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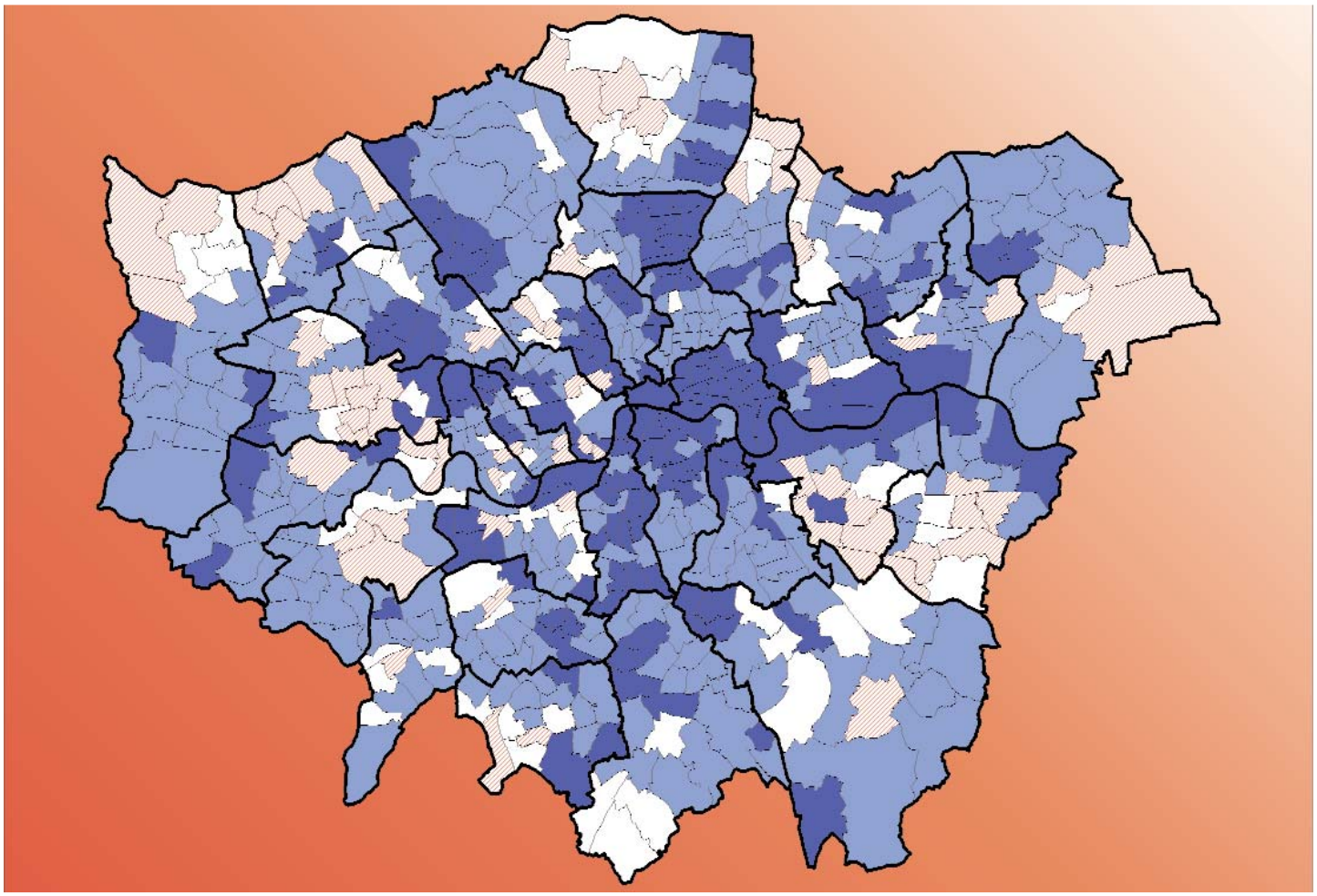
Data Management and Analysis Group

GLA Ward Population Projection Manual



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GLA Ward Population Projection Model

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Front Page
The data presented on the front cover of this Briefing are the percentage changes in the ward populations between 2001 and 2016 from the *GLA 2003 Round Demographic Projections – Scenario 8.1*.

