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**UNIVERSITY OF LEEDS**  
**Institute for Transport Studies**

*ITS Working Paper 184*

August 1984

**THE EFFECTS OF WHEEL CLAMPS IN CENTRAL  
LONDON: COMPARISON OF BEFORE AND AFTER  
STUDIES**

**A. D. MAY AND I. G. TURVEY**

*This work was sponsored by TRRL*

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ABSTRACT

This Report compares the results of the Before and After studies of some effects of the introduction of wheel clamps in Central London. Park and Visit and Vehicle Following studies were carried out in both cases, with Registration Number and Business Interview surveys taking place in the Before study only.

The two areas of Central London which were studied comprised an area of Mayfair in which wheel clamps were to be introduced, and an area of Bloomsbury in which they were not. The surveys were designed to identify changes related to congestion and ease of access effects and so complement a series of surveys conducted by consultants for TRRL.

The report describes each survey methodology, and presents the results of the Park and Visit and Vehicle Following surveys. A significant reduction in journey times is identified in Bloomsbury but not in Mayfair. However, the confidence intervals for Mayfair were too wide to determine whether the change in travel times in Bloomsbury was significantly different from the change in Mayfair. Significant reductions in search time are recorded in both areas, and a significant reduction in search plus walk time in Bloomsbury. An increase in empty meter spaces is identified in Mayfair and these findings from the Park and Visit surveys are supported by evidence from the Vehicle Following survey which suggests a drop in the degree of searching for meter spaces in Mayfair.

Note:

Further details of the survey are to be found in the associated technical note to this report (May et al, 1984b) and the individual reports on the Park and Visit and Vehicle Following surveys (May et al, 1984a).

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## 1. INTRODUCTION

### 1.1 Background

Parking control is a vital element of transport policy. By reducing the supply of on-street parking and controlling the time and price, traffic can flow more freely within the limits of the road capacity. As part of a comprehensive parking control strategy, on-street parking can also contribute to the restraint of unnecessary car use. Extensive areas of Greater London are now designated as controlled parking zones. However, parking controls are effective only to the extent that regulations are complied with.

Parking violation is centred around two main types of parking control: Firstly, meter bays, where a marked bay is governed by a coin operated timing mechanism and secondly, streets controlled by yellow line kerbside restrictions. The degree of control in the latter may vary between single or broken lines which impart some form of selective time restriction on parking during the day, and double yellow unbroken lines where parking is prohibited during the day and at other selected times. Surveys in Central London in 1981 (Roberts, 1981) indicated that 30% of those parked at meters were illegally parked - they had not paid for their full duration, remained at the same location for more than two hours, or returned to it in under one hour. The bulk of illegal parking, however, was at single or double yellow lines: 80% of the total. This meant that about 86% of all parked vehicles were illegally parked, and 74% of those were private cars. In respect of other parking violations, 80% of vehicles with disabled badges, 75% of diplomats' cars and 66% of doctors' cars were parked illegally.

Table 1.1 shows how these 1981 T.E.S.T. results relate to trends in violation rates for on-street parking controls in London. In particular the rise in non meter offences has the greatest effect on the overall parking violation rate.

Table 1.1 Trends in Violation Rates for On-Street Parking Controls in London

| Year                     | % of Parkers Offending |      |      |      |
|--------------------------|------------------------|------|------|------|
|                          | 1966/7                 | 1970 | 1978 | 1981 |
| Meter Feeding            | 2                      | 11   | 16   | 15   |
| Paid for Period Exceeded | 8                      | 12   | 16   | 15   |
| All Meter Offences       | 10                     | 23   | 32   | 30   |
| Non Meter Offences       | 39                     | 42   | n.a. | 68   |
| All Offences             | 25                     | 36   | n.a. | 61   |

Sources: 1966-1978 May, 1978.  
1981 Roberts, 1981.

On May 16, 1983 wheel clamping was introduced to parts of Central London as a means of vehicle immobilisation for illegally parked vehicles. Prior to this, in September 1982, the Institute for Transport Studies was awarded a contract by the T.R.R.L. to develop and undertake Before studies concerning the effects of wheel clamps on congestion, ease of access, and business operations. The objective of the studies was the development of survey and analysis techniques to aid in determining:

- (1) The costs of non-compliance with on-street parking regulations.
- (2) The effects of new enforcement strategies on compliance levels (and hence on the costs in (1)).
- (3) The cost-effectiveness of alternative enforcement strategies.

A number of survey methods were developed for use as part of the "Before" study, and these were designed to complement the more traditional parking activity and travel time surveys conducted for the T.R.R.L. by consultants. A subsequent contract was awarded in October 1983 to conduct After studies.

## 1.2 The Surveys

Four surveys were conducted by the Institute for the Before study:

- (1) A Park and Visit survey.
- (2) A Vehicle Following survey.
- (3) A Registration Number survey.
- (4) A Business Interview survey.

Table 1.2 summarises the effects which the surveys were designed to detect, and indicates the related contributions of the T.R.R.L. and Consultant's surveys. The basis for survey design is outlined in an earlier technical note (May, 1984).

The first two of these surveys, both piloted in November 1982, were designed, respectively, to measure time spent searching for parking spaces and walking from them to a final destination, and to detect vehicles searching for parking spaces and record the time which they spend doing so. By design, much of the data from one survey could be used to enhance that of the other so providing a robust structure for both Before and After studies. Additional information collected from these surveys included:

- (1) A measure of the need to search for parking spaces and hence of the amount of searching traffic (from the park and visit survey).
- (2) An alternative source of journey times on a selected route (from the park and visit survey).
- (3) Information on the amount of 'through' traffic at certain points (from the vehicle following survey).
- (4) An indirect measure of travel time (from the vehicle following survey).

The Registration Number survey tested an alternative method of identifying the amount of searching traffic. However it was found impractical and was not repeated in the After study.

Table 1.2 Surveys Conducted and Effects to be Measured

| ORGANISATION               | TRRL/CONSULTANTS  |                      |       | ITS (LEEDS)    |                   |             |                    |
|----------------------------|-------------------|----------------------|-------|----------------|-------------------|-------------|--------------------|
|                            | On-Street Parking | Journey Time Surveys | Other | Park and Visit | Vehicle Following | Reg. Number | Business Interview |
| <u>FIRST ORDER EFFECT</u>  |                   |                      |       |                |                   | *           | *                  |
| - <u>ON CONGESTION</u>     |                   |                      |       |                |                   |             |                    |
| Parked Vehicles            | ■                 |                      |       |                |                   |             |                    |
| Searching Traffic          |                   |                      |       | □              | ■                 | ■           |                    |
| Overall Effect             |                   | ■                    |       | □              | □                 | □           |                    |
| - <u>ON EASE OF ACCESS</u> |                   |                      |       |                |                   |             |                    |
| Time searching             |                   |                      |       | ■              | ■                 | ■           |                    |
| Time Walking               |                   |                      |       | ■              |                   |             |                    |
| Perceived Costs            |                   |                      |       |                |                   |             | ■                  |
| Available Parking Spaces   | ■                 |                      |       | ■              |                   |             |                    |
| - <u>ON ACCIDENTS</u>      |                   |                      | ■     |                |                   |             |                    |
| - <u>ON ENVIRONMENT</u>    | ■                 |                      |       |                |                   |             |                    |
| <u>SECOND ORDER EFFECT</u> |                   |                      |       |                |                   |             |                    |
| Fringe parking             | ■                 |                      |       |                |                   |             |                    |
| Off-street parking         |                   |                      | ■     |                |                   |             |                    |
| Through traffic            |                   |                      |       |                | ■                 | □           |                    |
| Business effects           |                   |                      |       |                |                   |             | ■                  |

■ Major source of information

□ Minor source of information

\* Only conducted in the Before study

The Business Interviews were designed to obtain information on the perception of enforcement problems and the implications for business of improved enforcement generally. It had been intended to investigate any changes in attitude in the After survey and also to assess the effects, if any, on trade. However, the T.R.R.L. decided not to conduct a business interview survey in the After study.

Full details of all four surveys are given in an earlier Institute working paper (May, 1983), and experience with the two main survey methods is discussed in a companion report (May et al, 1984a) in the report of the individual surveys. All four surveys have been conducted in two areas: Mayfair; in which wheel clamps were to be used from 16 May 1983; and Bloomsbury, on the fringe of, but outside the intended area of application. The areas are consistent with those used by the consultants for their journey-time surveys and were two of the areas employed for their parking surveys. The survey areas are described more fully in Section 2.

### 1.3 Report Outline

Section 2 of this report describes the methods adopted for the four Institute surveys. Section 3 looks at similarities and differences between survey implementation of the Before and After studies, and Section 4 compares the survey results of the two studies. Section 5 presents a summary of the findings of the Park and Visit and Vehicle Following surveys and comments on the implications arising from the two studies.

