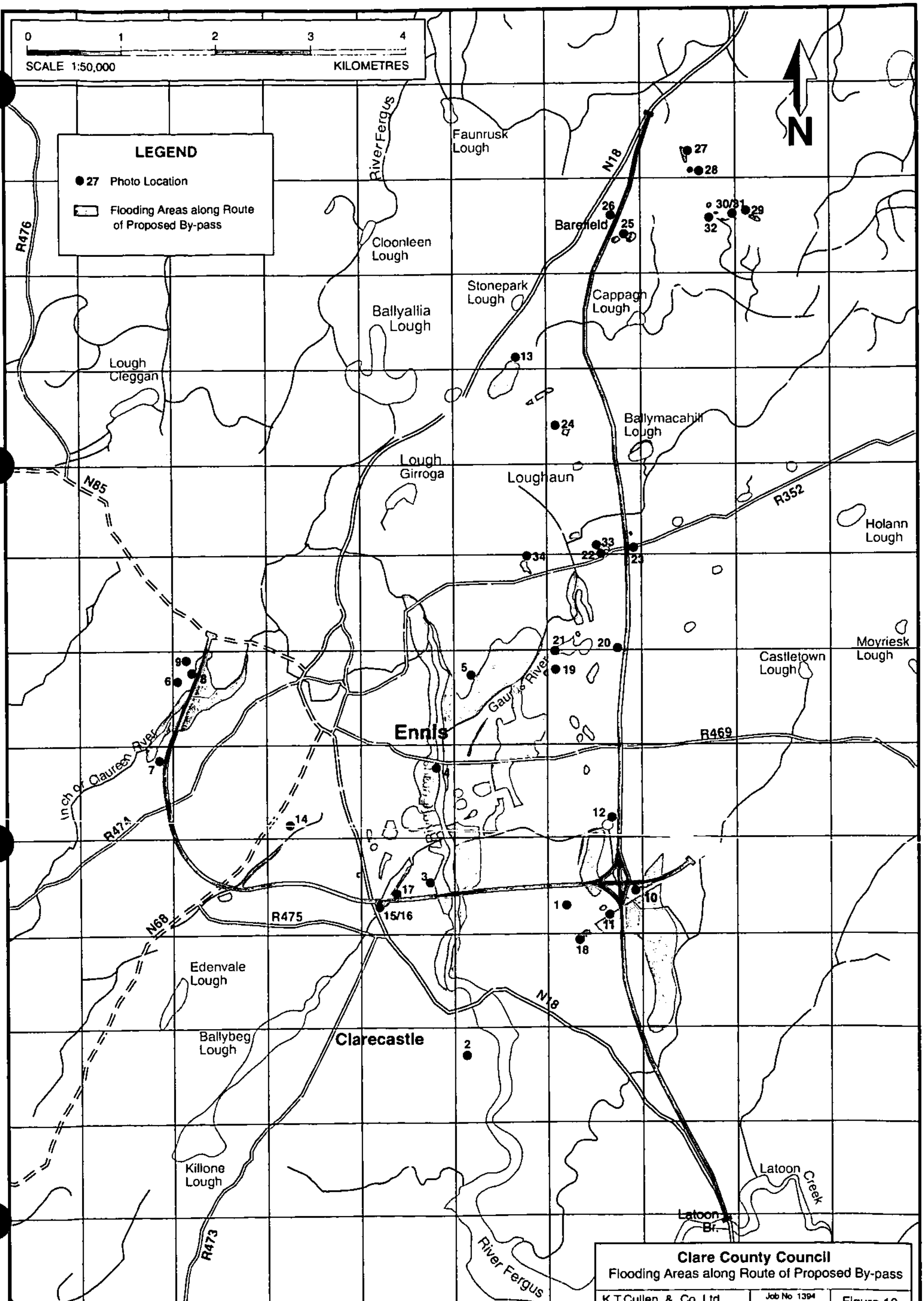
Figure 7

KF



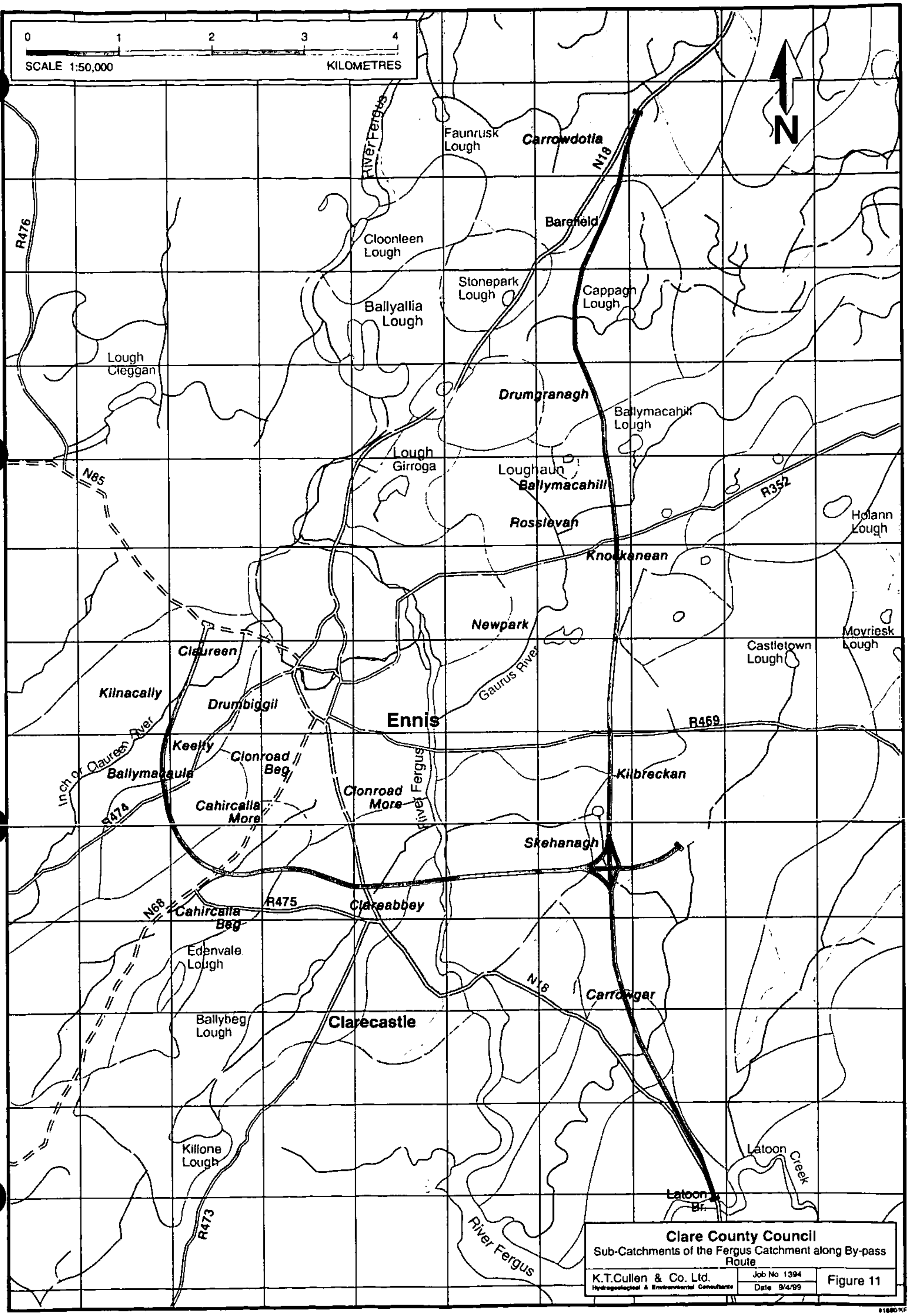
Clare County Council
Ground Depression Features From Aerial Photographs Around Ennis Town
K.T.Cullen & Co. Ltd. Hydrogeological & Environmental Consultants | Job No 1394 | Date 29/2/99 | Figure 8


0
200
400
600
Scale 1 : 10,560 or 6" = 1 mile.
METRES
N
DRUMGRANAGH
BALLYMACAHILL
Ballymacahill Lough
LEGEND
Peat Deposits
Depressions
Escarpment
Proposed Road
Tooreen Lough
Small Pond
Power Plant
ROSSLEVAN
KNOCKANEAN
NEWPARK
itALL
Clare County Council
Ground Depression Features from Aerial Photos
K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants
Job No 1394
Date 29/2/99
Figure 9



Clare County Council
Flooding Areas along Route of Proposed By-pass

K.T.Cullen & Co. Ltd. Hydrogeological & Environmental Consultants | Job No 1394 | Date 9/4/99 | Figure 10



Clare County Council

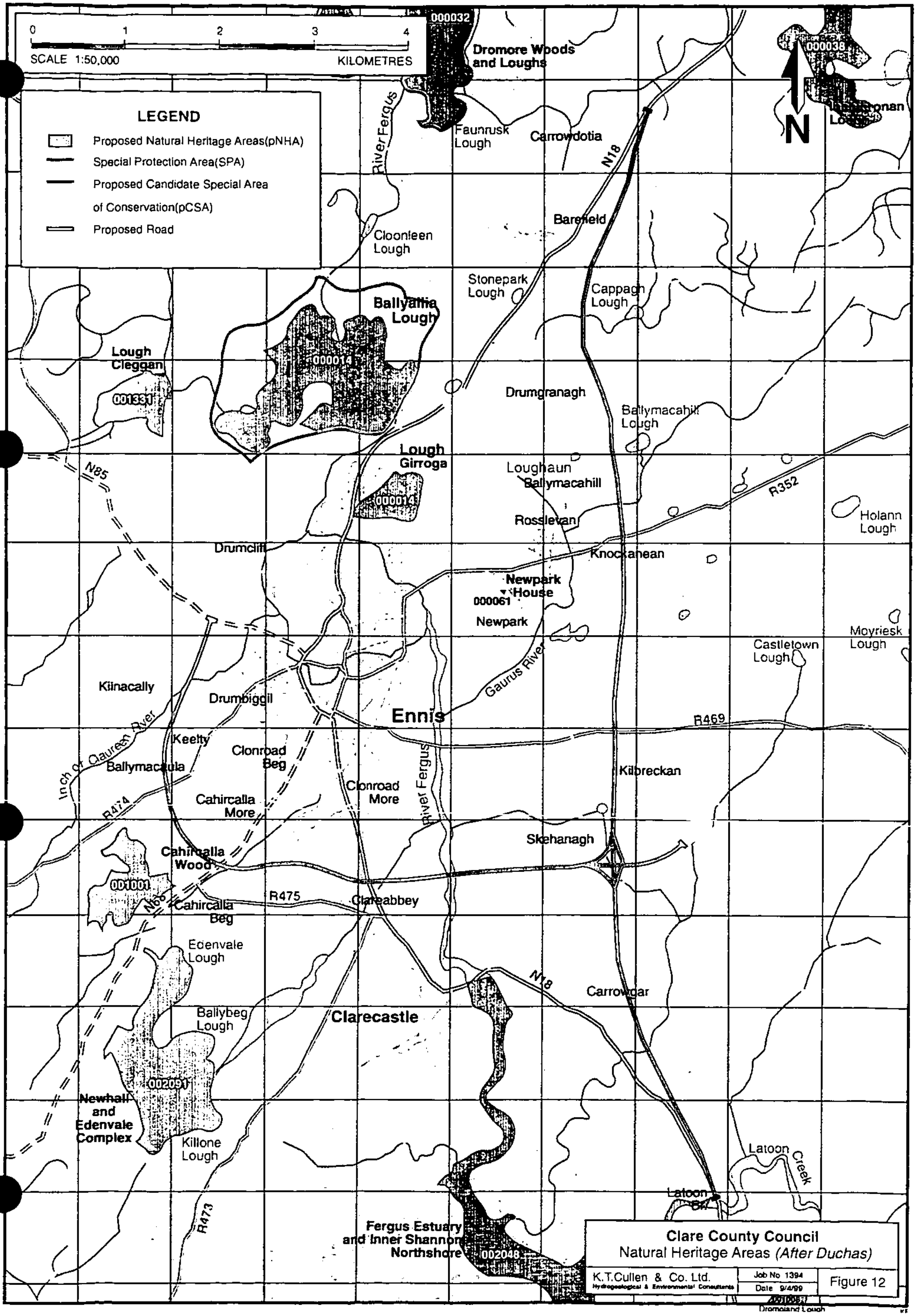
Sub-Catchments of the Fergus Catchment along By-pass Route

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

Job No 1394

Date 9/4/99

Figure 11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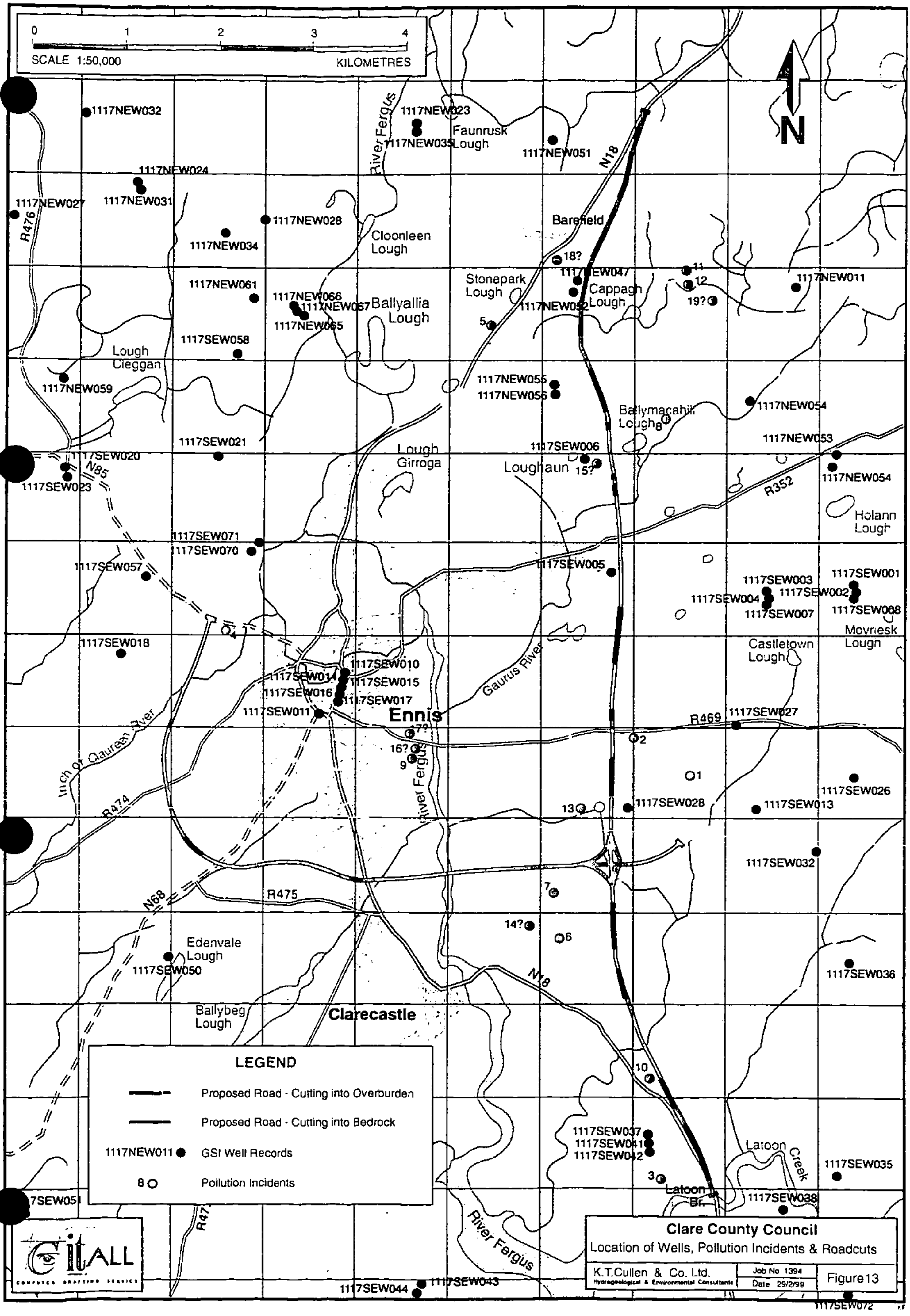
SCALE 1:50,000
KILOMETRES
LEGEND
Proposed Natural Heritage Areas(pNHA)
Special Protection Area(SPA)
Proposed Candidate Special Area of Conservation(pCSA)
Proposed Road
N
000032
Dromore Woods and Loughs
000038
Faunrusk Lough
Carrowdotia
River Fergus
N18
Barefield
Cloonleen Lough
Stonepark Lough
Cappagh Lough
Ballyallia Lough
000014
Lough Cleggan
001331
Drumgranagh
Ballymacahill Lough
Lough Girroga
000014
Loughaun
Ballymacahill
R352
Holann Lough
N85
Rosslevan
Drumcliff
Knockanean
Newpark House
000061
Newpark
Castletown Lough
Moyriesk Lough
Kilnacally
Drumbiggil
Gaurus River
Ennis
R469
Inch of Claureen River
Keelty
Clonroad Beg
Ballymacaula
Kilbreckan
Cahircalla More
Clonroad More
River Fergus
R474
Skehanagh
Cahircalla Wood
001001
R475
Clareabbey
Cahircalla Beg
Edenvale Lough
N18
Carrowgar
Ballybeg Lough
Clarecastle
002091
Newhall and Edenvale Complex
Killone Lough
Latoon
Creek
Latoon Br.
R473
Fergus Estuary and Inner Shannon Northshore
002048
Clare County Council
Natural Heritage Areas *(After Duchas)*
K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants
Job No 1394
Date 9/4/99
Figure 12
Dromoland Lough



0 1 2 3 4
SCALE 1:50,000
KILOMETRES
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LEGEND
Proposed Road - Cutting into Overburden
Proposed Road - Cutting into Bedrock
1117NEW011 GSI Well Records
8 Pollution Incidents
Clare County Council
Location of Wells, Pollution Incidents & Roadcuts
K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants
Job No 1394
Date 29/2/99
Figure13
Ennis
Clarecastle
Barefield
River Fergus
Gaurus River
Inch or Clauren River
Faunrusk Lough
Cloonleen Lough
Ballyallia Lough
Stonepark Lough
Cappagh Lough
Lough Cleggan
Lough Girroga
Loughaun
Ballymacahill Lough
Holann Lough
Moyriesk Lough
Castletown Lough
Edenvale Lough
Ballybeg Lough
Latoon Creek
Latoon Br.
N18
N85
N68
R476
R352
R469
R474
R475
1117NEW032
1117NEW023
1117NEW035
1117NEW051
1117NEW024
1117NEW031
1117NEW027
1117NEW028
1117NEW034
1117NEW061
1117NEW066
1117NEW067
1117NEW065
1117NEW047
1117NEW052
1117NEW011
1117NEW059
1117NEW055
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1117SEW058
1117SEW020
1117SEW023
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1117SEW013
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1117SEW050
1117SEW036
1117SEW037
1117SEW041
1117SEW042
1117SEW035
1117SEW038
1117SEW044
1117SEW043
1117SEW072

Table 1: Complaints of Pollution of Private Wells and Boreholes (Clare County Council)

Map No.*	Name & Address	Nature of Pollution Complaint	Name of Complainant	Year
1	John Lynch, Doora	Control of farm effluent	Mary Burns, Kilbricken, Doora	1989, 1992-1994
2	Michael O'Connell, Knocklogan, Doora	Farm effluent and landspreading slurry	Fintan Quinn, Ballaghboy, Doora	1994 & 1998
3	Dan Killeen, 134 Cahercalla Est., Ennis	Control of farm effluent at Manusmore, Clarecastle	Bridget Hickey, Latoon	1994
4	Michael Howard, Claureen, Ennis	Control of farm effluent		1995
5	P.J. Purcell, Barefield	Waste water from car washing	Cllr. P.J. Kelly	1996
6	Mr. Mulhearn, Knocknamana, Clarecastle	Septic tank waste	Michael Slattery, Knocknamana, Clarecastle	1996
7	Andrew Maloney, Killow, Clarecastle	Burning of refuse and plastic	Jack Mc Carthy, Killow, Clarecastle	1996
8	Christy Roughan, Ballymacahill, Ennis	Control of farm effluent	Paddy Cloon, Ballymacahill, Ennis	1997
9	SFADCo Industrial Est., Doora	Query of river water quality	Ennis & District Angler's Association	1997
10	Patrick McInerney, Manus Hse., Clarecastle	Foul odour from slatted units	Gerard Mc Carthy, Glenard Hse., Clarecastle	1998
11	Martin Doolaghty, Cappagh Beg, Barefield	Control of farm effluent	Mr. & Mrs. K. Cahir, Cappagh Beg, Barefield	1997 & 1998
12	John Carolan, Muckinish, Spancelhill	Control of farm effluent	Mr. & Mrs. K. Cahir, Cappagh Beg, Barefield	1997
13	Oliver Plunkett	Control of farm effluent	John Keane, Kilbricken, Doora	1993 & 1998
14**	J.J. McCabe, Skehana House, Clarecastle	Illegal dumping of paint barrels		1984
15**	Mrs. McInerney, Ballymacahill, Ennis	Private well		1986
16**	Joe Queally, Doora	Private well		1987
17**	Thomas Frawley, Doora	Private well		1988
18**	Bill Halloran, Barefield	Private well		1990
19**	Tom Casey, Cappa Beg, Barefield	Private well		1994

* See Fig. 13

** No locations identified by Clare Co.Co.

SITE SYNOPSIS

SITE NAME: INCHICRONAN LOUGH

SITE CODE: 000038

Inchicronan Lough is a medium sized lake situated approximately 2km south of Crusheen. Fringing reedbeds of Phragmites australis (Common reed), Club rush (Scirpus lacustris) and Red Canary Grass (Phalaris arundinaceae) surround much of the lake verge. There are a number of small scrubby islands located around the western side of lake. Inchicronan Island which lies through the centre of the lake is inhabitated and is mainly in use as pastue, although some wooded pockets still remain. A variety of habitats are found around the lake including an area of cut-over bog to the north, Ash and Hazel woodland along the eastern shore and a complex mosaic of wet grassland dense scrub and marsh at the southern end. The western side is partially bounded by the Limerick-Sligo railway line (still in use as a cargo line), providing an added habitat of significant interest.

Inchicronan Lough has interesting aquatic and terrestrial lant communities and its station for Malitrum (rue-meadow) forms the western limit of this species in Ireland. Although disturbance from attempts at agricultural improvement have taken place around all sides of the lake. There is still a good degree of naturalness reflected in the remaining habitats. The lake is of local arnithological interest. During the survey a flock of 30 wild swans, some duck and Cormorants were seen. The whole area is of high scenic value.

SITE SYNOPSIS

SITE NAME: BALLYALLIA LAKE

SITE CODE: 000014

Ballyallia Lake is a relatively small shallow lake situated on the River Fergus approximately 4km N of Ennis Town. This is a base rich lake with relatively clear water. The lake is set amongst heavily farmed land to the north and south, with a low-lying flood plain of wet grassland and rough grazing to the west.

There are very few emergent plants, with some patches of Club Rush (Scirpus lacustris) and Common Reed (Phragmites australis). Habitat and species diversity around the lake is low. L. Girroga, about 1km to the South of Ballyallia is included in the site. It is a small lake with high habitat and species diversity. There is a well developed reed fringe with a fen like community of Saw Sedge (Cladium mariscus), Club Rush (Scirpus lacustris), Purple Moor-Grass (Molinia caerulea) and the less common Black Bog Rush (Schoenus nigricans). A well established hazel woodland slopes down to the northern lakeshore.

Waterfowl numbers on Ballyallia Lake and the flood plain to the west are high, with internationally important numbers of Shoveler and possibly as high for Teal and Wigeon. It is nationally important for Gadwall and holds significant numbers of Tufted Duck, Coot, Lapwing and Curlew.

Ballyallia Lake is being managed as a Wildfowl Sanctuary that has been established for over 20 years. Unfortunately, due to much agricultural improvement the adjacent land to the north and south of the lake is intensively managed and being situated on sloping ground leading to the southern lake edge poses a serious threat to the water quality of the system.

13 February, 1995.

SITE SYNOPSIS

SITE NAME: LOUGH CLEGGAN

SITE CODE: 001331

Lough Cleggan is a small freshwater lake situated east of the larger Ballyallia Lake. The Poulacorry River connects the two lakes. The lake has a substantial reed fringe of Phragmites australis, which merges with stands of Carex rostrata and Yellow Iris (Iris pseudacorus) in places. A good stand of woodland with Hazel (Corylus avellana), Willow (Salix spp.) and Ash (Fraxinus excelsior) occurs in the south west of site. A mosaic of wet grassland and freshwater marsh occurs in places around the lake. Here typical species include rushes (Juncus spp.), sedges (Carex spp.), Marsh Marigold (Caltha palustris) and Meadowsweet (Filipendula ulmaria).

The lake is of local importance for wintering wildfowl, although recent counts are not available. Breeding bird species include Tufted Duck and Coot.

The lake is used widely for fishing and hunting, which probably cause disturbance. There has been some agricultural improvement resulting in loss of scrub and woodland. The lake is likely to be suffering from slight eutrophication from agricultural activities.

The main interest of this site is that it has a good diversity of habitats and plant species. It is also of at least local importance for wintering wildfowl and probably should be considered as part of the Ballyallia complex. The site provides habitat for some breeding species. Further monitoring of bird populations is required.

SITE SYNOPSIS

SITE NAME: NEWPARK HOUSE (ENNIS)

SITE CODE: 000061

This site consists of a nursery site of the lesser horseshoe bat (Rhinolophus hipposideros), 66 bats were recorded here in 1985. The bats roost in an outbuilding in the grounds of Newpark House, which is currently operating as a guest house.

Although there has been no recent observation of bats at this site, it should be considered a site of national importance. The owners are aware of the bats and have no objections to them. The house is surrounded by mature trees that provide important foraging habitats for the bats.

11th July, 1995.

SITE SYNOPSIS

SITE NAME: CAHIRCALLA WOOD

SITE CODE: 001001

This wood is situated about 2 km S.W. of Ennis and is a fine example of woodland over limestone. The main canopy species is Ash (Fraxinus excelsior), with some Sycamore (Acer pseudoplatanus) and Beech (Fagus sylvatica). The understorey is mixed with Hazel (Corylus avellena), Hawthorn (Crataegus monoygna), Blackthorn (Prunus spinosa) and occasional Holly (Ilex aquifolium) and Rowan (Sorbus aucuparia).

There is a rich herb flora with typical woodland plants such as Wood Avens (Geum urbanum), Bluebells (Endymion non-scripta), Lords and Ladies (Arum maculatum), Early Purple Orchid (Orchis mascula) and Golden Saxifrage (Chrysosplenium oppositifolium). Ferns are found in places, with Dryopteris spp. and Hart's Tongue Fern (Phyllitis scolopendrium). The shaded areas allow luxuriant moss growth. An area of scrub occurs in the north west of the site.

Habitat diversity is increased by a small area of wet woodland dominated by Willow (Salix spp.). Further diversity is created by the presence of shattered limestone pavement in the northern sector, with species such as Sesleria albicans, Devil-bits scabious (Succisia pratensis) and Rue-leaved saxifrage (Saxifraga tridactylites).

A good range of woodland bird species occurs, including Sparrowhawk, Treecreeper, tits and finches. Grey heron, Snipe and Stonechat were also observed. Fox and Badger are present.

The main interest of this site is that it is a fine example of a relatively intact mostly native woodland. Habitat diversity is provided by the presence of scrub, wet woodland and limestone pavement.

13 February, 1995

SITE SYNOPSIS

SITE NAME: FERGUS ESTUARY AND INNER SHANNON, NORTH SHORE

SITE CODE: 002048

This is a very large estuarine complex consisting of the River Fergus estuary from where it becomes tidal at Clarecastle Co. Clare, to where it meets the Shannon Estuary and sweeps inland in an easterly direction as far as Limerick City. This is an extensive area of intertidal mudflats with fringing reedbeds, swamps, salt marsh and wet marsh habitats. The mudflats are generally unvegetated with a few patches of cord grass (Sparting sp) in places. Dense Stands of fringing Common Reed (Phragmites australis) are common throughout both estuaries becoming more noticable in the Shannon and in some of the more sheltered creeks of both systems. Species rich salt marsh habitat some of which are large and undisturbed are present throughout both estuaries.

The site is of international importance for wintering and migrating wildfowl. Such extensive areas of mudlfats are uncommon in Ireland and Europe. The area provides a rich source of nutrients for huge numbers of waters and wildfowl. The number of birds it supports are greater than any other site and it seems to act as a refuge from the south-Clare lakes during the autumn and winter when fishermen or wildfowlers are a disturbing factor.

Along with the ornithological interest, the site is of high botanical value with recent records of the very rare rush, the Triangular Clubrush (Scirpus triqueter) along the Shannon Estuary. Other less common species include a specialised species of salt marsh grass (Fuccinellia sp) for which the Fergus Estuary is part headquarters. The most immediate threat to the site is from industrial pollution and any propsosed development or reclaimation plans in theory. Close monitoring of waste disposal activities are a must along with strict planning controls, if the present high scientific value of the site is to be maintained. The area has great potential as a source of education and as a scenic walkway during times of least disturbance to the wildfowl populations.

13 February, 1995

SITE SYNOPSIS

SITE NAME: NEWHALL AND EDENVALE COMPLEX

SITE CODE: 002091

This complex is situated approximately 4 km south of Ennis. It consists of three distinct locations which are used, at various times throughout the year, by the Lesser Horseshoe Bat (*Rhinolophus hipposideros*), a species listed on Annex II of the EU Habitats Directive.

There are two small fossil limestone caves, which are used as winter hibernation sites, and a two-storey farm outbuilding which is used as a breeding site. Two of the locations, Newhall Cave and the farm building, are in the grounds of Newhall House, and the second cave, Edenvale Cave, is in the grounds of Edenvale House, within 1 km of Newhall House. The bats have uninterrupted access to all sites. In 1983 grilles were fitted to both caves.

The surrounding areas of mature mixed woodland, parkland and lakes provide ideal foraging habitat and shelter for the bats throughout the year and are included within the site.

Bats have been recorded at this site since 1983 and the population is estimated at more than 500 individuals. The site is of international importance for Lesser Horseshoe Bat, and ranks as one of the most important sites in Europe for the species.

19.10.1997

SITE SYNOPSIS

SITE NAME: DROMOLAND LOUGH

SITE CODE: 001008

Dromoland Lough lies about 3 km north-west of Newmarket on Fergus. It is set in parkland within Dromoland Castle Estate and golf course.

The lake is fringed with Reeds (Phragmites australis) and Club-rush (Schoenoplectus lacustris), behind which a large marshy area spreads to the firmer shore. This contains many marsh species, with Sedges (Carex spp.) being particularly well represented including Carex rostrata, C. lasiocarpa, C. elata, C. diandra, C. riparia, C. appropinquata and C. lepidocarpa. Reed-grass (Phalaris arundinacea) is dominant in some areas. Other species include Grass of Parnassus (Parnassia palustris), Red Rattle (Pedicularis palustris) and Eyebright (Euphrasia scotica).

Other species which have been recorded at this site are Creeping Jenny (Lysimachia nummularia), Marsh Fern (Thelypteris palustris), Yellow Water-lily (Nuphar luteum) and Pondweeds (Potamogeton spp.). Dark Red Helleborine (Epipactis atrorubens), a species typical of Burren areas, has been recorded from the site.

Scrub occurs around parts of the lake, mostly Willow (Salix spp.), Birch (Betula spp.) and Alder (Alnus spp.).

Driven Pheasant and rough duck shoots and gun dog trials are held in the area. These activities cause disturbance and damage to vegetation from trampling. This site is of interest as it contains a diverse flora, particularly marsh species.

SITE SYNOPSIS

SITE NAME: DROMORE WOODS AND LOUGHS

SITE CODE: 000032

Situated in central Clare 9 km north-north-west of Ennis, the site lies on the southern edge of the Clare limestone. The topography is a continuation of the Burren type landscape although at a lower elevation, with most of the land lying between 15 and 35 m. The site includes several lakes which are mostly linked by the River Fergus.

The site is very diverse and contains a mosaic of different habitats: limestone pavement, scrub, dry broadleaved woodland, mixed woodland, lakes, rivers, grasslands, cutaway bog, fen, freshwater marsh and reedbeds.

The site contains extensive areas of limestone pavement, with a covering of soil which is thin or absent, interrupted by corridors and pockets of slightly deeper soil. The limestone pavement on the site is floristically species-rich and occurs in association with calcareous grassland, Hazel (Corylus avellana)/Ash (Fraxinus excelsior) scrub, lakes and fen.

The natural vegetation of much of the site is Hazel and Ash scrub, but there has been considerable planting of conifers - mostly Scots Pine (Pinus sylvestris), Norway Spruce (Picea abies) and Larch (Larix spp.), and to a lesser extent Beech (Fagus sylvatica). Much of the broadleaved woodland on the site has been underplanted with conifer species.

The lakes on the site are naturally eutrophic, a habitat listed on Annex I EU Habitats Directive, and contain some fringing reed beds of Common Reed (Phragmites australis) and Common Club-rush (Scirpus lacustris) and large beds of Pondweed (Potamogeton), including P. lucens and P. perfoliatus.

The site supports a wide range of plants and animals, including several rarities and important populations. The rare lichen, Usnea glabrescens, known from counties Clare, Cork and Galway has been recorded from the site. Dromore Lough holds regionally/locally important numbers of waterfowl (numbers are the average of two counts made in one season, between 1984 and 1987): Little Grebe (20), Whooper Swan (73), a species listed on Annex I of the EU Birds Directive, Wigeon (130), Gadwall (4), Teal (80), Tufted Duck (169), Coot (152), Lapwing (350) and Curlew (50). The site also provides ideal habitat for birds of prey; Kestrel, Sparrowhawk and Hen Harrier, a species also listed on Annex I of the EU Birds Directive, have all been recorded.

Mammals found on the site include Pine Marten, Otter, Badger, Fox and Stoat. The site is of particular importance for its population of Pine Marten, a rare, Red Data Book species. The site also includes a nursery roost for a population (some 200

individuals) of Lesser Horseshoe Bat. This nursery colony is one of the biggest in the country and of international importance. Lesser Horseshoe Bat is a rare and threatened species that is listed on Annex II of the EU Habitats Directive.

The site is of importance for its invertebrate fauna, which includes several rarities: Agonum lugens, Anasimyia transfuga, Xylota tarda, Dyschirius luedersi, Pherbellia aryra and Geomyza majuscula.

Dromore Woods and Loughs is of considerable conservation significance for the wide diversity of habitats found (including two listed on Annex I of the EU Habitats Directive) and for the important populations of rare and threatened mammals, birds and invertebrates that it supports. Part of the site has been designated as a Statutory Nature Reserve.

5.2.1997

Photo 1 Wetlands in the Fergus floodplain at Skehanagh, 12/1/'99

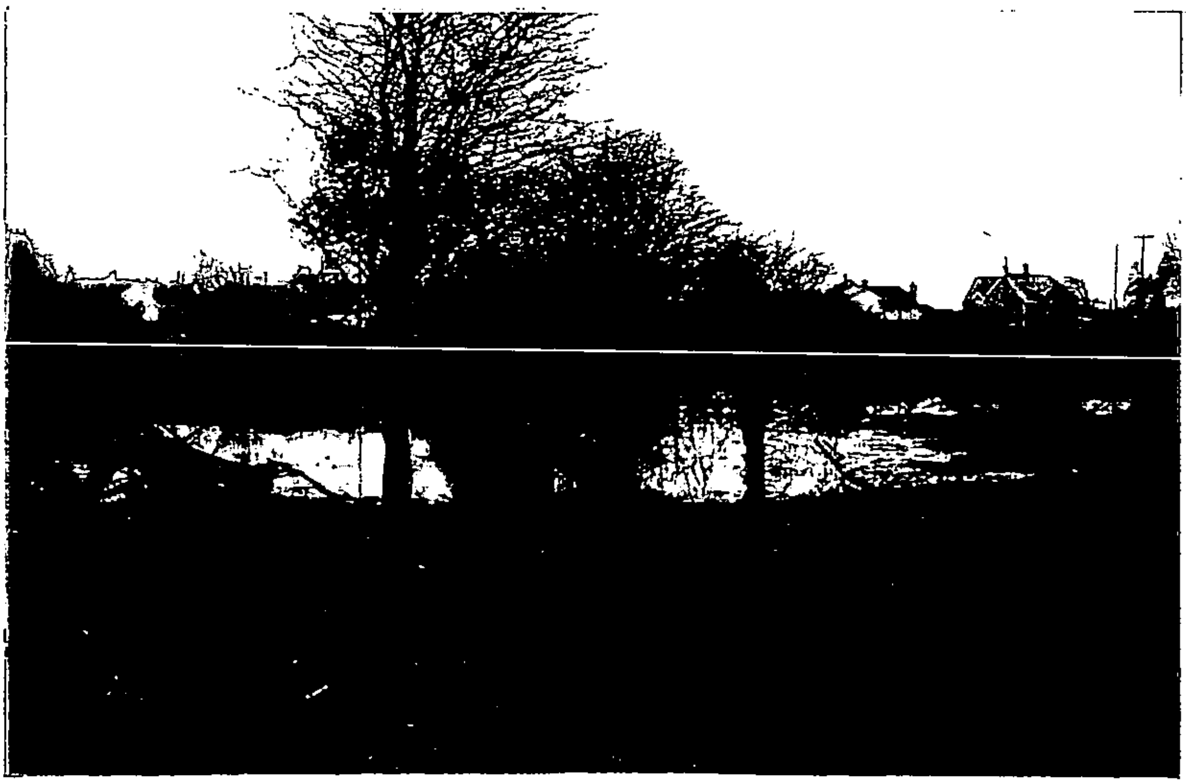

Photo 15 Flooded field at Clareabbey junction, 12/1/'99

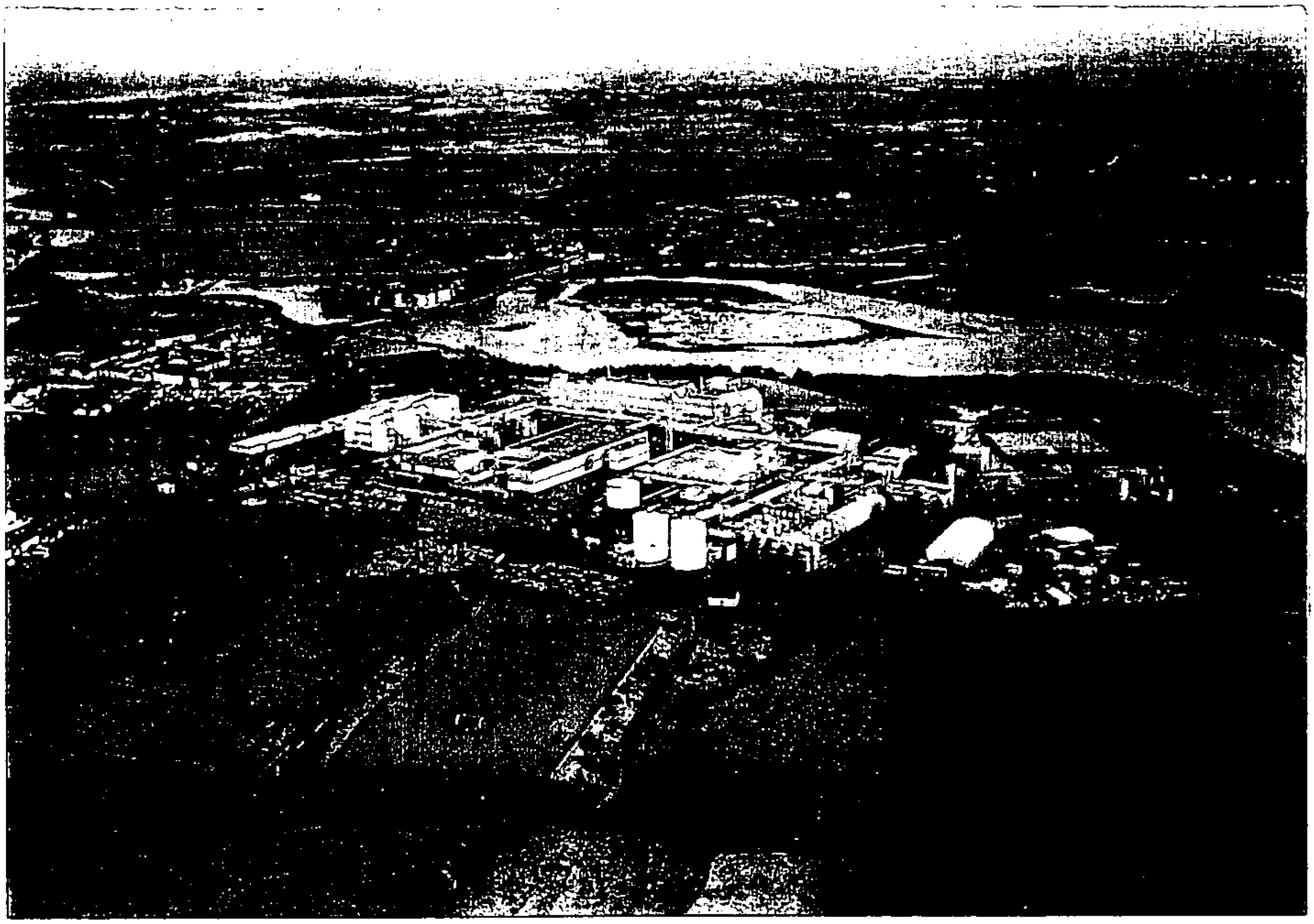

Photo 2 Clarecastle with Skehanagh in the background (Clare County Council. 5/11/'98)

Photo 3 River Fergus floodplain from Clarecastle to Gaurus (Clare County Council, 5/11/'98)

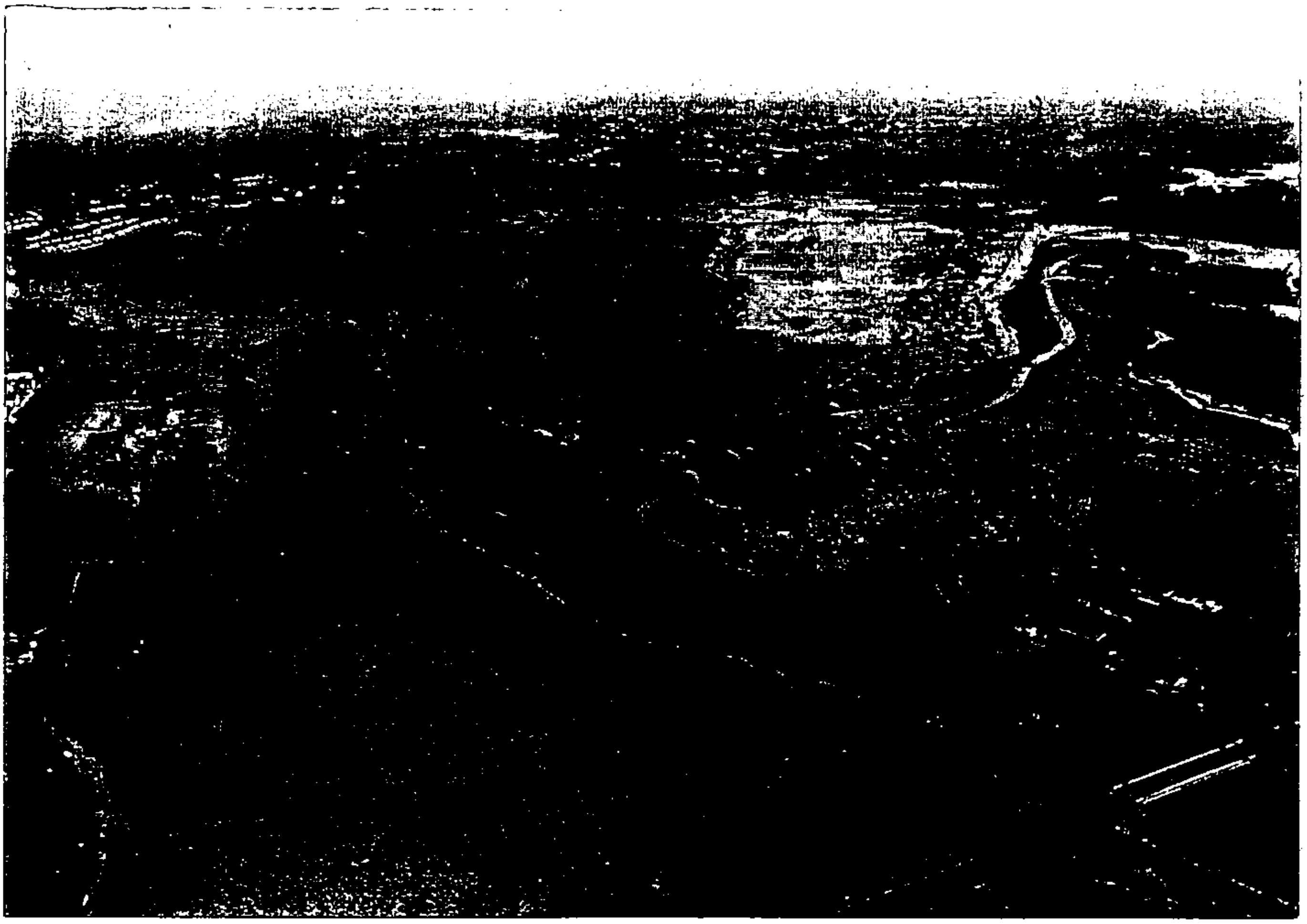

Photo 4 Flooding in the Doora to Newpark area (Clare County Council, 5/11/'98)

Photo 5 Flood areas from Cappahard to Gaurus (Clare County Council, 5/11/'98)

Photo 6 Floodplain of the Claureen river, 12/1/'99

Photo 7 Floodplain of the Claureen river, north of Ballymacaula, 12/1/'99

Photo 9 Flooded lowlands south of Claureen House where two rises occur. 12/1/'99

Photo 8 Northern floodplain of the Claureen river, south of the two rises. 12/1/'99

Photo 10 Wetlands of Killow. 12/1/'99

Photo 11 Flooded field north of Killow. 12/1/'99

Photo 12 Kilbreckan Lough. Kilbreckan. 12/1/'99

Photo 13 Large scale flooding. Ballyduff. 12/1/'99

Photo 16 Flooded field at Clareabbey junction. 12/1/'99

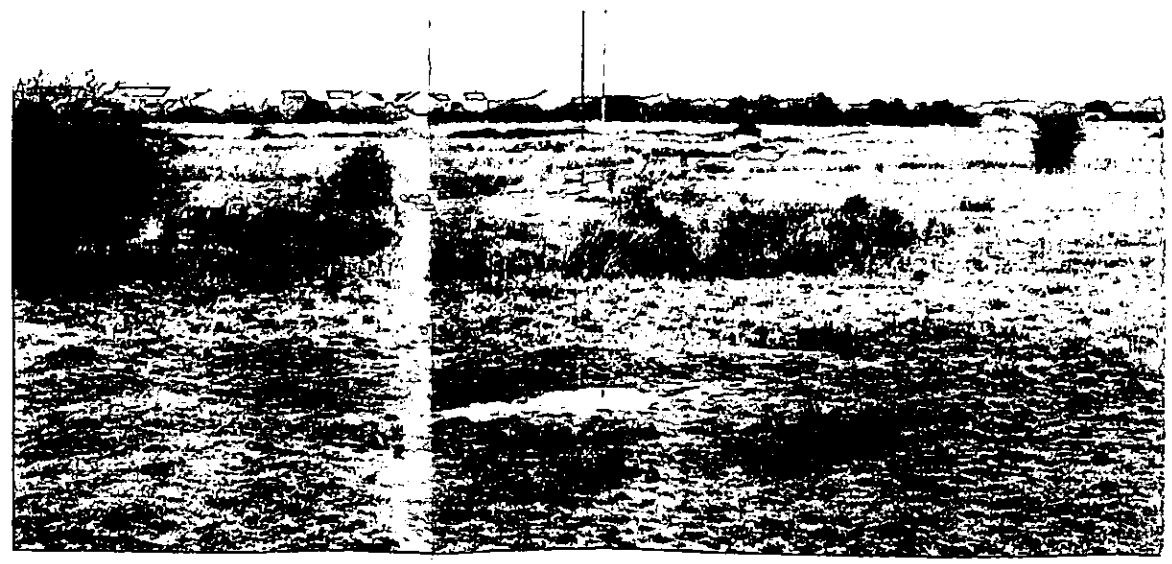

Photo 17 Peat wetlands north of Clareabbey. 12/1/'99

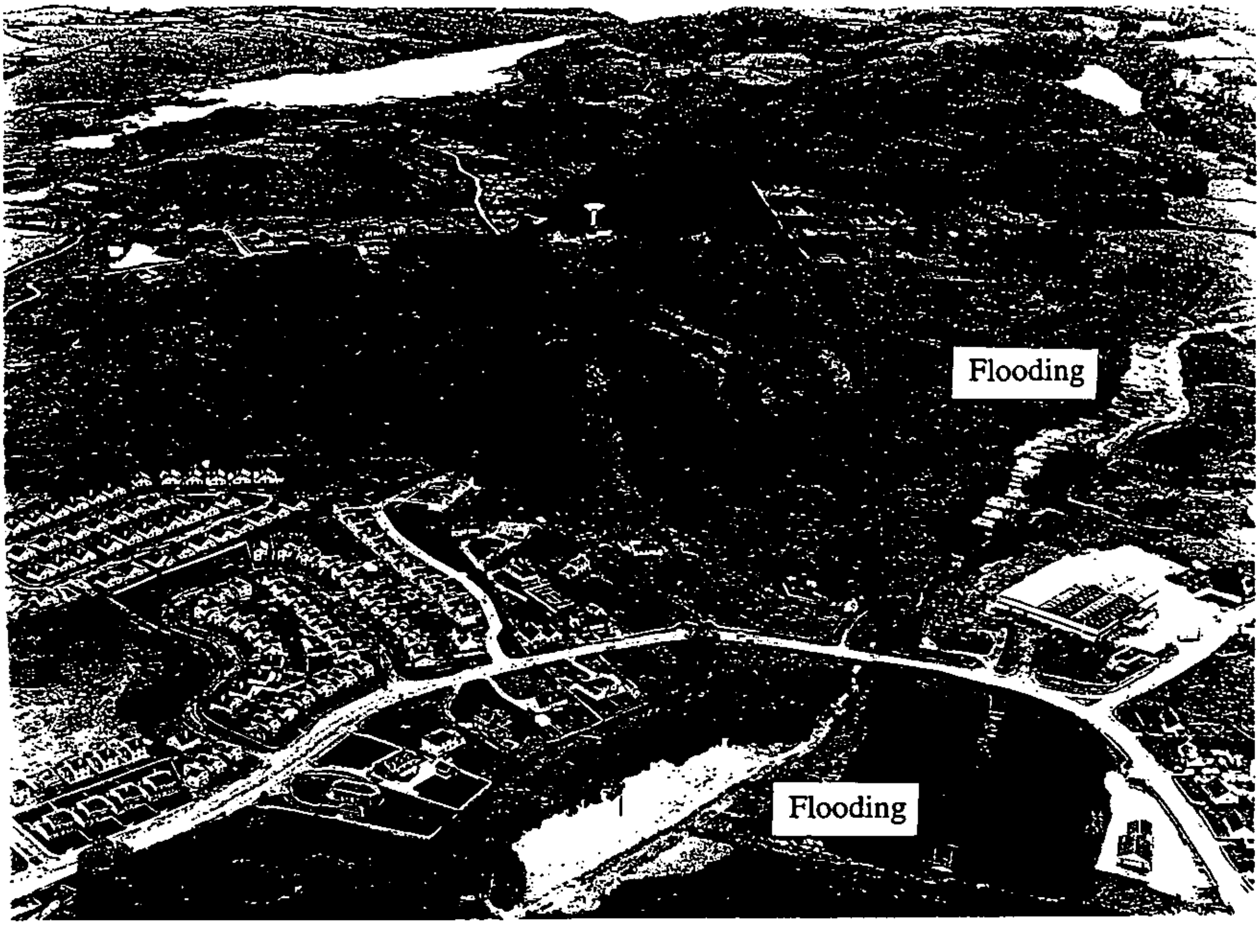

Photo 14 East of Cahircalla More (Clare County Council, 6/2/'90)

Photo 18 Pond at Killow, 12/1/'99

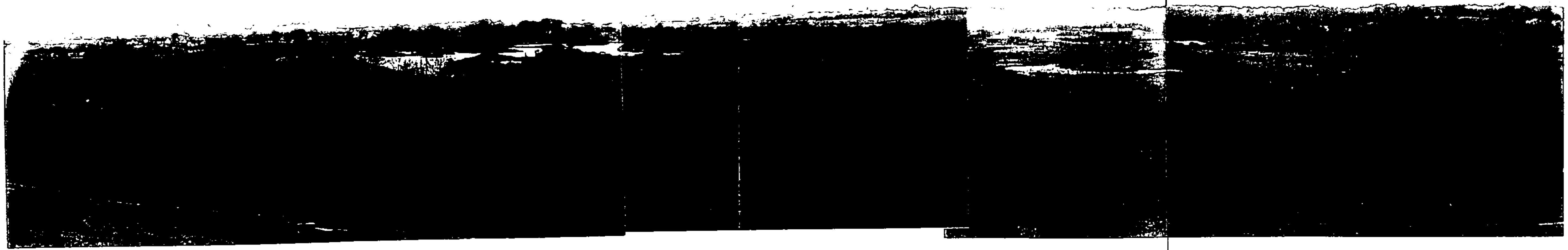

Photo 20 Looking down on the Gaurus area. 12/1/'99

Photo 21 Western margin of the lake at Gaurus. 12/1/'99

Photo 19 Ponding in a low-lying field. Gaurus. 12/1/'99

Photo 22 Flooding of low-lying field, north of Knockanean. 12/1/'99

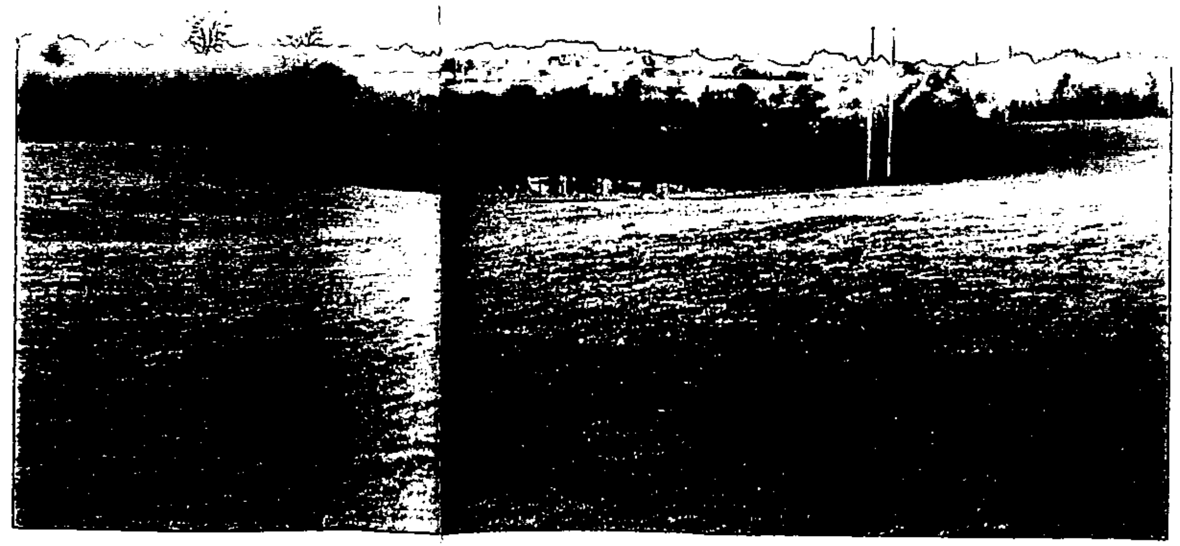

Photo 23 Pond in a ground depression, north of Knockanean. 12/1/'99

Photo 24 Ponding at Drumgranagh, 12/1/'99

Photo 26 Flooded marshland, north of Barefield School, Drumquin, 12/1/'99

Photo 25 Large ponding at Drumquin, east of Barefield School, 12/1/'99

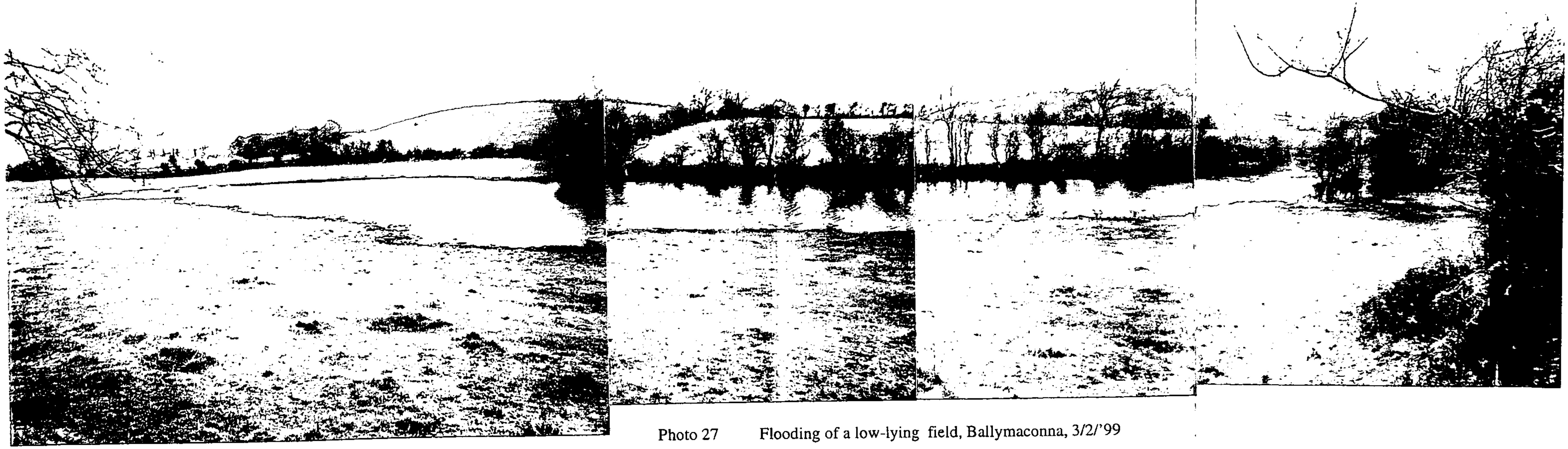

Photo 27 Flooding of a low-lying field, Ballymaconna, 3/2/'99

Photo 28 Flooded field at Ballymaconna, 3/2/'99

Photo 29 Large pond, south of Ballymaconna, 3/2/'99

Photo 30 Flooded field, south of Ballymaconna, 3/2/'99

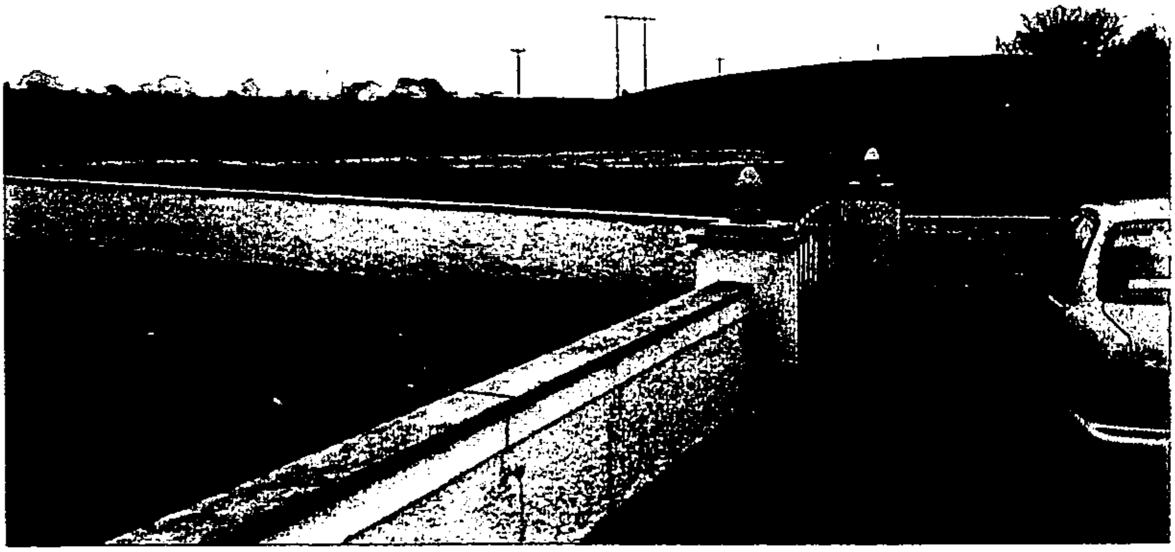

Photo 31 Flooded field, south of Ballymaconna. 3/2/'99

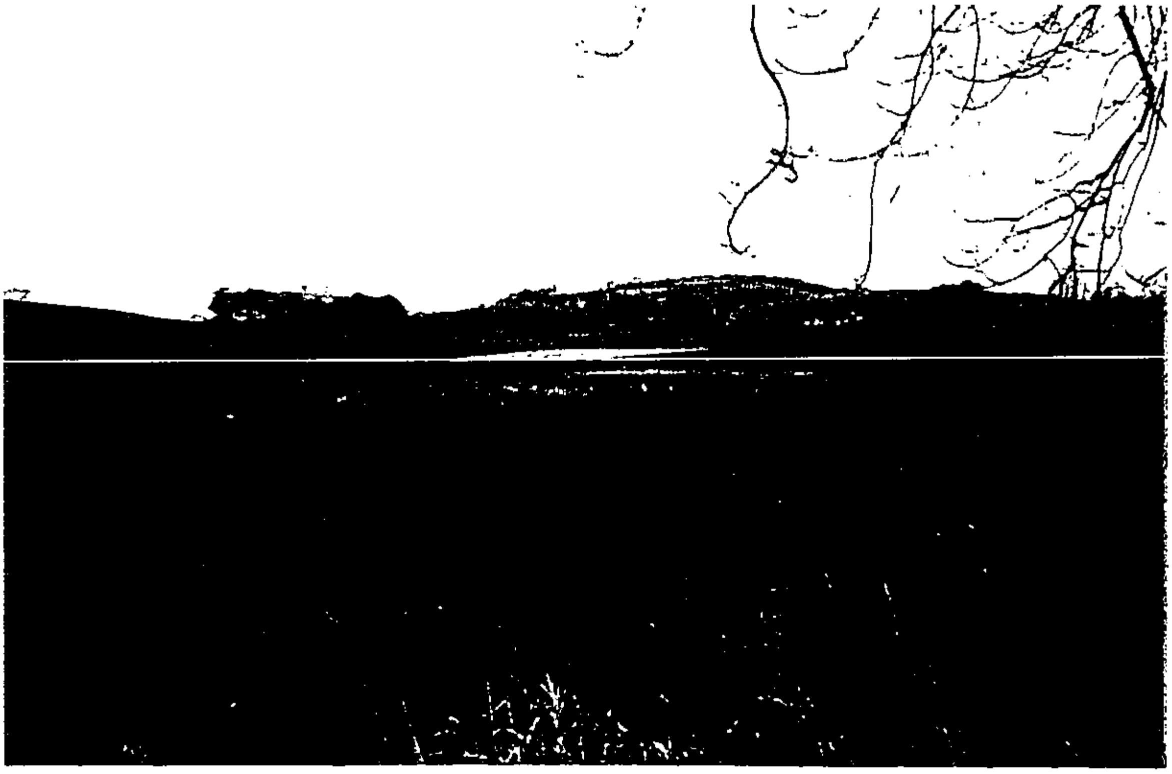

Photo 32 Pond, south of Ballymaconna, 3/2/'99

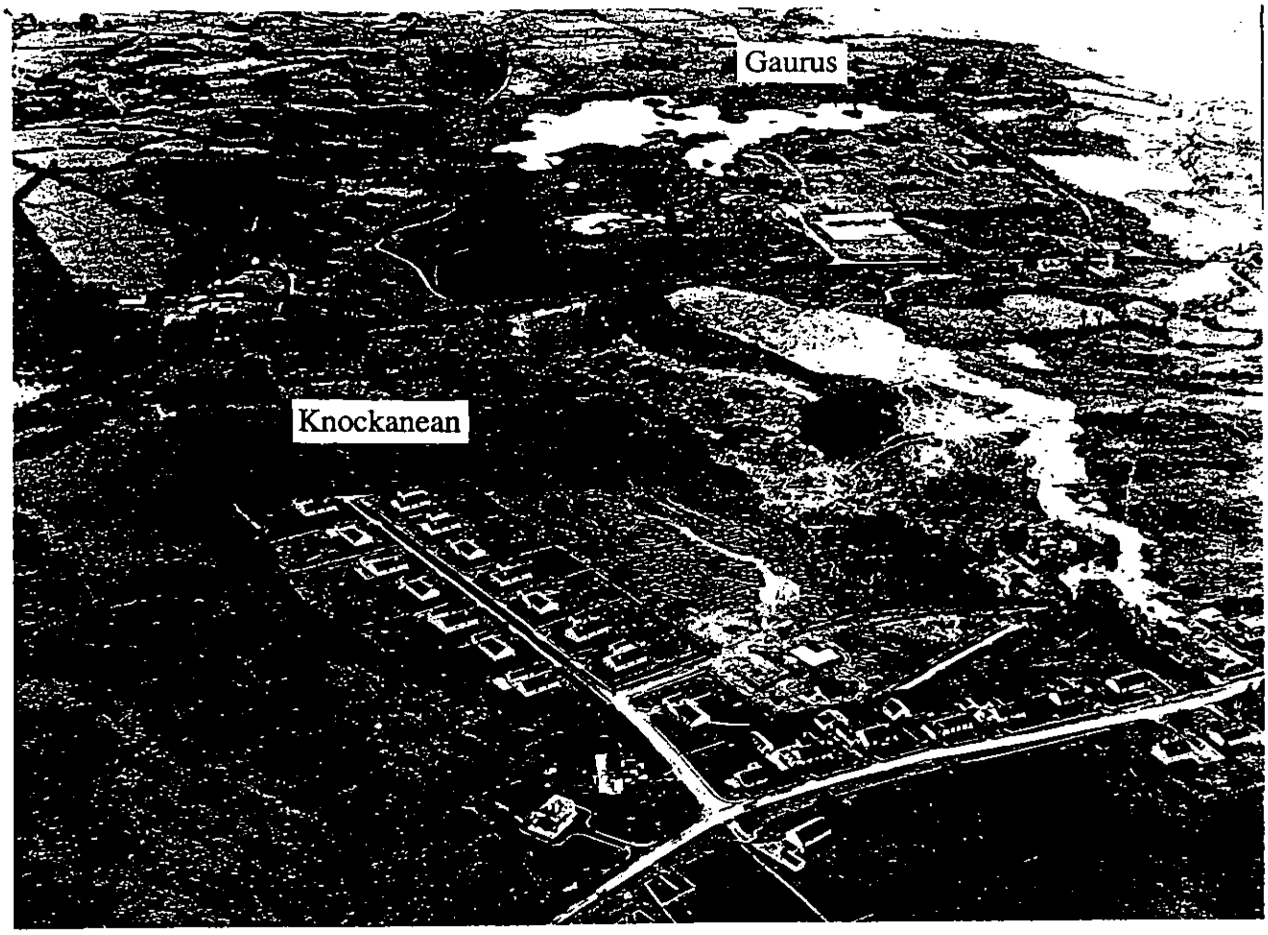

Photo 33 Flooding along the south-flowing stream at Knockanean (Clare County Council, 6/2/'90)

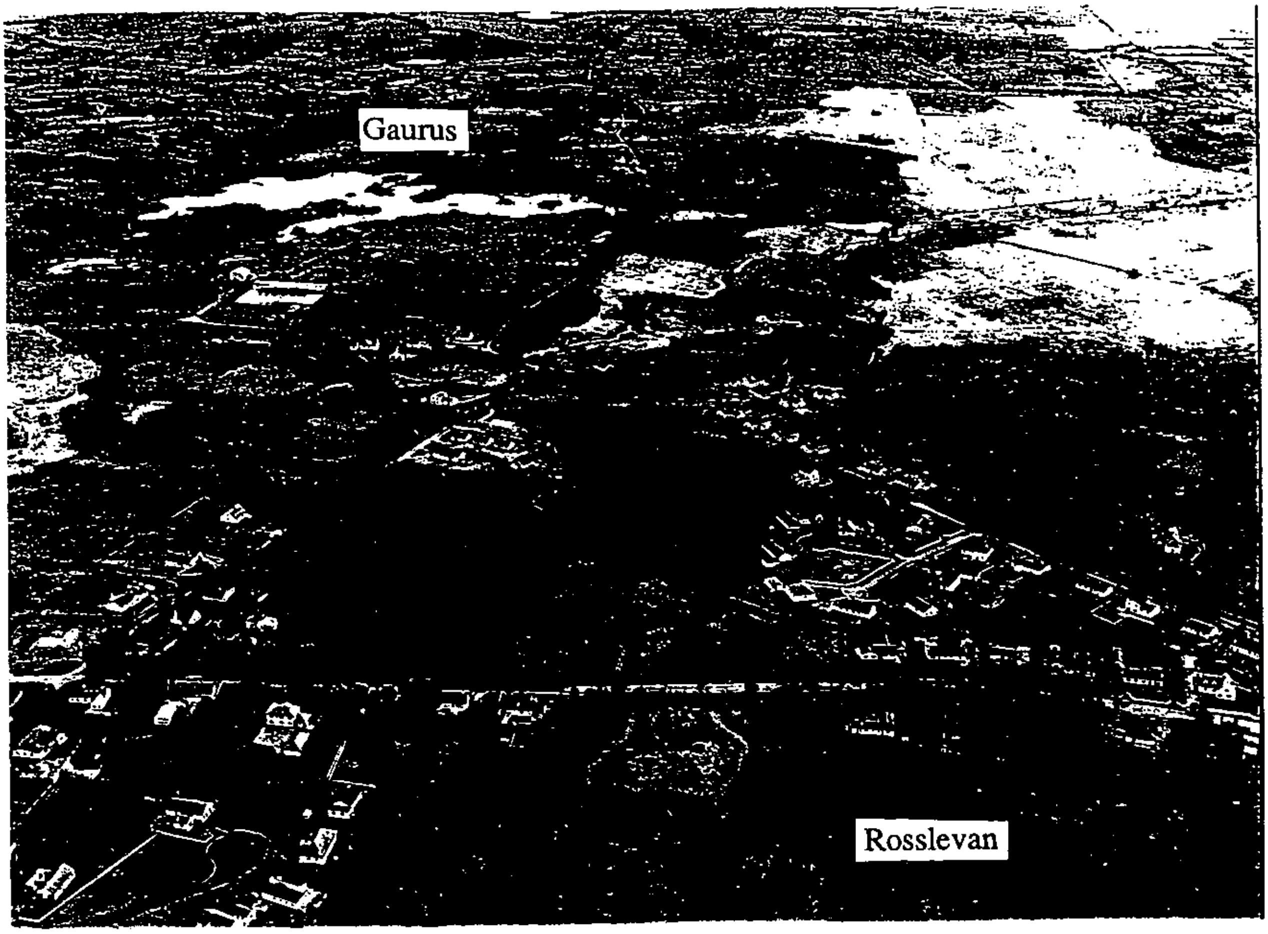

Photo 34 Flooded fields south of Rosslevan (Clare County Council, 6/2/'90)

A

APPENDIX V

WATER QUALITY

PART A **Ecology & Water Quality Assessment (RPS Cairns Ltd.)**

APPENDIX V – PART A

Ecology & Water Quality Assessment (RPS Cairns Ltd.)

ENNIS BYPASS

ECOLOGY AND WATER QUALITY ASSESSMENT

WATER QUALITY AND FISHERIES REPORT

DRAFT 3

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REPORT NUMBER	**IR527/2**
STATUS OF REPORT:	**Third draft**
DATE OF REPORT:	**02 March 2000**
PROJECT MANAGER:	**Tom Gittings**

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NON-TECHNICAL SUMMARY

The proposed route crosses a number of watercourses. The most significant of these are the Rine River (Latoon Creek), the River Fergus and the Kilmaley or Claureen River. The remainder are small streams or field ditches. The River Fergus is one of the most important salmonid rivers in Ireland, although the section which the proposed route will cross is tidal and is not an important angling stretch. The Kilmaley or Claureen River is the most important source of salmonids for the main channel of the Fergus. While it is not heavily fished, some angling takes place in the stretch just downstream of the proposed crossing. The Rine River holds salmonid stocks, but these were affected by a fish kill in 1997. Water for public supply is not abstracted from any of the rivers, streams or lakes below crossing points or surface water drainage points from the proposed road.

Provided, that good practise in relation to construction near watercourses is adhered to, the likely impact of the construction phase of the proposed road as well as the continuing impact of engineered structures at water course crossing points will be minimal. It is recommended that sediment-trapping lagoons be provided at the Claureen, Fergus and Gaurus crossing points to protect these rivers from silts or solids escapement during construction. The Shannon Regional Fisheries Board should be consulted in advance about the design of the bridges and culverts

The most likely impact of on-going untreated surface drainage from the roadway is increased total and suspended solids loading to receiving waters and associated trace amounts of hydrocarbons and heavy metals. It is likely that the concentrations of these substances will be relatively low from all sections of the road except Section 1, 3B, 3C, 4 (and to a lesser extent Section 2), where projected 2020 traffic levels will be quite high. Both french drains and lagoons have high rates of contaminant removal efficiencies for road run-off and either of these systems would be more than adequate to provide a high degree of protection of receiving waters from normal road run-off were they to be included in the drainage designs of the proposed road. Constructed wetlands and the use of natural wetlands are other options, but may require specialist expertise for their design.

Major road spillages are relatively rare. Nevertheless there have been instances of spillages in recent years on Irish roads involving escapes of diesel from both tankers and truck fuel tanks following road accidents. The predicted accident rate for Heavy Commercial Vehicles carrying hazardous material in 2020 varies from one every two years to one every 58 years depending upon the section of road. Valve-controlled spillage storage areas for protection against accidental spillages could be incorporated into either lagoon or constructed wetland systems.

1. INTRODUCTION

This report presents an assessment of the potential impacts of the proposed Ennis Bypass and Western Relief Road on surface water quality. The report includes recommendations for methods of mitigating these impacts.

This report has been prepared by Ger Morgan of the Aquatic Services Unit, University College Cork, and edited by Tom Gittings of RPS Cairns. Scientific names of plants mentioned in the text are listed in Appendix 3.

2. EXISTING ENVIRONMENT

2.1. Watercourse crossings

2.1.1. Introduction

The following is a description of the main crossing points of the proposed bypass and western relief roads, concentrating in particular on streams large enough to hold salmonid fish (salmon or trout). The locations are shown in Figure 1. Smaller watercourses, principally very small streams or field drains have not been considered individually. The descriptions were made during periods of wet weather in November 1998.

2.1.2. Latoon Creek Crossing

General Description: A bridge (# 1) will be constructed at this point. The channel is part of a relatively wide, muddy bottomed tidal stretch of the Rine River, immediately upstream of the present N18 crossing. The channel is steep-sided with stone flood defence walls and marginal beds of Common Reed. The in-channel substrate is mainly of mud or mud/algae-coated rocks and gravel. The field immediately upstream (east) of the existing bridge on the Ennis side was wet with many stands of rushes. There are also drainage channels behind the present flood embankments (along Latoon Creek) and east of the existing road.

Water Quality: The non-tidal portion of this river is know as the Rine and the EPA water quality surveys between 1986, 1988 and 1991 have all indicated that the water quality is good to fair. The nearest Bridge upstream of the proposed crossing point i.e. Blackweir Bridge about 2 km upstream had Q4-5, Q5 and Q4 Biotic Index ratings respectively in the three surveys quoted, all of which place the river in the non-polluted category (Table 1).

TABLE 1 EPA Q Values for the Rine River (from McGarrigle *et al.*, 1996)

EPA Sampling Stations		Biological Quality Ratings (Q Values)		
No.	Location	1986	1988	1991
0100	Bridge E. of Lough Blarnagh	-	4-5	4
0200	Bridge W.S.W. of Commons	-	4-5	5
0300	Bridge N. of Derryulk	-	5	5
0500	Eyrehill Bridge	4	5	4-5
0600	Newgrove Bridge	-	5	-
0700	Bridge near Moymore	5	3-4	3
0900	Ballynafersha Bridge	-	4-5	-
1100	Creevagh Bridge (New)	4-5	4-5	4
1200	Bridge in Quin	4-5	4-5	4
1300	Ford u/s Ardsollus Bridge	4-5	4	4
1400	Ardsollus Bridge	5	4-5	4-5
1500	Blackweir Bridge	4-5	5	4

2.1.3. Stream Immediately South of Bridge #3

General Description: This site, which will be culverted, is located on a stream just SSE of Bridge No. 3, which will cross over the railway line. It is in an area where the land is liable to winter flooding and there are networks of deep field ditches; it also has flood-protection embankments near the site of the proposed road crossing. This stream crosses beneath the N18 at Carnelly Bridge and enters the lower estuary of the River Fergus upstream of Latoon Creek. It was deep

and with bank-full flow when visited the day after heavy rain (9/11/98) which suggests that it is normally a sluggish, moderate to slow flow channel rather than a swift or turbulent watercourse. There is an automatic flow gauging station on the stream at Carnelly Bridge. The stream drains a low-lying catchment incorporating Kilbrecken Lough, Lough Naslatty and Poulacapeen. The land adjacent to the site has several deep ditches traversing it, containing such emergents as Common Reed, Reed Canary-grass, rushes and Greater (?) Pond-sedge. Ponded water as well as the presence of vegetation such as Yellow Iris, and Soft Rush (extensive in places) indicates that winter flooding is not uncommon in the adjoining fields. There is also a marginal wetland / back ditch along the railway embankment.

Water Quality: The stream in question is too small to be included in the EPA river quality. However, given the general land appearance (i.e. damp and not suitable for very intensive farming), there is every chance that the quality of the stream is good to fair.

Fisheries and Angling: This site is probably too small to be important for salmon, however, it may be suitable for trout. It is unlikely to have any significant value for angling.

2.1.4. Stream Crossing East of Bridge #12

General Description: This site is located just east of proposed Bridge No. 12 on the western relief road. It is a small stream which at the point at which the road will cross it, runs through very wet pasture. The stream itself was completely choked with a very heavy growth of aquatic vegetation dominated by Fool's Water-cress. The wet pasture through which the stream flows is heavily dominated by rushes (Soft and Hard Rush) and also includes an abundance of Creeping Bent, Creeping Buttercup, Jointed Rush, Meadowsweet, Yellow Iris and Reed Canary-grass in places. The area of this rushy meadow is greater on the western bank of the stream, however, it also occurs on the eastern side backed by a band of woodland.

Water Quality: Because of its small size, there is no water quality data available for this stream from the EPA River Quality Surveys. The appearance of the stream gave no indication of serious pollution and it is likely that the water quality is no worse than slightly polluted and possibly fair to good.

Fisheries and Angling: This stream may contain small brown trout, however, they would not be any spawning or feeding in the sluggish, plant-choked stretch where the road would cross. The stream would not be suitable for angling although like all streams in and around urban areas children or juveniles might use it for recreation.

2.1.5. Claureen River Crossing

General Description: This is the last river/stream crossing before the Western Relief Roads joins the N85 on the western side of Ennis. When surveyed, the river was in flood flow with elevated water levels, following intermittent heavy rain during the previous days. Travelling from the south, the road routes NNE through a large damp meadow just before it crosses the Claureen. At the time of the survey this meadow held an extensive area of ponded water, more or less along the route of the proposed road. On the northern side of the crossing, the proposed road will again traverse a damp meadow and then terminate in a reed swamp just before it reaches the N85. At the Claureen River crossing point heavy bankside vegetation and the deep water made it impossible to assess the in-channel vegetation. However, just upstream the channel held marginal beds of Water Forget-me-not, Fool's Water-cress and Reed Canary-grass, indicating the sluggish

meandering nature of this section of the channel. The deep water of the crossing point makes it very suitable as a fish holding area.

As indicated above a large meadow south of the crossing is liable to flooding and extensive surface water and flood trash lines were in evidence at higher points in the field during the survey. One field north of the crossing, the road traverses a sizeable reed swamp (dominated by Reed Canary-grass and rushes). Water levels were elevated also in this marsh which drains to the Claureen via a drainage ditch which joins the Claureen at the first pronounced meander downstream of the proposed road crossing point.

Water Quality: According to the EPA's 1991 river quality survey, the Claureen was moderately polluted (Q3) along most of its channel length from Ballymacooda Lough in the upper reaches to Claureen Bridge in the lower reaches (see Table 2). The latter bridge is only just downstream of the proposed road crossing point. It is possible that extensive field drainage in this very low-lying catchment may be introducing diffuse pollution into this river whose quality declined slightly since the late 1980's

TABLE 2 EPA Q Values for the Claureen River (from McGarrigle *et al.*, 1996)

EPA Sampling Stations No.	Location	Biological Quality Ratings (Q Values) 1986	1988	1991
	Ballymacooda Lough Branch			
0100	Bridge d/s Ballymacooda L	-	3	3
0300	Bridge N.E. of Darragh	-	3	3
0500	Bridge d/s Rathmeehan Bridge	-	4	2-3
	Main Channel			
0600	Claureen Bridge	4	4	3

Fisheries and Angling: According to the Shannon fisheries board this river holds stocks of seatrout, brown trout and salmon. Some limited angling may also take place at this site (see Section 2.2 below).

2.1.6. Gaurus River Crossing (North of Bridge #7)

General Description: At a point about two fields north of Bridge #7, the road crosses the upper section of the Gaurus River which at this point is only about 2m wide. At the crossing point the stream is sluggish and consists of a glide. Marginal areas of the channel hold Reed Canary-grass, and Fool's watercress and adjoining land is of damp grassland with Creeping Bent and Creeping Buttercup on the south and dominated by Soft Rush on the northern bank. There is also some willow scrub in the area and scattered Gorse.

Water Quality: There doesn't appear to be any published data on the water quality of the River Gaurus. However, to judge from the surrounding land use and very low density of housing in the catchment above this point, there is no reason to suspect that the water quality is not satisfactory.

Fisheries and Angling: This section of the Gaurus is unlikely to be of any great fisheries significance (given its small size) but probably holds a healthy stock of small to medium-sized brown trout, given the limestone geology of the area. (see also Section 2.2.5).

2.1.7. *River Fergus (Bridge #10)*

General Description: The Fergus is the largest watercourse to be crossed by the proposed road scheme, in this case by the western relief road at Bridge #10. At this point the river is in its upper estuary and is tidal. It is also flanked by flood protection embankments and back-drains and the channel is fringed by dense Common Reed beds. Adjoining land is damp pasture, heavily intersected by deep land drains.

Water Quality: As this section of the Fergus is tidal with daily flow reversals and occasional saline incursion, the EPA Biotic Index System is not operable here. However, the last site within the freshwater section of the river sampled was assigned a biotic index value of Q4 (in 1991) indicating un-polluted conditions (see Table 3). Between that station and the crossing point in question, the treated sewage from Ennis Sewage Treatment Plant enters the Fergus and this is likely to be associated with a slight deterioration in the quality of the Fergus in the stretch upstream of the crossing point.

TABLE 3 EPA Q Values for the Fergus Main Channel (from McGarrigle *et al.*, 1994)

EPA Sampling Stations		Biological Quality Ratings (Q Values)						
No.	Location	1971	1975	1979	1982	1985	1988	1991
0600	Drehidnagower Bridge	4	4-5	4	4	4	4	4
0640	2nd Br d/s Drehidnagower	-	-	-	-	-	-	4
0700	Bridge near Clonroad House	4-5	4-5	4	-	4	4	4
0720	Bridge S.W. of Doora	-	-	-	-	-	-	-
0780	W Br Clarecastle	-	-	-	-	-	-	-

There are water chemistry data available for the period 1991 to 1994 at the bridge immediately upstream of the crossing (at Doora, EPA Station no. 0720) and downstream (at Clarecastle, EPA Station No. 0780). These indicate generally acceptable conditions with median oxygen, BOD and ammonia concentrations of 90-92%, 1.6 mg/l, and 0.03 mg/l, N respectively. Median ortho-phosphate and nitrate concentrations were 0.030 mg/l, P and 0.40-0.43 mg/l, N respectively, also satisfactory. Occasionally elevated ammonia and BOD have been recorded in the stretch (up to 0.46mg/l, N as total ammonia, and 6.0 mg/l, BOD) neither of which would be considered excessive as maximum values (see Table 4)

Fisheries and Angling: The River Fergus is an important salmon and trout fishery with game fishing for salmon, seatrout and brown trout and commercial fishing in the estuary for salmon. A limited amount of coarse angling also takes place on the Fergus (see Section 2.2.4 below).

TABLE 4 Water chemistry data for the River Fergus around Ennis (from McGarrigle *et al.*, 1996)

EPA Station	Chemical parameters											
	Dissolved Oxygen % saturation				Dissolved Oxygen mg O_2 l^{-1}				B.O.D. mg O_2 l^{-1}			
	No	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
0720	*45*	74	92	108	*44*	7.6	10.2	13.6	*45*	0.1	1.6	**6.0**
0780	*45*	74	90	110	*43*	7.3	10.1	13.5	*45*	0.1	1.6	3.9
Station	Chloride mg Cl l^{-1}				Total Ammonia mg N l^{-1}				Un-Ionised Ammonia mg mg NH_3 l^{-1}			
	No	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
0720	*42*	23	36	804	*36*	0.001	0.030	**0.460**	*36*	<0.000	0.000	0.010
0780	*42*	25	41	>999	*36*	0.002	0.030	**0.380**	*36*	<0.000	0.000	0.007
Station	Oxidised Nitrogen mg N l^{-1}				ortho-Phosphate mg P l^{-1}				Colour Hazen			
	No	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
0720	*41*	0.10	0.40	2.10	*38*	0.007	0.030	0.110	*45*	10	30	85
0780	*41*	0.10	0.43	2.55	*37*	0.007	0.030	0.127	*45*	7	30	70

2.1.8. Other Crossing Points

All other crossing points were of very small streams with no fisheries importance and very little ecological importance compared to the very minor impact likely to result from their being carefully culverted.

2.2. Fisheries and Angling

2.2.1. Introduction

The Ennis Bypass will traverse a number of waterways with important fisheries beneficial uses. The most important of these in relative order are (i) the Fergus, (ii) the Kilmaley or Claureen River and (iii) the Rine River

2.2.2. The River Fergus

The Fergus is the main salmon and seatrout angling river in the region and is one of the most important in the county. It holds significant stocks of salmon, seatrout and brown trout. The Fergus is tidally influenced as far as the 'Brothers Field' upstream of Knox's Bridge in the town. Most serious salmon angling occurs upstream of Ennis although, within the town, the stretch between Knoxes bridge and 'The Point' is also intensively fished. Below this point, although some casual angling takes between Ennis and the tidal fishpass at Clarecastle e.g. around Doora Bridge, by comparison with the town reach and upstream, relatively little angling takes place. Until recently, two draft-net licences operated as far upstream as the town, but these are now confined to the estuary proper i.e. downstream of Clarecastle. In addition, ten drift licences operate between Clarecastle and the mouth of the Shannon.

