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Project Appraisal Guidelines for National Roads Unit 5.3 - Travel Demand Projections

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PE Planning & Evaluation

Technical

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1. Introduction

1.1 Overview

PAG Unit 5.1: Construction of Transport Models provides guidance on the development of transport models for use in the appraisal of transport infrastructure. The guidance addresses the scoping and construction of transport models which reflect transport demand and supply in a 'Base Year'.

This Unit of the Project Appraisal Guidelines (PAG) provides guidance on the preparation of future travel demand projections for use in scheme modelling and appraisal.

The guidance set out in this Unit is applicable for the modelling and appraisal of National Road schemes, although the guidance is equally applicable to traffic on regional and local road schemes.

In certain circumstances, localised factors may dictate the use of alternative growth projections. The methodology for projecting future year demand needs to be set out in the Project Appraisal Plan and agreed with the TII Strategic and Transport Planning Section prior to the commencement of modelling/appraisal of a National Road scheme.

2. The Role of National Travel Demand Projections

Unbiased future travel demand projections are a critical input in ensuring that the capacity for transport infrastructure is neither too large nor too small to meet future demand. Furthermore, travel demand projections inform the economic and environmental appraisal of transport schemes and therefore play a fundamental role in deciding whether a scheme should progress.

Consistency in the appraisal of National Road projects is achieved by the use of common predications of growth in transport demand which are based on national and local projections of demographic and economic factors. These demographic and economic factors are used to project the future demand for travel across all zones in the TII National Transport Model (NTpM). The procedures discussed in this PAG Unit outline the application of such growth projections to scheme modelling and appraisal.

Travel demand projections should not be viewed as what will happen in the future or what we want the future to look like, but instead what may happen based on our current understanding of how people make travel choices and the expected key drivers of travel demand. The benefits of major roads projects are generally appraised over an extended period of time (up to 60 years); therefore scheme promoters and decision makers need to understand that projecting travel demand over an extended period is uncertain.

The adoption of this approach means that travel demand projections are realistic in the light of current trends and travel behaviour. Nevertheless, they should be regarded as constituting a set of Baseline Projections that may warrant revision in line with the implementation of future spatial strategies.

3. Demographic and Economic Growth Projections

Future travel demand projections were developed as part of the NTpM, based on demographic and economic projections at a zonal level. The NTpM includes travel demand projections for two future years, 2030 and 2050 across both private and public transport modes. These future years were selected to reflect the projected delivery of the EU TEN-T core and comprehensive networks.

TII have developed three future growth scenarios for use in the NTpM. A central growth scenario and two sensitivity growth scenarios (Low and High) which are based on adjusted demographic and economic projections.

In order to estimate the level of demand across these modes, various demographic and economic projections were required. An overview of the demographic and economic models used to inform the future travel demand projections for the NTpM is provided below:

- **Population and Jobs Models**: The population and jobs models generate projections of future growth in population and jobs at Electoral Division (ED) level, which is subsequently aggregated to NTpM zone level. The central projection is based on the ESRI Recovery Scenario from their Medium Term Review (2013). The low and high growth sensitivity scenarios are based on the CSO M2 and M3 scenarios respectively, which assume different levels of migration;
- **Car Ownership Model**: Detailed car ownership projections were developed using statistical models based on current trends and an analysis of saturation levels across Europe. Car ownership was projected at county level then aggregated to national projections. NTpM zone car ownership projections were based on disaggregated county level projections;
- **Goods Vehicles**: The projected increase in Heavy Goods Vehicles (HGV) is based on the predicted increase in the size and structure of the national goods vehicle fleet. This relates the total carrying capacity of the fleet to GDP projections and results in a uniform growth rate in HGV traffic across all zones; and
- **Travel Demand**: In order to convert future socio-economic projections (population, jobs, car ownership, etc.) into car vehicle trips and public transport passenger trips, a range of trip rate equations were required for each trip purpose and transport mode. These trip rate equations were developed based on the relationship between the number of trips in the base year and a range of socio-economic variables for the same base year.