## 2. SURVEY TECHNIQUES

### 2.1 Park and Visit Survey

The basis of the Park and Visit survey method was developed by Inwood (1966). The concept was to select a sample address and determine the time taken firstly to find a parking space and then to walk back to the address.

Four addresses were selected to be visited within the survey area and evenly distributed within it. In each case four start of run points, on the periphery of a designated area (Figures 2.1, 2.2), were selected, and each start point was then associated with one of the addresses. Starting from the first start point a route was chosen to the associated address that would be sensible for a driver seeking somewhere to park. This procedure was repeated for all start points and addresses. A planned route then linked each address with the next start point, so forming a comprehensive fixed circuit of each survey area. Figures 2.1 and 2.2 show the address start points and fixed routes for Mayfair and Bloomsbury respectively.

On arrival at an address the driver then used his initiative and knowledge of the area to search for an acceptable parking space.

The acceptable parking spaces were of three types and were defined as:

- (1) The nearest conceivable parking space.

The type of space that may be used if making a short call of a minute or two e.g. the nearest vacant length of kerb to the address.

- (2) The nearest reasonable (illegal) parking space.

The type of space that may be used if making a longer call e.g. the nearest length of single yellow line, diplomatic space, residents' space or disabled space.

- (3) The nearest available legal meter space.

Time and mileage were recorded at the passing of start points and addresses and again when passing each of the three types of parking space. The route to the legal space was plotted on a map and the number of available meter spaces on the fixed route noted.

If 5 minutes' search time had elapsed without a legal space being found the search was abandoned. When this happened, or once a

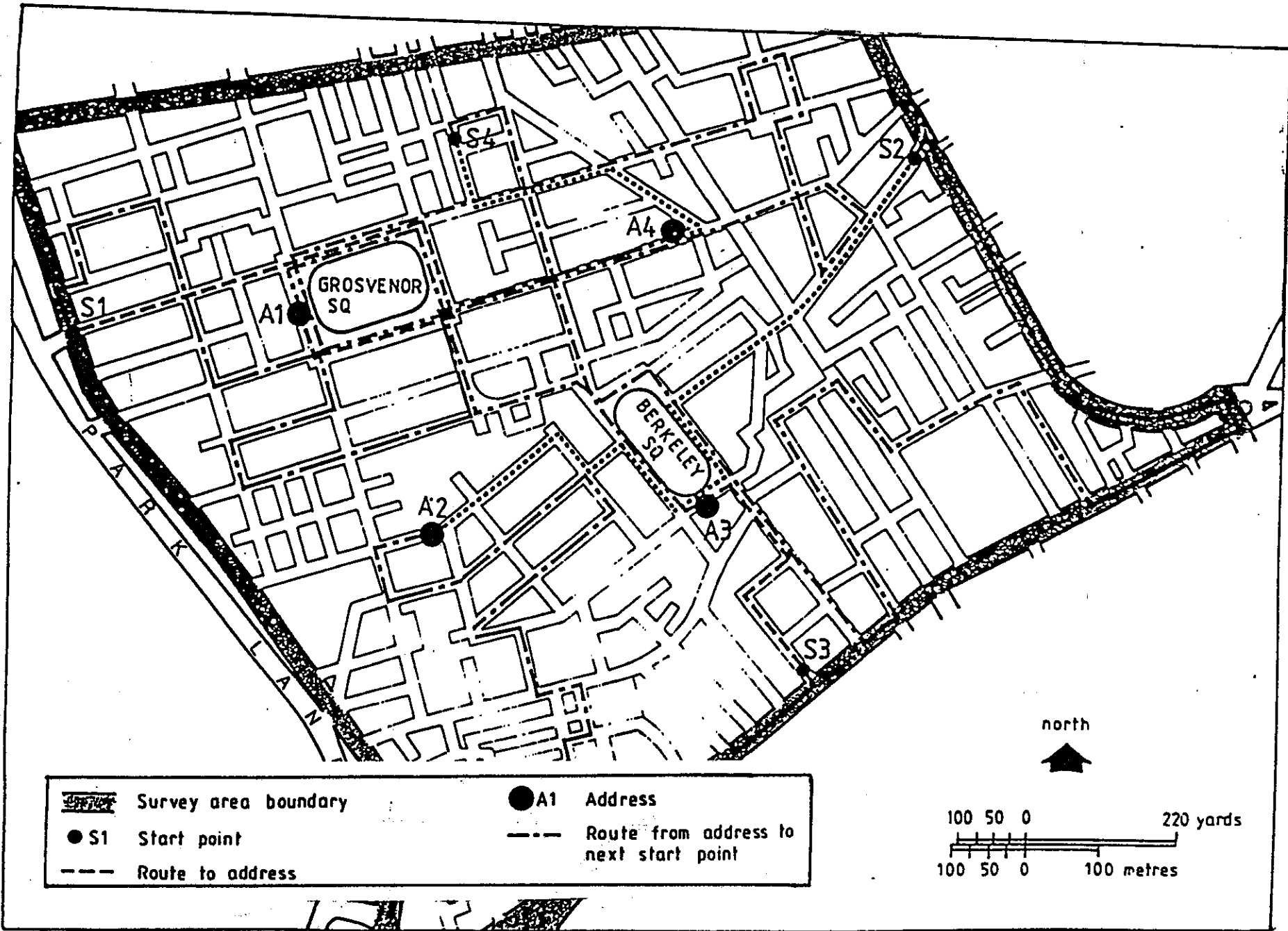


Figure 2.1 Mayfair Survey Area and Boundaries

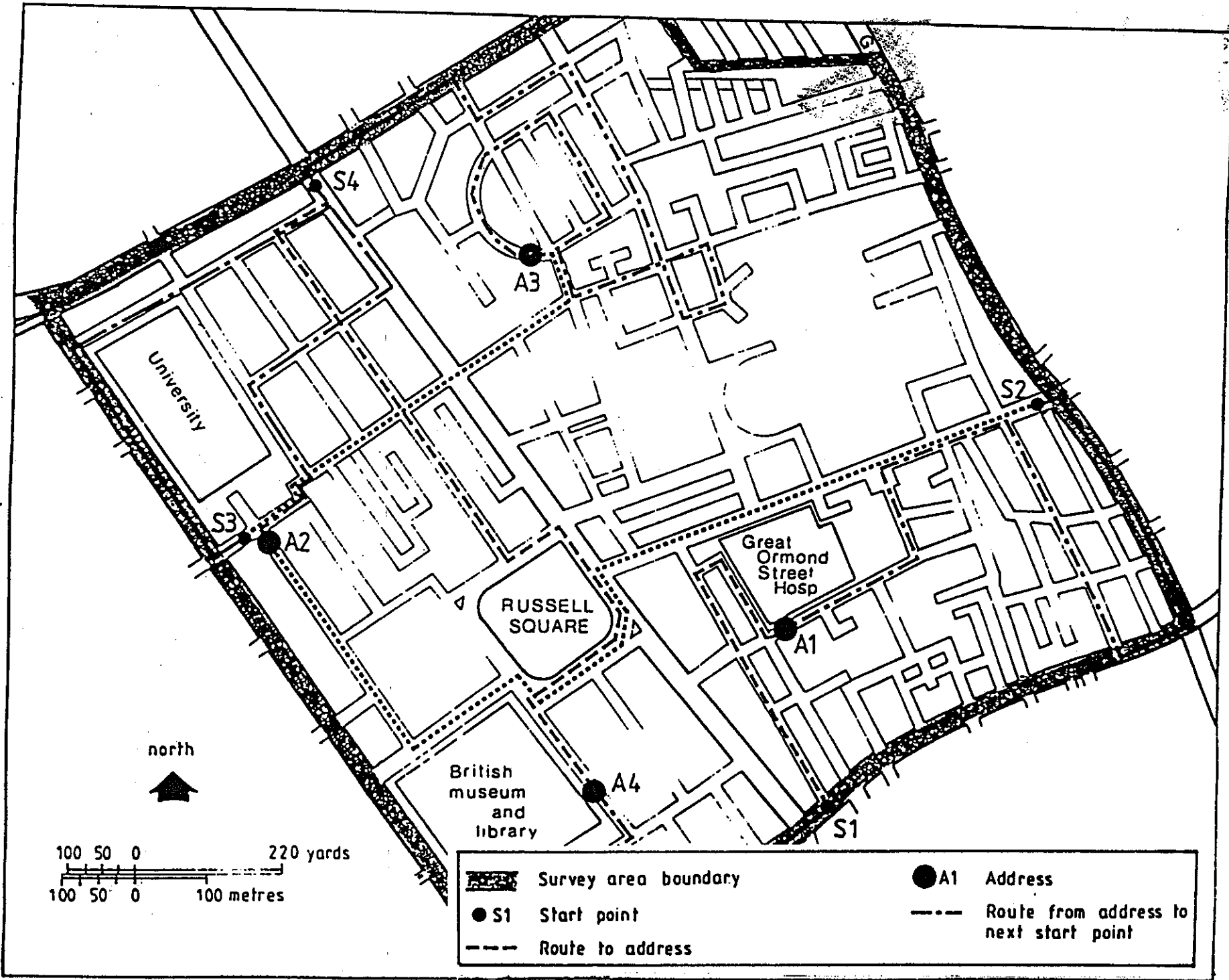


Figure 2.2 Bloomsbury Survey Area and Boundaries



legal space had been found, the driver returned to the address and then proceeded to the next start point via the fixed route.