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GLA Ward Population Projection Model

Contents

Introduction

The GLA produces population projections on an annual basis. The borough level projections are produced first, using the most recent data on fertility, mortality and migration together with the latest estimates of future housing developments. The borough projections are used to constrain the ward projections, and both are produced by gender, single years of age from 0 to 90+ and in single years of time from the current base of mid-2001. The end year of the projections moves forward through the decade. The 2003 round projections were produced to 2021.

Ward projections are produced for all boroughs, with the exception of the City of London, which only has the population of a small London ward and where the ward populations are considered to be too small to produce robust and statistically sound projections.

The projections are used for a number of purposes; primarily they feed into the Mayor's planning document, the *London Plan*, and are used by TfL in transport demand modelling. The London boroughs use the projections for planning their services, particularly school places provision. They are also used by and health services and the utilities to plan for future demands. The data are also of interest to academics, who use demographic projections in their research.

This *Briefing* outlines how the post-2001 Census version of the ward model currently operates.

Running the Model

The model is separately run for each borough, using a macro, so the process outlined in the following paragraphs takes place in 32 individual models. Figure 1 is a flow chart showing the main steps within the model. Each step is discussed in more detail. However, before the model can be run, a number of spreadsheets need to be updated with the 'base' data.

The macro is used to automate what would otherwise be an arduous task, it relies on a number of intermediate spreadsheets, which contain links and are used to convert the 'raw' data into the final output. For each projection year there is an intermediate spreadsheet; the macro picks up the 'first' year of data – for 2001-2 this is the base year, for 2002-3 onwards this is the projection – and copies it to the intermediate sheet. The links within the sheet work through the steps (shown in the diagram on page 3) producing a 'final' year, which is copied into the output file. The final year then becomes the first year in producing the next projection.

There is an intermediate spreadsheet for each projection year; the first year of data (Y) are copied into the sheet by the macro, the links follow all the steps (shown in the diagram on page 3), and then the final year (Y + 1) are copied into the output file.

Appendices A and B provide lists of the datasets used in the 'base' and subsequent years in the model, and these are also covered in the steps following.

Mid-2001 Ward Population Estimates

It is necessary to calculate ward mid-year estimates by single years of age and gender for the latest Census year. The current set of projections is based on the 2001 Census. The main reason for the ward calculation is that the Census populations for wards are based upon the Census date at the end of April, about 9 weeks before the mid-year date of 30 June. The ONS mid-year estimates are currently only available down to local authority level and while being based upon the census enumeration of usual residents also contain a number of subsequent adjustments, which must be apportioned amongst the wards. These borough level adjustments take account of any births, deaths and migration that took place in this 9-week period between Census and mid-year. There are also the post-Census borough adjustments that ONS have made to the original mid-year estimates. The following is the general method for moving from the ward Census populations to ward mid-year estimates, but the recent adjustments made by ONS to the Southwark and Westminster populations were concentrated in a number of wards. In these two boroughs the ward adjustments followed the advice given in the ONS 2004 Local Authority Studies reports.

