



THE COLLEGE OF AERONAUTICS

DEPARTMENT OF MATHEMATICS

MILTON KEYNES -

PRELIMINARY ESTIMATES OF REGIONAL TRAFFIC FLOWS IN 1981

- by -

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S U M M A R Y

The Milton Keynes Development Corporation and their planning consultants have asked the College Transport Group to investigate the scale of likely regional traffic flows into and out of Milton Keynes. At this stage the emphasis is on providing information for the preparation of a Master Plan for the city itself, rather than detailed traffic estimates for planning transport systems in the surrounding region.

Population estimates for 1981 have been obtained from County Councils for areas within a 20 mile radius of the new city, and the proportions attracted to Milton Keynes for work and shopping assessed using gravity model techniques. Separate estimates have been made of work journeys from the city to regional employment and to London.

Possible upper and lower limits to these forecasts are included to account for many uncertainties in the absolute and relative growth of population, employment and shopping opportunities in the city itself and in the surrounding region. The results are presented as traffic flows into and out of octant sectors around the city. Flows to the east are greater than to the west with work trip flows of the order of 2,500 person trips each way in the most heavily loaded sectors. A 1981 city population of 150,000 is likely to produce at least 1,500 daily commuters to London using the fast rail service, with an additional 200 commuters from the region using Milton Keynes railway station.

No specific assignments have been made of traffic flows to individual roads or modes of transport. Newport Pagnell is so close that transport links with Milton Keynes should be closely integrated with the new city's internal transport systems. There are also likely to be considerable



flows between the new city and Leighton Buzzard - Linslade. It is generally assumed that the M.1 will be an important transport link for Milton Keynes. No doubt this is true, but it is likely that the M.1 route near Milton Keynes will reach design capacity before the new city is developed: Milton Keynes traffic flows will contribute only 5-10% of this level. It is probable that A.5 traffic will build up both as an alternative through route to the M.1 and as alternative access to the new city from North and South. East-West traffic flows seem unlikely to justify major route investment, although no estimates have been made of commercial vehicle movements.

Extended forecasts to the year 2001 have not been included. Some population forecasts are available but these are incomplete for the 20 mile region around the new city. There are also likely to be major changes in modes of living and travelling by that date. Some provisional estimates could be obtained by factoring the 1981 estimates by the 2001/1981 ratios of population and employees in Milton Keynes.

Introduction

People travel from a point of origin to one of a number of alternative destinations. The choice of destination is related to the relative attractiveness of the alternatives and to the available transport facilities. Total travel aggregates these individual choices for a complete population.

The relative attractiveness of Milton Keynes compared with other regional opportunities for employment, shopping, schooling and social trips is subject to conjecture, but some guidance can be derived from the range of trip making behaviour in existing communities. There are also likely to be errors in forecasts of population growth and its distribution over a region. Against this background of uncertainty no attempt has been made to develop elaborate models of traffic distribution in the region. The approach has been to use simple models for predicting possible upper and lower limits of travel demand.

Discussions with the planning consultants Llewelyn-Davies, Weeks, Forestier-Walker and Bor and with the transport consultants, Traffic Research Corporation indicated that the primary requirements were for estimates of peak traffic flows into and out of the new city under alternative assumptions about regional growth and travel mobility. Peak weekday trips are assumed to be generated by journeys to and from work and an additional check has been made on possible Saturday shopping journeys.

Population

1966 census data and population estimates for 1981 for Milton Keynes and the region within a 20 mile radius were obtained from the County Planning Offices for Bedfordshire, Buckinghamshire and Northamptonshire. These are by parish within a 10 mile radius and by local authority areas beyond.

Estimates of future population structure, employment, schooling and shopping opportunities, household income and car ownership levels were asked for but were not available for the whole region. Lacking better information 1981 estimates of male and female employees were obtained by factoring 1966 census data by the 1981 estimates of total population.

Data was assembled into traffic generation zones shown in Fig. 1, zone size increasing with distance from the city. Corresponding estimates of population and employees are shown in Table 1.

1966 census workplace data for Greater London and counties bordering the Milton Keynes region was provided by Traffic Research Corporation. This was used to derive and calibrate employment travel distribution models.

Traffic Surveys

Numerous traffic studies were used to assess likely levels of travel demand, e.g. references 1 and 2. Specific information was used from the

Stevenage Traffic Survey, ref. 3, in assessing the shopping attraction of a new town.

Road traffic counts on some of the regions main roads were provided by the Buckinghamshire and Northamptonshire County Surveyors and Ref. 4 from the Road Research Laboratory gave an indication of M.1 traffic growth. British Rail's Area Manager provided data on rail passenger traffic at Bletchley and Wolverton since main line electrification.