## 2.2 Vehicle Following Survey

The vehicle following surveys were based on a method developed by Wright (1976) to study routes, origins and destinations in complex road networks. The aim of the study was to determine the route taken and the parking type (if applicable) of a sample of vehicles which had been followed.

The boundaries of the two survey areas are shown in Figures 2.3 and 2.4 together with the associated start points. The start points, 3 in each area, were addresses on local roads entering the area which provided entry points across the inner boundary into the specified area.

Each start point was located within a few yards of a road junction, and the cars followed were evenly distributed between the right turn, left turn and straight ahead traffic entering the road from the junction. Black London taxis were used to follow the sampled vehicles which were selected at random but with a view to the ease with which the taxi could enter the traffic stream immediately behind the selected car.

The start of the run was noted together with details of the weather, driver's car nationality and sex: the car was followed, and the time at which it passed every convenient junction was noted together with the route which the car was taking. Hence the following was recorded:

- (1) The exact route being taken.
- (2) The exact location of all the start points and junction timing places.

The run ended when one of the following occurred:

- (1) The car stopped adjacent to the kerb to pick-up/drop a passenger.

Figure 2.3 Vehicle Following Surveys - Mayfair

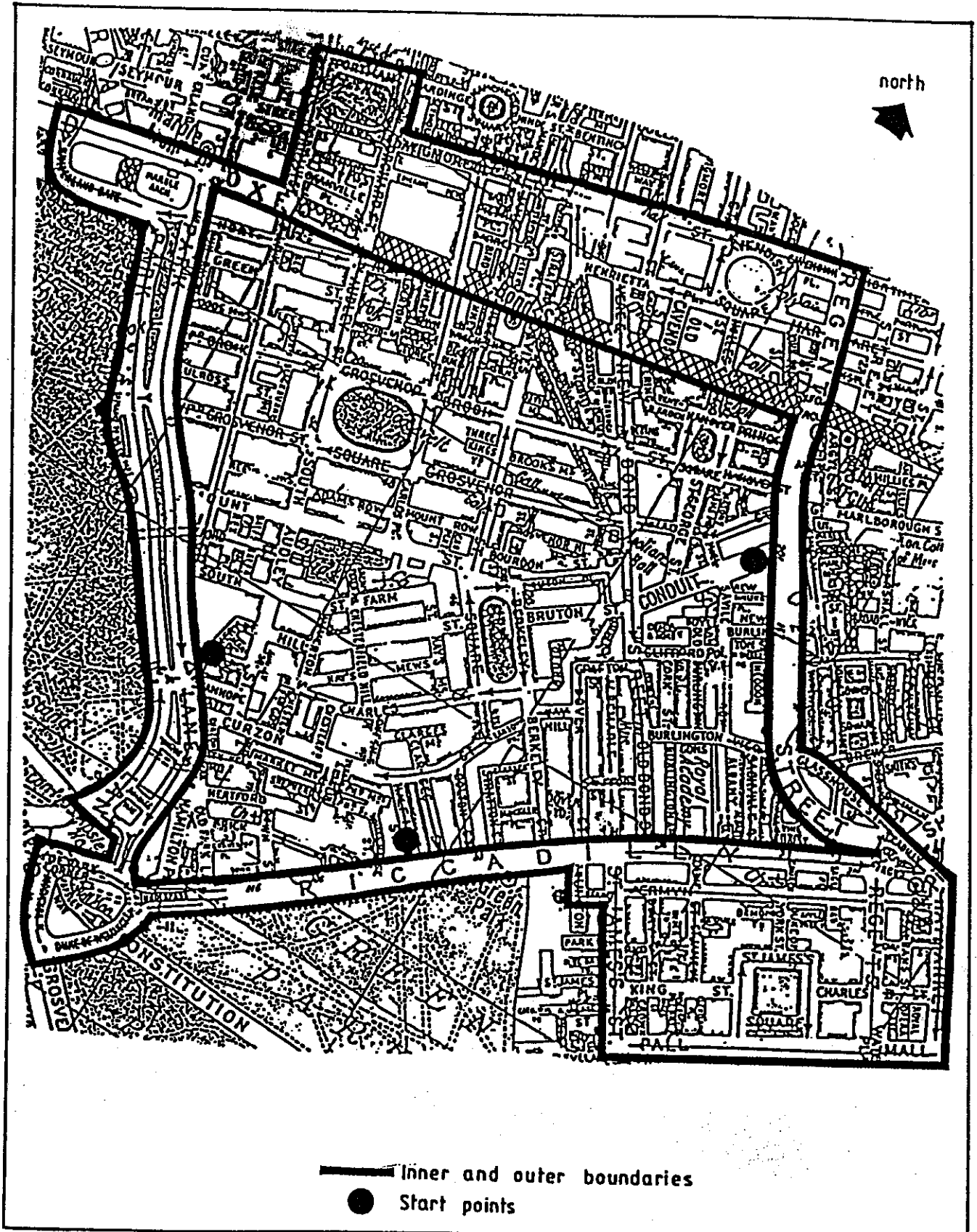
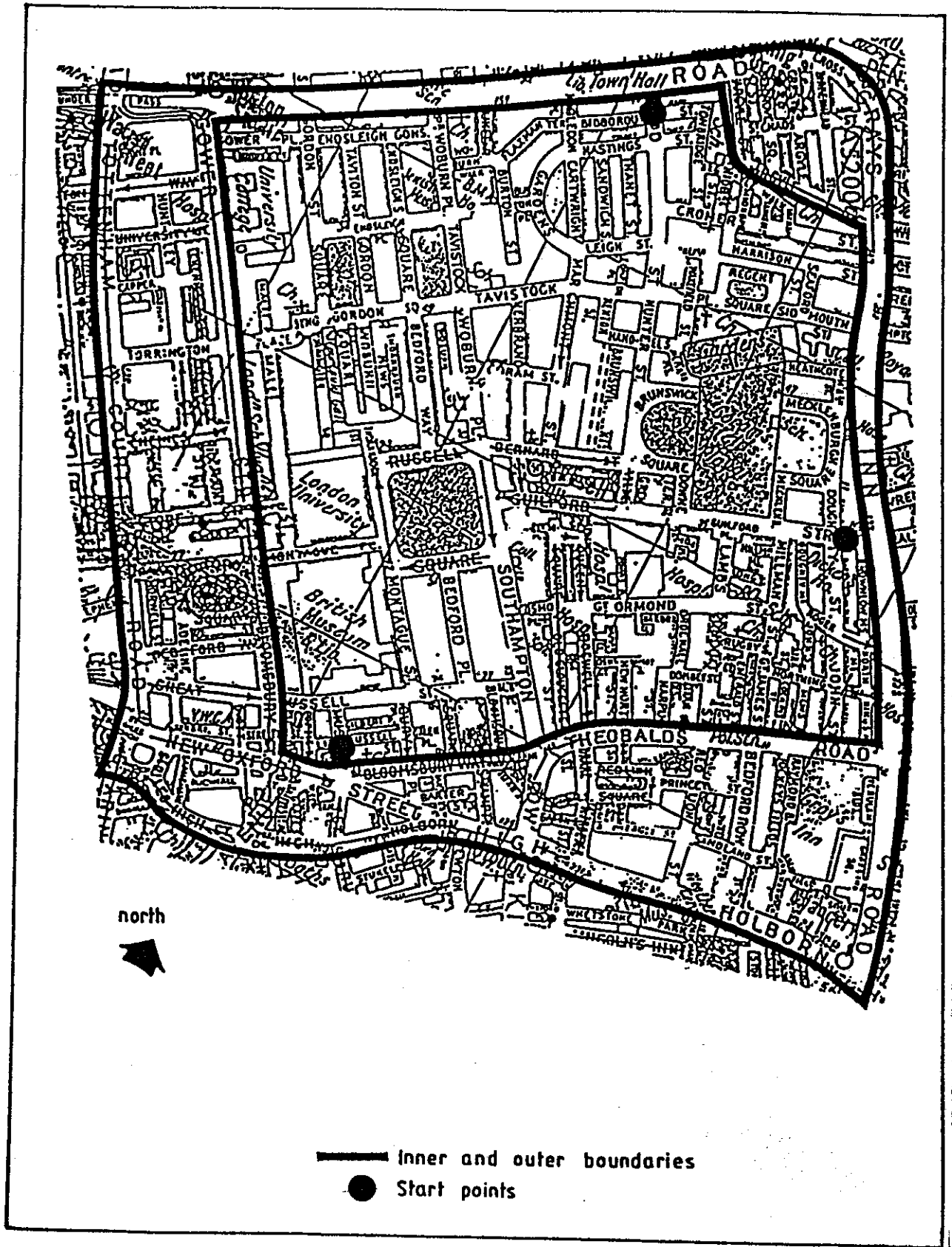


Figure 2.4 Vehicle Following Surveys - Bloomsbury



- (2) The car parked at an on-street or off-street location and the driver left the car.
- (3) Contact with the car was lost.
- (4) The car crossed the outer boundary of the survey area.