To adjust the Census data to mid-year, the borough mid-year estimates are used as a constraint. The following formulae are applied:

$$WardPHH_{(Census,x)} = WardTotal_{(Census,x)} - WardCE_{(Census,x)}$$

$$BoroughPHH_{(MYE,x)} = BoroughTotal_{(MYE,x)} - BoroughCE_{(Census,x)}$$

$$WardPHH_{(MYE,x)} = \frac{BoroughPHH_{(MYE,x)} * WardPHH_{(Census,x)}}{BoroughPHH_{(Census,x)}}$$

$$WardTotal_{(MYE,x)} = WardPHH_{(MYE,x)} + WardCE_{(Census,x)}$$

Where:

x = single year of age
PHH = population in private households
CE = population in communal establishments

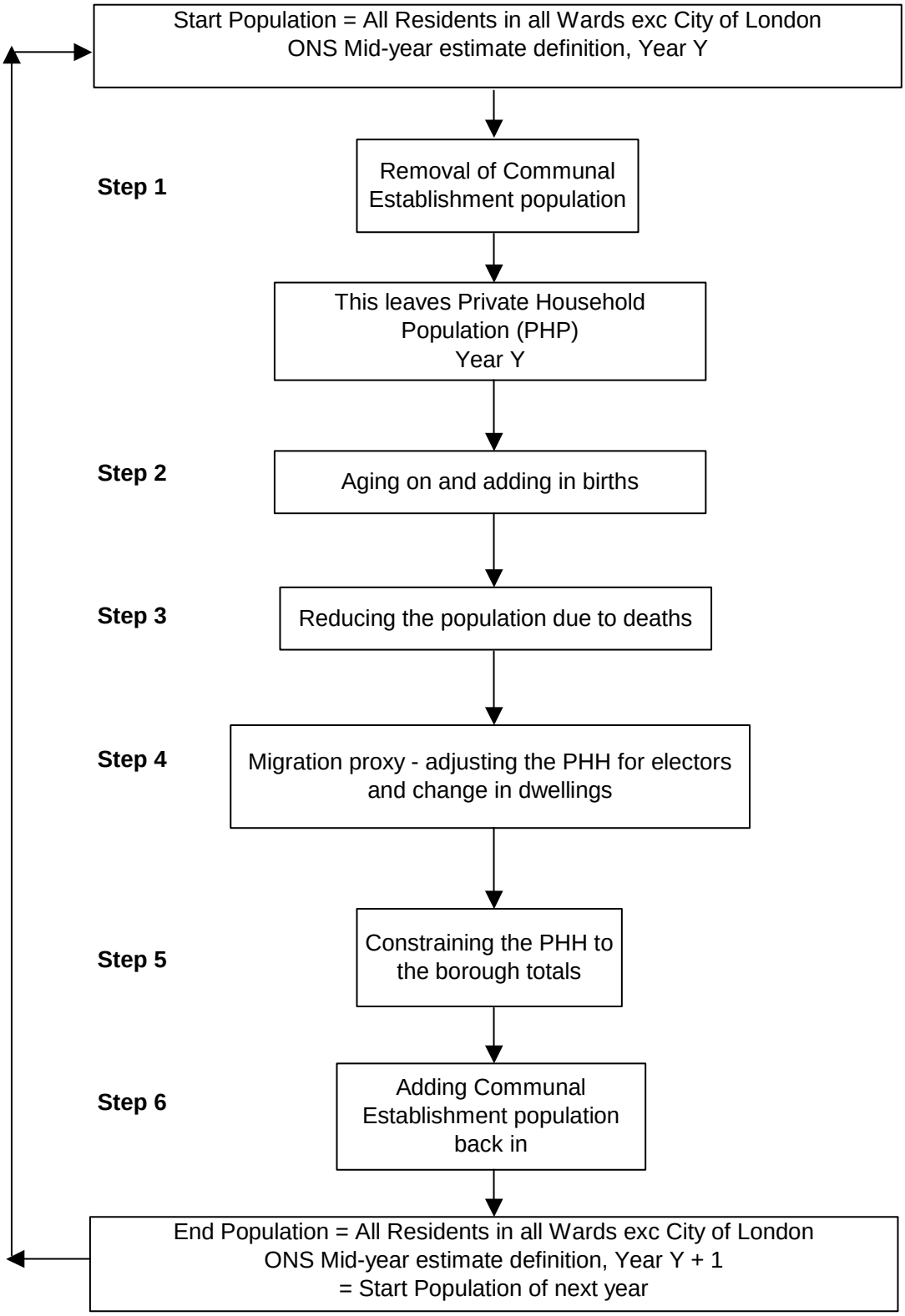
See Appendix C for an example of the calculations.

