DAVID SIMMONDS CONSULTANCY
Suite 14, Millers Yard, Mill Lane
Cambridge CB2 1RQ England
Tel +44 1223 316098
Fax +44 1223 313893
dsc@davidsimmonds.com
www.davidsimmonds.com

in collaboration with MVA Consultancy

TRANSPORT/ECONOMIC/LAND-USE MODEL OF SCOTLAND (TELMoS):

MODEL DESCRIPTION

Report prepared for Transport Scotland

February 2007

This document has been prepared by David Simmonds Consultancy Limited, under sub-contract to MVA Ltd, for Scottish Executive. Any views expressed are those of the consultants and not necessarily those of the client. The document is intended for electronic circulation and use, and the consultants cannot accept responsibility for changes made by others.

This report is a revised version of the TELMoS DELTA model implementation report prepared for the Scottish Executive in February 2005. The objective in revision was to provide a clearer picture of the model by adding further information and removing a substantial amount of detail especially about the exact location and organization of inputs. The main revisions were therefore

- to omit some lengthy tables of zone names and detailed area definitions;
- to cross-references to DELTA software documentation (and material included only for correspondence to software documentation);
- to add key equations;
- revise the Introduction to be appropriate to the new document.

File TELMoS_description_060207.doc.doc last saved 06/02/2007 17:22:00.

SUMMARY

Introduction

This Report is one of the deliverables from a project in which MVA and David Simmonds Consultancy (DSC) have been commissioned by Scottish Executive to develop a Transport Model for Scotland (TMfS) and the related Transport/Economic/Land-use Model of Scotland (TELMoS). It documents the implementation of the land-use/economic components of TELMoS, and their interactions with the transport components.

Definitions

Chapter 2 deals with definitions and with the correspondence between definitions, data and the database files themselves. The key characteristics of the model are that it represents

- 18 types of household, classified by composition and socio-economic status; for each of these, the proportions owning no car, one car or 2+ cars are modelled;
- 4 categories of persons: children, working adults, non-working adults of working age, retired persons;
- 27 categories of employment, classified by sector and (in the industrial sectors) by whether the activity is "production" or "administration" (the former employing manual workers and occupying industrial floorspace, the latter non-manual workers in office floorspace);
- 7 categories of floorspace, including housing.

The zone system for the model exactly matches that of TMfS. The areas outwith the main TMfS area are treated as Buffer Zones; these are modelled in less detail than the Fully Modelled Zones within the main TMfS area, but their inclusion means that the whole population and employment of Scotland are represented.

Chapter 3 documents the database files within the model system in terms of these definitions.

Processing of 2001 Census data

Chapter 4 explains the processing of the 2001 Census data, which formed the major starting point for the model database.

For **households**, the process had to disaggregate the household/population information in ways which cannot be directly obtained from the published Census tables. An element of estimation is therefore involved, typically using proportions from one Census output to split another output. This results in a database which represents the number of households of each type in each zone; the numbers of persons by person type in households by type

and zone; and the car ownership levels of the household by type and zone. **Housing** data was also obtained from the Census.

Employment data was fairly readily extracted from the Census for much of the sector/zone detail required; the greater detail available in Scotland compared with the English Census outputs is enormously helpful in this respect. Some further disaggregation then had to be estimated, mainly to implement the production/administration split as described above.

Other 2001 data

Chapter 5 discusses the remainder of the 2001 data. This consists of

- non-residential floorspace data, which was estimated starting from the Census employment data
- converting the Census housing (dwellings) data into residential floorspace
- the area environment files, assembled from published data
- distance matrices for the migration and trade models
- the generalised cost data which are obtained from the transport model (TMfS).

Regional Economic Model database

Chapter 6 reports very briefly on the the database for the Regional Economic Model (REM). This was largely taken from previous work on the CSTCS model, which in turn was developed from a mixture of published statistics and estimation.

Urban models and input files

Chapter 7 documents the models which operate at the urban (zonal) level, ie

- the accessibility calculations within DELTA
- the inputs to the development models, which forecast the construction of the main floorspace types
- the inputs to the demographic model (which works in terms of household transitions)
- the inputs determining the mobility of employment activities
- the inputs to the car ownership model
- the inputs to the household and employment location models, and to adjust the vacancy rates of floorspace in response to changes in rents
- the inputs to the employment status model
- the inputs to the model for changes in residential quality.

All of these inputs have been developed from previous work rather than from original calibration.

Regional model input files

Chapter 8 documents the models and inputs at the regional level, namely

- the conversion of transport costs from costs per vehicle movement to costs per unit of trade
- the area accessibility calculations
- the coefficients of the investment model
- the coefficients of the trade and production model
- the coefficients of the household migration model.

As at the urban level, these coefficients have mostly been taken from previous work, with some adjustment.

DELTA/TMfS interface

Chapter 9 documents the interface between DELTA and TMfS. This primarily involves output of a table of "planning data" which form the inputs to the trip generation and trip attraction calculations within TMfS. The synthetic matrix of freight movements is also used.

Scenario inputs

Chapter 10 brings together the list of inputs which constitute the scenarios within which strategies are tested, and reports how the scenarios were defined during the course of the project. The scenario inputs mainly control

- the growth of the Scottish economy, in total and by sector, in both value and employment terms
- the changes in the Scottish population, in terms of persons by type and households by type (as defined earlier).

Planning policy inputs

Chapter 11 identifies the planning policy inputs used in the application of the model to date. The preparation of these inputs was the subject of a separate report.

[end of summary]

Contents

LIST OF TABLES

ABBREVIATIONS

Abbreviation	Meaning
CSTCS	Central Scotland Transport Corridor Studies (and the associated LUTI model)
DELTA	Land-use/economic modelling package developed by DSC
DSC	David Simmonds Consultancy
ICOM	Improved Car Ownership Models
LUTI	land-use/transport interaction
REM	Regional Economic Model
SEG	Socio-economic group
SHS	Scottish Household Survey
SITLUM	Strathclyde Integrated Transport and Land-Use Model
SWYMMS	South and West Yorkshire Multi-Modal Study
TELMoS	Transport/Economic/Land-use Model of Scotland
TMfS	Transport Model for Scotland

1 INTRODUCTION

1.1 Background

1.1.1 This Report is one of the deliverables from a project in which MVA Consultancy and David Simmonds Consultancy (DSC) have been commissioned by Transport Scotland to maintain and enhance the Transport Model for Scotland (TMfS) and the related Transport/Economic/Land-use Model of Scotland (TELMoS).

1.1.2 This Report is intended for use of the TMfS auditors.

1.2 Structure

1.2.1 The overall sequence of this Report is to present or describe

- definitions (defining the scope of the model);
- database (sources and outline of data processing to create the inputs representing Scotland in the base year or earlier);
- other inputs (mainly coefficients to describe household, individual or firms' behaviour);
- scenarios (inputs defining the overall changes in Scottish economy and population); and finally
- policy inputs (inputs quantifying land-use planning policies).

1.2.2 Chapter 2 sets out the definitions of the model components.

1.2.3 Chapter 3 describes the content of the urban model database files which are generally

- input to the model as the initial description of land-use in Scotland
- output by the model as its forecasts of future land-uses.

1.2.4 This chapter contains links to subsequent chapters to identify

- how inputs were prepared
- how outputs are calculated by the model.

1.2.5 Chapter 4 explains the processing of the 2001 Census data, which formed the major starting point for the model database.

1.2.6 Chapter 5 discusses how the remainder of the 2001 data was processed through the use of spreadsheets.

1.2.7 Chapter 6 discusses how the database for the Regional Economic Model (REM) was derived, and how it was adjusted for TELMoS.

1.2.8 Chapter 7 deals with the urban model input files.

1.2.9 Chapter 8 documents the other inputs to the urban level of the model.

1.2.10 Chapter 9 documents the interface between DELTA and TMfS.

1.2.11 Chapter 10 brings together the list of inputs which constitute the scenarios within which strategies are tested, and reports how the scenarios were defined during the course of the project.

1.2.12 Chapter 11 documents the planning policy inputs used in the application of the model to date.

2 MODEL DEFINITION

2.1 Model definition file

2.1.1 The DELTA model definition file, DELTAMOD.DEF, defines the overall dimensions of the model and is used to specify the different elements to be operated in a particular model application. All the DELTA programs read this file.

2.1.2 The following sections document the various blocks of the model definition file.

2.1.3 Additional sections at the end of this Chapter refer to the other definition files and to definitions included in other inputs.

2.2 DELTA and transport model years

2.2.1 The DELTA model is operated in one-year steps. The model definition file

- lists all years from 1981 to 2022;
- defines 2001 as DELTA base year (year 0) for model running (so that the model cannot attempt to change the input data for 2001 or earlier years). Note that the base year for TMfS is 2005 and this difference doesn't cause any conflicts;
- defines the two-character alphanumeric codes used as abbreviations for the year.

2.2.2 DELTA needs to know in which years the transport model (TMfS) is run. This information is input in the **test** definition file – **not** in the model definition file. When required, DELTA-only tests are carried out by deleting some transport model years.

2.3 Zones, areas and other model dimensions

2.3.1 There are a number of key model dimensions which are input as numbers. (Other dimensions, such as the number of household types, are input by listing the different categories, as shown below.) These dimensions must not be changed.

2.3.2 The different types of zones are defined as follows:

- Fully Modelled zones are modelled in full throughout all sub-models;
- Buffer zones are not modelled in terms of development and property factors;

- External zones are modelled only as sources and sinks for commuting and imports and exports (in DELTA) and for trips (in TMfS).

Dimension	Value
Fully Modelled Area Zones	1103
Buffer Area Zones	25
External Zones	9
Household socio-economic groups	2
Worker socio-economic groups	2
Person types	4
Car-ownership levels in household data	3
Car-ownership levels in matrix data	3
Modes in accessibility inputs	5
Purposes in accessibility inputs	6
Model Version	1230
Number of socio-economic groups in transport model	1
Number of car-ownership levels in transport model	3

Table 2.1 Model dimensions entered as values

2.3.3 The three different categories of zones – Study, Buffer and External – are numbered consecutively. This zones system has been revised in April 2006 in order to include four additional zones for the airports (Edinburgh, Glasgow, Aberdeen and Prestwick). Hence

- the Fully Modelled Area consists of zones 1 to 970 and 972 to 1100 ;
- the Buffer Area consists of zones 971, 1101 to 1109, and 1114 to 1128;
- the External Zones are 1129 to 1137.

2.3.4 The regional system definition records the number of internal, intermediate and external areas in the model. These areas are simply an aggregation of zones to a specified area. TELMoS defines internal areas of which there are 17 (originally defined on a travel to work areas basis for CSTCS) and external areas in terms of trade routes.

2.4 Activity definitions

2.4.1 The term "activity" is used throughout DELTA to refer to households and employment. Activities 1 to 18 inclusive are household types, which are based on a mixture of age, composition and employment status, further disaggregated by socio-economic group. There are 18 household types, 27 employment types and 2 socio-economic groups. Table 2.2 shows the household activity number by each type and socio-economic group.

Activity	Description
1	One younger (16-44) person, non manual
2	One younger (16-44) person, manual
3	One older (45-74, not retired) person, non manual
4	One older (45-74, not retired) person, manual
5	One adult (16-74, not retired) and child(ren), non manual
6	One adult (16-74, not retired) and child(ren), manual
7	One person retired, non manual
8	One person retired, manual
9	Two adults, no children, non manual
10	Two adults, no children, manual
11	Two adults, with child(ren), non manual
12	Two adults, with child(ren), manual
13	Two adults, both retired, non manual
14	Two adults, both retired, manual
15	Three+ adults, no children, non manual
16	Three+ adults, no children, manual
17	Three+ adults, with child(ren), non manual
18	Three+ adults, with child(ren), manual

Table 2.2 Household activity definitions

2.4.2 The person types are defined as shown in Table 2.3.

Type	Description
Children	Any person under 16 years of age
Non-workers	Any person between the ages of 16 and 74 inclusive, who is not in employment and who is not retired
Workers	Any person between the ages of 16 and 74 inclusive who is in paid employment
Retired	Any person aged 75 or over and any person between the ages of 16 and 74 inclusive who is classified as 'economically inactive retired'

Table 2.3 Person types

2.4.3 Table 2.4 shows the employment activity classification. Many activities are split into separate activities by socio-economic group, on the basis that different types of workers occupy different types of floorspace. The socio-economic groups are defined in Table 2.5 and the floorspace types in Table 2.6.

