Appendix A

A.3.1 Traffic Modelling Report - Appendices

Galway County Council

N6 Galway City Transport Project

Traffic Modelling Report Appendices

GCOB-4.04-10.1 (Phase 2 TM Report) /

Final Issue | 31 August 2015

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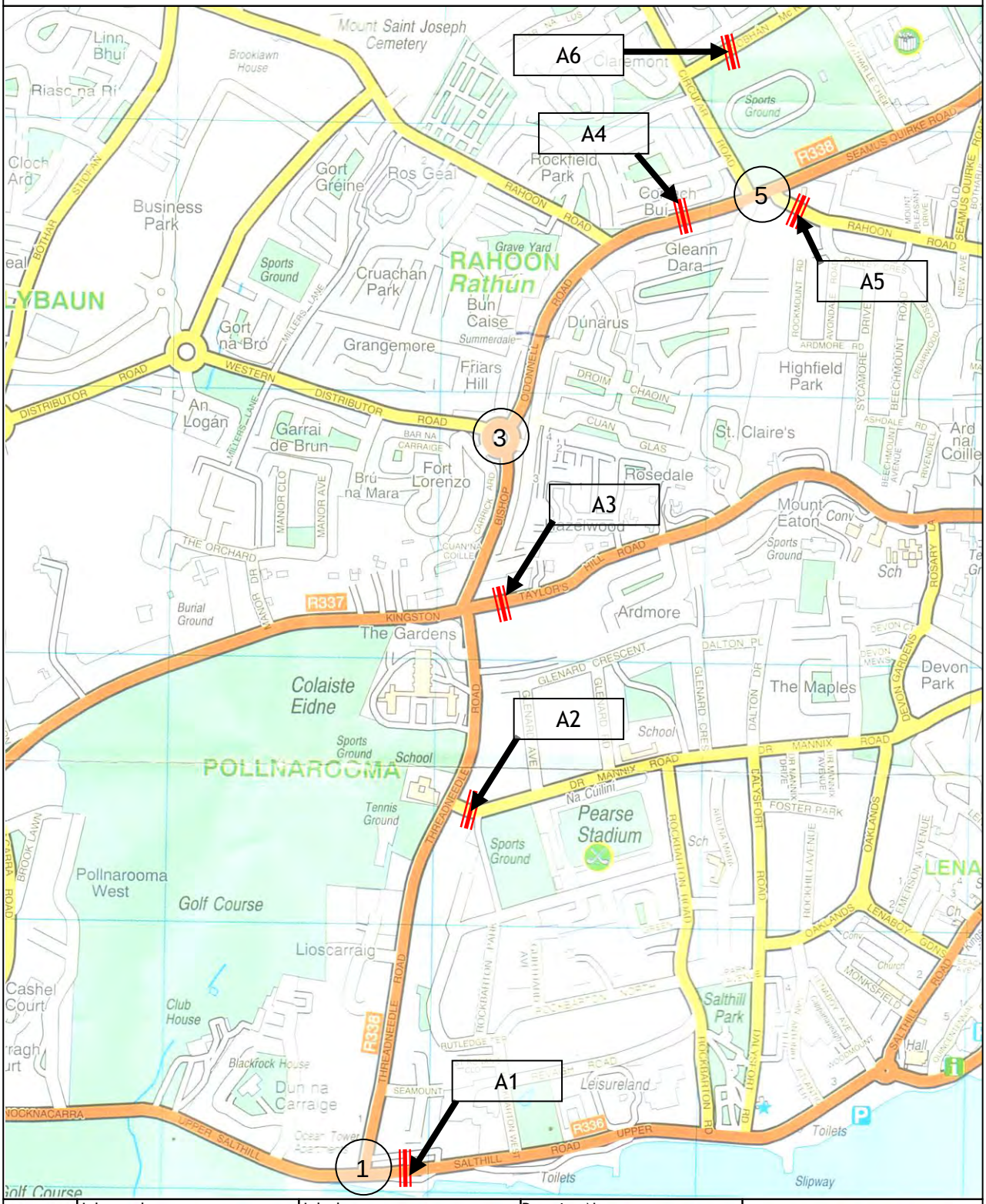
Appendix A: Traffic Count Locations

Site Locations



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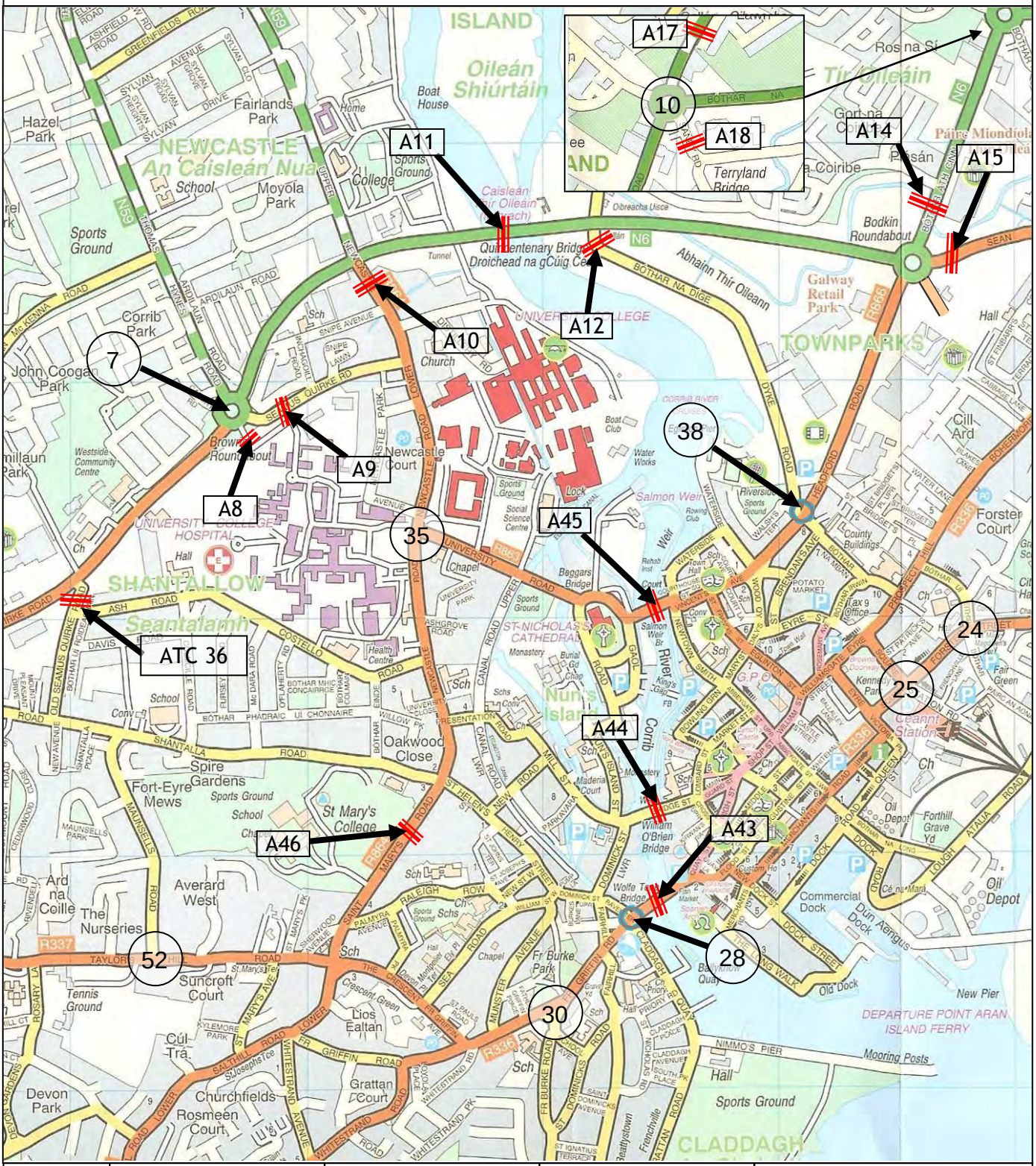
	Client: Galway City Council		Author: ITK	

Site Locations



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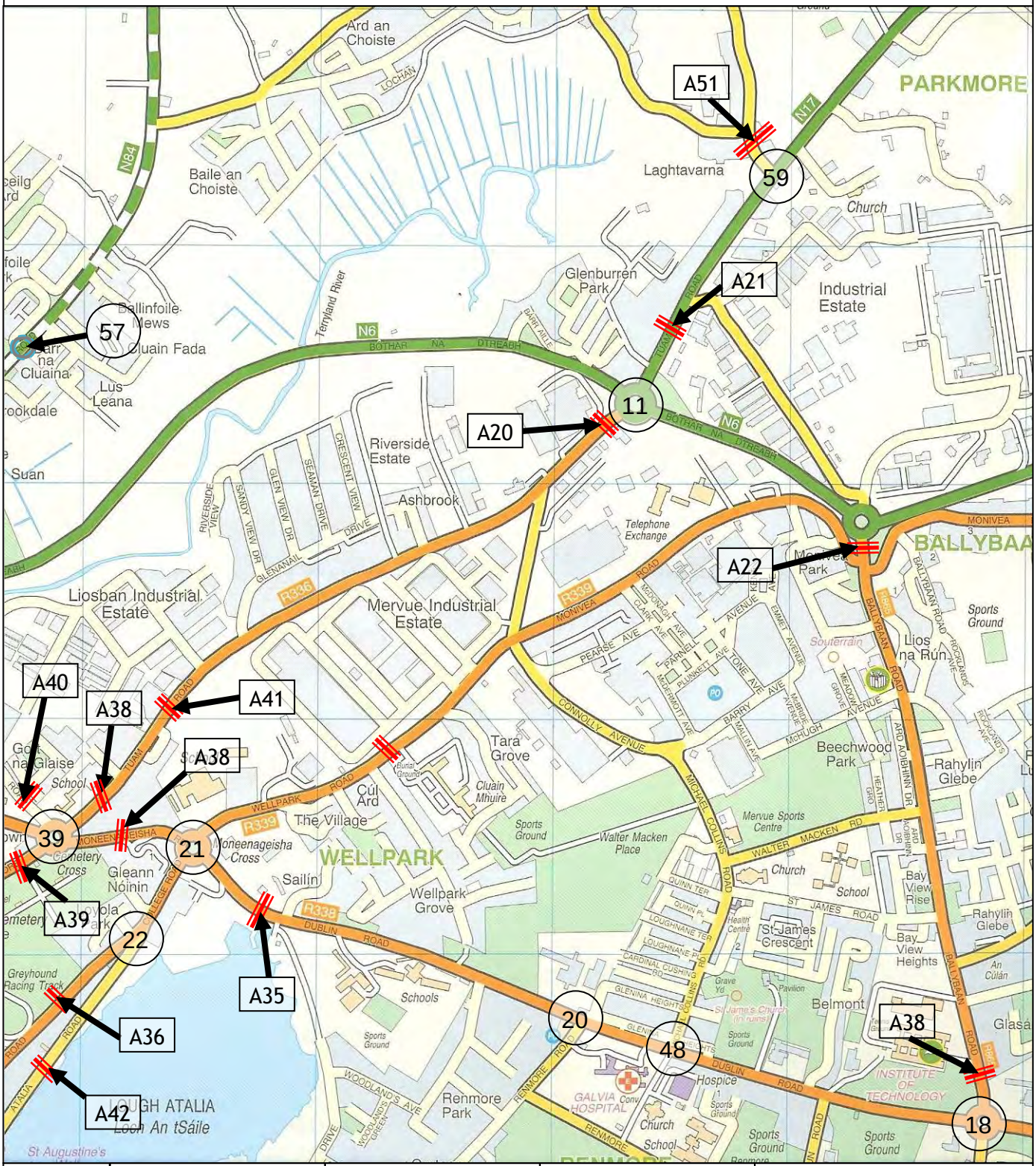
Site Locations



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	Client: Galway City Council		Author: ITK	

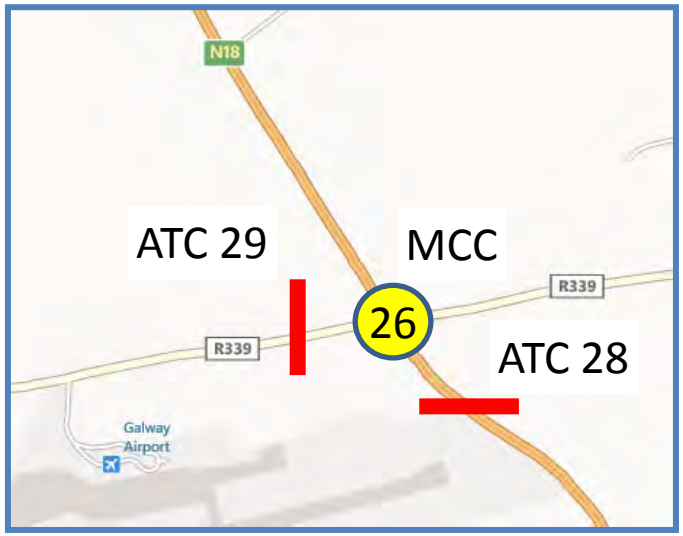
Site Locations

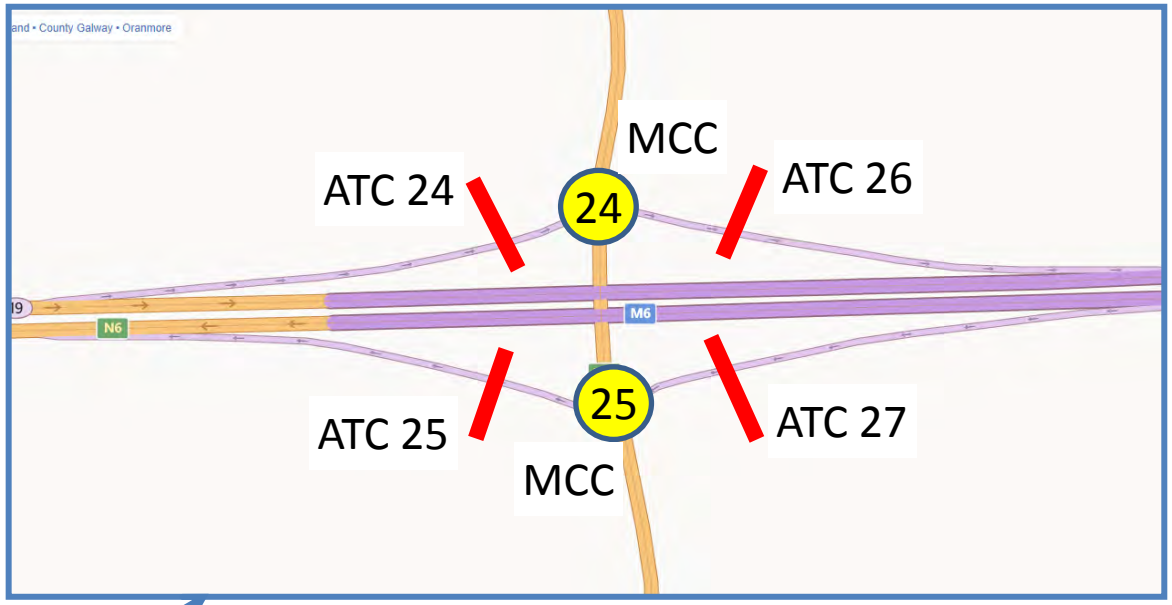
Job number: ATH/12/072	Job date: 12th - 18th November 2012	Drawing No: ATH/12/072-1.4	abacus Transportation Surveys
Client: Galway City Council		Author: ITK	

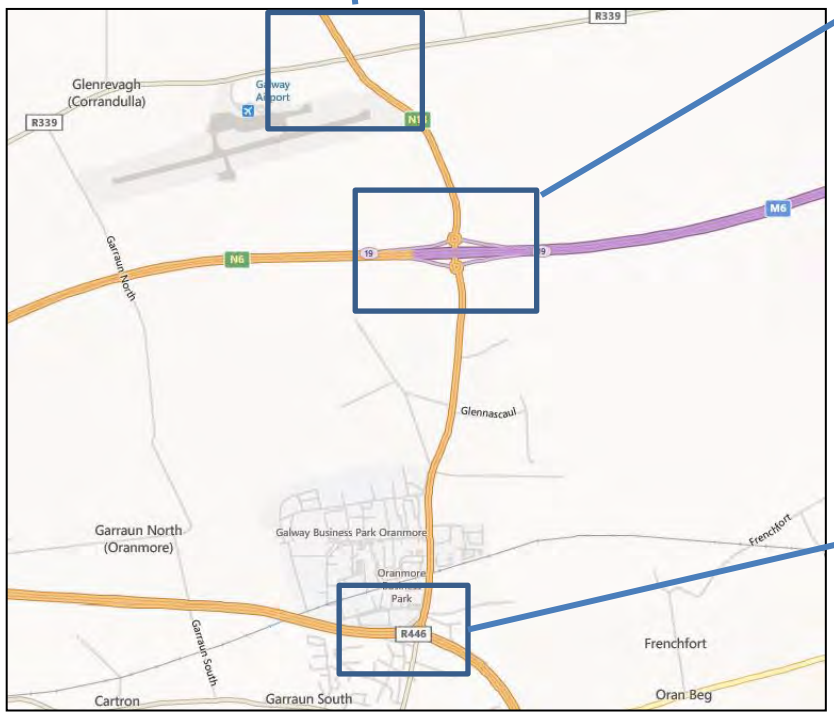
Site Locations

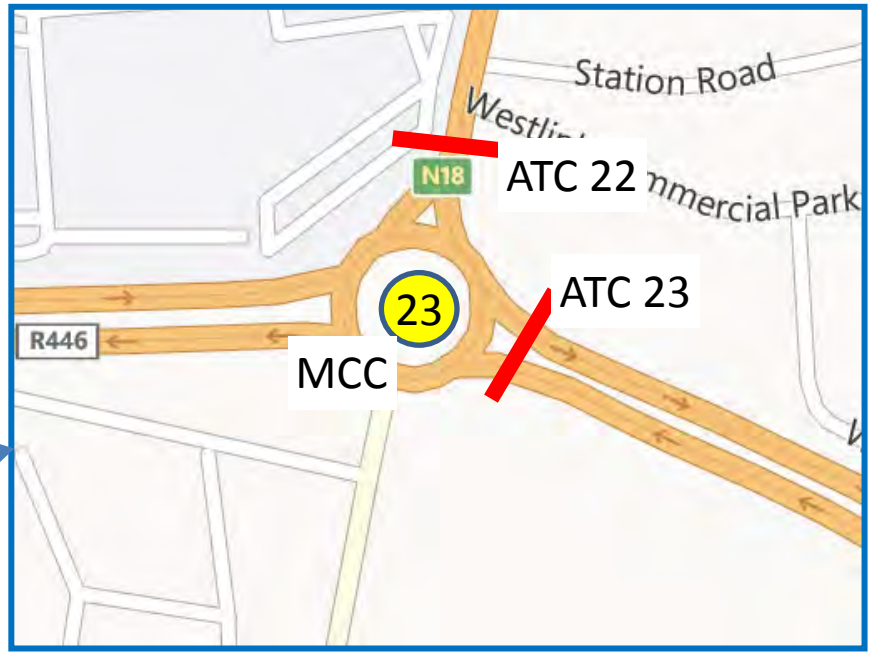
Job number: ATH/12/72	Job date: 12th - 18th November 2012	Drawing No: ATH/12/072-1.5	abacus Transportation Surveys
Client: Galway City Council		Author: ITK	

Proposed additional traffic counts for Galway – 8th Nov 2013







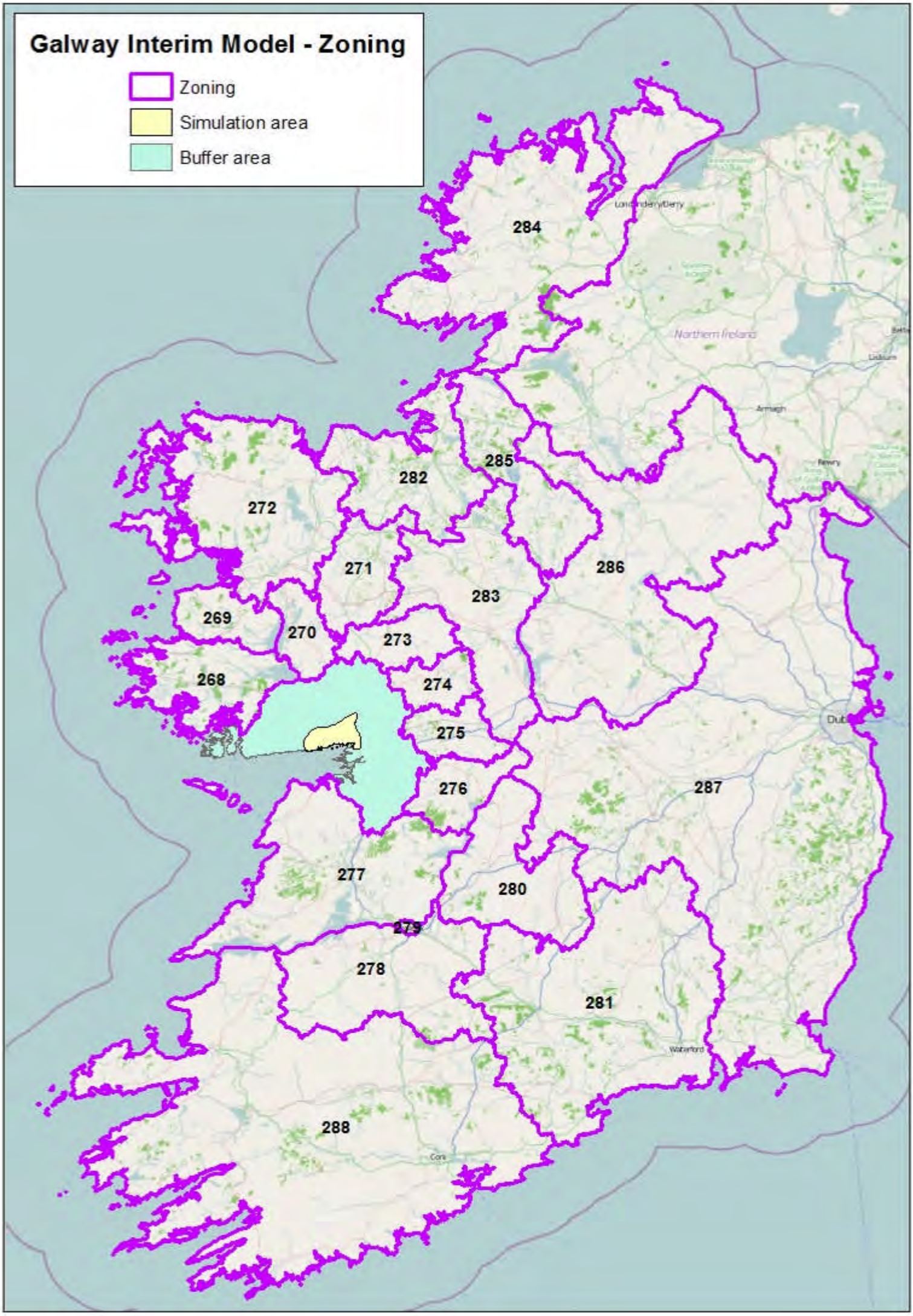


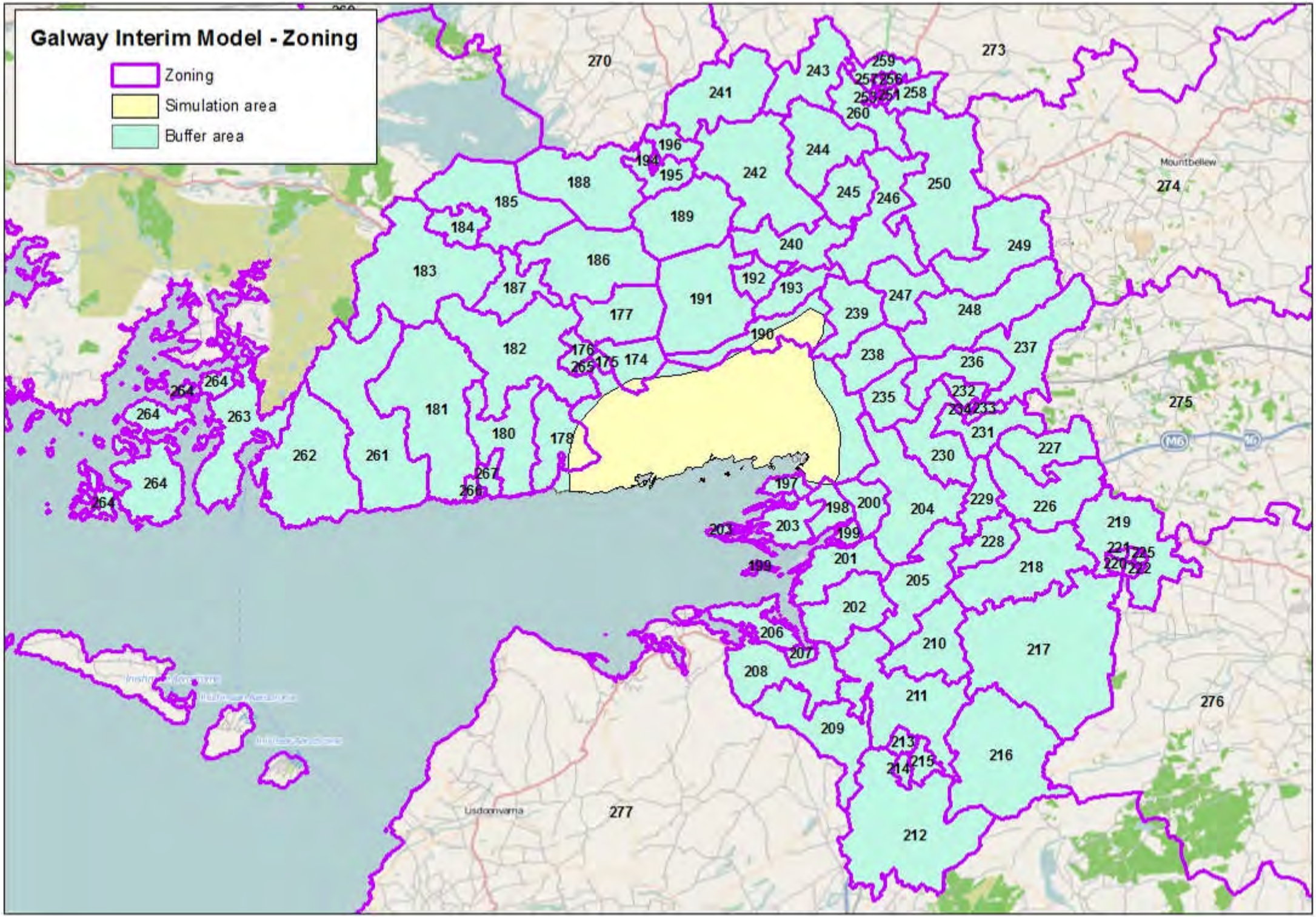
Appendix B: TomTom Speed Data Sample Sizes

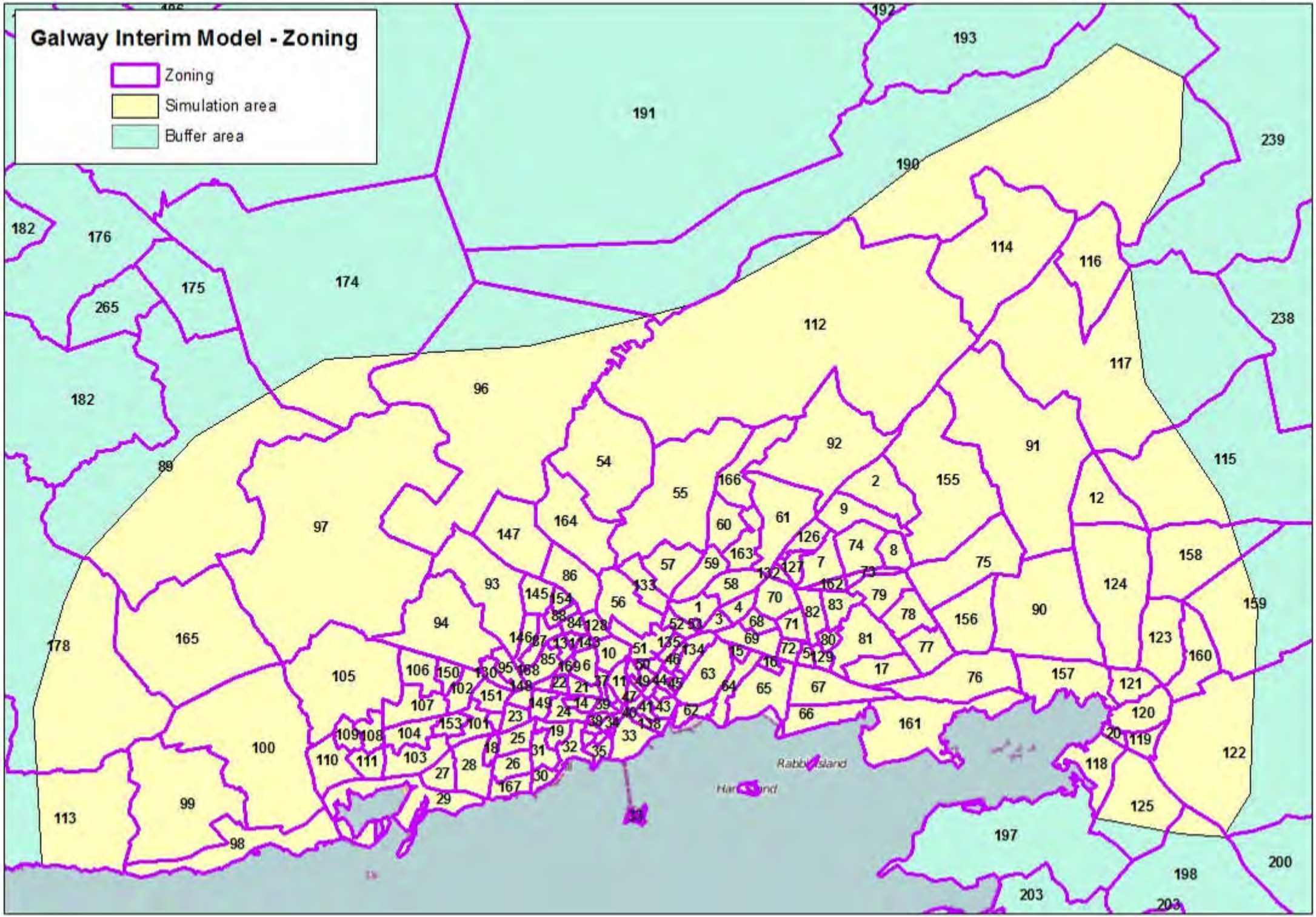
Functional Road Class (FRC)		
FRC	**Short Description**	**Long Description**
0	Motorways; Freeways; Major Roads	All roads that are officially assigned as motorways.
1	Major Roads less important than Motorways	All roads of high importance, but not officially assigned as motorways, that are part of a connection used for international and national traffic and transport.
2	Other Major Roads	All roads used to travel between different neighboring regions of a country.
3	Secondary Roads	All roads used to travel between different parts of the same region.
4	Local Connecting Roads	All roads making all settlements accessible or making parts (north, south, east, west and central) of a settlement accessible.
5	Local Roads of High Importance	All local roads that are the main connections in a settlement. These are the roads where important through traffic is possible e.g.:
		arterial roads within suburban areas, industrial areas or residential areas;
		a rural road, which has the sole function of connecting to a national park or important tourist attraction.
6	Local Roads	All roads used to travel within a part of a settlement or roads of minor connecting importance in a rural area.
7	Local Roads of Minor Importance	All roads that only have a destination function, e.g. dead-end roads, roads inside living area, alleys: narrow roads between buildings, in a park or garden.
8	Other Roads	All other roads that are less important for a navigation system:
		a path: a road that is too small to be driven by a passenger car;
		bicycle paths or footpaths that are especially designed as such;
		stairs;
		pedestrian tunnel;
		pedestrian bridge;
		alleys that are too small to be driven by a passenger car.

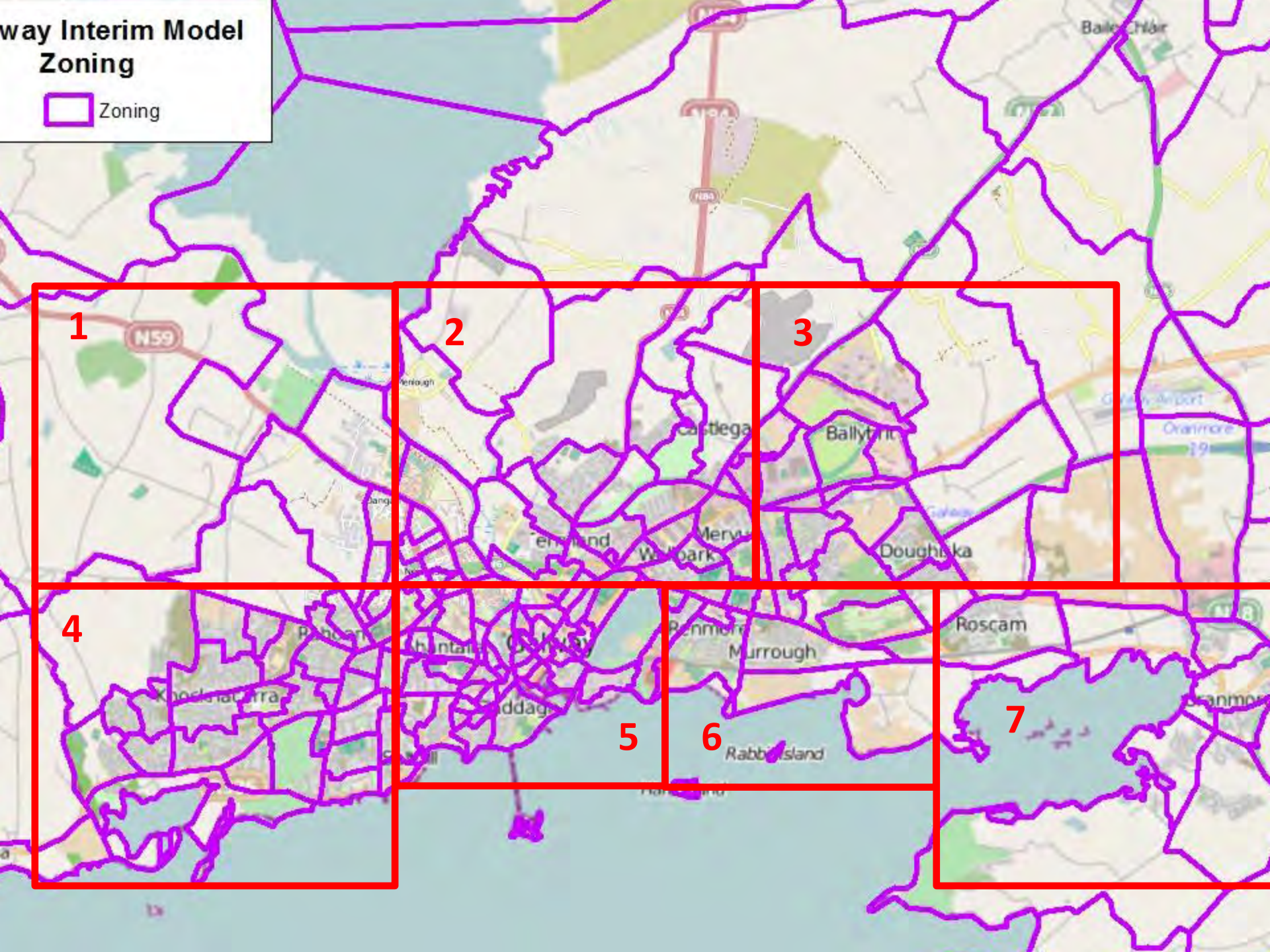
	Sample size [avg per segment]		
	Nov 2012	**Sep - Nov 2012**	**Sep 2012 - May 2013**
AM_Peak (FRC 0)	< 10	30	80
AM_Peak (FRC 1)	< 10	20	60
AM_Peak (FRC 2)	< 10	< 10	30
AM_Peak (FRC 3)	< 10	10	30
AM_Peak (FRC 4)	< 10	< 10	10
AM_Peak (FRC 5)	< 10	< 10	< 10
AM_Peak (FRC 6)	< 10	< 10	< 10
AM_Shoulder (FRC 0)	20	70	100
AM_Shoulder (FRC 1)	10	50	100
AM_Shoulder (FRC 2)	< 10	30	70
AM_Shoulder (FRC 3)	< 10	20	50
AM_Shoulder (FRC 4)	< 10	10	30
AM_Shoulder (FRC 5)	< 10	< 10	< 10
AM_Shoulder (FRC 6)	< 10	< 10	< 10
Base Set (FRC 0)	< 10	20	50
Base Set (FRC 1)	< 10	10	30
Base Set (FRC 2)	< 10	10	20
Base Set (FRC 3)	< 10	30	50
Base Set (FRC 4)	< 10	< 10	10
Base Set (FRC 5)	< 10	< 10	< 10
Base Set (FRC 6)	< 10	< 10	10
IP_10_13 (FRC 0)	50	200	400
IP_10_13 (FRC 1)	30	100	300
IP_10_13 (FRC 2)	20	100	200
IP_10_13 (FRC 3)	10	60	100
IP_10_13 (FRC 4)	< 10	30	60
IP_10_13 (FRC 5)	< 10	< 10	< 10
IP_10_13 (FRC 6)	< 10	< 10	10
IP_13_16 (FRC 0)	50	200	400
IP_13_16 (FRC 1)	30	100	300
IP_13_16 (FRC 2)	20	90	200
IP_13_16 (FRC 3)	10	60	100
IP_13_16 (FRC 4)	< 10	20	50
IP_13_16 (FRC 5)	< 10	< 10	< 10
IP_13_16 (FRC 6)	< 10	< 10	10
PM_Peak (FRC 0)	10	50	100
PM_Peak (FRC 1)	10	40	90
PM_Peak (FRC 2)	10	30	70
PM_Peak (FRC 3)	< 10	20	50
PM_Peak (FRC 4)	< 10	< 10	20
PM_Peak (FRC 5)	< 10	< 10	< 10
PM_Peak (FRC 6)	< 10	< 10	< 10
PM_Shoulder (FRC 0)	20	100	300
PM_Shoulder (FRC 1)	20	90	200
PM_Shoulder (FRC 2)	10	70	100
PM_Shoulder (FRC 3)	< 10	40	90
PM_Shoulder (FRC 4)	< 10	20	40
PM_Shoulder (FRC 5)	< 10	< 10	< 10
PM_Shoulder (FRC 6)	< 10	< 10	10

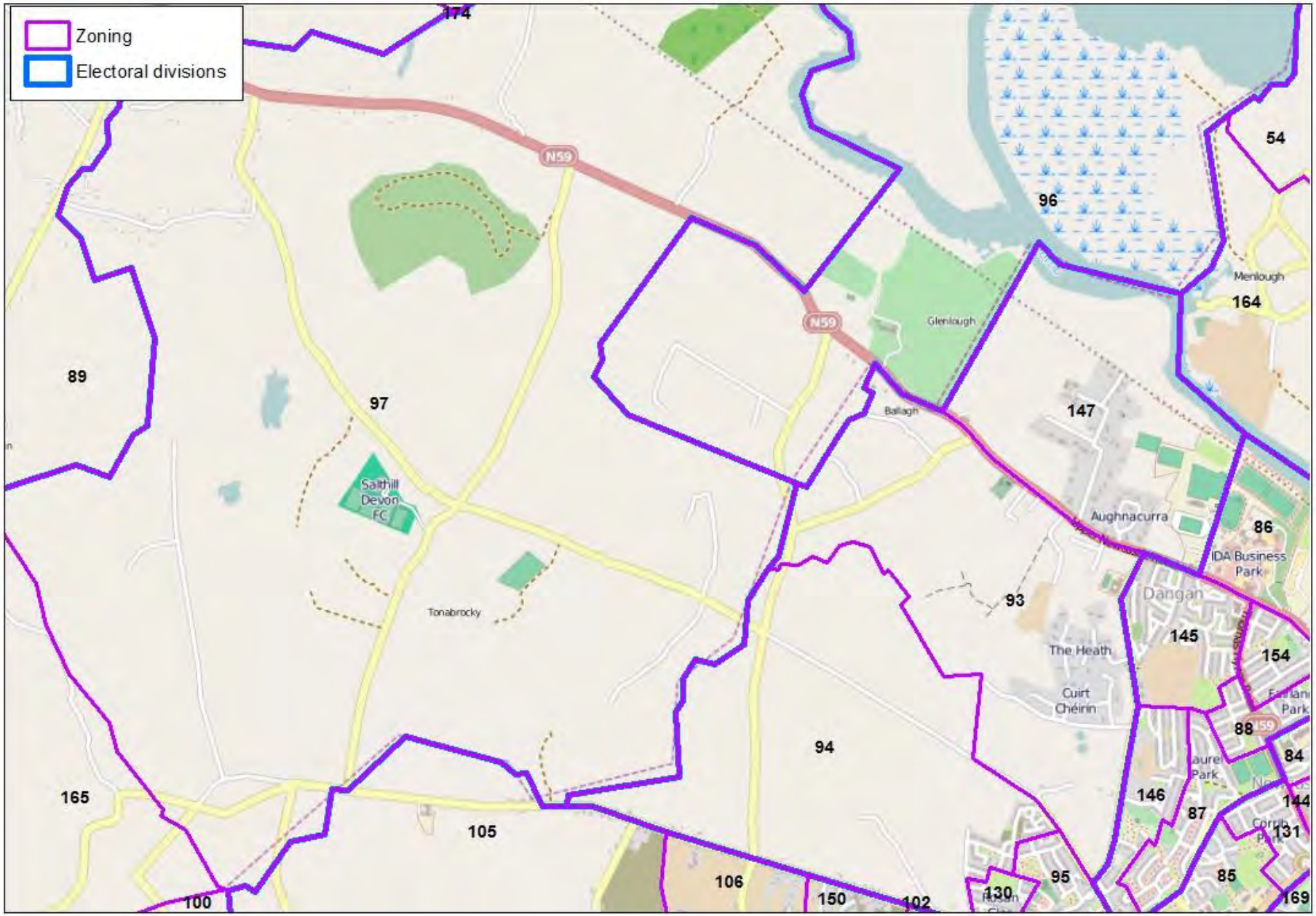
Appendix C: Model Zone System


Galway Interim Model - Zoning
Zoning
Simulation area
Buffer area
284
285
282
272
271
286
283
269
270
273
268
274
275
276
287
277
280
279
278
281
288
Northern Ireland
Armagh
Newry
Waterford
Cork

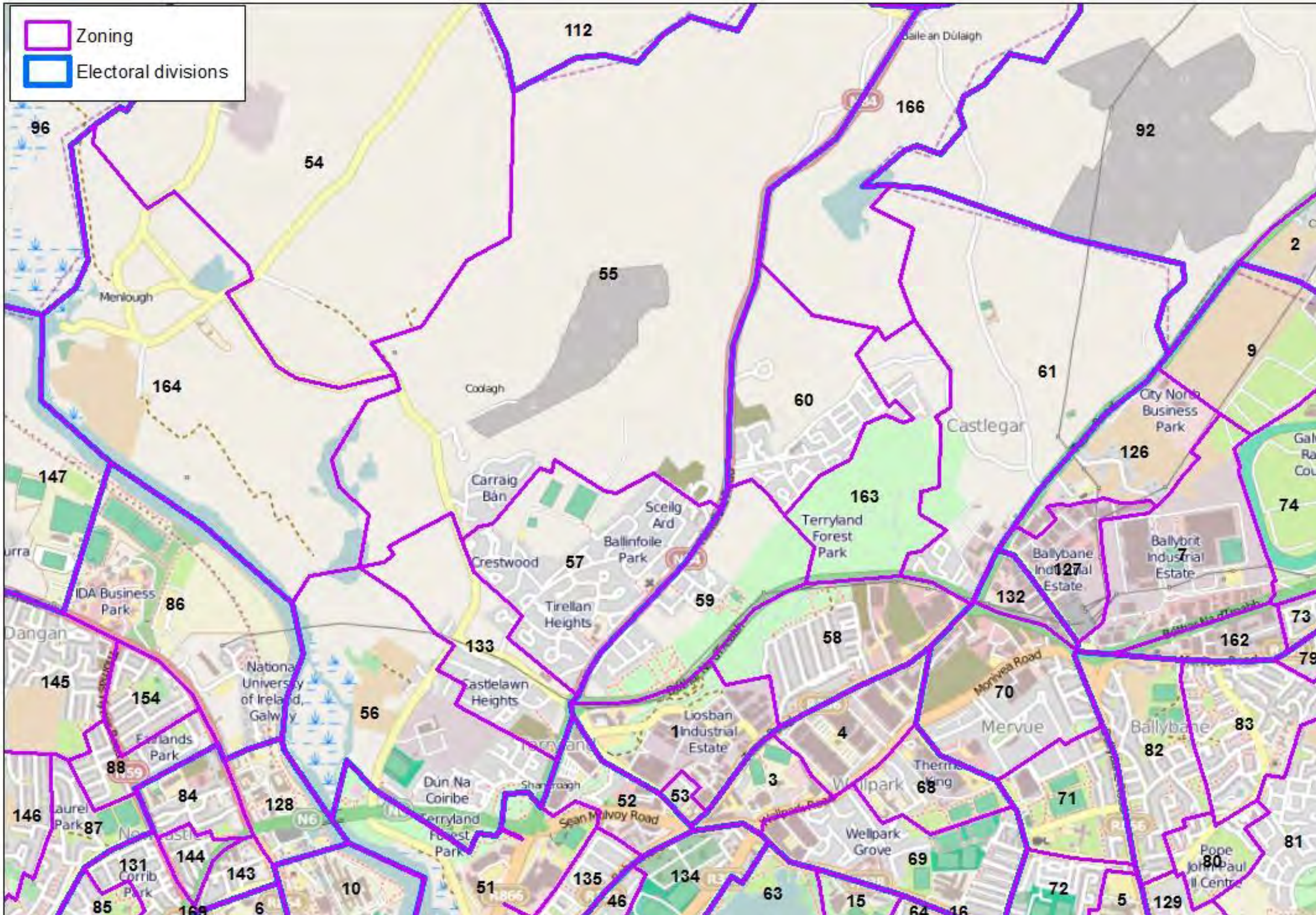

Galway Interim Model - Zoning
Zoning
Simulation area
Buffer area
Mountbellew
Lisdoonvarna
M6
M6


Galway Interim Model - Zoning
Zoning
Simulation area
Buffer area
Rabbit Island


way Interim Model
Zoning
Zoning
1
2
3
4
5
6
7
N59
N84
Murrough
Roscam
Doughiska
Ballybrit
Rabbit Island

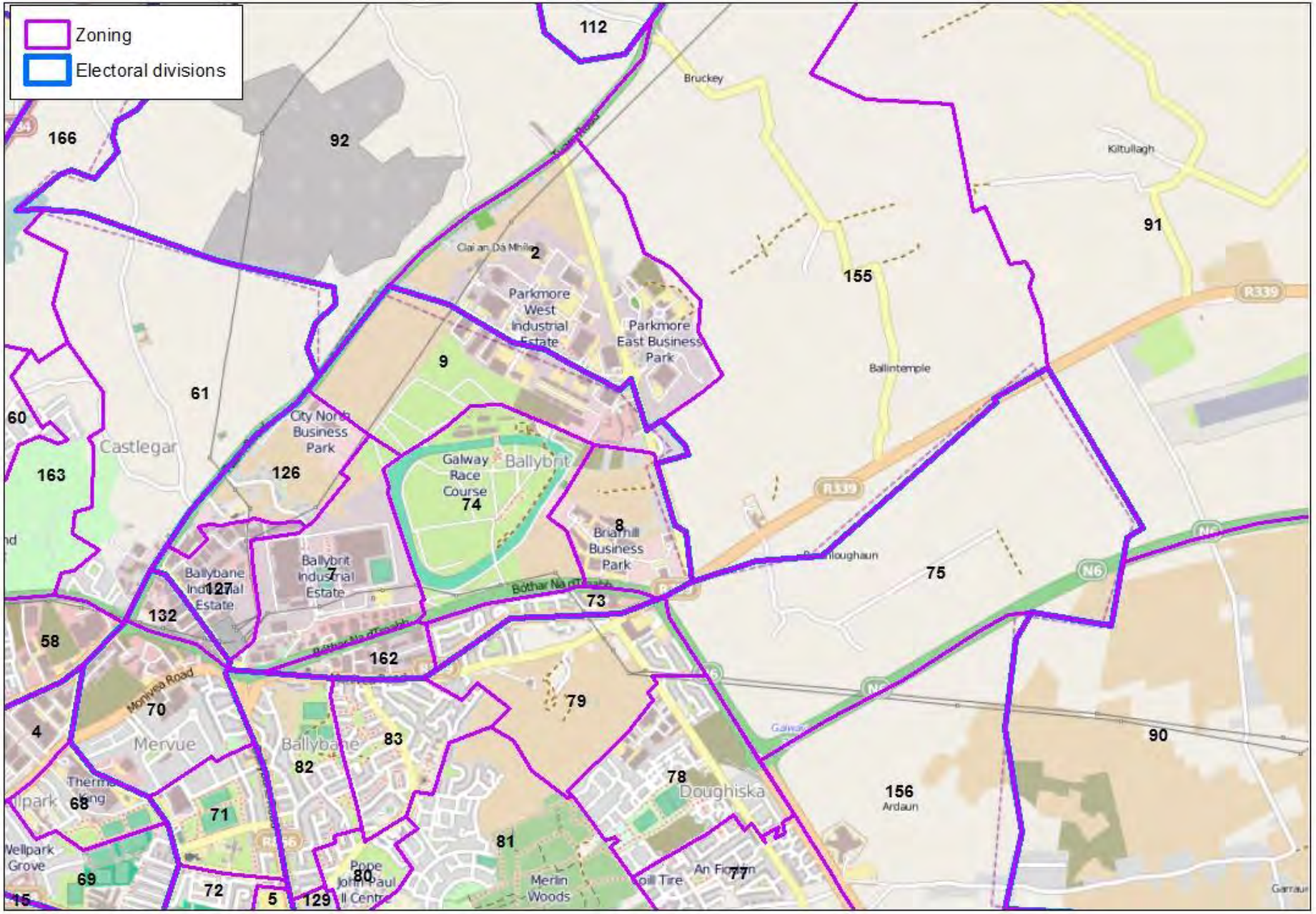

Zoning
Electoral divisions
174
N59
54
96
Menlough
164
Glenlough
89
97
Ballagh
147
Salthill
Devon
FC
Aughnacurra
86
IDA Business
Park
Dangan
Tonabrocky
93
145
154
The Heath
Cuirt
Chéirin
88
84
94
165
146
144
87
105
131
106
95
85
150
102
130
100
169

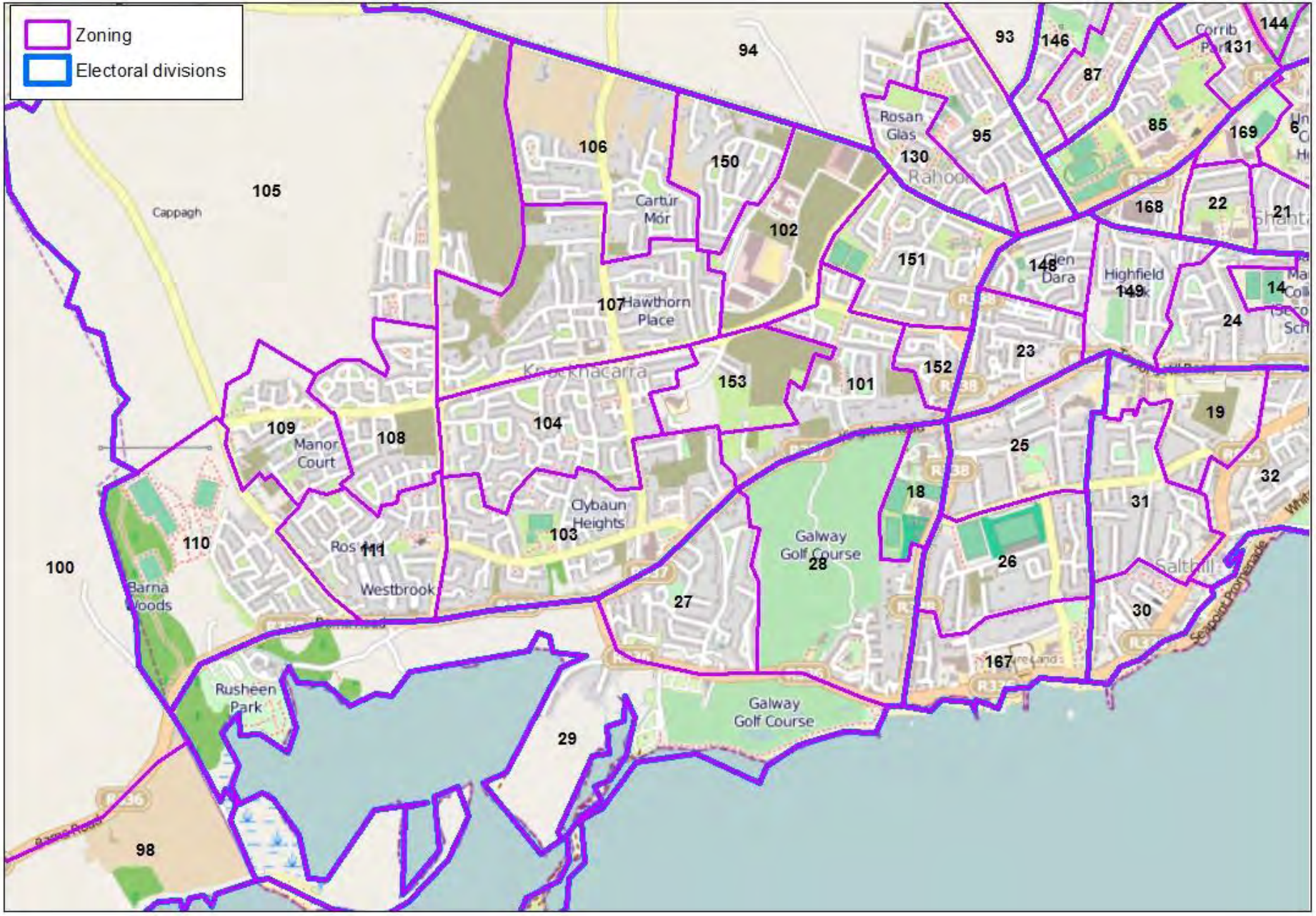
1



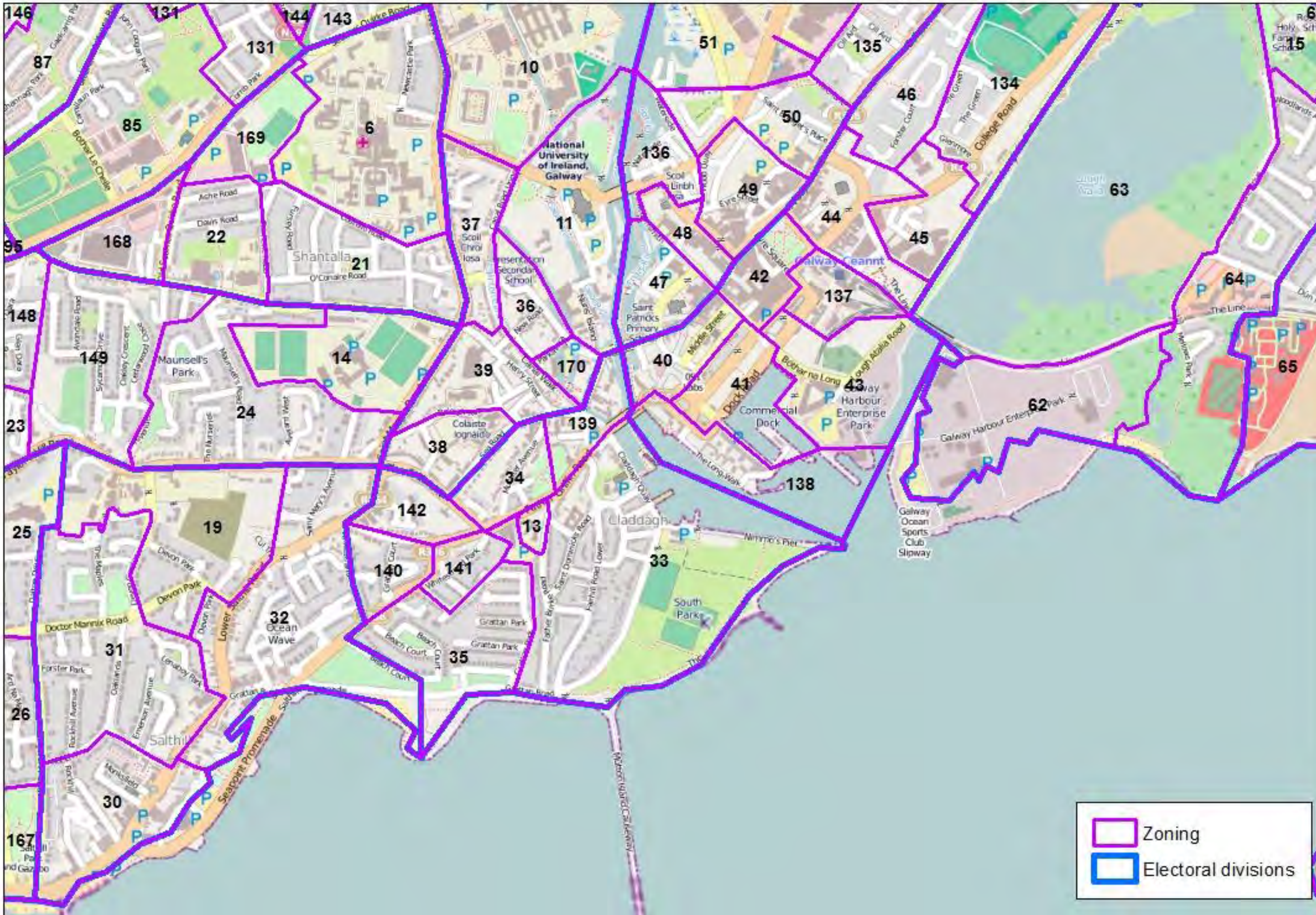
Zoning
Electoral divisions
112
Baile an Dúlaigh
166
92
96
54
55
Menlough
Coolagh
164
60
61
Castlegar
2
9
City North Business Park
126
Galway Racecourse
74
147
Carraig Bán
Sceilg Ard
Ballinfoile Park
163
Terryland Forest Park
Crestwood
57
59
Tirellan Heights
Ballybane Industrial Estate
127
Ballybrit Industrial Estate
7
132
IDA Business Park
86
Dangan
133
58
73
162
79
145
154
National University of Ireland, Galway
56
Castlelawn Heights
Liosban Industrial Estate
1
4
70
Mervue
Ballybane
83
82
Monivea Road
Exlands Park
88
84
128
Dún Na Coiribe
Terryland Forest Park
Shantalla
52
53
3
Wellpark
68
71
146
Laurel Park
87
Sean Mulvoy Road
Wellpark Grove
81
131
Corrib Park
144
143
10
51
135
134
63
69
72
Pope John Paul II Centre
80
85
169
6
46
15
64
16
5
129