Distribution Models

Gravity models have been used to estimate future traffic flows. These are of the form

$$T_{ij} = \frac{K_1 O_i D_j}{(d_{ij})^n} \quad - \text{Type A}$$

or,
$$T_{ij} = K_2 O_i D_j e^{-m d_{ij}} \quad - \text{Type B}$$

where T_{ij} is the number of journeys from origin i to destination j

K_1 , K_2 , n and m are constants

O_i is the number of people wanting to travel for a specific purpose from zone i

D_j is the number of vacancies for a specific purpose at zone j

d_{ij} is a measure of travel deterrence,
e.g. journey distance, journey time, journey cost or some linear combination of the three.

The most appropriate model for each case was derived from an examination of current data. If a log-log plot of T_{ij} against d_{ij} showed a straight line relationship then a type A gravity model was used. If a better straight line fit was obtained for log T_{ij} against linear d_{ij} then type B was chosen. Initially road distance was used to measure d_{ij} and time and cost only included if the results for pure distance were anomalous.

Best straight lines were fitted by eye to the plotted data. All that was needed was the general form of the distribution equations and their parameters rather than precise relationships established by regression analysis.

Attracted to work in Milton Keynes

An analysis of 1966 Census work trips to Bedford, Bletchley, Luton and Northampton produced a type B gravity model with pure distance as deterrent. For male workers the constant m varied between 0.26 for Luton and 0.36 for

Bletchley where the higher figure represents a less widespread attraction. The corresponding variation for female workers was between 0.30 for Bedford and 0.40 for Northampton. As might be expected this indicates that women are more restricted than men in the distance they travel to work.

Increasing car ownership leads to improved mobility which may well be reflected in an increased commuting range for people who choose to live in small towns and villages. Calculations for Milton Keynes have been made under three assumptions:

- a) High mobility
m = 0.20 male, 0.25 female
- b) Average mobility
m = 0.30 male, 0.35 female
- c) Poor mobility
m = 0.40 male, 0.40 female

The scaling constant K_2 for the 1966 Census work trips from the surrounding areas to Bedford, Bletchley, Luton and Northampton averaged 40 for males and 100 for females. Applying these factors, with m values for average mobility, to 1981 regional population and Milton Keynes employment estimates (40,000 male and 20,000 female jobs) showed that 13% of the male and 10% female workers would come from the region. These are low percentages compared with existing employment areas in the region, Table 2.

In preparing estimates the following alternative assumptions for percentages of workers not resident in the city have been examined.

- A 20% male and female workers from region
- B 15% male and female workers from region
- C 10% male and female workers from region

The higher percentage values correspond to a higher ratio of employment attractiveness compared with residential attractiveness. This may be compounded from a number of factors, e.g.

- Good jobs in Milton Keynes.
- Shortage of jobs in the region.
- Relatively attractive housing in the region.

These alternative assumptions for mobility and percentages of non-resident workers have been combined in 7 ways,

aA, aB, bA, bB, bC, cB, cC.

Combinations aC, high mobility/low attraction and cA, low mobility/high attraction have been excluded as unlikely.

Resulting traffic estimates have been assembled as flows into the city from eight equal geographical sectors or octants. These are listed in Table 3 and average values, assumptions Bb, are plotted in Fig. 2, where the width of the traffic band in each octant is proportional to traffic flow.

The range of the maximum and minimum estimates about the average is between double and half the average estimate. This is for the aggregate traffic flows into each octant and larger differences exist for the flows from individual zones. The most heavily loaded octants are NNE including Newport Pagnell and Olney and SSE which includes Leighton Buzzard and Linslade. Newport Pagnell is estimated to provide the most employees to Milton Keynes of any individual traffic zone.

Attracted from Milton Keynes to work elsewhere

In 1966 74% of employed men and 78% of employed women in Bletchley and Wolverton worked locally. Proportions for other towns and small cities are listed in Table 4. For the larger towns, comparable with Milton Keynes in 1981, the proportions of men working locally range from 70 to 90% and of women 85 - 95%.

As before, we have made three assumptions:

- D) High attraction of outside employment
male 30%, female 15%.
- E) Mid attraction of outside employment
male 20%, female 10%.
- F) Low attraction of outside employment
male 10%, female 5%.

In 1981 there are assumed to be about 40,000 male and 20,000 female workers resident in Milton Keynes.

Work trips to London have been assessed as part of the total outside employment. Analysis of the census data for New Towns around London, (Bracknell, Bletchley, Basildon, Crawley, Harlow, Hatfield, Hemel Hempstead, Stevenage and Welwyn Garden City) gives a reasonable fit to a type B gravity model using generalised cost as the deterrence function taking journey cost = 2d/mile distance plus 1d per minute of train journey time. The results for men are more consistent than for women and no account has been taken of the relative attractiveness of other employment opportunities between one new town and another. There is a good deal of scatter in these results but the 1966 Bletchley figures are close to the average line. The mid-attraction projections for 1981 and 2001 of commuting to London are

based on the same rates per 1,000 employees as the census data.