Activity	Description (with SIC code to which the activity belongs)		Floorspace occupied
31	A - Agriculture, hunting and forestry	Non-manual	3
32	A - Agriculture, hunting and forestry	Manual	-
33	B – Fishing	Non-manual	3
34	B – Fishing	Manual	-
35	C – Mining and quarrying	Non-manual	3
36	C – Mining and quarrying	Manual	-
37	D – Manufacturing	Non-manual	3
38	D – Manufacturing	Manual	4
39	E - Electricity, gas and water supply	Non-manual	3
40	E - Electricity, gas and water supply	Manual	4
41	F – Construction	Non-manual	3
42	F – Construction	Manual	4
43	G – Wholesale and retail trade, repairs	Manual and Non-manual	2
45	G – Wholesale and retail trade, repairs (other)	Non-manual	3
46	G – Wholesale and retail trade, repairs (other)	Manual	4
47	H – Hotels and restaurants	Manual and Non-manual	5
48	I – Transport, storage and communications	Non-manual	3
49	I – Transport, storage and communications	Manual	4

Activity	Description (with SIC code to which the activity belongs)		Floorspace occupied
50	J – Financial intermediaries (financial management)	Manual and Non-manual	3
51	J – Financial intermediaries (local financial services)	Manual and Non-manual	3
52	K – Real estate, renting and business activities	Manual and Non-manual	3
53	L – Public administration & defence, social security	Non-manual	3
54	L – Public administration & defence, social security	Manual	4
55	M – Education	Manual and Non-manual	6
56	N – Health and social work	Manual and Non-manual	7
57	O, P, Q – Other	Non-manual	3
58	O, P, Q – Other	Manual	4

Table 2.4 Employment activity definitions

2.4.4 The DELTA definition file only tells the model that a certain activity exists; it does not specify the composition of that activity. The definition of the numbers of persons of each type in each household activity, ie the information which actually tells the software that a household of activity 1 contains a single non-manual adult, is input to the employment status model (see section 7.15).

DELTA SEG	Title	Contains 2001 Census of Population SEGs:	
1	Non-manual workers	AB	Higher and intermediate managerial/administrative/professional
		C1	Supervisory, clerical, junior managerial/administrative/professional
2	Manual workers	C2	Skilled manual workers
		D	Semi-skilled and unskilled manual workers
		E	On state benefit, unemployed, lowest grade workers

Table 2.5 Definition of DELTA socio-economic groups

2.4.5 The information on number of households and on numbers of persons by type is recorded in the activity database file. The process of changing employment status

within the model is carried out in the employment sub-model, and is documented in section 7.15.

2.5 Activity group definitions

2.5.1 The DELTA software uses "activity groups" to specify (a) categories of activities which have to be distinguished, e.g. to identify which activities are households and which are employment; and (b) to provide an abbreviated way for the user to refer to multiple activities in setting up input files. The definitions are critical to the interpretation of other model inputs and should not be changed, but they are not significant in this Report.

2.6 Floorspace

2.6.1 The model works with seven categories of floorspace, all measured in square metres. These are defined in Table 2.6.

DELTA floorspace category	Represents	Greenfield development process	Brownfield development process
1	Housing	1	8
2	Retail	2	9
3	Office	3	10
4	Industrial	4	11
5	Hotel	5	12
6	Education	6	13
7	Health	7	14

Table 2.6 DELTA floorspace category and development process definitions

2.6.2 The DELTA model does not represent land directly. The software is designed to expect a category of land corresponding to each category of floorspace, but in the present implementation any data about "land" is a measure of floorspace.

2.7 Development model definitions

2.7.1 TELMoS is set up to represent fourteen development processes. These represent greenfield and brownfield development of each of the seven floorspace types, as specified in Table 2.6.

2.8 Definition of car-owning activities

2.8.1 Car ownership is modelled for all 18 household activities, with three levels of car-ownership, as shown in Table 2.7.

DELTA car ownership level	Represents households with….
1	no car
2	one car
3	two or more cars

Table 2.7 DELTA car ownership levels

2.8.2 Beware of the possible confusion between the **numbering** of the levels (1,2,3) and their **meaning** (0 cars, 1 car, 2+ cars).

2.9 Migration model definition

2.9.1 This definition specifies which activity groups are to be considered as possible migrants. The present implementation allows all non-retired households to migrate.

2.10 Regional Economic Model Definition

2.10.1 The matching between urban model activities (measured as employment by zone) and regional economic sectors (measured primarily by output and value-added by area) is shown in Table 2.8.

URBAN Activities		REM Sectors	
31	Agriculture, hunting and forestry	201	Agriculture, forestry and fishing
32			
33	Fishing		
34			
35	Mining and quarrying	202	Mining
36			
37	Manufacturing	203	Manufacturing
38			
39	Electricity, gas and water supply	204	Energy and water
40			
41	Construction	205	Construction
42			
43	Wholesale & retail trade, repairs - retail	206	Distribution and catering
45	Wholesale & retail trade,		

URBAN Activities		REM Sectors	
46	repairs - other		
47	Hotels & restaurants		
48	Transport, storage & communications	207	Transport and communication
49			
50	Intermediaries – financial management	208	Finance and business
51	Intermediaries – local financial services		
52	Real estate, renting & business activities		
53	Public administration, defence, social security	209	Public administration
54			
55	Education		
56	Health		
57	Other	210	Other services
58			

Table 2.8 Match of urban activities to REM sectors

2.10.2 The additional sectors used to represent different categories of imports to Scotland are as shown in Table 2.9.

Sector	represents
211	Goods from Rest of UK
212	Goods from Rest of World through England
213	Goods from Rest of the World
214	Services from Rest of UK
215	Services from Rest of World through England
216	Services from Rest of the World

Table 2.9 Definition of import sectors

2.10.3 Note that these sectors are defined as special sectors representing different categories of imports by the area capacities database. This is set up so that each of these sectors has a non-zero capacity only in the External Area to which it refers

(see 8.4.3). This ensures that these imports cannot be supplied from anywhere except that Area.

2.10.4 The demand for these imports is specified in the technical coefficients of the input-output model (see 8.6). Note that this specification means that as these coefficients are fixed input values, the proportion of imports in the total inputs of each sector cannot be changed by the model itself. In particular, changes in the transport system will not change the ratio of imported to domestic (Scottish) inputs in any sector's consumption.

2.11 Quality change sub-model definition

2.11.1 The quality model is currently set up so that

- quality is represented for housing floorspace;
- housing quality is adjusted by the model (see 7.16);
- retail quality is changed only by exogenous inputs (see 7.16).

2.12 Activity:floorspace relationships

2.12.1 The model definition file specifies

- which type of floorspace, if any, each activity uses
- which of the utility and/or cost functions controls how the activity changes its use of floorspace in response to rent changes.

2.12.2 Activities not listed in this block do not occupy modelled floorspace. The activities in TELMoS which do not occupy floorspace are

- 32: Manual agriculture;
- 34: Manual fishing;
- 36: Manual mining.

2.12.3 The activities which occupy each modelled floorspace type are shown in Table 2.10.

2.12.4 The floorspace/rent relationships are

- for all employment types, a simple rent-density elasticity;
- for all household activities, a utility-maximising function with income constraint.

Floorspace category		**Activity**	
1	Housing	1 to 18	Households
2	Retail	43	Retail trade
3	Office	31	Non-manual agriculture
		33	Non-manual fishing
		35	Non-manual mining
		37	Non-manual manufacturing
		39	Non-manual electricity
		41	Non-manual construction
		45	Non-manual other trade
		48	Non-manual transport
		50	Financial management
		51	Local financial services
		52	Real estate
		53	Non-manual public administration
		57	Non-manual other
4	Industrial	38	Manual manufacturing
		40	Manual electricity
		42	Manual construction
		46	Manual other trade
		49	Manual transport
		54	Public administration
		58	Manual other
5	Hotel	47	Hotels
6	Education	55	Education
7	Health	56	Health & social

Table 2.10 Activities using each floorspace category

2.13 Location model timelags

2.13.1 The model definition file specifies

- the timelags used in the location model;
- the choice of location model function and related options.

2.13.2 The timelags are documented in sections 7.12 (households) and 7.13 (employment activities).

2.13.3 The location model function is function 1 (incremental logit model) for all activities.

2.14 Land-use/transport interface definition

2.14.1 Some additional definitions used in the land-use/transport model interfaces are documented in section 9.2 of this Report.

2.15 Accessibility measure definitions

2.15.1 These are documented in section 7.2 of this Report.

2.16 Other definitions

2.16.1 It should be kept in mind that the model definition file sets up and names different activities, but most of the information which makes them behave in accordance with those names is introduced elsewhere.

2.16.2 Important aspects of "definition" input to specific sub-models include the following:

- the "life-cycle" processes are defined by inputs to the transition model(see 7.9) - it is these that define (for example) that younger households age into older households, etc;
- the numbers of persons within households are defined by inputs to the employment status model (see 7.15);
- whilst the definition file identifies household activities as belonging to different socio-economic groups, the corresponding differentials in incomes are input to the location model (see 7.13) and the relationships between the socio-economic groups of workers and the economic sectors are input to the regional economic model (see 8.4.3 and 8.6).

3 URBAN DATABASE DEFINITIONS

3.1 Introduction

3.1.1 This Chapter documents the data contained in the urban database (ie by zone). This data is generally

- **input** for the base year (and in some cases for previous years)
- **output** for forecast years. (Note that this includes **outputs** from the transport model which are **inputs** to the land-use/economic model.)

3.1.2 There are one or two exceptions where the files contain input assumptions for future years, though most of the zonal assumptions about future change are input in the planning policy file (see Chapter 11). These exceptions are noted where they occur.

3.2 Activity database file

3.2.1 The main function of this file is to record the number of units of each activity in each zone, i.e. the number of households and of jobs by activity.

3.2.2 For household activities, the file also records the numbers of persons by type within households of each activity in each zone.

3.2.3 For employment, the file shows

- the nominal number of workers by employment activity and workplace zone, and
- the actual/forecast number of workers by activity, zone and socio-economic group.

3.2.4 In the base year, the nominal number of workers by activity and zone equals the total over socio-economic groups for that activity and zone. In forecast years, the nominal number represents the number of workers which firms expect to employ and for whom they provide floorspace, in line with their investment decisions, whilst the actual number represents the outturn given current levels of production; these may vary.

3.2.5 Note that the classification of households and their members into socio-economic groups is a classification of each household, whilst the classification of workers at the workplace is a classification of each worker. The total set of working adults belonging to households of SEG 2 is therefore not the same as the total set of

workers belonging to SEG 2. The fuzzy relationship between workers and the households to which they belong is dealt with in the employment status sub-model, ME12.

3.2.6 The derivation of the 2001 figures is documented

- for households and resident persons, in section 4.3;
- for employment by workplace in section 4.6.

3.2.7 The forecast activity database files are written by the employment status model..

3.3 Space database file

3.3.1 The database contains, for each zone and space category, the total quantity of floorspace (occupied plus vacant) in square metres, the rent in £/m2 per week, the amount of vacant floorspace and the quality of the floorspace.

3.3.2 In the current implementation of the model, land is not explicitly modelled. The figures in this block are quantities of floorspace, actual and permitted. The permitted figures are the total permitted but not yet used, ie the accumulated, unused allocation of permissible development. If the model forecasts that all permissions for development of a particular type in a particular zone will be used as fast as they are allocated, the permitted development figures in this block will remain zero.

3.3.3 The preparation of the residential space data is documented in section 5.3, and the preparation of the non-residential data in section 4.5.

3.4 Space-activity database file

3.4.1 The space-activity database file relates the model activities (the 18 household types and 24 of the 27 employment categories) to the space they occupy. It defines the utility of consumption and density for households and employment activities and the consumption of other goods and services, in terms of expenditure, for household activities only.

3.4.2 The preparation of the space-activity data in relation to both household and employment activities is documented in section 4.2.

3.5 Car ownership database file

3.5.1 The car ownership database file contains proportions by activity and zone for the 18 household activities. Employment activities do not have car ownership and are omitted from the file. Three categories of car ownership are defined; 0, 1 and 2+ cars (see Table 2.7). For each household type the proportion of all households in each of the three car ownership categories is given (ie the three values always some to one).

3.5.2 The preparation of the base year car ownership proportions is documented in section 7.11.

3.6 Development database file

3.6.1 This file records the amount of development which is under construction in each zone at the end of each one year period. The data is classified by the development process as specified in the model definition file (see 2.7) and by the year in which it will be completed (and hence available to activities for occupation).

3.7 Travel-to-work database file

3.7.1 There are two sets of travel-to-work database files in the TELMoS system, both containing the zonal travel to work matrix disaggregated by car ownership and socio-economic group.

3.7.2 The two sets of files are

- the "TTWS" files, which are generated immediately by the travel-to-work distribution model immediately after the TMfS runs (and at the equivalent point in non-transport model years)
- the "TTWM" files, which are output from the employment status model ME12 in each year.

3.7.3 Note that in these files, socio-economic group is that of the individual workers, not that of the households to which they belong. The destination (workplace) totals are therefore directly comparable and consistent with the data for workers by workplace and socio-economic group, summed over employment activities. The origin (home) totals are comparable and consistent with the data on working adults by home zone and car ownership, but are not directly comparable with the breakdown by household and socio-economic group.

3.7.4 The preparation of the base year TTWS file is discussed in section 5.9.

3.8 Space-development database file

3.8.1 The space-development file contains the amount of unconstrained development that is occurring for each floorspace category. The data is classified by the floorspace category as specified in the model definition file.