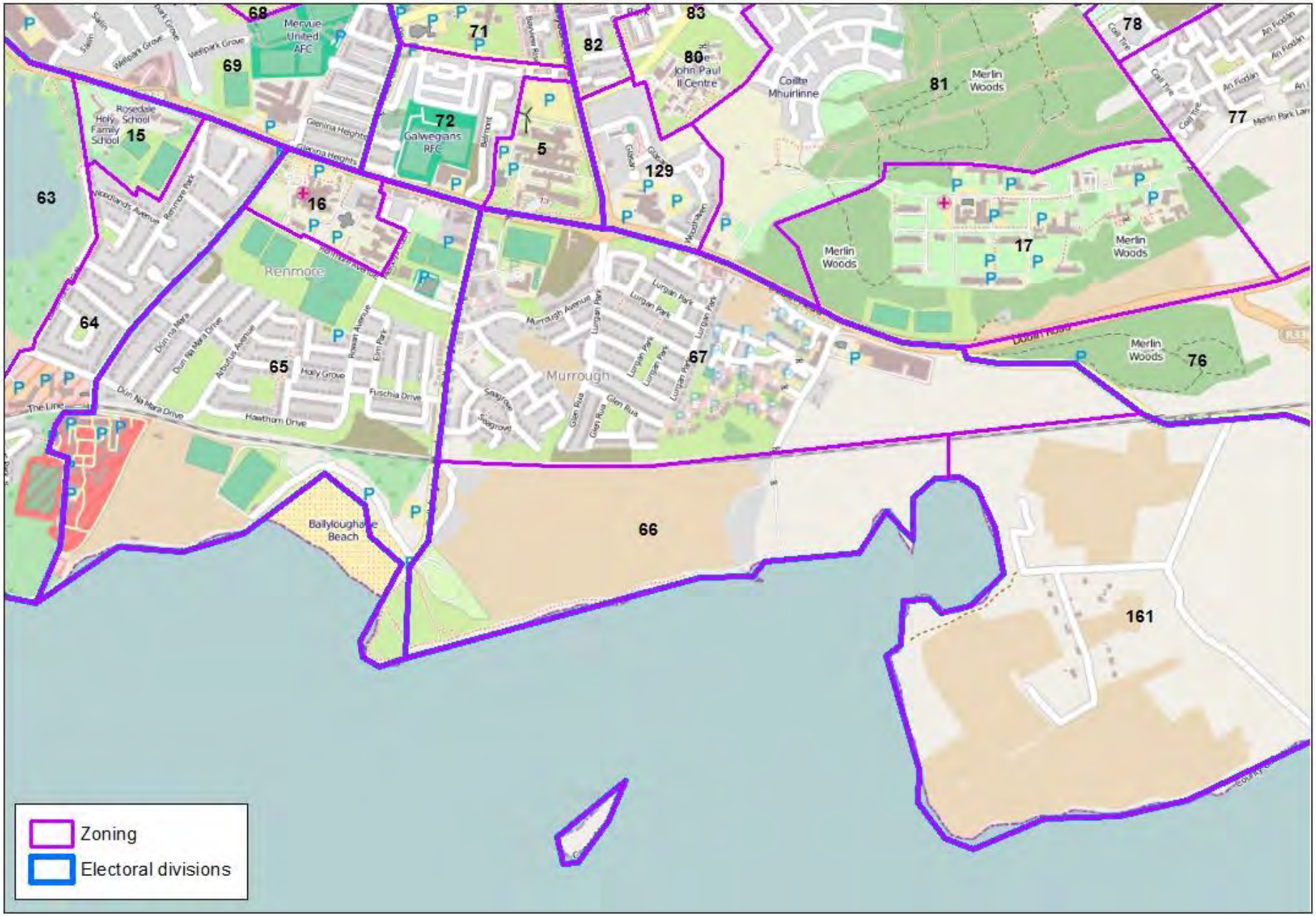
2


Zoning
Electoral divisions
112
Bruckey
166
92
Kiltullagh
91
Clai an Dá Mhile
2
155
Parkmore West Industrial Estate
Parkmore East Business Park
R339
9
Ballintemple
61
60
City North Business Park
Castlegar
Galway Race Course
Ballybrit
163
126
74
8
Briarhill Business Park
R339
N6
75
Ballybane Industrial Estate
127
Ballybrit Industrial Estate
7
Bóthar Na dTreabh
73
132
58
162
Monivea Road
79
70
4
Mervue
Ballybane
83
90
82
78
Doughiska
156
Ardaun
68
71
81
Wellpark Grove
69
72
80
Merlin Woods
77
15
5
129


Zoning
Electoral divisions
94
93
146
144
131
87
Rosan Glas
95
85
169
6
130
Rahoon
106
150
105
Cappagh
Cartúr Mór
102
168
22
21
151
148
Glen Dara
Highfield
149
14
107
Hawthorn Place
24
23
152
153
101
19
109
Manor Court
108
104
25
32
18
31
Clybaun Heights
103
110
111
Galway Golf Course
28
26
100
Barna Woods
Westbrook
27
30
167
Rusheen Park
Galway Golf Course
29
98

4


Zoning
Electoral divisions


Zoning
Electoral divisions
Renmore
Murrough
Merlin Woods
Ballyloughane Beach
Mervue United AFC
Galwegians RFC
Rosedale Holy Family School
John Paul II Centre
Coillte Mhuirlinne
63
64
65
66
67
68
69
71
72
82
83
80
81
78
77
76
5
15
16
17
129
161


Zoning
Electoral divisions
156
90
124
123
Ros Caoin
Roscam
Boireann Bheag
76
Oranmore Railway Station
157
Cóst Na Mar
160
121
R338
Lios Na Ri
120
161
Oranmore
Oranmore Bay
20
119
Cloch Óg
122
Bluebell Woods
118
Oran Court
125
197
198
Rinville

Appendix D: Road Calibration & Validation Data

Screenline Calibration

Morning Peak Hour

				Counts	Modelled Flow	Flow Difference
Screenline	**A**	**B**	**Site**	**Total (pcu)**	**Total (pcu)**	**Total (pcu)**
1IN	51403	50910	Site 55	1,055	1,065	10
1IN	51410	51413	Site 54	85	82	-3
1IN	51428	51427	Site 48	197	80	-117
1IN	50129	51417	Site 53	743	741	-2
1IN	51426	50131	Site 47	29	29	0
				2,109	**1,997**	**-112**
					Flow Diff (%)	**5%**
					GEH	**2**

				Counts	Modelled Flow	Flow Difference
Screenline	**A**	**B**	**Site**	**Total (pcu)**	**Total (pcu)**	**Total (pcu)**
1OUT	50910	51403	Site 55	183	183	0
1OUT	51413	51410	Site 54	8	10	2
1OUT	51427	51428	Site 48	39	22	-17
1OUT	51417	50129	Site 53	471	471	0
1OUT	50131	51426	Site 47	38	31	-7
				739	**716**	**-23**
					Flow Diff (%)	**3%**
					GEH	**1**

				Counts	Modelled Flow	Flow Difference
Screenline	**A**	**B**	**Site**	**Total (pcu)**	**Total (pcu)**	**Total (pcu)**
3EB	52246	50925	Site 43	1057	1046	-11
3EB	50805	52310	Site 44	571	506	-65
3EB	50918	50798	Site 45	446	371	-75
3EB	50942	50486	Site 11	1656	1820	164
				3,730	**3,744**	**14**
					Flow Diff (%)	**0%**
					GEH	**0**

				Counts	Modelled Flow	Flow Difference
Screenline	**A**	**B**	**Site**	**Total (pcu)**	**Total (pcu)**	**Total (pcu)**
3WB	50925	52246	Site 43	702	676	-26
3WB	52310	50805	Site 44	145	12	-133
3WB	50798	50918	Site 45	802	806	4
3WB	50486	50942	Site 11	1495	1537	42
				8,530	**8,595**	**65**
					Flow Diff (%)	**1%**
					GEH	**1**

Screenline Calibration

Inter-Peak Hour

				Counts	Modelled Flow	Flow Difference
Screenline	**A**	**B**	**Site**	**Total (pcu)**	**Total (pcu)**	**Total (pcu)**
1IN	51403	50910	Site 55	392	392	0
1IN	51410	51413	Site 54	17	17	0
1IN	51428	51427	Site 48	47	39	-8
1IN	50129	51417	Site 53	432	432	0
1IN	51426	50131	Site 47	17	17	0
				905	**896**	**-9**
					Flow Diff (%)	**1%**
					GEH	**0**

				Counts	Modelled Flow	Flow Difference
Screenline	**A**	**B**	**Site**	**Total (pcu)**	**Total (pcu)**	**Total (pcu)**
1OUT	50910	51403	Site 55	357	357	0
1OUT	51413	51410	Site 54	17	17	0
1OUT	51427	51428	Site 48	48	37	-11
1OUT	51417	50129	Site 53	426	427	1
1OUT	50131	51426	Site 47	14	13	-1
				862	**851**	**-11**
					Flow Diff (%)	**1%**
					GEH	**0**

				Counts	Modelled Flow	Flow Difference
Screenline	**A**	**B**	**Site**	**Total (pcu)**	**Total (pcu)**	**Total (pcu)**
3EB	52246	50925	Site 43	718	666	-52
3EB	50805	52310	Site 44	355	363	8
3EB	50918	50798	Site 45	540	520	-20
3EB	50942	50486	Site 11	1168	1229	61
				2,781	**2,779**	**-2**
					Flow Diff (%)	**0%**
					GEH	**0**

				Counts	Modelled Flow	Flow Difference
Screenline	**A**	**B**	**Site**	**Total (pcu)**	**Total (pcu)**	**Total (pcu)**
3WB	50925	52246	Site 43	613	610	-3
3WB	52310	50805	Site 44	128	0	-128
3WB	50798	50918	Site 45	667	645	-22
3WB	50486	50942	Site 11	1192	1228	36
				2,600	**2,483**	**-117**
					Flow Diff (%)	**5%**
					GEH	**2**

Link Count Calibration

Morning Peak Hour

			Counts		Modelled Flow			Flow Difference			Flow Criteria			GEH		
A	B	Site	Cars	HGV (pcu)	Cars	HGV (pcu)	Total (veh)	Cars	HGV (pcu)	Total (veh)	Cars	HGV (pcu)	Total (veh)	Cars	HGV (pcu)	Total (veh)
50648	50546	Site 57	689	17	645	17	653	-44	0	-45	YES	YES	YES	1.7	0.0	1.7
50546	50648	Site 57	333	5	316	5	318	-17	0	-17	YES	YES	YES	1.0	0.1	1.0
50539	52285	Site 46	503	12	482	12	488	-21	0	-21	YES	YES	YES	0.9	0.1	0.9
52285	50539	Site 46	242	16	220	15	227	-22	-1	-23	YES	YES	YES	1.5	0.4	1.5
52685	52367	Site 12	34	0	22	0	22	-12	0	-12	YES	YES	YES	2.2	0.0	2.2
52367	52685	Site 12	554	2	813	0	813	259	-2	258	NO	YES	NO	9.9	2.0	9.9
50960	50962	Site 16	467	17	500	21	510	33	4	35	YES	YES	YES	1.5	1.0	1.6
50487	52667	Site 14	1222	157	1342	148	1416	120	-9	116	YES	YES	YES	3.4	0.7	3.1
53003	52803	Site 14	1193	156	1153	134	1220	-40	-22	-51	YES	YES	YES	1.2	1.8	1.4
50966	50750	Site 40	151	7	163	8	167	12	1	12	YES	YES	YES	1.0	0.2	1.0
53011	50930	Site 35	753	46	695	75	733	-58	29	-43	YES	YES	YES	2.1	3.7	1.6
50930	52583	Site 35	970	51	969	53	996	-1	2	0	YES	YES	YES	0.0	0.3	0.0
52561	50577	Site 38	365	23	431	23	443	66	0	66	YES	YES	YES	3.3	0.1	3.3
50577	52561	Site 38	625	28	538	26	551	-87	-2	-88	YES	YES	YES	3.6	0.5	3.6
52248	52707	Site 20	538	31	504	29	518	-34	-2	-35	YES	YES	YES	1.5	0.3	1.5
52707	52248	Site 20	942	51	936	87	980	-6	36	12	YES	YES	YES	0.2	4.3	0.4
52704	52683	Site 21	655	52	706	60	736	51	8	55	YES	YES	YES	2.0	1.0	2.1
52683	52704	Site 21	729	82	751	40	772	22	-42	2	YES	YES	YES	0.8	5.3	0.1
52703	52698	Site 22	572	16	586	13	593	14	-3	13	YES	YES	YES	0.6	0.8	0.5
52698	52703	Site 22	626	22	588	20	598	-38	-2	-39	YES	YES	YES	1.5	0.4	1.6
50629	50588	Site 56	697	64	656	26	668	-42	-38	-61	YES	YES	YES	1.6	5.7	2.3
50588	50629	Site 56	541	22	514	21	524	-27	-1	-28	YES	YES	YES	1.2	0.2	1.2
51363	52614	Site 30	430	174	355	114	412	-75	-60	-105	YES	YES	NO	3.8	5.0	4.9
52614	51363	Site 30	472	25	637	40	657	165	15	172	NO	YES	NO	7.0	2.6	7.2
50110	52427	Site 28	699	35	664	36	682	-35	1	-34	YES	YES	YES	1.3	0.2	1.3
52959	50111	Site 28	548	50	652	50	677	104	0	104	NO	YES	NO	4.2	0.1	4.2
52536	50150	Site 31	597	23	303	12	309	-294	-11	-299	YES	YES	YES	13.9	2.6	14.0
50150	52536	Site 31	168	11	109	11	114	-59	0	-59	YES	YES	YES	5.0	0.0	4.9
53013	52695	Site 25	1664	92	1601	92	1647	-63	0	-63	YES	YES	YES	1.6	0.0	1.5
52695	53013	Site 25	752	66	798	66	831	46	0	46	YES	YES	YES	1.7	0.0	1.6
52623	52695	Site 23	854	76	876	74	913	22	-2	21	YES	YES	YES	0.7	0.2	0.7
52695	52623	Site 23	1570	289	1600	265	1733	30	-24	18	YES	YES	YES	0.8	1.4	0.4
51376	51377	Site 24	744	35	711	32	727	-33	-3	-34	YES	YES	YES	1.2	0.5	1.3
51377	51376	Site 24	554	81	572	83	614	18	2	19	YES	YES	YES	0.8	0.2	0.8
50752	52772	Site 37	503	41	510	32	526	7	-9	3	YES	YES	YES	0.3	1.5	0.1
50753	52771	Site 41	549	22	597	78	636	48	56	76	YES	YES	YES	2.0	7.9	3.1
52771	50753	Site 41	566	33	563	32	579	-3	-1	-4	YES	YES	YES	0.1	0.2	0.2
50906	55004	Site 4	853	49	1100	58	1130	247	9	252	NO	YES	NO	7.9	1.3	8.0
50542	52319	Site 6	665	1	666	0	666	1	-1	1	YES	YES	YES	0.0	0.8	0.0
55004	50906	Site 4	560	32	589	37	607	29	5	31	YES	YES	YES	1.2	0.8	1.3
52319	50542	Site 6	88	2	66	2	67	-22	0	-22	YES	YES	YES	2.5	0.0	2.5

Link Count Calibration

Inter-peak Hour

			Counts		Modelled Flow			Difference			Flow Criteria			GEH		
A	B	Site	Cars	HGV	Cars	HGV	Total (veh)	Cars	HGV	Total (veh)	Cars	HGV (pcu)	Total (veh)	Cars	HGV	Total (veh)
50648	50546	Site 57	305	12	298	12	304	-7	0	-7	YES	YES	YES	0.4	0.1	0.4
50546	50648	Site 57	341	11	337	11	343	-4	0	-4	YES	YES	YES	0.2	0.1	0.2
50539	52285	Site 46	325	7	317	7	321	-8	0	-8	YES	YES	YES	0.4	0.0	0.4
52285	50539	Site 46	309	8	297	8	301	-12	0	-12	YES	YES	YES	0.7	0.1	0.7
52685	52367	Site 12	138	1	172	0	172	34	-1	33	YES	YES	YES	2.7	1.4	2.7
52367	52685	Site 12	136	1	146	0	146	10	-1	10	YES	YES	YES	0.9	1.4	0.8
50960	50962	Site 16	654	9	549	10	554	-105	1	-105	YES	YES	YES	4.3	0.2	4.3
50487	52667	Site 14	1131	142	1276	143	1347	145	1	145	YES	YES	YES	4.2	0.1	4.1
53003	52803	Site 14	974	95	944	96	992	-30	1	-29	YES	YES	YES	1.0	0.1	0.9
50966	50750	Site 40	207	7	175	7	178	-32	0	-32	YES	YES	YES	2.3	0.2	2.3
53011	50930	Site 35	774	48	622	35	640	-152	-13	-158	YES	YES	YES	5.7	2.1	5.9
50930	52583	Site 35	823	32	738	29	752	-85	-3	-87	YES	YES	YES	3.0	0.6	3.1
52561	50577	Site 38	403	28	413	29	427	10	1	10	YES	YES	YES	0.5	0.1	0.5
50577	52561	Site 38	426	21	455	21	466	29	0	30	YES	YES	YES	1.4	0.0	1.4
52248	52707	Site 20	617	46	427	34	444	-190	-12	-196	YES	YES	YES	8.3	1.9	8.4
52707	52248	Site 20	688	32	872	36	890	184	4	186	NO	YES	NO	6.6	0.7	6.6
52704	52683	Site 21	664	60	654	59	684	-10	-1	-10	YES	YES	YES	0.4	0.1	0.4
52683	52704	Site 21	711	72	644	72	680	-67	0	-67	YES	YES	YES	2.6	0.0	2.5
52703	52698	Site 22	568	18	648	22	659	80	4	82	YES	YES	YES	3.3	0.9	3.3
52698	52703	Site 22	519	17	615	17	624	96	0	97	YES	YES	YES	4.0	0.1	4.0
50629	50588	Site 56	437	32	424	14	431	-13	-18	-22	YES	YES	YES	0.6	3.7	1.0
50588	50629	Site 56	448	27	471	26	484	23	-1	22	YES	YES	YES	1.1	0.2	1.0
51363	52614	Site 30	426	166	430	110	485	4	-56	-24	YES	YES	YES	0.2	4.8	1.1
52614	51363	Site 30	466	23	417	20	427	-49	-3	-50	YES	YES	YES	2.3	0.7	2.4
50110	52427	Site 28	564	38	568	49	592	4	11	9	YES	YES	YES	0.1	1.6	0.4
52959	50111	Site 28	578	50	535	61	566	-43	11	-37	YES	YES	YES	1.8	1.5	1.5
52536	50150	Site 31	212	10	166	3	167	-46	-7	-50	YES	YES	YES	3.4	2.6	3.6
50150	52536	Site 31	235	10	248	10	253	13	0	13	YES	YES	YES	0.8	0.0	0.8
53013	52695	Site 25	740	60	791	63	823	51	3	53	YES	YES	YES	1.8	0.4	1.9
52695	53013	Site 25	746	71	737	92	783	-9	21	2	YES	YES	YES	0.3	2.3	0.1
52623	52695	Site 23	909	95	936	112	991	27	17	35	YES	YES	YES	0.9	1.6	1.1
52695	52623	Site 23	841	112	902	115	959	61	3	62	YES	YES	YES	2.1	0.3	2.0
51376	51377	Site 24	377	21	382	22	393	5	1	6	YES	YES	YES	0.3	0.3	0.3
51377	51376	Site 24	427	55	423	55	451	-4	0	-4	YES	YES	YES	0.2	0.0	0.2
50752	52772	Site 37	568	31	369	15	376	-199	-16	-207	YES	YES	YES	9.2	3.3	9.5
50753	52771	Site 41	576	20	773	24	785	197	4	199	NO	YES	NO	7.6	0.8	7.6
52771	50753	Site 41	604	33	480	23	491	-124	-10	-129	YES	YES	YES	5.3	1.8	5.5
50906	55004	Site 4	743	32	765	33	782	22	1	23	YES	YES	YES	0.8	0.2	0.8
50542	52319	Site 6	179	3	190	4	192	11	1	11	YES	YES	YES	0.8	0.4	0.8
55004	50906	Site 4	761	34	768	34	785	7	0	7	YES	YES	YES	0.3	0.0	0.3
52319	50542	Site 6	201	4	189	4	191	-12	0	-12	YES	YES	YES	0.8	0.0	0.8

Turn Count Calibration

Morning Peak Hour

A	B	C	JTC Site	Counts Cars	Modelled Flow Cars	Difference Cars	Flow Criteria Cars	GEH Cars
50035	50107	50353	Site 26 Nov 13	21	25	4	YES	1
50035	50107	52395	Site 26 Nov 13	446	452	6	YES	0
50035	50107	50421	Site 26 Nov 13	139	128	-11	YES	-1
50421	50107	50035	Site 26 Nov 13	51	42	-9	YES	-1
50421	50107	50353	Site 26 Nov 13	75	56	-19	YES	-2
50421	50107	52395	Site 26 Nov 13	49	28	-21	YES	-3
52395	50107	50035	Site 26 Nov 13	288	203	-85	YES	-5
52395	50107	50353	Site 26 Nov 13	40	28	-12	YES	-2
50353	50107	52395	Site 26 Nov 13	259	153	-106	YES	-7
50353	50107	50421	Site 26 Nov 13	221	145	-76	YES	-6
50353	50107	50035	Site 26 Nov 13	53	10	-43	YES	-8
50044	52742		Site 23 Nov 13	387	443	56	YES	3
52766	50049		Site 23 Nov 13	528	530	2	YES	0
50156	50155		Site 23 Nov 13	388	253	-135	YES	-8
50048	51347		Site 23 Nov 13	1330	1129	-201	YES	-6
50050	50044		Site 23 Nov 13	873	469	-404	YES	-16
50043	51372		Site 23 Nov 13	893	1026	133	YES	4
50155	50156		Site 23 Nov 13	282	158	-124	YES	-8
52898	50045		Site 23 Nov 13	583	703	120	NO	5
52596	50413	50129	Site 16 Nov 13	104	85	-19	YES	-2
52596	50413	51573	Site 16 Nov 13	31	28	-3	YES	-1
51573	50413	52596	Site 16 Nov 13	29	26	-3	YES	-1
51573	50413	50129	Site 16 Nov 13	494	640	146	NO	6
50129	50413	51573	Site 16 Nov 13	388	448	60	YES	3
50129	50413	52596	Site 16 Nov 13	38	14	-24	YES	-5
51604	51422	53102	Site 17 Nov 13	22	14	-8	YES	-2
51604	51422	51421	Site 17 Nov 13	26	26	0	YES	0
51604	51422	51580	Site 17 Nov 13	1	1	0	YES	0
51580	51422	51604	Site 17 Nov 13	2	5	3	YES	2
51580	51422	53102	Site 17 Nov 13	16	59	43	YES	7
51580	51422	51421	Site 17 Nov 13	1	1	0	YES	0
51421	51422	51580	Site 17 Nov 13	6	3	-3	YES	-1
51421	51422	51604	Site 17 Nov 13	39	27	-12	YES	-2
51421	51422	53102	Site 17 Nov 13	30	1	-29	YES	-7
53102	51422	51421	Site 17 Nov 13	7	1	-6	YES	-3
53102	51422	51580	Site 17 Nov 13	3	14	11	YES	4
53102	51422	51604	Site 17 Nov 13	6	3	-3	YES	-2
51199	51404	50130	Site 18 Nov 13	862	921	59	YES	2
51199	51404	51606	Site 18 Nov 13	61	27	-34	YES	-5
51606	51404	51199	Site 18 Nov 13	36	34	-2	YES	0
51606	51404	50130	Site 18 Nov 13	54	62	8	YES	1
50130	51404	51606	Site 18 Nov 13	12	7	-5	YES	-2
50130	51404	51199	Site 18 Nov 13	196	182	-14	YES	-1
52260	50642	50654	Site 1	134	86	-48	YES	-5
53057	50642	52260	Site 1	229	331	102	NO	6
53057	50642	50654	Site 1	823	853	30	YES	1
50654	50642	53057	Site 1	316	304	-12	YES	-1
50654	50642	52260	Site 1	102	68	-34	YES	-4
50632	50643		Site 3	295	326	31	YES	2
50643	50632		Site 3	868	844	-24	YES	-1
53056	50638		Site 3	50	62	12	YES	2
50638	53056		Site 3	9	27	18	YES	4
50671	50680		Site 3	813	868	55	YES	2
50680	50671		Site 3	230	237	7	YES	0
50670	50678		Site 3	410	509	99	YES	5
50678	50670		Site 3	480	675	195	NO	8
53061	50677		Site 3	36	36	0	YES	0
50677	53061		Site 3	17	18	1	YES	0
50673	50672	52815	#N/A	584	468	-116	YES	-5
52815	50677	52773	#N/A	977	959	-18	YES	-1
50677	52773	50679	#N/A	145	150	5	YES	0
50679	50676	50675	#N/A	431	449	18	YES	1
50675	50674	50673	#N/A	251	275	24	YES	1
52243	50665	50551	Site 5	208	220	12	YES	1
52243	50665	53060	Site 5	2	2	0	YES	0
52243	50665	55004	Site 5	128	91	-37	YES	-4
55004	50665	52243	Site 5	75	72	-3	YES	0
55004	50665	53060	Site 5	4	0	-4	YES	-3
53060	50665	55004	Site 5	8	0	-8	YES	-4
53060	50665	52243	Site 5	6	5	-1	YES	0
53060	50665	50551	Site 5	34	52	18	YES	3
50551	50665	53060	Site 5	17	6	-11	YES	-3
50551	50665	55004	Site 5	415	498	83	YES	4
50551	50665	52243	Site 5	61	40	-21	YES	-3
50513	50551	50665	Site 5	150	148	-2	YES	0

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55003	50551	50513	Site 5	48	58	10	YES	1
50922	50923		Site 7	1209	1334	125	YES	4
50923	50922		Site 7	548	609	61	YES	3
50523	50914		Site 7	707	491	-216	YES	-9
50914	50523		Site 7	416	418	2	YES	0
50942	52770		Site 7	950	1137	187	NO	6
52770	50942		Site 7	1456	1417	-39	YES	-1
50773	52827		Site 7	132	130	-2	YES	0
52827	50773		Site 7	198	243	45	YES	3
52032	50943		Site 7	177	176	-1	YES	0
50943	52032		Site 7	557	580	23	YES	1
50784	52781	50783	#N/A	498	521	23	YES	1
50783	50782	50781	#N/A	1291	1437	146	YES	4
50781	52770	52769	#N/A	542	510	-32	YES	-1
52770	52769	52826	#N/A	1294	1403	109	YES	3
52826	52825	50784	#N/A	869	954	85	YES	3
50532	52246	52274	Site 28	47	24	-23	YES	-4
50532	52246	50925	Site 28	794	815	21	YES	1
50532	52246	50712	Site 28	8	0	-8	YES	-4
50712	52246	50532	Site 28	5	0	-5	YES	-3
50712	52246	50925	Site 28	168	177	9	YES	1
50925	52246	50712	Site 28	182	206	24	YES	2
50925	52246	50532	Site 28	270	228	-42	YES	-3
50925	52246	52274	Site 28	116	204	88	YES	7
50709	50717	50534	Site 30	458	619	161	NO	7
50709	50717	50716	Site 30	35	40	5	YES	1
50716	50717	50709	Site 30	90	17	-73	YES	-10
50716	50717	50534	Site 30	15	5	-10	YES	-3
50534	50717	50716	Site 30	94	65	-29	YES	-3
50534	50717	50709	Site 30	300	200	-100	YES	-6
52251	52285	50792	Site 34	78	81	3	YES	0
52251	52285	50539	Site 34	227	205	-22	YES	-2
52251	52285	50793	Site 34	40	28	-12	YES	-2
50793	52285	50792	Site 34	207	253	46	YES	3
50793	52285	50539	Site 34	23	10	-13	YES	-3
50539	52285	50793	Site 34	42	6	-36	YES	-7
50539	52285	52251	Site 34	426	456	30	YES	1
50539	52285	50792	Site 34	30	20	-10	YES	-2
50792	52285	50539	Site 34	11	5	-6	YES	-2
50792	52285	50793	Site 34	101	90	-11	YES	-1
50792	52285	52251	Site 34	52	36	-16	YES	-2
50546	50647	53224	Site 32	435	344	-91	YES	-5
50546	50647	53063	Site 32	370	380	10	YES	1
53063	50647	50546	Site 32	206	221	15	YES	1
53063	50647	53224	Site 32	0	6	6	YES	3
53224	50647	53063	Site 32	25	3	-22	YES	-6
53224	50647	50546	Site 32	170	131	-39	YES	-3
51411	51413	51412	Site 43	11	14	3	YES	1
51411	51413	51415	Site 43	31	28	-3	YES	-1
51411	51413	51410	Site 43	3	0	-3	YES	-2
51410	51413	51411	Site 43	26	9	-17	YES	-4
51410	51413	51412	Site 43	59	56	-3	YES	0
51410	51413	51415	Site 43	4	16	12	YES	4
51415	51413	51410	Site 43	3	5	2	YES	1
51415	51413	51411	Site 43	227	166	-61	YES	-4
51415	51413	51412	Site 43	545	409	-136	YES	-6
51412	51413	51415	Site 43	5	1	-4	YES	-2
51412	51413	51410	Site 43	0	3	3	YES	2
51412	51413	51411	Site 43	0	0	0	YES	0
50636	50514	55000	Site 49	944	1080	136	YES	4
50515	50514	50636	Site 49	38	32	-6	YES	-1
50515	50514	55000	Site 49	265	254	-11	YES	-1
55000	50514	50515	Site 49	208	255	47	YES	3
55000	50514	50636	Site 49	328	354	26	YES	1
52315	50695	50540	Site 52	97	75	-22	YES	-2
52315	50695	53225	Site 52	168	195	27	YES	2
53225	50695	52315	Site 52	332	311	-21	YES	-1
53225	50695	50540	Site 52	380	348	-32	YES	-2
50540	50695	53225	Site 52	115	59	-56	YES	-6
50540	50695	52315	Site 52	63	47	-16	YES	-2
50826	50841	50818	Site 51	62	56	-6	YES	-1
50826	50841	50840	Site 51	27	61	34	YES	5
50826	50841	50840	Site 51	46	61	15	YES	2
50840	50841	50818	Site 51	639	932	293	NO	10
50818	50841	50840	Site 51	407	395	-12	YES	-1
50818	50841	50826	Site 51	54	26	-28	YES	-4
50841	50818	52255	Site 42	247	175	-72	YES	-5

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50841	50818	50819	Site 42	454	813	359	NO	14
50819	50818	50841	Site 42	250	260	10	YES	1
50819	50818	52255	Site 42	13	14	1	YES	0
52255	50818	50819	Site 42	81	100	19	YES	2
52255	50818	50841	Site 42	211	162	-49	YES	-4
52704	52705	52706	Site 11	47	2	-45	YES	-9
52704	52705	52707	Site 11	424	487	63	YES	3
52704	52705	53403	Site 11	221	263	42	YES	3
53403	52705	52704	Site 11	296	358	62	YES	3
53403	52705	52706	Site 11	856	873	17	YES	1
53403	52705	52707	Site 11	35	15	-20	YES	-4
52707	52705	53403	Site 11	15	43	28	YES	5
52707	52705	52704	Site 11	289	255	-34	YES	-2
52707	52705	52706	Site 11	282	206	-76	YES	-5
52706	52707		Site 11	483	435	-48	YES	-2
52706	52705	53403	Site 11	717	726	9	YES	0
52706	52705	52704	Site 11	98	93	-5	YES	0
50752	52332	52331	Site 21	179	237	58	YES	4
50752	52332	52811	Site 21	392	371	-21	YES	-1
50752	52332	52333	Site 21	39	3	-36	YES	-8
52333	52332	50752	Site 21	62	81	19	YES	2
52333	52332	52331	Site 21	205	190	-15	YES	-1
52333	52332	52811	Site 21	312	258	-54	YES	-3
52662	52333		Site 21	572	693	121	NO	5
52662	52332	50752	Site 21	340	274	-66	YES	-4
52662	52332	52331	Site 21	34	3	-31	YES	-7
52331	52811		Site 21	23	66	43	YES	6
52331	52332	52333	Site 21	318	285	-33	YES	-2
52331	52332	50752	Site 21	104	156	52	YES	5
50588	50629		Site 18	523	514	-9	YES	0
50629	50588		Site 18	651	656	5	YES	0
50631	50630		Site 18	632	589	-43	YES	-2
50630	50631		Site 18	980	1041	61	YES	2
50553	50625		Site 18	198	184	-14	YES	-1
50625	50553		Site 18	193	193	0	YES	0
52038	51367		Site 18	622	572	-50	YES	-2
51367	52038		Site 18	1103	1157	54	YES	2
50586	50585	50587	#N/A	519	468	-51	YES	-2
50587	52808	52807	#N/A	420	410	-10	YES	0
52807	50553	50908	#N/A	1325	1383	58	YES	2
50553	50908	50586	#N/A	538	535	-3	YES	0
50966	50114		Site 39	165	99	-66	YES	-6
50114	50966		Site 39	137	163	26	YES	2
52664	50751		Site 39	616	665	49	YES	2
50964	52686		Site 39	574	585	11	YES	0
52603	50965		Site 39	600	550	-50	YES	-2
50965	52603		Site 39	449	501	52	YES	2
50752	52772		Site 39	507	510	3	YES	0
52772	50752		Site 39	610	611	1	YES	0
50753	52771		Site 39	544	597	53	YES	2
52771	50753		Site 39	662	563	-99	YES	-4
50751	50114	52771	#N/A	1180	1149	-31	YES	-1
50114	52771	52772	#N/A	683	686	3	YES	0
52771	52772	50965	#N/A	617	672	55	YES	2
52772	50965	50964	#N/A	675	681	6	YES	0
50965	50964	50751	#N/A	701	647	-54	YES	-2
52360	50766		Site 10	485	300	-185	YES	-9
50766	52360		Site 10	297	299	2	YES	0
50762	50767		Site 10	331	254	-77	YES	-5
50767	50762		Site 10	126	80	-46	YES	-5
52688	52689		Site 10	1539	1594	55	YES	1
52768	50963		Site 10	1308	1153	-155	YES	-4
50754	52631		Site 10	187	181	-6	YES	0
52631	50754		Site 10	577	585	8	YES	0
52630	52954		Site 10	953	1045	92	YES	3
52954	52630		Site 10	1187	1257	70	YES	2
52689	50113	50765	#N/A	1636	1746	110	YES	3
50765	50764	52824	#N/A	1670	1700	30	YES	1
52824	52823	52822	#N/A	968	744	-224	YES	-8
52822	52631	52768	#N/A	1344	1204	-140	YES	-4
52768	52689	50113	#N/A	223	231	8	YES	1
52623	52695	50857	Site 13	300	309	9	YES	1
52623	52695	53013	Site 13	532	546	14	YES	1
52623	52695	53390	Site 13	21	21	0	YES	0
53390	52695	52623	Site 13	52	140	88	YES	9
53390	52695	50857	Site 13	111	81	-30	YES	-3
53390	52695	53013	Site 13	13	55	42	YES	7

Turn Count Calibration

Morning Peak Hour

53013	52695	53390	Site 13	66	105	39	YES	4
53013	52695	52623	Site 13	1213	1078	-135	YES	-4
53013	52695	50857	Site 13	385	418	33	YES	2
50622	50932	52041	Site 20	534	473	-61	YES	-3
50622	50932	52039	Site 20	90	70	-20	YES	-2
52039	50932	50622	Site 20	172	132	-40	YES	-3
52039	50932	52041	Site 20	83	73	-10	YES	-1
52041	50932	50622	Site 20	639	863	224	NO	8
50738	50498	50497	Site 22	177	223	46	YES	3
50681	50741	50498	Site 22	7	1	-6	YES	-3
50681	50741	50497	Site 22	372	306	-66	YES	-4
52333	50495	50741	Site 22	728	734	6	YES	0
52333	50495	50497	Site 22	228	247	19	YES	1
50560	52041	50552	Site 48	87	40	-47	YES	-6
50560	52041	50932	Site 48	134	135	1	YES	0
50932	52041	50560	Site 48	68	49	-19	YES	-3
50932	52041	50552	Site 48	549	497	-52	YES	-2
50741	50681	50683	Site 23	614	605	-9	YES	0
50741	50681	52325	Site 23	117	128	11	YES	1
50683	50681	52325	Site 23	74	81	7	YES	1
50683	50681	50741	Site 23	312	301	-11	YES	-1
52942	50737	50740	Site 24	207	262	55	YES	4
52942	50737	50736	Site 24	120	115	-5	YES	0
52942	50737	52941	Site 24	414	462	48	YES	2
50736	50737	52941	Site 24	66	77	11	YES	1
50736	50737	50740	Site 24	31	35	4	YES	1
50740	50737	50736	Site 24	21	18	-3	YES	-1
50740	50737	52941	Site 24	169	181	12	YES	1
52233	50735	52232	Site 25	449	504	55	YES	3
52819	50735	52233	Site 25	14	0	-14	YES	-5
52819	50735	52232	Site 25	46	40	-6	YES	-1
52941	50735	52233	Site 25	333	431	98	YES	5
52941	50735	52232	Site 25	314	288	-26	YES	-1
52303	52284	50747	Site 38	6	0	-6	YES	-3
52303	52284	52293	Site 38	26	21	-5	YES	-1
52303	52284	50795	Site 38	150	190	40	YES	3
50795	52284	52303	Site 38	39	28	-11	YES	-2
50795	52284	50747	Site 38	335	197	-138	YES	-8
50795	52284	52293	Site 38	36	22	-14	YES	-3
52293	52284	50795	Site 38	4	7	3	YES	1
52293	52284	52303	Site 38	11	17	6	YES	2
52293	52284	50747	Site 38	35	39	4	YES	1
50747	52284	52293	Site 38	120	140	20	YES	2
50747	52284	50795	Site 38	321	366	45	YES	2
50747	52284	52303	Site 38	0	0	0	YES	0
50525	50945	50763	Site 54	153	204	51	YES	4
50525	50945	52585	Site 54	431	577	146	NO	7
52585	50945	50525	Site 54	17	22	5	YES	1
52585	50945	50763	Site 54	40	0	-40	YES	-9
50763	50945	52585	Site 54	173	236	63	YES	4
50763	50945	50525	Site 54	23	49	26	YES	4

Turn Count Calibration

Inter-peak Hour

A	B	C	JTC Site	Counts Cars	Modelled Flow Cars	Difference Cars	Flow Criteria Cars	GEH Cars
50035	50107	50353	Site 26 Nov 13	26	7	-19	YES	-4.7
50035	50107	52395	Site 26 Nov 13	185	154	-31	YES	-2.4
50035	50107	50421	Site 26 Nov 13	82	86	4	YES	0.4
50421	50107	50035	Site 26 Nov 13	86	65	-21	YES	-2.4
50421	50107	50353	Site 26 Nov 13	124	110	-14	YES	-1.3
50421	50107	52395	Site 26 Nov 13	37	34	-3	YES	-0.5
52395	50107	50035	Site 26 Nov 13	187	173	-14	YES	-1.0
52395	50107	50353	Site 26 Nov 13	53	44	-9	YES	-1.3
50353	50107	52395	Site 26 Nov 13	54	44	-10	YES	-1.4
50353	50107	50421	Site 26 Nov 13	124	101	-23	YES	-2.2
50353	50107	50035	Site 26 Nov 13	26	6	-20	YES	-5.1
50044	52742		Site 23 Nov 13	412	359	-53	YES	-2.7
52766	50049		Site 23 Nov 13	590	590	0	YES	0.0
50156	50155		Site 23 Nov 13	315	167	-148	YES	-9.5
50048	51347		Site 23 Nov 13	717	679	-38	YES	-1.4
50050	50044		Site 23 Nov 13	390	329	-61	YES	-3.2
50043	51372		Site 23 Nov 13	628	629	1	YES	0.0
50155	50156		Site 23 Nov 13	251	159	-92	YES	-6.5
52898	50045		Site 23 Nov 13	650	678	28	YES	1.1
52596	50413	50129	Site 16 Nov 13	54	34	-20	YES	-2.9
52596	50413	51573	Site 16 Nov 13	26	22	-4	YES	-0.9
51573	50413	52596	Site 16 Nov 13	25	22	-3	YES	-0.7
51573	50413	50129	Site 16 Nov 13	314	379	65	YES	3.5
50129	50413	51573	Site 16 Nov 13	315	375	60	YES	3.2
50129	50413	52596	Site 16 Nov 13	54	38	-16	YES	-2.3
51604	51422	53102	Site 17 Nov 13	7	6	-1	YES	-0.5
51604	51422	51421	Site 17 Nov 13	26	24	-2	YES	-0.5
51604	51422	51580	Site 17 Nov 13	1	1	0	YES	0.1
51580	51422	51604	Site 17 Nov 13	2	1	-1	YES	-0.8
51580	51422	53102	Site 17 Nov 13	4	29	25	YES	6.2
51580	51422	51421	Site 17 Nov 13	2	2	0	YES	0.2
51421	51422	51580	Site 17 Nov 13	3	3	0	YES	0.2
51421	51422	51604	Site 17 Nov 13	29	25	-4	YES	-0.8
51421	51422	53102	Site 17 Nov 13	5	1	-5	YES	-2.7
53102	51422	51421	Site 17 Nov 13	6	1	-5	YES	-3.0
53102	51422	51580	Site 17 Nov 13	4	29	25	YES	6.2
53102	51422	51604	Site 17 Nov 13	7	5	-2	YES	-0.6
51199	51404	50130	Site 18 Nov 13	314	323	9	YES	0.5
51199	51404	51606	Site 18 Nov 13	29	26	-3	YES	-0.5
51606	51404	51199	Site 18 Nov 13	31	27	-4	YES	-0.8
51606	51404	50130	Site 18 Nov 13	21	21	0	YES	0.0
50130	51404	51606	Site 18 Nov 13	20	21	1	YES	0.1
50130	51404	51199	Site 18 Nov 13	298	296	-2	YES	-0.1
52260	50642	50654	Site 1	103	82	-21	YES	-2.2
53057	50642	52260	Site 1	60	27	-33	YES	-5.1
53057	50642	50654	Site 1	345	415	70	YES	3.6
50654	50642	53057	Site 1	412	408	-4	YES	-0.2
50654	50642	52260	Site 1	87	79	-8	YES	-0.9
50632	50643		Site 3	355	380	25	YES	1.3
50643	50632		Site 3	441	444	3	YES	0.1
53056	50638		Site 3	21	36	15	YES	2.8
50638	53056		Site 3	20	35	15	YES	2.9
50671	50680		Site 3	358	362	4	YES	0.2
50680	50671		Site 3	340	368	28	YES	1.5
50670	50678		Site 3	508	532	24	YES	1.0
50678	50670		Site 3	444	468	24	YES	1.1
53061	50677		Site 3	22	22	0	YES	0.0
50677	53061		Site 3	19	18	-1	YES	-0.3
50673	50672	52815	#N/A	177	180	3	YES	0.2
52815	50677	52773	#N/A	666	694	28	YES	1.1
50677	52773	50679	#N/A	247	272	25	YES	1.5
50679	50676	50675	#N/A	582	617	35	YES	1.4
50675	50674	50673	#N/A	263	285	22	YES	1.3
52243	50665	50551	Site 5	65	71	6	YES	0.8
52243	50665	53060	Site 5	3	2	-1	YES	-0.4
52243	50665	55004	Site 5	99	84	-15	YES	-1.6
55004	50665	52243	Site 5	89	64	-25	YES	-2.9
55004	50665	53060	Site 5	7	0	-7	YES	-3.7
53060	50665	55004	Site 5	5	0	-5	YES	-3.2
53060	50665	52243	Site 5	4	4	0	YES	-0.2
53060	50665	50551	Site 5	24	19	-5	YES	-1.1
50551	50665	53060	Site 5	20	21	1	YES	0.2
50551	50665	55004	Site 5	625	684	59	YES	2.3
50551	50665	52243	Site 5	48	111	63	YES	7.0
50513	50551	50665	Site 5	145	269	124	NO	8.6

Turn Count Calibration

Inter-peak Hour

55003	50551	50513	Site 5	20	12	-8	YES	-2.1
50922	50923		Site 7	711	740	29	YES	1.1
50923	50922		Site 7	708	749	41	YES	1.5
50523	50914		Site 7	402	417	15	YES	0.7
50914	50523		Site 7	506	508	2	YES	0.1
50942	52770		Site 7	911	936	25	YES	0.8
52770	50942		Site 7	846	909	63	YES	2.1
50773	52827		Site 7	212	238	26	YES	1.7
52827	50773		Site 7	193	195	2	YES	0.1
52032	50943		Site 7	230	243	13	YES	0.8
50943	52032		Site 7	213	212	-1	YES	0.0
50784	52781	50783	#N/A	588	623	35	YES	1.4
50783	50782	50781	#N/A	793	855	62	YES	2.2
50781	52770	52769	#N/A	354	362	8	YES	0.4
52770	52769	52826	#N/A	1072	1104	32	YES	1.0
52826	52825	50784	#N/A	1071	1129	58	YES	1.8
50532	52246	52274	Site 28	43	22	-21	YES	-3.8
50532	52246	50925	Site 28	580	464	-116	YES	-5.1
50532	52246	50712	Site 28	18	7	-11	YES	-3.1
50712	52246	50532	Site 28	9	0	-9	YES	-4.2
50712	52246	50925	Site 28	71	172	101	NO	9.1
50925	52246	50712	Site 28	197	219	22	YES	1.5
50925	52246	50532	Site 28	261	222	-39	YES	-2.5
50925	52246	52274	Site 28	103	136	33	YES	3.1
50709	50717	50534	Site 30	386	269	-117	YES	-6.4
50709	50717	50716	Site 30	34	13	-21	YES	-4.3
50716	50717	50709	Site 30	52	16	-36	YES	-6.1
50716	50717	50534	Site 30	30	24	-6	YES	-1.1
50534	50717	50716	Site 30	36	15	-21	YES	-4.2
50534	50717	50709	Site 30	339	262	-77	YES	-4.5
52251	52285	50792	Site 34	63	84	21	YES	2.4
52251	52285	50539	Site 34	254	249	-5	YES	-0.3
52251	52285	50793	Site 34	29	34	5	YES	0.9
50793	52285	50792	Site 34	122	132	10	YES	0.9
50793	52285	50539	Site 34	29	25	-4	YES	-0.8
50539	52285	50793	Site 34	41	47	6	YES	0.8
50539	52285	52251	Site 34	258	251	-7	YES	-0.5
50539	52285	50792	Site 34	15	20	5	YES	1.2
50792	52285	50539	Site 34	22	23	1	YES	0.3
50792	52285	50793	Site 34	98	129	31	YES	2.9
50792	52285	52251	Site 34	49	71	22	YES	2.8
50546	50647	53224	Site 32	237	118	-119	YES	-8.9
50546	50647	53063	Site 32	97	216	119	NO	9.5
53063	50647	50546	Site 32	193	220	27	YES	1.9
53063	50647	53224	Site 32	6	9	3	YES	1.0
53224	50647	53063	Site 32	11	16	5	YES	1.4
53224	50647	50546	Site 32	179	157	-22	YES	-1.7
51411	51413	51412	Site 43	1	1	0	YES	-0.5
51411	51413	51415	Site 43	38	52	14	YES	2.1
51411	51413	51410	Site 43	3	4	1	YES	0.6
51410	51413	51411	Site 43	3	2	-1	YES	-0.3
51410	51413	51412	Site 43	6	8	2	YES	0.6
51410	51413	51415	Site 43	5	6	1	YES	0.6
51415	51413	51410	Site 43	7	7	0	YES	0.0
51415	51413	51411	Site 43	36	33	-3	YES	-0.6
51415	51413	51412	Site 43	17	0	-17	YES	-5.8
51412	51413	51415	Site 43	16	13	-3	YES	-0.8
51412	51413	51410	Site 43	4	5	1	YES	0.4
51412	51413	51411	Site 43	2	0	-2	YES	-2.0
50636	50514	55000	Site 49	533	640	107	NO	4.4
50515	50514	50636	Site 49	187	72	-115	YES	-10.1
50515	50514	55000	Site 49	191	100	-91	YES	-7.5
55000	50514	50515	Site 49	204	230	26	YES	1.8
55000	50514	50636	Site 49	496	518	22	YES	1.0
52315	50695	50540	Site 52	46	59	13	YES	1.8
52315	50695	53225	Site 52	122	137	15	YES	1.3
53225	50695	52315	Site 52	125	129	4	YES	0.4
53225	50695	50540	Site 52	229	178	-51	YES	-3.6
50540	50695	53225	Site 52	148	184	36	YES	2.8
50540	50695	52315	Site 52	47	38	-9	YES	-1.4
50826	50841	50818	Site 51	56	54	-2	YES	-0.3
50826	50841	50840	Site 51	24	27	3	YES	0.7
50826	50841	50840	Site 51	29	27	-2	YES	-0.3
50840	50841	50818	Site 51	400	469	69	YES	3.3
50818	50841	50840	Site 51	414	458	44	YES	2.1
50818	50841	50826	Site 51	55	51	-4	YES	-0.6
50841	50818	52255	Site 42	253	251	-2	YES	-0.2

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Inter-peak Hour

50841	50818	50819	Site 42	202	273	71	YES	4.6
50819	50818	50841	Site 42	243	232	-11	YES	-0.7
50819	50818	52255	Site 42	23	42	19	YES	3.4
52255	50818	50819	Site 42	20	45	25	YES	4.3
52255	50818	50841	Site 42	226	276	50	YES	3.2
52704	52705	52706	Site 11	94	100	6	YES	0.6
52704	52705	52707	Site 11	401	334	-67	YES	-3.5
52704	52705	53403	Site 11	204	210	6	YES	0.4
53403	52705	52704	Site 11	216	294	78	YES	4.9
53403	52705	52706	Site 11	539	668	129	NO	5.2
53403	52705	52707	Site 11	31	25	-6	YES	-1.2
52707	52705	53403	Site 11	28	2	-26	YES	-6.6
52707	52705	52704	Site 11	327	245	-82	YES	-4.9
52707	52705	52706	Site 11	301	180	-121	YES	-7.8
52706	52707		Site 11	321	513	192	NO	9.4
52706	52705	53403	Site 11	460	327	-133	YES	-6.7
52706	52705	52704	Site 11	133	116	-17	YES	-1.5
50752	52332	52331	Site 21	121	99	-22	YES	-2.1
50752	52332	52811	Site 21	368	266	-102	YES	-5.7
50752	52332	52333	Site 21	72	0	-72	YES	-12.0
52333	52332	50752	Site 21	92	42	-50	YES	-6.1
52333	52332	52331	Site 21	170	275	105	NO	7.0
52333	52332	52811	Site 21	299	322	23	YES	1.3
52662	52333		Site 21	420	505	85	YES	4.0
52662	52332	50752	Site 21	288	208	-80	YES	-5.1
52662	52332	52331	Site 21	30	25	-5	YES	-1.0
52331	52811		Site 21	42	34	-8	YES	-1.2
52331	52332	52333	Site 21	219	304	85	YES	5.3
52331	52332	50752	Site 21	159	119	-40	YES	-3.4
50588	50629		Site 18	439	471	32	YES	1.5
50629	50588		Site 18	423	424	1	YES	0.0
50631	50630		Site 18	677	597	-80	YES	-3.2
50630	50631		Site 18	748	662	-86	YES	-3.2
50553	50625		Site 18	137	137	0	YES	0.0
50625	50553		Site 18	177	177	0	YES	0.0
52038	51367		Site 18	755	733	-22	YES	-0.8
51367	52038		Site 18	770	711	-59	YES	-2.2
50586	50585	50587	#N/A	608	551	-57	YES	-2.3
50587	52808	52807	#N/A	292	289	-3	YES	-0.2
52807	50553	50908	#N/A	925	864	-61	YES	-2.1
50553	50908	50586	#N/A	354	379	25	YES	1.3
50966	50114		Site 39	197	125	-72	YES	-5.6
50114	50966		Site 39	175	175	0	YES	0.0
52664	50751		Site 39	547	502	-45	YES	-2.0
50964	52686		Site 39	623	740	117	NO	4.5
52603	50965		Site 39	527	421	-106	YES	-4.9
50965	52603		Site 39	427	430	3	YES	0.1
50752	52772		Site 39	535	369	-166	YES	-7.8
52772	50752		Site 39	575	366	-209	YES	-9.6
50753	52771		Site 39	564	773	209	NO	8.1
52771	50753		Site 39	570	480	-90	YES	-3.9
50751	50114	52771	#N/A	1017	864	-153	YES	-5.0
50114	52771	52772	#N/A	644	509	-135	YES	-5.6
52771	52772	50965	#N/A	633	917	284	NO	10.2
52772	50965	50964	#N/A	741	856	115	YES	4.1
50965	50964	50751	#N/A	645	537	-108	YES	-4.5
52360	50766		Site 10	446	449	3	YES	0.2
50766	52360		Site 10	472	473	1	YES	0.0
50762	50767		Site 10	239	265	26	YES	1.6
50767	50762		Site 10	209	209	0	YES	0.0
52688	52689		Site 10	1205	1317	112	YES	3.1
52768	50963		Site 10	1106	944	-162	YES	-5.1
50754	52631		Site 10	415	471	56	YES	2.7
52631	50754		Site 10	424	429	5	YES	0.2
52630	52954		Site 10	692	553	-139	YES	-5.6
52954	52630		Site 10	786	1000	214	NO	7.2
52689	50113	50765	#N/A	1341	1558	217	YES	5.7
50765	50764	52824	#N/A	1158	1351	193	YES	5.4
52824	52823	52822	#N/A	818	800	-18	YES	-0.6
52822	52631	52768	#N/A	1086	924	-162	YES	-5.1
52768	52689	50113	#N/A	395	451	56	YES	2.7
52623	52695	50857	Site 13	260	290	30	YES	1.8
52623	52695	53013	Site 13	520	518	-2	YES	-0.1
52623	52695	53390	Site 13	129	127	-2	YES	-0.1
53390	52695	52623	Site 13	94	114	20	YES	2.0
53390	52695	50857	Site 13	140	143	3	YES	0.2
53390	52695	53013	Site 13	66	52	-14	YES	-1.8

