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THE IRISH ACADEMY OF ENGINEERING

TOWARDS AN ISLAND POPULATION OF 6 MILLION

IMPLICATIONS FOR SPATIAL DEVELOPMENT

MAY 2000

THE IRISH ACADEMY
OF ENGINEERING

This paper has been prepared by the Irish Academy of Engineering as a scoping document to stimulate debate on the issues which will arise as the population of the island grows over the first decade of the new century. It suggests one approach among the many which might be chosen to determine the manner in which infrastructure might be developed to ensure sustainable expansion.

The Academy welcomes the "National Development Plan 2000-2006" in the Republic of Ireland published in November 1999, and the regional strategic framework for Northern Ireland entitled "Shaping our Future – towards a Strategy for the Development of the Region" published in December 1998. These documents contain valuable guidelines on how the development of both areas is envisaged. In preparing this paper the Academy has drawn on many official publications and has presented the information in a way which it considers offers a scenario for more balanced development. It has drawn on the extensive knowledge of its members in both the public and private sectors.

The Government in the Republic has recently initiated a two year project to prepare a National Spatial Development Strategy. The Academy welcomes this initiative, and looks forward to contributing further to the evolution of the strategy.

This paper is presented for consideration by the authorities and the public in both the Republic and Northern Ireland . The Academy will be pleased to discuss the recommendations and other related issues raised in the report. It is felt that our members have a special contribution to make to the debate on spatial development.

Gordon Millington
President

April 2000

Contents:

1. Introduction

This is a scoping paper aimed at stimulating debate about an issue which is of considerable importance to the future quality of life of all the inhabitants of the island of Ireland.

Since 1960 the population of the island has increased from 4.3 million to an estimated 5.5 million in 1999. Over the ten year period to 1996 it increased by about 250,000, and since then the rate of increase has accelerated as a result of the continuation of rapid economic growth particularly in the area comprising the Republic of Ireland. It now seems likely that the population of the island will rise from its current level to about 6 million over the next ten years.

The exceptional economic growth of recent years has resulted in increased pressure on the physical infrastructure, particularly in the main urban centres. Many areas of the island have not been sharing equally in economic development. The completion of the European Internal Market in 1992 leading to the removal of border controls, and the restoration of peace on the island, has made it easier for individuals to live in one jurisdiction on the island and work in the other.

The continued expansion of the island economy is desirable, as it leads to higher living standards and increased employment. However, if this growth is concentrated in too small an area, it will lead to traffic congestion, other infrastructural deficiencies, and a disimprovement in the quality of life, even for those who benefit economically.

Early in 1999, the Irish Academy of Engineering, with membership drawn from the whole island, decided to prepare a scoping paper to open a debate on where the additional half a million inhabitants should be encouraged to live so as to achieve the optimum benefits in terms of continued economic growth and improved living standards for the population at large.

This paper is being prepared at a time when spatial development issues are on the agenda for Governments both in the Republic and Northern Ireland. In the Republic the "National Development Plan 2000-2006" (N.D.P.) was published in November 1999. It stated that:

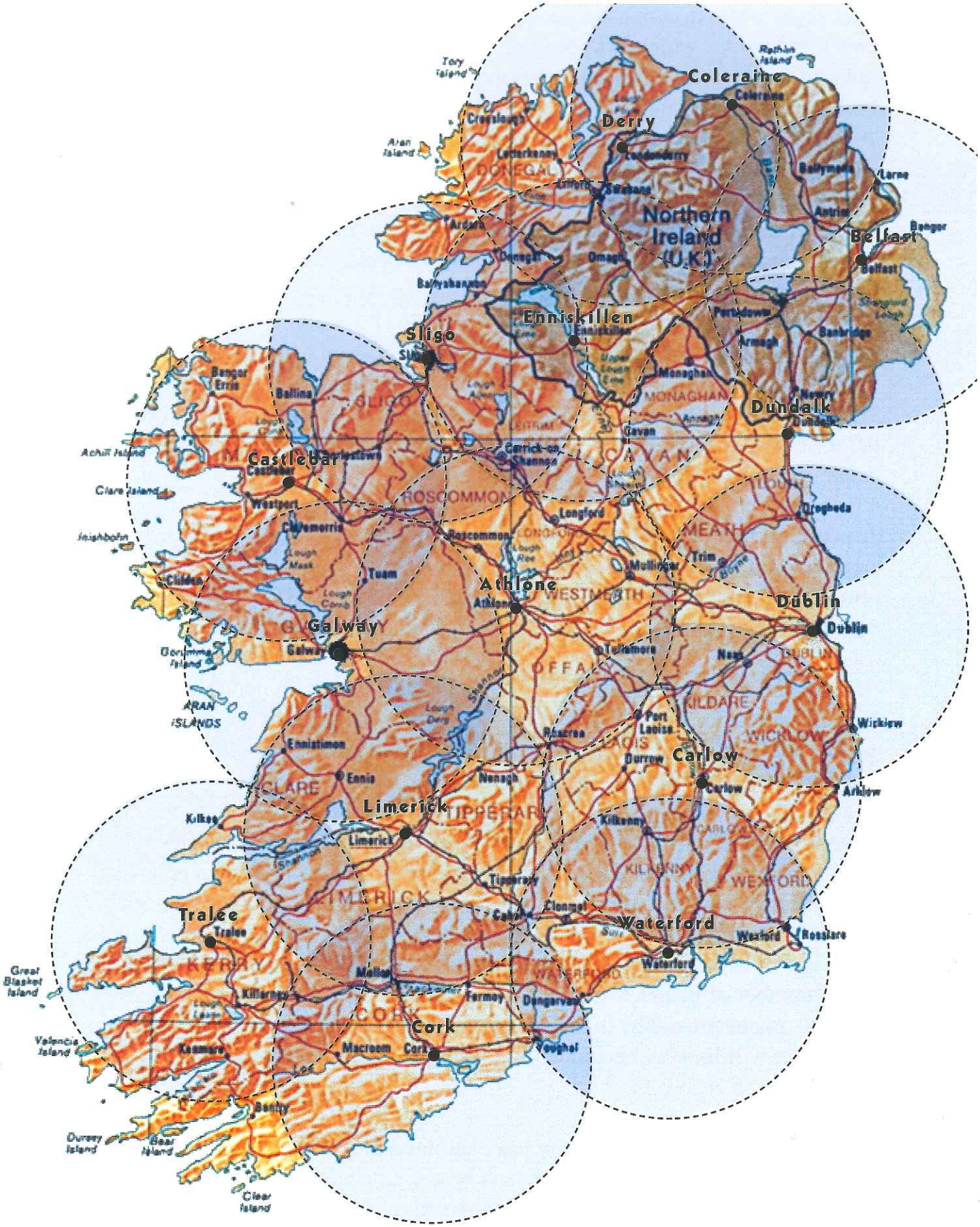
" The Government's objective for regional policy in the N.D.P. is to achieve more balanced regional development. A key component of the Government's Regional Development Policy will be to facilitate further development of the existing major Gateways and the focused development, as Regional Gateways, of a limited number of strategically placed centres. The challenge is to create the conditions whereby a second tier of larger urban centres can start to act as Regional Gateways as a means of wider regional development, thus spreading economic growth more widely. Only a limited number of locations should be selected as Gateways so as to ensure the necessary concentration of resources and investment. The Gateway approach will help to create the critical mass to spur growth in the designated centres and in their wider zones of influence. The Government has mandated the Department of the Environment and Local Government to prepare a National Spatial Strategy which will translate the broad approach to regional development in the Plan into a more detailed blueprint for spatial development over the longer term."

In December 1998 the Department for the Environment for Northern Ireland published a draft Regional Strategic Framework for Northern Ireland entitled "Shaping Our Future- towards a Strategy for the Development of the Region". It stated that " the proposed Spatial Development Strategy for Northern Ireland is a hub, corridor and gateway approach based on five fundamental strategies for the future physical development of the Region. The aim is to give a strategic focus to future development and achieve balanced growth within the Region by developing:

- The key transport corridors;
- A compact and thriving metropolitan core centred on Belfast;
- A strong Northwest regional centre based on Derry/Londonderry;
- A polycentric network of strong Regional Towns and
- A vibrant rural community."

Nodal Catchments

40m / 65km radius



Map 1.

This is the context within which the Academy has prepared its discussion paper, the aim of which is to provide a useful framework for the development of an integrated Spatial Development Strategy, which is relevant to both parts of the island.

The Academy also recognises that it is more feasible during a period of population expansion, such as that currently pertaining in both parts of the island to consider where the additional workforce, many of them mobile immigrants from other EU member states (particularly Great Britain), might be encouraged to locate.

In past decades the question of encouraging relocation of families, either within the island or abroad, was often a cause for trauma. Perhaps for the first time it is possible to consider the development of policies, which will offer individuals the option of continuing to live and work within their home regions on the island.

It is a stark reality that the alternative may be to create further imbalances in population densities on the island, which may have greater economic and social costs, and place at risk the sustainability of the current high rate of economic growth.

The Academy therefore decided to focus its attention on the possibility of creating conditions which would enable the vast majority of the population to live within a 65km radius of a major development centre to which they would have the option of commuting to work. (Map 1)

It is proposed that the development of 15 urban centres on the island, so chosen that no individual would live more than 65km from a main centre of employment, would achieve this objective. However the Academy recognises that many policy decisions will be necessary if such an objective is to be achieved. It is inevitable, given the irregular nature of the coastline, that a small number of places, such as Bantry, fall outside the 65m km radius from a main urban centre. The inclusion of these places in the overall development plan will have to be addressed when the detailed planning phase is reached.

In the first instance the Academy has examined the performance of each centre or node from 1986 to 1996, and how well each centre is endowed with the capability to develop its employment creation potential.

The attributes of each location have been assessed against 15 criteria, each of which is regarded as having a relevance to the promotion of development. These are:

- Housing development
- Road infrastructure
- Rail network
- Bus services
- Ports
- Broadband telecommunications
- Electricity supply
- Natural gas pipeline
- Waste water treatment
- Water supply
- Solid waste treatment
- Hotel beds
- Hospital service
- Third-level enrolment
- Inward industrial investment.

The Academy wishes to emphasise that approximations have had to be made in a number of areas because of the way in which the statistics are normally collected. The primary intention of the paper is to suggest the type of process necessary, and how conditions can be created so as to ensure that the island economy can develop in a way which offers the optimum result for the great majority of the inhabitants. The purpose of the report is not to offer prescriptive solutions, but a number of recommendations are made which it is hoped will stimulate debate.

2. Population Changes.

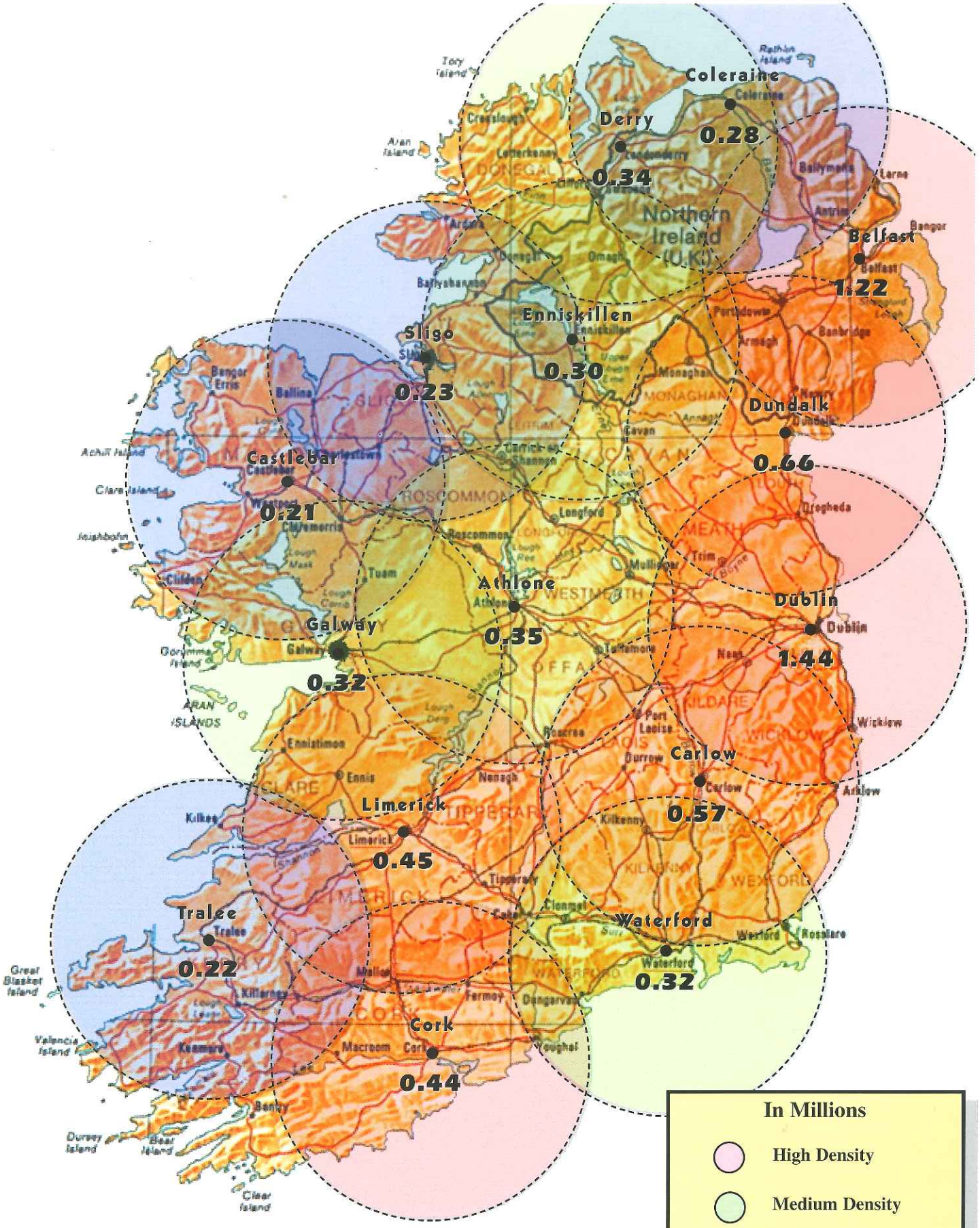
There is a wide variation in the density of population living in the catchment areas around each of the identified nodes or development gateways. Population density reflects migration patterns over a long period. The population in each catchment, based on the 1996 census, is shown in the following table (and in Map 2)

Dublin	1,437,900
Belfast	1,225,200
Dundalk	662,300
Carlow/Kilkenny	572,200
Limerick	446,400
Cork	445,800
Athlone	347,700
Derry	339,200
Galway	317,600
Waterford	321,200
Enniskillen	304,100
Coleraine	284,100
Sligo	235,100
Tralee	222,600
Castlebar	206,500

The population living in areas of overlap between catchments are counted in each catchment so that the magnetic attraction of each centre can be analysed more effectively. (Map 2)

It is worth noting that no urban centre has a catchment population of less than 200,000. Nine have populations between 200,000 and 400,000; four have between 400,000 and 1 million. Dundalk has the third largest catchment on the island followed by Carlow/Kilkenny , Limerick and Cork.