3.8.2 The preparation of this data is documented in section 5.2.

3.9 Land-use/transport interface database file

3.9.1 This file contains additional "planning data" required for input to the transport model for variables which are **not** modelled within DELTA. In TELMoS, this consists of

- non-household population, i.e. persons living in institutions, and
- school places.

3.9.2 The preparation of this data is described in section 5.7.

3.10 Environmental database file

3.10.1 DELTA allows for environmental data to feed back from the transport model (or, in principle, a wider environmental model taking account of transport and other impacts) as an influence on the location of residents (and, again in principle, of businesses). This has not been implemented in TELMoS.

3.11 Active and passive accessibilities by measure

3.11.1 DELTA program AC12 produces a range of measures grouped into

- active accessibilities – how easily people located in zone *i* can get to "opportunities" (eg for work, for shopping) given the numbers of such opportunities in every zone *j* and the generalised costs of travel from *i* to each *j*;
- passive accessibilities – how easily opportunities in zone *j* can be reached by people (potential workers, potential shoppers) who might come from each zone *i*, given their distribution across the zones *i* and the generalised costs of travel from each *i* to *j*.

3.11.2 These accessibility measures relate to a specific set of opportunities and a specific set of generalised costs (eg off-peak, non-work travel). These are input to program IA12 which combines them into measures of accessibility by activity – see below.

3.12 Accessibility and environmental values by activity

3.12.1 This contains the information about transport-related variables in the main forms in which they are used by the land-use model, ie

- accessibility by activity and (for households) car-ownership level;
- environment quality by activity.

4 DATABASE DEVELOPMENT – 2001

4.1 Introduction

4.1.1 This chapter outlines the process by which Scottish Census of Population 2001 and other data were used to produce the 18 household types and the 27 employment types modelled in the TELMoS application of DELTA.

4.1.2 There are three main stages to the work relating to households and population that will be described in the following sections:

- to extract household data to determine the number and types of households and employment in each zone;
- to determine the number, composition and employment status of the population of the households in each zone;
- to deduce the number and composition of the non household population in each zone.

4.2 Assembly of the Scotland's Census 2001 data

4.2.1 The TELMoS zoning system divides the whole of Scotland into 1128 zones. The Census data splits Scotland into 42604 Census output areas. Each of the 1128 TELMoS zones comprises of either one Census output area or a group of Census output areas.

4.2.2 Wherever possible the primary source of data is the 2001 Census. Data from the Census is taken by Census output area (the most detailed available) and converted to TELMoS zones by renumbering and/or summing data where appropriate.

4.2.3 In cases where the data required is unavailable in the Census material that has been released thus far it is necessary to find a secondary data source. The 1999-2000 Scottish Households Survey (SHS) is used in this role to find necessary proportions that are applied to data from the Census to provide the required categorisations.

4.3 Household data

4.3.1 TELMoS households are split into 18 activities as defined in the following tables, consisting of 9 base household categories each split between manual and non manual socio-economic levels. The 18 household activities were defined in Table 2.2. Each type of household contains a person or persons in one or more of the categories listed in Table 2.3.

4.3.2 The vast majority of the data required to find the number of households in each TELMoS zone for the 18 base categories was found in tables UV65 and UV66 from the 2001 Census.

4.3.3 There are two instances where a proportion from the SHS data set is required to split categories from table UV 66 in a constant ratio across all zones to match the TELMoS household definitions. These were:

- to split the one single non retired adult household category in to the younger and older activities used in TELMoS;
- to divide a Census category labelled '2 adults and 3 or more children or 3 or more adults and 1 or more children' to obtain the TELMoS activity 'three or more adults with children', with any remaining households are added to the 2 adults with children TELMoS activity.

4.3.4 There is data available from both the Census and the SHS that could be used to provide the manual/non-manual split.

4.3.5 Table CAS 66 from the Census covers all people aged 16 and over in households (therefore all people whether working, not working or retired) and assigns an "Approximated social grade" which is linked to that of the household reference person.

4.3.6 'Higher and intermediate managerial/ administrative/ professional' and 'supervisory, clerical, junior managerial/ administrative/ professional' categories are classified as non manual. The remaining categories of 'skilled manual workers', 'semi-skilled and unskilled manual workers' and 'on state benefit, unemployed, lowest grade workers' are therefore classified as manual.

4.3.7 This Census data is not ideal to use alone to achieve the manual/non manual split because the proportion of households that are manual or non manual is unlikely to be uniform across all household types in any zone.

4.3.8 Data from the SHS is used to find the proportion of each household type that, when considered over Scotland as a whole, would be expected to be manual or non manual.

4.3.9 SHS data considers only a sample of Scottish households, as compared to the Census whose data should include all Scottish households.

4.3.10 The Census data gives manual/non-manual split by zone but not by household type and the SHS data gives manual/non-manual split by household type but not by zone.

4.3.11 In the current manual/non manual split calculations, the data from the Census is given a 75% weighting and that from the SHS a 25% weighting.

4.4 Population Data

4.4.1 Data was taken from Census tables as follows:

- Children: CAS 004 (total all people aged 0-15 inclusive).
- Non-workers and workers: CAS 061 (those in the categories of 'economically active employee' and 'economically active self employed' are classified as working and all others with the exception of those 'economically inactive retired' are classified as not working). In particular 'economically active full time student' are classified as not working.
- Retired: people aged 75 or over from CAS 004 and people aged 16 to 74 inclusive who are classified as economically inactive retired from CAS 061.

4.4.2 The population assignment is complicated because the question of splitting the working/non-working population between the various household categories needs to be addressed, as well as the fact that the working age population is split between all household categories apart from those that are all retired.

4.4.3 Proportions from the SHS are used to estimate the number of workers/non-workers living in each of the household categories.

4.5 Non-Household Population

4.5.1 This population data together with that in the AVZN file described previously accounts for all the population in any one zone and when summed over all zones is equal to the total Scottish population defined in the 2001 Census.

4.5.2 The non-household population for each population category in each zone is obtained by finding the total population in each zone for each population, and then simply subtracting the household population.

4.6 Employment Data

4.6.1 The employment activities considered in TELMoS (see section 2.4) are defined in Table 2.4.

4.6.2 Data from Census UV77 provide the number of jobs in SIC categories A to Q in each TELMoS zone.

4.6.3 The first manipulation required is to split the category G, "Wholesale and retail trade, repairs", in "Retail" and "Other". This split has been made considering the proportion of the activities J and K in each TELMoS zone.

4.6.4 The second manipulation required is to split the category J, "Financial intermediaries", in "Financial management" and "Local financial services". This split has been made considering the proportion of the activity J in each TELMoS zone.

4.6.5 The third manipulation required is to determine in each zone what proportion of the jobs is manual or non-manual, to create all the 27 employment activities. At the same time it must be ensured that the proportion of jobs that are either manual or

non manual should be very similar to the proportion of workers in the corresponding category.

4.6.6 There are a number of ways of approaching this objective. An obvious one would be to make assumptions about the proportion of manual/non manual workers in each of the employment activities. However, this would not take into account any differences between zones, for example the possible concentration of non-manual service jobs in the major city centres.

4.6.7 In an attempt to capture some of the inter-zonal differences in the proportion of manual/non manual jobs that may be expected to exist the data available in the 2001 Census is examined.

4.6.8 Census table UV78 contains exactly the data that is required to achieve the manual/non manual split because it gives the number of jobs by the same approximated social grade definitions as are used in process of splitting the households between the manual and non manual classifications.

4.6.9 The proportion of manual/ non manual workers in each zone is found by classifying those in the 'higher and intermediate managerial/ administrative/ professional' and 'supervisory, clerical, junior managerial/ administrative/ professional' categories as non manual. Those in the remaining categories of 'skilled manual workers', 'semi-skilled and unskilled manual workers' and 'on state benefit, unemployed, lowest grade workers' are therefore classified as manual.

4.7 Use of the data

4.7.1 The data about households and their members, and that on employment, is used in the main activity database file.

4.7.2 The data on non-household population is used in the land-use/transport interface data file.

5 PROCESSING OTHER 2001 DATA

5.1 Introduction

5.1.1 This chapter documents the other components of the TELMoS database which were created for 2001.

5.2 Space database file

5.2.1 Floorspace is a fundamental component in the DELTA model as it provides an indication of the capacity of zones in terms of their ability to hold households and employment. When floorspace is used alongside rents and densities it provides a key supply side constraint essential in analysing the effects of particular policies.

5.2.2 DELTA uses rents as the mechanism by which activities (households or employment) compete for and allocate floorspace. The interaction between supply and demand will determine future rents in a forecasting DELTA run.

5.3 Residential floorspace

5.3.1 The 2001 Census dwelling data has been aggregated into the 4 main dwelling categories; detached, semi-detached, terraced and flats for both occupied and vacant dwellings. To calculate the total floorspace in each dwelling category by zone the number of dwellings by type were multiplied by an average size for each type. The average size was taken from Valuation Office Property Market Report, autumn 1991. This procedure was followed for both occupied and vacant dwellings.

5.4 Area environment database file

5.4.1 This file was taken directly from our earlier work on the CSTCS LUTI model.

5.4.2 Three variables were chosen that were deemed to be the main influences on migration flows. The variables were:

- numbers of listed buildings;
- crime levels;
- levels of urbanisation.

5.4.3 This choice of variables was a judgement informed by a report on migration prepared for DETR (Stillwell et al, 1998).

5.4.4 Data was collected from the following sources:

- recorded crime in Scotland 1999 from the Scottish Executive website www.scotland.gov.uk;
- listed buildings by council from the Historic Scotland website www.historic-scotland.gov.uk;
- population density was used as a proxy for levels of urbanisation. This came from Regional Trends 2001, Table 16.1.

5.4.5 Listed buildings were found per sq km and crimes per 10,000 people. The average for Scotland for each of these variables was calculated, and a value for each of the 17 areas in the model calculated using the following equation:

$$\left(\frac{LBa}{LBs}\right)^{1} \times \left(\frac{Da}{Ds}\right)^{-1} \times \left(\frac{Ca}{Cs}\right)^{-1}$$

where:

a= area

s= averaged over Scotland

LB= listed buildings

D= density

C= crime

5.5 Migration model distances

5.5.1 The migration model database files contain information on the distances between origin and destination for the migration matrices. The distances are calculated in the following way:

- For the migration model to run a MMDS data file is required that specifies the distances between the different areas identified by the model.
- For each area a six figure grid reference was found using the Ordnance Survey 2001 Road Atlas of Britain.
- This information for each zone was listed in a spreadsheet. A formula based upon a lookup table was then applied to calculate the distance between one particular zone and all other zones based upon the co-ordinates of the central point of each zone.
- The distances were then formatted into a file, which could be read by DELTA.

5.6 Generalised cost data

5.6.1 Generalised cost data is supplied from TMfS to DELTA. The purposes, modes and household car ownership levels that are considered in the DELTA side of the TELMoS application are defined in Table 5.1, Table 5.2 and Table 5.3 respectively. Note: Modes and car ownership levels are only applicable to purposes 1, 2 and 3.

Purpose	Definition
1	Travel to work
2	Shopping and leisure trips
3	Business travel
4	Light goods vehicle trips
5	Heavy goods vehicle trips

Table 5.1 Purposes in TELMoS

Mode	Definition
1	Car
2	Public transport
3	'Slow modes' (walk and pedal cycle)

Table 5.2 Modes in TELMoS

Car Ownership level	Definition
1	No car
2	1 car
3	2+ cars

Table 5.3 Car Ownership levels in TELMoS

5.6.2 Mode constants and mode split parameters are only required for those purposes for which more than one mode is available (i.e. a mode choice is at all possible). Purposes 1, 2 and 3 fall into this category. Therefore, purposes 4 and 5 are ignored in the calculation procedure for these variables.

5.6.3 TMfS produces generalised costs for 2 modes, car and public transport. The aim in DELTA is to consider 3 modes, these being car and public transport as in TMfS,

along with an additional mode to represent non-motorised travel by walk or pedal cycle.

5.6.4 In order to calculate mode constants and mode split parameters, generalised costs along with the number of trips undertaken by each mode are required. This data is only available for those modes that are modelled in TMfS, i.e. car and public transport. Therefore, the calculation procedure is carried out for these two modes only.

5.6.5 The extra DELTA mode representing non motorised travel will only be available for trips that are less than 10 km in length. Therefore, this will only act as an extra mode possibility in the calculations for trips within that range of distances.

5.6.6 The generalised costs for the DELTA mode representing 'slow modes' are calculated directly from the distance travelled. When calculating the generalised cost it is assumed that the monetary cost is zero and therefore that only the time component is to be considered. A speed of 6 km per hour is assumed in calculating the time component of the generalised cost and that each minute after the first 20 will count as double. Therefore, for a 6 km trip by 'slow mode' the generalised cost before any mode constant is applied will be 100 minutes. This comprises of 20 minutes for the first 2 kilometres and then 40 minutes for the final 4 kilometres, which are doubled to arrive at a total of 100 minutes.

5.6.7 TMfS does not consider household car ownership levels whereas DELTA considers 3 household car ownership levels as defined in Table 5-3. Different mode constants and mode split parameters would be expected not only for each purpose but also for each car ownership level. As we do not have the data to enable us to calculate separate mode constants and mode split coefficients for each car ownership level in each purpose, assumptions have to be made to make it possible to obtain the required inputs.