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Inter-peak Hour

53013	52695	53390	Site 13	87	90	3	YES	0.3
53013	52695	52623	Site 13	503	562	59	YES	2.6
53013	52695	50857	Site 13	150	139	-11	YES	-0.9
50622	50932	52041	Site 20	593	480	-113	YES	-4.9
50622	50932	52039	Site 20	98	32	-66	YES	-8.1
52039	50932	50622	Site 20	148	138	-10	YES	-0.9
52039	50932	52041	Site 20	85	53	-32	YES	-3.9
52041	50932	50622	Site 20	621	574	-47	YES	-1.9
50738	50498	50497	Site 22	180	250	70	YES	4.8
50681	50741	50498	Site 22	6	3	-3	YES	-1.7
50681	50741	50497	Site 22	354	388	34	YES	1.8
52333	50495	50741	Site 22	563	622	59	YES	2.4
52333	50495	50497	Site 22	143	187	44	YES	3.4
50560	52041	50552	Site 48	65	52	-13	YES	-1.7
50560	52041	50932	Site 48	89	73	-16	YES	-1.8
50932	52041	50560	Site 48	70	7	-63	YES	-10.1
50932	52041	50552	Site 48	609	525	-84	YES	-3.5
50741	50681	50683	Site 23	489	524	35	YES	1.6
50741	50681	52325	Site 23	89	98	9	YES	1.0
50683	50681	52325	Site 23	57	58	1	YES	0.2
50683	50681	50741	Site 23	313	347	34	YES	1.9
52942	50737	50740	Site 24	139	190	51	YES	4.0
52942	50737	50736	Site 24	127	156	29	YES	2.4
52942	50737	52941	Site 24	412	303	-109	YES	-5.8
50736	50737	52941	Site 24	81	138	57	YES	5.5
50736	50737	50740	Site 24	31	53	22	YES	3.5
50740	50737	50736	Site 24	18	9	-9	YES	-2.4
50740	50737	52941	Site 24	123	146	23	YES	1.9
52233	50735	52232	Site 25	327	363	36	YES	1.9
52819	50735	52233	Site 25	25	0	-25	YES	-7.1
52819	50735	52232	Site 25	45	53	8	YES	1.1
52941	50735	52233	Site 25	326	304	-22	YES	-1.3
52941	50735	52232	Site 25	278	283	5	YES	0.3
52303	52284	50747	Site 38	6	0	-6	YES	-3.5
52303	52284	52293	Site 38	17	15	-2	YES	-0.4
52303	52284	50795	Site 38	67	73	6	YES	0.7
50795	52284	52303	Site 38	65	83	18	YES	2.1
50795	52284	50747	Site 38	388	447	59	YES	2.9
50795	52284	52293	Site 38	51	35	-16	YES	-2.4
52293	52284	50795	Site 38	30	0	-30	YES	-7.7
52293	52284	52303	Site 38	20	7	-13	YES	-3.7
52293	52284	50747	Site 38	128	155	27	YES	2.3
50747	52284	52293	Site 38	172	205	33	YES	2.4
50747	52284	50795	Site 38	359	236	-123	YES	-7.2
50747	52284	52303	Site 38	1	0	-1	YES	-1.4
50525	50945	50763	Site 54	49	67	18	YES	2.4
50525	50945	52585	Site 54	46	121	75	YES	8.2
52585	50945	50525	Site 54	31	54	23	YES	3.5
52585	50945	50763	Site 54	92	118	26	YES	2.6
50763	50945	52585	Site 54	87	25	-62	YES	-8.3
50763	50945	50525	Site 54	57	111	54	YES	5.9

Screenline Validation

Morning Peak Hour

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
2IN	51352	51361	Site 32	730	339	-391
2IN	50043	51372	Site 29	947	1081	134
2IN	52964	53012	Site 52	1180	1187	7
2IN	51378	50860	Site 27	808	526	-282
2IN	51389	51391	Site 50	1165	1489	324
2IN	51065	50137	Site 49	1103	1023	-80
				5,933	**5,644**	**-289**
					Flow Diff (%)	**5%**
					GEH	**4**

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
2OUT	51361	51352	Site 32	292	85	-207
2OUT	52766	50049	Site 29	656	659	3
2OUT	52392	52694	Site 52	370	356	-14
2OUT	50860	51378	Site 27	222	233	11
2OUT	51391	51389	Site 50	324	476	152
2OUT	50137	51065	Site 49	241	367	126
				2,105	**2,176**	**71**
					Flow Diff (%)	**4%**
					GEH	**2**

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
4AIN	50741	50681	Site 42	762	758	-4
4AIN	50738	50739	Site 36	246	272	26
4AIN	50965	52603	Site 39	484	524	40
4AIN	52686	52820	Site 15	622	670	48
4AIN	50754	52631	Site 18	236	220	-16
4AIN	52705	53403	Site 19	1040	1119	79
4AIN	52360	50766	Site 17	558	333	-225
				3,948	**3,895**	**-53**
					Flow Diff (%)	**1%**
					GEH	**1**

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
4AOUT	50681	50741	Site 42	419	336	-83
4AOUT	50739	50738	Site 36	190	233	43
4AOUT	52603	50965	Site 39	703	588	-115
4AOUT	52821	52664	Site 15	710	720	10
4AOUT	52631	50754	Site 18	591	612	21
4AOUT	53403	52705	Site 19	951	1316	365
4AOUT	50766	52360	Site 17	222	314	92
				3,786	**4,119**	**333**
					Flow Diff (%)	**9%**
					GEH	**5**

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
5AIN	50642	50654	Site 1	977	969	-8
5AIN	50549	52253	Site 2	636	553	-83
5AIN	50632	50664	Site 3	488	527	39
5AIN	50551	50513	Site 5	388	703	315
5AIN	50515	52318	Site 7	213	186	-27
5AIN	50943	52032	Site 8	675	602	-73
5AIN	52827	50773	Site 9	236	256	20
5AIN	50942	52235	Site 10	523	618	95
				4,136	**4,415**	**279**
					Flow Diff (%)	**7%**
					GEH	**4**

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
5AOUT	50654	50642	Site 1	380	385	5
5AOUT	52253	50549	Site 2	144	188	44
5AOUT	50664	50632	Site 3	142	81	-61
5AOUT	50513	50551	Site 5	161	157	-4
5AOUT	52318	50515	Site 7	300	349	49
5AOUT	52032	50943	Site 8	181	180	-1
5AOUT	50773	52827	Site 9	154	140	-14
5AOUT	52235	50942	Site 10	187	132	-55
				1,649	**1,612**	**-37**
					Flow Diff (%)	**2%**
					GEH	**1**

Screenline Validation

Inter-Peak Hour

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
2IN	51352	51361	Site 32	235	148	-87
2IN	50043	51372	Site 29	669	669	0
2IN	52964	53012	Site 52	452	468	16
2IN	51378	50860	Site 27	299	267	-32
2IN	51389	51391	Site 50	510	610	100
2IN	51065	50137	Site 49	388	482	94
				2,553	**2,645**	**92**
					Flow Diff (%)	**4%**
					GEH	**2**

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
2OUT	51361	51352	Site 32	262	125	-137
2OUT	52766	50049	Site 29	734	733	-1
2OUT	52392	52694	Site 52	488	463	-25
2OUT	50860	51378	Site 27	315	230	-85
2OUT	51391	51389	Site 50	528	686	158
2OUT	50137	51065	Site 49	387	384	-3
				2,714	**2,620**	**-94**
					Flow Diff (%)	**4%**
					GEH	**2**

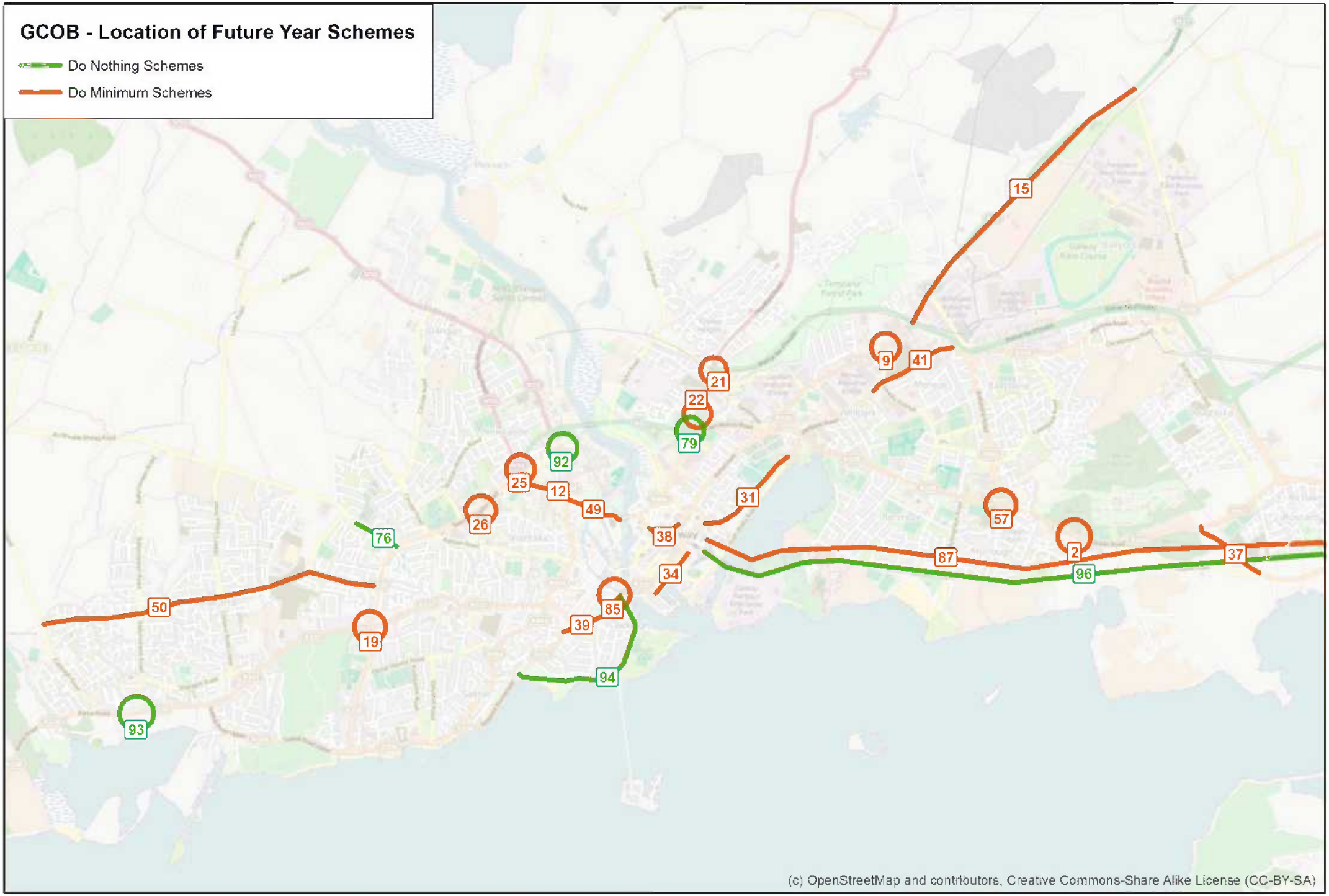
				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
4AIN	50741	50681	Site 42	591	649	58
4AIN	50738	50739	Site 36	167	200	33
4AIN	50965	52603	Site 39	436	442	6
4AIN	52686	52820	Site 15	692	763	71
4AIN	50754	52631	Site 18	493	552	59
4AIN	52705	53403	Site 19	748	600	-148
4AIN	52360	50766	Site 17	564	473	-91
				3,691	**3,679**	**-12**
					Flow Diff (%)	**0%**
					GEH	**0**

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
4AOUT	50681	50741	Site 42	391	421	30
4AOUT	50739	50738	Site 36	210	261	51
4AOUT	52603	50965	Site 39	611	444	-167
4AOUT	52821	52664	Site 15	573	524	-49
4AOUT	52631	50754	Site 18	452	443	-9
4AOUT	53403	52705	Site 19	743	1079	336
4AOUT	50766	52360	Site 17	521	501	-20
				3,501	**3,672**	**171**
					Flow Diff (%)	**5%**
					GEH	**3**

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
5AIN	50642	50654	Site 1	493	513	20
5AIN	50549	52253	Site 2	151	241	90
5AIN	50632	50664	Site 3	280	265	-15
5AIN	50551	50513	Site 5	165	217	52
5AIN	50515	52318	Site 7	287	262	-25
5AIN	50943	52032	Site 8	232	219	-13
5AIN	52827	50773	Site 9	232	209	-23
5AIN	50942	52235	Site 10	389	363	-26
				2,229	**2,289**	**60**
					Flow Diff (%)	**3%**
					GEH	**1**

				Counts	Modelled Flow	Flow Difference
Screenline	A	B	Site	Total (pcu)	Total (pcu)	Total (pcu)
5AOUT	50654	50642	Site 1	517	505	-12
5AOUT	52253	50549	Site 2	161	232	71
5AOUT	50664	50632	Site 3	192	234	42
5AOUT	50513	50551	Site 5	167	283	116
5AOUT	52318	50515	Site 7	354	189	-165
5AOUT	52032	50943	Site 8	239	252	13
5AOUT	50773	52827	Site 9	251	250	-1
5AOUT	52235	50942	Site 10	262	243	-19
				2,143	**2,189**	**46**
					Flow Diff (%)	**2%**
					GEH	**1**

Appendix E: List of Future Year 'Do-Minimum' Schemes


GCOB - Location of Future Year Schemes
Do Nothing Schemes
Do Minimum Schemes
15
9
41
21
22
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N6 Galway City Outer Bypass
Review of City Schemes (Doc Ref. GCOB-4.03-2.1-001)
Committed Projects

Ref.	NTA Ref.	Scheme Name	Scheme Description	Committed / planned	Transportation Option
001		Fairgreen Road Cycleway / Pedestrian Facilities Scheme	The project will involve the introduction of cycling facilities and the upgrading of pedestrian facilities along approximately 300 metres of Fairgreen Road, between Lough Atalia Road and Forster Street. This section of roadway forms the final section of the Dublin to Galway National Cycle Route and links to Ceannt Station for bus and rail services and with the Galway City Coach Station for other bus services.	Committed	"Do Minimum"
002	016	Merlin Park Hospital Bus Access (NTA Plan 16)	Planning and design work: Completion of design development work on this project and the preparation of a statutory planning process application. This project will deliver a new junction and access road with on-road cycleway, approximately 350 metres long commencing at Dublin Road / Galway Crystal junction and finishing at Merlin Park Hospital, providing safer access / egress to Merlin Park Hospital for all road users It will also connect directly to the existing Dublin Road bus lane and, through linking with the UTMC system, will reduce delays for buses exiting Merlin Park.	Committed	"Do Minimum"
003		Eyre Square Pedestrian Crossings	Upgrade pedestrian facilities at the junctions at Eyre Square South / Forster Street / Ceannt Station and Eyre Square South / Victoria Place, thus improving the pedestrian connectivity between Ceannt Station (Iarnród Éireann & Bus Éireann - Expressway Services) and Eyre Square (Bus Éireann - City Services) for pedestrians and public transport users.	Committed	N/A
004	031	Variable Message and Parking Guidance Signs (Phase 3) (NTA Plan 31)	Provision of Phase 3 of the overall Variable Message Signage and Parking Guidance strategy for the city. Providing car parking and traffic information, the signage will allow motorists make informed decisions and minimise the impact of circulating traffic on the network. The signs will be linked to and controlled by the Urban Traffic Management and Control system, which will facilitate the automatic dissemination of traffic and parking information.	Committed	N/A
005	044	Tour Bus Parking (NTA Plan 44)	Implementation of proposals identified in the Tour Bus Parking Study completed in late 2013. The objective is to provide facilities for the parking of tour buses close to the city centre. To be completed in early summer 2014.	Committed	N/A
006		Bus Stop Upgrade	The project will involve the upgrading of bus stops at a number of locations across Galway City and County. These locations will include the following: Moycullen, Bearna, Shangort Road, Monivea Road, Bearna Road and Monivea Road.	Committed	N/A
007		Cycle Parking	Installation of cycle parking at various locations involving the upgrading of existing facilities and the provision of new, high quality cycle parking at Bearna, Moycullen, Oranmore & Clare-Galway in Galway County.	Committed	N/A
008	026	Threadneedle Road Cycleway (NTA Plan 26)	This scheme will link the Western Distributor Road and Seamus Quirke Road Cycleways to the Salthill area and two secondary schools. Comprising two sections of cycleway,the first section is a northbound cyclelane,approximately 350 metres long. commencing at ThreadneedleRoad/SalthillRoad junction and finishing at ThreadneedleRoad/KingstonRoadjunction.The secondsection,approximately 200 metres long, commences at BishopO'DonnellRoad/KingstonRoad junction and finishes at BishopO'DonnellRoad/Western Distributor Road junction.Construction to be completed during 2014.	Committed	"Do Minimum"
009		Tuam Road /Joyce Road Junction Improvement and Bus Prioritisation Scheme	Upgrade of junction of Tuam Road (R336)/Joyce's Road from a priority junction to a signalised junction, to provide bus prioritisation. Project will include widening on approaches, right turn lanes, improved pedestrian and cyclist facilities and linkage to Urban Traffic Management Centre. The junction upgrade will serve all bus operators accessing/egressing Galway via the Tuam Road (R336) and is anticipated to reduce bus journey times by 7-15 minutes during evening peak hours. To be completed in 2014.	Committed	"Do Minimum"
010	002	Bearna Greenway - Route Option Development (NTA Plan 2)	Evaluation of route options for a Greenway cycle route, commencing at Wolfe Tone Bridge and finishing at the western edge of Bearna Village. This is the first step in the development of a 6 kilometre Greenway linking southern Connemara to Galway City via Bearna in County Galway. This stage of the project will identify a route that is most appropriate to the needs of the project, while taking regard of the various environmental and engineering issues along the corridor.	Committed	N/A
011		Pedestrian Improvements	Implementation of pedestrian improvements to enhance permeability and safety for pedestrians at a number of locations in Galway City.	Committed	N/A
012	025	Old Seamus Quirke/Newcastle Roads Bus/Cycle Corridor (NTA Plan 25)	Design and planning in 2013: Development of inbound Bus/Cycle Lane, approximately 950 metres long, commencing at Old Seamus Quirke Road/N6 junction and finishing at Newcastle Road/University Road junction. The Bus/Cycle lane is linked to the Seamus Quirke Road bus lane at the Old Seamus Quirke Road/N6 junction and serves to extend that bus lane towards the city centre via NUI Galway and Galway University Hospital. The bus lane will serve Bus Éireann routes 402, 404 & 405 and Galway City Direct route 412. Anticipated savings of 5-10 minutes in the AM & PM peaks.	Committed	"Do Minimum"
014		Galway Cycle Planner App	Development of a cycle planner app for Galway City similar to the recently launched Dublin Cycle Planner. To be developed by the National Transport Authority in collaboration with Galway City Council.	Committed	N/A
015	027	Tuam Road Bus Corridor Project (NTA Plan 27)	Design and planning in 2014: Design of an inbound bus lane, approximately 2,750 metres long, along the N17 Tuam Road, commencing at the Parkmore Road junction and finishing at the junction with the N6. The bus lane will serve all bus operators entering Galway via the N17. It is anticipated that 7-15 minutes would be saved on bus journeys during the AM peak, following implementation of the project.	Committed	"Do Minimum"
016		Behavioural Change Support Measures	Implementation of behaviour change support initiatives during 2014 to support the introduction of other transport initiatives such as the public bike share scheme to be introduced in 2014. To be developed in conjunction with the National Transport Authority and designed to complement existing measures under Smarter Travel Workplaces, Smarter Travel Campus and Green Schools.	Committed	N/A
017		Transport Model Update	Updating and upgrading the Galway City Transport Model with the new 2011 Census and 2012 National Household Survey data.	Committed	N/A
018		N59 Dangan Upgrade	Upgrade of the N59 Junction at Dangan.	Committed	"Do Minimum"

Review of City Schemes (Doc Ref. GCOB-4.03-2.1-001)
Committed Projects

Ref.	NTA Ref.	Scheme Name	Scheme Description	Committed / planned	Transportation Option
019		Reconfiguration of Threadneedle Road Junction	Right turning movements will be prohibited/removed.	Committed	"Do Minimum"
020		Alteration of the Clybaun Junction on the Western Distributor Road	Upgrade of this junction to a continental style roundabout.	Committed	"Do Minimum"
021	040	Kirwin Roundabout Upgrade (NTA Plan 40)	Proposal to replace the Kirwan Roundabout (N6/N84 junction) with a signalised junction. This is one of three remaining roundabouts on the N6 in the city and is a major congestion point for bus services.	Committed	"Do Minimum"
022		Terryland Right turn lane on the N6	Provision of a right turning lane on the N6 at Terryland.	Committed	"Do Minimum"
025	039	Browne Roundabout Upgrade (NTA Plan 39)	Proposal to replace the Browne Roundabout (N6/N59 junction) with a signalised junction. This is one of three remaining roundabouts on the N6 in the city and is a major congestion point for bus services. It is also a major access point for University Hospital Galway for ambulances and patients.	Committed	"Do Minimum"
026		Seamus Quirke Access Road to Tesco.	This involves the addition of a right turning lane on the Seamus Quirke Road and the introduction of a through access from the Seamus Quirke Road to the Old Seamus Quirke Road.	Committed	"Do Minimum"
027	001	Ballybaan Road Cycleway (NTA Plan 1)	On-Road Cycleway, approximately 1,250 metres long. Running on both sides of the road from the Ballybaan Road/N6 junction to the Ballybaan Road/Dublin Road junction.	Committed	"Do Minimum"
028	003	Canal Greenway (NTA Plan 3)	Mixed Greenway, approximately 800 metres long. Running from the University Road/Canal Road junction to the Raven Terrace/Wolfe Tone Bridge junction.	Committed	"Do Minimum"
029	004	Castlepark Road Cycleway (NTA Plan 4)	Cycle Lanes, approximately 1,250 metres long. Running from the Ballybaan Road/Castlepark Road junction to the Castlepark Road/Monivea Road junction.	Committed	"Do Minimum"
030	005	Clybaun Road Cycleway (NTA Plan 5)	Cycle Lanes, approximately 850 metres long. Commencing at Clybaun Road/Kingston Road junction and finishing at Clybaun Road/Western Distributor Road junction.	Committed	"Do Minimum"
031	006	College Road Corridor (NTA Plan 6)	Bus Gate, Situated between City Hall and Sports Ground. The Bus Gate will convert College Road into two Cul-de-sacs, permitting only buses and cyclists to travel from its junction with Lough Atalia to its junction with Bothar Uí hEithir and vice-versa. The project will include Cycle Lanes, approximately 1,100 metres long. Commencing at College Road/Lough Atalia junction and finishing at College Road/Bóthar Uí hEithir Road junction.	Committed	"Do Minimum"
032	007	Cross-Middle St Pedestrianisation (NTA Plan 7)	This will extend the existing Pedestrian Zone southwards to Galway Docks. It will enable the revitalisation of the historic centre of the city.	Committed	"Do Minimum"
033	008	Dangan Greenway (NTA Plan 8)	Phase 1 – Off-Road Greenway, approximately 300 metres long. Commencing at University Road and finishing at NUI Galway Car-park (Orbsen Building). Phase 2 – Off-Road Greenway, approximately 750 metres long. Commencing at NUI Galway Car-park (Orbsen Building) and finishing at south of N6 Underpass. Phase 3 – Off-Road Greenway, approximately 2,400 metres long. Commencing at north of N6 Underpass and finishing at Dangan Playing Fields, with link along existing access road to N59. Phase 4 – Off-Road Greenway, approximately 10,000 metres long. Commencing at Dangan Playing Fields and finishing at Moycullen.	Committed	"Do Minimum"
034	009	Dock Road Corridor (NTA Plan 9)	Bus Lane and Cycleway, approximately 500 metres long. Commencing at Victoria Place and finishing at Dock Road/Dock Street junction.	Committed	"Do Minimum"
035	010	Doughiska Road Cycleway (NTA Plan 10)	Phase 1 – On-Road Greenway, approximately 200 metres long. Commencing at Doughiska Road/Brierhill Road junction and finishing at Brierhill Road/Monivea Road junction. Phase 2 – On-Road Greenway, approximately 1,000 metres long. Commencing at Doughiska Road/Merlin Park Lane junction and finishing at Doughiska Road/Coast Road junction.	Committed	"Do Minimum"
036	011	Dr Mannix Road Cycleway (NTA Plan 11)	On-Road Greenway, approximately 1,600 metres long. Commencing at Dr. Mannix Road Road/Threadneedle Road junction and finishing at Ocean Wave/Whitestrand Road junction.	Committed	"Do Minimum"
037	012	Dublin Road Bus Lane (NTA Plan 12)	Inbound Bus Lane, approximately 300 metres long. Commencing South-east of the Coast Road/Dublin Road junction and finishing at the junction.	Committed	"Do Minimum"

Review of City Schemes (Doc Ref. GCOB-4.03-2.1-001)
Committed Projects

Ref.	NTA Ref.	Scheme Name	Scheme Description	Committed / planned	Transportation Option
038	013	Eglinton Street Shared Space (NTA Plan 13)	Phase 1 - A Shared Space, approximately 200 metres long. Commencing at Eglinton Street/Mary street junction and finishing at Williamsgate Street/Eyre Square junction. Phase2 - A Shared Space, approximately 200 metres long. Commencing at Eyre Square/Williamsgate Street junction and finishing at Eyre Square/Bohermore Road junction.	Committed	"Do Minimum"
039	014	Fr Griffin Road Corridor (NTA Plan 14)	Phase 1 – Inbound Bus/Cycle Lane, approximately 400 metres long. Commencing at Fr. Griffin Road/Whitestrand Road junction and finishing at Fr. Griffin Road/Fairhill junction. Phase 2 – Inbound & Outbound Bus/Cycle Lanes, approximately 200 metres long. Commencing at Fr. Griffin Road/Fr. Burke Road junction and finishing at Wolfe Tone Bridge.	Committed	"Do Minimum"
040	015	Headford Road Cycleway (NTA Plan 15)	Phase 1 – Cycle Lanes, approximately 700 metres long. Commencing at Headford Road/Wood Quay junction and finishing at Headford Road/Sean Mulvoy Road junction. Phase 2 – Cycle Lanes, approximately 1,200 metres long. Commencing at Headford Road/Coolagh Road junction and finishing at Headford Road/Bóthar na Coiste junction. Phase 3 – Cycle Lanes, approximately 2,250 metres long. Commencing at Headford Road/ Bóthar na Coiste junction and finishing at Ballindooley Cross.	Committed	"Do Minimum"
041	017	Monivea Road Corridor (NTA Plan 17)	Phase 1 – Outbound Bus/Cycle Lane, approximately 200 metres of Bus/Cycle Lane and a further 500 metres of Cycle lane . The Bus/Cycle lane commences at Mervue Industrial Estate and finishes at Monivea Road/Connolly Avenue junction. The additional 500 metres of cycle lane commences at Moneenageisha Cross and links into the Bus/Cycle lane. Phase 2 – Inbound Bus/Cycle Lane, approximately 700 metres long. Commencing at Monivea Park and finishing at Monivea Road/Connolly Avenue junction. Phase 3 – Cycle Lanes, approximately 1,750 metres long. Commencing at Monivea Road/Ballybaan Road junction and finishing at Monivea Road/Brierhill Road junction. Phase 4 – Cycle Lanes, approximately 3,750 metres long. Commencing at Monivea Road/Parkmore Road junction and finishing at Monivea Road/N18 junction.	Committed	"Do Minimum"
042	018	Newtownsmith Cycleway (NTA Plan 18)	In-Bound Cycle Lane, approximately 550 metres long. Commencing at Newtownsmith/Salmon Weir Bridge junction and finishing at Nicholas Street/Dock Road junction.	Committed	"Do Minimum"
043	019	Oran Mor Greenway (NTA Plan 19)	Phase 1 – On-Road Greenway, approximately 5,500 metres long. Commencing at Órán Mór and finishing at Dublin Road/Ballybaan Road junction. Phase 2 – On-Road Greenway, approximately 1,750 metres long. Commencing at Dublin Road/Ballybaan Road junction and finishing at Moneenageisha Cross.	Committed	"Do Minimum"
044	020	Parkmore Road Cycleway (NTA Plan 20)	Cycle Lanes, approximately 900 metres long. Commencing at Parkmore Road/Monivea Road junction and finishing at Parkmore Roundabout.	Committed	"Do Minimum"
045	021	Race Course Cycleway (NTA Plan 21)	Off-Road Greenway, approximately 2,750 metres long. Running from the Ballybaan Road/N6 junction to the Racecourse Avenue/Parkmore Road junction.	Committed	"Do Minimum"
046	022	Rahoon Road Bus Lane (NTA Plan 22)	Inbound Bus Lane, approximately 400 metres long. Commencing at Rahoon Cemetery and finishing at Rahoon Road/Bishop O'Donnell Road junction. Outbound Cycle Lane, approximately 550 metres long. Commencing at Rahoon Road/Bishop O'Donnell Road junction and finishing at Rahoon Road/Millers Lane junction.	Committed	"Do Nothing"
047	023	Renmore Cycleway (NTA Plan 23)	Mixed Greenway, approximately 3,500 metres long. Commencing at Dublin Road/Ballyloughan Road junction and finishing at Galway Harbour.	Committed	"Do Minimum"
048	024	Siobhan McKenna Road Cycleway (NTA Plan 24)	Phase 1 - Siobhan McKenna Road – Cycle Lanes, approximately 1,000 metres long. Commencing at Circular Road/Siobhan McKenna Road junction and finishing at Siobhan McKenna Road/Thomas Hynes Road junction. Phase 2 - Thomas Hynes Road – Cycle Lanes, approximately 1,200 metres long. Commencing at Seamus Quirke Road/Thomas Hynes Road junction and finishing at Thomas Hynes Road/Newcastle Road junction. Phase 3 - Circular Road – Cycle Lanes, approximately 700 metres long. Commencing at Seamus Quirke Road/Circular Road junction and finishing at Circular Road/Cnoic an Oir junction.	Committed	"Do Minimum"
049	028	University Road Corridor (NTA Plan 28)	Inbound Bus/Cycle Lane, approximately 400 metres long. Commencing at Newcastle Road/University Road junction and finishing at the Salmon Weir Bridge.	Committed	"Do Minimum"
050	029	Western Distributor Road Corridor (NTA Plan 29)	Phase 1 – Inbound Bus Lane, approximately 600 metres long. Commencing at Gort na Bro/Western Distributor Road junction and finishing at Western Distributor Road/Bishop O'Donnell Road junction. Phase 2 – Inbound Bus Lane, approximately 2,400 metres long. Commencing at Western Distributor Road/Cappagh Road junction and finishing at Gort na Bro/Western Distributor Road junction.	Committed	"Do Minimum"

Review of City Schemes (Doc Ref. GCOB-4.03-2.1-001)
Committed Projects

Ref.	NTA Ref.	Scheme Name	Scheme Description	Committed / planned	Transportation Option
051	030	City Centre 30kph Zone (NTA Plan 30)	Proposal to establish a 30kph zone in the City Centre. Initial Study to determine extent of zone and possible one way traffic flows & turning prohibitions. The second phase will include the production of Tender Documents, any assessments required for planning and the implementation of the zone.	Planned	"Do Minimum"
052	032	CCTV Phase2 (NTA Plan 32)	Provision of CCTV cameras at various signalised junctions in Galway City & County.	Committed	N/A
053	033	UTMC Expansion (NTA Plan 33)	Continued expansion of the Urban Traffic Management & Control System in Galway City and to incorporate Traffic Signals in Galway County, to include the towns of Maigh Cuillínn, Órán Mór, Tuam, Ballinasloe, Loughrea and Baile Chlair.	Committed	"Do Minimum"
054	034	Freight Management (NTA Plan 34)	Proposal to examine options for the improvement of Freight Management & Movements in the Galway Metropolitan Smarter Travel Area (City & County). Options to be examined as part of the study include the possible development of a freight distribution hub.	Committed	N/A
055	035	Cycle Network Signage (NTA Plan 35)	Proposal to Install Cyclist Road Signage in the Galway Metropolitan Smarter Travel Area (City & County). Initial Study to determine sign locations based on Walking and Cycling Strategies developed by Galway City & County .	Committed	N/A
056	036	Coolagh P&R (NTA Plan 36)	Carry-out a feasibility study of the location, including production of a preliminary design. The production of Tender Documents for the site, may also be required depending on the conclusions of the feasibility report. The proposed site is at the end of the Dublin to Galway Motorway and at the main access point for traffic entering the city for South, East & North East Galway.	Planned	N/A
057	037	Skerrit Roundabout (NTA Plan 37)	Replacement of the Skerrit Roundabout (Dublin Road/Ballybaan Road junction) with a signalised junction. This is the only remaining un-signalised major junction on the Dublin Road Corridor.	Committed	"Do Minimum"
058	038	Cemetery Cross (NTA Plan 38)	Replacement of the Cemetery Cross Roundabout (Tuam Road/Bohermore Road junction) with a signalised junction. This is one of the three most critical junctions in the city and is a major congestion point for bus services.	Committed	"Do Minimum"
059	041	Wolfe Tone Bridge (NTA Plan 41)	Study to examine options for the improvement of bus, cycling and pedestrian movement at this river crossing location, having regard to its busy traffic function. Options to be examined as part of the study include possible conversion to one way traffic flow, signal controlled shuttle traffic running and the construction of a new bridge. Any low cost measures outlined in the study to be implemented where practicable	Planned	N/A
060	042	Salmon Weir Bridge (NTA Plan 42)	Produce a Design and Tender Documents for a new river crossing in the vicinity of the existing Salmon Weir Bridge, having regard to its busy traffic function. The proposal would also include carrying out any necessary assessments that may be required as part of the planning process.	Planned	N/A
061	043	Cathedral Parking (NTA Plan 43)	Study to examine options for the improvement of coach & car parking at Galway Cathedral and cycling & pedestrian movements at this location. The area is a major hub for tour coaches and also for student and commuter bus services.	Committed	"Do Minimum"
062	045	School Zones (NTA Plan 45)	Proposed study to examine options for the improvement of car, cycling and pedestrian movements at the city's schools. Options to be examined as part of the study include traffic flow & parking restrictions, drop off points and speed limiting. As with other urban centres, school traffic has a large negative impact on road safety and traffic management.	Committed	N/A
063	046	Miller's Lane (NTA Plan 46)	Off-Road Pedestrian way, approximately 1km long. Commencing at Kingston Road and finishing at Rahoon Road. The scheme will involve the upgrading of an existing pedestrian route.	Committed	"Do Minimum"
064	047	Galway Bike Scheme (NTA Plan 47)	-	Committed	"Do Minimum"
065	048	Menlo Area Traffic Plan (NTA Plan 48)	-	Committed	N/A
066	049	Coach-Bus Station Link (NTA Plan 49)	-	Committed	N/A
067	050	Way-finding (NTA Plan 50)	-	Committed	N/A
068		Wellpark Road/Connolly Avenue Junction Improvements (Allocations 2012)	Proposal to upgrade the Wellpark Road/Connolly Avenue junction in advance of bus lane works being carried out on Wellpark Road (see 15 below) to include widening the approaches to the junction to provide right turning lanes, upgrading of signals, provision of pedestrian facilities and provision of vehicle detection incorporating a link to the Urban Traffic Management Centre. Vehicle detection and link to UTMC will allow priority to be given to buses at the junction.	Committed	"Do Nothing"
070		Footpath Widening at Bridge Street (Allocations 2012)	Proposal to widen the southern footpath on Bridge Street between the Cross Street junction and the Dominick Street Lower junction. The footpath is restricted in width at present whilst catering for significant numbers of pedestrians. Includes works to O'Brien's Bridge.	Committed	"Do Nothing"
071		Improvements to Bus Routes (Allocations 2012)	Realignment of the junction between the Headford Road and Tirellan Heights to allow access for Route No. 7 bus which currently cannot negotiate the turn from Headford Road in to Tirellan Heights, resulting in inbound buses not being able to appropriately serve the Tirellan Heights area. In addition, it is proposed to upgrade a number of bus stops with Kassel Kerbs and upgraded shelters.	Committed	"Do Nothing"

Review of City Schemes (Doc Ref. GCOB-4.03-2.1-001)
Committed Projects

Ref.	NTA Ref.	Scheme Name	Scheme Description	Committed / planned	Transportation Option
072		Variable Message and Parking Guidance Signs (Allocations 2012)	Phase 2 of the provision of Variable Message Signs (VMS) and Parking Guidance Signs in city centre and on approaches to the city centre on non-national routes. The signs will link into the urban traffic management and control system currently under construction (See 2 above). The signs will allow the dissemination of information to drivers on availability of car parking, traffic incidents, journey times and other information.	Committed	"Do Nothing"
073		NUI Galway to Fisheries Field Greenway (Allocations 2012)	Continuation of construction of the Greenway from the Clifden Road (N59) entrance to the NUI Galway Playing Fields to Galway Cathedral on University Road. Forms part of the Galway to Clifden Cycle Route. The route in its entirety passes through NUI Galway grounds. At the southern end it would link to Fisheries Field Bridge (currently under construction) and the previously constructed Fisheries Field Greenway which links to Galway City Centre.	Committed	"Do Nothing"
075		CCTV Cameras at Junctions (Allocations 2012)	Provision of CCTV cameras at various locations in Galway City to facilitate better traffic management through improved monitoring. The works will include the installation of poles, or extensions to existing poles, ducting if required, cabling and communications back to the Urban Traffic Management Centre (UTMC).	Committed	"Do Nothing"
076		Rahoon Road Bus Lane (Allocations 2012)	Provision of an eastbound bus lane on Rahoon Road between the junctions with Cruachan Park and Bishop O'Donnell Road. In conjunction with this, a cycle lane will be provided in the westbound direction. The total length of the scheme is approximately 350m and will provide approximately 320m of bus lane. The scheme received Part 8 approval in November 2011, and is due to commence construction in June 2012. The scheme will primarily be used by City Direct bus routes 33, 34 and 35.	Committed	"Do Nothing"
077		Merlin Transport Corridor (Allocations 2012)	Proposed bus only link incorporating pedestrian and cycling facilities (Greenway) between the Dublin Road and the N6 Coolagh Roundabout Junction. Funding in the current year is for the commissioning of a study to access the potential of alternative routes using existing infrastructure.	Planned	"Do Minimum"
079		Junction Upgrades Galway City	Upgrade of Junctions at Briarhill, Ballybaan, N17 Tuam Road and Terryland	Committed	"Do Nothing"
080		Galway Transportation Unit	Include for all upgrades and improvements which have resulted from the establishment of the Galway Transportation Unit.	Committed	"Do Nothing"
081		M17M18 Motorway	Account for the construction of the M17M18 and the effects it is likely to have on the way traffic approaches Galway City. The effects that are anticipated at villages along the existing N18 needs to be considered (Clarinbridge, Ardrahan and Oranmore etc.).	Committed	"Do Minimum"
082		N59 Maigh Cuilinn (Moycullen) bypass	Northern Bypass of Moycullen	Committed	N/A
083		N17 Baile An Chlair (Claregalway) bypass	-	Suspended	N/A
084		Monivea Road / Connolly Av Junction	Add lanes at junction to increase capacity	Constructed	"Base"
085		Fr Griffin road / Raven Terrace	Ban right-turn from Fr Griffin Rd to Raven Terrace and modify Fairhill Rd / Fr Griffin Rd junction	Committed	"Do Minimum"
086		Rail - Ennis to Athenry	Hourly rail service between Athenry & Ennis	Committed	"Do Minimum"
087		Rail - Athenry to Galway	Half Hourly rail service between Athenry & Galway	Committed	"Do Minimum"
088		Rail - Athenry to Tuam	Reopening of an old railway line between Athenry & Tuam	Planned	N/A
089		Rail - Tuam to Claremorris	Reopening of an old railway line between Tuam & Claremorris	Planned	N/A
090		Bus - City services improvement	15min headways on city services at peak hours	Committed	"Do Something" - PT
091		Bus - Commute services improvement	30min headways on commuter services at peak hours	Committed	"Do Something" - PT
092		New Junction - Distillary Road Neigh.	Revised primary junction into NUIG with the downgrade of Distillary Road.	Constructed	"Do Nothing"
093		Bearna Road / Ballymoneen Road Junction	Signalisation Works.	Constructed	"Do Nothing"
094		Traffic Calming Grattan Road / Claddagh Quay	Installation of traffic calming measures.	Constructed	"Do Nothing"
095		BRT	Crosscity Bus Rapid Transit	Planned	"Do Something" - PT
096		Oranmore rail services		Operational	"Do Nothing"
097		Bus - City services improvement	10min headways on all city bus services	Planned	"Do Something" - PT
098		PT Complementary measures	Integrated fares, improved PT interchange, integrated PT information, demand responsive transport, travel plans, car clubs, reduced access to parking	Planned	"Do Something" - PT
099		Park and ride (north and west)	Proposed P&R: one at the western end of the Western Distributor Road, and one at the N17 near Ballybrit. To complement proposed P&R at Coolagh (ref 056)	Planned	"Do Something" - PT
100		Enhanced bus network	Amended and/or extended routes of existing services	Planned	"Do Something" - PT

Appendix F: NTA NDFM Development Report

Modelling Services Framework

NDFM Development Report

Model Release Version 3

July 2015

National Transport Authority,
Dun Scéine,
Harcourt Lane,
Dublin 2.

DOCUMENT IDENTIFICATION TABLE	
Client/Project owner	National Transport Authority
Title of Document	National Demand Forecasting Model Development Report
Task Order	004
Task	Phase 4/5
Version	1.8
Document Status	For final client review

DOCUMENT STATUS TABLES

Version 1.0

	Name	Position	Date
Originated by	Chris Cullen	Senior Consultant	28/01/2015
Checked by	Seán Kearns	PM	11/02/2015
Approved by			
NTA Reviewer			

Version 1.2

	Name	Position	Date
Originated by	Seán Kearns	PM	12/02/2015
Checked by	Chris Cullen	Senior Consultant	13/04/2015
Approved by			
NTA Reviewer			

Version 1.6

	Name	Position	Date
Originated by	Chris Cullen	Principal Consultant	04/05/2015
Checked by	Seán Kearns	PM	05/05/2015
Approved by			
NTA Reviewer			

Version 1.8

	Name	Position	Date
Originated by	Chris Cullen	Principal Consultant	06/07/2015
Checked by	Paul Gray	Associate Director	07/07/2015
Approved by			
NTA Reviewer			

Contents

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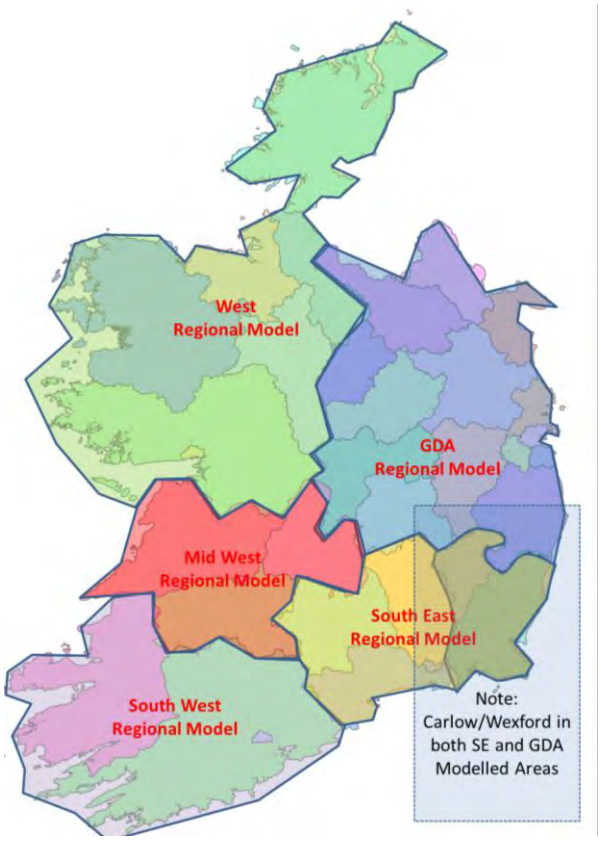
1 Background

1.1 Introduction

As part of the Modelling Services Framework (MSF), the National Transport Authority (NTA) has commissioned the development of a system of strategic models for each city-region in Ireland. These are shown in the boundary map below.



The National Demand Forecasting Model (NDFM) provides inputs to each of the regional models, including:

- Greater Dublin Area Regional Model
- South West Regional Model (Cork City)
- West Regional Model (Galway City)
- Mid West Regional Model (Limerick City)
- South East Regional Model (Waterford City).

The NDFM includes the set of models and tools that are used to derive levels of trip making (nationally) from planning data for input to each of the regional models. The NDFM outputs levels of trip making at the smallest available spatial aggregation (Census Small Area or CSA).

This version of the report corresponds to the third release version of the NDFM, which catalog is labelled *NDFM_20150706_V1_3.CAT*.

The key components of the NDFM are as follows:

- The **Planning Data Adjustment Tool** (PDAT), which controls the planning data inputs to the core NDFM system, and is used to amend planning data to represent the combination of general changes over time and the relevant land-use planning scenarios;

- The **Car Ownership/Car Competition Model**[1], a spreadsheet model which estimates the level of car ownership in a CSA, (sub-dividing the number of households in the CSA between 'No Car', 'Cars < Adults' and 'Cars >= Adults' households);
- The **National Trip-End Model (NTEM)**, which converts the planning data into person trips, using the calculations described in this report;
- The **Car Availability** Model, which classifies the set of individual person trips as either 'Car Available' or 'Car-not-available' using calibrated relationships between the three car competition bands and the trip purpose; and
- The **Regional Model Strategic Integration Tool (RMSIT)**, which estimates the level of trip-making by main mode (car, bus, rail and goods vehicles) between 56 of the main urban settlements (including ports and airports) in Ireland.

Figure 1 shows the system of NDFM models and the key regional model components that the NDFM interacts with.

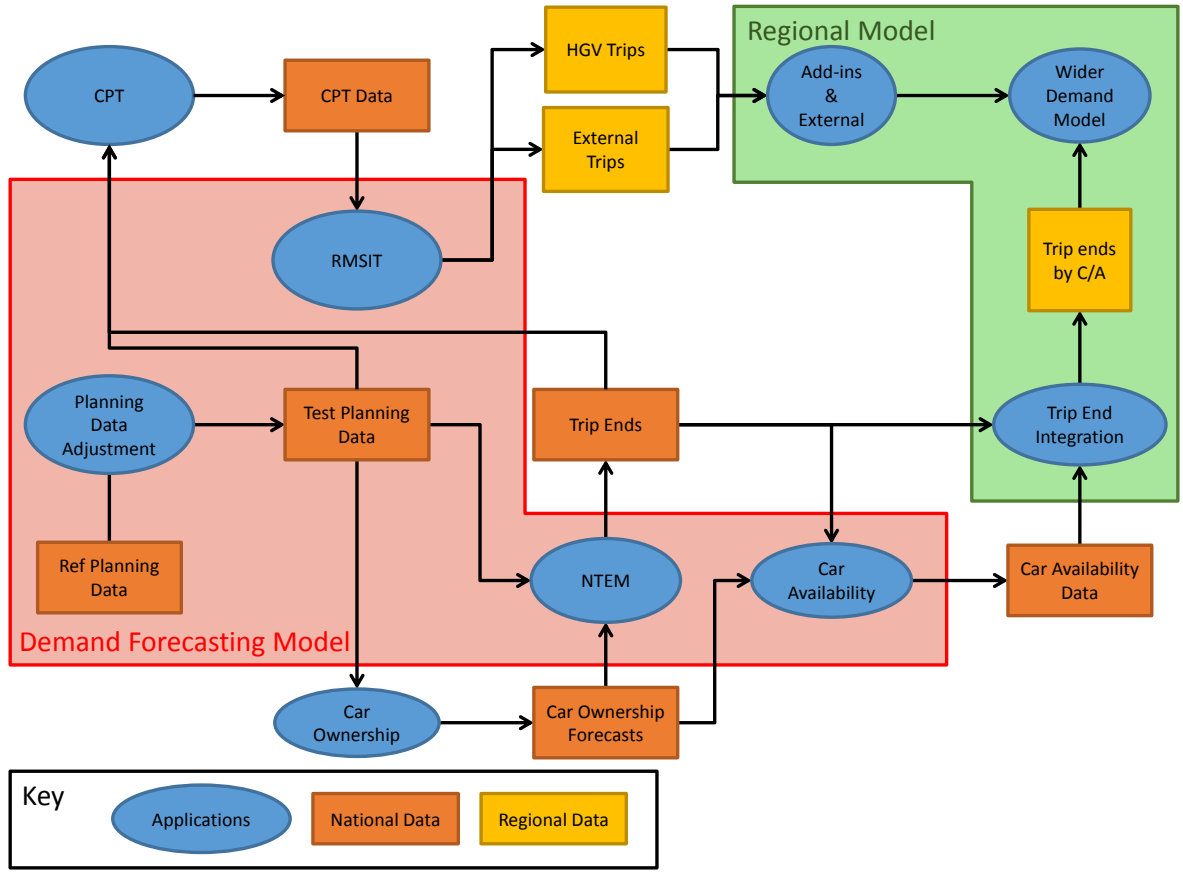


Figure 1 NDFM Placement within Modelling Hierarchy

Each regional model performs the following processing steps to utilise the NDFM output:

- Amalgamation of the CSA-based trip-ends to the relevant model zoning system;
- Amalgamation and/or splitting of the zone purposes to match the relevant demand model demand segments (e.g. splitting commuting trips between 'blue collar' and 'white collar' demand segments); and

[1] Specified in the Task 8.1.5 Car Ownership Modelling Scoping Report

- Incorporation of the relevant information from the RMSIT (i.e. trips to/from external zones and goods vehicle growth etc.).

An expanded diagram is shown below which covers the interactions between the various modelling systems in more detail.

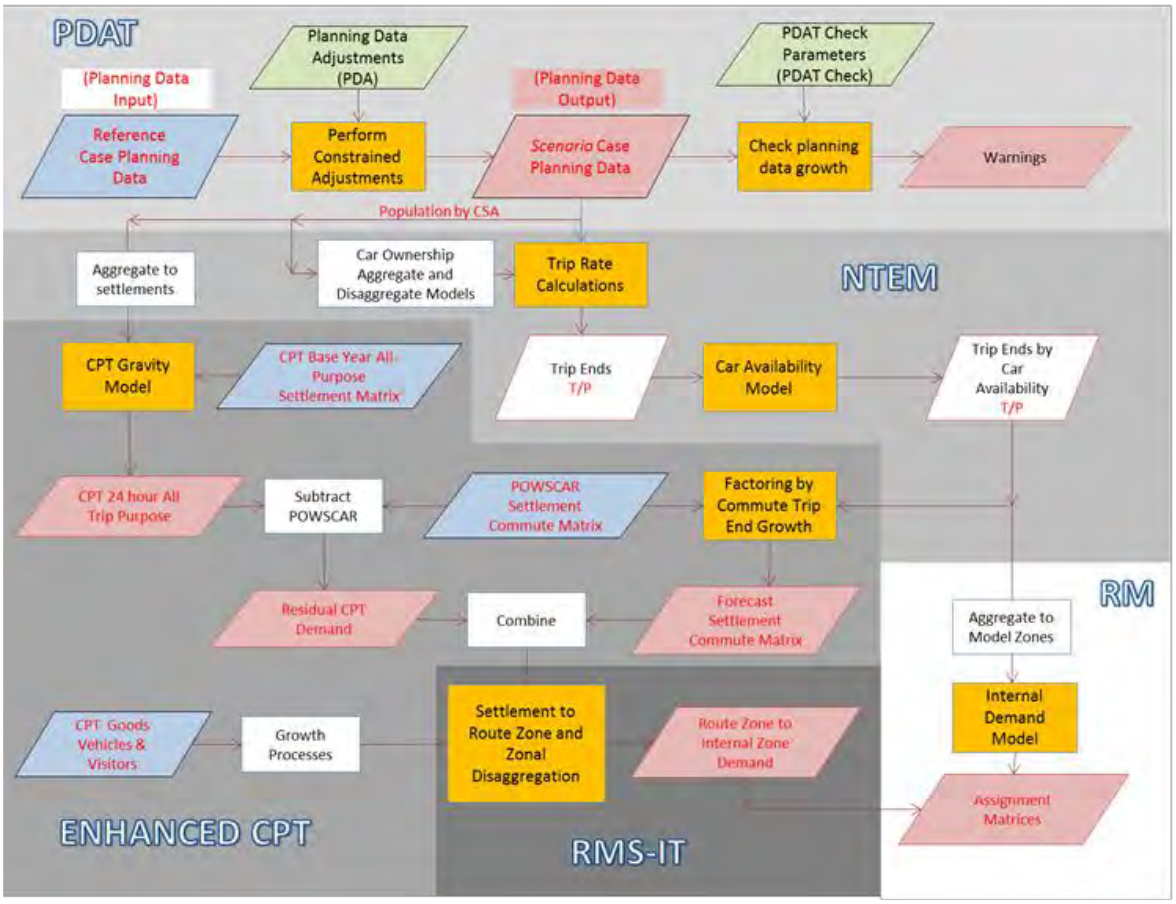


Figure 2 Expanded National Modelling System

2 Planning Data Adjustment Tool

2.1 Overview

The PDAT software tools prepare and check the planning data forecasts which are used by the NTA's Trip End Model and the National Car Ownership Model to create forecast travel demand for the various regional multi-modal transport models.

The PDAT governs two aspects of the planning data used by the model: growth and checking. Two processes provide these functions within the NDFM and each is implemented as its own application.

The 'Planning Data Growth' aspect of PDAT applies a set of user-defined growth factors to an input 'Reference Case' planning data file, to create a future land-use 'forecast' – this tool can be used by the NTA and other users of the regional models to facilitate the production of internally-consistent planning data forecasts.

The 'Planning Data Checking' element of the PDAT (the PCHECK application) compares two land-use data files ('Reference' and 'User') and reports the level of growth in the key variables between them. Warnings are produced when the changes between related variables exceed a set of user-defined limits. This component can be used by the NTA and/or others to check the internal consistency of the 'User' planning data forecasts relative to the corresponding patterns in the 'Reference Case' (which will be either the current base-year data or an existing approved future land-use scenario).

2.2 PDAT Inputs

The inputs to the PDAT are:

- **Planning data** at the Census Small Area (CSA) level for a predefined reference case (e.g. base or standard future year scenarios).
- A **Planning Data Adjustment** file which defines the adjustment to be made to the reference case, subject to certain adjustment constraints.
- A **Check File** that defines, for every planning data variable, what the allowed range of additive or multiplicative change in the value will be at the specified geographic level.
- A **User Sectors File** that defines up a user sector system which is available for the check file as a geographic level.

2.3 The Planning Data

The planning data is a database of 18,488 records of CSA data representing the reference case for various demographic variables. The main categories of planning data are:

- References and spatial definitions;
- Origin-based person types; e.g. age bands, gender, principal economic status (PES), employment type, and various combinations of categories;
- Destination-based person types; e.g. employment type or education type; and
- Households.

The full list of variables can be found in Appendix A.

2.4 The Planning Data Adjustment File

2.4.1 Overview

The Planning Data Adjustment (PDA) file stores user specified adjustments and is used by the PDAT to adjust the reference case planning data. Both the variable to be adjusted and the desired geographic level are specified. The adjustment can be made either on an additive or multiplicative basis. The PDA is in the form of a database of five variables and is linked to via a catalog key.

2.4.2 Use

It is recommended that changes to this file are made based on a copy of the original file supplied with the installation, in order to ensure the correct structure is preserved.

It is also recommended that the planning data should only ever be adjusted using the PDAT tool via the PDA file as it provides a structured approach to alterations and an audit trail for all alterations from the original planning data scenario. Planning data should never be structurally altered (e.g. adding, removing, or reordering variables), as this may render the PDAT unable to process the data.

The column width and decimals are given below in a description of the planning data file as they must be in that format for PDAT

Table 1 Planning Data Adjustment File Structure

Field	Type	Width (Dec)	Notes
Variable	String	20	Must take **a value** of one the Planning Data variables (see Appendix A).
Alpha (α)	Numeric	10.5	Specified multiplicative adjustment
Beta (β)	Numeric	10.5	Specific additive (absolute) adjustment
Apply	String	70	Must take **a value** of the following geography specific variables: CSA, DED, NUTS3, USER, GLOBAL. The PDAT automatically recognises which geography an Apply value belongs to.
Constrain	String	20	Must be one of the following 6 values: CSA, DED, NUTS3, USER, GLOBAL, UNCON. Assuming that the overall planning data total cannot change, this is the level at which the Alpha or Beta adjustment total is constrained. [Note that if Constrain is set to the same value as the geography of the Apply value, then there will be no change in the planning data].

Each entry in the PDA is applied in sequence from the top to bottom of the file. This control line or argument will then implement a series of changes which will be discussed below.

2.4.3 Initial Mathematical Adjustment

The initial adjustment will be the application of the two mathematical factors—α and β—to the reference data. These will alter the original value of a field as

$$Field_{Adj} = \alpha \times Field_{Ref} + \beta$$

The adjustment will be applied at the spatial area dictated by the Apply value (see table 1 above). Other spatial areas as specified by the Constrain value will also be adjusted, and may also further impact other fields as governed by the dependencies. Constrain and dependency functionality are discussed further below.

2.4.4 Geographic Changes

The PDAT works on a series of geographies, specifically:

- Census Small Area (CSA);
- Divisional Electoral Division (DED);
- Nomenclature of Territorial Units for Statistics (NUTS3);
- The National level (Global[2]); and
- User defined sector (User).

The PDA therefore has the following geography-level fields:

- OBJECT_ID;
- ALPHAMERIC;
- SMALL_AREA
- NUTS3_NAME;
- DED_NAME;
- USER_SEC.

All of these are standard spatial references except the last field, which is user specified.

2.4.5 User Sectors

User sectors are defined using a single file located in the base scenario. The location is always

{CATALOG_DIR}\Planning_Data\{Base_Scenario}\NTEM_User_Sectors.DBF

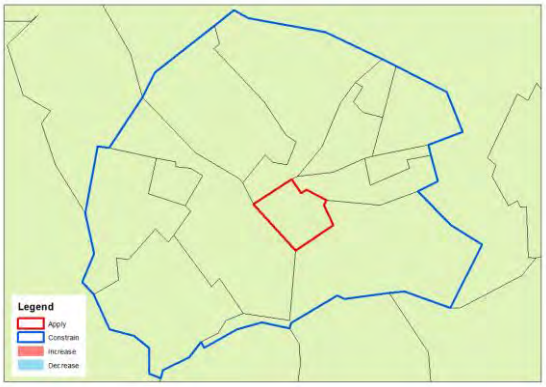
User sector values must be alphanumeric, not numeric, and so a value of "1" is invalid, but "A1" is acceptable. The above list is ordered by increasing magnitude with the exception being the user-defined sectors, which can be comprised of any combination of CSAs and therefore cannot be ranked.

If the User Sectors are to be changed it is recommended that a copy of the original planning data scenario is made, either within Windows or using a PDA file with no changes specified, and then the new scenario has the user sectors changed. This again allows the audit trail or record of changes to be preserved for future users.