In addition to salmonids, the Fergus also holds eel, pike, perch, rudd and roach, all of which are caught on a casual basis. However, most serious coarse angling in the region takes place in lakes, although in none of those within the study area.

2.2.3. *Kilmaley River or Claureen River*

This is by far the most important source of salmon and trout for the main channel of the Fergus and is thus of prime importance to the success of angling within the River Fergus catchment, principally the Ennis area. Despite having impaired water quality (McGarrigle *et al.*, 1996), this river annually receives large numbers of spawning salmon and trout especially, though not exclusively, in the stretch around Kilmaley village. Despite its importance as a nursery and spawning river for the main Fergus, it is not itself heavily fished. What fishing does take place, mainly for trout and grilse (1 sea-winter salmon), occurs in the lower reaches upstream of Claureen Bridge, where there are many sizeable holding pools in the lower reach meanders in the area known locally as Pine's and Madden's. Some limited fishing also takes place upstream e.g. in the Kilclother Bridge and Iron Bridge stretches. Two small lakes in the catchment near Kilmaley, i.e. Lough Gortaganniv and the small reservoir west south west of it are stocked with brown and rainbow trout by the local Kilmaley angling club.

2.2.4. *The Rine River*

The Rine River will be traversed by the proposed route immediately upstream of the existing road N18 bridge at Latoon Creek. The Rine River constitutes the main freshwater channel leading to Latoon Creek where the river is estuarine and joins the Fergus estuary. The Rine River is noted for its salmon, seatrout and brown trout stocks. Also within the catchment is a large lake, Lough Cullaunyheeda or Cullaun Lake which in 1997 suffered a severe algal bloom which led in turn to a very serious fish kill in the Rine River which is unlikely yet to have recovered its stocks. Angling on the Rine is not owned by a club and fishing is generally open. The main angling stretch is upstream of the site of the proposed crossing between Blackweir Bridge and Creevagh Bridge. Spawning areas are also in the middle and upper reaches e.g. around the Hell River confluence.

2.2.5. *Other Waters*

Within the rest of the study area only the Gaurus River holds a significant number of trout. However, this river has a sluice on its lower reaches and therefore does not have migratory species (salmon and seatrout). It is not an important fishing river, although some casual adult and juvenile angling may take place for brown trout, some of which may be relatively sizeable. Other than this, the stream which drains to the estuary of the Fergus just upstream of Latoon Creek (i.e. crossing the N18 under Carnelly Br.) the next largest stream within the area is of no angling significance, although there is no reason why it shouldn't hold perhaps numerous small trout. Because of its small size and the fact that it has a tidal sluice, it probably does not have either salmon or seatrout. All other crossing points are of small streams, most of them no more than drainage ditches and consequently of little or no significance from the fisheries standpoint.

2.2.6. *Angling and Commercial Fishing Seasons.*

The salmon angling season opens on the 1st of February and closes on September 30th, while the trout season, which opens on the same date closes a fortnight later on October 14th. The main spring run of salmon occurs during February and depending on the year may also extend well into March. The angling normally quietens down again until June/July, when the grilse and seatrout runs are often concentrated. Although angling for both species can take place at any time within the season, these tend to be the peak periods of activity.

Commercial fishing in the estuary opens on May 12th and closes July 25th (1999). Sometimes a few days extension are granted at the end of the season. Within the season, drift net licences do not operate on Saturdays and Sundays and the drafts net licences do not operate on Sundays or Mondays of each week.

2.3. Water supply

Water for public supply is not abstracted from any of the rivers, streams or lakes below crossing points or surface water drainage points from the proposed road.

3. IMPACT

3.1. Introduction

Water quality impacts from highways can be broadly categorised under three headings: (i) construction phase pollution and impacts, (ii) continuous or on-going pollution and impact and (iii) incidental pollution and impacts associated mainly with accidents involving vehicles carrying hazardous materials. Construction phase impacts are typical of those associated with any heavy civil engineering site and relate in the main to solids (soil and silt) escapements to water ways, cement run-off and site vehicle oil or fuel loss. Continuous impacts are those associated with the normal day to day use of the highway (post construction) and which are generated by the intermittent wash off by rainwater (or occasionally snowmelt) of contaminants deposited on the road surface by vehicle emissions, vehicle ware, minor load losses, animal excrement, etc. Incidental impacts are those associated with significant load losses of liquid or soluble materials of a hazardous nature, which find there way via the drainage system to adjoining surface waters. The latter are generally the result of road accidents or poorly secured cargoes. Clearly, those impacts associated with day to day use of highways are more likely to be widespread but of a less dramatic nature. In contrast, incidental impacts are by their nature much less common but potentially far more serious. Finally, construction phase impacts have also been reported to be serious on occasion and are often the most visible. In the following section, the nature and potential impact of highway run-off are discussed under each of these three headings.

This assessment has included an extensive review of the technical literature to allow potential impacts to be identified and evaluated, using the experience derived from previous case studies. A full list of sources consulted are provided in the references list.

3.2. Construction Phase Pollution and Associated Potential Impacts

3.2.1. Introduction

Major construction sites including highway construction, if not properly managed, may lead to very serious pollution of receiving waters. The main source of contamination tends to be from solids but can also significantly include liquid cement and oil (diesel and lubricating oil for heavy vehicles).

3.2.2. Potential Impacts

Silt and solids

Silty water can arise from de-watering excavations, exposed ground, stockpiles of soil, plant and wheel washing, site roads and disturbance of stream beds. Escape of inert solids to waterways may give rise to water pollution i.e. high suspended solids levels, high turbidity, high colour and reduced water transparency. It may also adversely affect the health and general ecology of fish stocks. Discoloration of water due to solids escapement can seriously reduce the success of angling in the affected stretches because salmon and trout cannot see the lures.

Previous studies (Barton, 1977; McNeill, 1996) indicate that impacts due to solids escapement are likely to relate to the severity and to a lesser extent the timing of those releases. Where the releases are of a minor nature the impact is likely to be minor and the recovery to the pre-

construction situation rapid. Conversely moderate to severe solids release might require up to 12 months or more before a stream fully recovers.

Cement

Liquid cement due to its highly alkaline and corrosive nature can and has given rise to major fish kills in Ireland. While, the discharged cement may be rapidly flushed from the system in the space of hours or days, it may take several years for a fish population to recover from a major kill. The dangers associated with poor management of bulk cement on construction sites cannot be over stated.

Structures (Bridges and Culverts)

Structures placed in a river or stream may impede the natural two-way movement of fish where, for example, the channel beneath the bridge or forming the base of the culvert is concreted and raised significantly higher than the original stream bed leaving a sudden vertical drop at the downstream end which fish may not be able to pass during low water. Culverts, which are too narrow, may increase water velocities to levels too high for fish passage. Screening culverts to prevent trash build-up can also prevent fish passage.

3.2.3. Predicted Impacts

The degree of actual impact from the construction phase will depend upon the extent to which good practise (in relation to construction near watercourses; see Section 4.2) is adhered to. Provided, that the mitigation measures outlined or similar ones are adopted in a comprehensive and planned manner, the likely impact of the construction phase of the proposed road as well as the continuing impact of engineered structures at water course crossing points will be minimal. The most likely adverse impact will be that associated with the escapement of limited amounts of silt to watercourses. These will be of greater significance in rivers and streams holding viable populations of salmonids i.e. the Claureen, the Gaurus and perhaps the small stream just north of Latoon Creek. The Rine river itself and the main crossing of the Fergus will take place in the tidal portion of these rivers where the substrate and water column are already silty in nature such that small temporary increases in the silt levels are unlikely to have any significant impact. No salmonid spawning areas are likely to be impacted by the development as no significant ones are known to exist below any of the river or stream crossings, with the possible exception of the Gaurus. However, there was no indication that fish spawn in the area immediately downstream of the designated crossing point on this stream.

Angling success might be reduced if water is seriously discoloured during the Claureen crossing construction as some angling is reported to take place in the deep pools at and below the crossing point and in limited areas of the Fergus downstream of the Claureen confluence. This possible impact could be avoided if the in-channel works were scheduled outside the angling season or outside the main part of the season. Game angling does not take place with any degree of intensity downstream of the proposed Fergus crossing or the Latoon Creek crossing so that angling impacts are likely to be minimal as a result of any potential water discoloration at these crossings. The commercial salmon fishery in the Fergus estuary downstream of the Clarecastle will not be adversely affected by the construction.

3.3. Operational Phase Run-off from Highways

3.3.1. *Introduction*

A review of some of the literature on the subject (see References) indicates that the nature and environmental implications of highway run-off has only received serious attention within the last 10-15 years in Europe and perhaps five years earlier in the United States. Perhaps, understandably, because of the, until recently, fairly light traffic densities, and underdeveloped major road network in Ireland, the subject of surface water impacts from on-going highway use does not appear to have been studied here (with one exception; Clinton, 1992). The majority of the literature concentrates on characterising and quantifying the nature of the contaminant mix associated with on-going highway use, identifying its various source contributions, and examining methods for the control and attenuation of contaminated run-off. In contrast, there appear to be considerably fewer papers on the direct impact of highway run-off on receiving waters and much of what has been written relates in particular to laboratory based toxicity studies.

3.3.2. *Nature and Sources of Highway Pollution*

Quality Characteristics of Highway Run-off

Highway run-off is generally noted for its heavy metals (total and dissolved) and hydrocarbon contents, including PAH's (Polycyclic Aromatic Hydrocarbons), which are both relatively persistent and toxic in the environment, and where weather conditions are harsh with de-icing agents (mainly sodium chloride). In addition to the above, highway run-off can be a source of solids and suspended solids, BOD, COD, total kjeldahl nitrogen, total and dissolved phosphorus and coliform bacteria. The quality of untreated highway run-off is likely to be extremely variable depending on site-specific characteristics such as: ADT (average daily traffic) including the proportion of heavy commercial vehicles (HVC's); the weather (e.g. rainfall intensity and duration and the length of the antecedent dry period) and seasonal factors such as the use in some areas of de-icing salts. One Irish study (Clinton, 1992) did not find any demonstrable impacts on water quality of a small stream from highway run-off, but the significance of these results are difficult to evaluate without information on the traffic volumes, length of road being drained and method of road drainage system involved. Data from other studies of highway run-off are included in Appendix 1.

Association of Pollutants with Solids

An important characteristic of highway run-off is the fact that much of the polluting matter is associated with the suspended solids fraction with greater proportions of pollutants associated with the smaller particle sizes. This is true for heavy metals, oils and PAH's (Hvitved-Jacobsen and Yousef 1991). This fact also has important implications for treatment.

De-Icing Salts

Crushed rock salt is used widely as a de-icing mechanism during the winter months, although its use in Ireland is likely to be less frequent than in either the UK or on the Continent due to our maritime climate. Within Ireland one might expect salt to be used less in the Western and south-western counties compared to the midlands, north and east. In addition to its principle component, sodium chloride, rock salt may contain trace amounts of heavy metals including cadmium, zinc, copper and lead.

Scale of the Impact

An important consideration in the assessment of on-going highway run-off impacts is its scale. Based on previous studies (Maltby *et al.*, 1995a, Yousef *et al.*, 1996), one might expect that the larger the river or stream receiving highway run-off (treated or untreated) the more dilute will be the concentration of contaminants deposited in its bottom sediments and consequently the lower will be the associated impact. Another important factor to be considered in this context, is the average daily traffic volume. The higher the latter, especially with elevated proportions of HCV's (Heavy Commercial Vehicles), the greater will be concentration of contaminants emanating from a given stretch of highway. Thus we can expect the greatest impacts to occur in smaller water-courses or in localised areas of larger water courses receiving drainage from highways with heavy traffic volumes.

Nature of the Impact

Several laboratory and field studies (e.g., Maltby *et al.*, 1995a, b; Yousef *et al.*, 1996) have shown that bottom dwelling macro-invertebrates living in ponds and streams are vulnerable to highway run-off. Although these studies suggest that the occurrence of highway run-off and associated contamination may be widespread, to-date, demonstrable adverse impacts appear to be confined to small water bodies, within relatively short distances of run-off discharges. One Irish study (Clinton, 1992) did not find any demonstrable impacts from highway run-off on the macro-invertebrates assemblage in a small stream, but the significance of these results of this study are difficult to evaluate without information on the traffic volumes, length of road being drained and method of road drainage system involved.

Although the impact of 'normal' highway run-off on fisheries doesn't appear to have been studied, the fact that *Gammarus*, an important food item for juvenile salmon and trout can in certain situations be reduced in density indicates that salmon and trout might be locally impacted in some cases. Moreover, the fact that the community below highway run-off discharges can shift to one dominated by a reliance on fine organic sediments would also be unfavourable to salmonids generally. However, such impact might be expected to be localised in most situations and most probably confined to the smaller streams draining heavily used stretches of highway.

Suspended solids from highway run-off could, potentially impact on salmonid spawning beds. However, no spawning areas were noted downstream of any of the river or stream crossings of the proposed road.

3.3.3. Predicted Impacts

The likely impact of the various sections of the proposed road are discussed here in relation to their respective receiving waters. Drainage Outlet numbers are taken from the Clare County Council plan 'Drainage - Possible Outfalls' and are shown in Figure 1. Road Sections are as used for the traffic data and are shown in Figure 2.

In general, the most likely impact of on-going untreated surface drainage from the roadway is increased total and suspended solids loading to receiving waters and associated trace amounts of hydrocarbons and heavy metals. It is likely that the concentrations of these substances will be relatively low from all sections of the road except Section 1, 3B, 3C, 4 (and to a lesser extent Section 2), where projected 2020 traffic levels will be quite high.

The southern third of Section 1 will drain to Latoon Creek (Drainage Outlet # 1) where the estuarine flush will likely make any impact from run-off from this section virtually un-measurable, past a local increase in heavy metals and hydrocarbons in the mud very close to the drainage point. The northern two thirds of this Section 1 will drain to a small steam (Drainage Outlet #2) which eventually flows under the N18 at Carnelly bridge and joins the Fergus estuary about 5km downstream of the drainage inlet. This stream may be locally impacted by run-off from the road, manifesting itself as reduced macroinvertebrate diversity over a limited length of channel. The stream is not important in the fisheries context but probably holds a stock of small brown trout.

Most of the drainage from Section 2 discharges to a small stream/field-drain, which is within the Gaurus River catchment (Drainage Outlet #3A). Impact on this stream is likely to be significant given its small size relative to the length of road being drained. However, the stream is too small to be of any fisheries or other ecological significance.

Drainage from the northern third of Section 2 and the southern third of Section 3A will discharge to the upper Gaurus River (Drainage Outlet #4). The stream at this point is a combination of sluggish pools, small glides and riffles. This stream is likely to be slightly impacted close to the discharge point from the highway. The most likely impact is a reduction in macroinvertebrate diversity. However, dilution and mixing is likely to confine this effect to within a short distance of the drainage outlet, perhaps the first 100 - 150 m downstream.

Drainage from the remainder of Section 3A and the southern half of 3B will enter a small stream/drain (Drainage Outlet #5), which drains to Cappagh Lough. The impact on this stream may be locally significant because of its small size. However, in overall ecological terms it will be very slight and will ensure a measure of improvement before the drainage reaches Cappagh Lough proper. There will likely be some carry over effect on Cappagh Lough whose sediments will act as a trap for solids-associated heavy metals and hydrocarbons. It is very difficult to estimate what the impact on the Lough would be. However, by comparing the size of the lake (2.63 ha) to that of the area of carriageway, which will be draining to it (2.58 ha), i.e. just over 1:1 ratio, we can get some feel for possible magnitude of the impact. In their study of drainage treatment systems for the M1 Motorway in the UK, Colwill *et al.* (1985) indicated a lagoon about 5-6% of the area of the carriageway draining to it was sufficient to very effectively attenuate contaminants in that that drainage. This would suggest that any contamination from the proposed roadway would sediment out in a small corner of Cappagh Lough. Any impact from the road drainage, which might include a localised reduction in macro-invertebrate diversity, would be largely confined to this corner. Any in built drainage treatment system would reduce this impact. Neither Cappagh Lough itself nor the small stream draining to it, are noted for their fishery importance.

Drainage from section 3B will enter a very small stream/drain (Drainage Outlet #6), which is too small to be of ecological importance.

Most of the drainage from Section 4 will go directly to the Fergus (Drainage outlet #10) where the extremely large dilutions afforded would counteract any significant adverse impact from the discharge.

Drainage from Sections 5B and 6 (i.e. Drainage Outlets #7 and #8) are unlikely to have any significant impact on their receiving waters, by virtue of the relatively small existing and projected traffic volumes on these sections. Section 5A of the western relief may have some minor impact

on the small stream receiving run-off through drainage point # 9. Such impact is most likely to take the form of increased silt levels and reduced macro-invertebrate diversity downstream of the drainage outlet.

3.4. Accidental Spillages of Hazardous Materials

3.4.1. Introduction

Major road spillages are relatively rare (Anon 1993). Nevertheless there have been instances of spillages in recent years on Irish roads involving escapes of diesel from both tankers and truck fuel tanks following road accidents (pers. comm. Mr. Michael Fitzsimons, Shannon Regional Fisheries Board).

3.4.2. Accident Prediction

Trying to predict the occurrence of a spill with any degree of certainty is likely to be fraught with problems. Nevertheless, some assessment may serve to indicate those sections of road where the risk is perceived, theoretically at least, to be greatest and, depending on possible receiving waters, impacts may therefore warrant more comprehensive mitigation measures. The UK Department of Transport (Anon. 1993) provides a simple formula for assessment of the likelihood of an accident involving a heavy commercial vehicle carrying hazardous liquids (mainly oil and petrol tankers) with the assumption that this will give some indication of the risk of pollution. The formula predicts the frequency of accidents along a given stretch of road in a year as follows:

$$AADT \times 365 \times \%HGV's \times 0.1 \times K \times RL$$

Where AADT = Annual Average Daily Traffic (worst year in first 15, high growth); HGV = Heavy Goods Vehicle; 365 = days in a year; 0.1 = the estimated proportion of HGV's carrying hazardous material; $K = 0.47 \times 10^{-6}$ i.e. the accident rate of HGV's per million vehicle kilometres per annum in the UK (1991 figures); RL = road length in kilometres.

Using this formula the accident rates for hazardous liquid carrying HGVs, for different sections of the proposed Ennis roadway were predicted (Table 5). Clearly this can only be used as a guide, given that the accident rate in the formula (K) is the 1991 UK rate and which is itself an average rate over the whole country.

TABLE 5 Predicted accident rate for Heavy Commercial Vehicles carrying hazardous materials (primarily oil and petrol tankers) on each section of the proposed road at Ennis (see text for formula).

Section No.	Section length	AADT (existing)	AADT (2010)	% HCV's	(A) Predicted Accident Rate per Year (1997)	(B) Predicted Accident Rate per Year (2010)	Accident Return Rate 1997 (1/A) (years)	Accident Return Rate 2020 (1/B) (years)
1	5.87	17,887	35,522	13	0.234	0.465	4	2
2	3.18	5,799	11,516	23	0.073	0.144	14	7
3A	2.03	4,750	9,431	13	0.022	0.043	46	23
3B	2.05	9,590	19,043	13	0.044	0.087	23	11
3C	0.72	9,380	18,614	13	0.015	0.030	67	34
4	2.65	12,421	24,666	13	0.073	0.146	14	7
5A	1.17	4,922	9,769	13	0.013	0.025	78	39
5B	1.54	3,205	6,326	13	0.011	0.022	90	46

6	1.87	2,073	4,121	13	0.009	0.017	116	58

Table 5 indicates that road accidents involving heavy commercial vehicles are predicted by the formula to occur more frequently on Sections 1, 2 and 4, and to a lesser extent Section 3B. These rates relate to a combination of traffic volume (AADT), proportion of HCV's and length of roadway involved. The predicted (theoretical) figures for 2020 show a doubling on the predicted 1997 accident rate because the AADT is also predicted to double in that time. These sections are principally situated along the eastern by-pass (nos. 1, 2, and 3B) and on the first section (no. 4) of the western relief. It should be borne in mind that these rates refer to accidents not to accidents resulting in pollution incidents. 'Neither an accident nor a spill will necessarily have the potential to cause run-off. Research suggests that there is approximately one major spill for every ten spills. This is the probability against which the consequences of contamination affecting receiving waters should be assessed' (Anon 1993, Bickmore and Sutton 1984).

In evaluating the above assessment, it should be noted that traffic growth and the associated accident risk will occur regardless of whether or not the proposed bypass is built.

3.4.3. Predicted Risk and Potential Impact of Accidental Spillages

In the present context only Sections 1, 2, 3B and 4 of the proposed road are of particular interest given that the risk assessment indicated that accidents were likely to be more frequent on these stretches.

In the case of 3B (Drainage Outlet #6) the receiving stream is very small and of no fisheries importance. However, about 3 km to the west it does drain to the Fergus. The section of the Fergus involved is upstream of the town, above the tidal section, and is an important angling area. As such, Outlet #6 must be considered a possible source of risk to the Fergus.

The drainage from the southern third of Section 1 is likely to flow to Latoon Creek in the tidal section of the Rein River (Drainage Outlet Point #1) where tidal dispersion should help reduce the impact of any spillages which might enter the system. Drainage from the northern two thirds of the same section including part of the drainage from the main intersection with Section 4 on the Western Relief Road is likely to be directed to a small stream flowing south from Kilbreckan Lough (Drainage Outlet Point #3). This stream eventually flows under the N18 at Carnelly Bridge and from there to the Fergus estuary. The distance from the drainage discharge point to the Fergus estuary is about 5 km. Although this stream probably holds a good stock of small trout it is not a significant fisheries resource. Considering this, its distance from the Fergus, which would serve to dilute any spillages which might reach it, and the fact that the stream enters the Fergus in the lower estuary, the requirement to include special holding facilities in the road design, is arguably much diminished.

Most of the drainage from Section 4, which includes a major junction with Section 1, is likely to enter the upper Fergus estuary directly, just south of Clare Abbey (Drainage Outlet #10). Given the heavy traffic on this section of roadway and the fact that most of its drainage will enter the Fergus directly, serious consideration should be given to the feasibility of including a spillage retention facility within the design of the highway at this point.

The significantly lower traffic volumes on the other sections of the proposed roadway, coupled with the lower associated risk of accidents with vehicles carrying hazardous materials, obviates the requirement of designing in a special spillage retention system at these points

4. MITIGATION

4.1. Introduction

Mitigation measures are discussed separately for the construction and operational phases of the scheme. The operational phase mitigation integrates considerations of both potential impacts from normal run-off and from accidental spillages.

4.2. Construction Phase and Design Mitigation

Several sets of guidelines are available which are designed to minimise or eliminate adverse water quality and fisheries impacts in surface waters, associated with the operation of construction sites. These include those of the Scottish Environmental Protection (SEPA) (Anon 1996) and the related SEPA/Environment Agency Pollution Prevention Guideline Series. In addition the, the Department of Marine and Natural Resources has issued its own guidelines to local authorities (Anon 1998) directed at minimising fisheries impacts from various construction operations and with regard to the design of in-channel structures such as bridges, culverts and fords.

Silt and Solids Escapement

The main principle of control is based on the protection of the soil surface from rainfall and run-off, and on containing eroded soil particles on site. As fine particles can be very difficult to contain once they have been mobilised the best way to control the generation of sediment is to prevent erosion taking place. Specific measures can be found in the documents listed above, however, the following points are worth emphasising.

Whereas it is highly desirable to minimise the amount of erosion on construction sites it will usually also be necessary to provide settlement ponds or lagoons to remove the sediment, which will invariably be present in site drainage. These would be especially important where drainage enters sensitive fisheries waters. It is recommended that sediment-trapping lagoons be provided at the Claureen, Fergus and Gaurus crossing points to protect these rivers from silts or solids escapement during construction.

Furthermore, temporary culverts and/or bridges should be provided to enable vehicles to cross rivers and streams and thus prevent disturbance of the river bed. This would be particularly important in the case of the Claureen, the Gaurus and the small stream SSE of Bridge #3 as these are probably small enough to be crossed by vehicles and large enough to hold healthy fish stocks, particularly the Claureen.

Finally, stockpiles and spoil heaps should be located well away from drainage ditches and water courses. This recommendation applies to all watercourses crossed by the proposed route.

Cement

It is essential to ensure that the use of cement and wet concrete in or close to any watercourse is carefully controlled so as to minimise the risk of any material entering the water, particularly from shuttered structures or the washing of equipment. All bulk liquid cement should be handled well away from watercourses including drains in order to prevent accidental spillages. This recommendation applies to all watercourses crossed by the proposed route.

Oil and Chemicals

Fuel, oil and chemical storage where necessary on site should be situated on an impervious base within an impervious bund and secured. Everything should be locked and held at a safe distance from watercourses including drains. Re-fuelling of mobile plant should be undertaken well away from watercourses including drains. Diesel pumps and similar equipment should be placed on drip trays to collect minor spillages or leaks. This recommendation applies to all watercourses crossed by the proposed route.

Bridge and Culvert Design

The Shannon Regional Fisheries Board should be consulted in advance about the design of certain river and stream crossing structures before these are finalised. These include the two bridge crossings proposed for the road i.e. over the Latoon Creek (Bridge #1) and the Fergus (Bridge #10), as well as about at least three of the culverts i.e. those crossing the Claureen (very important), the upper Gaurus (i.e. the small stream just north of Bridge #7) and the culvert for the stream SSE of Bridge #3 (near the railway line). In any case, the recommendations in Department of Marine and Natural Resources guidelines to Local Authorities (Anon. 1998) should be adhered to wherever feasible.

4.3. Operational Phase Mitigation

4.3.1. Mitigation Options

There are a number of potential options for the treatment of highway run-off. The most widely used tends to be either a french drain or lagoon/sedimentation pond system. These methods are discussed below, followed by two other options (constructed wetlands and use of natural wetlands). Specific recommendations are then made for each of the crossing points.

Sedimentation Tanks, Lagoons, French Drains

Colwill *et al.* (1983) compared the effectiveness of using (i) a sedimentation tank, (ii) french drains and (iii) a lagoon to treat surface run-off from the M1 Motorway in England (see Appendix 2 for details). The average annual removal efficiencies of each treatment system for suspended solids was 52%, 85% and 92% respectively for the sedimentation tank, the french drains and the lagoon respectively. It is important to note that these treatment systems will have no impact on TDS (Total Dissolved Solids) including such constituents as sodium chloride and the other soluble components of de-icing salt, as well as most dissolved heavy metals and dissolved hydrocarbons.

It was estimated by Colwill *et al.* (1983) that the sedimentation tank would have to be desludged every 7-10 years, the french drain replaced every 10 years and the lagoon de-sludged every 20-25 years. Thus, it is important to note that none of these treatment systems would operate efficiently, beyond a certain period without maintenance and that period would depend on the design characteristics of that particular treatment system which would vary from place to place depending on the rainfall and size of the area to be drained.

Wetland Treatment Systems

There have been some recent studies of the use of constructed wetlands in treating highway and airport runway run-off (Hvitved-Jacobsen *et al.*, 1994; Mungur *et al.*, 1995; Revitt *et al.*, 1997).

An important feature of all wetland treatment systems is their generally high efficiency in removing solids and solids-associated contaminants (e.g. heavy metals, phosphorus, PAH's etc.). Constructed wetlands can also remove BOD and COD to various efficiencies but cannot generally remove chloride and other non-reactive ions and TDS (total dissolved solids) in general. Constructed surface flow wetlands, which are one of the types that have been tested for highway run-off treatment (Mungur *et al.*, 1995) and airport runway treatment (Revitt *et al.*, 1997) consist essentially of an area of shallow water usually densely planted with tall wetland plants. The latter can include Great Reedmace, Common Club-rush, Common Reed, Yellow Iris, etc., all of which are common in Irish wetlands.

Advantages for using wetlands: Wetlands tend to be cheap to construct relative to conventional treatment systems, and don't require sophisticated construction technologies. When they include provision for open water areas may be inhabited by a variety of wildlife, especially bird life and therefore incorporate an intrinsic amenity value. Finally, they require very little operation and maintenance and have a long life.

Disadvantages: Although simple in concept and essentially uncomplicated in design, constructed wetlands must be seen as both as biological entities with their own very complex internal functioning's linked to material cycles and as having diverse hydraulic microclimates which may not always produce the treatment efficiencies predicted.

Existing Wetlands

Several of the proposed surface drainage discharge points from the proposed road are adjacent to small wetlands or heavily vegetated drainage ditches which might be suitable for development as contaminant attenuation areas, alone or in combination with french drains or lagoon systems built into the roadway itself. It must be borne in mind however, that a number of factors might make the existing wetland/drainage systems unsuitable from immediate use for the reception of drainage water. These include: the presence of rare or interesting botanical or faunal communities, insufficient size, inappropriate local hydraulic regime which might for instance lead to local flooding, need for too much manipulation in order to optimise for contaminant removal purposes.

Mitigation of Impacts from Highway Runoff due to Hazardous Spillages

Given that most of the incidents associated with the run-off of large volumes of hazardous materials are likely to result from accidents, any measures to reduce the risk of accidents should also help to reduce the likelihood of accidental spillage. In the event of an accident occurring, early notification of the Regional Fisheries Board and local angling interests might allow fish stocks to be transferred from threatened water courses to un-affected waters in advance of possible pollution. The most fail-safe method of protection would be at the design stage itself, when valve controlled spillage storage areas could be incorporated into the highway drainage system along stretches which, by virtue of traffic volume etc. were considered most at risk. Such storage areas might also serve as sedimentation basins/ponds for on going highway run-off treatment. However, their design would have to be such that they were able to cope with the size of the spill, a certain volume of fire water or wash-down water, as well as rainfall during the period of the accident and clean-up. If it were considered too expensive to incorporate such structures into the civil works, a constructed wetland with a controlled outlet might be used instead to contain spillages. The latter would have to be lined to insure that groundwater was not impacted and would have the disadvantage that any spill might damage the wetland itself. This, however, might be preferable to polluting of a watercourse.

Summary

To judge from Colwill *et al.* (1985), both french drains and lagoons have high rates of contaminant removal efficiencies. In fact it would seem that either of these systems would be more than adequate to provide a high degree of protection of receiving waters from normal road run-off were they to be included in the drainage designs of the proposed road. Constructed wetlands and the use of natural wetlands are other options, but may require specialist expertise for their design.

Valve-controlled spillage storage areas for protection against accidental spillages could be incorporated into either lagoon or constructed wetland systems.

4.4. Specific Mitigation Recommendations

The following are suggestions for mitigation measures for each of the drainage outlets based on the various considerations discussed above. These incorporate consideration of both normal road run-off and the potential for impacts from spillages of hazardous material. No specific mitigation recommendations are made for Drainage Outlet #2; this is located at a high point/crest in the proposed route.

4.4.1. Drainage Outlet #1

No specific mitigation is required because tidal dispersion should be sufficient to reduce the impact of any run-off.

4.4.2. Drainage Outlet #3

A French Drain, Lagoon or Constructed Wetland system is recommended.

4.4.3. Drainage Outlet #3A

A French Drain, Lagoon or Constructed Wetland system is recommended.

4.4.4. Drainage Outlet #4

A French Drain, Lagoon or Constructed Wetland system is recommended.

4.4.5. Drainage Outlet #5

A French Drain, Lagoon or Constructed Wetland system is recommended.

4.4.6. Drainage Outlet #6

A Lagoon or Constructed Wetland system incorporating a Spillage Holding Facility is recommended.

4.4.7. Drainage Outlet #7

The potential for impacts from either normal run-off, or accidental spillages, is considered to be low here. However, the receiving water (the Claureen) is of angling importance, and there are

angling pools downstream of the outlet. There may be a case, therefore, for incorporating some form of mitigation here.

4.4.8. Drainage Outlet #8

No specific mitigation is required.

4.4.9. Drainage Outlet #9

A French Drain, Lagoon or Constructed Wetland system is recommended.

4.4.10. Drainage Outlet #10

A Spillage Holding Facility is recommended.

REFERENCES

Anon (undated). *Pollution Prevention Guidelines (PPG 1, general guide to the prevention of pollution; PPG 5 Works in, near or likely to affect watercourses, PPG 6 Working at construction and demolition sites).* Jointly produced of the Scottish Environmental Protection Agency, the Environment Agency and Environment and Heritage Services.

Anon. (1993). *Design Manual for Roads & Bridges Volume II Environmental Assessment* (Department of Transport, UK). HMSO, London, UK.

Anon (1996). *Guidelines for water pollution prevention from civil engineering contracts.* Scottish Environmental Protection Agency.

Anon (1998). *Fishery guidelines for local authority works.* Department of the Marine and Natural Resources, Dublin.

Ball, R., Hamilton and R. Harrison (1991). The influence of highway-related pollutants on Environmental quality. in *Highway Pollution.* R. Hamilton & R Harrison (eds.) Elsevier Science, New York.

Barton B. A. (1997). Short-term effects of highway construction on the limnology of a stream in southern Ontario. *Freshwater Biology.* 7, 99-108.

Bickmore, C. and Sutton D. (1984). Oil and Toxic Spillages in Motorway Run-off. *The Surveyor* (May 10th, 1984)

Clinton, S. (1992). A baseline survey of water quality in six streams along the route of the proposed new road between Adare and Limerick City. In: *N20/N21 Road Improvements, Patrickswell (Lantern Lodge) to Limerick: Environmental Impact Statement* (Volume III - B Reference Reports), Limerick County Council.

Colwill D.M, Peters, C.J. and Perry R. (1985). *Motorway Run-off- The Effect of Drainage Systems on Water Quality,* Research Report No. 37 Transport and Road Research Laboratory, Crowthorne, Berkshire, England.

Hvitved-Jacobsen, T. and Yousef, Y.A. (1991). Highway run-off quality, environmental impacts and control. *Highway Pollution.* R. Hamilton & R Harrison (eds.) Elsevier Science, New York.

Hvitved-Jacobsen, T., Johansen, N.B. and Yousef, Y.A. (1994). Treatment systems for urban and highway run-off in Denmark. *The Science of the Total Environment,* 146/147.

Kadlec, R.H. (1995). Overview: surface flow constructed wetlands. *Wat. Sci. Tech.* 32, 1-12

Maltby, L., Boxall, A.B.A., Forrow, D.M., Callow, P. and C.I. Betton (1995b). The effects of motorway run-off on freshwater ecosystems: 2. Identifying major toxicants. *Environment. Toxicol. Chem.* 14, 10939-1101.

Maltby, L., Forrow, D.M., Boxall, A.B.A., Callow, P. and C.I. Betton (1995a). The effects of motorway run-off on freshwater ecosystems:1. Field study. *Environment. Toxicol. Chem.* 14, 1079-1092.

McGarrigle, M.L, Clabby, K.J., Toner, P.F., Neill, M, Lucey, J. Flanagan, M. and M. B. Quinn (1996). *Water Quality in Ireland (1991-1994) - Statistical Compendium of River Quality Data* Environmental Protection Agency, Ardcavan Wexford.

McNeill, A. (1996). Road construction and river pollution in south-west Scotland. *Water Environ. Manage.* 10, 175-182.

Mungur, A.S., Shutes, R.B.E., Revitt, D.M. and M. A. House, (1995). An assessment of metal removal from highway run-off by a natural wetland *Wat. Sci. Tech.* 32 169-175.

Revitt, D.M., Shutes, R.BE. Llewellyn, N.R. and P. Worrall (1997). Experimental reedbed systems for the control of airport run-off. *Wat. Sci. Tech.* 8-9, 385-390.

Sansalone, J.J., Buchberger, G. and S. Al-Abed (1996). Fractionation of heavy metals in pavement run-off. *Sci. Total Environ.*, 189/190, 371-378.

Shelly, P.E. and Gaboury, D.R. (1986). Pollution from highway runoff - preliminary results, *Proceedings of Stormwater and Water Quality Model, Users Group Meetings, March 25-26, 1986, Orlando, Florida*, EPA/600/9-86/023, 1986

Stace, C. (1991). *New Flora of the British Isles*. Cambridge University Press, Cambridge, UK.

Yousef, A Y, Baker, D. and Hvitved-Jacobsen, T. (1996). Modeling and impact of metal accumulations in bottom sediments of wet ponds. *The Science of the Total Environment* 189/190, 349-354.

APPENDICES

APPENDIX 1

Highway run-off: water quality data

Tables A1-A3 present data from a study of the M1 Motorway in the UK in the mid 1980's (Colwill *et al.*, 1985). Table A4 presents data from a study of several sites in the USA (Shelly and Gaboury, 1986).

Table A1 Ranges of concentrations in water quality parameters observed on M1 Motorway run-off study (Nov 1980-March 1983) (Colwill *et al.*, 1985)

Parameter	Units	Sample Type	Winter	Summer
pH		max	7.6	7.0
		min	6.1	5.7
		(n)	(13)	(11)
Conductivity	µS/cm @ 25°C	max	22,000	552
		min	80	25
		(n)	(13)	(n)
Total Solids	mg/l	max	12,860	672
		min	167	<15
		(n)	(13)	(10)
Total Suspended Solids	mg/l	max	812	4,269
		min	10	18
		(n)	(25)	(16)
Total Volatile Solids	mg/l	max	940	229
		min	56	<20
		(n)	(10)	(10)
Total Dissolved Solids	mg/l	max	15,560	455
		min	1,441	12
		(n)	(6)	(5)
Oil	mg/l	max	26	52
		min	8	6
		(n)	(9)	(7)
COD	mg/l	max	362	845
		min	44	14
		(n)	(5)	(9)
Chloride	mg/l	max	6,714	40
		min	12	1
		(n)	(13)	(11)
Total Lead	mg/l	max	2.87	8.59
		min	0.32	0.054
		(n)	(25)	(14)
Total Zinc	mg/l	max	4.05	3.87
		min	0.28	0.08
		(n)	(25)	(14)
Total Cadmium	mg/l	max	0.10	0.039
		min	<0.003	<0.003
		(n)	(13)	(13)

(n) = number of events sampled

TABLE A2 Seasonal flow-weighted event mean concentrations for untreated surface run-off (winter and summer sampling periods) on the M1 Motorway - Nov 1980 – September 1981. (in Colwill *et al.*, 1985)

	TS (mg/l)	TVS (mg/l)	TSS (mg/l)	Cl (mg/l)	Pb (µg/l)	Zn (µg/l)	Cd (µg/l)
Winter							
Mean	3,003	242.2	169	1,551	630	1,130	15.2
RSD %	105.2	71.6	40.8	113.0	47.8	81.9	67.1
(n)	(10)	(9)	(13)	(9)	(10)	(10)	(7)
Summer							
Mean	325	98.1	230	17.5	550	1,176	11.4
RSD %	24.4	39.6	73.5	56.9	19.5	25.9	36.9
(n)	(4)	(4)	(10)	(11)	(6)	(5)	(3)

RDS = Relative Standard Deviation (per cent)

TABLE A3 Mean concentration of Total Suspended solids, oil and total (four*) polycyclic aromatic hydrocarbons (PAH) from samples collected during a single run-off event on th M1 Motorway (Colwill *et al.*, 1985)

	TSS (mg/l)	Oil (mg/l)	PAH (µg/l)
Untreated	92	30	3.7

4 PAH's were: Benzo(a)pyrene, Benzo (ghi)perylene, Fluoranthene, Indeno (123 cd) Pyrene

TABLE A4 Median highway run-off constituent concentrations for several sites in the USA (Shelly. and Gaboury,, 1986).

Parameter	Urban Sites (mg/l)	Rural Sites (mg/l)	All Sites (mg/l)
Suspended Solids	220	26	108
COD	124	41	86
TKN	2.72	1.4	2.18
TP	0.19	0.04	0.11
Lead	0.55	0.09	0.31
Zinc	0.38	0.09	0.24

APPENDIX 2

Details of three highway run-off treatment systems from a study of the M1 Motorway in the UK in the mid 1980's (Colwill *et al.* 1985)

Sedimentation Tank

The sedimentation tank was 3.49m long x 0.72m wide x 0.90 m deep with a nominal capacity of 1,450 l (determined by the position of the inflow and outflow pipes).

French Drain

The french drain consisted of a 50 m long vitrified clay pipe, 150 mm in diameter with two rows of 6.25 mm perforations along its upper surface. The pipe was 75 mm above the base of the train and was covered to a depth of 1.2 m by specified granular material. The drain was lined with 0.4 mm polythene sheeting to prevent infiltration.

Lagoon

The lagoon was 28 m long x 2 m wide, of approximately trapezoidal section with a maximum depth of 0.3 m. Each treatment system drained approximately 800m^2 of motorway surface. The annual rainfall was 560 mm.

TABLE A5 Mean annual removal efficiencies (%) of materials for different treatment systems in a study of run-off from the M1 Motorway in the UK (Colwill *et al.*, 1985)

Parameter	Sedimentation Tank	French Drain	Lagoon
Total Suspended Solids	52	85	92
Total Lead	4-	83	90
Total zinc	47	81	76
Solid Associated Zinc	57	84	84
Dissolved Zinc	15	56	62
COD (Chemical Oxygen Demand)	35	59	54
Oil	<30*	70*	>70*
PAH's	<30*	70*	>70*

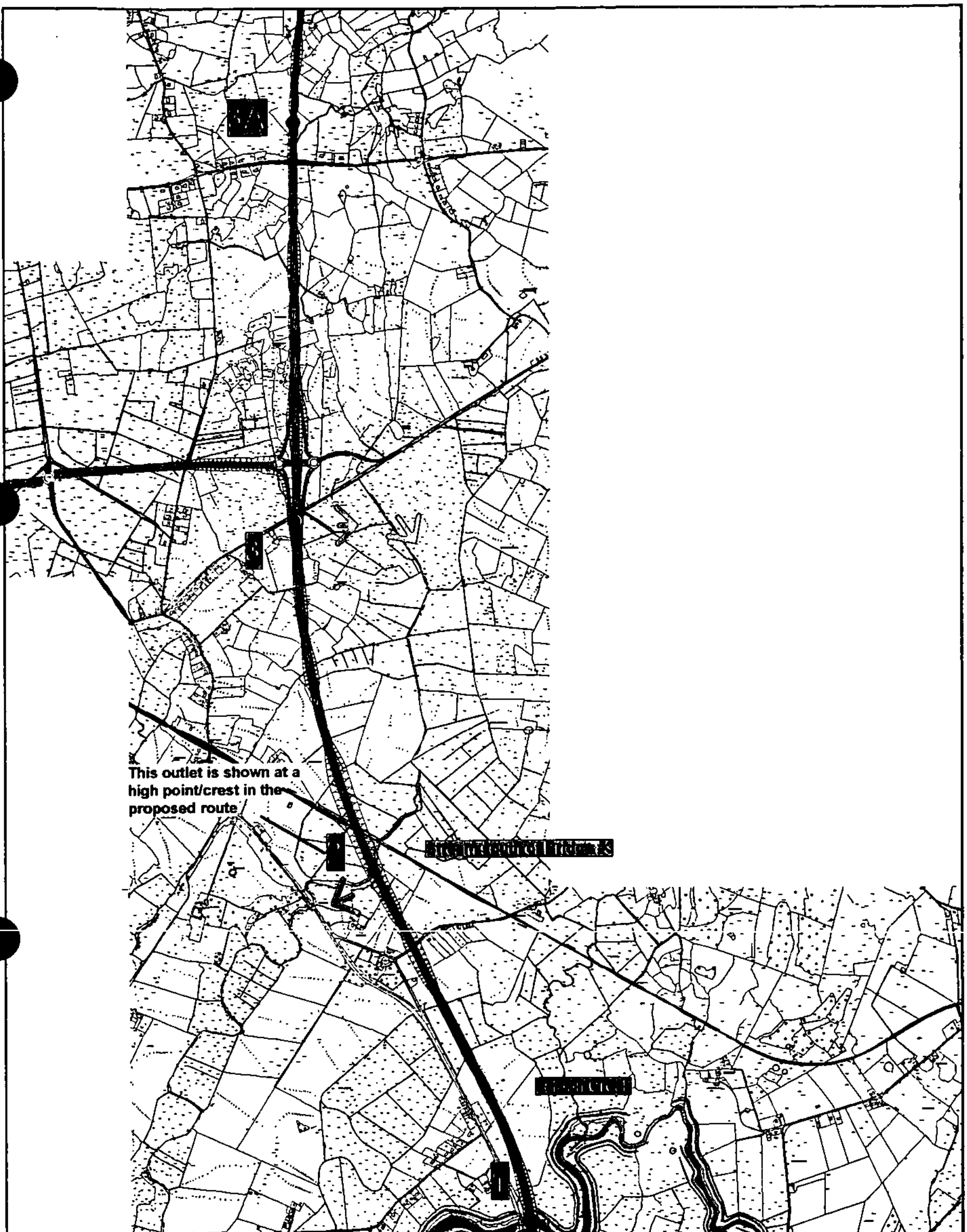
* estimated, not verified statistically.

APPENDIX 3

Scientific names of plants mentioned in the text

Nomenclature follows Stace (1991)

Common Name	Scientific Name
Common Reed	*Phragmites communis*
Reed Canary-grass	*Phalaris aurundinacea*
Greater Pond-sedge	*Carex riparia*
Yellow Iris	*Iris psuedacorus*
Fool's Water-cress	*Apium nodiflorum*
Soft Rush	*Juncus effusus*
Hard Rush	*Juncus inflexus*
Creeping Bent	*Agrostis stolonifera*
Creeping Buttercup	*Ranunculus repens*
Jointed Rush	*Juncus articulatus*
Meadowsweet	*Filipendula ulmaria*
Water Forget-me-not	*Myosotis* sp.
Gorse	*Ulex europaeus*
Great Reedmace	*Typha latifolia*
Common Club-rush	*Schoenoplectus lacustris*



Watercourse crossings and drainage outlets

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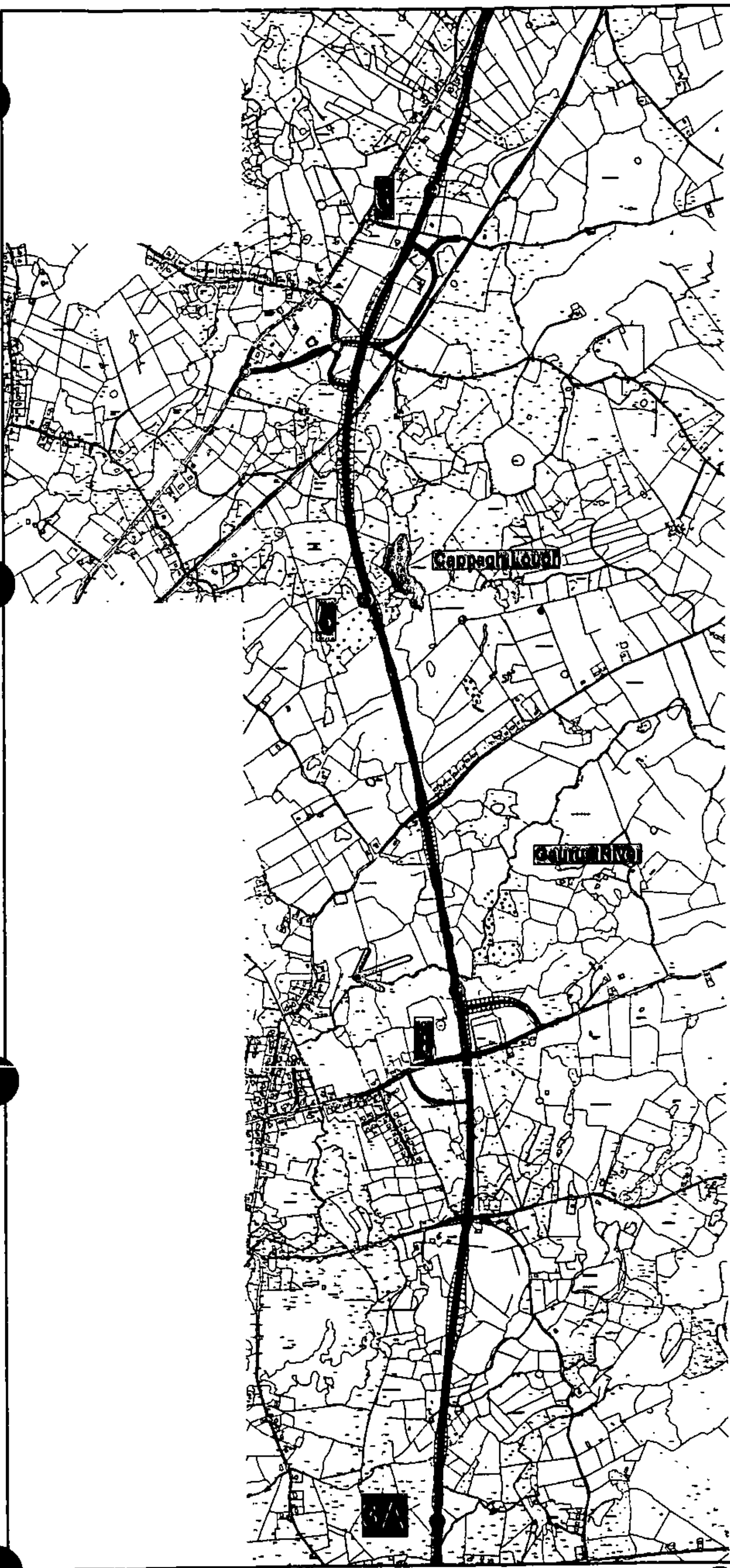
Figure 1a



Watercourse crossings and drainage outlets

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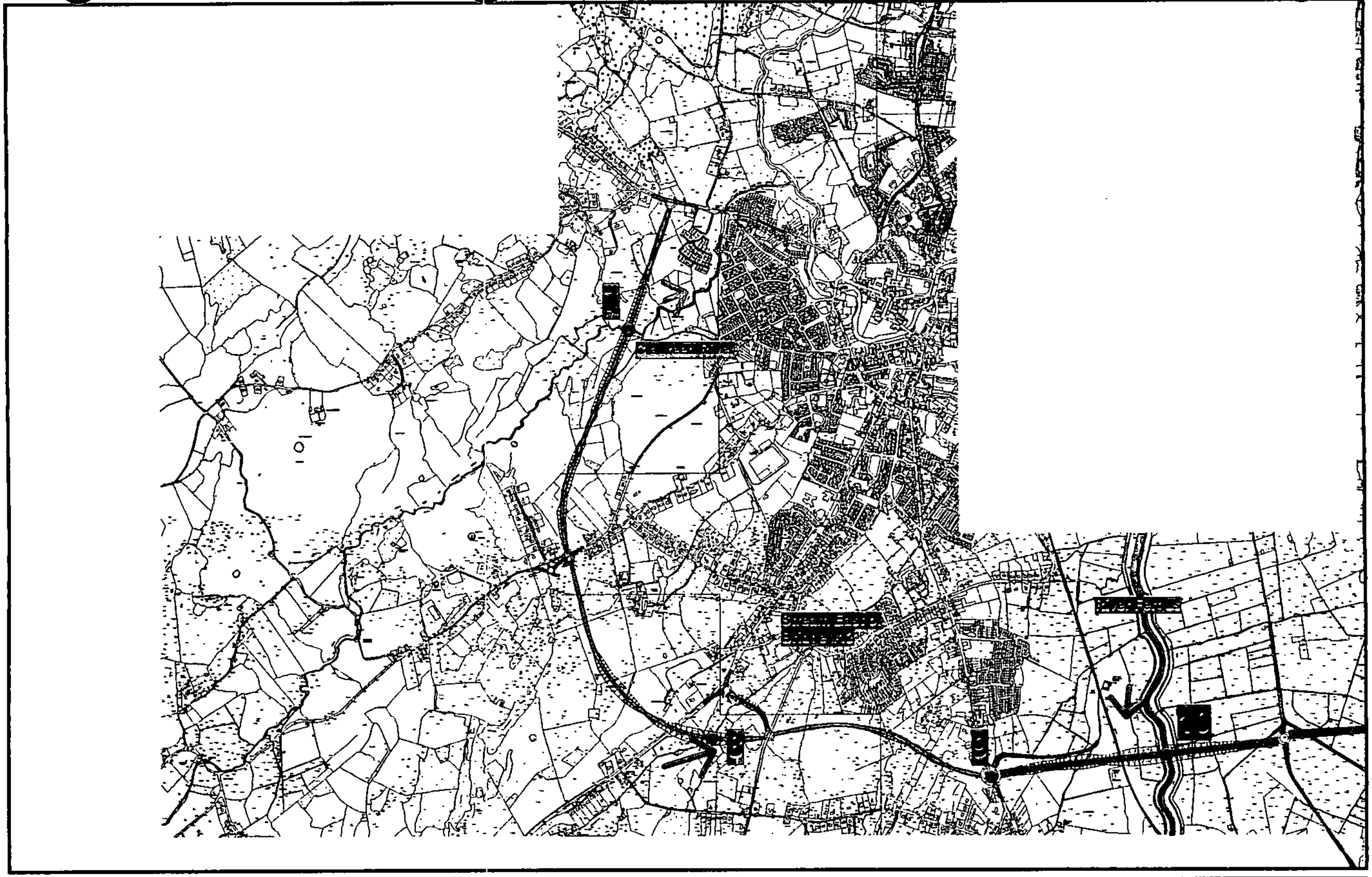
Figure 1b



Watercourse crossings and drainage outlets

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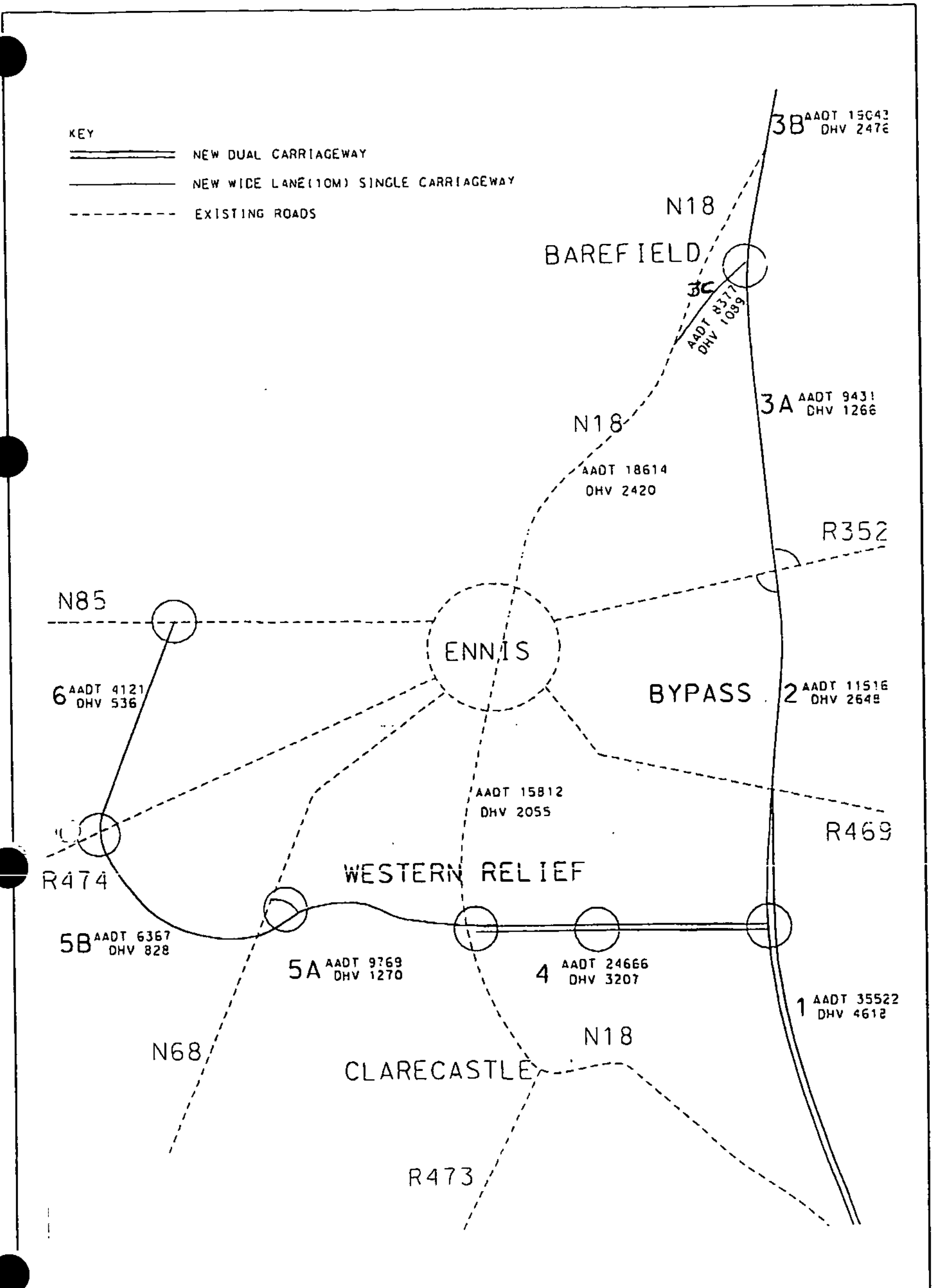
Figure 1c



Road Sections

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Figure 2

APPENDIX VI

NOISE & VIBRATION

PART A **Environmental Noise Impact Assessment (ANV Technology)**

APPENDIX VI – PART A

Environmental Noise Impact Assessment
(ANV Technology)

ANV TECHNOLOGY
ENVIRONMENTAL & OCCUPATIONAL HYGIENE CONSULTANTS

July '99

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

N18 Dromoland to Crusheen

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ANV TECHNOLOGY

Environmental Noise Impact Assessment
N18 Dromoland to Crusheen

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ANV TECHNOLOGY

Environmental Noise Impact Assessment
N18 Dromoland to Crusheen

1. INTRODUCTION

ANV Technology has conducted a noise impact assessment of the proposed N18 Dromoland to Crusheen road development on behalf of Clare County Council.

This assessment determines and evaluates the noise and vibration impact of the proposed road development. The impact is assessed during construction, in the proposed year of opening of the scheme 2005, and fifteen years later, in 2020. The impact of not proceeding with the scheme is also assessed.

2. PROPOSED DEVELOPMENT

The proposed N18 road development extends from Dromoland to Crusheen, (Chainage 24554 to 28000).

The section of the proposed development to the east of Ennis is termed the Eastern Bypass. The proposed route, as shown in maps A to D, will pass mainly through rural areas. The AADT in 2020 is estimated to be 35522 vehicles with 13% DHV at the segment with heaviest traffic loading.

The scheme also includes a Western Relief road to the south of Ennis, as indicated in map E. The maximum AADT on the Western Relief road is 24666 vehicles, again with 13% DHV.

2.1 ALTERNATIVE ROUTES

Four route options A to D were considered with respect to potential noise impact. Route option D is assessed in detail in this report.

Option B
The potential noise impact of route option B, a route to the east of Ennis, would be almost identical to the impact of option D discussed in this report. It would bring the advantages of an improved noise environment through by-passing Clarecastle and Barefield. The noise exposure along the eastern route would increase to a similar extent as that detailed in this report for option D.

Options A and C
The impact of options A and C, the western and far-western routes respectively would be similar to the impact of the Western Relief section discussed in this report which extends as far as the N85 junction. There is no significant noise impact to that point.

Route options A and C extend further than the Western Relief róad through rural, sparsely populated areas. The noise impact is expected to be an increase in background traffic noise similar to that described in this report for houses along the Eastern Bypass, that is, from noise levels of 30-40dB(A) to 50-60dB(A). Both of these route options will by-pass Clarecastle, with the attendant benefits described in this report. Barefield, however, would not be by-passed and there would be an increase in traffic noise here.

There are no particularly noise sensitive locations on the proposed alternative routes.

The bypass of Barefield, included in route options B and D, reduces the noise exposure of about 17 houses significantly. With this exception, there are no significant differences between the four route options in terms of potential noise impact.

3. EXISTING NOISE ENVIRONMENT

The existing N18 passes through Clarecastle and Ennis. Much of the proposed Eastern Bypass route is through rural areas with a low population density. The proposed Western Relief road passes to the south of Ennis.

A noise survey was conducted to establish the existing noise environment along the current and the proposed routes.

3.1 MEASUREMENT METHODOLOGY

Noise measurements were conducted in accordance with ISO 1996 "Description and measurement of environmental noise " and the UK Department of Transport "Calculation of Road Traffic Noise".

Instrumentation used was Type 1 Sound Level Meters, Brüel & Kjær Type 2260 and CEL Model 480, calibrated with Brüel & Kjær Calibrator Type 4231.

A description of relevant noise parameters is given in Appendix 1. To maintain consistency, all noise levels referred to in this report are in terms of $L_{A10,18hrs}$ at the facade of the buildings. Where other parameters are used, this is stated explicitly.

3.2 MEASUREMENT LOCATIONS

Baseline noise measurements were performed at 33 locations.

These locations were selected for measurement based on how representative they are of other houses in the area and/or that the impact of the proposed development is likely to be greatest at these locations.

Measurement locations are marked on the maps attached to this report.

3.3 EXISTING TRAFFIC NOISE

The results of the measurement survey are presented in Table 1. Detailed results are contained in Appendix 2.

In rural areas along the proposed Eastern Bypass route, the measured noise levels are generally low. The underlying levels are typically 30 - 35 dB(A) L_{A90}. With increasing proximity to secondary routes such as the Quin Road and Tulla Road, the noise levels increase up to about 60dB(A).

At houses near the proposed Western Relief road, measured noise levels are in the range 40 to 60 dB(A), depending on exposure to traffic noise.

At houses along the existing N18, measured noise levels are in the range 60 to 80 dB(A), depending on the distance of houses from the road and the extent of noise screening.

3.4 EXISTING VIBRATION

It has been found that the $L_{A10,18hr}$ traffic noise parameter is closely correlated with average disturbance ratings due to airborne vibration *(Baughan and Martin, 1981; Watts, 1984)*. The percentage of people annoyed by noise and vibration is presented in Figure 1.

Based on measured noise levels on the existing N18 route, it is likely that airborne vibration causes annoyance on parts of the route, especially at houses facing the road in Clarecastle and the route through Ennis. For existing noise levels of about 75 dB(A), it is likely that about 40% of people are annoyed by airborne vibration.

Given the proximity of the existing road to these houses and the uneven surface, there is also a probability of noticeable ground borne vibration, which could prove disturbing to residents.

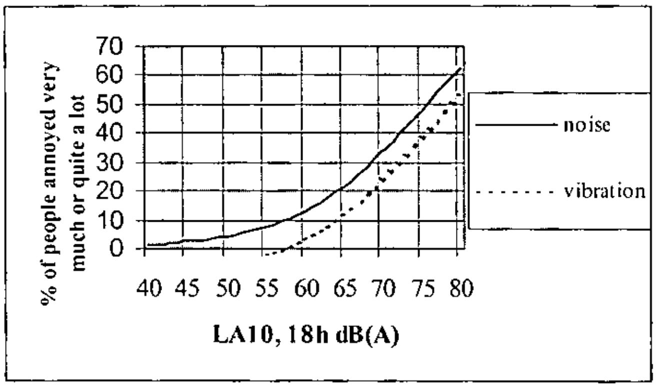


Figure 1: Estimation of nuisance due to traffic noise and vibration

Location	Map Ref.	Description	Equivalent Locations	$L_{10,18hr}$ dB(A) [1]	Vehicle count, 1 hour	% dhv
Latoon	1A;2	Front cottage	1A;1	78	1122	9
	1A;2	Rear cottage		59	1122	9
	1B;1	Dunne	1B;4	58	1122	9
	1B;2	Vacant	1B;3,	59	1122	9
Killow	2A,2	Ch15650	2A;1	46 (30) [1]	11	6
Quin Rd.	2B;4	At vacant site		62	164	4
	2B;5	Occupant unknown		60	164	4
Gaurus	2B;2	Clune, ch 18000		46 (36) [1]		
	2B;1	Adj. Rockville	2A;3	52		
Tulla Rd.	3A;3	Vacant house	3A;4, 3A;5	60	180	5
	3A;6	Lane @ Hillcrest		39 (34) [1]	180	5
Ballymacahill	3A;1	Ch 20460	3A;2	47 (31) [1]	3	-
Cappaghmore	3B;4	Lynch		44 (32) [1]		
Barefield	3B;1	M. Doolaghty		65	582	19
	3B;2	Mrs. Doolaghty		48	582	19
	3B;3	Hogan		40 (33) [1]		
	3C;2	School front		74	524	10
	3C;3	Hynes		53	498	15
	3C;4	O'Shea	3C;5	51	498	15
	3C;6	Callinan, front		71	480	9
		Callinan, rear		56	480	9
	3C;1	Fahey, front		67	430	9
		Fahey, rear		50	524	10
Clarecastle	5;7	Main St.		79	1140	7
	5;8	houses opp. school		74	1185	9
Limerick Rd	5;1	Behan	5;2	67	1140	7
College Grdn	5;3	rear of estate		50	1140	7
Abbey View	5;6	Adj. no 30		52	-	-
Kilrush Rd.	5;4	Ashline House		53	-	-
Cahercalla	5;5	Hospital grounds		44	-	-
Miltown rd.	6;4	opp. Eyredemense		59	160	11
Golf course	6;3	12th green		51 (39) [1]	-	-
	6;2	house adj. 11th tee		48 (38) [1]	-	-
Brookville	6;1	No. 22		60 (43) [1]	-	-
Limerick Rd.	6;5	No. 1		71	864	9
Mill Rd.	6;6	Ennis Motor Factor		76	1072	7

Table 1: Measured L_{A10} values to establish existing noise environment

[1] Where noise is not dominated by nearby traffic, L_{A90} is presented in parentheses. This represents the steady underlying noise level due to distant traffic

4. PREDICTED NOISE AND VIBRATION IMPACTS

The likely impacts are considered for the following conditions;

- without the proposed scheme (a "do minimum" scenario)
- with the proposed scheme
- during the construction phase

The noise and vibration impacts are predicted for the nominal year of opening of the proposed route, 2005, and 15 years later, 2020. The impact is assessed by comparing the predicted noise level in 2020 with and without the proposed scheme.

4.1 ASSESSMENT LOCATIONS

43 locations were selected for assessment of the noise and vibration impact based on their proximity to the proposed road and the existing road. The existing noise environment had been measured for 33 of these locations (section 3). The remainder were judged to have an existing noise environment equivalent to the measurement locations specified in Table 1.

The assessment locations are outlined as follows:

<u>N18 Eastern Bypass</u>
29 house locations were selected for assessment along the proposed route passing to the east of Ennis. Barefield N.S. is included as a noise sensitive location.

<u>Western Relief</u>
10 locations were selected for assessment along the proposed route passing to the south of Ennis. Cahercalla hospital is included as a noise sensitive location, as is Ennis Golf Club.

<u>Existing N18 passing through Clarecastle Ennis</u>
4 representative house locations were selected for assessment along the route of the existing N18.

Houses close to the selected assessment locations are likely to experience similar noise exposures.

4.2 PREDICTED "DO MINIMUM" NOISE LEVELS

The predicted noise levels in the absence of the proposed development are presented in Tables 2 and 3 for the Eastern Bypass and Western Relief road respectively.

The noise levels at the assessment locations are predicted based on existing noise levels and based on assumed traffic growth of 3% per annum. The predictions are made for 2005 and 2020. The increase on current noise levels is 1dB and 3dB respectively.

4.3 "DO MINIMUM" IMPACT ASSESSMENT

In 2020, in the absence of the road scheme, the noise environment compared with the existing environment is expected to be as follows:

- The noise levels at rural locations along the route of the proposed Eastern Bypass will be essentially unchanged, with underlying noise levels of about 33-38 dB(A) L_{A90}
- The noise levels along the existing N18 will increase by 3dB due to increased traffic flow
- In Clarecastle, over 50 houses front directly onto the road. The noise levels at these houses will be in excess of 80 dB(A), which would be considered a severe noise environment.
- Houses located within 20 m of the N18 will experience noise levels in excess of 68 dB(A). Almost all houses along the road in Clarecastle and Barefield fall into this category.
- The noise levels along the route of the proposed Western Relief road will increase by 3dB due to the increased traffic flow along all routes.

At houses very close to the existing N18, vibration levels will also increase, resulting in an increase of about 10% in the percentage of people annoyed by vibration by the year 2020.

4.4 PREDICTED NOISE AND VIBRATION LEVELS WITH PROPOSED ROAD

The methodology used in predicting noise levels is described in Appendix 3.

4.4.1 PREDICTED TRAFFIC NOISE LEVELS WITH ROAD SCHEME

The predicted traffic noise levels for the assessment locations are shown in Tables 2 and 3.

In 2020, noise levels at the assessment locations along the proposed Eastern Bypass will be in the range 47 to 72 dB(A) (Table 2), depending on the proximity to the road and the screening. Noise levels at greater distances from the road are discussed further in section 4.4.1.1.

For locations near the Western Relief road, the predicted noise levels are in the range 47 to 63 dB(A).

Houses in Clarecastle will experience a large decrease in traffic noise. Noise levels will be in the range 56-61 dB(A). Houses on the existing N18 route through Ennis will experience no significant change in noise levels.

Houses in the centre of Barefield village will experience noise levels of about 60dB(A), while at the northern end of the village, levels will be about 70dB(A).

Location	Map ref.	Existing L_{A10} (L_{A90}*)	Do Minimum L_{A10}		With Scheme L_{A10}		Difference 2020	
			2005	2020	2005	2020	dB	Impact
Latoon	**1A;1**	78	79	81	62	64	-17	significant
	~~1A;2 F~~	~~78~~	~~79~~	~~81~~				
	1A;2 R	**59**	60	62	64	66	-15	significant
	1B;1	**58**	59	61	62	64	+ 3	negligible
	1B;2	**59**	60	62	66	68	+ 6	slight
	1B;3	59	60	62	59	61	-1	negligible
Carrowgar	1B;4	58	59	61	59	61	-	negligible
Killow	2A;1	30*	31*	33*	58	60	+ 27	significant
	2A;2	**30***	31*	33*	65	67	+ 34	significant
	2A;3	52	53	55	60	62	+ 7	significant
Quin Rd	**2B;4**	**62**	63	65	65	67	+ 2	negligible
	2B;5	**60**	61	63	64	66	+ 3	slight
Gaurus	**2B;2**	**36***	37*	39*	66	68	+ 29	significant
	2B;1	**52**	53	55	64	66	+ 11	significant
Tulla Rd./-Hillcrest	**3A;3**	**60**	61	63	66	68	+ 5	moderate
	3A;4	61	62	64	64	66	+ 2	negligible
	3A;5	61	62	64	61	63	- 1	negligible
	3A;6	**34***	35*	37*	51	53	+ 16	moderate
Ballyma-cahill	**3A;1**	**31***	32*	34*	60	62	+ 28	significant
	3A;2	31*	32*	34*	61	63	+ 29	significant
Cappagh-more	**3B;4**	**32***	33*	35*	45	47	+ 12	moderate
Barefield	**3B;1**	**65**	66	68	66	68	-	negligible
	3B;2	**48**	49	51	56	58	+ 7	slight
	3B;3	**33***	34*	36*	55	57	+ 21	significant
	3C;2	**74**	75	77	57	59	- 18	significant
	3C;3	**53**	54	56	69	71	+ 15	significant
	3C;4	**51**	52	54	66	68	+ 14	significant
	3C;5	51	52	54	60	62	+ 8	significant
	3C;6 F	**71**	72	74	-	-	-	
	3C;6 R	**56**	57	59	64	66	+ 7	significant
	3C;1 F	**67**	68	70	-	-	-	
	3C;1 R	**50**	51	53	69	71	+ 18	significant

Table 2: **N18 Eastern Bypass.** Existing noise levels, Do Minimum noise levels, and noise levels With Scheme, L_{A10} in dB(A)

Data in bold is measured, remainder inferred

Location	Map ref.	Existing L_{A10}	Do Minimum L_{A10}		With Scheme L_{A10}		2020 Difference	
			2005	2020	2005	2020	dB	Impact
Clarecastle	**5;7**	**79**	80	82	59	61	- 21	significant
	5;8	**74**	75	77	54	56	- 21	significant
Limerick Rd.	**5;1**	**67**	68	70	65	67	- 3	moderate
	5;2	58	59	61	60	62	+ 1	negligible
	6;5	**71**	72	74	69	71	- 3	slight
Mill Rd.	**6;6**	**76**	77	79	73	75	- 4	slight
College Green	**5;3**	**50**	51	53	55	57	+ 4	slight
Abbey View	**5;6**	**48**	49	51	53	55	+ 4	slight
Ashline House	**5;4**	**53**	54	56	59	61	+ 5	moderate
Cahercalla Hospital	**5;5**	**44**	45	47	46	48	+ 1	negligible
Miltown Rd.	**6;4**	**59**	60	62	61	63	+ 1	negligible
Golf course	**6;3**	**39***	**40***	**42***	45	47	+ 5	slight
House adj. golf course	**6;2**	**38***	**39***	**41***	51	53	+ 12	moderate
Brookville	**6;1**	**43***	**44***	**46***	48	50	+ 4	slight

Table 3: Western Relief and **existing N18** (through Clarecastle/Ennis). Existing noise levels, Do Minimum noise levels, and noise levels With Scheme, L_{A10} in dB(A)

Data in bold is measured, remainder inferred.

4.4.1.1 Rural Traffic Noise Prediction

For existing very quiet rural areas there may be a noticeable increase in noise levels at considerable distances from the road. The approach described in *Rural Traffic Noise Prediction - an Approximation* is used for these situations (see Appendix 3).

Based on this method, four L_{A10} contours, 45dB(A) to 60 dB(A) in steps of 5dB have been calculated as shown in Table 4. As there is a considerable difference in traffic density south and north of the junction for the Western Relief road, the contour range has been determined for both segments.

The area of land enclosed by the various contours of L_{A10} for the projected road development has been determined and is included in Table 4. The free-field L_{A10} values are used, which are about 2.5dB below facade L_{A10} values.

It can be seen from Table 4 that approximately 1840 hectares of previously very quiet land will become influenced by noise levels in excess of 45 dB(A).

dB contour L_{A10} free-field	Contour Range (m from road)		Area enclosed Hectares
	South of Ennis Junction Bridge 4	North of Ennis Junction Bridge 4	
60	170	80	220
55	350	160	450
50	700	330	900
45	1400	670	1840

Table 4: Calculated noise contour ranges

4.4.2 Predicted Vibration Impact with Road Scheme

4.4.2.1 Air borne vibration

The relationship between vibration annoyance and noise levels is very similar to that for noise nuisance except that the percentage of people annoyed by vibration is lower at all vibration levels, usually by about 10%. The impact can be determined from Figure 1, section 3.4, and is discussed in section 4.6.

4.4.2.2 Ground Borne Vibration

Ground-borne vibrations are unlikely to be important when considering disturbance from new roads. Given that the new road will have a smooth surface, and distances to houses will generally be in excess of 30m, there is no indication of any significant ground borne vibration.

Houses in Clarecastle, which are likely to be currently exposed to ground borne vibrations, will have greatly reduced exposure.

4.5 Noise Impact Assessment of Proposed Road Development

The environmental noise impact of the proposed scheme is assessed as follows;

1. by consideration of the predicted change in noise level compared to the "do minimum" levels
2. by comparison of the predicted noise levels with generally accepted criteria
3. by estimating the likelihood of annoyance
4. by assessment of the land area influenced by the proposed development

4.5.1 Predicted Change in Noise Levels

There is broad agreement between WHO (World Health Organisation) and the EU Fifth Environmental Action plan which recommend, among other points, that noise exposure in quiet areas should ideally not increase beyond 55dB(A) L_{Aeq}. This corresponds to an L_{A10} (facade) of 61dB(A).

These recommendations have been incorporated in many national guidelines and standards, such as the UK Planning Policy Guidance Note on Noise PPG24. PPG24 specifies four exposure categories for houses exposed to road traffic noise. These are shown in Table 5 and defined further in Appendix 3.

Noise Exposure Category[1]			
A	B	C	D
<61	61-69	69-78	>78

Table 5: Noise Exposure Categories

[1] expressed as facade L_{A10} values

The guidelines in PPG 24 are generally used for assessing the suitability with respect to environmental noise of a location for housing. However it is a useful means of categorising existing houses exposed to noise and in quantifying the impact. A change upward by one category is considered a significant impact. A change downward by one category is considered a significant benefit.

A detailed analysis has been performed on 43 locations and the impact is described in Tables 2 and 3. From these tables, the change in noise exposure category for the assessment locations can be ascertained.

Based on the detailed analysis, consideration of all houses in the vicinity of the proposed development shows the significant changes in categories to be as follows:

- Along the Eastern Bypass, about 30 houses previously in category A will move into Category B or C, a significant negative impact
- In Clarecastle, approximately 100 houses currently in category C or D will move into Category A. The typical reduction is 20dB, a significant positive impact
- Along the Western Relief road, no significant impacts have been identified
- In Ennis Town, there is not likely to be significant change.
- In Barefield, about 11 locations currently in category B and 6 in Category C will move to Category A, a significant positive impact. Approximately 3 currently in Category A will move to Category B, a significant negative impact. The overall noise exposure of 3-4 houses in the north of the village will remain unchanged but exposure will move from the front to the rear of the houses, resulting in a significant negative impact to the rear.

Overall, about 120 locations will experience a significantly improved noise environment. Approximately 30 locations will experience a significantly disimproved noise environment.

4.5.2 Noise levels in excess of 68dB(A)

The UK Noise Insulation Regulations 1975 set 68dB(A) as an action level.

Detailed assessment shows 7 houses are predicted to experience noise levels of 68dB(A) or over as a consequence of the proposed scheme. There are about 2 equivalent locations to the ~~assessment location at Knockaskibbole which would also experience this exposure.~~ Location 2A;2 at Killow has a predicted noise level of 67dB(A). Due to the uncertainties involved in the prediction method, this location is included in this category.

The direction of traffic noise exposure of two of these houses changes from the front to the rear. While there is a significant negative noise impact to the rear of house, there is a significant benefit at the front.

map ref.	Location	do minimum L_{A10} dB(A)	with scheme L_{A10} dB(A)
1B;2	Latoon	62	68
2A;2	Killow	33	67
2B;2	Knockaskibbole plus 2 equivalent houses	39	68
3A;3	House adjacent Tulla Rd./N18 junction	63	68
3C;1	Fahey, Barefield	53	71
3C;3	Hynes, adj. Barefield interchange[1]	56	71
3C;4	O'Shea, adj. Barefield interchange	54	68

Table 6: summary of locations with predicted noise levels in excess of 68dB(A), 2020

[1] if comparing with noise exposure to the front, the impact is negligible

4.5.3 Likelihood of annoyance

Figure 1 in section 3.4 shows the relationship between noise exposure and noise nuisance, described further in Appendix 3.

Of the 120 locations assessed in section 4.5.1 as having significantly reduced noise exposure, the percentage annoyed by traffic noise will decrease from typically 50% to 10%. Of the 35 locations experiencing increased noise exposure, the percentage annoyed will increase from less than 10% to about 20%.

4.5.4 Land Area influenced by Noise

As detailed in section 4.4.1.1, approximately 1840 hectares of previously very quiet land will become influenced by noise levels in excess of 45 dB(A) (L_{A10} free-field). Given that there are no national parks in the region, the question of lands being affected by noise levels in the region of 45 dB(A) is not deemed to constitute a significant impact.

A relatively small strip, about 270 hectares, will become exposed to levels in excess of 61dB(A), that is, in Category B as defined by PPG 24. About 50 hectares will be classified in Category C, where planning permission should not normally be granted and 12 hectares classified in Category D, where planning permission should normally be refused. These changes are not likely to influence housing development significantly.

4.6 VIBRATION IMPACT ASSESSMENT WITH SCHEME

Vibration assessment takes account of TRRL Report 246 "Traffic-induced vibration in buildings", and BS 7385 "Evaluation and measurement for vibration in buildings".

No vibration issues have been identified in connection with the new road. The existing road probably generates disturbing vibration levels at houses close to the road at Clarecastle and in Mill Road Ennis,. The level of vibration disturbance will decrease when traffic diverts to the new N18.

Of the 120 locations assessed in section 4.5.1 as having significantly reduced noise exposure, the percentage annoyed by vibration will decrease from typically 40% to a negligible amount. Of the 35 locations experiencing increased noise exposure, the percentage annoyed will increase from a negligible amount to about 10%.

Overall the vibration impact of the new road will be beneficial, with fewer people disturbed by vibration.

4.7 NOISE & VIBRATION IMPACT DURING CONSTRUCTION PHASE

Prediction of noise impact during the construction phase is based on UK Minerals Planning Guidance MPG11, and British Standard BS 5228 "Noise Control on Construction and Open Sites".

During construction of the new road there will inevitably be significant noise generated due to earth moving, surfacing, and other construction activities. There may also be rock blasting in some sections, with generation of blast noise, and ground borne vibration which may disturb nearby residents.

The order of magnitude of the possible construction noise levels is considered in this section.

4.7.1 CONSTRUCTION NOISE

Based on noise emissions for typical earth moving equipment, trucks and machinery, the typical construction noise levels expected at houses 50 metres from the road are about 65 dB(A).

This would be considered a tolerable noise level for a period of a few months while construction operations proceed past the house

4.7.2 Blast Noise and Vibration

The pressure wave (blast overpressure) associated with blasting can rattle windows and light building panels and could potentially prove disturbing to residents. In extreme cases it can result in broken windows. There are no international standardised limits for blast overpressure. The EPA guidance note on noise suggests a limit of 125 dB(L). Below this level there will be minimal rattling of windows and annoyance.

Blasting will inevitably generate ground borne vibration, which may be noticed at nearby houses. People are very sensitive to ground vibration and may notice very low levels the order of a few mm/s peak particle velocity.

5. MITIGATION

5.1 MITIGATION "WITH SCHEME"

5.1.1 NOISE MITIGATION

This study has identified about 30 locations where there will be a significant increase in noise level. For those houses in rural areas, the noise environment will change in character from peaceful rural, to an environment more typical of the traffic noise that most suburban dwellers are exposed to. Despite a significant increase, the predicted level may be below a level at which mitigation should be considered.

The UK Noise Insulation Regulations 1975 sets 68dB(A) as an action level. In the absence of national guidelines, it is reasonable to accept this as the level at which mitigation should be considered. A total of 9 houses have a predicted noise level due to the proposed scheme in excess of 68dB(A) (Table 6).

Mitigation for these houses can be in the form of earthen embankments, walls, or special purpose noise screens, to block line of sight to those road segments contributing most to the overall noise level.

Incorporation of these mitigation measures will ensure that noise levels are kept below 68dB(A). Typically a noise screen of 1.5 to 2 m height blocking line of sight to the 150m road segment adjacent to the house will produce screening of about 5-10dB.

5.1.2 VIBRATION MITIGATION

As there is no significant vibration issue as a consequence of the proposed development, no mitigation measures are required.

5.2 MITIGATION DURING CONSTRUCTION

5.2.1 NOISE MITIGATION DURING CONSTRUCTION

The predicted level of about 65dB(A) at nearby houses is considered a tolerable noise level for a period of a few months while construction operations proceed past the house. Mitigation would not be required, or necessarily desirable, as it may result in prolonging the construction period and increase the annoyance.

5.2.2 VIBRATION MITIGATION DURING CONSTRUCTION

The minimisation of the impact of blast overpressure and vibration is the responsibility of the blast engineers. It is normal practice to inform residents of the timings of any proposed

blasts, so they will not be startled when it occurs. Engineers will need to ensure that the EPA guidance limit for blast overpressure of 125 dB(L) is not exceeded.

People are very sensitive to ground vibration and may notice very low levels the order of a few mm/s peak particle velocity. Where blasting is conducted within a few hundred metres of a house, it may be impossible to reduce vibration levels below the level of human sensitivity.

The main concern is to avoid structural damage. British Standard BS 7385 specifies a vibration limit of 20 mm/s (15 Hz) to protect light framed structures from cosmetic damage.

In critical cases where blasting is planned close to houses, test charges may need to be detonated to measure the effect at the nearby houses before proceeding with the blasting.

6. SUMMARY

6.1 EXISTING N18 TRAFFIC NOISE LEVELS

Existing noise levels at houses close to the N18 route from Dromoland to Crusheen are in the range 60 to 80 dB(A). The highest levels are experienced by houses in Clarecastle and Ennis which front directly onto the road. At these houses there is also likely to be perceptible airborne and ground-borne vibration from passing traffic.

Existing traffic noise levels along the proposed Eastern Bypass route are in the range 30 to 60 dB(A). The higher noise levels are experienced at houses on the Quin and Tulla Roads.

Along the route of the proposed Western Relief road, existing traffic noise levels are in the range 40 to 60 dB(A), which are typical of a suburban area.

6.2 PREDICTED NOISE AND VIBRATION IMPACT IN 2020

In 2020, in the absence of any new road scheme, it is predicted that noise levels will increase by 3 dB due to increased traffic flow. There will be an increase of 10% in the percentage of people annoyed by vibration along the existing N18.

The Eastern Bypass and Western Relief roads will result in a significant reduction in noise levels at houses in Clarecastle and in Barefield. Noise levels along the old N18 route through Clarecastle and Barefield are predicted to be in the range 55 to 70 dB(A). There is a predicted significant benefit at about 100 houses in Clarecastle and 20 in Barefield. Noise levels within Ennis will remain at existing levels.

Noise levels at houses near the Eastern Bypass are predicted to be in the range 50 to 70 dB(A). A significant noise increase is predicted at approximately 30 houses.

Noise levels at houses near the Western Relief road will be in the range 50 to 65 dB(A). No significant noise impact has been identified along this route.

There is no adverse vibration impact associated with the proposed development. The percentage annoyed by vibration by the estimated 100+ houses affected will decrease from about 40% to 10%.

6.3 MITIGATION

Of the 30 houses predicted to experience a significant noise impact, 9 of these may exceed the 68dB(A) noise level at which mitigation measures are required by UK Noise Regulation 1975. Traffic noise levels at these houses can be reduced by 5 –10 dB by means of suitable noise screens, consisting of earthen embankments or walls.

APPENDIX 1 - NOISE PARAMETERS & TERMINOLOGY

dB(A) a logarithmic noise scale (decibel). The "A" indicates that a frequency weighting has been applied to take account of the variation in the sensitivity of the human ear as a function of frequency.

L_{Aeq} the average noise level during the measurement period, which includes all noise events. The L_{Aeq} value has been found to correlate well with human tolerance of noise, and is the value normally used in setting and monitoring industrial noise limits.

L_{A90} the noise level exceeded for 90% of the time. It is generally taken as being representative of the steady background noise at a location. It tends to exclude short events such as cars passing, dogs barking, aircraft flyovers etc.

L_{A10} the noise level exceeded for 10% of the time. It is a measure of the higher noise levels present in the ambient noise. The L_{A10} parameter is generally used to describe traffic noise. In continuous traffic, it is typically 3dB above the L_{Aeq}.

Free-field/Facade

Noise measurements made away from reflecting surfaces (apart from the ground), are termed free-field measurements. Measurements at the façade of a building are typically 3dB higher, due to reflection from the façade.