Population Density



Map 2.

The Academy recommends a catchment radius of 65 km as being the equivalent of a one-hour journey to work. This figure varies from that suggested by the Economic Social & Research Institute in its report "National Research Priorities for the Period 2000-2006" which indicated that the choice of a similar number of development centres in the Republic within a one-hour drive time at peak times would leave many areas of the country inaccessible.

The catchment radius chosen in this report is greater than that suggested by the Economic Social & Research Institute because the Academy considers that excessive driving time is required owing to deficiencies in infrastructure. The elimination of these deficiencies, as recommended in the National Road Needs Study published under the auspices of the National Roads Authority, which sets a target traffic speed of 80 kph, will reduce the travel times to the main urban nodes to less than one hour.

There have been substantial changes in the relative catchment populations since the mid-1980's. Examination of the population data indicates a continuation of the population drift from west to east, which has persisted for more than a century. From 1986 to 1996 the population of the island increased by 250,000 or about 4.5%. Of the 15 nodal catchments on the island the fastest growing, as shown in Map 2.1 were:

Carlow/Kilkenny	5.2%
Dublin	5.2%
Dundalk	5.0%
Belfast	5.0%
Derry	4.0%

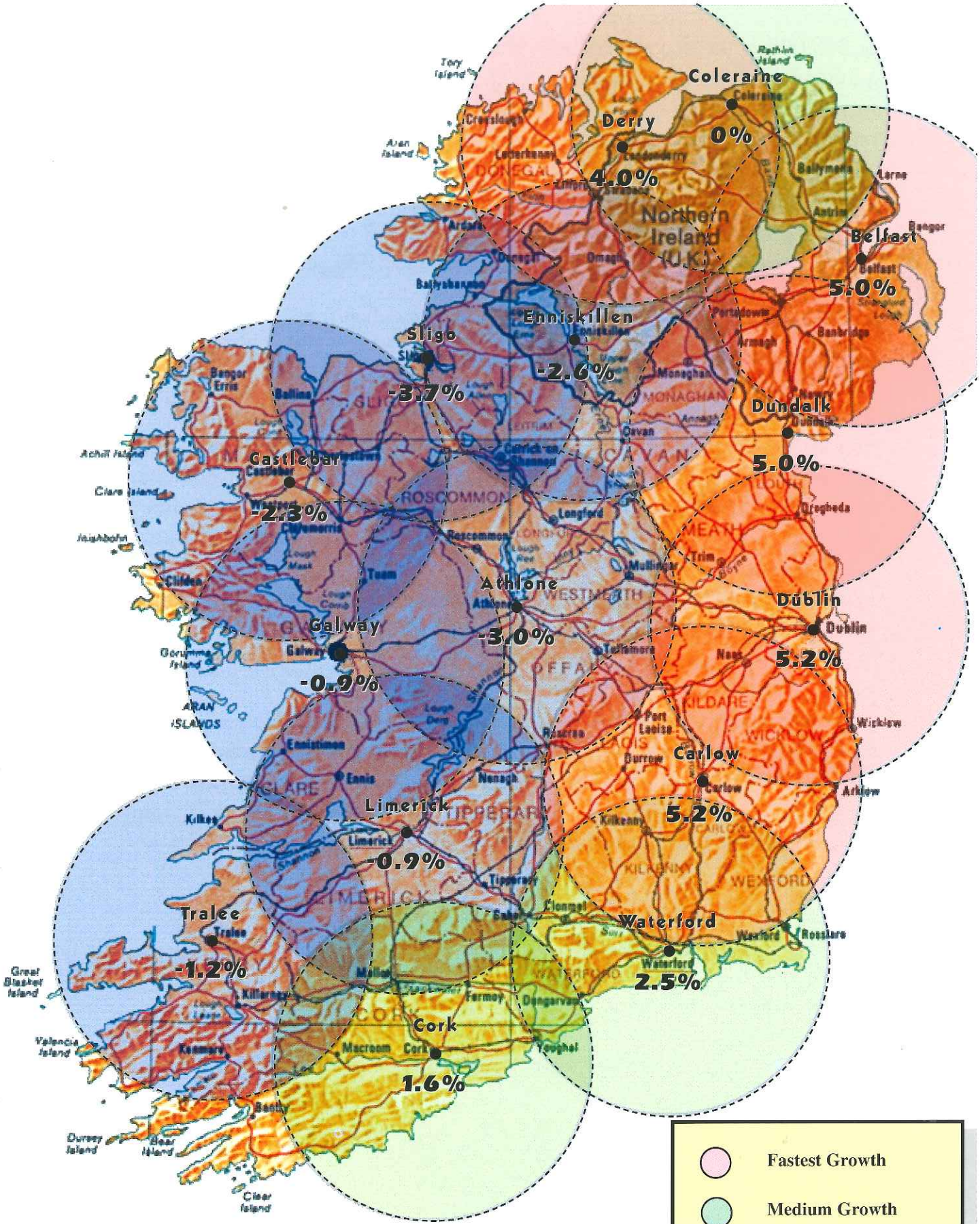
Those showing a stable population or medium growth were:

Waterford	2.5%
Cork	1.6%
Coleraine	0%

Those showing a declining population were:

Galway	-0.9%
Limerick	-0.9%
Tralee	-1.2%
Castlebar	-2.3%
Enniskillen	-2.6%
Athlone	-3.0%
Sligo	-3.7%

Population Changes



Map 2.1

It is estimated that the population of the island will increase by about 10% or 550,000 in the decade to 2009. This increase in the total population offers a unique opportunity to alter the seemingly inexorable drift of population from the west to the east, which has persisted for more than a century. It is recommended that:

- The rate of growth in the catchments of the two main cities of Dublin and Belfast should be restricted to about 5% over the period, similar to that which occurred between 1986 and 1996, and that

- A target growth rate of 12% be adopted for all other centres, compared to modest growth , or decline, between 1986 and 1996.

It might be argued that a greater degree of differentiation in target population increases might be adopted between the various centres. However, the adoption initially of a uniform expansion target has the merit of mobilising effort throughout the island around a single common decentralisation objective.

Such targets will not be achieved unless a comprehensive series of actions are taken to promote investment in the areas outside the two main cities and to eliminate infrastructural deficiencies.

The achievement of a slower rate of growth of 5% in the two main cities, and a higher rate in the other nodes, will be a major challenge in the decade up to 2009. However it would lay the foundation for halting growth completely in Dublin and Belfast during the following decade, whilst enabling the other nodes to absorb all of the net growth in population.

In summary, the following table shows the percentage of the gross population* in each development node catchment area in 1986, 1996, and the recommended targets for 2009:

Nodal Catchment	1986	1996	2009
Dublin	19.00%	19.51%	18.84%
Belfast	16.28%	16.63%	15.95%
Dundalk	8.77%	8.99%	9.20%
Carlow/Kilkenny	7.56%	7.77%	7.95%
Limerick	6.26%	6.06%	6.20%
Cork	6.10%	6.05%	6.19%
Athlone	4.94%	4.72%	4.83%
Derry	4.53%	4.60%	4.71%
Galway	4.46%	4.31%	4.41%
Waterford	4.35%	4.36%	4.46%
Enniskillen	4.34%	4.13%	4.22%
Coleraine	3.98%	3.86%	3.95%
Sligo	3.32%	3.19%	3.26%
Tralee	3.13%	3.02%	3.09%
Castlebar	2.96%	2.80%	2.87%

* The gross population of all catchments is greater than the total population of the island due to the considerable overlap between nodal catchments as indicated in Maps 1 and 2.

The resultant population figures are as follows:

	1986	1996	2009
Dublin	1,366,900	1,437,900	1,509,800
Belfast	1,171,000	1,225,200	1,286,300
Dundalk	631,000	662,300	741,800
Carlow/Kilkenny	544,000	572,200	640,900
Limerick	450,400	446,400	500,000
Cork	438,800	445,800	499,300
Athlone	355,400	347,700	389,400
Derry	326,200	339,200	379,900
Galway	320,400	317,600	355,700
Waterford	313,300	321,200	359,700
Enniskillen	311,900	304,100	340,600
Coleraine	286,500	284,100	318,200
Sligo	238,700	235,100	263,300
Tralee	225,200	222,600	249,300
Castlebar	213,000	206,500	231,300

It is suggested that the recommended 2009 population distribution should serve as the guideline for all development policies. The following table indicates the magnitude of the turnaround in population growth rates, which would be necessary to achieve the recommended targets.

	1986-1996	1999-2009
	%	%
Dublin	5	5
Belfast	5	5
Dundalk	5	12
Carlow/Kilkenny	5	12
Limerick	-1	12
Cork	-2	12
Athlone	-3	12
Derry	4	12
Galway	-1	12
Waterford	3	12
Enniskillen	-3	12
Coleraine	0	12
Sligo	-4	12
Tralee	-1	12
Castlebar	-2	12

3. Housing Development

The availability of housing plays a significant role in increasing the attraction of an area for resettlement of people, and also in the location of new commercial activities. Housing shortages drive up prices, and force people to commute long distances to work. Balanced housing development can ensure that an appropriate trade-off is struck between the commercial development and the quality of life of employees.

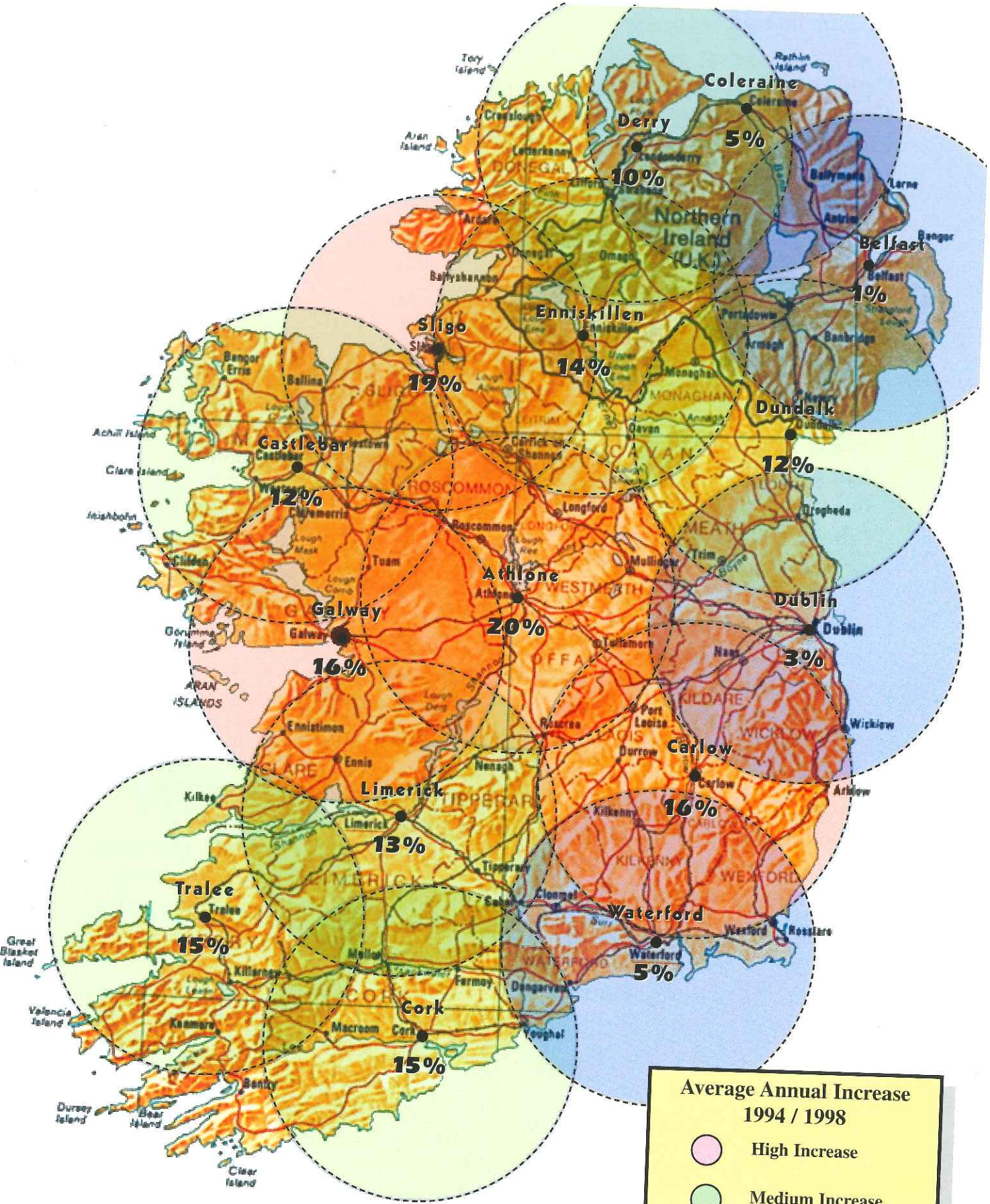
The total annual supply of new houses on the island increased from about 40,000 in 1994 to almost 60,000 in 1998 i.e. by about 10% per annum.