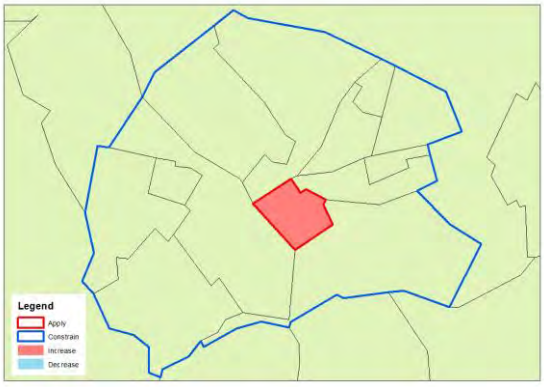
[2] The term global is used here to reflect that it covers the entire model area

2.4.6 PDAT Calculation Example

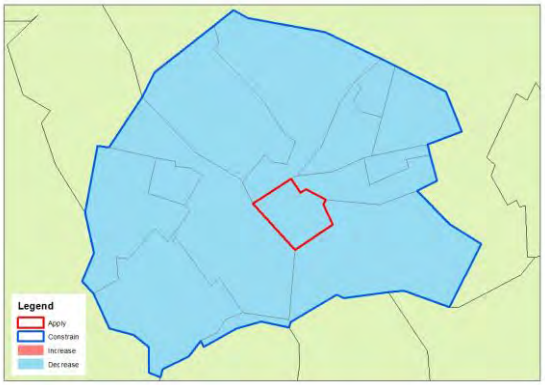
The figure below shows the sequence of steps that are undertaken when adjusting a planning data variable.



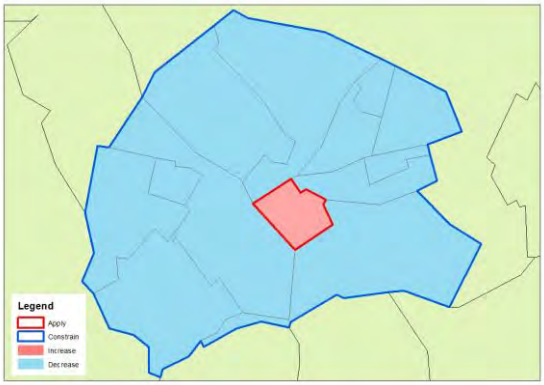
1 Initial Conditions: Everything at reference case levels



2 Preliminary Adjustment: Increase Applied Area



3 Constrain: Reduce all areas within constrained region by a standard proportion



4 Final Changes: Reduced increase in applied area, decrease in remainder of constrained area

Figure 3 Example of Application of Geographic Changes

As a worked example, consider adding 100 to the total population variable in one CSA and increasing that variable in another CSA by 10%. In the example below both CSAs belong to the same DED (Tullow Urban).

The entries in the PDA for the desired adjustment of the two selected CSAs would be:

Variable	Alpha	Beta	Apply	Constrain
T_POP	1	100	017051005	DED
T_POP	1.1	0	017051006	DED

Note that PDAT recognises the value of the Apply string as a CSA. Note also that a PDA entry with an alpha value of 1 and a beta value of 0 results in no change to the specified variable.

The summary of changes are shown in Table 2.

Table 2 Example Calculations Data

SMALL_AREA	DED_NAME	T_POPN	Alpha	Beta	Alpha*T_POPN + Beta	Result
017051005	Tullow Urban	172.00	1.00	**100**	272.00	261.79
017051006	Tullow Urban	197.00	**1.10**	0	216.70	208.56
017051008	Tullow Urban	288.00	1.00	0	288.00	277.19
017051009	Tullow Urban	320.00	1.00	0	320.00	307.98
017051010	Tullow Urban	285.00	1.00	0	285.00	274.30
017051011	Tullow Urban	291.00	1.00	0	291.00	280.07
017051012	Tullow Urban	182.00	1.00	0	182.00	175.17
017051013	Tullow Urban	308.00	1.00	0	308.00	296.43
017051001	Tullow Urban	238.00	1.00	0	238.00	229.06
017051002	Tullow Urban	230.00	1.00	0	230.00	221.36
017051003	Tullow Urban	268.00	1.00	0	268.00	257.94
017051004	Tullow Urban	289.00	1.00	0	289.00	278.15
Total		**3,068.00**			**3,187.70**	**3,068.00**

The T_POPN column is the input data found in the source CSA file. α and β are as configured in the PDA. The shaded column is the direct result of applying the equation α * x + β. The result column is the shaded column constrained to the selected geography, in this case, the total population of the Tullow Urban DED. As can be seen, the sum of the T_POPN column is equivalent to the sum of the result column.

It is worth highlighting that the initial change to the specified CSAs is not directly apparent in the outputs, as the request CSAs have been adjusted to match the constraint area total along with each other CSA in the constraint area. This assumption underpinning this approach is that people are equally likely to move from within the original area as anywhere within the constrained area.

2.4.7 PDA File Checking

A checking mechanism has been included to evaluate the PDA file both for syntax and for logical checks (this is a separate function to PDAT Check, which is discussed in the next section). These checks include:

- The variable must exist and be recognisable by the program;
- The 'apply' (spatial) definition must exist and be recognisable by the program; and
- The 'constrain' (spatial) definition must exist, be recognisable by the program, and contain the apply definition.

It should be noted that the program does not have the functionality to check user defined sectors as they do not have to follow any rules or hierarchy. If these are used in either apply or constrain variable then a warning will be printed requesting the user undertake appropriate checks offline.

2.5 Planning Data Consistency Checking

The PDAT also incorporates a 'Check' sub-application that performs logic checks on the requested planning data adjustments and also checks (and warns users) if the magnitude of adjustments exceed specified thresholds.

Predefined ratios are also used as checks and include:

- Proportion of males;
- Children per households (where children are considered as <15);
- Percentage of labour force in employment, where the labour force is considered as 15+;
- Jobs to employed ratio;
- Primary students to primary places ratio; and
- Five user defined ratios.

Variables may also have an additional series of arguments (columns) in the check file which are used to specify the bounds of what is considered to be a reasonable adjustment in the variable. These include:

- Maximum difference;
- Minimum additive difference;
- Maximum percentage difference;
- Minimum percentage difference;
- Checks; and
- Spatial level.

Each variable has the additive and multiplicative difference evaluated for each geographic area, and these are then compared with the bounds for additive and percentage differences to evaluate whether they lie outside the identified bounds specified in the check file. The user can specify the level of checking to be performed on each variable by specifying one of the following values under Checks in the check file:

- 0: the adjusted values are always reported independent of variation;
- 1: the adjusted values are reported when **either** the additive or multiplicative bounds are breached;
- 2: the adjusted values are reported when **both** additive and multiplicative bounds are breached; and
- 3: the variable is completely ignored for warnings.

Each variable difference (at each spatial level) is then reported in two files, one which states what happens in all spatial regions, and the other which specifically lists those spatial regions with a change in a variable which falls outside the specified bounds (to reduce the data that needs consideration and to provide a targeted summary).

In addition to the geographic summaries, a warning file is created which warns where differences outside the specified bounds were identified at particular geographies (as defined by the spatial level specified in the check file).

It should be noted that the PDAT will always produce the user specified adjustments, regardless of the validity of the change, and therefore it is crucial to check the PCheck outputs for every run.

2.5.1 The PDAT Check File

The check file is linked through catalog keys pointing to specific windows locations, and must take a standard structure. Similar to the PDA file it is strongly recommended that the file is either copied or else just altered rather than recreated; though unlike the PDA file this has no consequence on downstream scenarios and therefore can be altered with less concern. However, it is expected that a standard library of check files will be created to deal with standard levels of variation associated with reference cases.

Table 3 Check File Structure

Field	Type	Notes
ID	Numeric	Numeric identifier, must not be altered
VARIABLE	String	Variable name, must not be altered
MAX_ADD	Numeric	Maximum increase which is considered noise
MIN_ADD	Numeric	Minimum increase which is considered noise
MAX_PER	Numeric	Maximum percentage increase which is considered noise
MIN_PER	Numeric	Minimum percentage increase which is considered noise
CHECKS	Numeric	Indicates required branch, must take a value of 0, 1, 2, or 3 which determines the type of check
LEVEL	String	Must take one of the following values: CSA, DED, NUTS3, USER, GLOBAL
VAR1	Numeric	Must take a value of 0, 1, or 2
VAR2	Numeric	Must take a value of 0, 1, or 2
VAR3	Numeric	Must take a value of 0, 1, or 2
VAR4	Numeric	Must take a value of 0, 1, or 2
VAR5	Numeric	Must take a value of 0, 1, or 2

It should be noted that if either MAX_ADD <= 0 or MIN_ADD <= 0 then the variable will automatically exceed the bounds, and similarly the same applies should MAX_ PER <= 0 or MIN_PER <= 0, and these should be borne in mind when setting up a check file.

The recognisable values which the user specified variables (VAR1-VAR5) can take are either 0, 1, or 2. A 0 indicates the variable is not included in the calculation, while a 1 indicates it is a component of the numerator, and a 2 indicates the denominator. Thus the ratio specified for a user variable is

$$Var = \frac{\sum Fields\ with\ a\ 1}{\sum Fields\ with\ a\ 2}$$

For example, to get the male gender ratio for employed persons, the employed males should have a 1 flag while total employed should have a 2 flag. The variables are evaluated within the process in numerical order so that variable 2 can consider variable 1, but the reverse is not true.

2.5.2 Planning Data Inter-dependencies

The planning data contains a series of variables for each spatial area, and many of these are interdependent. For instance, should overall population increase, then every origin-based person value within the affected spatial areas will have to be altered to reflect this.

Such interdependency requires relevant variables above the affected variable in the 'hierarchy' to have the change carried up, while for the lower levels of the hierarchy a ratio is retained between all variables on that tier.

Appendix B contains a full description of all dependencies within the model, while the figure below gives an indication of the production dependencies used within the model which represent the vast majority of interactions. A key for this diagram is also located within Appendix B.

It should be highlighted that there are actually two versions of the tree available, depending on whether the total of gender-specific version of a variable have been altered. The version shown below is the male specific version, but should the total variable be changed then the tree will be the same except the male-female ratio of each variable, effectively drawing a new tier under each box.

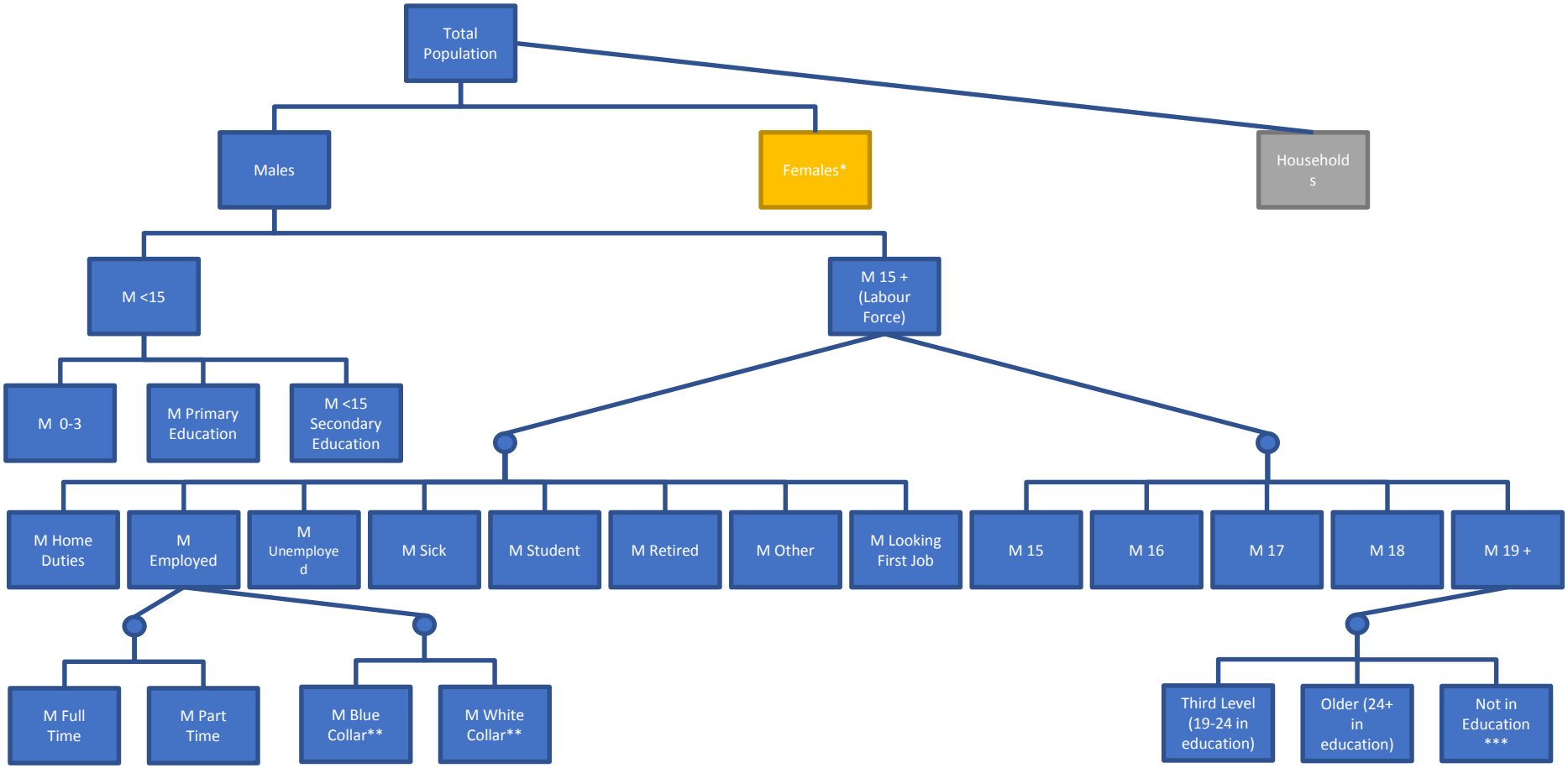
Dependencies are considered for every affected spatial area, that is every area within the constrained region, not just the applied region.

There are some additional assumptions that come into effect in isolated circumstances, in particular, where a total variable is grown from zero such that there is no male/female ratio to retain, an even split is assumed (rather than copy from a higher tier or neighbouring variable).

2.5.3 Operation

Operation of the PDAT is described in more detail in a separate note:

MSF_004.5_NDFM_User_Manual_v1_2_20150504.docx



*Female tree is identical in structure to the male tree
** NTEM Definition of blue/white collar
*** Not related to 'Student' Principal Economic Status

Figure 4 PDAT Production Dependencies

3 Car Ownership / Car Competition Model

3.1 Overview

The car ownership model predicts the number of households or people in each census small area segmented into each of the following competition categories:

- Households with no cars;
- Households with fewer cars than people; and
- Households with the same number or more cars than people.

The model is split into two parts, an aggregate and disaggregate model.

The Aggregate model determines the overall number of cars owned per 1,000 adults and is undertaken at a national level.

The Disaggregate model determines the distribution of cars within each individual small area, with the total number controlled by the output from the Aggregate model based on the number of cars in each household, the number of households (and population) in each competition category.

3.2 Implementation

3.2.1 Aggregate Model

The Aggregate Model is a type of cohort model which predicts car ownership in future years by looking at the impact of population growth/decline and car ownership levels in each age/gender cohort.

The model works by segmenting the population into five-year age and gender cohorts. Each age/gender cohort is given its own car owning characteristics, based on observations over time. To predict ownership levels in future, the cohorts are "aged", with cohorts acquiring cars as they become older (with more disposable income) and then losing them as they enter retirement.

This type of model is specifically tailored to developed countries in Western Europe and the US, where car ownership is at or near saturation. The reasoning behind the model is that older generations grew up when car ownership was not yet firmly established and have continued to have a relatively low motorisation rate (i.e. low saturation of licence holding), whereas younger generations are more likely to have grown up in a car-owning household and therefore have an aspiration to acquire a licence (and a car) as soon as possible. A cohort survival model describes how the older cohorts with low car ownership die out and are replaced by younger generations with much higher saturation level for licence holding. As cohorts age, their income increases and car ownership increases.

The model considers two aspects of car ownership: aspiration/ability and affordability. The second aspect incorporates the impact of the economy on car ownership.

Aspiration and ability predicts the maximum car ownership level for each cohort over time. This assumes that, from the age of 17, the aspiration to own a car will increase following an "S-curve" until the saturation level for that cohort is reached. The rate of increase differs for each cohort and is generally higher for younger cohorts. The saturation level is also specified for each cohort and has increased consistently over time, although recent evidence indicates that this may start to lower for cohorts born after 1992. At a certain age, ability starts to become an issue and there is a decline in

maximum car ownership. The age when this decline starts and the rate of decline are both specified for each cohort. As would be expected, younger cohorts will be older than their forebears when the decline starts and will happen more gradually.

Figure 5 below provides aspiration/ability curves for select cohorts.

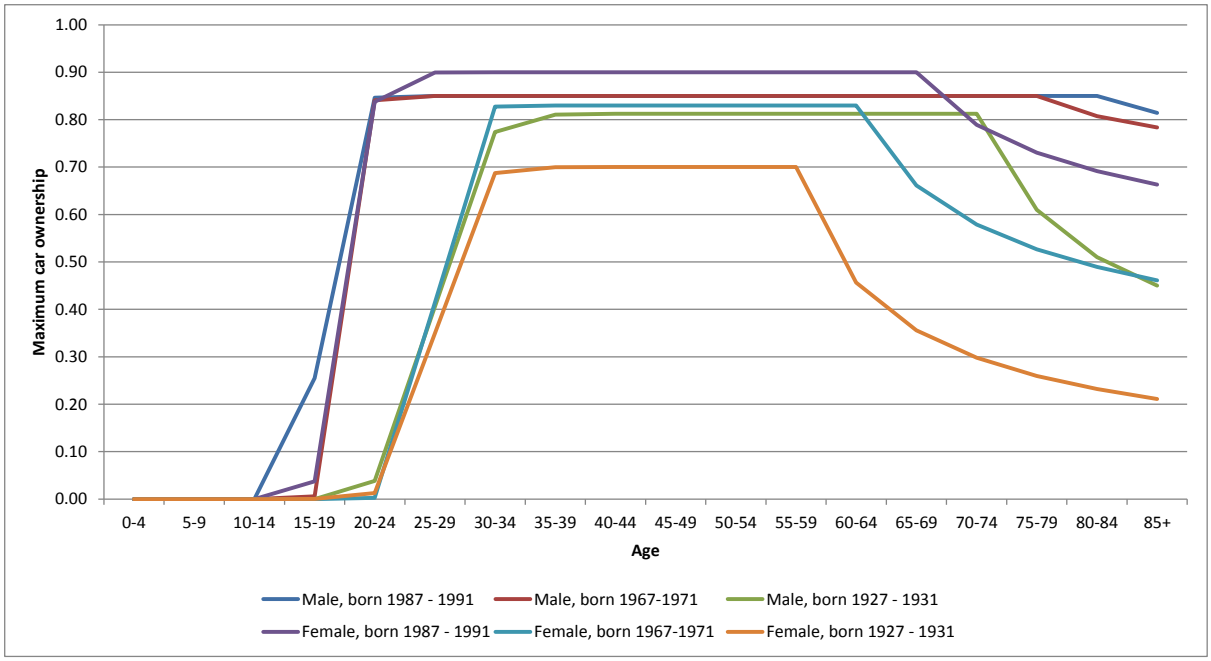


Figure 5 Car Ownership Aspiration and Ability Curves

Aspiration and ability define the upper limit for car ownership, but the predicted level for each cohort is determined by the proportion of people who can afford to own a car. The affordability element utilises a logit model which calculates the proportion of each cohort that can afford a car based on the average income of the cohort relative to a "threshold salary". The threshold salary has been calibrated as the salary required to afford a car, and is calibrated so that half of the people in a cohort will own a car if the average salary is at the threshold level. If the average income of the cohort is above the threshold then more than half of the cohort population will own a car.

The average income for all cohorts is based on growth in GNP which correlates well to reported average salaries. Figure 6 below shows average salaries between 1991 and 2041 (historic data is included to assist in the calibration of the model).

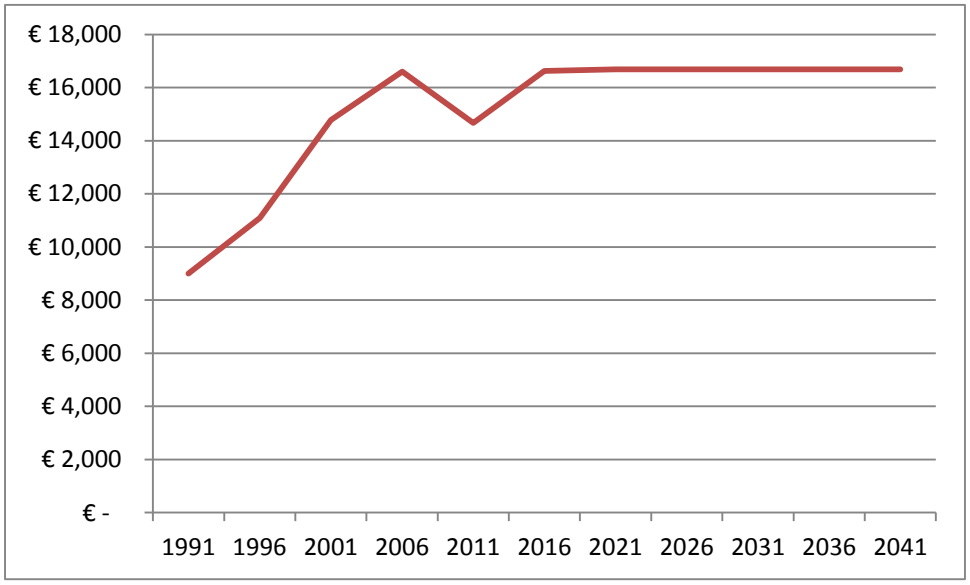


Figure 6 General Average Salaries

Average salaries also vary by age group and the distribution of income by age is shown below in Figure 7.

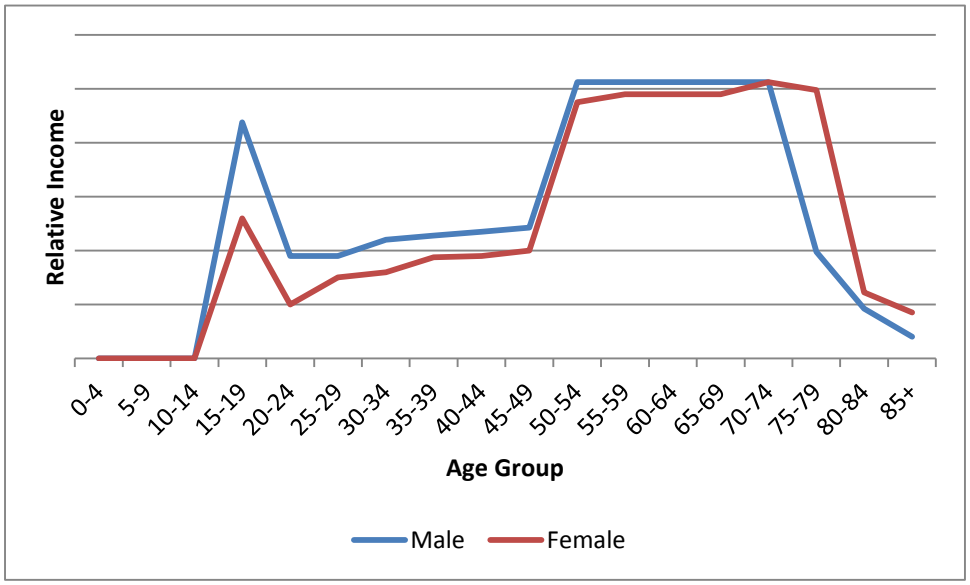


Figure 7 Average Salary by Age Group

The figure above clearly shows that income increases with age until retirement, when it starts to decline. There is a lag before this effect is shown, since many people who have recently retired will still be using a car bought prior to retirement (or bought with savings accrued before retirement). It should also be noted that the high relative income for the younger age groups relates to their parent's income rather than their own (i.e. many young people will have cars bought for them).

The relative income for each age group is applied to the relevant cohort in the forecast year, this determines the average income for that cohort which can then be input to the logit model to calculate the proportion of people in that cohort who can afford a car. This proportion is then applied to the maximum car ownership levels for each cohort as specified by the aspiration/ability curves. The resultant car ownership levels are then applied to the cohort populations for the

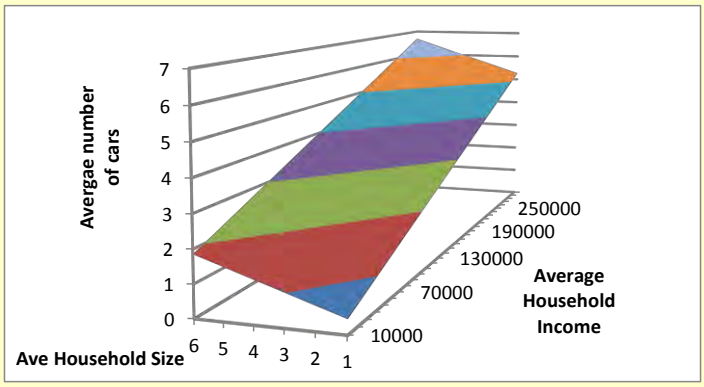
forecast year and summed to give the total number of cars owned in the forecast year (expressed as cars per thousand over-17s).

3.2.2 Disaggregate Model

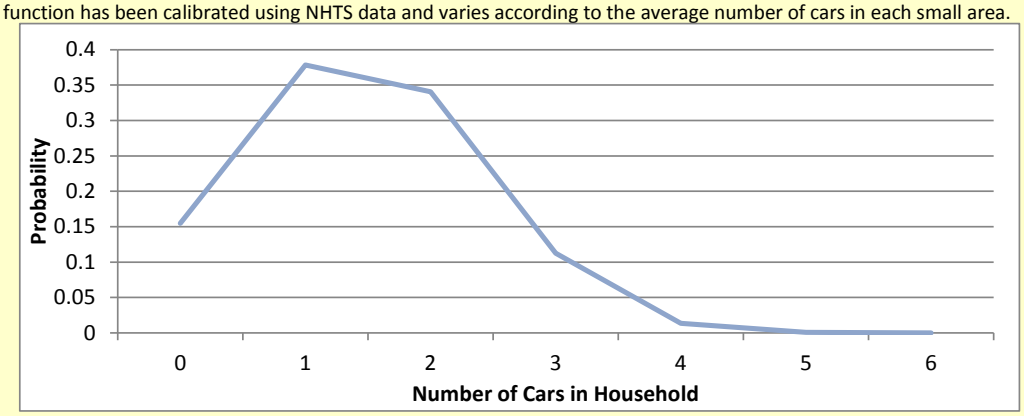
The Disaggregate model determines the number of cars owned in each small area, using a linear function which relates average household cars to average household income and average household size for each area. The coefficients of the function vary by settlement type.

The model then categorises households based on the number of adults and number of cars in the household. This stage is done by assuming a skew-normal distribution and applying this to the average household size and average household cars in each small area. The figure below describes this process in more detail.

In Step 1, the average number of cars in each small area was calculated by applying a function based on the average household size and average household income of the small area. This function was calculated using linear regression.



In Step 2, the households in each small area are firstly distributed into groups based on the number of cars in each household. This is done by assuming that the number of cars per household follows a skew-normal distribution. The function has been calibrated using NHTS data and varies according to the average number of cars in each small area.



The households are then distributed according to household size, again using a skew-normal distribution. In this case, different functions are used depending on the number of cars in each household. The function varies according to the average household size in the small area.

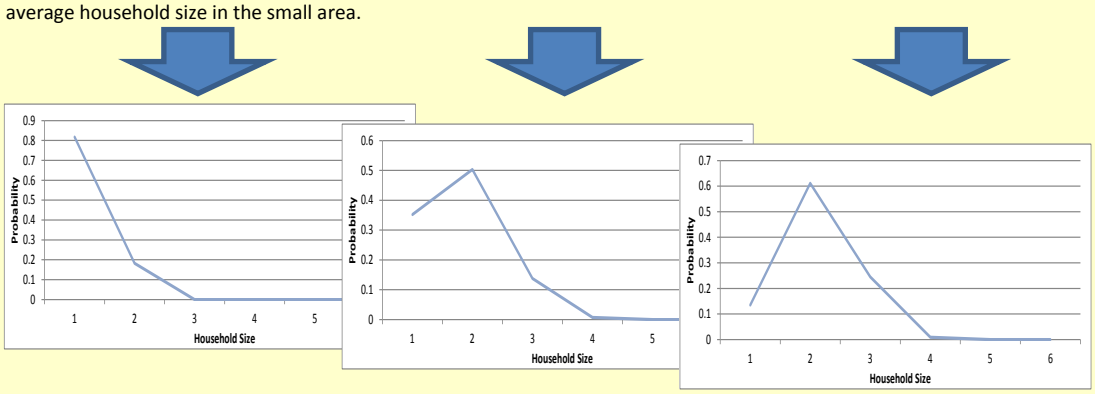


Figure 8 Disaggregate Model Description

3.3 Key Outputs

The output from the disaggregate model is the number of households in each small area, segmented by number of cars and number of adults. This data can be aggregated into the three car competition categories.

4 National Trip End Model

4.1 Overview and Terminology

The National Trip End Model (NTEM) component of the NDFM suite provides information on the numbers of trips which are made on a typical weekday both from and to an area. NTEM derives trips by purpose associated with each CSA based on various zonal attributes such as levels of employment, population etc.

The first steps of the NTEM process ensure CSA referencing is clean and consistent. Following this the model creates five types of trip ends as shown in Figure 9 by undertaking the following steps:

- Establish total levels of home-based productions by purpose;
- Derive corresponding home-based attractions by purposes;
- Evaluate the number of non-simple tours and thus the levels of one-way trip making;
- Remove the one-way trips from total levels to find simple tours; and
- Establish the non-home-based trips levels.

These different aspects will be detailed in the following sections. The next sections explain the Demand Segments operated on by the NTEM followed by the concept of tours as implemented by NTEM.

4.1.1 Demand Segments

The NTEM demand segments were derived from the National Household Travel Survey (NHTS) data and *Place of Work, School or College - Census of Anonymised Records* (POWSCAR) data sets. The demand segments are noted in Table 4 below.

Table 4 Demand Segments

Demand Segment	Description
HBW	Home-based commute trips
HBEB	Home-based employers business trips
HBEd	Home-based education trips
HBFS	Home-based food shopping
HBVis	Home-based visiting
HBEsc	Home-based escort trips
HBO	Home-based other trips

Demand Segment	Description
NHBEB	Non-home-based employers business trips
NHBO	Non-home-based other trips[3]
RET	Retired trips (used in car availability model)

4.1.2 Tours

Tours are an important aspect of how Trip Ends are modelled. The main concept is that every person is expected to make a distinct series of trips, beginning from their house and ultimately returning home (signalling the end of a tour).

The five distinct trip types which may comprise a tour are shown graphically below in Figure 9 and include:

- Simple From Home;
- Simple To Home;
- One-way From Home;
- One-way To Home; and
- Non-Home-Based trips.

All tours are defined relative to a home or a destination. This corresponds to the concept of productions and attractions where productions are associated with homes and attractions are associated with destinations. The terms productions and attractions are not used when discussing one-way or non-home-based trips. These are dependent on direction, are not defined to return to a home or a particular attraction, and therefore in these cases the labels origin and destination are used referring to the start and finish location of such trip.

It is worth noting that non-home-based trip chains (a series of trips beginning and terminating at home) are shown as only a single trip but there is no limit to the number of trips that can take place between the outbound (one-way From Home) and inbound (one-way To Home) legs.

[3] Other here is treated as a catch-all and includes all non-home-based trips apart from employer's business, unlike the home-based other trips which include trips not encapsulated by the other home-based purposes

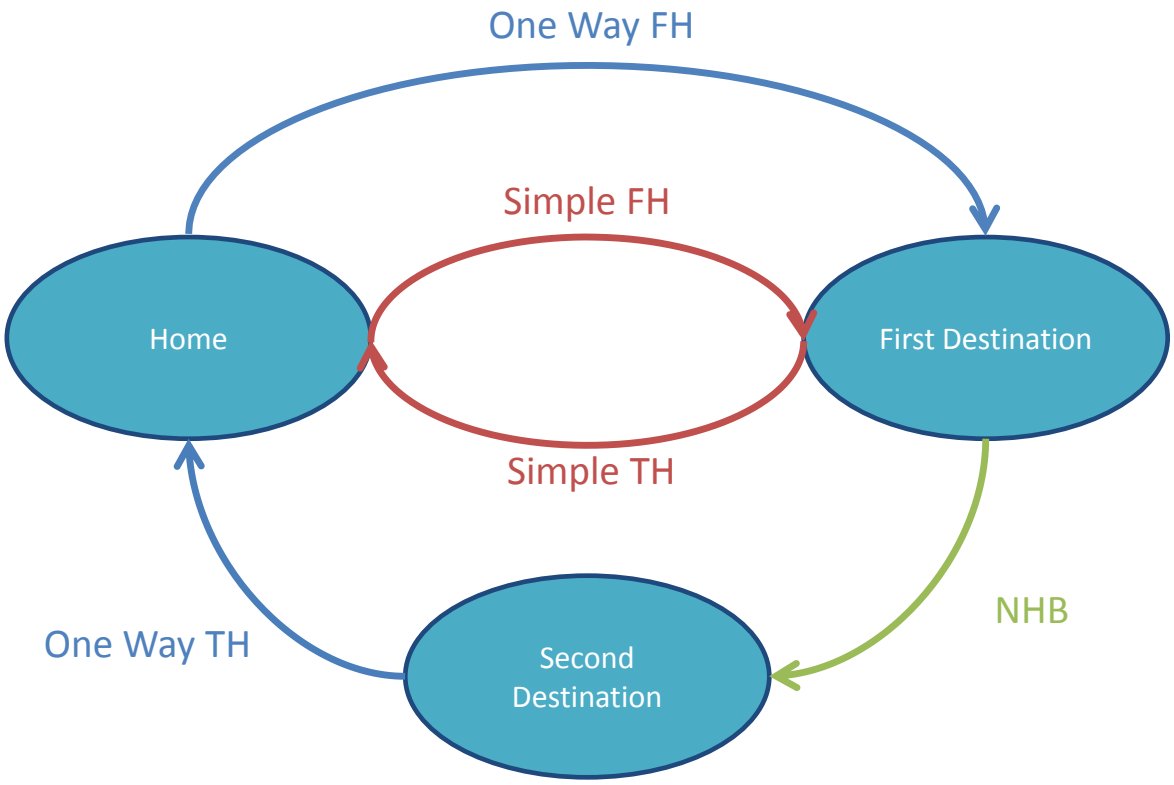


Figure 9 Tour Description

There is further confusion associated with the concept of productions and attractions, particularly with how they relate to origins and destinations which assignment matrices usually correspond to, and which must be considered in this model given that one-way and non-home-based trips are being considered.

Figure 10 shows the most basic relation of origins and destinations with respect to directional trips, comparable to simple tours.

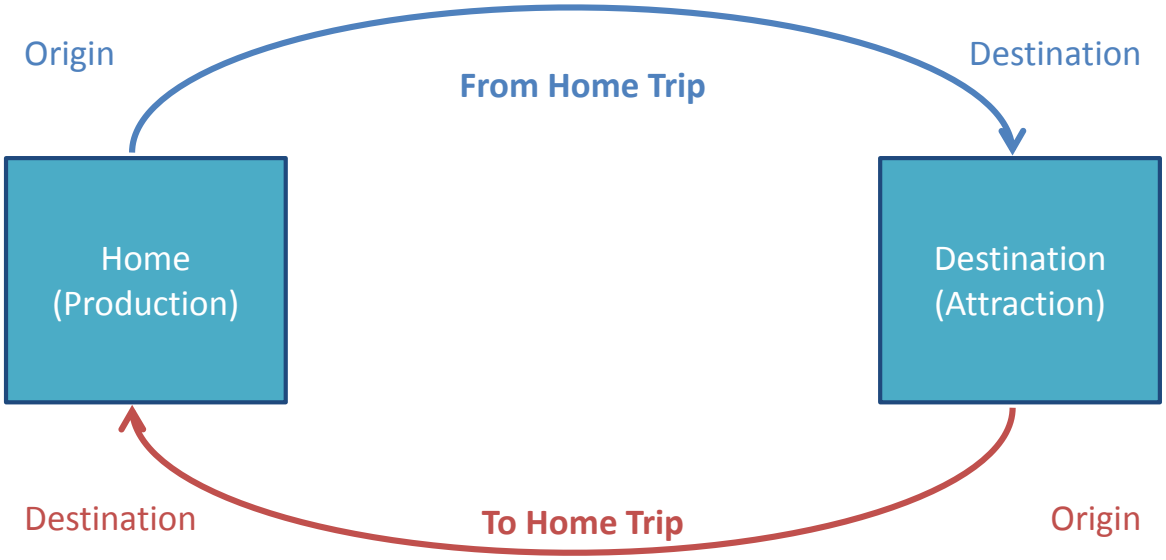


Figure 10 PA V OD for Simple Tours

Figure 11 shows the same relations for extended tours, where it is particularly noted that both ends of a non-home-based tour correspond to attractions.

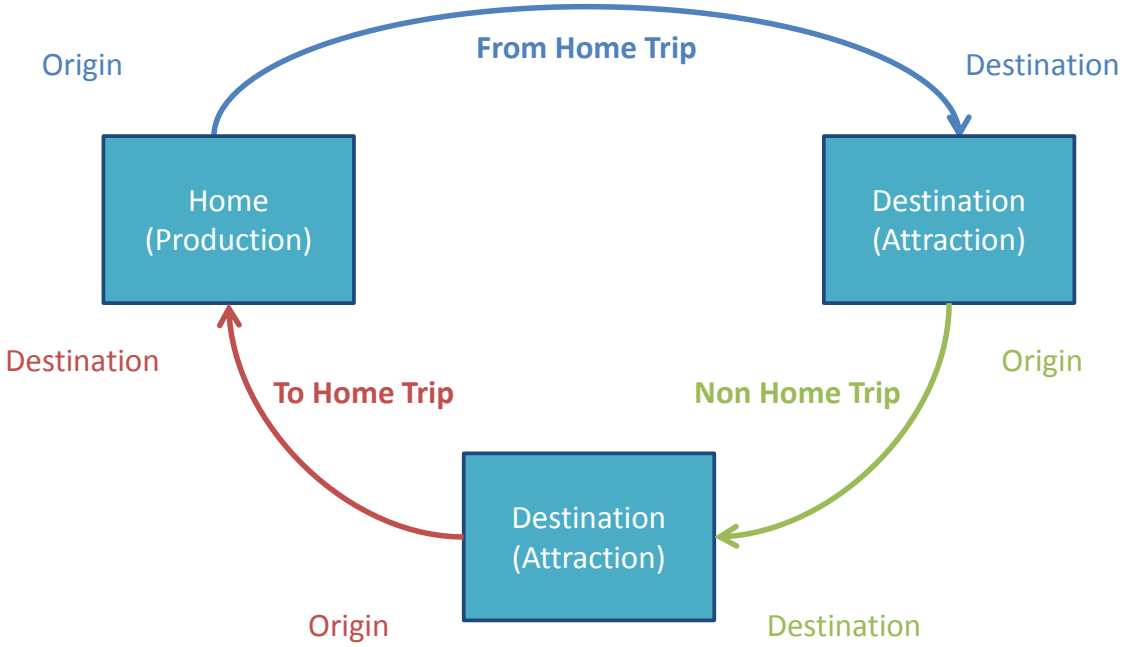


Figure 11 PA V OD for Extended Tours

4.1.3 Standard Mathematical Approach to Trip Rate Derivation

The home-based productions are calculated entirely based on population, with total trip ends separated out by relevant variables. The majority of demand segments are derived in the same manner, which at its most basic (assuming the entire demand segment behaves in a similar manner), follows the calculation:

$$Pr_d = \frac{(Pe_d * e^I) * W * T}{2}$$

Where:

Pr_d are the trip end productions by CSA relevant to demand segment d;

Pe_d are the persons residing in the CSA by demand model type d;

I is the 'Intercept' coefficient;

W is the weekday sample factor; and

T is the two day sample factor.

The two in the denominator of the formula accounts for the fact that each diary in the NHTS was surveyed over two days, while the two day sample factor and weekday sample factor account for under-reporting in the second day and weekends.

The more expanded case however accounts for variations in trip level making within a demand model segment due to other factors, for instance settlement type, employment type, or car competition. As an example, the home-based work segment is further segregated by employment type (full or part time) and so the total trip ends are calculated as the summation of the individual components as follows:

$$Pr_{HBW} = \frac{\left(Pe_{HBW\_FT} * \ e^{I+C_{FT}}\right) * W * T}{2} + \frac{\left(Pe_{HBW\_PT} * \ e^{I+C_{PT}}\right) * W * T}{2}$$

Where:

Pr_{HBW} are the home-based work trip end productions by CSA;

Pe_{HBW_FT} are the full-time employed persons residing in the CSA;

Pe_{HBW_PT} are the part-time employed persons residing in the CSA;

C_{FT} is the coefficient for full-time employment; and

C_{PT} is the coefficient for part-time employment.

When discussed in the following text a list of variables that are considered will be provided at each stage as well as a list of available values.

4.1.4 Coefficients

The production coefficients for NTEM have been derived using regression analysis of the NHTS as part of the original model development and have been taken directly from the previously agreed NTEM model as implemented in the Ruby software platform as part of Phase 3 of the project.

Attractions are derived using an attraction rate applied to the productions or in the case of some purposes (HBW for instance) by comparing against a valid known variable such as POWSCAR attractions. By definition productions must equal attractions and thus attractions are always constrained to marry their corresponding levels of productions at a national area.

It is worth noting that previous versions of the model had been constrained to a more local level (NUTS3) but this created large factors for areas where large numbers of people commuted across NUTS3 boundaries, particularly between the mid-east and Dublin areas and so was subsequently altered in release version 3 of the model.

4.2 NTEM by Demand Segment

4.2.1 Home-based Work Trips

Home-based work productions are evaluated based on employment status (full-time or part-time) with the coefficients noted in Table 5.

Table 5 Home-Based Work Coefficients

Coefficient	Value
Intercept	0.1764
Full Time	0
Part Time	-0.7005
Weekday factor	1.19814378314673
Two Day Sample Factor	0.926

For attractions, the POWSCAR attractions (24 hour, based solely on commuters) are used to create attraction factors which are then scaled back to match levels of productions at NUTS3 level.

It should be noted that at the time of development there was no available data on employment type at zonal level and so a full-time and part-time split has been applied nationally (the default proportion of full time employees and part-time employees are assumed to be 71.4% and 28.6% as taken from the NHTS).

While this in effect could reduce the number of constants that are considered within the model it was shown during early analysis that employment type had a significant effect and thus the mechanism for using the data has been retained in the model should zonal data become available.

It should also be noted that during development there was concern over whether POWSCAR attractions less than 12 could be used in the dataset (due to the sensitivity of the data) and while that is currently used in the base, should circumstances change in the future then a revision should be made to all base year and forecast data from that point onwards.

4.2.2 Home-Based Employers Business Trips

Home-based employers business productions are evaluated based on area type (urban or rural) with the coefficients noted in Table 6.

Table 6 Home-Based Employers Business Coefficients

Coefficient	Value
Intercept	-2.0331
Urban	0
Rural	0.5219
Weekday factor	1.224443606
Two Day Sample Factor	0.938

For attractions, the POWSCAR attractions (24 hour, based solely on commuters) are used to create attraction factors which are then scaled back to match levels of productions at NUTS level.

4.2.3 Home-Based Food Shopping Trips

Home-based food shopping productions are evaluated based on two coefficients, car ownership and employment status, and the coefficients are shown in Table 7.

Car ownership proportions are applied to each of the employment categories based on 'No Car Households' equalling 'No Car Ownership' and the remainder of household categories equating to 'Some Car Ownership' which allows a proportion to be derived. This assumed that there is no relationship between car ownership and employment status which is contrary to expectations, but accounts for the fact that data is not available at the more detailed level (employment status and car ownership together).

Table 7 Home-Based Food Shopping Coefficients

Coefficient	Value

Coefficient	Value
Intercept	-2.0968
Some Car Ownership	0
No Car Ownership	0.2942
Full-time employed	0
Full-time employed	0.7034
Unemployed	0.2511
Student	-0.3796
Home duties	0.9756
Retired	1.1163
Weekday factor	1.235758408
Two Day Sample Factor	0.83

4.2.4 Home-Based Other Trips

Home-based other productions are evaluated based on two coefficients, car ownership and employment status, and the coefficients are shown in Table 8. The same assumptions regarding car ownership proportions that were inherent in the home-based food shopping trips (see Chapter 4.2.3) are applied here.

Table 8 Home-Based Other Coefficients

Coefficient	Value
Intercept	-0.7028
Some Car Ownership	0
No Car Ownership	-0.0647
Full-time employed	0
Full-time employed	0.6668
Unemployed	0.7515
Student	-0.1472
Home duties	0.4262

Retired	0.7994
Weekday factor	-0.7028
Two Day Sample Factor	0

For attractions, a compound variable has been created which consists of

$$Attr = A \times \frac{HealthEmp}{x} + B \times \frac{NonFoodRetail}{y} + C \times \sum Buildings$$

Where:

Attr is the unadjusted attraction factor i.e. prior to matching NUTS3 levels of productions;

Buildings is the number of health and other purpose related buildings based on the NACE data;

HealthEmp is the health employment extracted from a special interrogation of the POWSCAR data; and

NonGroceryRetail is the non-food retail employment extracted from special interrogation of the Census data.

The variables **x** and **y** are the health factor and non-food retail factor. They are the average number of jobs per health-related building and the average the number of jobs per non-food retail buildings respectively. Their values are:

- **x** = 14.920238043; and
- **y** = 2.11584042168822.

The full list of NACE data categories that are considered within the other buildings can be found in Appendix C.

The coefficients **A**, **B** and **C** are proportions of the compound variable for health visit, shopping non-food and all other trips derived from the valid weekday trips obtained from the National Household Travel Survey (NHTS)[4]. Their values are:

- **A** - 0.455183;
- **B** - 0.063233; and
- **C** - 0.481584[5].

4.2.5 Home-Based Visit Trips

Home-based visit productions are evaluated based on employment. The associated coefficients are noted below in Table 9.

Table 9 Home-Based Visit Coefficients

Coefficient	Value

[4] Considering only Health or medical visit, Shopping - non-food, Social (Entertainment / recreation / participate in sport, pub / restaurant, Use services / Personal Business (bank, hairdresser, library etc.) and Worship or religious observance

[5] In the model parameter file this value is stored as three distinct variables which reflect social, personal, and worship trips, but they are applied identically to the same planning data variable.

Intercept	-2.4526
No Car Ownership	0
Full-time employed	0.7514
Full-time employed	1.3465
Unemployed	0.1
Student	0.3883
Home duties	0.6064
Weekday factor	1.254272184
Two Day Sample Factor	0.915

Given that visit trips are defined as going to visit other people, the derived attraction factors are based on overall population levels matched to NUTS3 productions.

4.2.6 Home-Based Education Trips

Home-based education productions are evaluated based on education level with the coefficients noted above. Note that secondary and tertiary students are not available explicitly from the base SAPS data but instead are inferred from several attributes where it is assumed that:

- Secondary students are equal to the sum of the secondary pupils and ages 15 to 18 categories; and
- Tertiary students are differentiated by 19-24 and 25+ age bands (<19 are not considered as tertiary students) which in the planning data are referred to as 'Third_L' and 'Older' respectively.

The data for tertiary students has been collected using an expanded census interrogation and is not available from the initially available SAPS data. This extraction was based on the number of persons in education by the highlighted age bands, and is not the same as the principal economic status 'students' and hence comparisons against that variable are not necessarily valid.

This area in particular represents a major update from release version 1 which considered tertiary students as a valid population type to apply the trip rate to, and was not disaggregated by age but instead had a unique trip rate coefficient evaluated.

Table 10 below notes the associated coefficients for education productions.

Table 10 Home-Based Education Coefficients

Coefficient	Value
Intercept	0.1755
Primary	0
Secondary	-0.0776

Third Level	-0.1559
Older	-0.6972
Weekday Factor	1.19948037
Two Day Sample Factor	0.886

For attractions, the POWSCAR attractions (24 hour, based solely on the relevant education level) are used to create attraction factors which are then scaled back to match levels of productions at NUTS level.

Education trips within this model are output at different levels to allow for separate inclusion in the regional models.

4.2.7 Home-Based Escort to Education Trips

Home-based escort to education productions are not estimated in a similar manner to other trips but instead are related to the education trips through a series of escort factors available by direction. These are shown in Table 11.

Similarly to education trips, escort to education trips within this model are output at different levels to allow for separate inclusion in the regional models.

Table 11 Home-Based Escort to Education Proportions

Coefficient	Value
Primary From	0.495695186
Secondary From	0.238389094
Tertiary From	0.041666667
Primary To	0.396174961
Secondary To	0.200308769
Tertiary To	0.047120419

4.2.8 One-Way Trips

One-way trips are derived based on applying a set of factors to both the production and the attraction end of the previous steps, where it is assumed that each trip has a probability that it will ultimately return home by a particular purpose. The proportions are shown below in Table 12 remembering that the From Home or outbound trip refers to the original purpose (as has been established in the previous steps).

Things to note about this table are that each row totals to 100% which reflects the fact that all home-based trips must return home within this model, and also that the diagonals (shown in red) tend to be the largest proportions which reflects the fact that most trips are simple tours. Columns do not sum to 100% and there is no reason that they should as the focus of the model is on the production end of the trip.

Table 12 Outbound and Inbound Non-Retired Purpose Proportions

FH\ TH	EB	Ed	O	V	FS	W	Esc
EB	84.3%	0.2%	6.1%	2.0%	2.4%	3.8%	1.2%
Ed	0.5%	89.9%	5.1%	1.8%	1.7%	0.4%	0.6%
O	0.5%	0.7%	91.5%	2.5%	3.1%	1.1%	0.6%
V	0.6%	1.2%	8.7%	83.7%	3.0%	1.8%	1.1%
FS	0.1%	0.2%	5.2%	2.4%	90.8%	0.5%	0.8%
W	1.1%	0.2%	4.9%	1.2%	2.6%	89.3%	0.7%
Esc	0.7%	1.1%	7.0%	1.7%	4.2%	5.2%	80.2%

A key assumption here and in the next step is that if a trip involves going out and returning via the same purpose it **must** be a simple tour and involve no trip chaining.

There is a separate matrix that has been established for Retired trips which ensures that these trips do not go on to undertake illogical purpose trips. This is shown below.

Table 13 Outbound and Inbound Non-Retired Purpose Proportions

FH\ TH	EB	Ed	O	V	FS	W	Esc
EB	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
O	0.0%	0.0%	94.8%	1.9%	3.3%	0.0%	0.0%
V	0.0%	0.0%	4.8%	93.9%	1.3%	0.0%	0.0%
FS	0.0%	0.0%	5.4%	2.7%	91.9%	0.0%	0.0%
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Esc	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Clearly there are four purposes for which retired persons are assumed not to make trips: employers business; commute; education; and escort to education. While the first three are entirely reasonable assumptions, the final purpose (escort to education) is a simplification which revolves around the approach for deriving escort to education. Since escort to education trips are considered as a proportion of education trips and these are set to zero for retired trips, the consequence is that there are zero escort to education trips.

While this could be addressed by preparing an additional retired factor and passing between the retired and non-retired models, the overall effect is minimal as the trips are still included in the non-retired trip rates and so this extension has not been expanded at this time.

Initial production and attraction vectors by purpose are multiplied by these factors to get a set of 98 trip types from the original 14 (education and escort to education are aggregated for this aspect of the calculation removing the segmentation by education level).

These are then summed by purpose and original vector as shown in Table 14.

Table 14 One-Way Derivation Summary

Original Vector	Summed Direction	One-Way Trip Component
Production	From home	One-way from home origins
Production	To home	One-way to home destinations
Attraction	From home	One-way from home destinations
Attraction	To home	One-way to home origins

It should be highlighted that this approach is **not** identical to the approach implemented in the original trip end model, but a lack of confidence in the results and insufficient clarity in the approach necessitated the revised methodology which is documented here.

4.2.9 Non-Home-Based Trips

The origins for non-home-based trips are derived by a simple trip rate which is applied to the from-home destinations of the outbound trips by purpose, with the trip rates shown below. The destinations for these trips are then extrapolated based on the original relevant attraction factors: POWSCAR attractions for employers business and a bespoke 'other' attraction factor (see chapters 4.2.4 for further details). As with the home-based equivalents, these attraction factors are scaled to match the origins at the NUTS3 level to produce non-home-based destinations.

The destinations for these trips are then extrapolated based on the original relevant attraction factors: POWSCAR attractions for employers business and a bespoke 'other' attraction factor (see chapters 4.2.4 for further details). As with the home-based equivalents, these attraction factors are scaled to match the origins at the NUTS3 level to produce non-home-based destinations.

Table 15 Non-Home-Based Trip Rates

Initial Purpose	NHBO	NHBEB
HBEB	1.352941176	1.610294118
HBEd	1.582142857	0.064285714
HBO	2.755670103	0.082474227
HBV	1.544392523	0.039719626
HBFS	1.71541502	0.019762846
HBW	1.800458716	0.28440367
HBEsc	2.196190476	0.08952381

4.2.10 Urban Centre Variances in NHBO Trips

Analysis of initial outputs of the NTEM indicated that there were significant variations in the non-home-based other trip rates that can be observed in certain locations, primarily relating to five major city centres:

- Limerick;
- Waterford;
- Galway;
- Cork; and
- Dublin.

The observed variations in NHBO trip rate are shown below in Table 16.

Table 16 Observed Trips by Geographical Area Destination and Other Journey Purposes

Geographical area	HBO	NHBO	Total	HBO (ratio)	NHBO (ratio)
Dublin City Centre	148	114	262	56%	44%
Cork City Centre	107	77	184	58%	42%
Galway City Centre	75	43	118	64%	36%
Limerick City Centre	79	32	111	71%	29%
Waterford City Centre	48	30	78	62%	38%
All Ireland	9,926	3,011	12,937	77%	23%

To account for this within the model, a post-processing mechanism has been derived which creates additional non-home-based other trips within these areas and rebalances the one-way and simple tour trips to account for it. The mechanism uses two databases (urban adjustment ID and urban centre variances) which allocate a variance in NHBO trip making at CSA level based on a city region.

4.2.11 Urban Variance Implementation

The steps which are undertaken to create additional trips in these urban centres are as follows:

- Apply corrected rate of trip ends to NHBO trips;
- Increase the one-way To Home trips that terminate in these locations by the same amount as the new additional NHBO trips;
- Increase the one-way To Home trips that originate in these locations by the same amount as the new additional NHBO trips;
- Rebalance the From Home origins with the From Home destinations at NUTS3 level;
- Rebalance the To Home destinations with the From home origins at NUTS3 level;
- Subtract From Home origins from total productions to create simple tour productions; and
- Subtract From Home destinations from total attractions to create simple tour attractions.

Where trips are adjusted in the steps discussed above they are spread in the same pattern as the original trip ends i.e. by a scalar uplift across all affected trip ends. These additional adjustments are undertaken on both retired and non-retired trips which is only possible because the adjustment is a scalar.

4.3 NTEM Inputs

The NTEM is a set of equations (all similar in form to the equation discussed in the section above) which are applied per demand segment at the CSA level. The NTEM therefore requires data for each of the 10 demand segment specific models.

The input data consists of number of grouped database files which form a planning data scenario. The user can define a new scenario by changing the relevant catalog key to 'point' to a new directory with identically structured databases which represent a new planning data scenario (for instance a forecast year).

The planning data for a given scenario consists of seven distinct databases:

- Demographic data;
- Car competition data;
- NACE data;
- Sector identification and NHBO uplifts;
- Employment data;
- Urban adjustment ID; and
- Urban centre variances.

4.3.1 Demographic Data

This is the main file of demographic planning data and is the key input to the PDAT process.

4.3.2 Car Competition Data

Car competition data is an input to the NTEM Car Availability Model from the Car Ownership Model. Although considered as an input, is actually considered an intermediary step of the Demand Forecasting Model given that it is reliant on the planning data to inform its outputs.

There are three columns of data which state the number of households in each CSA which have:

- No car;
- Fewer cars than persons; and
- Greater than or equal cars than people.

The number of households do not need to match the number of households forecasted as it is the proportion of households in each category which is relevant.

4.3.3 NACE Data

NACE data provides information about the number and types of buildings in a CSA. These are mainly used to calculate health and retail shopping attraction weights. The full list of NACE codes that are included in this database can be found in Appendix D.

The NACE data has been processed prior to inclusion in the model to give totals of relevant buildings by small area as opposed to totals of individual categories by small area which is the original format – this reduces the number of processing steps required.

4.3.4 Urban Adjustment ID

In order to correct the noted variation of NHBO trip rates in urban centres which were observed during calibration and application of the trip ends (e.g. sector 104 of the GDA model), there is a requirement to identify which sectors should be corrected and this database identifies them on a CSA basis.

This database contains a full list of small areas with an additional field, CITY_ID, which is used in combination with the next database to correct urban non-home-based levels of trip making. Further details on this particular aspect of the model can be found in chapter 4.2.10.

4.3.5 Urban Centre Variances

This file details the alterations to non-home-based other trip rates by particular region/sector as noted in the CITY_ID field which corresponds to the previous database. Although there are three numeric fields, only the variance field is used and the others merely provide an audit trail for the derivation of variance.