Comprehensive forecasts of likely employment growth in the 20 mile region around Milton Keynes are not available. The preliminary estimates which have been made assume that future work journeys will follow the same pattern as 1966 work journeys from Bletchley and Wolverton. This is probably adequate for assessing the general direction of outgoing work flow around the city but is unlikely to be accurate for individual destinations. Results are summarised in Table 5 and the mid estimates shown on Figure 3.

Attracted to shop in Milton Keynes

Saturday shopping leads to congestion and parking problems in many towns and cities. Shopping habits may change; e.g. weekday evening shopping or mail ordering. Even so it is probably worthwhile to examine what might happen if existing shopping patterns are translated to future Milton Keynes.

Stevenage, ref. 3 have conducted shopping surveys to find out where shoppers from outside the town originate. A Saturday survey in March 1965 showed that about 40% of shoppers travelling by car came from outside the town. Analysis of the distribution of these shoppers shows that the journeys fit a Type A gravity model with journey distance as the deterrent and exponents $n = 3.0$.

If the number of external shoppers attracted is proportional to urban population then Milton Keynes could expect to attract as many as 18,000 Saturday shoppers. However the region around Milton Keynes is expected to be less densely populated than that around Stevenage. If the gravity model derived for Stevenage:

$$\text{Shoppers} = \frac{150}{d^3} / 1,000 \text{ pop. at origin} / 1,000 \text{ pop. at centre}$$

is applied to the Milton Keynes region only 7,000 Saturday shoppers are generated from the region in 1981.

In preparing shopping projections three levels of external Saturday shoppers have been assumed:

X	18,000	high attraction
Y	12,000	mid attraction
Z	6,000	low attraction

These have been combined with three mobility assumptions for the exponent n .

x, $n = - 2.5$	high mobility
y, $n = - 3.0$	average mobility
z, $n = - 3.5$	low mobility

Results have been calculated for seven combinations of mobility and shopping attraction:

xX, yX, xY, yY, zY, yZ, zZ.

These are listed in Table 6 and the average results plotted on Figure 4.

Journeys to London

The section on work journeys from Milton Keynes above, discusses commuting journeys from Milton Keynes to London and indicates that these may amount to around 1,750 a day for a 1981 population of 150,000. There will be additional commuters to London who travel from the near region via Milton Keynes railway station. Subtracting 1966 census commuters at Bletchley and Wolverton from British Rail figures of total commuting at these stations leaves 150 commuters from the near region. Local regional growth can be expected to raise this to 200 by 1981, most of whom will probably travel to the railhead by car.

Total British Rail day trips to London from Bletchley and Wolverton in 1968 are averaging 2,400, i.e. about 1,750 over and above commuting. A 3.75 times population growth by 1981 may not produce a proportionate increase in day trips but it would seem probable that the total daily trips could increase to well over 5,000 if adequate station access and rail service capacity is made available.

Conclusions

Some preliminary broad band estimates have been made of peak traffic flows between Milton Keynes and the surrounding region, indicating the effects of variations in the main assumptions. These are intended as estimates of inflows and outflows to the city itself and not as detailed estimates of traffic flows within the region itself.

Detailed regional estimates could be made if more comprehensive information was available on the growth and distribution of employment opportunities throughout the region and on population structure.

Commercial vehicle flows could be most important both during the construction of the city and subsequently. This would require special consideration of vehicle traffic generation for specific purposes such as earth moving, constructional work, industry and business.

Estimates of total traffic flows on through trunk routes such as the M.1, A.5 and the mainline railway obviously involve traffic flows over a much wider area than are considered in this memorandum. However, such estimates are very relevant to the use of these routes for locally generated traffic.

References

1. Washington New Town Master Plan and Report.
Llewelyn-Davies Weeks and Partners - December, 1966.
2. Cardiff Development and Transportation Study.
Colin Buchanan and Partners, April 1968.
3. Stevenage Traffic Survey, Part Two, 1965-1966.
Stevenage Development Corporation - November 1966.
4. Traffic Flows on the London-Birmingham Motorway, 1964.
G.R. Green, Road Research Laboratory Note September, 1965.

