

Appendix B

Modelling and Appraisal



Straitéis Iompair na Gaillimhe
Galway Transport Strategy



Modelling Services Framework

Galway Transport Strategy

Modelling and Appraisal Report

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Table of Contents

1	Introduction	4
1.1	Background	4
1.2	Study Aim and Objectives	4
1.3	Study Area	5
1.4	Purpose of Study	6
1.5	Report Structure	6
2	NTA Regional Modelling System	8
2.1	Introduction	8
2.2	WRM Structure	9
2.3	Calibration of the WRM	10
2.4	Application of the WRM to the GTS	10
3	Appraisal Methodology	11
3.1	Overview	11
3.2	Assessment of Individual Measures by Mode	12
3.3	Quantitative Assessment of Scenarios	12
4	Transport Measures and Combined Scenarios	14
4.1	Overview	14
4.2	Measures	14
4.3	Development of Scenarios for Assessment	19
4.4	Summary of Scenarios for Testing	25
5	Evaluation of the Sustainable Mode Transport Proposals	26
5.1	Overview	26
5.2	Quantitative Assessment of Active Mode/ PT Scenarios	26
5.3	Summary Assessment of Active Mode/ PT Scenarios	35
5.4	Benefits of the Emerging Preferred Active Mode & PT Scenario	36
5.5	Development of Additional Scenarios	38
5.6	Summary of Additional Scenarios for Testing	42
6	Evaluation of Integrated Transport Proposals	43
6.1	Quantitative Assessment of Integrated Scenarios	43
6.2	Summary Assessment of Scenarios	50
7	Conclusion of the Assessment	51
7.1	Findings	51
7.2	Benefits	53
7.3	Risks	53

1 Introduction

1.1 Background

The National Transport Authority, Galway City Council and Galway County Council are preparing the Galway Transport Strategy (GTS). This report provides a summary of the modelling and appraisal of the potential transport solutions contained within the strategy.

As Galway City continues to grow, it is crucial to safeguard the future development of the city as the principal economic centre of the west. There is a strong need to address existing transportation issues facing the city, and to underpin future growth by establishing a long-term plan for transport to, within and around the city. Galway City currently experiences congestion problems as a result of over reliance on private car and lack of alternative modes of transport which impacts upon the journey time reliability of existing public transport services and limits the available road space for introducing bus and cycle lanes.

The GTS will set down a framework for how Galway City's transport network can be redefined to address these transport issues, as well as cater for the future development of the city. The primary focus of the GTS will be to examine how existing infrastructure can be best utilised and to ensure the most efficient and sustainable use of the limited available road space. The GTS will also provide Galway with an opportunity to grow both physically and economically, whilst creating the opportunity for improvements to the urban environment.

In recent years both Galway City and County Councils have developed the following of plans, strategies and studies:

- Galway City Development Plan;
- Galway County Development Plan;
- Galway Metropolitan Area Smarter Travel Area Action Plan 2010-2015;
- Galway City and Environs Walking and Cycling Strategy 2010-2017; and
- Galway Public Transport Feasibility Study.

In addition there are several national and regional policies and guidelines which impact on the region as outlined below:

- Smarter Travel Policy for Ireland 2009-2020;
- Regional Planning Guidelines for the West Region;
- Strategic Framework for Investment in Landside Transport; and
- Spatial Planning and National Roads.

The GTS will ensure that the transport policies and proposals outlined above and those of the NTA are aligned. Ultimately the strategy will provide Galway with a clear implementation framework over the next 20-30 years and will underpin the development and economic objectives of the Galway City Development Plan forming the basis for selection and funding of transport projects in Galway City.

1.2 Study Aim and Objectives

In line with the aim and objectives of existing plans and previous studies, the principal aim of the GTS for Galway embraces the need to consider all transport modes within the strategy and emphasises the sustainable movement of people. The GTS for Galway seeks to:

'Examine potential options to improve Galway's transport network and identify a package of measures within an agreed programme of infrastructural development which will enable the transport network of Galway City to serve travel demand in the most efficient, effective and sustainable manner'.

The objectives of the GTS build upon the principal aim of the strategy outlined above and from the objectives of the existing plans and previous studies listed in section 1.1. The objectives for the GTS also support the broader economic, social and environmental objectives of both local and national plans. The GTS objectives have been categorised under the objective headings outlined in the Department of Transport, Tourism and Sport's (DTTAS) *Common Appraisal Framework (CAF) for Transport Projects and Programmes* which are as follows:

- Economy;
- Safety & Physical Activity;
- Environmental;
- Integration; and
- Accessibility and Social Inclusion.

Table 1 collates all of the key objectives of the GTS under the CAF categories. These objectives have been used to assess potential options and packages of measures for inclusion in the GTS. The assessment process is further described in Chapter 4.

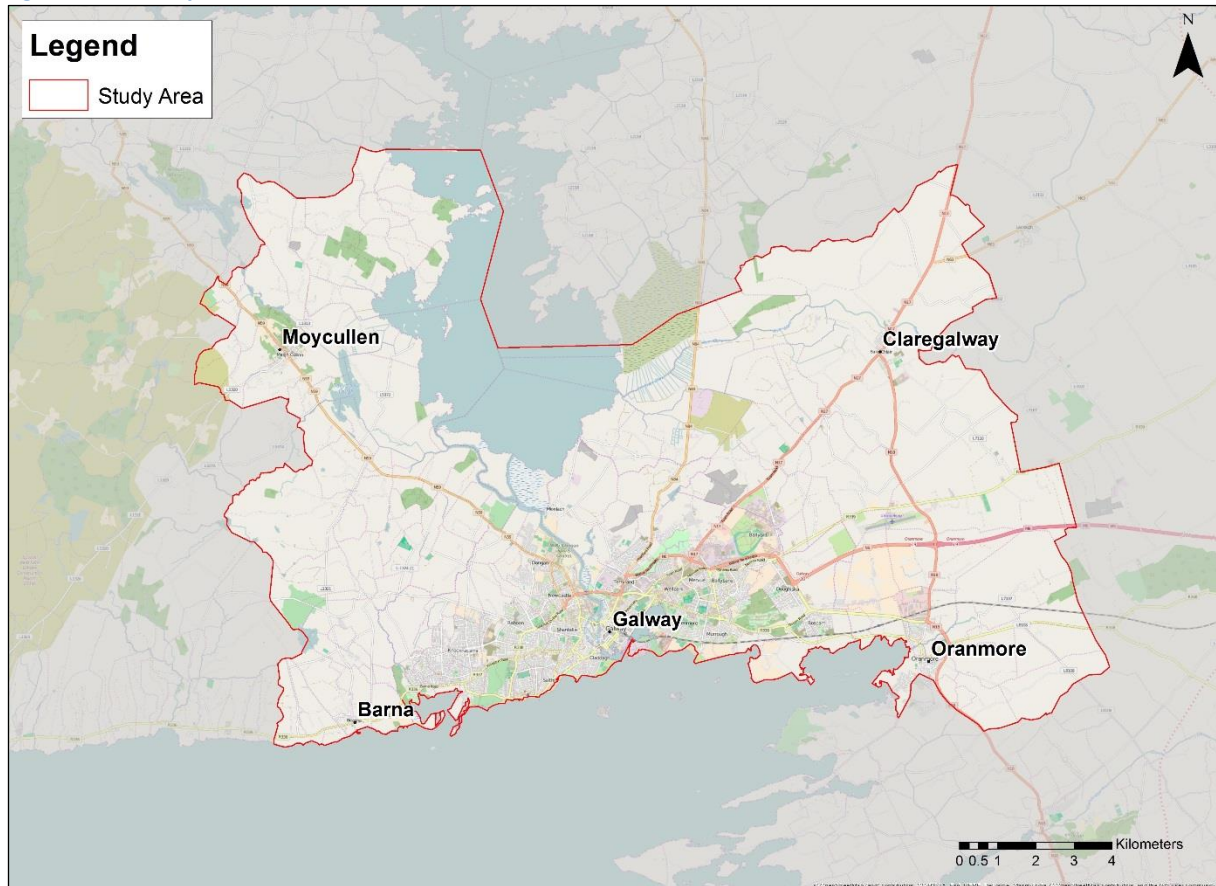
Table 1 GTS Objectives

Category	Objectives
Economy	Ensure value for money in the implementation of proposals
	Support Galway City's function as a regional centre for employment, education, retail, leisure and tourism by providing access for all through an efficient and reliable transport network
Safety & Physical Activity	Develop a safer & healthier City Centre for all transport modes and users
	Exploit transport's role in facilitating a healthier lifestyle
Environmental	Improve the urban realm by minimising the impact of transport
	Minimise harmful transport emissions
Integration	Support integration between sustainable transport and land use planning and policies
	Provide for better transport integration
Accessibility and Social Inclusion	Improve multi-modal accessibility within residential, employment and retail centres
	Provide a socially inclusive transport network

1.3 Study Area

The GTS study area covers Galway City, as shown in Figure 1, and its environs with a boundary broadly delineated by, and including, the towns/villages of Bearna, Moycullen, Baile-Chlair (Claregalway) and Oranmore.

Figure 1. GTS Study Area



1.4 Purpose of Study

The purpose of this assessment is to identify the optimum transport solution for Galway. Based on the estimated level and pattern of demand a set of appropriate sustainable travel solutions were identified for Galway. This included development of a comprehensive walking and cycling network to accommodate short distance trips and consideration of various public transport options (both bus and light rail systems) to meet the demand of trips longer than 3km.

The GTS also reviewed the existing road network in the Study Area and has included the proposed Galway Ring Road in its assessment. The identification process of potential transport solutions for each travel mode is detailed in the 'Galway Transport Strategy Technical report'.

Through the consideration of the various transport solutions documented in the 'Galway Transport Strategy Technical report', this report identifies viable transport scenarios and assesses each one against the study objectives previously described in Table 1. Each scenario comprises of a package of transport measures previously which have been tested using the NTA Regional Modelling System.

1.5 Report Structure

The report is divided into the following sections;

- Section 2 provides an overview of the NTA Regional Model development and the suitability of the Western Regional Model for testing the Galway GTS measures;

-
- Section 3 outlines the appraisal methodology and the evaluation criteria against which measures are being assessed;
 - Section 4 describes briefly each of the proposed transport measures by mode and the package of measures combined to form the four public transport and active mode scenarios;
 - Section 5 assesses each of the sustainable mode scenarios against the evaluation criteria set out in section 3, identifies a preferred public transport and active mode scenario and outlined the additional phases of road infrastructure to be assessed;
 - Section 6 assesses three road based improvements in combination with the previously identified public transport and active mode scenarios;
 - Section 7 presented the conclusion of the assessment and the final emerging preferred scenario.

2 NTA Regional Modelling System

2.1 Introduction

The GTS has been assessed using the NTA's West Regional Model (WRM). The WRM is one of 5 regional models which comprise the NTA Regional Modelling System (RMS). The RMS covers the Republic of Ireland and is centred on the five main cities of Dublin, Cork, Galway, Limerick, and Waterford. Each regional model has the following key attributes:

- Full geographic coverage of the relevant region;
- A detailed representation of the road network;
- A detailed representation of the public transport network & services;
- A representation of all major transport modes including active modes (walking and cycling) and includes accurate mode-choice modelling of residents;
- A detailed representation of travel demand of four time periods (AM, Inter-Peak, PM and Off-Peak); and
- A prediction of changes in trip destination in response to changing traffic conditions, transport provision and/or policy.

Figure 2 illustrates the geographical extents of the Regional Model Areas.

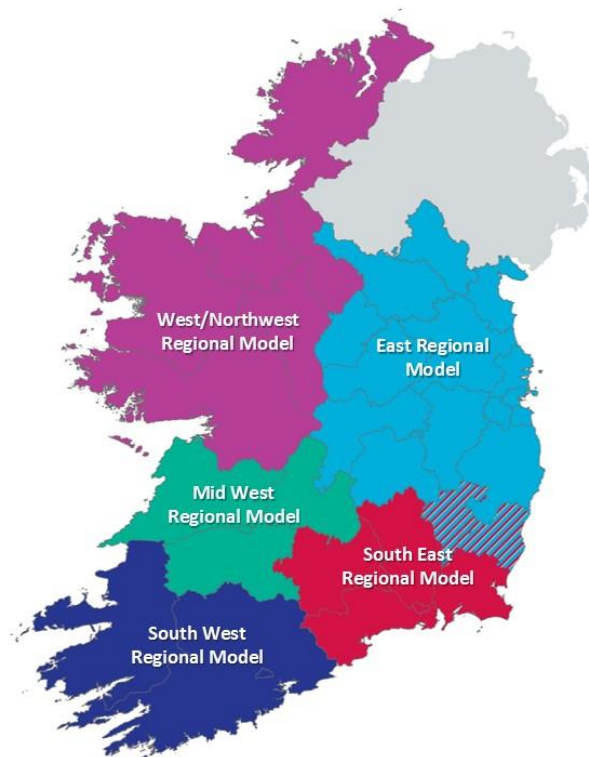


Figure 2. NTA Regional Modelling System-Model Extents

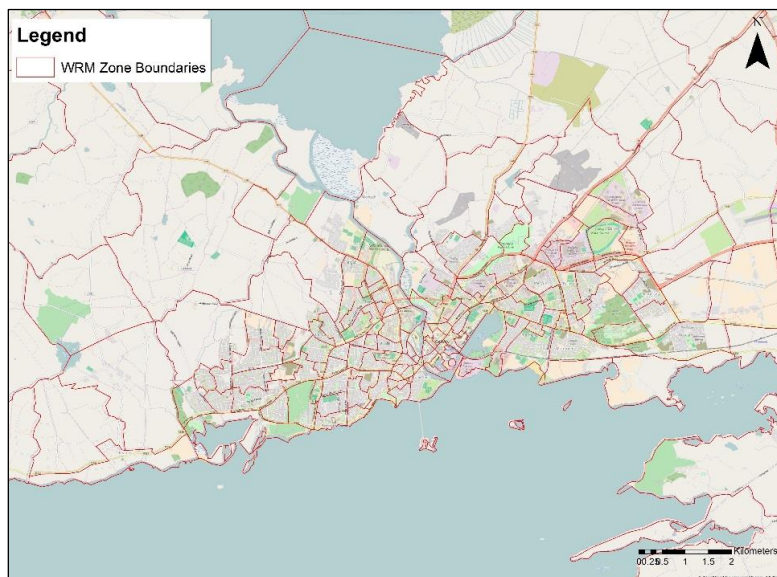
The model covers all surface access modes for personal travel and goods vehicles including private vehicles (taxis and cars), public transport (bus, rail, Luas, BRT, Metro), active modes (walking and cycling). The impact of the movement of goods is represented through the inclusion of goods vehicles (light goods vehicles and heavy goods vehicles) in the highway model. The travel demand is segmented according to trip purpose, car availability, employment type and educational level in order to group people with similar travel behaviours (for example, blue collar commuters who own a car). This allows groups to be treated differently according to their behaviour. In total the demand

has been segmented into 33 distinct classifications. The base year of the model is 2012 and it represents an average weekday with five separate peak periods modelled:

- AM peak (07:00-10:00);
- Morning Inter peak (10:00-13:00);
- Afternoon Inter peak (13:00-16:00);
- PM peak (16:00-19:00); and
- Off peak (19:00-07:00).