Growth projections are implemented on the basis of zonal trip-ends, which in turn define growth throughout a trip matrix. This accounts for spatial variation in local and regional land use and demographic patterns as opposed to a more simplified approach of defining traffic growth by applying global growth factors to a trip matrix.

A detailed discussion on the background data and methodologies used to inform the estimates of future travel demand in the NTpM is presented in Volume 3 of the National Transport Model's suite of supporting documentation entitled "Demographic and Economic Forecasting Report" (TII, Sept 2014). This report is available to download from TII's library of publications: http://www.tii.ie/tii-library/strategic-planning/national-transport-model/Demographic-and-Economic-Forecasting-Report_15.09.14.pdf.

4. Application of Traffic Growth Projections

As outlined in PAG Unit 5.1: Construction of Transport Models, it is neither practicable nor efficient to develop highly complex models for low levels of investment where limited changes to travel patterns would be expected. Likewise, it is important that larger investments which will lead to significant changes in travel patterns are based on a detailed understanding of user responses to inform the economic, safety and environmental impacts of the scheme. The Project Appraisal Guidelines describe three levels of transport model functionality as follows:

- Simple Models, which reflect traffic volumes on the basis of link flows. Such models do not attempt any route assignment, and hence are only applicable for small networks where no change in traffic flows will result from a proposed scheme;
- Assignment Models which allocate demand matrices through traffic networks, thereby replicating route choice by vehicles for each origin-destination pair; and
- Variable Demand Models, which replicate demand responses where they might be expected to occur as a result of a scheme, for example in larger towns and cities with congested road networks. The demand responses considered here comprise changes in trip rates, choice of destination and travel mode.

The application of traffic growth will differ for each of these model types. Future projections can be undertaken by applying growth factors to link flows (Link Based Growth Projections) or by applying trip end growth to demand matrices (Zone-Based Growth Projections). Table 5.3.1 sets out the traffic growth projection methodology to be used in the three transport model categories defined.

Table 5.3.1: Criteria for Projecting Traffic Growth

Category	Simple Models	Assignment Models	Variable Demand Models
Description	Manual assignment calculations using fixed demand flows. Can comprise spreadsheet modelling, junction modelling or static microsimulation modelling	Models which use a fixed traffic demand matrix, and assess impacts of reassignment only.	Models which include consideration of demand responses (Trip Generation, Distribution and Mode Share)
Nature of Scheme	• Road safety schemes • Localised improvement • Schemes falling under Unit 12 or Unit 14	• New roads • Significant upgrades to existing roads • Rural areas • Small urban areas	• New roads • Significant upgrades to existing roads • Major urban areas
Likely Impacts of Scheme	• Rural road networks with no route-switching • Single or multiple junctions in urban areas with no route-switching	• Schemes which will lead to changes in routing • Areas with limited public transport • Areas where induction or suppression of traffic is not anticipated • May use microsimulation models to model complex merging/shockwaves	• Schemes which will generate traffic impact • Major urban areas where congestion will exist • Schemes which lead to large reductions in journey time • Areas where induction or suppression of traffic is anticipated • Schemes which will increase competition with public transport
Applicable Methodology	**Link-Based Growth Rates**	**Zone-Based Growth Rates**	

5. Link-Based Growth Rates

For simple models, traffic flows are generally represented as vehicular traffic flows on links, with limited information on origin, destination or trip length. In such cases, future year traffic growth is projected using growth rates which describe likely traffic growth that may occur over the appraisal period of the scheme.

The derivation of link-based growth rates is based on an aggregate projection of growth in vehicle kilometres within a defined geographical area, with appropriate classifications by vehicle type and projected period. This allows the specification of a series of growth factors which can be applied directly to traffic flows on simple networks to generate a best estimate of future traffic flows.

The NTpM was used to generate aggregate growth in vehicle kilometres over the projected periods from 2013 to 2030 and 2030 to 2050. In preparing growth projections, it was determined that there was limited correlation between road type and anticipated growth rates. Geographical location was instead determined to be the most significant factor influencing growth in vehicle kilometres.