TABLE 1

POPULATION AND EMPLOYMENT IN TRAFFIC ZONES

No.	ZONE NAME	1966 CENSUS			1981 ESTIMATE				
		Pop'n. 000's	EMPLOYMENT			Pop'n. 000's	EMPLOYMENT		
			MALE	FEMALE	TOTAL		MALE	FEMALE	TOTAL
1	Newport Pagnell	5.12	1690	950	2640	8.90	2930	1650	4580
2	Moulsoe/Cranfield	3.59	1186	467	1653	4.20	1390	550	1940
3	Wavendon/W. Sands	4.27	1360	710	2070	4.70	1500	780	2280
4	Brickhill/Woburn	2.86	820	440	1260	3.15	900	480	1380
5	N. Longville/Soulbury	2.99	950	570	1520	3.29	1050	630	1680
6	Whaddon/Harwood	2.46	740	445	1185	2.71	810	490	1300
7	Deanshanger/Stratford	4.12	1365	645	2010	4.89	1620	760	2380
8	Hanslope/Haversham	2.50	842	271	1113	3.52	1190	380	1570
9	Sherrington/Emberton	2.08	650	230	880	2.38	740	260	1000
10	Marston/Ridgmont	4.29	1554	666	2220	4.98	1810	770	2580
11	Heath/Eversholt	2.66	868	490	1358	2.90	940	530	1470
12	Ampthill/Millbrook	4.73	1495	704	2199	5.65	1790	840	2630
13	Flitwick	4.91	870	450	1320	5.40	960	500	1460
14	Leighton/Linslade	17.82	5430	2950	8380	33.50	10200	5500	15700
15	Wing/Stewkley	2.88	1030	470	1500	4.04	1440	660	2100
16	Winslow	3.40	970	560	1530	8.02	2290	1320	3610
17	Claydon/Padbury	2.55	790	410	1200	4.54	1400	730	2130
18	Buckingham	4.99	1550	710	2260	13.70	4400	2020	6420
19	Silverstone	2.67	810	372	1182	2.93	890	410	1300
20	Paulersbury	2.61	835	399	1234	3.20	1020	490	1510
21	Olney	4.20	1280	680	1960	13.11	4000	2120	6120
22	Brackley	15.29	4640	2320	6960	16.82	1500	2550	7650
23	Towcester	9.82	3119	1483	4602	10.80	3430	1630	5060
24	Daventry	23.17	7770	3570	11340	26.08	8550	3930	12480
25	Northampton	144.3	44710	25870	70580	232.2	72100	41700	113800
26	Brinworth	16.11	4880	2540	7420	17.72	5370	2740	8110
27	Kettering	105.2	18160	17870	49690	115.7	19980	19660	39640
28	Wellingborough	83.23	26850	15110	41960	91.55	29540	16620	46160
29	Oundle	19.79	6300	3120	9420	21.77	6930	3430	10360
30	Bedford	113.5	36210	18470	54680	150.5	48050	24500	72550
31	Ampthill	18.2	6457	2957	9414	21.95	7790	3560	11350
32	Biggleswade	45.4	14920	6750	21670	57.0	18750	8490	27240
33	Luton/Dunstable	212.4	69260	34450	103710	236.8	77140	38340	115480
34	Wing	77.03	2355	1055	3410	9.48	3180	1420	4600
35	Aylesbury	69.5	22280	11320	33600	91.3	29300	14820	44120
36	Buckingham	4.46	1370	580	1950	5.85	1800	760	2560
37	Bicester U.D.						2770	1650	4420
38	Ploughley R.D.						11520	4660	16180
Σ 000's							357	193	550
MILTON KEYNES			8.3	4.6	12.9	150	40	20	60

Zones 22 - 38 exclude population within 10 miles radius of Milton Keynes

TABLE 2

PROPORTIONS OF EMPLOYEES WHO ARE LOCAL RESIDENTS

(1966 Census)

PLACE	EMPLOYEES		LOCAL RESIDENT EMPLOYEES		% LOCAL RESIDENTS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
Bedford	22020	15170	14490	10190	66	67
Bletchley	6710	4130	4960	3220	74	78
Luton	56130	27180	40480	23360	72	86
Newport Pagnell	5050	2480	3110	1820	62	73
Northampton	44760	27950	33440	21880	75	78
Wolverton	3980	1370	2860	1200	72	88

TABLE 3

WORK JOURNEYS TO MILTON KEYNES FROM REGION

		SECTOR	A	B	C	D	E	F	G	H
1981	Male	aA himobile, hiattraction	1322	1480	1153	1341	550	465	472	887
		aB " , mid "	991	1110	864	1004	413	348	355	667
		bA midmobile, hi "	1708	1038	1137	1576	471	448	593	523
		bB " , mid "	1280	778	853	1182	351	335	445	395
		bC " , lo "	853	517	569	778	236	224	296	263
		cB lowmobile, mid "	1487	559	920	1122	327	302	496	275
		cC " , lo "	993	371	614	747	219	202	330	186
Female	aA	860	546	560	777	277	239	242	319	
	aB	599	409	420	504	207	171	183	240	
	bA	977	347	603	800	257	229	290	165	
	bB	733	258	449	614	191	172	218	123	
	bC	488	172	299	409	127	116	147	82	
	cB	784	226	469	602	182	167	218	98	
	cC	518	150	312	399	120	116	149	66	
Total	AA	2122	2026	1713	2118	827	704	714	1206	
	aB	1590	1519	1284	1598	620	519	538	907	
	bA	2685	1385	1740	2376	728	677	883	688	
	bB	2013	1036	1302	1800	545	507	663	518	
	bC	1341	689	868	1187	363	340	443	345	
	cB	2271	785	1389	1724	509	469	714	373	
	cC	1511	521	926	1146	339	318	479	252	