Description of Traffic Noise Levels

Traffic noise level dB(A)	**Qualitative Description**
>80	Severe (right beside a busy motorway)
70-80	Very high (~10m from busy motorway)
60-70	High (~10m from busy urban street)
50-60	Moderate (~20m from road with free-flowing traffic)
40-50	Low (~50m from road with light traffic)
30-40	Very low (~ typical quiet countryside, slight distant traffic noise)

Table A.1 Description of traffic noise levels

APPENDIX 2 – NOISE MEASUREMENT RESULTS

Label	1A;2,	Time	L_{A10}	L_{Aeq}	L_{A90}	total veh.	hgv	%hgv
Description	near Latoon bridge	14	75.6	71.5	54.8	1086	120	11
Position	free field front	15	76.8	72.7	56.2	996	78	8
Date	3/2/99	16	76.8	72.5	55.4			
Façade L10, front	**77.9**							
Position	facade rear	14	60.2	57.3	48.8			
		15	60.6	58.0	51.8			
Façade L10, rear	**59.0**	16	59.2	56.9	51.0	1284	90	7

Label	1B:1	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Dunne, Latoon	6	54.0	50.7	44.5
Position	Free-field	7	56.5	54.4	51.0
Dates	26/06/1998 &	8	57.0	54.3	50.5
	4/2/99	14	57.6	75.2	50.4
Façade L10	**58.4**	15	57.2	55.4	50.6
		16	57.2	56.5	52.8
		17	55.8	53.7	50.2
		18	57.4	55.7	53.0
		19	55.0	52.6	49.0
		20	56.0	53.4	49.5
		21	54.5	52.8	48.0
		22	54.0	51.2	47.0
		23	55.0	52.9	45.5

Label	1B;2	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Vacant house	14.37	60.4	57.5	49.8
Position	façade	15.18	60.6	58.2	50.6
Date	3/2/99	16.35	60.0	57.2	51.8
Façade L_{A10}	**59.3**				

Label	2A;2	Time	L_{A10}	L_{Aeq}	L_{A90}	total veh.	hgv	%hgv
Description	Doora/Killow Ch 15650	12	44.0	45.2	32.0	9	1	11%
Position	Free field	13	47.5	47.6	30.0	8	0	0%
Dates	Tues 19/5/98	14	41.5	44.3	28.0	15	1	7%
L_{A90}	30.0	ave	44.3	45.7	30.0			

Label	2B;2	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Clune ch18000	15:00	44.5	42.9	35.5
Position	Free-field	16:00	45.5	45.0	36.5
Dates	02/02/99	ave	45.0	44.5	36.0
L90	36				

Label	2B;1	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Rockville	16:00	50.5	47.9	40.5
Position	Free-field				
Dates	02/02/99				
Façade L10	52				

Label	2B;4	Time	ref. L_{A10}	sat. L_{A10}	offset
Description	Quin Rd.	14	58.0	59.8	1.8
Position	Free-field	15	59.5	61.6	2.1
Dates	8/5/98	21	55.5	57.8	2.3
Satellite	to 2B;5				
Façade L_{A10}	61.9	average offset			2.1

Label	2B;5	Time	L_{A10}	L_{Aeq}	L_{A90}	total veh.	hgv	%hgv
Description	Quin Rd., field opp. hse	6	48.5	43.4	31.5	4	0	0%
Position	Free-field	7	58.5	54.1	36.5	141	9	6%
Dates	8/5 7 22/5	8	57.5	53	35.5	146	6	4%
Satellites	2B;4	9	58	53.1	35	185	8	4%
Façade L10	59.8	10	57	51.9	34	142	6	4%
		11	58.5	53.4	35.5	205	13	6%
		12	58.5	54.3	38.5	140	8	6%
		13	58.5	55.3	36	180	12	7%
		14	58	54.1	35.5	180	14	8%
		15	59.5	56.3	41	200	12	6%
		16	61	57.1	42	240	28	12%
		17	59	53.9	39	320	4	1%
		18	60	54.7	40.5	296	4	1%
		19	56.5	53.3	37.5	106	4	4%
		20	57.5	53	39	162	4	2%
		21	55.5	51.8	36	116	1	1%
		22	57.5	57.4	34	136	0	0%
		23	51.5	49.5	29.5	60	0	0%
		ave	57.3	53.3	36.5	2959	133	4%

Label	3A;1	Time	L_{A10}	L_{Aeq}	L_{A90}	total veh.	hgv	%hgv
Description	Ballymacahill, Ch 20460	9	42.5	39.9	32	1		
Position	Free field (opp house)	10	42.5	39.6	31	3		
Dates	Tues 19 May	11	52	40.2	30	5		
L_{A90}	31.0	ave	45.7	39.9	31.0			
Weather	dry, calm							

Label	**3A;3**	**Time**	**L_{A10}**	**L_{Aeq}**	**L_{A90}**	**total veh.**	**hgv**	**%hgv**
Description	Tulla Rd.	6	50.5	59	30.5	32	4	13%
Position	Facade plus corrected	7	56	54.9	32.5	80	4	5%
	Free-field*	8*	62.5	58.2	38.5	187	3	2%
Dates	8/5 & 22/5	9*	63	59	37.5	192	10	5%
Satellites	3A;6	10	63.5	60.5	36	204	15	7%
Façade L10	**60.3**	11	61.5	58.5	34.5	156	16	10%
		12	61.5	58.8	35	138	15	11%
		13	63.5	61	38	264	21	8%
		14	64	60.6	37	258	24	9%
		15	62.5	58.8	39.5	244	8	3%
		16	63	60.4	38.5	240	16	7%
		17	63.5	59.6	37.5	312	8	3%
		18	65.5	61.9	41.5	210	9	4%
		19	63.5	60.2	42.5	222	6	3%
		20	61.5	57.6	40	160	0	0%
		21	62	58.9	40.5	204	4	2%
		22	57.5	54.4	31.5	64	0	0%
		23	59	57.4	32.5	76	0	0%
		ave	61.3	58.9	36.9	3243	163	5%

Label	**3A:6**	**Time**	**ref. L_{A10}**	**sat. L_{A10}**	**offset**
Description	Lane at back of Hillcrest	10	63.5	43.5	-20.0
Position	free-field/corrected for façade	14	64.0	42.1	-21.9
Date	08-May				
Satellite	to 3A;3	average offset			-21.0
Façade L10	**39.3, L_{A90}, 34.0**				

Label	**3B;1**	**Time**	**L_{A10}**	**L_{Aeq}**	**L_{A90}**	**total veh.**	**hgv**	**%hgv**
Description	Doolaghty, Gort Road,	10	65.5	60.8	39.0			
Date	02-Feb	11	65.5	60.9	42.0	582	96	19
Position	façade	12	65.7	61.1	41.0			
Façade L10	**64.6**							

Label	**3B;2**	**Time**	**L_{A10}**	**L_{Aeq}**	**L_{A90}**
Description	Mrs. Doolaghty, off Gort Road	10	50.8	49.6	42.2
Position	free-field	11	44.8	42.8	39.4
Façade L10	**48.4**	12	45.0	45.6	39.0
		ave	46.9	46.0	40.2

Label	**3B;3**	**Time**	**L_{A10}**	**L_{Aeq}**	**L_{A90}**
Description	Hogan	11	39.0	39.3	32.8
Position	free-field	12	37.4	38.0	33.2
Date	02/02/99				
L90	**33.0**				

Label	3B;4	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Lynch, Cappaghmore	17	42.7	41.5	32
Position	free-field				
Date	01/01/99				
L90	**32.0**				

Label	**3C;1**	**Time**	**L_{A10}**	**L_{Aeq}**	**L_{A90}**	**total veh.**	**hgv**	**%hgv**
Description	Barefield, Fahey	6.00	67.0	62.3	39.0	234	30	13%
Position	façade	7.00	68.0	63.5	40.0	316	40	13%
Dates	6/26	12.00	68.5	64.0	46.0	524	44	8%
Satellites	3C;2	13.00	69.0	64.3	47.0	552	48	9%
Façade L10	**66.8 (front)**	14.00	68.0	63.7	44.3	536	56	10%
		15.00	68.0	63.7	47.0	615	52	8%
		16.00	69.0	64.0	47.5	620	44	7%
		17.00	69.5	64.9	48.5	616	60	10%
		19.00	69.0	64.3	47.0	468	28	6%
		20.00	66.5	61.3	42.5	280	12	4%
		21.00	64.5	61.2	40.0	212	36	17%
		22.00	64.0	59.9	39.5	184	10	5%
		23.00	57.5	57.0	39.0	430	38	9%
		ave	66.8	62.6	43.6	430	38	9%
Façade L10	**50.3 (rear)**							
	rear of cottage	13:35	51.0	46.8	37.5			
		14:49	52.0	48.8	42.5	average offset –16.5		

Label	**3C;2**	**Time**	**ref. L_{A10}**	**sat. L_{A10}**	**offset**
Description	front Barefield School	13:15	74.8	69.0	5.8
Position	façade	14:30	75.0	67.5	7.5
Satellite	to 3C:1				
Façade L10	**73.5**	average offset			6.7

Label	**3C;3**	**Time**	**L_{A10}**	**L_{Aeq}**	**L_{A90}**	**total veh.**	**hgv**	**%hgv**
Description	Hynes, rear Barefield School	14.40	50.2	46.7	39.8			
Date	02/02/99	15.12	52.2	49.5	42.8	498	0	
Position	free-field	16.35	52.6	50.0	44.6			
Façade L10	**53.2**							

Label	**3C;4**	**Time**	**L_{A10}**	**L_{Aeq}**	**L_{A90}**
Description	O'Shea, Barefield School	14.38	49.5	47.0	42.0
		15.08	52.0	49.7	43.5
Position	façade	16.24	55.0	53.9	47.0
Façade L10	**51.2**				

Label	3C;6		Time	Sat. L10	Ref. L10	Offset
Description	Callinan, N18	Front	12:30	72.8	68.5	4.3
Position	façade		13:45	73.2	68.5	4.7
Satellite	to 3C;1					
Façade L10	**71.3 (front)**		average offset			4.5
Façade L10	**55.9 (rear)**		12:45	56.4	68	-11.6
			14:00	58.4	68.5	-10.1
			average offset			-10.9

Label	5;1	Time	L_{A10}	L_{Aeq}	L_{A90}	total veh.	hgv	%hgv
Description	M. Behan, Clarecastle rd.	6.00	66.0	61.8	40.5	312	48	15%
Position	facade	7.00	67.3	63.8	52.3	1231	77	6%
Date	5-May	8.00	67.8	65.1	58.3	1656	86	5%
Satellite	5;3, Clarecastle St.	9.00	67.3	64.0	54.6	1290	78	6%
Façade L10	**67.0**	10.00	67.8	64.6	54.1	1221	120	10%
		11.00	69.0	65.7	53.8	1080	88	8%
		12.00	69.0	65.6	55.0	1368	150	11%
		13.00	68.0	64.6	54.5	1236	120	10%
		14.00	67.5	64.2	54.5	1392	132	9%
		15.00	67.5	64.2	56.0	1146	126	11%
		16.00	67.5	65.3	60.0	1656	78	5%
		17.00	67.5	64.7	59.0	2142	102	5%
		18.00	67.0	64.6	58.0	1627	82	5%
		19.00	66.5	63.2	51.0	860	60	7%
		20.00	65.5	62.2	49.0	800	26	3%
		21.00	65.0	61.5	48.0	684	16	2%
		22.00	64.5	61.2	45.5	474	18	4%
		23.00	64.5	60.3	45.0	348	30	9%
		ave	67.0	63.7	52.7	1140	80	7%

Label	5;3	Time	ref. L_{A10}	sat. L_{A10}	offset
Description	College Green	11.00	69.0	50.0	-19.0
Position	free-field	14.00	67.5	48.0	-19.5
Date	5/5	average offset			-19.3
Satellite	to 5;1				
Façade L10	**50.2**				

Label	5;4	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Ashline House	10:00	52.0	49.0	44.5
Position	free-field	11:00	49.0	46.8	41.0
Date	7/26	12:00	53.0	49.9	44.0
Façade L10	**52.8**	ave	51.3	48.6	43.2

Label	5;5	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Cahercalla	9:00	40.5	37.9	33.5
Position	free field	10:00	42.5	41.5	33.5
Date	26-Jun	11:00	45.0	41.9	38.0
L90	35	ave	44.2		35.0

Label	5;6	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Abbey View	12:00	50.4	48.5	45.6
Position	free field	13:00	49.6	48.0	45.2
Date	25-Jun	14:00	51.5	49.5	46.0
Façade L10	**52.0**	ave	50.5		47.1

Label	5;7	Time	ref. L_{A10}	sat. L_{A10}	offset
Description	Clarecastle street	12.00	69.0	81.0	12.0
Position	façade	13.00	68.0	80.0	12.0
Date	1.00				
Satellite	to 5;2, L10=67.0	average offset			12.0
Façade L10	**79.0**				

Label	5;8	Time	L_{A10}	L_{Aeq}	L_{A90}	total veh.	hgv	%hgv
Description	opp school	11:00	73.5	70.5	58.6	1168	96	8%
Position	free field	12:00	72.2	70.1	59.4	1112	100	9%
Date	25-Jun	13:00	72.8	70.5	60.4	1276	124	10%
Façade L10	**74.3**							

Label	6;1	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Brookville	11:00	62.5	57.8	44.5
Position	free-field	12:00	51.5	50.6	41.5
Date	4-Jun	13:00	61.5	56.5	41.5
Façade L10	**60.0**				

Label	6;2	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	cottage, 11th tee)	11:00	48.0	47.3	42.0
Position	free field	12	51.0	46.6	39.0
Date	4-Jun	13	39.0	37.4	32.0
Façade L10	**47.5. L90 37.7**	ave	46.0		37.7

Label	6;3	Time	L_{A10}	L_{Aeq}	L_{A90}
Description	Golf course (12th green)	11:00	50.5	47.1	38.5
Position	free field	12:00	53.5	51.2	42.0
Date	04/06/1998 &29/6/98	13:00	44.0	41.5	37.5
L90	**39**	ave	49.3		39.3

Label	6;4	Time	L_{A10}	L_{Aeq}	L_{A90}	total veh.	hgv	%hgv
Description	Miltown Malbay Rd. opp. Eyredemense	10	58.5	61.3	32.5	180	24	13%
Position	free-field	11:00	57.5	55.6	33.0	153	9	6%
Date	29-Jun	12:00	56.5	54.8	33.0	148	20	14%
Façade L10	**59.0**	ave	57.5			160	18	11%

Label	6;5	Time	L_{A10}	L_{Aeq}	L_{A90}	total veh.	hgv	%hgv
Description	No. 1 Limerick Rd	12:00	72.5	69.0	51.0	861	107	12%
Position	facade	13:00	70.5	67.3	51.5	796	36	5%
Date	11-Jun	14:00	72.0	68.8	53.0	937	69	7%
Façade L10	**70.7**	ave	71.7	68.4	50.8	865	71	8%

Label	6;6	Time	L_{A10}	L_{Aeq}	L_{A90}	total veh.	hgv	%hgv
Description	Mill Rd., EMF	12:00	77.0	74.2	61.0	1083	86	8%
Position	facade	13:00	77.5	75.2	60.5	1020	72	7%
Date	11-Jun	14:00	77.5	75.7	62.0	1114	77	7%
Façade L10	**76.3**	ave	77.3	75.0	60.2	1072	78	7%

APPENDIX 3 – METHODOLOGY AND REFERENCES

The noise impact assessment is conducted broadly in accordance with the Design Manual for Roads and Bridges (DMRB) of the UK Highways Agency.

A3.1 CALCULATION METHODS

Calculation of noise predicted levels is performed in accordance with UK Dept of Transport "Calculation of Road Traffic Noise" and UK Transport and Road Research Laboratory (TRRL) Report 425 "Rural traffic noise prediction - an approximation".

For CRTN, the velocities used were the appropriate speed limit, 100km/h and 60km/h. The traffic volumes are as shown in Figure 2.

The CRTN method of calculating road traffic noise is valid up to distances of 300m. Where noise estimates are required beyond this, the "Rural traffic noise prediction" is used. This is a "broad-brush" method of predicting the noise due to traffic in rural areas. It is a useful method of obtaining a quantitative measure of potential noise impact in very quiet country areas. In calculating the noise contours, all the land affected is defined as farmland.

A3.2 ASSESSMENT CRITERIA

The assessment of the degree of noise impact is made with reference to absolute criteria which are outlined here.

U.K. PPG 24
U.K. 68 dB(A) criterion
EPA 55 dB(A) L_{Aeq} criterion

The noise exposure categories in UK PPG24 are used to assess the noise impact in section 4.5.1. These noise exposure categories are defined as follows:

Category	Façade L_{A10} dB(A)	Definition
A	<61	noise need not be considered as a determining factor in granting planning permission
B	61-69	noise should be considered when determining planning applications
C	69-78	planning permission should not normally be granted
D	>78	planning permission should normally be refused

Table A.2: Definition of noise exposure categories in PPG 24

PPG 24 specifies noise levels in terms of L_{Aeq} away from reflecting surfaces. The L_{Aeq} values have been converted to approximate L_{A10} values at the facade of a building in Table 5 and Table A.2 to enable immediate comparison with other data in this report.

According to the U.K. Noise Regulations 1975, a road development which causes the noise level to exceed 68 dB(A) L_{A10} is considered to have an impact, and mitigation is required.

The impact of the road scheme in 2020 has been described in Table 2 and 3 in terms of a 4 point scale: negligible, slight, moderate and significant. In the absence of any standardised or widely used definitions of impact, these descriptors have been derived both from the absolute value and the relative change in noise level and are assigned as follows:

significant:	change ≥ 20dB; or increase over 68dB(A); or increase/decrease > 5dB resulting in change of PPG 24 noise exposure category.
moderate:	a 10-20dB change; or increase/decrease ≤ 5dB resulting in change of PPG 24 noise exposure category.
slight:	a small change, 3 - 10 dB, not entailing a change in PPG category.
negligible:	a change ≤ 3dB or predicted noise level < 45dB(A)

The likelihood of annoyance, as shown in Figure 1, has been derived from a number of surveys in the UK and is contained in "Design manual for Roads and Bridges". Nuisance is measured as the percentage of people annoyed by traffic noise "very much" or "quite a lot", on a four point worded scale.

Vibration assessment takes account of TRRL Report 246 "Traffic-induced vibration in buildings", and BS 7385 "Evaluation and measurement for vibration in buildings".

Prediction of noise impact during the construction phase is based on UK Minerals Planning Guidance MPG11, and British Standard BS 5228 "Noise Control on Construction and Open Sites".

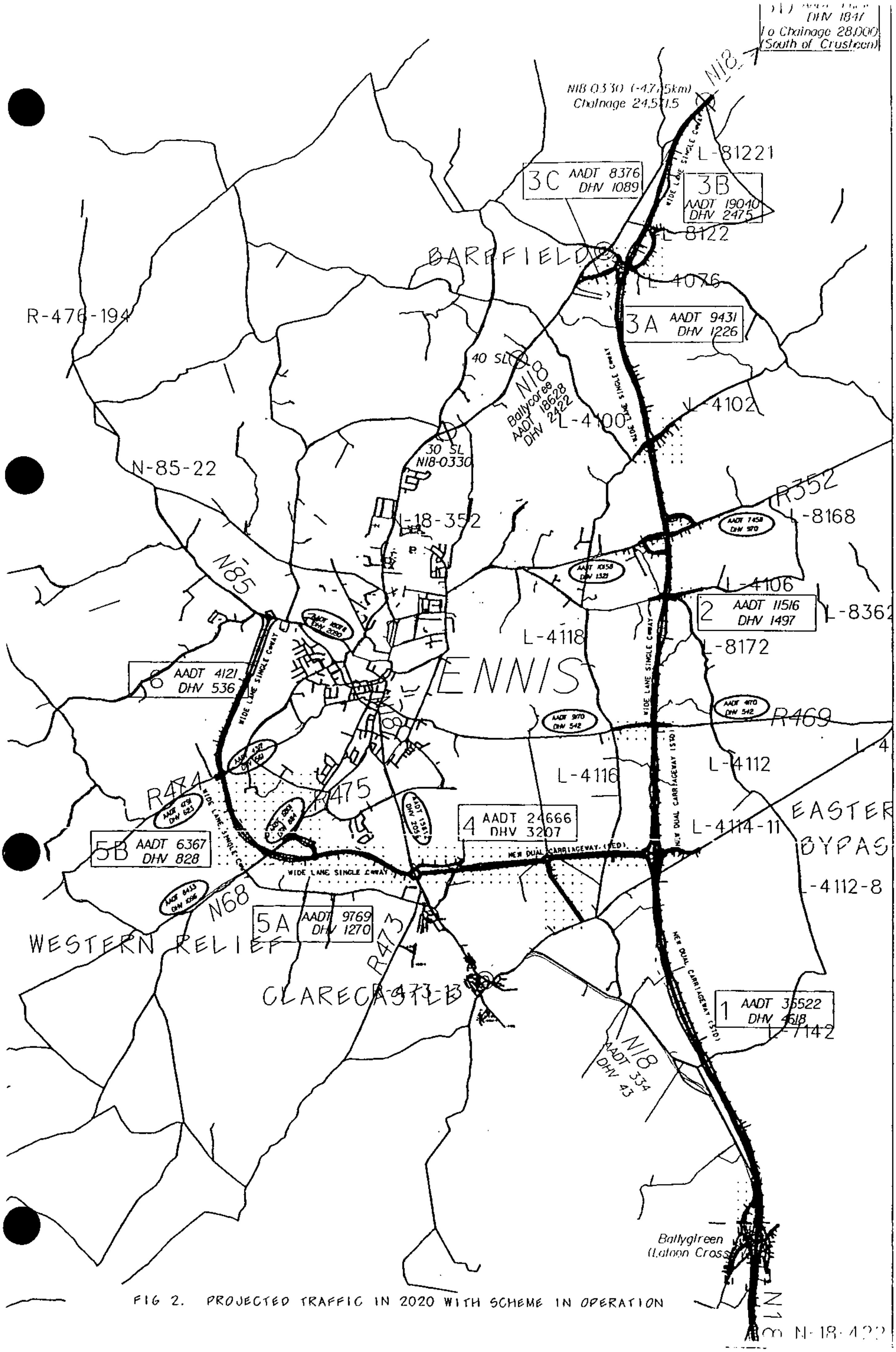


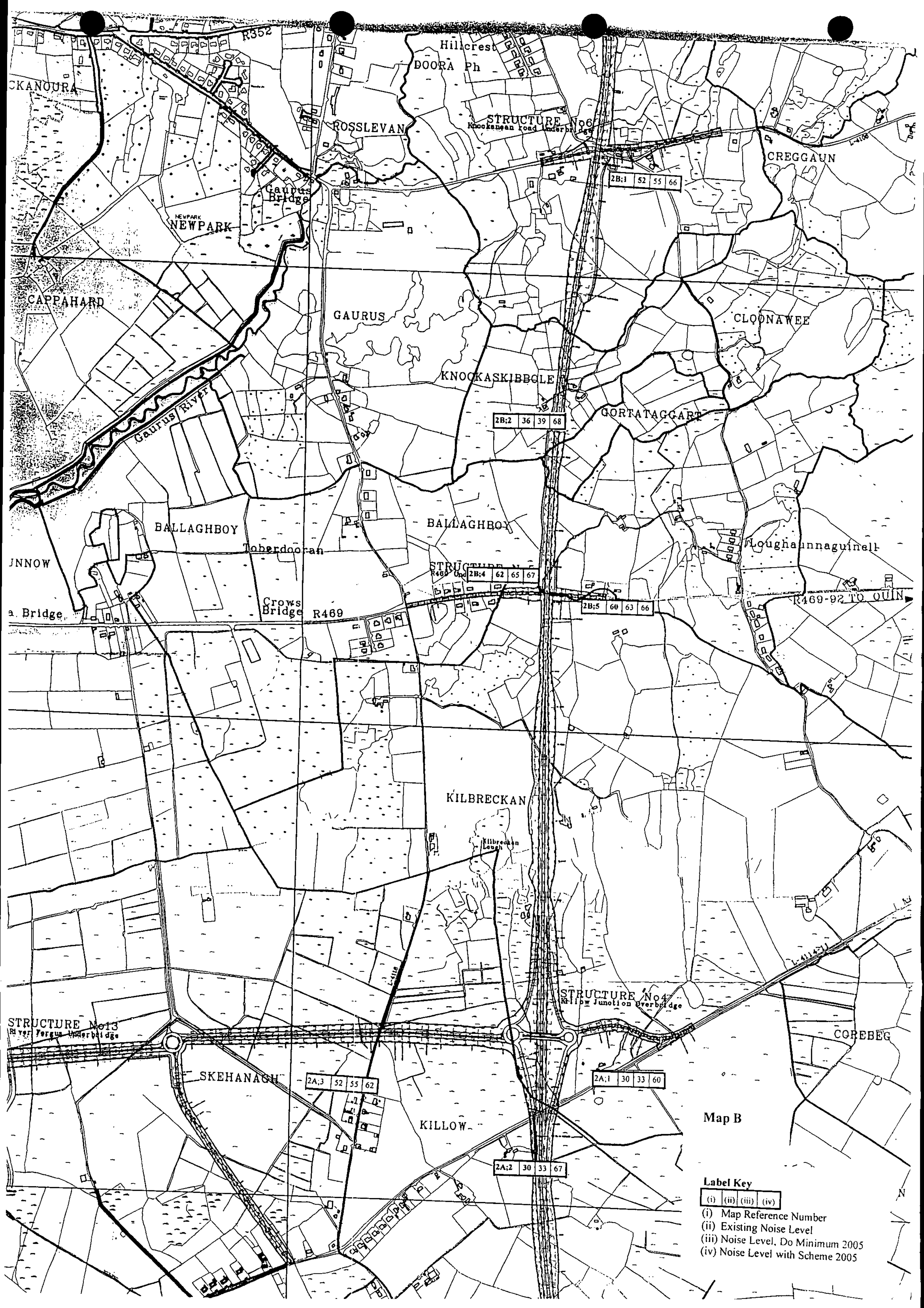
FIG 2. PROJECTED TRAFFIC IN 2020 WITH SCHEME IN OPERATION

Map A

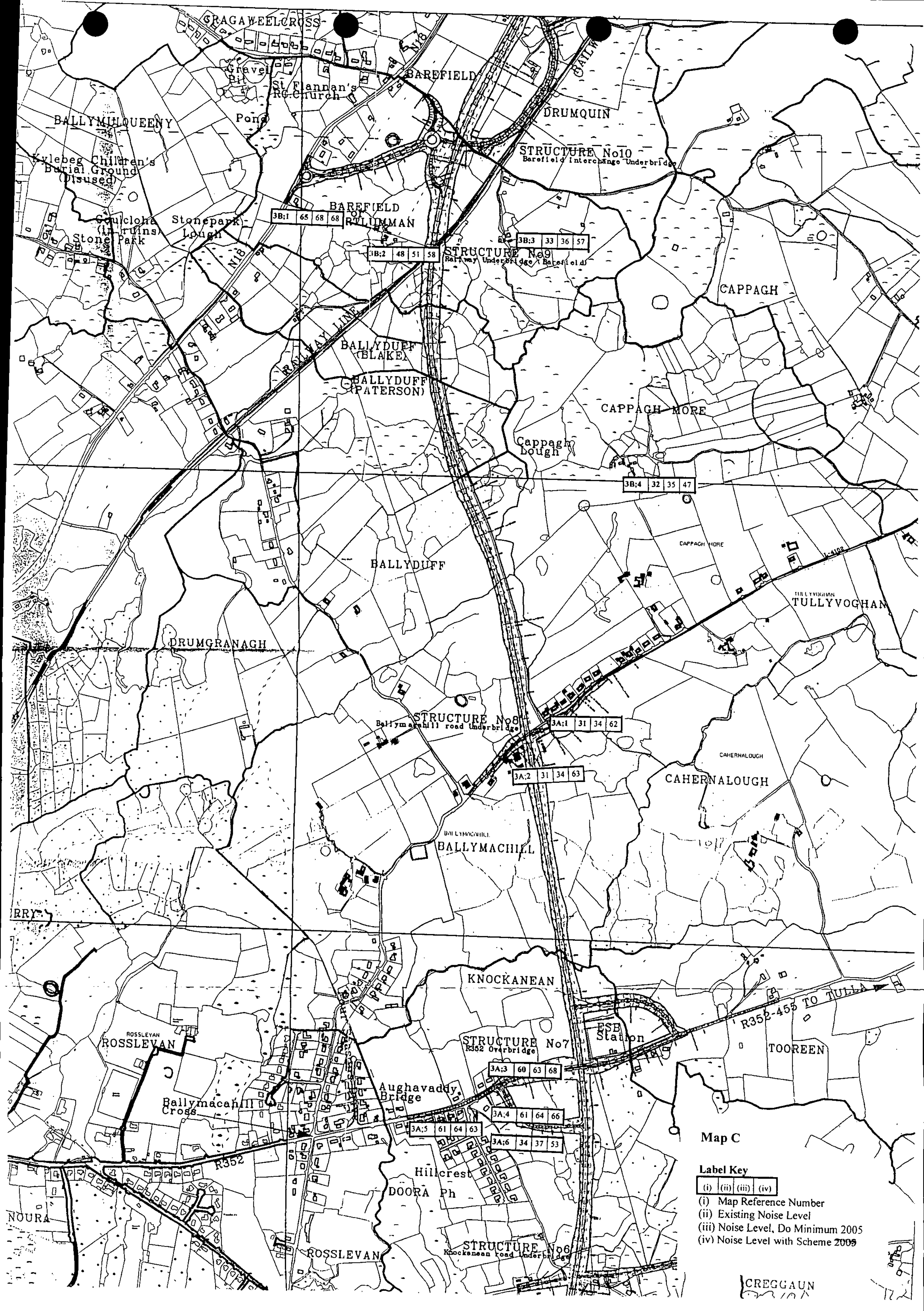
Label Key

(i)	(ii)	(iii)	(iv)

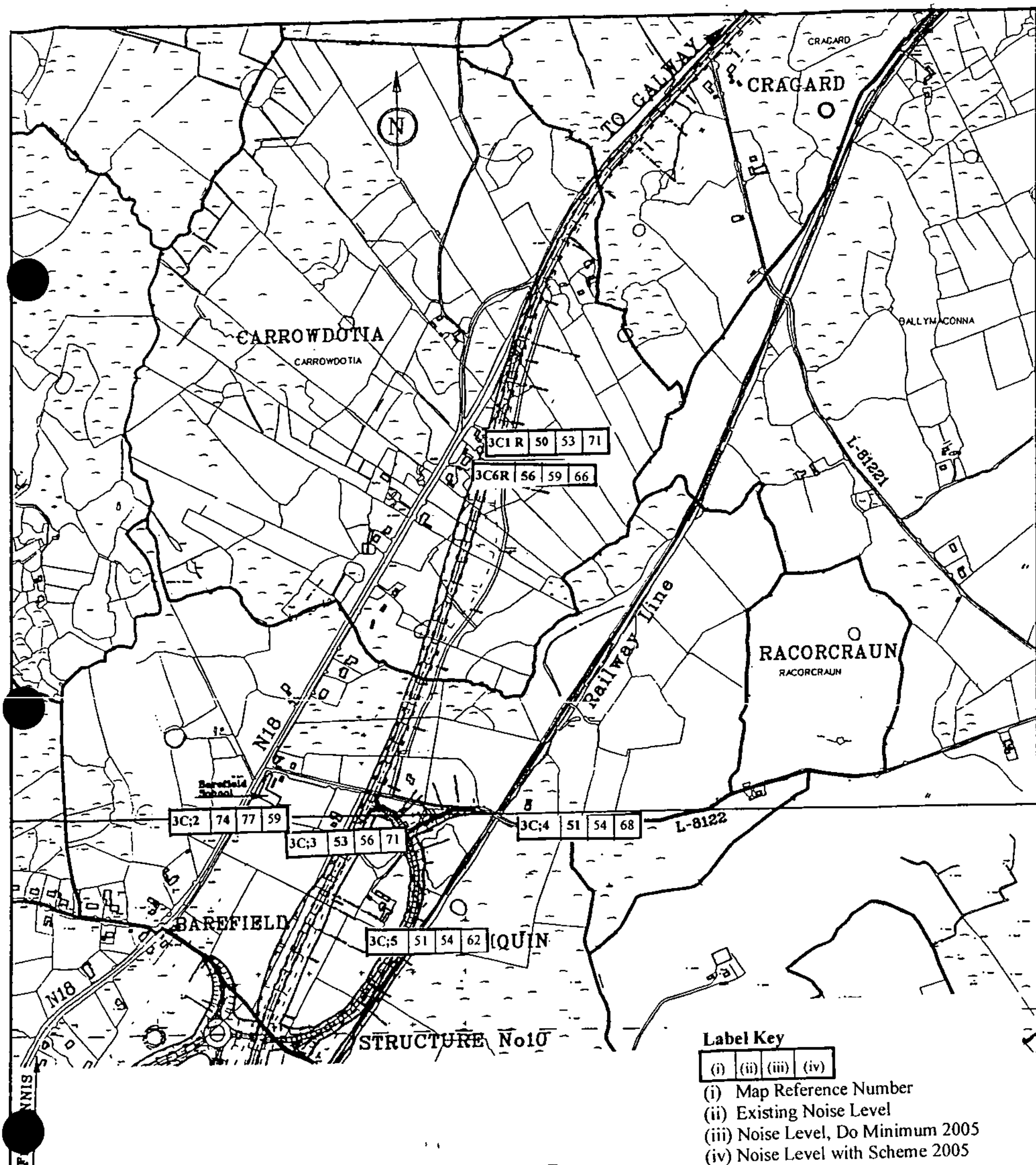
(i) Map Reference Number
(ii) Existing Noise Level
(iii) Noise Level, Do Minimum 2005
(iv) Noise Level with Scheme 2005



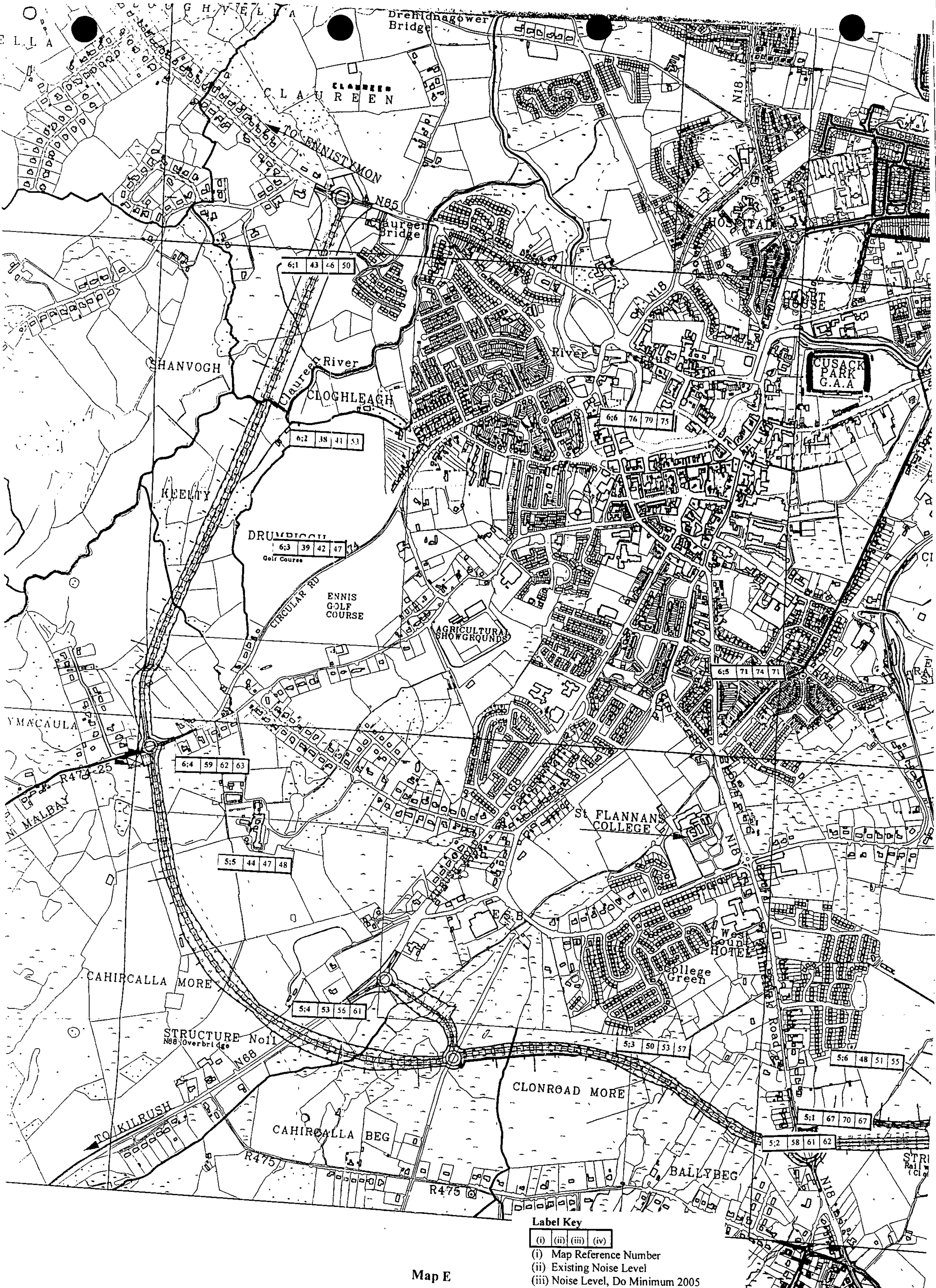
R352
Hillcrest
DOORA Ph
CKANOURA
ROSSLEVAN
STRUCTURE No6
Knockanean road Underbridge
CREGGAUN
2B;1 52 55 66
Gaurus Bridge
NEWPARK
CAPPAHARD
GAURUS
CLOONAWEE
KNOCKASKIBBOLE
Gaurus River
2B;2 36 39 68
GORTATAGGART
BALLAGHBOY
BALLAGHBOY
Toberdooran
Loughaunnaguinell
UNNOW
2B;4 62 65 67
R469-92 TO QUIN
a Bridge
Crows Bridge
R469
2B;5 60 63 66
KILBRECKAN
Kilbreckan Lough
STRUCTURE No4
Killow Junction Overbridge
STRUCTURE No13
River Fergus Underbridge
COREBEG
SKEHANAGH
2A;3 52 55 62
2A;1 30 33 60
KILLOW
Map B
2A;2 30 33 67
Label Key
(i) (ii) (iii) (iv)
(i) Map Reference Number
(ii) Existing Noise Level
(iii) Noise Level, Do Minimum 2005
(iv) Noise Level with Scheme 2005



Map C
Label Key
(i) (ii) (iii) (iv)
(i) Map Reference Number
(ii) Existing Noise Level
(iii) Noise Level, Do Minimum 2005
(iv) Noise Level with Scheme 2005
CRAGAWEELCROSS
BAREFIELD
DRUMQUIN
St Flannan's RC Church
Gravel Pit
Pond
BALLYMULQUEENY
Kylebeg Children's Burial Ground (Disused)
STRUCTURE No10
Barefield Interchange Underbridge
BAREFIELD or RTLUMMAN
Stonepark Lough
Coulcloha (in ruins)
Stone Park
N18
3B:1 65 68 68
3B:2 48 51 58
3B:3 33 36 57
STRUCTURE No9
Railway Underbridge (Barefield)
CAPPAGH
RAILWAY LINE
BALLYDUFF (BLAKE)
BALLYDUFF (PATERSON)
CAPPAGH MORE
Cappagh Lough
3B:4 32 35 47
BALLYDUFF
TULLYVOGHAN
DRUMGRANAGH
STRUCTURE No8
Ballymacahill road Underbridge
3A:1 31 34 62
3A:2 31 34 63
CAHERNALOUGH
BALLYMACHILL
KNOCKANEAN
ESB Station
R352-455 TO TULLA
TOOREEN
ROSSLEVAN
STRUCTURE No7
R352 Overbridge
3A:3 60 63 68
Aughavaddy Bridge
Ballymacahill Cross
3A:4 61 64 66
3A:5 61 64 63
3A:6 34 37 53
R352
Hillcrest
DOORA Ph
NOURA
ROSSLEVAN
STRUCTURE No6
Knockanean road Underbridge
CREGGAUN


TO GALWAY
CRAGARD
CRAGARD
CARROWDOTIA
CARROWDOTIA
BALLYMACONNA
L-81221
3C1 R 50 53 71
3C6R 56 59 66
Railway Line
RACORCRAUN
RACORCRAUN
N18
Barefield School
3C;2 74 77 59
3C;3 53 56 71
3C;4 51 54 68
L-8122
BAREFIELD
3C;5 51 54 62
QUIN
N18
STRUCTURE No10
Label Key
(i) (ii) (iii) (iv)
(i) Map Reference Number
(ii) Existing Noise Level
(iii) Noise Level, Do Minimum 2005
(iv) Noise Level with Scheme 2005

Map D



Label Key

(i)	(ii)	(iii)	(iv)

(i) Map Reference Number
(ii) Existing Noise Level
(iii) Noise Level, Do Minimum 2005
(iv) Noise Level with Scheme 2005

Map E

vii

APPENDIX VII

AIR & CLIMATE

PART A	**Air Quality Aspects of the Proposed Improvements to the N18 between Dromoland to Crusheen (K.T. Cullen & Co. Ltd.)**

APPENDIX VII – PART A

Air Quality Aspects of the Proposed Improvements to the N18 between Dromoland to Crusheen (K.T. Cullen & Co. Ltd.)

AIR QUAILTY
ASPECTS OF THE
PROPOSED IMPROVEMENTS
TO THE
N18 BETWEEN DROMOLAND TO CRUSHEEN
ENVIRONMENTAL IMPACT STATEMENT

November 1999

K.T. Cullen & Company Limited
Bracken Business Park
Bracken Road
Sandyford Industrial Estate
Dublin 18

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Air Quality Aspects of the Proposed Improvements to the N18 between Dromoland to Crusheen Environmental Impact Statement

November 1999

1.0 INTRODUCTION

In March 1999, at the request of Clare County Council, Limerick County Council Road Design Office, K.T. Cullen & Co. Ltd. were requested to carry out an assessment of the impact of emissions from proposed road improvements to the N18 between Dromoland to Crusheen. Figure 1 presents the location of the proposed route. These works are an extension of the road improvements undertaken on the N18 and N19 between Ballycasey to Dromoland.

The proposed N18 Road Improvement Scheme will have two sections. The eastern section will link the existing N18 between Latoon Bridge and Barefield. The western section will run in an east-west direction, south of Ennis Town, linking the eastern section of the scheme with the N85 to the north-west of Ennis Town. This western section will intersect the existing N18, N68, and R474.

This report details the air quality aspects of the Environmental Impact Statement (EIS). The assessment was undertaken in two parts. Existing air quality along the proposed route was first measured and discussed, and secondly this data was used in conjunction with the "Breezeway CAL3QHC" model to predict pollutant concentrations at different locations near the proposed route. Further modelling was undertaken in October 1999 to assess do-nothing and scheme impacts within Ennis and Clarecastle. The results of all assessments undertaken to date are detailed in this report.

2.0 RECEIVING ENVIRONMENT

A baseline air quality assessment was carried out along the proposed route. Air quality was sampled at six locations. Samples were collected at three locations near the proposed Eastern Bypass Section (AQ 1, AQ 2 and AQ 3), at two locations near the proposed Western Bypass Section (AQ 4 and AQ 6) and at one location near Ennis Town (AQ 5). The survey was undertaken in August 1998. The sample locations are shown on Figure 1.

The survey targeted the following parameters associated with vehicle emissions; Sulphur Dioxide, (SO_2), Particulate Matter, (PM), Lead, Nitrogen Dioxide, (NO_2), Hydrocarbons, (HC), benzene and Carbon Monoxide, (CO). The SO_2 and PM analytical results for the samples collected in August 1998 were suspect, therefore sampling for these two parameters was repeated in October 1998. Only the repeat analytical results for PM and SO_2 are discussed in this report.

During sample collection in August 1998 two samples were collected from each monitoring location. The sampling intervals targeted the two busiest periods of vehicle movements, 07:30 hrs to 09:30 hrs, and 16:30 hrs to 18:30 hrs. In the case of the repeat sampling for SO_2 and PM in October 1998 one sample was collected at each monitoring location between 07:30 hrs and 16:30 hrs.

Analysis of the samples was carried out by Analytical and Environmental Services, Tyne and Wear in the UK.

2.1 Air Quality Standards

The measured concentrations of sulphur dioxide, suspended particulates, lead and nitrogen dioxide are compared with standards published in the regulations, Air Pollution Act, 1987 (Air Quality Standards), Regulations 1987 (S.I. No. 244 of 1987). The published standards in these regulations are summarised in the following table.

Table 1

Air Quality Parameter	**Air Quality Standard (S.I. No. 244 of 1987)**
Sulphur Dioxide (SO_2)	350 $\mu g/m^3$ (98 percentile of daily values obtained over a year)
Suspended Particulates	250 $\mu g/m^3$ (98 percentile of daily values obtained over a year)
Lead	2 $\mu g/m^3$ (annual mean of daily values)
Nitrogen Dioxide (NO_2)	200 $\mu g/m^3$ (98 percentile of daily values obtained over a year)

The Air Quality Standards are not available in this country for Carbon Monoxide, Hydrocarbons or Benzene. Standards were originally set by the World Health Organisation (WHO) for Hydrocarbons (HCs), Benzene and Carbon Monoxide of 120, 100 and 30,000 $\mu g/m^3$, respectively. The carbon monoxide guideline is based on an averaging time of 1 hour. (WHO, 1987). It is understood that the values for HCs and Benzene were withdrawn by the WHO but that they are still used by the Californian Air Resources Board. For the purposes of this report the WHO values are used for guideline purposes.

2.2 Sampling and Analytical Methods

Sulphur Dioxide (SO_2)

Sulphur dioxide concentrations were measured by drawing a known volume of air through a hydrogen peroxide solution. The sulphur dioxide concentration was then determined in the laboratory using ion chromatography.

Lead and Particulate Matter

Lead and particulate concentrations were measured by drawing a known volume of air through pre-weighed filter papers. Particulate concentrations were determined gravimetrically and lead concentrations were measured by Atomic Absorption.

Nitrogen Dioxide (NO_2)

Nitrogen Dioxide concentrations were measured by drawing a known volume of air through a solution of sodium hydroxide – sodium arsenite. Nitrogen dioxide concentrations were then determined in the laboratory using the Greiss Saltzman Method which is a colourimetric test.

Carbon Monoxide (CO)

Carbon Monoxide concentrations were measured on "Draeger Carbohesive Tubes". A volume of air specified by the manufacturer is pumped through the tube using a hand-operated bellows. The material in the tube gives a colour-coded response to CO concentrations in the sampled air.

Hydrocarbons (HCs) and Benzene

Hydrocarbon and benzene concentrations were measured by pulling a known volume of air through a sorbent tube (T017). The tube was then desorbed in the laboratory using liquid desorbtion and the concentrations of hydrocarbons and benzene measured using Gas Chromatography.

2.3 *Existing Air Quality Concentrations*

Sulphur Dioxide

The sulphur dioxide concentrations measured at the six sampling locations are presented in Table 2. The concentrations measured ranged from 20.72 $\mu g/m^3$ to 135.37 $\mu g/m^3$. These concentrations are all less than the air quality standard of 350 $\mu g/m^3$.

Particulate Matter

The particulate matter concentrations measured are presented in Table 2. At four of the sampling locations (AQ 1, AQ 2, AQ 4 and AQ 5) the concentrations were less than the laboratory detection limit. At sample location AQ 3 the particulate matter concentration was 131.7 $\mu g/m^3$ while at sample location R6 the particulate matter concentration was 44.6 $\mu g/m^3$. These concentrations are less than the air quality standard of 250 $\mu g/m^3$.

Lead

The lead concentrations measured are presented in Table 3. The concentrations in all samples were less than the laboratory detection limit and less than the air quality standard of 2 μg/l.

Benzene

The benzene concentrations measured are presented in Table 3. The concentrations in all samples were less than the laboratory detection limit and less than the WHO air quality standard of 100 $\mu g/m^3$.

Nitrogen Dioxide

The nitrogen dioxide concentrations measured are presented in Table 3. Concentrations measured ranged from less than the laboratory detection limit to 14.77 $\mu g/m^3$. These concentrations are less than the air quality standard of 200 $\mu g/m^3$.

Hydrocarbons

The hydrocarbon concentrations measured are presented in Table 3. Concentrations detected in samples AQ 1, AQ 2, AQ 3, AQ 4 and AQ 6 ranged from 1.01 $\mu g/m^3$ to 13.13 $\mu g/m^3$. These concentrations are less than the WHO standard of 120 $\mu g/m^3$. The concentrations detected in AQ 5, the sampling location beside Ennis town of 1313.13 $\mu g/m^3$ during the morning sampling and 121 $\mu g/m^3$ during the evening sampling exceed the WHO standard of 120 $\mu g/m^3$.

Carbon Monoxide

The carbon monoxide concentrations measured are presented in Table 3. At five of the sampling locations (AQ 1, AQ 2, AQ 3, AQ 4 and AQ 6) carbon monoxide was not detected. At sampling location AQ 5 carbon monoxide was detected at a concentration of 3,300 $\mu g/m^3$. This concentration is significantly less than the WHO air quality standard of 30,000 $\mu g/m^3$

3. FINDINGS

Except for elevated hydrocarbon concentrations in the sample collected beside Ennis (AQ 5) the concentrations of all parameters are less than the Irish and WHO air quality standards. The elevated hydrocarbon concentration in the sample from Ennis is expected to result from the incomplete combustion of fuel, from idling vehicles at this location.

If the bypass proceeds it is anticipated that traffic congestion will be reduced significantly at this location, therefore lowering the hydrocarbon concentrations.

4. AIR QUALITY MODELLING AND PREDICTION

Air dispersion modelling was initially undertaken in March 1999, with traffic figures supplied by Limerick County Council Road Design Office for the year 2020. The aim of this modelling was to assess the effect that the proposed road would have on local air quality. Receptors located close to the proposed road, particularly in rural locations were concentrated on during this assessment.

Further assessment was carried out in October 1999 to predict future trends in local air quality resulting from the existing road network under a do nothing situation. The Do nothing situation had not been modelled previously and revisions were made to the air dispersion model in order to incorporate these changes. The impacts of the proposed Ennis Bypass on existing urban receptors were examined and in particular the benefits anticipated at large numbers of residencies adjacent to the existing route in Clarecastle and Ennis.

Concentrations of carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide, particulate matter, and lead were determined at 42 locations in close proximity to the proposed route. The majority of receptors were located in the urban areas of Ennis town centre and Clarecastle. A number of receptors were also placed in rural areas. The locations where predictions were made are presented on Figure 2. The 42 receptor locations are identified as R 1 to R 42.

The predictions were undertaken using the Breezeway CAL3QHC air dispersion model. The model requires user-defined parameters including meteorological, spatial and vehicle emission data. The data is entered as a series of links each having a set of values for the user defined parameters listed above.

4.1 Input Data for the Breezeway model

Road design features such as length and width and predicted traffic volumes for the proposed route were supplied by Clare County Council. The proportion of the road used by heavy goods vehicles was taken to be 10 % of the total traffic for the proposed route.

As the entire route is not at grade, reference was made to Clare County Council and K. T. Cullen cross sections of the route and the corresponding section of road was entered as *At Grade*, *Depressed*, *Fill* or *Bridge*. Depressed road sections tend to cause a channelling and eddying effect such that pollutants are not transported out of the road channel as quickly as a section of road that is at grade with the surrounding topography.

Wind speed and wind direction were taken from the "Climate of Ireland" by P.K. Rowan, 1986. The average wind speed at Shannon airport over the 23 year period from 1962 to 1984 was 5.2m/sec. For each receptor the model was also run at a wind speed of 10.8 m/sec. The predominant wind direction at Shannon Airport was from west to east (270 degrees).

Receptor heights were placed at a height of 1.8m (typically breathing height) as per the Breezeway CAL3QHC manual.

The surface roughness of the surrounding area was taken as agricultural land.

The stability categories for the area was taken from data published by the Meteorological Service. The frequency of the various stability categories are summarised in Table 4 below:

Table 4: Stability Categories For Shannon Airport

Stability Category	**Specification**	**Frequency**
A	Very Unstable	< 0.1
B	Unstable	1.2
C	Slightly Unstable	4.0
D	Neutral	77.2
E	Slightly Stable	9.7
F/G	Stable	7.8

The stability category for Shannon Airport was neutral .i.e. stability category D.

Vehicle emission factors were taken from the CORINAIR study for the EC Commission (1991). The results are summarised in Table 5.

Table 5: Emission Factors (grams per kilometre)

Pollutants	**Cars**	**HGV**
Carbon Monoxide	2.72	6.65
Hydrocarbons	0.49	4.2
Nitrogen Oxides	0.97	15
Sulphur Dioxide	0.05	1.73
Particulates	0.03	1.25
Lead	0.0	0.0

Different emission factors are used for vehicles in different stages of movement and operation e.g. idling, deceleration etc. Idling emission factors were only readily available for Carbon monoxide, Nitrogen Dioxide and Hydrocarbons. These emission factors were used for road links where traffic would be queued or idling and for road links with traffic lights. The values were taken from the US EPA MOBILE 5 model for highway vehicle emissions. Idling emission factors were not available for sulphur dioxide, lead and particulates. The three main pollutants produced by petrol engines are; unburnt hydrocarbons, carbon monoxide produced by the incomplete combustion of hydrocarbons, and nitrogen oxides produced by nitrogen in the air reacting with oxygen at high engine temperatures.

When modelling the **Rural receptors** (R 1 to R 7 and R 30 to R 42), background concentrations from AQ 1 to AQ 4 were used depending on which monitoring point was closer to a certain section of the proposed motorway (see Tables 2 and 3). The measured background concentrations are much lower at locations AQ 1 to AQ 4 (rural sampling locations) than at AQ 5 which was measured close to Ennis town on the N 18 road.

For the **Urban receptors** (R 8 to R 29) the background pollutant concentration for input into the model was taken from the concentrations measured by K. T. Cullen & Co. Ltd. in 1998 for monitoring location (AQ 5) which is closest to Ennis town (see Tables 2 and 3). The pollutant values at this measured location would represent typical urban air quality for use in the model.

The model assumes that all receptors will have the measured 1998 background value for each particular parameter (carbon monoxide, sulphur dioxide etc.). Then, depending on traffic volume, emission factors etc. the model will calculate a predicted value at the receptor location based on the information inputted. Therefore, in the tabulated results presented in Appendices A to G, a figure which is presented as less than (<) the background value may be considerably less than this background figure. However the lowest figure that the model will display will be the background value. This is an important point to note when interpreting the model results.

4.2 Air Quality modelling for Rural receptors

The initial Breezeway modelling exercise was undertaken in March 1999 to assess the impact of the proposed scheme on local air quality. This exercise concentrated on rural receptors around the main intersections and junctions of the proposed routes . The results detailed in this report are from the March 1999 report. Traffic figures were supplied by Clare County Council for the year 2020 only. It

should be noted that in some cases the traffic figures used in March for the assessment of rural receptors are up to 20 % lower than revised traffic information now available. However, as can be seen from the modelled results, such variations in traffic in the rural locations will not exceed the Irish or equivalent WHO air quality standards. The following scenario was modelled for the March 1999 report;

- ***Proposed route scenario*** - Anticipated future traffic figures for the proposed and existing road network for the year 2020 were used to model local air quality.

When modelling the rural receptors, background concentrations from AQ 1 to AQ 4 were used depending on which monitoring point was closer to a certain section of the proposed route. The results from AQ 1 to AQ 4 presented on tables 2 and 3.

The model assumes that all receptors will have the measured 1998 background value for each particular parameter (carbon monoxide, sulphur dioxide etc.). Therefore, in the tabulated results presented in Appendices A to G, a figure which is presented as less than (<) the background value may be considerably less than this background figure. However the lowest figure that the model will display will be the background value. This is an important point to note when interpreting the model results.

4.3 Air Quality monitoring for Urban receptors

An assessment of the local air quality was made using the model for the following years; 1999, 2005 and 2020. The following scenarios were modelled for each of the above years;

- ***Do nothing scenario*** - The existing road network and its anticipated future traffic were used to model local air quality.

- ***Proposed route scenario*** - Anticipated future traffic figures for the proposed and existing road network were used to model local air quality and the possible benefits that the proposed route may have on the local air quality in the residential areas of Ennis town and Clarecastle in particular.

Road design features such as length and width and predicted traffic volumes for the proposed route were supplied by Clare County council. The proportion of the road used by heavy goods vehicles was taken to be 10 % for the proposed route. An assessment of the local air quality was made using the model for the years 1999, 2005 and 2020.

4.4 Predicted Concentrations for Rural Receptors - 2020

The predicted concentrations for the pollutants are presented in the attached Tables in Appendix G.

4.41 Carbon Monoxide

The model predicted a carbon monoxide concentration of less than 994.3 μg/m³ for all rural receptors for the year 2020. This indicates that there will be no significant increase in carbon monoxide concentrations as a result of the proposed scheme.

All modelled carbon monoxide results are below the WHO guideline value of 30, 000 μg/m³.

4.42 Hydrocarbons

Receptors **R 1**, **R 30** and **R 37** show the highest predicted concentrations of hydrocarbons for the year 2020. These three receptors are all located along the proposed N18 , and close to a junction between the existing road network and the proposed route. For example, **R 30** is situated close to the R 353 and Tulla Road junction and therefore will be exposed to emissions from both of these sources.

4.43 Nitrogen Dioxide

Receptors **R 2**, **R 30** and **R 37** show the highest predicted concentrations of nitrogen dioxide. However, all modelled nitrogen dioxide results were less than the Irish Air Quality standard of 200 μg/m³.

4.44 Lead

Similar to the modelled results for urban receptors, the model indicates a zero concentration for lead at all rural receptor locations for the year 2020.

All modelled lead results were below the Irish Air Quality Standard of 2 μg/m³.

4.45 Particulate Matter

Receptors **R 2**, **R 30** and **R 37** show the highest predicted concentrations of particulate matter for the year 2020. However, these receptors remain very close to their relative background concentrations.

All modelled particulate matter results are below the Irish Air Quality Standard of 250 μg/m³.

4.46 Sulphur Dioxide

Again, receptors **R 2**, **R 30** and **R 37** show the highest predicted concentrations of particulate matter for the year 2020. Although the model has predicted that these receptors will have the highest concentrations, the results are only very slightly above their respective background concentration. For example the modelled concentration for **R 2** was 102 µg/m^3 with a background concentration of 101.2 µg/m^3

All modelled sulphur dioxide results were below the Irish Air Quality Standard of 350 µg/m^3.

4.5 Predicted Concentrations for Urban Receptors - 1999, 2005 and 2020.

The predicted concentrations for the pollutants are presented in the attached Tables in Appendix A to F. The three main pollutants from petrol driven vehicular engines are Hydrocarbons, Carbon monoxide and Nitrogen oxides. The result for these three parameters will be discussed in detail below. Lead, Sulphur dioxide and Particulate matter will be discussed also but to a lesser extent due to their lower contribution to present day vehicular pollution.

4.51 Carbon Monoxide

The background concentration used in the model for all scenarios and years was 3, 300 µg/m^3. The Carbon Monoxide results from the model are presented in Appendix A. All modelled carbon monoxide results are below the WHO guideline value of 30,000 µg/m^3.

1999

The model calculated **R 10**, **R 13**, **R 17** and **R 29** to have the highest concentrations for the do nothing scenario. All of these receptor locations lie very close to the N 18 with **R 10**, **R 13** and **R 17** located in Ennis town and **R 29** located in the Clarecastle area. This also reflects the current position as both of these areas along the N 18 are experiencing heavy traffic congestion.

For the proposed route scenario **R 13** and **R 25** are calculated as the receptors with the highest carbon monoxide concentrations. **R 25** is located close to the roundabout where the Limerick road (N 18) meets the proposed route at Clareabbey. As vehicles approach junctions and roundabouts etc. they will decelerate and vehicles may be idling depending on driver reactions and traffic conditions. Exhaust emissions will be higher at these locations than under cruising motorway conditions. Receptors in the vicinity of these junctions would therefore be experiencing higher pollutant concentrations than those adjacent to free flowing traffic. **R 13** in the centre of Ennis town remains slightly above background levels as would be expected for an urban centre.

2005

The model calculated **R 10**, **R 13**, **R 17**, **R 27**, and **R 29** to have the highest concentrations for the do nothing scenario. In comparison, for the proposed route scenario, **R 13** was calculated as the receptor with the highest concentrations. The concentrations of all the above receptors slightly increases from the 1999 values as one would expect due to increased volume of traffic.

2020

The model calculated **R 9**, **R 10**, **R 13**, **R 17**, **R 27** and **R 29** to have the highest concentrations for the do nothing scenario. **R 10**, **R 13**, **R 16** and **R 25** have the highest modelled concentrations for the proposed route scenario. It can be seen that the number of receptors with concentrations above background has increased from the 1999 and 2005 period. However it is expected that future increases in traffic may be offset through the impact of improved vehicle technology and cleaner fuels. As a result vehicle emission factors which will be lower in 2020 than they are at present.

4.52 Hydrocarbons

The background concentration used for hydrocarbons was 121.21 $\mu g/m^3$. Hydrocarbon results from the model are presented in Appendix B. The measured background concentration for hydrocarbons actually exceeds the WHO standard of 120 $\mu g/m^3$. However, it must be noted that this measurement was taken very close to the existing N 18 during periods of heavy traffic.

1999

The model calculated **R10**, **R 13** and **R 29** to have the highest concentrations for the do nothing scenario.

For the proposed route scenario the model calculates **R 13** and **R 25** to be the receptors with the highest hydrocarbon concentrations.

2005

Results for 2005 display a similar trend to that of 1999 with **R 10**, **R 13** and **R 29** to have the highest concentrations for the do nothing scenario and **R 13** calculated as the receptor with highest concentration for the proposed route scenario.

2020

For the do nothing scenario **R10**, **R 13**, **R 27** and **R 29** were calculated to have the highest concentrations. For the proposed route scenario **R 13**, **R 16** were predicted to have the highest modelled concentrations. The reason for **R 13** and **R 16** still having higher than background concentrations is that the traffic volumes for the R 474 road leading into Ennis town centre, actually steadily increase from 1999 up to 2020. However it is expected that future increases in traffic may be offset through the impact of improved vehicle technology and cleaner fuels. Another important point to note at these receptors is that there are a number of traffic lights at junctions in the Carmody Street and Cornmarket Street area of Ennis town. As a result cars would be idling and decelerating etc. causing an increase in emissions from traffic in this area.

4.53 Nitrogen Dioxide

The background concentration used for Nitrogen dioxide was 4.17 $\mu g/m^3$. Tabulated model results for Nitrogen dioxide are presented in Appendix C. All modelled nitrogen dioxide results were less than the Irish Air Quality standard of 200 $\mu g/m^3$.

1999

For the do nothing scenario receptors **R 10**, **R 13**, **R 27** and **R 29** were calculated to have the highest concentrations of nitrogen dioxide. For the proposed route scenario **R 13** , **R 16** and **R 25** were calculated as the receptors with the highest nitrogen dioxide concentrations.

2005

For the do nothing scenario receptors **R 9**, **R10**, **R 13**, **R 27** and **R 29** were calculated to have the highest concentrations of nitrogen dioxide. For the proposed route scenario **R 13** and **R 16** have the highest concentrations.

2020

For the do nothing scenario receptors **R 9**, **R10**, **R 13**, **R 27** and **R 29** were calculated to have the highest concentrations of nitrogen dioxide. For the proposed route scenario **R 10**, **R 13**, **R 16** and **R 25** have the highest concentrations.

4.54 Lead

The background concentration used for lead was 0.42 μg/m³. The emission factor used in the model for lead was zero, based on the EC CORINAIR study (1991). As can be seen from the tabulated results in Appendix D, lead values for all years modelled have resulted in a zero concentration for all receptors. This is not surprising due to the small percentage of vehicles using leaded fuel still on the road. Also the implementation of the European Communities (Lead Content of Petrol) Regulations 1985 and 1986 (S.I. No. 378 of 1985 and S.I. No. 373 of 1986) resulted in a decrease in ambient lead concentrations from vehicular pollution.

All modelled lead results were below the Irish Air Quality Standard of 2 μg/m³.

4.55 Particulate Matter

The background concentration used for particulate matter was 36.6 μg/m³. Due to the low vehicle emission factors and background concentration the model has predicted very little increase in particulate matter concentrations. Tabulated model results for particulate matter are presented in Appendix E. The model has indicated that for the do nothing scenario the receptor with the highest particulate matter concentration is **R 29** in the Clarecastle area for the years 1999, 2005 and 2020. For the proposed route scenario in 1999, 2005 and 2020 the particulate matter results are not much different than the do nothing scenario with the exception that receptors concentrations in the Clarecastle area have decreased slightly.

All modelled particulate matter results are below the Irish Air Quality Standard of 250 μg/m³.

4.56 Sulphur Dioxide

When the do nothing scenario is modelled **R 10** and **R 13** are calculated as the receptors with the highest concentrations of sulphur dioxide. For the proposed route scenario the model indicates that **R 25** is the receptor with the highest concentration of sulphur dioxide.

All modelled sulphur dioxide results were below the Irish Air Quality Standard of 350 μg/m³.

5 CONCLUSIONS

The modelled results for all parameters indicate a number of common trends for both the rural and urban and receptors. These trends are listed below.

Rural receptors

As would be expected, all of the concentrations from the modelled rural receptors are significantly less than the receptors located in urban areas. None of the parameters exceed Irish standards or WHO guideline values.

The rural receptors with the highest modelled concentrations appear on the eastern side of the proposed N18 route i.e. **R 1**, **R 2**, **R 30** and **R 37**. The predominant wind direction in this area are south westerly in direction. As one would expect in a rural location the main source for the modelled pollutants would be vehicular emissions. The model therefore indicates that vehicular emissions from the Barefield to Latoon Bridge section of the proposed N 18 route are being moved by the predominant wind direction in a west to east direction. Receptors on the western side of the proposed N 18 showed no increase above their respective background concentrations. Overall, the model indicates that rural receptors located close to junctions and intersections of the proposed route will show a slight increase in the concentrations of vehicular pollutants based on the traffic volume supplied for the year 2020, but at concentrations significantly less than relevant guidelines and standards.

Urban receptors

For the **do nothing scenario** the areas with highest modelled concentrations for all years and parameters (except lead) were the centre of Ennis town near **R 10** and **R 13** and the Clarecastle area near **R 27** and **R 29**. This is consistent with the current traffic congestion in both of these areas. It can also be noticed between 1999 and 2020 that as traffic volume increases and hence vehicle emissions, the number of receptors with concentrations above the 1998 measured background levels also increases. For example in 1999 the receptors with highest carbon monoxide concentration were **R 10**, **R 13**, **R 17**, and **R 29**. This is a total of 4 receptors. However in 2020 **R 9**, **R 10**, **R 13**, **R 17**, **R 27** and **R 29**. are above the measured background carbon monoxide concentration bringing the total number of receptors up to 6.

For the **proposed route scenario** the areas with highest modelled concentrations for all years and parameters (except lead) were close to main junctions of the proposed route such as **R 25** which is located close to the roundabout where the Limerick road (N 18) meets the proposed route at

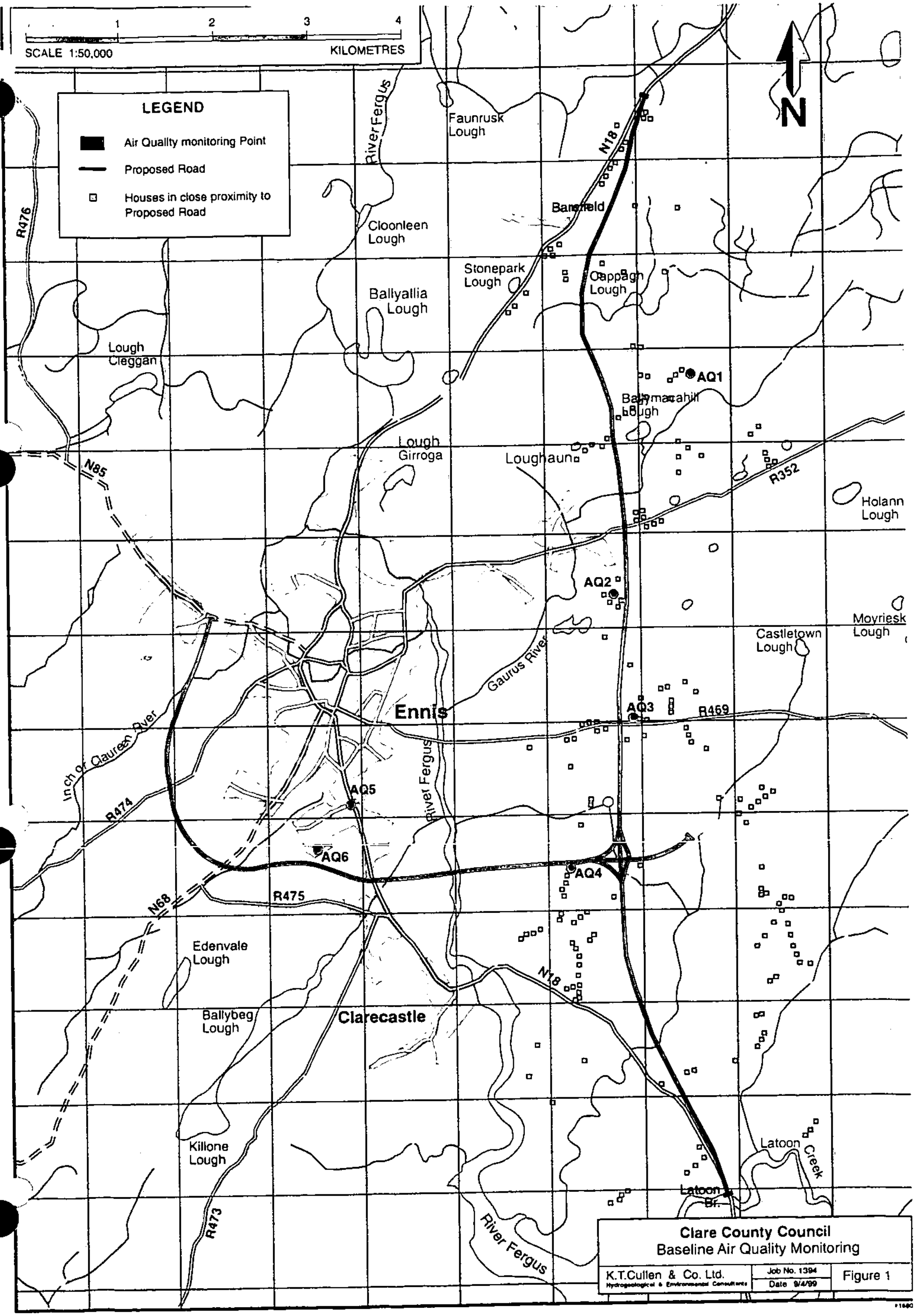
Clareabbey. **R 13** at Cornmarket Street in the centre of Ennis remains above the measured background concentrations as one would expect for an urban centre of its size, however a decrease in concentrations is indicated from the model at all receptors in Ennis town once the proposed route is installed. Correspondingly, a decrease in receptor concentrations in the Clarecastle area is indicated (**R 29**) once the proposed road is in operation.

On a global scale, signatories of the 1997 Kyoto Summit protocol are attempting to meet commitments for reducing pollutant emissions to the atmosphere. Car manufacturers and users have a part to play in this reduction. On a European level, the new NCT testing scheme introduced this month aims to improve the roadworthiness of vehicles on the road. An emissions check is included in the list of tests for the NCT. If consistently failed, this will result in the removal of older cars from the road due to their excessive exhaust emissions

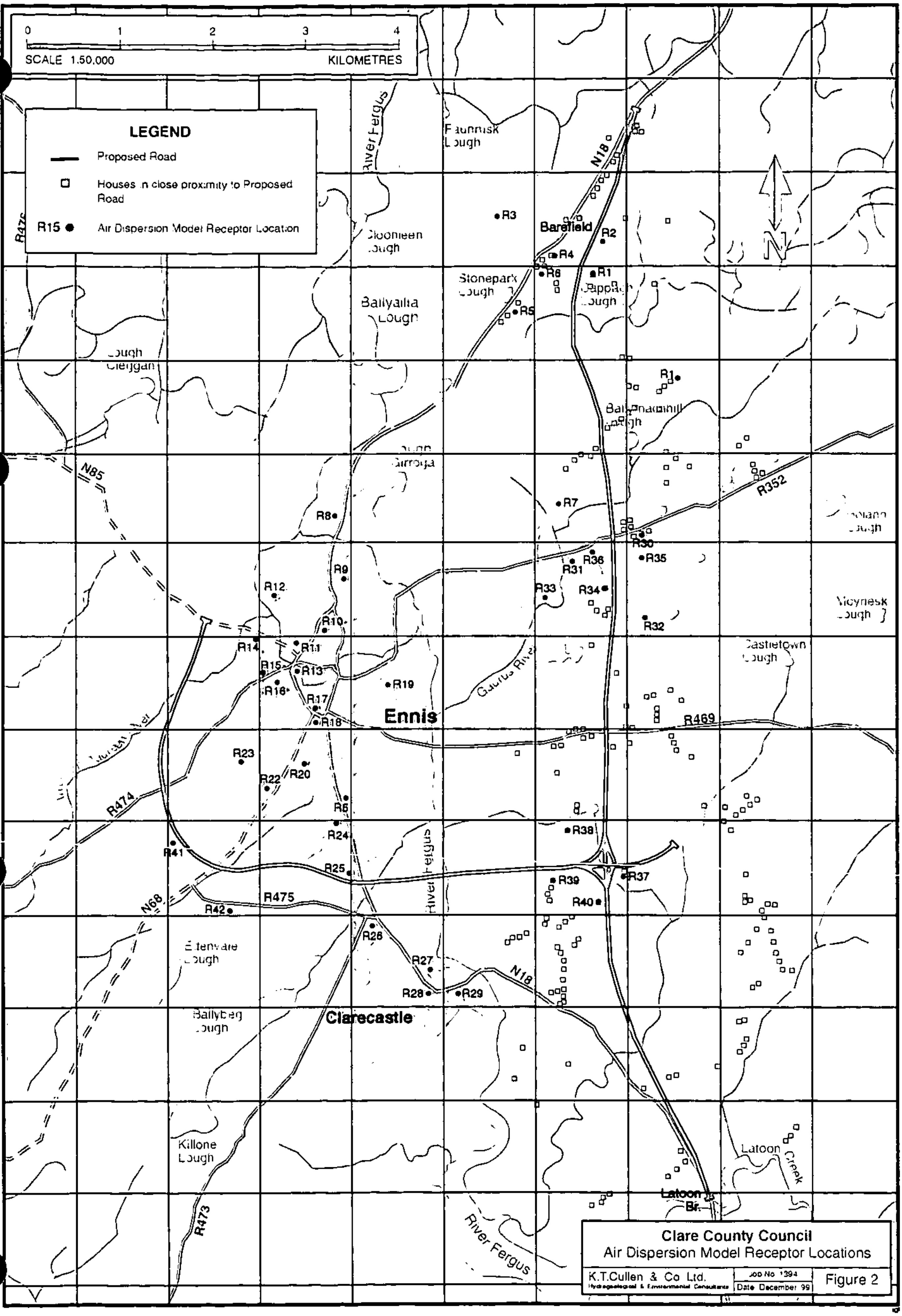
Lower emission factors are proposed for new motor vehicles for the year 2000 and even lower levels from 2005 for the parameters carbon monoxide, hydrocarbons, nitrogen dioxide and particulates. The emissions rates used in the model for this prediction are based on current emission levels, therefore the proposed new standards will result in lower pollutant concentrations from cars purchased in the future. The increased installation of catalytic converters and lean burning engines in modern cars will also reduce the impact that vehicular emissions will have on local air quality.

With the exception of hydrocarbon concentrations which slightly exceed WHO guideline values at certain urban receptors, all other predicted concentrations from the model are below appropriate standards as suggested by the European Community (EC) and the World Health Organisation (WHO). Traffic currently passing through Ennis is frequently experiencing delays therefore impacting on air quality in the town of Ennis. With the proposed new route it is anticipated the delays through Ennis will be significantly reduced and accordingly air quality will improve in Ennis town and the Clarecastle area.

FIGURES



SCALE 1:50,000
1
2
3
4
KILOMETRES
LEGEND
Air Quality monitoring Point
Proposed Road
Houses in close proximity to Proposed Road
N
Faunrusk Lough
River Fergus
N18
R476
Cloonleen Lough
Barefield
Stonepark Lough
Cappagh Lough
Ballyallia Lough
Lough Cleggan
AQ1
Ballymacahill Lough
Lough Girroga
Loughaun
N85
R352
Holann Lough
AQ2
Moyriesk Lough
Castletown Lough
Gaurus River
Ennis
AQ3
R469
Inch or Claureen River
AQ5
River Fergus
R474
AQ6
AQ4
R475
N68
Edenvale Lough
N18
Ballybeg Lough
Clarecastle
Killone Lough
Latoon Creek
Latoon Br.
R473
River Fergus
Clare County Council
Baseline Air Quality Monitoring
K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants
Job No. 1394
Date 9/4/99
Figure 1



Clare County Council
Air Dispersion Model Receptor Locations
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Hydrogeological & Environmental Consultants
Job No 1394
Date December 99
Figure 2

TABLES

Table 2: Baseline Air analytical Results: Sulphur Dioxide and Particulates

Air Sampling Locations	Sulphur Dioxide SO_2 ($\mu g/m^3$)	Particulate Matter (PM) ($\mu g/m^3$)
AQ1	101.0	< 83.3 *
AQ2	42.0	< 34.3
AQ3	135.4	131.7
AQ4	20.7	< 82.2 *
AQ5	20.7	< 36.6
AQ6	59.3	44.6
S.I. No. 244 of 1987	350	250

Legend

Samples collected 9th and 10th October 1998,
except * which were collected 5th to 7th of August, 1998.

The quoted S.I. Values for these compounds relates to the 98 percentile of daily values obtained over a year.