At the end of the run, the time and reason for ending the run was noted, i.e.

- (1) At a parking meter.
- (2) On yellow lines.
- (3) At a residents' space.
- (4) At a disabled persons' space.
- (5) Off street.
- (6) Vehicle lost.
- (7) Crossed outer boundary.

At the end of the run the taxi proceeded to the nearest start point, subject to attempting to cover equal numbers of runs from each start point.

### 2.3 Registration Number Survey (Before Study Only)

In this survey the aim was to obtain a comprehensive record of all movements within a part of the Mayfair and Bloomsbury networks, and to co-ordinate this with records of parked vehicles collected by consultants. A part of the network was selected which could be covered comprehensively by a team of 20 observers.

At each junction an observer recorded the last four characters of a normal British registration, on a survey sheet, in the column appropriate to the turning movement which the vehicle was making. Foreign, diplomatic and other unusual registration numbers were recorded in full. The time, at 1 minute intervals, was also recorded. Figures 2.5 and 2.6 give the junctions in Mayfair and Bloomsbury at which data was collected and the turning movements which each observer recorded.

Figure 2.5 Registration Number Survey and Turning Movements  
- Mayfair

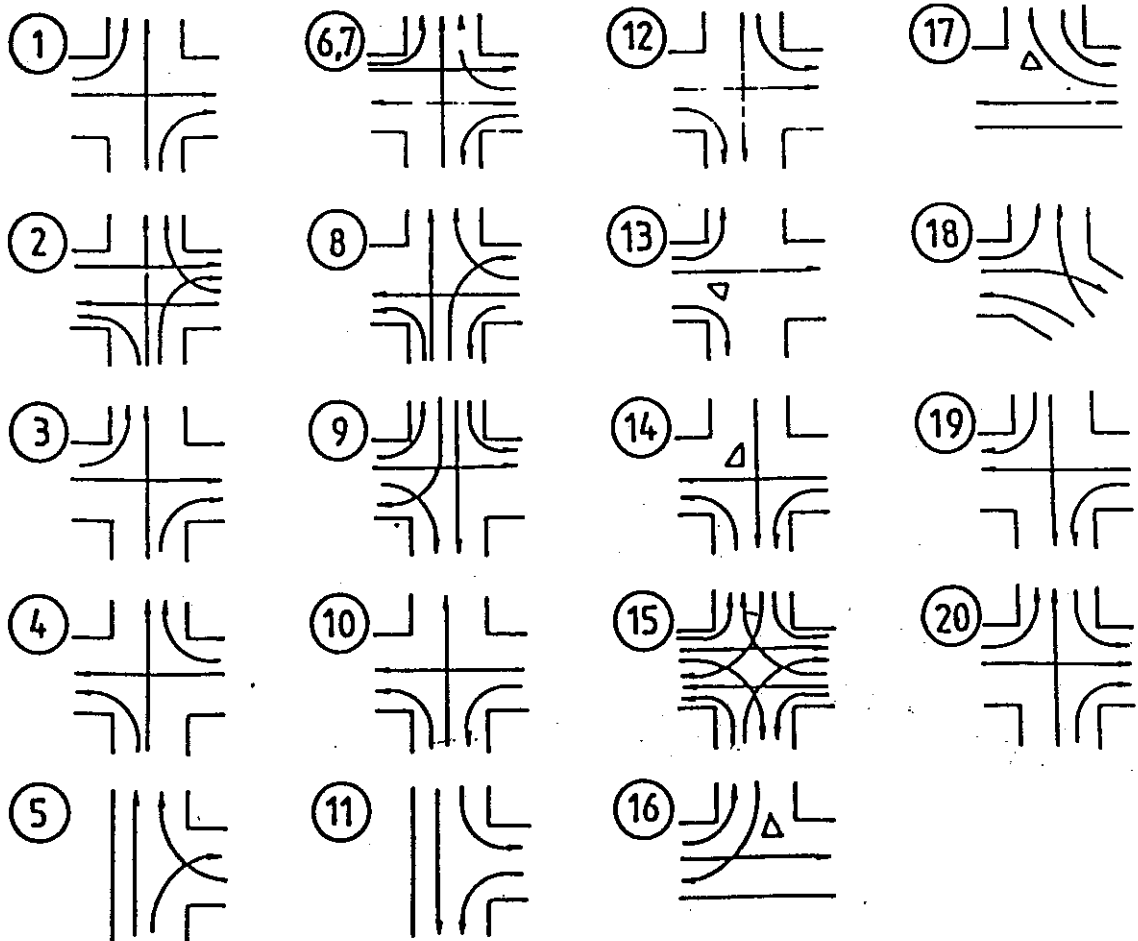
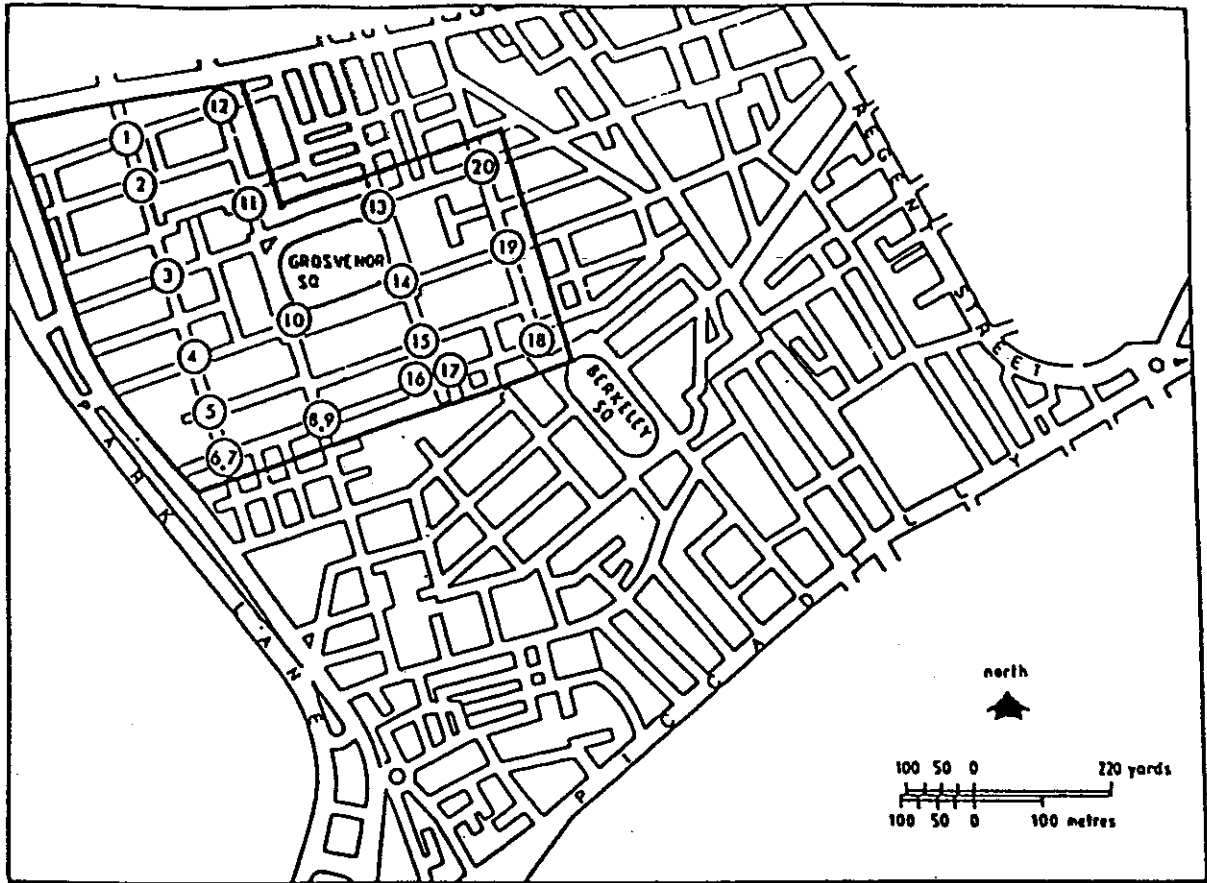
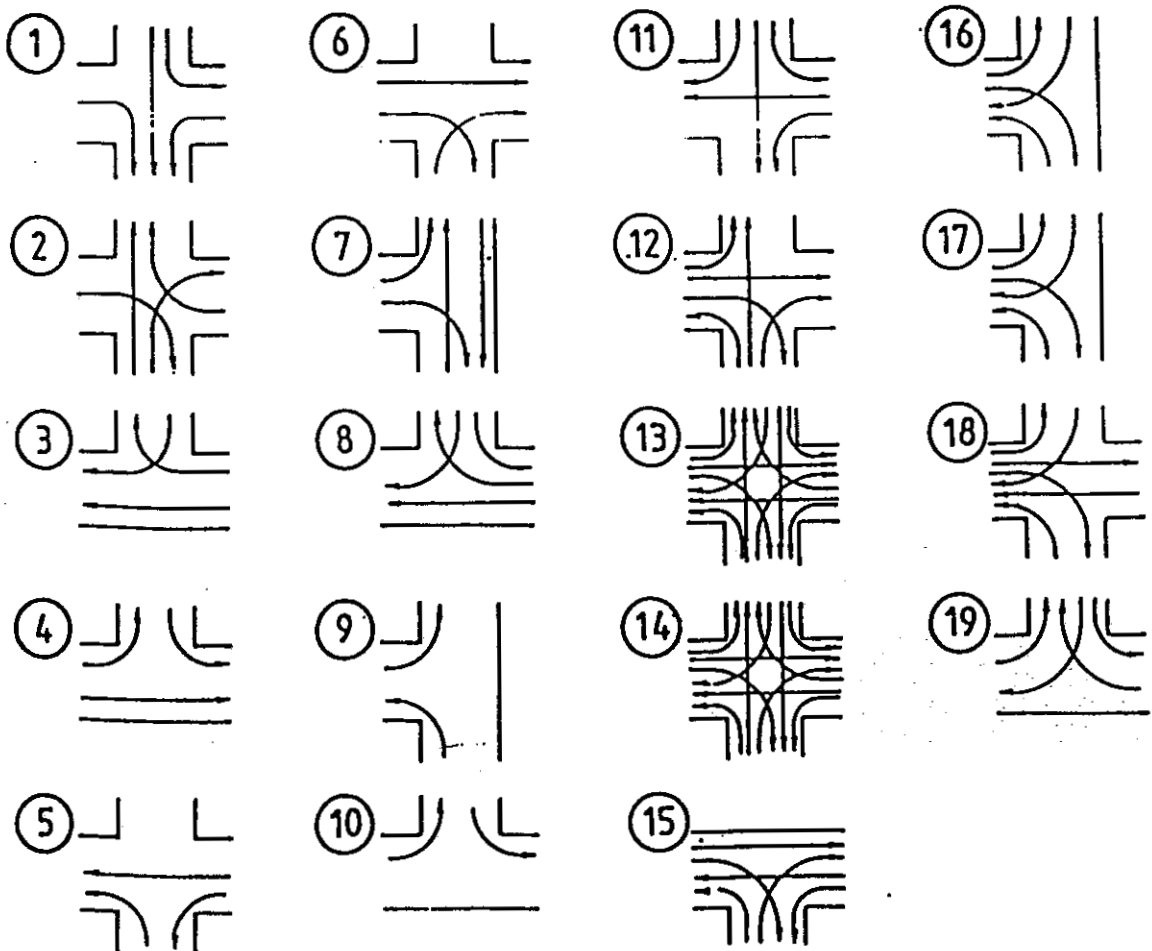
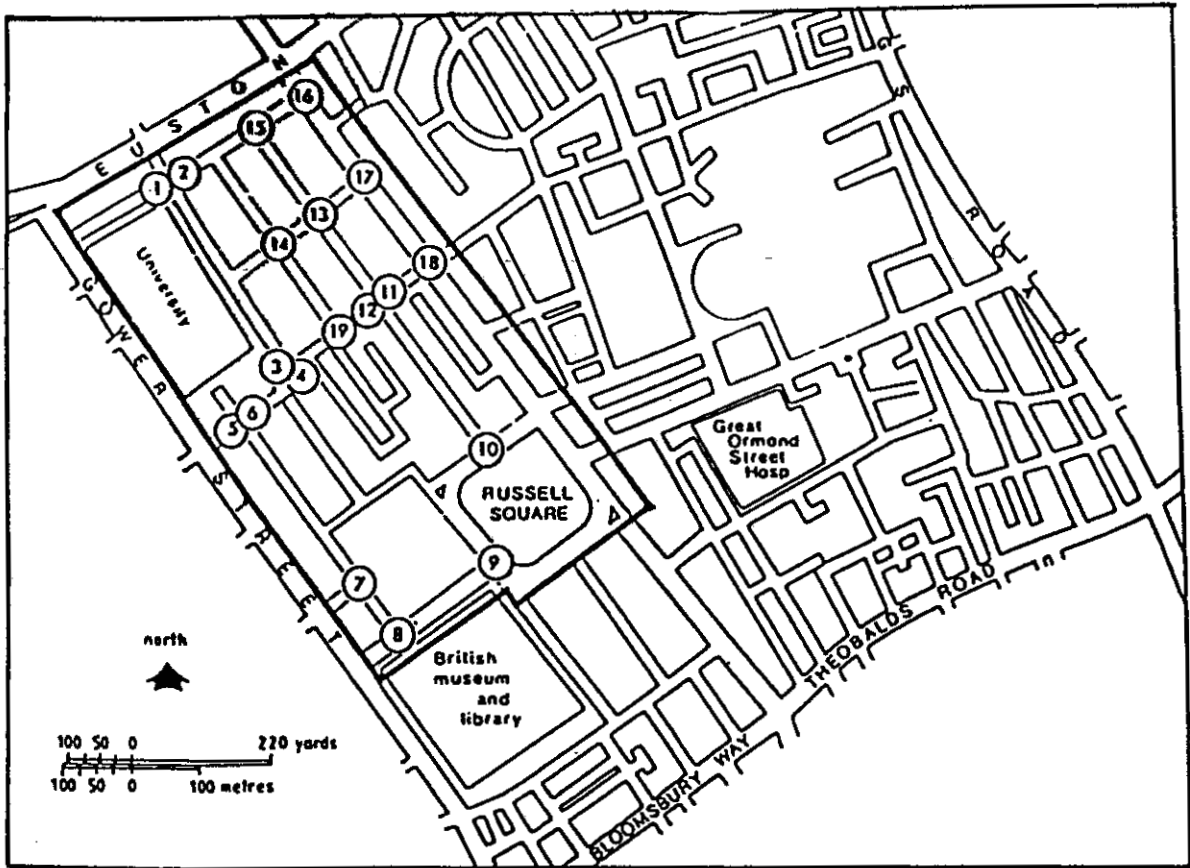


Figure 2.6 Registration Number Survey and Turning Movements  
- Bloomsbury



The survey was carried out in Mayfair and Bloomsbury from Monday 11 October 1982 until Thursday 14 October 1982 inclusive with the times and locations being as follows:

|           |          |   |            |                            |