The geographical regions selected were the NUTS (Nomenclature of Territorial Units for Statistics) 3 regions and are shown in Figure 5.3.1.

Traffic growth is also strongly determined by vehicle type, with growth in Light Vehicles (Cars & Light Goods Vehicles) being driven by different factors than growth in Heavy Vehicles (Ordinary Goods Vehicles 1 & 2). Growth rates are therefore calculated separately for the different vehicle types (Light Vehicles and Heavy Vehicles).

Link Based Growth Rates for each of the eight geographical NUTS regions is provided in Table 5.3.2 across the two projected periods and for both Light and Heavy Vehicles.

The central growth rates are intended for use in project appraisal with the low and high growth rates to be used as sensitivity tests for economic and environmental impacts.

Figure 5.3.1: Geographical Regions

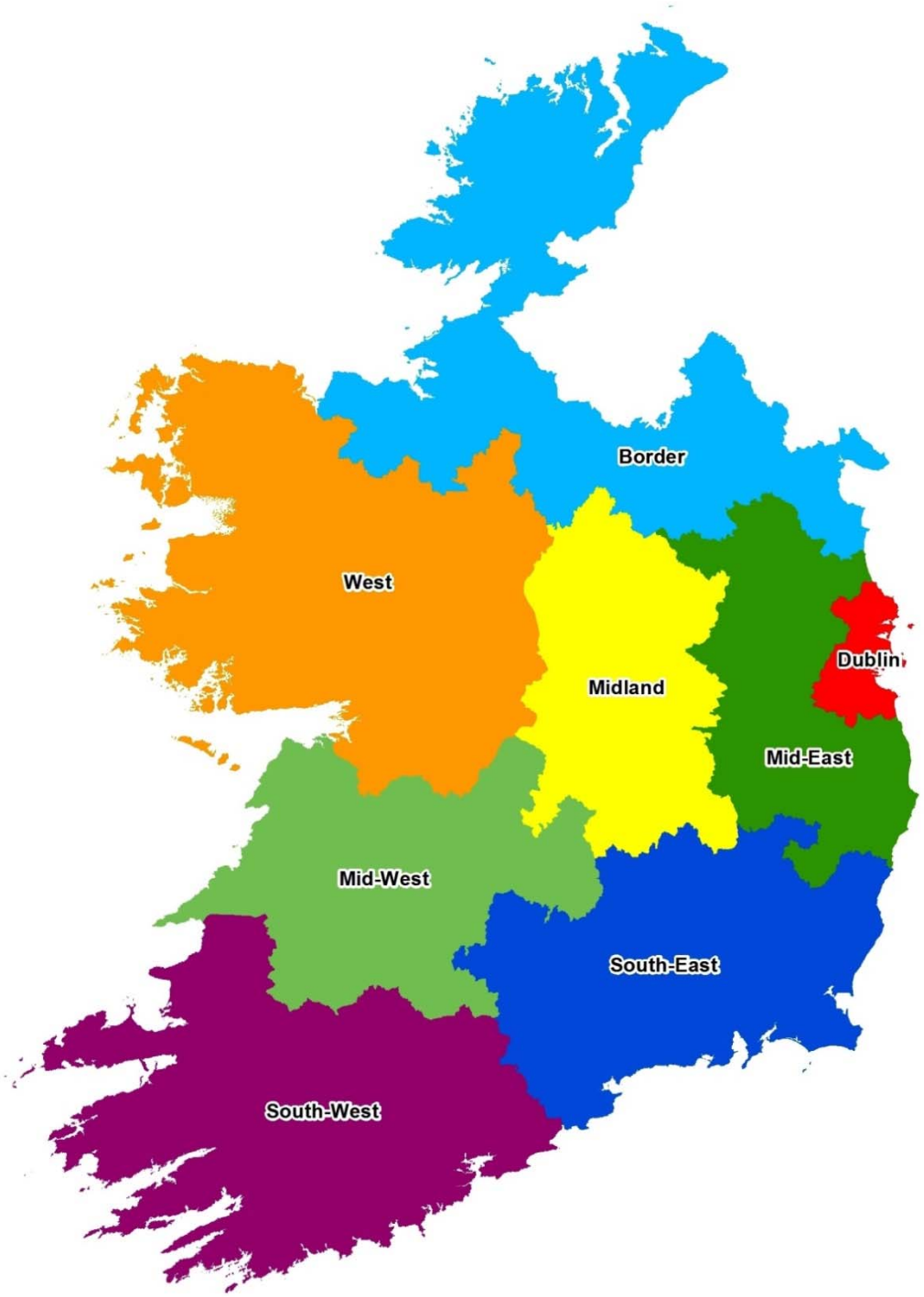


Table 5.3.2: Link-Based Growth Rates: Annual Growth Factors

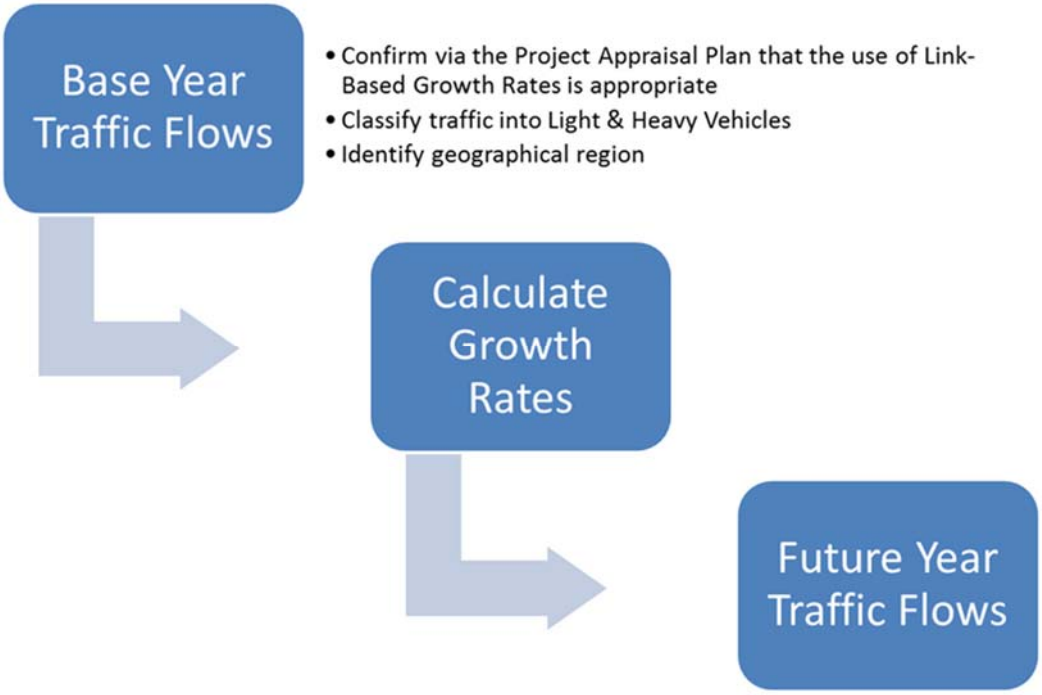
Region		Low Sensitivity Growth				Central Growth				High Sensitivity Growth			
		2013 - 2030		2030 - 2050		2013 - 2030		2030 - 2050		2013 - 2030		2030 - 2050	