Table 3: Baseline Air Analytical Results: Lead, Nitrogen Dioxide, Benzene, Hydrocarbons, and Carbon Monoxide

Air Sampling Location	Lead $\mu g/m^3$	NO_2 $\mu g/m^3$	Benzene $\mu g/m^3$	Hydrocarbons $\mu g/m^3$	Carbon Monoxide $\mu g/m^3$
AQ1morming (5th Aug '98)	< 0.277	< 3.47	< 0.1	1.01	<1,000
AQ1evening (5th Aug '98)	< 0.39	7.950	< 0.1	1.01	<1,000
AQ2 morning (5th Aug '98)	< 0.3	3.78	< 0.08	6.10	<1,000
AQ2 evening (5th Aug '98)	< 0.44	14.77	< 0.08	7.60	<1,000
AQ3 morning (6th Aug '98)	< 0.32	< 3.846	< 0.101	13.13	<1,000
AQ3 evening (6th Aug '98)	< 0.33	6.80	< 0.1	1.01	<1,000
AQ4 morning (6th Aug '98)	< 0.31	3.91	-	-	<1,000
AQ4 evening (6th Aug '98)	< 0.274	5.38	< 0.08	3.51	<1,000
AQ5 morning (7th Aug '98)	< 0.333	<4.16	< 0.1	1313.13	3300
AQ5 evening (7th Aug '98)	< 0.42	<4.166	< 0.1	121.21	3300
AQ6 morning (7th Aug '98)	< 0.33	11.25	< 0.08	5.87	<1,000
AQ6 evening (7th Aug '98)	< 0.33	-	< 0.08	3.13	<1,000
S.I. No. 244 of 1987	2	200			
WHO Standards *			100*	120*	30,000 *

Legend

Samples collected on the 5th to the 7th of August 1998

" - "Samples Damaged in Transit to the Laboratory

APPENDIX A

Carbon Monoxide Results for Existing Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	Carbon Monoxide Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	3,300	< 3300	< 3300
R 9	3,300	3307	3303
R 10	3,300	3316	3308
R 11	3,300	3305	3302
R 12	3,300	< 3300	< 3300
R 13	3,300	3441	3369
R 14	3,300	< 3300	< 3300
R 15	3,300	< 3300	< 3300
R 16	3,300	3304	3302
R 17	3,300	3322	3311
R 18	3,300	< 3300	< 3300
R 19	3,300	3304	3302
R 20	3,300	< 3300	< 3300
R 21	3,300	< 3300	< 3300
R 22	3,300	< 3300	< 3300
R 23	3,300	< 3300	< 3300
R 24	3,300	< 3300	< 3300
R 25	3,300	< 3300	< 3300
R 26	3,300	< 3300	< 3300
R 27	3,300	3310	3305
R 28	3,300	< 3300	< 3300
R 29	3,300	3318	3309

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Carbon Monoxide Results for Existing and Proposed Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	Carbon Monoxide Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	3,300	< 3300	< 3300
R 9	3,300	3302	3301
R 10	3,300	3307	3303
R 11	3,300	3302	3301
R 12	3,300	< 3300	< 3300
R 13	3,300	3433	3365
R 14	3,300	< 3300	< 3300
R 15	3,300	< 3300	< 3300
R 16	3,300	3307	3304
R 17	3,300	3301	3301
R 18	3,300	3301	< 3300
R 19	3,300	3301	3301
R 20	3,300	3301	< 3300
R 21	3,300	3301	< 3300
R 22	3,300	3301	3301
R 23	3,300	3301	< 3300
R 24	3,300	3301	< 3300
R 25	3,300	3312	3306
R 26	3,300	< 3300	< 3300
R 27	3,300	< 3300	< 3300
R 28	3,300	< 3300	< 3300
R 29	3,300	< 3300	< 3300

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : 10/11/99

Carbon Monoxide Results for Existing Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	Carbon Monoxide Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	3,300	< 3300	< 3300
R 9	3,300	3308	3304
R 10	3,300	3319	3309
R 11	3,300	3306	3303
R 12	3,300	< 3300	< 3300
R 13	3,300	3442	3369
R 14	3,300	< 3300	< 3300
R 15	3,300	< 3300	< 3300
R 16	3,300	3305	3302
R 17	3,300	3354	3326
R 18	3,300	< 3300	< 3300
R 19	3,300	3305	3302
R 20	3,300	< 3300	< 3300
R 21	3,300	< 3300	< 3300
R 22	3,300	< 3300	< 3300
R 23	3,300	< 3300	< 3300
R 24	3,300	< 3300	< 3300
R 25	3,300	< 3300	< 3300
R 26	3,300	< 3300	< 3300
R 27	3,300	3312	3306
R 28	3,300	< 3300	< 3300
R 29	3,300	3321	3310

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Carbon Monoxide Results for Existing and Proposed Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	Carbon Monoxide Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	3,300	< 3300	< 3300
R 9	3,300	3302	3301
R 10	3,300	3308	3304
R 11	3,300	3302	3301
R 12	3,300	< 3300	< 3300
R 13	3,300	3443	3370
R 14	3,300	3301	< 3300
R 15	3,300	< 3300	< 3300
R 16	3,300	3309	3304
R 17	3,300	3301	3301
R 18	3,300	3301	< 3300
R 19	3,300	3302	3301
R 20	3,300	3301	< 3300
R 21	3,300	3301	< 3300
R 22	3,300	3301	3301
R 23	3,300	3301	3301
R 24	3,300	3301	< 3300
R 25	3,300	3302	3301
R 26	3,300	< 3300	< 3300
R 27	3,300	< 3300	< 3300
R 28	3,300	< 3300	< 3300
R 29	3,300	3301	< 3300

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Carbon Monoxide Results for Existing Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	Carbon Monoxide Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	3,300	< 3300	< 3300
R 9	3,300	3313	3307
R 10	3,300	3323	3311
R 11	3,300	3309	3304
R 12	3,300	3301	< 3300
R 13	3,300	3446	3371
R 14	3,300	< 3300	< 3300
R 15	3,300	< 3300	< 3300
R 16	3,300	3308	3304
R 17	3,300	3378	3338
R 18	3,300	< 3300	< 3300
R 19	3,300	3308	3304
R 20	3,300	< 3300	< 3300
R 21	3,300	< 3300	< 3300
R 22	3,300	< 3300	< 3300
R 23	3,300	< 3300	< 3300
R 24	3,300	3301	< 3300
R 25	3,300	< 3300	< 3300
R 26	3,300	< 3300	< 3300
R 27	3,300	3318	3309
R 28	3,300	< 3300	< 3300
R 29	3,300	3333	3316

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Directior
Shaded results indicate highest modelled receptor concentration

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Carbon Monoxide Results for Existing and Proposed Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	Carbon Monoxide Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	3,300	< 3300	< 3300
R 9	3,300	3303	3301
R 10	3,300	3313	3306
R 11	3,300	3303	3301
R 12	3,300	3301	< 3300
R 13	3,300	3449	3373
R 14	3,300	3301	< 3300
R 15	3,300	3301	< 3300
R 16	3,300	3314	3307
R 17	3,300	3301	3301
R 18	3,300	3301	3301
R 19	3,300	3303	3301
R 20	3,300	3301	3301
R 21	3,300	3301	3301
R 22	3,300	3302	3301
R 23	3,300	3302	3301
R 24	3,300	3302	3301
R 25	3,300	3323	3311
R 26	3,300	< 3300	< 3300
R 27	3,300	3301	< 3300
R 28	3,300	< 3300	< 3300
R 29	3,300	3301	< 3300

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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APPENDIX B

Hydrocarbon Results for Existing Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	Hydrocarbon Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	121.21	< 121	< 121
R 9	121.21	123	122
R 10	121.21	126	123
R 11	121.21	123	122
R 12	121.21	< 121	< 121
R 13	121.21	124	123
R 14	121.21	< 121	< 121
R 15	121.21	< 121	< 121
R 16	121.21	122	122
R 17	121.21	< 121	< 121
R 18	121.21	< 121	< 121
R 19	121.21	< 121	< 121
R 20	121.21	< 121	< 121
R 21	121.21	< 121	< 121
R 22	121.21	< 121	< 121
R 23	121.21	< 121	< 121
R 24	121.21	< 121	< 121
R 25	121.21	< 121	< 121
R 26	121.21	< 121	< 121
R 27	121.21	124	123
R 28	121.21	< 121	< 121
R 29	121.21	126	124

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Hydrocarbon Results for Existing and Proposed Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	Hydrocarbon Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	121.21	< 121	< 121
R 9	121.21	122	< 121
R 10	121.21	123	122
R 11	121.21	122	< 121
R 12	121.21	< 121	< 121
R 13	121.21	124	123
R 14	121.21	< 121	< 121
R 15	121.21	< 121	< 121
R 16	121.21	123	122
R 17	121.21	< 121	< 121
R 18	121.21	< 121	< 121
R 19	121.21	< 121	< 121
R 20	121.21	< 121	< 121
R 21	121.21	< 121	< 121
R 22	121.21	< 121	< 121
R 23	121.21	< 121	< 121
R 24	121.21	< 121	< 121
R 25	121.21	125	123
R 26	121.21	< 121	< 121
R 27	121.21	< 121	< 121
R 28	121.21	< 121	< 121
R 29	121.21	< 121	< 121

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Hydrocarbon Results for Existing Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	Hydrocarbon Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	121.21	< 121	< 121
R 9	121.21	123	122
R 10	121.21	126	124
R 11	121.21	123	122
R 12	121.21	< 121	< 121
R 13	121.21	125	123
R 14	121.21	< 121	< 121
R 15	121.21	< 121	< 121
R 16	121.21	123	122
R 17	121.21	122	< 121
R 18	121.21	< 121	< 121
R 19	121.21	< 121	< 121
R 20	121.21	< 121	< 121
R 21	121.21	< 121	< 121
R 22	121.21	< 121	< 121
R 23	121.21	< 121	< 121
R 24	121.21	< 121	< 121
R 25	121.21	< 121	< 121
R 26	121.21	< 121	< 121
R 27	121.21	125	123
R 28	121.21	< 121	< 121
R 29	121.21	127	124

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Hydrocarbon Results for Existing and Proposed Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	Hydrocarbon Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	121.21	< 121	< 121
R 9	121.21	122	< 121
R 10	121.21	123	122
R 11	121.21	122	< 121
R 12	121.21	< 121	< 121
R 13	121.21	125	123
R 14	121.21	< 121	< 121
R 15	121.21	< 121	< 121
R 16	121.21	124	122
R 17	121.21	< 121	< 121
R 18	121.21	< 121	< 121
R 19	121.21	< 121	< 121
R 20	121.21	< 121	< 121
R 21	121.21	< 121	< 121
R 22	121.21	< 121	< 121
R 23	121.21	< 121	< 121
R 24	121.21	< 121	< 121
R 25	121.21	122	< 121
R 26	121.21	< 121	< 121
R 27	121.21	< 121	< 121
R 28	121.21	< 121	< 121
R 29	121.21	< 121	< 121

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : 10/11/99

Hydrocarbon Results for Existing Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	Hydrocarbon Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	121.21	< 121	< 121
R 9	121.21	125	123
R 10	121.21	128	124
R 11	121.21	124	122
R 12	121.21	< 121	< 121
R 13	121.21	126	124
R 14	121.21	< 121	< 121
R 15	121.21	< 121	< 121
R 16	121.21	123	122
R 17	121.21	122	< 121
R 18	121.21	< 121	< 121
R 19	121.21	< 121	< 121
R 20	121.21	< 121	< 121
R 21	121.21	< 121	< 121
R 22	121.21	< 121	< 121
R 23	121.21	< 121	< 121
R 24	121.21	< 121	< 121
R 25	121.21	< 121	< 121
R 26	121.21	< 121	< 121
R 27	121.21	126	124
R 28	121.21	< 121	< 121
R 29	121.21	130	126

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

Hydrocarbon Results for Existing and Proposed Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	Hydrocarbon Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	121.21	< 121	< 121
R 9	121.21	122	122
R 10	121.21	125	123
R 11	121.21	122	122
R 12	121.21	< 121	< 121
R 13	121.21	127	124
R 14	121.21	< 121	< 121
R 15	121.21	< 121	< 121
R 16	121.21	125	123
R 17	121.21	122	< 121
R 18	121.21	122	< 121
R 19	121.21	122	< 121
R 20	121.21	122	< 121
R 21	121.21	< 121	< 121
R 22	121.21	122	< 121
R 23	121.21	122	< 121
R 24	121.21	122	< 121
R 25	121.21	128	124
R 26	121.21	< 121	< 121
R 27	121.21	< 121	< 121
R 28	121.21	< 121	< 121
R 29	121.21	< 121	< 121

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

APPENDIX C

NO x Results for Existing Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	Particulate Matter Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	4.17	< 4	< 4
R 9	4.17	10	7
R 10	4.17	16	10
R 11	4.17	8	6
R 12	4.17	< 4	< 4
R 13	4.17	13	9
R 14	4.17	< 4	< 4
R 15	4.17	< 4	< 4
R 16	4.17	7	6
R 17	4.17	5	< 4
R 18	4.17	< 4	< 4
R 19	4.17	5	< 4
R 20	4.17	< 4	< 4
R 21	4.17	< 4	< 4
R 22	4.17	< 4	< 4
R 23	4.17	< 4	< 4
R 24	4.17	< 4	< 4
R 25	4.17	< 4	< 4
R 26	4.17	< 4	< 4
R 27	4.17	12	8
R 28	4.17	< 4	< 4
R 29	4.17	18	11

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : 10/11/99

NO x Results for Existing and Proposed Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	NOx Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	4.17	< 4	< 4
R 9	4.17	5	5
R 10	4.17	9	7
R 11	4.17	5	5
R 12	4.17	< 4	< 4
R 13	4.17	13	8
R 14	4.17	5	< 4
R 15	4.17	< 4	< 4
R 16	4.17	10	7
R 17	4.17	5	< 4
R 18	4.17	5	< 4
R 19	4.17	5	< 4
R 20	4.17	5	< 4
R 21	4.17	< 4	< 4
R 22	4.17	5	< 4
R 23	4.17	5	5
R 24	4.17	5	5
R 25	4.17	14	9
R 26	4.17	< 4	< 4
R 27	4.17	< 4	< 4
R 28	4.17	< 4	< 4
R 29	4.17	< 4	< 4

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : 10/11/99

NO x Results for Existing Road Network - 2005

Receptor No.	**Background Concentration** (ug/m3)	NO x Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	4.17	< 4	< 4
R 9	4.17	11	7
R 10	4.17	19	11
R 11	4.17	9	6
R 12	4.17	< 4	< 4
R 13	4.17	14	9
R 14	4.17	< 4	< 4
R 15	4.17	< 4	< 4
R 16	4.17	8	6
R 17	4.17	5	5
R 18	4.17	< 4	< 4
R 19	4.17	5	< 4
R 20	4.17	< 4	< 4
R 21	4.17	< 4	< 4
R 22	4.17	< 4	< 4
R 23	4.17	< 4	< 4
R 24	4.17	5	< 4
R 25	4.17	< 4	< 4
R 26	4.17	< 4	< 4
R 27	4.17	13	9
R 28	4.17	< 4	< 4
R 29	4.17	20	12

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : 10/11/99

NO x Results for Existing and Proposed Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	NO x Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	4.17	< 4	< 4
R 9	4.17	6	5
R 10	4.17	10	7
R 11	4.17	6	5
R 12	4.17	< 4	< 4
R 13	4.17	15	9
R 14	4.17	5	< 4
R 15	4.17	5	< 4
R 16	4.17	11	7
R 17	4.17	5	5
R 18	4.17	5	< 4
R 19	4.17	5	5
R 20	4.17	5	< 4
R 21	4.17	5	< 4
R 22	4.17	5	< 4
R 23	4.17	5	5
R 24	4.17	5	5
R 25	4.17	6	5
R 26	4.17	< 4	< 4
R 27	4.17	< 4	< 4
R 28	4.17	< 4	< 4
R 29	4.17	< 4	< 4

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : 10/11/99

NO x Results for Existing Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	NO x Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	4.17	< 4	< 4
R 9	4.17	14	9
R 10	4.17	22	13
R 11	4.17	11	7
R 12	4.17	5	< 4
R 13	4.17	17	10
R 14	4.17	< 4	< 4
R 15	4.17	< 4	< 4
R 16	4.17	10	7
R 17	4.17	6	5
R 18	4.17	< 4	< 4
R 19	4.17	5	< 4
R 20	4.17	< 4	< 4
R 21	4.17	< 4	< 4
R 22	4.17	< 4	< 4
R 23	4.17	< 4	< 4
R 24	4.17	5	< 4
R 25	4.17	5	< 4
R 26	4.17	< 4	< 4
R 27	4.17	18	11
R 28	4.17	< 4	< 4
R 29	4.17	29	16

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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NO x Results for Existing and Proposed Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	Particulate Matter Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	4.17	< 4	< 4
R 9	4.17	6	5
R 10	4.17	14	9
R 11	4.17	6	5
R 12	4.17	5	< 4
R 13	4.17	19	11
R 14	4.17	5	5
R 15	4.17	5	< 4
R 16	4.17	14	9
R 17	4.17	5	5
R 18	4.17	5	5
R 19	4.17	5	5
R 20	4.17	5	5
R 21	4.17	5	< 4
R 22	4.17	5	5
R 23	4.17	5	5
R 24	4.17	5	5
R 25	4.17	22	13
R 26	4.17	< 4	< 4
R 27	4.17	5	< 4
R 28	4.17	< 4	< 4
R 29	4.17	5	< 4

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : 10/11/99

APPENDIX D

Lead Results for Existing Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	Lead Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	0.42	0	0
R 9	0.42	0	0
R 10	0.42	0	0
R 11	0.42	0	0
R 12	0.42	0	0
R 13	0.42	0	0
R 14	0.42	0	0
R 15	0.42	0	0
R 16	0.42	0	0
R 17	0.42	0	0
R 18	0.42	0	0
R 19	0.42	0	0
R 20	0.42	0	0
R 21	0.42	0	0
R 22	0.42	0	0
R 23	0.42	0	0
R 24	0.42	0	0
R 25	0.42	0	0
R 26	0.42	0	0
R 27	0.42	0	0
R 28	0.42	0	0
R 29	0.42	0	0

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

Lead Results for Existing and Proposed Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	Lead Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	0.42	0	0
R 9	0.42	0	0
R 10	0.42	0	0
R 11	0.42	0	0
R 12	0.42	0	0
R 13	0.42	0	0
R 14	0.42	0	0
R 15	0.42	0	0
R 16	0.42	0	0
R 17	0.42	0	0
R 18	0.42	0	0
R 19	0.42	0	0
R 20	0.42	0	0
R 21	0.42	0	0
R 22	0.42	0	0
R 23	0.42	0	0
R 24	0.42	0	0
R 25	0.42	0	0
R 26	0.42	0	0
R 27	0.42	0	0
R 28	0.42	0	0
R 29	0.42	0	0

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

Lead Results for Existing Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	Lead Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	0.42	0	0
R 9	0.42	0	0
R 10	0.42	0	0
R 11	0.42	0	0
R 12	0.42	0	0
R 13	0.42	0	0
R 14	0.42	0	0
R 15	0.42	0	0
R 16	0.42	0	0
R 17	0.42	0	0
R 18	0.42	0	0
R 19	0.42	0	0
R 20	0.42	0	0
R 21	0.42	0	0
R 22	0.42	0	0
R 23	0.42	0	0
R 24	0.42	0	0
R 25	0.42	0	0
R 26	0.42	0	0
R 27	0.42	0	0
R 28	0.42	0	0
R 29	0.42	0	0

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

Lead Results for Existing and Proposed Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	Lead Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	0.42	0	0
R 9	0.42	0	0
R 10	0.42	0	0
R 11	0.42	0	0
R 12	0.42	0	0
R 13	0.42	0	0
R 14	0.42	0	0
R 15	0.42	0	0
R 16	0.42	0	0
R 17	0.42	0	0
R 18	0.42	0	0
R 19	0.42	0	0
R 20	0.42	0	0
R 21	0.42	0	0
R 22	0.42	0	0
R 23	0.42	0	0
R 24	0.42	0	0
R 25	0.42	0	0
R 26	0.42	0	0
R 27	0.42	0	0
R 28	0.42	0	0
R 29	0.42	0	0

Legend :
ug/m3 : micrograms per cubic metre
* :, Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

Lead Results for Existing Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	Lead Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	0.42	0	0
R 9	0.42	0	0
R 10	0.42	0	0
R 11	0.42	0	0
R 12	0.42	0	0
R 13	0.42	0	0
R 14	0.42	0	0
R 15	0.42	0	0
R 16	0.42	0	0
R 17	0.42	0	0
R 18	0.42	0	0
R 19	0.42	0	0
R 20	0.42	0	0
R 21	0.42	0	0
R 22	0.42	0	0
R 23	0.42	0	0
R 24	0.42	0	0
R 25	0.42	0	0
R 26	0.42	0	0
R 27	0.42	0	0
R 28	0.42	0	0
R 29	0.42	0	0

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

Lead Results for Existing and Proposed Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	Lead Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	0.42	0	0
R 9	0.42	0	0
R 10	0.42	0	0
R 11	0.42	0	0
R 12	0.42	0	0
R 13	0.42	0	0
R 14	0.42	0	0
R 15	0.42	0	0
R 16	0.42	0	0
R 17	0.42	0	0
R 18	0.42	0	0
R 19	0.42	0	0
R 20	0.42	0	0
R 21	0.42	0	0
R 22	0.42	0	0
R 23	0.42	0	0
R 24	0.42	0	0
R 25	0.42	0	0
R 26	0.42	0	0
R 27	0.42	0	0
R 28	0.42	0	0
R 29	0.42	0	0

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : 10/11/99

APPENDIX E

Particulate Matter Results for Existing Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	Particulate Matter Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	36.6	< 37	< 37
R 9	36.6	< 37	< 37
R 10	36.6	< 37	< 37
R 11	36.6	< 37	< 37
R 12	36.6	< 37	< 37
R 13	36.6	< 37	< 37
R 14	36.6	< 37	< 37
R 15	36.6	< 37	< 37
R 16	36.6	< 37	< 37
R 17	36.6	< 37	< 37
R 18	36.6	< 37	< 37
R 19	36.6	< 37	< 37
R 20	36.6	< 37	< 37
R 21	36.6	< 37	< 37
R 22	36.6	< 37	< 37
R 23	36.6	< 37	< 37
R 24	36.6	< 37	< 37
R 25	36.6	< 37	< 37
R 26	36.6	< 37	< 37
R 27	36.6	< 37	< 37
R 28	36.6	< 37	< 37
R 29	36.6	38	< 37

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

Particulate Matter Results for Existing and Proposed Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	Particulate Matter Concentration (ug / m3) 270 degrees * Ave Wind Speed	Particulate Matter Concentration (ug / m3) 270 degrees * Max Wind Speed
R 8	36.6	< 37	< 37
R 9	36.6	< 37	< 37
R 10	36.6	< 37	< 37
R 11	36.6	< 37	< 37
R 12	36.6	< 37	< 37
R 13	36.6	< 37	< 37
R 14	36.6	< 37	< 37
R 15	36.6	< 37	< 37
R 16	36.6	< 37	< 37
R 17	36.6	< 37	< 37
R 18	36.6	< 37	< 37
R 19	36.6	< 37	< 37
R 20	36.6	< 37	< 37
R 21	36.6	< 37	< 37
R 22	36.6	< 37	< 37
R 23	36.6	< 37	< 37
R 24	36.6	< 37	< 37
R 25	36.6	< 37	< 37
R 26	36.6	< 37	< 37
R 27	36.6	< 37	< 37
R 28	36.6	< 37	< 37
R 29	36.6	< 37	< 37

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

K. T. Cullen & Co. Ltd
Hydrogeological and Environmental Consultants
Job No. 1394
Date : 10/11/99

Particulate Matter Results for Existing Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	Particulate Matter Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	36.6	< 37	< 37
R 9	36.6	< 37	< 37
R 10	36.6	38	< 37
R 11	36.6	< 37	< 37
R 12	36.6	< 37	< 37
R 13	36.6	< 37	< 37
R 14	36.6	< 37	< 37
R 15	36.6	< 37	< 37
R 16	36.6	< 37	< 37
R 17	36.6	< 37	< 37
R 18	36.6	< 37	< 37
R 19	36.6	< 37	< 37
R 20	36.6	< 37	< 37
R 21	36.6	< 37	< 37
R 22	36.6	< 37	< 37
R 23	36.6	< 37	< 37
R 24	36.6	< 37	< 37
R 25	36.6	< 37	< 37
R 26	36.6	< 37	< 37
R 27	36.6	< 37	< 37
R 28	36.6	< 37	< 37
R 29	36.6	38	< 37

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : 10/11/99

Particulate Matter Results for Existing and Proposed Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	Particulate Matter Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	36.6	< 37	< 37
R 9	36.6	< 37	< 37
R 10	36.6	38	< 37
R 11	36.6	< 37	< 37
R 12	36.6	< 37	< 37
R 13	36.6	< 37	< 37
R 14	36.6	< 37	< 37
R 15	36.6	< 37	< 37
R 16	36.6	< 37	< 37
R 17	36.6	< 37	< 37
R 18	36.6	< 37	< 37
R 19	36.6	< 37	< 37
R 20	36.6	< 37	< 37
R 21	36.6	< 37	< 37
R 22	36.6	< 37	< 37
R 23	36.6	< 37	< 37
R 24	36.6	< 37	< 37
R 25	36.6	< 37	< 37
R 26	36.6	< 37	< 37
R 27	36.6	< 37	< 37
R 28	36.6	< 37	< 37
R 29	36.6	38	< 37

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

Particulate Matter Results for Existing Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	Particulate Matter Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	36.6	< 37	< 37
R 9	36.6	38	< 37
R 10	36.6	< 37	< 37
R 11	36.6	< 37	< 37
R 12	36.6	< 37	< 37
R 13	36.6	< 37	< 37
R 14	36.6	< 37	< 37
R 15	36.6	< 37	< 37
R 16	36.6	< 37	< 37
R 17	36.6	< 37	< 37
R 18	36.6	< 37	< 37
R 19	36.6	< 37	< 37
R 20	36.6	< 37	< 37
R 21	36.6	< 37	< 37
R 22	36.6	< 37	< 37
R 23	36.6	< 37	< 37
R 24	36.6	< 37	< 37
R 25	36.6	< 37	< 37
R 26	36.6	< 37	< 37
R 27	36.6	38	< 37
R 28	36.6	< 37	< 37
R 29	36.6	38	< 37

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

Particulate Matter Results for Existing and Proposed Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	Particulate Matter Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	36.6	< 37	< 37
R 9	36.6	< 37	< 37
R 10	36.6	< 37	< 37
R 11	36.6	< 37	< 37
R 12	36.6	< 37	< 37
R 13	36.6	38	< 37
R 14	36.6	< 37	< 37
R 15	36.6	< 37	< 37
R 16	36.6	< 37	< 37
R 17	36.6	< 37	< 37
R 18	36.6	< 37	< 37
R 19	36.6	< 37	< 37
R 20	36.6	< 37	< 37
R 21	36.6	< 37	< 37
R 22	36.6	< 37	< 37
R 23	36.6	< 37	< 37
R 24	36.6	< 37	< 37
R 25	36.6	38	< 37
R 26	36.6	< 37	< 37
R 27	36.6	< 37	< 37
R 28	36.6	< 37	< 37
R 29	36.6	< 37	< 37

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration.

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APPENDIX F

SO x Results for Existing Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	SOx Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	20.7	< 21	< 21
R 9	20.7	< 21	< 21
R 10	20.7	22	< 21
R 11	20.7	< 21	< 21
R 12	20.7	< 21	< 21
R 13	20.7	22	< 21
R 14	20.7	< 21	< 21
R 15	20.7	< 21	< 21
R 16	20.7	< 21	< 21
R 17	20.7	< 21	< 21
R 18	20.7	< 21	< 21
R 19	20.7	< 21	< 21
R 20	20.7	< 21	< 21
R 21	20.7	< 21	< 21
R 22	20.7	< 21	< 21
R 23	20.7	< 21	< 21
R 24	20.7	< 21	< 21
R 25	20.7	< 21	< 21
R 26	20.7	< 21	< 21
R 27	20.7	< 21	< 21
R 28	20.7	< 21	< 21
R 29	20.7	22	< 21

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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SO x Results for Existing and Proposed Road Network - 1999

Receptor No.	Background Concentration (ug/m3)	SOx Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	20.7	< 21	< 21
R 9	20.7	< 21	< 21
R 10	20.7	< 21	< 21
R 11	20.7	< 21	< 21
R 12	20.7	< 21	< 21
R 13	20.7	22	< 21
R 14	20.7	< 21	< 21
R 15	20.7	< 21	< 21
R 16	20.7	< 21	< 21
R 17	20.7	< 21	< 21
R 18	20.7	< 21	< 21
R 19	20.7	< 21	< 21
R 20	20.7	< 21	< 21
R 21	20.7	< 21	< 21
R 22	20.7	< 21	< 21
R 23	20.7	< 21	< 21
R 24	20.7	< 21	< 21
R 25	20.7	22	< 21
R 26	20.7	< 21	< 21
R 27	20.7	< 21	< 21
R 28	20.7	< 21	< 21
R 29	20.7	< 21	< 21

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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SO x Results for Existing Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	SOx Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed.
R 8	20.7	< 21	< 21
R 9	20.7	< 21	< 21
R 10	20.7	22	< 21
R 11	20.7	< 21	< 21
R 12	20.7	< 21	< 21
R 13	20.7	22	< 21
R 14	20.7	< 21	< 21
R 15	20.7	< 21	< 21
R 16	20.7	< 21	< 21
R 17	20.7	< 21	< 21
R 18	20.7	< 21	< 21
R 19	20.7	< 21	< 21
R 20	20.7	< 21	< 21
R 21	20.7	< 21	< 21
R 22	20.7	< 21	< 21
R 23	20.7	< 21	< 21
R 24	20.7	< 21	< 21
R 25	20.7	< 21	< 21
R 26	20.7	< 21	< 21
R 27	20.7	22	< 21
R 28	20.7	< 21	< 21
R 29	20.7	22	< 21

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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SO x Results for Existing and proposed Road Network - 2005

Receptor No.	Background Concentration (ug/m3)	SOx Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	20.7	< 21	< 21
R 9	20.7	< 21	< 21
R 10	20.7	< 21	< 21
R 11	20.7	< 21	< 21
R 12	20.7	< 21	< 21
R 13	20.7	22	< 21
R 14	20.7	< 21	< 21
R 15	20.7	< 21	< 21
R 16	20.7	< 21	< 21
R 17	20.7	< 21	< 21
R 18	20.7	< 21	< 21
R 19	20.7	< 21	< 21
R 20	20.7	< 21	< 21
R 21	20.7	< 21	< 21
R 22	20.7	< 21	< 21
R 23	20.7	< 21	< 21
R 24	20.7	< 21	< 21
R 25	20.7	< 21	< 21
R 26	20.7	< 21	< 21
R 27	20.7	< 21	< 21
R 28	20.7	< 21	< 21
R 29	20.7	< 21	< 21

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : 10/11/99

SO x Results for Existing Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	SOx Concentration (ug / m3)	
		270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	20.7	< 21	< 21
R 9	20.7	22	< 21
R 10	20.7	22	22
R 11	20.7	< 21	< 21
R 12	20.7	< 21	< 21
R 13	20.7	22	< 21
R 14	20.7	< 21	< 21
R 15	20.7	< 21	< 21
R 16	20.7	< 21	< 21
R 17	20.7	< 21	< 21
R 18	20.7	< 21	< 21
R 19	20.7	< 21	< 21
R 20	20.7	< 21	< 21
R 21	20.7	< 21	< 21
R 22	20.7	< 21	< 21
R 23	20.7	< 21	< 21
R 24	20.7	< 21	< 21
R 25	20.7	< 21	< 21
R 26	20.7	< 21	< 21
R 27	20.7	22	< 21
R 28	20.7	< 21	< 21
R 29	20.7	23	22

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration.

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Job No. 1394
Date : 10/11/99

SO x Results for Existing and Proposed Road Network - 2020

Receptor No.	Background Concentration (ug/m3)	SOx Concentration (ug / m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 8	20.7	< 21	< 21
R 9	20.7	< 21	< 21
R 10	20.7	22	< 21
R 11	20.7	< 21	< 21
R 12	20.7	< 21	< 21
R 13	20.7	22	< 21
R 14	20.7	< 21	< 21
R 15	20.7	< 21	< 21
R 16	20.7	22	< 21
R 17	20.7	< 21	< 21
R 18	20.7	< 21	< 21
R 19	20.7	< 21	< 21
R 20	20.7	< 21	< 21
R 21	20.7	< 21	< 21
R 22	20.7	< 21	< 21
R 23	20.7	< 21	< 21
R 24	20.7	< 21	< 21
R 25	20.7	22	< 21
R 26	20.7	< 21	< 21
R 27	20.7	< 21	< 21
R 28	20.7	< 21	< 21
R 29	20.7	< 21	< 21

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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APPENDIX G

Carbon Monoxide Results for the Existing and Proposed road network - 2020.

Receptor No.	Background Concentration (ug/m3)	Carbon monoxide concentration (ug/m3 270 degrees *	
		AveWind Speed	Max Wind Speed
R 1	<994.3	<994.3	<994.3
R 2	<994.3	<994.3	<994.3
R 3	<994.3	<994.3	<994.3
R 4	<994.3	<994.3	<994.3
R 5	<994.3	<994.3	<994.3
R 6	<994.3	<994.3	<994.3
R 7	<994.3	<994.3	<994.3
R 30	<994.3	<994.3	<994.3
R 31	<994.3	<994.3	<994.3
R 32	<994.3	<994.3	<994.3
R 33	<994.3	<994.3	<994.3
R 34	<994.3	<994.3	<994.3
R 35	<994.3	<994.3	<994.3
R 36	<994.3	<994.3	<994.3
R 37	<994.3	<994.3	<994.3
R 38	<994.3	<994.3	<994.3
R 39	<994.3	<994.3	<994.3
R 40	<994.3	<994.3	<994.3
R 41	<994.3	<994.3	<994.3
R 42	<994.3	<994.3	<994.3

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : Mar 1999

Hydrocarbon Results for the Existing and Proposed road network - 2020

Receptor No.	Background Concentration (ug/m3)	Hydrocarbon concentration (ug/m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 1	1.01	4	2
R 2	1.01	3	2
R 3	1.01	1	1
R 4	1.01	1	1
R 5	1.01	1	1
R 6	1.01	1	1
R 7	7.6	8	8
R 30	7.6	11	9
R 31	7.6	8	8
R 32	7.6	8	8
R 33	7.6	8	8
R 34	7.6	8	8
R 35	7.6	9	8
R 36	7.6	10	9
R 37	3.5	14	9
R 38	3.5	4	4
R 39	3.5	4	4
R 40	3.5	4	4
R 41	5.9	6	6
R 42	5.9	6	6

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : Mar 1999

Nitrogen Dioxide Results fot the Existing and Proposed road network - 2020

Receptor No.	Background Concentration (ug/m3)	Nitrogen dioxide concentration (ug/m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 1	7.9	13	10
R 2	7.9	14	11
R 3	7.9	8	8
R 4	7.9	8	8
R 5	7.9	8	8
R 6	7.9	8	8
R 7	14.8	15	15
R 30	14.8	24	19
R 31	14.8	15	15
R 32	14.8	17	16
R 33	14.8	15	15
R 34	14.8	15	15
R 35	14.8	19	17
R 36	14.8	21	18
R 37	5.4	15	10
R 38	5.4	5	5
R 39	5.4	5	5
R 40	5.4	5	5
R 41	11.3	11	11
R 42	11.3	11	11

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Date : Mar 1999

Lead Results for the Existing and Proposed road network - 2020

Receptor No.	Background Concentration (ug/m3)	Lead concentration (ug/m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 1	0.39	0	0
R 2	0.39	0	0
R 3	0.39	0	0
R 4	0.39	0	0
R 5	0.39	0	0
R 6	0.39	0	0
R 7	0.44	0	0
R 30	0.44	0	0
R 31	0.44	0	0
R 32	0.44	0	0
R 33	0.44	0	0
R 34	0.44	0	0
R 35	0.44	0	0
R 36	0.44	0	0
R 37	0.31	0	0
R 38	0.31	0	0
R 39	0.31	0	0
R 40	0.31	0	0
R 41	0.33	0	0
R 42	0.33	0	0

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Particulate Matter Results for the Existing and Proposed road network - 2020

Receptor No.	Background Concentration (ug/m3)	Particulate matter concentration (ug/m3), 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 1	83.3	84	83
R 2	83.3	84	84
R 3	83.3	83	83
R 4	83.3	83	83
R 5	83.3	83	83
R 6	83.3	83	83
R 7	34.3	34	34
R 30	34.3	35	35
R 31	34.3	34	34
R 32	34.3	34	34
R 33	34.3	34	34
R 34	34.3	34	34
R 35	34.3	34	34
R 36	34.3	34	35
R 37	82.2	83	82
R 38	82.2	82	82
R 39	82.2	82	82
R 40	82.2	82	82
R 41	44.6	45	45
R 42	44.6	45	45

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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Job No. 1394
Date : Mar 1999

Sulphur Dioxide Results for the Existing and Proposed road network - 2020

Receptor No.	Background Concentration (ug/m3)	Sulphur dioxide concentration (ug/m3) 270 degrees *	
		Ave Wind Speed	Max Wind Speed
R 1	101.02	101	101
R 2	101.02	102	101
R 3	101.02	101	101
R 4	101.02	101	101
R 5	101.02	101	101
R 6	101.02	101	101
R 7	42	42	42
R 30	42	43	43
R 31	42	42	42
R 32	42	42	42
R 33	42	42	42
R 34	42	42	42
R 35	42	42	42
R 36	42	43	42
R 37	20.7	22	21
R 38	20.7	21	21
R 39	20.7	21	21
R 40	20.7	21	21
R 41	59.3	59	59
R 42	59.3	59	59

Legend :
ug/m3 : micrograms per cubic metre
* : Wind Direction
Shaded results indicate highest modelled receptor concentration

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APPENDIX VIII

LANDSCAPE

PART A	**Landscape Impact Report (Brady Shipman Martin)**
PART B	**Photomontages of Proposed Road Development**

APPENDIX VIII – PART A

LANDSCAPE IMPACT REPORT (Brady Shipman Martin)

BRADY SHIPMAN MARTIN

N18 DROMOLAND - CRUSHEEN ROAD PROJECT (ENNIS BYPASS)

LANDSCAPE IMPACT REPORT

FEBRUARY 2000

Doc. No. 2857-200

LANDSCAPE CONTENTS

LANDSCAPE

1.0 INTRODUCTION

1.1 Terms of Reference

Brady Shipman Martin, Landscape and Environmental Consultants were commissioned by Clare County Council to prepare the landscape and visual impact section of an Environmental Impact Study for the proposed road improvements to the N18 from Dromoland to Crusheen, bypassing the town of Ennis to the east.

1.2 Landscape

Landscape has two separate but closely related aspects. The first is visual impacts, that is the extent to which new developments can be seen. The second is impacts on the character of the landscape which includes responses which are felt towards the combined effects of the new development. The significance of impacts on the perceived landscape will depend partly on the number of people affected, but also on judgements about how much the changes will matter and in relation to other senses i.e. sound, feeling, etc., experienced by those concerned[1].

This section deals with the above in so far as they may determine the landscape and visual characteristics of the locality, and on which the proposal may have environmental effects.

1.3 The Proposal

The proposal involves the construction of 12.5 kilometres of new National Primary dual carriageway, from Dromoland to Barefield. A further 2 kilometres of the existing N18 National Primary Road from Barefield to Crusheen, will also upgraded to dual carriageway. The proposed National Primary Road will pass to the east of both Clarecastle and Ennis. The proposal also involves the construction of approximately 7 kilometres of a part single / part dual carriageway Relief Road from the new N18 west to the south / south-west of Ennis Town.

A full description of the alternative routes and the proposal is given in Chapter 3.

[1] ADVICE NOTES ON CURRENT PRACTICE (in the preparation of Environmental Impact Statements), 1995.

2.0 THE RECEIVING LANDSCAPE

2.1 The Landscape Context

2.1.1 Clare County

Clare, a seaboard county, is situated in the mid-west of the country, with Limerick City to the south-east and Galway City to the north, both within 50 kilometres of the county. The River Shannon and County Limerick bound County Clare to the south, Lough Derg, the River Shannon and Tipperary (North Riding) to the east, County Galway to the north and the Atlantic Ocean to the west. The principal urban centres of Ennis, Shannon and Kilrush, all have a population of over 2,500 people, while, Newmarket-on-Fergus, Kilkee, Sixmilebridge, Killaloe, Ennistymon, Lisdoonvarna, Scarriff, Ballycannan, Ardnacrusha, Miltown Malbay, Lahinch and Cratloe are important towns with populations of over 500 people.

Over the years the major industry both in terms of output and employment in the county has been agriculture. However, the importance of the industrial, service and particularly the tourism sectors has increased significantly in recent years.

The county has an area of some 3,188 sq. km. and a total population of 94,006 people[2]. The population has shown a 3.4% increase from the previous census in 1991, reversing a previous decrease. Since the first recorded census in 1841, the overall population of Clare County has fallen from a high of 286,394 in 1841, to a low of 73,597 in 1966.

2.1.2 Ennis

Ennis, the largest town with a central location and on the Limerick to Galway Road, is very much the principal urban centre of the county. The town is an important administrative, commercial and service centre with a large agriculturally based hinterland and the centre of an expanding tourist industry. The town with its environs has an area of some 2 sq. km. and a population of 17,726 people[3]. The population figure represents an increase of 10.4% on the 1991 census.

Ennis is the focus for a number of National Primary (N18, N68, N85) and Regional (R352, R469, 473, 474 & 476) Roads. Consequently the narrow streets of the town centre are often heavily congested with both local and through traffic which has a detrimental effect on the overall visual character of the town centre.

2.1.3 Clarecastle

Clarecastle is a small town on a tortuous section of N18 National Primary Road just south of Ennis where the road crosses the River Rine. As the road winds through the town it is usually heavily congested with traffic. In recent years the town has become

2 : 1996 Census of Population of Ireland
3 : 1996 Census of Population of Ireland

increasingly subsumed into an expanding Ennis. In 1996 Clarecastle had a population of 1,935 people[4] which represented a decrease of 3.2 % on the 1991 figure.

2.2 Planning Control Context

The proposal is located within County Clare, and as such, development is controlled under the 1988 Clare County Development Plan. The following outlines the references to the landscape in the 1988 County Development Plan.

2.2.1 1988 Clare County Development Plan

The Development Plan makes a direct reference to the project in Section 3.3 Objectives (Roads) and other references are made to aspects of the environment, which may have significance in view of the proposal. The references are detailed in the following as labeled in the Development Plan and located on **Figure 1**.

PART 1

1.2 *POPULATION TRENDS*

The development plan makes reference to the size, structure and distribution of the population on a countywide level. However the basis for the references is the 1981 and 1986 Census of Ireland, and as such has now been superseded by the 1991 and 1996 Census, to which reference is made in the previous sections.

1.10 *DEVELOPMENT PRESSURE*

All but the very northern end of the proposal corridor is located within an area of high development pressure.

1.11 *ENVIRONMENTAL QUALITY*

- No Area of Outstanding Amenity is located within the vicinity of the proposal corridor.
- No area of High Amenity is located within the vicinity of the proposal corridor.
- 3 areas of Scientific Interest fall within the vicinity of the proposal corridor:

22 *Lake at Dromoland* - *Botanical*, (1 km south-east of proposal) **SI22**

29 *Inchicronan Lough* - *Botanical*, (500 m east of proposal) **SI29**

40 *Wood near Ennis*. - *Ecological, Botanical*, (1 km south-east of proposal) **SI40**

4 : 1996 Census of Population of Ireland

- 5 groups of Protected Trees fall within the vicinity of the proposal corridor:

18 *Trees in the area beside the Riverside Tavern on the Ennis – Galway Road including a hill half covered in trees,* (350 m west of proposal) **T18**

26 *Trees in the Grounds of Newpark House, Ennis,* (1.5 km east of proposal) **T26**

30 *Trees in the grounds of Carnelly House bordering the Limerick Road,* (350 m east of proposal) **T30**

31 *Trees in the parkland of Manus House,* (150 m east of proposal) **T31**

107 *Trees in park of Dromoland Estate,* (500 m-1 km south-east of proposal) **T107**

1.12 *QUALITY OF AGRICULTURAL LAND*

The entire proposal corridor is located within areas described as being of good land quality.

PART 2

DEVELOPMENT STRATEGY AND OBJECTIVES

2.3.1 *SETTLEMENT AND DEVELOPMENT LOCATION OBJECTIVES*

- *'Special Development Zones',*

The entire proposal corridor is located within the large Special Development Zone in the south-east of the county which extends from Limerick to north of Ennis.

PART 3

OBJECTIVES

3.3 *Roads*

R.2: - *The design and reservation of land for the Ennis Outer Relief Road, and the construction if the first phase of this road from Clarecastle to the Kilrush Road (N.68)* **(R2)**

R.3: - *The design and reservation of land for a relief road, from the Clon Road to the Limerick Road in Ennis (N.68)* **(R3)**

R.4: - *The improvement of the N.18 national Primary Route in Ennis from its junction with the Lahinch Road (N.85)* **(R4)**

R.5: - *The design and reservation of land for the Newmarket on Fergus Bypass.* (south of proposal) **(R5)**

R.6: - *The design and reservation of land for the Crusheen Bypass.* (north of proposal)*)* **(R6)**

3.6 *Amenities*

- *A.4:* *The continuation of the preparation of playing pitches at the old Doora dump, Ennis* **(A4)**

No views within the vicinity of proposal corridor are listed for preservation.

2.3 Landscape Character

2.3.1 Overall Landscape Character

The proposal corridor forms part of a large lowland landscape zone extending north from the Fergus River Estuary between the more upland areas of Slieve Aughty and Slieve Bernagh in the east and Ben Dash, Slievecallan, Cliften Hill and the Burren in the west. The town of Ennis, the principal urban centre, is located in the southwest of this large lowland zone. Newmarket on Fergus, Clarecastle, Kilkishen, Kilmurry, Quinn, Ruan and Crusheen are smaller towns.

The lowlands comprise a low undulating landscape, which is of a rural and predominantly agricultural character, with occasional hills rising to between 200 - 300 feet. The area east of Newmarket on Fergus, and Ennis through Kilmurry and Kilkishen is dotted with lakes of varying sizes. Loughs Cullaunyheeda, Inchicronan, Fin and Roscoe are amongst the largest.

The geology of the lowland areas is predominantly carboniferous limestone, which occasionally outcrops, and generally give rise to good agricultural soils. However, many areas especially around the River Fergus and east of Ennis are flat, low-lying liable to flooding and therefore marshy in appearance.

2.3.2 Landscape Character of Proposal Corridor

Within this large landscape zone the proposal corridor and its immediate surrounds form part of a much smaller, more distinct landscape compartment of approximately 50 sq. km. This compartment follows the proposal corridor and is linear in nature running north from Newmarket on Fergus through Ennis and Crusheen.

The central area around Ennis is flat and immediately east of the town is marshy. A slightly elevated and rugged area often with outcrops of rock surrounds this central area and in turn this area is surrounded by a series of low drumlin type hills. Both the drumlin and outcrop areas are interspersed with *turloughs* or permanent lakes, eg. Gaurus Pond, Cloonawee Lough, and Ballyduff Pond. The primary axis of the

drumlins tends to run in an almost north - south direction, in line with the southward progress and northward regress of ice during the last ice age.

Hazel, gorse and scrub is very common on the more un-enclosed rock outcrop areas. In particular, there are large areas of hazel scrub woodland south of the R352 Tulla Road at Knockanean and south of the Rail-line at Ballyduff. Otherwise, field sizes are small to medium with increasingly tall and dense tree - lined hedgerows. on the drumlin landscape. East of Ennis, hedgerows are lower with fewer trees and visually, fields often run into each other. However, blocks of woodland are more extensive especially in association with period houses such as Manus, Glenard, and Ballymacahill House and at Knockanean. Dromoland Lake, the River Rine (Latoon Creek), Claureen River, Gaurus River, Gaurus and Ballyduff Ponds, Cappagh Lough, Cloonawee Lough and Lough Inchicronan are some of the principal waterbodies.

In summary, the areas both north and south of Ennis have of a general rural and agricultural character as would be expected for much of the area. However, the area east and south of Ennis is often a mix of marshy ground which is liable to flooding and a slightly more elevated rugged or rock outcrop landscape with scrub vegetation. Despite the ever-increasing pressure from sub-urban residential ribbon type development, this mix of landscape type has a strong 'natural' quality or character, which has a scenic attraction.

2.3.3 The Existing N18

The existing N18 follows a long established route which outside the towns of Ennis and Clarecastle has been widened and somewhat straightened over the years. An example of such works is clearly seen at Manus House, where the old N18 originally passed east of the property.

However, the ever-merging towns of Ennis and Clarecastle dictated a narrowing and torturous route through commercial and linear residential areas. North of Ennis, through Barefield, residential development is particularly evident to either side of the route.

As such, while south of Clarecastle and north of Barefield the route has a rural hedgerow delineated character, the existing N18 is dominated by its urban stretch through Clarecastle and Ennis.

2.3.4 Amenity Character

The existing N18 is an important tourist corridor linking the west with the south-west and in particular, linking Shannon, a major tourist airport, with the important tourist areas of County Clare. However in general, the proposal corridor in itself is not considered an amenity area, as the landscape, though attractive, is of a semi-urban, sub-urban or agricultural nature.

The primary focus of organised amenity in the area is Dromoland Estate, the Clare Inn Hotel and the urban centres of Clarecastle and Ennis. A riverside walk along Latoon

Creek appears to be used occasionally and the 'Rock Road' south of Ennis Town is a well used walking amenity accessing a local forested hilltop at *Cahircalla*.

2.4 Existing Landuse

The existing land within the area falls into four distinct uses at present:

2.4.1 Agriculture

Almost the entire proposal corridor is set in a rural landscape on the suburban edge of Clarecastle and Ennis and as such, while agriculture is the primary land use, residential ribbon development extends along all roads radiating from the towns. The soils overlying limestone are particularly suitable to grass growing and as such pastoral farming, dairying and dry stock rearing, predominates. However, much of the land is not free draining and this significantly limits the potential for intensive agricultural landuse, especially during winter / spring months.

This agricultural landuse has largely determined the visual character of the landscape with its patchwork of small to medium sized fields bounded by bramble, hawthorn and tree dotted hedgerows. Farm sizes are generally small to medium (less than 5 hectares) with owners residing in on-farm residences.

2.4.2 Woodland

As with the remainder of the country, this area was one covered with deciduous forests, which were cleared to create the open farmland that now dominates the landscape. However, during the 17th and 18th centuries, many estates were planted with extensive tracts of deciduous woodland and the remnants of these survive in many areas today. In particular, Dromoland Estate is a good example of this practice while the plantings around Manus, Glenard and Carnelly Houses and south of Ennis around the hospital and at Edenvale and *Cahircalla* are also notable.

Areas of hazel and scrub woodland is common on many of the limestone outcrop areas such as south of Ennis town at *Clonroad More* and *Ballybeg* along the R475 and south of the R352 Tulla Road at *Knockanean*.

2.4.3 Amenity

As stated above (Section 2.3.3) the amenity is largely associated with areas surrounding Dromoland and Ennis, however, other small developments such as pitch and putt courses and horse riding centres are present.

2.4.4 Built Environment

Ennis and Clarecastle are the principal urban centres within the proposal corridor, though Crusheen is becoming an increasingly built-up. The general area is within easy commuting distance of Ennis and indeed Limerick and Shannon and as such is under pressure from expanding residential landuse. This is illustrated by the high level of ribbon development, common along many of the county and other minor roads in the area. Planning application notices are also a common sight along many of the regional and minor roads. As elsewhere this type of development tends to be modern bungalow type houses with their associated suburban gardenscape which, contrasts somewhat with the more traditional style of the residential farmhouse and clustered outbuildings.

3.0 PROJECT DESCRIPTION

3.1 Introduction

The principal features of the proposal with relevance to the Landscape are discussed in this chapter.

3.2 The Alternatives

As part of a preliminary assessment 4 alternative route corridors were considered for the alignment of the proposed N18. Routes A and C pass Clarecastle to the east before turning westwards to pass Ennis to the west. The two remaining Routes, B and D, pass to the east of both Clarecastle and Ennis, however, Route D also included a Southern Relief Road around Ennis. See Figure 1.

3.2.1 Description of Alternative Routes

Route A runs to the west of the existing N18 as far as Clarecastle crossing the River Rine and a minor road with much ribbon development. The route passes close to Carnelly House before crossing over the existing N18 to turn westward around Clarecastle and over the River Fergus close to the rail-line. The route runs between the R475 and Ennis crossing an area of dense scrub woodland before crossing the N68 Kilrush Road and turning northwards around by the Hospital. Continuing northwards the route crosses the R474, the Claureen River and the N85 Ennistymon Road before cutting through the scenic Drumcliff area and re-crossing the River Fergus south of Ballyalla Lough, an Area of Scientific Importance. The route re-joins the existing N18 at Barefield.

Route B runs to the east of the existing N18 and Clarecastle crossing the River Rine, a minor road with some ribbon development and the rial-line. The route also passes to the east of Ennis crossing the R469 Quin Road and the R352 Tulla Road. The area between these two roads has an existing isolated and scenic rural character. North of the R352 the route cuts through some areas of hazel and scrub woodland before re-crossing over the rail-line and rejoining the N18 north of Barefield.

Route C is similar to Route A, however, from the N68 Kilrush Road to the re-crossing of the River Fergus Route C takes a much more westerly alignment across low-lying lands. The route then turns north-eastwards over the scenic Drumcliff area and crosses the River Fergus south of Ballyalla Lough, an Area of Scientific Importance. The route re-joins the existing N18 at Barefield.

Route D is as for Route B however, this option also includes for relief road for Ennis. The road runs south from the N85 Ennistymon Road across the Claureen River and the R474 before turning eastwards across the N68 Kilrush Road and the existing N18 and the River Fergus to tie-in to Route D east of Ennis. The Relief Road has two **Sub-options (1 & 2)** which differ only in that sub-option 1 has a more southerly tie-in alignment with Route D.

3.2.2 Impact Comparison of Alternative Routes

In general the eastern routes (B & D) are preferable, as the western routes (A & C) would have likely significant impacts on residential property at Carnelly, Clarecaslte and Barefield, 3 major river crossings and appreciable amenity impact at Rock Road, Drumcliff and Ballyalla Lough.

As might be expected, Route B without the additional length of the relief road is the least impacting route in landscape and visual terms, however, Route D with the Relief Road extension will have a significant beneficial impact on the character of Ennis town. Sub-option 2 for the Relief Road has a slightly lesser impact on residential amenity.

The results of the preliminary assessment of likely impact on landscape and visual aspects are summarised and compared in Table 3.2.1.

Table 3.2.1 Alternative Routes-Summary of Landscape and Visual Impacts

Impacted Aspect	**Route A**	**Route B**	**Route C**	**Route D Sub-option 1**	**Route D Sub-option 2**
Residential Amenity	4	3	4	3	3
Community Aspects	4	3	3	3	3
Trees	4	2	4	3	3
River and Lakes	4	2	3	3	3
Amenity	4	2	4	3	3
Total	20	12	18	15	15
Comparison Average	4	2.4	3.6	3	3

1 = Low Overall Impact
3 = Moderate Overall Impact
5 = High overall Impact

3.3 The Selected Route

Following consideration of all of the preliminary assessments, Route D with sub-option 2 for the Relief Road was selected as the preferred route for the proposed N18 upgrade.

3.3.1 Outline Description of the Proposed N18 Up-grade

The proposed N18 will cross the existing Limerick – Ennis road immediately north of Latoon Cross (See Photoview 1) continuing to closely parallel the existing N18 down hill over open landscape to bridge Latoon Creek (River Rine). See Photoview 2 from Clare Inn Hotel

From the river cossing the proposed road will gradually rise northwards over open agricultural land cutting through a local ridgeline and underpassing Local Road L742 (to Quin) east of Manus House at Ch. 13,450. See Photoview 3

The road will switch on to embankment and cut through a mature field boundary planting of pine, poplar and spruce east of Glenard House, from where it will cross the Limerick to Galway Rail-line at Ch. 14,100.

Continuing northwards, the proposal will pass to the east of the site of Killow Church and cross Local Road L4114 (to Hurlers Cross). See Photoview 4 & 5. A grade separated junction at Ch. 15,800 will facilitate access to both the Local Road and to the proposed Southern Relief Road for Ennis (See below). See Photoview 6a & 6b (view west towards Ennis in summer and winter respectfully). The landscape in this area is low lying especially west of the proposed N18 alignment where there is a sizeable area of marsh, see Photoview 6a & 6b. Limestone rock outcrop is evident on locally elevated areas such as the proposed location for the junction.

Passing between the small lakes of Lough Naslatty to the east and Lough Kilbreckan to the west, the proposed N18 continues northward cutting through a hill at Ch. 17,000 (see Photoview 7 & 8). The road also bridges over the R469 Quin Road near Ch. 17,300 at a break in ribbon housing development. See Photoview 10.

North of the R469 Quin Road the proposal will cross through a low lying area in *Ballaghboy* and *Knockaskibbole*. In the latter townland, the road will pass between two cottage type residences, which have an isolated and attractive rural setting. See Photoview 11.

From *Knockaskibbole*, the proposal will cut through the western side of an agricultural drumlin (see Photoviews 12 & 13) and cross over Local Road L4106 (towards Hurlers Cross) immediately west of the now derelict and overgrown Knockanean National School.

Continuing northwards over low-lying hazel/scrub woodland the proposed N18 will pass under the R352 Tulla Road immediately west of and ESB Sub-station at Ch. 19,400. See Photoview. Two slip roads will facilitate access to the R352 Tulla Road. See Photoview 14, 15 & 16.

From the Tulla Road, the proposed N18 will again cross over a low lying agricultural landscape before crossing Local Road L4102 (Ballymacahill Road) between a farmhouse with outbuildings to the west and a ribbon-type development of residences to the east. See Photoview 17. Ballymacahill Lough lies close to the eastern side of the proposal.

Continuing northwards the proposal will pass to the west of Cappagh Lough and again, cross over the Limerick to Galway Rail-line at Ch. 22,000. Immediately north of the rail crossing a major grade separated junction will allow access south-westwards towards Ennis via the existing N18, (see Photoview 18) to a minor road at *Barefield* and to Local Road L8122 (Drumquin Road). See Photoview 19. In crossing the latter road, the proposed N18 will closely pass between two prominent residences east of Barefield School.

From Local Road L8122, the proposal will turn more north-westerly, passing to the rear of houses along the existing N18 (see Photoviews 20 & 21) and crossing over a partly excavated or small quarry area, (see Photoviews 22 & 23) before rejoining the Galway Road at Ch. 24,000 north of Barefield. See Photoview 24.

A further two kilometres of minor re-alignment works will be completed along the section of the existing N18 from the tie-in point on the Galway Road to the 'Riverside Tavern' public house just south of Crusheen. See Photoviews 25 & 26.

3.3.2 Outline Description of the Proposed Ennis Southern Relief Road

The proposed Ennis Relief Road will pass to the west and south of Ennis picking up traffic from the N85, R474, N68 and existing N18 north of Clarecastle.

Commencing at a proposed roundabout on the N85 Ennistymon Road to be located just east of a Filling Station, the single carriageway Relief Road will pass southwards through the Claureen River Valley west of Ennis Golf Club. The road will cross the Claureen River at Ch. 750 and gradually climb out of the valley to an at grade roundabout proposal on the R474 Miltown Malbay Road coinciding with the present location of a halting site. The halting site will be relocated to the west of the proposed road.

Turning eastwards the Relief Road will pass around the wooded setting of the Hospital and cut through a local ridge before bridging over the N68 Kilrush Road on embankment at Ch. 2,950. Access will be provided to the N68 via a roundabout and slip road to a proposed roundabout on the N68 south-west of an existing Filling Station. The proposed alignment will cross an existing walking amenity, 'Rock Road' at Ch. 3,500 and as such walkers will have to cross the proposed Relief Road in order to continue using the amenity.

The proposal will continue eastwards through somewhat attractive scrub woodland areas in *Clonroad More* and *Ballybeg* before exiting to met with the existing N18 at an at grade roundabout proposal immediately north of a Filling Station at Ch. 4,650.

An existing access to the ruins of Clare Abbey will be re-aligned of the proposed roundabout to the north of the proposed relief Road.

From the existing N18, the Relief Road will be upgraded to 'reduced width dual carriageway' as it passes over low-lying marsh and bridges over the Limerick to Galway rail-line and the River Fergus.

A proposed roundabout at Ch. 6,050 and short link to Local Road L4114 (to Hurlers Cross) will allow for the re-alignment of the local road over the proposed N18 described above.

Finally, the Southern Relief Road will tie-in to the proposed N18 at a major grade separated junction in *Killow / Kilbreckan* at Ch. 15,800 on the N18 proposal. See Photoviews 4, 5, 6a & 6b.

3.4 Principal Features of the Proposal

The principal visual features including, embankments, cuttings bridges, etc. of the selected route option and the associated Relief Road are set out in the following with

reference to Chainage lengths and as indicated on Figure 2 (2a to 2g). Further to the features indicated below, the overall proposal will also include for lighting of all junctions, fencing along the land take line and appropriate signage and traffic control measures.

3.4.1 Principal Features of the N18 Proposal

The proposal which involves bypassing the town of Ennis to the east, see Figures 2a to 2e includes:

- 12.5 km. of new dual carriageway N18
- junction with existing N18/end of proposed bypass of Newmarket-on-Fergus and two Local Roads at start of scheme. Ch. 11,500
- bridge over River Rine (Latoon Creek) at Ch. 12,000
- Local Road L7142 bridged over proposal at Ch. 13,450
- bridge over Limerick - Ennis Railway at Ch. 14,100
- major grade seperated junction at Killow with Local Road L4114 and proposed Ennis Southern Relief Road at Ch. 15,800
- bridge over Quin Road R469 at Ch. 17,300
- bridge over Local Road L4106 at Ch. 18,700
- Tulla Road R352 bridged over proposal at Ch. 19,400 with accesses provided to proposal.
- bridge over Local Road L4102 at Ch. 20,500
- bridge over Ennis – Galway Railway at Ch. 22,200
- major grade seperated junction and slip roads to existing N18, Local Road L8122 and a minor roads all at Ch. 22,500 to 23,000 in Barefield
- tie-in to existing N18 at Ch. 24,000
- 2km up-grade of existing N18 from Ch. 24,000 to Ch. 26,000 (Crusheen)

Lighting will be provided at limited sections of the following junctions:

- Killow Junction (Ch. 15900)
- Tulla Road (R352) Junction (Ch. 19400)
- Barefield Interchange (link to existing N18) (Ch. 22500)

The proposal involves some limited realignment of:

- Two Local Roads at Ch. 11,500 – start of scheme
- Local Road L7142 at Ch. 13,450
- Local Road L4114 at Ch. 15,800
- Quin Road R469 at Ch. 17,300
- Local Road L4106 at Ch. 18,700
- Tulla Road R352 at Ch. 19,400
- Local Road L4102 at Ch. 20,500
- Minor Road at Ch. 22,500
- Local Road L8122 at Ch. 23,000

The principal earthworks associated with the construction of the dual carriageway includes approximately 1,700 metres of significant embankment and 1,500 metres of

minor embankment, 1,000 metres of significant cutting and 1,200 metres of minor cutting as follows;

- significant embankment for dual carriageway and access road from Ch. 11,500 to 12,000
- minor cutting from Ch. 12,350 to 12750
- significant cutting through local ridgeline from Ch. 13,250 to 13, 600 to underpass Local Road L7142
- significant embankment from Ch. 12,600 to 14,500 to overpass railway
- minor embankment over low ground from Ch. 14,800 to Ch. 15,000
- significant earthworks including re-grading, embankments and cuttings for grade separated junction from Ch. 15,500 to 16,300
- minor embankment from Ch. 16,300 to Ch. 16,600
- minor cutting through local ridge from Ch. 16,600 to 17,000
- significant cutting across side of ridge from Ch. 18,200 to 18,600
- minor embankment from Ch. 18,700 to 18,900 as dual carriageway overpasses Local Road L4106
- significant embankment for 300 m along R352 Tulla Road to overpass dual carriageway at Ch 19,400 and also minor cutting along two access roads from R352 to proposal.
- minor embankment from Ch. 20,300 to 20,500 and minor cutting along 200 m of Local Road L4102 as dual carriageway overpasses the Local Road
- minor embankment from Ch. 21,900 to 22,300
- significant earthworks including regrading, embankments and cuttings from Ch. 22,300 to 23,000 for grade separated junction and associated access roads
- significant cutting as dual carriageway crosses side of ridge from Ch. 23,300 to 23600

Noise bunds, 2.0m high will be provided at the following locations:

- east of Manus House on both of the proposed N18 (Ch. 13250-13480)
- at Killow west of the proposed N18 (Ch. 15400-15600)
- at Knockaskibbole both sides of the proposed N18 (Ch. 17880-18060)

Noise barriers, 2.0m high will be provided at the following locations:

- north of Barefield west of the proposed N18 (Ch. 22900-22980)
- north of Barefield east of the proposed N18 (Ch. 22980-23060)
- north of Barefield west of the proposed N18 (Ch. 23580-23700)

3.4.2 Principal Features of the Ennis Southern Relief Road

The proposal also includes for the provision of a Southern Relief Road for Ennis picking up traffic from the R473, N 68, R474 and N85 roads to the west and south-west of the town centre. See Figures 2b, 2f & 2g. The construction of this southern relief road involves:

- 7.1 km. of proposed Southern Relief Road including 4.7 km of single carriageway and 2.4 km of reduced width dual carriageway.
- at-grade roundabout junction with Ennistymon / Corrofin Road (N85/R476) at start of Relief Road.

- crossing of Claureen River at Ch. 750.
- at-grade roundabout junction with Miltown Malbay Road (R474) at Ch. 1,900
- bridge over existing Kilrush Road (N68) at Ch. 2,950
- roundabout, junction (at Ch 3,500) and slip road to proposed roundabout at Kilrush Road (N68)
- at-grade roundabout junction with existing Limerick Road (N18), at Ch. 4,650
- bridge over Limerick to Galway Rail-line, at Ch. 5,300
- bridge over River Fergus, at Ch. 5,500
- proposed roundabout at Skehanagh as access to Local Road L4114 (and Claregalway) at Ch. 6,050

Lighting will be provided at limited sections of the following junctions:

- Junction with Existing N85 at Claureen (Ch. 0)
- R474 Road Junction at Ballymacaula (Ch. 1900)
- N68 Road Junction at Ballybeg/Cahircalla (Ch. 3450)
- Roundabout Junction with existing N18 at Clareabbey (Ch. 4600)
- Skehanagh Roundabout (Ch. 6000)

The southern relief road proposal will also involve some limited realignment of:

- Ennistymon Road (N85) at new roundabout at start of scheme
- Miltown Malbay Road (R474) at new roundabout at Ch. 1900
- Kilrush Road (N68) at new roundabout
- Limerick Road (N18) at new roundabout at Ch. 4,600
- 500mm of realigned access road will be provided off the new roundabout at Ch. 4,600 to the ruins of Clare Abbey.

The principal earthworks associated with the construction of the Southern Relief Road includes approximately 800 metres of significant embankment and 2,000 metres of minor embankment, 400 metres of significant cutting and 600 metres of minor cutting as follows;

- minor cutting from Ch. 1,400 to 1,800
- significant cutting crossing local ridge from Ch. 2,400 to 2,800
- significant embankment in overpassing Kilrush Road (N68) from Ch. 2,850 to 3,350
- significant embankment along 300 m of access from Kilrush Road (N68) to proposed relief road at Ch. 3,500
- minor cutting from Ch. 4,000 to 4,200
- minor embankment over marshy ground and across River Fergus from Ch. 4,750 to 5,900
- minor embankment over marshy ground from Ch. 6,200 to 7,100

4.0 IMPACT APPRAISAL

4.1 Introduction

The proposals were assessed for impact on various aspects of the landscape including landscape and amenity character, visual character (general, residential, etc.) and for views from the scheme. The following assesses each of the above in turn.

4.2 Impact on Landscape Character

4.2.1 General

The analysis of the impact on the landscape character is based on survey and evaluation of the landscape made from the line of the scheme over a period from summer 1998 to spring 1999.

The assessment of Landscape Impacts was carried out by:

i Assessing the proposal through plans, sections and aerial photography.

ii Visiting the proposal corridor and the surrounding areas to assess the landscape and the visual implications of the proposals.

Impacts on the landscape character will arise through a number of factors, including:

- A change in the existing character of the area.
- A change in the perceived use or activity in an area.
- The introduction of new visual built elements into an area.

4.2.2 Impact on Landscape Character of Surrounds

The existing character of the landscape is determined by the rural agricultural landscape with range from marsh to outcrop to low drumlin type hills. Farm and field sizes tend to be small to medium often with tall dense tree lined hedgerows. Residential development is increasingly prevalent.

As the proposal is a ground-based development generally following the flow of the landscape, the impact on the overall landscape character will be relatively low. However, more significant impacts will arise at specific locations along the proposal, in particular;

- *from incongruity*, at the start and the end of the proposal N18 Ennis Bypass, where two road corridors (the existing and proposed N18) will appear close together in the landscape. This tends to be a longer term impact gradually mitigated by good landscaping aimed at integrating the development and its surrounds. The overall impact will not be significant.

- *from disturbance and change*, in that the proposal will have a significant disturbance on the hazel & scrub woodland and general 'natural' character of the marsh and rock outcrop areas west of Ennis. Hazel and scrub will re-colonise off-road areas after construction, however, it is likely that the road development will encourage other development to spread eastwards from Ennis towards the bypass. The overall impact arising from disturbance and change will remain locally significant in the *Killow* and *Kilbreckan* areas east of Ennis.

- *from disharmony*, in that the relatively straight horizontal and vertical alignments of the proposal will contrast with the more rounded rolling nature of the drumlin or hilly landscape. In general the proposal tends to follow a relatively low-lying flat corridor, however, the proposal will cut through local ridges at Ch. 13,500, 14,700, 16,800, 18,500, 22,500 and 23,500.

- *from intrusion*, where a major road development with associated traffic and lighting is to be provided in an area which is clearly of distinct rural character at present. The impact from intrusion on character will be greatest where existing development is absent and a distinct character prevails. Such situations arise along the Ennis Bypass from;

  - Ch. 14,500 to 16,500 where the proposal crosses an area on the edge of the marsh with frequent rock outcrops
  - Ch. 19,000 to 19,500 where the proposal passes through an area of hazel scrub woodland

  Such situations arise along the Southern Relief Road from;

  - Ch. 3,300 to 4,500 where the proposal passes through an isolate area of rock outcrop and dense scrub woodland
  - Ch. 5,300 to 7,000 where the proposal crosses an area of low lying marsh

In summary the impact will be most pronounced during the construction phase when visual disturbance will be at its maximum and the potential for and effect of mitigation measures are limited. However, the negative impact of the road on landscape character of distinct 'natural and rural areas' will tend to be lasting and progressive in that it will encourage development especially between Ennis and the proposed bypass.

4.2.3 Impact on Amenity Character

The existing N18 an important tourist corridor the upgrading of which, will improve the accessibility of the major tourist areas and their attractions. Furthermore, the removal of through traffic from Clarecastle and Ennis will have a beneficial impact on the character of these presently busy towns and this should be conducive to the improvement of their amenity potential.

As the proposed N18 corridor is largely within an agricultural landscape and the proposal does not impact directly on the primary amenity features and there will be no appreciable impact on the amenity of the area. However, the Southern Relief Road will cross the walking amenity of 'Rock Road' which leads to a forested hilltop in

Cahircalla. In using this amenity, walkers will have to cross the proposed Relief Road near a proposed roundabout. As such a locally high impact will arise especially during the construction and early operation phases. However, even if the road did not proceed, expanding pressure from residential development is already altering the character of this end of the 'Rock Road'.

4.3 Impact on Visual Character

4.3.1 Introduction

The analysis of the visual impact of the scheme is based on survey and evaluation made from the line of the scheme in summer and autumn 1998.

The impacts on the visual character of an area and can be rated as;

Little/None arises where the proposal is adequately screened by existing landform, vegetation or built environment.

Low arises where views affected by the proposal form only a small element in the overall panorama or where the duration of the impact is only of a short term.

Moderate arises where an appreciable segment of the panorama is affected or where there is an intrusion into the foreground.

High arises where the view is significantly affected, obstructed or so dominated by the proposal as to form the focus of attention or where an appreciable impact will persist in the long term.

The impacts on visual character may arise from a number of factors including;

- A change in the existing visual character of the site.
- The temporary construction activity.
- The intrusion of visual elements, including traffic, of the proposal.

4.3.2 General Impact On The Visual Character

The landscape through which the proposal passes is generally rural, agricultural and hilly in nature. As such, extensive viewing of the proposal is limited as the intervening hills and field boundary vegetation obscures long views. Furthermore the mix if hilly and marshy land generally ensures low residential densities. However, ribbon development along the roads radiating from Clarecastle and Ennis is very evident.

Significant impacts tend to be limited to two scenarios;

- Firstly to properties at or near the proposal, especially where the road is on embankment, and

- Secondly in the vicinity of junctions, over-passes, underpasses of existing roads, where the density of residential development tends to be higher due to ribbon developments.

In overall terms, the most significant impacts arise as a result of

- Under-passing Local Road L7142 at Ch. 13,450,
- The junction with the Southern Relief Road at Ch. 15,800 (especially impact from lighting)
- Passing between two isolated houses in *Knockaskibbole* at Ch. 17,950,
- Over-passing Local Road L4106 at Ch. 18,750,
- The grade separated junction in *Barefield* at Ch. 22,500
- Crossing Local Road L8122 at Ch. 23,000 and
- The tie-in with the existing N18 north of Barefield at Ch. 24,000.

Significant visual impact is less common along the Southern Relief Road as the context is sub-urban where road development, traffic and lighting is commonplace. However appreciable impact will arise in crossing the N68 Kilrush Road on a high embankment. The bridge across the River Fergus will not have a particularly adverse impact. Though of appreciable length the bridge is set on a low embankment. However, traffic using the Relief Road will be more readily visible on the bridge.

In particular visual impacts and the potential for impact will be greatest during the construction and early operation phase when disturbance is at its maximum and mitigation measures are limited. As such, the visual impact on properties is discussed under two stages, firstly, construction to early operation, see Figures 2a - 2e and secondly operation from 3 years after completion of construction, See Figures 3a - 3e.

4.3.3 Visual Impact on Residential/Community Property - Construction Stage + 3 Years

N18 In total, it is considered that up to 94 individual residential and community properties will have some level of visual impact during the construction and early operation stage when disturbance is at a maximum and mitigation measures are limited. However, of these only 25 have incidents (27%) of high visual impact and one of these, Knockanean National School near Ch.18,750, is derelict. These sensitive locations are primarily located at the crossings of County and Regional Roads. In particular, at Ch. 12,600 (1), near Ch. 13,450 (4), 15,500- 16,250 (3), Ch. 17,400(1), Ch. 17,950 (2), Ch. 18650-18,900 (5), Ch. 20,450 (1), Ch. 22,800-23,100 (3), and Ch. 23,400-23,700 (5). See Figures 2a – 2e.

The potential impact of the road is illustrated using 5 no. Photomontages, Views 1-5inclusive. These were taken at a number of the sensitive locations, namely Ch. 13,450, Ch. 15,500-16,250, Ch. 18650-18,900, Ch.22,500 and Ch. 22,750, as indicated on Figures 4a-4e inclusive. For each location the Existing View and the Proposed View (Before Planting) is shown. The Proposed View (5/7 years after Planting) is also given, see 4.3.4 below.

The proposal has a further 23 incidents (24%) of moderate impact (including two derelict houses near Ch. 23,300) and 46 incidents (49%) of low visual impact. The

latter include a public house, a shop and filling station, a church, a hall and a school all at Barefield. The locations of the moderate and low visual impacts are similar to the locations for the high incidents described above. See Figures 2a – 2e. Other residential / community properties will have no appreciable visual impact. See Table 4.3.1 for the overall results.

Southern Relief Road In total, it is considered that up to 32 individual properties (including a proposed halting site location) will have some level of visual impact during the construction and early operation stage. Five incidents (15.5%) of high visual impact arise at the crossing of the existing N18 at Ch. 4,600 (3), crossing the N68 at Ch.2,950 (1) and at the N85 tie-in (1).

The potential impact of the road is illustrated using 2 no. Photomontages, Views 2 & 6, taken at sensitive locations, namely Ch. 2900-3000, and Ch. 6000, as indicated on Figures 4b & 4f. For each location the Existing View and the Proposed View (Before Planting) is shown. The Proposed View (5/7 years after Planting) is also given, see 4.3.4 below.

The proposal will also give rise to 13 incidents (40.5%) of moderate impact and 14 incidents (44%) of low visual impact. Other residential properties will have no appreciable visual impact. See Figures 2b, 2f & 2g and Table 4.3.1 for the overall results.

4.3.4 Visual Impact on Residential / Community Property - Operation Stage after 3 Years +

N18 In total, it is considered that up to 51 of original 94 individual residential and community properties described above will have some level of appreciable visual impact even after mitigation measures have become established.

Of these only 22 have incidents (23%) of high visual impact and these include the derelict school at *Knockanean*. These sensitive locations are primarily located at the crossings of County and Regional Roads. In particular, at Ch. 13,450 (3), 15,500-16,250 (3), Ch. 17,400(1), Ch. 17,950 (2), Ch. 18650-18,900 (4), Ch. 20,450 (1), Ch. 22,800-23,100 (3), and Ch. 23,400-23,700 (5). See Figures 3a – 3e.

The potential impact of the road is illustrated using 5 no. Photomontages, Views 1-5 inclusive. These were taken at a number of the sensitive locations, namely Ch. 13,450, Ch. 15,500-16,250, Ch. 18650-18,900, Ch.22,500 and Ch. 22,750, as indicated on Figures 4a-4e inclusive. For each location the Existing View and the Proposed View (Before Planting) the Proposed View (5/7 years after Planting) is shown.

The proposal has a further 16 incidents (17%) of moderate residual impact and 13 incidents (14%) of low residual visual impact and in both cases one house is derelict. Again these impacts arise at similar locations to the above high incidents. See Figures 3a – 3e. The remaining 43 (46%) properties which were considered to have visual impact at the construction and early operation stages will have no appreciable residual visual impact. See Table 4.3.1 for the overall results.

Southern Relief Road In total, it is considered that up to 19 of the original 32 individual residential and community properties will have some level of residual visual impact even after mitigation measures have become established.

Only one incident (3%) of high residual visual impact arises at the crossing of the existing N68 at Ch. 2,950.

The potential impact of the road is illustrated using 2 no. Photomontages, Views 2 & 6, taken at sensitive locations, namely Ch. 2900-3000, and Ch. 6000, as indicated on Figures 4b & 4f. For each location the Existing View and the Proposed View (Before Planting) is shown. For each location the Existing View and the Proposed View (Before Planting) the Proposed View (5/7 years after Planting) is shown.

The proposal will have 4 incidents (12.5%) of moderate residual impact and 14 incidents (44%) of low visual impact. The remaining 13 (40.5%) properties which were considered to have visual impact at the construction and early operation stages will have no appreciable residual visual impact. See Figures 3b, 3f & 3g. See Table 4.3.1 for the overall results.

4.3.5 Long Term Impact

N18 In general road developments are quickly accepted and integrated into the fabric of a landscape and its community as the benefits gained from use gradually alter the perceptions of initial negative impact.

As such, of the total of 94 properties it is considered that only 12 will have incidents of long term negative visual impact. These especially sensitive locations are located at Ch. 15,550, Ch. 15,800 (Photomontage View 2), Ch. 17,950 (2), Ch. 18,650 (Photomontage View 3), Ch. 23,000 (2) (Photomontage View 5), and Ch. 23,600-23,700 (3). In particular the two houses near the proposed junction at *Killow*, the two houses in *Knockaskibbole* and the three houses at the tie-in with the existing N18 will continue to be significantly impacted.

Southern Relief Road Given the urban/sub-urban context of the relief road and the appreciable level of local on-going development (primarily residential) it is considered that no incident of long term high negative impact will arise.

Table 4.3.1 Summary of Visual Impact On Residential / Community Properties

	N18 Const.	N18 Operation	N18 Long Term	Relief Road Const.	Relief Road Operation	Relief Road Long Term
High	25 *	22*	10	5	1	0
Moderate	23***	16**		13****	4	
Low	46	13**		14	14****	
Total	**94**	**46**	**10**	**32**	**19**	**0**

* one school building is derelict
** one house is derelict
*** two houses are derelict
**** includes a proposed halting site

4.3.6 Lighting Impact

N18 Lighting has the effect of emphasising the change, which a road development brings about, particularly where the illuminated sections occur in a rural or remote area. Under the proposed scheme only limited sections of three junctions will be specifically illuminated, namely the Killow Junction, the Tulla Road Junction and the link to the existing N18 at Barefield. ~~The lighting at Killow will~~ highlight the significant change to the existing rural character of this area while the impact at Tulla Road and at Barefield will not be appreciable given the extent of existing development particularly at the latter location.

Southern Relief Road In general the relief road runs around the sub-urban edge of the Ennis where lighting is already an integral aspect of the landscape. As such appreciable impact will not arise, except at the Skehanagh Roundabout, east of the River Fergus, where the illuminated junction is set in a remote area.

4.4 Off-Scheme Views

4.4.1 Introduction

The analysis of the views available from the scheme is based on a survey and evaluation of the landscape and the visual horizons made from the line of the scheme between Summer 1998 and Spring 1999.

The classification of the landscape is based on recommendations in "Planning Amenity, Recreation and Tourism - An Foras Forbatha (1970)", modified to suit the terrain through which the proposal is to pass. Views were divided between landscape or townscape and categorised as follows;

Unsightly: *Visually focusing, however, the view detracts from the overall character and is aesthetically displeasing.*

Such views are generally to unattractive land uses or where the built environment has an appearance of disorganisation or poor quality.

Neutral: *Visually relaxing, the view is generally undramatic and expected.*

Such views are generally of rural landscapes with agricultural fields, boundary hedges and occasional trees.

Scenic: *Visually focusing, however, the view adds to the overall character and is aesthetically pleasing.*

Such views are generally to landscape or countryside with diversity of elements, including water and woodland cover, sympathy or absence of built environment, and variation in altitudes.

4.4.2 Views From The Scheme

The views available from the proposed scheme are indicated in terms of views from either side of the proposal and whether the views are confined, local or distant.

N18 In general, the majority of views from the proposed N18 can be considered *local* and *neutral* in nature, in that they are to a rural agricultural or rural urban landscape.

The proposal has some 25 kilometres of off-scheme views when both sides of the 12.5 km of new N18 dual carriageway are considered. Of this some 5.8 km (23%) are *confined* to the road corridor by side cuttings. The proposal has a further 1 km. (3%) of *distant* and *scenic* views to the west of the proposal. All other views are considered neutral in nature as they take in a rural agricultural landscape.

Southern Relief Road The proposal some 14.2 kilometres of off-scheme views when both sides of the 7.1 km of road are considered. Of this some 2 km (14%) are *confined* to the road corridor by side cuttings. The remainder is considered neutral views to either a sub-urban or rural setting. See Table 4.4.1 for the overall results.

Table 4.4.1 Summary of Off-Scheme Views

	N18	**Southern Relief Road**
Confined Views	5.8 km	2.0 km
Scenic Views	1.0 km	0
Neutral Views	19.5 km	12.2 km
Unsightly Views	0	0 km
Total	**25 km**	**14.2 km**

5.0 MITIGATION MEASURES

5.1 Introduction

This section gives a brief outline of the mitigation measures, which were considered ~~both at the design, and routing~~ stages and which will be addressed during the construction stage.

5.2 Project Design

The proposal is to upgrade the existing N18, Limerick to Galway Road, from Dromoland to Crusheen, bypassing Ennis to the east, a distance of approximately 14.5 kilometres. A 7.1 km relief road for Ennis will also be constructed from the west of the town southwards and eastwards towards the new N18 to pick up through traffic approaching the town from the west and south-west.

During the design of the proposal, consideration was taken of all known adverse environmental impacts, and a number of investigations including engineering property aspects, residential and commercial amenity, etc. were undertaken prior to the commencement of the Environmental Impact Statement study. This information was used in the design of the road, and also influenced the choice of routes as described in Chapter 3.

Therefore the adoption of the selected route option (Option D and Sub-option 2) was based not only on engineering grounds, but also on the impact of these routes on the landscape, residential and other amenity.

The proposed route considered in detail in the Environmental Impact Statement therefore already incorporates measures to ameliorate the impact on the environment.

5.3 Construction Aspects

Contracts will be framed to ensure good working practices that will reduce any adverse impacts arising from construction to the lowest possible level.

5.4 Landscaping

Visual impact will be ameliorated and the appearance of the road enhanced, through a series of landscape proposals consisting of landscaping along the road reservation.

5.4.1 Landscape Objectives

To give a logical and coherent approach to landscaping of the proposal, objectives for such works were considered as follows:

- the physical and visual integration of the road, its embankments and associated features into the local surrounds;

- the protection, reinstatement and conservation of the existing landscape, directly or indirectly affected by proposal;
- the creation of pleasant safe driving conditions;
- minimisation of visual intrusion and reduction of the adverse nature of any obstruction.

5.4.2 Landscape Guidelines

To achieve the above objectives, the following design guidelines will be used :

- planting design to complement views, and reduce unsightly impacts of the proposal;
- road safety, with particular regard to junctions, bridges and sightlines;
- boundary treatment to soften harsh lines;
- wildlife conservation and the creation of habitats similar to surrounds;
- maintenance to be minimal by selection of progressive naturalistic systems where possible.

5.4.3 Landscape Proposals

The proposal traverses a landscape of mainly rural character where natural features such as lakes, rivers, hedgerows, scrubwood, woodland, and open land predominate. Therefore a mainly 'natural approach' will be adopted for the landscape amelioration. The specific landscape treatments along a number of typical sections of the road are illustrated on Figures 4a-4f inclusive and in the views represented in the six Photomontages.

Areas in Cut and on Fill A wildflower/grass sward will be established over the entire slope. In addition, planting at sensitive locations will be used to reduce the visual intrusion and mitigate against visual obstruction caused by the raising of the road onto embankments. Shrub planting will be used at the edge of the plantings to increase density and diversity. A three metre grass verge will be provided along the edge of the road, and will be maintained by regular cutting for safety reasons. Post and rail fences will generally be positioned at the base of the slope.

Areas at Grade Proposed planting will ameliorate the adverse impacts of vehicles, and the visual expanse of the road. The post and rail boundary fence will be positioned as close as possible to the road (with respect to safety regulations and by agreement with the affected landowners). The fence will be augmented by means of an infill hedge, which will also screen the proposal.

5.4.4 Planting Specification

The proposed planting will generally be established with forestry planting techniques, i.e.. 'bare root transplants', 'whips' and 'feathered trees' which adapt readily to disturbed ground conditions. A proportion of 'standard' size trees especially in the vicinity of residential areas will supplement these plantings.

Trees: Species utilised will be selected from a list, which will include Alder, Ash, Beech, Birch, Maples, Pine, and Willow. Planting sizes will be from 750 mm, to 2.8 m high and planted at average 2.0 m centres.

Shrub Planting: Species utilised will be selected from a list which will include Blackthorn, Dogwoods, Hawthorn, Hazel, Holly, Willows and other plants found naturalised in the affected localities.

Hedge Planting: This planting will be primarily of Beech, Field Maple and/or Hawthorn planted at sizes of 750 - 900mm and at 500 mm centres.

Wildflower Mix: This species rich mixes will utilise plants found naturalised in the local surrounds and native grasses and flora adapted to growing on disturbed soils.

Grassland: Grass seeding areas to be topsoiled and seeded with a low maintenance mix.

6.0 CONCLUSION

The proposal is to upgrade the existing N18, Limerick to Galway Road, from Dromoland to Crusheen, a distance of approximately 14.5 kilometres, bypassing Ennis to the east. A southern Relief Road will also be provided for the town Ennis.

The landscape through which the proposal passes is generally rural, agricultural and occasionally hilly in nature. As such, extensive viewing of the proposal will be limited as intervening hills and vegetation obscure long views and the agricultural nature of the land generally bestows low residential densities. However, ribbon type residential development is increasingly common on all roads radiating from Ennis.

6.1 Landscape Character

The impact on the overall landscape character will be relatively low. However more significant impacts will arise at specific locations along the proposal from four aspects;

from incongruity, near the start and the end of the proposal, where two road corridors (the existing and proposed N18) will appear close together in the landscape,

from disturbance, in that the proposal will have a significant disturbance on the hazel & scrub woodland and general 'natural' character of the marsh and rock outcrop areas south and west of Ennis,

from disharmony, in that the relatively straight horizontal and vertical alignments of the proposal will contrast with the more rounded rolling nature of the drumlin or hilly landscape and finally

from intrusion, where a major road development with associated traffic and lighting is to be provided in an area which is clearly of distinct rural character at present. This will be most pronounced in the vicinity of the junction with Southern Relief Road and the proposed N18.

In summary the impact will be most pronounced during the construction phase when visual disturbance will be at its maximum and the potential for and effect of mitigation measures are limited. However, the negative impact of the road on landscape character of distinct 'natural and rural areas' will tend to be lasting and progressive in that it will encourage development especially between Ennis and the proposed bypass.

6.2 Visual Impact

Appreciable visual impact tend to be limited to two situations, firstly to properties at or near proposed road embankments, and secondly in the vicinity of junctions, over-passes or under-passes of existing roads, where the density of residential development tends to be higher due to ribbon development.

In particular, visual impacts and the potential for impact will be greatest during the construction and early operation phase when disturbance is at its maximum and mitigation measures are limited.

It is considered that up to 94 individual residential and community properties will have some level of visual impact during the construction and early operation stage however, only 51 of these will have any operation impact. Of these, 22 incidents (23% of total) of high visual impact will arise and a further 16 properties (17% of total) will have moderate visual impact. Some 13 properties (14% of total) will have low levels of visual impact during the early operation stages. In the long term it is considered that up to 10 properties at specific locations will continue to experience high levels of negative visual impact..

Significant visual impact is less common along the Southern Relief Road as the context is sub-urban where road development, traffic and lighting is commonplace. However some impact will arise in crossing the N68 Kilrush Road on a high embankment. In this regard of the 32 properties visually impacted (5 high impact) during construction only 19 (1 high impact) properties will have any operation impact. In the longer term it is considered that due to the urban/sub-urban context and the on-going development in the vicinity, no long term impact will arise from the Relief Road.

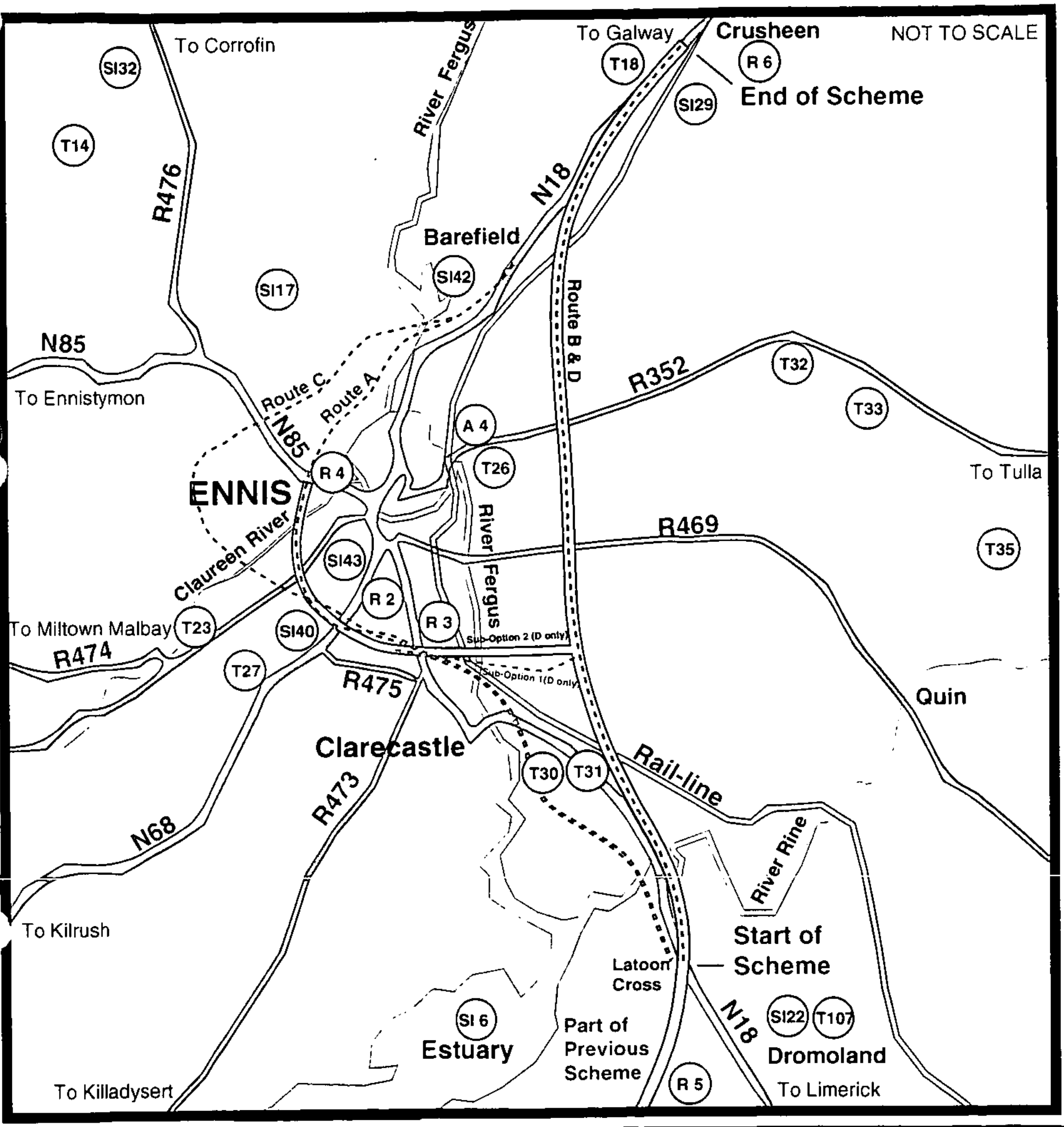
6.3 Off-Scheme Views

The proposed N18 will have has some 25 kilometres of off-scheme views when both sides of the 12.5 km of new N18 dual carriageway are considered. Of this some 5.8 km are *confined* to the road corridor by side cuttings. The proposal has a further 1 km. (3%) of *distant* and *scenic* views to the west of the proposal. The remaining views are of a rural agricultural landscape.

The proposed Southern Relief Road will have some 14.2 kilometres of off-scheme views when both sides of the 7.1 km of road are considered. Of this some 2 km (14%) are *confined* to the road corridor by side cuttings. The remainder is considered *neutral* views to either a sub-urban or rural setting.

6.4 Summary

Given the extent and level of the proposed development, the overall level of impact is not considered significant. However, appreciable and lasting impact will arise at three principal locations. Firstly in the townland of *Killow*, at the location of the N18/Relief Road junction and its associated lighting. Secondly in the townland of *Knockaskibbole* where the N18 passes between two isolated residences and thirdly at the northern tie-in with the existing N18 where 3 properties will be sandwiched between the two roads. In these instances the proposal will constitute a major change in the local character of the area and will have a significant impact on the views from nearby properties.



KEY (See Text)

- Route Option A
- Route Option B
- Route Option C
- Route Option D + Sub-Option 2
- Sub-Option 1

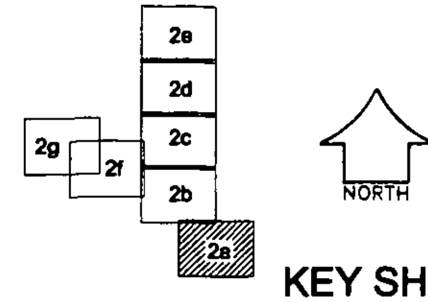
- SI Area of Scientific Interest
- T Tree Group to be Perserved
- R Road Objective
- A Amenity Objective

Figure 1 Context & Route Options

N18 Dromoland - Crusheen Road Improvement Scheme

BRADY SHIPMAN MARTIN

Landscape Architects
26, Temple Road,
Dartry, Dublin 6.