|-----------|----------|---|------------|----------------------------|
| Monday    | 11.10.82 | - | Mayfair    | 8-9.30, 10-12, 1-3, 3.30-5 |
| Tuesday   | 12.10.82 | - | Mayfair    | 8-10, 10.30-1, 2-4, 4.30-6 |
| Wednesday | 13.10.82 | - | Bloomsbury | 8-9.30, 10-12, 1-3, 3.30-6 |
| Thursday  | 14.10.82 | - | Bloomsbury | 8-10, 10.30-1, 2-4, 4.30-5 |

The need to coordinate the survey with work being carried out by T.R.R.L. consultants meant that the registration number survey had to be carried out before results from other surveys were available. Hence it was impossible to pilot the survey and test analysis procedures and to check beforehand that the level of searching was sufficient to justify the survey. The registration number survey proved to be extremely laborious to conduct and analyse. While the data obtained would have been valuable had searching for a parking space been great, the vehicle following survey later indicated that this was not the case.

It was decided on this basis that the registration number survey should not be repeated in the After study. Details of problems encountered in the analysis of the survey are contained in May (1983).

#### 2.4 Business Survey (Before Study Only)

The survey was intended to collect data to determine the effects on business of the present parking situation and their attitudes towards improved enforcement, and to act as a Before study for an assessment of the effects on businesses of wheel clamps. Both firms within the study area and their external suppliers were interviewed since earlier work of Patterson and May (1981) had demonstrated that the perception of parking problems and resulting impacts on business operations were likely to differ between businesses and their suppliers.