The WRM covers the five counties of Connacht and Donegal County with a focus on Galway City. These areas are represented by 693 detailed internal zones with 56 external zones presenting travel between the modelled area and the rest of Ireland. The zone structure around Galway City and its environs is shown in Figure 3. Further information on the model's zone structure can be found in the WRM Zone System Development Note.¹

Figure 3. WRM Zone Structure - Galway city



2.2 WRM Structure

The WRM can be described as three core modelling components which receive inputs from the National Demand Forecasting Model (NDFM), a separate modelling system that estimates the total quantity of daily travel demand generated by and attracted to every Census Small Area using data from the 2011 Census and the 2012 NHTS. These three components are as follows;

- Demand Model;
- Road Assignment Model; and
- Public Transport Assignment Model.

All demand and Public Transport model components of the WRM are implemented in Cube Voyager software with SATURN modelling software used for the Road Model Assignment. Further details on the each element of the WRM can be found in the Model Development Reports.²

¹ WRM Transport Model Zoning Development Note

² WRM Road Model Development Report, WRM Public Transport Model Development Report, WRM Active Mode Model Development Report & WRM Highway Model Development Note.

2.3 Calibration of the WRM

The WRM has been calibrated and validated against observed data sources in terms of overall demand, highway assignment and public transport assignment in line with best practice guidance. The list below represents the main features of the model that have been calibrated against observed data in terms of its three main components;

- Demand
 - Demand Share by Trip Purpose
- Highway Assignment
 - Link Flows
 - Turning Volumes
 - Journey Times
- Public Transport Assignment
 - Boardings & Alightings
 - Passenger Link Flows
 - Journey Times

The observed data includes data from the 2011 Census, 2012 NHTS, Journey Time Data, Rail Census, Annual PT Ticket Sales and Traffic Count Data. Further details on the calibration of each component of the model can be found in the model development report.

2.4 Application of the WRM to the GTS

The WRM has been used to appraise proposed measures in order to identify the optimum package of measures to be included in the GTS. These measures includes improvements to public transport frequency and prioritisation, walking and cycling infrastructural improvements, junction improvements and traffic management measures. The model produces the following outputs which allow the impact of these measures to be assessed:

- Public Transport Patronage, Occupancy & Utilisation;
- Mode Split;
- Modelled Emissions;
- Traffic Speeds & Volumes;
- Impact of Parking Charges;
- Park & Ride Utilisation;
- Journey Times; and
- Travel Costs by Mode.

There are however, as with all transport models, limitations to what the model can be used to assess. There are proposed measures within the GTS that will contribute towards achieving the study objectives but cannot be assessed using the WRM. These include, amongst others;

- ITS measures which improve wayfinding, management of parking and route choices;
- Behavioural Change Initiatives which influence choice of mode and time of travel;
- Demand Management measures which restrict / control traffic movements; and
- Public Realm enhancements – which improve the quality of the environment and likelihood for walking/cycling trips.

Further details on the development of these proposed measures can be found in ‘Galway Transport Strategy Technical Report’.

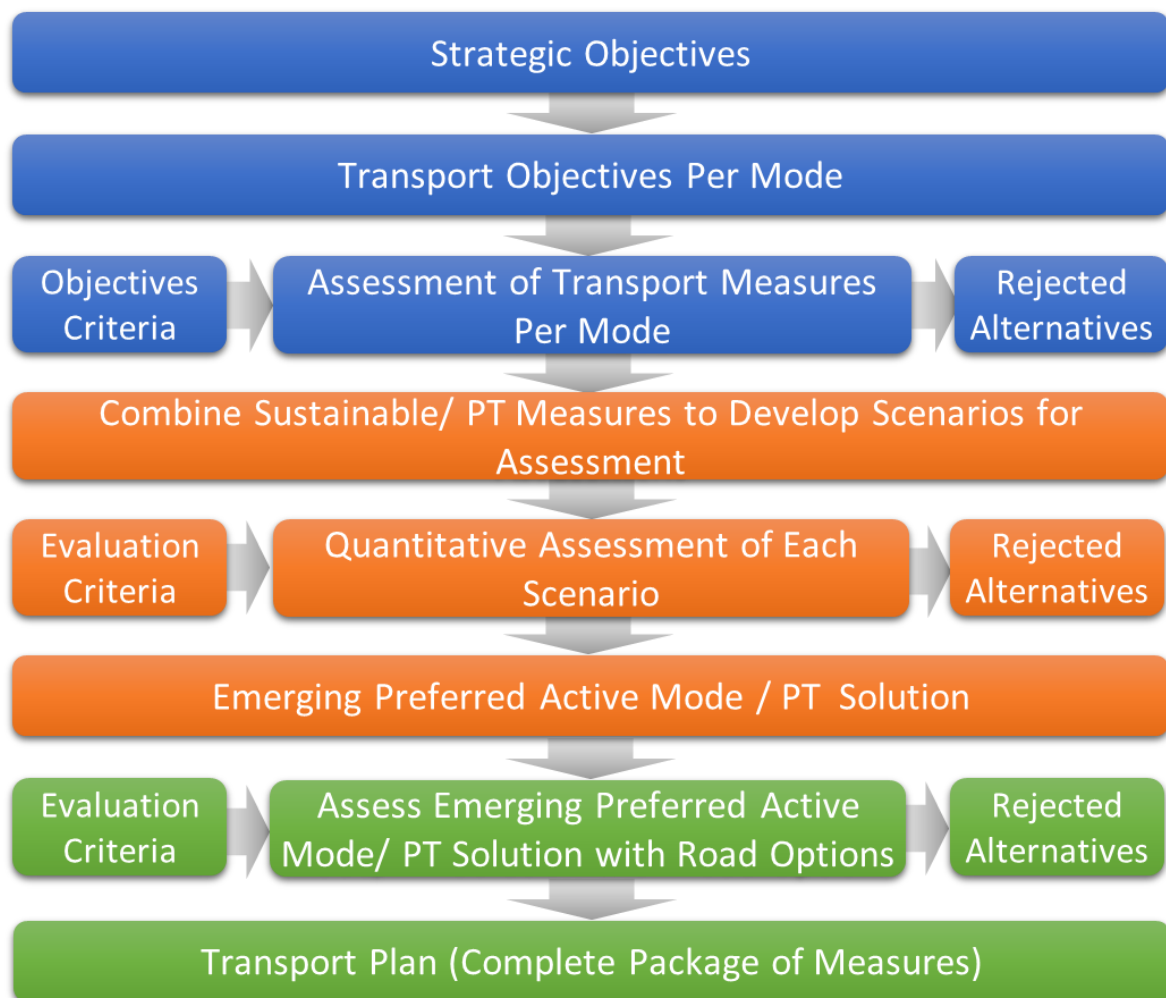
3 Appraisal Methodology

3.1 Overview

The overall appraisal methodology is outlined below in Figure 4. The methodology has three distinct phases. In the first phase (highlighted in blue) a long list of possible individual transport measures was created based on previous relevant studies, current policy and best practice. These measures were then qualitatively assessed against the criteria outlined previously in Table 1.

A hierarchical approach was adopted for the assessment of combined strategies that sets out the order of interventions required to support sustainable travel choices. These start with interventions for walking and cycling, followed by the need for additional public transport infrastructure, supported by demand management measures aimed at encouraging a switch to sustainable modes. Finally, options for new strategic road infrastructure were examined.

Figure 4. GTS Appraisal Methodology



Following this hierarchical approach, Active Mode/ Public Transport (PT) mode measures were firstly combined to form four scenarios for testing in the second phase (highlighted in orange). The scenarios were assessed against the agreed evaluation criteria to find the Emerging Preferred Active Mode & PT solution. In the third phase (highlighted in green) the preferred Active Mode / Public Transport solution was then assessed in combination with three different road based measures to find the optimal complete package of transport measures. The quantitative assessment of the combined active travel, PT and road based scenarios is described in greater detail in section 3.3.

3.2 Assessment of Individual Measures by Mode

As outlined above initially a set of transport plan principles were derived based on the rationalisation of key objectives from previous studies and strategies outlined for the Galway Area. These principles formed the basis for the development of transport measures by mode which were qualitatively assessed against the objectives outlined in Table 1. Further details of the assessment and development of the transport options can be found in 'Galway Transport Strategy Technical report'. The transport measures are briefly summarised in Section 4 of this report.

3.3 Quantitative Assessment of Scenarios

3.3.1 Quantitative Assessment of Active Mode/PT Scenarios

Following the development of individual measures by mode, the measures were then combined into scenarios for quantitative assessment using the WRM. As described previously this was undertaken in a two part process. Initially four scenarios were tested to find the optimal Preferred Active Mode & PT solution in order to establish the sustainable infrastructures requirements before the introduction of road based interventions.

The quantitative assessment of the scenarios required the development of more detailed Key Performance Indicators (KPIs) based on the GTS objectives outlined in Table 1. Methods of measurements were then identified for each KPI predominantly using outputs from the WRM. Table 4 outlines the KPIs associated with each objective and the methods used to measure each KPI.

3.3.2 Quantitative Assessment of Additional Scenarios

Once the optimal Active Mode & PT scenario was identified it was combined with three potential road options to form an additional three scenarios in order to find the final emerging preferred package of measures. The road options were based on the phasing of the preferred route from the N6 Galway City Ring Road. The scenarios were again assessed against the KPIs outlined in Table 4.

Table 4 Assessment Measures: Study Objectives Evaluation Framework

Category	Objectives	Key Performance Indicators	Measured By
Economic	Ensure value for money in the implementation of proposals	Cost	High level estimates capital, operating and maintenance costs.
	Support Galway City's function as a regional centre for employment, education, retail, leisure and tourism by providing access for all through an efficient and reliable transport network	PT capacity versus demand Road congestion	PT capacity versus modelled utilisation % Change in number of links modelled to be over capacity
Safety & Physical Activity	Develop a safer & healthier City Centre for all transport modes and users	Consider safety and health implication of all interventions Traffic management measures	% change in particulate emissions within the City Centre % change in traffic volumes within the City Centre
	Exploit transport's role in facilitating a healthier lifestyle	Measures which support walking and cycling	modelled change in overall levels of walking and cycling
Environmental	Improve the urban realm by minimising the impact of transport	Reduce traffic volumes in sensitive areas	% change in traffic volumes in the City Extent of public realm improvements (by street length)
	Minimise harmful transport emissions	Quantum of transport emissions	% change in modelled emissions
Integration	Support integration between sustainable transport and land use planning and policies	Compatibility of transport measures with local, regional and national spatial planning and transport policy	Review of proposed transport measures against policies within Galway City Development Plan, Smarter Travel Policy % change in modelled mode share for sustainable modes
	Provide for better transport integration	Public transport interchange opportunities Park and ride facilities	Number of routes accessible through interchange points on the PT network. Modelled Park and Ride performance
Accessibility and Social Inclusion	Improve multi-modal accessibility within residential, employment and retail centres	Accessibility by walking and cycling, public transport, car and HGV	Accessibility Index – change in travel cost between key origins and destinations, accessibility to education, employment and tourist areas, for both road and public transport based demand.
	Provide a socially inclusive transport network	Coverage and quality of service of public transport network	% of population within 10 minute walk of high frequency public transport (at most 15 minute headways)

4 Transport Measures and Combined Scenarios

4.1 Overview

As mentioned previously transport measures by mode have been selected through a qualitative assessment of options and a review of previous strategies and best practice. This section provides a brief description of the final proposed measures by mode. For more details on the measures and their development refer to the 'Galway Transport Strategy Technical Report'.