KEY SHEET

LEGEND

Major Visual Ridgeline

Minor Visual Ridgeline

Screening Trees or Hedgerows

Lake

High Visual Impact

Moderate Visual Impact

Low Visual Impact

Photoview Location

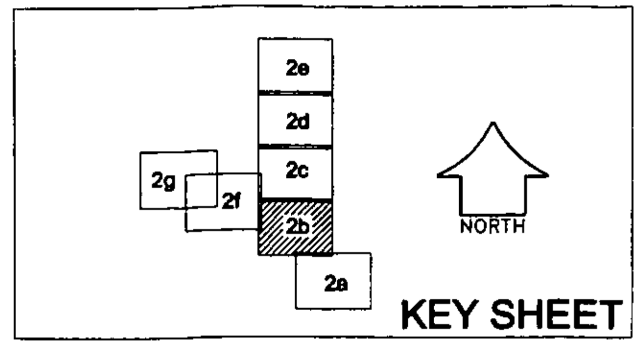
DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (including The Ennis Bypass)

LANDSCAPE IMPACT
Construction & Initial Operation Stage

Scale 1:10,000
Date MARCH '00
Job No. 2857
Drawing No. FIGURE 2a

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS



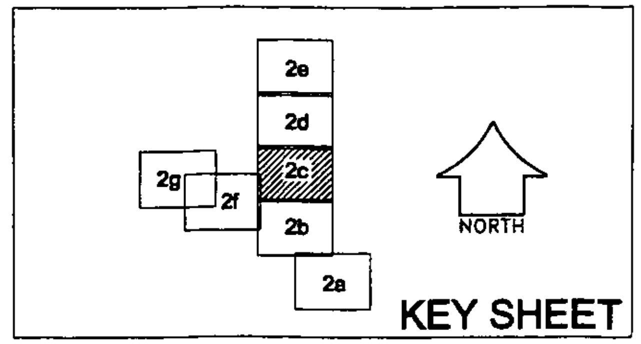
LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	1:10,000	B3	
	March '00		
LANDSCAPE IMPACT Construction & Initial Operation Stage	2857	FIGURE 2b	

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS



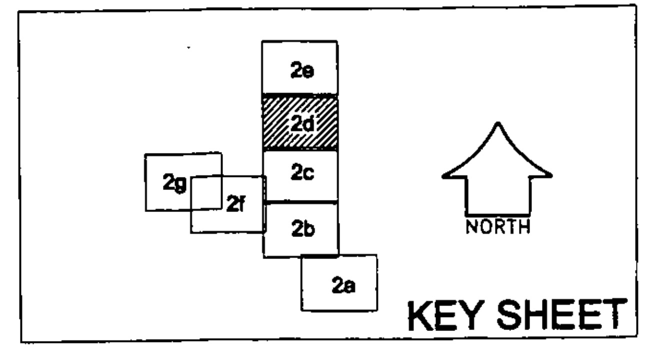
LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

DO NOT SCALE

N16 DROMOLAND TO CRUSHEEN (including The Ennis Bypass)	1:10,000	B8
	March '00	
LANDSCAPE IMPACT Construction & Initial Operation Stage	2657	FIGURE 2c

BRADY SHIPMAN MARTIN CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS

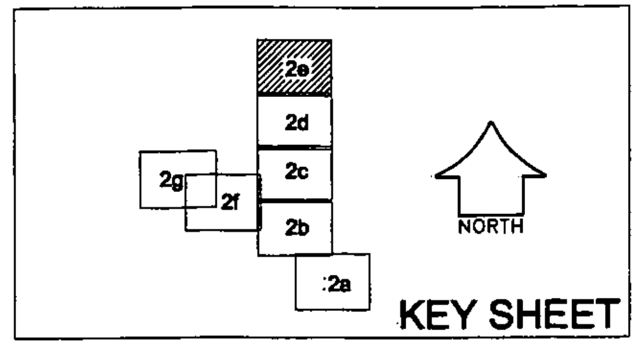


LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

N18 DROMOLAND TO CRUSHEEN (including The Ennis Bypass)	1:10,000	EIS
	March '00	
LANDSCAPE IMPACT Construction & Initial Operation Stage	2857	FIGURE 2d

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS
26 TEMPLE ROAD DARTRY DUBLIN 6



LEGEND

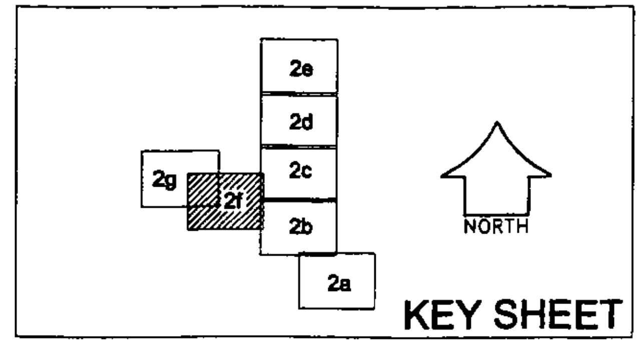
- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

DO NOT SCALE figured dimensions only to be taken from this drawing

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	Scale 1:10,000	Status EIS	
	Date March '00	Drn.	Chd. Passed
LANDSCAPE IMPACT Construction & Initial Operation Stage	Job No. 2857	Drawing No. FIGURE 2e	Rev.

BRADY SHIPMAN MARTIN

CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS
24 TEMPLE ROAD DARTRY DUBLIN 6

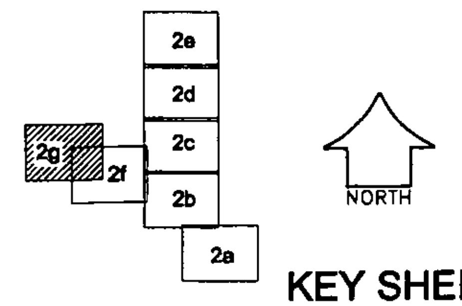


LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	Scale 1;10,000	Status EIS	
	Date March '00	Drn.	
LANDSCAPE IMPACT Construction & Initial Operation Stages	Job No. 2857	Drawing No. FIGURE 2f	Rev.

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS



KEY SHEET

LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	1:10,000		
	March '00		
LANDSCAPE IMPACT Sheet 7 of 7	2857	FIGURE 2g	

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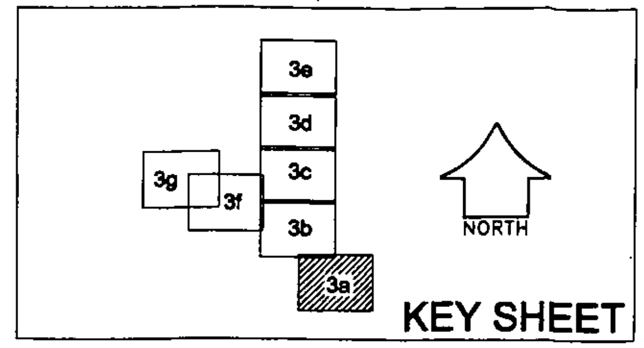
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS
26 TEMPLE ROAD DARTRY DUBLIN 6

CAD REF FT3000/Drawings/Jobs/2857



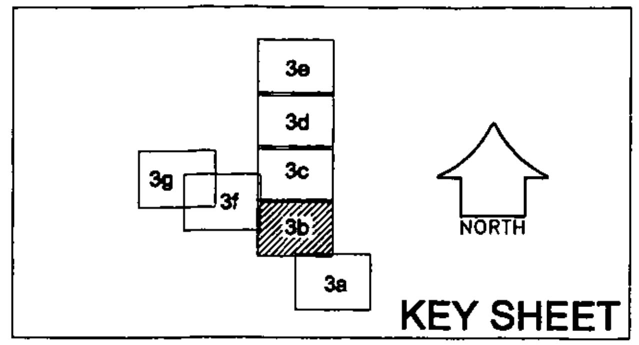
LEGEND

Major Visual Ridgeline	
Minor Visual Ridgeline	
Screening Trees or Hedgerows	
Lake	
High Visual Impact	
Moderate Visual Impact	
Low Visual Impact	
Photoview Location	2

DO NOT SCALE figured dimensions only to be taken from this drawing

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	1:10,000	EB	
	March '00	Dn. tb	Chd.
LANDSCAPE IMPACT After Construction & Initial Operation	2857	FIGURE 3a	

BRADY SHIPMAN MARTIN CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS 26 TEMPLE ROAD DARTRY DUBLIN 6



LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

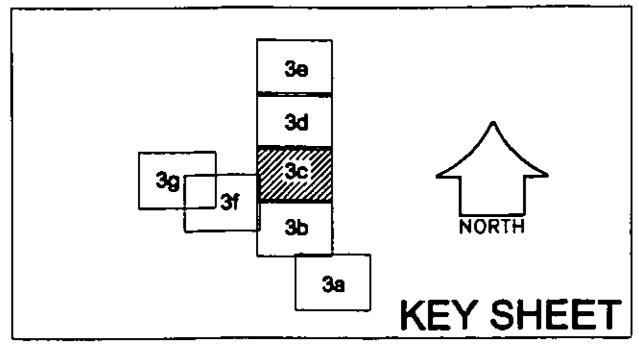
DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (including The Ennis Bypass)	1:10,000	B8
	March '00	
LANDSCAPE IMPACT After Construction & Initial Operation	2857	FIGURE 3b

BRADY SHIPMAN MARTIN

CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS

KEY SHEET



LEGEND

Major Visual Ridgeline

Minor Visual Ridgeline

Screening Trees or Hedgerows

Lake

High Visual Impact

Moderate Visual Impact

Low Visual Impact

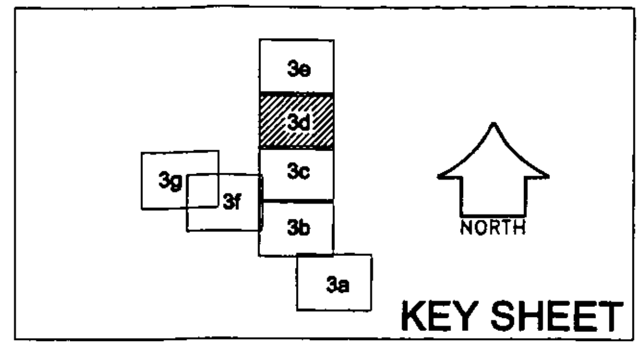
Photoview Location

DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	1:10,000	ES	
	March '00		
LANDSCAPE IMPACT After Construction & Initial Operation	2857	FIGURE 3c	

BRADY SHIPMAN MARTIN

CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS



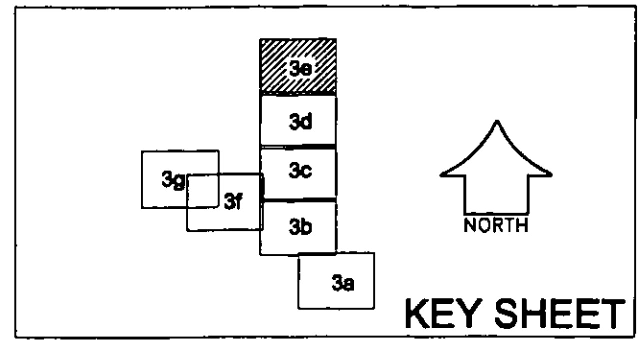
LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location 2

DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	Scale 1:10,000	Date March '00	
LANDSCAPE IMPACT After Construction & Initial Operation	Job No. 2857	Drawing No. FIGURE 3d	

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS



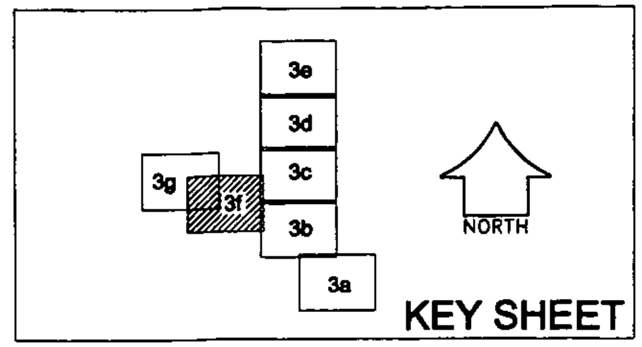
LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	1:10,000	E8
	March '00	
LANDSCAPE IMPACT After Construction & Initial Operation	2857	FIGURE 3e

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS

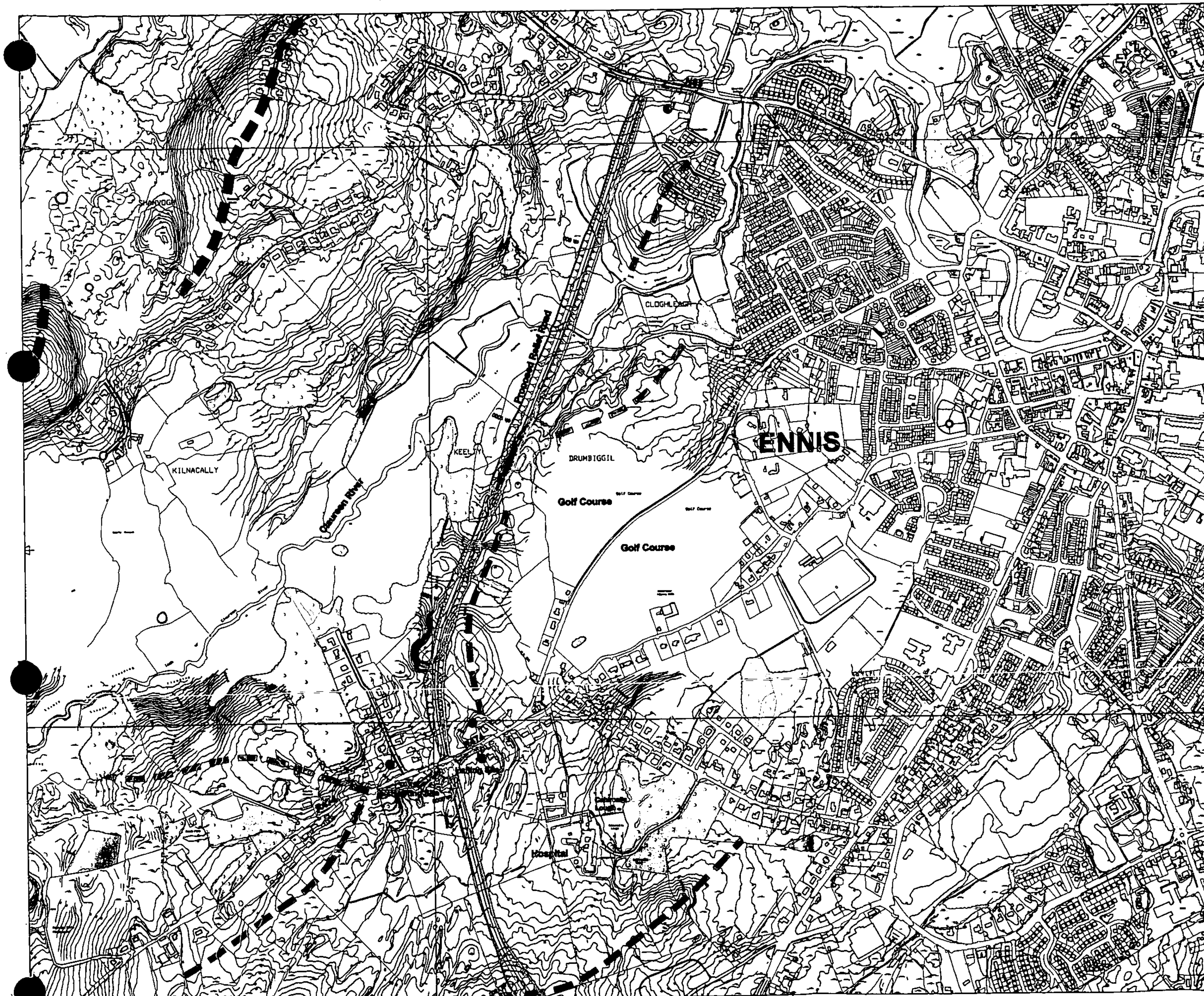


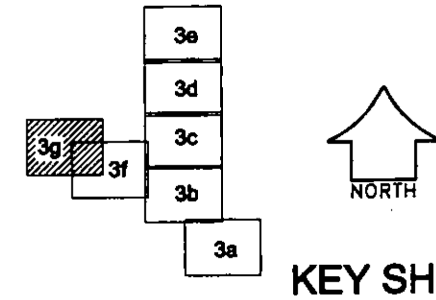
LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	1;10,000	E6
	March '00	
LANDSCAPE IMPACT After Construction & Initial Operation	2857	FIGURE 3f

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS
26 TEMPLE ROAD DARTRY DUBLIN 6





LEGEND

- Major Visual Ridgeline
- Minor Visual Ridgeline
- Screening Trees or Hedgerows
- Lake
- High Visual Impact
- Moderate Visual Impact
- Low Visual Impact
- Photoview Location

DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	Scale 1:10,000	BS	
	Date Sept. 1999		
LANDSCAPE IMPACT After Construction & Initial Operation	Job No. 2857	FIGURE 3g	0

BRADY SHIPMAN MARTIN CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS

CAD REF FT3000/Drawings/Jobs/2857

NORTH

LEGEND

EXISTING FEATURES

Screening Trees or Hedgerows

Lake

Residence

Noise Bund

PROPOSED MITIGATION MEASURES

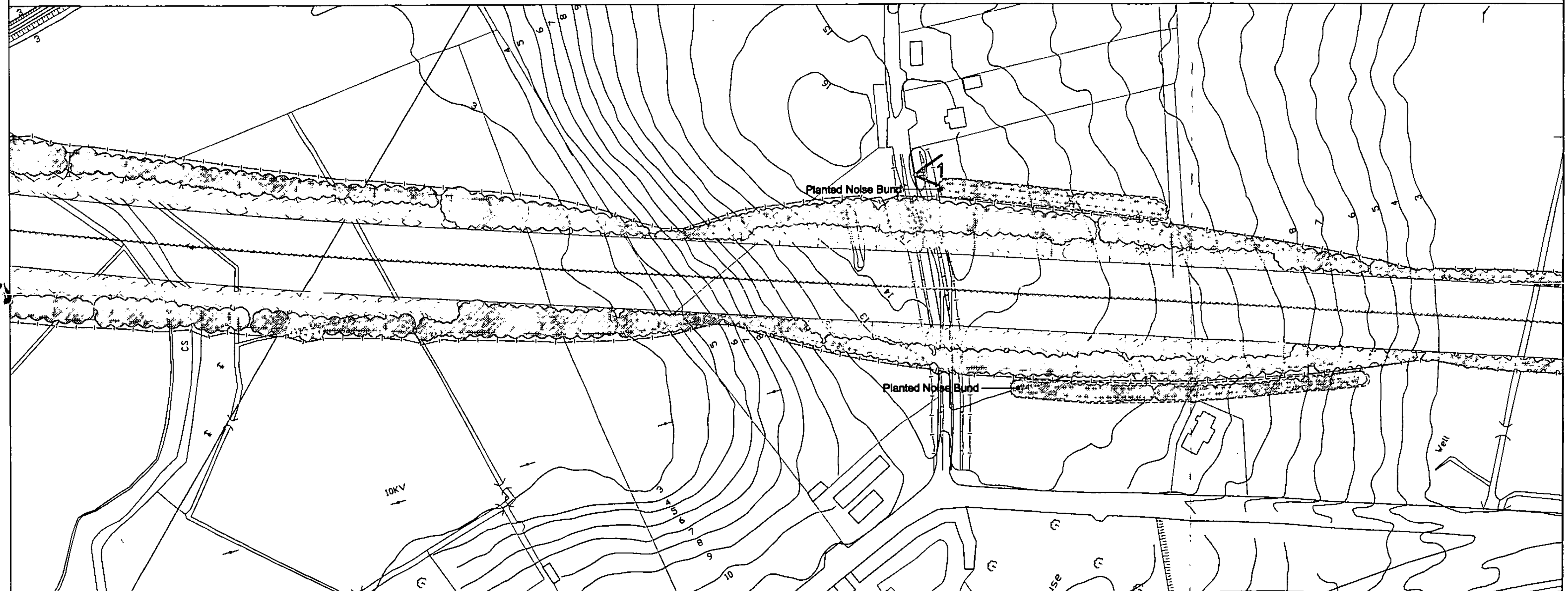
Woodland planting

Standard tree planting

Shrub planting

Median hedge planting

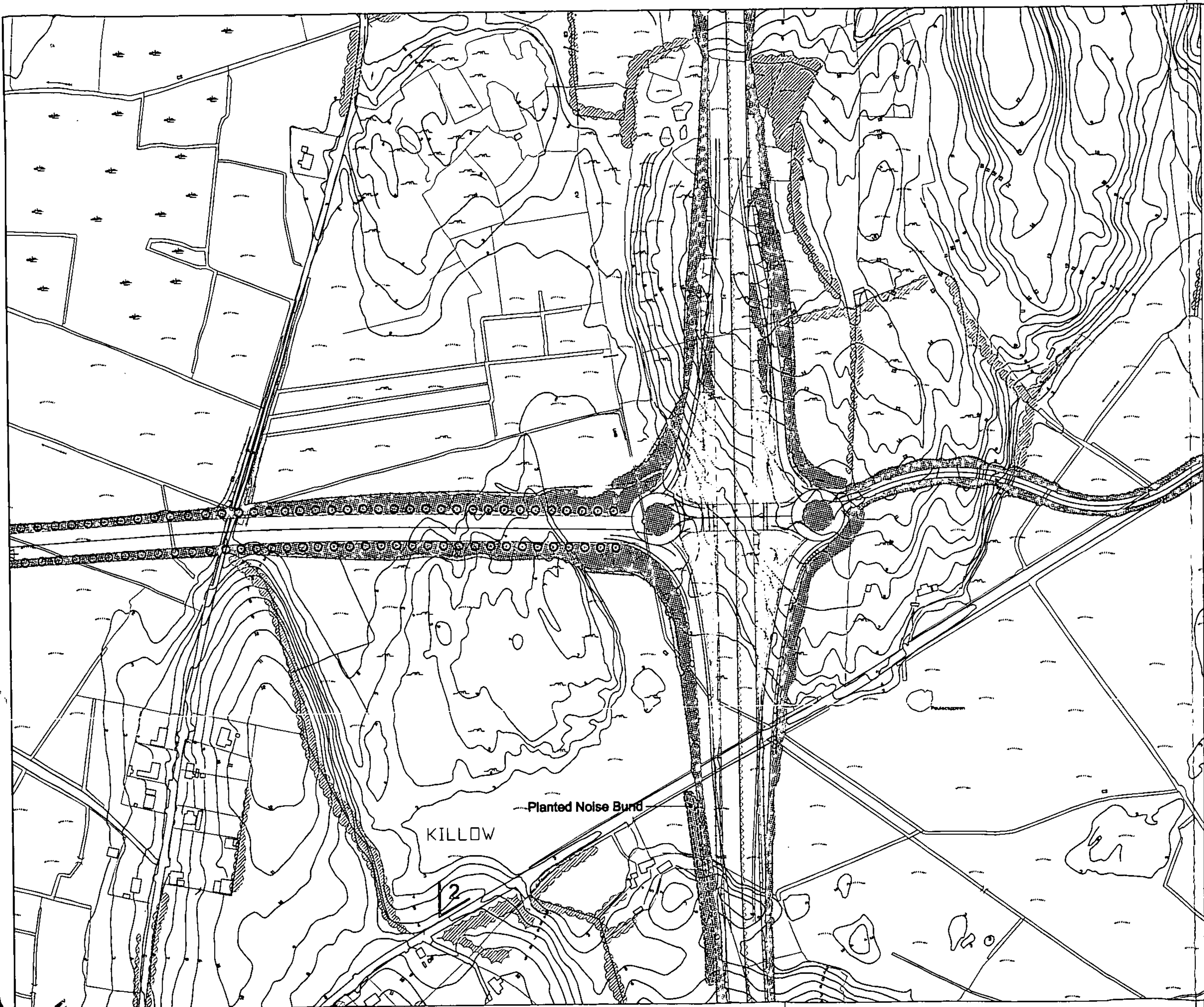
Photomontage location



DO NOT SCALE figured dimensions only to be taken from this drawing

N18 DROMOLAND TO CRUSHEEN (including The Ennis Bypass)	Scales 1:2,000	Status EIS	
	Date March '00	Drn. DoT	Chd. TB
LANDSCAPE MITIGATION DETAIL Ch. 13,000 - 13,800	Job No. 2857	Drawing No. FIGURE 4a	Rev

BRADY SHIPMAN MARTIN CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS



NORTH

LEGEND

EXISTING FEATURES

Screening Trees or Hedgerows

Lake

Residence

Noise Bund

PROPOSED MITIGATION MEASURES

Woodland planting

Standard tree planting

Shrub planting

Median hedge planting

Naturalistic planting (Ash & Hazel)

Photomontage Location

DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)

LANDSCAPE MITIGATION DETAIL Ch. 15,400 - 16,400

Scale 1:4,000

Date March '00

Status ES

Dr. DoT Chd TS

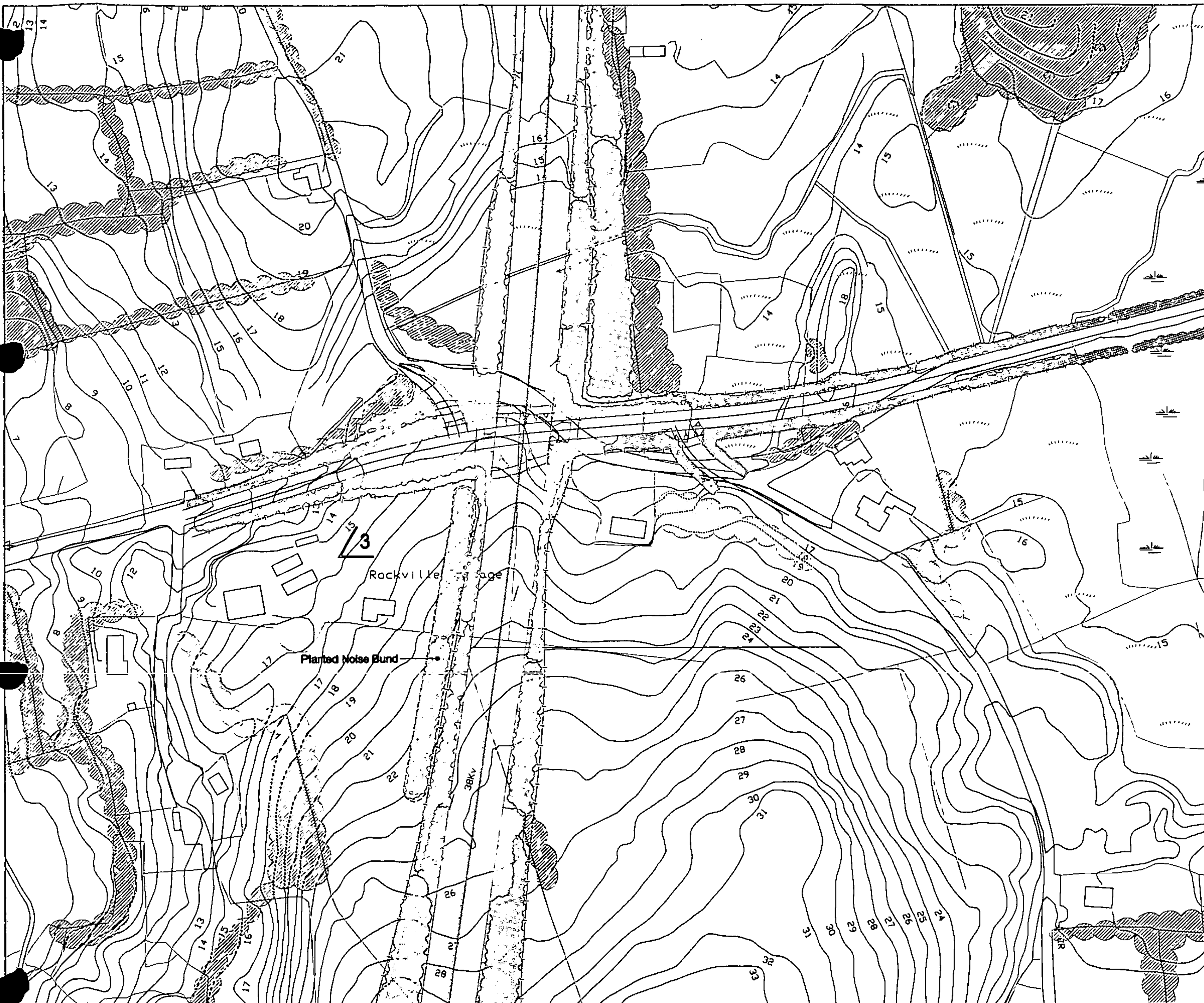
Job No. 2857

Drawing No. FIGURE 4b

BRADY SHIPMAN MARTIN

CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS

26 TEMPLE ROAD DARTRY DUBLIN 6



NORTH

LEGEND

EXISTING FEATURES

- Screening Trees or Hedgerows
- Lake
- Residence
- Noise Bund

PROPOSED MITIGATION MEASURES

- Woodland planting
- Standard tree planting
- Shrub planting
- Median hedge planting
- Photomontage location

DO NOT SCALE figured dimensions only to be taken from this drawing

N18 DROMOLAND TO CRUSHEEN (including The Ennis Bypass)	Scale 1:2,000	Status EIS	
	Date March '00	Drn. OoT Chd. TB	
LANDSCAPE MITIGATION DETAIL Ch. 18,500 - 18,900	Job No. 2857	Drawing No. FIGURE 4c	Rev

BRADY SHIPMAN MARTIN CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS

NORTH

LEGEND

EXISTING FEATURES

- Screening Trees or Hedgerows
- Lake
- Residence

PROPOSED MITIGATION MEASURES

- Woodland planting
- Standard tree planting
- Shrub planting
- Median hedge planting
- Naturalistic planting (Ash & Hazel)
- Photomontage Location

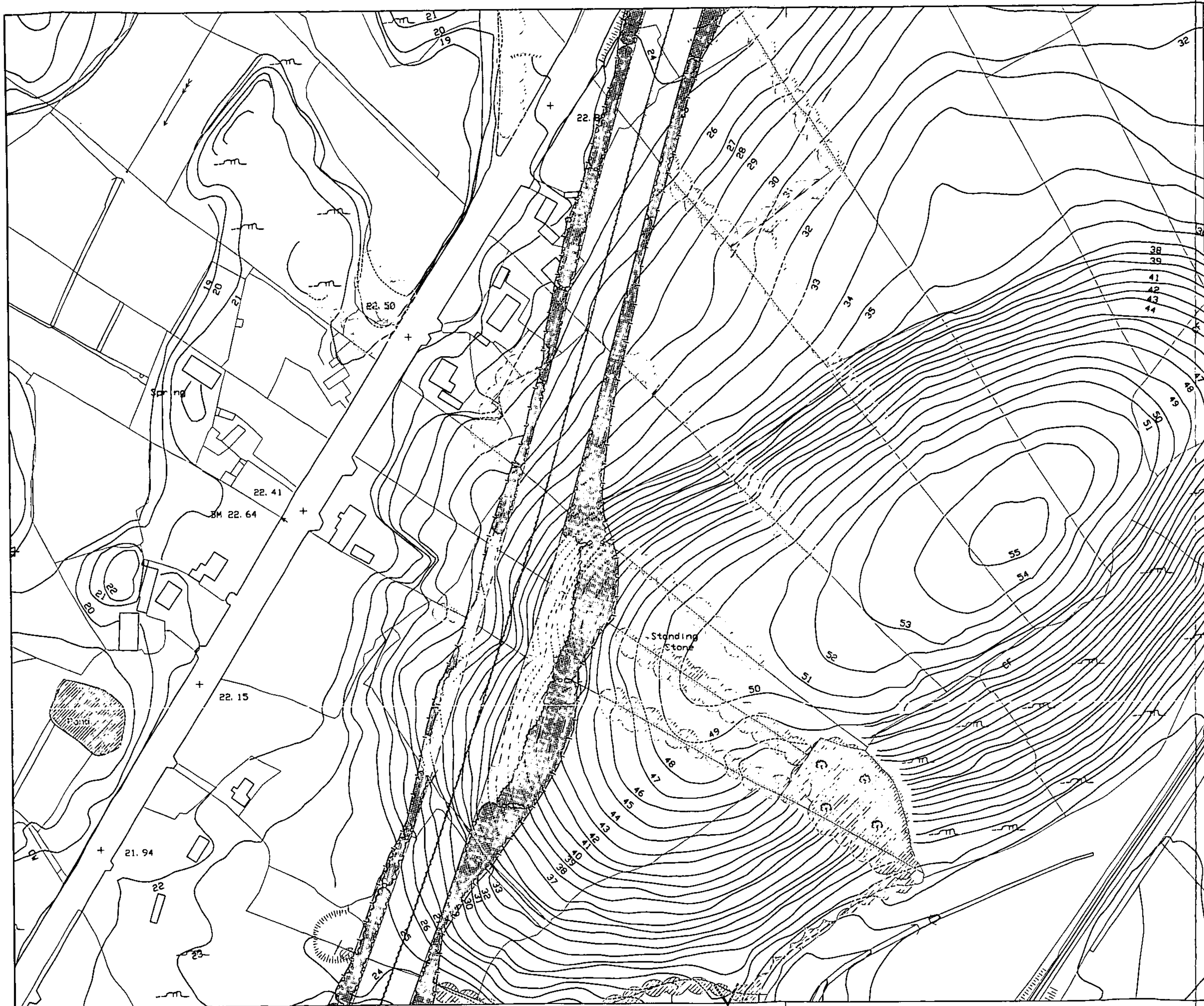
DO NOT SCALE

N18 DROMOLAND TO CRUSHEEN (including The Ennis Bypass)

LANDSCAPE MITIGATION DETAIL Ch. 22,200 - 23,200

Scale	1:4,000
Date	March '00
Status	ES
Drn.	DoT
Chd.	TB
Job No.	2857
Drawing No.	FIGURE 4d

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS
26 TEMPLE ROAD DARTRY DUBLIN 6



CAD REF FT9000/Drawings/Jobs/2857

NORTH

LEGEND

EXISTING FEATURES

- Screening Trees or Hedgerows
- Lake
- Residence

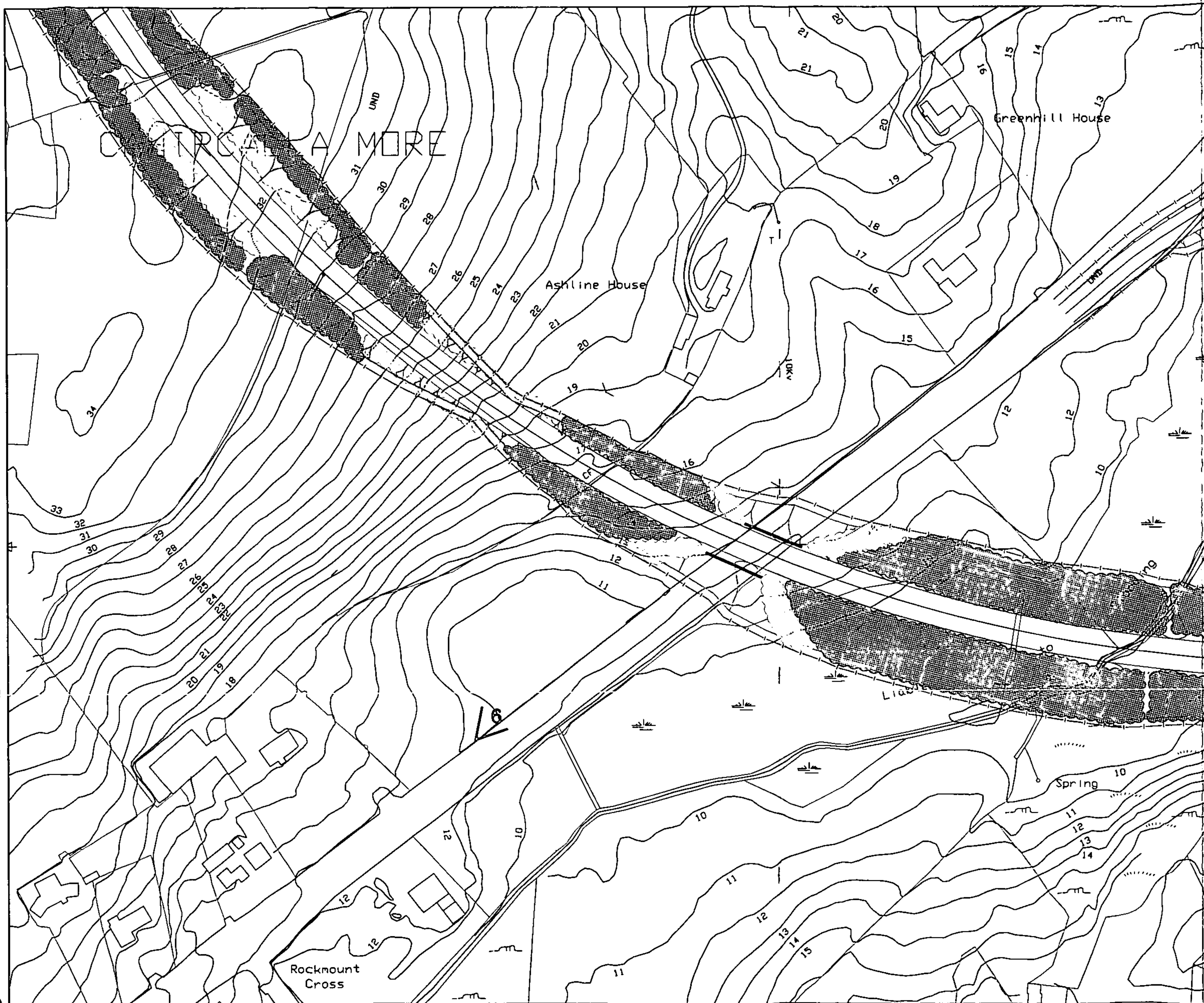
PROPOSED MITIGATION MEASURES

- Woodland planting
- Standard tree planting
- Shrub planting
- Median hedge planting

DO NOT SCALE figured dimensions only to be taken from this drawing

N18 DROMOLAND TO CRUSHEEN (Including The Ennis Bypass)	Scale 1:2,000	Status EIS	
	Date March '00	Drn. DoT Chd. TB	Passed
LANDSCAPE MITIGATION DETAIL Ch. 13,000 - 14,000	Job No. 2857	Drawing No. FIGURE 4e	Rev

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS
24 TEMPLE ROAD DARTRY DUBLIN 6



LEGEND

NORTH

EXISTING FEATURES

- Screening Trees or Hedgerows
- Lake
- Residence

PROPOSED MITIGATION MEASURES

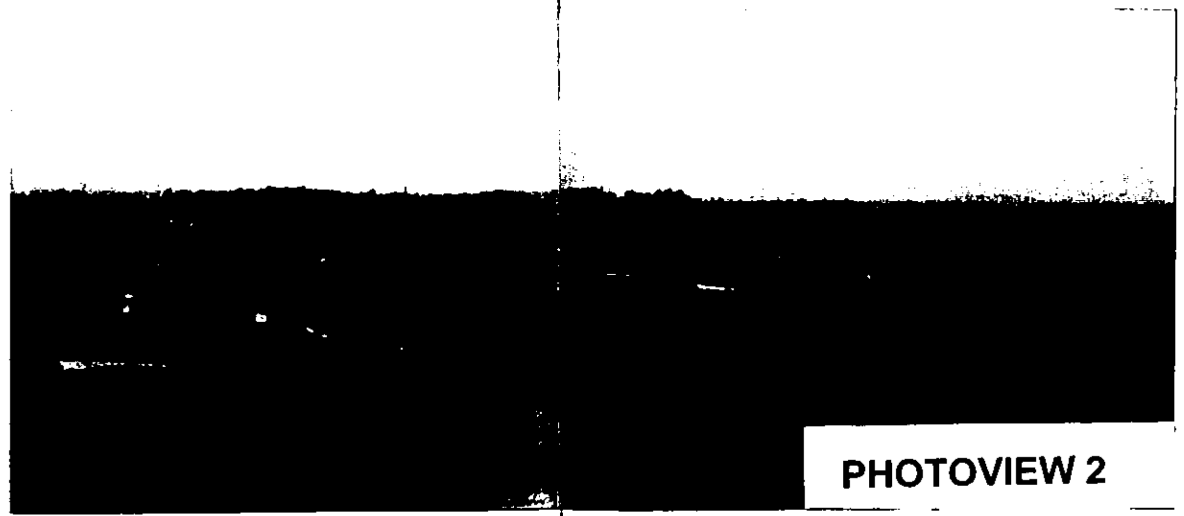
- Woodland planting
- Standard tree planting
- Shrub planting
- Photomontage Location

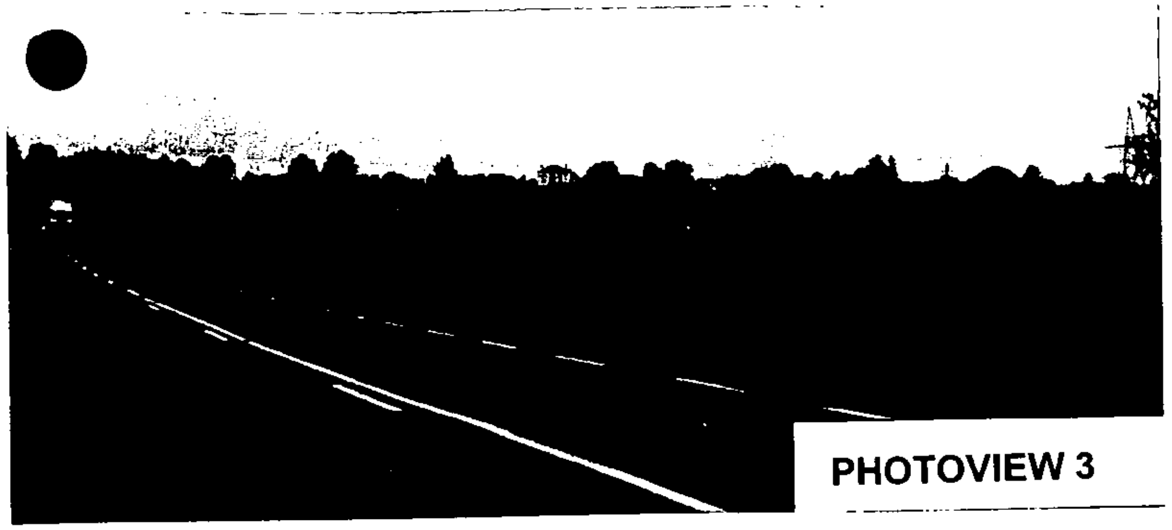
DO NOT SCALE figured dimensions only to be taken from this drawing

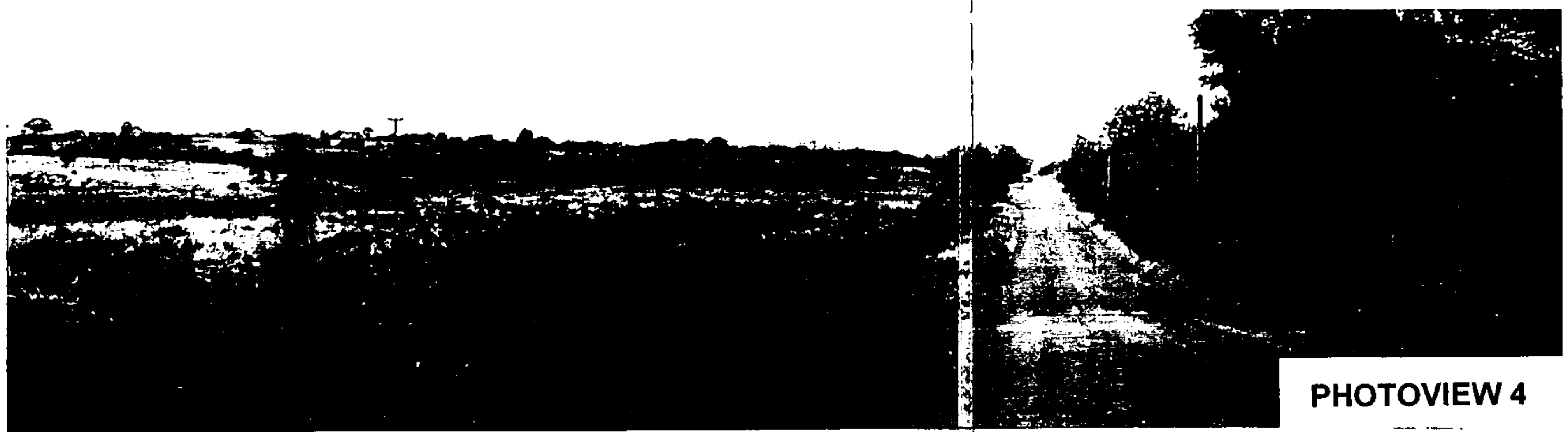
N18 DROMOLAND TO CRUSHEEN (including The Ennis Bypass)	1:1,000	EIS	
	March '00	DoT TB	
LANDSCAPE MITIGATION DETAIL Ch. 2,500 - 3,200	2857	FIGURE 4f	

BRADY SHIPMAN MARTIN
CONSULTANTS PLANNERS ARCHITECTS LANDSCAPE ARCHITECTS
84 TEMPLE ROAD DARTRY DUBLIN 6


PHOTOVIEW 1

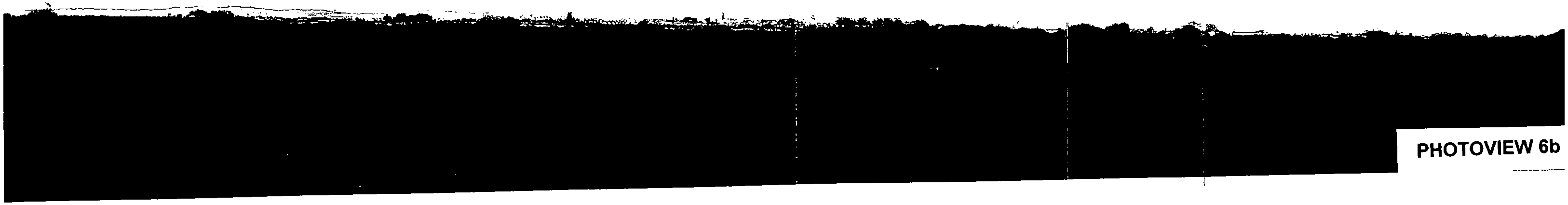

PHOTOVIEW 2


PHOTOVIEW 3

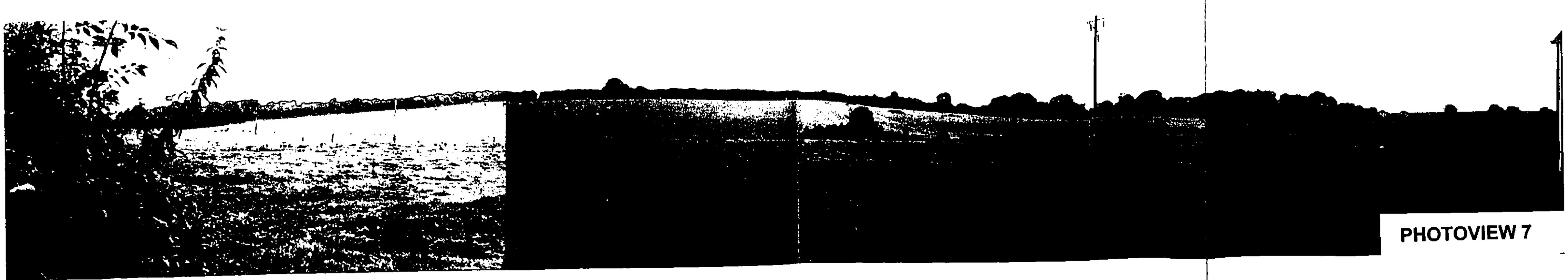

PHOTOVIEW 4


PHOTOVIEW 5

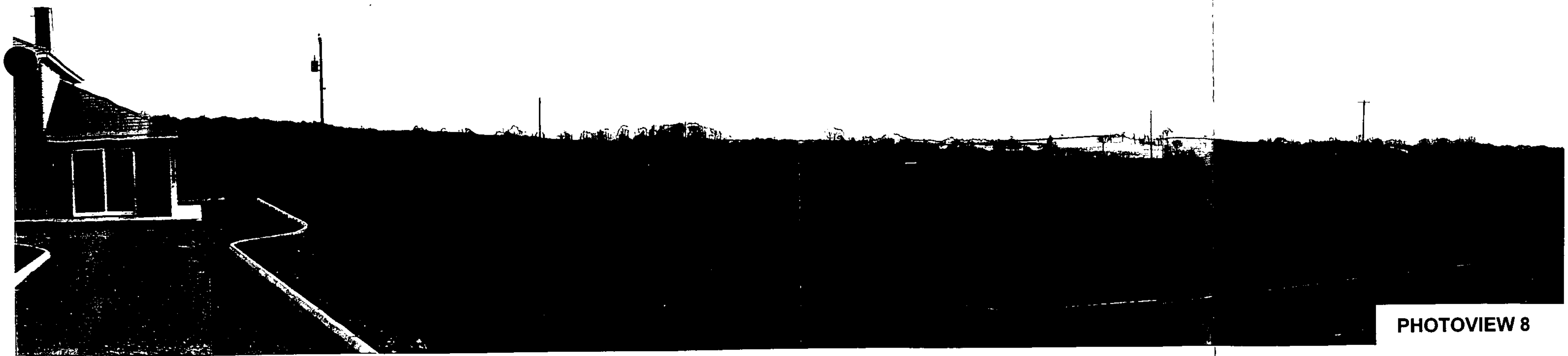
PHOTOVIEW 6a



PHOTOVIEW 6b



PHOTOVIEW 7



PHOTOVIEW 8

PHOTOVIEW 9

PHOTOVIEW 10

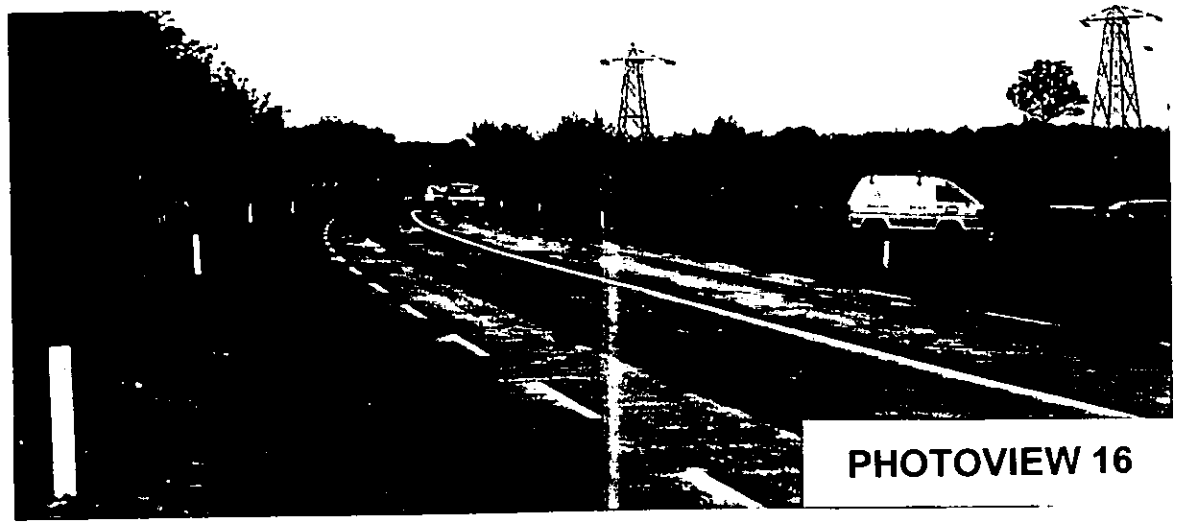
PHOTOVIEW 11

PHOTOVIEW 12

PHOTOVIEW 13

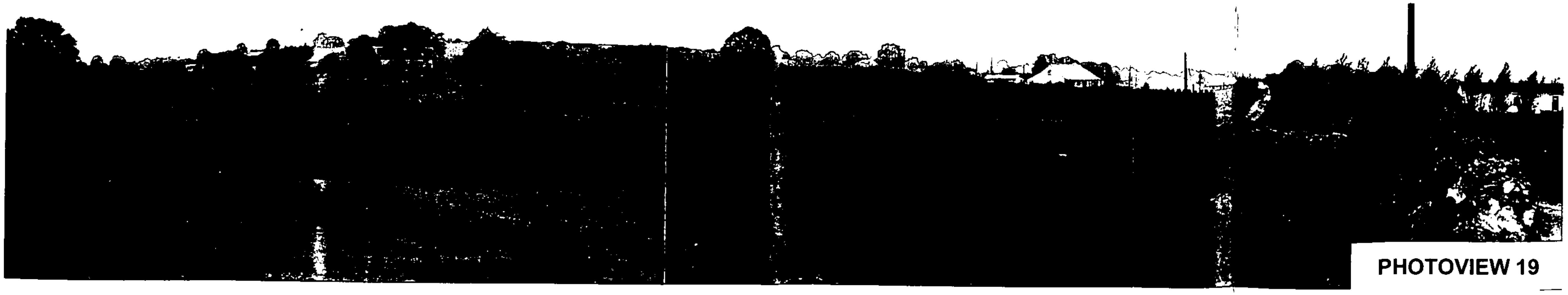

PHOTOVIEW 14


PHOTOVIEW 15


PHOTOVIEW 16


PHOTOVIEW 17

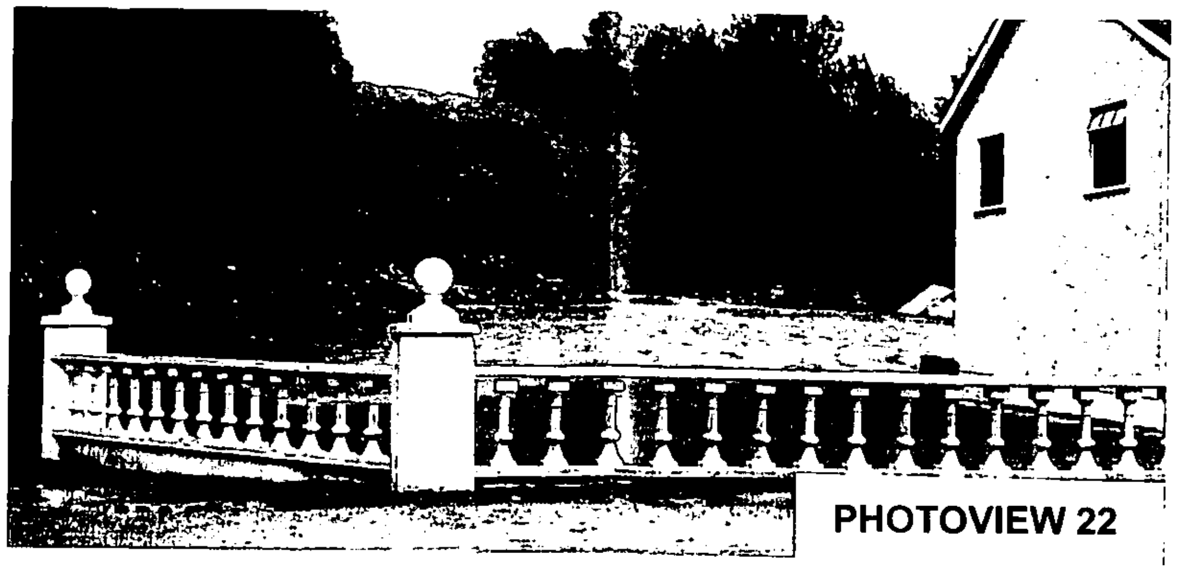

PHOTOVIEW 18



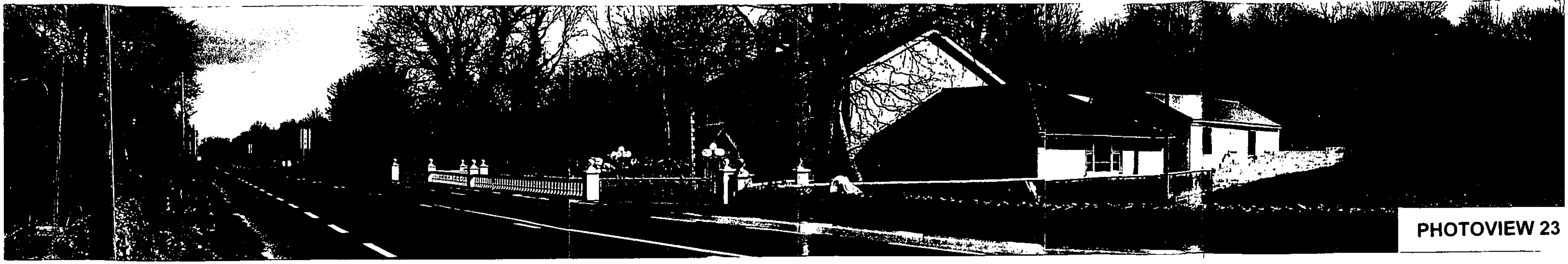
PHOTOVIEW 19

PHOTOVIEW 20

PHOTOVIEW 21



PHOTOVIEW 22


PHOTOVIEW 23

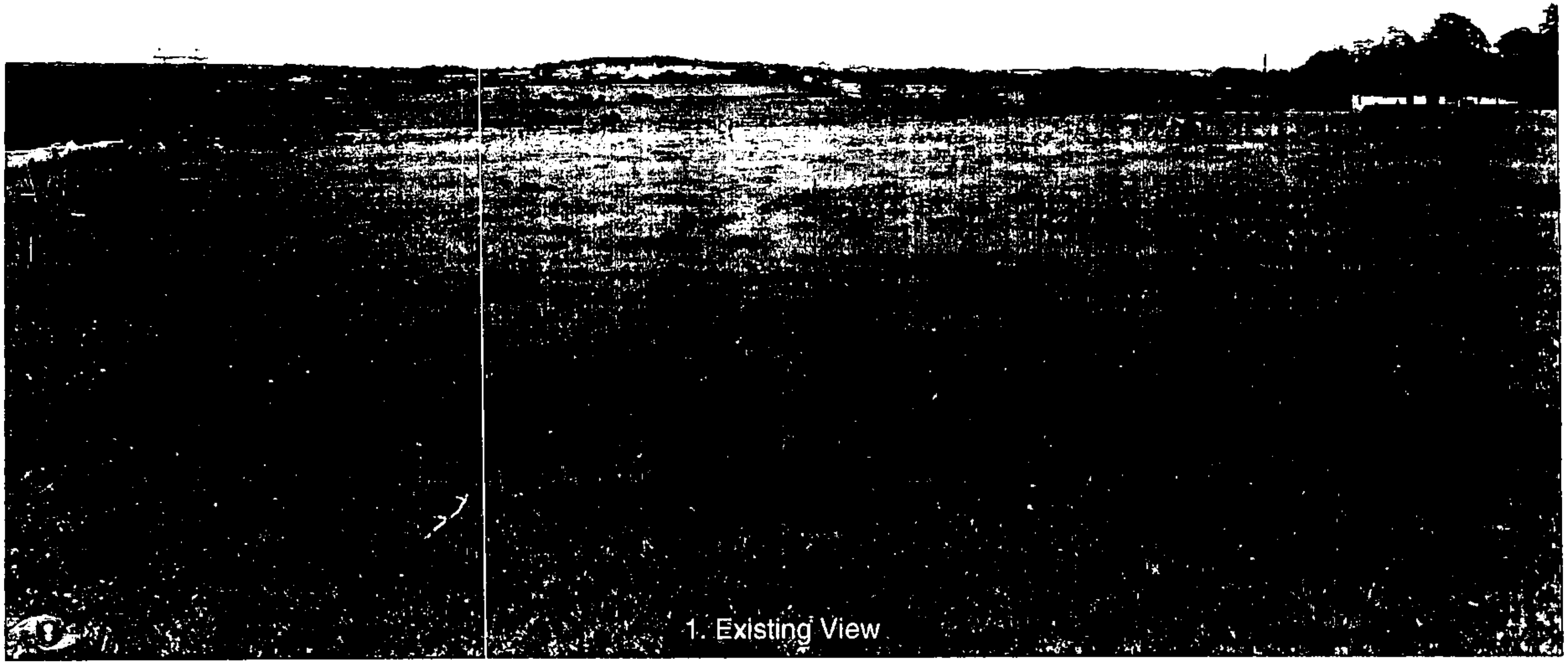

PHOTOVIEW 24


PHOTOVIEW 25

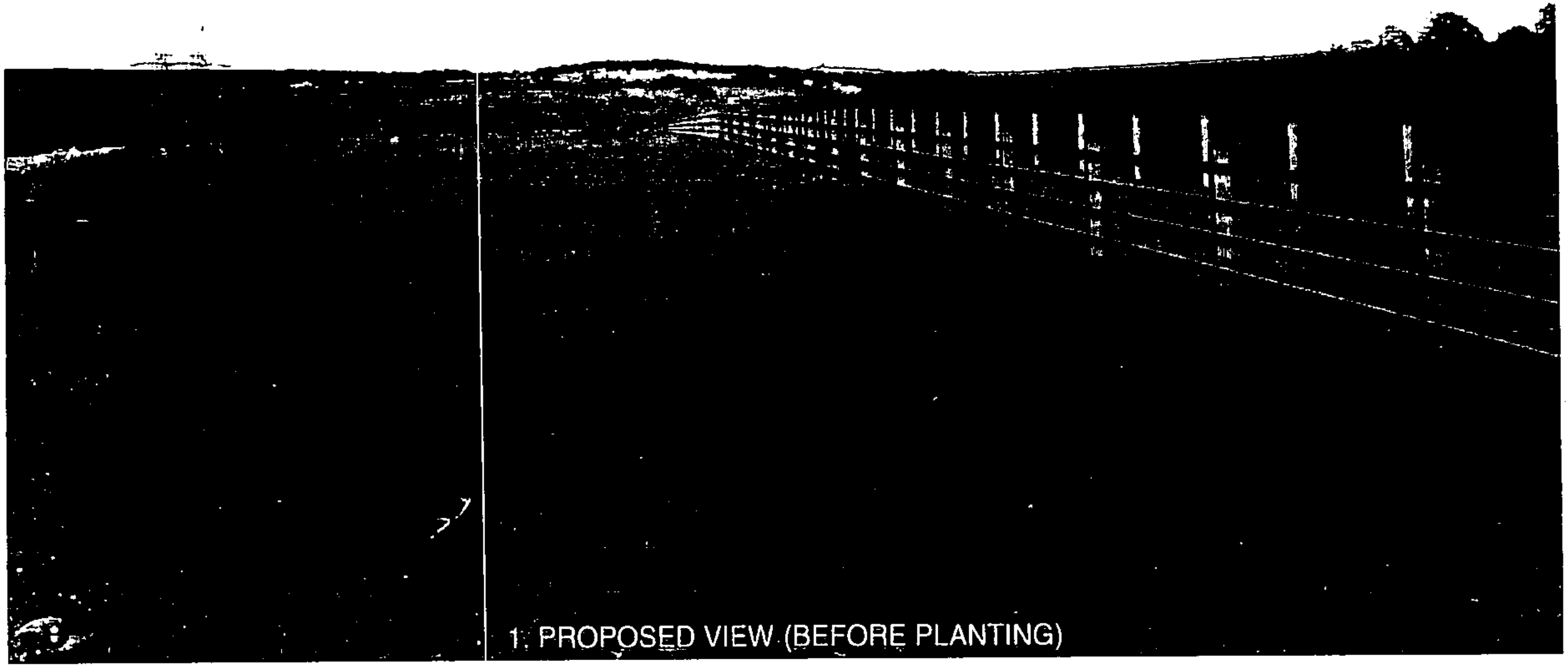

PHOTOVIEW 26

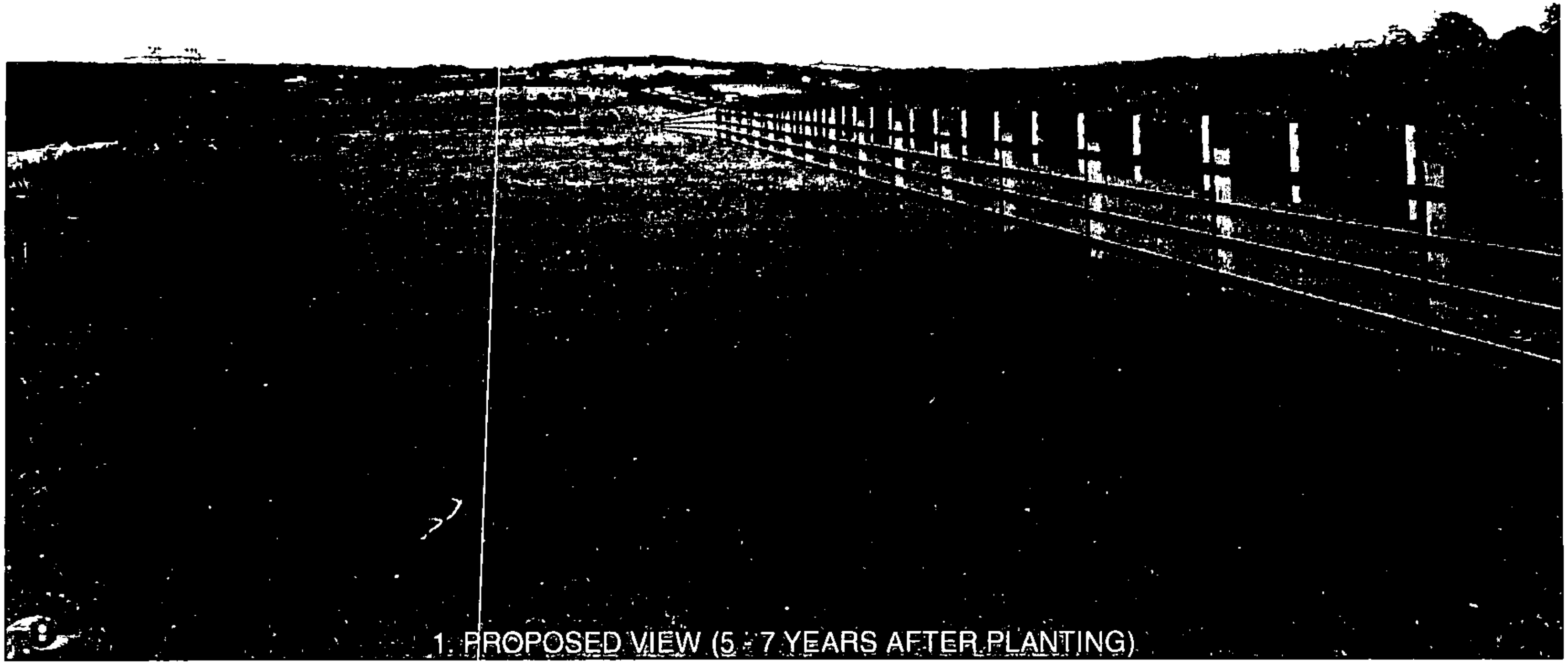
APPENDIX VIII- PART B

PHOTOMONTAGES OF PROPOSED ROAD DEVELOPMENT

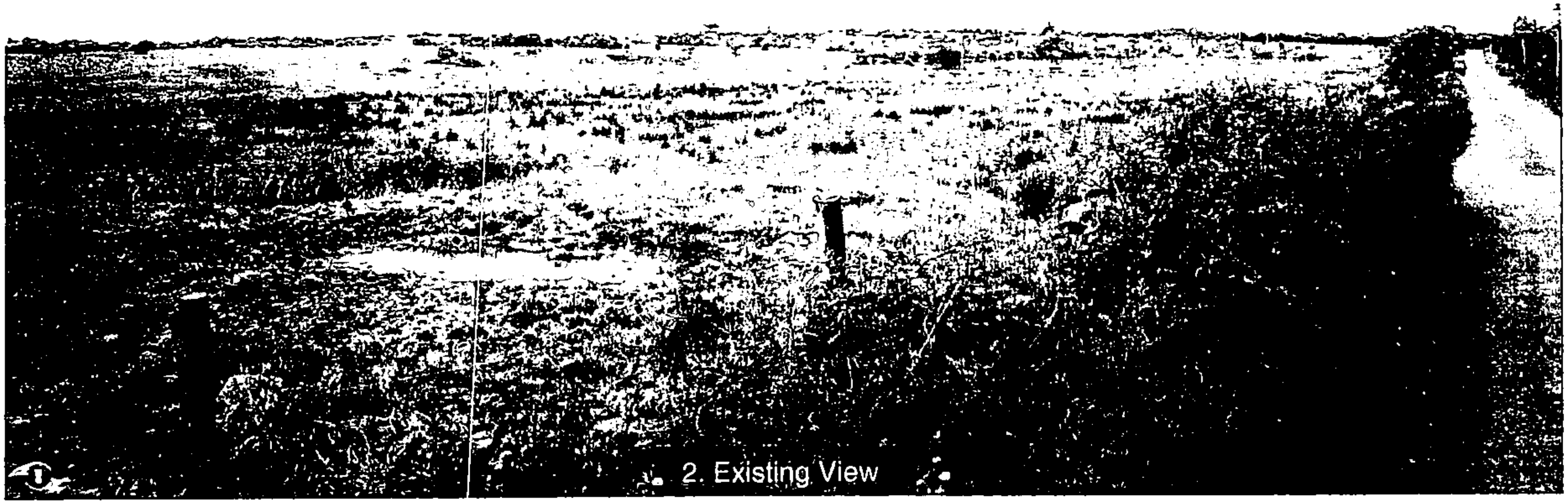


1. Existing View


1. PROPOSED VIEW (BEFORE PLANTING)



1. PROPOSED VIEW (5 - 7 YEARS AFTER PLANTING)

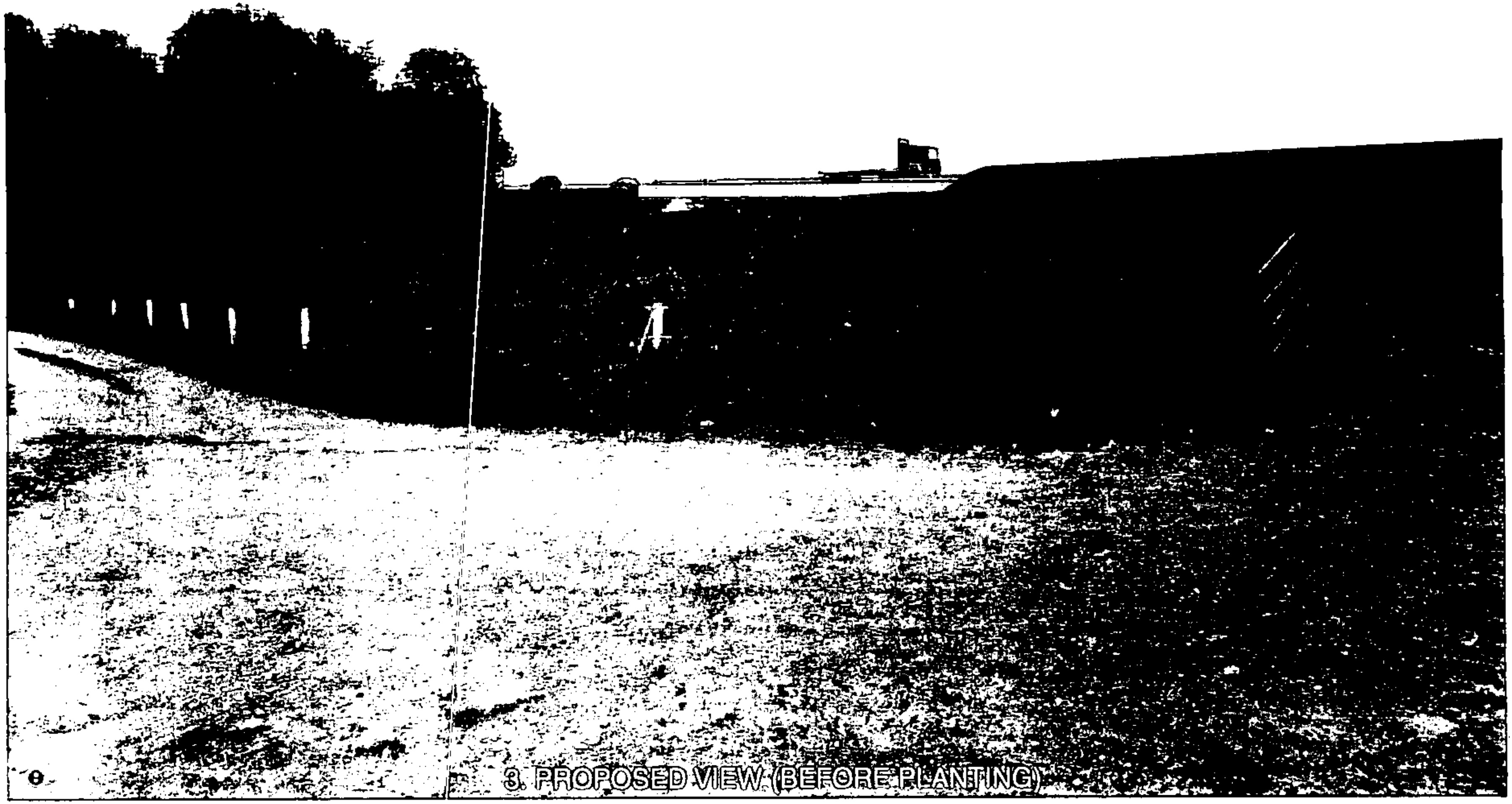


2. Existing View


2. PROPOSED VIEW (BEFORE PLANTING)

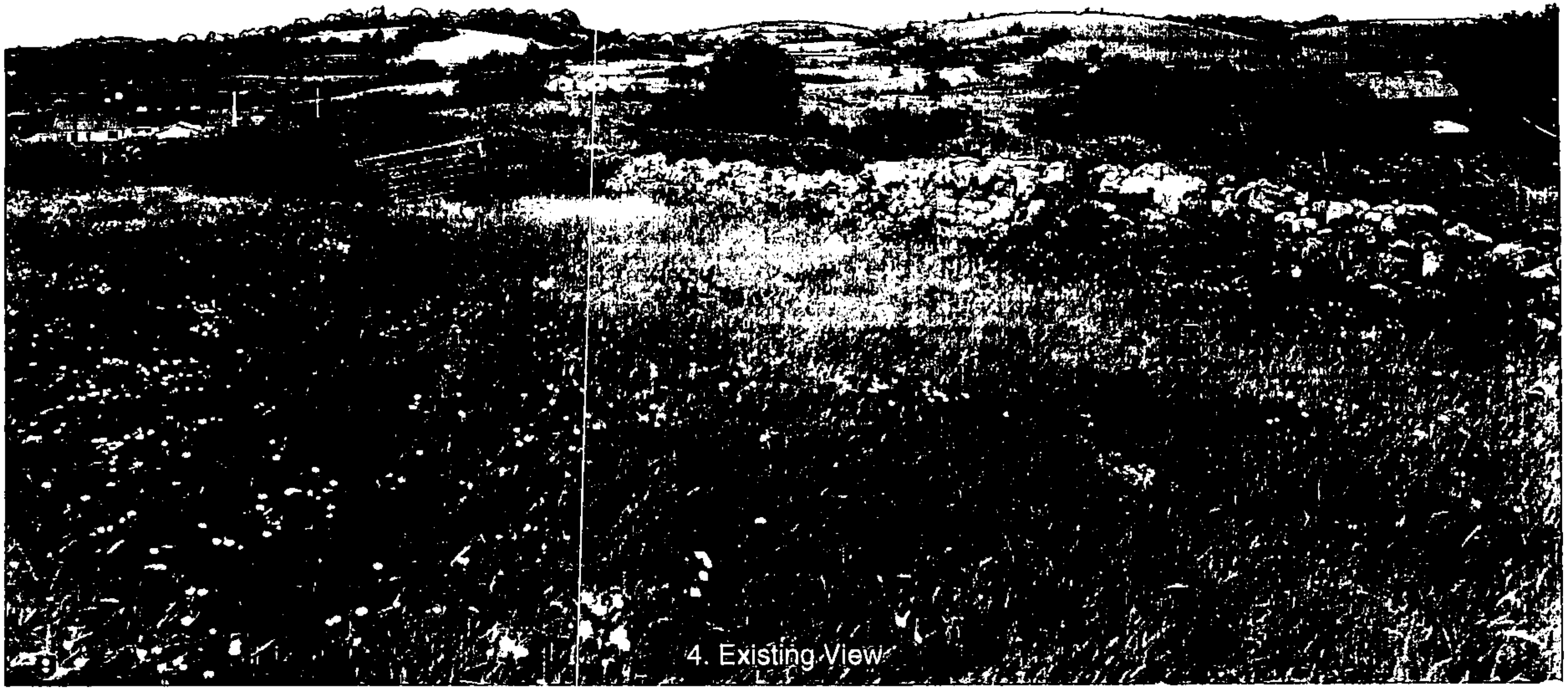
2. PROPOSED VIEW (5 - 7 YEARS AFTER PLANTING)

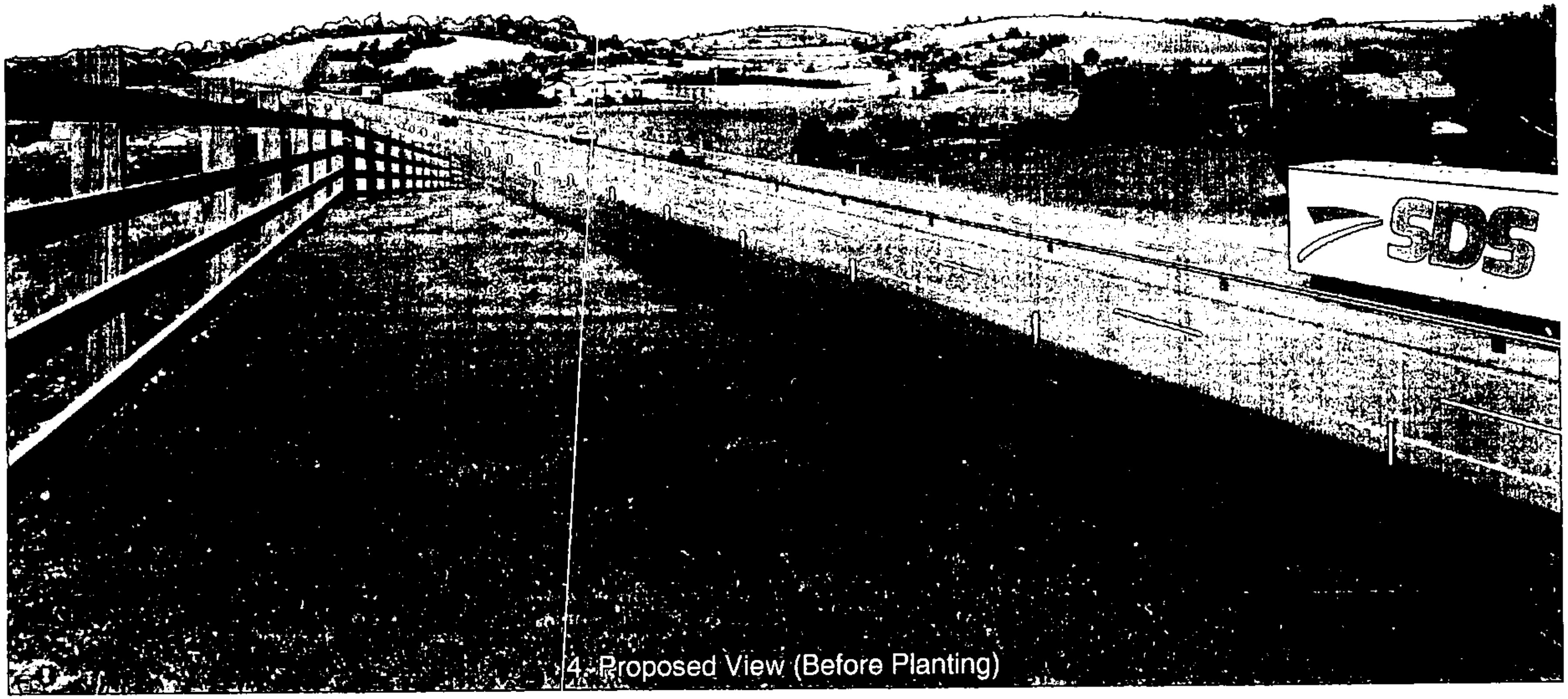
3. Existing View



3. PROPOSED VIEW (BEFORE PLANTING)


3. PROPOSED VIEW (5 - 7 YEARS AFTER PLANTING)

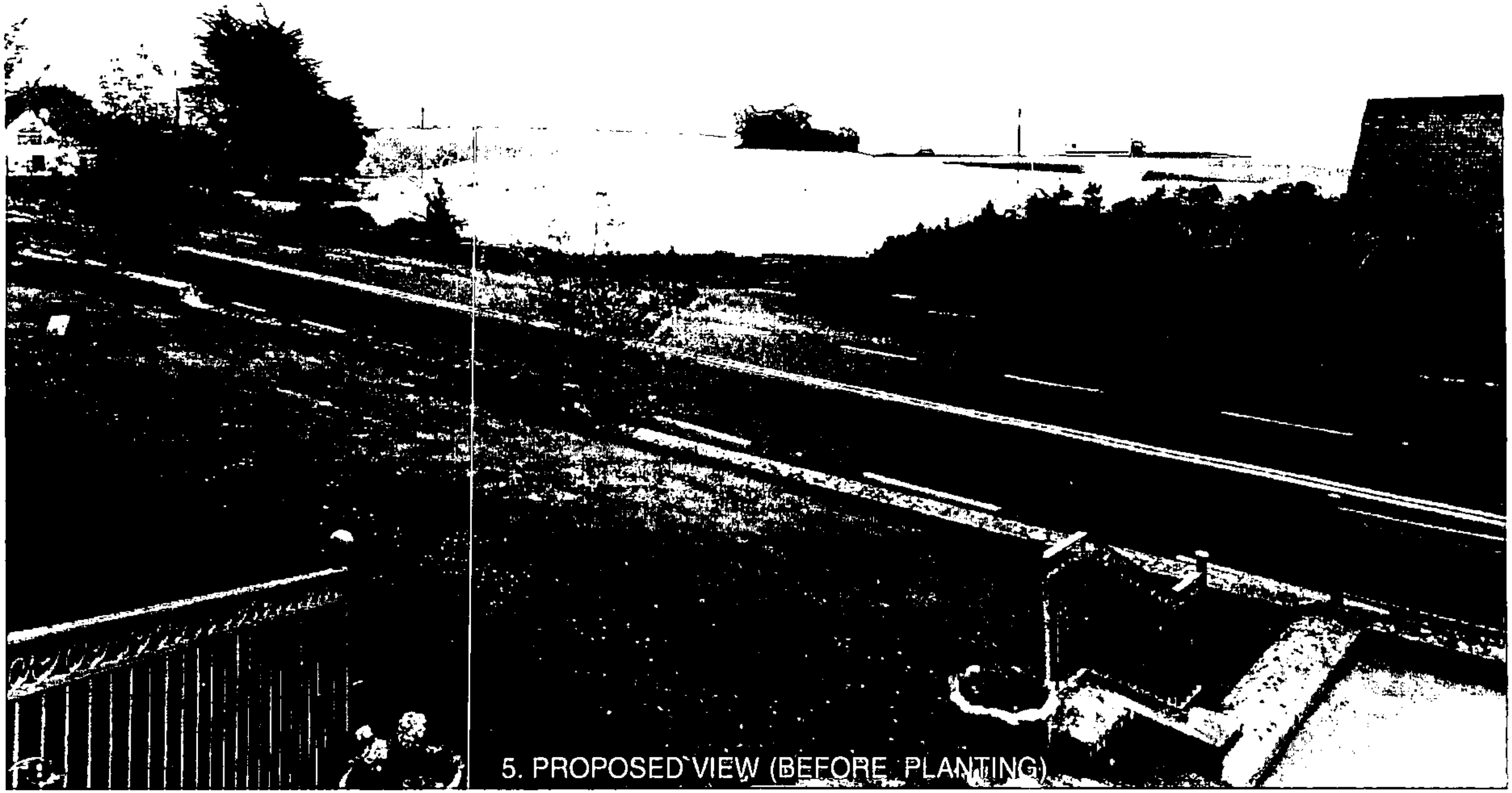

4. Existing View



4 - Proposed View (Before Planting)


SDS
4. Proposed View (5-7 Years After Planting)

5. Existing View



5. PROPOSED VIEW (BEFORE PLANTING)

5. PROPOSED VIEW (5 - 7 YEARS AFTER PLANTING)

6. PROPOSED VIEW (BEFORE PLANTING)


6. PROPOSED VIEW (5 - 7 YEARS AFTER PLANTING)

XI

APPENDIX IX

CULTURAL HERITAGE

PART A	**ARCHITECTURAL, CULTURAL & HISTORICAL ASPECTS (Michael Leahy & Paul Conway)**
PART B	**N18 DROMOLAND TO CRUSHEEN ROAD IMPROVEMENT SCHEME (INCLUDING ENNIS BYPASS) CULTURAL HERITAGE (Babtie Group)**
PART C	**ARCHAEOLOGICAL STUDY FOR EIS OF PROPOSED N18 ROAD DEVELOPMENT, DROMOLAND TO CRUSHEEN (ENNIS BYPASS), CO. CLARE (Archaeological Development Services Ltd.)**

APPENDIX IX – PART A

ARCHITECTURAL, CULTURAL & HISTORICAL ASPECTS
(Michael Leahy & Paul Conway)

ENVIRONMENTAL IMPACT ASSESSMENT FOR N18/N19 ROAD IMPROVEMENTS DROMOLAND TO CRUSHEEN (INCLUDING ENNIS BY-PASS)

ARCHITECTURAL, CULTURAL AND HISTORICAL ASPECTS

PART OF MATERIAL ASSETS AND CULTURAL HERITAGE.

Michael Leahy & Paul Conway,
Chartered Architects
Regional & Urban Planners,
Harvey's Quay,
Ennis, Co. Clare.
Tel. No : (065) 6821155
Email : maleahy@iol.ie

September 1999.

CONTENTS

INTRODUCTION

The purpose of this report is to set out the impacts which will be experienced by features of architectural, historical or cultural importance on or close to the proposed N18 road improvements, from Dromoland to Crusheen, hereinafter referred to as the "Ennis by-pass" or "the bypass". The features above referred to form part of “material assets and cultural heritage” as defined in Article 3 of the European Community Environmental Impact Assessment Directive No. 85/337

This report is structured in the following way:

Chapter 1 : Gives the historical context of the area through which the by-pass route passes.

Chapter 2 : Lists the historical and architectural features and artefacts which are on or close to the by-pass route. Many of the historical impacts are dealt with in a separate section of the Environmental Impact Statement dealing with archaeological impacts. In some locations specific archaeological remains are not mentioned and a general description of the type of remains in an area is given.

In addition an assessment is made of the type of impacts if any which will be experienced by any of the features listed. A grading system is set up to enable the nature of the impact to be assessed in relative terms and the criteria for this are explained. In each case the relative significance of each feature identified is assessed and again the assessment criteria are explained.

Chapter 3 : A matrix is established which allows the relative significance of each feature to be scored against the relative impact which it will experience. This allows an objective framework to be established which highlights areas where action needs to be taken.

Suggested mitigations are listed separately.

Chapter 4 : A brief non technical summary concludes the report. A map identifying the principal features assessed as well as a series of photographs are included as one appendix

WORK METHOD

One architect and one local historian who is also an archaeologist were employed on the assessment team. Histories were studied and researched including annual journals and recently published local studies. The national inventory of architectural heritage was examined and main features noted.

The route was walked by members of the team over a three week period in August 1998 and historical sites and architectural features examined and recorded. The more important sites have been photographed.

CHAPTER 1 - HISTORICAL CONTEXT :

Like many areas in Co. Clare the route taken by the Ennis By-Pass is rich in archaeological and historical monuments which cover all periods of habitation in Ireland from the Neolithic to the present.