		LV	*HV*	*LV*	*HV*	*LV*	*HV*	*LV*	*HV*	*LV*	*HV*	*LV*	*HV*
1	**Dublin**	1.0089	1.0221	1.0004	1.0135	1.0134	1.0237	1.0038	1.0176	1.0149	1.0242	1.0054	1.0195
2	**Mid-East** *Kildare* *Meath* *Wicklow*	1.0109	1.0221	1.0018	1.0135	1.0140	1.0237	1.0048	1.0176	1.0154	1.0242	1.0054	1.0195
3	**Midland** *Laois* *Longford* *Offaly* *Westmeath*	1.0088	1.0221	0.9997	1.0135	1.0120	1.0237	1.0030	1.0176	1.0131	1.0242	1.0018	1.0195
4	**Border** *Cavan* *Donegal* *Monaghan* *Leitrim* *Louth* *Sligo*	1.0082	1.0221	0.9998	1.0135	1.0114	1.0237	1.0030	1.0176	1.0124	1.0242	1.0044	1.0195
5	**Mid-West** *Limerick* *Clare* *North Tipperary*	1.0066	1.0221	0.9962	1.0135	1.0099	1.0237	1.0000	1.0176	1.0110	1.0242	1.0018	1.0195
6	**West** *Galway City/County* *Mayo* *Roscommon*	1.0048	1.0221	0.9967	1.0135	1.0082	1.0237	1.0007	1.0176	1.0092	1.0242	1.0024	1.0195
7	**South-East** *Carlow* *Kilkenny* *Wexford* *South Tipperary* *Waterford City/County*	1.0076	1.0221	0.9996	1.0135	1.0106	1.0237	1.0022	1.0176	1.0118	1.0242	1.0038	1.0195
8	**South-West** *Cork City/County* *Kerry*	1.0070	1.0221	0.9983	1.0135	1.0102	1.0237	1.0012	1.0176	1.0112	1.0242	1.0031	1.0195