Appendix 1 contains the interview questionnaire, which discusses parking problems in relation to business problems both in general

and by particular parking type. The questionnaire used for suppliers was modified slightly to cater for the transport problems associated with making deliveries. The surveys were conducted in Mayfair and Bloomsbury by two professional interviewers. They took place in a two week period from 18.4.83 for businesses, and during the first fortnight of May for suppliers.

A sampling frame was drawn up using the 1983 edition of Kelly's directory and the sample was chosen to reflect the variety of businesses and locations within each area. Shops were classified into two groups:

Class 1 : Convenience and apparel shops.

Class 2 : Department/variety stores, household goods,  
specialist non food stores.

It was not practical to classify businesses due to the wide variety within both areas.

From the sample frame 54 completed questionnaires were achieved from Bloomsbury and 55 from Mayfair, representing a response rate of about 80%. A total of 14 suppliers identified from 120 mentioned in the business surveys were approached for information. All responded.

### 3. SURVEY IMPLEMENTATION

#### 3.1 Before Study (1983)

3.1.1 Park and Visit Survey: The survey was carried out from Tuesday 15 February 1983 until Thursday 24 February 1983, excluding the weekend. The pre-arranged timetable for each circuit is shown in Table 3.1(i). The preceeding Monday was used to train the survey team, which comprised 3 persons:

- \* 1 car driver/supervisor )
- \* 1 mileage/parking space recorder ) in each 1300 cc car
- \* 1 trip route/time recorder )



No real problems were encountered in the running of the survey except for a road closure in Montague Street, on the last 2 days, caused by a burst water main. The route was diverted via Bedford Place and an alternative address was chosen in Bedford Place corresponding to the location of the address in Montague Street, which could no longer be reached by car. Also on about 3% of occasions the random search route was left unrecorded by the survey teams. The fixed route lengths travelled were 12.3 km in Mayfair and 8.5 km in Bloomsbury.

3.1.2 Vehicle Following Survey: The same black taxi was used for both morning and afternoon survey periods; the times are shown in Table 3.1(ii). Start points were selected by proceeding, at the end of a run, to the nearest start point. The numbers of runs from each start point were maintained in equal proportions on each day and in each area. The initial approach of the followed car was also recorded so that equal numbers of right, left turn and straight ahead cars could be followed.

Again, the preceeding Monday was used to train the one member of the survey team.

### 3.2 After Study (1984)

3.2.1 Park and Visit Survey: The survey methodology was identical to the Before survey, with the same amount of time being devoted to the training of the survey teams. Table 3.1(i) shows the circuit timetable for each day in each area. Each survey team had 3 survey members as before and the duration of the survey was from Tuesday February 14, 1984 to Thursday, February 23, 1984, excluding the intervening weekend. From the lessons of the Before study however, a greater emphasis was placed on the supervision of the survey teams. As a result there were no incidents of survey information not being recorded as requested.

In Bloomsbury, two route changes were required. A banned left turn at the Bidborough Street junction with Judd Street resulted in a

Table 3.1 Survey Timetables

(i) Park and Visit

| Day/Date        | Circuit Number | Start Time | Area              |
|-----------------|----------------|------------|-------------------|
| Each Survey Day | 1              | 07.30      | Both survey areas |
|                 | 2              | 08.50      |                   |
|                 | 3              | 10.40      |                   |
|                 | 4              | 13.00      |                   |
|                 | 5              | 14.20      |                   |
|                 | 6              | 16.10      |                   |

(ii) Vehicle Following

| Day | Date 1983 | 1984 | Area       | Times                    |
|-----|-----------|------|------------|--------------------------|
| Tu  | 15/2      | 14/2 | Mayfair    | 09.30-12.30, 14.30-17.30 |
| W   | 16/2      | 15/2 | Bloomsbury | 09.30-12.30, 14.30-17.30 |
| Th  | 17/2      | 16/2 | Mayfair    | 07.30-10.30, 12.30-15.30 |
| F   | 18/2      | 17/2 | Bloomsbury | 07.30-10.30, 12.30-15.30 |
| M   | 21/2      | 20/2 | Mayfair    | 09.30-12.30, 14.30-17.30 |
| Tu  | 22/2      | 21/2 | Bloomsbury | 09.30-12.30, 14.30-17.30 |
| W   | 23/2      | 22/2 | Mayfair    | 07.30-10.30, 12.30-15.30 |
| Th  | 24/2      | 23/2 | Bloomsbury | 07.30-10.30, 12.30-15.30 |

rerouting via Euston Road only to Upper Woburn Place instead of via Bidborough Street, Mabledon Place and then Euston Road. Also, due to road closure from Wednesday 15 February 1984, the fixed route was altered to avoid Little Russell Street. Coptic Street and Bloomsbury Way provided the new route. As a result, the fixed route length increased to 9.3 km.

In Mayfair, on 16 February and 17 February 1984 the Park Lane traffic signals at the junction with Upper Brook Street were out of order causing some delays at peak times. Also, the segment of Grosvenor Square facing the American Embassy was unavailable for meter parking during the whole of the survey period. This was the only change in available meter provision, in either area, from the 1983 situation.

3.2.2 Vehicle Following Survey: The form of the survey was that of the Before study, and the same taxi hire firm was used. No problems were encountered. The number of runs in each survey period (see Tables 3.1(ii) and 3.3) was able to be increased over 1983 values because of increased journey speeds and by permitting the taxi to return to the same start point when a run ended near to it. An even distribution of runs from each start point across the day was, however, still maintained.

### 3.3 Comparative Analysis

3.3.1 Park and Visit Survey: Table 3.2 shows the performance of the Before and After surveys. It can be seen that more runs were achieved in the After survey. Indeed only one run was missed - Mayfair, 15 February 1984 - due to car failure. Runs which were missed by design in the Before study to enable cars to be collected were able to be scheduled in the After study.

3.3.2 Vehicle Following Survey: Table 3.3 indicates the details of the Before and After surveys. In the 1984 survey the number of cars followed was able to be increased by about 25%, whilst the number of vehicles lost was not significantly changed.

Table 3.2 Park and Visit Survey - Summary

| Area       | Day   | 1983 |          |                            | 1984 |          |                            |
|------------|-------|------|----------|----------------------------|------|----------|----------------------------|
|            |       | Date | No. Runs | Average No. Spaces/Circuit | Date | No. Runs | Average No. Spaces/Circuit |
| Mayfair    | Tu    | 15/2 | 5        | 71.0                       | 14/2 | 6        | 74.8                       |
|            | W     | 16/2 | 5        | 87.0                       | 15/2 | 5        | 73.8                       |
|            | Th    | 17/2 | 6        | 72.7                       | 16/2 | 6        | 58.3                       |
|            | F     | 18/2 | 6        | 56.8                       | 17/2 | 6        | 89.5                       |
|            | M     | 21/2 | 5*       | 21.2                       | 20/2 | 6        | 78.5                       |
|            | Tu    | 22/2 | 6*       | 73.7                       | 21/2 | 6        | 100.8                      |
|            | W     | 23/2 | 6*       | 65.7                       | 22/2 | 6        | 106.3                      |
|            | Th    | 24/2 | 6        | 62.2                       | 23/2 | 6        | 71.8                       |
|            | Total |      | 45       | 66.6                       | 47   | 81.6     |                            |
| Bloomsbury | Tu    | 15/2 | 6        | 89.7                       | 14/2 | 6        | 90.1                       |
|            | W     | 16/2 | 6        | 80.7                       | 15/2 | 6        | 87.0                       |
|            | Th    | 17/2 | 6        | 85.2                       | 16/2 | 6        | 67.3                       |
|            | F     | 18/2 | 6        | 86.8                       | 17/2 | 6        | 82.3                       |
|            | M     | 21/2 | 5        | 53.0                       | 20/2 | 6        | 48.0                       |
|            | Tu    | 22/2 | 6        | 80.5                       | 21/2 | 6        | 82.3                       |
|            | W     | 23/2 | 6        | 75.2                       | 22/2 | 6        | 86.0                       |
|            | Th    | 24/2 | 5        | 87.6                       | 23/2 | 6        | 109.0                      |
|            | Total |      | 46       | 80.2                       | 48   | 81.5     |                            |

\* On one run on each of these days the search route was not recorded.