4.2 Measures

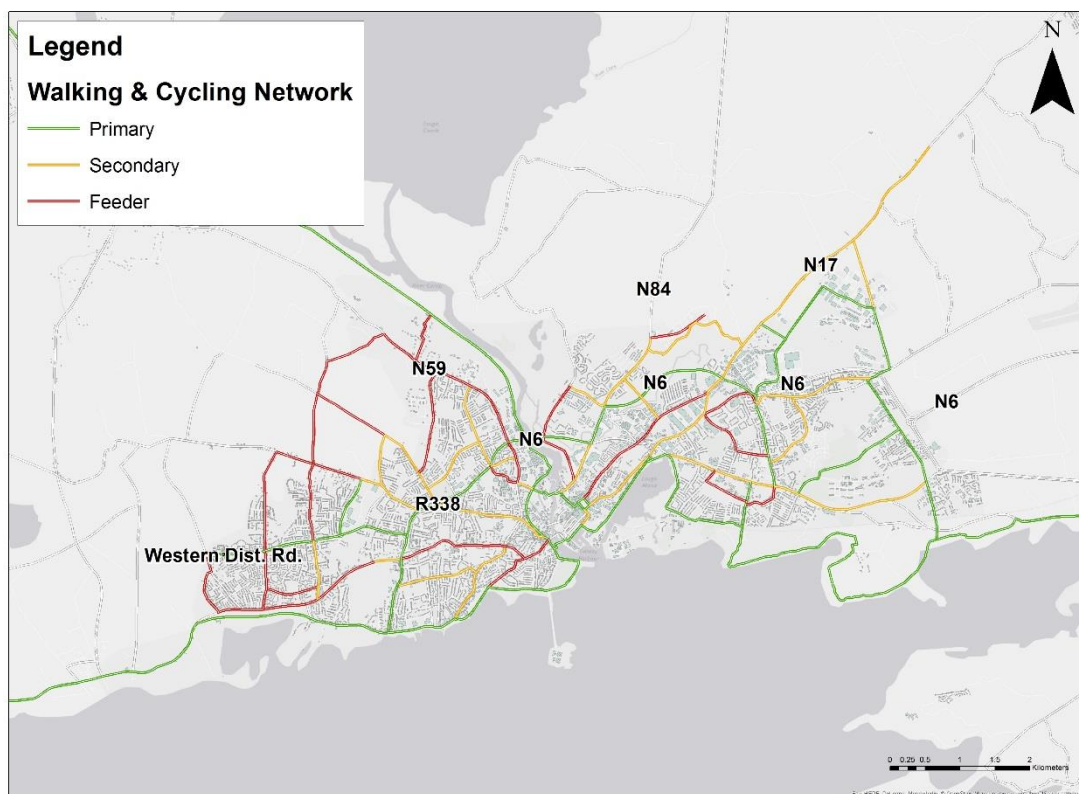
4.2.1 Walking and Cycling

The walking measures selected aim to prioritise pedestrian movements within the study area, particularly within the City Centre. Outside of the city centre, emphasis will be given to increasing permeability within suburban residential areas, improving and updating the pedestrian network, increasing pedestrian safety and maximising pedestrian accessibility to the public transport network.

The cycle measures consist of the delivery of the Core Cycle Network which will provide a safe and segregated network for cyclists in the western, eastern and northern corridors. A secondary network of on-street cycle facilities will also be provided, which will also serve as feeders to the core segregated network. Figure 5 shows the proposed Core, Secondary and Feeder Cycle Network.

There are also additional measures aimed at increasing walking and cycling trips including pedestrian/cyclist favoured signals, a new pedestrian only bridge over the River Corrib and improvement to the public realm within the city centre.

Figure 5. Walking & Cycling Network



4.2.2 Public Transport

The public transport network will consist of a cross city network. The network will serve east-west movements traversing the city. The network will consist of the following proposed routes:

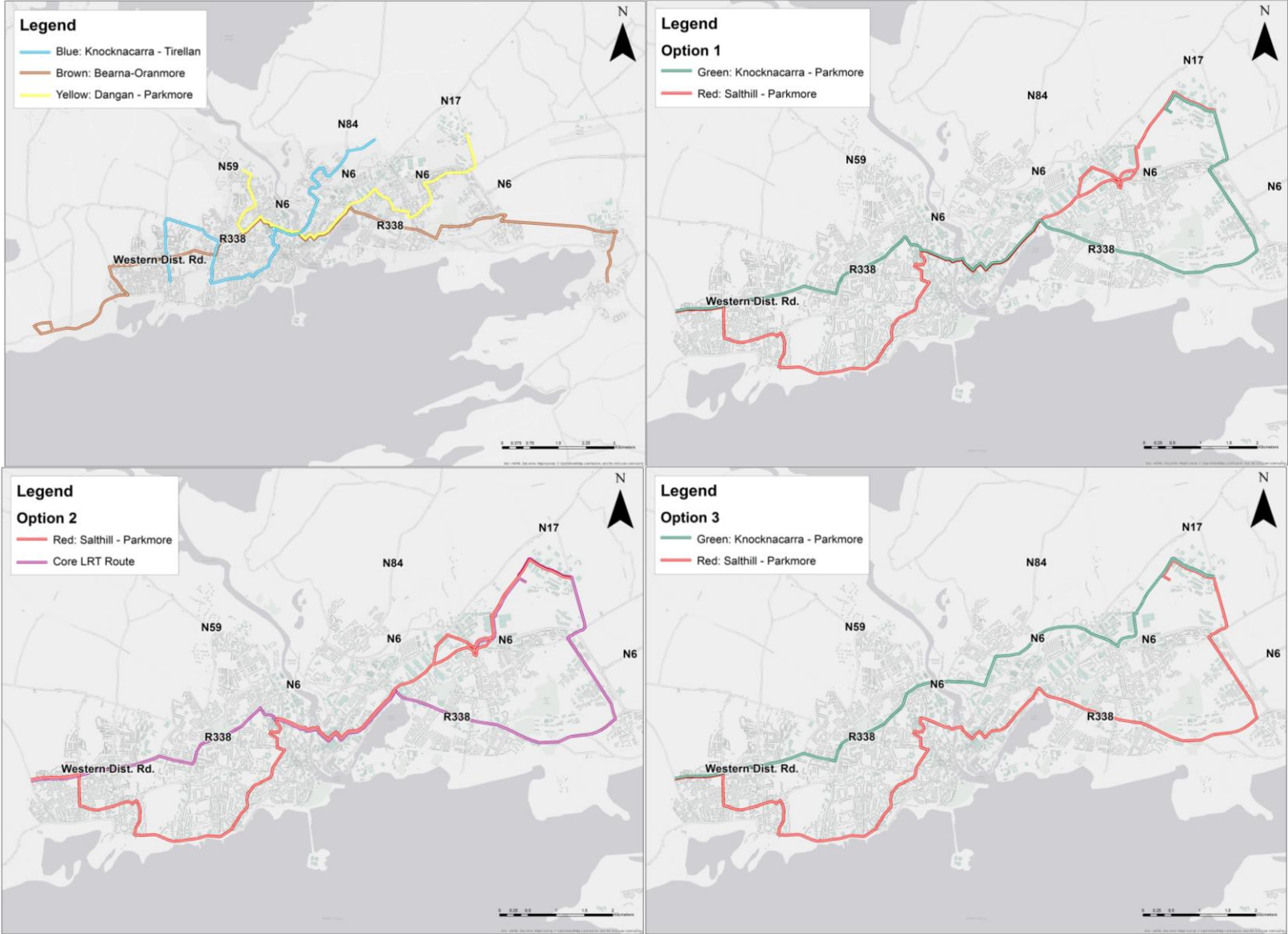
- **Green Route:** Knocknacarra – City Centre – Parkmore Industrial Estate;
- **Red Route:** Knocknacarra – City Centre – Parkmore Industrial Estate;
- **Blue Route:** Clybaun Road – City Centre – Castlegar;
- **Yellow Route:** Dangan – City Centre – Parkmore Industrial Estate; and
- **Brown Route:** Bearna – City Centre – Oranmore.

There are three options proposed for the red and green route which have been considered as part of the assessment as follows:

1. Two east-west orientated Bus Routes both traversing the City Centre;
2. One Bus Route and One LRT Route traversing the City Centre; and
3. Two Bus Routes with one passing through the City Centre and one Orbital Route travelling along the N6.

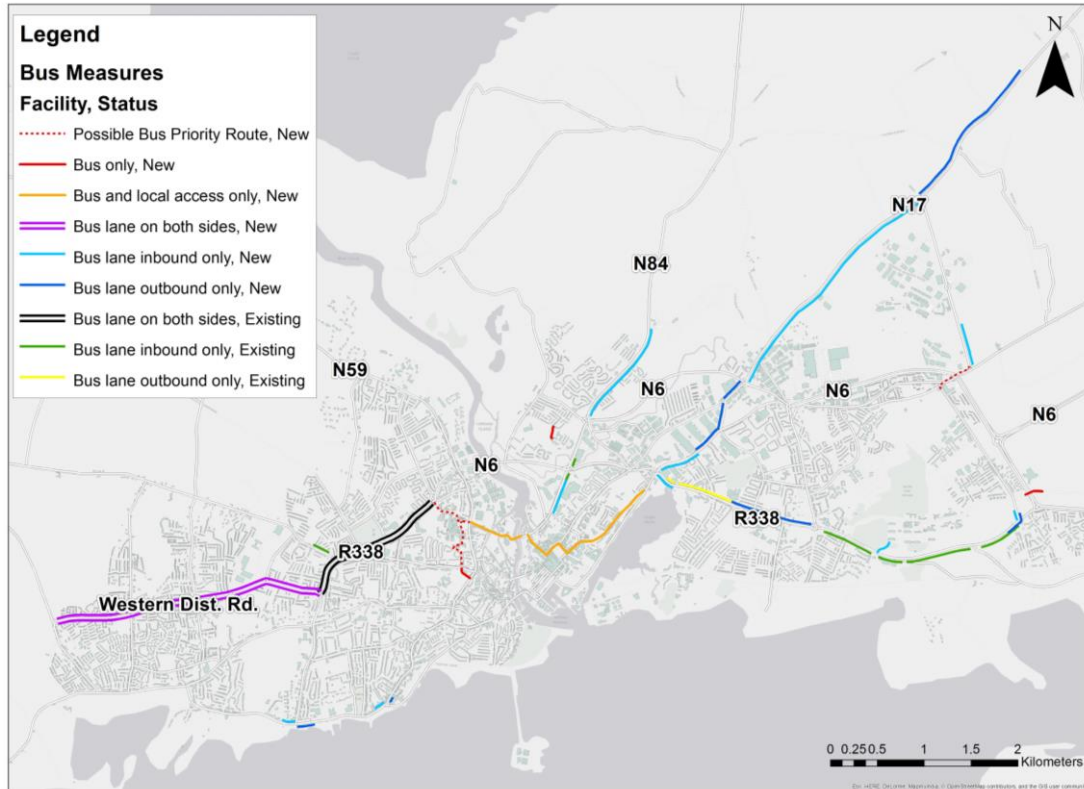
All these options for the green and red routes have been combined with the same Yellow, Blue and Brown bus network. The network will provide numerous opportunities for interchange between all routes. Further information on the Public Transport Network can be found in Appendix C – Public Transport Network Development. The figures below illustrates the Yellow, Blue and Brown bus network and each of the proposed options for the Green and Red routes.

Figure 6. Public Transport Networks



In addition there will be supporting infrastructure in place in the form of bus lanes, public transport priority routes and public transport hub/Interchanges. Figure 7 below shows the full extent of the proposed infrastructure. There are also supporting measures in the form of park and ride facilities, ticketing measures, bus fleet and stop improvements.

Figure 7. Public Transport Infrastructure- Existing & Proposed

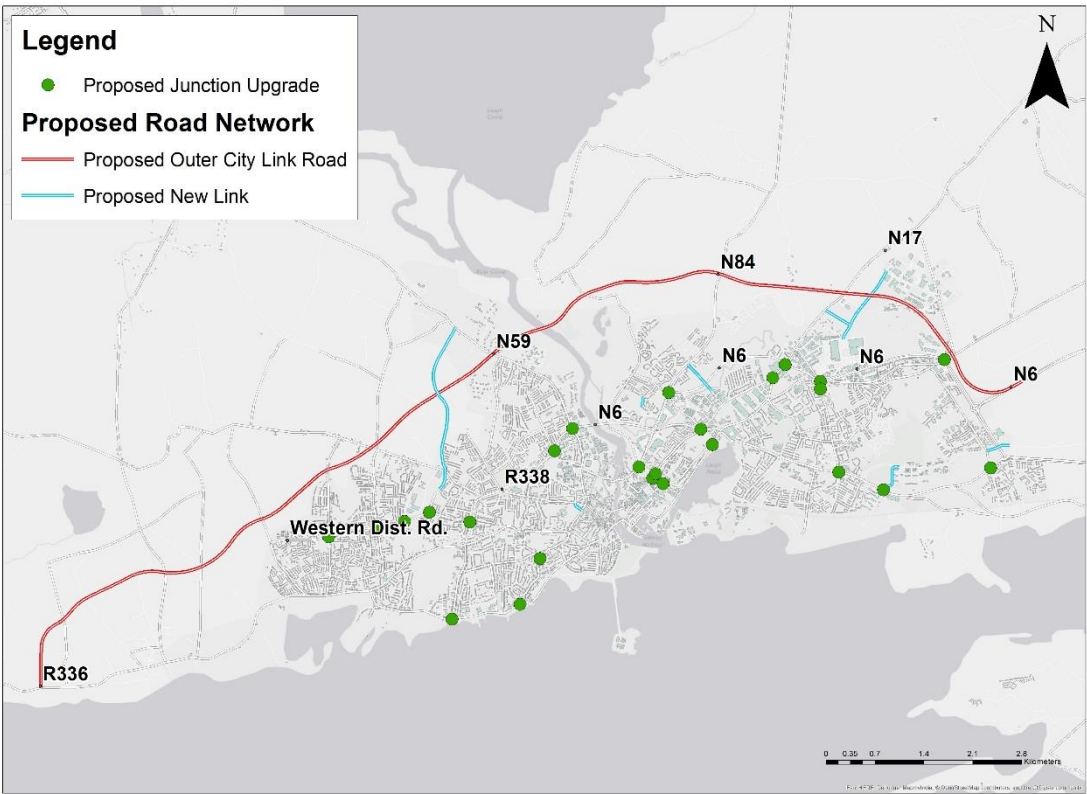


4.2.3 Roads

In terms of road based measures there are new link roads and junction upgrades proposed throughout the city with several roundabouts converted to fully signalised junctions. The purpose of these improvements is to improve safety and accessibility for pedestrians and cyclists, facilitate priority measures for public transport and improve the overall efficiency of the transport network.