5.6.8 It is assumed that the coefficients (mode split parameter and mode constant) calculated for each purpose from the data produced by TMfS represents the central (and most common) household car ownership level of 1 car. Adjustments are then made to the mode constants to reflect the fact that people living in households with no cars will find it more difficult to use a car as a mode of transport and those people living in households with more two or more cars are more likely to use a car to make a trip regardless of the availability or cost of the equivalent trip by any other mode. Checks are made at the end of the process to ensure that the resulting mode shares in the different car ownership categories and the mode share for the 'slow modes' appear reasonable in all categories of purpose and car ownership level.

5.7 Data processing procedure

5.7.1 In order to carry out the required calculations the generalised cost of travel by each available mode (car and public transport) along with the number of trips undertaken by each mode is required for each zone pair in the study area.

5.7.2 Generalised costs are available for each mode in each of three times of day (AM peak, inter peak and PM peak) and for in-work and not in-work time status.

5.7.3 On the other hand trip rates are only available for the three times of day, with no distinction between whether it is in-work or not in-work time.

5.7.4 A separate set of costs and trip rates (separate costs and number of trips for each of the modes being considered: car and public transport) are required for each DELTA purpose that requires calibration. Table 5.4 defines the cost and trip data that has been used in the mode constant and mode split parameter calculation procedure for each purpose.

Purpose	Trip data	Cost data
1	sum of AM peak and PM peak trips	combination of not in work AM peak and PM peak costs weighted by proportion of number of trips in trip data that come from corresponding time period.
2	inter peak trips	not in work, inter peak costs
3	inter peak trips	in work, inter peak costs

Table 5.4 Cost and Trip data

5.7.5 The software package SPSS is used to compile the necessary data for each purpose and output this in a series of files corresponding to the following distance bands that are suitable for processing in the ALOGIT program.

5.7.6 ALOGIT is the program that calculates the mode constants and mode split parameter that are implied in the data sets for each purpose/distance band combination.

5.7.7 In the initial rounds of processing it was noticed that the mode constants and mode split parameters varied significantly within each purpose if trips in certain distance bands are considered separately. Therefore, each purpose was analysed considering trips in the distances bands defined in Table 5.5separately.

Distance band	Distance (km)
1	0 – 2.5
2	2.5 – 6
3	6 - 12
4	12 – 30
5	30 – 100
6	100+

Table 5.5 Distance bands

5.7.8 AC12 currently has the capability to apply a formula to calculate the mode split parameter according to the distance of the trip being considered. Therefore, it is the aim to use this and to find coefficients that produce a curve that matches that which links the points found from the ALOGIT analysis. This has been implemented for each purpose.

5.7.9 Distribution parameters currently used in TELMoS vary by purpose and are constant across car ownership level. The values used are approximately half the mode split parameter that is estimated in the trip distance band with the largest number of trips in the ALOGIT analysis.

5.7.10 AC12 currently has no facility to allow the mode constant to vary with distance. Therefore, mode constants have to be chosen that will produce reasonable mode shares over the full range of possible trip distances. In order to achieve reasonable predicted mode shares over short distance trips relatively modest mode constants have been used.

5.7.11 The differences in accessibility between the car ownership levels will be achieved by using different mode constants. A process of using an example logit choice model set of calculations with cost data from a typical trip length of around 8 kilometres, altering the mode constants and comparing the results was used to deduce what variation in mode constants to use between the car ownership levels.

5.7.12 It was found that altering the car mode constant by 20 minutes changed the mode share of car by around 15%. This was considered realistic and therefore this variation in mode constant was implemented. In addition, to reduce the mode share of the non-motorised modes (walk and pedal cycle) for people who live in households with 1 or more cars a mode constant against non motorised modes of 10 minutes for households with 1 car and 20 minutes for households with two cars was implemented. Table 5.6 shows all mode constants that are being used in TELMoS. The mode constant for all purpose/car ownership level/mode combinations that are not listed in Table 5.6 is zero.

Purpose	Car ownership level	Mode	Mode constant (minutes)
1	1	1	40
1	2	3	20
1	3	1	-40
1	3	3	30
2	1	1	100
2	2	3	20
2	3	1	-100
2	3	3	40
3	2	1	-20

Purpose	Car ownership level	Mode	Mode constant (minutes)
3	2	3	10
3	3	1	-40
3	3	3	20

Table 5.6 Mode constants

5.8 The cost files

5.8.1 Four modes are defined:

Mode	Description
C	Car
P	Public Transport
L	Light Good Vehicle
O	Other Good Vehicle

Table 5.7 Modes in cost files

5.8.2 Three time periods are defined:

Time	Description
A	AM peak
O	Off peak
P	PM peak

Table 5.8 Time periods in cost files

5.8.3 Two purposes are defined:

Purpose	Description
W	in work
N	not in work

Table 5.9 Purposes in cost files

5.8.4 Generalised costs are available for each of three times of day.

5.8.5 Generalised costs are available for "Car", "Public Transport", "Light Good Vehicle" and "Other Good Vehicle", for in-work time status.

5.8.6 Generalised costs are available only for "Car" and "Public Transport", for "not in work" time status.

5.8.7 Therefore 18 cost files are present in the database.

XXXXYYTT.DAT			
XXXX	**YY**	**TT**	name of the Cost files read by DELTA
XXXX			letters and/or numbers to identify the file
CXXX			the first character **C** to denote cost file
X**A**XX			the second character **A** to denote AM peak
X**O**XX			the second character **O** to denote Off peak
X**P**XX			the second character **P** to denote PM peak
XX**W**X			the third character **W** to represent in work
XX**N**X			the third character **N** to represent not in work
XXX**C**			the fourth character **C** to denote Car
XXX**L**			the fourth character **L** to denote LGV
XXX**O**			the fourth character **O** to denote OGV
XXX**P**			the fourth character **P** to denote Public transport
	YY		numbers to identify the year
		TT	letters to identify the DELTA test code

Table 5.10 Cost files

5.8.8 In addition the distance matrix is used as the basis for calculating walking times.

5.9 Travel to work matrices

5.9.1 At the time the TELMoS model was implemented the travel-to-work data from the 2001 Census had not been released. The base year matrices were therefore synthesized using a conventional logit distribution model constrained to match

- numbers of workers by car-ownership group and socio-economic level at the home zone, and
- numbers of workers by socio-economic level at the work zone.

5.9.2 The same synthetic model is used in each forecast year, using the most recent set of generalised costs from the transport model.

6 REGIONAL ECONOMIC MODEL DATABASE

6.1 Introduction

6.1.1 The REM database already existed from the Central Scotland Transport Corridor Studies (CSTCS) application of DELTA. This was taken from CSTCS and adjusted to fit with the TELMoS areas.

6.2 Area environment database file

6.2.1 The AREN.DAT file contains the environmental inputs for the migration model. A value is applied to each of the 17 model areas.

6.3 Migration model distances database file

6.3.1 The blocks MMDS01 of MMDS.DAT, were amended to incorporate the changes made to the number and definition of model areas. This involved calculating the new distances between origin and destination for the migration matrices.

6.4 Exports and Government expenditure

6.4.1 The block ARFD01 of ARFD.DAT file (see Manual Section: 16.2), details the final demand from exports and Government expenditure by sector and area. It forms part of the database of the regional economic model and is read by the investment model.

6.5 Area capacity database file

6.5.1 The block ARCP01 of ARCP.DAT file (see Manual Section: 16.7), provides data on the area capacity of each employment activity sector. This too forms part of the REM database and is read by the production and trade model. In the base year, the capacity measure is calculated based upon observed employment.

6.6 Other regional model database files

6.6.1 The following files are output from the synthetic components of the REM:

File	Content
ARCD	Final demand from private consumers
ARCS	Costs of production
ARMX	Matrices of generalised costs by transport purposes
MPTR	Trade between areas, by sector
MPPR	Production by area and sector
MPEM	Expected employment in production, by sector, area and socio-economic group
ARAC	Accessibility by sector and area
MKEM	Expected employment related to capacity, by sector, area and socio-economic group
ARMC	Costs of trade by sector and production-consumption areas

Table 6.1 Synthetic data in REM files

6.7 Adjustments to the REM

6.7.1 Originally all files were used in the adaptation of the SITLUM project to the TELMoS REM.

6.7.2 Afterwards MP1202<>.INP file was updated upon the input-output table on page 70 of Scottish Economic Statistics 2003.

6.7.3 The growth factors were calculated to reproduce the economic scenario in SITLUM.

6.7.4 The trade distances in the monitoring output were examined, and the trade distribution coefficients were adjusted to get reasonable values.

7 URBAN MODELS AND INPUT FILES

7.1 Introduction

7.1.1 This Chapter sets out the main equations of the sub-models which produce the TELMoS forecasts, and documents the parameter inputs which, together with the database variables, determine the behaviour of activities within the sub-models. In addition to the actual sub-models, it includes the calculation of intermediate variables such as accessibility measures. It goes through the urban-level sub-models in the model sequence, starting with the accessibility calculations that are carried out on the outputs of the transport model.

7.1.2 The inputs can be classified into two broad types:

- those which determine the overall scenario of economic and demographic change;
- those which determine the behaviour of activities in response to the conditions arising within that scenario.

7.1.3 It is helpful to keep this classification in mind in thinking about the use of the model. However, many of the sub-models take inputs of both types, partly as a result of the way the model design has developed over successive versions of DELTA. Rather than splitting the documentation of these inputs between separate "scenario" and "behaviour" chapters, we have kept them together (so that each .INP file corresponds to a section or consecutive group of sections in this chapter), and have added a summary of the "scenario" inputs in section 10.2.

7.1.4 It has never been the intention that DELTA models should be extensively calibrated in each of the areas to which they are applied. The philosophy behind the model is that the coefficients should be chosen so that the model reflects the accumulated understanding obtained from past research and analysis. This may mean that particular coefficients (or ratios of coefficients) can be taken directly from previous work; more often, it means that the coefficients must be adjusted so that the model reproduces particular effects (such as elasticities) which are expected on the basis of previous work. In practice, many of the coefficients were chosen and tested in earlier DELTA applications and have been reapplied, with limited testing of their individual effects. The earlier values themselves represent a mixture of:

- values derived from reports of other research;

- values taken from our own work on calibration of earlier models (eg research in collaboration with ITS on the valuation of accessibility and environmental factors in residential location choice, and previous work on car ownership);
- a limited element of direct calibration, where data was available;
- values chosen to reproduce expected elasticities or other relationships.

7.2 Accessibility calculations by measure

7.2.1 The first stage in the accessibility calculations is carried out by program AC12. This is run in each year, whether or not it is a transport model year. It takes as input:

- matrices of generalised costs for different purposes, by mode, from the most recent year of TMfS outputs;
- vectors of production and attraction weights, derived from the current DELTA database;
- modal constants, mode choice coefficients and destination choice coefficients. These are all input by purpose, mode and car ownership level.

7.2.2 These data and coefficients are used to calculate active (origin) and passive (destination) accessibility measures[1] for each combination of purpose and weights defined in the accessibility definition file. The accessibility definition file specifies six different pairs of accessibility measures, each pair being an active accessibility (eg residents' access to jobs of seg 2) and the corresponding passive accessibility (how easily workplace zones can be reached by workers of seg 2). The definitions of the six pairs of measures are shown in Table 7.1. Not all of the accessibilities calculated are necessarily used - the choice of accessibility measures is controlled in the next step, accessibility calculations by purpose (see following sections).

7.2.3 See Table 5.4 for the link with costs, trips and purposes.

7.2.4 The calculations are standard logsum forms. First an average generalised cost over modes is found using equations of the form

$$g_{ij} = \frac{1}{-l_{ij}^{M}} \ln \sum_{m} \exp\left(-l_{ij}^{m} \cdot g_{ijm}\right) \qquad \textbf{(1)}$$

where

g_{ijm} is the generalised cost from i to j by mode m (input from TMfS modified by mode-specific constants)

---

[1] Note that we have generally used the terms origin and destination accessibility in the past, but are moving to active and passive as these are slightly clearer about the distinction between "ease of reaching places" and "ease of being reached".

l_{ij}^{M} is a value for the mode choice coefficient over the distance *ij*.