In the Republic there was a 58% increase to 42,349 in the number of new houses completed between 1994 and 1998. This was an average increase of 12% per annum. In Northern Ireland there was an increase in housing starts of 21% over the same period or an annual average increase of 5 % per annum. The figures quoted are indicative estimates, as the published statistics available do not correspond exactly to the nodal catchments.

The following table (and Map 3) show the relative increases:

	1998 completions. /starts	1994/98 average increase per annum
High Increase		
Westmeath/Longford/Offaly/Roscommon	2334 dwellings	20%
Sligo	1457 dwellings	19%
Galway	2875 dwellings	16%
Carlow/Kilkenny/Laois/Wexford / Wicklow	4575 dwellings	16%

Housing Development



Map 3.

Medium increase

Cork	5169 dwellings	15%
Kerry	1638 dwellings	15%
Limerick/ Clare	3324 dwellings	13%
Enniskillen	1825 dwellings	14%
Dundalk	3681 dwellings	12%
Mayo	1527 dwellings	12%
Derry/ Donegal	3532 dwellings	10%

Low increase

Coleraine	2418 dwellings	5%
Waterford	1059 dwellings	5%
Dublin	8957 dwellings	3%
Belfast	6593 dwellings	1%

The overall supply of new housing must meet the aggregated needs of a population likely to increase by about 1% per annum, a reduction in the number of inhabitants per household of at least 1.5% per annum, and the replacement of derelict dwellings. It is worth noting that a recent survey of house prices by county indicated that the price of housing in those regions, where supply has increased at a rate commensurate with demand, appears to be much lower than that in areas, such as Dublin, Belfast and Waterford, where this has not been the case.

It is recommended that the total supply of new housing on the island should continue to increase at a rate of 10% per annum for at least the next five years, after which the position should be reviewed in the light of experience in occupancy rates, and the attainment of housing targets. The recommended distribution of this increase should be about 6% per annum in the Dublin and Belfast regions and 14% per annum in the other regions.

4. Road Development

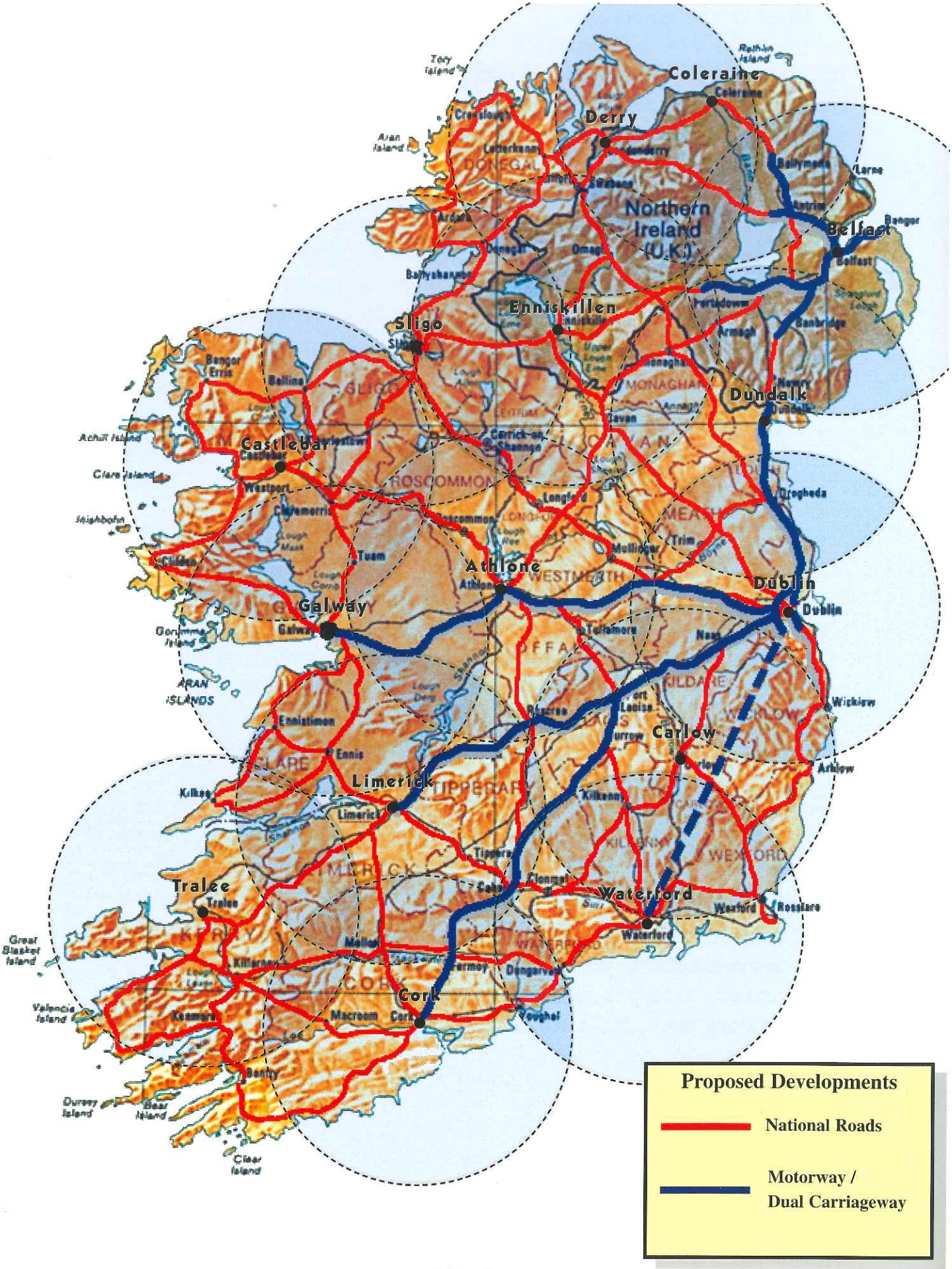
The development of the National Primary Road network is based on an assessment of road needs resulting from predicted traffic growth, which in turn is based on an assumption of a continuation of historic patterns of development.

The Programme for the development of the National Primary Road network in the Republic, and the Proposed Trunk Road Network in Northern Ireland 1998 indicate that the following urban centres will be serviced by dual carriageway / motorway linkages to other centres by 2006(see Map 4):

	No of links to other nodes
Dublin	4
Belfast	2
Athlone	2
Galway	2
Cork	1
Limerick	1
Dundalk	1
Coleraine	1
Waterford	1
Carlow/ Kilkenny	1
Castlebar	0
Derry	0
Sligo	0
Tralee	0
Enniskillen	0

To stimulate economic development the aim should be to ensure that all nodes are connected to at least one other node by a road of dual carriageway standard. Priority in achieving this goal should be given to the urban centres having the largest population.

Road Network



Map 4.

5. Rail Passenger Services

Direct rail services have become increasingly important for the rapid transfer of large numbers of people, particularly commuters within a one-hour travel time of each node (see Map 5).

The following is the distribution of direct rail passenger connections from each centre to other nodes:

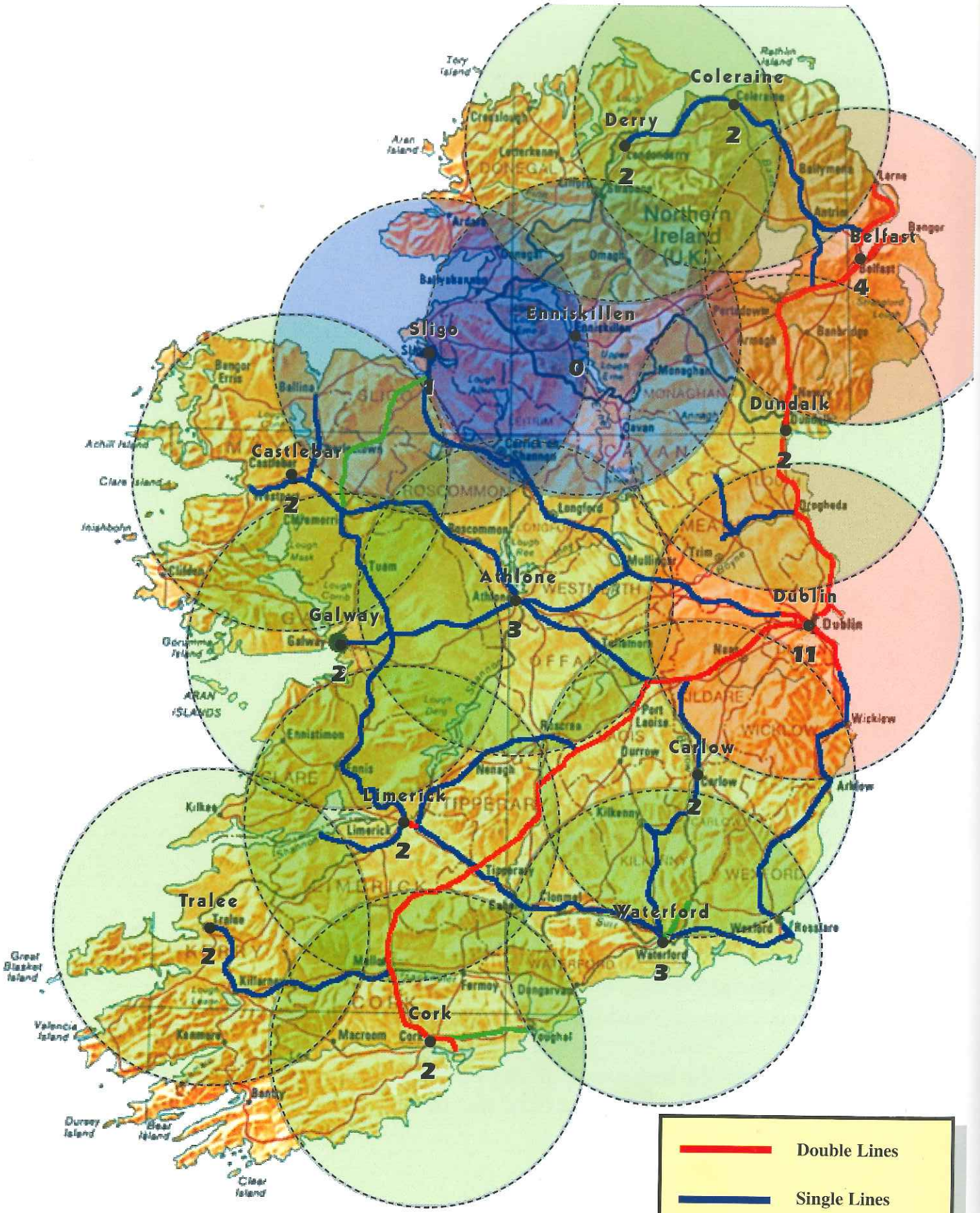
Dublin	11
Belfast	4
Waterford	3
Athlone	3
Cork	2
Limerick	2
Galway	2
Carlow/Kilkenny	2
Tralee	2
Castlebar	2
Derry	2
Dundalk	2
Coleraine	2
Sligo	1
Enniskillen	0

It is recommended that each nodal catchment should have access to at least two other nodes by rail. Centres such as Sligo are particularly poorly served by rail links with which to attract commuters from adjacent nodes, whilst Enniskillen has no rail service.

It is recommended that, where rail services have been reduced or discontinued in recent years, the infrastructure should be maintained intact for possible future use. For example, where double lines have been reduced to single in the past but the formation still exists; where lines are out of service but are not abandoned; and where old rights of way exist.

Rail Network

No. of direct services to other nodes



Map 5.

6. Bus Services

The availability of direct scheduled bus services between nodes contributes greatly to effective communication between the island population and to economic interchange. They also enable companies to gain access to a wider labour market when staff are in short supply thus increasing the attractions of an area for industrial investment.