There is also provision for the inclusion of a potential ring road of Galway City as designed by TII. Further information on the bypass can be found in the 'N6 Galway City Transport Project – Route Selection Report'. The inclusion of the bypass in the GTS has been considered incrementally with three options being assessed. All options commence at the current N6 on the approach to Coolagh roundabout with the first ending at the N84, the second at the N59 and the final option at the R336 forming a full bypass of the City. Figure 8 shows the full extent of the road proposals under consideration.

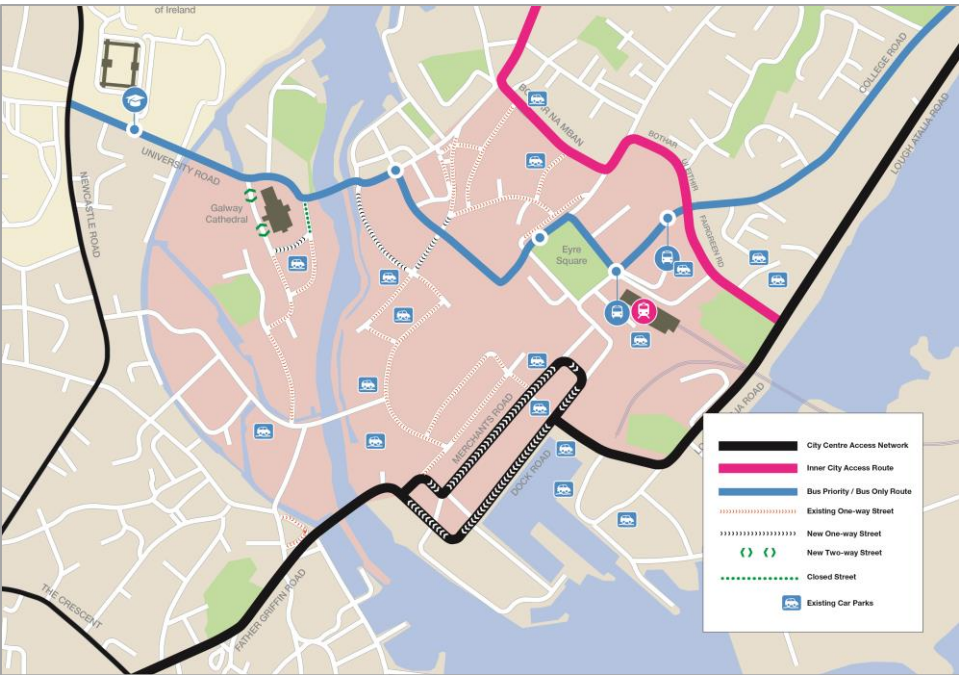
Figure 8. Porposed Road Network Improvements



4.2.4 Traffic Management

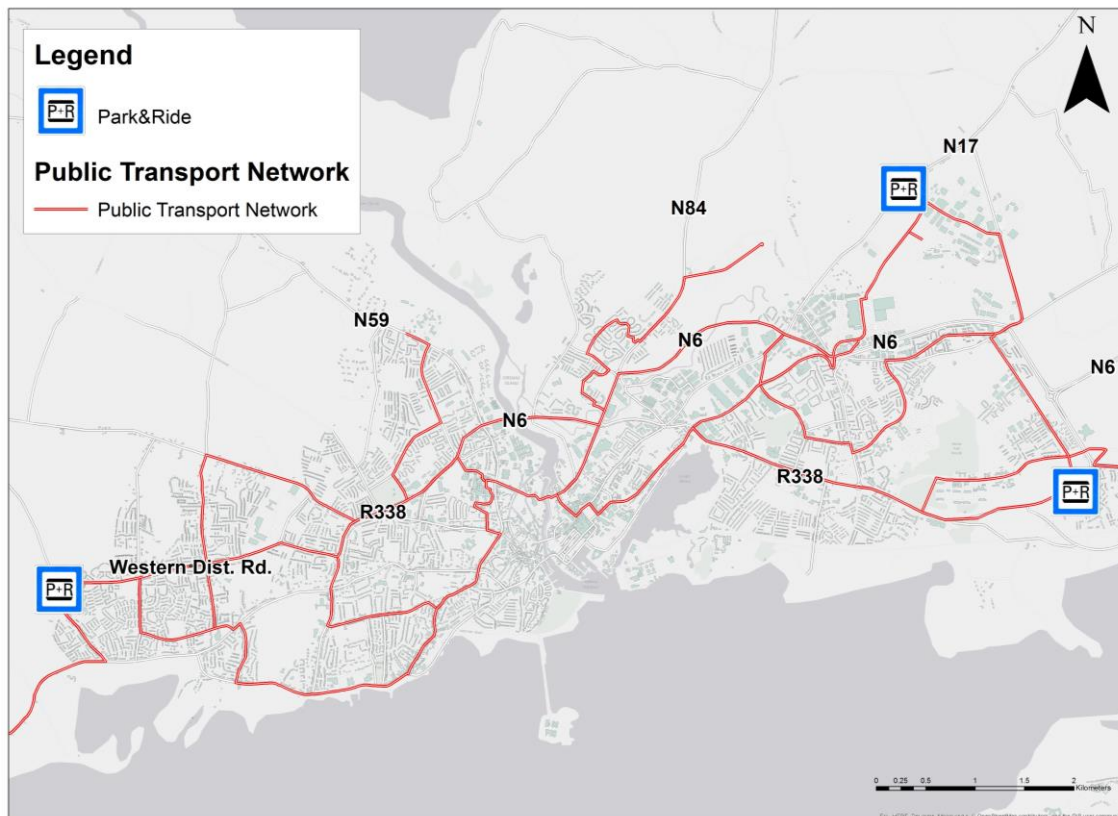
The aim of the traffic management measures proposed is to reduce through-car movement and speeds and prioritise Public Transport movements in the city centre. This will be achieved through the creation of an inner orbital access route for cars as illustrated in Figure 9. This will be combined with a new Public Transport link through the core city centre area which will have restrictions on its use by other traffic.

Figure 9. Proposed Traffic Management Measures



In addition there are three park and ride facilities proposed at strategic locations around the city as shown in Figure 10. Further information of the development of the park and ride measures can be found in Appendix E – Park and Ride Location Analysis.

Figure 10. Proposed Park & Ride Sites



4.2.5 Demand Management

It is proposed to reduce the dominance of the private car through management of demand which can include pricing and parking availability within the city in order to encourage a shift to more sustainable modes of transport. This can be partially achieved through ensuring the price of parking is in line with typical bus fares and through the removal of a portion of on-street parking in the city centre to provide more space for pedestrians, cyclists and public transport. In addition major employers will be encouraged to develop robust mobility management plans.

4.3 Development of Scenarios for Assessment

The transport measures outlined above have been combined into scenarios in a manner consistent with recent local, regional and national policies as outlined in section 1. Central to these policies is the need to promote a mode shift from the private car to more sustainable modes, such as walking, cycling and public transport. In this way, the transport strategy is consistent with the most up to date policy as it effects the needs of the population of Galway to produce a transport environment that promotes the sustainable, safe and healthy movement of people.

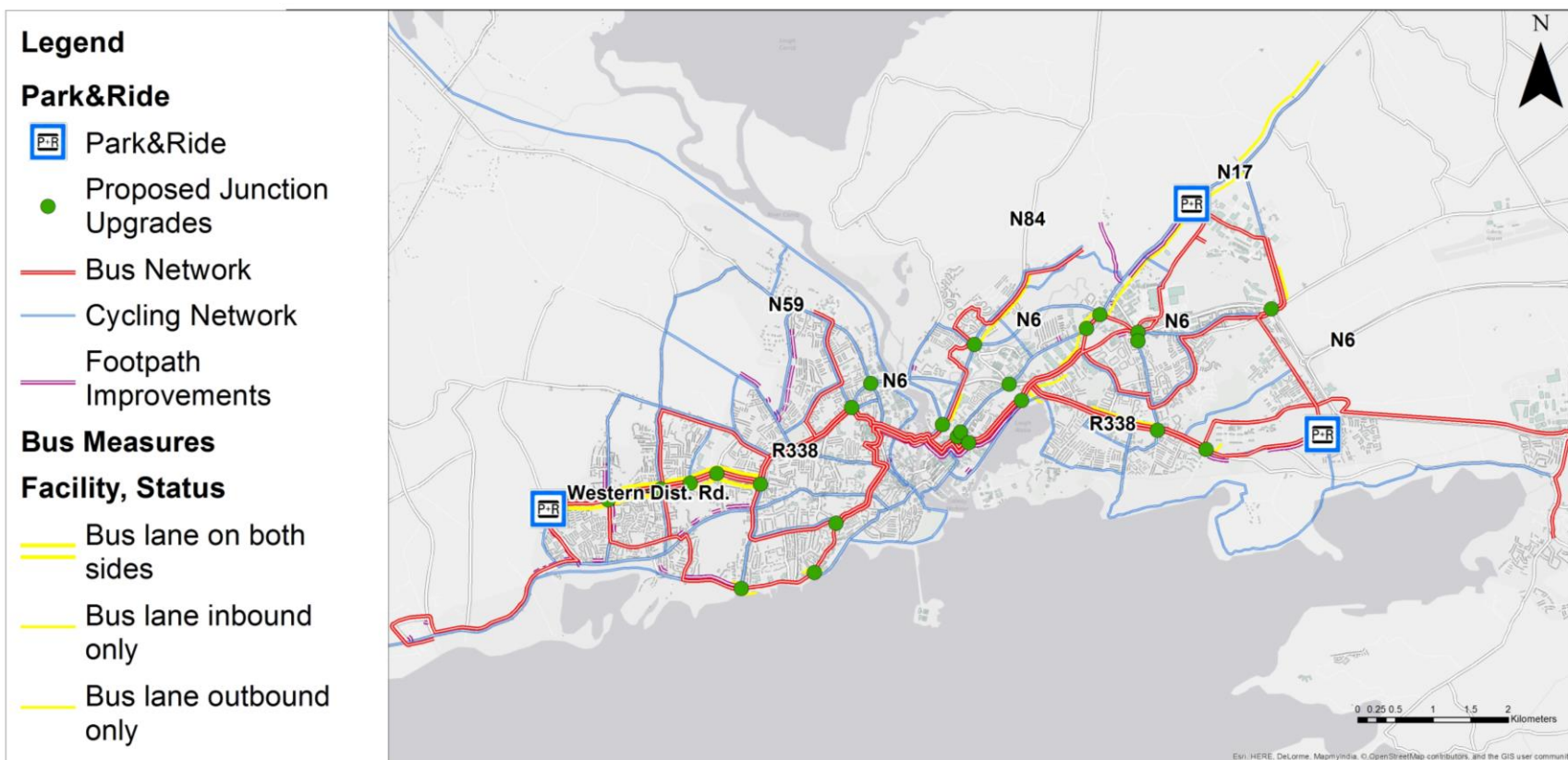
The initial scenarios of the appraisal seek to identify a transport solution that meets the transport policy objectives for Galway without the need for substantial investment in additional road infrastructure. These scenarios have also been developed in a hierarchical fashion layering up the level of investment and overall changes required to the existing transport network. In summary, these are as follows:

-
- **Scenario 1:** includes for improvements to walking and cycling facilities along the existing transport network, as well as the delivery of an enhanced public transport network.
 - **Scenario 2:** includes the same improvements to walking, cycling and bus as contained in Scenario 1, but also seeks to improve permeability and journey time reliability through the provision of additional walking/cycling links, as well as increased priority for buses in the city centre.
 - **Scenario 3:** is the same as scenario 2, but allows for the assessment of orbital and cross city bus services.
 - **Scenario 4:** includes for all of the measures contained in scenario 2, but with the inclusion of a LRT route running through the City Centre.

Following the assessment of the scenarios 1-4 against the Galway GTS objectives, the preferred active mode / public transport solution is combined with various phases of the N6 Galway City Transport project emerging preferred route as described in section 5. The performance of all 7 scenarios against the Galway GTS objectives and a summary of the benefits of the emerging preferred integrated scenario is presented in Sections 5 and 6. A description of scenarios 1-4 is presented in pages 21-24 along with a graphical overview of each scenario.