4.3.6 Separating Retired

The NTEM considers two distinct datasets, the Retired set of persons and non-retired set of persons. This is a preliminary stage of the model and simply creates two identically structured files with different aspects of person type. There is no difference to the calculations or parameters applied except where explicitly mentioned.

The data is separated based on those shown in Table 17.

Table 17 Rules for Separating Retired Persons

Field	Retired	Non-Retired
Population	Retired + Unable to work due to illness	Population - Retired - Unable to work due to illness
Aged under 15	0	Aged under 15
Aged 15+	0	Aged 15+
Age 15	0	Age 15
Age 16	0	Age 16
Age 17	0	Age 17
Age 18	0	Age 18
Age 19 and over	0	Age 19 and over
Third Level	0	Third Level

Older	0	Older
Non-students	0	Non-students
Age 0 to 3	0	Age 0 to 3
Primary students	0	Primary students
Secondary students	0	Secondary students
Tertiary students	0	Tertiary students
Employed		Employed
Home duties	0	Home duties
Unemployed having lost or given up first job	0	Unemployed having lost or given up first job
Retired	Retired	0
Looking for first job	0	Looking for first job
Unable to work due to sickness or disability	Unable to work due to sickness or disability	0
Other labour status	0	Other labour status
Student	0	Student
Full time job	0	Full time job
Part time job	0	Part time job
Blue collar job	0	Blue collar job
White collar job	0	White collar job

It can be readily seen that the majority of categories fall neatly into either retired or non-retired (with the irrelevant category simply set to zero), but some fields such as households are maintained consistent for both sets; this works mathematically as the proportion is required by the model and this is maintained but should the household occupancy need to be evaluated at any point (to account for variances by retired households and non-retired households) then care should be taken and offline correction should be used.

While it is expected that retired persons would have a different car competition and gender split, there was a lack of data to calibrate this aspect during development, and hence as a best assumption they are assumed to follow the same proportions as the entire dataset.

4.4 NTEM Outputs

There are a series of output files produced in a model run which appear in the NTEM standard outputs folder (see *MSF_004.5_NDFM_User_Manual_v1_2_20150504.docx*).

There are nine files, namely:

- One_Way_NonRetired.CSV;
- One_Way_Retired.CSV;
- Two_Way_Attractions_NonRetired.CSV;
- Two_Way_Attractions_NonRetired.CSV;
- Two_Way_Productions_NonRetired.CSV;
- Two_Way_Productions_NonRetired.CSV;
- Prods_CA.CSV;
- Blue_White_Collar.CSV; and
- Emp_Split.CSV.

These files are clearly grouped into three sets, the one-way trips, the two trips, and the car available proportions. The format is consistent between these three sets of files and is detailed below.

4.4.1 One Way Trips

The one-way trips are left at their finest level of detail for export from the model and consist of five sets of data detailing:

- Spatial reference;
- From Home origins by purpose;
- From Home destinations by purpose;
- To Home origins by purpose; and
- To Home destinations by purpose.

The full expanded set of columns is as follows:

- Sequential ID;
- CSA;
- NUTS3 ID;
- Electoral Division;
- From Home origins – employers business;
- From Home origins – education;
- From Home origins – other;
- From Home origins – visit;
- From Home origins – food shopping;
- From Home origins – work;
- From Home origins – escort to education;
- From Home destinations – employers business;
- From Home destinations – education;
- From Home destinations – other;
- From Home destinations – visit;

- From Home destinations – food shopping;
- From Home destinations – work;
- From Home destinations – escort to education;
- To Home origins – employers business;
- To Home origins – education;
- To Home origins – other;
- To Home origins – visit;
- To Home origins – food shopping;
- To Home origins – work;
- To Home origins – escort to education;
- To Home destinations – employers business;
- To Home destinations – education;
- To Home destinations – other;
- To Home destinations – visit;
- To Home destinations – food shopping;
- To Home destinations – work; and
- To Home destinations – escort to education.

4.4.2 Two Way Trips

The two-way trip files detail productions and attractions in separate files as well as differentiate the retired and non-retired trips into unique files (thus there are four files in total). These files contain 20 columns of data for each CSA as follows:

- Sequential ID;
- CSA;
- NUTS3 ID;
- Electoral Division;
- Home-based work
- Home-based employers business;
- Home-based education (primary);
- Home-based education (secondary);
- Home-based education (tertiary);
- Home-based escort to (primary);
- Home-based escort to (secondary);
- Home-based escort to (tertiary);
- Home-based escort from (primary);
- Home-based escort from (secondary);
- Home-based escort from (tertiary);
- Home-based food shopping;
- Home-based other;
- Home-based visit;
- Non-home-based other; and

- Non-home-based employers business.

Strictly speaking the non-home-based trips should be referred to as origins and destinations rather than productions and attractions (see Chapter 4.1.2) but to reduce the number of files involved are passed through as productions and attractions.

4.4.3 Blue/White Collar Split

The blue and white collar population split data file consists of 6 columns for each CSA, where the first 4 are the unique identifiers and spatial references:

- Object ID;
- Numeric ID;
- Alphanumeric; and
- Small Area.

The total population for each segment obtained from PDAT are outputted in the final 2 columns as:

- Total blue collar; and
- Total white collar.

4.4.4 Employed Split

The employed split data file consists of the 6 columns where the first 4 are the same references as the blue/white collar split above (4.4.3). The last 2 columns in the output file shows the total employed population and the labour force for each CSA. The labour force is the total population aged 15 and over.

5 Car Availability Modelling

5.1 Overview

The Car Availability Model estimates the likelihood of whether a car was available for a set of outgoing (production-based) trip ends, based primarily on car competition within an area but also accounting for purposes. This is a key component of the model as car availability has large implications within the regional models, in particular for mode choice.

The car availability model is a sub-application of NTEM rather than and explicit model and so is run as standard during an NTEM procedure, and cannot be run in standalone. The inputs for the model are a combination of standard NTEM inputs (see Chapter 2.3 for further details) and the outputs of the previous stages of the NTEM model.

5.2 Car Availability Model Inputs

The inputs for the car availability model are the NTEM base data (split by retired and non-retired) and the outputs form the Car Ownership Model which consists of three columns identifying no car households, 'cars less than persons' households, and households with cars equal or greater than persons.

5.3 Standard Mathematical Approach to Car Availability

The car availability rates are calculated entirely based on population, with persons split into particular 'types'. The majority of demand segments are derived in the same manner, which at its most basic (assuming the entire demand segment behaves in a similar manner), follows the calculation:

$$Pr_d = Pe_d * e^I$$

Where:

Pr_d are the trip end productions by CSA relevant to demand segment d;

Pe_d are the persons residing in the CSA by demand model type d;

I is the 'Intercept' coefficient.

The more expanded case however accounts for variations in trip level making within a demand model segment due to other factors, for instance settlement type, employment type, or car competition. As an example, the home-based work segment is further segregated by employment type (full or part time) and so the total trip ends are calculated as the summation of the individual components as follows:

$$Pr_{HBW} = Pe_{HBW\_FT} * e^{I+C_{FT}} + Pe_{HBW\_PT} * e^{I+C_{PT}}$$

Where:

Pr_{HBW} are the home-based work trip end productions by CSA;

Pe_{HBW_FT} are the full-time employed persons residing in the CSA;

Pe_{HBW_PT} are the part-time employed persons residing in the CSA;

C_{FT} is the coefficient for full-time employment; and

C_{PT} is the coefficient for part-time employment.

5.4 Estimation of Coefficients

The coefficients were derived from the NHTS using linear regression to establish which variables were significant in travel choice for a purpose as well as estimate the actual coefficient. All values are rebased against a particular reference variable (so that the value for that particular coefficient is zero) and so the 'intercept' coefficient represents the underlying baseline.

As standard, the following cleaning exercises were performed on the data:

- Only weekdays were considered;
- Undefined car availability was removed[6];
- Undefined area types are removed (primarily due to a missing CSA at either end of the journey);
- 'Other' employment types are removed (as ambiguous); and
- Only outbound trips (From Home) were considered.

Having produced this restricted set of data with clear results, a set of data exists with the observations noted in Table 18 (at aggregate level).

Table 18 Summary of Cleaned Car Available Data

Purpose	Car Available	No Car Available	Total	Car Available Proportion
COM	2,631	290	2,921	90%
EDU	2,664	750	3,414	78%
EB	1,721	105	1,826	94%
ESC	1,605	121	1,726	93%
FSH	1,085	201	1,286	84%
OTH	2,905	357	3,262	89%
VIS	778	109	887	88%
RET	5,966	944	6,910	86%
Total	23,208	2,914	26,122	89%

With each purpose containing a complete set of trips identified by car availability and segmented by dependent variables (see Chapter 5 for further details on each purposes dependent variables), the

[6] Note that trips undertaken by car are flagged as undefined but in this analysis are clearly assumed to be travelling by car rather than undefined

SOLVER add-in from excel was used to minimise the difference between observed and predicted observations by stratification both at a total level and a disaggregate level.

To apply this technique, each variable was assumed to have a car availability proportion so that the overall car availability was considered the product of the individual components. The chosen sets of values were those that reduced the weighted absolute difference between observed and modelled car availability, where the weight was the total number of observations by stratum.

In order to produce a set of values consistent with the mathematical approach used in the modelling, the natural log of the car availability value of each variable was taken and then rebased against the reference variable (to provide the 'intercept' value).

The results of each calibration by purpose are provided in Appendix E through to Appendix L in both tabular and graphical format. Note that in some instances the calibration matches exactly (particularly employers business) and so the observed and modelled graphs are identical. These appendices show clearly that the calibration is extremely close in the majority of stratum for each purpose, particularly on those with a large number of observations (as would be expected from the method).

It should be noted that these results are inconsistent with those available from the previous incarnation of the car availability model as it was unclear what the exact mathematical formulation adopted in that approach was. With no formal report available on their derivation or comparison with observed values it was felt that a revised calibration would provide greater confidence going forwards.

When discussed in the following text a list of variables that are considered will be provided at each stage as well as a list of available values.

5.5 Calculation Steps

The car availability model calculations are undertaken in a similar manner to the productions of the trip end model, in that persons of a particular type are identified and then a trip rate based on exponents of summed coefficients applied (see Chapter 5.2 for further details). It should be noted however that there is no inclusion of the sample rates or the 2 day availability factor as these will be consistent throughout the standard trip production and car available calculations.

Each of the eight demand segments considered within car availability are evaluated in a separate matrix step which evaluates the total productions followed by the car available productions before then producing a proportion of car available trips (the ratio of the two previous values).

Note that the variables which are considered relevant for standard trip rates may not be consistent with those which are relevant for car availability. Where standard productions are split by a variable which is not considered relevant for car availability, the values are combined to remove the split before going further. Conversely, where car availability considers a variable that is not considered in standard trip productions, it is assumed that the initial split of person type is appropriate to segment the data as the trip rate will be unaffected.

All purposes consider the spatial area as a variable, and the classification is more disaggregate than with the standard trip productions, considering four unique possible values:

- City;
- Large urban;
- Small town; and

- Rural.

Rural corresponds to the rural category used in standard trip rates while the summation of the rest corresponds to the urban classification.

The calculations which are undertaken will be discussed below by demand segment.

5.5.1 Home-based Work Trips

Home-based work car available trips are evaluated based on gender and car competition and the associated coefficients are shown below in Table 19.

Table 19 Home-Based Work Car Availability Coefficients

Coefficient	Value
Intercept	-1.07195848
City	0
Large Urban	0.123316885
Small Town	0.128560868
Rural	0.164099711
Male	0
Female	-0.02717009
No Car	0
Under	0.852839428
Parity plus	0.925028774

Neither gender nor car availability are segmented in the original trip productions so the proportions of total population for gender and household proportions for car availability are applied to segment the persons into their relative strata.

5.5.2 Home-Based Employers Business Trips

Interrogation of the NHTS showed that the only significant factor for employer's business trips was urban classification, and the derived values applied in the model are shown below in Table 20.

Table 20 Home-Based Employers Business Car Availability Coefficients

Coefficient	Value
Intercept	-0.132834771
City	0

Large Urban	0.051531824
Small Town	0.087609673
Rural	0.118945659

5.5.3 Home-Based Food Shopping Trips

Home-based food shopping car available trips are evaluated based on gender and car competition and the associated coefficients are shown below in Table 21.

Table 21 Home-Based Food Shopping Car Availability Coefficients

Coefficient	Value
Intercept	-0.663761963
City	0
Large Urban	0.088289446
Small Town	0.129390028
Rural	0.150778389
Male	0
Female	-0.004556361
No Car	0
Under	0.426105497
Parity plus	0.491562986

Neither gender nor car availability are segmented in the original trip productions so the proportions of total population for gender and household proportions for car availability are applied to segment the persons into their required definitions.

5.5.4 Home-Based Other Trips

Home-based other car available trips are evaluated based on car availability and employment status and the coefficients are shown in Table 22.

Table 22 Home-Based Other Car Availability Coefficients

Coefficient	Value
Intercept	-0.608054604
City	0

Coefficient	Value
Large Urban	0.065458276
Small Town	0.0163569
Rural	0.067820709
No Car	0
Under	0.460133921
Parity plus	0.511664511
Full Time Employed	0
Part Time Employed	0.008579871
Unemployed	-0.00691245
Student	0.008615645
Home Duties	0.028671877
Retired	0.014368852

Employment status is available directly from the NTEM data with the caveat that a full-time / part-time proportion must be applied (as already noted in the standard NTEM calculations), and car competition is applied proportionally to all of these persons equally to segment to the desired level.

5.5.5 Home-Based Visit Trips

Home-based visit car available trips are evaluated based on car ownership only and the associated the coefficients are noted below in Table 23.

Table 23 Home-Based Visit Car Availability Coefficients

Coefficient	Value
Intercept	-0.726659064
City	0
Large Urban	0.006113069
Small Town	0.067277919
Rural	0.130633493
No Car	0

Under	0.560866806
Parity plus	0.654947922

5.5.6 Home-Based Education Trips

Home-based education car available trips are evaluated based on gender, car ownership, and education level with the coefficients noted in Table 24.

Table 24 Home-Based Education Car Availability Coefficients

Coefficient	Value
Intercept	-1.007177968
City	0
Large Urban	0.112742096
Small Town	0.124120549
Rural	0.192045753
Male	0
Female	0.050922279
No Car	0
Under	0.688606448
Parity plus	0.704369373
Primary	0
Secondary	-0.181430941
Tertiary	-0.307602804
Older	-0.016791472

As noted previously, third level students and older students are not available explicitly from the data but instead are inferred from several attributes where it is assumed that:

- Secondary students are equal to the sum of the secondary pupils and ages 15 to 18 categories; and
- Tertiary student are taken from an expanded census extraction, but unlike the standard trip end derivations are not segregated by age band for car availability modelling.

Neither gender nor car availability are segmented in the original trip productions so the proportions of total population for gender and household proportions for car availability are applied to segment

the education levels into their relevant strata. This assumes that there is no variation of gender or car availability by education level.

5.5.7 Home-Based Escort to Education Trips

Home-based escort to education car available trips are estimated based on gender and car ownership only, and the factors applied are shown in

Table 25.

Table 25 Escort to Education Car Availability Coefficients

Factor	Value
Intercept	0
City	-0.994047284
Large Urban	-0.957130814
Small Town	-0.94878603
Rural	-0.938664858
Male	0.274145354
Female	0.272410849
No Car	0.03452797
Under	0.612557533
Parity plus	0.645579924

Neither gender nor car availability are segmented in the original trip productions so the proportions of total population for gender and household proportions for car availability are applied to segment the persons into their relative strata.

5.5.8 Retired Trips

Retired car available trips are evaluated using gender and car ownership, both of which are mutually exclusive from the variables which are considered in the standard productions and thus can be applied as proportions rather than overall levels of trip-making. The derived coefficients applied to each segment are shown in Table 26.

Table 26 Home-Based Retired Car Availability Coefficients

Factor	Value
Intercept	-0.685373961
City	0

Large Urban	0.03691647
Small Town	0.045261254
Rural	0.055382426
Male	0
Female	-0.001734505
No Car	0
Under	0.578029564
Parity plus	0.611051954

5.6 Car Availability Model Outputs

The Car Availability output data has 26 columns, where the first two detail an object ID and census small area for referencing, and the latter 24 are grouped by eight purposes:

- Home-based work;
- Home-based employers business;
- Home-based education;
- Home-based food shopping;
- Home-based other;
- Home-based visit;
- Home-based escort; and
- Retired.

These purposes have three columns each which note:

- Total trips by CSA;
- Car available trips by CSA; and
- Car available proportions by CSA.

While the primary output is the car availability proportion, for interface with the regional models the total trips need to be summed across zones (aggregations of CSA's) and therefore the absolute numbers are required to derive the car availability proportions by zone.

It must be highlighted that due to the different variables considered between the trip end model and the car availability models, the total number of trips may not necessarily be consistent and thus only the car availability proportion should be used from this model in combination with the trip end model outputs.

6 Corridor Prioritisation Tool

6.1 Overview

The CPT is a spreadsheet tool which defines long distance inter-urban travel movements across Ireland and Northern Ireland. While initially developed to define base year movements (based on POWSCAR and NHTS observations) it was later extended to allow a forecasting capability.

The CPT models all trips made by Irish residents and visitors by mode (car, bus and rail), and goods vehicles using a set of the 40 main settlements across Ireland (with at least one in each county) plus the 16 key ports and airports. The CPT also takes account of hinterland populations as opposed to strict movements between settlements.

As the CPT is not a core component of the NDFM it is not covered in any detail in this report and instead is summarised in *CPT Modelling report v2.0.DOCX*. As the CPT interacts during the NDFM however, its operation is covered in the NDFM user manual, *MSF 004.5 NDFM User Manual v1 2 20150504.DOCX*.

7 Regional Model System Integration Process

7.1 Introduction

This section outlines the RMSIT application which converts the CPT outputs to the zone system of each of the regional models.

This conversion process converts the settlement to settlement travel patterns into regional model specific zones by mode, journey purpose (commute, employer's business and other) and time period. A definition of the CPT settlements is provided in Appendix M along with details on the actual settlement and hinterland populations.

As the CPT matrices provide an annual demand for all purposes, an annualised factor[7] has been applied based on the NHTS in order to convert from the units of the CPT (annual demand) and those of the regional models (24 hour demand).

The steps in the RMSIT process are described in sequence after the inputs to the model are detailed.

7.2 RMSIT Inputs

RMSIT has a number of inputs which can broadly be categorised as parameters and inputs. The parameters primarily consist of base year inputs and geographic definitions for each of the regional models. These have been calibrated and/or derived in the base year and should not need updating throughout the models lifecycle, but they are linked to a parameter version in case this should not be the case.

The base year demand parameters include:

- Base_CPT_M1.CSV, settlement to settlement synthesised demand for car;
- Base_CPT_M1_H.CSV, settlement to settlement synthesised hinterland demand for car;
- Base_CPT_M2.CSV, settlement to settlement synthesised demand for bus;
- Base_CPT_M3.CSV, settlement to settlement synthesised demand for rail;
- Base_CPT_HGV.CSV, settlement to settlement synthesised demand for car;
- POWSCAR_W_M1.CSV, settlement to settlement POWSCAR observed demand for goods;
- POWSCAR_W_M2.CSV, settlement to settlement POWSCAR observed demand for bus; and
- POWSCAR_W_M3.CSV, settlement to settlement POWSCAR observed demand for rail.

There are two parameter files used to create an assigned network, namely:

- Network_v3.0.NET, the road network which gets assigned to derive travel movements; and
- Tolls.DBF, a toll definition of the settlement to settlement assignment.

There are a set of spatial definitions for each modelled area including:

- HGV_Settlement_Zones_Prop.CSV, proportions of HGV's to convert settlements to zones;
- HW_RZ_to_Z.DBF, a correspondence between external zones and route zones;
- JP_TP_SPLIT.TXT, containing proportions of travel movements by time of day and purpose;

[7] Spreadsheet titled: 'Annualisation_GDA_v4_20150205'

- POWSCAR_Set_2_Sec.MAT, detailing the base year POWSCAR demand which travelled between settlements and internal sectors for the particular model;
- Rail_RZ_to_Z.DBF, a correspondence between external zones and route zones;
- Rail_Select_Links.CSV, a series of links which define the select links procedure corresponding to route zones and forming a strict boundary around the model for that mode;
- REGIONAL_MODEL_ATRIBUTES.TXT, a list of specific attributes such as relevant zones, sectors etc.;
- Sector_Settlement_Alignment.DBF, a mapping from sequential sectors to settlements;
- Sectors_Zones_Prop.CSV, containing proportions of trips by settlement within a sector;
- SELECT_LINKS.TXT, a series of links which define the select links procedure corresponding to route zones and forming a strict boundary around the model for that mode; and
- Settlement_Zones_Prop.CSV, defining the proportion of a settlement which is allocated to a zone.

The second set of inputs reflect forecast year conditions and are obtained from the CPT. These include:

- Fore_CPT_M1.CSV, settlement to settlement synthesised demand for car;
- Fore_CPT_M1_H.CSV, settlement to settlement synthesised hinterland demand for car;
- Fore_CPT_M2.CSV, settlement to settlement synthesised demand for bus;
- Fore_CPT_M3.CSV, settlement to settlement synthesised demand for rail;
- Fore_CPT_HGV.CSV, settlement to settlement synthesised demand for car;
- Fore_PCOM_FAC.CSV, settlement factor files for productions (from base in IJ:V format); and
- Fore_ACOM_FAC.CSV, settlement factor files for attractions (from base in IJ:V format).

7.3 Removing Long Distance Commute from 24-hour demand

The CPT produces an 'All-Purpose' trip matrix that encompasses all journey purposes including commute. However, the regional models already include all of the POWSCAR purpose trips (including the long-distance ones), so to remove double counting it is necessary to remove these from the CPT travel demand matrices.

This is achieved by allocating the POWSCAR trips (and their corresponding return home trips) to the CPT settlement to settlement movements and subtracting these from the CPT 24-hour matrices (by mode).

The POWSCAR-purpose trips are stored directly in the Cube Voyager model in the *RMSIT_inputs* folder and do not have to be recalculated.

In order to predict the future POWSCAR, the forecasted NTEM Home Based Work productions and attractions trip ends are used to produce growth factors. A furnessing process is then applied to the base year POWSCAR matrices to retain the base year pattern while matching the forecast trips ends. This process is singly constrained against productions.

The RMSIT allows the user to choose a proportion of the future POWSCAR taken into consideration when subtracting the commute purpose from the CPT demand. The relevant calculations are:

$$CPT\ Commute_{Future} = xPOWSCAR_{Base} + (1 - x)POWSCAR_{Future};$$

Where $0 \leq x \leq 1$ is the POWSCAR Prop, defined by a catalog key in the NDFM;

$$CPT\ Other_{Future} = CPT\ Total\ Demand_{\ Future} - CPT\ Commute_{Future};\ \text{and}$$

$$RMSIT\ Output\ Demand = POWSCAR_{Future} + CPT\ Other_{Future}.$$

The value of the parameter *x* in the equations above is a measure of how much of the predicted growth in POWSCAR commuting is to be added to the population-based travel growth predicted by the CPT tool. A value of *x* = 0 will ensure that all of the growth in commuting is assumed to be already included in the CPT growth (e.g. subtracting all of the POWSCAR future demand will be required to leave only the CPT Other purposes), while a value of *x*=1 will assume that all of the long-distance commuting growth is assumed to be in addition to the population-based CPT growth (e.g. all of POWSCAR future is added, while the reduction applied to CPT All-Purpose demand is based only on POWSCAR base).

The remaining steps within this note explain how the model converts the settlement residual demand matrix and the commuting matrix to conform to the regional models. It should be noted that the remaining steps use parameters that are model specific as it is based on the internal settlements, sectors, and internal zones of a particular model. These are input via the *Params**RMSIT* folder in the specific regional model sub folder.

7.4 Assignment of Inter Settlement Demand to Regional Model Route Zones

Route zones are the links (at the model boundary) at which internal and external demand is aggregated to represent the flow of demand in and out the internal modelled area.

CPT demand, which only represents demand among settlements, has to be converted by the RMSIT to the regional model route zones. To illustrate the initial step of converting settlement to settlement demand to route zones, a representative model area with route zones at its boundary is shown in Figure 12 below.

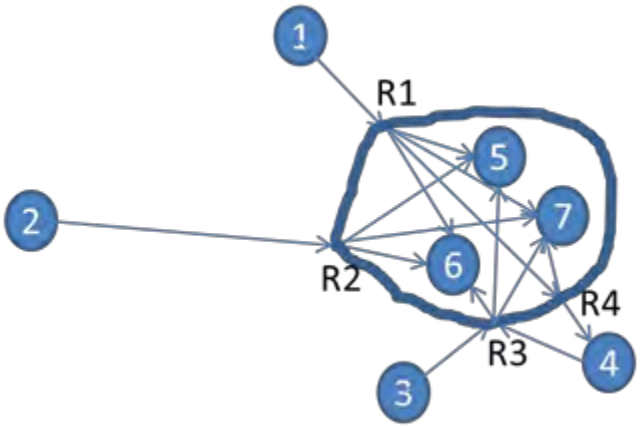


Figure 12 Route Zones Definition

In the figure above each node represents a settlement, which can be inside or outside the modelled area, as denoted by the boundary. CPT matrices are converted from demand between settlements, to demand between routes zones and the internal settlements. Thus, all CPT settlement demand outside the model area is linked to the approach route zone, e.g. in the figure, Settlement 1 is linked to Route Zone 1, and Settlement 2 is linked to Route Zone 2.

The link between settlements and hence particular route zones was established by assigning a settlement to settlement matrix to the CPT's strategic road and rail network and using 'select link' analysis to determine which links are route zones.

Trips which travel through the model area (e.g. both origin and destination settlements are not in the internal regional model area), are represented by demand between two route zones.

7.4.1 Road Network

The road network was obtained from the NavTeq GIS layer representation of the current road networks in the Republic of Ireland & Northern Ireland. Functional classes 1, 2 and 3 from this layer give a good representation of the major roads used in the long distance trips to and from the settlements.

The association between this network and the required route zones is obtained by selecting links at the model boundary (please see Appendix N). There is a requirement to allocate all links at the boundary to a single link representing a route zone. There is a roughly one-to-one correspondence between route zones and the zones at the periphery of the model (and thus defining the boundary). Those links crossing into a common internal zone are grouped.

There were several assumptions made when selecting and aggregating the route zones, as follows:

- Only links on a path from an external settlement to an internal settlement are selected;
- Links are aggregated based on the internal zone they enter the model and the external zone they leave; and
- All links at the boundary edge are allocated to route zones except where they enable an internal settlement to internal settlement trip. In this case the closest link to the modelled area was selected such that only an external to internal trip could be possible.

Figure 13 illustrates how the select links were matched to a particular route zone. In the figure the model area is on the right hand side; hence the flows from external to internal settlements are from the left to the right. The route zones are represented by the different coloured dots.

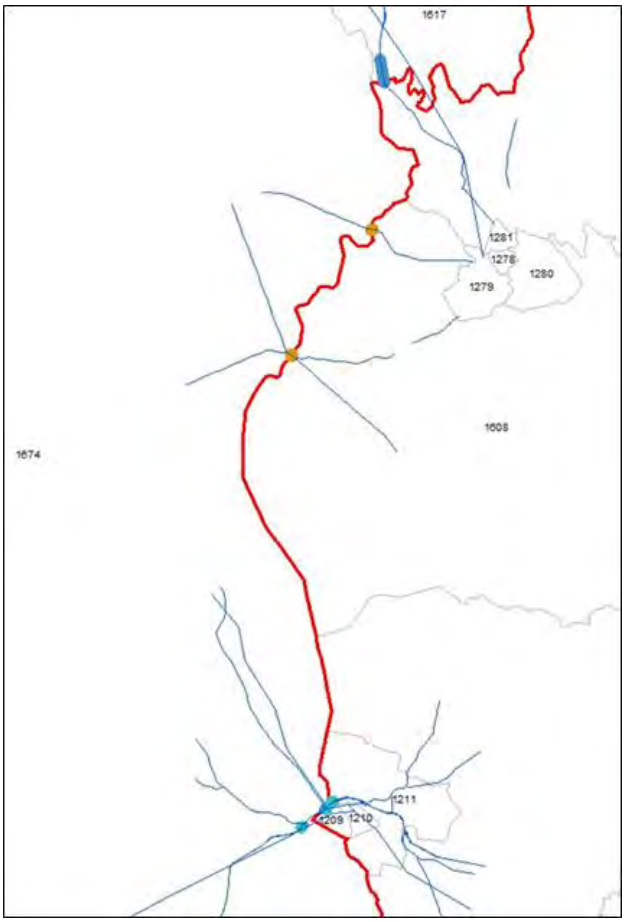


Figure 13 Detailed Route Zone Evaluation

The Cube process uses a 'select links' procedure in order to calculate which route zone (if any) is used for a particular long distance trip. Note that there will not be any route zone attached to any internal flows or external only flows. As per the CPT, the select link (route choice) calculation is based on generalised cost which is a function of time, distance and the toll costs.

$$COST = (0.24 \times TIME) + (0.07 \times DISTANCE) + TOLL$$

The road speeds are given below for each of the various road types.

Table 27 Road Network Speed Category

Road Category	Speed (km/h)
Category 1	130
Category 2	115
Category 3	95
Category 4	80
Category 5	60

Road Category	Speed (km/h)
Category 6	40
Category 7	20
Category 8	10

It should be noted the (potentially more detailed) regional networks are not relevant when selecting the links for mapping to route zones; the only consideration is ensuring that all external to internal demand is captured.

The HGV demand matrix also goes through this process. It should be noted that the same network is assumed for the long distance HGV trips.

7.4.2 Rail Network

The rail route zone was determined by evaluating the intercity rail map obtained from Irish Rail. As the model is only modelling long distance trips only significant changes to the intercity lines would affect the route zone determination. As there are only a few such lines, the route zone was manually determined. This has been individually defined for each of the regional models.

7.5 Disaggregation by Journey Purpose and Time Period

The resulting Route Zone <-> Internal Settlement Matrices from Step 2 is disaggregated by journey purpose and time period, using NHTS for the relevant regional model area.

The output demand matrix is further disaggregated firstly into two journey purposes, Employer's Business and Other. The latter includes purposes education, shopping, other and non-home based other from the NHTS. By aggregating across these purposes for the settlement to settlement trips a constant proportion is applied across the matrix. It is assumed that the variations between these splits for each O-D pair are negligible.

The time period split is calculated for the five time periods used in the regional models (AM, LT (IP1), SR (IP2), PM and OP) based on the midpoint between arrival and departure time. Similarly to the journey purpose the inter settlement trips are ignored and a constant proportion is calculated and applied across the matrices. In addition, it is assumed that there is no distinction between 'From Home' and 'To Home' trips. This is disaggregated in the regional models.

7.6 Route Zone to Internal Sectors

The next step of the process uses the base-year POWSCAR Commuting travel pattern (aggregated to the route zones as in the steps above) to produce factors for distributing the internal settlement demand between the relevant sectors within each internal settlement. This ensures that the broad pattern of these long-distance commuting trips will be retained and applied to the other journey purposes.

In particular, it helps to ensure that long distance PT trips are focussed on areas close to the relevant bus and rail stations within the relevant internal settlements.

The disaggregation should only be applied where the settlement size might offset the distribution of trips, in particular in the Dublin settlement where all of the PT trips would arrive in one or a few zones, and the subsequent dispersion of trips would only in general be within a particular sector.

The aggregation of the POWSCAR commuting pattern to route zones, rather than treating each settlement individually, will help ensure a sufficiently large number of long-distance commuting trips are used to provide these sector-based trip destination patterns.

Further to the aggregation of POWSCAR trips at the route zone levels, there is aggregation at the regional sector levels thus obtaining a demand matrix from route zones to sectors. The sectors within the model are assigned a settlement based on the closest proximity in order to carry out this disaggregation.

Dublin Sectors

Highlighted Sectors Where Trips are Made Via Route Zone 1

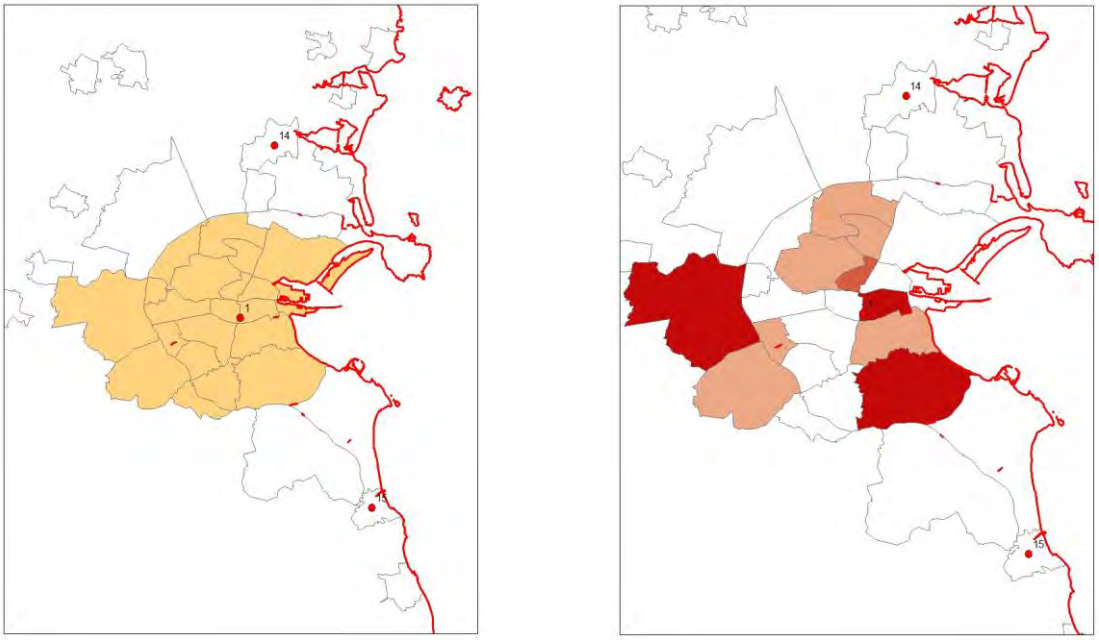


Figure 14 Disaggregation From Settlement to Zone Via Sector

An example is given above using the Greater Dublin Area (GDA) model and Dublin settlements which shows how a settlement is disaggregated to sectors and the identification of which sectors are prominent. It should be noted that the figure should be not be misinterpreted such that it only shows trip entering the settlement via route zone one. The same methodology is applied to all the route zones and disaggregated using the same method.

7.7 Sector to Internal Zone

The final step uses zonal trip-ends (by journey purpose and time period) to disaggregate the sector totals from the previous step across the zones contained within each sector or settlement if it has not being disaggregated into sectors. This ensures that the final matrices (for the non-POWSCAR purposes) match appropriate travel patterns at the detailed local zoning level.

The POWSCAR purpose patterns for Commute Educate (aggregated to Route Zone <->Internal Zone) at the zonal level, are be used for the POWSCAR commute purpose.

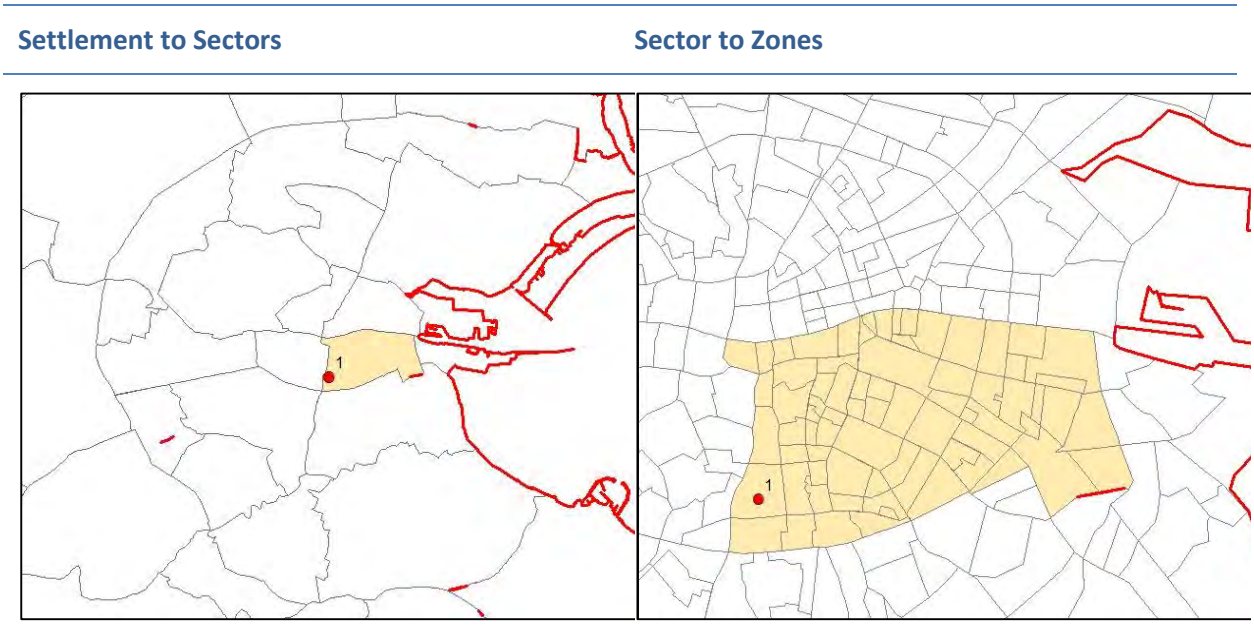


Figure 15 Example of Two Step Approach to Disaggregating Sectors to Internal Zone

7.8 Disaggregation of HGV Matrix to Internal Zone

Disaggregation from settlements to zonal level of the HGV matrix is undertaken by using the proportions obtained from the two POWSCAR categories highlighted in the separate report,

MSF 060 NRA Model Review - Good Vehicle - Alternative Regression Models v5.DOCX

The report suggests that the categories Agriculture, forestry and fishing (POWSCAR1) and Wholesale, Retail Trade, Transportation and Storage, Accommodation and Food Service Activities (POWSCAR4) provides an relationship for predicting HGV trip-ends.

The established relationship is:

$$HGV\ Trip\ Ends\ (000s) = (0.0858 \times POWSCAR1) + (0.0234 \times POWSCAR4)$$

A set of proportions based on these two POWSCAR categories was extracted in order to allocate trips from settlements to zones. Initially the proportions were calculated individually but then combined using the relationship above.

7.9 Outputs

The outputs of the RMSIT are created in the standard output directory and contain a consistent set of route-zone <-> route-zone and route-zone <-> internal modelled-area-zone by the following segmentations:

- Mode (road, PT, and goods);
- Time Period (AM, LT (IP1), SR (IP2), PM, OP); and
- Journey Purpose (commute, education, and other).

These can be added to the matrices of travel demand between the main modelled area zones created by the main regional demand model.

7.10 Summary of the RMSIT Model

In summary, the RMSIT model:

- Uses the corresponding POWSCAR 'Route Zone to Internal Sectors' patterns (by mode) to disaggregate the residual Route Zone<->Internal demand (from Step 4) to Route Zone <-> Sector matrices. This will help retain a 'reasonable' pattern for these long distance trips within the internal modelled area (for example ensuring than public transport trips are focussed on destinations close to the relevant rail/bus stations).
- Uses the main regional model trip-ends to disaggregate the Route Zone<->Sector matrices into Route Zone<->Internal Zone matrices
- Uses the zonal weights from regression model to disaggregate HGV matrix of Route Zones <-> Settlement to Route Zone <-> Internal Zone

8 Summary

The NDFM has been developed to produce a standardised and robust approach to trip modelling based on variations in persons and spatial areas based upon all available data sources.

Users can create adjusted scenarios which reflect projections of population, employment characteristics, and evaluate these against references to ensure viability before applying trip rates based on the NHTS to evaluate levels of trip making for inclusion in regional models.

Car availability projections can be established to provide more appropriate demand segmentations for use within the demand modelling aspects of the regional models. Finally users can also use the RMSIT component to evaluate consistent long distance travel movements for use in the regional models.

All aspects of the core NDFM have been recreated in a standard software (CUBE Voyager) with integration mechanisms between non-core components such as the CPT and car ownership model.

Appendix G: Cross-Section Selection

Memorandum

ARUP

To	Daniel Brennan, David Conlon, Andrew Archer.	Date	12 August 2015
Copies	Arup Design Team.	Reference number	233985
From	Michael Gaughan, Eileen McCarthy	File reference	GCOB-4.04-MEM001
Subject	Cross-section Assessment Rural Link Capacity | Urban Link Capacity | Junction Capacity		

1 Traffic Volumes

1.1 Automatic Traffic Counts

1.1.1 Motorway and National Road Network

Traffic counters are located on the M6, N17, N18 and N84 approaching Galway City. As these traffic counters are not on the immediate approach to the city, they do not provide definitive detail on traffic entering or exiting the city. However, these counters indicate the potential maximum number of vehicles entering the city each day from the motorway and national road network. **Table 1.1** details the Annual Average Daily Traffic (AADT) figures recorded at each of the traffic counters in 2012 / 2013. The traffic counter locations are shown on **Figure 1.1**.

Automated Traffic Counter	AADT
M6	13,606[1]
N17	12,841[2]
N18	16,393[3]
N59	6,895[4]
N84	11,511[5]

1. Based on M6 Glennascaul Counter for a 12 month period in 2012
2. Based on N63 Jn. Counter for a 10 month period in 2013
3.
4.
5.

Table 1.1: *Motorway and National Road Network Traffic Counts*

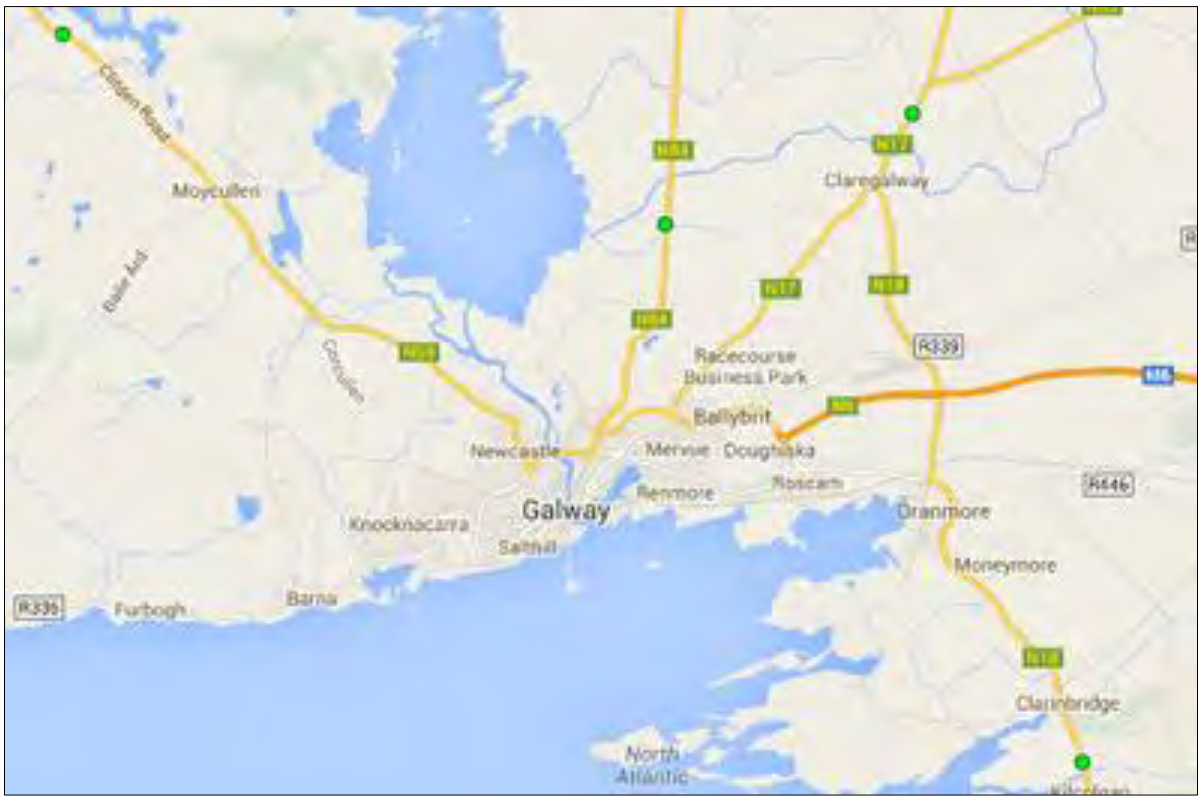


Figure 1.1: *National Road Network Traffic Counters*

1.1.2 National and Local Roads within Galway City

In November 2012 and November 2013 Galway City Council undertook traffic counts throughout the city on national, regional and local roads. Using these counts an estimation of the AADT was determined. This exercise clearly highlighted the most heavily trafficked networks within the city and the overall traffic volumes in the east, within and west of Galway City.

2 Cross-section Selection

2.1 Assessment of Rural Traffic Volumes – TA46/97 / NRA TD9/12

2.1.1 Capacity of Rural Road Network

TA46/97 of the UK Design Manual for Roads and Bridges is used to determine the capacity of new build rural roads. This standard is not formally implemented in Ireland but is considered as background reading which indicates good practice. Within this standard, classifications from single carriageway to motorway are used. The variable used in the determination of a suitable new build rural cross-section is the anticipated or opening year Annual Average Daily Traffic (AADT) volume.

The information provided within TA46/97 is similar to the guidance provided within TD9/12: Road Link Design of the National Roads Authority Design Manual for Roads and Bridges (NRA DMRB). Table 6/1 of NRA TD9/12 recommends edge treatments, access treatments and junction types that would be suitable in broad terms for each type of road as well as corresponding vehicle flow capacities (Annual Average Daily Traffic).

Table 1.2 below is extracted from NRA TD9/12 and details recommended rural road layouts and vehicle flow capacities.

Type of Road [1]	Capacity[2] (AADT) for Level of Service D	Edge Treatment	Access Treatment	Junction Treatment at Minor Road	Junction Treatment at Major Road
Type 3 Single (6.0m) Carriageway (S2)	5,000	0.5m hard strip. Footways/Cycle Tracks where required,	Minimise number of accesses to avoid standing vehicles and concentrate turning movements.	Simple Priority Junctions	Priority junctions, with ghost islands where necessary.
Type 2 Single (7.0m) Carriageway (S2)	8,600	0.5m hard strips. Footways/Cycle Tracks where required	Minimise number of accesses to avoid standing vehicles and concentrate turning movements.	Priority junctions, with ghost islands where necessary.	Ghost islands
Type 1 Single (7.3m) Carriageway (S2)	11,600	2.5m hard shoulders Footways/Cycle Tracks where required	Minimise number of accesses to avoid standing vehicles and concentrate turning movements.	Priority junctions, with ghost islands where necessary.	Ghost islands or roundabouts [3]
Type 3 Dual [4] (7.0m + 3.5m) Divided 2+1 lanes Primarily for retro fit projects	14,000	0.5m hard strips.	Minimise the number of accesses to avoid standing vehicles and concentrate turning movements.	Restricted number of left in/left out or ghost priority junctions.	Priority junctions or at-grade roundabouts.
Type 2 Dual [4] Divided 2 +2 Lanes (2x7.0m) Carriageways. ()	20,000	0.5m hard strips	No gaps in the central reserve. Left in / Left out	No gaps in the central reserve. Left in / Left out	At-grade roundabouts and compact grade separation
Type 1 Dual Divided 2+2 Lanes (2x7.0m) Carriageways ()	42,000	2.5m hard shoulders	No gaps in the central reserve. Left in / Left out	No gaps in the central reserve. Left in / Left out	At-grade roundabouts and full-or compact grade separation.
Standard Motorway Divided 2 +2 Lane (2X7.0m) (D2M)	52,000	2.5m hard shoulders	Motorway Regulations	No gaps in the central reserve.	Motorway standards Full-grade separation.
Wide Motorway Divided 2+2 Lane (2X7.5m) (D2M)	55,500	3m hard shoulders	Motorway Regulations	No gaps in the central reserve	Motorway standards Full-grade separation.

Notes:

1. For details of the standard road cross-sections, see NRA TD 27, NRA TD 10 'Type 2 and Type 3 Dual Carriageways' and Road Construction Details Series 000.
2. Capacity figures are indicative for general guidance. The appropriate cross section shall be selected in accordance with the NRA Project Appraisal Guidelines
3. Single lane dualling may be appropriate in some situations, but would be a Relaxation (see NRA TD 41-42).
4. See NRA TD 10 'Type 2 and Type 3 Dual Carriageways'
5. Refer to TA 79 for Urban Road capacities.

Table 6/1: Recommended Rural Road Layouts

Table 1.2: *Recommended Rural Road Layouts*

2.1.2 Assessment Procedure

It should be noted that AADT values are to be used as a starting point only in the assessment of options as they do not provide a guaranteed ultimate capacity a rural road can carry and therefore, should be used flexibly – this ultimate capacity depends on many other factors also. Therefore, vehicle flow capacities cannot be used in isolation for the selection and assessment of improvement or widening schemes.

2.1.3 Conclusion

The vehicle flow capacities (Annual Average Daily Traffic) provide an indication of the range of traffic flows over which each carriageway standard is likely to be economically justified and are to be used as a starting point only. Examination of Table 6/1 of NRA TD9/12 highlights that one of the main differentiators between the various rural road layouts is the form of junction / access treatment utilised. This highlights that the assessment of the suitability of cross-sections in rural areas is as dependent, if not more dependent on junction capacity as link / vehicle flow capacity.

2.2 Assessment of Urban Traffic Volumes – TA79/99

2.2.1 Capacity of Urban Road Network

TA79/99 of the UK DMRB is used to determine the capacity of urban roads. This standard is not formally implemented in Ireland but is considered as background reading which indicates good practice. Within this standard, classifications such as Urban Motorways or Urban All Purpose roads are used, with further sub-classification of Urban All Purpose Roads as UAP1 to UAP4.

Table 1.3 and **Table 1.4** below are extracted from TA79/99 and details the types of urban roads and the features that distinguish them and the Capacities of Urban Roads One-way hourly flows in each direction respectively.

Feature	ROAD TYPE				
	Urban Motorway	Urban All-purpose			
	UM	UAP1	UAP2	UAP3	UAP4
General Description	Through route with grade separated junctions, hardshoulders or hardstrips, and motorway restrictions.	High standard single/dual carriageway road carrying predominantly through traffic with limited access.	Good standard single/dual carriageway road with frontage access and more than two side roads per km.	Variable standard road carrying mixed traffic with frontage access, side roads, bus stops and at-grade pedestrian crossings.	Busy high street carrying predominantly local traffic with frontage activity including loading and unloading.
Speed Limit	60mph or less	40 to 60 mph for dual, & generally 40mph for single carriageway	Generally 40 mph	30 mph to 40 mph	30mph
Side Roads	None	0 to 2 per km	more than 2 per km	more than 2 per km	more than 2 per km
Access to roadside development	None. Grade separated for major only.	limited access	access to residential properties	frontage access	unlimited access to houses, shops & businesses
Parking and loading	none	restricted	restricted	unrestricted	unrestricted
Pedestrian crossings	grade separated	mostly grade separated	some at-grade	some at-grade	frequent at-grade
Bus stops	none	in lay-bys	at kerbside	at kerbside	at kerbside

Table 1 Types of Urban roads and the features that distinguish them

Table 1.3: *Types of Urban roads and the features that distinguish them*

		Two-way Single Carriageway- Busiest direction flow (Assumes a 60/40 directional split)									Dual Carriageway			
		Total number of Lanes									Number of Lanes in each direction			
		2				2-3	3	3-4	4	4+	2		3	4
Carriageway width		6.1m	6.75m	7.3m	9.0m	10.0m	12.3m	13.5m	14.6m	18.0m	6.75m	7.3m	11.0m	14.6m
Road type	UM	Not applicable										4000	5600	7200
	UAP1	1020	1320	1590	1860	2010	2550	2800	3050	3300	3350	3600	5200	*
	UAP2	1020	1260	1470	1550	1650	1700	1900	2100	2700	2950	3200	4800	*
	UAP3	900	1110	1300	1530	1620	*	*	*	*	2300	2600	3300	*
	UAP4	750	900	1140	1320	1410	*	*	*	*	*	*	*	*

Table 2 Capacities of Urban Roads
One-way hourly flows in each direction

Notes
1. Capacities are in vehicles per hour.
2. HGV ≤ 15%
3. (*) Capacities are excluded where the road width is not appropriate for the road type and where there are too few examples to give reliable figures.

Table 1.4: *Capacities of Urban Roads One-way hourly flows in each direction*

2.2.2 Assessment Procedure

The capacities given in **Tables 1.3, Table 1.4** and within TA79/99 provide a guide for the assessment of an appropriate carriageway width and standard. They may be applied to both the design of new urban roads and to the improvement of existing roads. The capacities are intended to help designers make a judgement as to which carriageway standard is likely to provide an acceptable level of service within an urban context when operating close to capacity. The capacities apply to links and take no account of the effects of junctions.

2.2.3 Conclusion

As noted, the capacities apply to links and take no account of the effects of junctions. The potential capacity of a link will not be reached if either the capacity of junctions along the link or the capacity of the adjoining network is lower than the link in question. The flow on an urban road may be affected by turning movements restricting the mainline capacity. For this reason the assessment of the suitability of cross-section is as dependent, if not more dependent on junction capacity as link capacity.

2.3 Cross-section Selection

As part of Phase 2 Route Selection of the N6 Galway City Transport Project cross-section capacity assessments for each of the route options were undertaken using the methods detailed above and as outlined below.

- In rural areas AADT values as per NRA TD9/12 were used as a starting point in selecting and assessing appropriate cross-sections.
- In rural / suburban areas AADT values as per NRA TD9/12 in conjunction with the procedures as per UK DMRB TA 79/99 were used as a starting point in selecting and assessing appropriate cross-sections.
- In suburban / urban the procedure as per UK DMRB TA79/99 were used as a starting point in selecting and assessing appropriate cross-sections.

Areas common to each of the offline route options were selected as reference points for the assessment of cross sections. These areas were selected as they represent distinct zones within the study area and along each of the offline route options. The reference points identified and utilised for the assessment of offline options are as follows:

- Bearna Area,
- Knocknacarra Area,
- River Corrib Crossing,
- N17 Area.

Alternative reference points were identified for the on-line or Red Route Option due to its distinct nature, the reference points for this option are as follows:

- Bearna Area,
- Knocknacarra Area,
- Rahoon Area,
- River Corrib Crossing,
- N6 at Terryland,
- N6 at City East Business Park,
- Briarhill at Ardaun.

Tables 1.5 to 1.9 detail the cross-section assessment of each route option.

Bearna Area - Cross-Section						
Option	**Setting**	**Anticipated AADT [1]**	**NRA TD9/12**	**Hourly Flows [2]**	**UK DMRB TA79**	**Cross-Section Selected**
Orange Route Option	Rural	< 11,600	Type 1 Single	-	-	Type 1 Single
Green Route Option	Rural	< 11,600	Type 1 Single	-	-	Type 1 Single
Yellow Route Option	Rural	< 11,600	Type 1 Single	-	-	Type 1 Single
Blue Route Option	Rural	< 11,600	Type 1 Single	-	-	Type 1 Single
Pink Route Option	Rural	< 11,600	Type 1 Single	-	-	Type 1 Single

Notes:

1. Annual Average Daily Traffic.
2. Hourly Flows Each Direction for Peak Periods.

Table 1.5: *Bearna Area Preliminary Cross Section Assessment*

Knocknacarra Area - Cross-Section						
Option	**Setting**	**Anticipated AADT [1]**	**NRA TD9/12**	**Hourly Flows [2]**	**UK DMRB TA79**	**Cross-Section Selected**
Orange Route Option	Rural	< 14,000	Type 3 Dual	-	-	Type 2 Dual [3]
Green Route Option	Rural	< 20,000	Type 2 Dual	-	-	Type 2 Dual
Yellow Route Option	Rural	< 20,000	Type 2 Dual	-	-	Type 2 Dual
Blue Route Option	Rural	< 14,000	Type 3 Dual	-	-	Type 2 Dual [3]
Pink Route Option	Rural	< 11,600	Type 1 Single	-	-	Type 2 Dual [3]

Notes:

1. Annual Average Daily Traffic.
2. Hourly Flows Each Direction for Peak Periods.
3. Type 2 Dual Cross-Section adopted in order to facilitate consistent comparative assessment across route options.

Table 1.6: *Knocknacarra Area Preliminary Cross Section Assessment*

River Corrib Crossing - Cross-Section						
Option	**Setting**	**Anticipated AADT [1]**	**NRA TD9/12**	**Hourly Flows [2]**	**UK DMRB TA79**	**Cross-Section Selected**
Orange Route Option	Rural / Suburban	< 42,000	Type 1 Dual	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [3]
Green Route Option	Rural / Suburban	< 42,000	Type 1 Dual	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [3]
Yellow Route Option	Rural / Suburban	< 42,000	Type 1 Dual	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [3]
Blue Route Option	Rural / Suburban	< 42,000	Type 1 Dual	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [3]
Pink Route Option	Rural / Suburban	< 42,000	Type 1 Dual	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [3]

Notes:

1. Annual Average Daily Traffic.
2. Hourly Flows Each Direction for Peak Periods.
3. Type 2 Dual Cross-Section adopted in order to facilitate consistent comparative assessment across route options. UAP 1 (Dual 2 Lane) as per UK DMRB is descriptively similar to the Type 1 and 2 Dual Carriageway Cross-Sections detailed within NRA TD27/14. The difference in characteristics between the Type 1 and 2 Dual Carriageways and the UAP 1 (Dual 2 Lane) cross-section as per UK DMRB TA79/99 relates to layout feature dimensions such as hard strip width, hard shoulder width, central reserve width and verge width. The dimension of such features will be determined via incremental assessment during Phase 3: Design.