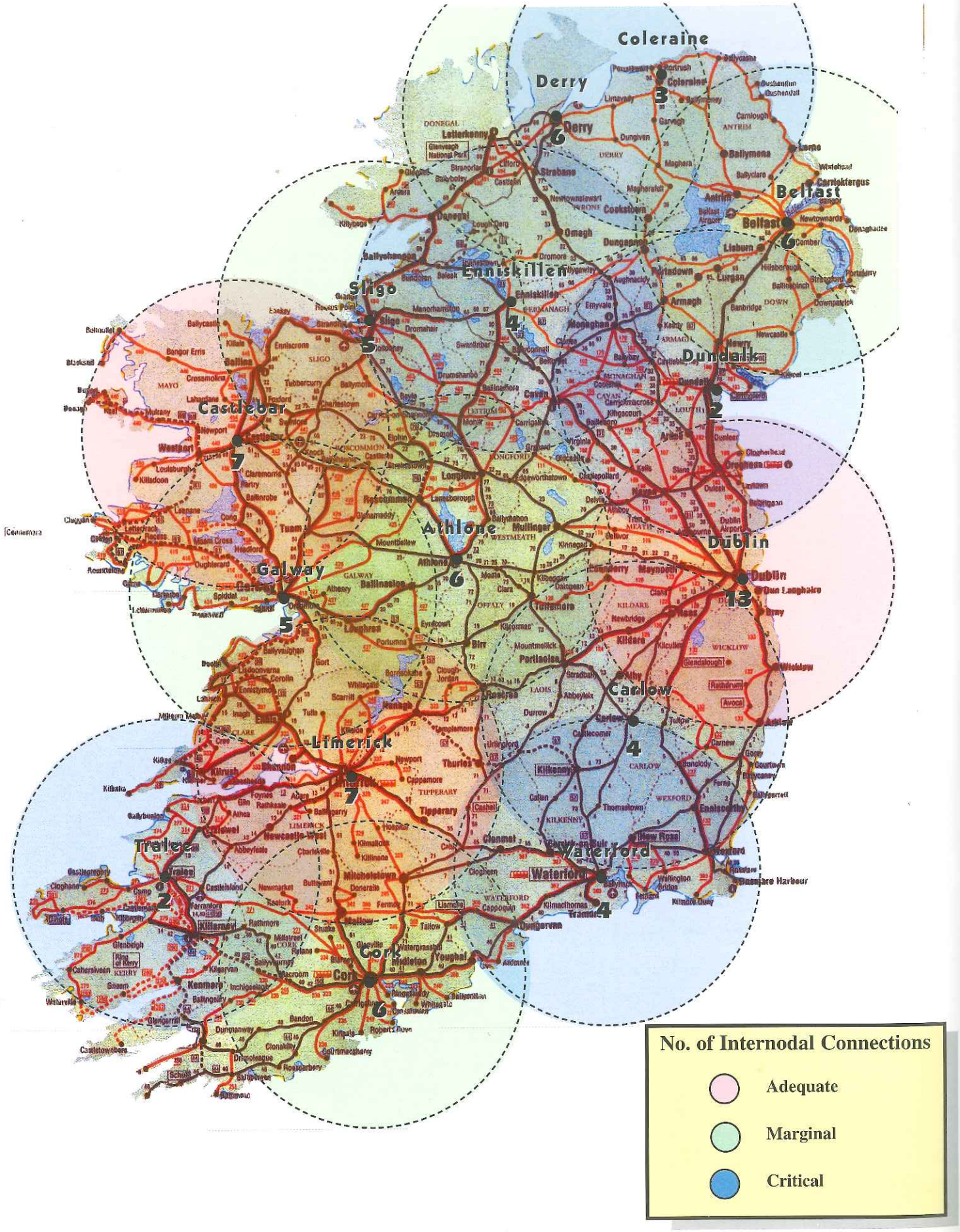
The following is a classification of urban centres in relation to the number of direct expressway passenger connections to other nodes (see Map 6):

Dublin	13
Limerick	7
Castlebar	7
Belfast	6
Cork	6
Athlone	6
Derry	6
Galway	5
Sligo	5
Waterford	4
Carlow/Kilkenny	4
Enniskillen	4
Coleraine	3
Tralee	2
Dundalk	2

It is worth noting that of the centres having only two connections, Dundalk has the third highest population catchment on the island. The provision of bus links between Dundalk and Enniskillen and Sligo might be considered.

Express Bus Internodal Links

No. of direct services to other nodes



Map 6.

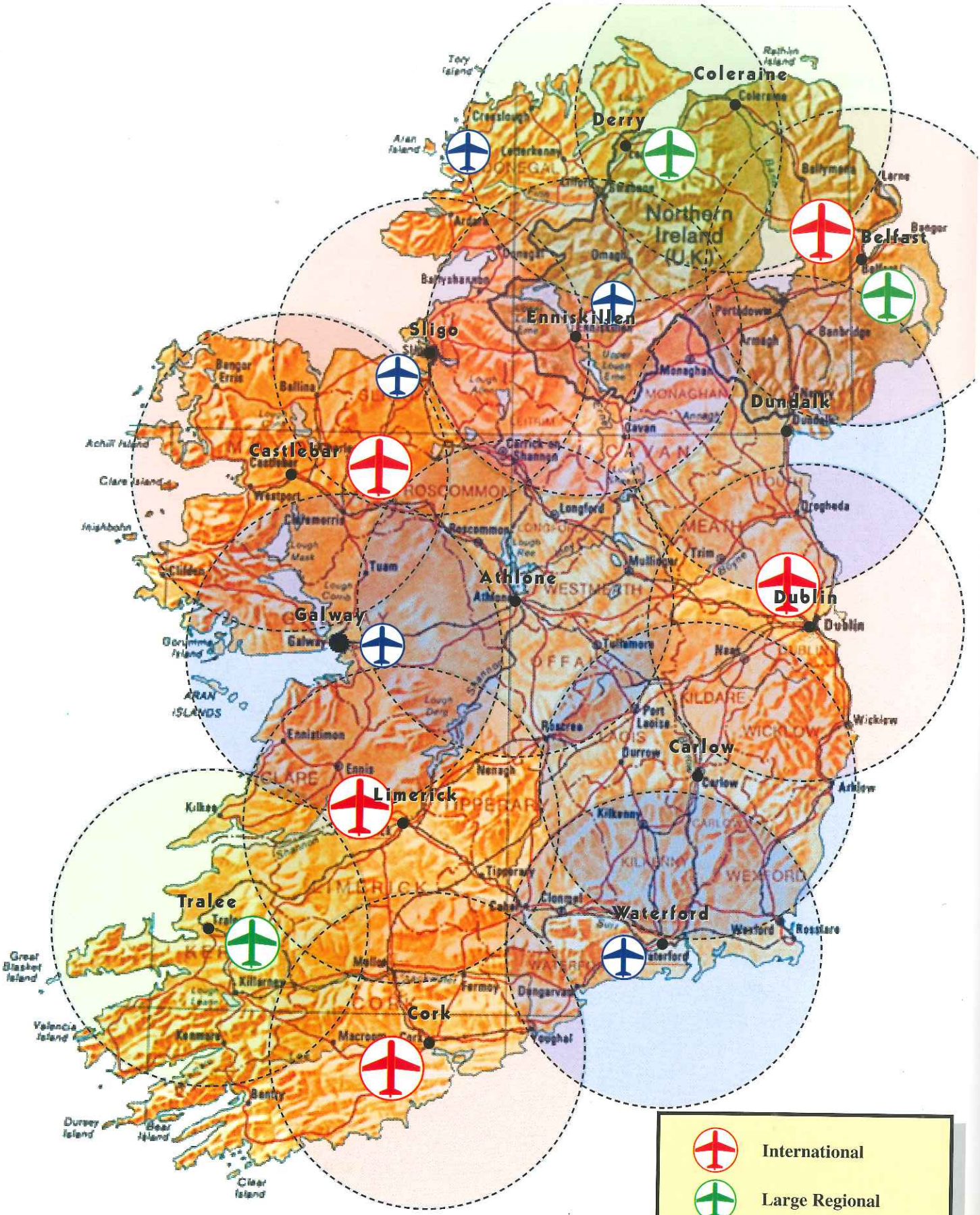
7. Air Services

There are thirteen airports on the island from which scheduled air services are operated (see Map 7). These are:

	Passengers per annum:	Traffic movements per annum:
Dublin Airport	11.6 million	162,086
Belfast (International plus City)	3.9 million	130,948
Shannon	1.84 million	45,776
Cork	1.3 million	37,742
Knock International	200,000	7,000
Kerry	156,000	5,600
City of Derry	70,000 (200,000 forecast)	18,000
Galway	100,000	8,000
Sligo	40,000	2,500
Waterford	20,000	1,000
Donegal	15,000	
Enniskillen	4,300	1,100

It is recommended that every node should be within a one and one half-hour car journey of an international airport. The range of international services from Knock, Kerry and City of Derry airports should be expanded.

Air Services



Map 7.

8. Port Services

Ports provide access for passengers and freight to and from the island. Map 8 shows the current traffic at the main ports. It is desirable that there are efficient transport corridors from each node to the nearest port. The following table shows the ports, which account for the highest annual volumes of passenger traffic:

	Passengers
Belfast/Larne	2.8m
Dublin/Dunlaoghaire	2.65m
Waterford /Rosslare Harbour	1.4m
Cork	0.21m

The quality of intermodal connections particularly those between roads and rail is a key issue in the development of ports. The following is a ranking of nodes by quality of access to the key passenger ports on the Northern, Central, and Southern Corridors:

High quality access to nearest main port by dual carriageway road

Dublin
Belfast
Cork

Planned motorway/dual carriageway access

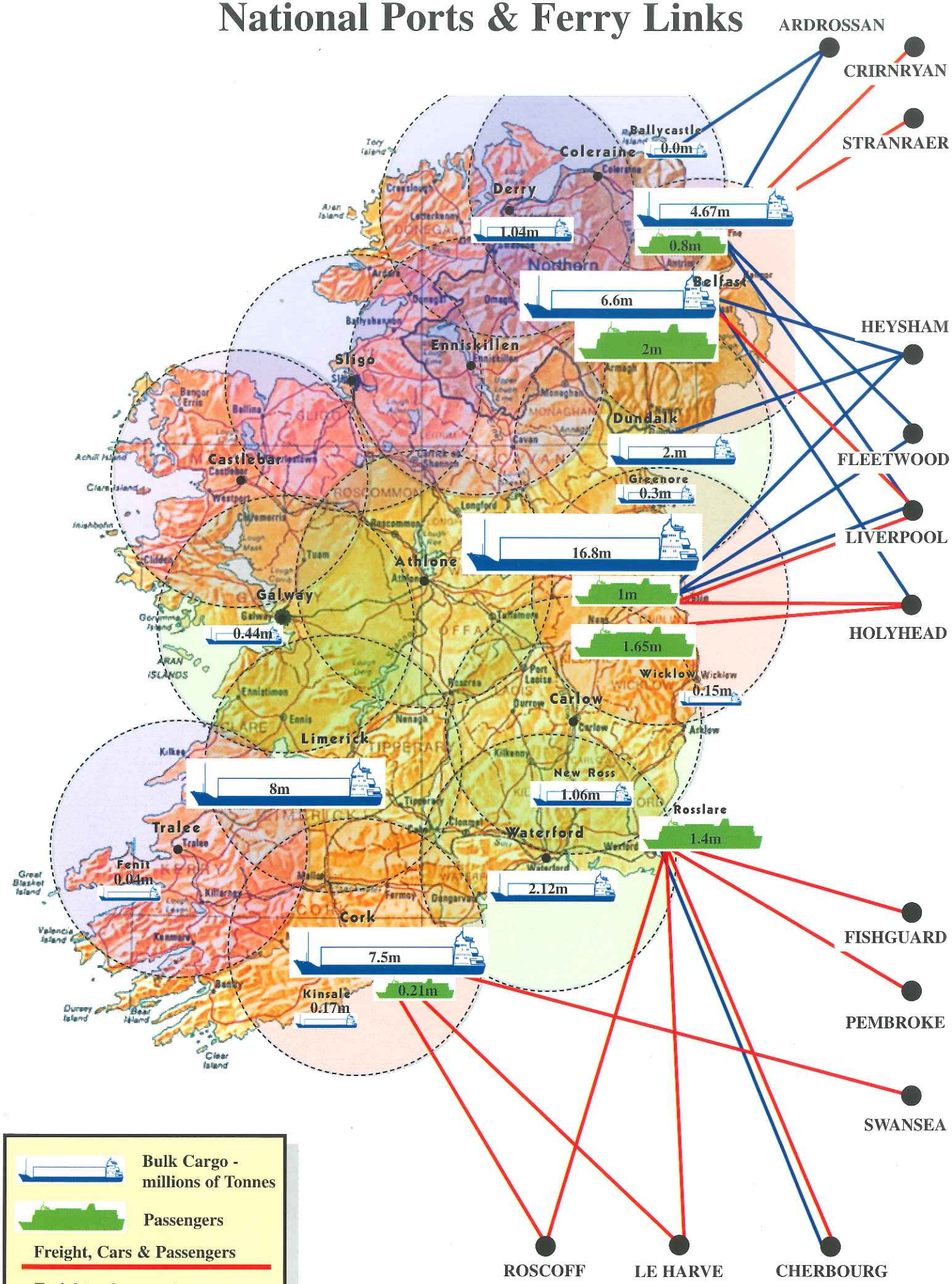
Dundalk
Athlone
Limerick
Galway
Carlow/Kilkenny
Waterford

Dual Carriageway access not yet planned

Derry
Coleraine
Tralee
Castlebar
Enniskillen

Priority should be given to the provision of dual carriageway access from Waterford and Derry to the passenger ports of Rosslare Harbour and Belfast respectively.

National Ports & Ferry Links



Map 8.

9. Broadband Telecommunications Network

The "Telecommunications for Business" report published by Forfas and the Irish Business and Employers Confederation stated that a universally accessible broadband network is required together with very high capacity international links. Five main reasons are cited:

- Ireland is at present the Call Centre capital of Europe;
- The top US computer and software companies are locating here, bringing with them demands for advanced services;
- The Government has stated its intention to provide Electronic Government within 3 years;
- The opportunity exists for all companies to use E- Commerce;
- Products that carry voice, data and video on a single network provide the opportunity for businesses and customers across the world to communicate at the same level of quality and speed as if they were in the same building.