The adjustment is only made to the population in private households because the number of people resident in communal establishments is assumed to remain constant. Communal establishments include student halls of residence, armed forces barracks, nursing homes, hotels, hostels and so on. Although the individuals within these communal establishments will change, the demographics of the people are likely to remain approximately the same – eg the population in student halls of residence is likely to be males and females aged 18 to 21 years old, while army barracks are likely to mainly contain males in their twenties and thirties. Therefore, they can be fairly safely removed from the population before the adjustments and added back in afterwards.

ONS recently released mid-2001 ward population estimates as 'experimental' statistics. GLA is evaluating these and will aim to use them in future as the base for ward projections. However, they are only available by gender and five-year age groups, so

further work will need to be done to disaggregate to single years of age before they can replace the current base populations.

Figure 1: Flow Chart of the main steps in the GLA ward projection model



Once the ward mid-year estimates, by single years of age and gender, have been produced, these are inserted into a spreadsheet to be picked up by the macro.

Step 1 – 'remove' the communal establishment population

The communal establishment population must be removed from the total population to leave the private household population for the main projection functions. Consistent with the adjustment from Census day to mid-2001, the static nature of the communal establishment population means that it cannot be treated in the same way as the population in private households. For example, if the population living in student halls of residence at age 19 were not removed prior to the aging-on and other processes, within a few years of the projection base year there would be artificially high numbers of people in their early twenties.

$$WardPHH_{(n, x, y)} = WardTotal_{(n, x, y)} - WardCE_{(n, x, y)}$$

Once all the other processes of the model have taken place, the communal establishment population is added back. If it is known that the communal establishment population is likely to change in a particular ward this can be handled at Step 6.

Step 2 – aging-on and fertility

The ward private household population is 'aged-on', ie the population aged x becomes the first estimate of the private household population aged x+1 one year later.

$$WardPHH_{(n, x+1, y+1)} = WardPHH_{(n, x, y)}$$

This step also adds in the births (by gender) in the ward as the first estimate of the population aged 0. If births from mid-y to mid–(y+1) are known from ONS vital statistics this is a trivial process.

$$WardPHH_{(n, 0, y+1)} = WardBirths_{(n, y, y+1)}$$

The Office for National Statistics produces actual births by gender at ward level, covering mid-year to mid-year periods, and these are fed into the model.

If births need to be projected the calculations go through a number of stages. Firstly, births have already been projected at a borough level using age-specific birth rates based upon data on births by age of mother in the years 2000-02. These birth rates are themselves projected using the trends in the Government Actuary's latest national projection, this is currently based on mid-2003. The projected borough births are used to constrain the total ward births. In the aging-on stage of the ward model, births are calculated using a ward fertility adjustment, and then constrained to the total borough births.

The ward fertility adjustment is produced as follows:

- For the latest year for which ward birth totals are known, the total number of births is estimated by applying borough age-specific fertility rates to the ward mid-year population of females 15 to 49, by single years of age
- The ratio of estimated births to actual births is then calculated for each ward

- This ratio is the fertility adjustment factor to be used for the individual wards in all subsequent projection years

For more information on fertility rates, refer to *DMAG Briefing 2005/9: Borough Fertility Rates 2000-02*.

Step 3 - mortality

The procedure with deaths is very similar to that used for births. Actual deaths in each ward (mid-year to mid-year) are provided by the Office for National Statistics. However, the future deaths are calculated using life tables for three borough groups, rather than single boroughs.

The three borough groups – Central, Rest of Inner and Outer – were used because the relatively small numbers of annual deaths in each borough are insufficient to produce robust single-year of age death and survival rates for each gender.