Scenario 1: Cross City Bus Network

Scenario 1 comprises of improvements and upgrades to walking and cycling facilities along the existing network. The Public Transport network consists of a **cross city bus network**. There will be new bus lanes along the Western Distributor Road, N17, N84 and R338 along with junction upgrades as shown. The Figure below gives a graphical overview of scenario 1.



Scenario 2: Cross City Bus Network with PT Prioritisation

Scenario 2 comprises of improvements and upgrades to walking and cycling facilities along the existing network, improvements to the pedestrian network permeability and inclusion of **active mode favoured signals**. The Public Transport network consists of a **cross city bus network** with additional bus lanes on the Western Distributor Road, N17, N84 and R338. There is also **public transport prioritisation measures** through the city centre to improve PT journey time reliability. **Demand management measures** will also be in place and will consist of parking restrictions and revised parking costs within the city centre. The Figure below gives a graphical overview of scenario 2.



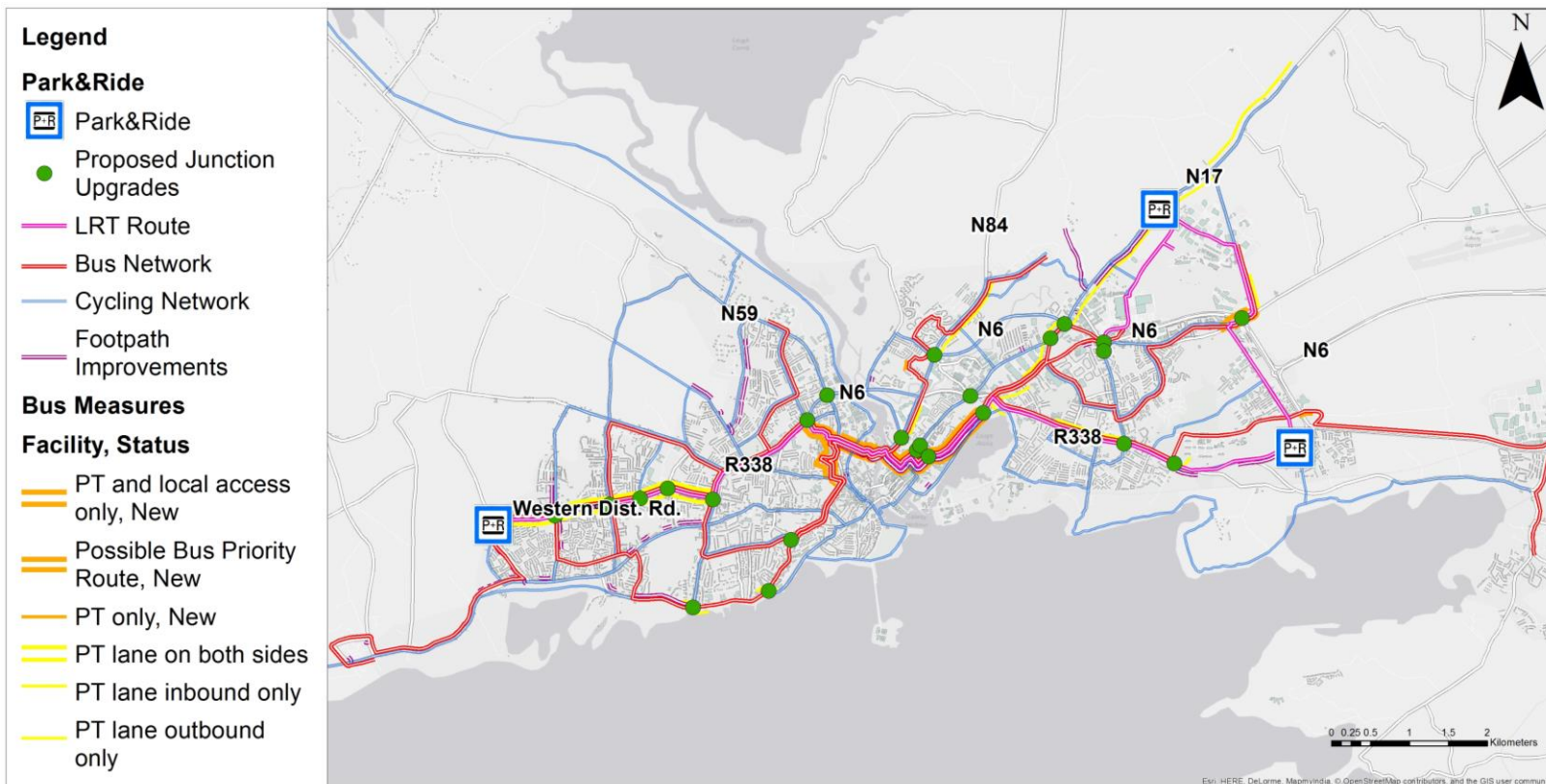
Scenario 3: Cross City & Orbital Bus Network with PT Prioritisation

Scenario 3 comprises of improvements and upgrades to walking and cycling facilities along the existing network, improvements to the pedestrian network permeability and inclusion of active mode favoured signals. The Public Transport network consists of a **cross city bus network** with one **orbital** route. There is also public transport prioritisation measures through the city centre to improve PT journey time reliability and integrated park and ride facilities. Demand management measures will also be in place and will consist of parking restrictions and revised parking costs within the city centre.



Scenario 4: New LRT City Centre Route & Cross City Bus Network with PT Prioritisation

Scenario 4 comprises of improvements and upgrades to walking and cycling facilities along the existing network, improvements to the pedestrian network permeability and inclusion of active mode favoured signals. The Public Transport network consists of a **cross city bus network**. This scenario includes a **new LRT route** running through the City Centre operating at a 5 minute frequency. There is also public transport prioritisation measures through the city centre to improve PT journey time reliability and integrated park and ride facilities. Demand management measures will also be in place and will consist of parking restrictions and revised parking costs within the city centre.



4.4 Summary of Scenarios for Testing

Table 5 below summaries the information presented in the Figures above for each scenario outlining the measures included in each.

Table 5 Summary of Scenarios for Testing

Mode	Measures	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Active Modes	1. Improvements via existing network	✓	✓	✓	✓
	2. Improvements to Permeability		✓	✓	✓
	3. Pedestrian favoured signals / Cyclists		✓	✓	✓
Public Transport	4. Revised Bus Routes at Higher Frequencies on Cross City Routes	✓	✓		
	5. Revised Bus Routes at Higher Frequencies on Cross City & Orbital Routes			✓	
	6. City Centre PT prioritisation measures		✓	✓	✓
	7. LRT Route through City Centre & Revised Bus Routes at Higher Frequencies on Cross City Routes				✓
	8. Integrated Park and Ride		✓	✓	✓
Demand Management	9. Demand Management Measures		✓	✓	✓

5 Evaluation of the Sustainable Mode Transport Proposals

5.1 Overview

This section outlines the comparative quantitative assessment of Scenarios 1-4 outlined in the previous chapter. The purpose of this assessment is identify an optimal sustainable mode scenario to bring forward for testing with the potential additional road infrastructure. The four scenarios identified have been assessed relative to each other³ (i.e. not against the existing situation) against the objectives identified under the five criteria outlined in the Department of Transport's Common Appraisal Framework for Transport Projects and Programmes (March 2016) using the following rating system.

Table 6 Assessment Rating Table

Colour	Relative Performance
Green	Excellent
Light Green	Very Good
Yellow	Good
Orange	Neutral
Red	Less Good

The overall result of the assessment for all criteria is summarised in Table 7 at the end of this section.

5.2 Quantitative Assessment of Active Mode/ PT Scenarios

As described in section 3, each scenario has been quantitatively assessed against agreed objectives under each of the CAF appraisal categories. This section outlines the results for each scenario using the Key Performance Indicators (KPIs) and Measurements outlined in Table 4. The modelling outputs presented in the following chapter are for the AM peak period. Results for the PM peak show similar impacts to the AM peak.

5.2.1 Safety & Physical Activity

Under Safety & Physical Activity, the following objectives are considered:

- Develop a Safer & Healthier City Centre for all transport modes and users; and
- Exploit transport's role in facilitating a healthier lifestyle.

5.2.1.1 Develop a Safer & Healthier City Centre for all Transport Modes

The safety and health implications of all interventions and traffic management measures must be considered for all modes within Galway City Centre to ensure a safer city centre. To assess the impact on safety and health the following modelling outputs have been assessed:

- Percentage Change in the traffic volumes within the City Centre; and
- Percentage Change in harmful Particulate Emissions within the City Centre.

³ For some objectives a comparison has been provided to the Do-Minimum scenario as a reference point, however each comparison is still a comparative assessment between Scenarios 1-4.

The results indicate the most significant impact on traffic levels in City Centre is the introduction of city centre prioritisation measures which are included in Scenarios 2, 3 & 4. These measures will bring about a considerable reduction in general traffic volumes within the City Centre creating a safer environment for walking and cycling.

The percentage change in transport emissions has been estimated from modelling outputs using the Environmental module of RMS appraisal tool kit, one of several appraisal tools available as part of the NTA Regional Modelling System. It estimates the levels the following emissions:

- Nitrogen Oxide & dioxide;
- Particulate Emissions;
- Hydrocarbon;
- Carbon Monoxide & Dioxide;
- Benzene;
- Methane; and
- Butadiene.

In order to assess the health implications of each scenario the percentage change in Particulate Matter 2.5 (PM 2.5) within the city centre has been calculated as this is considered to be particularly harmful to the health of people in close proximity to the emitted particulate. In summary the results, presented below, show that Scenarios 2 & 4 perform well with PM 2.5 reductions of 5.9% and 8.2% respectively. Scenario 3 performs less well due to increased congestion levels as a result of the reallocation of road space along the N6. Scenario 1 performs comparatively poorly to the other scenarios due to the lack of PT priority measures through the city centre.

Measurement	Scenario 1	Scenario 2	Scenario 3	Scenario 4
% Change in Traffic Volumes (City Cordon)	-5.0%	-12.4%	-12.1%	-14.5%
% Change harmful Particulate Emissions (City Centre)	1.8%	-5.9%	-2.3%	-8.2%

Assessment of the Development of a Safer and Healthier City Centre for all Transport Modes

Overall it is considered that Scenario 4 performs the best due to the greater reductions in city centre traffic and particulate emissions. Scenario 2 also performs quite well comparatively. Scenario 3 performs well in terms of the change in city centre traffic but comparatively less well in reducing particulate emissions. Scenario 1 performs the worst due the higher levels of city centre traffic and the slight increase in modelled particulate emissions,

Safer & Healthier City Centre for all Transport Modes	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.2.1.2 Exploit Transport's Role in Facilitating a Healthier Lifestyle

Transport infrastructure and policy can result in health benefits through the introduction of facilities designed to promote and encourage walking and cycling. In order to assess which scenario has the greatest impact in facilitating a healthier lifestyle, the walking and cycling mode shares have been outputted for each of the scenarios as shown in the graph below.

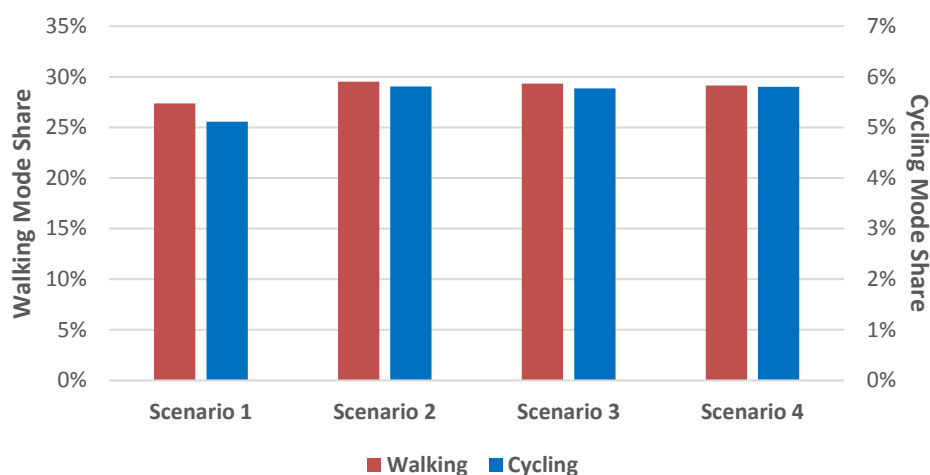


Figure 11. Walking & Cycling Mode Shares

The results of the assessment indicate that Scenarios 2, 3, & 4 perform well with increases in both walking and cycling mode shares. Scenario 1 however performs slightly less well when compared against the other scenarios due to lower level of walking mode share.

Assessment of Transport's Role in Facilitating a Healthier Lifestyle

As shown above Scenarios 2, 3 & 4 perform well in terms of increasing the walking and cycling mode share and thus exploiting the role of transport in facilitating a healthier lifestyle. Scenario 1 however has slightly less of an impact than the other scenarios.

Transport's Role in Facilitating a Healthier Lifestyle	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.2.2 Environment

Under environment, the following objectives are considered:

- Improve the urban realm by minimising the impact of transport; and
- Minimise harmful transport emissions.

5.2.2.1 Improve the Urban Realm by minimising the impact of Transport

The improvement to the Urban Realm has been assessed by measuring the reduction of traffic through the city centre, available through the modelling outputs, and the extent of public realm improvements (by street length).