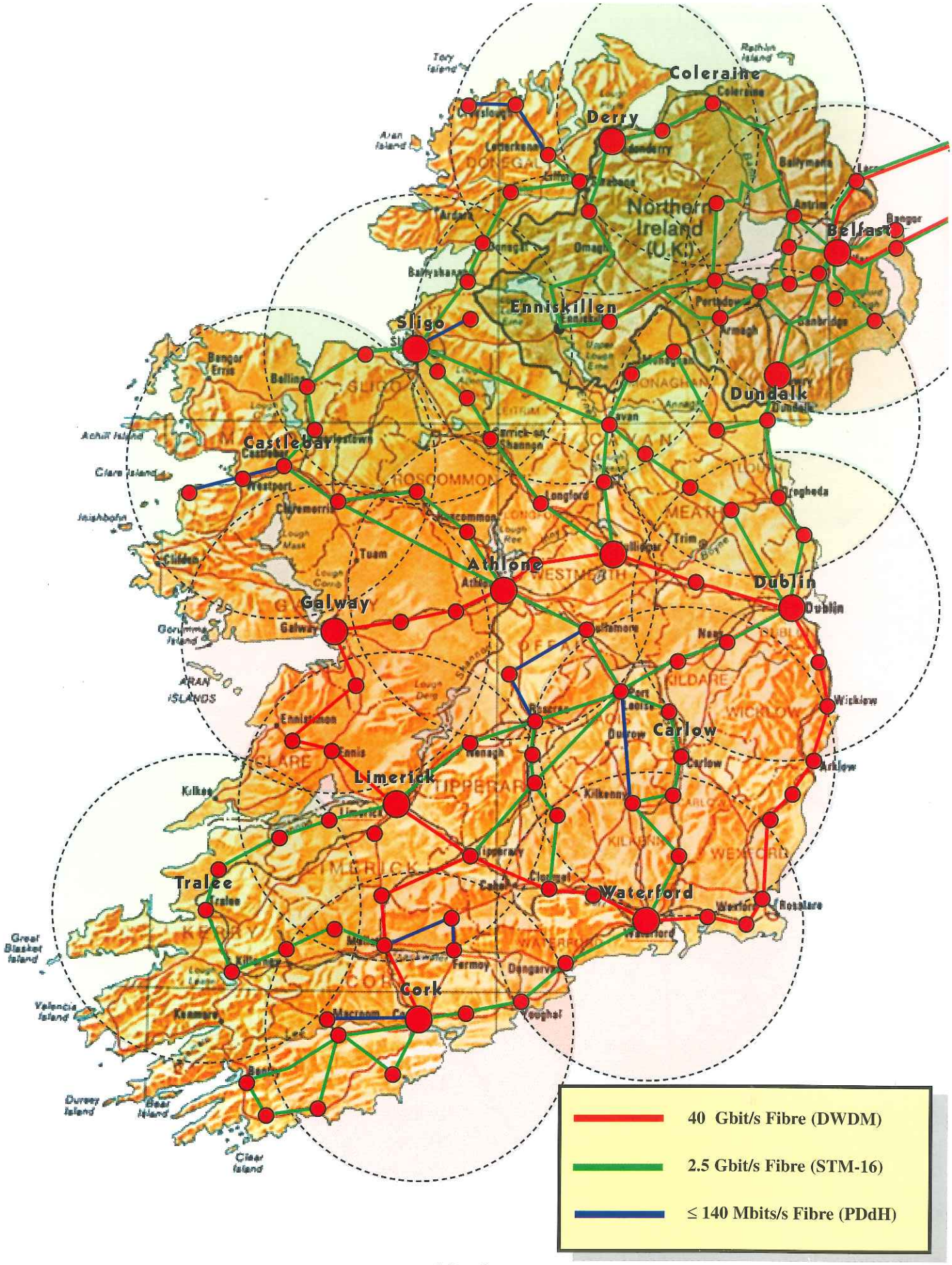
The above report indicates the expected capacity of the National Backbone Network in March 2000.

The proposed network for British Telecom Northern Ireland in March 2000 indicates the position in each of the nodes.

The following table (and Map 9) shows the forecast situation for each major urban centre:

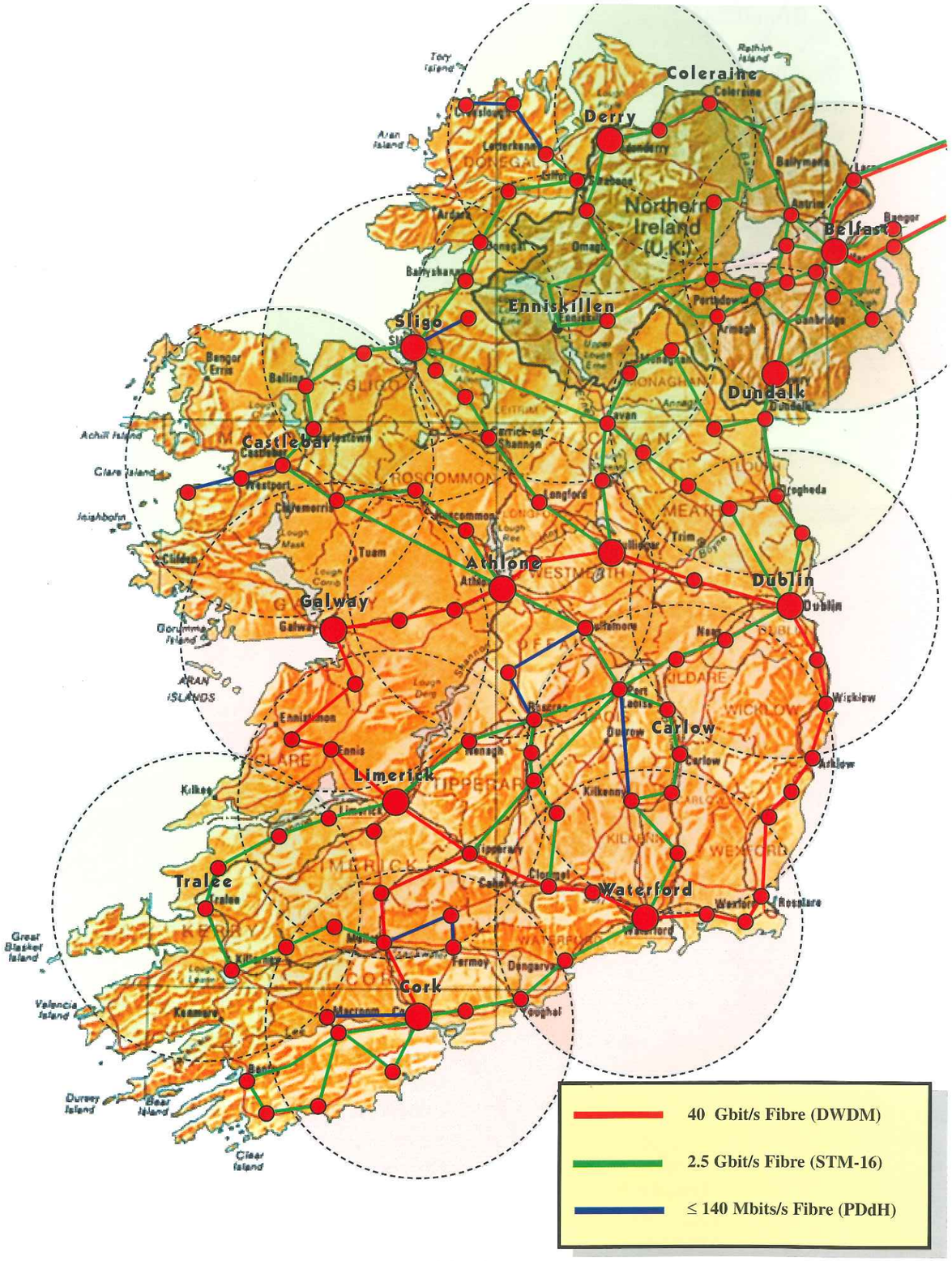
40 Gbits/sec Fibre	2.5 Gbits/sec Fibre
Belfast	Sligo
Dublin	Letterkenny
Cork	Coleraine
Limerick	Carlow/Kilkenny
Waterford	Castlebar
Galway	Derry
Athlone	Enniskillen
	Tralee
	Dundalk

Fibre Optic Cable Network



Map 9.

Fibre Optic Cable Network



Map 9.

10. Electricity Network

A high quality electricity supply with consistently stable voltage and frequency is an essential requirement for the operation of most industries. Where such a supply is not available, firms have no option but to locate elsewhere.

Map 10 shows the electricity transmission network classified according to the voltage of the supply available,

275/400 kv

- Belfast
- Derry
- Dublin
- Limerick

220 kv

- Carlow
- Cork
- Dundalk
- Galway
- Waterford

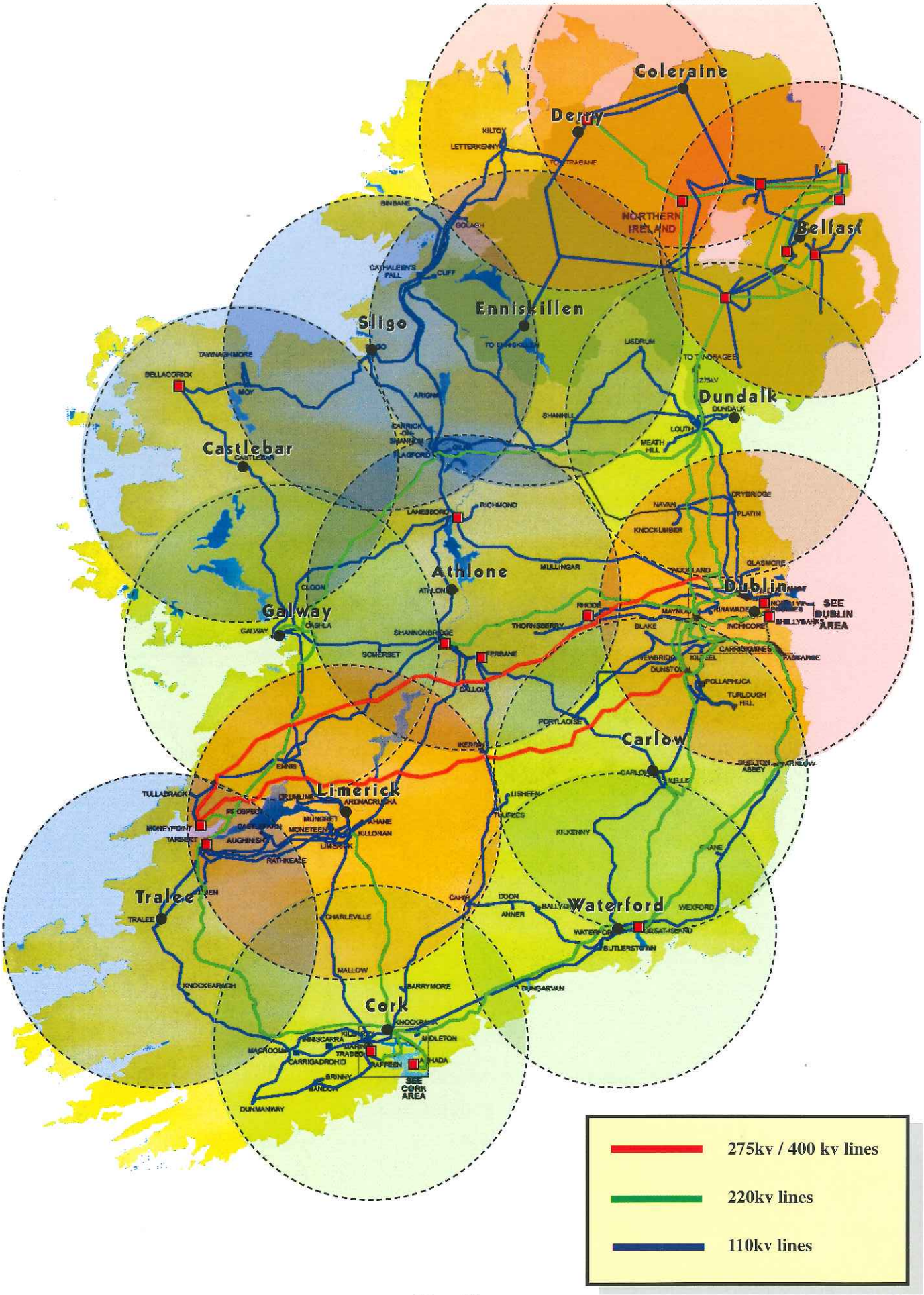
110 kv

- Athlone
- Castlebar
- Coleraine
- Enniskillen
- Letterkenny
- Sligo
- Tralee

It is desirable that at least a 220 kv supply is available in the seven centres where it is not currently available. Furthermore, should the Corrib gas find prove commercial, consideration should be given to the possibility of constructing an electricity power station of substantial capacity in the Northwest.

A strong grid is a prerequisite for development. It enables flexibility in the location of new loads and of new generating capacity. It also copes with the changing location of industry as technology changes. The time required to plan and construct a grid, now seven to ten years, is proving to be a constraint on the location of jobs throughout the island.

Electricity Transmission Network



Map 10.

11. Natural Gas Pipeline.

Access to a supply of natural gas is a significant factor in attracting industry to a locality. Apart from its use in many industrial processes, natural gas is also used frequently as a fuel for in-house electrical power generation particularly where the waste heat from combined heat and power plants can be used economically.