It is obvious from the presence of standing stones, megalithic tombs and fulachta fiadha that the area was cultivated during the Neolithic and Bronze Ages, while the huge hillfort of Mooghaun, which encompasses some 23 acres, bears witness to the importance of the area during the early Iron Age. The numerous univallate and bivallate forts, which dot the area around the route of the by-pass, probably date from the same period and indicate a landscape of intensive farming and high population density even in prehistory.

The old churches of Killow and Doora bear witness to the introduction of Christianity during the 5th and 6th centuries when this region was governed by the Dalcassian Dynasty under the leadership of the McNamaras and O'Briens, later to become kings of Thomond. The last centuries of the first millennium A.D. were spent in constant conflict with the Danes of Limerick who made great efforts to conquer the lands bordering the Shannon Estuary and Lough Derg. These were finally defeated by Brian Boru during the late 10th and early 11th centuries A.D.

The extinction of Viking power in the region and the powerful domination of the area by the O'Brien Dynasty brought a period of relative peace and prosperity during the following two centuries which allowed such monastic orders as the Augustinians to build monasteries at Clareabbey and Killone, both within sight of the proposed by-pass in the late 12th century, while the Franciscans settled and built their friaries at Ennis and Quin in the early 13th century.

This peace was shattered however, when the Norman knight Robert de Muscegros was granted lands in south-east Clare by Henry III in 1248 and set about consolidating his grants by building massive curtain walled strongholds at Bunratty, Clarecastle and Quin. The early decades of the 14th century were witness to many skirmishes and battles between the Normans and their allies on one side, and a confederation of Dalcassian Clans on the other. This conflict concluded on May 10, 1318 when the Norman army under Richard de Clare was annihilated by the O'Deas,

O'Loghlens, O'Hehirs, O'Connors and O'Briens under the command of Conor O'Dea at Dysert O'Dea. This resulted in the burning and demolition of Bunratty, the capture of Clarecastle and the construction of the great Franciscan Abbey of Quin by the MacNamaras.

The end of this conflict and the subsequent departure of Anglo-Norman influence in this area brought another period of peace and general prosperity, known as the "Golden Age of Irish Building", when over 80 abbeys and friaries were built west of the Shannon, while Co. Clare saw the construction of over 220 stone tower houses, over 80 of which were built by the MacNamaras, in south east Clare. Although no tower houses are close to the proposed by-pass it will be possible to see those of Ballyhannon, Castletown, Spancil Hill and Danganbrack in the distance.

The seventeenth century brought Co. Clare into three disastrous wars. The first, known as "The Nine Years War" 1594-1603 saw the town of Ennis burned on two occasions by the northern rebel army, due to the Earl of Thomond's (O'Brien) complicity with the English.

The second war 1641-51, which reflected the civil war in England, saw many English Protestants evicted from their lands and was cruelly brought to a conclusion by the Cromwellians who were garrisoned in Bunratty and Clarecastle. The resultant ruling that no Catholic could reside within three miles of a walled city brought much prosperity to Ennis in the late 17th century when many Limerick and Galway merchants moved their businesses to the town.

The close of the century saw the disastrous "War of Two Kings "1689-91 when Jacobites and Williamites from many parts of Europe decided to use Ireland as their battleground. The carving up of clan lands into large estates after this war allowed the new ascendancy to build magnificent houses during the 18th and 19th centuries (e.g. Carnelly, Cahercalla, Manusmore and Dromoland Castle) while the Catholic tenants were reduced to landless labourers, existing on a diet of potatoes and turnips.

During the prosperities which accompanied the Napoleonic Wars the town of Ennis expanded as a depot for corn, butter, vegetables, wool, etc. and supported such industries as milling, brewing, distilling and cooperage, while

Clarecastle became its port and, with major public finances, extended its quays and harbour facilities.

However the agricultural boom ended in 1815 and the great famine of 1845 - 1849 resulted in a decline of the rural population of Clare.

This drop in population, particularly during the latter half of the 19th century, saw an improvement in the general standard of living of those remaining, while the "Land Acts" allowed many peasants to again become tenant farmers - an option which had been denied them since the introduction of the penal laws in the 1690s.

This newfound affluence and reasonable leasehold of property allowed many farmers to build substantial houses, which are particularly attractive in the south Clare rural landscape. Some such houses will be close to the Ennis by-pass.

The increased prosperity in the post famine era was contributed to in no small way by the construction of the railway line from Limerick to Galway in the 1850s, which runs parallel to the proposed route. Its West Clare extension at the end of the century allowed the towns and villages of North and West Clare to share in prosperity, although also aiding the trend of emigration that continued up to the 1960s.

The opening of Shannon Airport in 1946 brought many multinational industries to the region and eventually resulted in a reversal of emigration trends.

In the past four decades Mid-Clare has seen an increase in population for the first time since the great famine. Due mainly to initiatives taken by the Shannon Development Company in the 1960s and '70s tourism has become one of the major employers in the area. The chemical plant of Roche Ireland (formerly Syntex) in Clarecastle is also a large employer and for over 20 years has supported upwards of 300 families locally.

With the development of motorised traffic in the inter war and post war years the road which is being by-passed became the main link between Limerick, Ennis and Galway and was designated as a national primary route. The increase in tourism in the 1960's and 1970's led to a massive increase in

traffic and numerous minor improvements have been carried out to the roads since then.

The development of the tourist industry has seen substantial investment in tourism facilities particularly in the town of Ennis with emphasis on the development of hotels, restaurant, guesthouse and public house facilities. Planning policy has generally sought to prevent development directly along the route to be by-passed and it has been largely successful in achieving this.

The success of Shannon Airport and its associated industrial estate has led to very significant growth in the town of Ennis which, as well as functioning as a service centre for the county, it is also a dormitory town for much of the Shannon Industrial area. Ennis has seen significant physical improvements in recent years and has the benefit of a very active Chamber of Commerce and Urban District Council. Both these bodies were instrumental in Ennis recently being awarded the status of Irelands first *"Information Age Town"* (1997) and this has led to a significant economic up turn in the town. Recent years have also seen an increased level of environmental consciousness and Ennis has managed to improve its rating in the National Tidy Towns Competition. Ennis is now a very rapidly growing town with a reputation as a high technology service centre.

CHAPTER 2 - DESCRIPTION OF FEATURES

This chapter contains a description of features of historical and architectural interest along the by-pass route.

Identification: All features are given a reference commencing either with the letter "M" or the suffix "ARC" and the location of each feature using these references is shown on the map accompanying this report.

The letter "M" before a feature indicates that it is a monument or other feature of historical importance.

The prefix "ARC" indicates that it is a feature of architectural significance.

A brief description of each feature is given together with a description of impact. A "score" is awarded to each monument or feature in accordance with the following system :

1. Insignificant/commonplace
   This refers to an object likely to be commonly found throughout the country and which is unlikely to be the subject of significant public or academic visit, research, or discussion.

2. Minor Importance
   A somewhat unusual feature or an amenity or architectural feature likely to cause some pleasure to those visiting and to attract some interest.

3. Moderate
   An object, facility or feature which is likely to attract a good deal of attention and likely to provide it's users with an important level of comfort or amentiy.

4. Important
   A feature which is likely to be a focal point for visitors.

5. Highly Significant
   A feature which is of National importance.

IMPACTS

In addition to the descriptions given of each feature an assessment is also made of the nature of the impact of the bypass in accordance with the following criteria. These are also scored in the following way :-

1. <u>Insignificant.</u>

   Where the nature of the impacted object is such that the proximity of the by-pass route will not affect it's value or where the route is at such a distance as to have no significant impact on the amenity of the feature.

2. <u>Minor.</u>

   Where the impact of the proposed by-pass will be evident but will not appreciably detract from the enjoyment of the feature.

3. <u>Moderate</u>

   Where the impact of the by-pass route will be continually evident to anyone visiting the feature but will not render the feature incapable of reasonable enjoyment.

4. <u>Significant.</u>

   Where the impact of the proposed by-pass route will be likely on an on-going basis to affect the feature in such a way as to significantly reduce the extent to which the feature can be enjoyed.

5. <u>Severe.</u>

   Where the impact of the by-pass proposal will be such as to render the feature incapable of reasonable enjoyment by the public or by it's owners.

   The listing of the featured score as well as the impact score for each feature is given in Chapter 3 in Matrix form.

Where appropriate historical monuments will be given a reference from the recorded monuments of Co. Clare as produced by the Archaeological Survey of Ireland / Office of Public Works.

This reference system will be in the following format :

Mon = Monument.

CL = Co. Clare.

3 digits for the Map Reference Number.

Followed by the Individual Reference Number (up to 5 digits)

Further information such as National Grid Reference can be determined from National Monuments Register. Architectural monuments which are more easily identified on the ground are described by their name.

In assessing architectural significance, reference was made where applicable to the Interim Report for Co. Clare "The National Inventory of Architectural Heritage" produced by Dúchas.

The following Ordnance Sheets are referred to:

Sheet No. 042,
Sheet No. 034,
Sheet No. 026,
Sheet No. 033

Features are referred to in this order.

Ordnance Sheet 042

M1

Various earthworks and megalithic structures close to Carnelly House. Sites and monuments reference no. MON CL042-004-01/02/03.

A number of different monuments are located close to Carnelly House indicating early settlement in this area. One is a collapsed standing stone, another a megalithic structure and the third a circular earthworks. These are approximately 550mtrs from the by-pass and are not affected by it.

ARC 1 BALLYGIREEN HOUSE

19th century two storey three bay hipped roof house with a central front door facing west / north west over the river Fergus estuary. There is a small high court-yard to the rear. There is also a walled garden some hundred metres distance from the house to the front. The by-pass will have some 250 metres distant from it. While the impact of the by-pass will be evident it will not detract from the amenity of the building.

ARC 2 LATOON HOUSE

Latoon House is a 19th century two storey three bay hipped roof house with a wide central fanlit doorway framed with sidepillars. The house faces North/North-east. There is a yard and substantial out-buildings to the rear. The property dates from circa 1855. The by-pass is some 200m distance from it. The impact of the by-pass will be minor.

ARC 3 DROMOLAND CASTLE

It is a large Gothical revival house built in the mid 19th Century. From an architectural point of view it is of national significance. Its entrance way will not be in any way affected by the proposed by-pass and the construction of the by-pass together with the Newmarket-on-Fergus by-pass is likely to have an overall positive impact in that it will reduce traffic on the road way from which the castle is accessed. The castle is a self contained property with its own views over Dromoland Lake. The by-pass will have a positive impact on the premises.

ARC 4 **MANUS HOUSE**

Manus House is a large 18th century two storey three bay hipped roof house facing south east with central glass protected front door. There are five bays along the side of the building. To the rear there are extensive yards and cut stone sheds and utility buildings. A large orchard to the south is now divided by the main Limerick & Ennis road. The house overlooks well wooded lawns and there is a wall garden beyond the yard. It dates to circa 1750. It will be some 120 metres from the by-pass, but this is greater than its present distance from the main road. The impact of the by-pass will therefore be minor.

ARC 5 **GLENARD HOUSE**

Townland of Manus Mor, Clarecastle. The grounds contain many mature trees. The gate lodge is inhabited. There is a rebuilt main gateway. The house has well maintained gardens. Glenard house is an "L" shaped two storey two and three bay house with a central fanlit front door protected by a 20th century glass porch facing North West. (The three bays are at the side). The yard and utility buildings stand to the South East. This was at one time a Church of Ireland Rectory and is now the residence of the Mc Carthys. The house is likely to date from the early to mid 19th century. Some of the trees of this property will be in the line of the by-pass. However, its proposed route is some 200 metres from the rear of the house and it will not affect the architecture of the house or the amenity of the house and the impact is considered minor.

ARC 6 **CARNELLY HOUSE**

This is one of Clare's most notable residences. It dates from the 18th century. Built in brick, it is a three storey five bay hipped roof house over a basement with a centre side panel and Venetian (or Ciriliano) style door-way approached by four steps. Large yard and utility buildings adjoin the rear. There are many

mature trees. The original gates, and gateway are standing and used. The gate lodge is inhabited. Original yard and utility buildings are standing and used. The ceilings are of very good stucco work. There are stone key-stones to the front windows.

This is possibly the earliest Georgian house in Co. Clare and was probably designed by Francis Bindon. It will not be significantly affected by the by-pass which will be some 850 metres from it.

Ordnance Sheet 034

There are a number of old ring forts and fulacht fiadhs in the Ballymacahill, Knockanean and Cappagh More areas. None of these are less than 400mtrs from the by-pass.

M2

Tooreen House (Bunratty Upper), O.D. 0-100
Mon. CL034-054

Late 17th House (in Ruins)

This large rectangular house (16m x 9m) is in a very dangerous condition. It consists of the shell of a three-bay, three storey edifice in stone with some brick features. The wooden lintels are rotten or collapsed. There is a small cut-stone ice-house against the field wall to the east. This property will be approximately 500 metres from the proposed by-pass. While this is an interesting remains it is in very poor condition. The impact of the by-pass will be insignificant.

Killow Church and Killow Graveyard

Killow, Church, O.D. 0 - 100
Mon. CL034 - 102-01

Late Mediaeval Church **(Cill Lugha)**

This almost perfect stone church (11.5m EW. And 6m NS.) is built of selected, undressed, field stones set in erratic mortared courses. The only feature of note is the gothic arched narrow window (15cm) in the east gable. This window is rebated externally with a splayed embrasure. Nearby on the south wall was another similar window, (now removed). The doorway on the south wall was also removed in the past but was probably of the pointed, gothic type. The walls of the church do not contain a base batter and both gables remain to full height. It was likely built during the 15th or 16th Century. This monument is approximately 170 metres from the line of the proposed by-pass. It will not immediately be threatened but will suffer on going loss of amenity.

Killow Graveyard, O.D. 0-100
Mon.CL034 - 102-02

The little graveyard which surrounds the old church of Killow is contained by a mortared wall, built of selected field stones in mortared erratic courses. The churchyard contains many fine headstones from the 19th century including a large mausoleum of the Lynch Family, at the SE Corner and a tomb of the Stamer family in the church against the S Wall. The graveyard, though still in use, is very over-grown with grass and weeds. This monument is approximately 170 metres from the line of the proposed by-pass. It will not immediately be threatened but will suffer on going loss of amenity.

M4

House ruins at Kilbreckan
Mon CLO34-209.

Well built rectangular cottage (10m x 5.5m) with added rear return (5.5m x 3m). There is a fireplace in each gable and narrow, splayed window in each of three rooms. This monument is approximately 120 metres from the line of the proposed by-pass and though it is not a significant remains the impact is considered moderate.

ARC 7 **KILBRECKAN BEG HOUSE, CLARECASTLE**

Townland - Kilbreckan. This house is standing and inhabited. It is a mid 19th century two storey three bay hip- roofed house facing southwards. It has a central fanlit front door. There is a walled garden to the east and the yard and utility buildings adjoin to the West. The house is approached by a front drive. It dates from circa 1855. It will be some 800 metres from the by-pass and will not be significantly affected by it.

Ordnance Sheet 026

There are a large number of archaeological remnants in the Barefield, Drumquin, Carrowdotia, Cragard, Ballyduff townlands and many of these are quite close to the by-pass route. In the main these are stone forts, enclosures, fulacht fiadhs and earthen forts and indicate a high level of pre-historic settlement in this area. However most of the features are relatively commonplace and without features of unusual or outstanding interest. These are assessed in greater detail in the section of the E.I.S. dealing with archaeological impacts.

M5

Standing Stone at Carowdotia O.D. 100-200
CLO26-035

Standing Stone and Outlier (possible)

On top of a steep hill, with an impressive vista to the west, is a leaning sandstone (height 2.80m). 9 metres due-west is a flat stone which may be significant, as may be some small granite boulders in nearby field wall. This monument is approximately 100 metres from the line of the proposed by-pass. Obviously care should be taken to protect the stone during construction work.

M6

Ruined Hamlet

Earthen Ring Fort

Circa 200m south east of the fort of MON CLO-026-077 is the ruined stone hamlet of Ballyduff containing three dwelling houses and outbuildings. There is much dressed stone (no brick) used in the construction including chimneys. In the doorjamb of an outbuilding was discovered a chamfered, chized-dressed jambstone, typical of the loop-jambs of 15th century towerhouses.

This enclosure is very close to the existing railway and will be some 300 metres from the by-pass as such the impact of the by-pass will be insignificant.

ARC 8 ST. FLANNAN'S CHURCH BAREFIELD

This is a large single aisled stone structure with cut limestone quoins. It is an attrative gable fronted building with buttressing at the sides. The former side entrance has been converted to a side chapel and the main entrance is now facing southwards to the main road. The church dates from 1874 and is in very good condition with attractive stonework. At present the church faces onto a very busy road. On completion of the by-pass it will be further removed from the main artery of traffic. The impact therefore is likely to be positive.

Ordnance Sheet 033

M7

Stone Fort at Ballymacaula, O.D. 100-200.
~~CL 033-114~~ Lissanard,

Stone Fort (Caiseal)

Lios an Aird (the fort on the height) is a very impressive circular (ext. diam. 42m.) stone fort with an almost perfect wall rising to 2m. all round. The wall is c. 3m. thick throughout and is constructed of well selected, undressed, field stones showing a flat face to the exterior and interior with rubble fill between. The wall is without mortar and no dressing can be seen even at the 2m. wide gateway to the NW.

The interior is clear of vegetation but the ground, which is uneven, is probably covered with rubble. To the south is a small dry stone enclosure against the interior of the wall of the fort, which may be contemporary with the fort. This fort is approximately 400 metres from the proposed by-pass and the impact of the by-pass will be insignificant.

M8

Clareabbey Abbey, O.D. 0-100
Mon. CL033-120,

Augustinian Abbey (in ruins)

12th century abbey. Most of the present ruins date from about 1460 when the church was repaired, the east window inserted, the tower built and the domestic ranges erected. The south range has a peculiar two-light transomed window with unusual tracery. Clareabbey ruins are approximately 500 metres from the line of the proposed by-pass. They are adjacent to the existing railway track which is likely to be a far greater amenity nuisance than the by-pass will be.

ARC 9 ASHLINE HOUSE

This house was originally named after a line of ash trees that lead to it. The existing entrance way including some of the very large ash trees are still intact. It appears the original house was demolished and the existing house is a part conversion of out buildings from the original house. The building is not of architectural significance. The by-pass will be passing approximately 100 metres from this house though this is approximately the same distance as the existing Kilrush Road at present. (Ref N68). The impact therefore will be slight.

ARC 10 CLAREABBEY HOUSE, CLARECASTLE

Named after "De Clare", or else after the nearby wooden bridge over the Fergus. It is in the town land of Clareabbey. It is located on a minor road to Clareabbey off the main Limerick road. The house is standing and inhabited. It is described in Weir as a "typical medium sized lancet window 19th century two storey three bay gable ended house with a simple gabled front entry breaking the front line of the house". The front door is top and side lit. The house is facing South / Southwest. There is a yard with utility buildings to the rear. The building is axially planned though the overall effect is picturesque rather than axial. Clare abbey house dates to circa early 19th century. The most attractive feature of the house is the front area. At the moment this is somewhat obscured by the wall of the nearby playing pitch. The by-pass will be approximately 100 mtrs. from the rear of Clareabbey House. It will not affect its front appearance or approach way. At present the house is approximately 150 yards from the Ennis to Limerick Road. While impact will be moderate it will not affect the principal architectural features of the house.

ARC 11 **ABBEY VIEW HOUSE**

Abbey View House is a low lying two storey house with gabled front windows, much modernised in recent years. Original stone work and arched brick work to out houses is still visible. The by-pass will be on the opposite side of the existing Limerick Road from this house and the impacts will be likely to be positive, by reducing the volume of traffic on the existing main road.

ARC 12 **GREENHILLS HOUSE, ENNIS**

In the townland of Cahercalla Mor or Drumcliffe located North West of the Kilrush road, two and a half kilometres south west of Ennis. The house is inhabited at the moment. It was originally a two storey three bay gable ended house which faces south east with a fanlit central door. The house dates to approximately 1841. The front of this building has been significantly altered and amended and little of its original character remains. The by-pass will pass some 250 yards from it and will not significantly affect its architecture.

ARC 13 **CAHERCALLA HOUSE**

Townland - Cahercalla Mor. This house is now part of a much larger complex which is used as a hospice and nursing home. The original building is a five bay house, hipped roofed with a gable fronted central portion containing the entrance. The front door is protected by a flat roofed porch. The building faces east. Drip mouldings are incorporated over the ground floor windows. The house is likely to date from the 18th century. The by-pass will pass some 300 yards from the central portion of Cahercalla House.

The original architecture of Cahercalla House has been significantly amended. One of the most attractive remaining feature of the premises is the meandering entrance way which

is tree lined and conveys something of the character of the house in its earlier days. This entrance way will not be affected by the by-pass. The nature of the impact therefore is insignificant.

ARC 14 BEECHPARK HOUSE

This house is no longer standing. The entrance way and tree lined demesne are still in evidence. The original site is approximately three quarters of a kilometre from the by-pass route.

ARC 15 HERMITAGE HOUSE

Hermitage house appears to be a late 17th or early 18th century house. (Weir). It is a two storey house with five bays, gable ended. It faces north. There is a glazed porch to the front and a monopitch area at the rear. There is a yard and utility buildings also at the rear of the house. The glazed porch is probably 19th century and of Gothic design. There is a miniature gate lodge at the east side of the entrance gate. The most important features of this house in addition to the architecture itself is the meandering entrance way which is attractive and tree lined. The by-pass will be located some 300 metres to the west and across the Claureen River from the property. Its impact from an architectural point of view will be slight, particularly in view of the fact that the area immediately to the East and South are already heavily built up.

ARC 16 CLAUREEN HOUSE

Claureen house is a long 19th century two storey, eight bay gable ended house. Its northern gable adjoins the main road. The house and front door face to the west over garden and orchard. High walls divide the house from the main road.

There is a narrow yard at the rear of the house with a row of utility buildings. One of the old Ennis water supplies is contained within its grounds i.e. a now covered-in well. The house dates from the 19th century and was at one time occupied by the Clare Militia. The western leg of the by-pass will be passing very close to Claureen House. However the character of Claureen House has changed significantly in recent years due to the build up of houses in the Lahinch Road and Claureen area. Permission has also been granted for developments to the rear of Claureen House. The by-pass will be passing to the north west of Claureen House and in close proximity to it. It will have a significant impact on the house. However the house is largely introspective and is already bounded by a very busy road.

ARC 17 ROCKMOUNT COTTAGE

This house which dates from approximately 1750 has been significantly altered in recent years with the addition of two wings to the central area. It is approximately 350 metres from the proposed by-pass and will not be significantly affected by it.

OTHER FEATURES

ARC 18 LATOON BRIDGE - MAP 42

Latoon Bridge is said to derive it's name from Leath Tuatha Mhumhan, half of North Munster and is believed to mark the point of division of Thomond which in the 14th century included large tracts of what are now the counties of Limerick and Tipperary, all of the present County Clare (with the exception of part of north-east Clare) and the Aran Islands. The bridge itself probably dates from the early nineteenth century but the river over which it passes probably acted as a boundary when Thomond was divided between Murtagh and Donnchadh O' Brien in 1312. Both men were inaugurated as kings of Thomond, in that year. The river, itself, is known at different points as The Hell, The Kiltannon or The Rine River.

The nearby tower-house, Castlefergus, which is actually within the old parish of Doora contains one of the oldest fireplaces in the County and may mark an earlier crossing point on this river.

Nature of impact : Moderate (3)

While the triple arched bridge will not be affected the new bridge over the river will now place it between two modern structures. This is an attractive bridge and could be developed in to a lay-by or small picnic area once the by-pass is complete. It is a bridge of attractive architecture and it would be ideal for that purpose. The East Clare Way passes along this bridge and the new bridge should allow pedestrian access underneath in order not to interfere with the East Clare Way.

CHAPTER 3 - MATRIX

The following pages show in Matrix form all the monuments and features listed in the text of Chapter 2. The feature, score or importance is determined in accordance with the criteria on page 8. The impact score is determined in accordance with the criteria on page 9. The cumulative score is found as a product of these two scores.

If the cumulative score exceeds 16 then this will be justification for a re-alignment. The higher the cumulative score, the greater level of remedial action should be taken.

IMPACT ASSESSMENT ON HOUSES OF HISTORICAL IMPORTANCE

SHEET	REF. CUM. SCORE	NAME	IMPORTANCE SUGGESTIONS	IMPACT	
042	Arc 1	Ballygireen House	2	2	4
042	Arc 2	Latoon House	2	3	6
042	Arc 3	Dromoland Castle	5	1	5
042	Arc 4	Manus House	3	3	9
042	Arc 5	Glenard House	3	3	9
042	Arc 6	Carnelly House	5	1	5
034	Arc 7	Kilbreakan Beg House	3	1	3
026	Arc 8	St. Flannans Church,	3	1	3
033	Arc 10	Clareabbey House	3	3	9
033	Arc 11	Abbey View House	2	1	2
033	Arc 12	Greenhills House	1	2	2
033	Arc 13	Cahercalla House	4	2	8
033	Arc 14	Beechpark House	1	1	1
033	Arc 15	Hermitage House	3	2	6
033	Arc 16	Claureen House	2	3	6
033	Arc 17	Rockmount Cottage	1	1	1

IMPACT ASSESSMENT ON ARCHAEOLOGICAL MONUMENTS

REF.	MON. NO CUM. SCORE	MON. TYPE SUGGESTIONS	IMPORTANCE	IMPACT	
M 1	CL042-00401	EARTH WORK	4	1	4
	CL042-00402	STANDING STONE	5	1	5
	CL042-00403	MEGALITHIC SITE	4	1	4
M 2	CL034-054	17TH CENTURY HOUSE	4	0	0
M 3	CL034-10201	CHURCH	4	4	16
	CL034-10202	GRAVEYARD	3	4	12
M 4	CL034-209	HOUSE RUIN	2	2	4
M 5	CL026-035	STANDING STONE	5	3	15
M6	CL026-077	EARTHEN FORT	3	1	3

SUGGESTED MITIGATIONS OF IMPACT :

In respect of the architectural features listed only in one case was the level of impact found to be significant. This was in the case of Claureen House, a building which is already significantly affected by a built up area around it. In addition this house is introspective in nature and from an architectural point of view is of minor importance. No efforts at mitigation therefore are felt to be necessary.

In the case of M3, Killow Church and Graveyard, the impact is also found to be significant and it is suggested here that this area be cleaned up and signposted in order to improve the amenity. While this is an important monument it is not one which at present is frequently visited.

In the case of the Standing Stone at Carrowdotia M5, this will be located quite close to the by-pass and it is suggested that this monument may need to be excavated or in any event care must be taken to ensure that no damage takes place during construction.

In the case of the 12th century Augustinian Abbey, Clareabbey, this is the most important and historical monument close to the route. It is however some 500mtrs from the proposed by-pass and the impact will be minor, particularly in view of the fact that the existing railway runs very close to the Abbey. There is an opportunity to create a vista looking towards this Abbey and this should be availed of. Sign posting to attract attention to this very significant monument should be incorporated if possible.

CHAPTER 4 - NON TECHNICAL SUMMARY :

There are 18 buildings or remnants of importance from an architectural/historical point of view close to the by-pass. No significant architectural monuments are going to be destroyed by the proposal. The significant buildings which are closest to the by-pass are Manus House and Glenard House. The proposal is located to the rear of these buildings and is unlikely to interfere with their architectural character but is of course likely to have some impact on their general amenity. This impact will not be such as to render them incapable of beneficial use or indeed not such as to interfere with the enjoyment of their main architectural features. In the case of Claureen House, which is close to the western leg of the by-pass, this particular building is an introspective building and again will not suffer significant damage from an architectural point of view.

There are a number of historical and archeological monuments along the route with a particular concentration around the Barefield area. Some of these will be destroyed but in the main they are features which are commonplace. The area around Killow Church and graveyard is of importance and measures should be taken to ensure a minimum of disruption during construction.

The most important historical monument affected by the by-pass is Clareabbey. While this is close to the by-pass it is already adjacent to a railway line which causes a more significant effective amenity loss to the Abbey. For this reason it was not felt that the impact of the by-pass will be significant.

This report does not see any reason why the by-pass should be re-aligned or significant changes made to it as a result of impact on any historical or architectural monument.

ENVIRONMENTAL IMPACT ASSESSMENT FOR N18/N19 ROAD IMPROVEMENTS DROMOLAND TO CRUSHEEN (INCLUDING ENNIS BY-PASS)

ARCHITECTURAL, CULTURAL AND HISTORICAL ASPECTS

PART OF MATERIAL ASSETS AND CULTURAL HERITAGE.

APPENDICES

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February 1999

APPENDIX 1

MAP SHOWING LOCATIONS OF FEATURES REFFERED TO IN TEXT

APPENDIX 2

SELECTED PHOTOGRAPHS

GLENARD HOUSE
ARC 5

CARNELLY HOUSE FROM NORTH
ARC 6

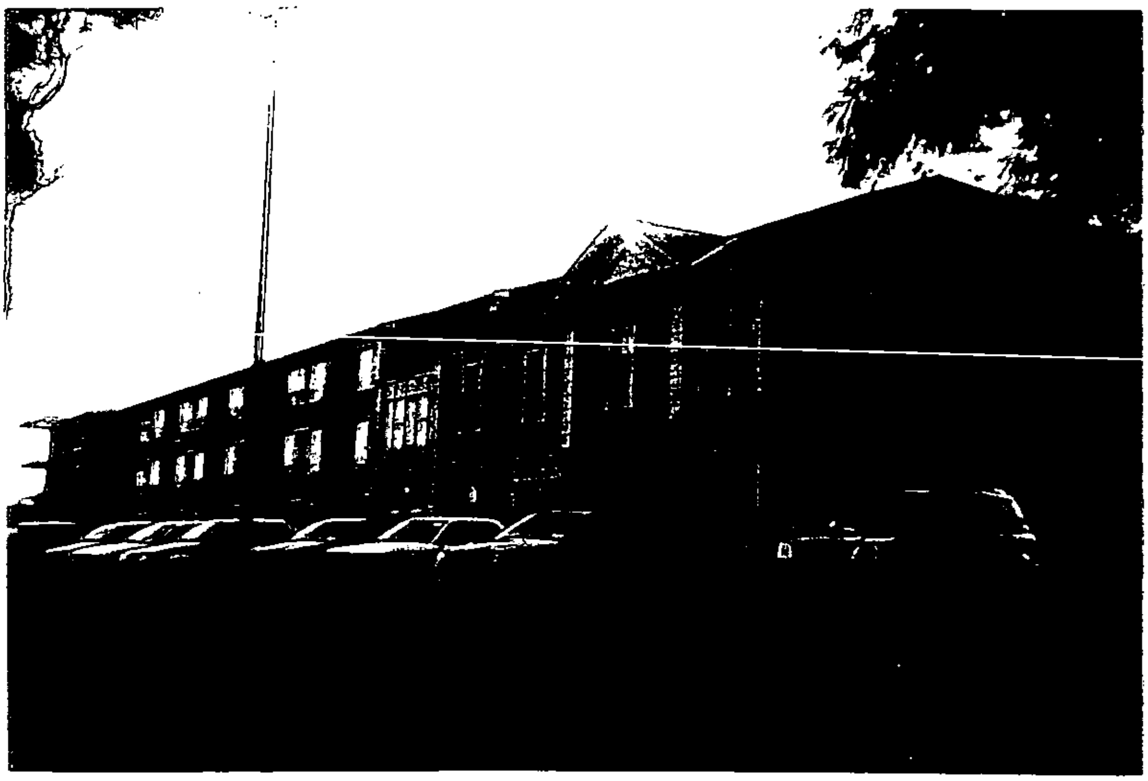
KILBRECAN BEG HOUSE
ARC 7

ST. FLANNANS CHURCH, BAREFIELD
ARC 8

ASHLINE HOUSE
ARC 9

ABBEYVIEW HOUSE
ARC 12

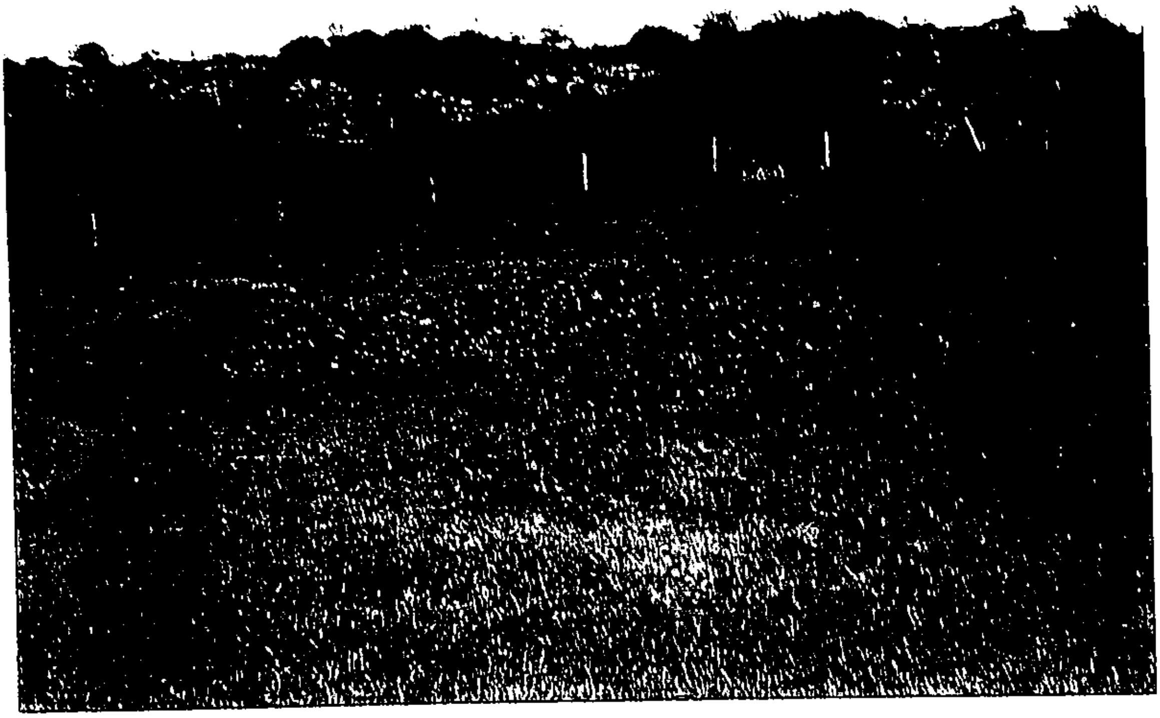
GREENHILLS HOUSE
ARC 13



CAHERCALLA HOUSE
ARC 14

CLAUREEN HOUSE
ARC 16

ROCKMOUNT COTTAGE
ARC 17



M19

DESTROYED FULACHT FIADH
MON. CLO34-165
CRAGARD, BAREFIELD

M2

STANDING STONE (collapsed)
MON.CL042-00402
CARROWNANELLY

M11

17th cent. TOOREEN HOUSE
Front view MON. CLO34-054

M11

17th cent. TOOREEN HOUSE
Rear view MON CLO34-054

RECTANGULAR FORT
MON. CL034-002 from the south.
BALLYMACAHILL

M9

CHURCH RUIN from the NE.
MON. CL034-003
BALLYMACAHILL

M 17

15th cent. PARISH CHURCH
from the SW. KILLOW
MON. CLO34-10201

M 15

15th cent. PARISH CHURCH
The interior looking east.
MON. CLO34-10201

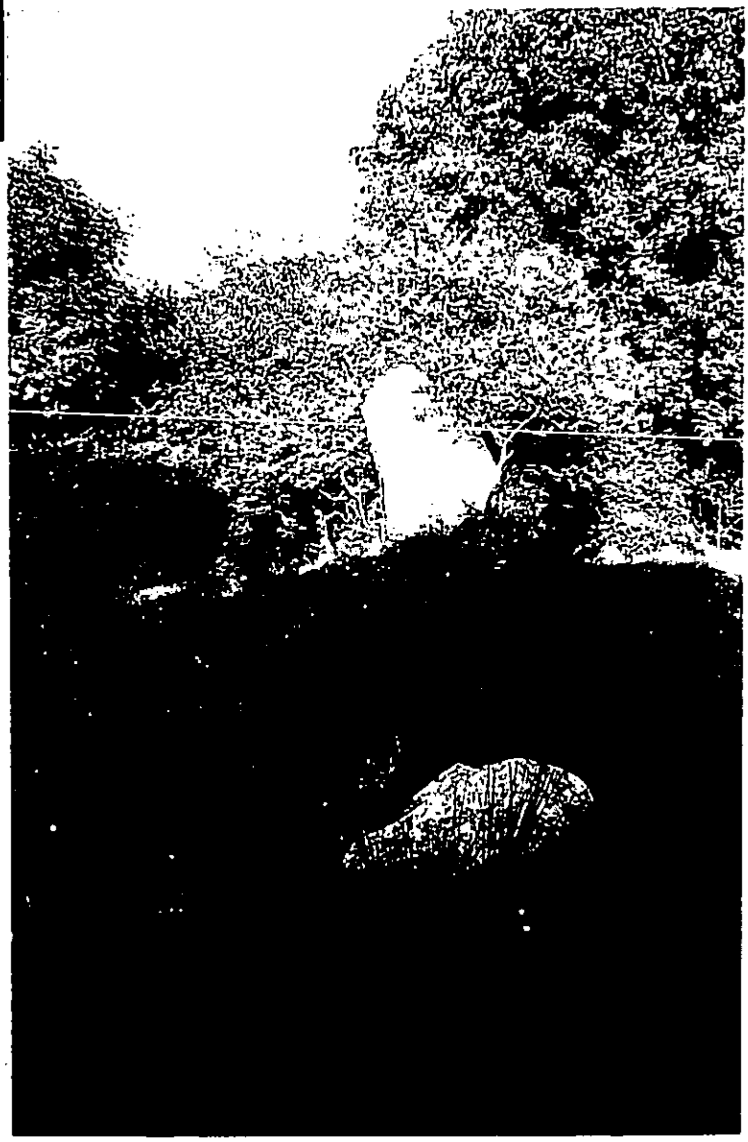
M 15

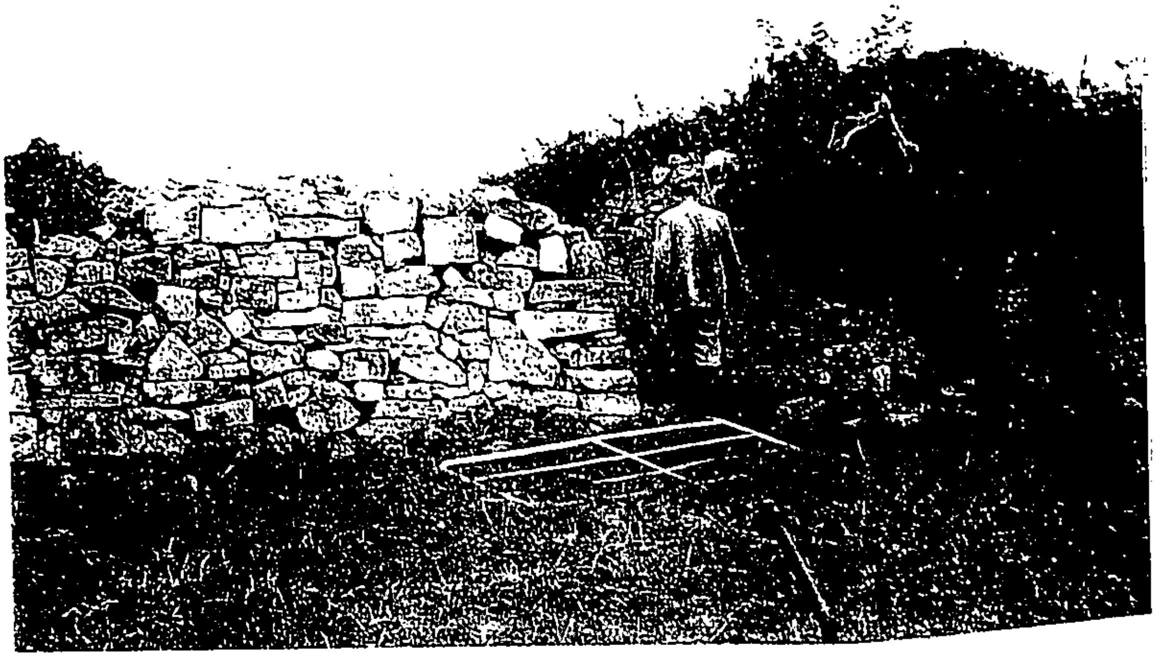
M 26

STANDING STONE
MON. CL026-035
From the north.
CARROWDOTIA

M 26

STANDING STONE & OUTLIER
MON. CL026-035 from the west.
CARROWDOTIA





M41

Lios an Áird   from the NW.
MON.CLO33-114 STONE FORT
BALLYMACAULA, ENNIS

M 41

Lios an Áird   from the W.
MON. CLO33-114 STONE FORT
BALLYMACAULA, ENNIS

RING FORT
DRUMQUIN, BAREFIELD
MON CL026-081

M 32

APPENDIX IX – PART B

N18 DROMOLAND TO CRUSHEEN ROAD IMPROVEMENT SCHEME (INCLUDING ENNIS BYPASS) CULTURAL HERITAGE (Babtie Group)

N18 DROMOLAND TO CRUSHEEN ROAD IMPROVEMENTS SCHEME (INCLUDING THE ENNIS BY-PASS)

CULTURAL HERITAGE

1 INTRODUCTION

1.1 Babtie Group has been commissioned by Clare County Council to review the draft Environmental Statement for the proposed N18 Dromoland to Crusheen Road Improvement Scheme (including the Ennis By-Pass). This review document provides an assessment of the potential impact of the scheme on cultural heritage sites. This provisional assessment has been based purely on the secondary sources used to produce the draft environmental assessment as new primary data gathering and fieldwork were beyond the scope of the study.

2 SCOPE OF THE ASSESSMENT

2.1 The scope of the assessment covers sites of potential cultural heritage value as identified in the secondary sources within the proposed road improvements corridor from Dromoland to Crusheen including the proposed Ennis Bypass. Although the study is concentrated on those sites within the road corridor, consideration has been given to the general context of the area as outlined in the secondary sources, in order to assess the overall impact of the road scheme on sites of cultural heritage value.

3 INFORMATION SOURCES

3.1 The scope of the review did not allow for the collection of any original data from the Sites and Monuments Record, or from cartographic studies or fieldwork. This cultural heritage assessment is based on two sources:

- *Archaeological Study for EIS of Proposed N18 Road Development, Dromoland to Crusheen (Ennis By-Pass), Co. Clare* produced by Archaeological Development Services Ltd, January 1999 & amended October 1999.
- *Environmental Impact Assessment for N18/19 Road Improvements Dromoland to Crusheen (including Ennis By-Pass)* produced by Michael Leahy & Paul Conway Chartered Architects, February 1999.

3.2 These two source documents were commissioned to provide the basis for the cultural heritage section in the *N18 Dromoland to Crusheen Road Improvements Scheme (including the Ennis By-Pass) Environmental Impact Statement draft copy.* They both draw upon original data sources such as the Sites and Monuments Record and include some field data. The two documents did not address issues such as importance and value of such sites, and the size and significance of predicted impact of the proposed road scheme. Furthermore 53% of the road corridor was either woodland, scrubland or wetland. It is not clear how much of this area was available for survey at the time.

3.3 The sites included within this assessment are those that, based on the secondary sources, appear to be within the proposed road corridor.

3.4 This review and revision attempts to resolve some of these deficiencies and deals with the issues in accordance with the Environmental Protection Agency guidelines but the lack of detail in the two sources prevents definitive assessment of value and of site significance. This review and revision therefore makes a series of provisional statements of site significance and recommends further pre-construction archaeological assessment to assist the preparation of mitigation proposals.

4 METHODOLOGY: ASSESSMENT OF CULTURAL HERITAGE VALUE

4.1 An assessment of the significance of each site has been attempted, with each site graded as being of national, regional or local importance. However, due to the limitations of the secondary sources, it has not been possible to give more than provisional gradings. However, it also took into account the criteria for assessing significance as set out in the Environmental Protection Agency Advice *Notes on Current Practice (in the preparation of Environmental Impact Statements)*.

4.2 As the assessments of importance are provisional, the grade assigned to any site could change if further information were to become available.

5 METHODOLOGY: ASSESSING THE SIGNIFICANCE OF POTENTIAL IMPACTS

5.1 The impact on each archaeological site can be assessed in terms of loss/damage, severance of linked features and setting. A three stage process can be applied. The first stage is a purely quantitative assessment of the impact as extensive, substantial or slight, the second combines this quantitative assessment with the grade of importance of the site to reach a preliminary assessment of the significance of potential impact as major, moderate or minor, while this assessment is adjusted and finalised in the third stage through the introduction of other qualitative factors.

5.2 It has been possible only to undertake a preliminary assessment of the potential impact as the extent, condition and true character and importance of each site has been hard to ascertain from the source documents. It has been assumed that as the sites considered in Tables 1 and 2 are described as being on the line of the road corridor there will be an impact, the significance of which cannot be ascertained.

6 EXISTING CONDITIONS: CULTURAL HERITAGE OF THE STUDY AREA

6.1 Cultural Heritage Background

6.1.1 Early evidence for human activity in south-west Ireland is limited. The majority of Mesolithic sites are located on or near the west and north-west coast. However, evidence indicates that later Mesolithic activity on the west coast was limited to locations that are close to water. This suggestion has received support from the recent discovery of a fragment of a possible canoe dating from between 4789-4585BC on the Shannon estuary mudflats at Carrigdirty Rock, Co. Limerick.

6.1.2 Neolithic activity is evidenced by the three court tombs and four portal tombs recorded on the Burren. Clare has the highest concentration of Late Neolithic/Early Bronze Age wedge tombs in Ireland. As these tombs are thought to reflect the settlement pattern at that time it is likely that Clare supported a relatively large population settled in a well-organised landscape.

6.1.3 The area around Mooghaun hillfort (south-east of Ennis) has been the subject of a detailed landscape study focussing on the Bronze Age settlement pattern. During the Early Bronze Age there is a paucity of settlement sites. However, the distribution of metal artefacts indicates that much of the landscape was exploited. Low-lying areas such as the river valleys appear to have been exploited for possibly the first time. The evidence suggests that in the river valleys burials were constructed in the valley bottom and settlements were slightly higher up the valley sides. The presence of large numbers of fulachta fiadha (over 500 have been recorded in the County Clare SMR) are evidence of this expansion.

6.1.4 North Munster was an important centre during the Late Bronze Age. Mooghaun hillfort appears to have become an important regional centre at the top of a structured settlement hierarchy consisting of defended hilltop enclosures, lakeside sites and enclosed house clusters, arranged within territorial divisions. It is thought that it was during the Late Bronze Age that human activity had its first substantial impact on the landscape as evidenced by the many standing stones, domestic enclosures, barrows, and stone circles known in County Clare.

6.1.5 There is a general lack of evidence for Iron Age settlement. However, it appears that the Late Bronze Age settlement pattern continued through most of the period. However, pressure on land and resources following improvements in iron technology and agricultural developments led to the emergence of ringforts.

6.1.3 Some 2680 'enclosures' are recorded in the County Clare SMR of which at least half are thought to be Early Christian raths or cashels. There are also 150 killeens many of which may be sited on earlier Christian ecclesiastical sites.

6.1.4 A Franciscan Abbey was established in Ennis following which the town became a focus of power and influence in the medieval period. Clare Abbey was established in 1189AD beside the River Fergus on the west bank of the River Fergus south of Ennis. The power of the Gaelic lords at this time is evidenced by the 121 castles and towerhouses in County Clare.

6.1.5 Ennis was burned at least two times during the 'Nine Years War' (1594-1603). The borough of Ennis was established in the 17th century.

6.2 Cultural Heritage of the Road Corridor

6.2.1 A total of 27 cultural heritage sites have been identified in the secondary sources as being totally or partially within the proposed road corridor. The methodology set out above was used to make a provisional assessment of the importance of these sites, with the following results. As stated above, this assessment is based purely on data contained within the secondary sources and is therefore provisional. These assessments of importance could change if further information were to become available. It has not been possible to assess the current state of preservation or the access of any of these sites from the secondary sources. The site numbers refer to those used in the secondary sources.

6.2.2 In addition to the 27 discrete archaeological sites, 16 areas of archaeological potential have been identified. These areas include river crossings, lanes, vernacular buildings, industrial sites and other cultural heritage sites. The 16 areas have been identified in the secondary sources as being totally or partially within or potentially affected by the proposed road corridor. The methodology set out above was used to make a provisional assessment of the importance of these sites, with the following results. As stated above, this assessment is based purely on data contained within the secondary sources and are therefore provisional. These assessments of importance could change if further information were to become available. Furthermore, it has not been possible to assess the current state of preservation or the access of any of these sites from the secondary sources.

Table 1 Sites of known or possible cultural heritage importance within the road corridor

Site No.	NGR	Townland	Site Type & Description	Extent	Condition	Importance
AR01	13680/ 17419	Carrowgar	Possible field clearance cairns consisting of 8 circular mounds	Unknown	Unknown	Unknown/ local?
AR04	13662/ 17533	Kilbreckan	Possible field system and clearance cairns consisting of 5 linear banks and 4 circular mounds	Unknown	Unknown	Unknown/ local?
AR05	13671/ 17548	Kilbreckan	Early field system consisting of drystone field boundaries and 1 cairn	Unknown	Unknown	Unknown
AR06	13672/ 15752	Kilbreckan	Possible clearance cairns & trackway consisting of 12 circular mounds and 1 line of stones	Unknown	Unknown	Unknown
AR08	136703/ 176495	Kilbreckan	Collapsed standing stone?	Unknown/ limited	Unknown	Regional/ local?
AR09	136773/ 177190	Ballaghboy	Possible souterrain consisting of a lintelled opening in disused laneway	Unknown	Unknown	Regional/ local?
AR12	13672/ 17965	Ballymacahill	Possible cairn	Unknown	Unknown	Unknown
AR13	136736/ 179758	Ballymacahill	Pre-bog (Bronze Age) field system consisting of single stone alignments	Unknown	Unknown	Regional/ local?
AR17	13661/ 18039	Ballymacahill	Possible souterrain consisting of a stone-filled hollow	Unknown	Unknown	Regional/ local?
AR19	13645/ 18079	Ballyduff	Possible clearance cairns, possible boulder burial & possible field system consisting of 5 boxed shaped cairns, 1 boulder burial and 20-30 cairns	Unknown	Unknown	Regional/ local?
AR20	136350/ 181425	Ballyduff	Possible clearance cairn	Unknown	Unknown	Unknown
AR22	136450/ 181736	Barefield	Possible cairn/fulachta fiadha	Unknown	Unknown	Regional/ local?
AR23	13629/ 18208	Barefield	Possible circular bivallate rath	Unknown	Unknown	Regional/ local?
AR24	13599/ 18187	Barefield	Possible cairn	Unknown	Unknown	Unknown
AR25	13682/ 18285	Carrowdotia	Possible rath	Unknown	Unknown	Regional/ local?
AR27	13715/ 18359	Carrowdotia	Possible field system and cairn/clearance complex consisting of 10 mounds, 3 banks and 1 standing stone	Unknown	Unknown	Regional?
AR28	137027/ 183540	Cragard	Possible field system/natural features consisting of 3 linear earthworks	Unknown	Unknown	Unknown
AR29	137160/ 183646	Cragard	Possible field system & clearance and possible fulachta fiadha consisting of 2 linear earthworks, 1 circular mound, 3 irregular mounds and 1 circular depression	Unknown	Unknown	Regional/ local?
AR30	137524/ 183977	Cragard	Cartographic reference to a circular enclosure	Unknown	Unknown/ poor?	Unknown
AR32	137682/ 184095	Cragard	Standing stone	Unknown	Unknown	Regional/ local?
AR33	137731/ 184154	Cragard	Possible megalithic structure/field clearance	Unknown	Unknown	Regional/ local?
AR34	138047/ 184450	Bearnafunshin	Possible field clearance consisting of an irregular cairn	Unknown	Unknown	Unknown
AR36	134311/ 175327	Clareabbey	Possible standing stone	Unknown	Unknown	Regional/ local?
AR38	131984/ 177111	Keelty	Possible hut site/quarry consisting of a circular depression	Unknown	Unknown	Unknown
AR39	131997/ 177194	Keelty	Possible crannog/cashel/field system consisting of a circular enclosure	Unknown	Unknown	Regional/ local?
M24		Carrowdotia	Possible fulachta fiadha	Unknown	Unknown	Unknown
M29		Drumquin	Possible fulachta fiadha	Unknown	Unknown	Unknown

Table 2 Areas of high archaeological potential, river crossings, lanes buildings and other sites of cultural heritage importance within or partially affected by the road corridor

NGR	Townland	Site Type & Description	Extent	Condition	Importance
		Mooghaun Hillfort, Latoon Creek & upper Fergus estuary – the settlement evidence for the upper Fergus estuary suggests a Late Bronze Age settlement pattern including Mooghaun hillfort, wooden boat jetty, fulchta fiadha settlement enclosures, standing stones and field systems	Unknown	Unknown	Regional
	Clareabbey	Clare Abbey founded in 1189 c.300m north of road corridor. Extent of the Abbey's acreage unknown. Site of battle between groups of the O'Brian clan in 1278	Unknown	Unknown	Regional
	Barefield, Drumquin, Carrowdotia	Within 1km of road corridor are 29 enclosures, 1 wedge tomb, 1 standing stone & 1 church and churchyard	Unknown	Unknown	Regional
		Killow church & churchyard c.70m west of road corridor and possible medieval settlement	Unknown	Unknown	Regional
	Latoon South/ Manusmore	Mud banks of Latoon Creek are of high archaeological potential. The site of the existing two bridges may also have been a fording point prior to bridge construction.	Unknown	Unknown	Unknown
	Cloonagowan/ Ballyline	A watermill is located c. 60m upstream from the current bridge. The site of the existing bridge may have been a fording point prior to its construction.	Unknown	Unknown	Unknown
	Ballagboy	The townland name refers to this laneway. It was superseded by the Ennis-Quin road in the 19th century	Unknown	Unknown	Unknown
	Clareabbey	The current lane to Clare Abbey may have been the original access to the abbey.	Unknown	Unknown	Unknown
	Clonroad More	Lane known as 'Rocky Road' was used by pilgrims until the 1960's and may be on the line of a medieval trackway connecting Ennis Friary & Killone Abbey.	Unknown	Unknown	Unknown
136695/ 175883	Kilbreckan	Derelict farm building	Unknown	Good?	Local?
13670/ 17663	Kilbreckan	Derelict two storey farmhouse	Unknown	Poor?	Local?
13665/ 17751	Knockaskibbole	Clachan type settlement consisting of two inhabited cottages, a derelict farmhouse and a group of neglected farm outhouses	Unknown	Poor?	Local?
131959/ 177075	Keelty	Limekiln complex	Unknown	Unknown	Unknown
139978/ 170276	Manusmore	Lintelled opening in stone wall	Unknown	Unknown	Unknown
13691/ 17383	Carrowgar	Stone faced field bank	Unknown	Unknown	Unknown
13673/1 7708	Ballaghboy Gortataggart	'Mass rock'	Unknown	Unknown	Unknown

6.2.3 From the two secondary sources it is not possible to ascertain whether all of the road corridor has been subjected to a walkover survey. However, it is clear in the Archaeological Development Services document that there are 7 areas of woodland and scrubland and 20 areas of wetland that were unavailable for survey. These areas may contain as yet unrecorded archaeological remains and therefore should be regarded as having high archaeological potential. It has not been possible to establish the extent, condition or importance of these 27 areas or of any archaeological remains within them.

6.3 Detailed site descriptions

6.3.1 The following descriptions of the sites within the road corridor are derived from the two secondary sources. The accuracy of these descriptions has not been confirmed by fieldwork undertaken by Babtie Group.

6.4 ~~Discrete cultural heritage sites~~

AR-01
Eight small circular mounds (average dimensions, 2.5m x 2.5m x 0.5m high) arranged roughly in two lines of four at the top of a slope. At the bottom of the slope is an area of scrub (sloe bushes) and wetland. Possible field clearance.

AR-04
Five low banks (average dimensions 7m x 0.8m) in improved grazing land, formerly marsh, three of which are roughly parallel to each other, with a stone footing (length 25m, one course high) running perpendicular between two of them. Associated with the banks are four small circular mounds (average dimension, 3m diam. x 0.5m high). These features are not depicted on the 1st edition OS map. Possible field system & clearance.

AR-05
a series of old drystone field boundaries and at least one cairn. (2.5m diam. x 0.5m high, three courses), in a limestone karst overlooking drained marshland. These features are not depicted on the 1st edition OS map (1840). Possible early field system

AR-06
Twelve small circular mounds (average dimension, 3m diam. x 0.5m high) running in a line N-S. A line of stones, one course high and 0.8m wide, runs parallel to the mounds. Aerial photograph 3491, taken in 1991, shows this field was formerly covered by scrub. Possible field clearance and trackway

AR-08
A recumbent boulder (1.1 m x 1.4m x 0.6m high) lying adjacent to field boundary. Possible collapsed standing stone

AR-09
Lintelled opening (0.4m x 0.2m high) built into the north facing wall of a disused laneway. Extending southwards is a low, narrow, stone lined passage (c.2m visible length). According to local folklore, religious objects and pikes were stored here during penal times. The adjacent townland is named Gortataggart *(Gort an tsaggart,* Field of the Priest) and local folklore records a Mass Rock in the vicinity. The laneway is depicted on the 1st edition OS map (1840). Possible souterrain.

AR-12
Low, roughly circular mound (1 5m x 13.5m x 1m high). The 1st edition OS map (1840) depicts an old field boundary crossing over it. The underlying bedrock in the hinterland undulates dramatically creating many natural mounds and depressions. Possible cairn mound.

AR-13
Single stone alignments, forming possible field system, lying in boggy land beside small lake. Landowner suggests they were uncovered after bog was stripped and thus predate the bog. Possible pre-bog (i.e. Bronze Age) field system.

AR-17
Stone filled hollow (2.6m x 1.0m x 0.5m depth, 3 courses visible) located in northeast corner of a large field. An aerial photograph (1991) shows this field to be covered in dense scrub. It has recently been cleared and amalgamated with neighbouring fields. AR-15 and AR-16 are also located in this field. Possible souterrain.

AR-19
In an enclosed wood are five box-shaped cairns (average, 2m x 2m x 1.5m high) and a possible boulder burial (1m x 0.65m x 0.8m high). In the neighbouring field, recently cleared of tree cover, 20-30 cairns are visible. Due to the fact that this field has been machine cleared it is difficult to differentiate between modem clearance cairns and older recently disturbed cairns. Also located within the woodland are a number of old field walls not depicted on the Ist edition. OS map (1840). Possible clearance cairns. Possible boulder burial and possible field system.

AR-20
Box shaped cairn (approx. 5m x 2m x 1m high) located on high ground overlooking wetland. It lies three fields north of the cairns of AR-1 9 and is similar in construction. Adjacent to cairn AR-21. Possible clearance cairn.

AR-22
Two oval mounds (average. 30m diameter), orientated E-W, located in grazing land immediately northwest of a small lake. Possible cairns/fulachta fladh.

AR-23
Circular bivallate rath (approx. 30m diam.). Heavily covered by trees and scrub. Depicted on 1st edition OS map (1840). Possible rath (ringfort).

AR-24
Low, circular mound (10.5m x 10.8m x 0.9m high). The top of the mound has been partially eroded by cattle trample to a depth of 0.2m. Possible cairn.

AR-25
A low lying circular enclosure/possible ringfort (approx. 20m diam.). Depicted on 1st edition OS map (1840). Possible rath (ringfort).

AR-27
A complex comprising of ten small mounds, three banks and one associated standing stone. The standing stone (1.3m x 0.37m x 0.72m high) is situated on top of the southern most bank (approx. 14m x 4.3m x 0.6m high), which is orientated roughly N-S, curves to the east and peters out. The other two banks (11m x 1.3m x 0.5m high; 20m x I.5m x 0.8m high, respectively) are perpendicular to each other and potentially the remains of a field system. The mounds (average, 4m diam. x 0.6m high) are uniformly circular and are spread throughout the field with no pattern or order apparent. The 1st edition OS map (1840) depicts this site as two adjacent enclosures. Possible standing stone, possible field system/enclosure and possible field clearance 1 cairn complex.

AR-28
Three parallel banks (average length, c.40m) running NW-SE, perpendicular to the present Ennis-Galway(N18) road. They are situated across the road from AR-27. These features are not depicted on the Ist edition OS map (1840). Possible field system/natural ridges.

AR-29
A complex situated north of AR-27, comprising two perpendicular banks (average length 10m, average height 0.5m) and a circular mound (approx. 2.5m diam. x 0.5m high). Further north in the same field is a bank (approx. 40m length x 0.6m high), a group of three irregular mounds (average 2m diam. x 0.4m high) and a circular depression (approx. 4m x 3m x 0.5m deep). The Ist edition OS map (1840) shows farm buildings and field boundaries that no longer exist. Possible field system & field clearance and possible fulachta fladh.

AR-30
The 3d edition OS map (19 0) shows a hachured circular enclosure (approx. 10m diam.) adjacent to the Ennis-Galway road (NI8). Subsequent road widening schemes would appear to have partially or totally removed this feature. Nothing was noted during field walking. Possible enclosure.

AR-32
Upright stone (approx. 1m x 0.3m x 0.8m high). Would appear to be standing on a base of smaller stones. Possible standing stone.

AR-33
Large boulder (visible length 2m) with smaller stones supporting it underneath. Very overgrown with scrub. Possible field clearance/megalithic structure.

AR-34
Irregular cairn (approx. 5m x 5m x 1.5m high) that is situated beside a low stone banked stream. The cairn is obscured by scrub. Possible field clearance.

AR-36
Recumbent boulder (approx. 1m x 2m x 1m high) situated beside a hawthorn tree and adjacent to the boundary between a field and the laneway to Clare Abbey. Nearby, incorporated within this boundary are two large stones obscured by overgrowth. Possible standing stone.

AR-38
Flat-based circular depression (approx. 2m diam. x 0.4m depth) cut into the north facing slope of a hill. Situated immediately north of limekiln and south east of AR-39. 17 Possible hut site/quarry pit.

AR-39
Circular enclosure (approx. 25m diam.) situated on the eastern side of the flood plain of the Claureen River. The enclosure is defined by a narrow band of small stones on all sides except to the NE where it is bounded by a field wall. The interior is very rocky, overgrown with trees and scrub and slightly higher than the surrounding land. This feature is depicted on 1st edition OS map (1840). Possible outcrop plus field clearance/crannog/cashel.

M24
There appears to be a fulcht fiadha on the site behind Mr. O'Halloran's house, known as the 'riasc'

M29
Fulcht fiadha. This monument has been obliterated by recent land reclamation.

6.5 Areas of high archaeological potential

Mooghaun Hillfort/Late Bronze Age settlement
Two kilometres southeast of the crossing at Latoon Creek is Mooghaun hillfort. Excavation by the North Munster project for the Discovery Programme at this massive trivallate hillfort has revealed that the stone ramparts were built in the Late Bronze Age (1055-917 BC). The land between Latoon Creek and Mooghaun hillfort, plus the nearby upper Fergus estuary, is rich in archaeological evidence. Sites include a wooden boat jetty or causeway on the mudflats, gold finds from the marshes, fulachta fiadh from the marsh/dryland boundary and settlement enclosures, standing stones and field systems from the lower dryland slopes. In *The Other Clare*, O'Sullivan & Condit point out that much of the settlement evidence around the upper Fergus estuary suggests a late Bronze Age settlement pattern. They further speculate that separate settlement units, located along the marsh edge, combined to construct the hillfort at Mooghaun. Immediately north of the hillfort is Mooghaun Lough. An important Early Bronze Age hoard (over 150 gold ornaments) was discovered in this lake during railway construction in the nineteenth century. A very high proportion of such hoards are found in wetland.

Clare Abbey/Battlefield/Possible settlement
The remains of Clare Abbey lie 300m north of the route in the townland of Clareabbey. Donald More O'Brien, the last King of Munster reputably founded it in 1189. It is likely that the monks cultivated some of the lands about the Abbey. However the extent of the acreage belonging to Clare Abbey is uncertain. It is possible that a medieval settlement developed around Clare Abbey (such as Ennis town evolved around Ennis Friary). However no such

settlement is recorded. In 1278 a battle is reputed to have taken place between rival groups of the O'Brien clan. The battlefield is recorded as being in a bog in the vicinity of Clare Abbey but the exact location is uncertain.

High concentration of archaeological sites
The townlands of Barefield, Drumquin and Carrowdotia, at the northern end of the route, are rich in recorded archaeological sites. Falling within a 1km strip either side of the route are twenty nine enclosures, one wedge tomb, one standing stone and one church/graveyard. This high concentration of archaeological evidence increases the likelihood of other sites being discovered in the three townlands.

Killow Church/Possible Medieval Settlement
The remains of Killow Church lie approximately 70m west of the route. It is a simple church building (11.5m x 5.9m) surrounded by a later walled graveyard. Field inspection identified a low bank (approx. 65m diam) enclosing the church and graveyard. Westropp suggests that in 1302, Killow *(CilLugha,* Church of St. Lugh) was a separate parish. Presumably, if it was a parish church, the community it served, inhabited the hinterland. Two likely locations for a possible medieval settlement are; the row of small holdings and derelict farm houses situated south of the church, and the group of abandoned farm buildings situated west of the church. It is also possible that the site could have a pre-medieval origin, as Lugh is a celtic god.

Latoon Creek (Ardsollus/Rine River)
Latoon Creek (approx. 20m wide) forms the townland boundary between Latoon South and Manusmore. Running parallel to the river on either side are high banks and drains, built to prevent flood damage. Latoon Creek is influenced by the tidal estuary of the River Fergus, with the daily ebb and flow exposing mud banks along the river. These mud banks are potentially rich in archaeological artefacts. There are two adjacent bridges where the Limerick-Ennis road (NI8) crosses Latoon Creek; one that is relatively modern; the other much older and stone built. The older bridge has passed out of use. Both bridges will presumably be replaced during road widening. This point on the river may have been used in the past as a fording point.

Millbrook River
The route from Barefield to Carrahil, follows the current line of the N18 (Ennis-Galway road) and crosses the Millbrook River at Ballyline Bridge. The Millbrook River is about 10m wide at the crossing point and has steep banks. It is proposed to widen the road 30m either side. This will presumably necessitate the rebuilding of the current bridge. Approximately 60m up-river is a Watermill site. It is possible that the point, where the route crosses the river, may have been used in the past as a fording point.

Laneway
The townland name, Ballaghboy *(Bealach Bui;* Yellow Road) possibly refers to the laneway that passes through this townland. This lane was superseded in the nineteenth century by the present Ennis-Quin road (R469). The nineteenth century village of Ballaghboy was focused about this laneway. The lane also passes by the remains of a limekiln.

Clare Abbey laneway
The current laneway that leads to the site of Clare Abbey is potentially the site of the original access route to the abbey. It circumnavigates the old Ennis Race Course and joins the Ennis/Clarecastle road (N18) near the present GAA grounds. The laneway appears on the Ist edition OS map (1 840); the Ennis racecourse first appears on the 3rd edition OS map.

'Rocky Road'
Passing through an area of rocky scrubland in Clonroad More is a N-S laneway known as the 'Rocky Road'. Beginning at Aughandayaud Bridge, it terminates about 31km south, at Killone Lough. This laneway was used until the 1960s by pilgrims visiting the Holy Well at Killone Lough14. It possibly could be on the line of an earlier, medieval trackway, connecting the ecclesiastical sites, Ennis Friary (est. c. 1240) and Killone Abbey (est. c. 1189).

Derelict farm building
The fabric of this one-storey stone building has been altered greatly. It has a corrugated iron roof and has been repaired with concrete cavity blocks. However the interior seems to be relatively unaltered. It has thick internal walls with an internal lintelled doorway.

Derelict farmhouse,
This farmhouse (approx. 18m x 10m) is two storeys high, very overgrown and roofless. It is depicted on the 1st edition OS map (1840).

Clachan type settlement
This group of houses includes two inhabited cottages, a disused farmhouse and a group of neglected farm outhouses. It is depicted on the Ist edition OS map (1840). A laneway connects it with the Ballaghboy-Knockanean Road. The disused farmhouse is very overgrown and inaccessible. This disused farmhouse and the group of farm outhouses will be directly affected by the proposed route.

Limekiln/Stone-filled cut
This limekiln (approx. 3m x 5m high) is cut into the base of a north sloping hill that overlooks water-logged fields. The northern face of the limekiln has a well preserved red-brick arched opening. However the central flue has been totally blocked from above. Located immediately west of the limekiln are the remains of a roofless, windowless building. Neither building is depicted on the 1st edition OS map (1840). The limekiln is situated at the southwestern end of a metalled laneway that circumnavigates the present Drumbiggil Golf Course . Along the laneway, just north of the limekiln is a circular feature, cut into the hillside. This cut (c.4m diam. x c.3m deep at rear) opens out onto the laneway and is filled with large stones and boulders that appear to have collapsed inwards. This feature may be the site of an earlier limekiln.

Lintelled opening/'Sheep-Run'
This lintelled opening (1m x 1m high) is built into a stone wall between two wet north facing field. Field inspection revealed no other structure. Its purpose may have been to allow sheep access to both fields.

Field boundary kink
This is a right-angled stone-faced bank (approx. 10m x 25m x 1m high) which kinks out from the field boundary, that separates a field of rough pasture from wetland. The landowner mentioned a well/spring nearby.

Natural ridge/'Mass rock'
This is a high natural ridge that would been a good vantage point for settlement/fortification in the past. However no archaeological remains are evident. According to local folklore there was a Mass Rock in the immediate hinterland. This might explain the townland name, Gortataggart *(Gort an tsaggart,* Field of the Priest). Local folklore also records that the lintelled passageway (see AR-09) as a repository for religious objects and pikes.

6.6 Areas covered by woodland & scrubland

6.6.1 The route passes through seven areas of scrub & woodland (approx. 17% of the route). In two of these areas (Knockanean & Clonroad More/Cahircalla Beg) full survey of the line of the route was impractical due to the density of the scrub. In an other area (Knockanean/Ballymacahill) surrounding wetland made inspection infeasible. Full assessment of these three areas will only be possible after the scrub has been cleared.

Kilbreckan
Running along the western part of a limestone karst overlooking marshland is an area of scrub. Within this scrub are drystone features such as cairns and walls (AR-05).

Knockanean
The proposed route crosses an area of dense scrub and woodland in Knockanean Townland. Within this scrubland and on the line of the route, the 1st and 3rd edition OS maps show a

circular enclosure (approx. 20m diam.) circumscribed by a field boundary. However the dense scrubland made the field inspection and identification of this potential site not feasible.

Knockanean/Ballyrnacahill
On either side of the stream, flowing between the townlands of Knockanean and Ballymacahill, are steep wooded slopes. The wetland adjoining the stream made the northern wooded slope inaccessible.

Ballyduff
In the northeast corner of the townland of Ballyduff is an enclosed area of woodland. The groundcover consists of limestone boulders and weathered bedrock, between which deciduous trees and scrub grow.

Ballyduff (Paterson)
North of the townland boundary between Ballyduff and Ballyduff (Paterson) is an area of woodland. Recent field clearance has stripped the eastern half of this woodland. Within the wooded area were identified a number of cairns (AR-19) and stone field boundaries.

Cragard
Between the NI 8 road and the Ennis-Galway railway is a strip of rocky scrub. Located on the west edge of this area of scrub are AR-27, AR29, AR-30, AR-32. and AR-33.

Clonroad More/Cahircalla Beg
Between the Kilrush-Ennis road (N68) and the Clarecastle-Ennis road (NI8) is an expanse of limestone karst covered by dense scrub and woodland. The western part of this landscape has been extensively quarried. Identified within the eastern part of the landscape were drystone cairns and old field boundaries (not depicted on the OS maps). However the scrubland made accurate identification of their location, in relation to the proposed road, infeasible. A laneway known as the 'Rocky Road' crosses this region.

6.7 Wetland Areas

6.7.1 The route passes through twenty areas of wetland (approx. 36 % of the route).

Latoon North/South./ Manusmore
The land on either side of Latoon Creek is wet. Old field drains are visible in some of the fields. The gradient gently rises, north and south of the river.

Manusmore
Low-lying waterlogged fields on either side of a NE-SW drainage stream.

Manusmore
At the bottom of a north facing slope is a waterlogged marshy field. Further north is a stream that flows NE-SW, joining the Fergus River at Carrowneally Point.

Carrowgar
Bisected by the Limerick-Ennis railway line is an area of flat drained wetland. Upcast beside some of the field drains was noted. The land gradually rises to the north of the wetland.

Carrowgar/Killow
The boundary between the townlands of Carrowgar and Killow is a field drain. The land on either side of the boundary is mostly lowlying and wet. Situated on a small hill south of the townland boundary are a series of small mounds (AR-01).

Killow
Between Killow church and the Clarecastle road, is an area of drained bogland. Situated within this wetland are small bog islands (including AR-02 & AR-03).

Kilbreckan/Skehanagh/Bunnow
There is an area of extensive wetland stretching from Kilbreckan to the banks of the River Fergus. It is criss-crossed with an elaborate system of drains. A complex of caims and banks (AR-04) is located in the south east corner of this area.

Knockaskibbole/Gortataggart
The boundary between the townlands of Knockaskibbole and Gortataggart is a field-drain/stream. The fields either side of the boundary are low-lying, wet and boggy. Immediately south are a natural mound ('Mass rock') and AR-09. Immediately to the north is a clachan type settlement.

Knockanean
An area of bogland just north of the road that passes through Knockanean to Gaurus Bridge. Further north, on higher ground in the same field, is a field bank (AR-10).

Knockanean/Ballymacahill
The boundary between the townlands of Knockanean and Ballymacahill is an E-W running stream. Both sides of the stream are waterlogged, especially the north bank. There are steep wooded slopes to the north and to the south of this stream.

Ballymacahill
In the northeast corner of Ballymacahill townland is a small lough and surrounding it an area of wet bogland. Stone alignments and footings (AR-13), possibly predating the existence of the bog, were noted.

Ballyduff
Adjacent to the Ennis-Galway railway line is a small seasonal lough. The land bordering the lough is wet and boggy, and contains two mounds/bog-islands (AR-22).

Drumquin
Small lough surrounded by rough grazing land, situated about 200m southeast of Barefield School.

Drumquin
In the north of the townland of Drumquin, immediately east of the Ennis-Galway road (NI8) is an area of marshland.

Cragard
On the east side of the Ennis-Galway road (NI8) is an area of rocky badly drained land, within which were noted linear banks, small mounds and circular depressions (AR-29). To the west of the Ennis-Galway road (N18) is a large area of flat well drained marshland. The most obvious feature within this marshland is a large mound (probably natural).

Bearnafunshin
Running E-W under Ennis-Galway road (NI8) is a stream. The land on either side of the stream is wet rough pasture.

Clareabbey
East of the Limerick-Ennis railway are waterlogged fields. It is possible these fields were within the holdings of Clare Abbey. A medieval battlefield is recorded in bogland near Clare Abbey but the exact location is unknown.

Clareabbey
Between the laneway leading to Clare Abbey and the Clarecastle-Ennis road (NI8), is an extensive area of wet marshland. In the east of this area, adjacent to the laneway is a recumbent boulder (see AR-36).

Cahircalla Beg/Cahircalla More
A stream flows between the townlands of Caffircalla Beg and Cahircalla More. On either side is wet marshland.

Keelty/Claureen
The Claureen River flows between the townlands of Keelty and Claureen. The fields on either side of the river are wet and subject to flooding, and further northwards is marsh and bogland. Located within this area of wetland are a circular enclosure (AR-39), a field clearance mound and an area of overgrown outcrop.

7 'DO-NOTHING' SCENARIO

7.1 Based on data contained in the two secondary sources, it would appear that the majority of the sites described above would remain in agricultural production should the road not be constructed and therefore archaeological deposits would potentially be subject to gradual agricultural and arboricultural attrition. However, the impact of agricultural practices on archaeological remains is much less than the potential damage caused by the construction of roads. As a consequence, the 'do-nothing' scenario may entail a very gradual deterioration of some of the sites described above. However, the rate and effect of this deterioration is hard to quantify.

8 PREDICTED IMPACT

8.1 From the data contained in the two secondary sources it is not possible to assess the significance of the predicted impact of the proposed road scheme on cultural heritage sites. This is due to the fact that it has not been possible to ascertain the approximate date or date range of the remains, the approximate extent, the condition and state of preservation, the degree of complexity of the horizontal and/or vertical stratigraphy, the likely range, quality and quantity of the artefactual evidence or the potential of the site to provide palaeoenvironmental and/or economic evidence and the forms in which such evidence may be present. In the absence of such information it is only possible to assume that the construction of the proposed road will have an impact on all of the sites described above. The significance of the impact cannot be determined at present.

9 PRE-CONSTRUCTION ARCHAEOLOGICAL ASSESSMENT

9.1 In order to resolve some of the issues highlighted in 8.1 and to propose appropriate mitigation measures, it is recommended that further archaeological assessment involving a staged programme of fieldwork should be undertaken on all of the forty-three sites and areas of archaeological potential identified in Tables 1 and 2. This programme may include:

- Earthwork/topographic survey
- Geophysical survey
- Test excavation

9.2 All elements of the further archaeological assessment should be undertaken well in advance of the commencement of construction of the road scheme to enable appropriate mitigation measures to be agreed and undertaken in advance of construction. Indeed, the further archaeological assessment should be completed before tender documentation for the construction contract are prepared.

9.3 The twenty seven areas of woodland, scrubland and wetland that were previously unavailable for survey should be subject to clearance and a walk over survey so as to identify any additional areas requiring further archaeological assessment at this stage.

10 POSSIBLE MITIGATION STRATEGY

10.1 Following the archaeological assessment outlined in section 9, it will be possible to assess both the importance of, and the significance of impact on, each site identified and therefore to propose mitigation measures appropriate to each site. The mitigation should be related to

regional archaeological concerns which would provide a strategic framework for the method statements in the excavation licence applications. Such measures are likely to consist of one or more of the following:

- *Design solution to avoid or reduce the impact*
  Should any archaeological remains identified during the assessment be of sufficient importance, it may be possible to safeguard their preservation in-situ by means of redesigning the road so as to remove or significantly reduce the archaeological impact.

- *Open area excavation of some or all of impacted area*
  Where remains identified are not of sufficient importance to merit preservation in-situ, but will be subject to a significant impact, full excavation of some or all of the site will be necessary. This should be undertaken in advance of road construction. Mitigation measures will also include post-excavation analysis, publication and archiving to the appropriate standard.

- *Building recording*
  Any historic buildings likely to suffer an impact should be subject to an appropriate level of recording. This may range from a photographic record to full internal and external recording. This should be undertaken in advance of road construction. It may also involve excavation of the foundations.

- *Archaeological monitoring*
  The whole road scheme should be subject to archaeological monitoring during construction so as to identify any unrecorded remains that will be affected by the proposed road. It is possible that some remains identified at this stage may require preservation in-situ, however, the majority of remains are likely to require full or partial excavation prior to the road itself being constructed. So as to avoid unnecessary delays, it is recommended that topsoil stripping is undertaken at an early stage of the construction programme so as to allow for rescue excavation of archaeological remains identified at this stage.

APPENDIX IX – PART C

ARCHAEOLOGICAL STUDY FOR EIS OF PROPOSED N18 ROAD DEVELOPMENT, DROMOLAND TO CRUSHEEN (ENNIS BYPASS), CO. CLARE
(Archaeological Development Services Ltd.)

Archaeological Study for EIS Of Proposed N18 Road Development, Dromoland to Crusheen, (Ennis By-Pass), Co. Clare

Fieldwork
by
Norman Crothers &
Stephen Doyle

Report
by
Stephen Doyle

Client

Road Design Office, Mungret

January 1999

Important

The following report (*Archaeological study for the EIS of the Ennis By-pass,* January 1999) supersedes an earlier report (same title, July 1998). Amendments to the line of the route made revision of the earlier report necessary. Additional field inspection & desk study were required.

The two reports are substantially different in content. The most significant difference is a totally new sequence of AR numbers (see section 2, page 13). This was necessary, due to the inclusion of a number of sites that were not covered in the earlier report.

Consequently, **the earlier report** (July 1998) **has been rendered obsolete** and **should be shredded**, to avoid any confusion.

CONTENTS

FIGURES

PLATES

Appendix 3

January 1999

As the report was going to press, design changes to the route of the proposed Ennis By-Pass were made by the Road Design Office, Mungret. These route amendments do not directly affect any known archaeological monuments.

Archaeological study for EIS of proposed N18 Road Development, Dromoland to Crusheen [Ennis By-Pass], Co. Clare.

Authors: *Stephen Doyle &*
Norman Crothers
Client: *Road Design Office, Mungret*
Date: *11 January 1999*

Abstract
The following archaeological report for the proposed Ennis By-Pass EIS, sought to identify potential sites both on and in close proximity to the route. In all, forty-two sites were identified as being directly affected by the route and twenty-one identified in close proximity. The following EIS results are based on paper and field surveys as described in the methodology below.

Methodology

This study was carried out under the following headings:

1	**Desk based study**
1.1	*Sites & Monuments Record, Dúchas-The Heritage Service*
1.2	*Topographic Files, Irish Antiquities Division, National Museum of Ireland*
1.3	*Journal & documentary research*
1.4	*Cartographic research*
1.5	*Aerial photographic research*
2	**Field inspection**
2.1	*A. Sites affected by route*
2.2	*B. Sites in immediate proximity to route*
2.3	*C. Possible zones of archaeological potential affected by route*

Introduction

The Dromoland to Crusheen road improvement scheme (Ennis Bypass) is the latest phase of upgrading the N18 Limerick to Galway road. There are two components to this phase of proposed road construction.

- Section 1, the main component, is a fifteen kilometre stretch starting at Latoon Bridge, passing to the east of Ennis and terminating at Carrahil, about five kilometres north of Barefield village [Fig. 1]. This last stretch, from Barefield to Carrahil, involves widening the current line of the N18 (Ennis-Galway road). Section 1 ranges in height from 0-40 metres O.D., with steep gradients at several locations, notably in Knockean and Barefield. It crosses the Latoon Creek (Ardsollus River) and passes through twenty-one townlands.

- Section 2, the smaller component, is a seven kilometre stretch beginning at a new junction to be constructed at Kilbreckan, passing to the south of Ennis before swinging north to join the N85 Ennis/Ennistimon road at a new junction to be constructed in Claureen [Fig. 1]. Section 2 ranges in height from 0-30 metres O.D., with steep heavily wooded gradients at Clonroad More and Cahircalla Beg. It crosses the Fergus River passing through ten townlands.

The above route is Option D, chosen out of four options considered in the Broad Route Corridor Selection Report (Clare County Council 1993). (see Appendix 2).

During 1994/96, Celia O'Rahilly undertook a preliminary study of the route of the proposed Ennis By-Pass, for Clare County Council[1]. The route was walked and potential archaeological sites noted. In 1997 a subsequent desk study and field inspection was undertaken by ADS Ltd. at the behest of the Road Design Office, Mungret. The following report combines some of the sites identified by the earlier study, as well as a number of newly identified sites.

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[1] O'Rahilly, C 1994/96 *Archaeological report on route of Ennis By-pass.* A report commissioned by Clare County Council (unpublished)

Geological & Topographical background

The solid geology of the area consists mainly of Carboniferous limestone, with karst outcrops in many areas, overlying Old Red Sandstone [Fig. 2]. The area west of Ennis is composed of Namurian shales and flagstones, "which have been, weathered down to form a fairly acid and sterile soil that supports only peat bog and barren rush-filled pastures".[2] The drift geology comprises gleys, peats and peaty gleys.

The proposed route for the road is primarily through permanent grassland used for grazing, silage or hay making, but with areas of scrub, woodland and wetland. For the most part, the present field system was laid out in the eighteenth century with continued development in the form of land improvement and field amalgamation up to the present time.

There are several areas of poorly drained scrub and rough pasture, including an extensive area of wetland lying between the Kilbreckan junction and the River Fergus, close to Clarecastle. Field boundaries include post and wire fences, hedges, drystone walls, ditches and banks with the occasional combination of the separate elements. Settlement is dominated by scattered farms and housing, but with larger scale housing developments around Ennis and Clarecastle.

- Approximately 36% of the route passes through wetland.
- Approximately 17% of the route passes through wood and scrubland.
- The route crosses five rivers and a roughly two dozen small streams and field drains.

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2 Whittow, J B 1975 *Geology and Scenery in Ireland*, London

Archaeological & Historical background

The present land usage is merely the latest phase in the settlement and improvement of the area. There has been a human impact on the landscape of Co. Clare since the Middle Neolithic (c. 3000 BC), with the earliest evidence coming from the Burren where there are at least three court tombs and four portal tombs[3].

From the Late Neolithic onwards wedge tombs are found, with notable concentrations in the Burren and southeast Clare. The County Clare Sites & Monuments Record (SMR)[4] lists one hundred and twenty four wedge tombs in Clare, giving it the highest density in the country[5]. It has been surmised that the location of these monuments reflects very closely the distribution of domestic sites[3]. It seems that the use of wedge tombs continued into the Early Bronze Age (c. 2500-1200 BC), possibly as late as 1200 BC[6]. Analysis of contextual information for Irish stone axes[7], found that 44.5% came from river and lake-bed contexts, 11.8% from bogs, 14.9% from agricultural land. The deposition of such artefacts could be either accidental or ritual in nature.

A indication of the possible importance of north Munster during the Late Bronze Age (c.1200-600) is that a larger number of bronze axes have been found in this region, despite the principal production and mining centres being in south-west Munster[3]. Analysis of contextual information for Bronze Age flat axes, daggers, rapiers and swords[8] found that, by far, the highest concentrations of such artefacts have been in river, lake and bog contexts. The deliberate deposition of metal artefacts in bogs has been recognised as an important aspect of Irish Bronze Age activity. The stone ramparts of the trivallate hillfort at Mooghaun are attributed to the Late Bronze Age[9]. Immediately north of the hillfort is Mooghaun Lough. An important Early Bronze

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3 Grogan, E 1996 Changing places: settlement patterns in prehistory, *The Other Clare*, .20, 48-52

4 *Sites & Monuments Record, Co. Clare, 1992*, Archaeological Survey of Ireland, Office of Public Works.

5 Coffey, T 1994 Field Notes, *The Other Clare*, 18, 13-14

6 Mitchell, M & Ryan, M 1997 *Reading the Irish Landscape*, Town House, 195-196

7 Cooney, C & Mandal, S 1998 *The Irish stone axe project*, Bray: Wordwell, 34-37

8 Cooney, C & Grogan, E 1994 *Irish prehistory: a social perspective*, Dublin: Wordwell

9 O'Sullivan, A & Condit, T 1995 LBA settlement and economy by the marshlands of the upper Fergus estuary, *The Other Clare*, 19, 5-9

Age hoard (over 150 gold ornaments) was discovered in this lake during railway construction in the nineteenth century. An exceptionally high proportion of such hoards are found in wetland. The importance of Mooghaun hillfort continued well into the Iron Age (c. 400 BC-400AD). Other sites classifications that remained in use until the Iron Age include *fulachta fiadh* (cooking sites), standing stones, domestic habitation enclosures, barrows and stone circles. Over five hundred *fulachta fiadh* have been identified[10] since the completion, in 1992, of the Co. Clare SMR (*The Archaeological Survey of Ireland*, Office of Public Works).