Purpose	Measure	Origin (active) accessibility definition [weights]	Destination (passive) accessibility definition [weights]	Trip purpose supplying generalised costs
1	1	Access to work, non-manual workers [non-manual jobs - by workplace]	Access to non-manual labour [non-manual workers - by residence]	AM and PM peaks, not in work
	2	Access to work, manual workers [manual jobs - by workplace]	Access to manual labour [manual workers - by residence]	AM and PM peaks, not in work
2	3	Access to shop [retail floorspace]	Access to customers [total population]	Off-peak, not in work
3	4	Access to business [employment]	Access to business [employment]	Off-peak, in work
4	5	Access for LGV movement [employment]	Access for LGV movement [employment]	LGV
5	6	Access for OGV movement [employment]	Access for OGV movement [employment]	OGV

Table 7.1 Definitions of accessibility measures

7.2.5 Then active accessibilities are calculated using the form

$$A_i = \frac{1}{-l^D}\left(\ln\left\{\sum_j W_j \exp\left(-l^D g_{ij}\right)\right\} - K^J\right) \qquad \textbf{(2)}$$

where

l^D is the destination choice coefficient

W_j is the relevant weight for zone *j*, and

$$K^J = \ln \sum_j W_j^{base\_year} \qquad \textbf{(3)}$$

7.2.6 Similarly passive accessibilities are found using the form

$$A_j = \frac{1}{-l^D}\left(\ln\left\{\sum_i W_i \exp\left(-l^D g_{ij}\right)\right\} - K^I\right) \qquad \textbf{(4)}$$

where

l^D is the destination choice coefficient

W_i is the opportunity weight for zone i

$$K^I = \ln \sum_i W_i^{base\_year} \qquad \textbf{(5)}$$

7.2.7 Note that for ease of presentation the superscripts for car-ownership level, travel purpose/time-of-day and weight identifier have been omitted from these equations.

7.2.8 For the calibration process, data is output for the TMfS base year detailing generalised costs together with the predicted number of trips made by mode, car ownership level and purpose for each possible zone pair (origin/destination) combination in the study area. The data implies mode choice coefficients and modal constants by purpose and car ownership level due to the differing modal split that occur on trips between the same zones but for different purposes or by members of households with different car ownership levels. These mode choice coefficients and modal constants implied in the data are extracted through the use of a logit choice model analysis.

7.2.9 The calculation of the mode choice coefficients requires the identification of one mode that fulfils the criteria (or at least is the mode that comes nearest to fulfilling the criteria) of being available to everybody and available for trips between all zone pairs. This mode can then be used as a standard against which the mode constants for the other modes can be calculated. The mode chosen is public transport; therefore public transport (mode 2 in AC12 inputs, see Table 5.2) always has a zero mode constant and the other mode constants can be considered to be in relation to bus travel.

7.2.10 The values for mode choice coefficients and mode constants remain the same over all years of the test period.

Measure	Car ownership level	Mode Par	Ref Dist	Dist Par
1	1	-0.0014	400	-0.55
	2	-0.0014	400	-0.55
	3	-0.0014	400	-0.55
2	1	-0.0014	400	-0.55
	2	-0.0014	400	-0.55
	3	-0.0014	400	-0.55
3	1	-0.0008	2500	-0.40
	2	-0.0008	2500	-0.40
	3	-0.0008	2500	-0.40
4	1	-0.004	900	-0.35
	2	-0.004	900	-0.35

Measure	Car ownership level	Mode Par	Ref Dist	Dist Par
	3	-0.004	900	-0.35
5	1	-0.012	-	-
	2	-0.012	-	-
	3	-0.012	-	-
6	1	-0.012	-	-
	2	-0.012	-	-
	3	-0.012	-	-

Table 7.2 Choice coefficients in accessibility calculations

7.2.11 The outputs of AC12 are the ACOZ and ACDZ files of origin (active) and destination (passive) accessibilities respectively.

7.3 Accessibility calculations by activity - household activities

7.3.1 The second stage in the accessibility calculations is carried out by program IA12. This finds values of zonal accessibility for each activity from the various accessibility measures calculated by AC12. The DELTA activities are separated into two groups for this purpose; household activities (explained in this section) and employment activities (explained in the following section).

7.3.2 For households, this is done by multiplying the different accessibility measures by the expected frequency (trips per household per week) for each individual household activity. This is achieved by breaking each household category down into its constituent members (i.e. number of children, working adults etc...) and predicting how many trips per week by each measure each household member will make. This is then summed by measure to find the total number of trips by each measure that each household type is typically expected to make.

7.3.3 The accessibility value for a household therefore represents an expected generalised cost of travel per week. The differences between household types arise from the differences in household composition and in the types of trips they are likely to make.

7.3.4 The inputs defining household accessibilities in terms of different measures of more specific accessibilities are the same in all years. The outputs form the household-related data in the accessibilities by activity file. These values are recalculated in each year, whether or not it is a transport model year.

7.4 Accessibility calculations by activity - employment activities

7.4.1 Accessibility measures for employment activities are based on varying combinations of

- accessibility to the labour force (by socio-economic group)
- accessibility to consumers, and
- accessibilities to other businesses, for varying proportions of business travel, LGV movement and OGV movement.

7.5 Travel-to-work adjustment

7.5.1 Two additional programs, WAGES and TTWORK, have been added to DELTA to estimate the changes in travel-to-work patterns resulting from the generalised cost changes forecast by TMfS. These apply a standard doubly constrained logit model for each socio-economic group, adjusting wages until the number of workers commuting to each zone matches the number of jobs on offer.

7.6 Development model - total development forecast

7.6.1 This sub-model applies to the four "standard" floorspace categories in the model: residential, retail, office and industrial.

7.6.2 For each of these a base rate of development has been defined as an annual rate of addition to the existing stock. An elasticity of one is specified so that this rate will increase in proportion to the average rent.

7.6.3 Note that this effect controls the rate of development for the whole of the Fully Modelled Area - the distribution of this development across the Fully Modelled Zones is described in the next section.

7.6.4 The model allows for the likelihood that developers will tend to maintain a "land bank" of unused permissible development, since this represents their "stock" for future activity. These effects operate on the total quantity of development before the model considers constraints on development in individual zones.

7.6.5 For the other three floorspace categories, the development model is turned off, and development of these categories is entirely exogenous to the model (ie input via the planning policy files).

7.7 Development model (ii): development costs and characteristics

7.7.1 All model-forecast new development is assumed to have a quality index of 1.5, ie to be substantially better than average stock in the base year. (This is only relevant to housing and retailing.) Average development costs are input.

7.8 Development model (iii) distribution of development

7.8.1 The distribution of development to zones is forecast by a logit model of the form

$$F(P)^{u}_{pi} = F^{u}_{p*} \frac{F(\max,P)^{u}_{pi} . \exp(g^{u}_{p} . r^{u}_{ti} - c(P)^{u}_{pi})}{\sum_{p}\sum_{i} F(\max,P)^{u}_{pi} . \exp(g^{u}_{p} . r^{u}_{ti} - c(P)^{u}_{pi})} \quad \textbf{(6)}$$

where

$F(\max,P)^{u}_{pi}$ is the maximum permissible floorspace of development process P

r^{u}_{ti} is the rent at the beginning of the current period

$c(P)^{u}_{pi}$ is the (input) cost per unit of development (converted into rent-equivalent units)

$g_p{}^{u}$ = sensitivity of development location to expected profitability

The program then checks that the constraints on development are satisfied, ie that

$$F(P)^{u}_{pi} \leq F(\max,P)^{u}_{pi} \quad \textbf{(7)}$$

7.8.2 Any development in excess of the constraint is subtracted, so that constraint (9) is just satisfied. Excess development is accumulated and reallocated using a revised version of the above equation in which the weights are the amount of additional development permissible. This is repeated until the total quantity of development has been located.

7.8.3 The coefficients in the distribution of development were originally obtained by trial-and-error testing to reproduce the general distributions of development in Greater Manchester in the early 1990s, and subsequently adjusted to give plausible sensitivities with respect to differences in profitability.

7.9 Transition model (i) demographic scenario

Introduction

7.9.1 The household transition sub-model represents three main processes of change affecting households within the Modelled Area:

- formation;
- transformation;
- dissolution.

7.9.2 All three processes are defined as the probability that a particular change will happen to a particular kind of household within a one-year modelled period. Formations are therefore defined as the probability that an existing household of

one kind will "generate" a new household (usually of a different kind) within one year.

7.9.3 Some of the events modelled are represented by a single rate. For example, the probability that a couple's first child will be born during the year gives the probability of a simple transformation of the household from couple-without-children to couple-with-child(ren). Other events require two or more changes, the obvious example being that the marriage or cohabitation of two single persons has to be treated as both

- the transformation of one household from single person to couple, and
- the dissolution of another single person household.

7.9.4 Migration is treated separately. Rates for migrating out of the Modelled Area (Scotland) are specified by household category, along with coefficients defining the rate of migration into the Modelled Area as a multiple of the rate of out-migration. Migration between areas within Scotland is modelled explicitly in the migration sub-model (see section 8.7).

7.9.5 The remaining function of the transformation sub-model is to define which households are "mobile" in the location sub-model. All newly formed, newly arrived or newly transformed households are assumed to be mobile, as are those which have experienced a change of employment status in the previous period (see section 8). In addition, a proportion of wholly unchanged households is assumed to be mobile; this represents mobility in the housing market which is unrelated to any change in household composition or status.

7.9.6 Note that at present, all these processes are assumed to apply equally and independently to each socio-economic group.

<u>Rates of formation, transformation and dissolution</u>

7.9.7 The rates used in the model are the result of (a) estimating directly what these rates are likely to be, and then (b) adjusting the rates so that the overall changes in households and population are consistent with those previously produced by other methods (usually cohort-survival population forecasts and "headship-rate" household forecasts). No matter how thorough the estimation process, the adjustment stage is likely to be required because the household transformation process contains only very limited information about the age of the individuals within the households.

7.9.8 The basic estimates of the rates involved have been built up by DSC over the course of a number of projects by drawing on a variety of sources, especially

- official statistics;
- results from the British Household Panel Survey
- adjustment to match scenario forecasts.

7.9.9 The model inputs are therefore rates of transformation, formation and dissolution, together with rates generating migration between Scotland and the rest of the world.

Household other-mobility rates

7.9.10 These rates specify that a proportion of households of each type are mobile in addition to those influenced by changes in household composition.

Transition model calculations and outputs: households

7.9.11 All of the calculations are simple applications of the relevant rates to numbers of households, carried out separately for each zone.

7.9.12 The outputs are numbers of households by activity that

- are immobile in this period (by zone)
- may relocate ("mobile") in this period (by zone)
- must locate anew ("pool") in this period (by the **area** in which they are formed).

7.10 Transition model (ii) employment activity inputs

7.10.1 There are no "transition" or "growth" coefficients for employment activities in the transition model, since changes in employment activities are driven by the outputs of the regional economic model.

7.10.2 It is specified that 25% of nominal employment in each sector is mobile in each one-year period. This is calculated after adjusting nominal employment for changes in capacity (ie for the effects of investment and/or disinvestment). The result of this calculation controls the level of demand to (re)locate into commercial floorspace in the location model.

7.11 Car-ownership model

7.11.1 The car ownership model has been set up so that the car-ownership levels of each type of household in each zone respond to

- changes in average household income by type;
- changes in licence-holding.

7.11.2 Changes in household incomes are found by comparing the inputs to the location model (see 7.13 below) with those for the previous year. Changes in licence-holding are input directly to the car-ownership model.

7.11.3 Note that much of the change in car-ownership in each zone occurs as a result of households undergoing changes in composition (in the transition model) and/or of location (in the migration and/or location model). The probability of a household

owning cars is assumed to be dependent on household type and location, and hence any household which changes activity and/or zone immediately takes on the car-ownership probabilities of the activity and zone to which it has moved. To facilitate this the DELTA database holds car-ownership data as proportions, not as numbers of households; the proportions are applied to the absolute numbers of households as and when required.

7.11.4 and hence being transferred to a different activity with different proportions in each car-ownership level.

7.11.5 The mathematics of the model were developed for GMSPM from the "national" level of the Improved Car Ownership Models (ICOM) developed by MVA consultancy for the Department of Transport in 1996[2]. The only changes made to the model were

- to convert the model to an incremental form, so that it predicts changes from previous car-ownership levels instead of predicting absolute levels;
- to apply it to DELTA household types, which represent a further disaggregation of the types used in ICOM, and to zonal rather than national data.

7.11.6 The resulting incremental model form is

$$p^{h}_{(t+1)i(1+)} = \frac{s^{h}_{(1+)}}{1+\left[\frac{s^{h}_{(1+)} - p^{h}_{ti(1+)}}{p^{h}_{ti(1+)}}\right]\exp\left(-\Delta X^{\ h}_{pi(1+)}\right)} \qquad \textbf{(8)}$$

where

$p^{h}_{ti(1+)}$ is the proportion of households *h* located in *i* at time *t* (the beginning of the year being modelled) who have 1+ households

$p^{h}_{(t+1)i(1+)}$ is the equivalent proportion at the end of this period (to be calculated)

s^{h} is the saturation level of car ownership for household type *h*, and

$\Delta X^{\ h}_{pi(1+)}$ is a linear predictor of change in this period:

$$\Delta X^{\ h}_{pi(1+)} = b^{\ h}_{p(1+)}\left(l^{h}_{(t+1)} - l^{h}_{t}\right) + g^{\ h}_{p(1+)}.\ln\left[\frac{I^{\ h}_{(t+1)}}{I^{\ h}_{t}}\right] \qquad \textbf{(9)}$$

in which

$l^{h}_{ti(1+)}$ is the level of licence holding;

---

[2] An enhanced version of the model has since been developed and is being used by DfT. An implementation of that version is available in DELTA but has not yet been implemented for TELMoS.