TABLE 4

PROPORTIONS OF RESIDENT EMPLOYEES WORKING LOCALLY

PLACE	RESIDENT EMPLOYEES		RESIDENTS WORKING LOCALLY		% WORKING LOCALLY	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
Bedford M.B.	21120	10970	14490	10190	69	93
Bletchley U.D.	7020	3480	4960	3220	71	93
Hemel Hempstead M.B.	19460	11960	13280	10560	68	89
Luton C.B.	49130	25200	40480	23360	82	93
Newport Pagnell U.D.	1720	960	980	820	57	85
Northampton C.B.	37830	22630	33440	21880	88	97
Peterborough M.B.	20720	9710	18320	8670	88	89
Reading C.B.	38970	21960	28910	19570	74	89
Stevenage	16830	9310	13530	8680	80	93
Welwyn Garden City	11850	7060	8040	6450	68	91
Wolverton	4170	1820	2860	1200	69	66

TABLE 5

WORK JOURNEYS FROM MILTON KEYNES

		SECTOR	GREATER LONDON	A	B	C	D	E	F	G	H
1966	Male		320	820	140	465	460	195	265	153	115
	Female		50	280	30	45	50	30	70	87	15
	Total		370	1100	170	510	510	225	335	240	130
1981	Male	High	2250	3060	520	1725	1730	730	990	580	430
		Mid	1500	2040	345	1150	1155	490	660	385	285
		Low	750	1020	175	575	575	245	330	195	145
1981	Female	High	350	1215	125	195	220	130	310	375	75
		Mid	235	810	80	130	145	85	205	250	50
		Low	120	405	45	65	75	45	105	125	25
1981	Total	High	2600	4275	640	1920	1950	860	1295	955	455
		Mid	1735	2850	425	1280	1300	575	865	635	335
		Low	870	1425	215	640	650	285	435	320	120

TABLE 6

SATURDAY SHOPPING TO MILTON KEYNES

	SECTOR	A	B	C	D	E	F	G	H
	xX himobile hi attract	3214	2718	3090	2451	1278	1046	1001	2341
	xY " mid "	2153	1812	2060	1634	852	697	671	1565
1-1	yX midmobile hi "	3679	2354	3079	2718	1207	1005	1124	1873
0-1	yY " mid "	2420	1567	2053	1813	805	670	750	1216
	yZ " low "	1211	785	1027	906	402	335	374	608
1-1	zY lowmobile mid "	2702	1312	2094	1902	765	641	808	930
	zZ " low "	1352	656	1047	952	383	321	404	464

Assume 15% in peak hour.