The appropriate life table survival rates are applied to the ward mid-year estimates in order to produce an overall ward mortality adjustment in an equivalent way to the fertility adjustment.

Following the aging-on step, the ward population is adjusted for deaths, at single years of age and gender, by applying the life table survival rates together with the ward mortality adjustment.

More information on Life Tables can be found in the *DMAG Briefing 2005/10: Borough Life Tables 2000-02*.

This means that the model now has a second estimate of the estimated/projected private household population by age and gender, having applied aging-on, fertility and survival processes.

$$WardPHH_{(n,\ x+1,\ y+1)} = WardPHH_{(n,\ x+1,\ y+1)} * SurvivalRate_{(x+1,\ y+1)} * WardDeathAdj_{(n)}$$

Step 4 – migration proxy

Although there is a gross migration component to the borough projections, annual migration data at ward level are not available (with the exception of 2001 Census tables). In order to allocate the borough net migration change component appropriately among the wards by age and gender, ie not just splitting equally or proportionately to existing population structure, a suitable method needs to be used. The method adopted takes account of two annual measures that can give some indication of local population change.

The model uses the annual counts of electors (the number of local government electors for each ward) together with housing stock changes to estimate population changes that have actually happened since the base year. There are strengths and weaknesses to both sources, which can be dependent on the borough supplying the data, but used together the two indicators can be very useful for estimating past population changes, ie in years for which a borough mid-year estimate exists and usually one more year.

For future years there are no electorate data but there are estimates of future annual dwelling stock changes within wards. As the borough projections that constrain the ward projections also use consistent future estimates of the housing stock, using ward housing stock growth in projection years is a good way of allocating overall changes amongst the wards.

Electorate data is supplied by ONS on RPF29 forms and cover a count of electors as at the annual October canvass. The release schedule works as follows: the 2005 electoral roll statistics, with a qualifying date of 15 October 2004, were received in February 2005. A sequence of estimates of the ward electorates at mid-year starting at mid-2001 is built up by interpolation between the adjacent qualifying dates (ie for mid-2001 these would be October 2000 and October 2001).

The housing stock data primarily relate to the London Housing Capacity Study (LHCS), which is the Mayor's housing document (*London's Housing Capacity*, 2000). These data, covering net completions, non-self contained accommodation and allowable vacancies, are available at the borough level in five-year periods. Many development sites are specified and can be allocated to individual wards, but these become the minority of net additions after 2001-06. To enhance the LHCS additional data is requested from each borough on the annual net additions since mid-2001 as well as latest estimates of ward level future development. Although the borough-supplied totals from the summed ward data may be different to the totals from the LHCS, the ward data is constrained to the borough level LHCS data in order to get maximum consistency with the borough level projections.

Annual percentage changes, for both electors and dwellings, are calculated and fed into the model. For the years where only dwellings data exists, ie the 'true' projection years, the dwellings changes are taken as calculated, but where electorate data are also available, the two change rates are combined. As a general rule, the two sources are combined so that they have equal weight, however, in some cases, where one data source is considered to be poor, it is possible to weight differently, say 85% against 15%. This set of final changes is known as the combined rate and is calculated for each ward.

$$WardGrowth_{(n,\ y+1)} = (ElectGrowth_{(n,\ y+1)} + DwellGrowth_{(n,\ y+1)}) * 0.5, \text{ in estimate years}$$

or

$$WardGrowth_{(n,\ y+1)} = DwellGrowth_{(n,\ y+1)}, \text{ in projection years}$$

In Step 4 of the ward model, where the electorates and dwellings are incorporated, the combined change rate, or the dwelling growth rate, is applied to the population of the ward at single years of age and gender. This provides the third estimate/projection of the private household population:

$$WardPHH_{(n,\ x+1,\ y+1)} = WardPHH_{(n,\ x+1,\ y+1)} * WardGrowth_{(n,\ y+1)}$$

The method of calculating the combined rate is shown in Appendix D.