I^h_t is income,

$b^h_{p(1+)}$ and $g^h_{p(1+)}$ are coefficients.

7.11.7 The car-ownership model coefficients are input in two blocks. The first set of coefficients relates to the probability of a household owning one or more cars. The second set relates to the conditional probability of a household owning two or more cars given that it is in the one-or-more cars category.

7.11.8 The coefficients for the two stages of the model are shown in the Tables below. Note that the model database and the coefficients allow for the possibility of single-person households owning more than one car. However, the coefficients are such that the proportion of single-person car-owning households owning more than one car will not change over time. This is felt to be a more reasonable assumption than that the proportion of single-person households owning two or more cars should increase steadily with increasing incomes.

7.11.9 These coefficients are assumed constant for all forecast years.

Activity	Household type	Coefficients for 0/1+ car choice			
		Saturation level	Income coefficient	Licence coefficient	(Accessibility coefficient not used in TELMoS)
1	One younger (16-44) person, non manual	1	1.917	3.374	
2	One younger (16-44) person, manual	1	1.917	3.374	
3	One older (45-74) person, non manual	1	1.917	3.374	
4	One older (45-74) person, manual	1	1.917	3.374	
5	One adult (16-74) and child(ren), non manual	0.7	1.950	3.374	
6	One adult (16-74) and child(ren), manual	0.7	1.950	3.374	
7	One person retired, non manual	0.7	1.905	3.374	
8	One person retired, manual	0.7	1.905	3.374	
9	Two adults, no children, non manual	1	1.974	3.374	
10	Two adults, no children, manual	1	1.974	3.374	

Activity	Household type	Coefficients for 0/1+ car choice			
		Saturation level	**Income coefficient**	**Licence coefficient**	**(Accessibility coefficient not used in TELMoS)**
11	Two adults, with child(ren), non manual	1	1.995	3.374	
12	Two adults, with child(ren), manual	1	1.995	3.374	
13	Two adults, both retired, non manual	1	1.970	3.374	
14	Two adults, both retired, manual	1	1.970	3.374	
15	Three + adults, no children, non manual	1	1.935	3.374	
16	Three + adults, no children, manual	1	1.935	3.374	
17	Three + adults, with child(ren), non manual	1	1.912	3.374	
18	Three + adults, with child(ren), manual	1	1.912	3.374	

Table 7.3 Car-ownership coefficients, 0/1+ choice

Activity	Household type	Coefficients for 0/1+ car choice			
		Saturation level	**Income coefficient**	**Licence coefficient**	**(Accessibility coefficient not used in TELMoS)**
1	One younger (16-44) person, non manual	1	0	0	
2	One younger (16-44) person, manual	1	0	0	
3	One older (45-74) person, non manual	1	0	0	
4	One older (45-74) person, manual	1	0	0	
5	One adult (16-74) and child(ren), non manual	1	0	0	
6	One adult (16-74) and child(ren), manual	1	0	0	

Activity	Household type	Coefficients for 0/1+ car choice			
		Saturation level	Income coefficient	Licence coefficient	(Accessibility coefficient not used in TELMoS)
7	One person retired, non manual	1	0	0	
8	One person retired, manual	1	0	0	
9	Two adults, no children, non manual	0.9	1.778	2.749	
10	Two adults, no children, manual	0.9	1.778	2.749	
11	Two adults, with child(ren), non manual	1	1.792	2.749	
12	Two adults, with child(ren), manual	1	1.792	2.749	
13	Two adults, both retired, non manual	0.7	1.706	2.749	
14	Two adults, both retired, manual	0.7	1.706	2.749	
15	Three + adults, no children, non manual	1	1.860	2.749	
16	Three + adults, no children, manual	1	1.860	2.749	
17	Three + adults, with child(ren), non manual	1	1.833	2.749	
18	Three + adults, with child(ren), manual	1	1.833	2.749	

Table 7.4 Car-ownership coefficients, 1/2+ choice

7.11.10 The coefficients were extracted from the nationally-calibrated model (MVA, 1996) as follows.

7.11.11 The saturation level of car ownership was given for 8 household types in the ICOM report, which cover all the DELTA household types.

7.11.12 The parameter on income comprised a basic coefficient, adjusted by two household group modifiers; one for household type and one for socio-economic group.

7.11.13 The parameter on licence holding is a fixed parameter for each choice level (ICOM report page 24).

7.11.14 The parameter on accessibility has been set to zero meaning that this effect (which is allowed for in the DELTA code but was not part of the standard ICOM model) has been disabled in the TELMoS model.

7.11.15 The income values to which the income coefficients apply are taken from the inputs to the location sub-model (see 8.13). Note that since the incremental form of the car-ownership model always works with ratios of past to present income (sometimes in logarithmic forms) the parameter on income is independent of the units of income.

7.11.16 The increase in driving-licence holding is set at a constant rate of +0.65% per year. This applies to all household types throughout the forecast period.

7.11.17 The costs of car-owning are differentiated by household activity. The values used are shown in Table 7.5.

Household activity	Cost per week for 1 car (£)	Cost per week for two or more cars (£)
1	34.36	68.71
2	29.51	59.02
3	35.23	70.45
4	30.09	60.17
5	30.59	61.18
6	27.02	54.05
7	29.22	58.44
8	26.12	52.24
9	32.49	64.99
10	28.63	57.26
11	35.23	70.46
12	30.44	60.88
13	28.69	57.38
14	26.12	52.24
15	32.17	64.34
16	26.12	52.24
17	34.87	69.75
18	27.91	55.81

Table 7.5 Cost of car ownership

7.11.18 These values are assumed constant for all forecast years. The values aim to reflect the expectation that households with a higher disposable income are likely to spend more on their car(s). The cost of owning two or more cars is assumed to be exactly double that of owning one car.

7.12 Location model (i) household location

7.12.1 The inputs to the household location model consist of

- household incomes, which are part of the economic/demographic scenario (and are also used in the car-ownership model);
- coefficients of the expenditure function;
- coefficients of the location model itself.

7.12.2 These are dealt with in turn in the following paragraphs.

7.12.3 The timelags of the location model are also an important aspect of modelled behaviour.

7.12.4 Another set of coefficients specifies the scaling to be applied to

- car ownership costs;
- other transport costs.

before subtracting them from household budgets. However, "other transport costs" are not yet implemented, and the second term therefore has no effect.

Household location model and coefficients.

7.12.5 The main equation for household location is

$$H(L)^h_{pi} = \left[H(P)^h_{pa} + \sum_i H(M)^h_{pi} \right] \left\{ \frac{H(XA)^h_{pi} \cdot \exp(\Delta V^h_{pi})}{\sum_i H(XA)^h_{pi} . \exp(\Delta V^h_{pi})} \right\}, i \in a \qquad \textbf{(10)}$$

where

$H(L)^h_{pi}$ is the number of households type *h* located at *i* during period *p*

$H(P)^h_{pa}$ is the number of such households in the "pool" to be located within area *a*

$H(M)^h_{pi}$ is the number of mobile households which may relocate from zone *i*

$H(XA)^h_{pi}$ is the number of expected occupiers at *i*, reflecting the stock of vacant floorspace, the characteristics of newly-completed floorspace and the number of mobile households

ΔV^h_{pi} is the change in the utility of location of zone *i* for households *h* moving in period *p*.

7.12.6 The change in utility of location is calculated as:

$$\Delta V^h_{pi} = q^{hU}_p (U^h_{pi} - U^h_{(tB(U))i}) + q^{hA}_p (A^h_{(tA(A))i} - A^h_{(tB(A))i}) + q^{hQ}_p (Q^h_{(tA(Q))i} - Q^H_{(tB(Q))i}) + q^{hR}_p (R^h_{(tA(R))i} - R^h_{(tB(R))i}) \quad \textbf{(11)}$$

where:

ΔV^h_{pi} change in utility of locating at *i* affecting location of households *h* during period *p*

q^U_{ph} coefficient on Utility of consumption for households type *h* in period *p*

q^A_{ph} coefficient on Accessibility for households type *h* in period *p*

q^Q_{ph} coefficient on Quality for households type *h* in period *p*

q^R_{ph} coefficient on environment for households type *h* in period *p*

U^h_{pi} utility of consumption for households type *h* locating in zone *i* in period *p* (calculated from rent in current period, and revised as rent is adjusted in iterating the model)

$U^h_{(tB(U))i}$ utility of consumption for households type *h* locating in zone *i* in period ($tB(U)$) (calculated from rent in that period)

$A^h_{(tA(A))i}$ accessibility of zone *i* for households type *h* at time ($tA(A)$) (from accessibility calculations as described above)

$A^h_{(tB(A))i}$ accessibility of zone *i* for households type *h* at time ($tB(A)$) (from accessibility calculations as described above)

$Q^H_{(tA(Q))i}$ quality of housing areas in zone *i* at time ($tA(Q)$) (from quality model)

$Q^H_{(tB(Q))i}$ quality of housing areas in zone *i* at time ($tB(Q)$) (from quality model).

7.12.7 The timelags, *(tB( ))*and *(tA( ))* are discussed below. Another variable that can be included, the change in environmental quality, is not used in TELMoS.

7.12.8 (Note that the most recent version of DELTA involves an explicit model of relocation (identifying where from and where to) for appropriate households. This includes distance as a deterrent factor, and works across area boundaries as well as within areas. This is currently proposed as an enhancement to TELMoS.)

7.12.9 The estimation of the utility of location coefficients can be split into two stages.

7.12.10 The first is to estimate the relative values of the coefficients in the function for each household type. A number of methods can be used for this, and variety of

previous evidence is available, mainly in the form of "willingness-to-pay" estimates.

7.12.11 The second stage is to scale the coefficients to the appropriate absolute values. There is less existing evidence for this, and the process has to reflect the zoning system applied in the model.

7.12.12 The resulting values for the coefficients in the utility of location functions are shown in Table 7.6. Note that the coefficient on accessibility is negative, because accessibility is measured in generalised costs terms – more positive values are worse.

Household activity	Coefficient on Utility of consumption	Coefficient on Accessibility	Coefficient on Housing Quality
1	0.41481	-0.00691	6.74027
2	0.42188	-0.00631	4.45178
3	0.40629	-0.00691	7.17369
4	0.41815	-0.00633	4.73839
5	0.20642	-0.00322	5.03296
6	0.20904	-0.00302	3.32408
7	0.00000	0.00000	0.00000
8	0.00000	0.00000	0.00000
9	0.29580	-0.00631	11.08895
10	0.329830	-0.00585	7.32409
11	0.20304	-0.00498	10.93307
12	0.24308	-0.00481	7.22136
13	0.00000	0.00000	0.00000
14	0.00000	0.00000	0.00000
15	0.22612	-0.00497	17.82658
16	0.23555	-0.00496	11.77435
17	0.23872	-0.00494	17.48191
18	0.23872	-0.00494	11.54698

Table 7.6 Utility of Location parameters, households

Time-lags in the household utility of location function

7.12.13 The coefficients in the household utility of location function are used to scale changes in the modelled variables. These changes are measured over a number of

years related to the typical movement frequencies of different kinds of households. These timelags were revised on the basis of information from the Edinburgh Housing Needs Survey . The timelags are as shown in Table 7.7. Note that

- for the utility of consumption variable, the change to which households respond is from *N* years ago to the present (so that the change is affected by the current rent values, which are found within the location model);
- for all other variables, the change is from *N+1* years ago to the previous year (ie the database at the beginning of the present period).

Household activity	Timelag on utility of consumption	Timelag on other variables	
-4	-1	-2	-1
-5	-3	-4	-1
-6	-5	-6	-1
-7	-5	-6	-1
-8	-7	-8	-1
-9	-4	-5	-1
-10	-10	-11	-1
-11	-10	-11	-1
-12	-10	-11	-1

Table 7.7 Timelags in household location model

7.13 Location model (ii) employment location

7.13.1 This section deals with

- elasticities of floorspace per worker;
- employment location model in general

Floorspace per worker

7.13.2 An rent elasticity of -0.5 is specified for adjustment of floorspace per worker for all the employment activities which use modelled floorspace.

Employment location: general

7.13.3 The employment location model is similar to but simpler than the residential location model. Pool employment of sector *s* is located by:

$$E(LP)^s_{p(i\in a)} = E(P)^s_{pa} \cdot \frac{E^s_{ti} \cdot \left(\frac{F(A)^u_{pi}}{F(O)^u_{ti}} \right) \cdot \exp(\Delta V^s_{pi})}{\sum_{i\in a} E^s_{ti} \cdot \left(\frac{F(A)^u_{pi}}{F(O)^u_{ti}} \right) \cdot \exp(\Delta V^s_{pi})} \qquad \textbf{(12)}$$

and "mobile" activities are located by:

$$E(LM)^s_{p(i\in a)} = \left[\sum_{i\in a} E(M)^s_{pi} \right] \cdot \left\{ \frac{E(M)^s_{pi} \cdot \left(\frac{F(A)^u_{pi}}{F(M)^u_{pi}} \right) \cdot \exp(\Delta V^s_{pi})}{\sum_{i\in a} E(M)^s_{pi} \cdot \left(\frac{F(A)^u_{pi}}{F(M)^u_{pi}} \right) \cdot \exp(\Delta V^s_{pi})} \right\} \qquad \textbf{(13)}$$

where:

$E(LP)^s_{pi}$ is the employment sector s located from the pool to zone i;

$E(P)^s_{p*}$ is the total "pool" of employment in sector s to be located ;

$E(LM)^s_{pi}$ is mobile employment in sector s located to zone i;

$E(M)^s_{pi}$ is mobile employment in sector s initially located in zone i;

$F(A)^u_{pi}$ is available floorspace type u within which s can locate;

$F(O)^u_{ti}$ is previous occupied floorspace of type u; and

$F(M)^u_{pi}$ is space of type u previously occupied by employment (of any sector) now classified as "mobile".