The results indicate that Scenarios 2, 3 & 4 have the most significant impact in terms of reducing traffic volumes in the City Centre core and improving the urban realm due to the introduction of public transport priority measures. By restricting private vehicle access there is better opportunities for improvements to the urban realm whilst minimising the congestion, visual impact and noise pollution caused by traffic in the city centre. As there are no PT priority measures in Scenario 1 traffic volumes remain relatively high and the opportunity for urban realm improvements is limited.

Measurement	Scenario 1	Scenario 2	Scenario 3	Scenario 4
% Change in City Centre Traffic	-5.0%	-12.4%	-12.1%	-14.5%
Extent of Public Realm Improvements (m)	1100m	1700m	1700m	1700m

Assessment of Integration between Transport and Urban form

For the reasons outlined above Scenarios 2, 3 & 4 will provide better opportunities to improve the urban realm of the city centre due to the greater decreases in general traffic volumes.

Integration between Transport and Urban Form	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.2.2.2 Minimise Harmful Transport Emissions

As described in section 5.2.1 the percentage change in transport emission compared to the Do-Minimum scenario have been estimated from modelling outputs using the environmental appraisal module. In order to assess the impact of emissions on the environment the percentage change in the greenhouse gases Carbon Dioxide (CO₂) and Nitrogen Oxide (NO_x) was calculated for each scenario for the broader Galway City Area as presented below.

Measurement	Scenario 1	Scenario 2	Scenario 3	Scenario 4
% Change in Modelled CO ₂ emissions	2.2%	-0.2%	2.3%	-1.4%
% Change in Modelled NO _x	1.4%	-1.0%	1.0%	-2.1%

The results indicate that Scenarios 1 & 3 perform less well based due to the lower speeds observed in these scenarios due to congestion. Transport emissions are directly related to fuel consumption

which increases at lower speeds in congested networks. Scenarios 2 & 4 perform well in comparison particularly Scenario 4 due to the introduction of LRT. The reduction in emissions due to the decreased car mode share in Scenarios 2 & 4 is somewhat offset by the increase in the number of buses. This is due to an increase in transport emissions from vehicles with larger engine capacities as a result of greater fuel consumption. However studies have shown the potential reduction in greenhouse gas emissions achievable by switching from traditional diesel buses to Hybrid or Compressed Natural Gas (CNG) buses which could be implemented in the future.

Assessment of Transport Emissions

For the reasons outlined Scenarios 4 performs the best comparably with Scenarios 2 also performing well. Scenarios 1 & 3 perform comparably less well due to the overall increase in modelled CO₂ & NO_x emissions.

Transport Emissions	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.2.3 Integration

Under integration, the following objectives are considered:

- Support integration between Sustainable Transport and Land Use Planning and Policies; and
- Provide for better Transport Integration.

5.2.3.1 Support Integration between Sustainable Transport and Land Use Planning and Policies

In order to support integration between sustainable modes of transport and land use the compatibility of each package of measures was assessed against the objectives outlined in local, regional and national policies. In addition the percentage change in the modelled sustainable mode share was calculated for each scenario to assess the compatibility of each scenario with Smarter Travel policy.

All scenarios have been developed based on previous strategies and studies as outlined in section 1.1 and therefore broadly support local land use planning and policy objectives. With respect to Smarter Travel policies Scenarios 2, 3 & 4 are considered to perform better as they prioritise accessibility for walking, cycling and public transport, which in turn is reflected in the relative percentage change in sustainable mode share from the Do Minimum scenario as outlined below.

Measurement	Scenario 1	Scenario 2	Scenario 3	Scenario 4
% Change in Modelled Sustainable Mode Share	4.7%	12.9%	12.4%	15.9%

Assessment of Integration between Sustainable Transport and Land Use Planning and Policies

As outlined Scenarios 2 & 3 perform similarly well with increases of between 12.4%-12.9% in the sustainable mode share, Scenario 1 performs less well with only a 4.7% increase. Overall Scenario 4 performs the best with a total percentage increase from the Do-Minimum of 15.9%.

Integration between Sustainable Transport and Land Use	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.2.3.2 Provide for Better Transport Integration

In order to assess the level of transport integration in each scenario the number of public transport routes passing through interchange points on the public transport network has been estimated for each scenario, the results of which are presented below.

Measurement	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Number of Points on Public Transport Network where Interchange Opportunity exists.	55	55	50	55

Scenarios 1, 2 & 4 will provide an increased level of connectivity and improved integration, particularly in the city centre, relative to Scenario 3. This results greater opportunity to interchange between high frequency services. Scenario 3 performs marginally less well in terms of integration as one of the core routes circumvents the city centre thereby reducing the opportunity for interchange with other services.

In addition the total trips using the Park and Ride facilities was assessed for each scenario as detailed below. The results indicate that Scenarios 3 & 4 show the highest demand for park and ride, particularly Scenario 4. This is largely due to improved journey times from the Parkmore Park & Ride facility to the City Centre in both scenarios.

Measurement (AM peak trips 7-10am)	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Western Distributor P&R	24	24	23	58
Parkmore P&R	95	99	142	213
Roscam P&R	10	10	11	24
Total	129	133	176	295

Assessment of Improvement Transport Integration

As outlined above Scenarios 4 perform comparatively well with Scenarios 1 & 2 performing less well due to the lower park and ride demand. On balance Scenario 3 performs well due to the higher park and ride demand offsetting the reduction of opportunities for interchange due to the proposed orbital routing of one core bus service.

Improve Transport Integration	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.2.4 Accessibility & Social Inclusion

Under Accessibility & Social Inclusion, the following objectives are considered:

- Improve multi-modal accessibility within residential, employment and retail centres; and
- Provision of a socially inclusive transport network.

5.2.4.1 Improve Multi-Modal Accessibility within Residential, Employment and Retail Centres

The multi-modal accessibility has been measured by the percentage change in travel costs between a number of key origins and destinations for both public transport and road users. The results indicate that all scenarios will provide improved accessibility for public transport as reflected in the percentage change in travel costs. Scenario 4 performs marginally better on the basis of public transport access times but performs less well in terms of road travel costs compared to Scenarios 1 & 2. The benefits brought about by the improved public transport accessibility for Scenarios 3 is largely offset by the increases in the travel costs for road.

Measurement	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Average % change in PT Travel Cost	-22.0%	-22.4%	-23.9%	-30.7%
Average % change in Road Travel Cost	3.3%	3.9%	18.9%	7.3%

Assessment of Improvement Multi-Modal Accessibility

For the reasons outlined above Scenario 1, 2 & 4 on balance perform similarly well with Scenario 3 performing less well due to the significant increase in travel costs by road.

Improve Multi-Modal Accessibility	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.2.4.2 Provision of a Socially Inclusive Transport Network

The social inclusiveness of the transport networks provided in each scenario has been measured by assessing the estimated catchment within a 10 minute walk of high frequency public transport. The public transport networks in each scenario have been assessed using the network analyst module of ArcGIS in order to estimate the percentage of the population within a 10 minute walk of high frequency public transport. The analysis shows that each scenario provides for a similar sized catchments with Scenario 3 having a marginally smaller catchment due to the routing of one core bus route along the N6.

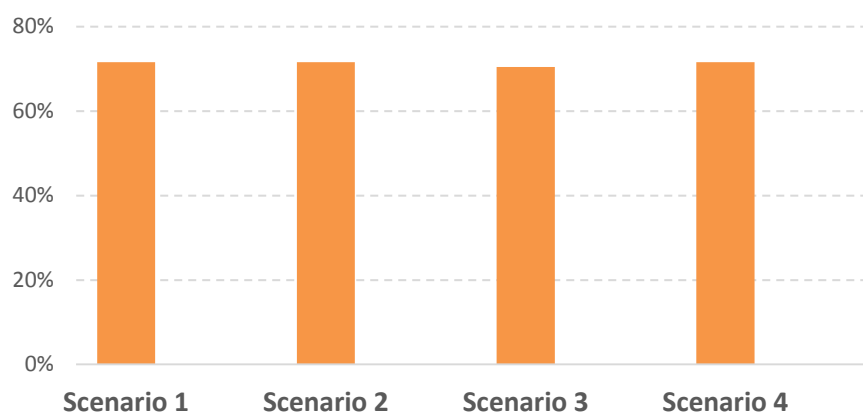


Figure 12. Population Percentage within 10 minute walk of High Frequency Public Transport

Assessment of the Provision of a Socially Inclusive Transport Network

As discussed above all scenarios provide high frequency public transport for similarly sized catchments and therefore perform similarly well.

Provision of a Socially Inclusive Transport Network	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.2.5 Economy

Under economy, the following objectives are considered:

- Support Galway City's function as a regional centre for employment, education, retail, leisure and tourism by providing access for all through an efficient transport network; and
- Ensure value for money in the implementation of proposals.

5.2.5.1 Access for all to an Efficient Transport Network

In order to support Galway City's function as a regional centre for employment, education, retail, leisure and tourism an efficient and reliable transport network is required. The extent by which this objective was realised by each scenario was assessed using the following modelling outputs;

- Total Queueing;
- Change in number of links modelled to be over capacity; and
- Public Transport Capacity versus Modelled Utilisation.

The results of this assessment indicate that in terms of general traffic efficiency and reliability, Scenario 1 & 2 perform equally well with a reduction in the total over capacity links. Scenario 4 results in a deterioration in the performance of the general traffic network as the LRT restricts the capacity of the local network for general traffic. Scenario 3 performs the worst due to the extensive reallocation of road space on both Salmon Weir Bridge and Quincentenary Bridge to public transport.

In terms of public transport efficiency, Scenario 2 performs the best as it provides a balance between capacity and demand supported by faster journey times resulting from increased public transport priority. It is noted, given the inclusion of LRT, that scenario 4 performs best in terms capacity however there is a significant difference between the PT capacity and utilisation which negatively effects the efficiency of the networks operation.

Measurement	Scenario 1	Scenario 2	Scenario 3	Scenario 4
% Change in number of links over capacity	-4.3%	-5.7%	9.3%	2.9%
PT Capacity versus modelled utilisation	54.7%	57.7%	55.2%	26.4%

Assessment of the Efficiency of the Transport Network

Overall on balance the analysis shows that Scenarios 1 & 2 performs best in meeting the objective of delivering an efficient transport network with access for all. Scenario 3 also performs comparatively well in terms of public transport utilisation, however the significant increase in road congestion negatively impacts on the transport network for general traffic. Scenario 4 performs significantly less well in terms of public transport utilisation and negatively impacts on the efficiency of the network for general traffic.

Efficiency and Reliability of the Transport Network	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.2.5.2 Cost

In order to ensure value for money in the implementation of proposals consideration is given to the estimated level of cost for delivery of the scenarios. The associated costs for each of the four scenarios is shown below.

Cost	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Capital Costs (€m)	€195	€210	€225	€1,120
Annual Operating Costs (€m)	€5	€5	€5	€17
10 Year Maintenance(€m)	€15	€16	€18	€81

Scenario 4 has significantly higher capital, operating and maintenance costs when compared against Scenarios 1-3. The combined costs for Scenario 4 are in the region of €1.1 billion, which is over 5 times the costs of the second most expensive scenario. Scenario 1 & 2 perform similarly well in terms of costs with both scenario costing approximately €200 million.

Assessment of Cost

The assessment shows that Scenario 4 performs less well in terms of cost due to the significantly higher capital costs and ongoing operating and maintenance costs. Though the costs for Scenarios are much less than Scenario 4 they are still higher than Scenarios 1 & 2 which perform comparatively very well in terms of total cost.

Ensure Value for Money	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Relative Performance				

5.3 Summary Assessment of Active Mode/ PT Scenarios

The table below summarises the result presented above for each of the categories and objectives previously discussed. The assessment demonstrates that Scenario 1 overall performs comparatively poorly against the other scenarios largely due to the lack of PT priority measures within the city centre. Scenario 3 also performs less well due to the increased congestion caused by the reallocation of road space along the N6 to public transport.

Scenario 4 (which includes for a high frequency cross city bus and light rail service and prioritisation measures) performs better overall when compared to scenarios 1, 2 & 3 in providing a safer city centre for all transport modes, improving the urban realm and integrating between sustainable transport and land use. However it performs significantly poorly compared to Scenario 2 in terms of efficiency of the public transport network and cost. Scenario 2 performs consistently well across all of the objectives particularly in terms of multi modal accessibility, transport network reliability and efficiency and cost. It is therefore considered on balance this is the preferred scenario.

Therefore, based on an overall assessment under the combined criteria of Economy, Safety & Physical Activity, Environment, Integration and Accessibility and Social Inclusion, Scenario 2 is considered to be the preferred Active Mode & PT scenario to be brought forward for testing with additional road infrastructure.

Table 7 Results Summary Scenario 1-4

Category	Objective	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Safety & Physical Activity	Safer & Healthier City Centre for all Transport Modes				
	Transport's Role in Facilitating a Healthier Lifestyle				
Environment	Improve the Urban Realm by minimising the impact of Transport				
	Transport Emissions				
Integration	Integration between Sustainable Transport and Land Use				
	Improve Transport Integration				
Accessibility & Social Inclusion	Improve Multi-Modal Accessibility				
	Provision of a Socially Inclusive Transport Network				
Economy	Efficiency and Reliability of the Transport Network				
	Cost				

5.4 Benefits of the Emerging Preferred Active Mode & PT Scenario

The benefits of Scenario 2, the emerging preferred active mode and PT scenario, are as follows:

- High Public Transport Utilisation and Reliability;
- Reduced number of overcapacity links in the network;
- Reduced speeds and traffic volumes through the city centre as a result of the city centre prioritisation measures ensuring greater transport integration and a safer city for pedestrians and cyclists;
- Increase in cycling and pedestrian facilities;
- Increase in all sustainable mode shares; and
- Provision of high frequency public transport.