Monuments of the Early Christian period (400-800 AD) include raths (ringforts), cashels (stoneforts), souterrains, church sites and graveyard sites, bullauns (basin stones) and holy wells. The largest number of sites recorded in the Clare SMR are termed 'Enclosures', numbering 2680. It is probable that at least half of this number will prove to be raths or cashels. There are one hundred and fifty children's graveyards (killeens) in Clare, some of which may prove to be the sites of earlier ecclesiastical sites[11]. The townland of Kilbreckan contains both a holy well and a children's graveyard but the proposed bypass will affect neither.

There are four abbeys listed for the county, the route passes close to one of these, Clare Abbey (est. c.1189AD), situated beside the river Fergus. In the Medieval period the focus of power in south Clare was centred in the area that became Ennis town. The two most important settlements at Ennis were the O'Briain castle of Clonroad (est. c.1210) and the Franciscan Friary (est. c.1240)[12]. The borough of Ennis itself was a seventeenth century creation. Towerhouses, whilst being of Anglo-Norman origin, were adopted by the Gaelic lords in the later Middle Ages as secure dwellings[13]. There are one hundred and twenty one castles, and eighty five towerhouses in the county[10]. Around 1570 the English established effective control of south Clare. There are eighty four known houses dating from the seventeenth century, the majority of which are in ruins[10].

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10 Coffey, T 1994 Field Notes, *The Other Clare*, 18, 13-14

11 Coffey, T 1994 Field Notes, *The Other Clare*, 18, 13-14

12 Bradley, J, Halpin, A & King H *Urban archaeological survey Part XV; County Clare; Ennis*, Office of Public Works

13 Barry, TB 1994 *The Archaeology of Medieval Ireland*, Routledge, 188

1. Desk based study

1.1 Sites & Monuments Record (SMR), Archaeological Survey of Ireland, Dúchas-The Heritage Service

A study of the Sites and Monuments Record, Co. Clare (1992) was carried out and all known archaeological sites marked onto the 1:10,000 map of the proposed route provided by Road Design Office, Mungret.

NB	The following is a list of sites from a paper search of the Clare SMR. For a full list and description of **all** sites, (including SMR recorded sites and newly identified sites), **affected by the route, see section 2:1.**

A total of twenty-five **recorded** sites lie within a two hundred metre strip either side of the route. Of these,

(i) three sites will be directly affected by the road,

(ii) seven lie within a fifty metre zone, and

(iii) the remaining fifteen lie within a two hundred metre zone.

i The proposed bypass will directly affect three **recorded** archaeological monuments

1.	SMR	CL026-079	AR-23 (see section 2:1)
	Townland.	Barefield (or Gortlumman)	
	Nat. Grid Co-ord.	13629/18208	
	Class.	Enclosure [Fig. 5, Fig. 6, Fig. 12]	
2.	SMR	CL026-033	AR-25 (see section 2:1)
	Townland.	Carrowdotia	
	Nat. Grid. Co-ord.	13682/18285	
	Class.	Enclosure [Fig. 6, Fig. 13]	

3a.	SMR	CL026-036 (01)	AR-27 (see section 2:1)
	Townland	Carrowdotia	
	Nat. Grid. Co-ord.	13715/18359	
	Class.	Enclosure [Fig. 6, Fig. 13]	

3b.	SMR	CL026-036 (02)	AR-27 (see section 2:1)
	Townland	Carrowdotia	
	Nat. Grid. Co-ord.	13714/18354	
	Class.	Enclosure [Fig. 6, Fig. 13]	

(ii) Listed below are the **recorded** sites that fall within a 50m strip either side of the road;

4.	SMR	CL034-163	AR-07 (see section 2:2)
	Townland	Kilbreckan	
	Nat. Grid. Co-ord.	13687/17652	
	Class.	Enclosure [Fig. 4, Fig. 8, Fig. 11]	

5.	SMR	CL034-051	AR-11 (see section 2:2)
	Townland	Knockanean	
	Nat. Grid. Co-ord.	13653/17904	
	Class.	Enclosure [Fig. 4, Fig. 5, Fig. 11]	

6.	SMR	CL034-002	AR-14 (see section 2:2)
	Townland	Ballymacahill	
	Nat. Grid. Co-ord.	13642/17980	
	Class.	Rectangular enclosure [Fig. 5, Fig. 12]	

7.	SMR	CL026-035	AR-26 (see section 2:2)
	Townland	Carrowdotia	
	Nat. Grid. Co-ord.	13702/18299	
	Class.	Standing Stone [Fig. 6, Fig. 13]	

8.	SMR	CL026-041	AR-31 (see section 2:2)
	Townland	Cragard	
	Nat. Grid. Co-ord.	13763/18422	
	Class.	Enclosure [Fig. 6, Fig. 13]	

9.	SMR	CL026-012	AR-35 (see section 2:2)
	Townland	Cloonagowan	
	Nat. Grid. Co-ord.	13843/18597	
	Class.	Watermill site [Fig. 6, Fig. 7, Fig. 14]	

10.	SMR	CL033-117	AR-37
	Townland	Clonroad More	
	Nat. Grid. Co-ord.	13360/17566	
	Class.	Enclosure [Fig. 9, Fig. 15]	

iii Listed below are the **recorded** sites that fall within a 200m strip either side of the road;

11a.	SMR	CL034-102 (01)
	Townland	Killow
	Nat. Grid. Co-ord.	13699/17496
	Class.	Church [Fig. 3, Fig. 10]

A small church (Cill Lugha), 11.5m x 5.9m.

11b.	SMR	CL034-102 (02)
	Townland	Killow
	Nat. Grid. Co-ord.	13699/17495
	Class.	Graveyard [Fig. 3, Fig. 10]

12.	SMR	CL034-053
	Townland	Knockanean
	Nat. Grid. Co-ord.	13724/17893
	Class.	Enclosure [Fig. 4, Fig. 11]

13.	SMR	CL034-003	
	Townland	Ballymacahill	
	Nat. Grid. Co-ord.	13653/18028	
	Class.	Enclosure	[Fig. 5, Fig. 12]
14.	SMR	CL026-078	
	Townland	Ballyduff (Patterson)	
	Nat. Grid. Co-ord.	13615/18129	
	Class.	Enclosure	[Fig. 5, Fig. 12]
15.	SMR	CL026-077	
	Townland	Barefield (or Gortlumman)	
	Nat. Grid. Co-ord.	13605/18168	
	Class.	Enclosure	[Fig. 5, Fig. 12]
16.	SMR	CL026-081	
	Townland	Drumquin	
	Nat. Grid. Co-ord.	13689/18232	
	Class.	Enclosure	[Fig. 5, Fig. 12]
17.	SMR	CL026-032	
	Townland	Carrowdotia	
	Nat. Grid. Co-ord.	13679/18308	
	Class.	Enclosure	[Fig. 6, Fig. 13]
18.	SMR	CL026-037	
	Townland	Carrowdotia	
	Nat. Grid. Co-ord.	13720/18340	
	Class.	Enclosure	[Fig. 6, Fig. 13]
19.	SMR	CL026-038	
	Townland	Carrowdotia/Cragard	
	Nat. Grid. Co-ord.	13723/18360	
	Class.	Enclosure	[Fig. 6, Fig. 13]

20.	SMR	CL026-042
	Townland	Cragard
	Nat. Grid. Co-ord.	13760/18382
	Class.	Enclosure [Fig. 6, Fig. 13]
21.	SMR	CL026-048
	Townland	Bearnafunshin
	Nat. Grid. Co-ord.	13781/18462
	Class.	Enclosure [Fig. 6, Fig. 13]
22.	SMR	CL026-053
	Townland	Bearnafunshin
	Nat. Grid. Co-ord.	13819/18447
	Class.	Enclosure [Fig. 6, Fig. 7, Fig. 13]
23.	SMR	CL026-058
	Townland	Bearnafunshin
	Nat. Grid. Co-ord.	13851/18550
	Class.	Enclosure [Fig. 6, Fig.7, Fig. 14]
24.	SMR	CL033-116
	Townland	Cahircalla Beg
	Nat. Grid. Co-ord.	13258/17525
	Class.	Enclosure [Fig. 9, Fig. 16]
25.	SMR	CL033-081
	Townland	Cloghleagh
	Nat. Grid. Co-ord.	13265/17750
	Class.	House – 17^{th} century possible [Fig. 9, Fig. 16]

1.2 Topographic Files, Irish Antiquities Division, National Museum of Ireland

The townlands the proposed route passes through are highlighted in bold. The remainder are neighbouring townlands. All were checked against the Topographic Files at the National Museum but no find spots were recorded.

Ballaghboy
Ballybeg
Ballyduff
Ballyduff (Blake)
Ballyduff (Patterson)
Ballyline
Ballymacahill
Ballymacaula
Ballymaconna
Ballyvonnavaun
Barefield (or Gortlumman)
Bearnafunshin
Bunnow
Caheraphuca
Cahernalough
Cahircalla Beg
Cahircalla More
Cappagh Beg
Carrahill
Carrowdotia
Carrowgar
Carrownanelly
Clareabbey
Claureen
Cloghleagh
Clonroad More
Cloonagowan
Cloonawee
Cloontymurphy
Corebeg
Cragaweelcross
Cragard
Derreen
Dromoland
Drumbiggil
Drumgranagh
Drumoolaghty
Drumquin
Gaurus
Gortataggart
Keelty
Kilbreckan
Killcally
Killow
Knockanean
Knockaskibbole
Latoon North
Latoon South
Manusmore
Skehanagh
Shanvogh
Tullyvoghan

1.3 Journal and documentary research

Various published sources, including local and national journals, were consulted (see footnotes and bibliography). The results of that research are incorporated into the main body of the report.

Various archaeological corpora (see appendix 1) were also consulted to check for reference to artefact finds from the above townlands (1.2). Nothing was found.

1.4 Cartographic research

The Ordnance Survey 6" (1:10,560) sheets 26, 33, 34 & 42, 1st edition (1840) and 3rd edition (1920) were examined. Also consulted were the geologically annotated OS 6" maps (sheets 26, 33, 34 & 42) from the Geological Survey of Ireland. The results of the cartographic study are incorporated into the main body of this report.

1.5 Aerial photographic research

The route of the proposed development was examined on colour aerial photographs (1991) provided by the Road Design Office, Mungret. The aerial photographs examined were: 3459, 3493, 3516, 3479, 3495, 3808, 3480, 3497, 3850, 3491, 3499, 3855 (photoscale 1:10,000).

The route of the proposed development was additionally examined on black & white aerial photographs provided by the Geological Survey of Ireland. The aerial photographs examined were: GSI R044, R045, R222, R223 (photoscale 1:30,000). Aerial photographs GSI R071 & R072 were not available due to viewing restrictions placed on them by the Department of Defence.

A potential circular cropmark was noted in the townland of Keelty [Fig. 9]. However field inspection revealed no sign of archaeological activity. The feature appears to be caused by the undulating bedrock.

No other new features, on the line of the road, were noted from the aerial photographs.

2. Field inspection

The inspection was carried out by Norman Crothers and Stephen Doyle during May 1998 and October 1998. Weather conditions during the period of the field inspection were variable. The walkover of the proposed road verified, for the most part, the known archaeological record. However, fifty-three previously unrecorded sites were found during the course of the fieldwork.

In total **sixty-three** sites are considered in this report; **forty-two** directly affected by the route, and **twenty-one** in close proximity (< 70m) to route.

The sites are subdivided according to archaeological significance and potential impact. They have been assigned AR numbers by *Archaeological Development Services Ltd* for map classification. The AR numbers include previously recorded and newly identified sites.

There are **thirty-nine** AR sites; **twenty-five** (Group A) which will be directly affected by the route of the proposed Ennis Bypass, and **fourteen** (Group B) in immediate proximity to the route of the proposed Ennis Bypass.

In addition to the AR sites, this report outlines zones and sites of possible archaeological potential (Group C) and considers them under nine headings (see overleaf). Within Group C there are twenty-four possible sites, and thirty-nine possible zones of archaeological potential. (Of the twenty-four possible sites, **seventeen** are directly affected and **seven** in close proximity, to the route.)

The thirty-nine zones of possible archaeological potential in Group C, include;

- Four areas where there are known monuments in the hinterland and the likelihood of encountering undiscovered archaeological sites is very high.
- Seven areas covered by wood & scrubland (approx. 17% of the route) including three areas where dense scrub made full survey infeasible.
- Twenty areas of wetland (approx. 36% of the route) on the line of the route.
- Eight townlands with placenames that suggest potential archaeological sites.

The combined field and desk survey results are laid out in the following manner;

2.1 (A) Previously recorded & newly identified sites **directly** affected by route. (twenty-five)

2.2 (B) Previously recorded & newly identified sites in immediate proximity to route. (fourteen)

2.3 (C) Zones & sites of possible archaeological potential, directly affected or in immediate proximity to the route (sixty-three)

- *i* *Areas where there are known monuments in hinterland (four)*
- *ii* *River crossings directly affected by the route (five)*
- *iii* *Sites of Industrial Archaeological interest (two)*
- *iv* *Sites of Vernacular Architectural interest (four)*
- *v* *Old roads and trackways directly affected by route (four)*
- *vi* *Miscellaneous sites (nine)*
- *vii* *Placename evidence (eight)*
- *viii* *Areas covered by wood & scrubland (seven)*
- *ix* *Areas of wetland (twenty)*

NB The National Grid co-ordinates, listed for any newly identified sites, are given merely to facilitate future surveys in locating their positions.
They are **not** accurate measurements and should only be considered as approximate locations.

2.1 (A) Previously recorded & newly identified sites directly affected by route (twenty-five in total)

AR-01

Townland. Carrowgar

Nat. Grid Co-ord. 13680/17419 (approx. location)

Description. [Figs. 3 & 10, Plate 1] **On line of route**

Eight small circular mounds (average dimensions, 2.5m x 2.5m x 0.5m high) arranged roughly in two lines of four at the top of a slope. At the bottom of the slope is an area of scrub (sloe bushes) and wetland.

- Possible field clearance.

AR-04

Townland. Kilbreckan

Nat. Grid Co-ord. 13662/17533 (approx. location)

Description. [Figs. 3, 8 & 10] **On line of route**

In improved grazing land, formerly marsh, are five low banks (average dimensions 7m x 0.8m), three of which are roughly parallel to each other, with a stone footing (length 25.2m, one course high) running perpendicular between two of them. Associated with the banks are four small circular mounds (average dimension, 3m diam. x 0.5m high). These features are not depicted on the 1st edition OS map.

- Possible field system & clearance.

AR-05

Townland. Kilbreckan

Nat. Grid Co-ord. 13671/17548 (approx. location)

Description. [Fig. 3 & 10, Plates 2 & 3] **On line of route**

In a limestone karst overlooking drained marshland are a series of old drystone field boundaries and at least one cairn. (2.5m diam. x 0.5m high, three courses). These features are not depicted on the 1st edition OS map (1840).

- Possible early field system

AR-06

Townland. Kilbreckan

Nat. Grid Co-ord. 13672/17572 (approx. location)

Description. [Figs. 3, 4 & 10, Plate 5] **On line of route**

Twelve small circular mounds (average dimension, 3m diam. x 0.5m high) running in a line N-S. A line of stones, one course high and 0.8m wide, runs parallel to the mounds. Aerial photograph 3491, taken in 1991, shows this field was formerly covered by scrub.

- Possible field clearance and trackway

AR-08

Townland. Kilbreckan

Nat. Grid Co-ord. 136703/176495 (approx. location)

Description. [Figs. 4 & 11] **On line of route**

A recumbent boulder (1.1m x 1.4m x 0.6m high) lying adjacent to field boundary.[14]

- Possible collapsed standing stone

AR-09

Townland. Ballaghboy

Nat. Grid Co-ord. 136773/177190 (approx. location)

Description. [Figs. 4 & 11, Plates 24, 25] **On line of route**

Lintelled opening (0.4m x 0.2m high) built into the north facing wall of a disused laneway. Extending southwards is a low, narrow, stone lined passage (c.2m visible length). According to local folklore, religious objects and pikes were stored here during penal times. The adjacent townland is named Gortataggart (*Gort an tSaggart,* Field of the Priest) and local folklore records a Mass Rock in the vicinity[14]. The laneway is depicted on the 1st edition OS map (1840).

- Possible souterrain

14 O'Rahilly C 1994/96 *Archaeological report on route of Ennis By-pass.* A report commissioned by Clare County Council (unpublished)

AR-12

Townland. Ballymacahill

Nat. Grid Co-ord. 13672/17965 (approx. location)

Description. [Figs. 5 & 12, Plate 6] **On line of route**

Low, roughly circular mound (15m x 13.5m x 1m high). The 1st edition OS map (1840) depicts an old field boundary crossing over it. The underlying bedrock in the hinterland undulates dramatically creating many natural mounds and depressions.

- Possible cairn / mound

AR-13

Townland. Ballymacahill

Nat. Grid Co-ord. 136736/179758 (approx. location)

Description. [Figs. 5 & 12] **On line of route**

Single stone alignments, forming possible field system, lying in boggy land beside small lake. Landowner suggests they were uncovered after bog was stripped and thus predate the bog. [15]

- Possible pre-bog field system

AR-17

Townland. Ballymacahill

Nat. Grid Co-ord. 13661/18039 (approx. location)

Description. [Figs. 5 & 12, Plate 7] **On line of route**

Stone filled hollow (2.6m x 1.5m x 0.5m depth, 3 courses visible) located in northeast corner of a large field. The aerial photograph (1991) shows this field to be covered in dense scrub. It has recently been cleared and amalgamated with neighbouring fields. AR-15 and AR-16 are also located in this field.

- Possible souterrain

[15] O'Rahilly C 1994/96 *Archaeological report on route of Ennis By-pass.* A report commissioned by Clare County Council (unpublished)

AR-19

Townland.	Ballyduff (Patterson)
Nat. Grid Co-ord.	13645/18079 (approx. location)
Description.	[Fig. 5 & 12, Plates 8 & 9] **On line of route**

In an enclosed wood are five box-shaped cairns (average, 2m x 2m x 1.5m high) and a possible boulder burial (1m x 0.65m x 0.8m high). In the neighbouring field, recently cleared of tree cover, 20-30 cairns are visible. Due to the fact that this field has been machine cleared it is difficult to differentiate between modern clearance cairns and older recently disturbed cairns. Also located within the woodland are a number of old field walls not depicted on the 1st ed. OS map (1840).

- Possible clearance cairns.
- Possible boulder burial.
- Possible field system

AR-20

Townland.	Ballyduff	
Nat. Grid Co-ord.	136350/181425	(approx. location)
Description.	[Figs. 5 & 20]	**On line of route**

Box shaped cairn (approx. 5m x 2m x 1m high) located on high ground overlooking wetland. It lies three fields north of the cairns of AR-19 and is similar in construction. Adjacent to cairn AR-21.

- Possible clearance cairn

AR-22

Townland.	Barefield (or Gortlumman)	
Nat. Grid Co-ord.	136450/181736	(approx. location)
Description.	[Figs. 5 & 12]	**On line of route**

Two oval mounds (average. 30m diameter), orientated E-W, located in grazing land immediately northwest of a small lake[16].

- Possible cairns / fulachta fiadh

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16 O'Rahilly C 1994/96 *Archaeological report on route of Ennis By-pass.* A report commissioned by Clare County Council (unpublished)

AR-23 SMR CL026-079

Townland. Barefield (or Gortlumman)

Nat. Grid Co-ord. 13629/18208

Description. [Figs. 5, 6 & 12, Plate 10] **On line of route**

Circular bivallate rath (approx., 30m diam.). Heavily covered by trees and scrub. Depicted on 1st edition OS map (1840).

- Possible rath (ringfort)

AR-24

Townland. Barefield (or Gortlumman)

Nat. Grid Co-ord. 13599/18187 (approx. location)

Description. [Figs. 5 & 12, Plate 11] **On line of route**

Low, circular mound (10.5m x 10.8m x 0.9m high). The top of the mound has been partially eroded by cattle trample to a depth of 0.2m.

- Possible cairn

AR-25 SMR CL026-033

Townland. Carrowdotia

Nat. Grid Co-ord. 13682/18285

Description. [Figs. 6 & 13] **On line of route**

A low lying circular enclosure/possible ringfort (approx. 20m diam.). Depicted on 1st edition OS map (1840).

- Possible rath (ringfort)

AR-27 SMR CL026-036(01-02)

Townland. Carrowdotia

Nat. Grid Co-ord. 13715/18359

Description. [Figs. 6 & 13, Plate 12] **On line of route**

A complex comprising of ten small mounds, three banks and one associated standing stone. The standing stone (1.3m x 0.37m x 0.72m high) is situated on top of the southern most bank (approx. 14m x 4.3m x 0.6m high), which is orientated roughly N-S, curves to the east and

peters out. The other two banks (11m x 1.3m x 0.5m high; 20m x 1.5m x .08m high, respectively) are perpendicular to each other and potentially the remains of a field system. The mounds (average, 4m diam. x 0.6m high) are uniformly circular and are spread throughout the field with no pattern or order apparent. The 1st edition OS map (1840) depicts this site as two adjacent enclosures.

- Possible standing stone
- Possible field system / enclosure
- Possible field clearance / cairn complex

AR-28

Townland.	Cragard	
Nat. Grid Co-ord.	137027/183540	(approx. location)
Description.	[Figs. 6 & 13]	**On line of route**

Three parallel banks (average length, c.40m) running NW-SE, perpendicular to the present Ennis--Galway (N18) road. They are situated across the road from AR-27. These features are not depicted on the 1st edition OS map (1840).

- Possible field system / natural ridges

AR-29

Townland.	Cragard	
Nat. Grid Co-ord.	137160/183646	(approx. location)
Description.	[Figs. 6 & 13]	**On line of route**

A complex situated north of AR-27, comprising two perpendicular banks (average length 10m, average height 0.5m) and a circular mound (approx. 2.5m diam. x 0.5m high). Further north in the same field is a bank (approx. 40m length x 0.6m high), a group of three irregular mounds (average 2m diam. x 0.4m high) and a circular depression (approx. 4m x 3m x 0.5m deep). The 1st edition OS map (1840) shows farm buildings and field boundaries that no longer exist.

- Possible field system & field clearance
- Possible fulachta fiadh

AR-30

Townland. Cragard

Nat. Grid Co-ord. 137524/183977 (approx. location)

Description. [Figs. 6 & 13] **On line of route**

The 3rd edition OS map (1930) shows a hachured circular enclosure (approx. 10m diam.) adjacent to the Ennis – Galway road (N18). Subsequent road widening schemes would appear to have partially or totally removed this feature. Nothing was noted during field walking.

- Possible enclosure

AR-32

Townland. Cragard

Nat. Grid Co-ord. 137682/184095 (approx. location)

Description. [Figs. 6 & 13, Plate 26] **On line of route**

Upright stone (approx. 1m x 0.3m x 0.8m high). Would appear to be standing on a base of smaller stones.

- Possible standing stone

AR-33

Townland. Cragard

Nat. Grid Co-ord. 137731/184154 (approx. location)

Description. [Figs. 6 & 13, Plate 27] **On line of route**

Large boulder (visible length 2m) with smaller stones supporting it underneath. Very overgrown with scrub.

- Possible field clearance / megalithic structure

AR-34

Townland. Bearnafunshin

Nat. Grid Co-ord. 138047/184450 (approx. location)

Description. [Fig. 6, 7 & 13] **On line of route**

Irregular cairn (approx. 5m x 5m x 1.5m high) that is situated beside a low stone banked stream. The cairn is obscured by scrub.

- Possible field clearance

AR-36

Townland.	Clareabbey	
Nat. Grid Co-ord.	134311/175327	(approx. location)
Description.	[Figs. 8 & 15]	**On line of route**

Recumbent boulder (approx. 1m x 2m x 1m high) situated beside a hawthorn tree and adjacent to the boundary between a field and the laneway to Clare Abbey. Nearby, incorporated within this boundary are two large stones obscured by overgrowth[17].

- Possible standing stone

AR-38

Townland.	Keelty	
Nat. Grid Co-ord.	131984/177111	(approx. location)
Description.	[Figs. 9 & 16, Plate 28]	**On line of route**

Flat-based circular depression (approx. 2m diam. x 0.4m depth) cut into the north facing slope of a hill. Situated immediately north of limekiln (see page 34, limekiln) and south east of AR-39.[17]

- Possible hut site / quarry pit

AR-39

Townland.	Keelty	
Nat. Grid Co-ord.	131997/177194	(approx. location)
Description.	[Figs. 9 & 16, Plate 29]	**On line of route**

Circular enclosure (approx. 25m diam.) situated on the eastern side of the flood plain of the Claureen River. The enclosure is defined by a narrow band of small stones on all sides except to the NE where it is bounded by a field wall. The interior is very rocky, overgrown with trees and scrub and slightly higher than the surrounding land. This feature is depicted on 1st edition OS map (1840)[17].

- Possible outcrop plus field clearance / crannog / cashel

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17 O'Rahilly C 1994/96 *Archaeological report on route of Ennis By-pass.* A report commissioned by Clare County Council (unpublished)

2.2 (B) Previously recorded & newly identified sites in immediate proximity to route (fourteen in total)

AR-02

Townland. Killow

Nat. Grid Co-ord. 13692/17502 (approx. location)

Description. [Figs. 3 & 10, Plate 13]

Low circular mound (11.6m diam. x 0.6m high) surrounded by drained marsh. This feature is located in the same field as AR-03.

- Possible mound / fulachta fiadh

AR-03

Townland Killow

Nat. Grid Co-ord. 13687/17508 (approx. location)

Description. [Figs. 3 & 10]

Low sub-rectangular platform (27.8m x 24.5m x 0.6m high) on top of low mound surrounded by drained marsh. Outside the platform, at a distance of 2m is a low bank running SE-NW and roughly parallel. This feature is located in the same field as AR-02.

- Possible mound / fulachta fiadh

AR-07 SMR CL034-163

Townland. Kilbreckan

Nat. Grid Co-ord. 13687/17652

Description. [Figs. 4 & 11]

Enclosure (approx. 25m diam.) defined by low earthen bank, partially incorporated into the adjacent field boundaries. In northeast quadrant of the enclosure is a cairn.

- Possible rath (ringfort)

AR-10

Townland. Knockanean

Nat. Grid Co-ord. 13679/17860 (approx. location)

Description. [Figs. 4 & 11]

Field bank (c.100m length, 3-4 courses visible) running E-W curving slightly south. This feature is depicted on 1st edition OS map (1840).

- Possible field bank

AR-11 SMR CL034-051

Townland. Knockean

Nat. Grid Co-ord. 13653/17904

Description. [Figs. 4, 5 & 11]

Overgrown circular enclosure (approx. 25m diam.) located within back garden of private residence. Depicted on 1st edition OS map (1840) as enclosure.

- Possible rath (ringfort)

AR-14 SMR CL034-002

Townland. Ballymacahill

Nat. Grid Co-ord. 13642/17980

Description. [Figs. 5 & 12]

Rectangular enclosure (approx. 50m x 40m) with earthen banks. The northern side faces onto the present road. Depicted on 1st edition OS map (1840).

- Possible rectangular enclosure

AR-15

Townland. Ballymacahill

Nat. Grid Co-ord. 13667/18027 (approx. location)

Description. [Figs. 5 & 12, Plate 14]

Irregular cairn (4.6m x 3.8m x 1.5m high) overgrown by blackberry bush. Possibly the result of field clearance. It is located in the northeast corner of a large field. The aerial photograph (1991) shows

this field to be covered in dense scrub. It has recently been cleared and amalgamated with neighbouring fields. AR-16 and AR-17 are also located in this field.

- Possible field clearance

AR-16

Townland. Ballymacahill

Nat. Grid Co-ord. 13662/18033 (approx. location)

Description. [Figs. 5 & 12, Plates 15 & 16]

Stone-lined, irregular hollow (1.7m x 1.4m x 0.5m depth, 3-4 courses visible) with tree growing from it. It is located in northeast corner of a large field. The aerial photograph (1991) shows this field to be covered in dense scrub. It has recently been cleared and amalgamated with adjacent fields. AR-15 & AR-17 are also located in this field.

- Possible souterrain

AR-18

Townland. Ballyduff (Patterson)

Nat. Grid Co-ord. 13637/18073 (approx. location)

Description. [Figs. 5 & 12, Plate 17, 18 & 19]

A complex of stone banks and surfaces located in a wooded depression. The complex is roughly oval (approx.18.6 x 15m) with drystone banks ranging between 1m and 2m in height.

- Possible cashel (stonefort)

AR-21

Townland. Ballyduff (Blake)

Nat. Grid Co-ord. 13630/18145 (approx. location)

Description. [Figs. 5 & 12, Plate 20]

Box shaped cairn (approx. 3m x 3m x 2m high) located on high ground overlooking wetland. It lies three fields north of the cairns of AR-19 and is similar in construction. Adjacent to cairn AR-20.

- Possible field clearance

AR-26	SMR CL026-035
Townland.	Carrowdotia
Nat. Grid Co-ord.	13702/18299
Description.	[Figs. 6 & 13]

Large standing stone/slab; aligned N-S; adjacent to field boundary.

- Possible standing stone

AR-31	SMR CL026-041
Townland.	Cragard
Nat. Grid Co-ord.	13667/18343
Description.	[Figs. 6 & 13]

An enclosure is recorded approximately 60m from the Ennis-Galway road (N18). This site was not visible during field inspection.

- Possible enclosure / rath (ringfort)

AR-35	SMR CL026-012
Townland.	Cloonagowan
Nat. Grid Co-ord.	13843/18597
Description.	[Fig. 6, 7 & 14]

Watermill site situated beside Millbrook River. Located approximately 60m from the Ennis–Galway road (N18).

- Possible watermill site

AR-37	SMR CL033-117
Townland.	Clonroad More
Nat. Grid Co-ord.	13360/17566
Description.	[Figs. 9 & 15]

The 1st edition OS map (1840) depicts this site as an oval enclosure. However a modern housing development has removed this site entirely.

- Possible enclosure / rath (ringfort)

2.3 (C) Zones & sites of possible archaeological potential

i Areas where there are known monuments in the hinterland

There are **four** areas where the likelihood of finding undiscovered archaeological sites is comparatively higher than elsewhere along the route. This is due, either to the existence of a number of known sites in the hinterland (eg. Barefield/Drumquin/Carrowdotia), or the proximity of one significant monument (eg. Mooghaun hillfort, Clare Abbey, Killow church).

1. Nature of Site/s — Mooghaun Hillfort / Late Bronze Age settlement
   Description — [Fig. 17]

   Two kilometres southeast of the crossing at Latoon Creek is Mooghaun hillfort. Excavation by the North Munster project at this massive trivallate hillfort has revealed that the stone ramparts were built in the Late Bronze Age (1055-917 BC). The land between Latoon Creek and Mooghaun hillfort, plus the nearby upper Fergus estuary, is rich in archaeological evidence [Fig. 10]. Sites include a wooden boat jetty or causeway on the mudflats, gold finds from the marshes, fulachta fiadh from the marsh/dryland boundary and settlement enclosures, standing stones and field systems from the lower dryland slopes. In *The Other Clare*, O'Sullivan & Condit[18] point out that much of the settlement evidence around the upper Fergus estuary suggests for a late Bronze Age settlement pattern. They further speculate that separate settlement units, located along the marsh edge, combined to construct the hillfort at Mooghaun. Immediately north of the hillfort is Mooghaun Lough. An important Early Bronze Age hoard (over 150 gold ornaments) was discovered in this lake during railway construction in the nineteenth century. A very high proportion of such hoards are found in wetland.

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18 O'Sullivan, A. & Condit, T., 1995, LBA settlement and economy by the marshlands of the upper Fergus estuary, *The Other Clare*, 19, 5-9

2. Nature of Site/s Clare Abbey / Battlefield / Possible settlement
   Description [Figs. 8 & 15]

   The remains of Clare Abbey (SMR CL033-120) lie 300m north of the route in the townland of Clareabbey. Donald More O'Brien, the last King of Munster reputably founded it in 1189. It is likely that the monks cultivated some of the lands about the Abbey. However the extent of the acreage belonging to Clare Abbey is uncertain. It is possible that a medieval settlement developed around Clare Abbey (such as Ennis town evolved around Ennis Friary). However no such settlement is recorded. In 1278 a battle is reputed to have taken place between rival groups of the O'Brien clan. The battlefield (SMR CL033-121) is recorded as being in a bog in the vicinity of Clare Abbey but the exact location is uncertain. (see also page 37, laneway)

3. Nature of Site/s High concentration of archaeological sites
   Description [Figs. 6 & 13]

   The townlands of Barefield, Drumquin and Carrowdotia, at the northern end of the route, are rich in recorded archaeological sites [Fig. 6]. Falling within a 1km strip either side of the route are twenty-nine enclosures, one wedge tomb, one standing stone and one church/graveyard. This high concentration of archaeological evidence increases the likelihood of other sites being discovered in the above townlands.

4. Nature of Site/s Killow Church / Possible Medieval Settlement
   Description [Figs. 3 & 10]

   The remains of Killow Church (SMR CL034-102) lie approximately 70m west of the route. It is a simple church building (11.5m x 5.9m) surrounded by a later walled graveyard. Field inspection identified a low bank (approx. 65m diam.) enclosing the church and graveyard.

Westropp[19] suggests that in 1302, Killow (*Cil Lugha*, Church of St. Lugh) was a separate parish. Presumably, if it was a parish church, the community it served, inhabited the hinterland. Two likely locations for a possible medieval settlement are; the row of small holdings and derelict farm houses situated south of the church, and the group of abandoned farm buildings situated west of the church. It is also possible that the site could have a pre-medieval origin, as Lugh is a celtic god.

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19 Westropp, TJ 1900-02 Churches of County Clare, *Proc Roy Ir Acad* 30, 118-135.

ii River crossings directly affected by route

The route crosses **five** rivers, ranging from 3m to 70m wide. The banks of the rivers were examined, where possible, for the presence of lithics, shell, charcoal, pottery and other archaeological material.

Analysis of contextual information for Irish stone axes[20], found that 44.5% came from river & lake-bed contexts. The deposition of such artefacts could be either accidental or ritual in nature. Also analysis of contextual information for Bronze Age flat axes, daggers, rapiers and swords[21] found that a very high proportion of such artefacts have been in river & lake-bed contexts.

On the basis of the above findings, and given that the route crosses five rivers, the possibility of discovering archaeological artefacts in riverine environments is high.

Additionally, Dúchas-The Heritage Service has stressed the importance of investigating riverrine archaeology, with special emphasis placed on the study of the impact of road developments.

1. Name of River — Latoon Creek (Ardsollus / Rine River)
   Townland — Latoon South / Manusmore
   Description — [Figs. 3 & 17] **On line of route**
   Latoon Creek (approx. 20m wide) forms the townland boundary between Latoon South and Manusmore. Running parallel to the river on either side are high banks and drains, built to prevent flood damage. Latoon Creek is influenced by the tidal estuary of the River Fergus, with the daily ebb and flow exposing mud banks along the river. These mud banks are potentially rich in archaeological artefacts. There are two adjacent bridges where the Limerick-Ennis road (N18)

20 Cooney, G & Mandal, S 1998 *The Irish stone axe project*, Bray: Wordwell
21. Cooney, G & Grogan, E 1994 *Irish prehistory: a social perspective*, Dublin: Wordwell

crosses Latoon Creek; one that is relatively modern; the other much older and stone built. The older bridge has passed out of use. Both bridges will presumably be replaced during road widening. This point on the river may have been used in the past as a fording point. It will be directly affected by the route.

2. Name of River — Stream
   Townland — Knockanean/Ballymacahill
   Description — [Fig. 5] — **On line of route**

This is a narrow stream (approx. 3m wide) that forms the townland boundary between Knockanean and Ballymacahill. It lies in marshland between steep tree covered slopes. The banks of the stream were examined for the presence of lithics, shell, charcoal, pottery and other archaeological material. Nothing of archaeological significance was noted. There is nothing to suggest that this point on the river may have been used in the past as a fording point.

3. Name of River — Millbrook River
   Townland — Cloonagowan/Ballyline
   Description — [Figs. 7 & 14] — **On line of route**

The route from Barefield to Carrahil, follows the current line of the N18 (Ennis-Galway road) and crosses the Millbrook River at Ballyline Bridge. The Millbrook River is about 10m wide at the crossing point and has steep banks. It is proposed to widen the road 30m either side. This will presumably necessitate the rebuilding of the current bridge. Approximately 60m up-river is a Watermill site (SMR CL026-012). It is possible that the point, where the route crosses the river, may have been used in the past as a fording point.

4. Name of River — River Fergus
   Townland — Skehanagh/Clareabbey
   Description — [Figs. 8 & 15] — **On line of route**

The proposed route crosses the River Fergus about 300m from the site of Clare Abbey (SMR CL033-120). The river at this point is about

70m wide. High banks have been built up on either side of the river to act as flood-breaks. Documents dating to 1772 refer to river bank repairs made in the vicinity of Clarecastle.[22] The land on either side of the river is low-lying and liable to flood, except for the site of Clare Abbey which is situated on slightly higher ground. A battlefield (SMR CL033-121) is recorded as being in a bog in the vicinity of Clare Abbey but the exact location is uncertain. There is nothing to suggest that the point where the road crosses the River Fergus was used in the past as a fording point.

5.	Name of River	Claureen River	
	Townland	Keelty/Claureen	
	Description	[Figs. 9 & 16]	**On line of route**

The Claureen River is about 10m wide at the proposed crossing point. The fields on either side of the river are prone to seasonal flooding. There is nothing to suggest that the point where the road crosses the river was used in the past as a fording point.

22 Spellissy, S 1998 *The Ennis Compendium*, 121. Ennis: The Book Gallery.

iii Sites of Industrial Archaeological interest

Two limekilns were noted during the field inspection. Limekilns were built and used by local communities. They are usually square stone structures, built into the side of a hill, close to the quarry from which the limestone was extracted. The limestone was brought to the kiln, crushed, burnt with turf in the central flue and the resultant powder raked out of the opening at the base of the kiln. This lime powder was used either as fertiliser for spreading on the land, or for making mortar and limewash for building.

1. | | | |
|---|---|---|
| Nature of Site | Limekiln | |
| Townland | Ballaghboy | |
| Nat. Grid. Co-ord. | 136794/177021 | (approx. location) |
| Description | [Figs. 4 & 11] | |

This limekiln is incorporated into the stone wall between two fields[23]. The central flue opens out into the southern field, which is the higher of the two. The opening at the base of the kiln (2.5m x 1.5m) faces north and has partially collapsed. The 1st edition OS map (1840) shows two buildings adjacent to this site, but field inspection revealed no other visible surface remains apart from the limekiln. (See also page 37, laneway)

2. | | | |
|---|---|---|
| Nature of Site | Limekiln / Stone-filled cut | |
| Townland | Keelty | |
| Nat. Grid. Co-ord. | 131959/177075 | (approx. location) |
| Description | [Figs. 9 & 16] | **On line of route** |

This limekiln (approx. 3m x 5m high) is cut into the base of a north sloping hill that overlooks water-logged fields[23]. The northern face of the limekiln has a well preserved red-brick arched opening. However the central flue has been totally blocked from above. Located

[23] O'Rahilly C 1994/96 *Archaeological report on route of Ennis By-pass*. A report commissioned by Clare County Council (unpublished)

immediately west of the limekiln are the remains of a roofless, windowless building. Neither building is depicted on the 1st edition OS map (1840). The limekiln is situated at the southwestern end of a metalled laneway that circumnavigates the present Drumbiggil Golf Course ~~(see page 38,~~ laneway). Along the laneway, just north of the limekiln is a circular feature, cut into the hillside. This cut (c.4m diam. x c.3m deep at rear) opens out onto the laneway and is filled with large stones and boulders that appear to have collapsed inwards. This feature may be the site of an earlier limekiln.

iv Sites of Vernacular Architectural interest

Vernacular buildings are generally defined as structures built by local craftsmen, working within a local tradition and using locally sourced raw materials. This building tradition did not leave records or plans; therefore any study of it depends entirely on field survey. The typical vernacular house is rectangular in plan, with thick walls, rooms occupying the full width of the house and windows & doors only in the long side walls. **Four** sites of vernacular architectural interest were noted during field inspection.

1. Nature of Site — Farm building, derelict
   Townland — Kilbreckan
   Nat. Grid. Co-ord. — 136695/175883 (approx. location)
   Description — [Figs. 4 & 10] **On line of route**

   The fabric of this one-storey stone building has been altered greatly. It has a corrugated iron roof and has been repaired with concrete cavity blocks. However the interior seems to be relatively unaltered. It has thick internal walls with an internal lintelled doorway.

2. Nature of Site — Farmhouse, derelict
   Townland — Kilbreckan
   Nat. Grid. Co-ord. — 13670/17663 (approx. location)
   Description — [Figs. 4 & 11] **On line of route**

   This farmhouse (approx. 18m x 10m) is two storeys high, very overgrown and roofless. It is depicted on the 1st edition OS map (1840).

3. Nature of Site — Clachan type settlement
   Townland — Knockaskibbole
   Nat. Grid. Co-ord. — 13665/17751 (approx. location)
   Description — [Figs. 4 & 11] **On line of route**

   This group of houses includes two inhabited cottages, a disused farmhouse and a group of neglected farm outhouses. It is depicted on

the 1st edition OS map (1840). A laneway connects it with the Ballaghboy-Knockanean Road. The disused farmhouse is very overgrown and inaccessible. This disused farmhouse and the group of farm outhouses will be directly affected by the proposed route.

4.	Nature of Site	Farmhouse, ruined / Walled garden
	Townland	Cahircalla More
	Nat. Grid. Co-ord.	131964/175683 (approx. location)
	Description	[Figs. 9 & 16]

The partial remains of a farmhouse (approx. 7.5m x 26m) are located southeast of rough rocky farmland. The west gable (7.45m wide x c.5m high), the east gable (c.7.5m wide x c.1m high) and a portion of the north wall (c.5m long) are all that remain of this building at ground level. The interior of the building is strewn with rubble and loose stone. The east gable is currently incorporated into a field boundary. The farmhouse is named on the 1st edition OS map (1840) as Beechpark House. (This is not to be confused with Beech Park House which is located about one kilometre northwest.) It is not possible to determine the age of the building. Located south of the farmhouse is a walled garden (approx. 50m x 45m x 3m high) which is partially overgrown but in very good condition.

v Old roads & trackways directly affected by route

The route crosses **four** laneways, that may be along the line of earlier roads.

1. Nature of Site — Laneway
Townland — Ballaghboy
Description — [Figs. 4 & 11] — **On line of route**

The townland name, Ballaghboy (*Bealach Buí*; Yellow Road) possibly refers to the laneway that passes through this townland. This lane was superseded in the nineteenth century by the present Ennis-Quin road (R469). The nineteenth century village of Ballaghboy was focused about this laneway. The lane also passes by the remains of a limekiln (see page 33, limekiln).

2. Nature of Site — Clare Abbey laneway
Townland. — Clareabbey
Description. — [Figs. 8 & 15] — **On line of route**

The current laneway that leads to the site of Clare Abbey (SMR CL033-120) is potentially the site of the original access route to the abbey. It circumnavigates the old Ennis Race Course and joins the Ennis/Clarecastle road (N18) near the present GAA grounds. The laneway appears on the 1st edition OS map (1840); the Ennis race course first appears on the 3rd edition OS map.

3. Nature of Site — Laneway / 'Rocky Road'
Townland — Clonroad More
Description — [Figs. 9 & 16] — **On line of route**

Passing through an area of rocky scrubland in Clonroad More is a N-S laneway known as the 'Rocky Road'. Beginning at Aughandayaud Bridge, it terminates about 3km south, at Killone Lough. This laneway

was used until the 1960s by pilgrims visiting the Holy Well at Killone Lough[24]. It possibly could be on the line of an earlier, medieval trackway, connecting the ecclesiastical sites, Ennis Friary (est. c.1240) and Killone Abbey (est. c.1189).

4. Nature of Site Hermitage laneway

Townland Keelty

Description [Figs. 9 & 16] **On line of route**

This laneway circumnavigates (and pre-dates) the present Drumbiggil Golf Course and passes by 'Hermitage'(SMR CL033-081), a possible 17th century house. According to the 1st edition OS map, this lane originally joined the Miltown Malbay Road, but at present it terminates beside the remains of a limekiln (see page 33, limekiln). It was superseded in the nineteenth century when the road that bisects the present Golf Course was constructed. Town documents from 1807 refer to it as the "the circular road to the western side of Hermitage", along which, the urban district boundaries were redrawn[24].

[24] Spellissy, S 1998 *The Ennis Compendium*, 121. Ennis: The Book Gallery.

vi Miscellaneous Sites [**nine** in total]

1. Nature of Site — Lintelled opening / 'Sheep-Run'

Townland — Manusmore

Nat. Grid. Co-ord. — 139978/170276 (approx. location)

Description — [Figs. 3 & 10] **On line of route**

This lintelled opening (1m x 1m high) is built into a stone wall between two wet north facing fields[25]. Field inspection revealed no further structure. Its purpose may have been to allow sheep access to both fields.

2. Nature of Site — Field boundary kink

Townland — Carrowgar

Nat. Grid. Co-ord. — 13691/17383 (approx. location)

Description — [Figs. 3 & 10] **On line of route**

This is a right-angled stone-faced bank (approx. 10m x 25m x 1m high) which kinks out from the field boundary, that separates a field of rough pasture from wetland. The landowner mentioned a well/spring nearby.

3. Nature of Site — Natural ridge / 'Mass rock'

Townland — Ballaghboy/Gortataggart

Nat. Grid. Co-ord. — 13673/17708 (approx. location)

Description — [Figs. 4 & 11, Plate 21]**On line of route**

This is a is a high natural ridge that would been a good vantage point for settlement/fortification in the past. However no archaeological remains are evident. According to local folklore there was a Mass Rock in the immediate hinterland[25]. This might explain the townland

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[25] O'Rahilly C 1994/96 *Archaeological report on route of Ennis By-pass*. A report commissioned by Clare County Council (unpublished)

name, Gortataggart (*Gort an tSaggart,* Field of the Priest). Local folklore also records that the lintelled passageway (see AR-09) as a repository for religious objects and pikes.

4. Nature of Site — Mound, natural
Townland — Ballyduff
Nat. Grid. Co-ord. — 13651/18037 (approx. location)
Description — [Figs. 5 & 12]
A mound (approx. 6m diam. x 0.5m high) with a tree growing from it. Archaeological potential is slight as outcrops of bedrock were noted.

5. Nature of Site — Re-used stonework
Townland — Barefield (or Gortlumman)
Nat. Grid. Co-ord. — 13588/18177 (approx. location)
Description — [Fig. 5, 12, Plate 22, 23]**On line of route**
Incorporated into the present N18 roadside drystone wall are many pieces of dressed and moulded stone that appear to be ecclesiastical in nature. Origin unknown. (Only south end of this wall will be directly affected by route) .

6. Nature of Site — Field boundary kink
Townland — Barefield
Nat. Grid. Co-ord. — 13598/18177 (approx. location)
Description — [Figs. 5 & 12]
The route passes nearby a field boundary containing a curved kink. Two large stones form part of the boundary kink.

7. Nature of Site — Mound, natural
Townland — Cragard
Nat. Grid. Co-ord. — 137088/183659 (approx. location)
Description — [Figs. 6 & 13]
This large overgrown mound (approx. 20m x 30m x 6m high) is the highest point in a field of flat well drained wetland. Its long axis is parallel with the Ennis-Galway Road (N18). It would appear to be

natural but in the past it might have been a good vantagepoint and refuge from flooding.

8. Nature of Site Overgrown natural outcrop
Townland. Claureen
Nat. Grid Co-ord. 132157/177504 (approx. location)
Description. [Figs. 9 & 16]
Area of outcrop and loose stone (approx. 60m x 20m) overgrown with scrub and bushes, situated in seasonal floodland near the Claureen River.

9. Nature of Site Mound, field clearance
Townland Claureen
Nat. Grid. Co-ord. 132074/177577 (approx. location)
Description [Figs. 9 & 16]
This overgrown mound (approx. 5m x 6m x 3m high) is situated adjacent to a field boundary and surrounded by waterlogged fields. It is probably the result of recent field clearance.

vii Placename evidence [**eight** townlands in total]

Ballybeg	Small homestead/s (*Baile Beag*)
Ballyduff	Black homestead/s (*Baile Dhubh*)
Ballymacahill	Homestead of Macahill (*Baile Macahill*)
Ballymacaula	Homestead of Macaula (*Baile Macaula*)

The first recorded use of *baile* (bally) as the root of a placename dates from the middle of the twelfth century. During medieval times it usually referred to a single or cluster of homesteads; whilst more recently it has assumed the role of townland name.[26]

Cahircalla Beg Small stone fort/dwelling (*Cathair Beag*)

There are three recorded enclosures in this townland:

Cashel	(SMR CL033-069),
Church site & enclosure	(SMR CL033-060),
Enclosure	(SMR CL033-116)

Cahircalla More Large stone fort/dwelling (*Cathair Mór*)

There is one recorded enclosure in this townland:

Enclosure	(SMR CL033-115)

In place names *cathair* (cahir) means stone enclosure, fort or dwelling (sometimes monastic enclosure, monastery). Its use as the placename root is strongly identified with the western and southwestern parts of the country[26].

26 Flanagan, D & Flanagan, L 1994 *Irish Place Names*, 20-26, 45-46, Gill & Macmillan

Kilbreckan Church of St. Breckan (*Cil Brecan*)

There are two recorded ecclesiastical sites in this townland:

St. Michael's Holy Well (SMR CL034-103),

Children's Burial Ground (SMR CL034-104)

Killow Church of St. Lugh (*Cil Lugha*)

There is one recorded ecclesiastical site in this townland:

Killow Church (SMR CL034-102).

In placenames *cill* (kil) has a range of associated meanings: church , monastic settlement or foundation, churchyard, graveyard. It is the most prevalent ecclesiastical element in townland names. Unfortunately since the seventeenth century the Anglicised version of *coill* (a wood) has also been kil(l) making translation difficult[27].

27 Flanagan, D & Flanagan, L 1994 *Irish Place Names*, 49-54, Gill & Macmillan

viii Areas covered by woodland & scrubland

The route passes through **seven** areas of scrub & woodland (approx. 17% of the route). In two of these areas (Knockanean & Clonroad More/Cahircalla Beg) full survey of the line of the route was impractical due to the density of the scrub. In an other area (Knockanean/Ballymacahill) surrounding wetland made inspection infeasible. Full assessment of these three areas will only be possible after the scrub has been cleared.

1. Townland Kilbreckan

Landscape Scrubland [Fig. 3]

Running along the western part of a limestone karst overlooking marshland is an area of scrub. Within this scrub are drystone features such as cairns and walls (AR-05).

2. Townland Knockanean [Fig. 4]

Landscape Scrubland / Field inspection infeasible

The proposed route crosses an area of dense scrub and woodland in Knockanean Townland. Within this scrubland and on the line of the route, the 1st and 3rd edition OS maps show a circular enclosure (approx. 20m diam.) circumscribed by a field boundary (see fig. 11). However the dense scrubland made the field inspection and identification of this potential site not feasible.

3. Townland Knockanean / Ballymacahill [Fig. 5]

Landscape Woodland / Field inspection infeasible

On either side of the stream, flowing between the townlands of Knockanean and Ballymacahill, are steep wooded slopes. The wetland adjoining the stream made the northern wooded slope inaccessible.

4. Townland Ballyduff [Fig. 5]
   Landscape Woodland
   In the northeast corner of the townland of Ballyduff is an enclosed area of woodland. The groundcover consists of limestone boulders and weathered bedrock, between which deciduous trees and scrub grow.

5. Townland Ballyduff (Paterson) [Fig. 5]
   Landscape Woodland
   North of the townland boundary between Ballyduff and Ballyduff (Paterson) is an area of woodland. Recent field clearance has stripped the eastern half of this woodland. Within the wooded area were identified a number of cairns (AR-19) and stone field boundaries.

6. Townland Cragard [Fig. 6]
   Landscape Scrubland
   Between the N18 road and the Ennis-Galway railway is a strip of rocky scrub. Located on the west edge of this area of scrub are AR-27, AR-29, AR-30, AR-32 and AR-33.

7. Townland Clonroad More / Cahircalla Beg [Fig. 9]
   Landscape Scrubland / Woodland / Field inspection infeasible
   Between the Kilrush-Ennis road (N68) and the Clarecastle-Ennis road (N18) is an expanse of limestone karst covered by dense scrub and woodland. The western part of this landscape has been extensively quarried. Identified within the eastern part of the landscape were drystone cairns and old field boundaries (not depicted on the OS maps). However the scrubland made accurate identification of their location, in relation to the proposed road, infeasible. A laneway known as the 'Rocky Road' crosses this region. (See also page 37, laneway.)

ix Areas currently under wetland

Approximately 36% of the route passes through wetland of some description, whether it be bog, marsh, flood plain or waterlogged pasture. **Twenty** such areas were noted during field walking.

Analysis of contextual information for Irish stone axes[28], found that 44.5% came from river and lake-bed contexts, 11.8% from bogs, 14.9% from agricultural land. The deposition of such artefacts could be either accidental or ritual in nature.

Analysis of contextual information for Bronze Age flat axes, daggers, rapiers and swords[29] found that, by far, the highest concentrations of such artefacts have been in river, lake and bog contexts. The deliberate deposition of metal artefacts in bogs has been recognised as an important aspect of Irish Bronze Age activity.

On the basis of the above findings, and given that the route crosses a substantial area of wetland (approx. 36% of route), the possibility of discovering archaeological artefacts in wetland is high.

Additionally there is the possibility of finding such archaeological features as wooden trackways, fulachta fiadhs and settlement sites. Wetland areas are seldom as intensively worked as higher-yielding agricultural land, and accordingly there is a greater chance of uncovering archaeology in bog, marsh and flood land.

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28 Cooney, G & Mandal, S 1998 *The Irish stone axe project*, Bray: Wordwell

29 Cooney, G & Grogan, E 1994 *Irish prehistory: a social perspective*, Dublin: Wordwell

1. Townland Latoon North/South./ Manusmore [Fig. 3]

The land on either side of Latoon Creek is wet. Old field drains are visible in some of the fields. The gradient gently rises, north and south of the river.

2. Townland Manusmore [Fig. 3]

Low-lying waterlogged fields on either side of a NE-SW drainage stream.

3. Townland Manusmore [Fig. 3]

At the bottom of a north facing slope is a waterlogged marshy field. Further north is a stream that flows NE-SW, joining the Fergus River at Carrowneally Point.

4. Townland Carrowgar [Fig. 3]

Bisected by the Limerick-Ennis railway line is an area of flat drained wetland. Upcast beside some of the field drains was noted. The land gradually rises to the north of the wetland.

5. Townland Carrowgar / Killow [Fig. 3]

The boundary between the townlands of Carrowgar and Killow is a field drain. The land on either side of the boundary is mostly low-lying and wet. Situated on a small hill south of the townland boundary are a series of small mounds (AR-01).

6. Townland Killow [Fig. 3]

Between Killow church (SMR CL034-102) and the Clarecastle road, is an area of drained bogland. Situated within this wetland are small bog islands (including AR-02 & AR-03).

7. Townland Kilbreckan / Skehanagh / Bunnow [Figs. 4, 8]

There is an area of extensive wetland stretching from Kilbreckan to the banks of the River Fergus. It is criss-crossed with an elaborate system

of drains. A complex of cairns and banks (AR-04) is located in the south east corner of this area.

8. Townland Knockaskibbole / Gortataggart [Fig. 4]

The boundary between the townlands of Knockaskibbole and Gortataggart is a field-drain/stream. The fields either side of the boundary are low-lying, wet and boggy. Immediately south are a natural mound ('Mass rock') and AR-09. Immediately to the north is a clachan type settlement.

9. Townland Knockanean [Fig. 4]

An area of bogland just north of the road that passes through Knockanean to Gaurus Bridge. Further north, on higher ground in the same field, is a field bank (AR-10).

10. Townland Knockanean / Ballymacahill [Fig. 5]

The boundary between the townlands of Knockanean and Ballymacahill is an E-W running stream. Both sides of the stream are waterlogged, especially the north bank. There are steep wooded slopes to the north and to the south of this stream.

11. Townland Ballymacahill [Fig. 5]

In the northeast corner of Ballymacahill townland is a small lough and surrounding it an area of wet bogland. Stone alignments and footings (AR-13), possibly predating the existence of the bog, were noted.

12. Townland Ballyduff [Fig. 5]

Adjacent to the Ennis-Galway railway line is a small seasonal lough. The land bordering the lough is wet and boggy, and contains two mounds/bog-islands (AR-22).

13. Townland Drumquin [Figs. 5, 6]

Small lough surrounded by rough grazing land, situated about 200m southeast of Barefield School.

14. Townland Drumquin [Fig. 6]

In the north of the townland of Drumquin, immediately east of the Ennis-Galway road (N18) is an area of marshland.

15. Townland Cragard [Fig. 6]

On the east side of the Ennis-Galway road (N18) is an area of rocky badly drained land, within which were noted linear banks, small mounds and circular depressions (AR-29).

To the west of the Ennis-Galway road (N18) is a large area of flat well drained marshland. The most obvious feature within this marshland is a large mound (probably natural) (see also page 40).

16. Townland Bearnafunshin [Figs. 6, 7]

Running E-W under Ennis-Galway road (N18) is a stream. The land on either side of the stream is wet rough pasture.

17. Townland Clareabbey [Fig. 8]

East of the Limerick-Ennis railway are waterlogged fields. It is possible these fields were within the holdings of Clare Abbey (SMR CL033-120). A medieval battlefield (SMR CL033-121) is recorded in bogland near Clare Abbey but the exact location is unknown.

18. Townland Clareabbey [Fig. 9]

Between the laneway leading to Clare Abbey (SMR CL033-120) and the Clarecastle-Ennis road (N18), is an extensive area of wet marshland. In the east of this area, adjacent to the laneway is a recumbent boulder (see AR-36).

19. Townland Cahircalla Beg/Cahircalla More [Fig. 9]

A stream flows between the townlands of Cahircalla Beg and Cahircalla More. On either side is wet marshland.

20. Townland Keelty/Claureen [Fig. 9]

The Claureen River flows between the townlands of Keelty and Claureen. The fields on either side of the river are wet and subject to flooding, and further northwards is marsh and bogland. Located within this area of wetland are a circular enclosure (AR-39), a field clearance mound and an area of overgrown outcrop.

3. Mitigation & Recommendations

3.1 Sites of potential archaeological significance as identified above in sections **A**, **B** and **C** (pages 15-50) will need further survey, investigation and impact analysis pre-construction. Such pre-construction work should enable delays on main construction to be kept to a minimum.

See details of recommended mitigation overleaf.

3.2 Should changes to the proposed road route involve a new road route falling outside the 100 metre corridor examined in this study, field walking of the new areas will be required. If at all possible the finite and irreplaceable archaeological resource should be preserved.

3.3 All recommendations herein are subject to discussion with, and approval of, the relevant heritage authorities.

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Recommendations

Please refer to main body of text for details of all sites. Page numbers listed below.

The ~~sites along the proposed~~ route fall into the following categories:

1. **Two sites** that are archaeological, are directly affected by the proposed route and should be archaeologically excavated.

AR-23	Page 19	AR-25	Page 19

2. (a) **Twenty-two sites** that may be archaeological, are directly affected by the proposed road and should be archaeologically investigated to determine their potential.

AR-01	Page 15	AR-22	Page 18
AR-04	Page 15	AR-24	Page 19
AR-05	Page 15	AR-27	Page 19
AR-06	Page 16	AR-28	Page 20
AR-08	Page 16	AR-29	Page 20
AR-09	Page 16	AR-30	Page 21
AR-10	Page 24	AR-32	Page 21
AR-12	Page 17	AR-33	Page 21
AR-13	Page 17	AR-36	Page 22
AR-17	Page 17	AR-39	Page 22
Laneway, 'Rocky Road'	Page 37	Clare Abbey laneway	Page 37

(b) **Two river crossings** that may be archaeological, are directly affected by the proposed road and require a riverrine survey and/or archaeological investigation to determine their potential.

Latoon Creek	Page 30	Millbrook River	Page 31

3. **Six sites** directly affected by proposed road, requiring a vernacular building survey and vernacular building record.

Lintelled opening	Page 39	Farmhouse, derelict	Page 35
Farm building derelict	Page 35	Clachan-type Settlement	Page 35
Re-used stonework	Page 40	Limekiln	Page 33

4. **Four sites** which are possibly archaeological, directly affected by the proposed road and should be cleared of surface growth / superfluous stones and reassessed.

AR-19	Page 18	AR-34	Page 21
AR-20	Page 18	Field boundary kink	Page 39

5. **Six sites** that may be archaeological, are directly affected by the proposed road and should be investigated during monitored stripping.

Ballaghboy laneway	Page 37	Stream	Page 31
Hermitage laneway	Page 38	River Fergus	Page 31
AR-38	Page 22	Claureen River	Page 32

6. **Fours areas** of high archaeological potential on the line of the road requiring early monitored stripping.

Area around Moogahun Hillfort & Late Bronze Age settlement pattern	Page 27	Area with high concentration of recorded archaeological sites	Page 28
Area around Clare Abbey	Page 28	Area around Killow Church	Page 28

7. **Ten sites** adjacent to the proposed road that could be affected. Prior to construction these sites should be either fenced off or archaeologically investigated / excavated / recorded.

AR-07	Page 23	AR-21	Page 25
AR-14	Page 24	AR-26	Page 26
AR-15	Page 24	Limekiln	Page 33
AR-16	Page 25	Farmhouse, ruins	Page 36
AR-18	Page 25	Walled garden	Page 36

8. **Six sites** that may be archaeological, are in the vicinity of the proposed road and may be affected by route alterations.

AR-02	Page 23	AR-31	Page 26
AR-03	Page 23	AR-35	Page 26
AR-11	Page 24	AR-37	Page 26

9. **Six sites** which are of uncertain archaeological potential and are in the vicinity of the proposed road.

Mound, natural	Page 40
Field boundary kink	Page 40
Mound, natural	Page 40
Overgrown outcrop	Page 41

Natural ridge, 'mass rock'	Page 39
Mound, field clearance	Page 41

10. (a) **Twenty wetland areas** with high archaeological potential, which require archaeological monitoring during stripping or draining process.

There are twenty wetland areas along the route of the proposed road.	Page 47-50

(b) **Seven woodland/scrubland areas** with high archaeological potential, which require archaeological monitoring during stripping.

There are seven woodland / scrubland areas along the route of the proposed road.	Page 44-45

Bibliography

Author	Date	Title
Barry, TB	1994	*The archaeology of medieval Ireland*, London: Routledge
Coffey, T	1994	Field notes, *The Other Clare*,18, Ennis
Cooney, C Grogan, E	1994	*Irish prehistory: a social perspective*, Dublin: Wordwell
Cooney, C Mandal, S	1998	*The Irish stone axe project*, Bray: Wordwell
Flanagan D Flanagan L	1994	*Irish place names*, Dublin: Gill & Macmillan
Grogan, E	1996	Changing Places: settlement patterns in prehistory, *The Other Clare*, 20, Ennis
Mitchell, M Ryan, M	1997	*Reading the Irish Landscape*, Dublin: Town House
O'Sullivan, A Condit, T	1995	Late Bronze Age settlement and economy by the marshlands of the upper Fergus estuary, *The Other Clare*, 19, Ennis
O'Rahilly, C	1994-96	*Archaeological report on route of Ennis by-pass*, A report commisioned by Clare County Council, (unpublished)
Spellissy, S	1998	*The Ennis compendium*, Ennis: The Book Gallery
Westropp, TJ	1900-02	Churches of County Clare, *Proc Roy Ir Acad,* 30
Whittow, J B	1975	*Geology and Scenery in Ireland,* London 1975

Appendix 1:

General archaeological corpora consulted for study

Author	Date	Title
Bourke, E,	1994	Glass vessels of the first nine centuries AD in Ireland, *J Roy Soc Antiq Ir*, 124, 163-209
Clarke, DL,	1970	*Beaker pottery of Great Britain and Ireland.* Cambridge: University Press
Collins, AEP,	1994	The flint javelin heads of Ireland, in D Ó Corráin (ed.) *Irish antiquity*, 111-33. Dublin: Four Courts Press
Earwood, C,	1994	*Domestic wooden artefacts in Britain and Ireland from Neolithic to Viking times.* Exeter: University of Exeter Press
Eogan, G,	1965	*Catalogue of Irish bronze swords.* Dublin: The Stationary Office
Eogan, G,	1983	*The hoards of the Irish Later Bronze Age.* Dublin: University College Dublin
Eogan, G,	1994	*The accomplished art. Gold and gold working in Britain and Ireland during the Bronze Age (c. 2,300-650 BC).* Oxford: Oxbow Books Ltd.
Harbison, P,	1976	Bracers and V-perforated buttons in the Beaker and Food Vessel Cultures of Ireland, *Archaeologia Atlantica Research Report*, 1
Harbison, P,	1969a	The axes of the Early Bronze Age in Ireland. *Praehistorische Bronzefunde*, IX.1. München: CH Beck
Harbison, P,	1969b	The daggers and the halberds of the Early Bronze Age in Ireland. *Praehistorische Bronzefunde*, VI.1. München: CH Beck
Kavanagh, RM,	1973	The encrusted urn in Ireland, *Proc Roy Ir Acad*, 73C, 507-617

Kavanagh, RM,	1976	Collared and cordoned cinerary urns in Ireland, *Proc Roy Ir Acad*, 76C, 293-381
Kavanagh, RM,	1991	A reconsideration of razors in the Irish Early Bronze Age, *J Roy Soc Antiq Ir*, 121, 77-104
Longworth, IH,	1984	*Collared urns of the Bronze Age in Great Britain and Ireland.* Cambridge: Cambridge University Press
O'Connor, L,	1991	Irish Iron Age and Early Christian whetstones, *J Roy Soc Antiq Ir*, 121, 45-76
O'Meadhra, U,	1984	Early Christian, Viking and Romanesque art motif-pieces from Ireland. *Theses & papers in North European archaeology*, 7. Stockholm: Almquist & Wiksell International
Raftery, B,	1983	A catalogue of Irish Iron Age antiquities. *Veröffentlichung des Vorgeschichtlichen Seminars Marburg, Sonderband*, 1.
Somerville, O,	1993	Kite-shaped brooches, *J Roy Soc Antiq Ir*, 123, 59-101

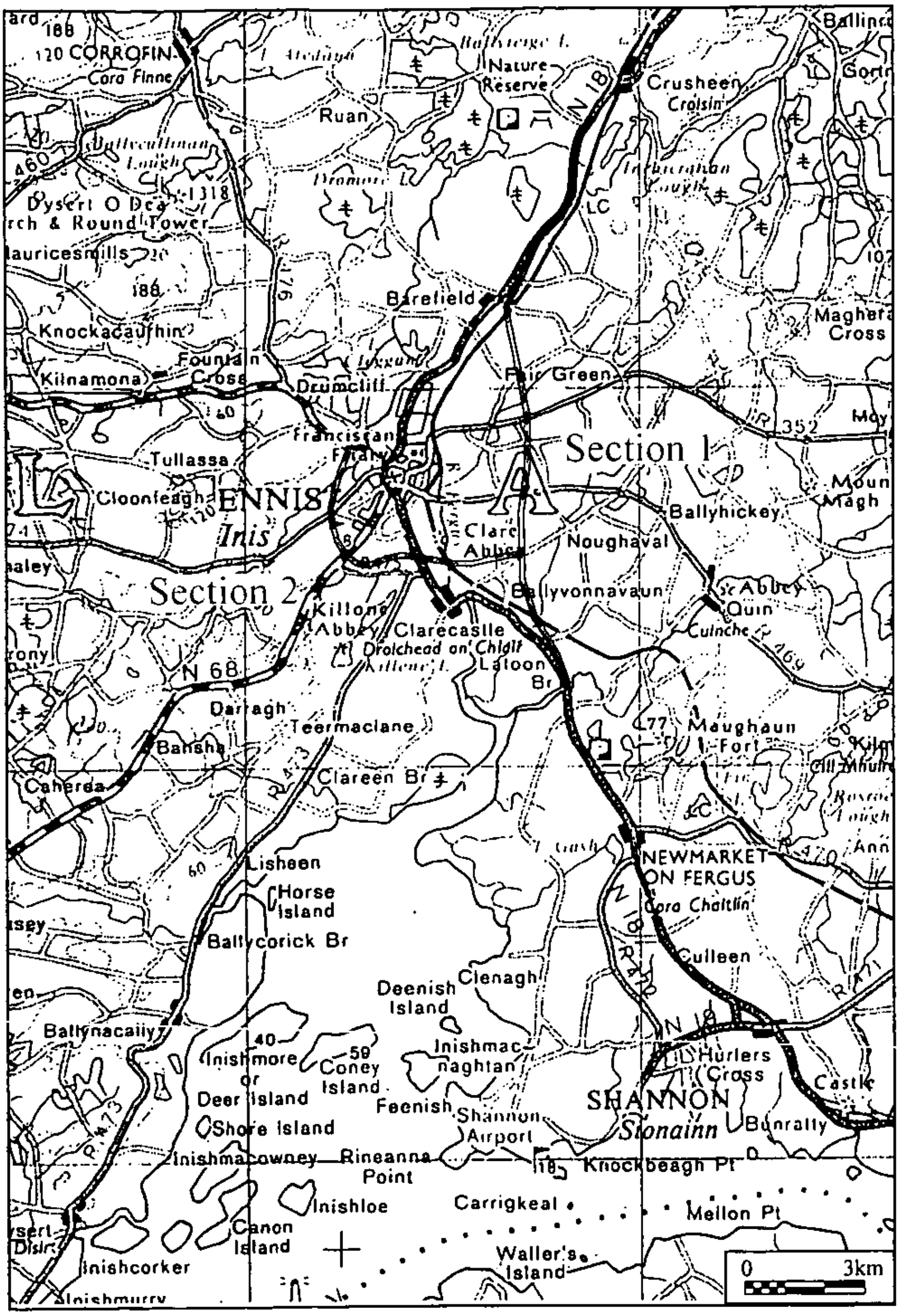


Fig. 1 General layout of proposed By-pass, Ennis, Co. Clare.

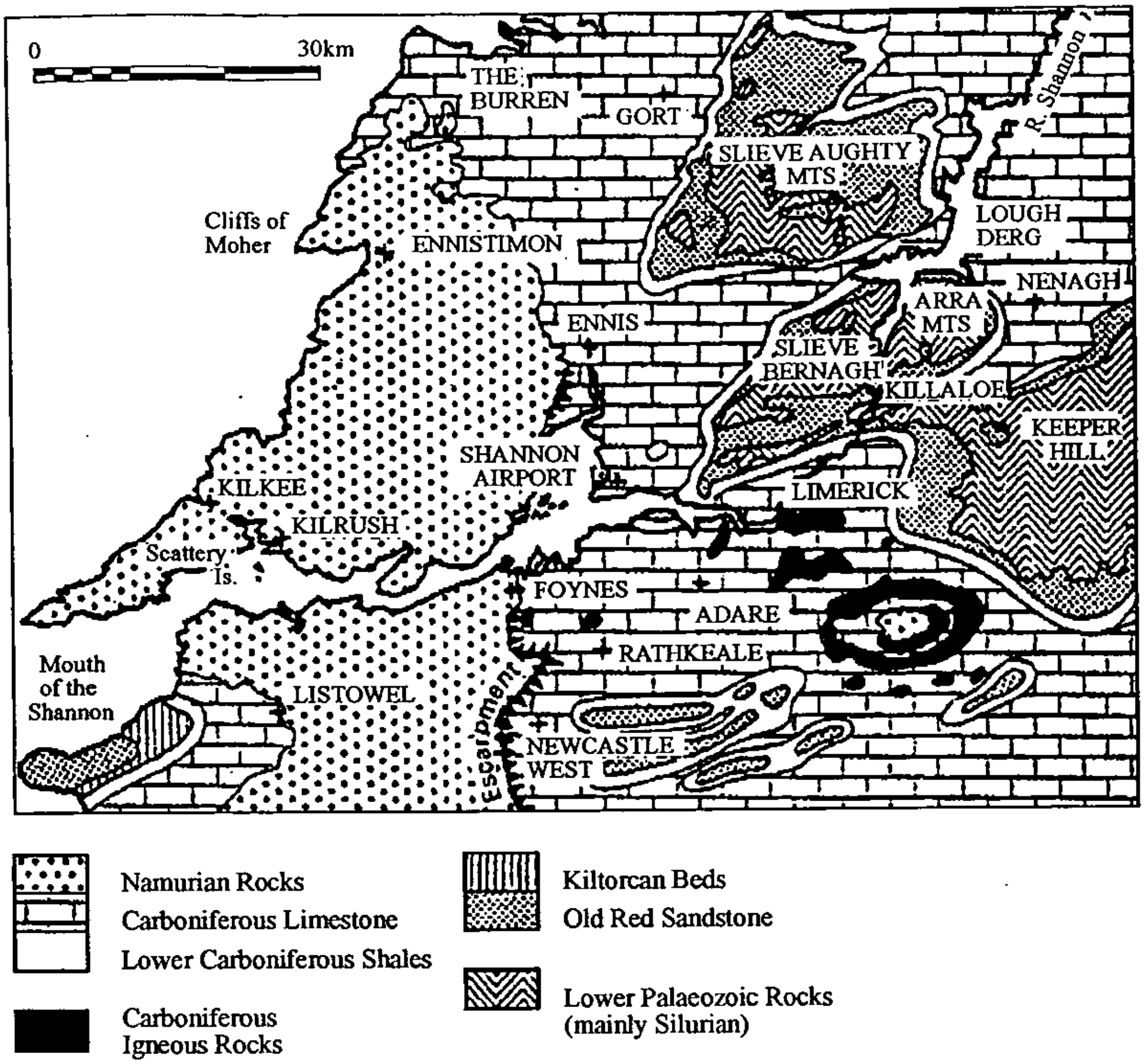


Fig. 2 Geology of the Lower Shannon region
(*from* Whittow, J.B., *Geology and Scenery in Ireland.*, 1975)

Location of Townlands relative to Figures 3-9

Figures	**Townlands**
Fig. 3	Latoon North, Latoon South, Manusmore, Carrowgar, Killow, Kilbreckan
Fig. 4	Killow, Kilbreckan, Ballaghboy, Gortataggart, Knockaskibbole, Knockanean
Fig. 5	Knockanean, Ballymacahill, Ballyduff, Ballyduff (Patterson), Ballyduff (Blake), Barefield (or Gortlumman), Drumquin
Fig. 6	Carrowdotia, Cragard, Bearnafunshin, Ballyline, Cloonagowan
Fig. 7	Bearnafunshin, Ballyline, Cloonagowan, Caheraphuca, Carrahill
Fig. 8	Killow, Kilbreckan, Skehanagh, Clareabbey
Fig. 9	Clareabbey, Ballybeg, Clonroad More, Cahircalla Beg, Cahircalla More, Ballymacaula, Keelty, Claureen

Key

	AR site numbers, 01 to 39
	Zones of possible archaeological potential - Industrial archeaological interest - Vernacular architectural interest
	Zones of possible archaeological potential - River crossings - Old roads and laneways
	Zones of possible archaeological potential - Miscellaneous sites
	Areas currently under wetland
	Areas currently under woodland/scrubland
042-005	SMR classification number eg. Co. Clare sheet 42, recorded monument number 005

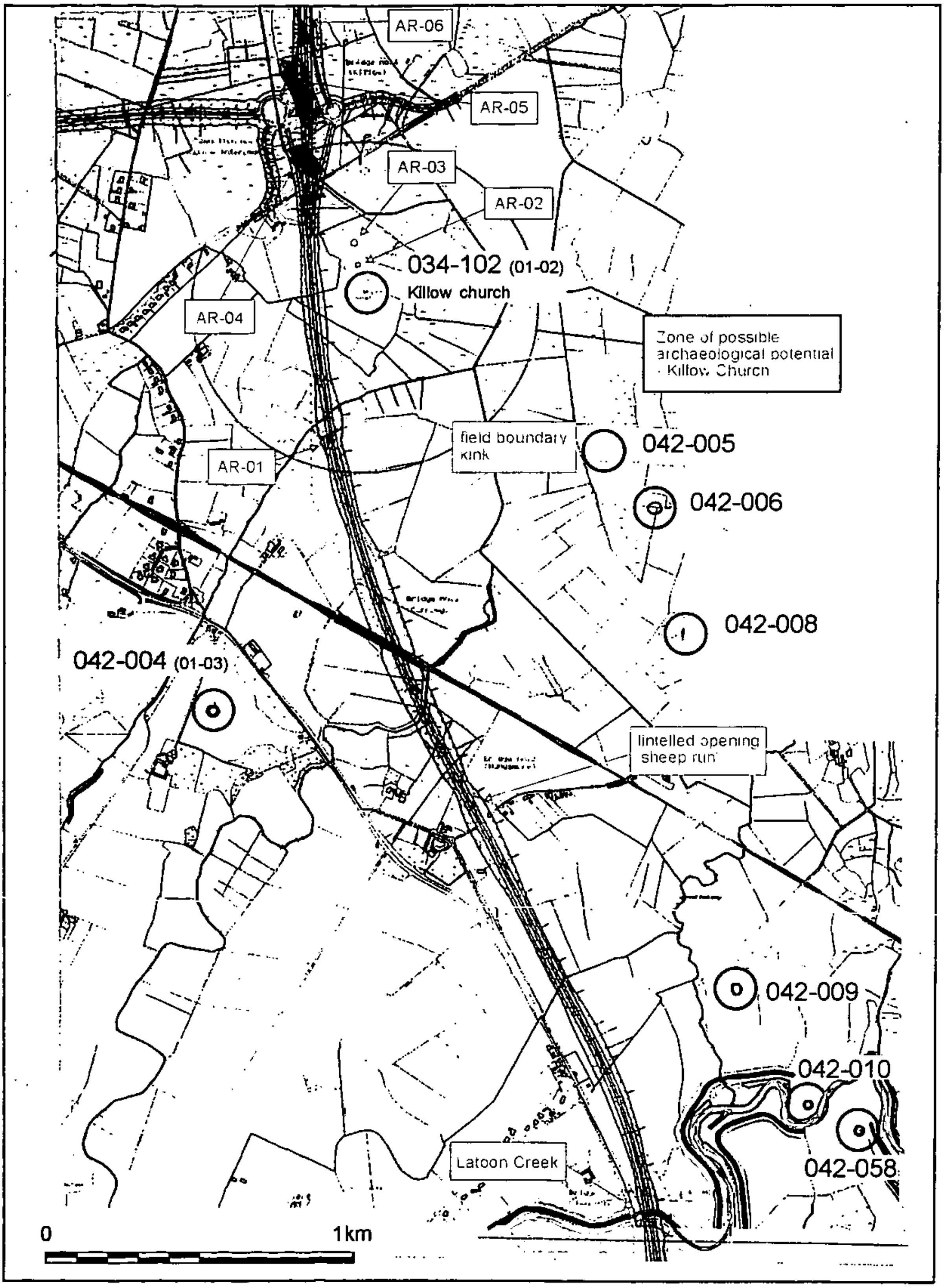


Fig. 3 Road Design Office map (April 1998) showing line of proposed route and location of sites of archaeological potential.

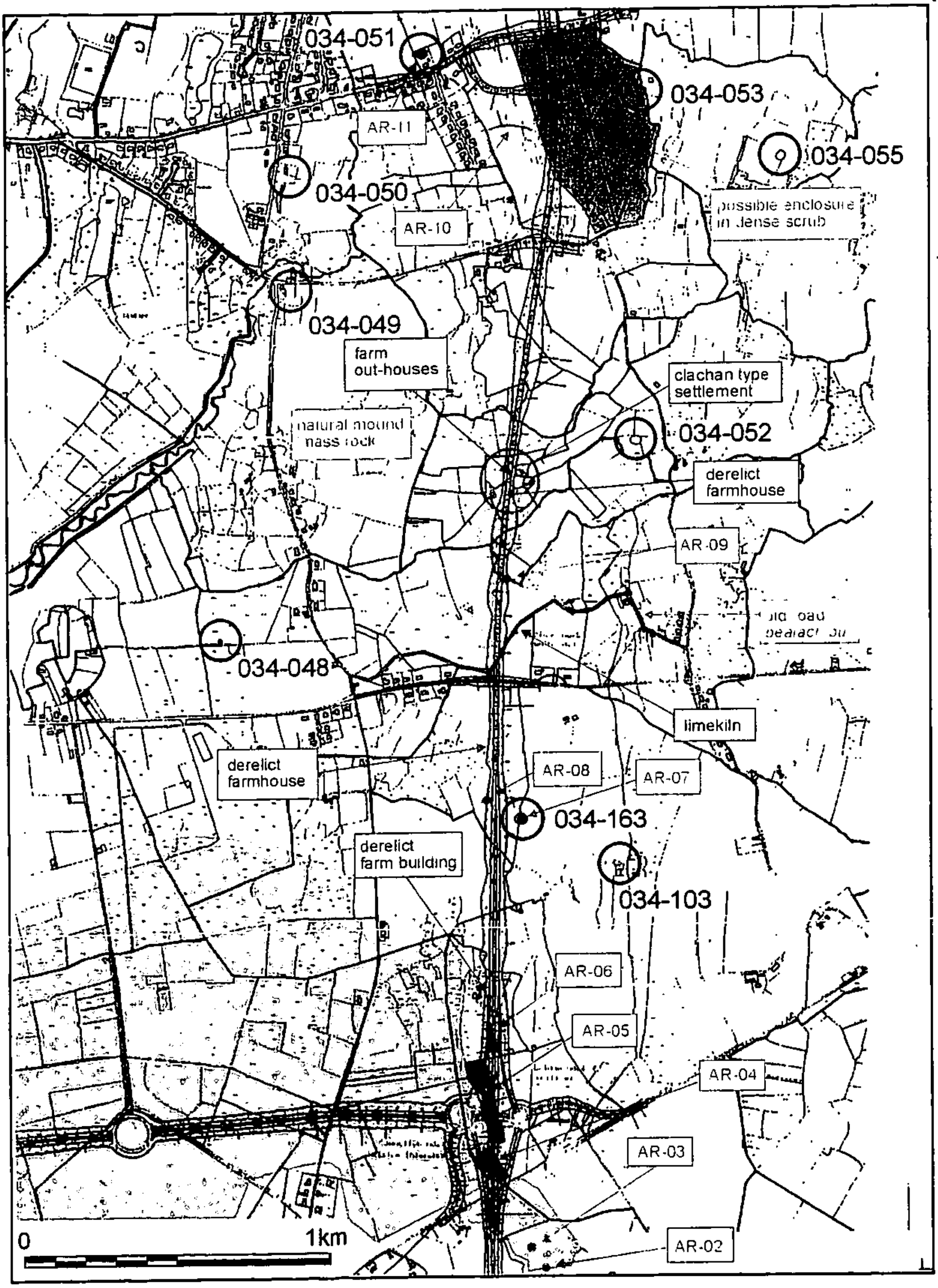


Fig. 4 Road Design Office map (April 1998) showing line of proposed route and location of sites of archaeological potential.

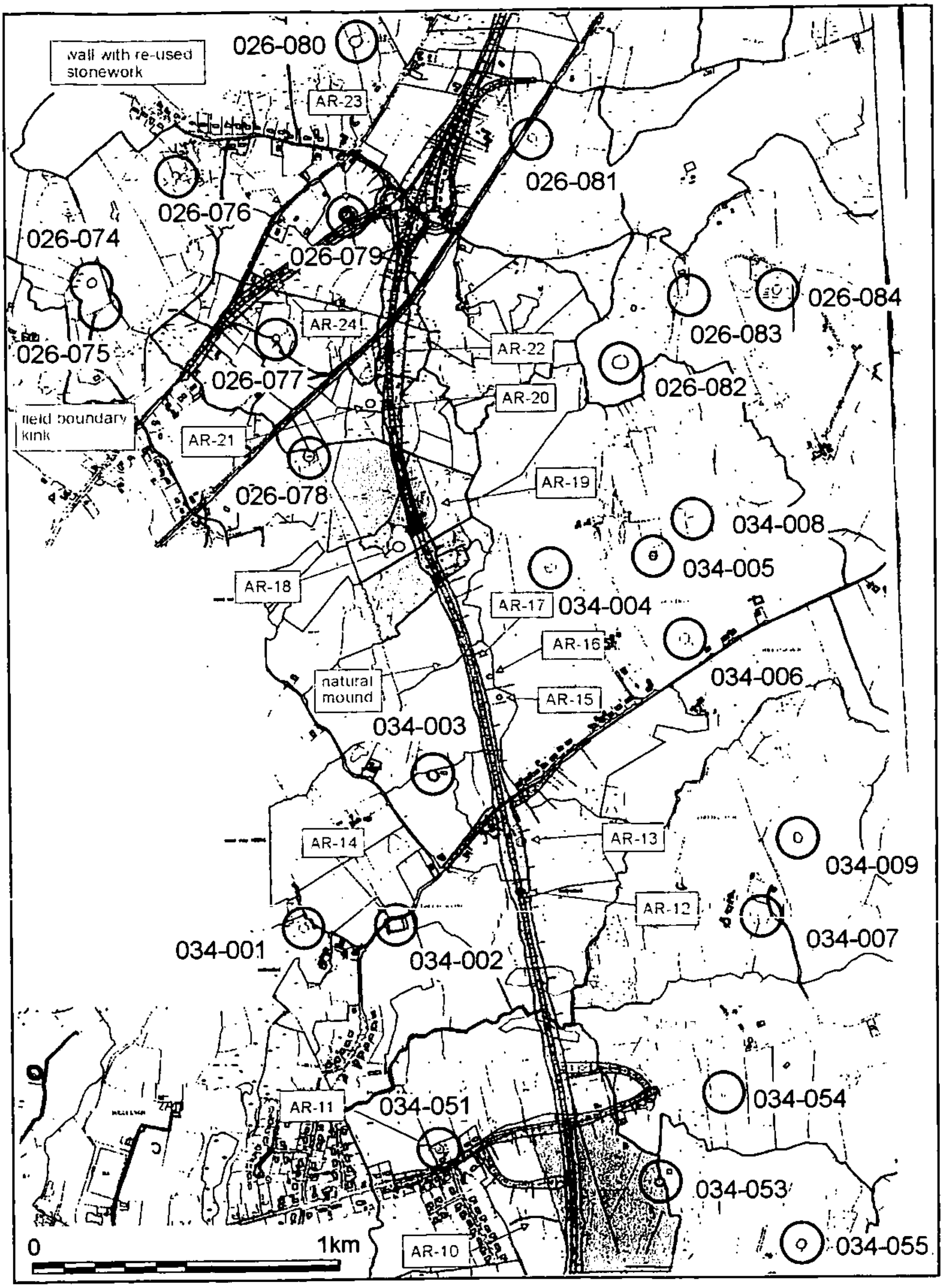


Fig. 5 Road Design Office map (April 1998) showing line of proposed route and location of sites of archaeological potential.