7.13.4 and the change in utility of location is defined as

$$\Delta V^s_{pi} = q^{sU}_p \left(c^s_{pi} - c^s_{(tB(U))i} \right) \quad + q^{sA}_p \left(A^s_{(tA(A))i} - A^s_{(tB(A))i} \right) \qquad \textbf{(14)}$$

7.13.5 This is similar to the equivalent term for household location except that

- the cost of location per worker is used instead of a utility of consumption term;
- the accessibility variable is a destination (passive) value per sector.

7.13.6 Table 7.8 shows the coefficients used to weight changes in accessibility and changes in cost of location in the employment location sub-model.

Employment activity	Coefficient on Cost of Location	Coefficient on Accessibility
31	-0.05000	-0.05000
32	0.00000	0.00000
33	-0.05000	-0.05000
34	0.00000	0.00000
35	-0.05000	-0.05000
36	0.00000	0.00000
37	-0.05000	-0.05000
38	-0.05000	-0.05000
39	-0.05000	-0.05000
40	-0.05000	-0.05000
41	-0.05000	-0.05000
42	-0.05000	-0.05000
43	-0.05000	-0.05000
45	-0.05000	-0.05000
46	-0.05000	-0.05000
47	-0.05000	-0.05000
48	-0.05000	-0.05000
49	-0.05000	-0.05000
50	-0.05000	-0.05000
51	-0.05000	-0.05000
52	-0.05000	-0.05000
53	-0.05000	-0.05000
54	-0.05000	-0.05000
55	-0.05000	-0.05000
56	-0.05000	-0.05000
57	-0.05000	-0.05000
58	-0.05000	-0.05000

Table 7.8 Coefficients of employment location model

7.14 Location model (iii) floorspace vacancy changes

7.14.1 The proportion of floorspace remaining vacant changes in response to changes in rent - at high rents, floorspace is less likely to remain vacant. Note that the elasticity is actually that of occupied floorspace with respect to rent, so it is a

positive value (higher rent will lead to more floorspace being let). Table 7.9 shows the values of elasticity. The other floorspace types are assumed to be always fully occupied.

Space Category	Elasticity
1	0.5
2	0.9
3	0.9
4	0.9

Table 7.9 Elasticity of available floorspace supply

7.15 Employment status model

Introduction

7.15.1 The employment status sub-model has four main functions:

- to convert employment by zone and sector into employment by zone and socio-economic group, ie to calculate the demand for labour in terms which can be related to the supply of labour (ie households);
- to adjust the numbers of persons in work to match the current demand for labour;
- to update the travel-to-work matrices used within the land-use model in line with the changes in labour demand and supply;
- to update the database for all categories of non-working persons.

7.15.2 The last of these steps deals with

- non-working, non-retired adults
- children
- retired persons.

7.15.3 The changes in numbers of non-working, non-retired adults within ME12 (ie after the demographic, migration and location processes) result from adults gaining or losing jobs - if the number of residents in work increases, the number of non-working, non-retired adults must reduce to maintain the correct total population of that household type in the zone. The numbers of children and retired persons, in contract, have nothing to do with employment status, but are calculated within the ME12 program simply because this is the one program in the DELTA model sequence which deals with persons rather than with households.

7.15.4 The changes in total employment by zone and area are calculated using growth factors (by area, activity and socio-economic group) determined by the regional

economic model. The allocation of jobs to zones is proportional to the distribution of "nominal" or "expected" jobs resulting from the location model. The conversion of workers by zone and activity into workers by zone and socio-economic group is, by default, extracted from the database for the beginning of the modelled period. A "no change" scenario has been assumed in this respect. There are therefore no parameters to report in relation to this component.

7.15.5 The application of the changes in jobs by zone and socio-economic group to residents and commuting is essentially a scaling process: in brief

- the commuting matrices for each socio-economic group are adjusted in proportion to the changes in residents and car-ownership;
- they are then rescaled to match the current numbers of jobs;
- the numbers of residents in work are adjusted to match the numbers of workers being taken up by the commuting matrices;
- if the supply of workers hits a constraint (eg the maximum number of non-working adults in work), the matrices are adjusted so as to draw the required workers from other zones.

7.15.6 (The most recent version of DELTA replaces this process (and the adjustments in response to changes in the generalised cost of commuting) with explicit choice models for whether-to-work and where-to-work. These are currently proposed as an enhancement to TELMoS.)

7.15.7 In contrast with most other DELTA applications, households do not change activity classification when the number of workers in the household changes. Instead of the latter process, the number of workers per household of each type in each zone is variable between zero and an input maximum value. These maxima are shown in Table 7.10.

Activity Group	Max Workers
-4	1
-5	1.826
-6	1.994
-7	3.16
-8	3.18
-9	1
-10	1

Table 7.10 ME12 coefficients: Maximum and minimum number of non-workers by household type

Children and retired persons

7.15.8 The definitions of the household activities are such that children and retired persons are found only in certain activities. The numbers of such persons by household composition are shown in Table 7.11.

7.15.9

Activity Group	Children	Retired
5	1.6091	0
6	1.6072	0
7	0	1
8	0	1
9	0	0.1741
10	1.8132	0.1786
11	1.8084	0.0070
12	0	0.0071
13	0	2
14	0	2
15	0	0.2734
16	0	0.2782
17	1.3907	0.0794
18	1.3859	0.0797

Table 7.11 Children and retired persons per household

7.15.10 All of the inputs to ME12 are assumed constant over time, though they could be varied as part of the demographic scenario.

7.15.11 An approximate commuting pattern is held in DELTA and is adjusted

- by ME12 in line with the forecast changes in residential and job location forecast by DELTA
- by additional programs WAGES and TTWORK as mentioned in section 7.5 above, to take account of the generalised cost changes output by TMfS.

7.16 Floorspace quality model

Housing quality model

7.16.1 The sub-model is intended to represent the impact which residents have on the area in which they live, and hence the externality effects which residents have on each

other. The specific hypothesis implemented is that quality is positively influenced by:

- residents with higher incomes (because they are more likely and better able to spend money on maintenance and improvement);
- low levels of vacancy (because vacancy is associated with rapid decay and with vandalism).

7.16.2 The quality effect is important for representing the way in which virtuous or vicious circles of change – in general, positive feedback mechanisms - can operate in urban areas. The effect is assumed to be strong but gradual. The sub-model therefore works by:

- calculating the "eventual quality" towards which the area will tend, given the present average income and occupancy level;
- adjusting the current quality part of the way towards that eventual quality.

7.16.3 If average income and vacancy rate remain constant in a zone, its actual quality will therefore be asymptotic to its eventual quality. The equations are that the eventual quality of a zone is calculated by

$$Q(E)^{s}_{pi} = a^{s}_{p} . (\overline{y_{pi}})^{b^{s}_{p}} . (O^{s}_{(t+1)i})^{g^{s}_{p}} \qquad \textbf{(15)}$$

where

$Q(E)^{s}_{pi}$ is the eventual quality of space category *s* in zone *i* given the influences at the end of period *p*

y_{pi} is the average income of households in zone *i* in period *p*

$O^{s}_{(t+1)i}$ is the occupany of housing at the end of period *p*.

7.16.4 The adjustment of quality in one year is calculated by

$$Q^{s}_{(t+1)i} = Q(D)^{s}_{pi} . (1 - f^{s}_{p}) + Q(E)^{s}_{pi} . f^{s}_{p} \qquad \textbf{(16)}$$

where

$Q^{s}_{(t+1)i}$ is the new quality of space category s in zone i

$Q(D)^{s}_{pi}$ is the existing quality (after changes due to new development, etc)

f^{s}_{p} is the proportion of change taking effect in one time period.

7.16.5 Note that the **impact** of changing quality (the completion of the positive feedback loop) is dependent upon the coefficients in the utility of location function for households.

7.16.6 The quality variable itself is defined such that in the base year, a value of one represents "average quality", a value of 1.1 represents quality which attracts a 10% premium on rents or prices, etc.

7.16.7 The calculation assumes that eventual quality is a function of income and the occupancy rate, each raised to a power. The average income and occupancy for the study area were used, and it was assumed that quality rose proportionally with the occupancy rate, but was less sensitive to income. These assumptions were used to calculate the remaining coefficient, alpha. The resulting coefficients are shown in Table 7.12.

Variable	Value
Alpha (constant)	0.061835
Beta (coefficient on income)	0.5
Gamma (coefficient on occupancy)	1.0

Table 7.12 Housing quality model: coefficients for eventual quality

7.16.8 It is assumed that the change in quality in one year is one tenth of the difference between current quality and eventual quality.

7.16.9 Both the eventual quality coefficients and the rates of changes are assumed the same for all forecast years.

Retail floorspace quality

7.16.10 Retail floorspace quality is treated as a variable which can only be changed by exogenous policy inputs. To achieve this, a quality model for floorspace type 2 is defined in the model definition file, but with no variables to modify quality. Exogenous quality changes can be introduced via the planning policy file.

8 REGIONAL MODEL INPUT FILES

8.1 Introduction

8.1.1 Like the inputs to the urban level of DELTA (see chapter 7), the inputs to the regional model are a mixture of scenario and behavioural coefficients. They are discussed here first in relation to the regional economic model, including its accessibility calculations, and then for the migration model.

8.2 Transport costs per unit of trade

8.2.1 The transport model measures the generalised costs of transport per unit of transport demand – for passenger travel, per trip or tour, and for goods movement, per vehicle. Program AC12 converts these costs into money costs for use in the REM. Program IT12 converts these costs per unit of transport demand into costs per unit of trade, ie into transport costs (in £M) per £M of trade.

8.2.2 To do this, inputs specify the number of goods vehicle and person movements needed to deliver each unit of trade from producer to consumer. These figures include business travel as well as goods movement.

8.3 Relationship of travel model purposes to freight model categories

8.3.1 There is one other input to IT12 which defines the relationship between the transport model freight purposes and the freight demand categories output by MF12. This information is used when MF12 uses the IT12 input ratios in the opposite direction, to convert trade flows into transport demands. Since the freight outputs from MF12 are not currently being used, this block is currently irrelevant.

8.4 Area accessibilities

8.4.1 Program AA12 calculates accessibility measures by area and sector, as input to the investment model. This program does not require any inputs of its own: the coefficients it uses in calculating accessibilities are the distribution coefficients of the trade model.

8.4.2 The area accessibilities output by AA12 are "size" measures rather than "cost" measures. Hence, in contrast with the majority of the urban model accessibilities,

- the values should always be positive values;
- larger (more positive) values indicate better accessibilities.

8.4.3 The equations are of the form

$$A_{ta}^{s} = \sum_{z} W_{tz}^{s} \exp\left(l_{t}^{s} c_{taz}^{s}\right) \qquad \textbf{(17)}$$

where

A_{ta}^{s} is the accessibility of area *a* for sector *s* (ie accessibility to the demand for sector *s* at time *t*;

W_{tz}^{s} is the demand for the outputs of sector *s* in area *z* at time *t*

c_{taz}^{s} is the cost of delivering one unit of *s* from *a* to *z* at time *t*

l_{t}^{s} is the distribution coefficient of the trade model for *s* at time *t*.

8.5 Investment model inputs

8.5.1 The inputs to the investment model are as follows:

- the depreciation rate, ie the proportion of capacity in each sector which expires in each year (see 8.5.3 below);
- the reference rate of total regional investment (see 8.5.4);
- the sensitivities to accessibility and cost change in allocating total investment to areas (see 8.5.5);
- the expected level of employment per unit of capacity (see 8.5.6).

8.5.2 All of these inputs are constant for all years.

Depreciation rate

8.5.3 The depreciation rate are input in block MKIN01, Manual Section: 17.3, and are fixed at 10% per year for sectors 201 to 210.