Figure 13 shows the various measures included within the emerging preferred Active Mode and PT Scenario.



Figure 13. Emerging Preferred Active Mode & PT Scenario

5.5 Development of Additional Scenarios

As discussed in Section 3.3 and 4.4 the emerging preferred active mode and PT scenario was then combined with various phases of the N6 transport project. There were three phases of the scheme considered to form the following 3 additional scenarios:

- **Scenario 5:** emerging preferred active mode / public transport solution plus the proposed N6 link up to the N84
- **Scenario 6:** emerging preferred active mode / public transport solution plus the proposed N6 link up to the N59
- **Scenario 7:** emerging preferred active mode / public transport solution plus the proposed N6 link up to the to R336 Bearna Road

Scenario 2 has been included in the additional assessment to establish whether any additional road infrastructure is required with public transport and active mode measures in place. The measures included in scenario 5-7 is shown graphically on pages 42-44.

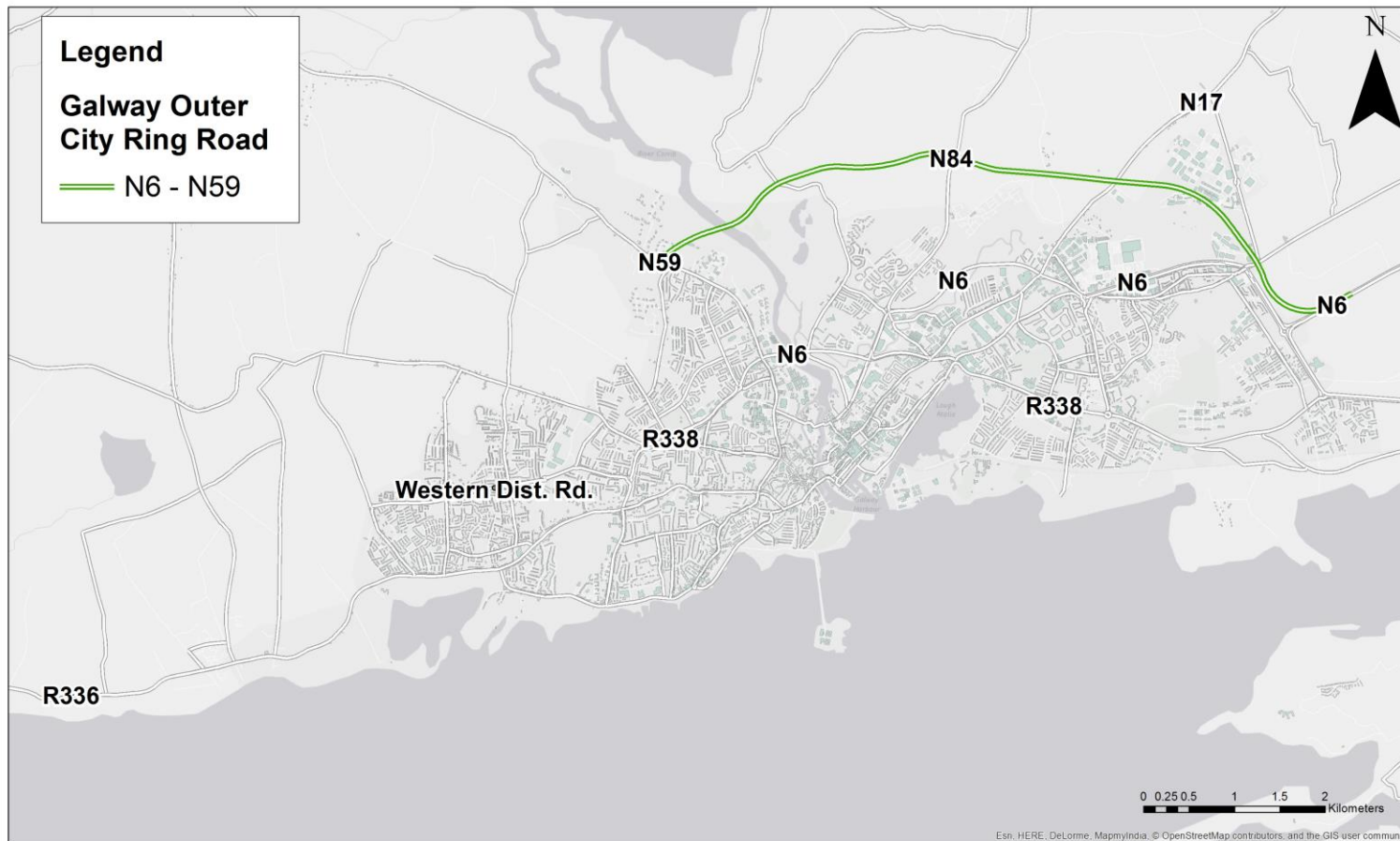
Scenario 5: Emerging Preferred PT/Active Mode Solution combined with N6 to N84 Link Road

Scenario 5 comprises of measures in the Emerging Preferred PT/Active Mode Scenarios identified from Scenarios 1-4. The road network will include a new link road extending from the current N6 as far as the N84 national road.



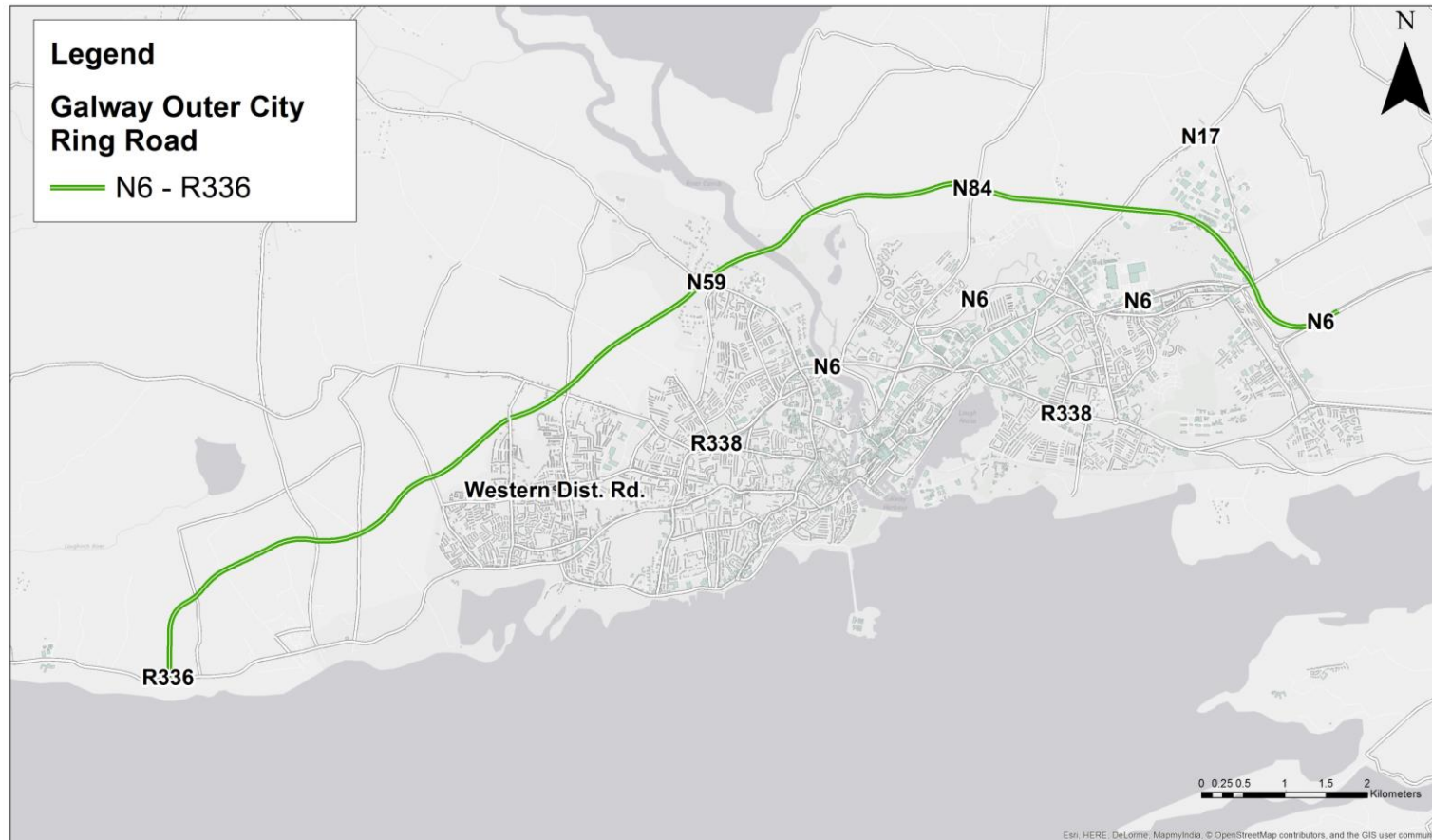
Scenario 6: Emerging Preferred PT/Active Mode Solution combined with N6 to N59 Link Road

Scenario 6 comprises of measures in the Emerging Preferred PT/Active Mode Scenarios identified from Scenarios 1-4. The road network will include a new link road extending from the current N6 over the river as far as the N59 national road.



Scenario 7: Emerging Preferred PT/Active Mode Solution combined with N6 to R336 Link Road

Scenario 7 comprises of measures in the Emerging Preferred PT/Active Mode Scenarios identified from Scenarios 1-4. The road network will include a new link road extending from the current N6 over the river as far as the R336 Bearna Regional Road.



5.6 Summary of Additional Scenarios for Testing

Table 8 below summaries the information presented in the Figures above for each additional scenario outlining the measures included in each.

Table 8 Summary of Scenarios for Testing

Mode	Measures	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Active Modes	1. Improvements via existing network	✓	✓	✓	✓
	2. Improvements to Permeability	✓	✓	✓	✓
	3. Pedestrian favoured signals / Cyclists	✓	✓	✓	✓
Public Transport	4. Revised Bus Routes at Higher Frequencies on Cross City Routes	✓	✓		
	5. Revised Bus Routes at Higher Frequencies on Cross City & Orbital Routes			✓	
	6. City Centre PT prioritisation measures	✓	✓	✓	✓
	7. LRT Route through City Centre & Revised Bus Routes at Higher Frequencies on Cross City Routes				✓
	8. Integrated Park and Ride	✓	✓	✓	✓
Demand Management	9. Demand Management Measures	✓	✓	✓	✓
Roads	10. New road link N6 to N84		✓		
	11. New road link N6 to N59			✓	
	12. New road link N6 to R336 Bearna Road				✓

6 Evaluation of Integrated Transport Proposals

6.1 Quantitative Assessment of Integrated Scenarios

The Emerging Preferred Active Mode & Public Transport Scenario identified in the last section has been assessed in combination with the three scenarios which provide for additional road infrastructure, i.e. scenarios 5-7 (see Section 4 for scenario descriptions). This section of the report outlines the results of this assessment, including the results from the emerging preferred active mode / PT Scenario (Scenario 2). The results have been determined using the same criteria, objectives and KPIs as outlined in Section 5 and measured using the same methods and ranking criteria (see Section 5). As with the previous assessment the results outputted from the model presented in the following assessment are AM Peak results. The PM results are contained within Appendix A of this report.

6.1.1 Safety & Physical Activity

Under Safety & Physical Activity, the following objectives are considered:

- Develop a safer and healthier City Centre for all transport modes and users; and
- Exploit transport's role in facilitating a healthier lifestyle.

6.1.1.1 Develop a Safer & Healthier City Centre for all Transport Modes

Scenarios 6 & 7 perform similarly well with significant reductions in both traffic volumes and harmful particulate emissions observed in both scenarios, Scenario 7 in particular results in a significant decrease in city centre emissions. This reduction is due to the transference of traffic from the city centre to the new outer link road. Scenarios 2 & 5 perform less well due to the lack of the additional road capacity. Notably the additional road capacity provided for in Scenario 5 results in no further reduction in city centre traffic or particulate emissions when compared to Scenario 2.

Measurement	Scenario 2	Scenario 5	Scenario 6	Scenario 7
% Change in City Traffic Volumes	-12.4%	-12.1%	-16.4%	-18.3%
% Change harmful Particulate Emissions (City Centre)	-5.9%	-5.8%	-16.4%	-22.2%

Assessment of the Development of a Safer and Healthier City Centre for all Transport Modes

For the reasons outlined, Scenario 7 is considered to perform well in terms of providing a safer and healthier city centre with Scenario 6 also performing well due to the greater reductions in city traffic and particulate emissions. Scenarios 2 & 5 perform considerably less well in comparison.

Safer & Healthier City Centre for all Transport Modes	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.1.1.2 Exploit Transport's Role in Facilitating a Healthier Lifestyle

As discussed in the previous chapter, the impact of the proposed measures in facilitating a healthier lifestyle has been assessed based on the walking and cycling mode shares for each scenario. These mode shares are shown for each scenario in the graph below. Each scenario results in an overall increase from the Do Minimum for both walking and cycling mode shares. However Scenarios 6 & 7 perform less well than Scenarios 2 & 5 due to the increased road capacity provided in each scenario resulting in less walking and cycling.