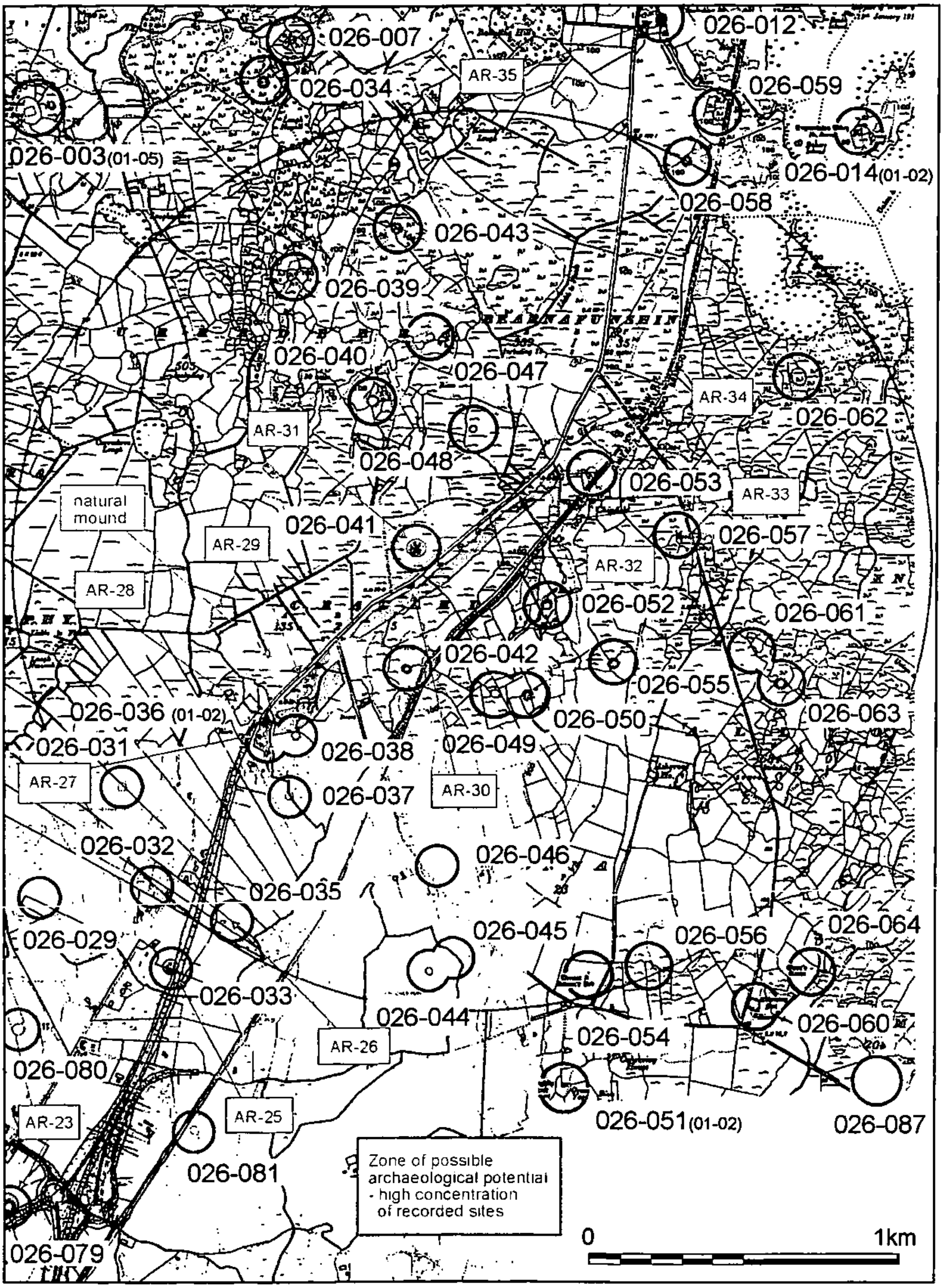


Fig. 6 Road Design Office map (April 1998) and Co. Clare SMR, sheet 26 (1992) showing line of proposed route and location of sites of archaeological potential.

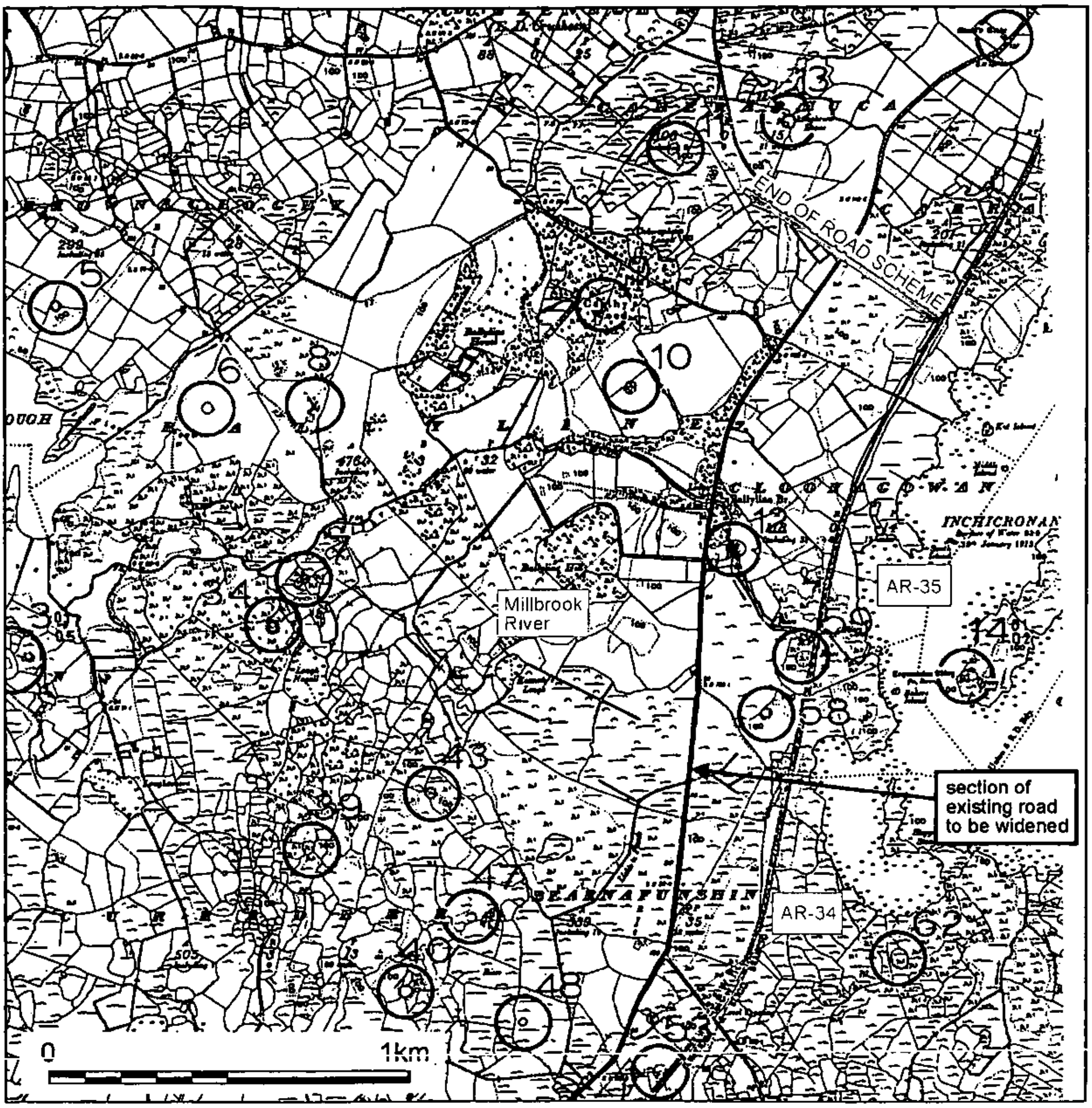


Fig.7 Co. Clare SMR, sheet 26 (1992) showing line of proposed route and location of sites of archaeological potential.

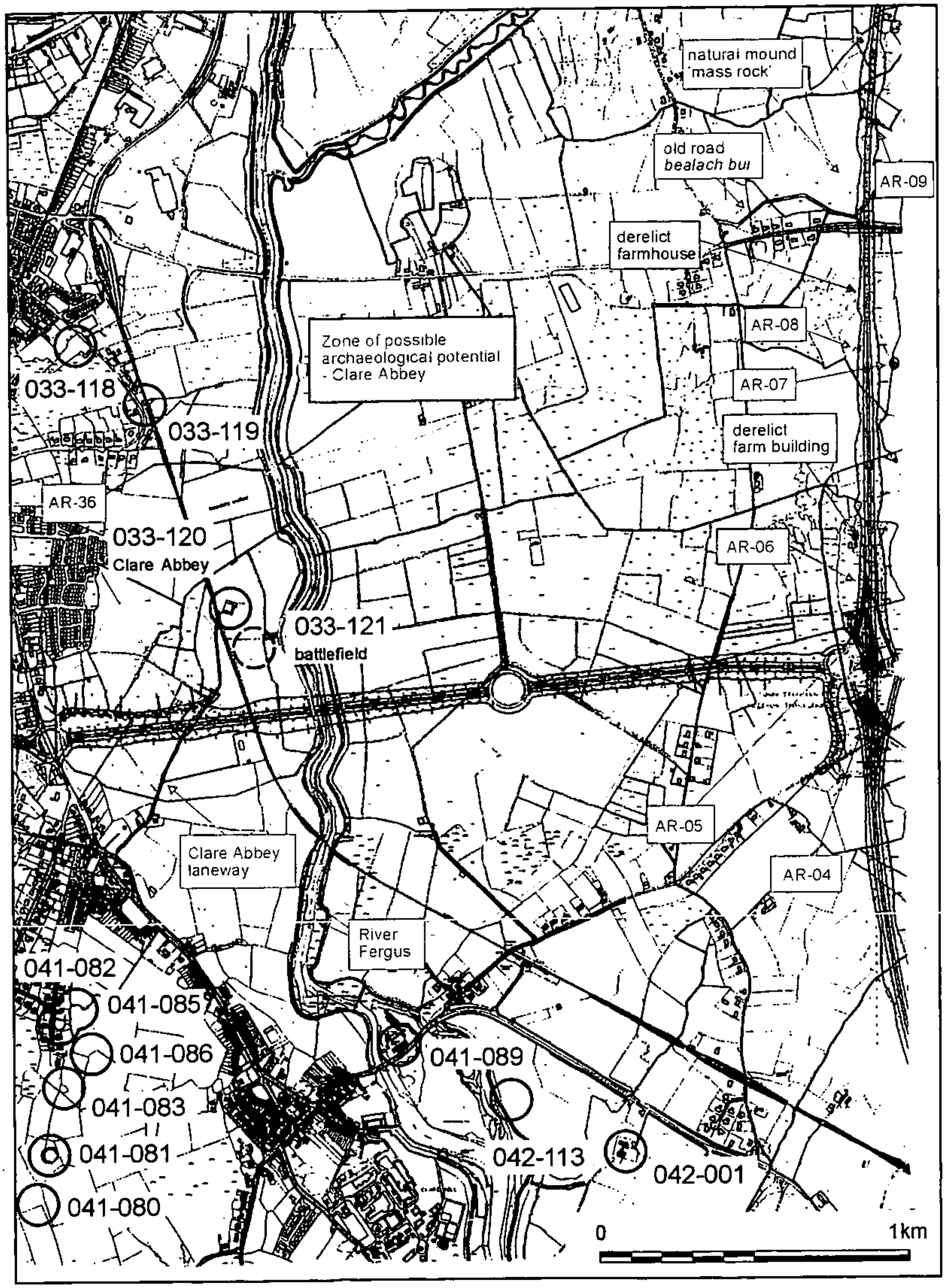


Fig. 8 Road Design Office map (April 1998) showing line of proposed route and location of sites of archaeological potential.

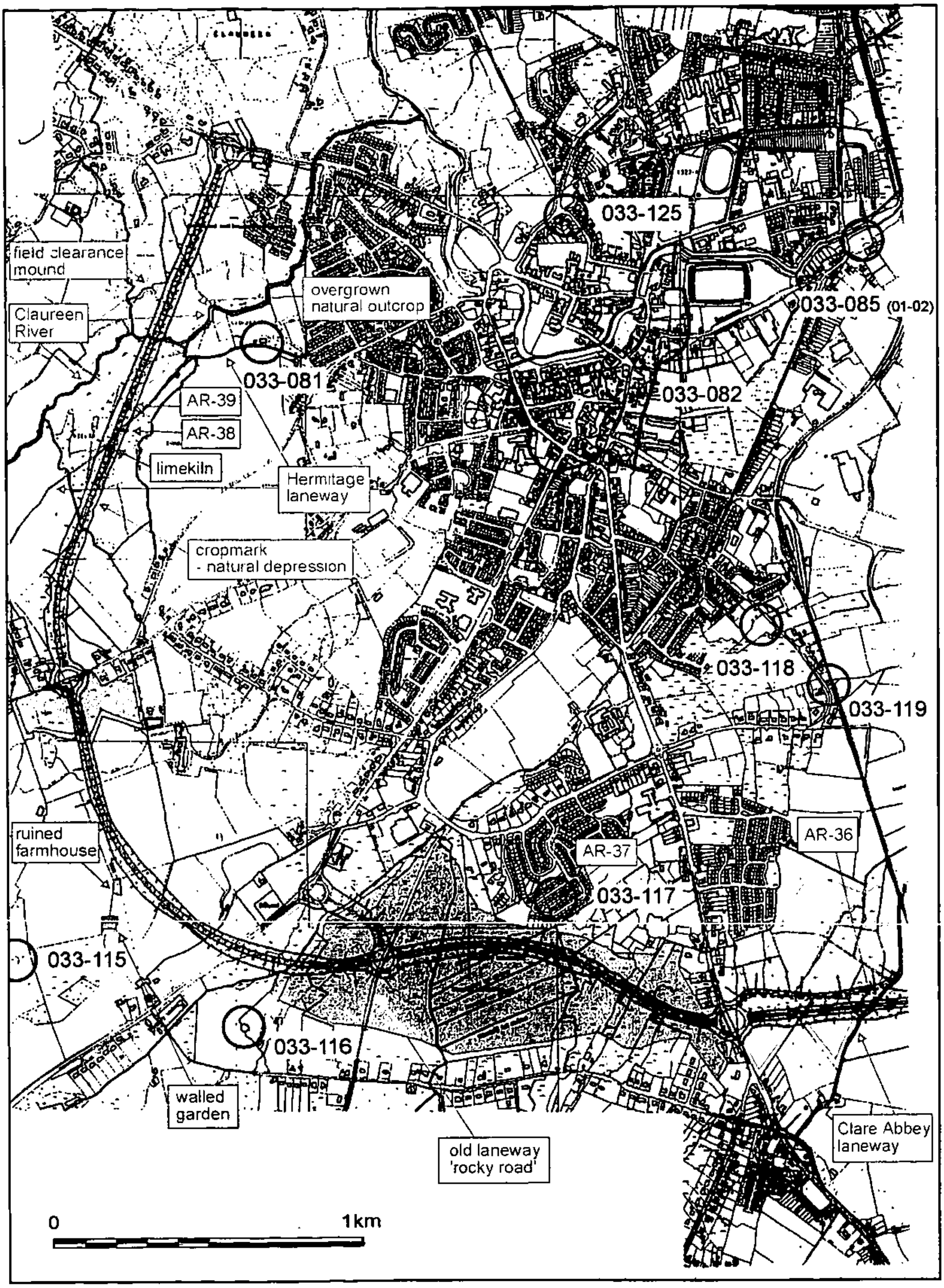


Fig. 9 Road Design Office map (April 1998) showing line of proposed route and location of sites of archaeological potential.

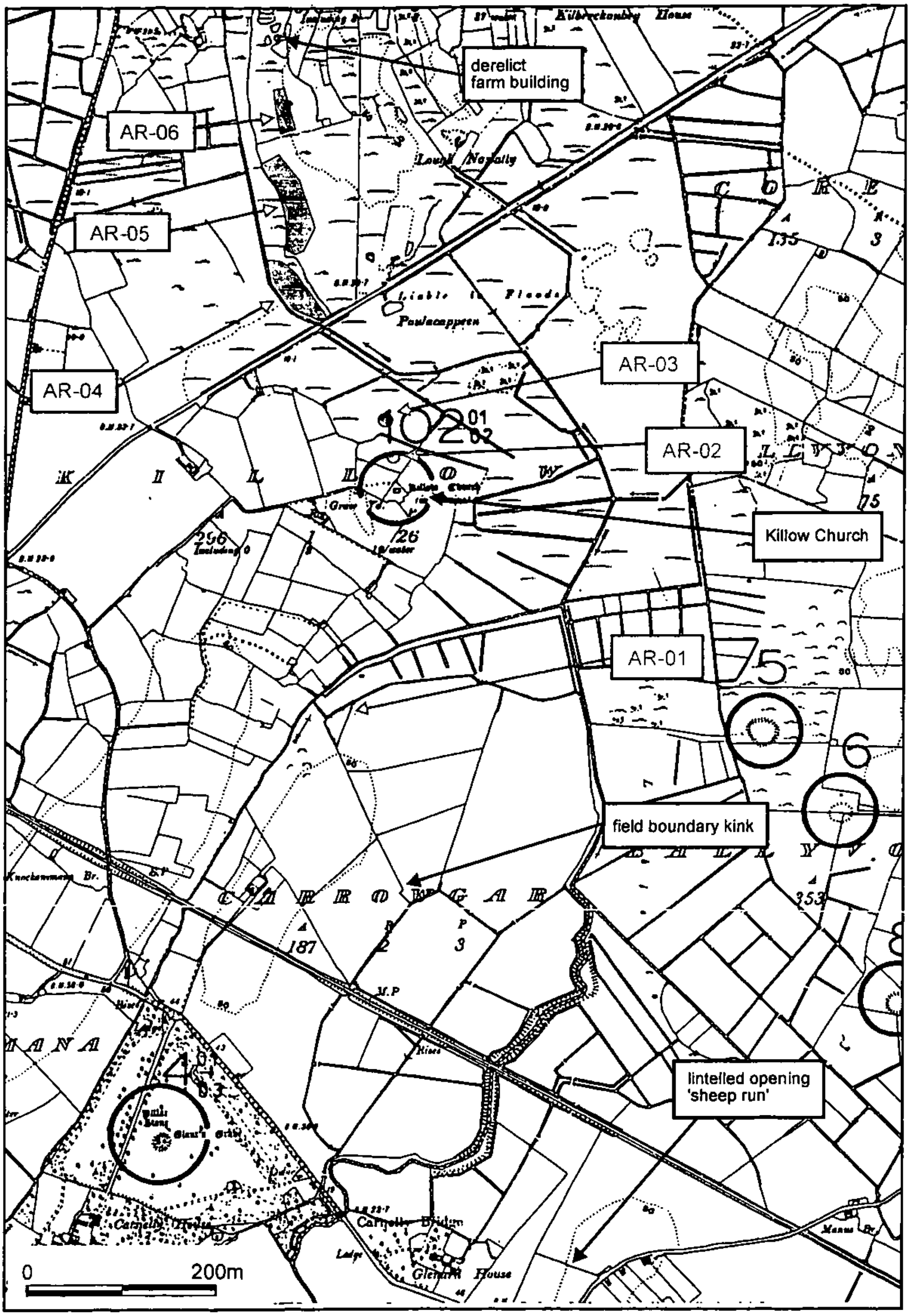


Fig. 10 Extract from Co. Clare SMR (sheets 34 & 42) showing location of sites of Archaeological Potential on route of Ennis By-Pass

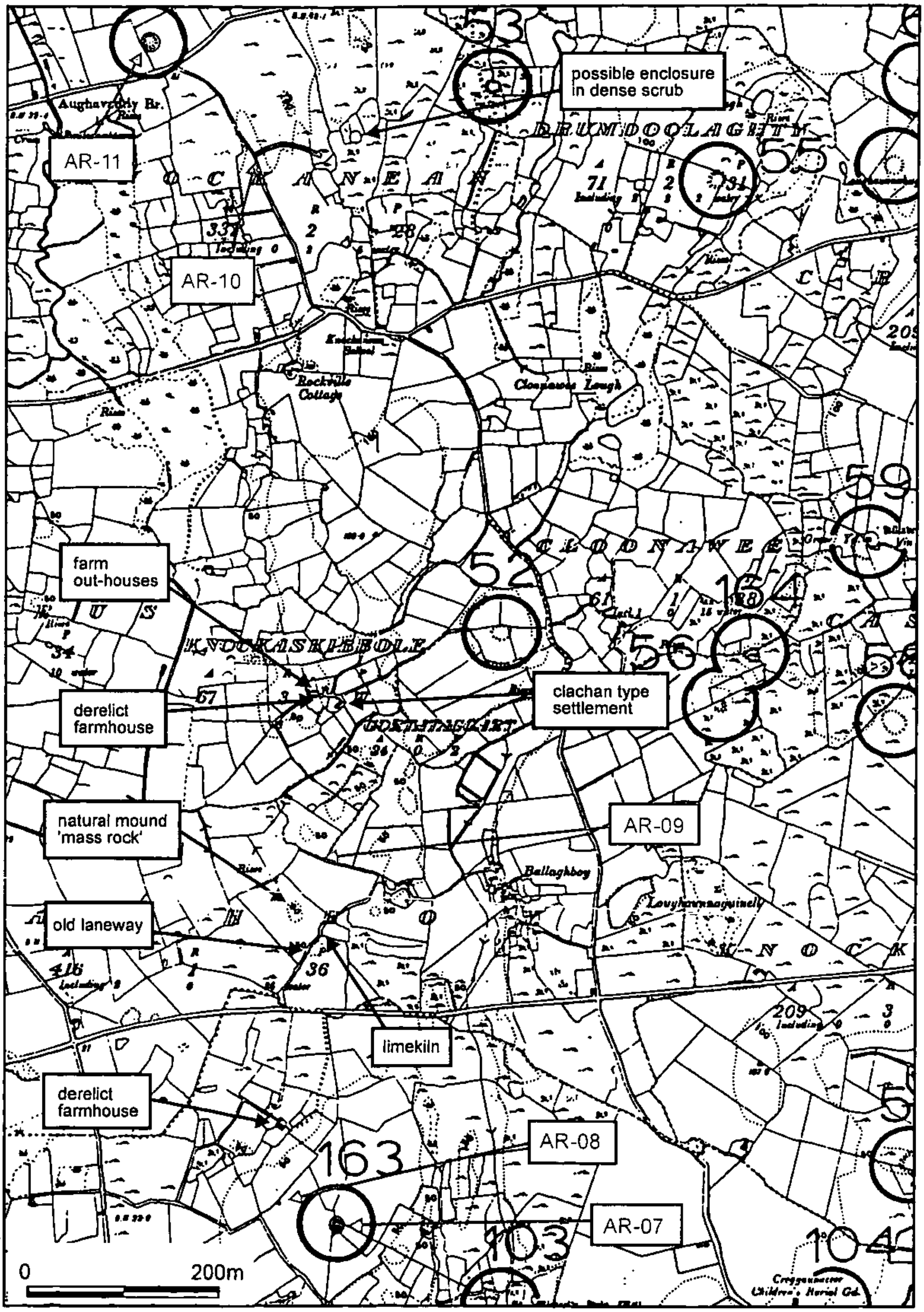


Fig. 11 Extract from Co. Clare SMR (sheet 34) showing location of sites of Archaeological Potential on route of Ennis By-Pass

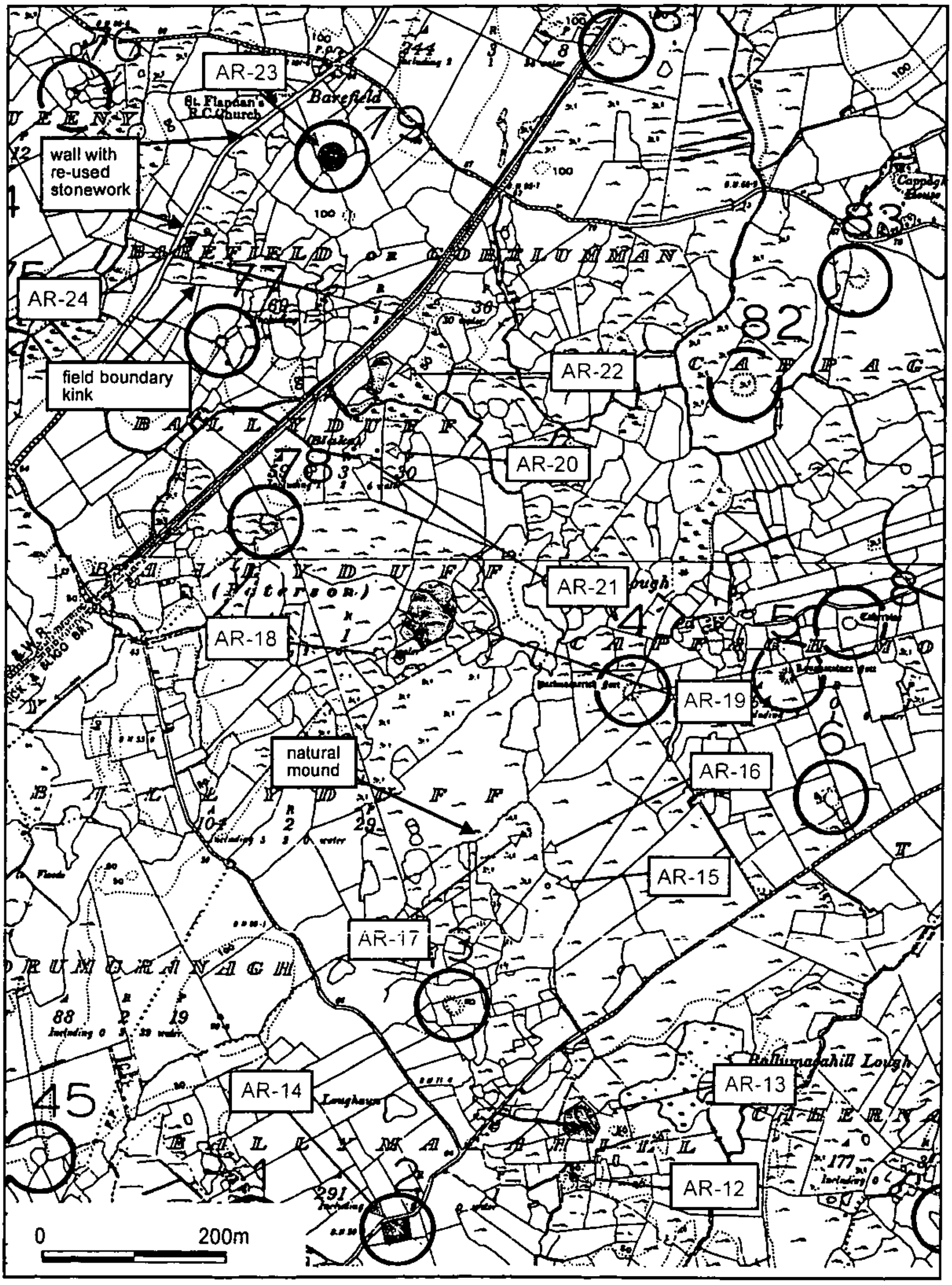


Fig. 12 Extract from Co. Clare SMR (sheets 26 & 34) showing location of sites of Archaeological Potential on route of Ennis By-Pass

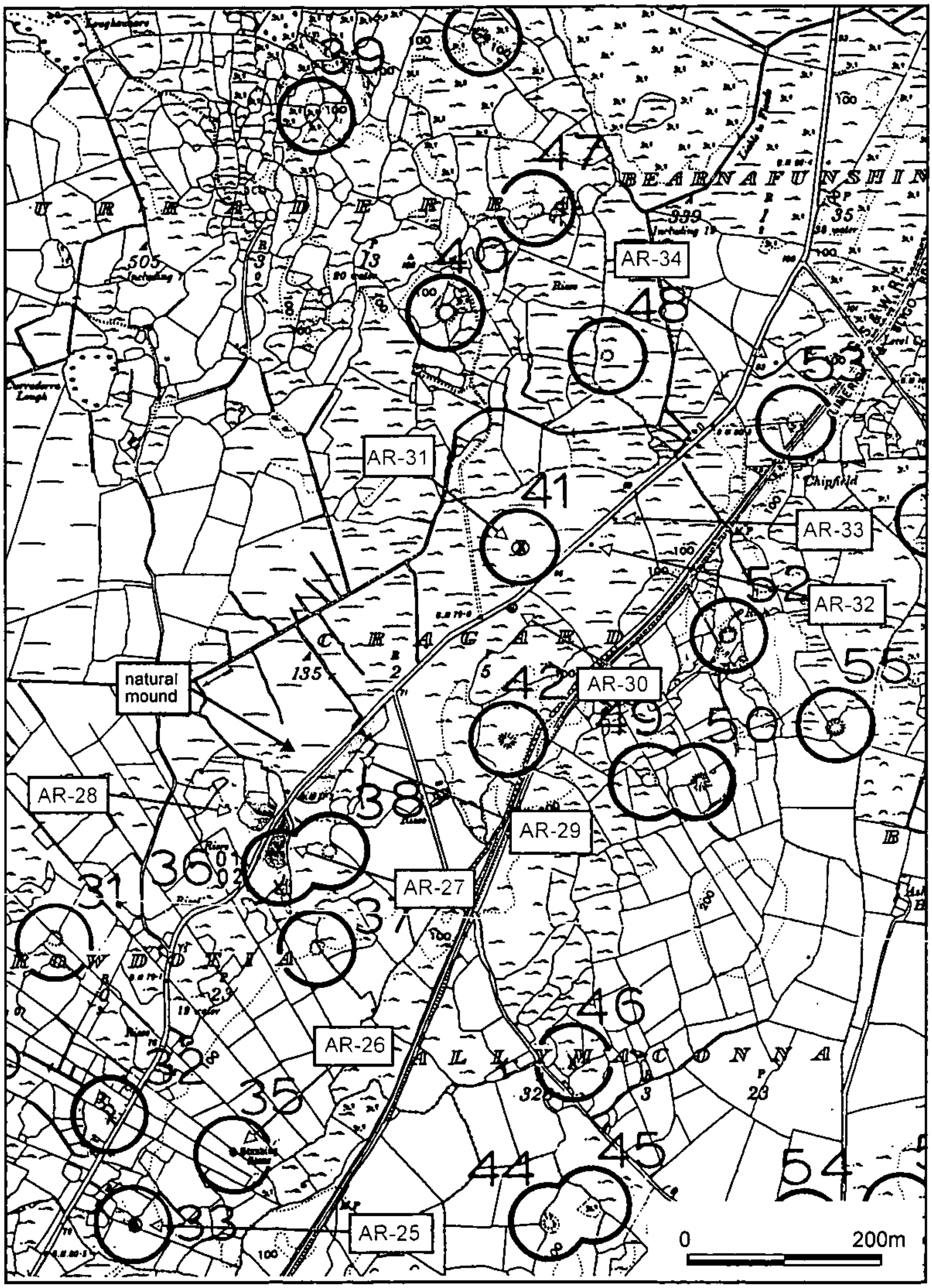


Fig. 13 Extract from Co. Clare SMR (sheet 26) showing location of sites of Archaeological Potential on route of Ennis By-Pass

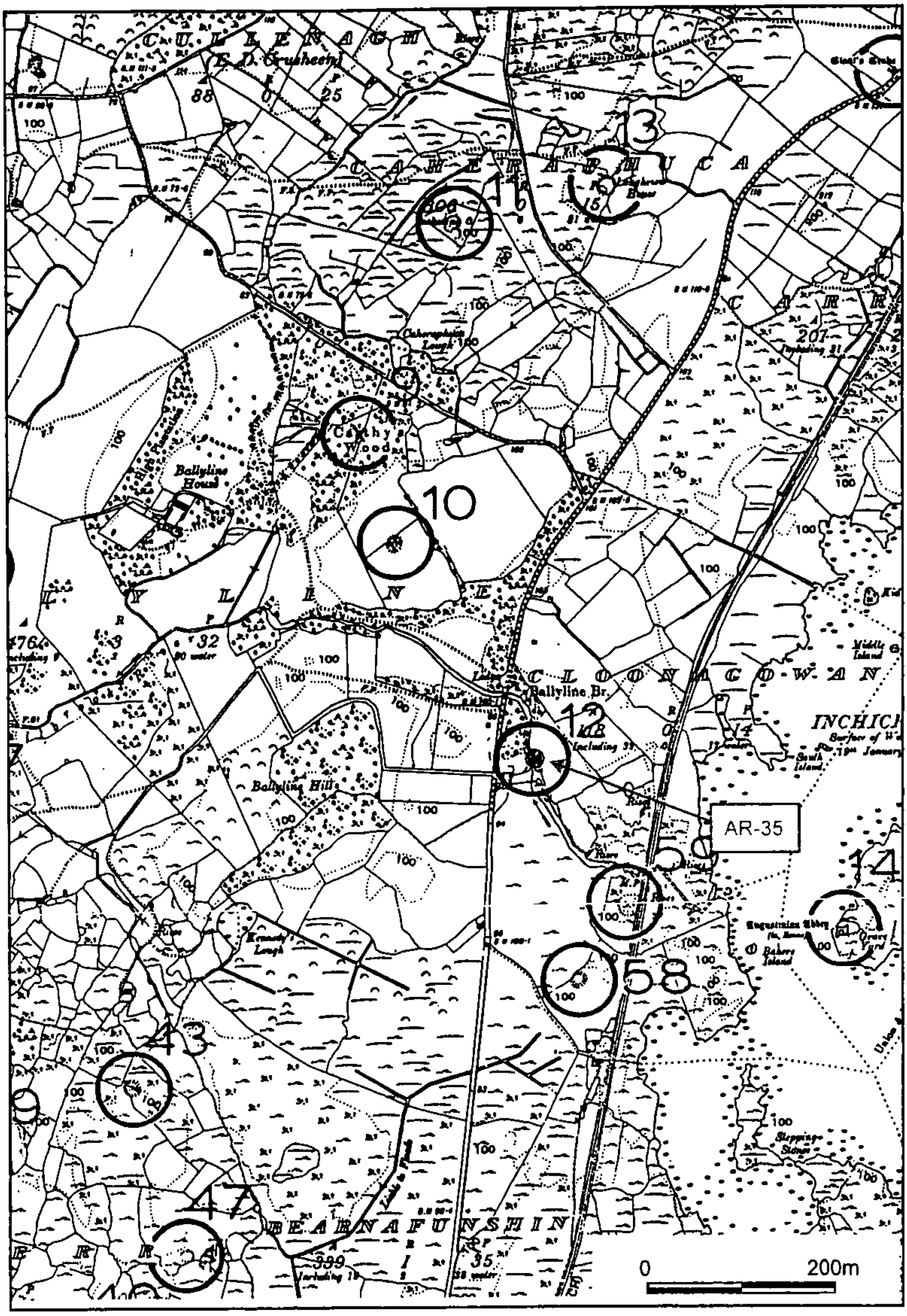


Fig. 14 Extract from Co. Clare SMR (sheet 26) showing location of sites of Archaeological Potential on route of Ennis By-Pass

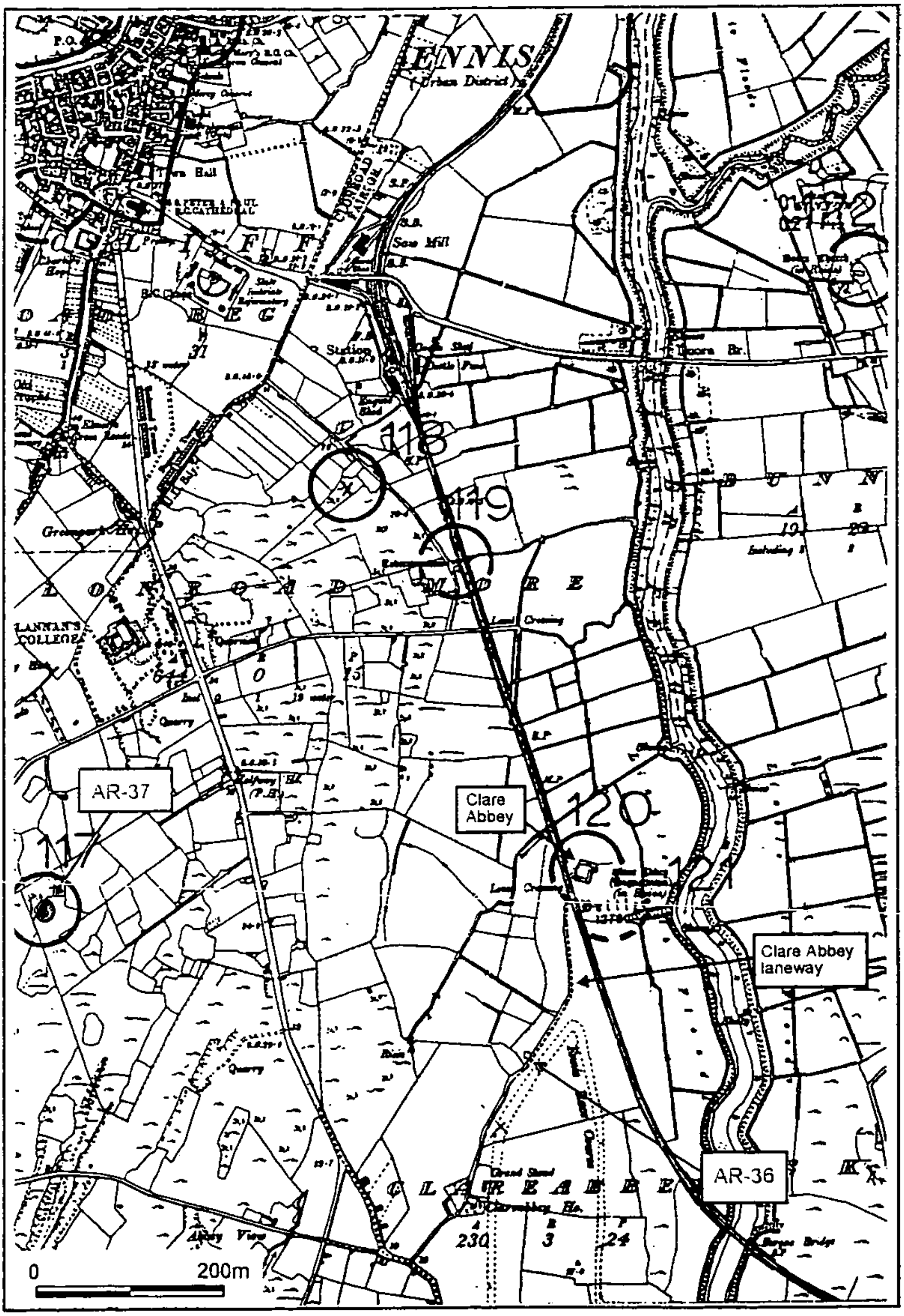


Fig. 15 Extract from Co. Clare SMR (sheet 33) showing location of sites of Archaeological Potential on route of Ennis By-Pass

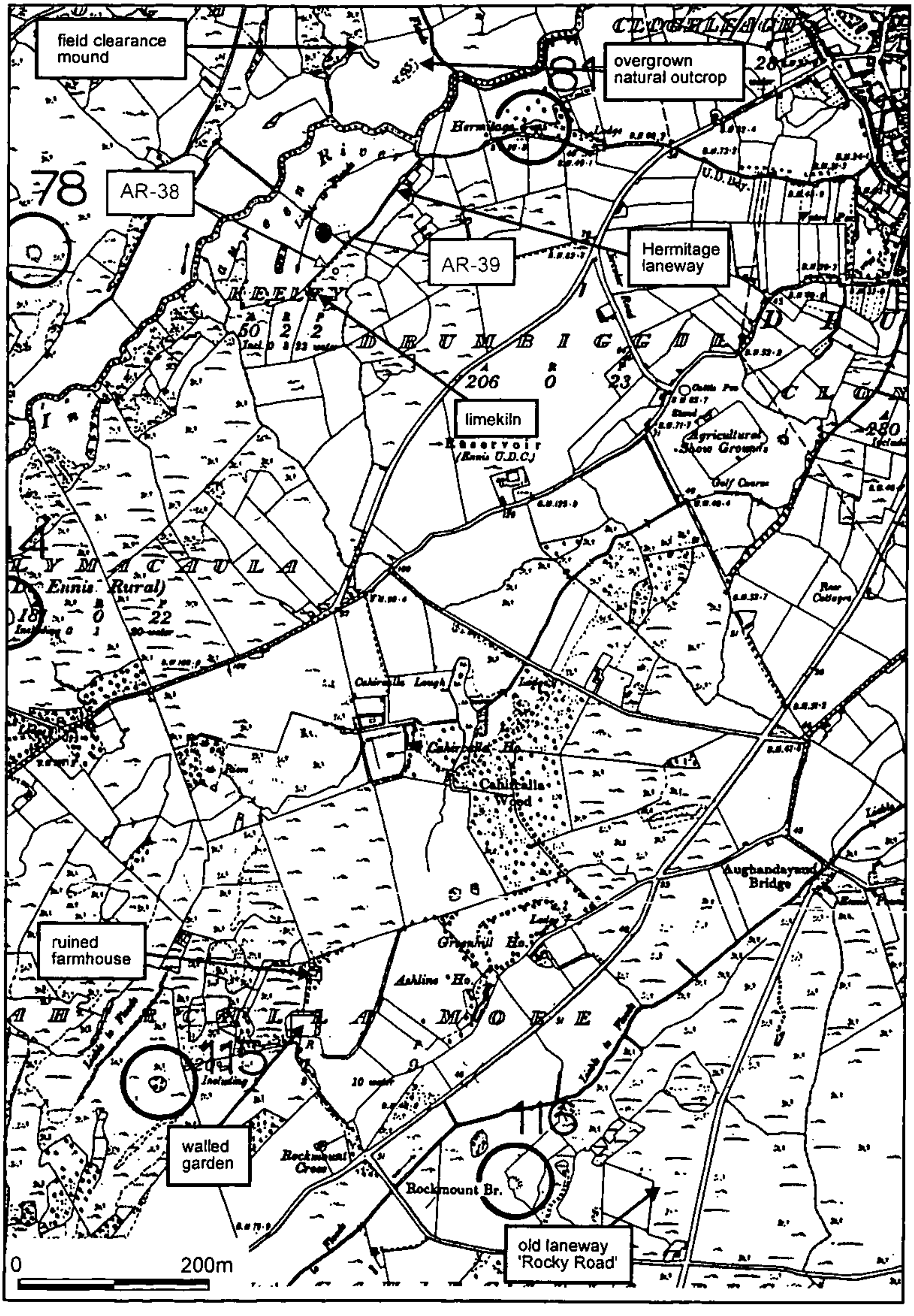


Fig. 16 Extract from Co. Clare SMR (sheet 33) showing location of sites of Archaeological Potential on route of Ennis By-Pass

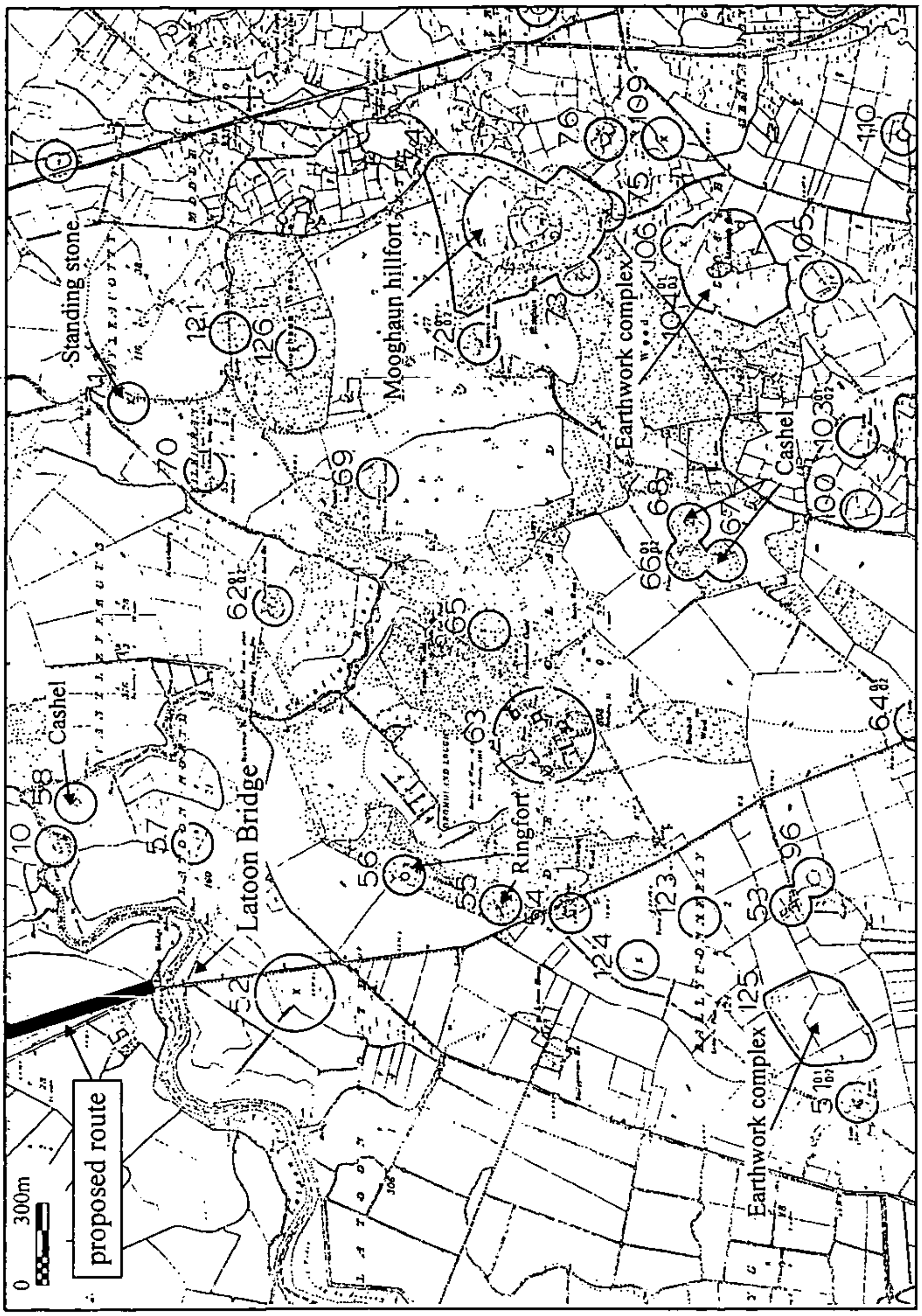


Fig. 17 Extract from SMR constraint map, Co. Clare sheet 42, showing, the hinterland about Moghaun hillfort.

Plate 3. Cairn from AR-05.

Plate 4. View of AR-06 from south, showing five of the small mounds.

Plate 1. View of AR-01 from south, showing four of the small mounds.

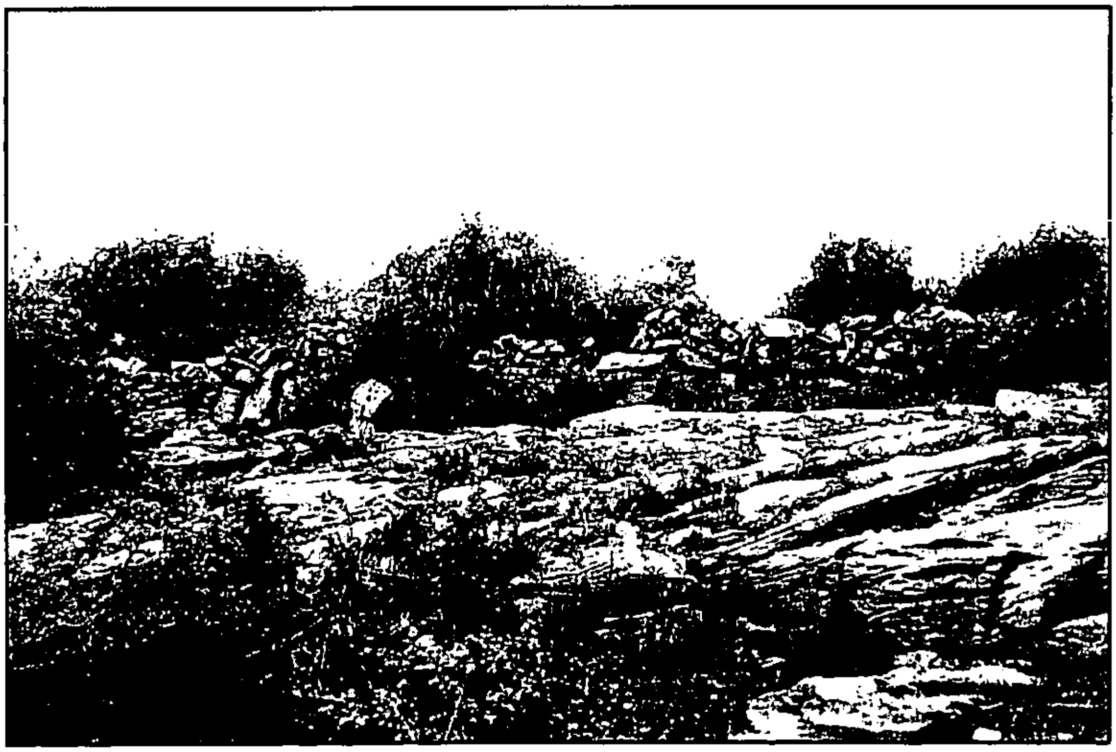


Plate 2. Old field boundary from AR-05.

Plate 5. AR-10 viewed from the south.

Plate 6. AR-12.

Plate 7. AR-17

Plate 8. Cairn from AR-19.

Plate 9. Possible Boulder burial from AR-19 (approx. scale provided by trowel).

Plate 10. AR-23 (Recorded monument CL026-079). Possible ringfort.

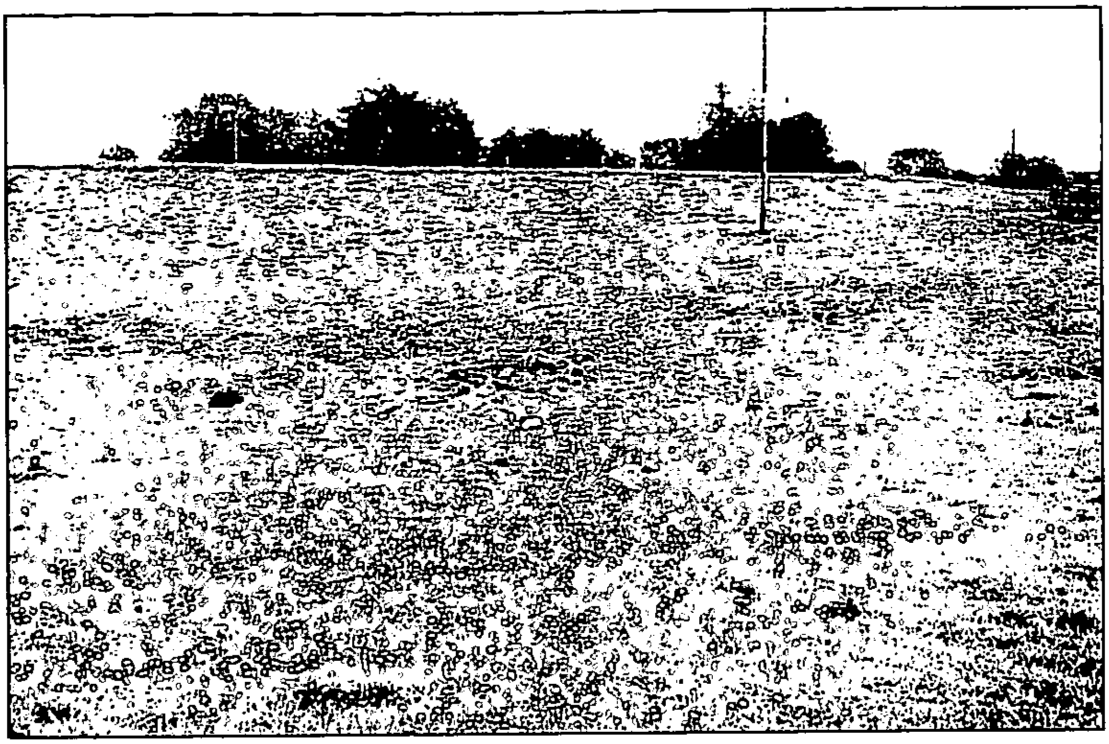


Plate 11. AR-24.

Plate 12. View of AR-27 showing two of the small mounds and a linear bank.

Plate 13. AR-02.

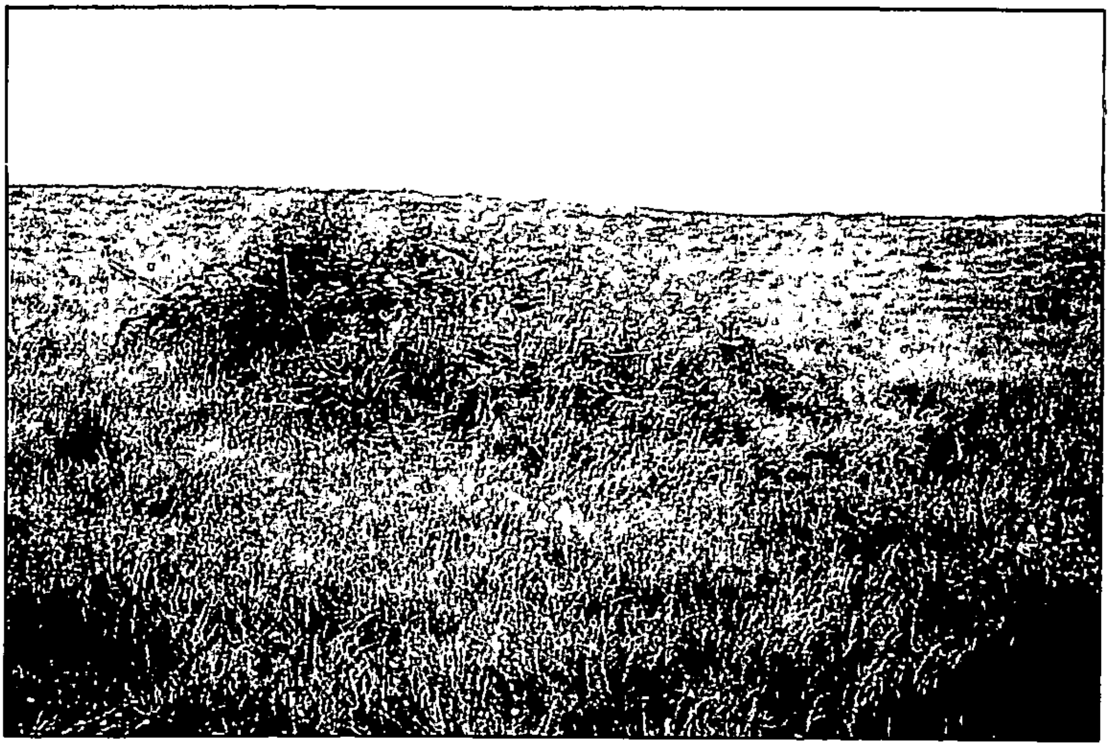


Plate 14. AR-15.

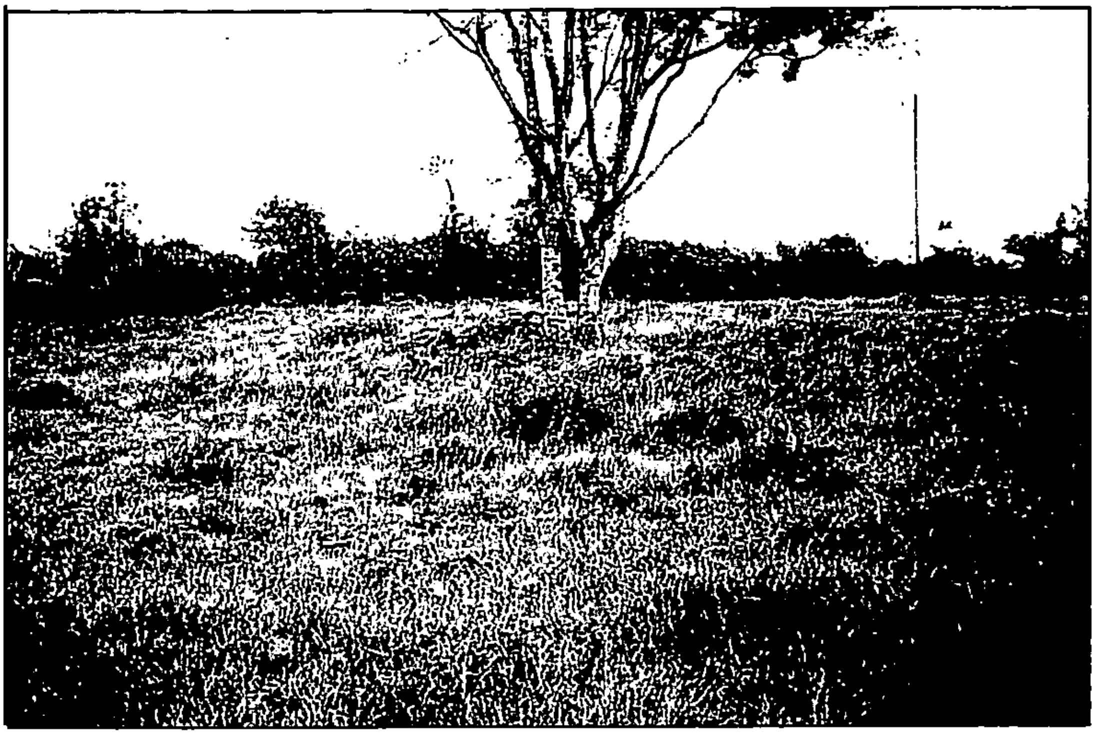


Plate 15. AR-16

Plate 16. Close-up of stone-lined hollow, AR-16.

Plate 17. AR-18 lying in a slight depression overgrown by trees and scrub.

Plate 18. One of the stone banks viewed from the interior of AR-18.

Plate 19. Top surface of a stone bank from AR-18.

Plate 20. AR-21

Plate 21. Natural ridge in the townland of Ballaghboy.

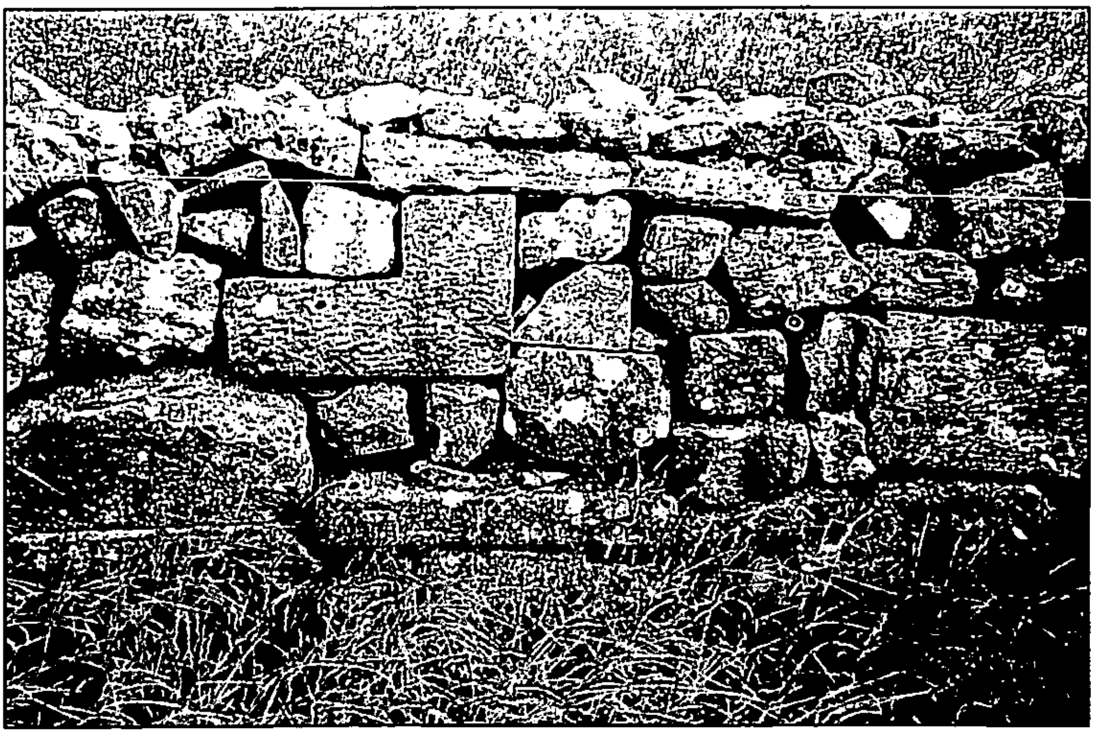


Plate 22. Roadside wall showing examples of re-used stonework, near Barefield

Plate 23. Roadside wall showing examples of re-used stonework near Barefield village

Plate 24. AR-09, possible souterrain. (approx. scale provided by trowel).

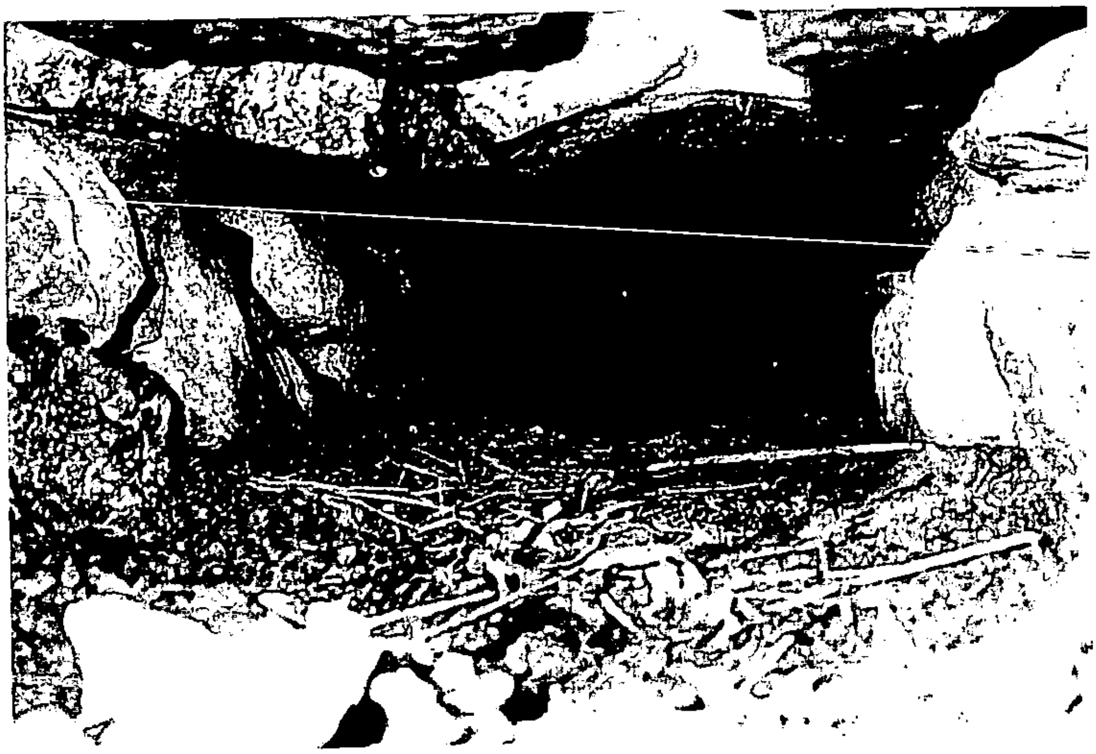


Plate 26. AR-32, possible standing stone.

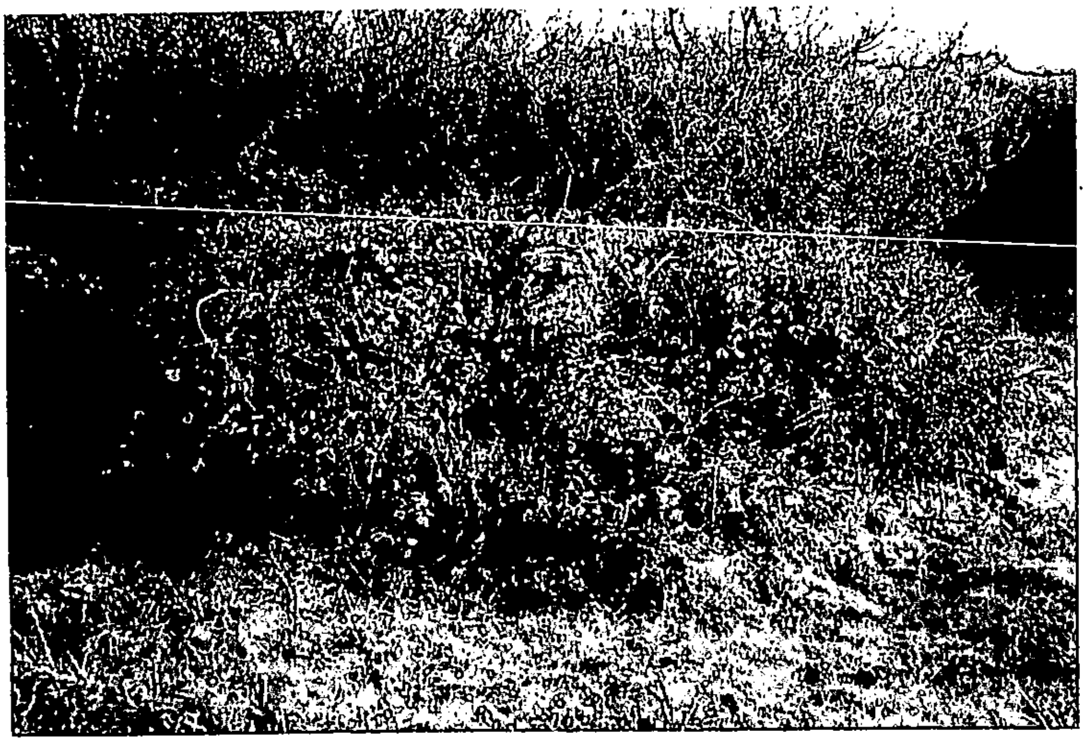


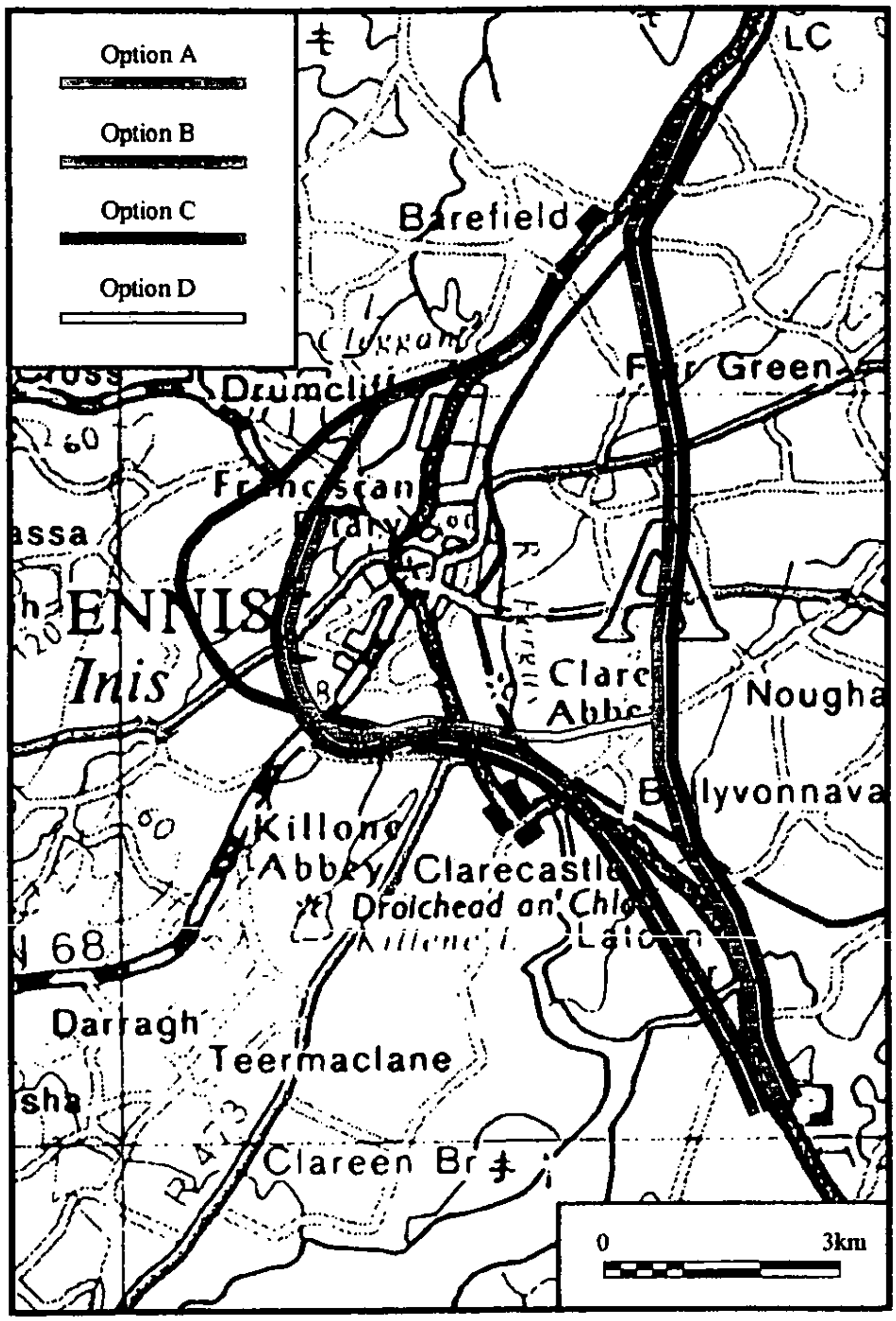
Plate 27. AR-33

Plate 28. AR-39.

Plate 29. AR-39, possible crannog.

Appendix 2

Route Options



Four options (A, B, C, D) were considered in the Broad Route Corridor Selection Report (November 1993 – Clare County Council)

Option A

Route Option A will directly affect three **recorded** archaeological sites.

Site No.	*Townland*	*Classification*
CL042-001	Knockanimana	Enclosure
CL042-002	Knockanimana	Enclosure
CL042-003	Knockanimana	Enclosure

There are six **recorded** sites that fall within a 200m strip either side of Option A.

CL042-113	Skehanagh	Standing Stone
CL033-081	Cloghleagh	17th Century House, possible
CL033-116	Cahircalla Beg	Enclosure
CL033-080	Claureen	Enclosure
CL033-131	Ballymaley	Fulachta Fiadh, possible
CL033-132	Ballymaley	Fulachta Fiadh, possible

Option B

Route Option B will directly affect three **recorded** archaeological sites.

Site No.		*Townland*	*Classification*
CL026-033		Carrowdotia	Enclosure
CL026-079		Barefield	Enclosure
CL026-036	01	Carrowdotia	Enclosure
	02	Carrowdotia	Enclosure

There are six **recorded** sites that fall within a 50m strip either side of Option B.

CL026-012	Cloonagowan	Watermill site
CL026-035	Carrowdotia	Standing Stone
CL026-041	Cragard	Enclosure
CL034-002	Ballymacahill	Rectangular enclosure
CL034-051	Knockanean	Enclosure
CL034-163	Kilbreckan	Enclosure

There are thirteen **recorded** sites that fall within a 200m strip either side of Option B.

CL026-032	Carrowdotia	Enclosure

Site No.		*Townland*	*Classification*
CL026-037		Carrowdotia	Enclosure
CL026-038		Carrowdotia	Enclosure
CL026-042		Cragard	Enclosure
CL026-048		Cragard	Enclosure
CL026-053		Bearnafunshin	Enclosure
CL026-058		Bearnafunshin	Enclosure
CL026-077		Barefield	Enclosure
CL026-078		Ballyduff (Patterson)	Enclosure
CL026-081		Drumquin	Enclosure
CL034-003		Ballymacahill	Enclosure
CL034-053		Knockanean	Enclosure
CL034-102	01	Killow	Church
	02	Killow	Graveyard

Option C

Route Option C will directly affect seven **recorded** archaeological sites.

Site No.	*Townland*	*Classification*
CL042-001	Knockanimana	Enclosure
CL042-002	Knockanimana	Enclosure
CL042-003	Knockanimana	Enclosure
CL033-069	Drumcaran Beg	Cashel
CL033-070	Drumcaran Beg	Cashel
CL033-075	Kilnacally	Enclosure
CL033-114	Ballymacaula	Cashel

There are two **recorded** sites that fall within a 50m strip either side of Option C.

CL033-067	Cragleagh	Enclosure
CL033-068	Cragleagh	Burial Ground

There are nine **recorded** sites that fall within a 200m strip either side of Option C.

CL042-113	Skenanagh	Standing Stone
CL033-116	Cahircalla Beg	Enclosure

Site No.		*Townland*	*Classification*
CL033-033	01	Drumcliff	Church
	02	Drumcliff	Graveyard
	03	Drumcliff	Round Tower
CL033-034	01	Drumcliff	Ecclesiastical enclosure
	02	Drumcliff	Church
CL033-066		Ballylannidy	Enclosure
CL033-073		Drumcarran More	Enclosure
CL033-074		Kilnacally	17th Century House, possible
CL033-113		Ballylannidy	Cashel site
CL033-117		Clonroad More	Enclosure

Option D

Option D is the same as Option B with the addition of a bypass section beginning west of Ennis and meeting Option B at a junction to be constructed at Kilbreckan

Option D is the route dealt with in the main body of the text.

Route Option D will directly affect three **recorded** archaeological sites.

Site No.		***Townland***	***Classification***
CL026-033		Carrowdotia	Enclosure
CL026-079		Barefield	Enclosure
CL026-036	01	Carrowdotia	Enclosure
	02	Carrowdotia	Enclosure

There are seven **recorded** sites that fall within a 50m strip either side of Option D.

CL026-012	Cloonagowan	Watermill site
CL026-035	Carrowdotia	Standing Stone
CL026-041	Cragard	Enclosure
CL034-002	Ballymacahill	Rectangular enclosure
CL034-051	Knockanean	Enclosure
CL034-163	Kilbreckan	Enclosure
CL033-117	Clonroad More	Enclosure

There are fifteen **recorded** sites that fall within a 200m strip either side of Option D.

Site No.		***Townland***	***Classification***
CL026-032		Carrowdotia	Enclosure
CL026-037		Carrowdotia	Enclosure
CL026-038		Carrowdotia	Enclosure
CL026-042		Cragard	Enclosure
CL026-048		Cragard	Enclosure
CL026-053		Bearnafunshin	Enclosure
CL026-058		Bearnafunshin	Enclosure
CL026-077		Barefield	Enclosure
CL026-078		Ballyduff (Paterson)	Enclosure
CL026-081		Drumquin	Enclosure
CL033-081		Cloghleagh	17^{th} Century House, possible
CL033-116		Cahircalla Beg	Enclosure
CL034-003		Ballymacahill	Enclosure
CL034-053		Knockanean	Enclosure
CL034-102	01	Killow	Church
	02	Killow	Graveyard

Appendix 3

Route changes (January 1999)

The Road Design Office, Mungret made the following route amendments as the report was going to press.

1. Skehanagh townland

   This is a new road that connects the present Clarecastle Road with the proposed Skehanagh roundabout [Fig. 18].

2. Knockanean townland

   This is a realignment of the junction between the present Doora Road and the proposed Ennis By-Pass [Fig. 19].

3. Barefield (or Gortlumman) townland

   The proposed Barefield junction has been redesigned with the addition of a new link road passing close to the railwayline [Fig. 20].

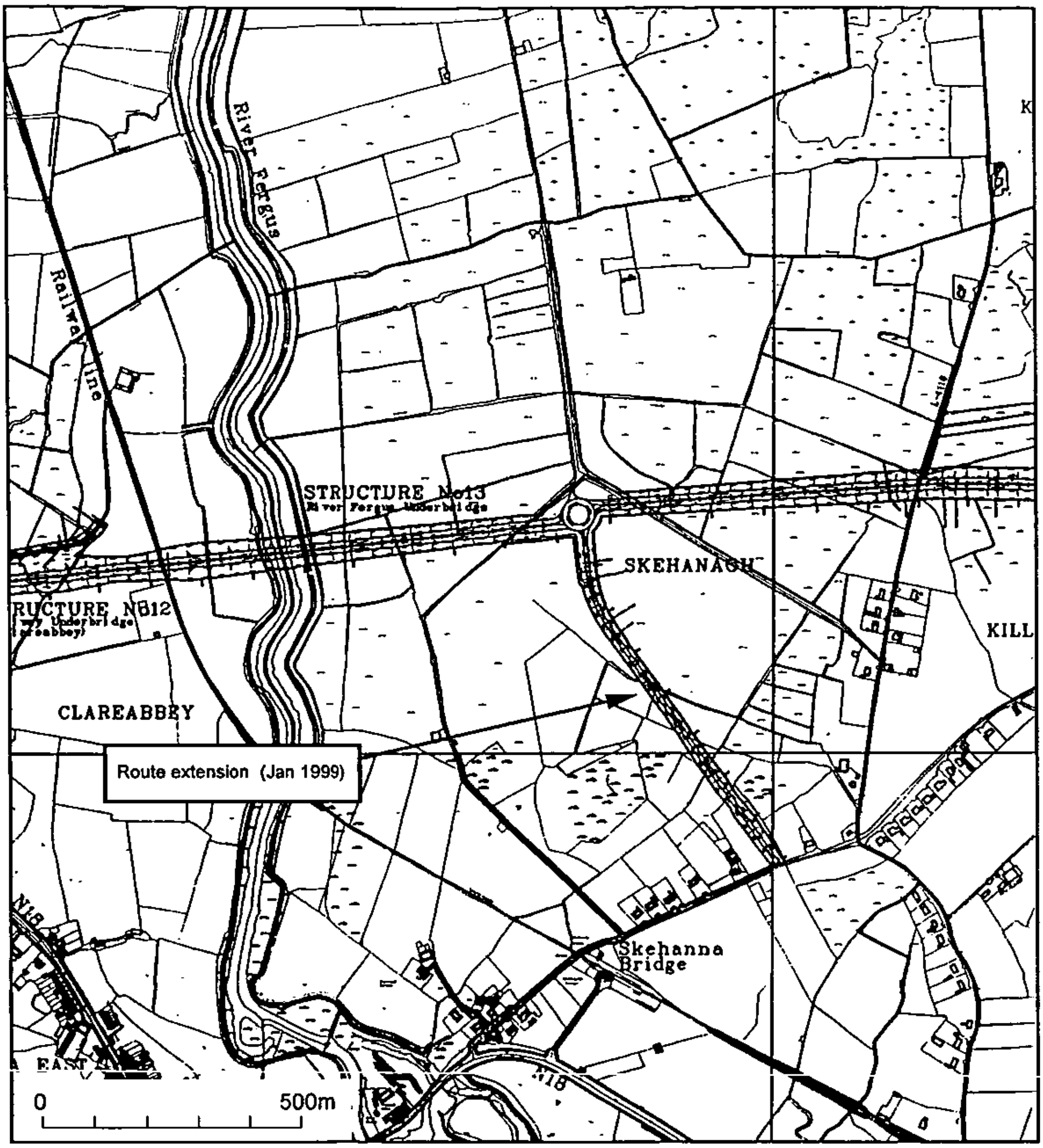


Fig. 18 Extract from Road Design Office map (Jan 1999) showing route alteration.

The route extension indicated above, does not directly affect any known monuments. This new road crosses the large area of drained marshland, that covers most of Skehanagh townland [see Fig. 8; page 64].
Refer to Section 2.3:ix:7 (pages 46-48) for additional information about this wetland area.

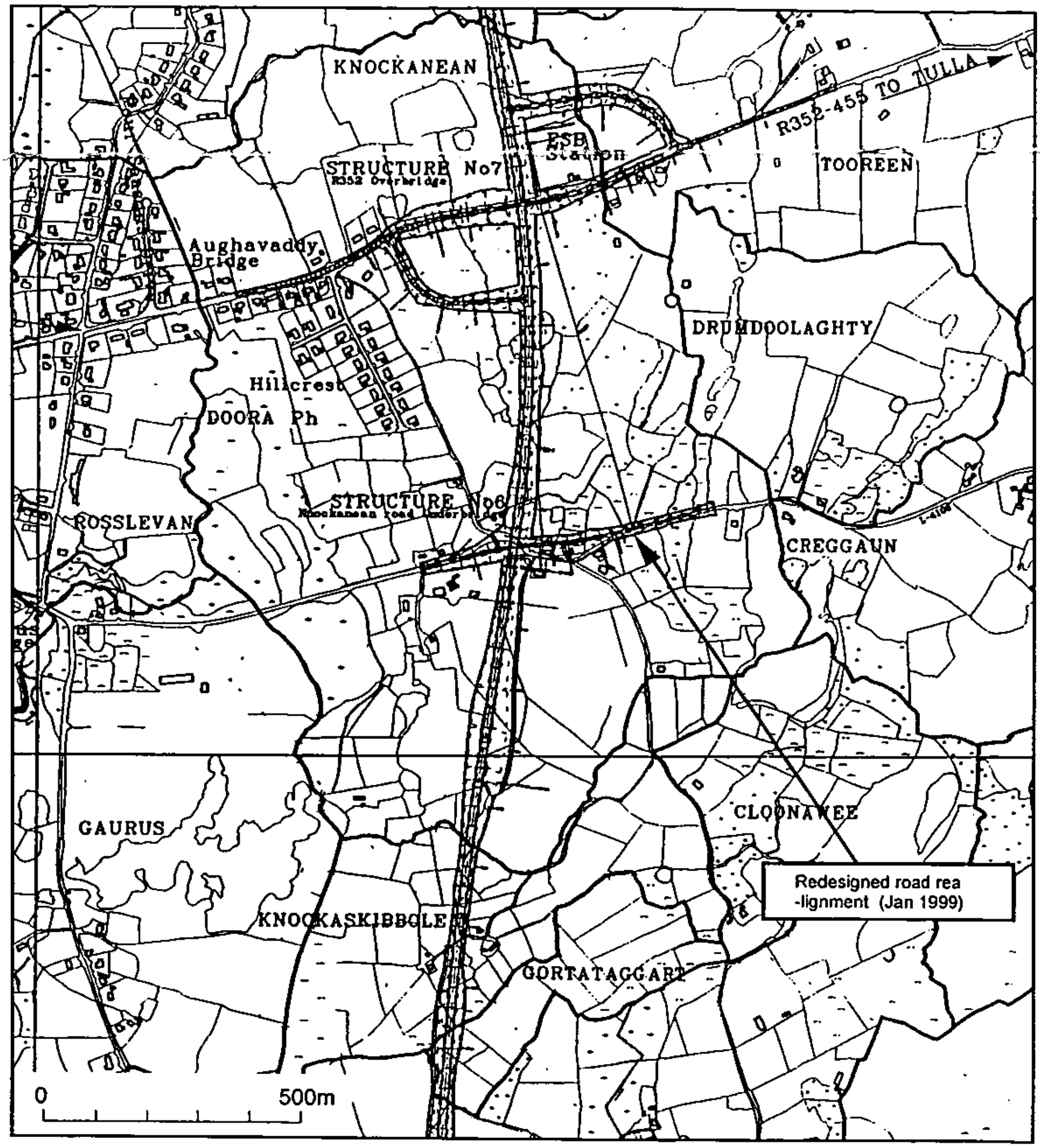


Fig. 19 Extract from Road Design Office map (Jan 1999) showing route alteration.

The road realignment indicated above, does not directly affect any known monuments. It crosses a small area of wet bogland [see Fig. 4; page 60]. Refer to Section 2.3:ix:9 (pages 46 & 48) for additional information on this area of wetland.

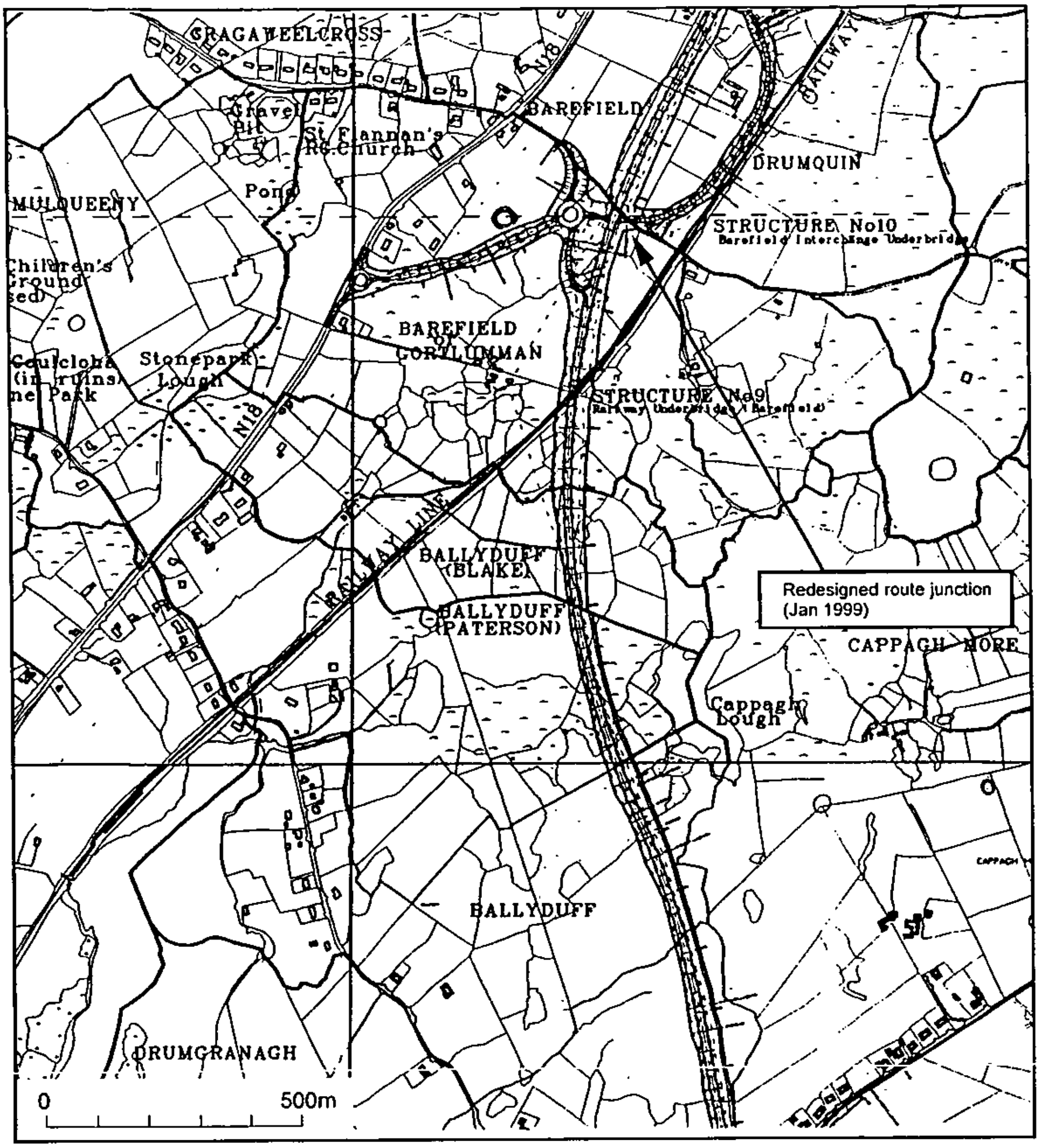


Fig. 20 Extract from Road Design Office map (Jan 1999) showing route alteration.

Barefield Junction has been redesigned, as indicated above. Its impact is virtually identical to that of the earlier junction design [see Fig. 5; page 61].
The only significant change is the addition of a link road that passes close to the railwayline. This new road passes within 50m of SMR site CL026-081 (enclosure, diam. c.15m). Refer to Section 1.1:iii:16 (page 9) & Fig.12 (page 68).