Step 5 - constraining the projections

Once the ward population in private households has been estimated/projected, using the adjustments calculated from the births, deaths, electors and dwellings in Steps 1 to 4, the populations need to be constrained to the totals at borough level. This is done by single years of age and gender, simply by proportions. That is, for each gender the sum of all the ward populations at a single age are compared to the appropriate borough projection total. Each ward population is then adjusted by multiplying by the same factor: the borough population divided by the sum of the ward populations. Which may be expressed as:

$$FinalWardPHH_{(n, x, y)} = \frac{BoroughPHH_{(x, y)}}{\Sigma_n (WardPHH_{(n, x, y)})} * WardPHH_{(n, x, y)}$$

Step 6 – add back the communal establishment population

Finally, the communal establishment population can be added back, producing the 'end' population. This then becomes the start population and the process repeats, until the last projection year. If it is known that the communal establishment population is likely to change in a particular ward this change can be handled here.

Changes to the Model

The GLA demographic projections are always based on the latest Census year, as this is when the most detailed small geography demographic data become available.

Until 2002, the 1991 Census, linked to the ONS mid-1991 borough population estimates was the base. In 2003, when much of the 2001 Census output became available, the projections were rebased. Aside from rebasing, there were a number of other changes necessary to the model:

- Ward boundaries changed – there were more than 700 wards after the 1991 Census, compared to less than 650 after 2001
- Single years of age was extended from 0-84 and 85+ to 0-89 and 90+
- Before the 2003 round of projections, the last projection year was 2016, in 2003, the projection period extended to 2021

Outputs and Uses

The model outputs the data in the form of single year of age and gender for the total usual residents of all the wards in each borough. As the macro needs to be run for each borough separately, the output for each borough is separate. Included as part of the output are numbers of births and deaths, and therefore migration can be calculated by residuals.

In addition to general demographic uses, both within the GLA and by organisations outside, the GLA utilises the projections in a number of ways:

- Total population projections are used in the *London Plan*

- Population by broad age groups are supplied to TfL to inform transport modelling
- Working-age population projections (ie 16-59(females)/64(males)) are used to calculate the resident economically active population (using gender and age-specific economic activity rates based on the 2001 Census) in order to produce bases for monthly unemployment claimant count rates by age and gender at ward level. More information about the claimant count model can be found in *DMAG Briefing 2005/7 – Claimant Count Model: Technical Note*.
- Population of children is used by the GLA School Roll Projections Service - to project required school places for 19 London Local Education Authorities.

Appendix A – Base Year Data

Ward

2001 Census Usual Residents by age/gender
2001 Census Usual Residents in Communal Establishments by age/gender
2001 Census Dwellings
Estimated Electorate at mid-2001, taken from RPF29 Forms

Borough

Revised ONS mid-2001 Population estimate by age/gender

Appendix B – Annual Update Data

Ward

Estimated electorate at mid-year – first few years only
Additional homes mid-year to mid-year – first few years only
Forecast additional homes mid-year to mid-year – all subsequent years
Births mid-year to mid-year by gender – first few years only
Deaths mid-year to mid-year by gender – first few years only
Changes to Communal Establishment population by age and gender - occasional

Borough

GLA population projection by age/gender

Appendix C – Adjusting Census to Mid-Year (Camden, females)

2001 Census - Total

	15	16	17	18	19	20	21
Camden	763	1,027	954	1,207	1,636	1,874	1,872
Belsize	28	44	34	36	37	68	80
Bloomsbury	18	17	30	170	358	245	251
Camden Town with Primrose Hill	45	67	74	47	47	73	89
Cantelowes	58	62	63	85	133	112	103
Fortune Green	35	62	48	45	57	54	59
Frognal and Fitzjohns	29	49	68	60	92	106	91
:							