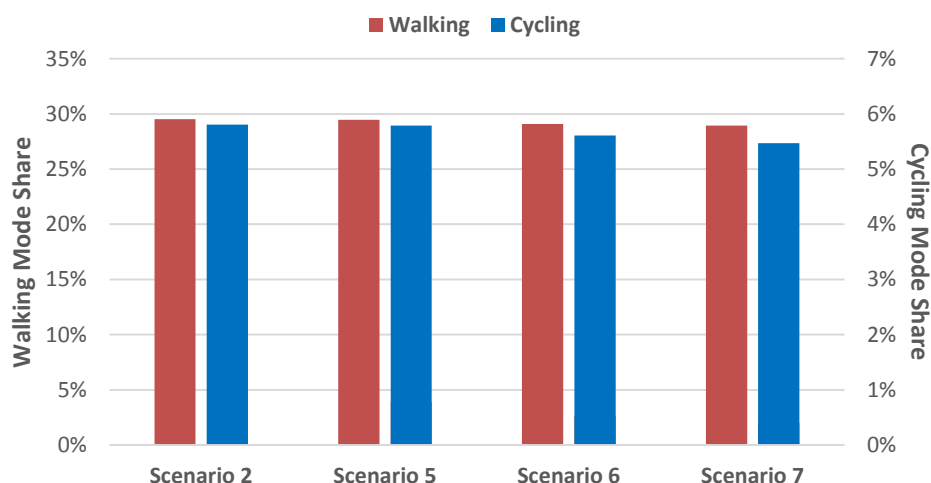


Figure 13. Walking & Cycling Mode Shares

Assessment of Transport's Role in Facilitating a Healthier Lifestyle

As outlined all scenarios results in a net increase in walking and cycling however Scenarios 6 & 7 perform less well when compared to Scenarios 2 & 5 and have thus been scored accordingly.

Transport's Role in Facilitating a Healthier Lifestyle	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.1.2 Environment

Under environment, the following objectives are considered:

- Improve the urban realm by minimising the impact of transport; and
- Minimise harmful transport emissions.

6.1.2.1 Improve the Urban Realm by minimising the impact of Transport

All scenarios include for public transport prioritisation through the city centre core and for the same level of enhancements to the public realm. Scenarios 6 & 7 do result in a further decrease in the volume of traffic within Galway City Centre due to traffic diverting onto the new orbital link road,

thus allowing for increased opportunities within the city which may allow for further opportunities to improve the urban form of the city centre.

Measurement	Scenario 2	Scenario 5	Scenario 6	Scenario 7
% Change in City Centre Traffic	-12.4%	-12.1%	-16.4%	-18.3%
Extent of Public Realm Improvements (m)	1700m	1700m	1700m	1700m

Assessment of Improvements to the Urban Realm

For the reasons outlined above Scenario 6 & 7 perform comparatively better than Scenarios 2 & 5 due to the further reduction in city centre traffic.

Improve the Urban Realm	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.1.2.2 Minimise Harmful Transport Emissions

Overall, Scenarios 2 & 5 perform well with a net reduction in both Carbon Dioxide and Nitrogen Oxide. Though the higher average speeds in Scenarios 6 & 7 results in a reduction in emissions this is offset by the increase in total travel distances on the network resulting in an overall increase in total Carbon Dioxide and Nitrogen Oxide emissions.

Measurement	Scenario 2	Scenario 5	Scenario 6	Scenario 7
% Change in Modelled CO ₂ emissions	-0.2%	-0.4%	2.4%	3.8%
% Change in Modelled NO _x	-1.0%	-1.2%	2.3%	3.6%

Assessment of Transport Emissions

For the reasons outlined it is considered that Scenarios 2 & 5 perform better than Scenarios 6 & 7 as they result in a decrease in total emissions. Scenario 7 in particular performs less well and has been ranked accordingly.

Transport Emissions	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.1.3 Integration

Under integration, the following objectives are considered:

- Support integration between Sustainable Transport and Land Use Planning and Policies; and
- Provide for better Transport Integration.

6.1.3.1 Support Integration between Sustainable Transport and Land Use Planning and Policies

The Galway County & City Development plans specifically aim to safeguard the strategic transport function and carrying capacity of the motorway and national road network and ensure the ease of movements of goods to and within the County and City. Scenarios 6 & 7 are most compatible with these aims as they will integrate the national network around Galway city and ensure improved journey time reliability for strategic traffic. In addition the increased level of road infrastructure will relieve congestion and release road space within the city centre creating an environment that is safer and more conducive to walking and cycling as demonstrated by the reduction in city centre traffic presented previously.

The relative change in the sustainable mode share is shown below and demonstrates that the combined public transport, walking and cycling mode shares increase from the Do-Minimum in all scenarios and therefore each scenario is in line with smarter travel policy and objectives.

Measurement	Scenario 2	Scenario 5	Scenario 6	Scenario 7
% Change in Modelled Sustainable Mode Share	12.9%	12.7%	11.0%	9.9%

Assessment of Integration between Sustainable Transport and Land Use Planning and Policies

Though the results show a slight reduction in the sustainable mode share for Scenarios 6 & 7 this is offset by the additional road infrastructure provided for in these scenarios which is a key objectives of the local development plans for the area. Therefore, on balance, each of the scenarios are considered to perform equally well in terms of supporting integration between sustainable transport and land use planning and policy.

Integration between Sustainable Transport and Land Use	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.1.3.2 Provide for Better Transport Integration

As each scenario has the same public transport network, the number of routes passing through each interchange is the same for each scenario. In terms of park and ride performance all scenarios perform similarly well as demonstrated by the results presented below with each scenario having comparably levels of demand for park and ride. It is worth noting however that Scenario 6 & 7 allow easy accessibility to the park and ride sites and will better integrate the national road network. In addition Scenario 7 will provide a high quality link from Connemara and the Gaeltacht area to the national road network.

Measurement (trips)	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Western Distributor P&R	24	25	23	31
Parkmore P&R	99	107	104	106
Roscam P&R	10	8	8	8
Total	133	140	135	145

Assessment of Improvement Transport Integration

Overall, based on the chosen measurements all scenarios are considered to perform equally well in terms of transport integration.

Improve Transport Integration	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.1.4 Accessibility & Social Inclusion

Under Accessibility & Social Inclusion, the following objectives are considered:

- Improve Multi-Modal Accessibility within residential, employment and retail centres; and
- Provision of a Socially Inclusive Transport Network.

6.1.4.1 Improve Multi-Modal Accessibility within Residential, Employment and Retail Centres

As described in Section 5, the multi-modal accessibility has been measured by the percentage change in travel costs between a number of key origins and destinations for both public transport and road relative to the Do-Minimum scenario. The results indicate that all scenarios will perform similarly well in providing improved accessibility for public transport with travel cost reductions between 22.4-22.9%. Scenarios 6 & 7 perform better in terms of percentage change in road travel costs due to the provision of additional road infrastructure.

Measurement	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Average % change in PT Travel Cost	-22.4%	-22.3%	-22.7%	-22.9%
Average % change in Road Travel Cost	3.9%	1.8%	-8.4%	-10.6%

Assessment of Improvement Multi-Modal Accessibility

Whilst all Scenarios perform comparably well in terms of PT accessibility, Scenarios 6 & 7 perform better due to the improved road based travel costs.

Improve Multi-Modal Accessibility	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.1.4.2 Provision of a Socially Inclusive Transport Network

As the same public transport network is provided in all scenarios the proportion of the population within a ten minute walk of high frequency transport remains the same in each scenarios. However Scenarios 6 & 7 will provide stronger links between the National Network and rural Galway to the West. Scenario 7 in particular will provide a direct link from the National Road Network to the R336 that circumnavigates the city allowing better accessibility for those living in Connemara and the Gaeltacht area.

Assessment of the Provision of a Socially Inclusive Transport Network

Scenarios 6 & 7 are considered to perform well in terms of providing a socially inclusive network as they provide a good quality link between the west of Galway and the rest of the national road network, Scenario 7 in particular will link the Connemara region with the national network and thus performs well.

Provision of a Socially Inclusive Transport Network	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.1.5 Economy

Under economy, the following objectives are considered:

- Support Galway City's function as a regional centre for employment, education, retail, leisure and tourism by providing access for all through an efficient and reliable transport network; and
- Ensure value for money in the implementation of proposals.

6.1.5.1 Efficiency and Reliability of the Transport Network

The assessment shows that Scenario 5 will only marginally improve the efficiency and reliability for general traffic as demonstrated in the change in the total number of links over capacity and the total queuing compared to Scenario 2. By comparison, Scenario 6 & 7 will significantly reduce the number of links over capacity and total over capacity queued hours. In addition Scenario 6 & 7 provide the highest level of road capacity with Scenario 7 resulting in higher utilisation of the new bridge crossing and slightly improved journey times to the west of Galway. Overall the PT utilisation is similar in all scenarios with a marginal reduction in scenarios 6 & 7 due to the provision of additional road capacity.

Measurement	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Total Queuing	1802.7	1705.5	1229.7	1198.6
% Change in number of links over capacity	-5.7%	-10.7%	-47.1%	-49.3%
PT Capacity versus modelled utilisation	57.7%	56.8%	56.8%	55.4%

Assessment of the Efficiency and Reliability of the Transport Network

Overall Scenarios 6 & 7 perform well, both in terms of maintaining level of public transport utilisation and significantly reducing the total over capacity links and queued hours in the network. Scenarios 2 & 5 perform less well as they do not provide sufficient relief to the road network despite their comparable levels of public transport utilisation.

Efficiency and Reliability of the Transport Network	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.1.5.2 Cost

In order to ensure value for money in the implementation of proposals, consideration has been given to the estimated level of cost for delivery of the scenarios. The costs associated with the delivery of each scenario is outlined below.

Cost	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Capital Costs (€m)	€210	€410	€775	€820
Annual Operating & Maintenance Costs (€m)	€5	€5.5	€6	€6.5
10 Year PT Maintenance(€m)	€16	€16	€16	€16

Overall Scenarios 6 & 7 have significantly higher capital costs than Scenario 2 with the costs around €800 million. The capital cost of delivering of Scenario 5 though less than Scenarios 6 & 7 is still significantly higher than Scenario 2. The operating and maintenance costs are also higher in Scenarios 5-7 when compared to Scenario 2.

Assessment of Cost

As the cost outlined above demonstrate Scenario 6 & 7 perform comparatively poorly in terms of costs due to the significant investment required to build the additional road infrastructure. Scenario 5 also perform poorly compared to Scenario 2 which performs the best.

Ensure Value for Money	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Relative Performance				

6.2 Summary Assessment of Scenarios

The table below summarises the results for each of the categories and objectives previously discussed. The findings of the assessment show that overall Scenario 2 performs comparatively poorly in terms of safety in the city centre, accessibility and social inclusion, efficiency of the transport network and improvements to the urban realm. Scenario 5 also performs less well against these same objectives.

Scenario 7 (which includes for full orbital bypass of the city) performs better overall when compared to scenarios 2, 5 & 6 in providing a safer city centre and a more socially inclusive transport network and improving accessibility. Scenarios 6 also performs reasonably well and similarly to Scenario 7 against most of the objectives and performs marginally better than Scenario 7 in terms of transport emissions. However on balance it is considered that Scenario 7 ensures better value for money and is therefore considered the preferable scenario.

Table 9 Results Summary Scenario 2, 5, 6 & 7

Category	Objective	Scenario 2	Scenario 5	Scenario 6	Scenario 7
Safety & Physical Activity	Safer & Healthier City Centre for all Transport Modes				
	Transport's Role in Facilitating a Healthier Lifestyle				
Environment	Improve the Urban Realm by minimising the impact of Transport				
	Transport Emissions				
Integration	Integration between Sustainable Transport and Land Use				
	Improve Transport Integration				
Accessibility & Social Inclusion	Improve Multi-Modal Accessibility				
	Provision of a Socially Inclusive Transport Network				
Economy	Efficiency and Reliability of the Transport Network				
	Cost				

7 Conclusion of the Assessment

7.1 Findings

The findings of the assessment indicate that Scenario 7 best meets the objectives of the GTS. Scenario 7 comprises the following measures:

- Upgraded & Integrated Public Transport Network;
- City Centre Public Transport Prioritisation;
- Improvements to walking and cycling infrastructure and priority;
- Integrated Park & Ride Facilities;
- Demand Management Measures; and
- Full Orbital Bypass of Galway from the N6 to the R336 Bearna Road linking the N6, N17, N84 & N59 national roads.

The measures included in Scenario 7 are shown in Figure 14.



7.2 Benefits

The Benefits of Scenario 7, when compared to the Do Minimum scenario, are as follows:

- 9.9% increase in the sustainable mode share;
- 50% reduction in the total number of road links over capacity;
- 18.3% reduction in City Centre traffic volumes;
- 22.2% reduction in harmful Particulate Emissions within the City Centre;
- A significant reduction of 77.5% in the overcapacity queued hours;
- A reduction of 10% in total travel time across all modes;
- Significant increase in the provision of cycling infrastructure with a 569% increase in cycle routes of LOS B or higher;
- A total of 1700m of public realm improvements;
- Reduction in travel costs for both Road and Public Transport of 10.6% and 22.9% respectively; and
- A relative increase of 6.2% in the combined walking and cycling mode share.

7.3 Risks

The risks associated with Scenario 7 are summarised as follows:

Design Risks:

- Design subject to detailed design and appraisal;
- Design capacity is based on current public transport modes; and
- Forecast Infrastructure costs are based on extrapolation of current costs.

General Uncertainty and Economic Risk:

- Ongoing availability of funding and securing funding allocation; and
- Full delivery of the GTS.