Rate of total investment

8.5.4 The rates of total investment are set to the same values as the depreciation rates.

Investment location coefficients

8.5.5 The investment location coefficients are set to values of +0.5 on accessibility and –0.6 on cost of production for all sectors. The investment distribution models are of the form

$$K(N)_{pa}^{s} = K(N)_{p*}^{s} \frac{K_{ta}^{s} \cdot \left(\frac{A_{ta}^{s}}{A_{(tB)a}^{s}}\right)^{l(A)_{p}^{s}} \left(\frac{c_{ta}^{s}}{c_{(tB)a}^{s}}\right)^{l(c)_{p}^{s}}}{\sum_{a}\left[K_{ta}^{s} \cdot \left(\frac{A_{ta}^{s}}{A_{(tB)a}^{s}}\right)^{l(A)_{p}^{s}} \left(\frac{c_{ta}^{s}}{c_{(tB)a}^{s}}\right)^{l(c)_{p}^{s}}\right]} \qquad \textbf{(18)}$$

where

$K(N)^s_{pa}$ is the additional capacity of sector *s* in area *a* resulting from investment during period *p*

$K(N)^s_{p*}$ is the total additional capacity of sector *s* resulting from investment in the modelled economy during period *p* (ie the product of the rate of total investment and the previous capacity)

K^s_{ta} is the existing capacity of sector *s* in area *a* at time *t*

A^s_{ta} is the accessibility of area *a* for sector *s* at time *t* (see above)

$A^s_{(tB)a}$ is the accessibility of area *a* for sector *s* at time *(tB)* (ten years before *t*)

c^s_{ta} is the cost of producing outputs of sector *s* in area *a* at time *t*

$c^s_{(tB)a}$ is the cost of producing outputs of sector *s* in area *a* at time *(tB)* (ten years before *t*)

$l(A)^s_p$, $l(c)^s_p$ are the coefficients for the distribution of investment.

Expected employment per unit of capacity

8.5.6 The expected numbers of jobs per unit of capacity are input. Given the assumption that capacity-related employment is white-collar employment, there are positive values for socio-economic group 1 and zero values for group 2.

8.6 Trade and production model inputs

8.6.1 The trade and production model is a conventional spatial input model in which the key equations are of the form

$$T^s_{(t+1)ij} = Y^s_{(t+1)j}\left[1 - m^s_p\right]\frac{K^s_{(t+1)i}.\exp\left[-\,l^s_t(p^s_{(t)i} + c^s_{Tij} + b^s_{(t+1)ij} + r^s_{ij})\right]}{\sum_i K^s_{(t+1)i}.\exp\left[-\,l^s_t(p^s_{(t)i} + c^s_{Tij} + b^s_{(t+1)ij} + r^s_{ij})\right]} \qquad (19)$$

where

$T^s_{(t+1)ij}$ is the trade in *s* from *i* to j at time *t+1*

$Y^s_{(t+1)j}$ is the total demand for *s* at *j*

m^s_p is the proportion of demand for *s* which is met by implicitly modelled imports in period *p*

$K^s_{(t+1)i}$ is the capacity of zone *i* to produce *s* at time *t+1*

– l_t^s is the distribution coefficient for *s* in period *p*

$p_{(t)i}^s$ is the production price of *s* at area i and time *t* – in TELMoS, set to 1

c_{Tij}^s is the cost of transporting one unit of *s* from *i* to *j* in the previous transport model year *T*

$b_{(t+1)ij}^s$ and r_{ij}^s are not used in TELMoS.

8.6.2 The total demand is the sum of

- consumer final demand (calculated from household numbers and expenditure)
- government final demand (user-defined)
- intermediate demand calculated by applying technical coefficients to the total production.

8.6.3 Hence

$$Y_{(t+1)j}^s = Y(F)_{(t+1)j}^s + \sum_r a_p^{sr}.P_{(t+1)j}^r \qquad \textbf{(20)}$$

where

$$P_{(t+1)i}^r = \sum_j T_{(t+1)ij}^r \qquad \textbf{(21)}$$

8.6.4 The coefficients listed below are used not only in the trade and production model itself (program MP12), but also in:

- calculating consumer final demand from urban model outputs (program PX12);
- calculating the costs of occupied floorspace from urban model outputs (program PC12);
- converting area-level trade to zone-level transport demand;
- calculating area-level accessibilities for use in the investment location model (program AA12).

8.6.5 The last two of these are at least partly a reuse of coefficients which are used within MP12 itself. The other cases simply reflect a reluctance to create additional, separate input files for each of the "data-processing" programs.

8.6.6 The following trade and production model inputs are used in TELMoS:

- scaling factors to convert consumer expenditure to final demand by sector;
- value-added per unit of production by sector;
- sensitivities of trade to cost;

- input-output coefficients (including demand for imports);
- expected employment per unit production;
- scaling factor to convert rents paid into space costs per unit production.

8.6.7 The expected employment per unit production changes from year to year, as explained below. All other inputs are assumed constant over time.

Convert consumer expenditure to final demand

8.6.8 These conversion convert total household expenditure (all households, Scotland total) to the consumer final demand by sector reported in Scottish Economic Statistics 2003.

Value-added per unit of production

8.6.9 These values were derived from Scottish Economic Statistics 2003.

Sensitivities of trade to cost, and accessibility constants

8.6.10 These coefficients are the result of direct calibration of the DELTA model itself, by adjusting the values to reproduce average trade distances for each sector.

8.6.11 For services, where distances are shorter, we have assumed that UK values are valid in all areas.

Input-output coefficients

8.6.12 These values, the technical coefficients of the conventional input-output model, were derived from the inter-sector trade statistics in Scottish Economic Statistics 2003.

8.6.13 Imports are treated as special sectors within the definition of the REM.

Expected employment per unit production

8.6.14 The ratios of expected employment per unit production are input. These were estimated so as to reconcile the economic scenario in monetary terms with the employment scenario in terms of numbers of jobs.

Convert rents into space costs per unit production

8.6.15 This conversion factor is input to convert £/week into £M/year.

8.7 Migration model inputs

8.7.1 The migration model is programmed to handle two distinct streams of migration (following the model developed by Gordon and Molho, 1998). Only stream 2 has been used in the TELMoS application. The migration model is influenced by

- the total number of households in the origin area
- the "push" factor for the origin area
- the deterrence factor of the origin-to-destination distance

- the total number of households in the destination area
- the "pull" factor for the destination area
- an overall scaling factor.

8.7.2 It is of the form

$$M(U)^{hs}_{paz} = H^{h}_{ta}.v(O)^{hs}_{pa}.d^{hs}_{paz}.H^{h}_{tz}.v(D)^{hs}_{pz}.s^{hs}_{p} \qquad (\mathbf{22})$$

where

$M(U)^{hs}_{paz}$	is the migration of households type *h* in stream *s* from area *a* to area *z* during period *p* (before considering constraints)
H^{h}_{ta}	is the total number of households of type *h* in area *a* at time *t*
$v(O)^{hs}_{pa}$	is the origin area *a* push factor for stream *s* migration of households *h* in period *p* (defined in Table 8.1)
d^{hs}_{paz}	is the deterrence effect of distance from *a* to *z* for stream *s* migration of households *h* in period *p*
H^{h}_{tz}	total households of type *h* in area *z* at time *t*
$v(D)^{hs}_{pz}$	origin area *z* pull factor for stream *s* migration of households *h* in period *p* (also defined in Table 8.1)
s^{hs}_{p}	a scaling factor for overall level of migration of households *h* in period *p.*

8.7.3 The following inputs are defined for each year:

- distance controls on the migration stream;
- distance deterrence effect, and scaling of the migration flow;
- weights on the different variables affecting migration.

8.7.4 The input file can also be used to specify constraints by activity group and area. This feature is not normally used in forecasting.

Distance controls on the migration stream

8.7.5 This used to specify that

- the minimum distance for the modeled migration stream (Stream 2) is zero (ie migration is modeled between all area pairs, no matter how close together);
- the distance for full effect of the modeled migration flow is 40Km.

Distance deterrence and scaling of migration

8.7.6 The model takes inputs for different household categories to specify

- the deterrence effect of distance;
- the scaling of the migration flows.

8.7.7 The deterrence coefficient is set to –0.05 for all household types.

8.7.8 The scaling factor has different values by household type, which were estimated (in SWYMMS) so as to obtain a reasonable mixture of migrants by age.

Weights on variables affecting migration

8.7.9 This input takes a set of coefficients to weight the migration-influencing variables as "push" and "pull" factors. It seems reasonable to expect that the "push" and "pull" factors are the same variables with opposite signs, and this condition has been imposed in applying the model. The factors and corresponding coefficients are assumed to be the same for all household types. The values used are shown in Table 8.1:

Variable	**Variable code in MM12<><>.INP (*Var* in MM12VR)**	**Coefficient as "push" factor**	**Coefficient as "push" factor**
Environmental factor	2	-0.07	0.07
Housing rent	3	0.2	-0.2
Area ratio of residents working to adults by seg	5	-4.5	4.5

Table 8.1 Variable weights in migration model

9 DELTA/TMFS INTERFACE

9.1 Introduction

9.1.1 This Chapter documents the interface programs and files through which DELTA passes information to TMfS. The interface in the opposite direction is defined by the generalised cost files documented section 5.6 above.

9.2 Interface definition file

9.2.1 The interface definition file is used to specify a miscellany of information used in the DELTA/transport interface programs. The file retains the name it was given in the original Edinburgh prototype of DELTA, IZ1_JIF1.DEF. Its contents are defined in the following table:

Block	link to Manual	Content
IX12D1	Manual Section: 13.5	Specifies that all two DELTA socio-economic groups are aggregated to one group for TMfS
IX12D2	Manual Section: 13.5	Not used in TMfS
IZ1JF2	Manual Section: 13.5	Identifies floorspace category 2 as the attractor for shopping trips
IZ1JF3	Manual Section: 13.5	Identifies activities to be used as planning data for production/attraction of freight movement
IZ1JF4	Manual Section: 13.5	Defines prior values of workers per household by car-ownership level in variable worker households. Relevant only in connection with IX12D2, Therefore not used (empty block) in present application.
IZ1JF6	Manual Section: 13.5	Not used in TMfS
IZ1JF7	Manual Section: 13.5	Not used in TMfS

Table 9.1 Interface definition file

9.3 Additional data

9.3.1 The file IZDA<><>.DAT contains additional data, particularly about the non-household population, which is used in the interface though it does not appear anywhere else in DELTA.

9.4 Interface programs and files

9.4.1 TELMoS uses a new program, ITMFS, to tabulate DELTA outputs in the formats required by TMfS. This outputs two files:

- TMfS<><>.CSV, containing zonal information on persons by person and household type,
- TAV_<><>.CSV, containing zonal information on households and on employment in selected aggregations of sectors.

9.5 Freight model MF12

9.5.1 DELTA has a sub-model MF12 which estimates goods vehicle movements for each zone pair from the area-to-area trade patterns calculated in the regional economic model. The calculations include an allowance for delivery vehicles returning empty (not least because the cost of these movements has to be included in the transport costs of trade). The resulting matrix is passed to TMfS in each transport model year as file TRFL<><>.DAT.

10 SCENARIO INPUTS

10.1 Introduction

10.1.1 The purpose of this Chapter is to identify those elements of the inputs which are typically regarded as defining the scenario within which strategies are being tested, and to point out some of the linkages between the various scenario inputs and between these inputs and other modeled variables.

10.1.2 For convenience we classify the scenario inputs into:

- the economic scenario;
- the socio-demographic scenario;
- other elements.

10.1.3 The "other" category includes variables which bring together aspects of both the economic and socio-demographic inputs.

10.2 The economic scenario

10.2.1 The main components of the overall economic scenario are:

- the annual totals of non-consumer final demand (see 6.4);
- the technical coefficients of the input-output model (see 8.6);
- the productivity assumptions in the production and capacity models (see 8.4.3 and 8.6);
- household incomes in the urban model (see 7.12).

10.2.2 Note that the household income inputs, in combination with all the factors affecting employment status, generate the consumer component of final demand and hence play a significant part in determining the overall level of economic activity.

10.2.3 Other components of the economic scenario include:

- development costs per unit floorspace, for the Fully Modelled Area in general and (optionally) by zone (in the development model – see 7.6.5)

10.3 The demographic scenario

10.3.1 The demographic scenario is defined (for the Modelled Area, ie Scotland, in total) by:

- the household formation/transition/dissolution rates and the rates of migration to and from Scotland, as defined in 7.9;
- the numbers of persons per household, which for working-age adults are determined by definition (implemented in 7.16) and for children and the retired by inputs in Table 7.11;
- the non-household population defined in 4.5.

10.3.2 Driving-licence holding (see 7.11.16) can also be regarded as an aspect of the demographic scenario.

11 POLICY INPUTS

11.1 Planning policy inputs

11.1.1 The planning policy inputs have been the subject of substantial effort in discussion with the local authorities throughout the TMfS area. That work and the resulting information is documented in the separate report on TELMoS: Assembly of Planning Policy Information.

11.2 Policy inputs

11.2.1 The planning policy inputs enter DELTA through the PLAN<><>.POL files documented in Manual Chapter 6.

12 REFERENCES

Gordon, I R and I Molho (1998): A multi-stream analysis of the changing pattern of interregional migration in Great Britain, 1960-1991. *Regional Studies*, 32(4), pp 309-324.

MVA (1996): *Improved Car Ownership Models*. Report to Department of Transport.

Stillwell, J and A Fotheringham (1998): *The determinants of migration flows in England*. Summary of report to Department of Environment, Transport and the Regions.