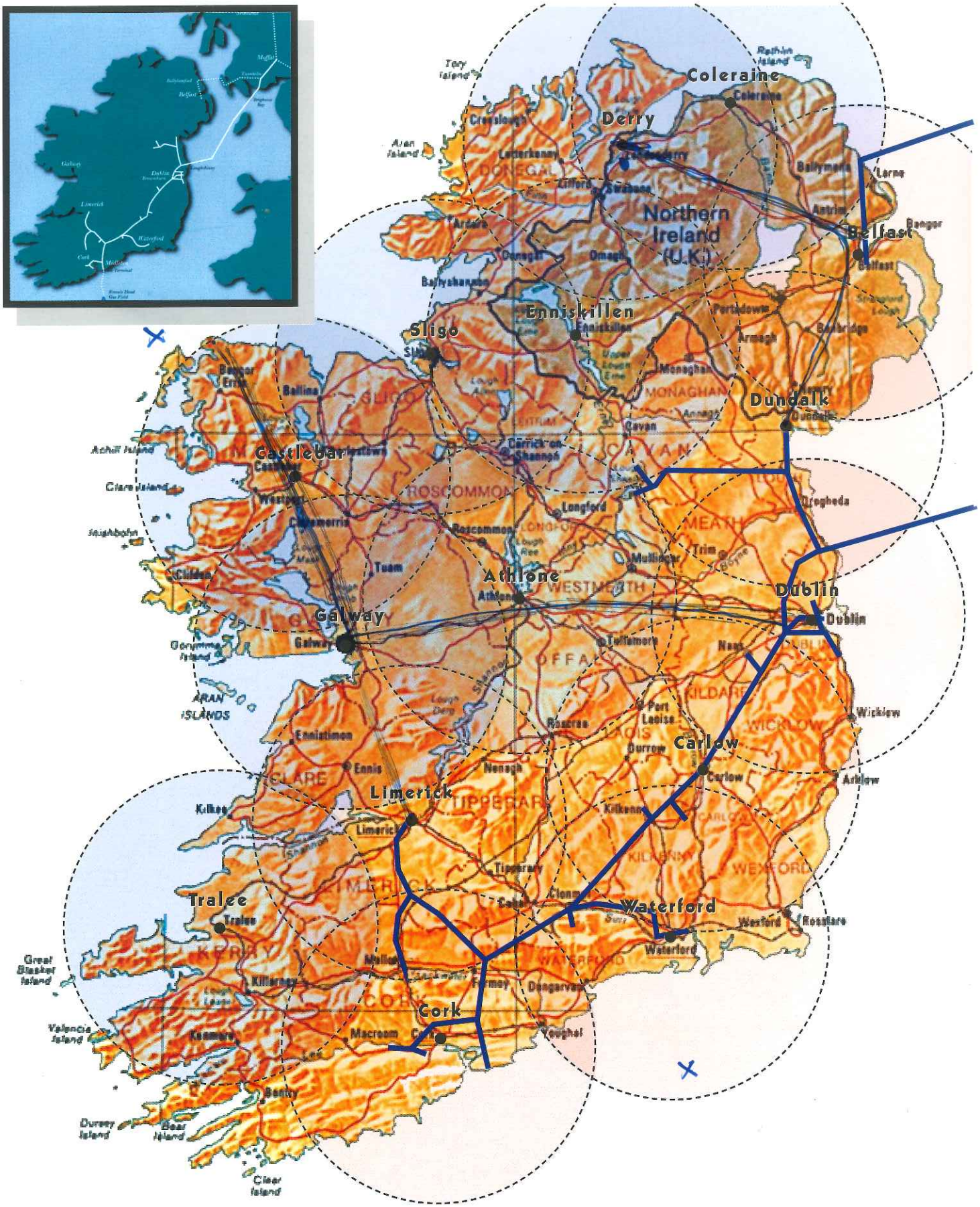
At present the natural gas pipeline services the following urban centres (Map 11):

Dublin
Belfast
Cork
Dundalk
Carlow / Kilkenny
Limerick

The recent Corrib find, if confirmed as commercial, opens up the possibility that natural gas can be made available to Sligo, Castlebar, Galway, Athlone, Enniskillen and Derry. In addition, the development of new electricity power stations in the Northwest fired by natural gas should also be examined.

It is recommended that all nodal catchment centres on the island should be included in the natural gas distribution network.

Natural Gas Network



Map 11.

12. Wastewater Treatment.

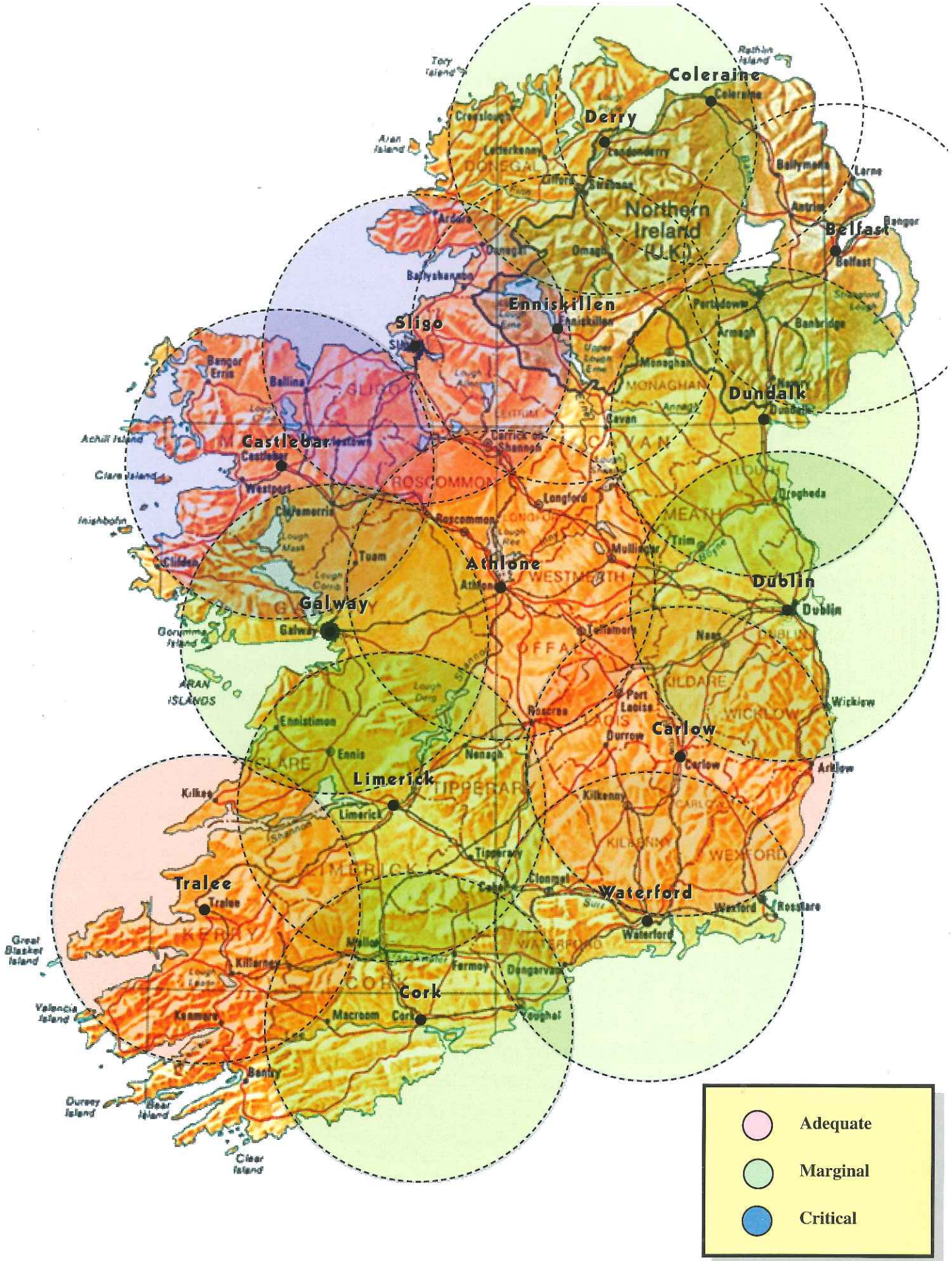
Wastewater treatment facilities are necessary for sustainable development, to deal with the waste products of an expanding population, and for the treatment of commercial and industrial effluent.

A survey conducted amongest members of the City and County Engineers Association in the Republic and a survey conducted in Northern Ireland shows Wastewater treatment supply provision classified as follows (Map 12):

Athlone	Tertiary Treatment.	Capacity adequate.
Belfast.	Secondary Treatment .	Capacity adequate.
Carlow	Secondary Treatment	Capacity adequate
Coleraine.	Secondary Treatment.	Capacity adequate.
Enniskillen.	Secondary Treatment.	Capacity adequate.
Derry	Primary Treatment	Capacity adequate. Secondary treatment plant planned to start construction 2002.
Dundalk	No treatment.	New plant due completion 2000.
Dublin	Primary Treatment.	New treatment plant contract awarded.
Galway	No Treatment.	New treatment plant to tender..
Limerick	No Treatment .	New treatment plant to tender.
Cork	No Treatment	New treatment plant to tender
Waterford.	No Treatment	New treatment plant to tender 2001
Sligo.	No Treatment .	Capacity inadequate. .
Castlebar	Tertiary Treatment.	Capacity inadequate.

It is recommended that action be taken to increase treatment capacity in Sligo and Castlebar.

Wastewater Treatment



Map 12.

13. Water Supply

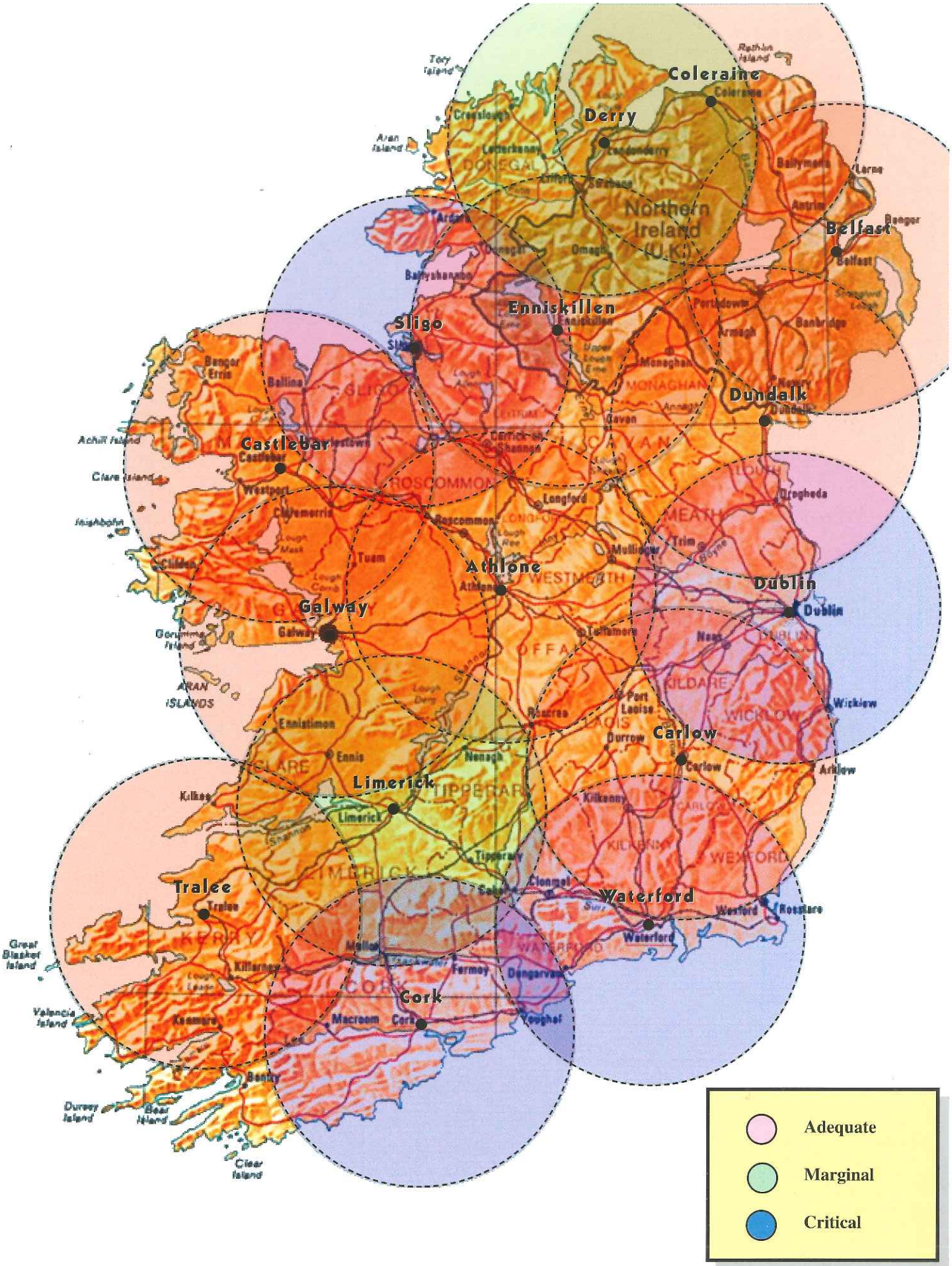
The expansion of urban areas may be inhibited by the lack of an adequate supply of clean water.

A survey conducted amongst members of the City and County Engineers Association in the Republic and a survey conducted in Northern Ireland resulted in the following assessment of the supply position. (Map 13):

Athlone.	Supply adequate.	
Belfast	Supply adequate, but expansion required by 2006.	
Carlow/Kilkenny	Supply adequate.	
Coleraine.	Supply adequate..	
Dundalk.	Supply adequate.	
Enniskillen.	Supply adequate.	
Galway	Supply adequate. Additional capacity will be available 2000.	
Castlebar.	Supply adequate.	
Tralee.	Supply adequate.	
Derry .	At capacity limit .	Additional capacity required by 2001.
Limerick.	At capacity limit.	Additional capacity planned 2001
Dublin	Present supply inadequate.	Additional capacity planned.
Sligo	Present supply inadequate.	Additional capacity planned 2000.
Cork	Present supply inadequate.	Additional capacity planned 2001.
Waterford	Present supply inadequate.	Additional capacity planned 2000.

It is recommended that early action be taken to provide the additional capacities required.