Table 1.7: *River Corrib Crossing Preliminary Cross Section Assessment*

N17 Crossing - Cross-Section						
Option	**Setting**	**Anticipated AADT [1]**	**NRA TD9/12**	**Hourly Flows [2]**	**UK DMRB TA79**	**Cross-Section Selected**
Orange Route Option	Urban	< 55,500	Wide Motorway	= ~ 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual (3 Lane) [4]
Green Route Option	Rural / Suburban	< 42,000	Type 1 Dual	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [3]
Yellow Route Option	Urban	< 42,000	Type 1 Dual	= ~ 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual (3 Lane) [4]
Blue Route Option	Rural / Suburban	< 42,000	Type 1 Dual	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [3]
Pink Route Option	Rural / Suburban	< 42,000	Type 1 Dual	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [3]

Notes:

1. Annual Average Daily Traffic.
2. Hourly Flows Each Direction for Peak Periods.
3. Type 2 Dual Cross-Section adopted in order to facilitate consistent comparative assessment across route options. UAP 1 (Dual 2 Lane) as per UK DMRB is descriptively similar to the Type 1 and 2 Dual Carriageway Cross-Sections detailed within NRA TD27/14. The difference in characteristics between the Type 1 and 2 Dual Carriageways and the UAP 1 (Dual 2 Lane) cross-section as per UK DMRB TA79/99 relates to layout feature dimensions such as hard strip width, hard shoulder width, central reserve width and verge width. The dimension of such features will be determined via incremental assessment during Phase 3: Design.
4. Type 2 Dual (3 Lane) carriageway adopted due to larger predicted traffic volumes.

Table 1.8: *N17 Crossing Preliminary Cross Section Assessment*

Red Route Option						
Location	**Setting**	**Anticipated AADT [1]**	**NRA TD9/12**	**Hourly Flows [2]**	**UK DMRB TA79**	**Cross-Section Selected**
Bearna	Rural	< 11,600	Type 1 Single	-	-	Type 1 Single
Knocknacarra	Suburban	< 20,000	Type 2 Dual	< 1470	UAP 2 (Single)	Dual Urban Relief Road [3]
Rahoon	Suburban	< 42,000	Type 1 Dual	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [4]
River Corrib	Urban	> 55,500	-	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [4]
N6 (Terryland)	Urban	> 55,500	-	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [4]
N6 (City East Business Park)	Urban	> 55,500	-	= ~ 3600	UAP 1 (Dual 3 Lane)	Type 2 Dual (3 Lane) [5]
Briarhill (Ardaun)	Suburban	< 55,500	Wide Motorway	< 3600	UAP 1 (Dual 2 Lane)	Type 2 Dual [4]

Notes:

1. Annual Average Daily Traffic.
2. Hourly Flows Each Direction for Peak Periods.
3. Dual Carriageway Urban Relief Road adopted so as to accommodate bus corridors.
4. Type 2 Dual Cross-Section adopted in order to facilitate consistent comparative assessment across route options. UAP 1 (Dual 2 Lane) as per UK DMRB is descriptively similar to the Type 1 and 2 Dual Carriageway Cross-Sections detailed within NRA TD27/14. The difference in characteristics between the Type 1 and 2 Dual Carriageways and the UAP 1 (Dual 2 Lane) cross-section as per UK DMRB TA79/99 relates to layout feature dimensions such as hard strip width, hard shoulder width, central reserve width and verge width. The dimension of such features will be determined via incremental assessment during Phase 3: Design.
5. Type 2 Dual (3 Lane) carriageway adopted due to larger predicted traffic volumes.

Table 1.9: *Red Route Option Preliminary Cross Section Assessment*

2.4 Conclusion

For rural, suburban and urban areas junction capacity is a significant consideration. In each of these areas the cross-section suitability is more dependent on junction capacity than link or vehicle flow capacity. Junctions with inadequate capacities act as a significant constriction in the road network restricting mainline road capacity and traffic movements on adjoining networks. The importance of junction capacity is highlighted by the fact that the capacity of a link will not be reached if either the capacity of junctions along the link or the capacity of the adjoining network is lower than the link in question.

The assessments noted are a starting point used to comparatively compare the cross-section capacity of each of the route options considered as part of Phase 2 Route Selection. More detailed analysis of traffic, economic and environmental aspects regarding the selection of the cross-section will be undertaken via incremental analysis during Phase 3 Design. This incremental analysis will include, but is not limited to the assessment of:

- Consistency of alignment with adjacent schemes along the inter-urban route;
- Predicted traffic volumes;
- Required carrying capacity in the design year;
- Scheme specific issues (e.g. topography, ground conditions, structures etc.)
- Access requirements and restrictions;
- Cost;
- Safety (reduction in frequency and severity of collisions);
- Government and/or NRA policy.

Appendix H: AADT Expansion Factors

Galway City Outer Bypass

Estimating AADT from modelled flows

AV – 9th March 2015

The note below intends to present the methodology adopted to estimate the AADT values from the modelled flows. The estimating method is mainly based on the *NRA Project Appraisal guidelines. Unit 16.1: Estimating AADT on National Roads.*

According to the PAG, the preferable method of estimating AADT is the **Permanent counter method**. However, the intention here is to estimate AADTs for across a broad geographical area around Galway and there are only 3 NRA Permanent Counters located at a certain distance from the area. Furthermore, it is believed that the daily traffic flow profiles at the NRA PC locations are significantly different to the flow profiles observed closer to town. The **Localised Period Count Method** is therefore preferable in this case and has been used in estimating expansion factors.

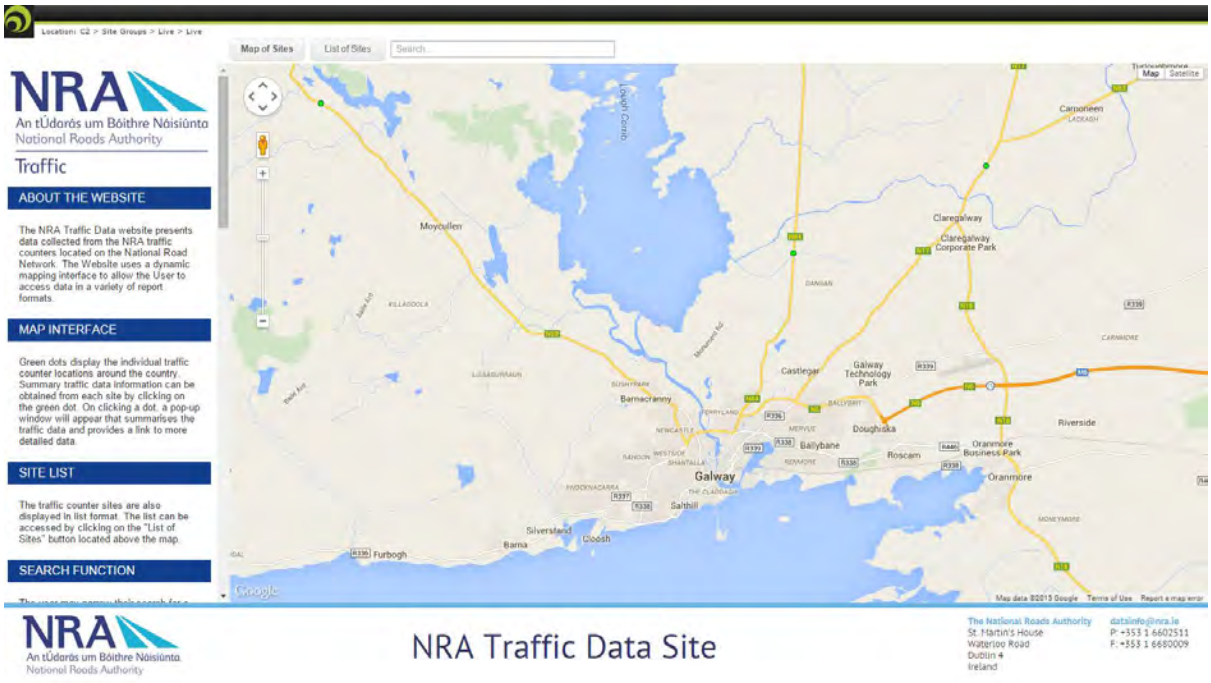


Figure 1: The three NRA PC locations around Galway (green spots).

Localised Period Count Method

The **Localised Period Count Method** combines data from ATCs (of 7 day, performed in November 2012) and NRA PCs.

An expansion factor is calculated for each type of vehicle (Cars, HGVs, LGVs).

The figure below shows the expansion factors calculation process.

Figure 2: Expansion factors calculation process

The calculation is done in two steps:

1. 8-9AM Monday-Friday ATC flows are expanded to 24h Monday-Sunday flows (Weekly Average Daily Traffic, WADT) in the observed period of the year (3rd week of November 2012). This is done based on the ATC data performed in 72 different locations across Galway on 12/11/2012 – 18/11/2012.

   For each ATC location, a factor (F1) can be estimated by:

$$F1 = \frac{Average\ 24h\ Monday - Sunday}{Average\ 8 - 9AM\ Monday - Friday}$$

   A large spread of factors is observed among ATCs according to the road type and whether they are located close to shopping areas, residential areas or industrial estates. Indeed the factors have values between 3.6 (Old Dublin Road, Galway) and 23.5 (R866 Headford Road, shopping area).
   The figure below shows those factors for each ATC and their location. It appears that there isn't any clear pattern in terms of geographic distribution of these factors and it doesn't seem to be a way of estimating factors specific to some sectors. Then, the estimated factor will be a unique value applied to the whole area, by kind of vehicle.

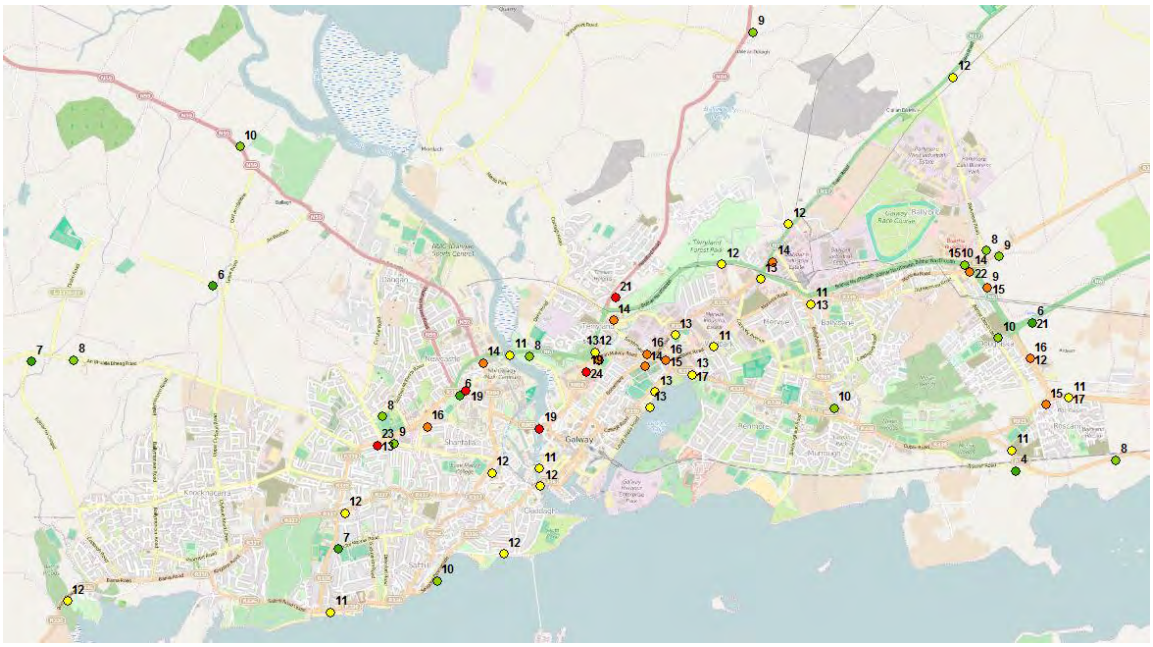


Figure 3: 8-9AM -> WADT expansion factors by location for cars.

Based on the PAG unit 16.1 methodology for multiple counts, a linear regression has been performed based on the 72 ATCs in order to estimate this first factor. We obtained:

$$WADT_{Nov2012} = 11.75 \times AM_{WD}\ for\ cars$$

$$WADT_{Nov2012} = 11.94 \times AM_{WD}\ for\ LGVs$$

$$WADT_{Nov2012} = 9.22 \times AM_{WD}\ for\ HGVs$$

Where:

$WADT_{Nov2012}$ is the weekly average daily traffic for the 3rd week of November 2012,

$AM_{WD}$is the average 8-9 AM weekday (Monday-Friday) traffic for the 3rd week of November 2012.

The next steps consists in converting the $WADT_{Nov2012}$ into $AADT_{2012}$.

2. The 24h Monday-Sunday flows of the observed period ($WADT_{Nov2012}$) are then expanded to the annual average daily flow of 2012 based on the closest NRA permanent counters. This is to take into account the seasonality of the traffic flows.
   To do so, the period when the ATC counts have been performed is to be compared with the rest of the year.

   In this case, there is no available data for 3 closest NRA Permanent Counters for November 2012. Indeed between the summer 2012 and March 2013 a number of NRA Permanent counters seem to have been relocated.
   Then, in order to estimate how the 3rd week of November relates to the rest of the year in terms of traffic, available data of the 3 closest PCs from 2011 and 2013 has been considered. This is not ideal considering the fact that it won't capture any specific event that happened November 2012 (e.g. weather[1], special event). Yet, apart from those special cases, one can assume that from year to year, the annual flow profile won't differ significantly.

A linear regression has been performed based on 4 annual counts to estimate the expansion factor (F2).

The Permanent counters and the periods taken into account are:

NRA PC Name	Location	Period start	Period end
Claregalway	N17-16	01/01/2011	31/12/2011
PC1841	N84	01/03/2013	28/02/2014
PC20172	N17	15/03/2013	14/03/2014
PC1591	N59	24/03/2013	23/03/2014

This extrapolation factor F2 is given by:

[1] Met.ie in its "MONTHLY WEATHER BULLETIN" reports rainfall and temperature below average in November 2012 but not dramatically different from previous year.
http://www.met.ie/climate/MonthlyWeather/clim-2012-Nov.pdf

$$F2 = \frac{WADT_{Nov}}{AADT}$$

Where:

$WADT_{Nov2012}$ is the weekly average daily traffic for the 3rd week of November of the considered year

$AADT$ is the annual average daily traffic for the considered year.

$$AADT = 1.005 \times WADT_{Nov}\ for\ cars$$

$$AADT = 0.96 \times WADT_{Nov}\ for\ LGVs$$

$$AADT = 0.97 \times WADT_{Nov}\ for\ HGVs$$

Estimated AADT expansion factors

To conclude, combining the two factors above, the expansion factors to estimate AADT from modelled 8-9AM flows are:

$$AADT = 11.81 \times AM_{WD}\ for\ cars$$
$$AADT = 11.52 \times AM_{WD}\ for\ LGVs$$
$$AADT = 8.96 \times AM_{WD}\ for\ HGVs$$

Where AM_{WD} is the average 8-9 AM weekday traffic flow (modelled).

Appendix I: NTA Galway Interim Model Forecasting – Briefing Note 1

Údarás Náisiúnta Iompair
National Transport Authority

Galway Interim Model- Forecasting – Briefing Note 1

Draft Report

Ref No.	Status	Author(s)	Issue Date
V1	Draft	EF	21/2/2014
V2	Draft	TM	26/2/2014
V3	Draft	EF	27/2/2014

Contents

1 Introduction

The purpose of this paper is to provide, for discussion, the disaggregation of land-use forecasts for population and employment for use in the Galway Interim Model. This Model will be used to assess the proposed Galway Bypass Road Scheme.

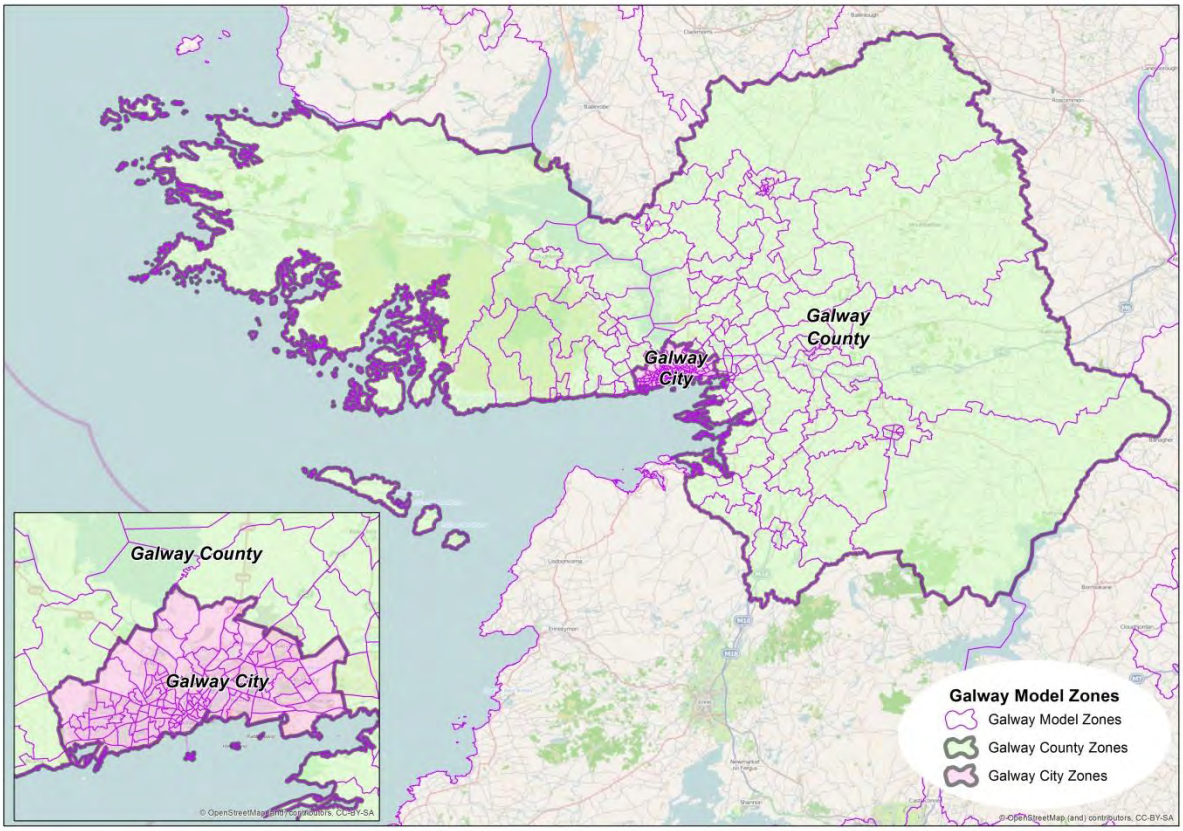
The first section of the paper outlines a set of macro forecast figures for the West Region, based on CSO Regional Population forecasts, setting out how the Model study area is expected to grow. The report then sets out the existing distribution of population and employment within the study area, with a particular focus on the Galway City Council area. The next section will identify areas identified by the NTA for potential growth, and the final section will outline a number of potential issues to be considered in the disaggregation of future year forecasts, and outline the steps to complete the forecast scenario.

1.1 Galway Interim Model Zones

Ultimately, this process will result in the allocation of future year growth forecasts being allocated into model zones. The model zones devised for the Galway Interim Model are closely related to the CSO Electoral District boundaries, with some modifications made by the modelling team. The model zones are set out in Figure 1. Given the timeframe for completing the Galway Interim Model and for running test scenarios, it has been decided that the model zones will not be reviewed or revised as part of this process. It is expected that the Model Zones for the full Galway Regional Model will involve a review of these model zones to better reflect existing land uses and areas likely to be subject to future development.

A key element of this process is the development of a close working relationship with both Galway City Council and Galway County Council to discuss and agree the forecast scenarios and the definition of the model zones.

Figure 1: Spatial Breakdown of Model Zones for the Galway Interim Model



2 Regional Projections

The basis for all of the NTA's model forecasting stems from population projections, which originate out of work carried out by the CSO. The NTA has used two primary data sources to establish the longer term population projections for use in the Galway Interim Model forecasts, these are:

- The NSS/RPG (West Region) forecast projections. These are based on the 2006 Census and associated 2008 projections (Regional Population Projections 2011-2026 –Dec 2008 and subsequent DoEHLG Regional Planning Guidelines Review – Gateway and Hub Population Targets, August 2008 '*the Managers Report*'). *It is noted that there have been serious economic changes since these forecasts were made.*
- CSO Regional Population Projections 2016-2031 (December 2013).

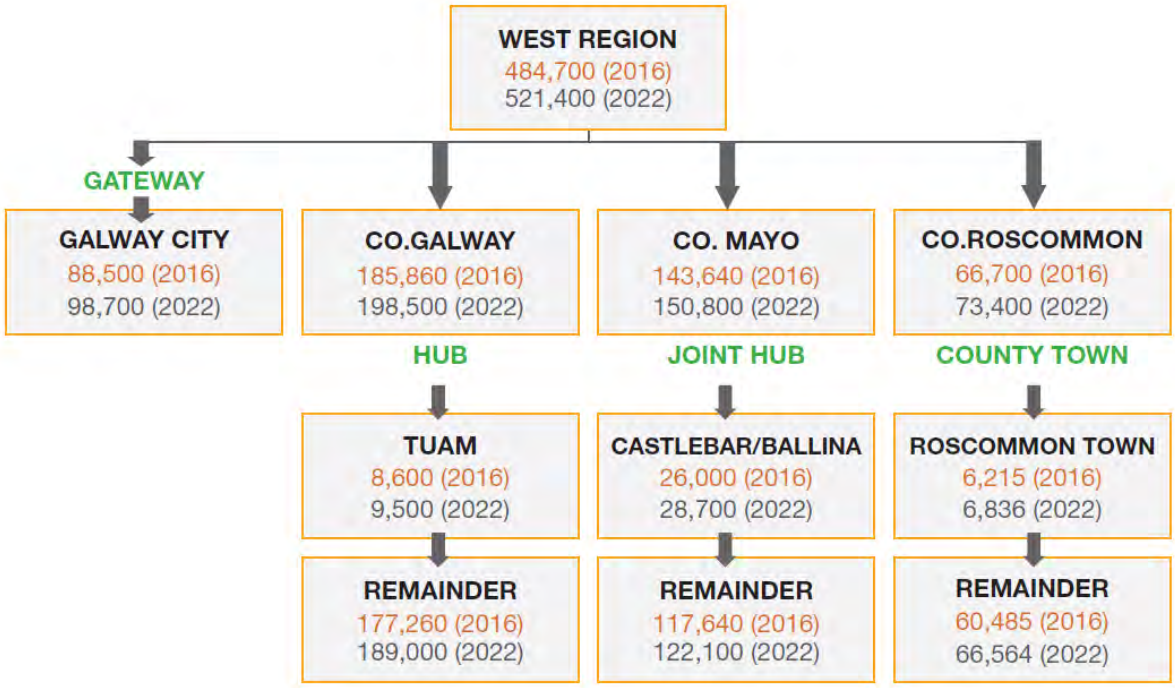
A combination of both datasets are used to develop future year population forecasts for the year 2022 (in line with the RPGs) and 2031 (long term forecast year of the CSO Regional Population Projections).

2.1 RPG forecasts for the West Region

The Regional Planning Guidelines for the West Region have a statutory role in the strategic planning of the region. These guidelines set out population targets for each of the Counties, Gateway and Hubs within the region. These targets are used to guide the distribution of population growth in the County Development Plans, and more specifically the County Core Strategies. The target population figures for 2016 and 2022 are set out in Figure 2.

The NTA have used these figures from the RPGs, in conjunction with more spatially specific guidance from the County Core Strategies to spatially allocate growth across the region for the purposes of the Galway Interim Model.

Figure 2: West Region Population Targets (2016 & 2022) (source: RPGs for West Region 2010)



2.2 CSO Population Projections – Summary

The NTA has also analysed the more recent population projections which has been developed by the CSO in light of the results of the 2011 Census. The following is a brief summary of the CSO Regional Population Projections:

- Population change is forecast from 2016 to 2031.
- Regional forecasts are available for the 8 regional authority areas (Border, Dublin, Mid-East, Midland, Mid-west, South-East, South-West and West.
- The forecasting of natural increase (inc. births and deaths) and external/internal migration are included in the figures.

- The projections contain a number of assumptions which influence the level of population growth (fertility and external migration), and in relation to the Regional Forecasts, assumptions are also made in relation to internal migration.

It should be noted that the CSO Regional Population Projections contain a number of assumptions which allow for different population scenarios to be projected, specifically Fertility and Migration. In relation to this analysis all work has been carried out using the M2F2 Scenario – This assumes that in relation to fertility, the Total Fertility Rate (TFR) will decrease from 2.1 to 1.8 by 2026 and stay the same up to 2031. In relation to migration the annual migration rates as set out in Figure 2 are assumed.

Figure 2 – National Migration Assumptions

	2011-2016	2016-2021	2021-2031
M2	-21,600	4,700	10,000

In addition the 'Traditional' internal migration scenario was used, which states that:

- Traditional – Gradual reversal to the 1996 internal migration patterns to 2021 and then holding constant up to 2031.

Based on these assumptions, the population forecasts for the West Region are set out in Table 3.

Figure 3: CSO Population Projections for the West Region (2011 -2031)

Regional Authority area	West ('000)	State ('000)
CSO Population 2011	441	**4,575**
Projected Population 2031		
2031 M2F2 Traditional	456	**5,188**
Projected Population Change - 2011-2031		
2031 M2F2 Traditional	15	**613**
Projected Population % Change - 2011-2031		
2031 M2F2 Traditional	3%	**13%**

2.3 Development of Regional Figures

It is clear that there is a discrepancy between the two sets of population figures. The RPGs forecast a growth in the West Region of roughly 80,000 between 2011 and 2022, or 7,250 per annum. On the other hand, the CSO M2F2 Traditional scenario predicts a growth of 15,000 between 2011 and 2031, or 750 per annum. There is a ten fold difference between the two annual projections. This will need to be discussed before forecast projections can be agreed for the study area.

2.4 Development of Destination Forecasts

Once population (or 'Origin') forecasts have been agreed, a ratio of growth for other trip destinations, primarily employment and education can be calculated. Growth in both employment and education can be directly associated with the overall growth in population, however it is the distribution of this growth which needs to be examined more carefully. The distribution of growth for population, employment and education is set out in the next section. Further information on how distribution assumptions have been calculated for the Greater Dublin Area model is set out in Appendix 1.

The overall growth destination factors will also influence growth in other trip destinations such as retail, shopping and leisure. The growth in such trips rates is an important input into the model, however it has not been considered at this stage of the process. Further information on how trip rate assumptions have been calculated for the Greater Dublin Area model is set out in Appendix 2.

3 Overview of Current Spatial Distribution of Land Use within the Model Area.

This section will give an overview of the current distribution of land uses across the Galway Interim Model area, and also highlight the recent trends in the build out of land uses. This information can be used to inform decisions as to how future year growth might be allocated across the area.

3.1 Review of Residential Development Trends

This section reviews how population growth has been accommodated over recent years within the Galway Interim Model area. Looking at the Housing Completion statistics from the CSO it is clear that the rate of house construction has dropped off significantly, from a high of 5,787 units built in Galway City and County in 2006 to only 499 units completed in 2012.

It is also interesting to note the spatial distribution of household construction. Looking simply at ratio of units constructed in Galway County versus Galway City, it is clear that in construction is heavily weighted towards the county, a trend which has become increasingly apparent as the period of economic difficulties has continued (ratio of construction 3.5:1 in favour of the county in 2006 has become a ratio of 15:1 in 2013).This is illustrated in Figure 5.

Figure 5: Household Completions by County 2006-2012 (CSO)

Year		2006	2007	2008	2009	2010	2011	2012
Total Housing Units	**Total**	5,787	4,581	2,877	1,472	902	692	499
Galway County Council	**HH Units**	4,512	3,849	2,332	1,273	825	620	467
Galway City Council	**HH Units**	1,275	732	545	199	77	72	32
Galway County Council	**%**	78%	84%	81%	86%	91%	90%	94%
Galway City Council	**%**	22%	16%	19%	14%	9%	10%	6%

The spatial distribution of this growth shows a dispersed pattern of development. This is illustrated in Figure 6.

Figure 6: Distribution of Household Growth 2002 -2011 (Geo-directory)

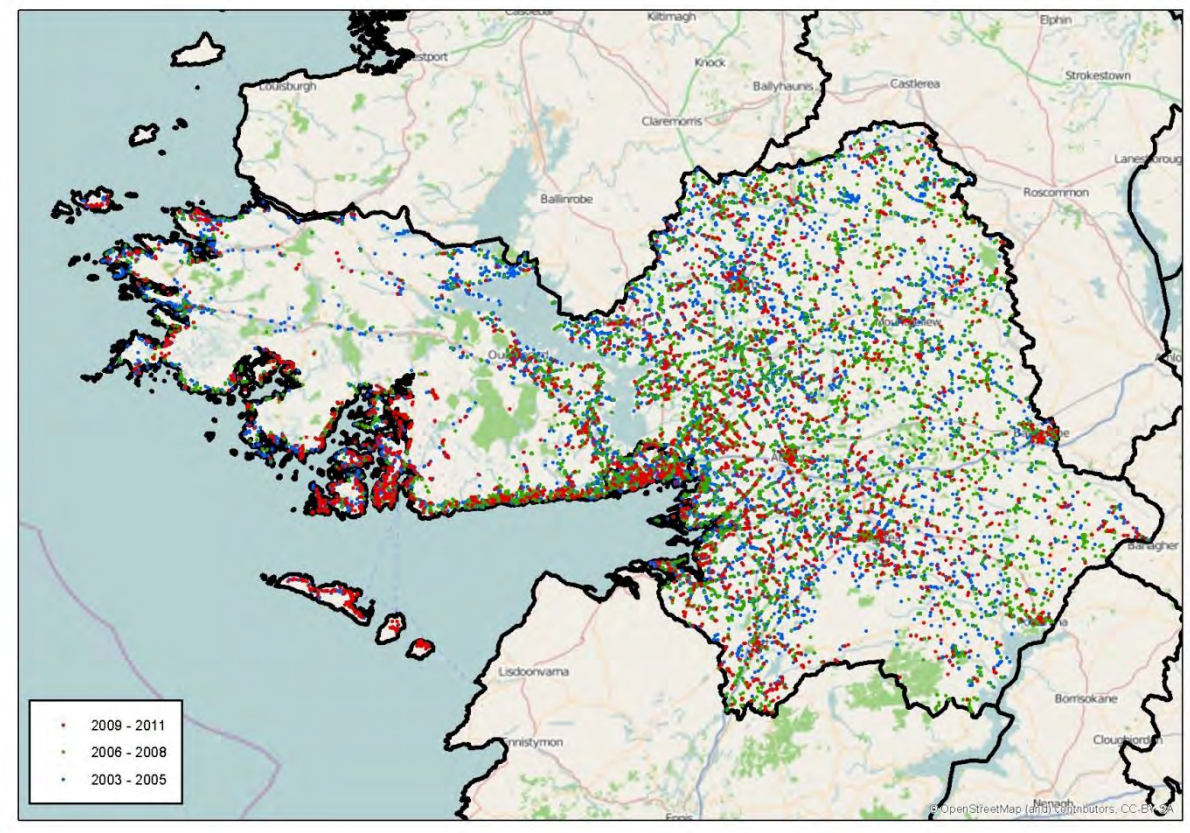


Figure 6 shows the point location of new residential units built in the last decade (2003-2011). It is clear that there is quite a dispersed pattern of development, which needs to be considered when looking at the allocation and distribution of future year population growth.

3.2 Review of Employment Destinations by Type of Employment.

In terms of the existing distribution of employment, it was possible to look at the breakdown of employment by sector based on the CSO 2011 POWSCAR data. This is a useful indicator to illustrate where different types of employment are located, which will have an influence on where future growth in employment might take place.

Figures 7 and 8 illustrate the 2011 distribution of total employment of the City and County respectively.

Figure 7: Location of Total Employment within Galway City

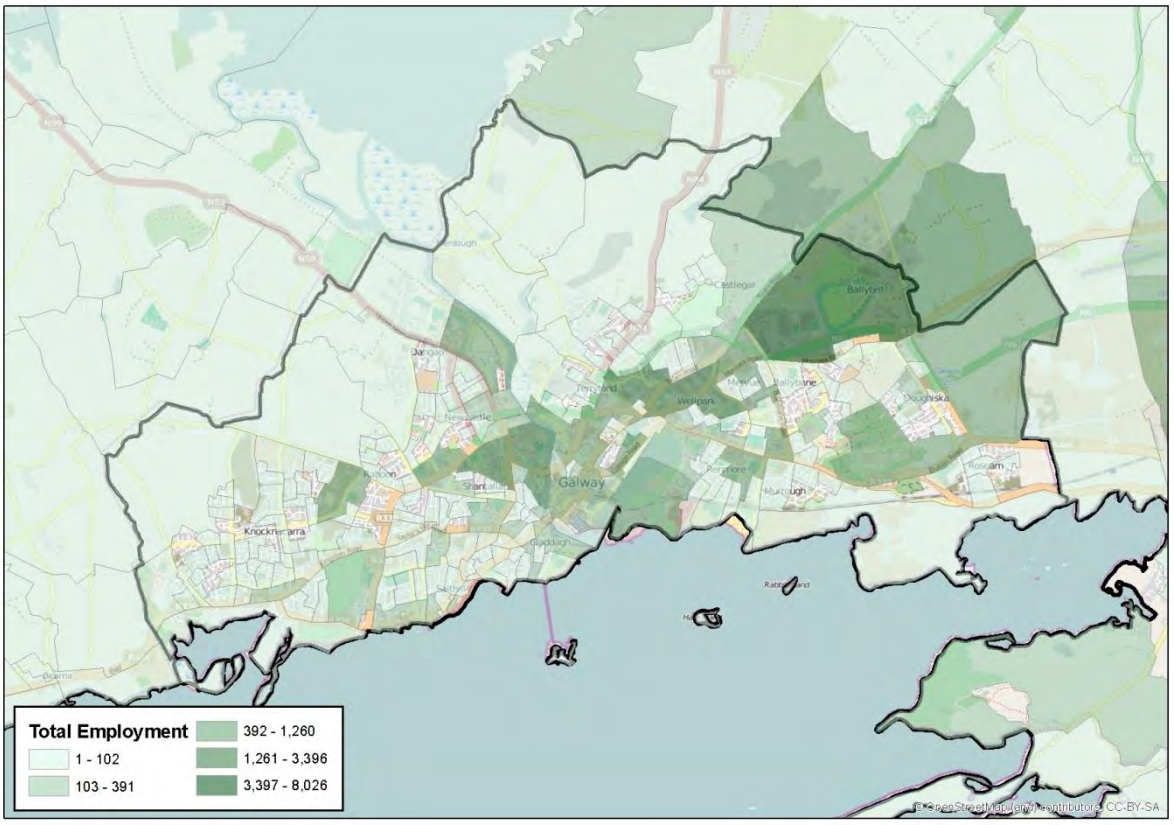
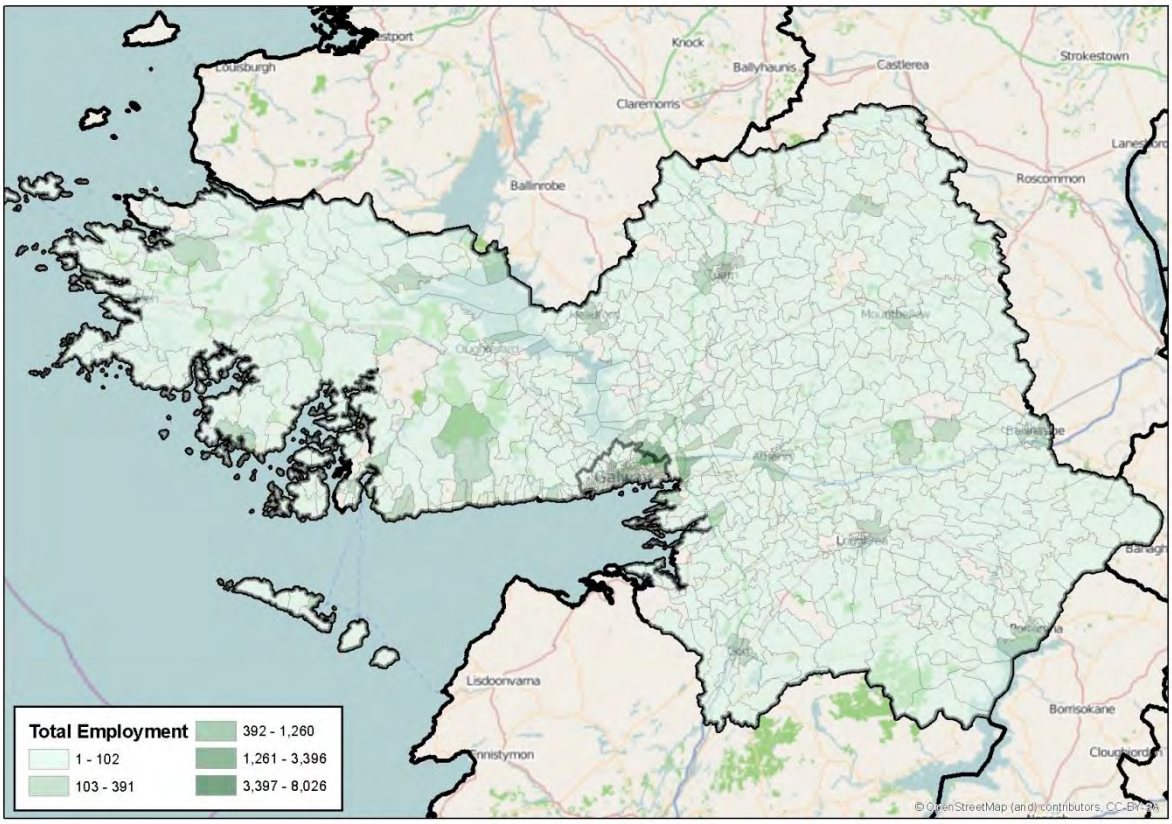


Figure 8: Location of Total Employment in Galway County



It is interesting to note the spread of employment across the model area, but it is also important to highlight key employment locations such as the trio of business parks around the Galway Racecourse which together employ around 8,500 people. Other employment locations to note are the hospitals and the University.

It is possible to break down the employment by sector to understand how different employment types have different locational characteristics. It is apparent in Figure 9 that significant locations of public administration employment are in the city centre at the City and County Council offices, and also at the University Hospital and the NUIG campus. Other locations are at Merlin Park Hospital and Renmore Barracks, due to defence employment being included in this category.

Figure 9: Location of Public Admin / Defence Employment

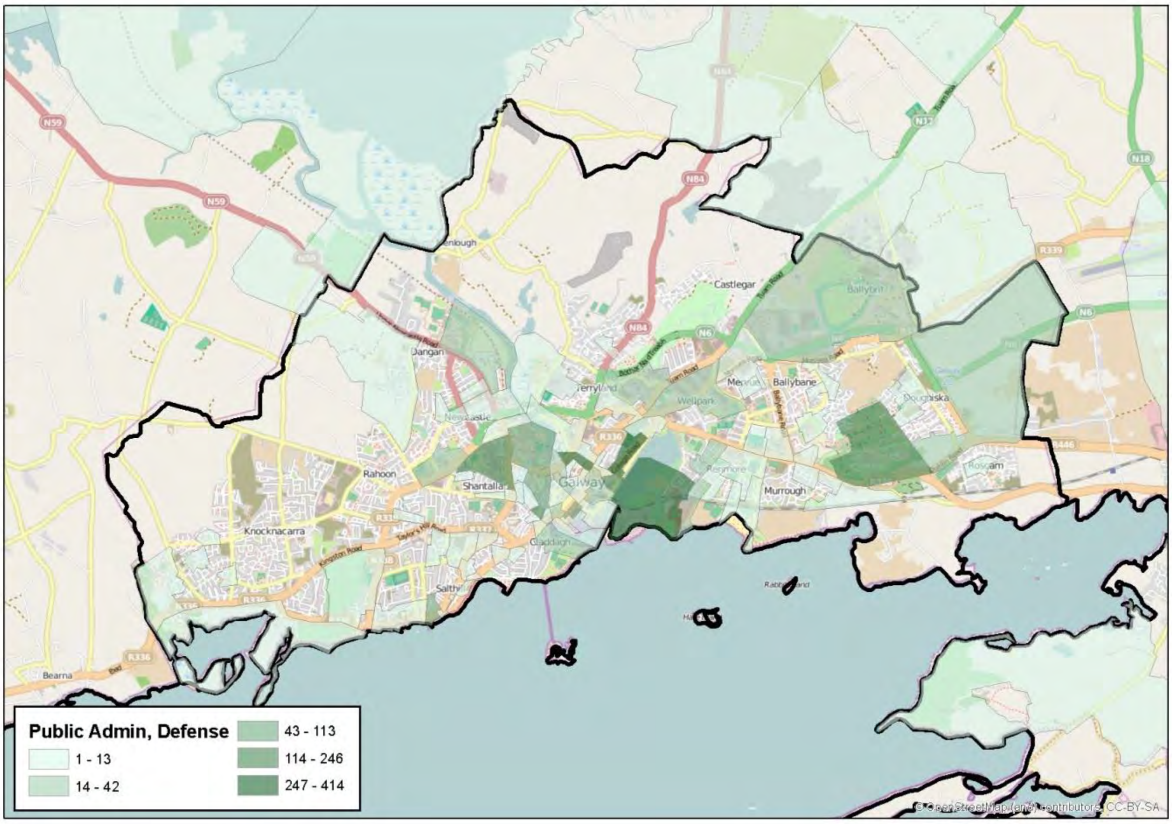


Figure 10: Location of Retail, Wholesale, Accommodation and Food Production Employment

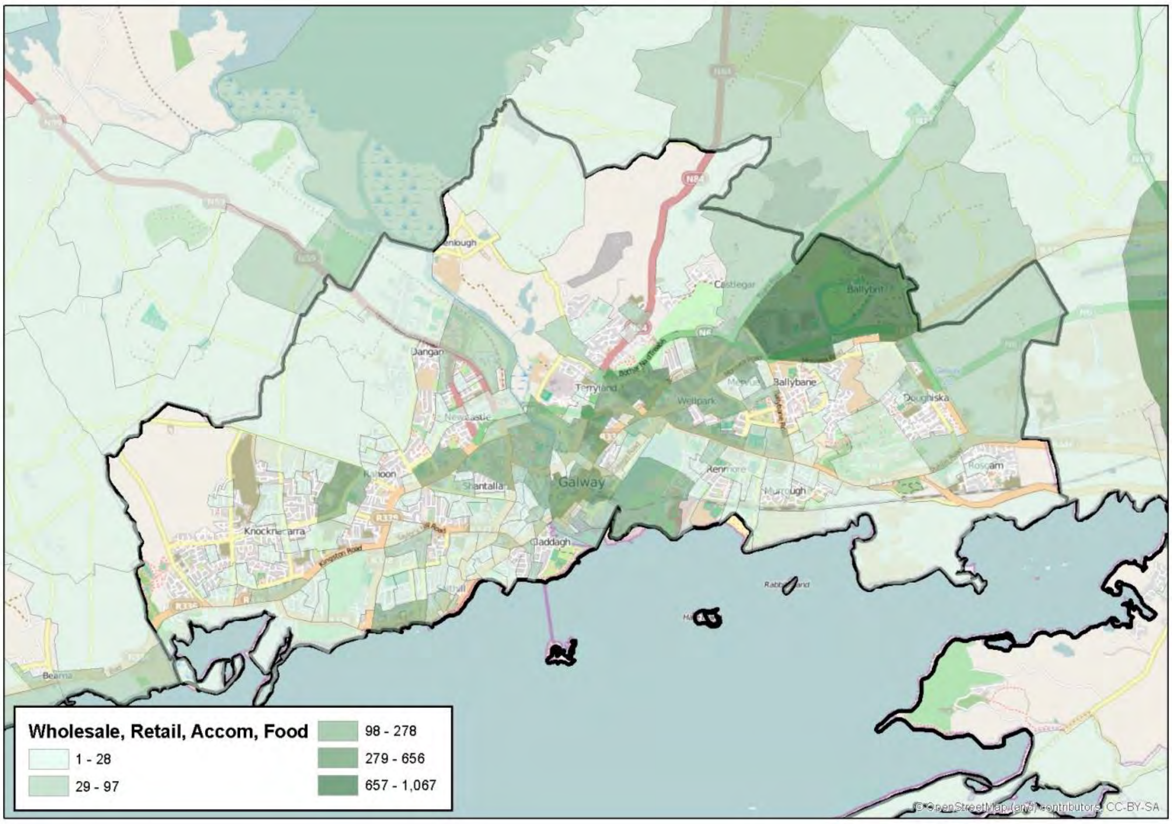


Figure 10 shows that employment in the Retail / Wholesale /Accommodation and Food Production classification is represented most strongly at the City Centre, the University area, at shopping centres such as Westside, Terryland and the Gateway Retail Park off the Western Distributor Road and at Salthill. Additionally, the N6 northern bypass has developed into a significant distributor road used to access a number of destinations with this employment type, with a high concentration visible at Ballybrit.

Indeed, the N6 northern bypass is a significant location for a wide spectrum of employment types, from Retail as set out above, to Manufacturing, and Professional Services (incl. Finance) (as illustrated in Figures 11 and 12 respectively). Professional Services are more widely represented throughout the city, including the IDA Business Park at Dangan, Galway West Business Park at Rahoon, the hospital area, the city centre and Mervue Business Park. Again there is a high concentration of this employment sector around Ballybrit Racecourse, both within the City and the County local authority areas.

Figure 11: Location of Manufacturing

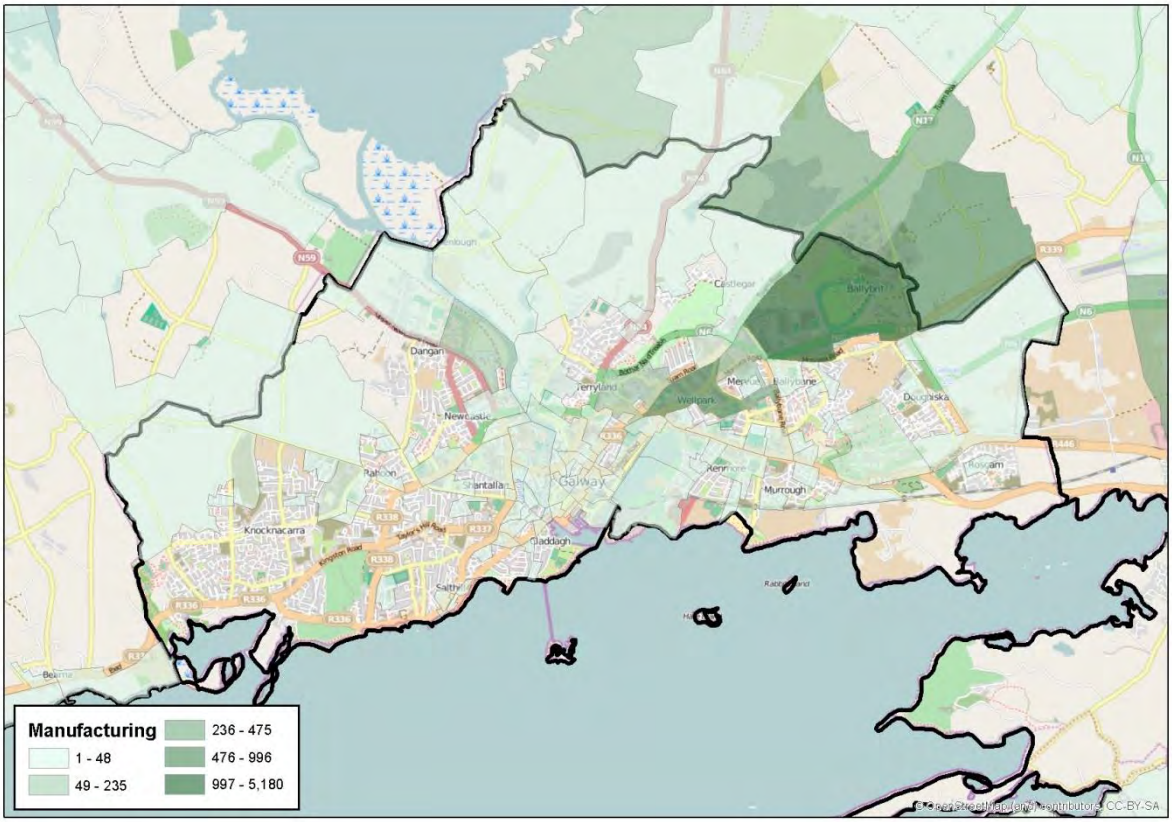
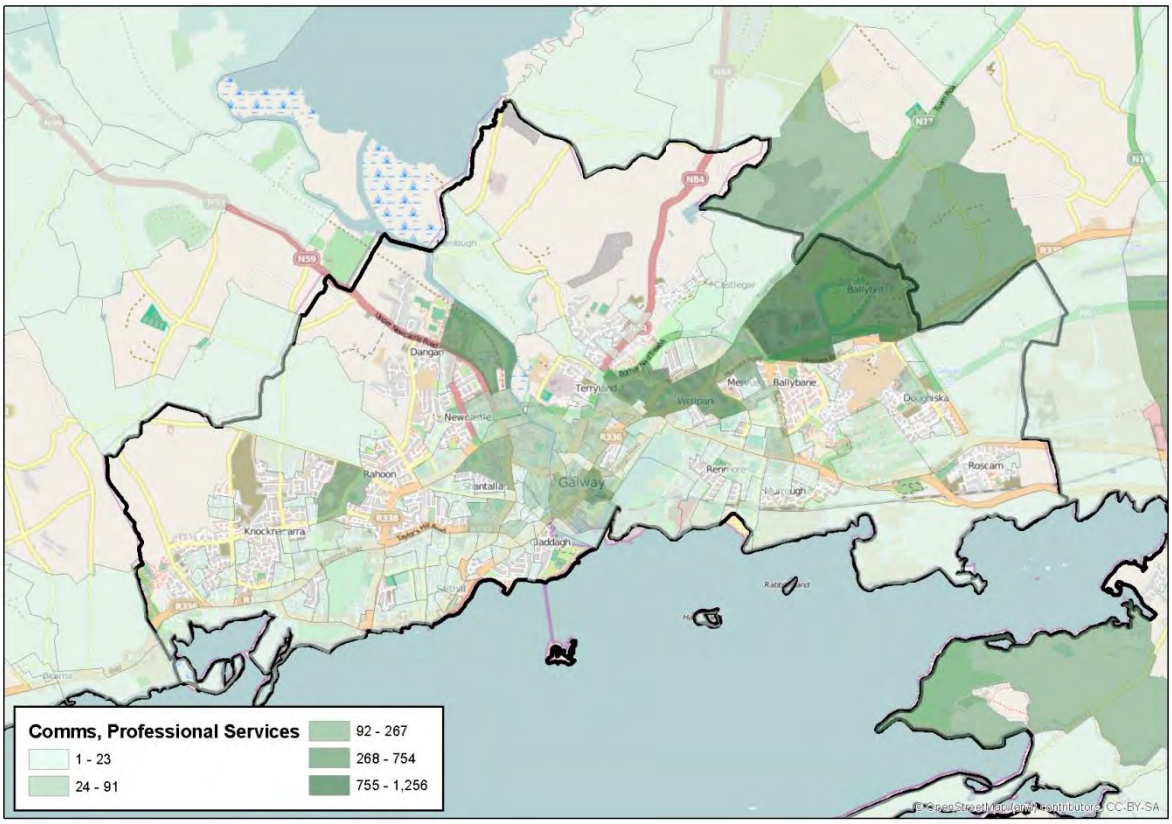


Figure 12: Location of Professional Services



3.2.1 Consideration of Future Locations of Employment Types

The role of the N6 as a location of major employment needs to be considered in terms of how employment might grow into the future. It is also clear that the city centre is predominantly occupied by retail / tourism related activities and public sector jobs. The scope for increased employment at these locations needs to be carefully considered, as there is likely to be limited room for expansion.

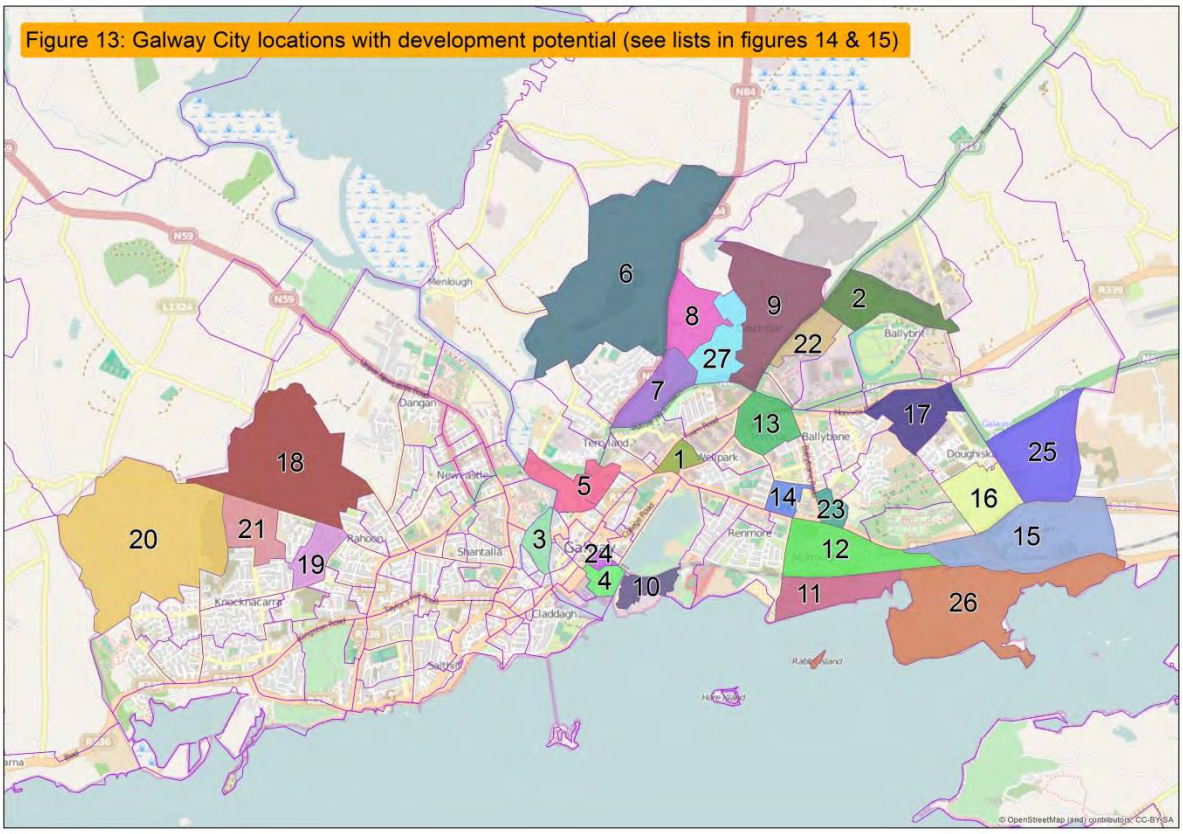
In a similar vein, the big employers of the Hospitals and the University / GMIT and how they might expand into the future needs to be understood to inform the distribution of future employment growth. For reference the breakdown of all employment types within the City and County are set out in Appendix 3.

4 Identification of Areas with Development Potential.

The NTA has carried out an initial desktop study that sought to identify areas within the city where potential for new development, or redevelopment, may exist. The locations have been identified from a review of the City Development Plan 2011-2017, in particular Chapter 11 Part A - Land Use Zoning Policies and Objectives. Figure 13 shows the locations of these areas, and their corresponding model zones. Figures 14 & 15 are tables that relate to the map, providing information on the sites where potential exists for residential or employment development.

The spatial disaggregation of this information to the Interim Model Zone level will be used by the NTA in assigning trip forecasting to any planned patterns of development for the city. The densities used in calculating the potential number of units at each residential site are indicative only.

Figure 13: Galway City Locations with development potential (see lists in figures 14 & 15)



4.1 Population Growth

The NTA has identified locations which have potential for residential development. They are shown in the map at Figure 13 above, and are identified by zone colour and number, as well as a location name being given. The site may have employment development potential, which is also flaged in Figure 14. A brief summary of City Development Plan policy is given, including the CDP zoning code. Finally, the potential yield of residential units is given, based on an indicative density that takes the site's location, surrounding development patterns and CDP policy into account.