5.1 Applicability

The link-based growth rates set out in this section of the Unit should not be used to derive traffic growth in Assignment Models or Variable Demand Models. The development of future year traffic growth projections for Assignment Models and Variable Demand Models is described in Section 6.

The application of link-based growth rates in simple models should follow the process outlined in Figure 5.3.2.

Figure 5.3.2: Application of National Traffic Growth Projections



For larger networks which straddle the defined geographical regions, it is acknowledged that the application of different growth rates to different elements of the network may lead to an imbalance in flows on the network. A process to addresses this issue should be set out in the Project Appraisal Plan and agreed with TII prior to the commencement of any modelling or scheme appraisal.

Due to the extended time horizon, traffic growth rates are only provided up to 2050. For the purposes of scheme appraisal no traffic growth beyond 2050 should be assumed unless specifically agreed with TII. Exceptions to this approach may include longer term schemes for which a significant proportion of the 30 year appraisal period is post 2050.

6. Zone-Based Growth Rates

For larger schemes which are supported by assignment models, demand is input in the form of a matrix which allocates demand based on defined trips between geographical zones. In such cases, growth rates should be applied as increases in trip ends at a zonal level. The factoring of origins and destinations at a zonal level leads to the definition of target trip ends. This is then translated into a future year matrix through furnessing, which adjusts the demand matrix such that row and column totals match the target trip ends.

6.1 Internal Zones

Application of zone-based growth rates requires a different approach for internal and external zones within the Local Area Model (LAM). For internal zones, trip end growth rates for the AM, PM and Inter Peak Periods is read from a shapefile that is available from the Downloads page on the TII Publications website. These growth rates are applied to the row and column totals of the base year trip matrix to produce target trip ends for the future year matrix.

The shapefile provides demographic and economic information for each zone in the NTpM, in addition to annual growth rates for origin and destination trip ends. The shapefile uses a standard naming convention to identify all variables in the data. A description of this data is provided below in Table 5.3.3.

Table 5.3.3: Schedule of Data Contained in NTpM Shapefile

Category	Parameter	Description
Demographic	Pop/Emp/CO	Population/Employment/Car Ownership
	13/30/50	Applicable Year (2013/2030/2050)
	L/C/H	Scenario (Low/Central/High)
Growth Factors	AM/IP/PM	Period of Assessment
	L/H	Vehicle Class (Light/Heavy)
	1/2	Period of Growth – (1 denotes 2013 to 2030, 2 denotes 2030 to 2050)
	O/D	Origin /Destination Trip End Factor
	L/C/H	Scenario (Low/Central/High)

Example 1		
Demographic	Emp_30C	Employment projection in 2030 for Central Growth Scenario

Example 2		
Demographic	CO_13	Car Ownership in 2013

Example 3		
Growth Factor	PML_1_OL	PM Peak period growth factor for Light Vehicles during period 2013-2030. Applies to Origin Trip Ends for Low Growth Scenario

Example 4		
Growth Factor	AMH_2_DM	AM Peak period growth factor for Heavy Vehicles during period 2030-2050. Applies to Destination Trip Ends for Medium Growth Scenario

This information is contained within the downloadable file PAG Unit 5.3_NTpM Zone-Based Growth Rates.xlsx which can be downloaded from the “Downloads” section of the TII Publications website under section PE-PAG-02017_Unit 5.3.