TRAFFIC ZONES

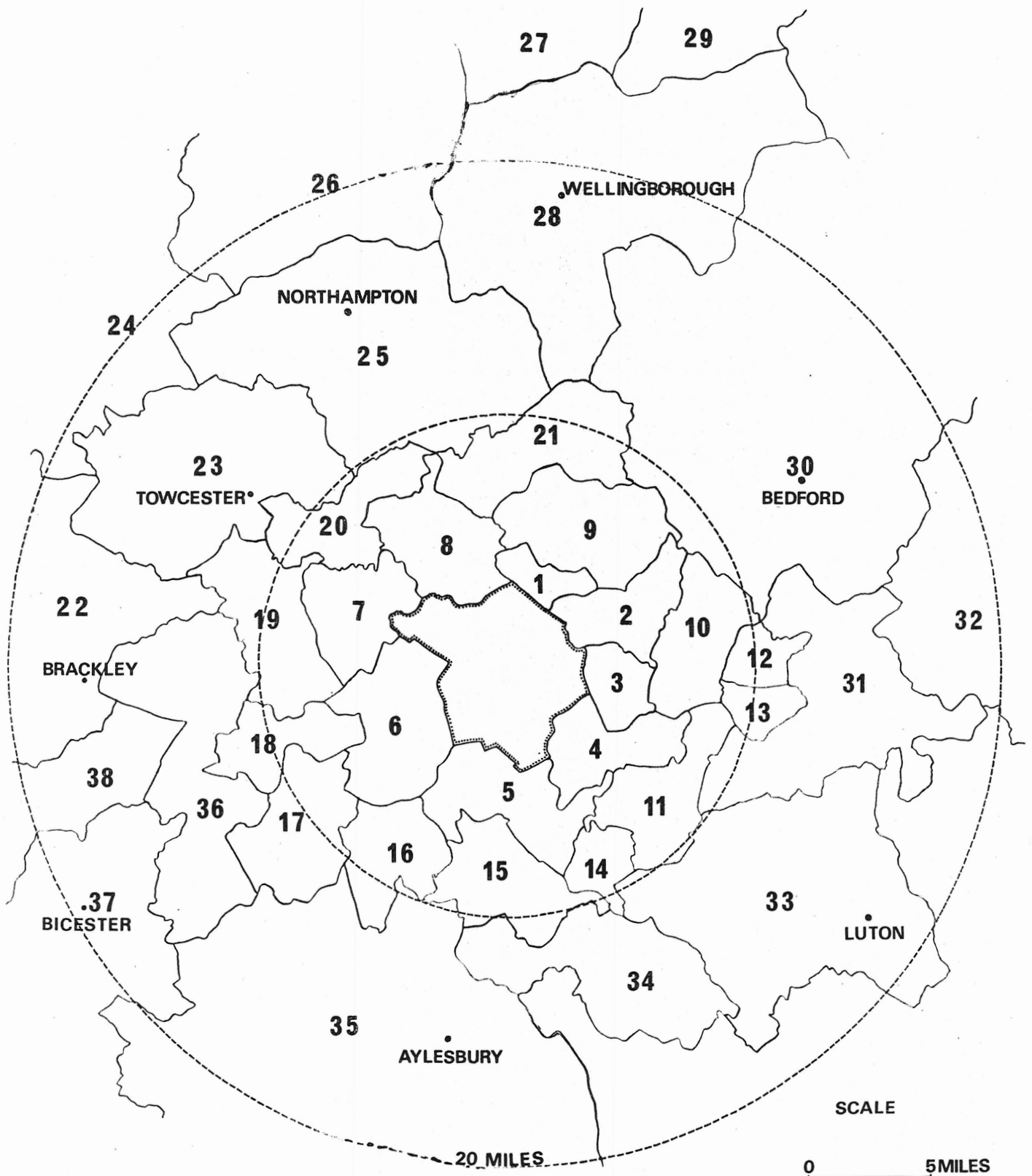


FIGURE 1.