2001 Census - Population in Communal Establishments

	15	16	17	18	19	20	21
Camden	6	15	42	313	699	518	408
Belsize	0	0	0	0	0	0	3
Bloomsbury	0	0	7	140	306	174	150
Camden Town with Primrose Hill	0	5	3	4	3	0	0
Cantelowes	0	0	4	33	59	31	20
Fortune Green	0	0	0	0	0	0	0
Frognal and Fitzjohns	0	3	16	28	64	44	37
:							

2001 Census - Population in Private Households (= Census Total - Census Communal Establishments)

	15	16	17	18	19	20	21
Camden	757	1,012	912	894	937	1,356	1,464
Belsize	28	44	34	36	37	68	77
Bloomsbury	18	17	23	30	52	71	101
Camden Town with Primrose Hill	45	62	71	43	44	73	89
Cantelowes	58	62	59	52	74	81	83
Fortune Green	35	62	48	45	57	54	59
Frognal and Fitzjohns	29	46	52	32	28	62	54
:							

2001 Mid-Year Estimate - Total

	15	16	17	18	19	20	21
Camden	784	984	972	1,183	1,678	1,835	1,869

2001 Mid-Year Estimate - Private Household - Calculated

	15	16	17	18	19	20	21
Camden	778	969	930	870	979	1,317	1,461

2001 Mid-Year Estimate - Population in Private Households - Calculated

	15	16	17	18	19	20	21
Belsize	29	42	35	35	39	66	77
Bloomsbury	18	16	23	29	54	69	101
Camden Town with Primrose Hill	46	59	72	42	46	71	89
Cantelowes	60	59	60	51	77	79	83
Fortune Green	36	59	49	44	60	52	59
Frognal and Fitzjohns	30	44	53	31	29	60	54
:							

2001 Mid-Year Estimate - Total - Calculated

	15	16	17	18	19	20	21
Belsize	29	42	35	35	39	66	80
Bloomsbury	18	16	30	169	360	243	251
Camden Town with Primrose Hill	46	64	75	46	49	71	89
Cantelowes	60	59	64	84	136	110	103
Fortune Green	36	59	49	44	60	52	59
Frognal and Fitzjohns	30	47	69	59	93	104	91
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Taking 18 year old females in Bloomsbury as an example:
2001 Census PHH = 170-140
MYE PHH = (30/894)*870 = 29
MYE Total = 29 + 140 = 169

Appendix D – Electors and Dwellings (Ealing)

Ward Dwelling Completions and Proposed Developments (London Housing Capacity Study/Borough Planners)

	2001-2	2002-3	2003-4	2004-5	2005-6	2006-7	2007-8	.....
Ealing	394	368	1,068	587	587	617	617	
Acton Central	52	107	16	16	16	18	18	
Cleveland	87	8	9	9	9	6	6	
Dormers Wells	3	3	-13	13	13	11	11	
Ealing Broadway	9	9	50	50	50	30	30	
Ealing Common	7	17	55	25	25	13	13	
East Acton	17	52	143	130	130	62	62	
:								

Ward Dwelling Totals	**Census**	**Adding in additional development data (as above)**						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	.....
Ealing	120,887	121,281	121,649	122,717	123,304	123,892	124,508	125,125	
Acton Central	5,733	5,785	5,891	5,907	5,923	5,939	5,957	5,975	
Cleveland	5,885	5,972	5,980	5,989	5,999	6,008	6,014	6,020	
Dormers Wells	4,318	4,321	4,325	4,312	4,324	4,337	4,348	4,358	
Ealing Broadway	5,879	5,888	5,898	5,948	5,998	6,048	6,077	6,107	
Ealing Common	5,801	5,808	5,826	5,880	5,905	5,929	5,942	5,955	
East Acton	5,877	5,894	5,946	6,089	6,219	6,350	6,411	6,473	
:								

Annual Ward Dwelling Change (%)