For LAM’s where internal zones are smaller than NTpM zones, the growth rates for the NTpM should initially be applied to all LAM zones within that NTpM zone. It is for this reason that it is advisable to ensure that LAM zones are defined as subzones of NTpM zones to avoid any overlapping of LAM zones between adjacent NTpM zones.

Within the LAM, there is some flexibility to reallocate growth between different LAM zones within a single NTpM zone, although the trip end growth for the collective LAM zones that form the NTpM zone should remain consistent with the zone-based trip end growth rates. For example, it may be possible to use county development plans/local area plans to allocate/distribute the growth based on the locations of future zoned land for residential, industrial/office park developments etc. These approaches should be well documented and are valid so long as the distributed growth within LAM zones is constrained by the overall growth in the NTpM zone.

6.2 External Zones

A cordon reflecting the boundary of the LAM is extracted from the Base Year (2013) and Future Year (2030) NTpM. The resulting growth factor is annualised, and then applied to the external zones in the LAM over the appropriate period. The same procedure is applied to the 2050 NTpM, comparing it to the 2030 cordon, to establish growth in external zones beyond 2030.

6.3 Future Year Demand Matrices

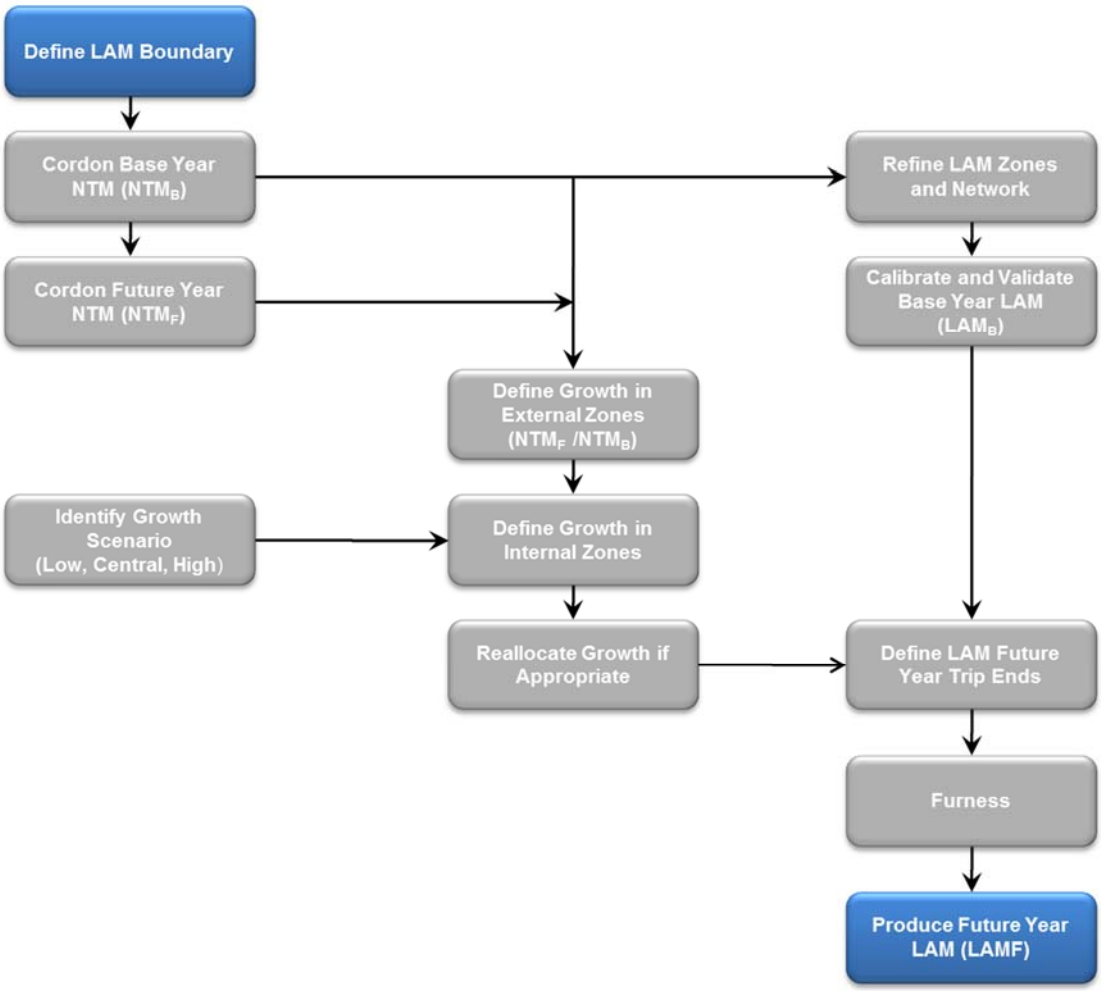
Once new trip end totals for each LAM zone (internal and external) have been developed, the future year trip matrix can then be derived via the ‘Furness’ trip distribution method, which manipulates matrix cells to match defined row and column totals. In undertaking this process, seeding of zero cells may be required using either a gravity modelling technique or through the application of distribution from an adjacent zone with similar travel patterns.