REGIONAL WORK JOURNEYS TO MILTON KEYNES: 1981

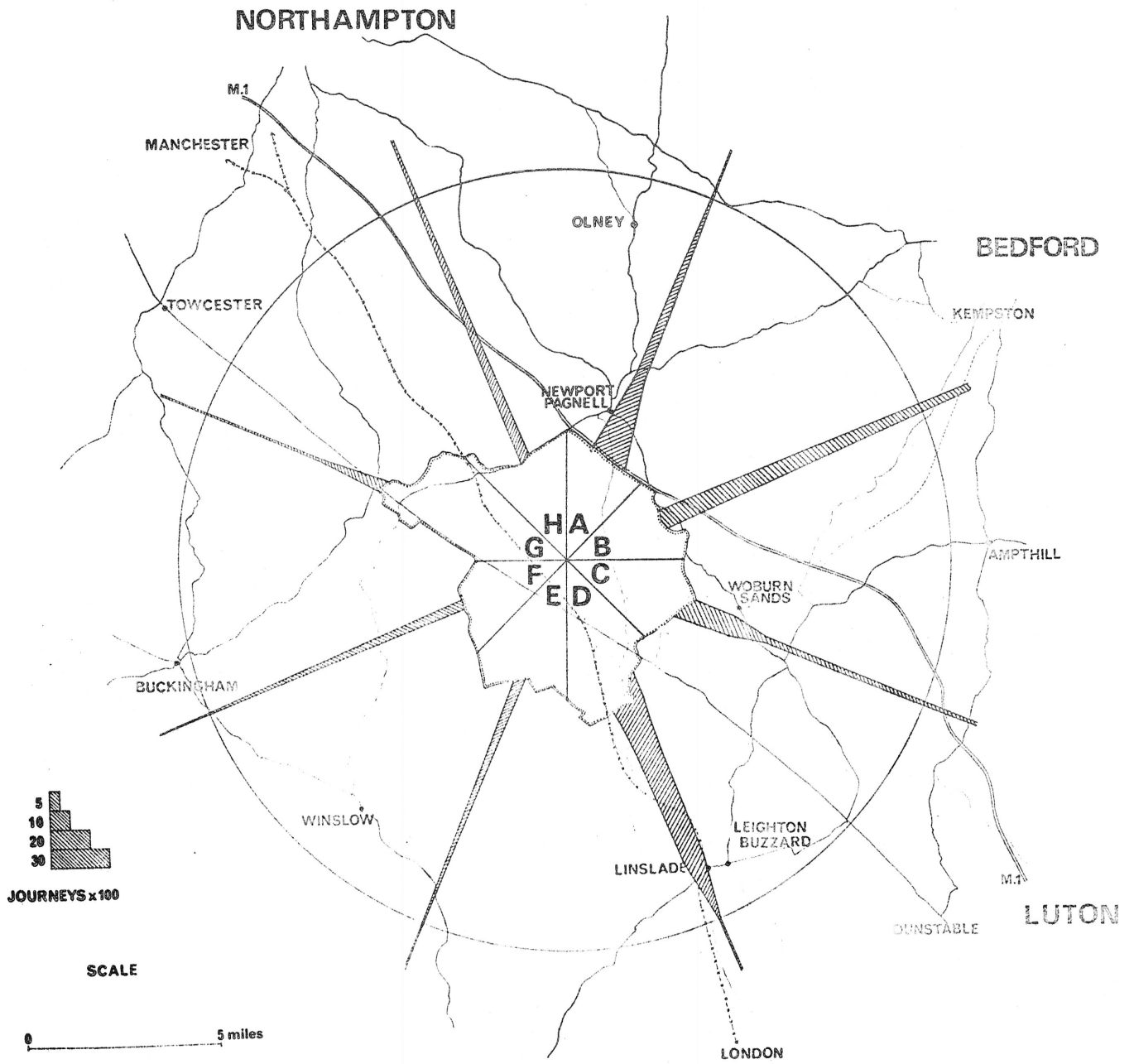


FIGURE 2.