	2001-2	2002-3	2003-4	2004-5	2005-6	2006-7	2007-8	.....
Ealing								
Acton Central	0.90	1.85	0.27	0.27	0.27	0.31	0.31	
Cleveland	1.48	0.14	0.15	0.15	0.15	0.10	0.10	
Dormers Wells	0.08	0.08	-0.31	0.29	0.29	0.25	0.25	
Ealing Broadway	0.16	0.16	0.85	0.84	0.83	0.49	0.49	
Ealing Common	0.13	0.30	0.94	0.42	0.42	0.22	0.22	
East Acton	0.30	0.88	2.41	2.14	2.09	0.97	0.96	
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Parliamentary Electorate	**2001**	**2002**	**2003**	**2004**
	(Oct. 00)	**(Oct. 01)**	**(Oct. 02)**	**(Oct. 03)**
Ealing	212,879	215,157	216,516	213,285
Acton Central	9,234	9,262	9,277	9,001
Cleveland	9,614	9,612	9,712	9,585
Dormers Wells	8,709	9,016	8,879	8,859
Ealing Broadway	9,546	9,244	9,304	9,086
Ealing Common	9,480	9,647	9,585	9,451
East Acton	9,264	9,498	9,607	9,301
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Adjusting to Mid-Year (Mid-2001=(0.25*2001)+(0.75*2002))

	2001	2002	2003
Ealing	214,588	216,176	214,093
Acton Central	9,255	9,273	9,070
Cleveland	9,613	9,687	9,617
Dormers Wells	8,939	8,913	8,864
Ealing Broadway	9,320	9,289	9,140
Ealing Common	9,605	9,601	9,485
East Acton	9,440	9,580	9,378
:			

Appendix D – Electors and Dwellings (Ealing) - continued

Annual Electorate Change (%)

	2001-2	2002-3
Ealing		
Acton Central	0.20	-2.19
Cleveland	0.78	-0.73
Dormers Wells	-0.29	-0.56
Ealing Broadway	-0.33	-1.60
Ealing Common	-0.05	-1.21
East Acton	1.49	-2.11
:		

Combining Electors and Dwellings	**Electors**		**Dwellings**							
	2001-2	**2002-3**	**2001-2**	**2002-3**	**2003-4**	**2004-5**	**2005-6**	**2006-7**	**2007-8**	**.....**
RATIO	**0.50**	**0.50**	**0.50**	**0.50**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	
Acton Central	0.20	-2.19	0.90	1.85	0.27	0.27	0.27	0.31	0.31	
Cleveland	0.78	-0.73	1.48	0.14	0.15	0.15	0.15	0.10	0.10	
Dormers Wells	-0.29	-0.56	0.08	0.08	-0.31	0.29	0.29	0.25	0.25	
Ealing Broadway	-0.33	-1.60	0.16	0.16	0.85	0.84	0.83	0.49	0.49	
Ealing Common	-0.05	-1.21	0.13	0.30	0.94	0.42	0.42	0.22	0.22	
East Acton	1.49	-2.11	0.30	0.88	2.41	2.14	2.09	0.97	0.96	
:										

Combining Electors and Dwellings	**Combined Rate**							
	2001-2	**2002-3**	**2003-4**	**2004-5**	**2005-6**	**2006-7**	**2007-8**	**.....**
Acton Central	0.55	-0.17	0.27	0.27	0.27	0.31	0.31	
Cleveland	1.13	-0.30	0.15	0.15	0.15	0.10	0.10	
Dormers Wells	-0.10	-0.24	-0.31	0.29	0.29	0.25	0.25	
Ealing Broadway	-0.08	-0.72	0.85	0.84	0.83	0.49	0.49	
Ealing Common	0.04	-0.45	0.94	0.42	0.42	0.22	0.22	
East Acton	0.89	-0.62	2.41	2.14	2.09	0.97	0.96	
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