During the trip distribution process, the matrix totals must be constrained to the NTpM trip ends. Even where it is appropriate to include the impact of known developments in particular zones and where a gravity model or the adjacent zone technique is used. The total number of trips within the local matrices must be constrained to the NTpM totals for the same area.

Any assumptions about the nature and location of specific developments should be clearly explained in the Transport Modelling Report and a rationale provided for their inclusion. The resulting impact on growth factors for the remaining zones within the model should also be reported and any unexpected results explained.

The process for developing future traffic growth projections is presented in Figure 5.4.1. The National Traffic Model is the traffic module of the NTpM and is used to provide the relevant outputs for the LAM.

Figure 5.4.1: Traffic Growth Projection Methodology for Assignment Models



An analysis of the impact of the Furness Method on trip length distribution should be undertaken and reported in the Transport Modelling Report. The report should also demonstrate the difference in net growth that occurs as a result of the furnessing procedure, both at zonal level and through the full LAM matrix. Further details are provided in PAG Unit 5.1: Construction of Transport Models.

Variable Demand Models will use zone-based growth rates to produce the initial demand projections for the Do-Minimum and Do-Something scenarios in the future year model. VDM techniques can then be used to adjust the demand matrices to reflect the demand responses associated with the scheme proposal.

The application of growth to other travel modes requires projections for public transport growth in order to allow a future year Production Attraction (PA) matrix to be developed. Further guidance on the preparation of growth projections for use in multi-modal models should be sought from TII.

7. Application to Economic Appraisal

One of the main uses of traffic growth projections in local area models is for the calculation of costs and benefits over the lifetime of the proposal and the calculation of the design parameters for the proposal. Cost and benefit calculations are used to derive the value for money a proposal may have when compared with other ways in which investment funding could be utilised. PAG Unit 6.1: Guidance on Conducting CBA provides guidance on the need for and use of cost-benefit analysis for road schemes.

The current methodology for assessing the costs and benefits set out in these Units requires the use of TUBA (Transport User Benefit Analysis) to calculate the Net Present Value (NPV) and Benefit-Cost Ratio (BCR) of the proposed scheme. TUBA is supplemented by COBALT (Cost and Benefit to Accidents – Light Touch) which provides estimates in relation to safety benefits. Both TUBA and COBALT use outputs taken directly from the transport model as their basis.

Further guidance on economic appraisal is provided in PAG Unit 6.1: Guidance on Conducting CBA.

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