Water Supply



Map 13.

14. Solid Waste Treatment

Modern society generates an increasing volume of domestic and industrial waste materials. The absence of suitable facilities for the recycling, recovery, treatment and disposal of waste materials discourages the establishment of employment creating enterprises, and reduces the quality of life of its citizens.

The only method of dealing with residual solid waste material following recycling, recovery and treatment is disposal to landfill. There is an urgent need for the implementation of an integrated solid waste collection, treatment and disposal strategy.

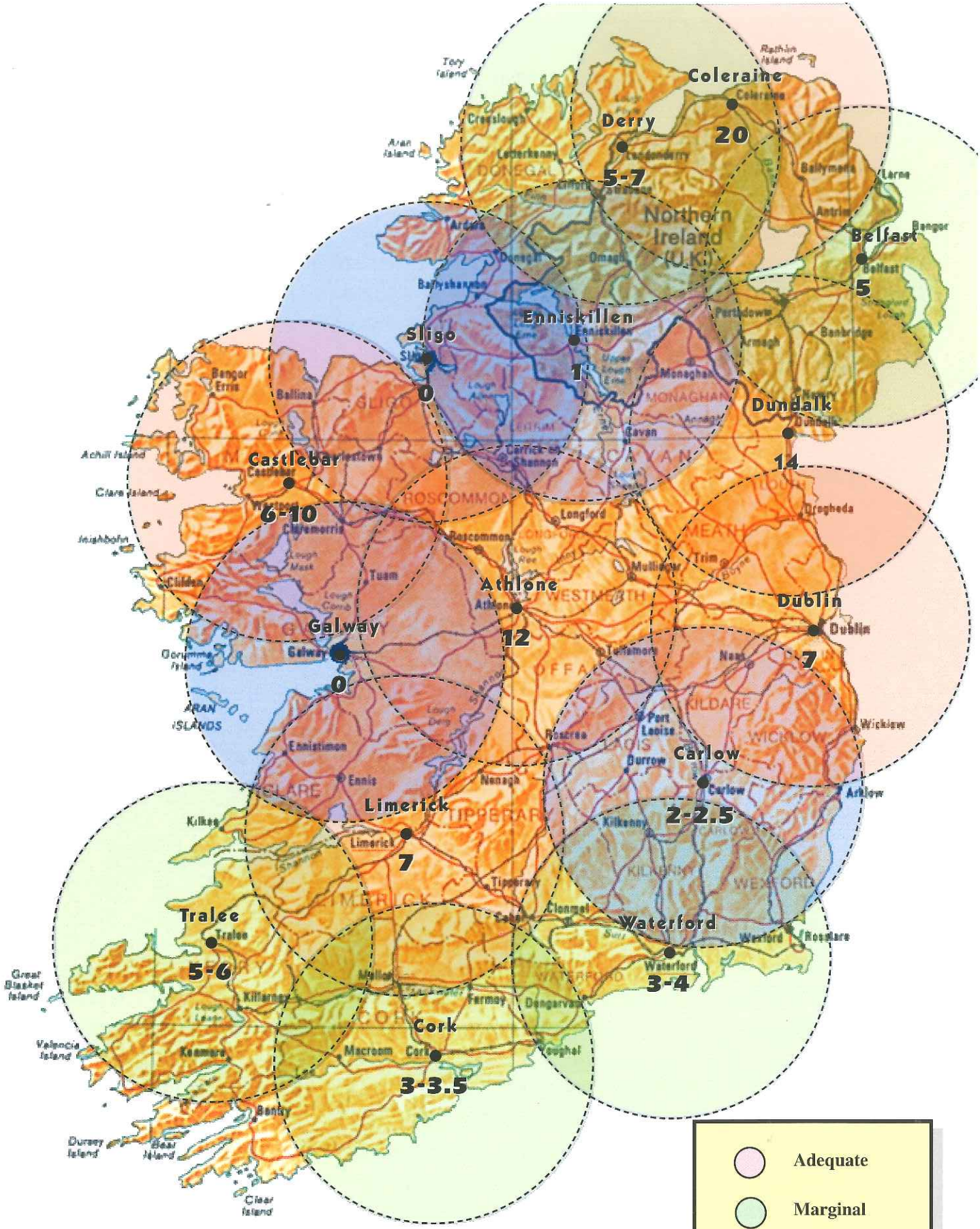
The following is a classification of the main urban centres as determined by the survey conducted by the City and County Engineers Association, and a survey conducted in Northern Ireland (Map 14):

Coleraine.	Remaining life 20 years.
Dundalk	Remaining life 14 years.
Athlone	Remaining life 12 years.
Castlebar	Remaining life 6-10 years.
Limerick	Remaining life 7 years.
Dublin	Remaining life about 7 years?
Derry .	Remaining life 5 to 7 years.
Tralee	Remaining life 5-6 years.
Belfast	Remaining life 5 years
Waterford	Remaining life 3-4 years.
Cork	Remaining life 3-3.5 years.
Carlow / Kilkenny	Remaining life of landfill 2- 2.5 years.
Enniskillen.	Remaining life 1 year. Planning application lodged.
Galway	Remaining life nil. Transfer to Ballinasloe until 2005.
Sligo	Remaining life nil. Transfer to Donegal .

The most critical situations regarding the disposal of solid waste are in Sligo, Galway, Enniskillen and Carlow/ Kilkenny.

Solid Waste Disposal

Remaining life for landfill in years



Map 14.

15. Hotel Beds

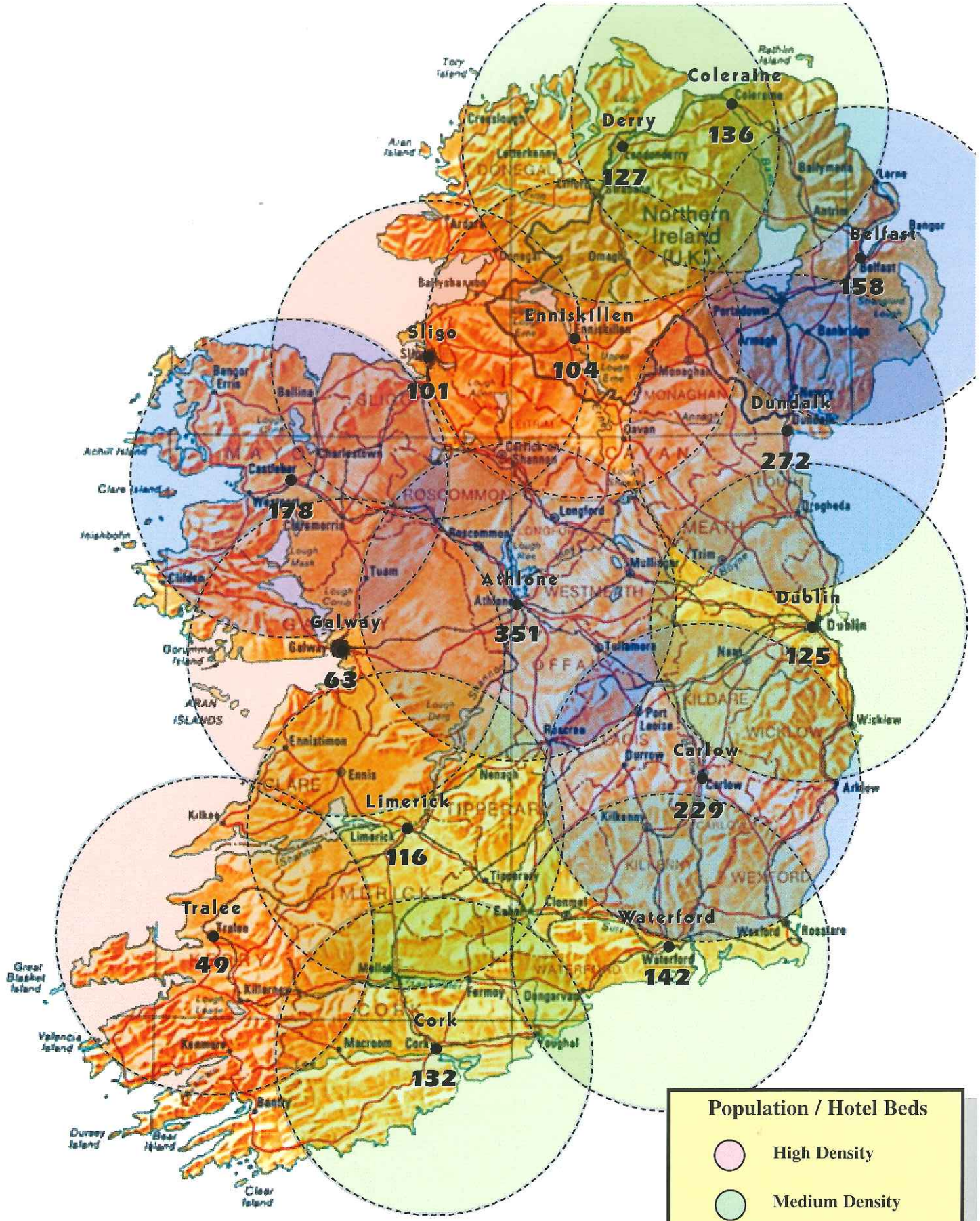
The availability of registered hotel bedrooms provides an indication of the ability of a region to cater for commercial customers and tourists.

The statistics available were collected on a different geographic basis to that used in this paper. As a result rough estimates have had to be made. The distribution of population per hotel bed is estimated as follows (Map 15):

	pop/ hotel bed
Tralee	49
Galway	63
Sligo	101
Enniskillen	104
Limerick	116
Dublin	125
Derry	127
Cork	132
Coleraine	136
Waterford	142
Belfast	158
Castlebar	178
Carlow /Kilkenny	229
Dundalk	272
Athlone	351

The highest density of hotel bedrooms in relation to population is in the main tourist areas such as Tralee, Galway, Sligo and Enniskillen.
The lowest density of hotel bedrooms is in Athlone, Dundalk and Carlow/ Kilkenny.

Hotel Beds



Map 15.

16. Hospital Beds

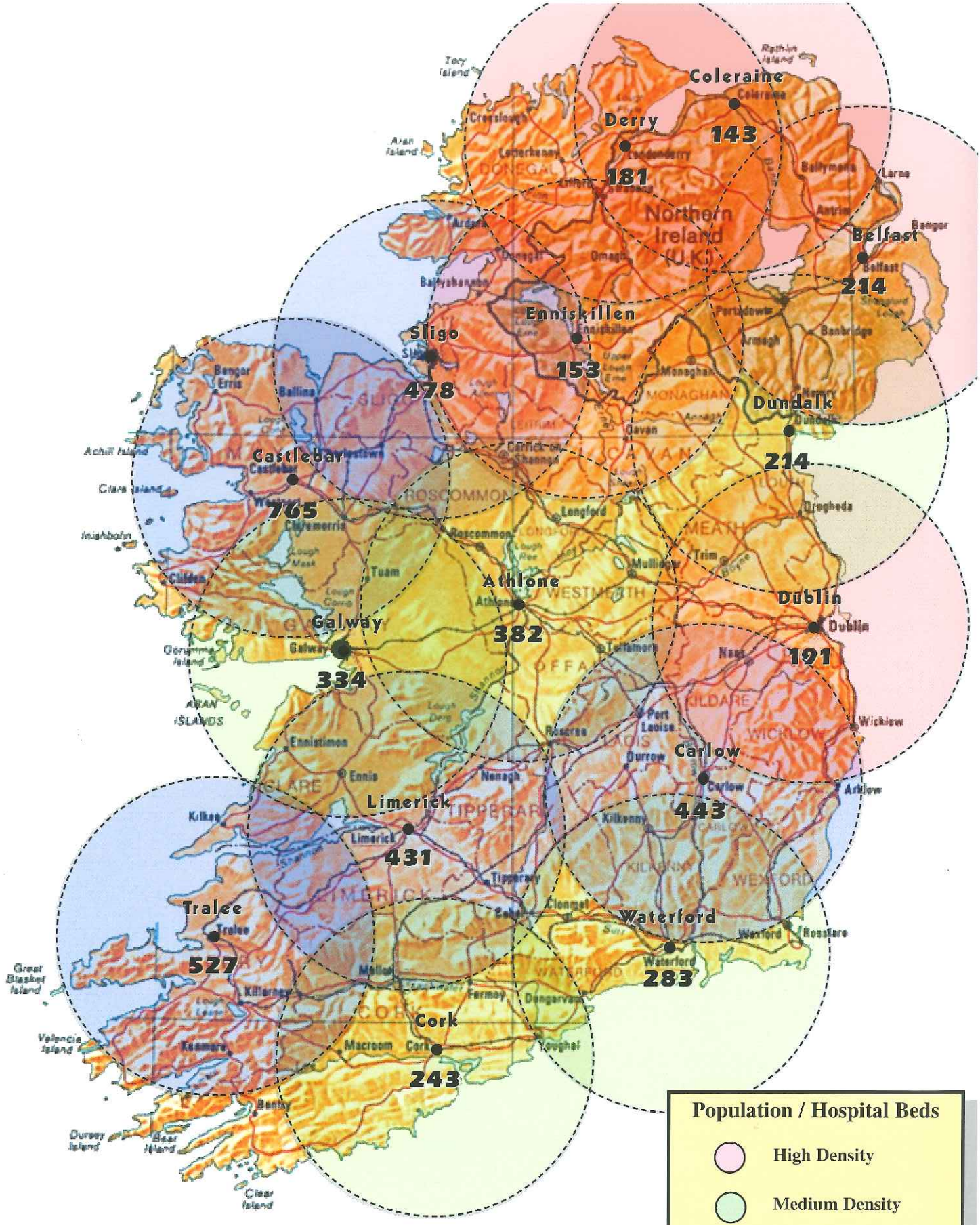
The lack of availability of hospital services in an area can be a significant deterrent to the establishment of new industry.