Table 3.3 Vehicle Following Survey - Summary

| Area                       | Day    | Date | 1983     |                   | Date | 1984     |                   |
|----------------------------|--------|------|----------|-------------------|------|----------|-------------------|
|                            |        |      | No. Runs | % Through Traffic |      | No. Runs | % Through Traffic |
| Mayfair                    | (1) Tu | 15/2 | 34       |                   | 14/2 | 43       |                   |
| Bloomsbury                 | (2) W  | 16/2 | 38       |                   | 15/2 | 48       |                   |
| Mayfair                    | (3) Th | 17/2 | 36       |                   | 16/2 | 41       |                   |
| Bloomsbury                 | (4) F  | 18/2 | 40       |                   | 17/2 | 41       |                   |
| Mayfair                    | (5) M  | 21/2 | 36       |                   | 20/2 | 46       |                   |
| Bloomsbury                 | (6) Tu | 22/2 | 29       |                   | 21/2 | 36       |                   |
| Mayfair                    | (7) W  | 23/2 | 38       |                   | 22/2 | 42       |                   |
| Bloomsbury                 | (8) Th | 24/2 | 29       |                   | 23/2 | 45       |                   |
| Total (Mayfair)            |        |      | 144      | 22.6              |      | 172      | 20.2              |
| of which vehicles lost (%) |        |      |          | 7.6               |      |          | 4.7               |
| Total (Bloomsbury)         |        |      | 136      | 50.0              |      | 170      | 46.7              |
| of which vehicles lost (%) |        |      |          | 2.9               |      |          | 4.1               |
| Overall Total              |        |      | 280      | 36.2              |      | 342      | 33.4              |
| of which vehicles lost (%) |        |      |          | 5.4               |      |          | 4.6               |

There was no significant difference in through traffic between the two surveys; the percentage of through traffic journeys in Bloomsbury was about double that for Mayfair.

### 3.4 Statistical Analysis

For all survey work the same procedures were adopted for the calculations of:

- (1) 95% confidence limits
- (2) Minimum significant difference.

#### 3.4.1 Means:

- (1) Confidence limits

$$CLM = \bar{X} \pm t \cdot s \cdot n^{-\frac{1}{2}}$$

where,  $t$  is the appropriate 2 tailed statistic at 95% confidence for  $(n-1)$  degrees of freedom.

$$\text{and, } s = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n-1}}$$

where,  $X$  = observed times

$\bar{X}$  = mean of observed times

$n$  = sample size

$s$  = sample standard deviation

- (2) Minimum significant difference in the mean

$$MSD = t \times \sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}$$

where,  $t$  is the appropriate 2 tailed statistic at 95% confidence for  $(n_1 + n_2 - 2)$  degrees of freedom.

$$s_p^2 = \frac{(n_1 - 1) s_1^2 + (n_2 - 1) s_2^2}{n_1 + n_2 - 2}$$

- and  $s_p^2$  = pooled variance
- $n_1$  = number of observations in Before study
- $n_2$  = number of observations in After study
- $s_1^2$  = variance in Before study
- $s_2^2$  = variance in After study

3.4.2 Proportions:

(1) Standard deviation

$$s_p = \frac{\hat{p}(1-\hat{p})}{n}$$

- where  $s_p$  = population standard deviation
- $\hat{p}$  = sample proportion as an estimate of population proportion
- $n$  = sample size

(2) Confidence limits around proportion

$$CLP = \hat{p} \pm 1.96 \times \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

(3) Minimum significant difference in proportion

$$MSD = 1.96 \times \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$$

- where  $p_1$  = sample proportion in Before study
- $p_2$  = sample proportion in After study
- $n_1$  = sample size in Before study
- $n_2$  = sample size in After study

4. COMPARISON OF RESULTS

4.1 Park and Visit Survey

4.1.1 Fixed Route Data: Table 4.1 shows that there has been a significant decrease in journey time per km. on the fixed routes in Bloomsbury, but not in Mayfair. The figures show a 12% reduction in Mayfair and a 20% reduction in Bloomsbury, with the same pattern of insignificant decreases in journey time on circuits 3 and 4 in both areas. However, the confidence intervals for Mayfair are large, suggesting a high degree of travel time variability. This in turn makes it impossible to determine whether the changes in travel time in Bloomsbury are significantly different from those in Mayfair.

Table 4.1 Park and Visit Survey

Total time on fixed route (minutes) and mean speed (kms/hr) for all days

| Circuit Number    | MAYFAIR        |           |                 |            | BLOOMSBURY     |           |                 |            |
|-------------------|----------------|-----------|-----------------|------------|----------------|-----------|-----------------|------------|
|                   | Mean Time 1983 | Time 1984 | Mean Speed 1983 | Speed 1984 | Mean Time 1983 | Time 1984 | Mean Speed 1983 | Speed 1984 |
| 1                 | 40.7           | 32.3      | 18.1            | 22.8       | 31.2           | 27.3      | 16.3            | 20.3       |
| 2                 | 46.7           | 38.2      | 15.8            | 19.3       | 37.1           | 32.3      | 13.7            | 17.4       |
| 3                 | 55.4           | 53.0      | 13.4            | 14.0       | 35.4           | 31.8      | 14.4            | 17.4       |
| 4                 | 58.4           | 53.9      | 12.7            | 13.7       | 36.0           | 31.8      | 14.1            | 17.6       |
| 5                 | 53.5           | 51.8      | 13.8            | 14.2       | 36.0           | 30.6      | 14.1            | 18.3       |
| 6                 | 49.6           | 39.1      | 14.8            | 18.4       | 37.1           | 33.4      | 13.7            | 16.6       |
| All circuits mean | 50.7           | 44.8      | 14.3            | 16.6       | 35.5           | 31.2      | 14.4            | 17.9       |
| 95% conf. limits  |                |           | $\pm 2.13$      | $\pm 3.96$ |                |           | $\pm 1.03$      | $\pm 1.72$ |
| Mean time/km      | 4.12           | 3.64      |                 |            | 4.18           | 3.36      |                 |            |
| Min. Sig. Diff.   | 0.82           |           |                 |            | 0.32           | (sig.)    |                 |            |

Table 3.2 shows that in Bloomsbury the average number of meter spaces per circuit is unchanged by day from the Before study. In Mayfair there is an increase in available spaces on the fixed route, but this is not significant.

4.1.2 Random Search Process: Table 4.2 looks at the random search time taken to reach the first reasonable (illegal) space. In the Before study a zero search time was recorded on 82% of occasions in Mayfair and on 91% of occasions in Bloomsbury, with searching tending to take place more frequently in the early days of the survey.



Table 4.2 Park and Visit Surveys

Random search time to first reasonable space in seconds, by circuit number and survey day

| Mayfair<br>Circuit    | Tu   |      | W    |      | Th   |      | F    |      | M    |      | Tu   |      | W    |      | Th   |      | *<br>Mean |      |
|-----------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----------|------|
|                       | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983      | 1984 |
| 1                     | 0    | 3    | 0    | 3    | 0    | 4    | 0    | 4    | -    | 44   | 0    | 11   | 0    | 5    | 0    | 5    | 0         | 5.5  |
| 2                     | 0    | 0    | 0    | 3    | 24   | 0    | 0    | 10   | 0    | 30   | 17   | 26   | 0    | 10   | 0    | 11   | 0         | 3.8  |
| 3                     | 40   | 16   | 0    | 62   | 0    | 36   | 0    | 23   | 0    | 17   | 0    | 34   | 0    | 7    | 0    | 7    | 5         | 16.5 |
| 4                     | 0    | 0    | 0    | 7    | 0    | 18   | 11   | 38   | 0    | 14   | 0    | 37   | 0    | 12   | 0    | 7    | 0         | 9.4  |
| 5                     | 104  | 15   | 48   | 30   | 84   | 6    | 0    | 7    | 0    | 11   | 0    | 8    | 15   | 13   | 0    | 6    | 29.5      | 3.8  |
| 6                     | -    | 21   | -    | -    | 0    | 6    | 0    | 33   | 0    | 13   | 0    | 5    | 0    | 7    | 0    | 8    | 0         | 4.7  |
| Bloomsbury<br>Circuit | Tu   |      | W    |      | Th   |      | F    |      | M    |      | Tu   |      | W    |      | Th   |      | *<br>Mean |      |
|                       | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 | 1984 | 1983      | 1984 |
| 1                     | 0    | 28   | 0    | 18   | 0    | 49   | 0    | 30   | -    | 55   | 0    | 50   | 0    | 22   | 0    | 20   | 0         | 23.0 |
| 2                     | 0    | 53   | 0    | 35   | 0    | 35   | 0    | 72   | 0    | 245  | 0    | 27   | 0    | 38   | 0    | 26   | 0         | 59.8 |
| 3                     | 64   | 152  | 0    | 67   | 0    | 61   | 0    | 77   | 0    | 100  | 0    | 34   | 0    | 133  | 0    | 33   | 8.0       | 82.1 |
| 4                     | 0    | 67   | 55   | 66   | 0    | 105  | 0    | 87   | 0    | 98   | 0    | 33   | 0    | 48   | 0    | 47   | 6.9       | 68.9 |
| 5                     | 130  | 61   | 0    | 141  | 0    | 110  | 0    | 85   | 0    | 77   | 0    | 83   | 0    | 46   | 0    | 56   | 16.3      | 82.3 |
| 6                     | 33   | 51   | 0    | 71   | 0    | 38   | 0    | 102  | 0    | 64   | 0    | 64   | 0    | 38   | 0    | 57   | 4.1       | 60.1 |

Note:

\* This mean value per circuit is the average number of seconds taken to reach the first reasonable space on each circuit, when a 30 second cut off is imposed. All values less than 30 seconds shown in the table have been assigned zero values to overcome differences between recording procedures in the two surveys.