WORK JOURNEYS FROM MILTON KEYNES: 1981

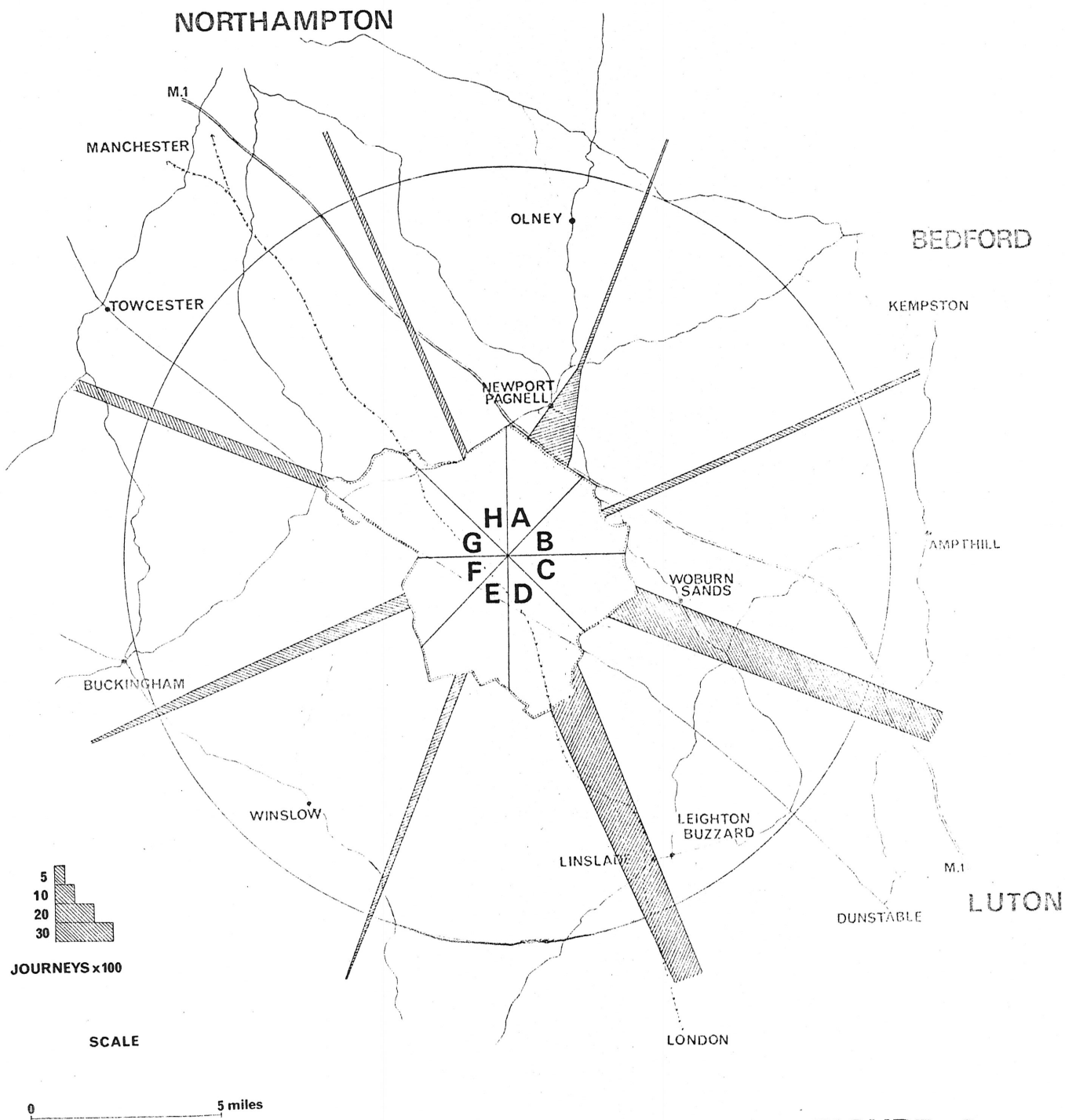


FIGURE 3.

REGIONAL SATURDAY SHOPPING JOURNEYS TO MILTON KEYNES : 1981

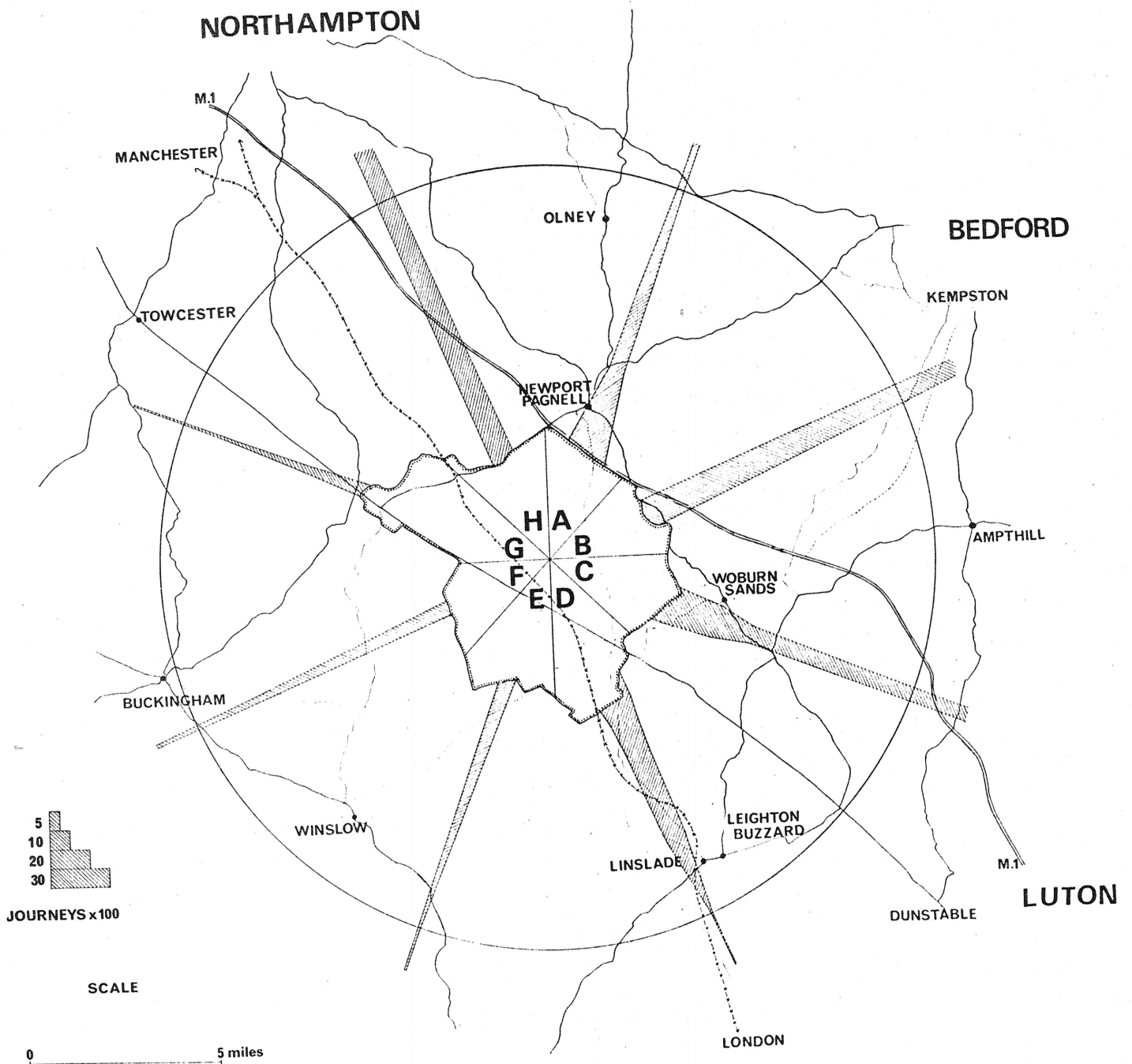


FIGURE 4.