The following is the population per hospital bed in each region (Map 16):

Coleraine	143
Enniskillen	153
Derry	181
Dublin	191
Belfast	214
Dundalk	214
Cork	243
Waterford	283
Galway	334
Athlone	382
Limerick	431
Carlow/Kilkenny	443
Sligo	478
Tralee	527
Castlebar	765

Castlebar and Tralee have the highest population per hospital bed followed by Sligo, Carlow/Kilkenny, and Limerick.

Hospital Beds



Map 16.

17. Third-Level Enrolment

The availability of an adequate number of student places in third-level institutions is a significant advantage for a nodal catchment. It allows industries have access to young graduates, and also enables people in employment to pursue part-time education, thus improving their ability to keep pace with accelerating changes.

The number of students enrolled in third-level institutions has been compared with the population around each node. The numbers of students per thousand of catchment population are given in the following table. (Map 17):

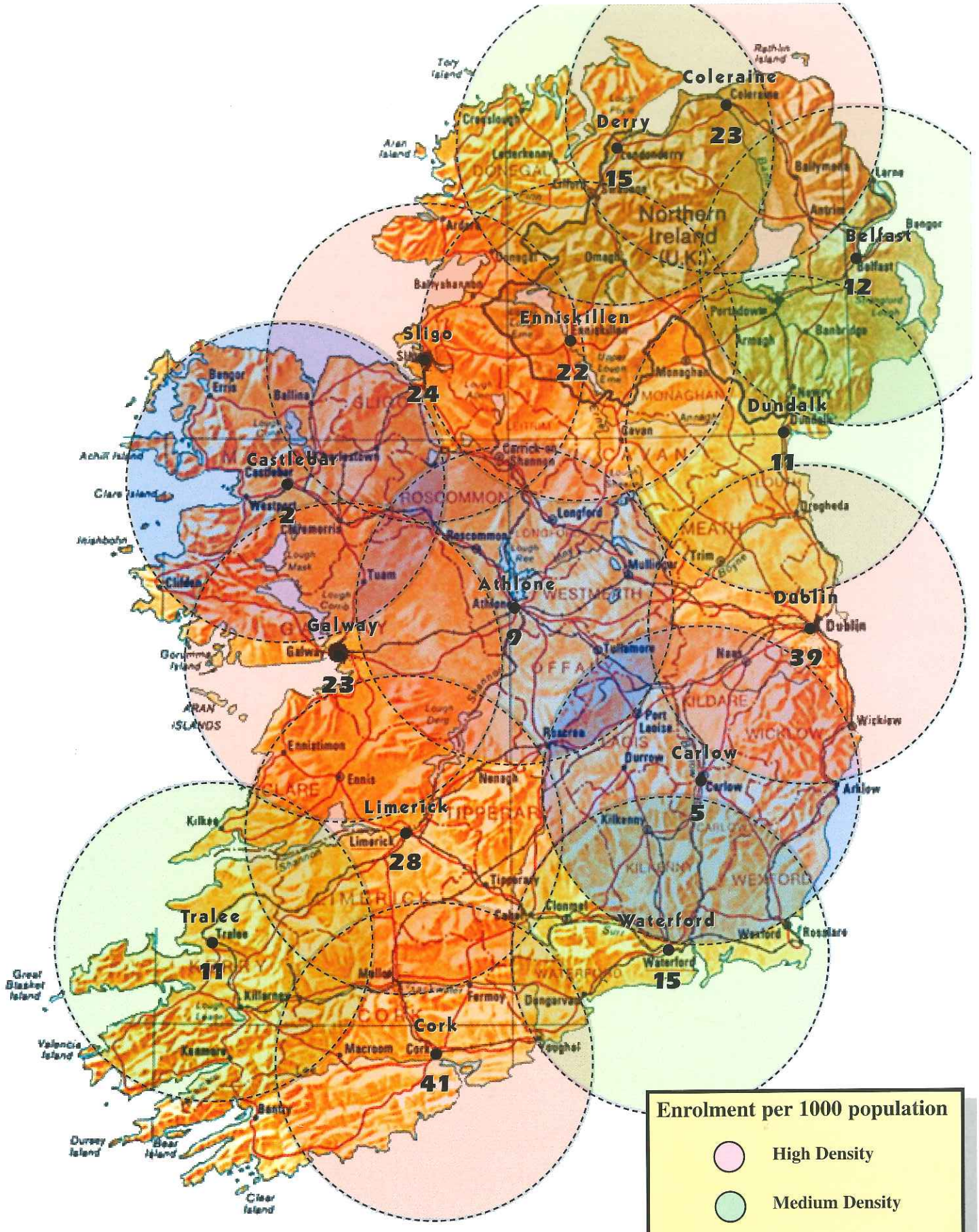
Cork	41
Dublin	39
Limerick	28
Sligo	24
Coleraine	23
Galway	23
Enniskillen	22
Derry	15
Waterford	15
Belfast	12
Dundalk	11
Tralee	11
Athlone	9
Carlow	5
Castlebar	2*

It should be noted that Castlebar was in its start up phase in 1997/98.

When analysing the figures for Northern Ireland, it was assumed that all full-time students in further education were pursuing third-level studies.

It is recommended that the third-level student capacity of all nodal catchments should be expanded to at least 10 per thousand.

Third-Level Enrolment



Map 17.

18. Inward Industrial Investment

The number of new manufacturing and internationally trading service firms which set up in an area is a primary influence on the growth of employment, and thus of the population, in the area.

In 1996/97 a total of 179 new inward investment projects were announced by the Industrial Development Board in the Republic and the Industrial Development Board in Northern Ireland. (Note that there is some double counting because of the overlap of nodal catchments)

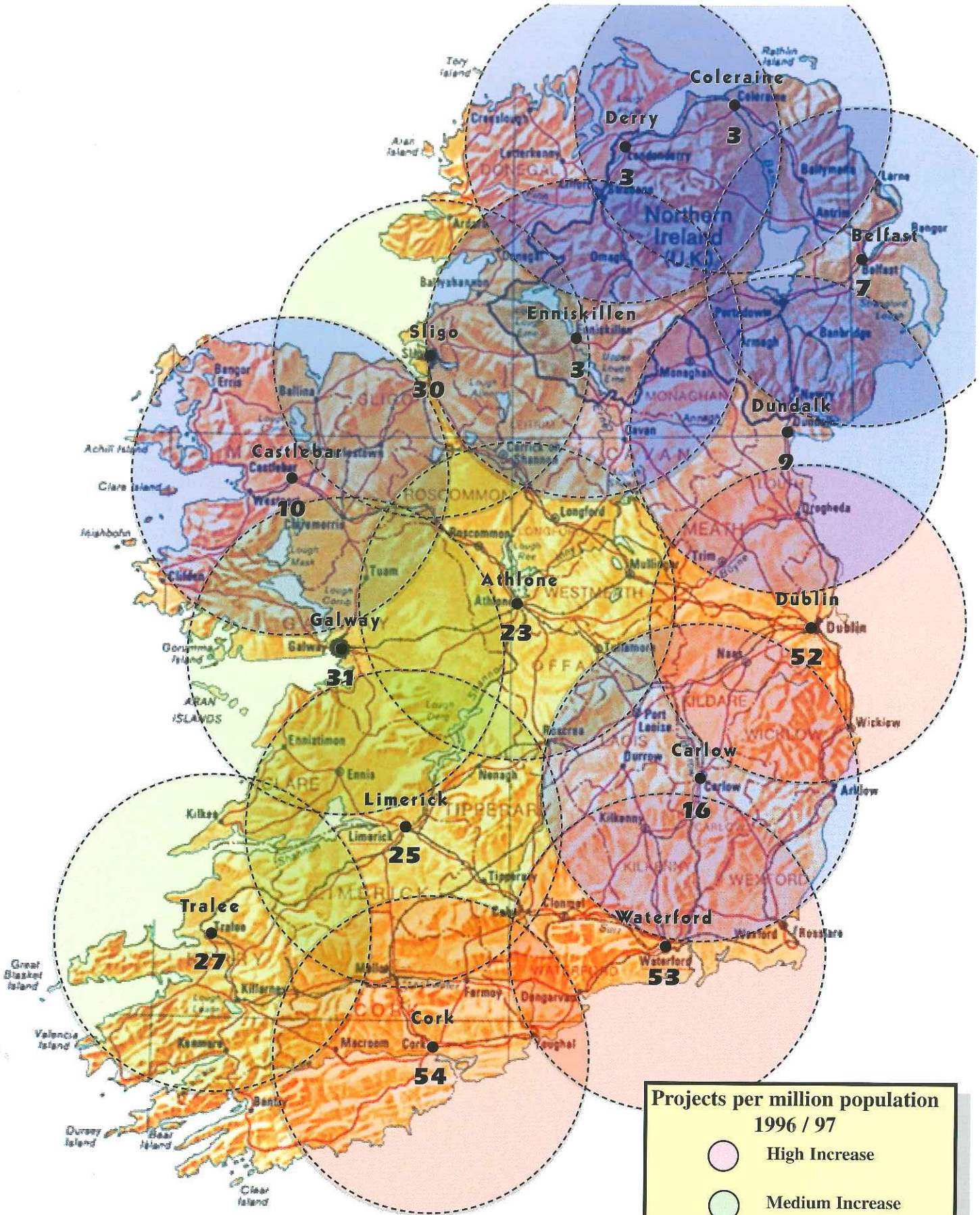
These projects were distributed as follows (Map 18):

	no of proj.	% of total Ratio of projects Per Million pop 1996
Cork	24	54
Waterford	17	53
Dublin	75	52
Galway	10	31
Sligo	7	30
Tralee	6	27
Limerick	11	25
Athlone	8	23
Castlebar	4	19
Carlow/Kilkenny	9	16
Dundalk	6	9
Belfast	9	7
Coleraine	1	3
Derry	1	3
Enniskillen	1	3

It is recommended that new industries on the island should be encouraged to locate generally in proportion to the desired spread of the population shown in the following table. No attempt is made in this paper to consider the development of specific industrial sectors. The actual spread of projects in 1996/97 is also indicated.

	Actual Project Spread 1996/97	Desired Spread 2009
Dublin	42%	19%
Belfast	5%	16%
Dundalk	3%	9%
Carlow/Kilkenny	5%	8%
Limerick	6%	6%
Cork	13%	6%
Athlone	4%	5%
Derry	1%	5%
Galway	6%	4%
Waterford	9%	4%
Enniskillen	1%	4%
Coleraine	1%	4%
Sligo	4%	3%
Tralee	3%	3%
Castlebar	2%	3%

Inward Industrial Projects



Map 18.

19. Recommendations.

The Irish Academy of Engineering recommends that:

- A spatial development plan for the whole island should be developed and implemented so that the maximum economic and social benefit can accrue to all its inhabitants, with the minimum duplication of facilities;

- That 15 nodal catchments should be developed on the island so that all inhabitants will live within a distance of 65km from a development gateway;

- That the expected half a million increase in the population of the island over the next decade be encouraged to locate in the nodal catchments according to a defined dispersal policy;

- That a differentiated population dispersal policy be adopted so that the population of the two main cities, Dublin and Belfast, will expand at a rate less than half as fast as that of the other nodes over the next decade.

- That the necessary infrastructure be developed in each node, outside the two principal cities, to enable its workforce and population to grow at a rate of 12% per annum over the next decade;

- That new inward industrial projects be encouraged to locate in the nodes outside Dublin and Belfast, according to a clearly defined spatial development policy for the whole island; and

- That a consistent, comprehensive, and integrated plan for the spatial development of each nodal catchment, comprising housing, transport, information technology, energy, environmental infrastructure, health care, third-level education, and inward industrial investment, be developed and implemented

20. Appendex

The Irish Academy of Engineering was founded in 1997 by The Institution of Engineers of Ireland as an independent All Ireland learned society of the engineering profession. Its overall objective is to advance the science and practice of engineering in Ireland as an essential element in national development and the enhancement of living standards.

This overall objective will be achieved by:

- Identifying areas of engineering and science which are developing rapidly and which are vital to future development.
- Advising Government's and other public institutions on all aspects of economic development where engineering has a significant part to play.
- Furthering the development and expansion of engineering R&D in Ireland.
- Observing international engineering development and making appropriate recommendations for national application.
- Maintaining contact with the European Union and other international organisations in matters of concern to the engineering profession.
- Furthering the pursuit of excellence in Irish engineering and encouraging creativity, innovation and quality in design, development, manufacture, construction, other engineering services and management.
- Preparing policy statements and drafting opinions on issues referred to the Academy by The Institution of Engineers of Ireland, the Government's, the European Union or other appropriate body or organisation.
- Supporting the expansion and enhancement of engineering education.
- Stimulating interest in the preservation and presentation of Ireland's engineering heritage.
- Identifying and honouring engineers whose achievements have been significant.
- Studying and commenting on the social, economic and environmental impact of new developments in science and engineering.
- Identifying and highlighting outstanding Irish engineering achievement.
- Maintaining contact with other international academies in matters of common concern.

For further information please contact:

The Irish Academy of Engineering, 23 Clyde Road, Dublin 4.
Tel: (01) 668 4341 Fax: (01) 668 5508.

The Irish Academy of Engineering
22 Clyde Road, Dublin 4 Ph: 01-6684341; Fax: 01- 6685508

Members of the Academy April 2000.

Mr Brendan Barrett
Dr. Anthony Barry
Dr. Nael Bunni
Mr Frank Burke
Prof Gerry Byrne
Prof James Calderwood
Dr. Finbar Callanan
Mr Phil Callery
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