Figure 14: Locations with residential development potential

List Number	NTA Zone Name	Employment Development	City Development Plan Site Policy	CDP Land Use Zoning	NTA Zone Number	Potential Res. Units Yield
1	Moneen-ageisha		2ha Site suitable for 75% Res	CI	3	70 @ 40dph
2	Parkmore		20 ha. 5dph due to levels and strategic drainage reqs	LDR	9	100 @ 5dph
3	Earl's Island		<2ha suitable for residential	CF	11	88 @ 50dph
4	CIÉ Lands	Ceannt Station Redevelopment	5.8ha CIÉ land, res at 30% of total GFA	CC	43	87 @ 50dph
5	Headford Road City Centre	Headford Road Redevelopment	30ha MU. Framework Plan abandoned.	CI	51	450 @ 50dph
6	Ballinfoile		2 plots: 3.5ha res at rear of n'hood ctr, 11ha LD	R	55	233 @ 35 & 10 dph
7	Headford Road		2 plots: 6ha + 2.5ha - subj to LAP?	R	59	298 @ 35 dph
8	Baile an Chóiste		12.5ha undev res land - subj LAP?	R	60	500 @ 40 dph
9	Tuam Road		17 ha undev res on N17 subj CG LAP	R	61	680 @ 40 dph
11	Murrough		11ha Residential land as part of LAP	LAP	66	440 @ 40 dph
12	Galway Crystal		2 plots: 5ha Res at E, 2.4ha LD at W.	R, LDR	67	224 @ 40 & 10 dph
13	Mervue	Major retailing at Crown Sq.	3 plots:Tara+nursery=5ha R. Crown Sq 20% FA R	CI	70	260 @ 40 dph
14	Gleninagh		3.6ha Res on Rugby pitches.	R	72	180 @ 50 dph
15	Roscam		2 plots:5ha Rosshill,22ha Reileán-incl C'Gar GAA?	R	76	1080 @ 40 dph
16	Doughiska		13ha, LD due to RPS, pNHA restrictions?	LDR	77	455 @ 35dph
17	Briarhill		14ha, - LD due to levels?	LDR	79	490 @ 35 dph
20	Ballyburke		B'Burke F'Work plan c18ha res	R	105	720 @ 40 dph
21	Keeraun-Mincloon		B'Burke F'Work plan c12ha res	R	106	480 @ 40 dph
22	Parkmore		5ha Infill LD Res at 5dph	LDR	126	25 @ 5 dph
23	Corrib Gt. Southern Hotel		2.6ha suited to student hsing with redev of hotel	CF	129	130 @ 50 dph
24	CIÉ Lands	Ceannt Station Redevelopment	5.8ha res at 30% of total GFA	CC	137	87 @ 50 dph
25	Ardaun		158ha gross area.LAP reqd, 5530 units deliverable	LAP	156	5530 @ 35 dph
26	Rosshill		15ha- LD due to strategic drainage req's?	LDR	161	300 @ 20 dph
27	Castlegar		4.3ha undev res land subj C'Gar LAP	R	163	172 @ 40 dph
Total						**13,079 units**

Based on the calculations included in the table, there is potential for 13,079 units. Omitting sites at Parkmore, Tuam Road, Ballyburke, Murrough, Ardaun and Rosshill, which are generally outside the current development footprint of the city, there is residential development potential for 5309 units. At an average household size of 2.5 persons, there would be capacity for 13,272 persons.

4.2 Employment Growth

In Figure 15 the NTA has also identified locations with potential for employment development. They are shown in the map at Figure 13 above, and are identified by zone colour and number, as well as a location name. Some of the sites would involve redevelopment of existing built forms. A brief summary of City Development Plan policy is given, including the CDP zoning code.

Figure 15: Locations with employment development potential

List Number	NTA Zone Name	Employment Development	City Development Plan Site Policy	CDP Land Use Zoning	NTA Zone Number
4	CIÉ Lands	Ceannt Station Redevelopment	5.8ha CIÉ land, res at 30% of total GFA	CC	43
5	Headford Road City Centre	Headford Road Redevelopment	30ha MU. Framework Plan abandoned.	CI	51
10	Lough Atalia	Harbour Expansion see current SID application	Only harbour activities and industrial related to harbour.	I	62
18	Rahoon	CDP objective for technology/business park	16ha Employment lands tech/business park	I	94
19	Millers Lane	CDP objective for technology/business park	12ha Employment lands tech/business park	I	102
24	CIÉ Lands	Ceannt Station Redevelopment	5.8ha res at 30% of total GFA	CC	137
25	Ardaun	Ardaun LAP	158ha gross area. LAP reqd, employment uses included	LAP	156

The table shows that there is potential for new employment at redevelopment sites in the city centre, and at a technology and business park at the west side of the city. There may also be capacity in the existing business parks that contain large numbers of employees at present, including Parkmore East (IDA Business Park), which is located on the Galway County Council side of the administrative boundary.

4.3 Distribution of Educational Growth

The distribution of space for education use, at each educational level, will have a strong relationship with those areas where population growth occurs. The allocation of educational space needs to be considered; whether new sites need to be considered, or whether existing schools and colleges can cater for future demand. This will be done following the completion of the population and employment analysis.

4.4 Growth External to Galway City

While in modelling terms it is critical to accurately distribute growth within the urban environment of Galway City, consideration also needs to be given to the growth of external and rural zones. Appendix 4 presents Athenry as an example where the Interim Model Zones are used to distribute popualtion growth, growth by employment sector, and growth by educational level. There is a need to identify and establish projected population, employment and education growth within rural towns and at any site-specific development locations across the study area.

5 Conclusions

This paper has provided, for discussion, a methodology for the disaggregation of land-use forecasts for population, employment and education, to be used in the Galway Interim Model. The paper sets out how the study area is expected to grow, based on regional population forecasts, as well as setting out the existing distribution of population and employment within the study area.

The paper then identifies areas for potential growth. In like of this, the following points need to be considered by all parties in order to finalise an agreed forecast scenario for the Galway Interim Model:

<u>Residential development</u>:

- There is a significant descrepancy between the forecast assumptions set out in the West RPGs and the CSO Population Projections. What forecast year figures should be used?
- Ratio of house completions was 15:1 in favour of Galway County vs City in 2012. Only 32 units completed in 2012 in the city, compared to 467 in the County Council area. Is this trend likely to continue?
- The NTA have identified a number of developable sites, are any other significant sites missing?
- Should infill development within existing residentail sites be considered as an area of potential population growth?
- Are there constraints on any of the sites listed, or on the densities of development that could be achieved at them, i.e. drainage, services, visual amenity, etc.

<u>Employment development:</u>

- Six sites have been identified – what is the potential for growth within them?
- Have any sites in the city been identified for specific employment types?
- Are any other significant sites missing?
- Are there constraints on any of the sites listed, or on the intensity of development that could be achieved at them, i.e. drainage, services, visual amenity, etc.

Educational development:

- Do any specific new education sites need to be identified, to cater for growth of primary, secondary and third-level sectors?

External Locations

- The proportion of growth to be located in the external/rural towns needs to be agreed.
- Are there any specific sites where significant growth (population or employment) is likely to occur?

6 Next Steps

The NTA will continue to work to develop a forecast year distribution of population, employment and education for all model zones within the study area. This will produce a Trip Attraction and Generation Model (TAGM) spreadsheet which will form the basis for discussions with the local authorities (a template spreadsheet has been set out in appendix 4).

It is proposed that a meeting will take place within the next three weeks to review the first draft TAGM spreadsheet and address the issues raised in this report.

Appendix 1

See Attached Document:

"SFILT Update Report 7 – Distribution of Forecasts - Development of an RPG-compliant Scenario"

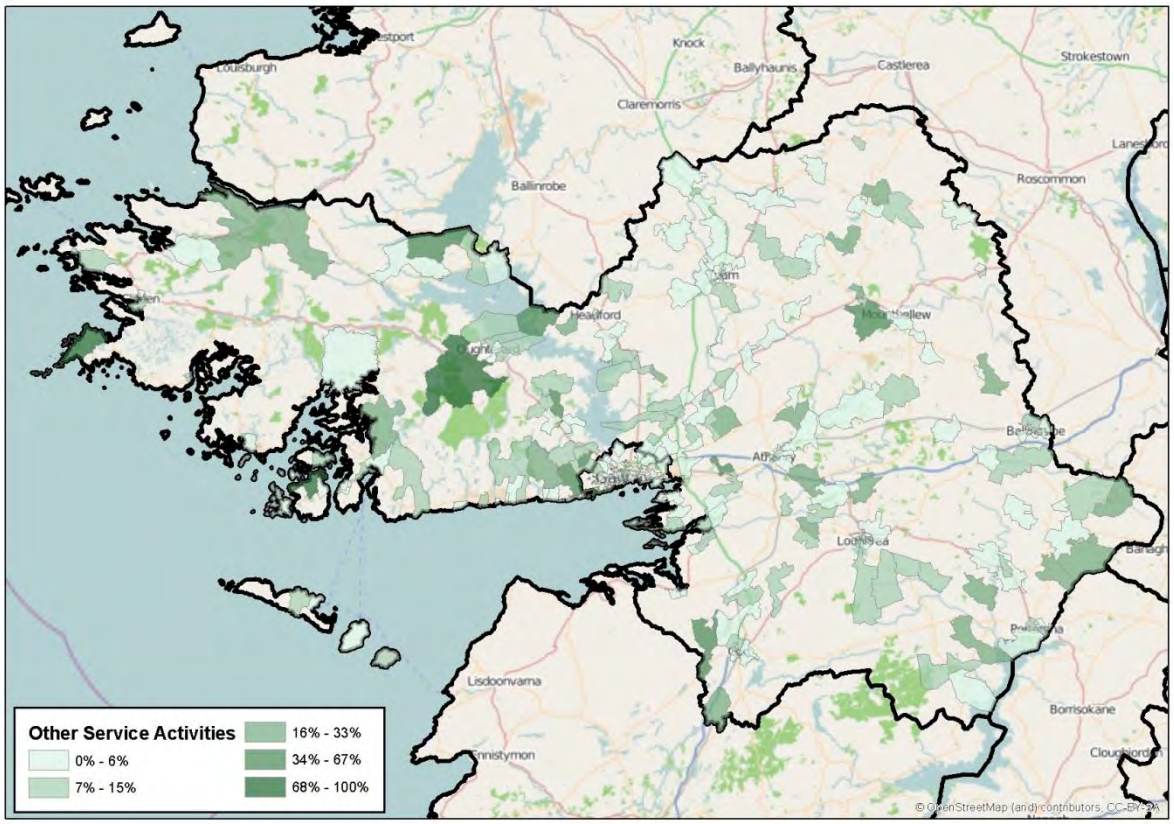
Appendix 2

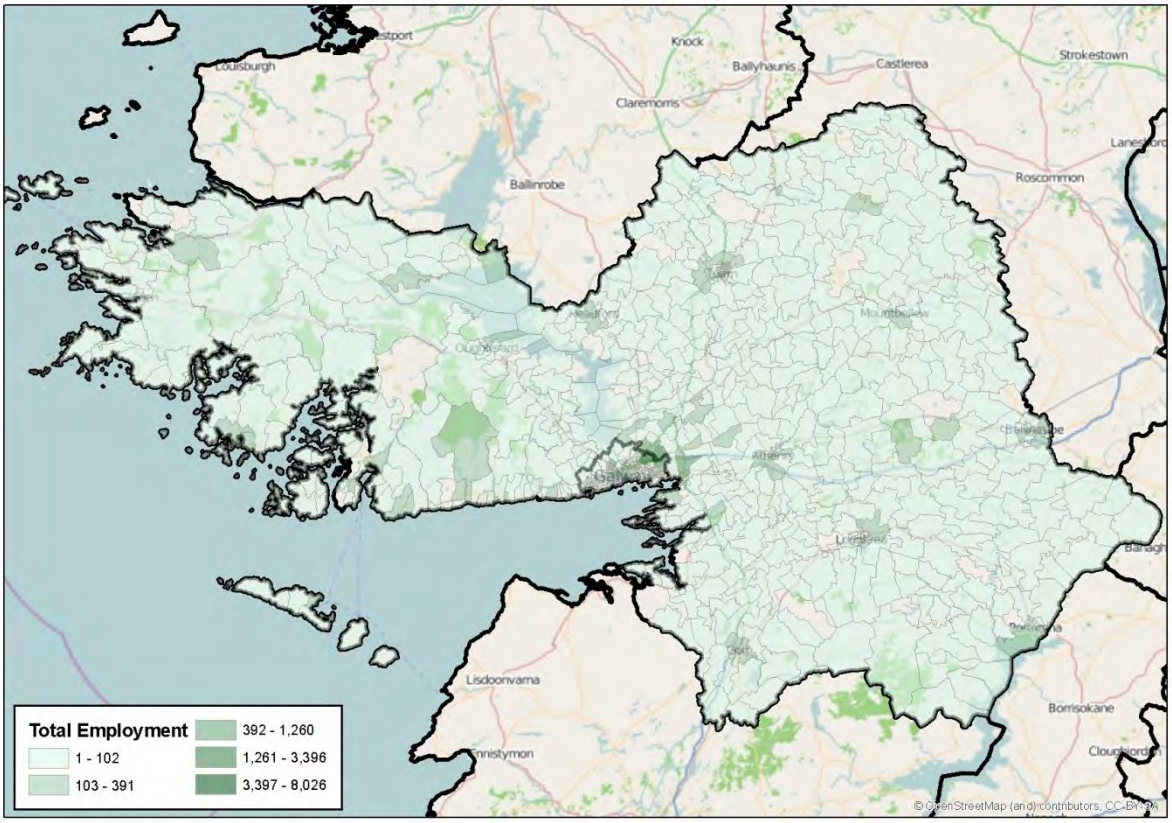
See Attached Document:

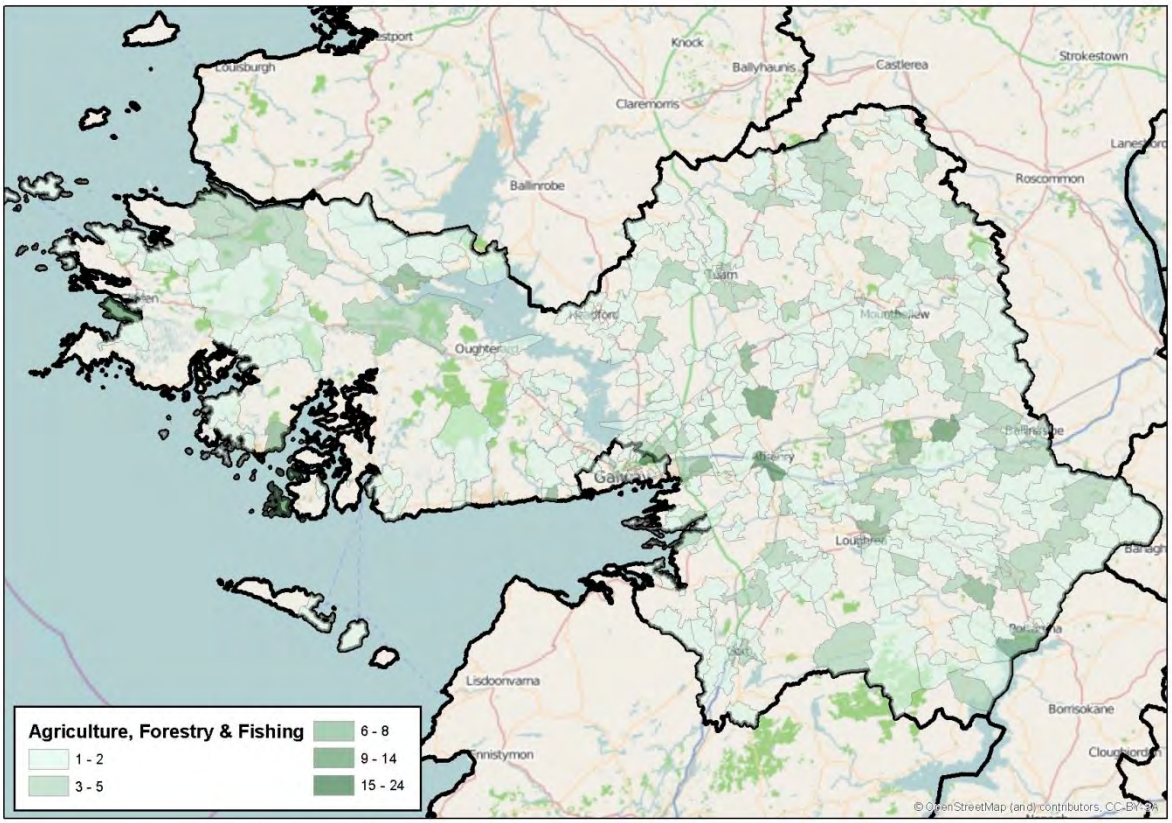
"SFILT Update Report 8 – Note on Trip Rates – from NTA's National Household Travel Survey 2012"

Appendix 3

Illustration of breakdown of all employment types within Galway City and County, 2011.



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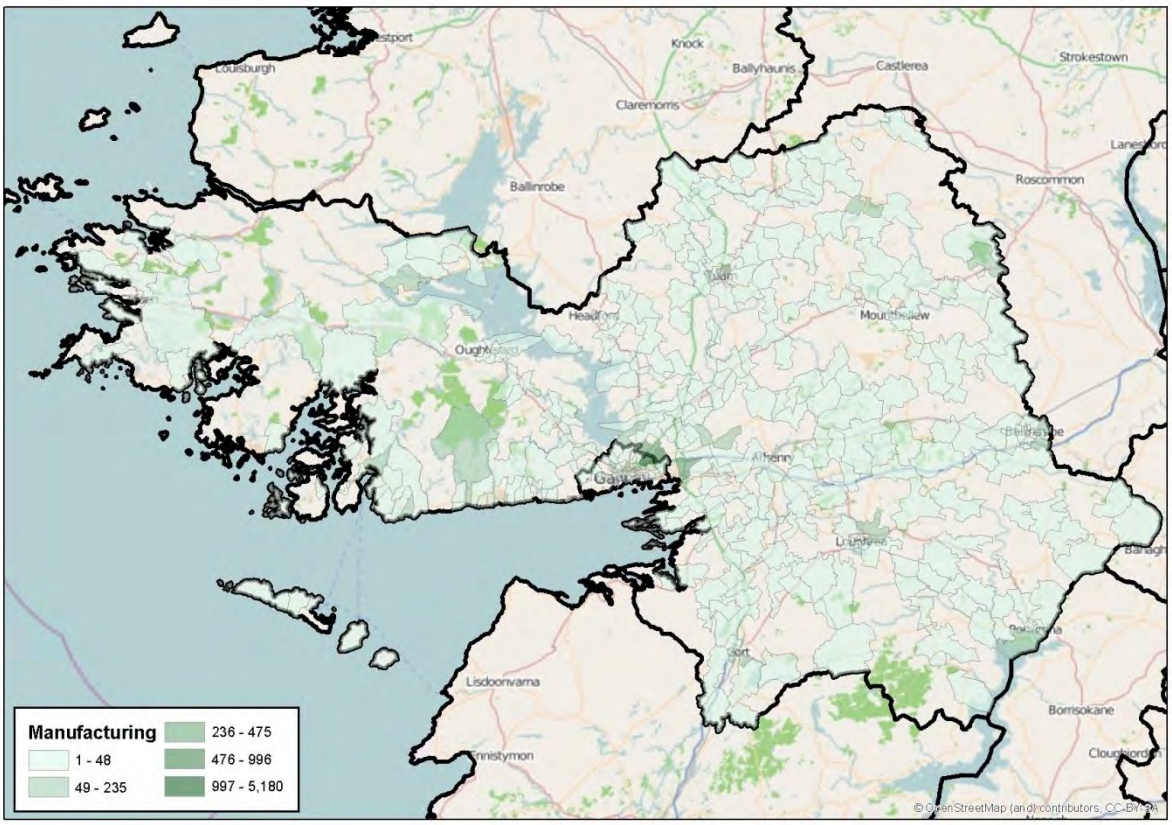
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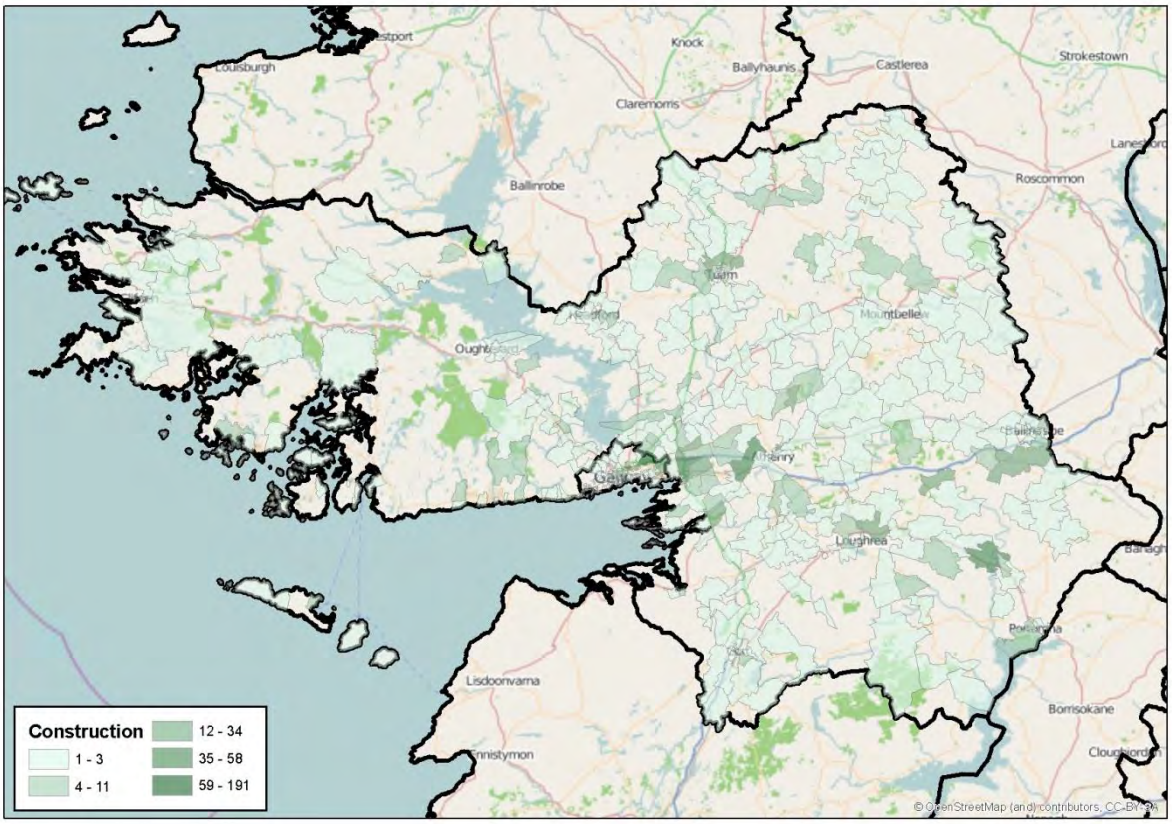
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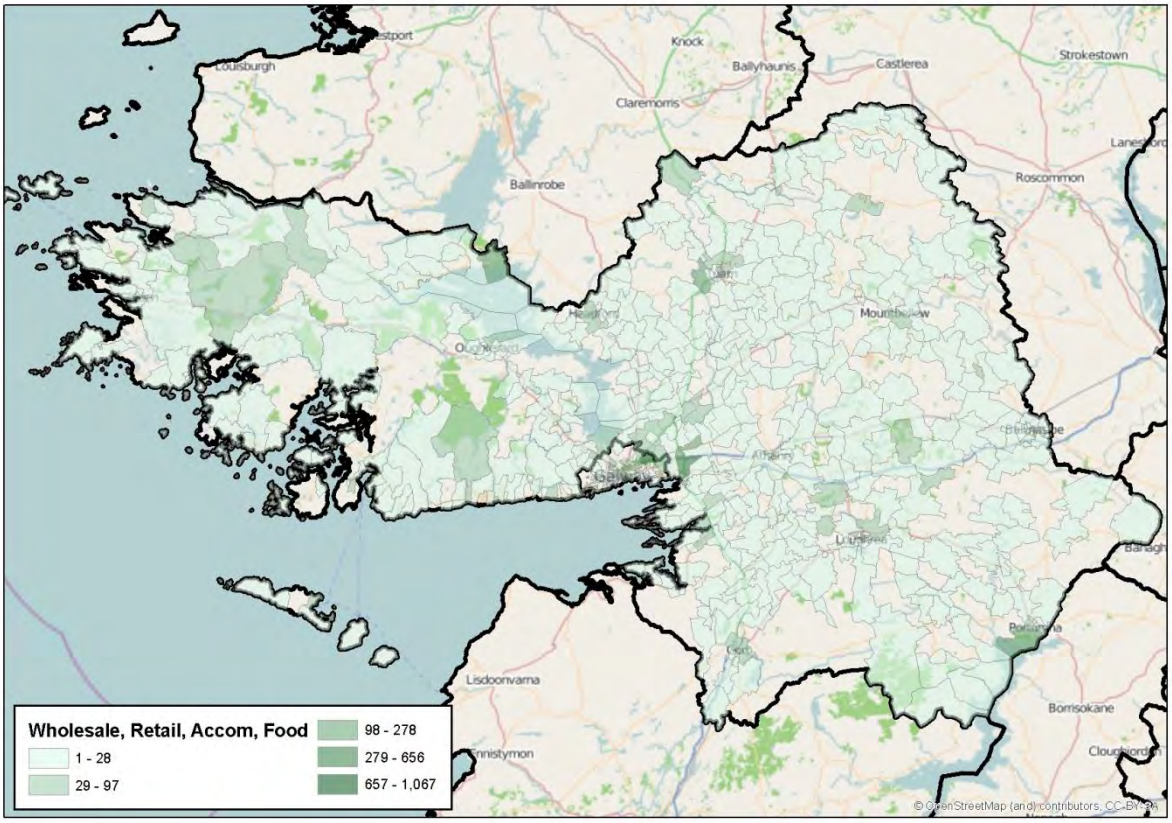
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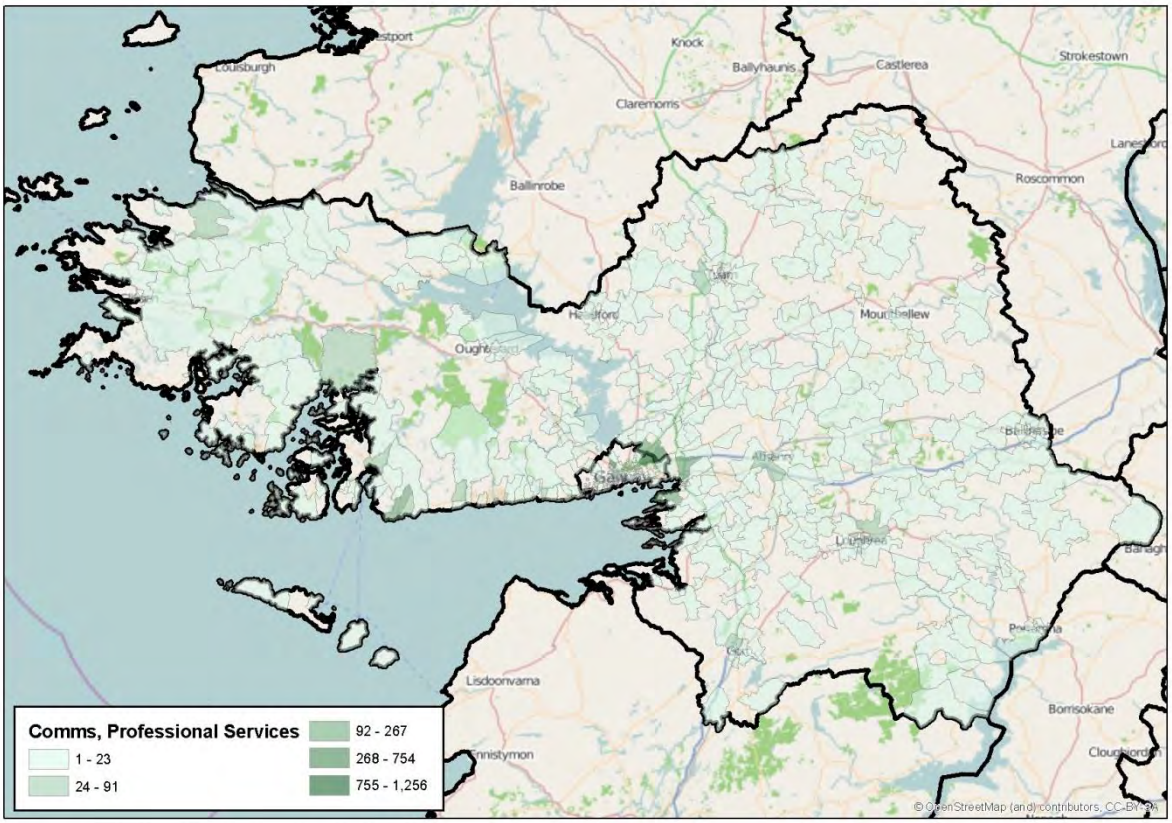
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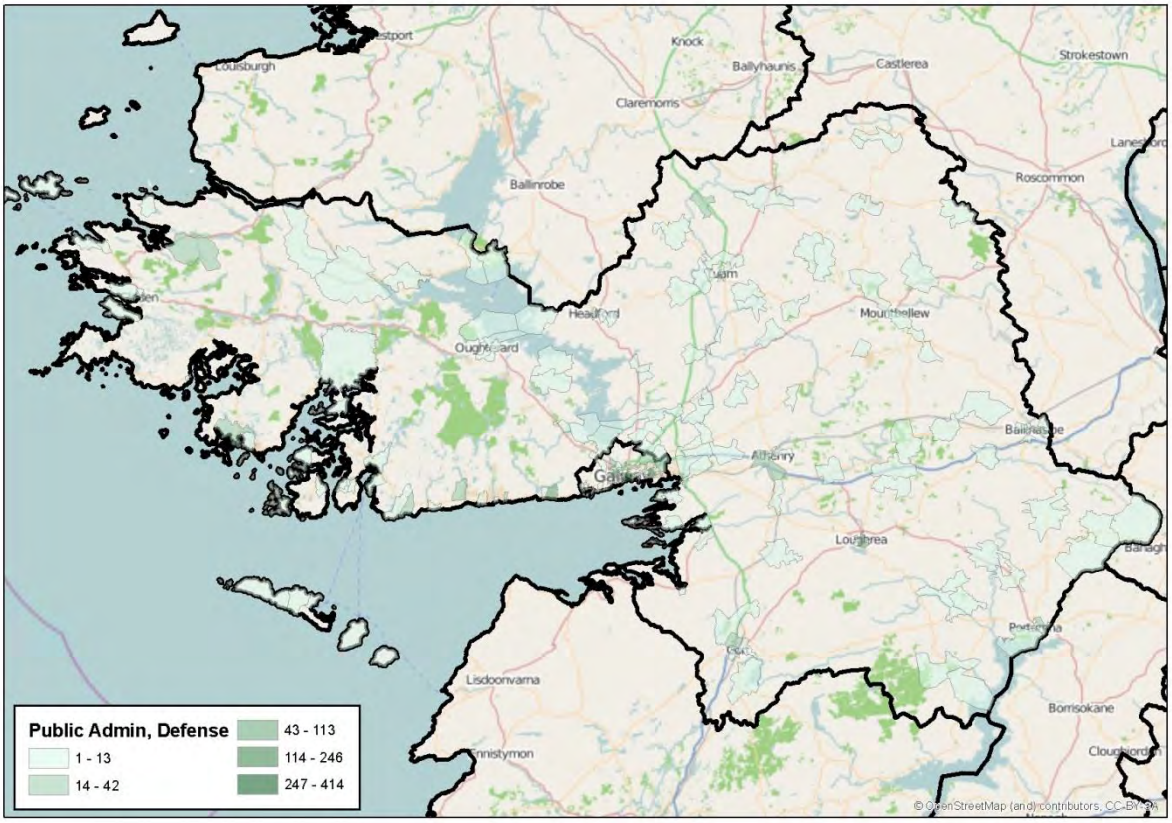
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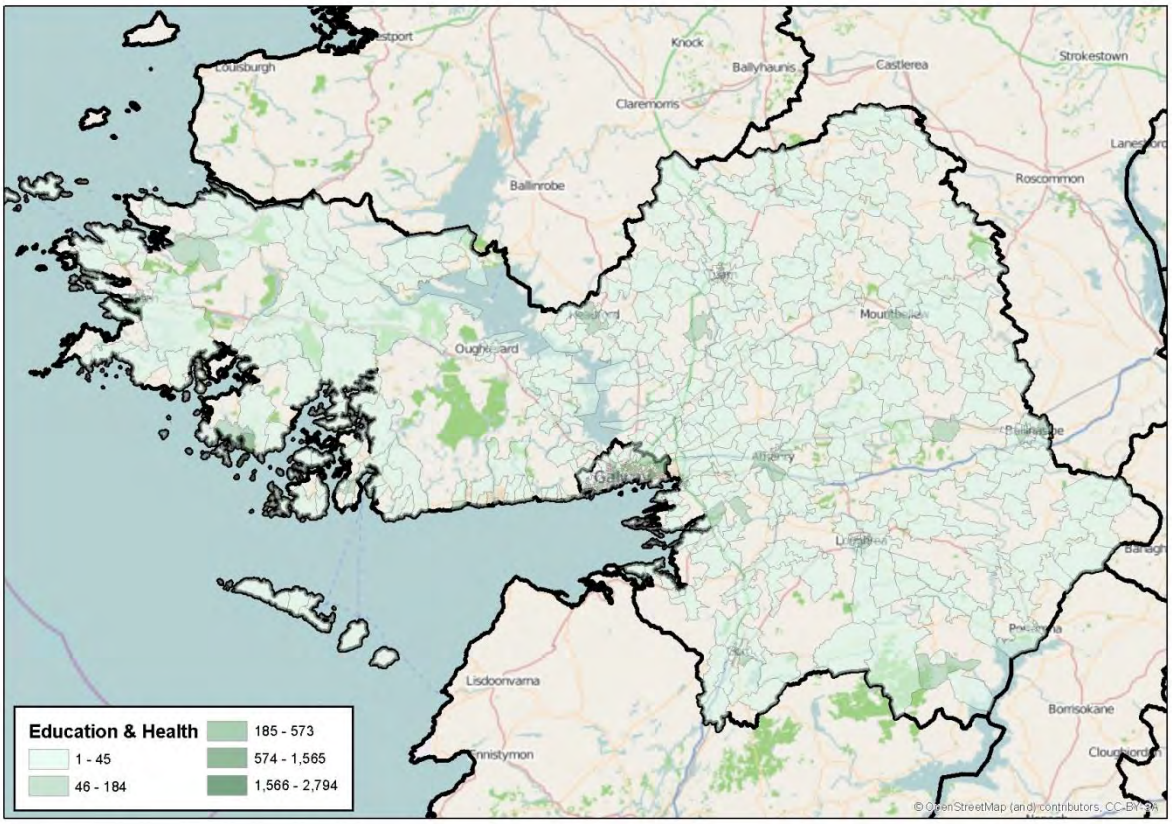
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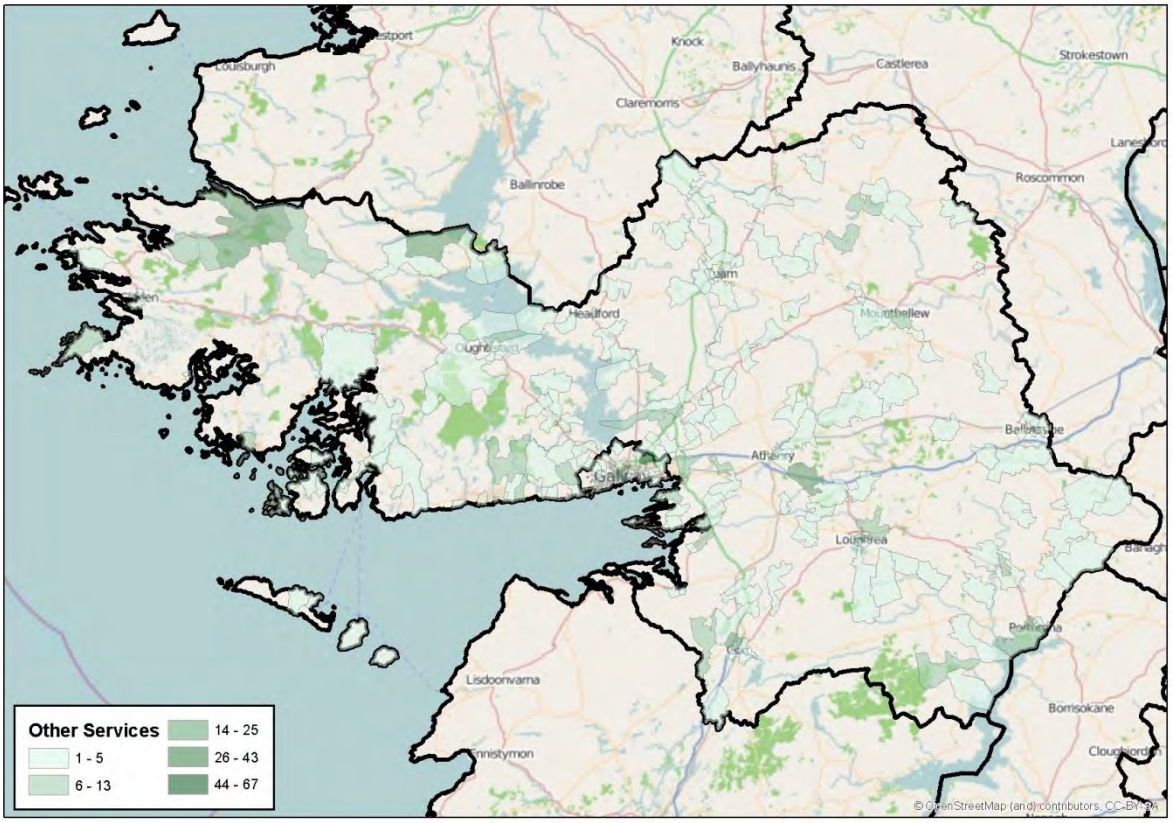
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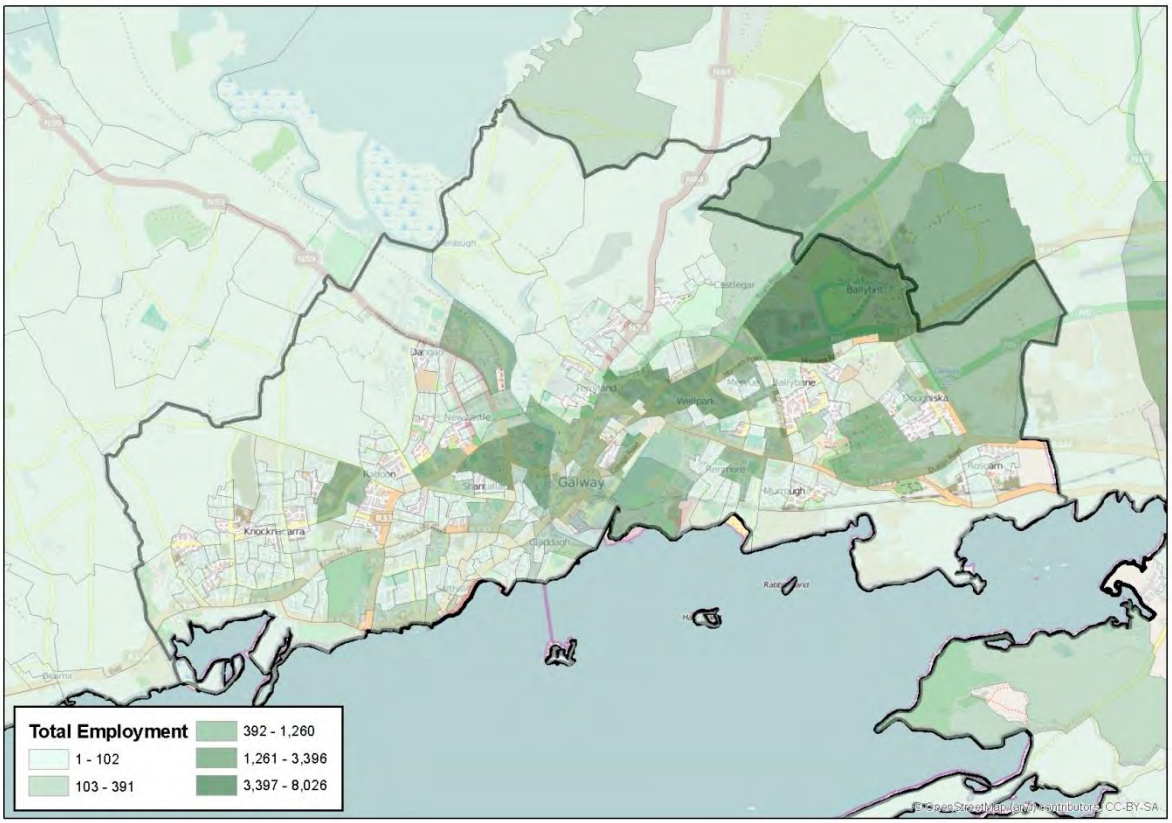
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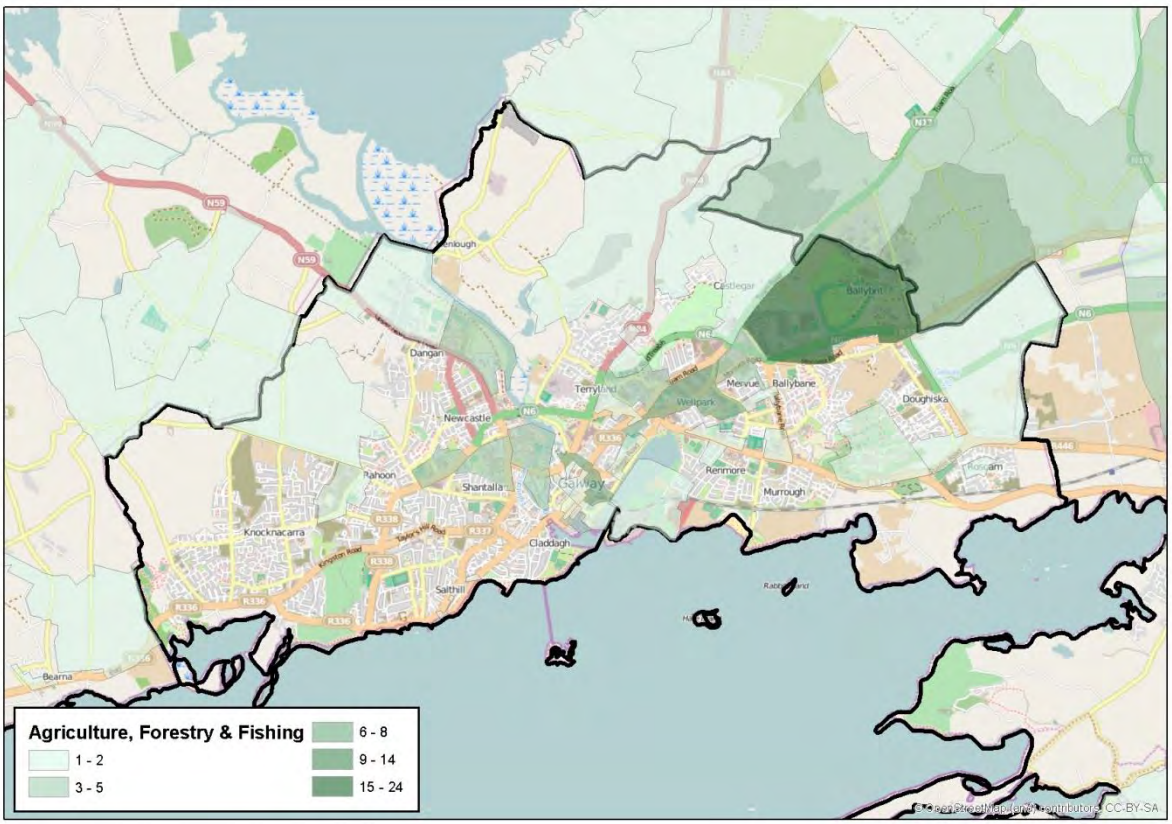
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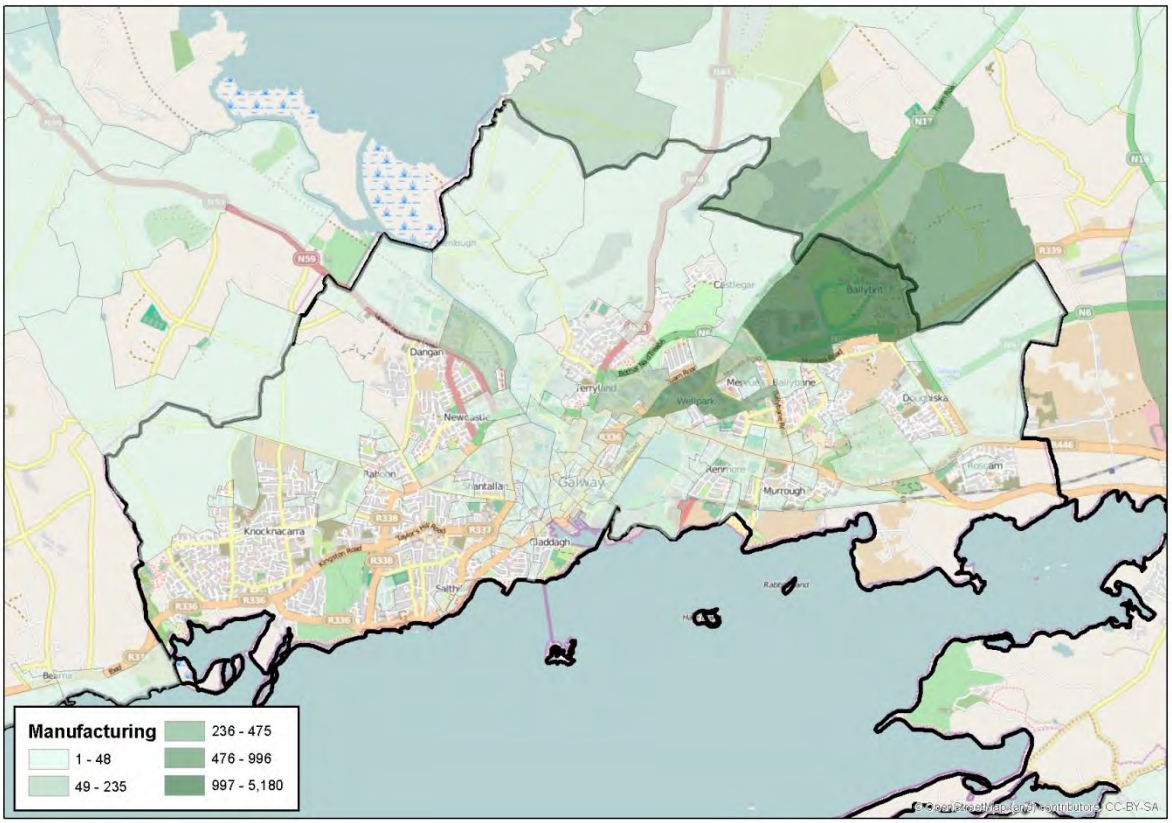
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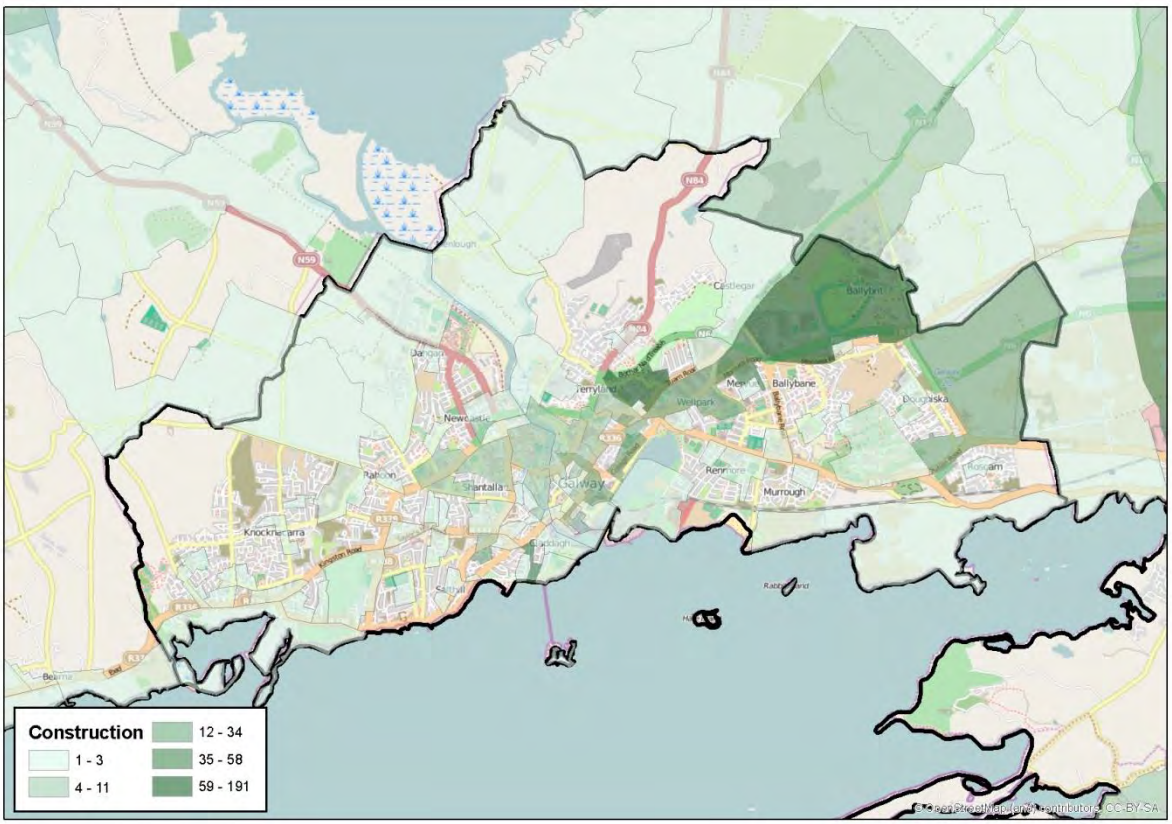
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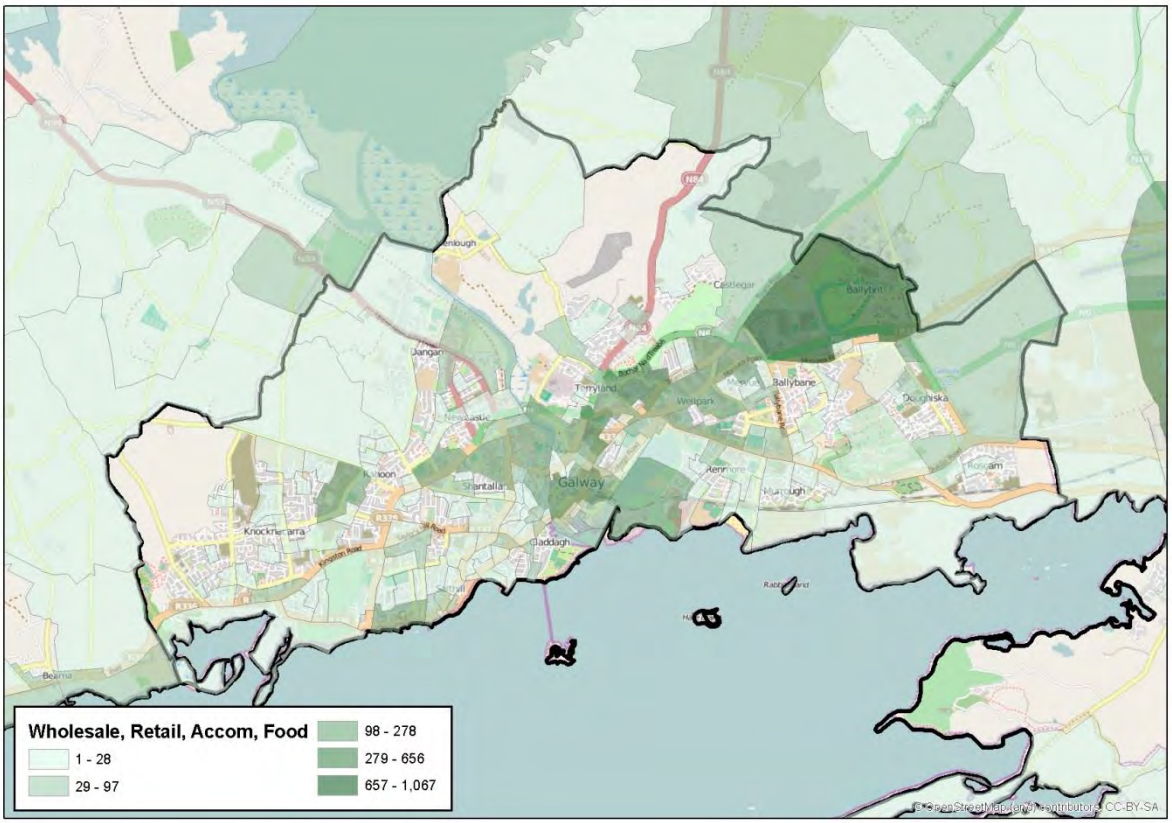
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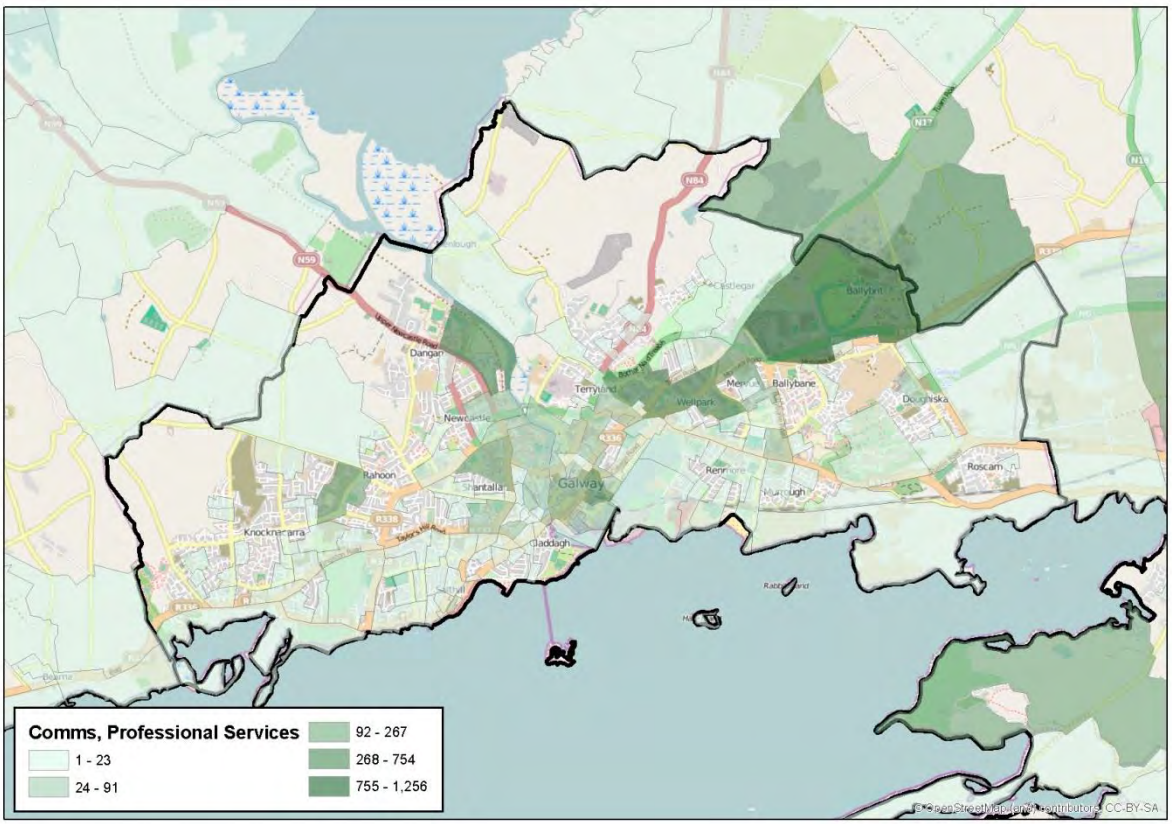
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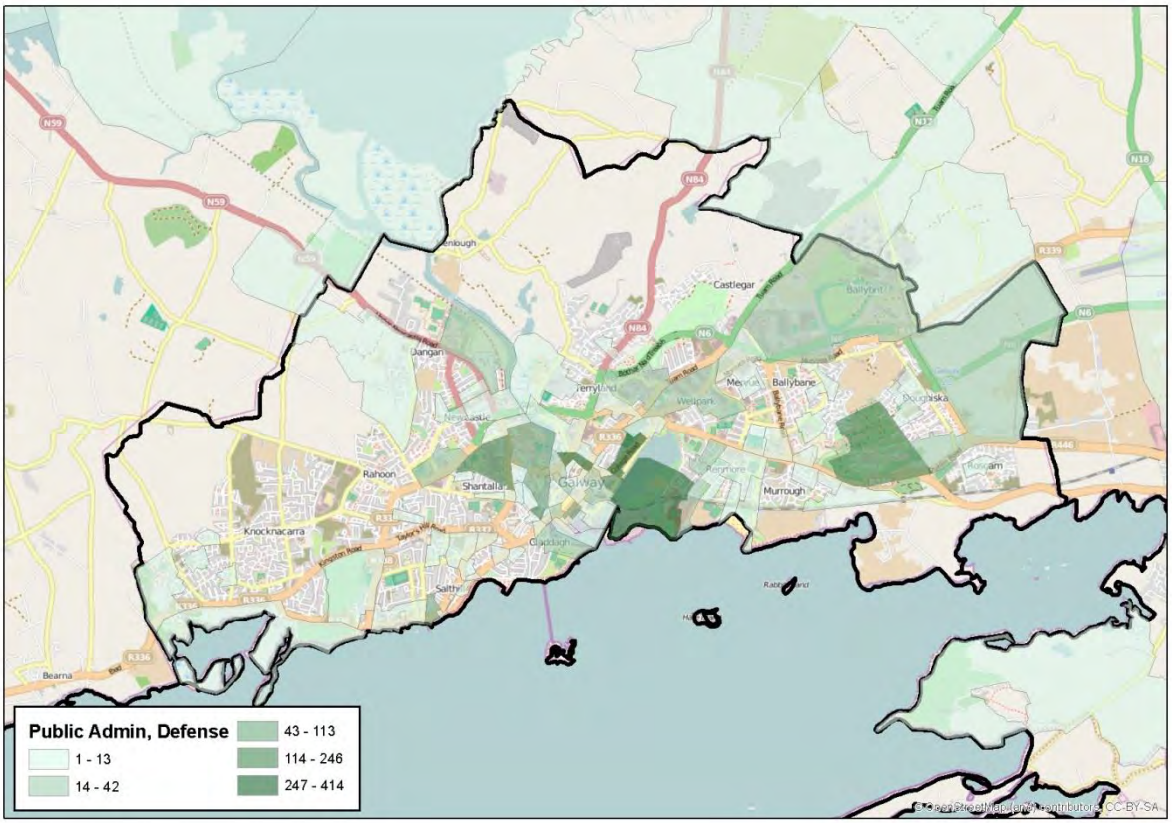
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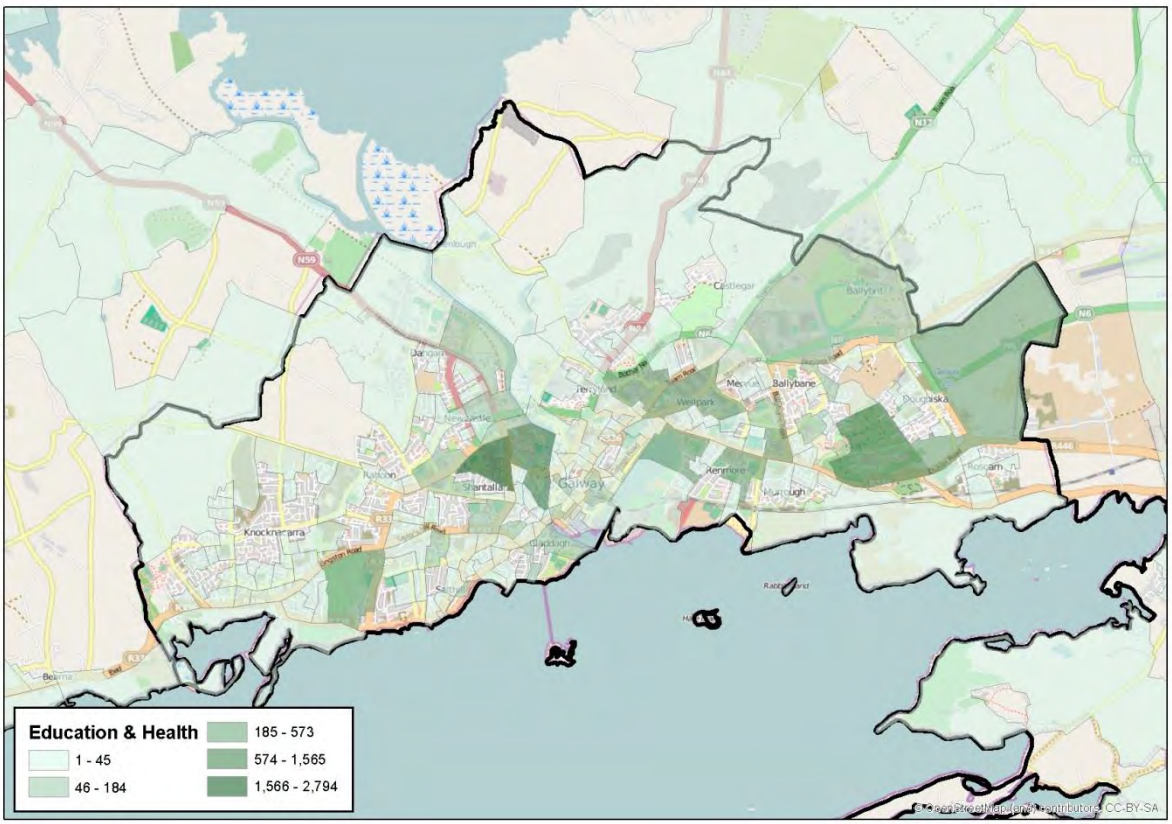
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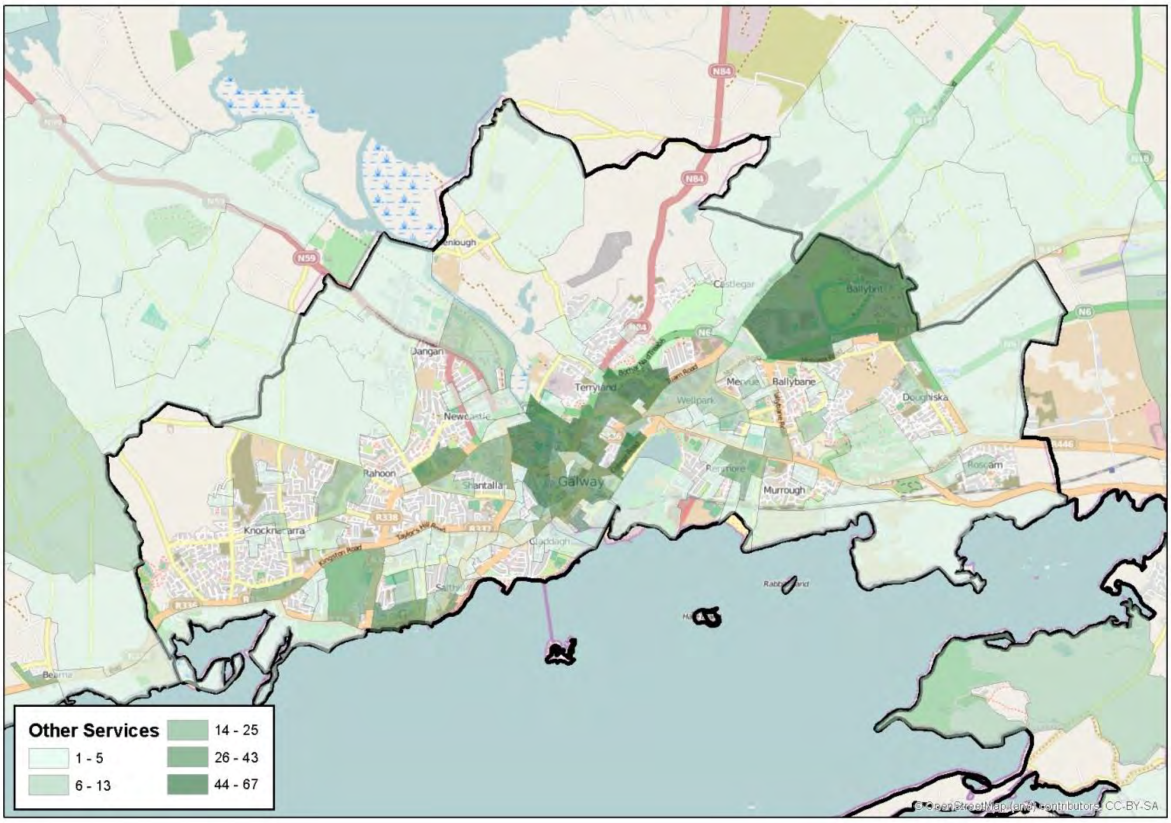
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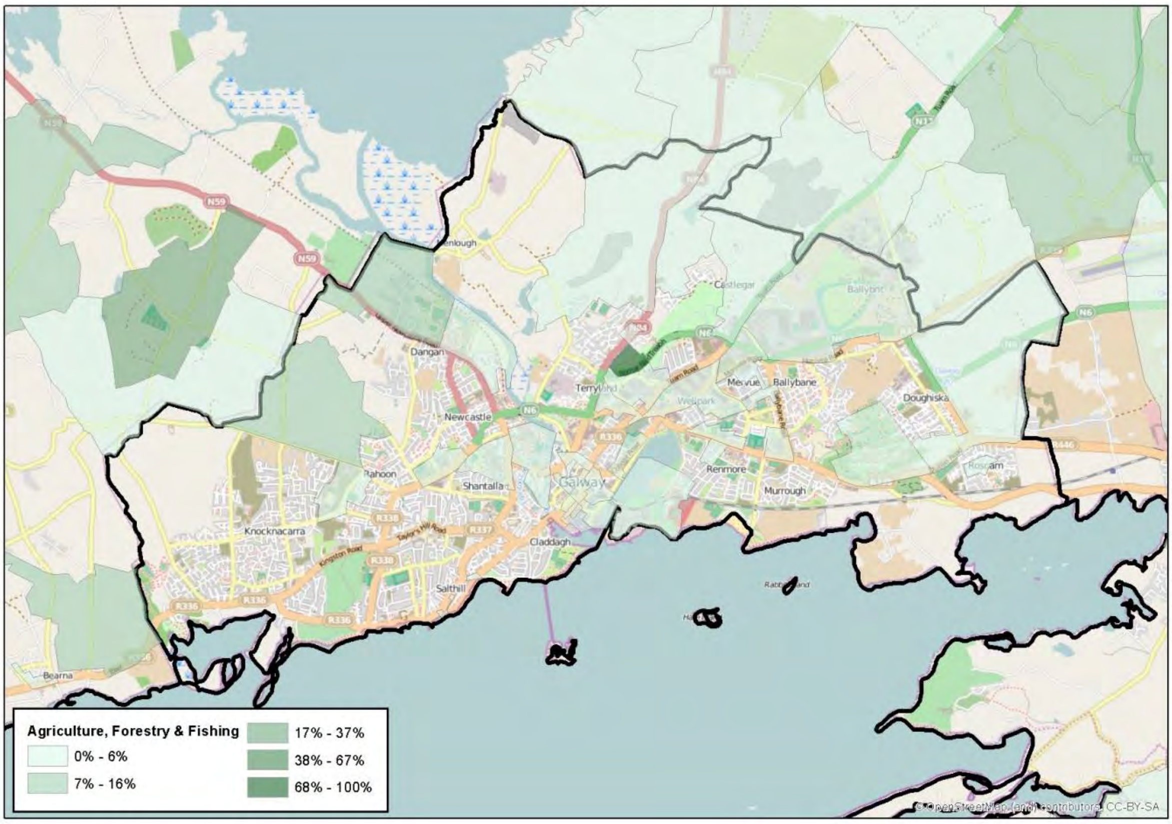
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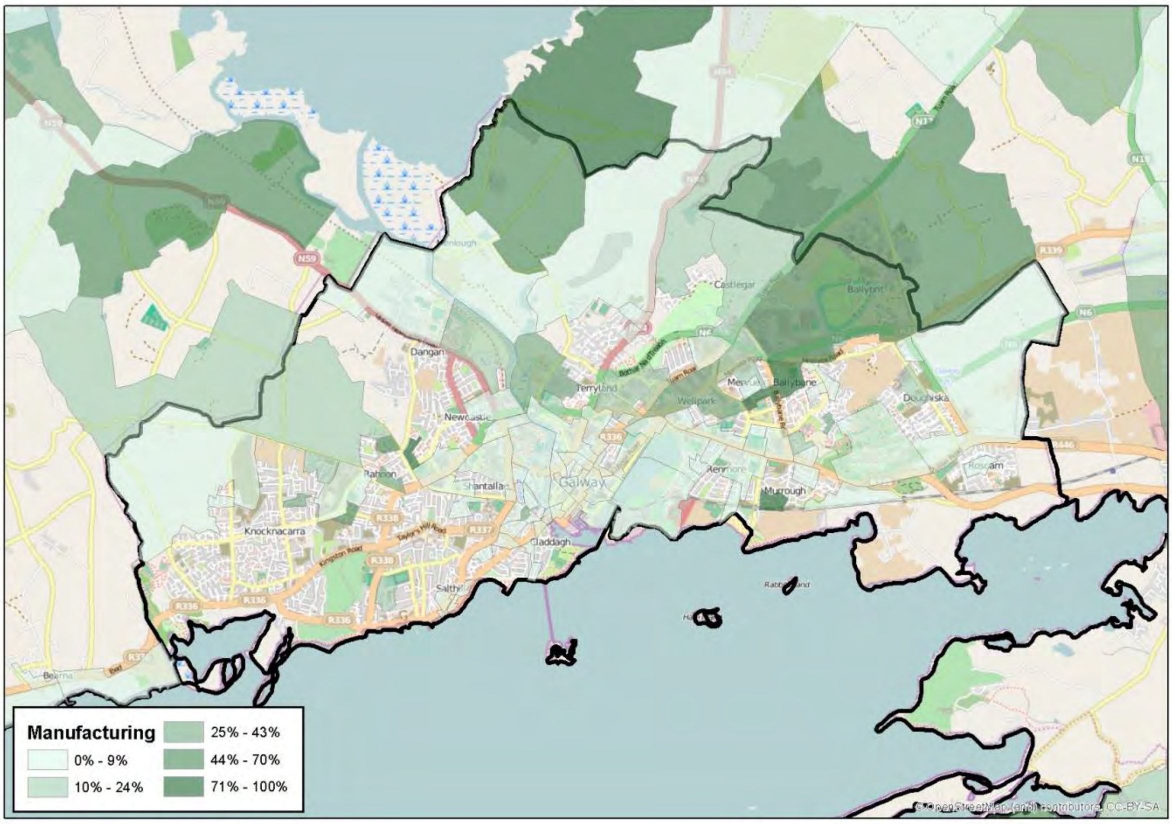
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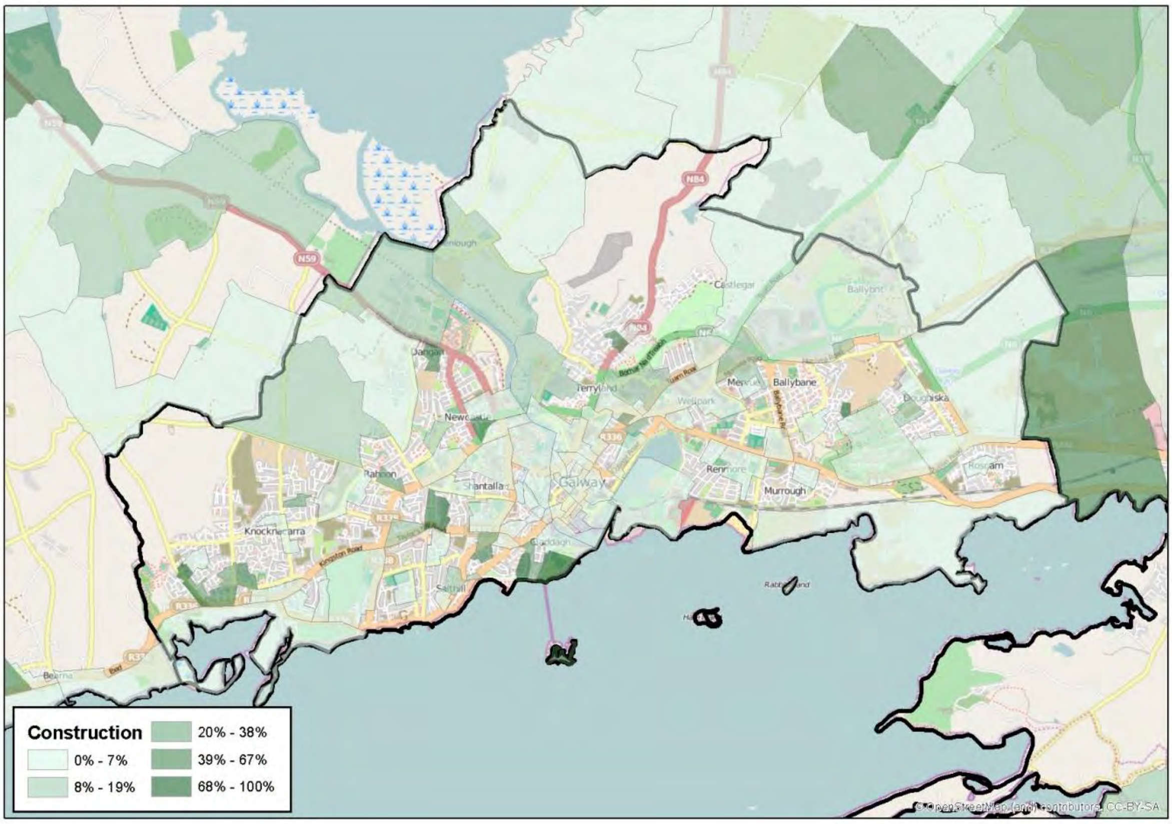
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Renmore
Murrough
Roscam
Knocknacarra
Claddagh
Salthill
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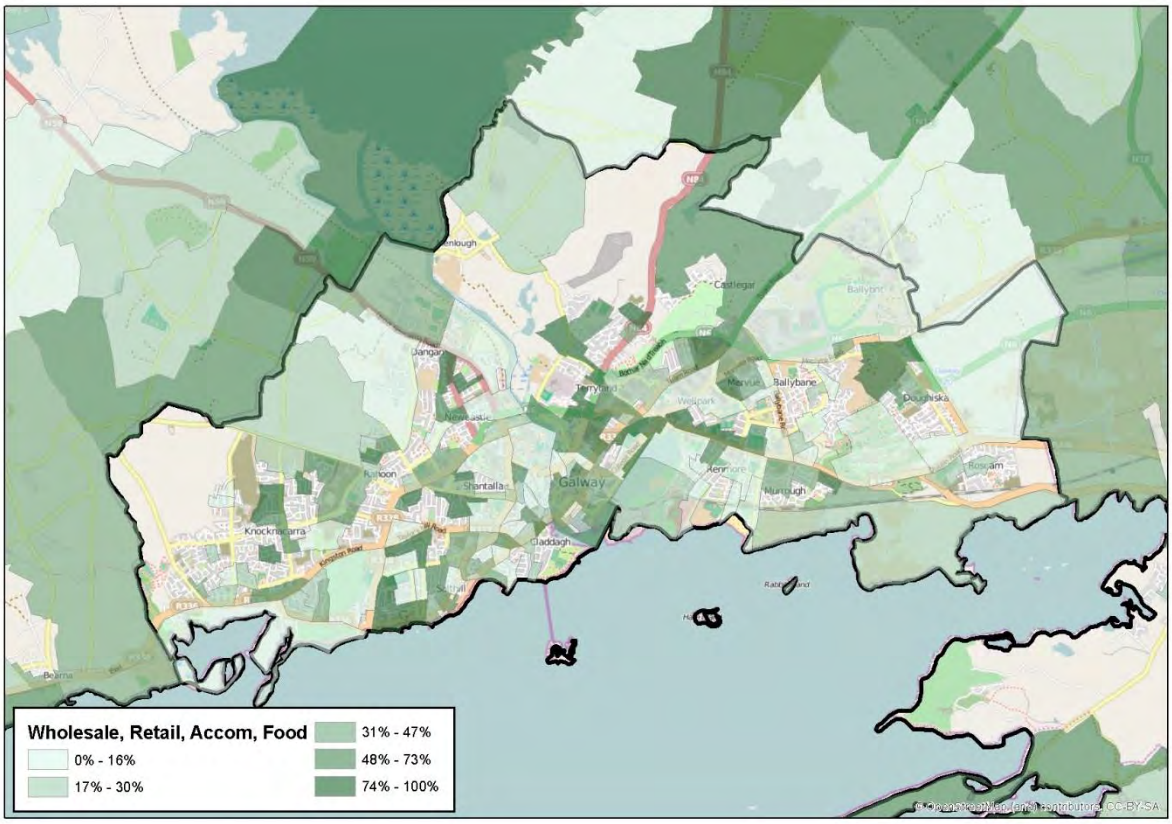
Wholesale, Retail, Accom, Food
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17% - 30%
31% - 47%
48% - 73%
74% - 100%
Galway
Knocknacarra
Rahoon
Shantalla
Claddagh
Newcastle
Dangan
Terryland
Castlegar
Menlough
Mervue
Ballybane
Wellpark
Renmore
Murrough
Doughiska
Roscam
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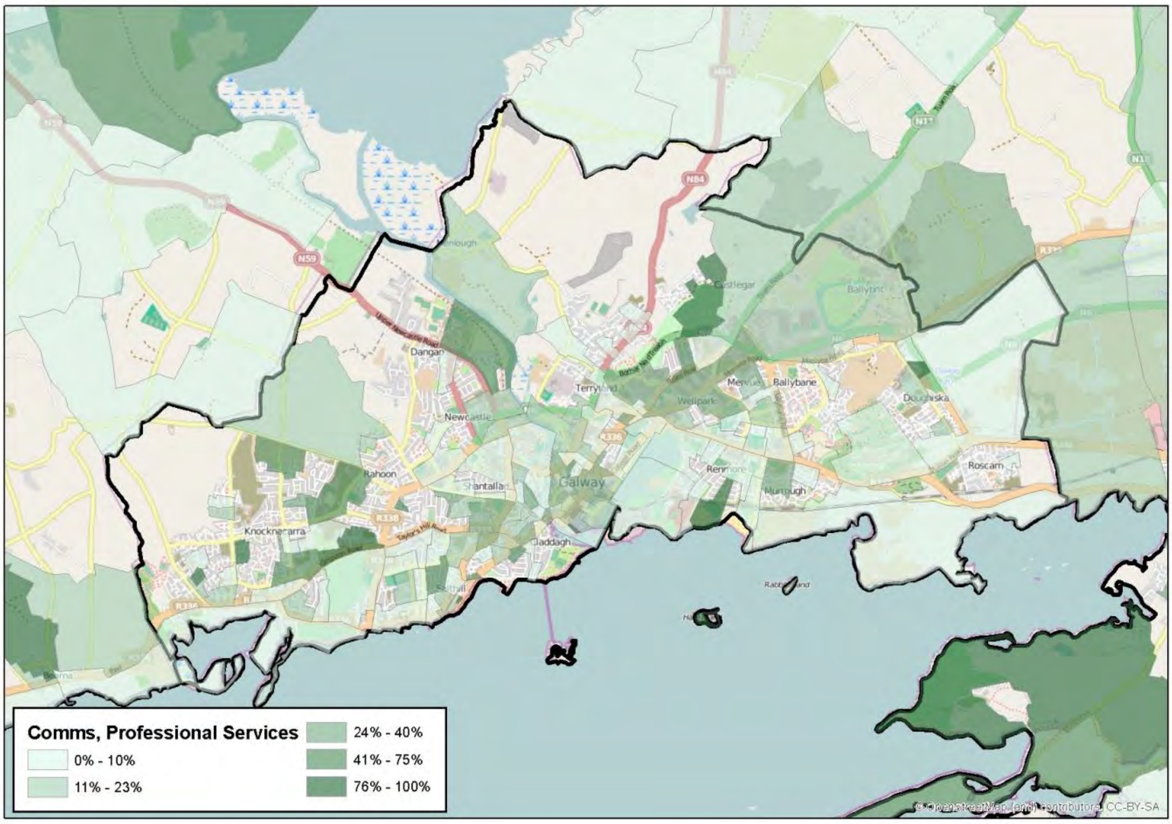
Comms, Professional Services
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11% - 23%
24% - 40%
41% - 75%
76% - 100%
Galway
Knocknacarra
Rahoon
Shantalla
Claddagh
Newcastle
Dangan
Terryland
Castlegar
Mervue
Ballybane
Wellpark
Renmore
Murrough
Doughiska
Roscam
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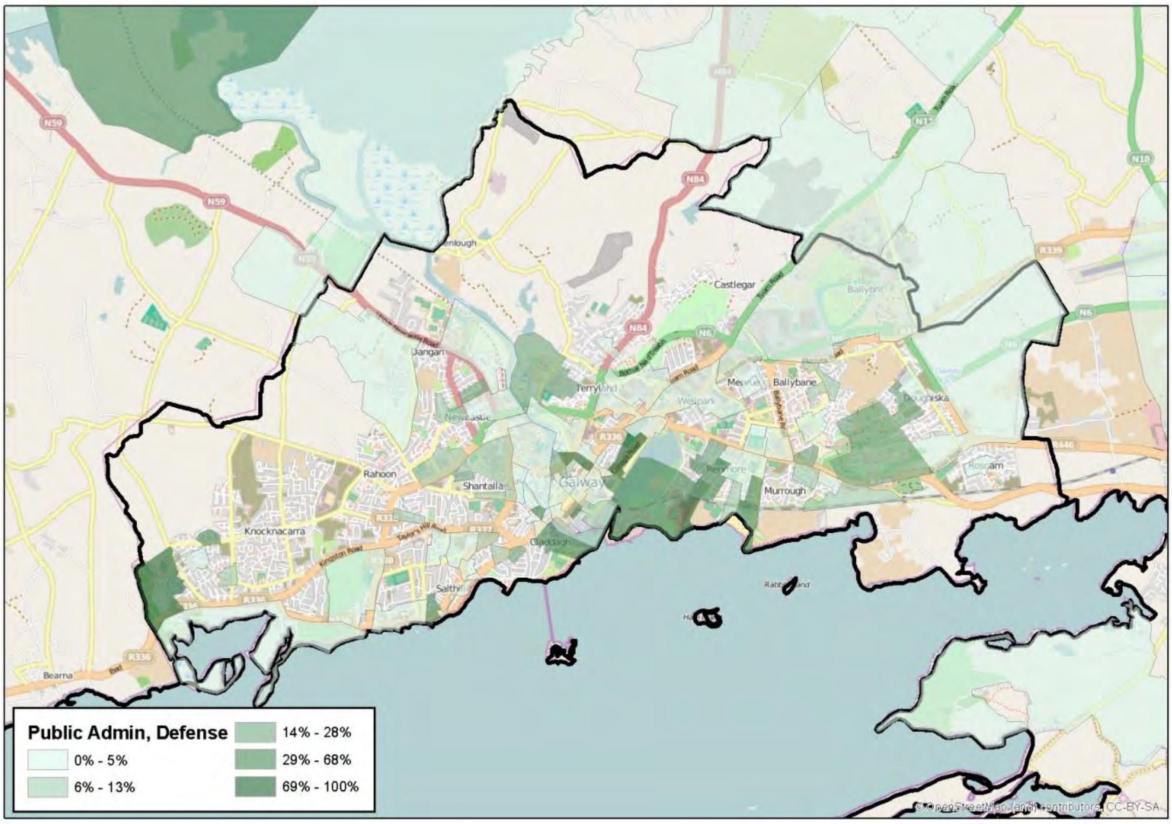
Public Admin, Defense
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6% - 13%
14% - 28%
29% - 68%
69% - 100%
Castlegar
Ballybane
Mervue
Wellpark
Terryland
Dangan
Newcastle
Rahoon
Shantalla
Galway
Renmore
Murrough
Knocknacarra
Claddagh
Salthill
Doughiska
Roscam
Bearna
N59
N84
N6
N17
N18
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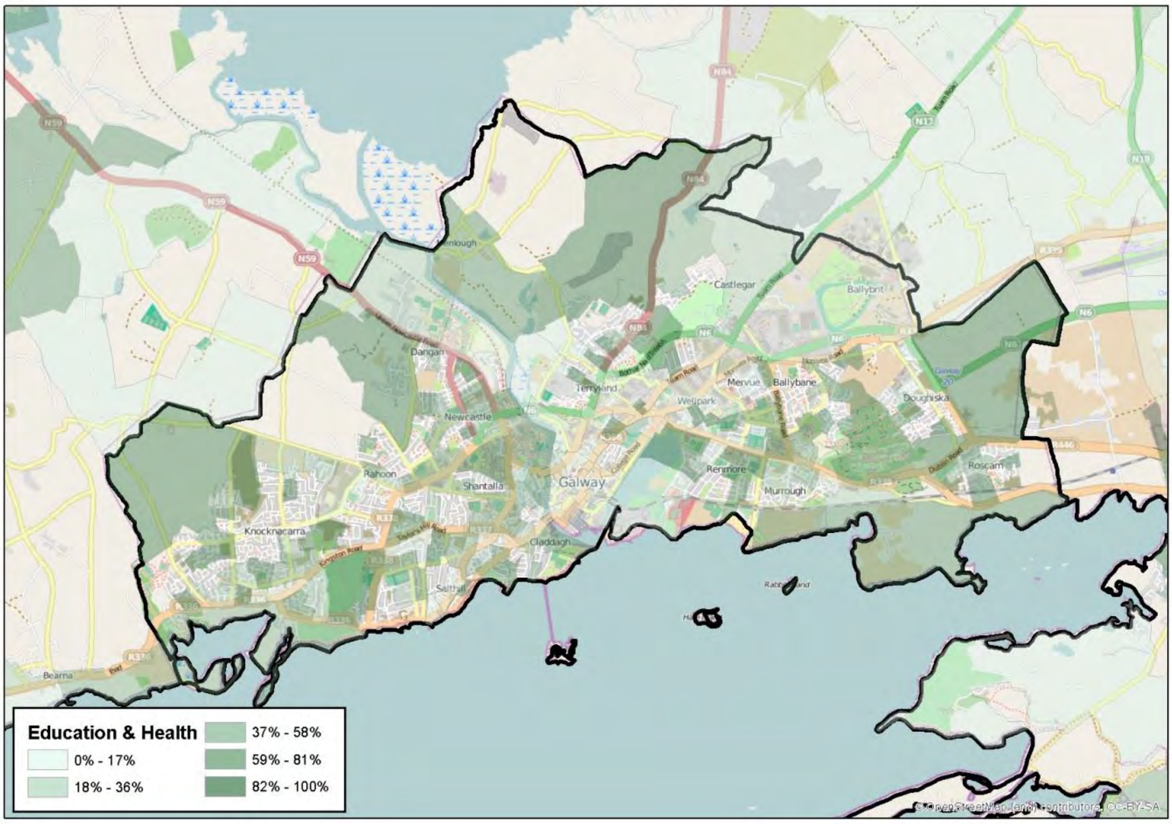
Education & Health
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18% - 36%
37% - 58%
59% - 81%
82% - 100%
Castlegar
Ballybane
Mervue
Wellpark
Terryland
Dangan
Newcastle
Rahoon
Shantalla
Galway
Renmore
Murrough
Knocknacarra
Claddagh
Salthill
Doughiska
Roscam
Bearna
N59
N84
N6
N17
N18
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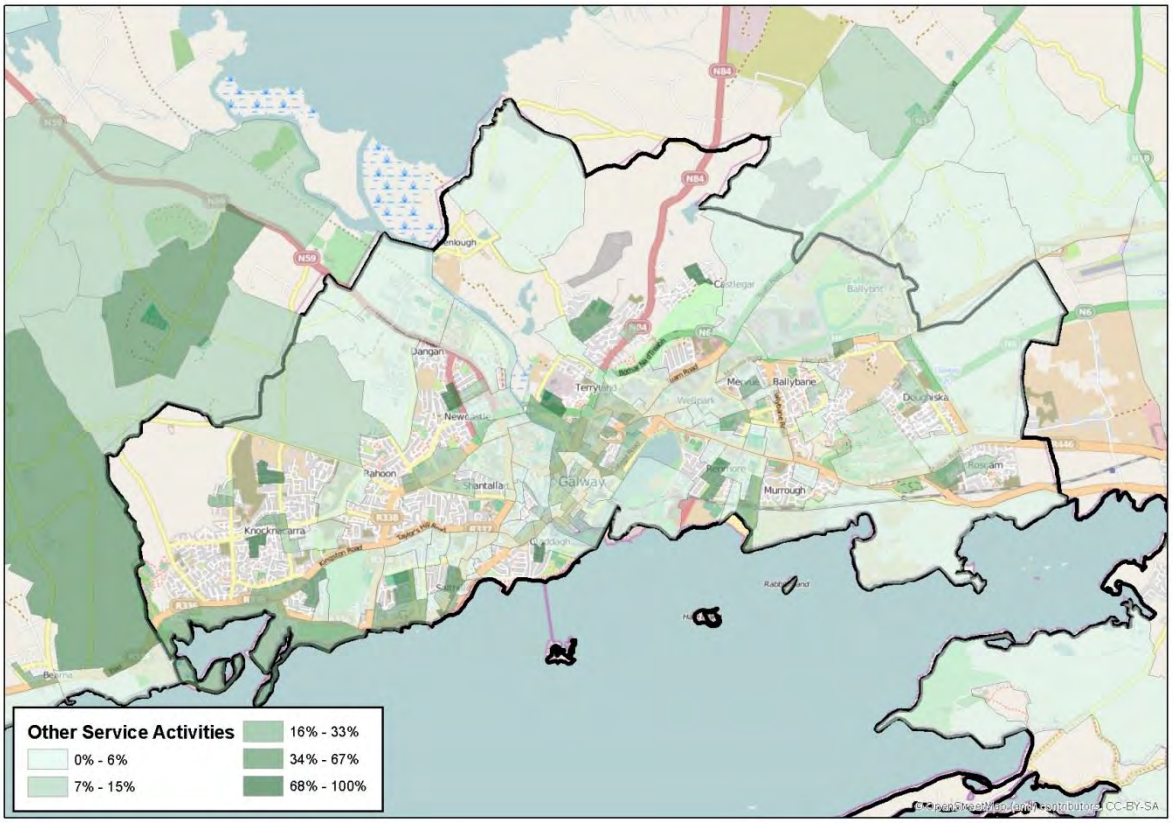
Other Service Activities
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7% - 15%
16% - 33%
34% - 67%
68% - 100%
Galway
Oranmore
Murrough
Roscam
Rahoon
Knocknacarra
Newcastle
Terryland
Castlegar
Ballybane
Doughiska
Claregalway
N59
N84
N6
R336
R117
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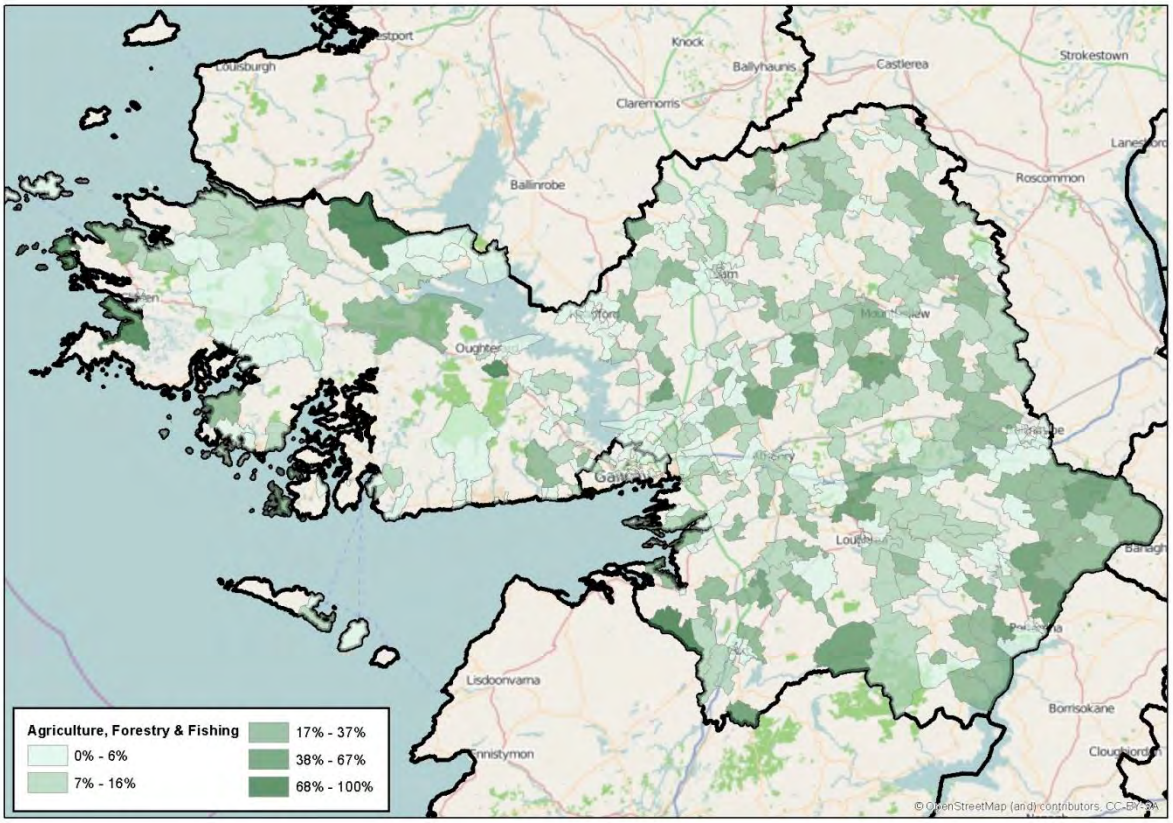
Agriculture, Forestry & Fishing
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7% - 16%
17% - 37%
38% - 67%
68% - 100%
Louisburgh
Knock
Ballyhaunis
Castlerea
Strokestown
Claremorris
Ballinrobe
Roscommon
Oughter
Lisdoonvarna
Borrisokane
Galway
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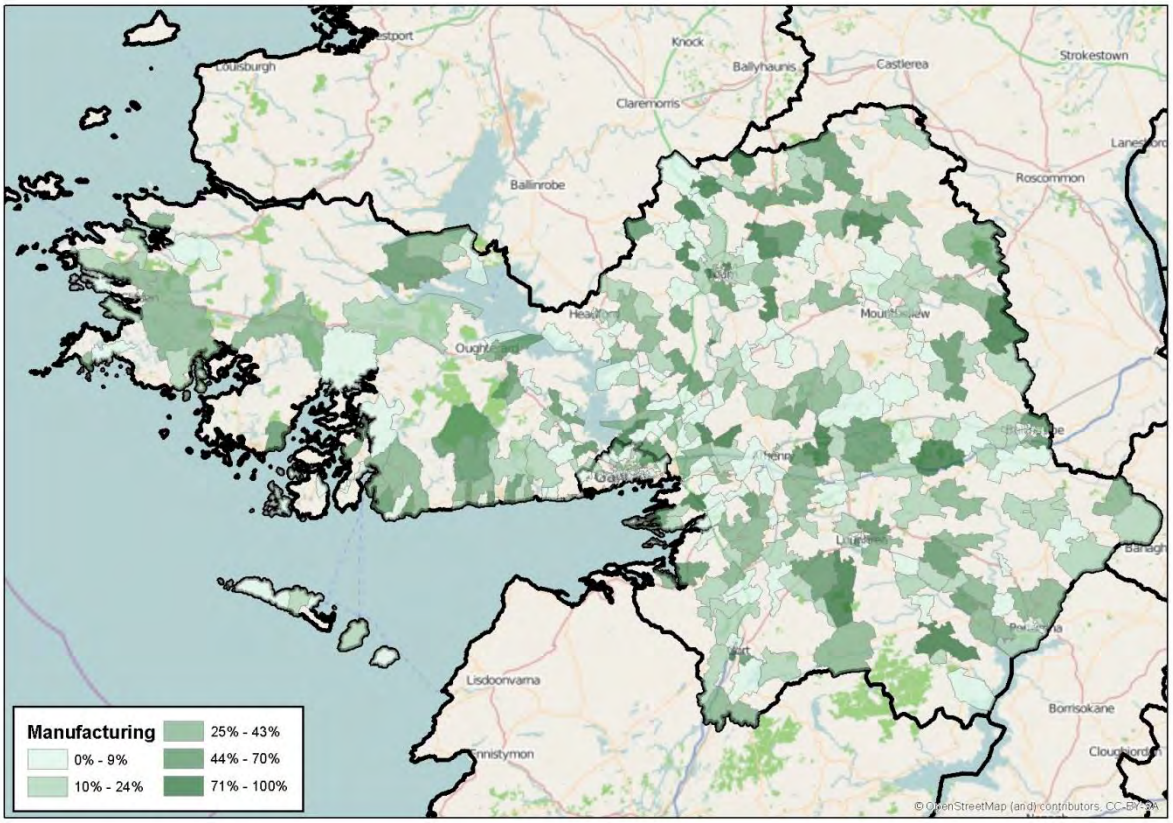
Knock
Ballyhaunis
Castlerea
Strokestown
Claremorris
Ballinrobe
Roscommon
Lisdoonvarna
Borrisokane
Manufacturing
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10% - 24%
25% - 43%
44% - 70%
71% - 100%
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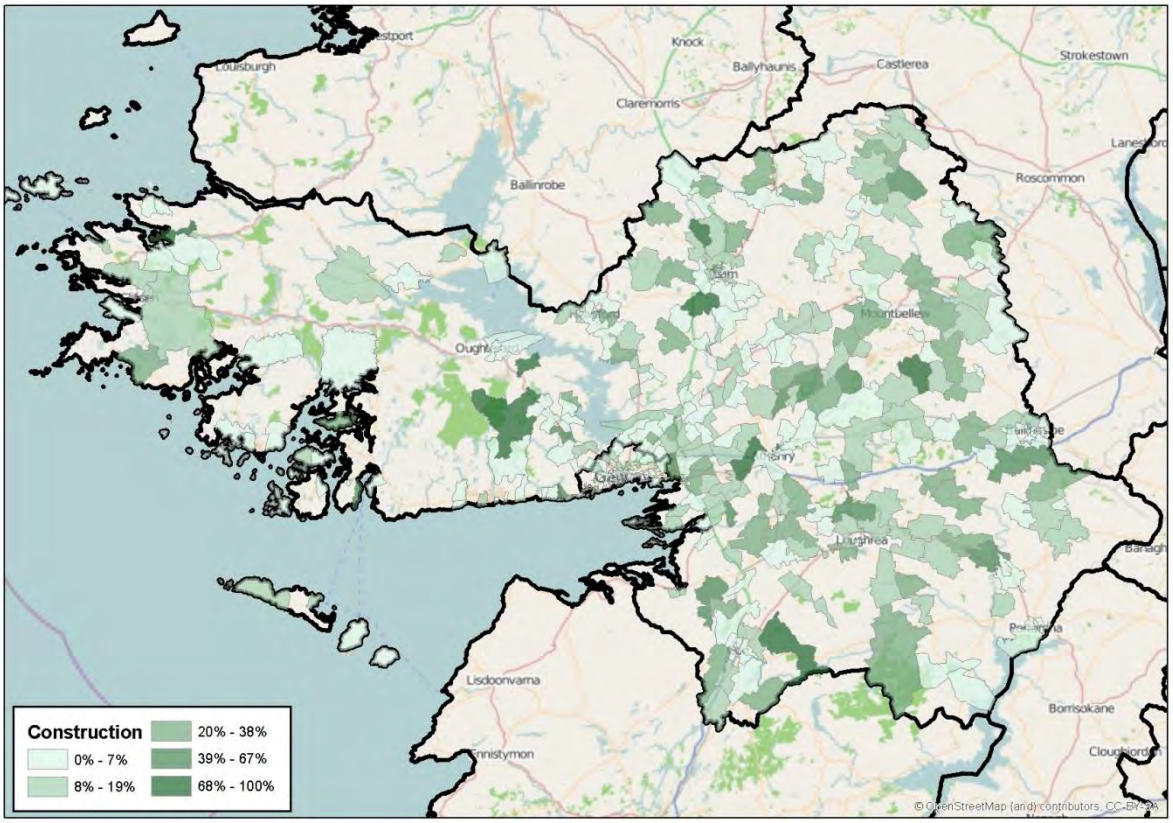
Knock
Ballyhaunis
Castlerea
Strokestown
Claremorris
Ballinrobe
Roscommon
Lisdoonvarna
Borrisokane
Construction
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8% - 19%
20% - 38%
39% - 67%
68% - 100%
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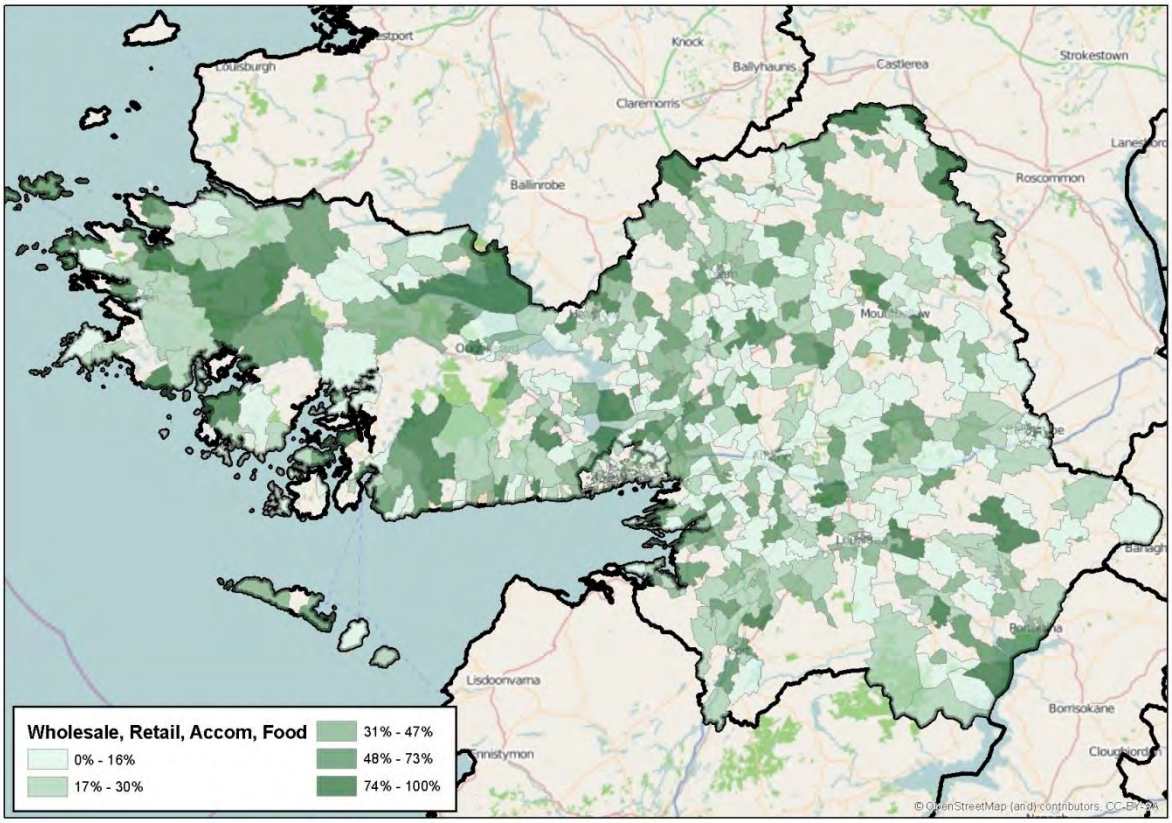
Knock
Ballyhaunis
Castlerea
Strokestown
Claremorris
Ballinrobe
Roscommon
Lisdoonvarna
Borrisokane
Wholesale, Retail, Accom, Food
0% - 16%
17% - 30%
31% - 47%
48% - 73%
74% - 100%
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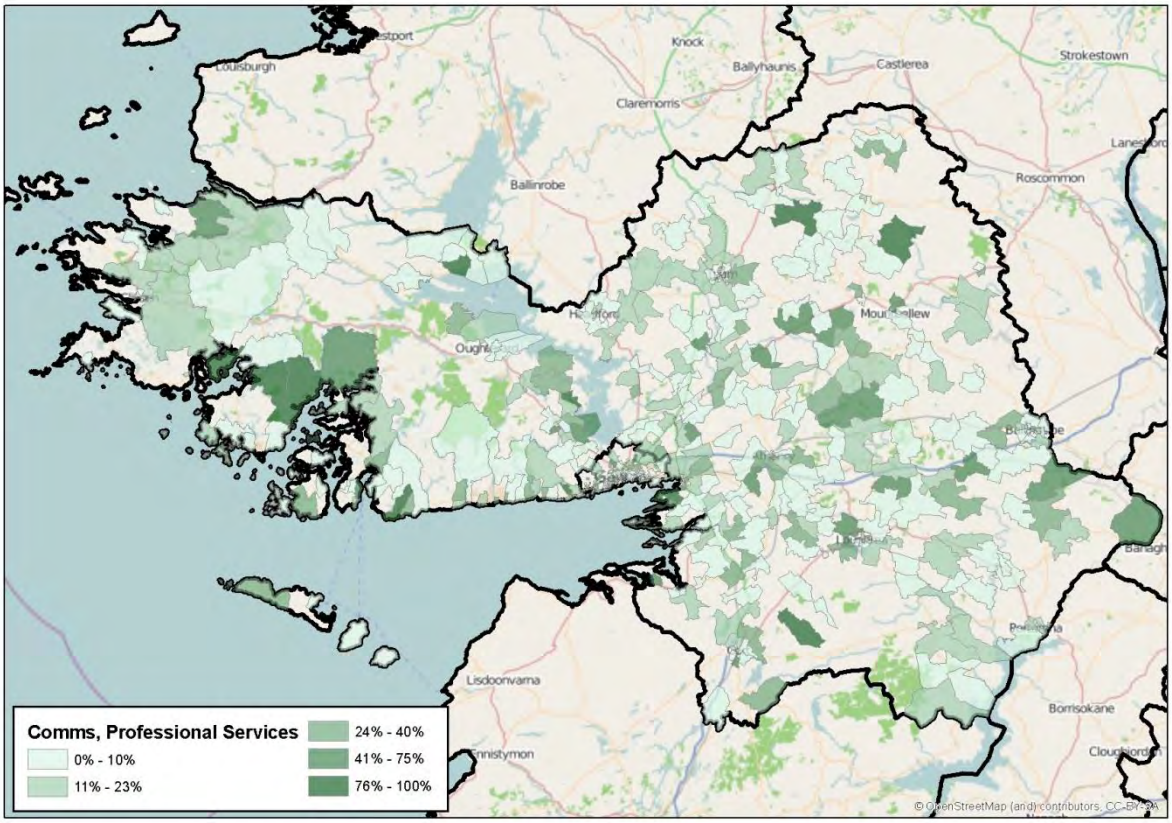
Knock
Ballyhaunis
Castlerea
Strokestown
Claremorris
Ballinrobe
Roscommon
Lisdoonvarna
Borrisokane
Comms, Professional Services
0% - 10%
11% - 23%
24% - 40%
41% - 75%
76% - 100%
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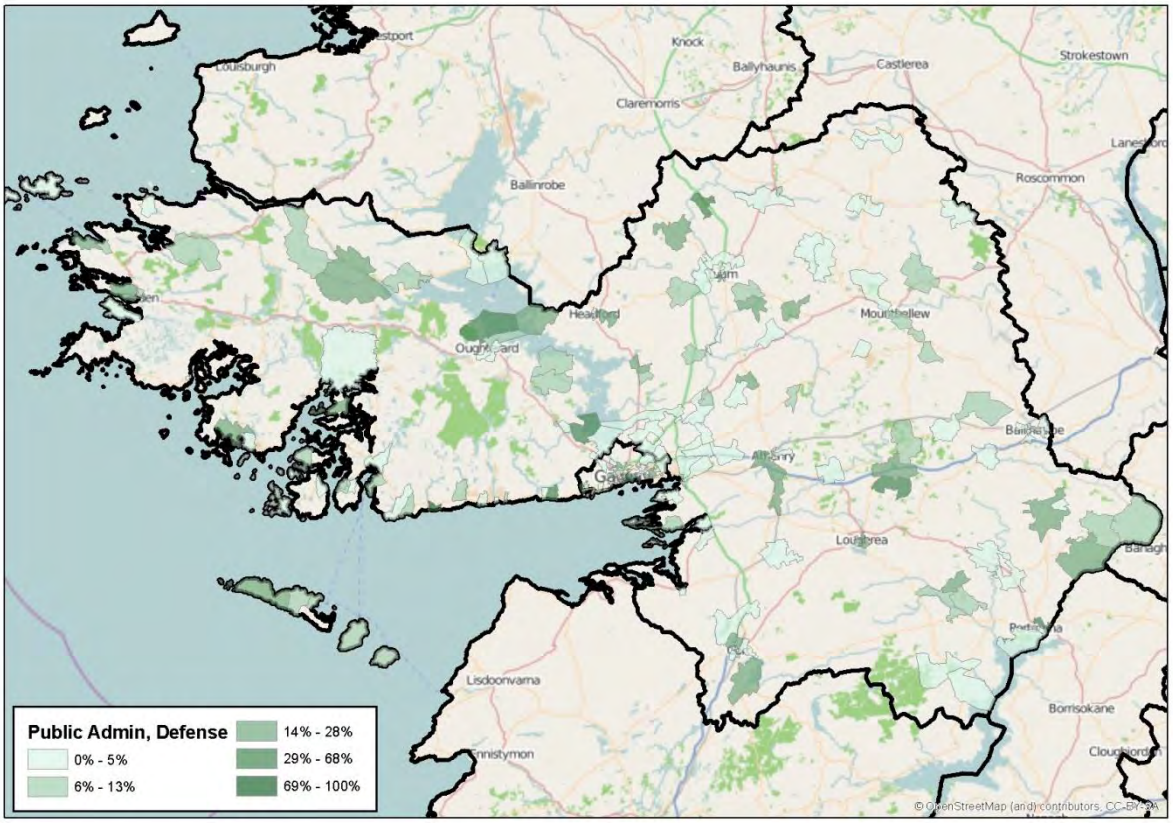
Knock
Ballyhaunis
Castlerea
Strokestown
Claremorris
Roscommon
Ballinrobe
Mountbellew
Lisdoonvarna
Borrisokane
Public Admin, Defense
0% - 5%
6% - 13%
14% - 28%
29% - 68%
69% - 100%
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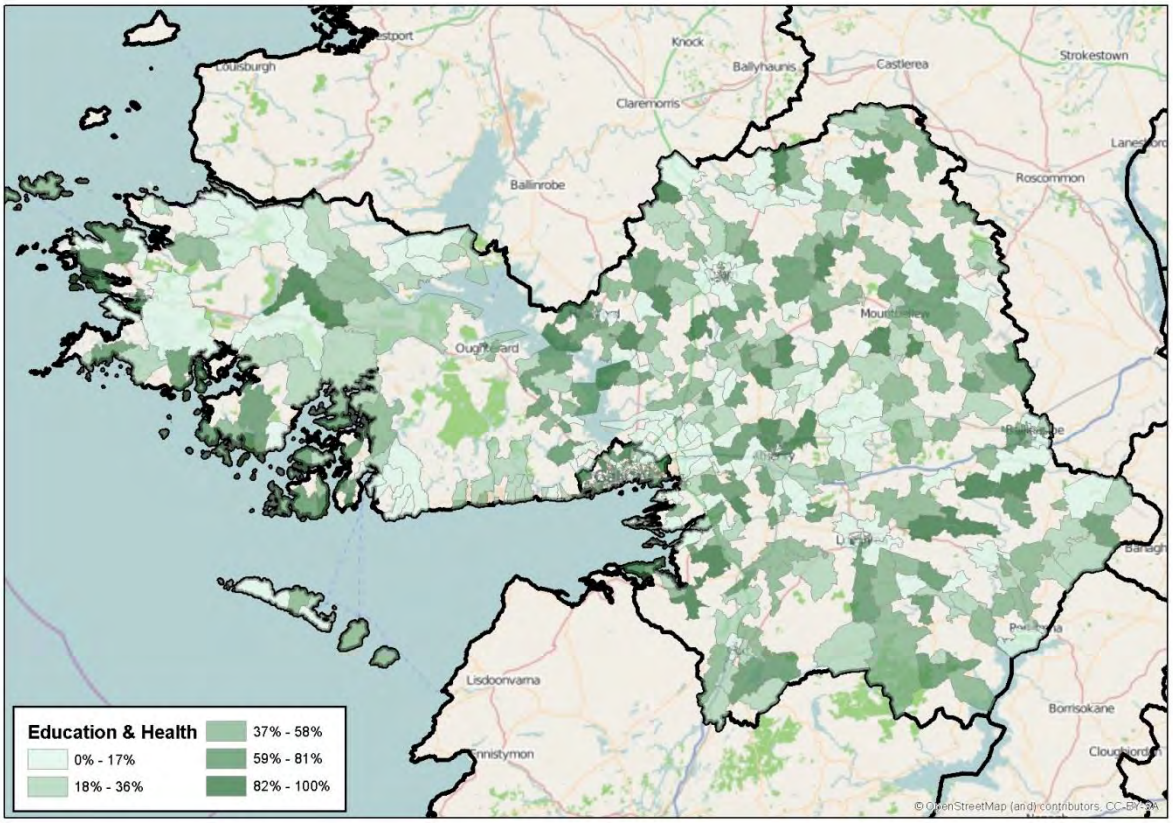
Knock
Ballyhaunis
Castlerea
Strokestown
Claremorris
Roscommon
Ballinrobe
Lisdoonvarna
Borrisokane
Education & Health
0% - 17%
18% - 36%
37% - 58%
59% - 81%
82% - 100%
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Appendix 4

CSO Population Forecasts to 2031								Employment*					Education**				Retail	Other
								1	2	3	4	Total	1	2	3	Total		
National	5,200,000	West	504,696	Galway City	90,090	Galway City and suburbs	90090	%	%	%	%	100%	%	%	%	100%	%	%
						Galway City Remainder	0											
				Galway County	196,863	Athenry	5804											
						Ballinasloe Town & Environs	9192											
						Loughrea	6924											
						Tuam & Environs	9412											
						Galway County Remainder	165532											
				Mayo County	145,573	Ballina Town & Environs	12441											
						Castlebar Town & Environs	14886											
						Westport Town & Environs	7580											
						Mayo County Remainder	110666											
				Roscommon County	72,170	Roscommon	6685											
						Roscommon County Remainder	65485											

*Employment
1: Public Administration/Defence.
2: Retail, Wholesale, Accommodation and Food Production.
3: Manufacturing.
4: Professional Services.

**Education
1: Primary
2: Secondary
3: Third-Level

Distribution by Zones, Within Settlements: Athenry (example).

		Zone No.	%Pop	Pop per Zone	Employment: Public Admin	Retail etc	Mfg	Prof. Services
	→	171	5	290				
Projected Pop	→	231	20	1161				
5,804	→	232	30	1741				
	→	233	25	1451				
	→	234	20	1161