With hindsight it was realised that zero search times are often unrealistic and small search times were recorded as such in the After study. As a result zero search times only occurred in 6% of cases in Mayfair and not at all in Bloomsbury. It is possible to compare results by employing a 30 second cut off. The search times less than 30 seconds are:

|              |   |            |     |
|--------------|---|------------|-----|
| Before Study | : | Mayfair    | 91% |
|              | : | Bloomsbury | 94% |
| After Study  | : | Mayfair    | 85% |
|              | : | Bloomsbury | 15% |

The change in Mayfair is not significant but in Bloomsbury there has been a significant increase in time taken to reach the first reasonable space. Such a result could be explained either by differences in perception of 'reasonable' spaces, or by a rise in illegal yellow line parking. It would have been useful to check this against the consultant's data.

Table 4.3 shows the mean search times and search plus walk times data for the available legal space. As noted in Section 2.1, a 5 minute cutoff was used for the search after which the driver proceeded to the next start point. To correct for this the mean search and search plus walk times were estimated using a curve fitting procedure. In each case, except Cartwright Gardens (Bloomsbury), the times follow a negative exponential distribution and hence the estimate of the mean may be gained from the expression:

$$\hat{\mu} = \hat{\sigma} = (T_2 - T_1) / \log_e 2$$

where  $T_1$ ,  $T_2$  are the tertiles of the distribution fitted to the data. This procedure allows for the percentage of unobserved points (which was never more than 30%). The fact that some values are unobserved means that the estimated minimum significant differences are greater than those which would be obtained solely

Table 4.3 Park and Visit Surveys - Mayfair and Bloomsbury

Estimated mean search and search plus walk times

| Site                          | Mean Search Time (Secs) |       |                    | Mean Search & Walk Time (Secs) |        |                  |
|-------------------------------|-------------------------|-------|--------------------|--------------------------------|--------|------------------|
|                               | 1983                    | 1984  | Min. Sig. Diff.    | 1983                           | 1984   | Min. Sig. Diff.  |
| <u>Mayfair</u>                |                         |       |                    |                                |        |                  |
| Grosv. Sq.                    | 205                     | 179   | 79                 | 455                            | 625    | 226              |
| South St.                     | 216                     | 107   | 70 <sup>+</sup>    | 454                            | 313    | 161              |
| Berkeley Sq.                  | 222                     | 196   | 86                 | 417                            | 667    | 230 <sup>+</sup> |
| Grosv. St.                    | 313                     | 189   | 108 <sup>+</sup>   | 834                            | 476    | 280 <sup>+</sup> |
| All Sites                     | 310                     | 247   | 57 <sup>+</sup>    | 772                            | 685    | 149              |
| <u>Bloomsbury</u>             |                         |       |                    |                                |        |                  |
| Gt. Ormond St.                | 199                     | 91    | 63 <sup>+</sup>    | 555                            | 294    | 182 <sup>+</sup> |
| Malet St.                     | 165                     | 78    | 53 <sup>+</sup>    | 345                            | 208    | 116 <sup>+</sup> |
| Cartwright Gdns <sup>**</sup> | 20(29)                  | 9(49) | 6(17) <sup>+</sup> | 17(7)                          | 17(10) | 8(4)             |
| Montague St.                  | 147                     | 100   | 51                 | 333                            | 208    | 116 <sup>+</sup> |
| All Sites <sup>*</sup>        | 193                     | 107   | 31 <sup>+</sup>    | 467                            | 258    | 76 <sup>+</sup>  |

Notes:

\* Except Cartwright Gardens.

\*\* Figures in brackets are for a negative exponential distribution, which is not supported by the data. Unbracketed figures are from a linear distribution.

+ Significant change.

from the observed values (May and Turvey, 1984a). Appendix 2 contains tabulations of the parameters of the 'best fit' curves for both search only and search plus walk distributions.

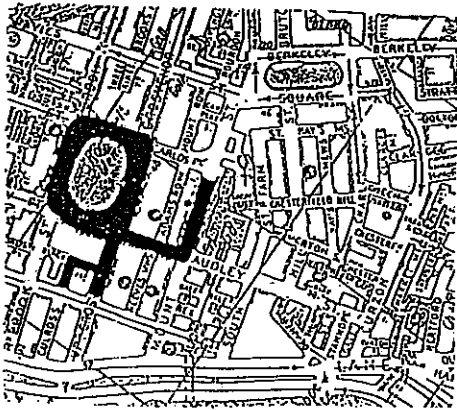
Table 4.3 shows several significant changes between surveys. For the mean search times there are significant reductions at South Street and Grosvenor Street in Mayfair, and at Great Ormond Street and Malet Street in Bloomsbury.

Significant reductions in search time plus walk time are also indicated at Grosvenor Square in Mayfair and at Great Osmond Street and Malet Street in Bloomsbury.

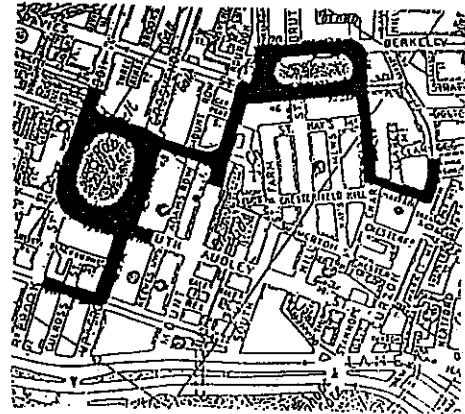
Where significant reductions in search times have been recorded this has been followed by a corresponding reduction in search plus walk times, except at the Berkeley Square address in Mayfair. There an insignificant reduction in search times has produced a significant increase in search plus walk times. This anomalous result was checked by studying the distributions of parking locations for each site in both areas. Figure 4.1 contains a selection of these parking location maps:

- (a) In Grosvenor Square the parking location pattern is more diverse in the After study. The search time has fallen, but distances are higher as a result of reduced congestion. This has resulted in a longer walk back time being recorded.
- (b) In Berkeley Square the parking locations are similar except for some locations around Grosvenor Square in the After survey. These locations distort the mean walk time. Such an effect may have occurred if the driver had gained a good knowledge of Grosvenor Square and realised that at certain times of the day a meter space would be available at Grosvenor Square sooner than if he was to circle Berkeley Square (near to the address) to await an available space. Much of the Before data shows legal parking spaces available right outside the address and hence registers zero walk times on these occasions. In the After study

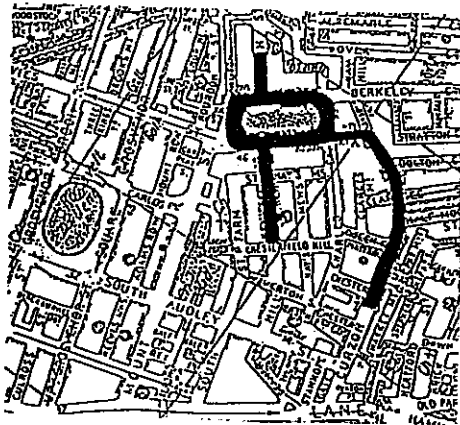
Figure 4.1 Park and Visit Survey - Parking Distributions



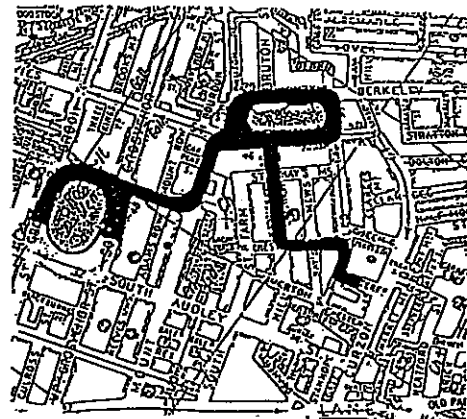
GROSVENOR SQUARE - MAYFAIR  
(BEFORE)



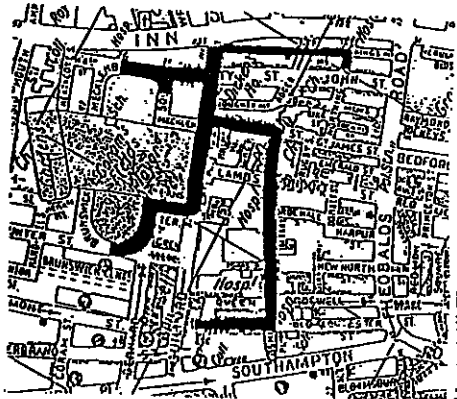
GROSVENOR SQUARE - MAYFAIR  
(AFTER)



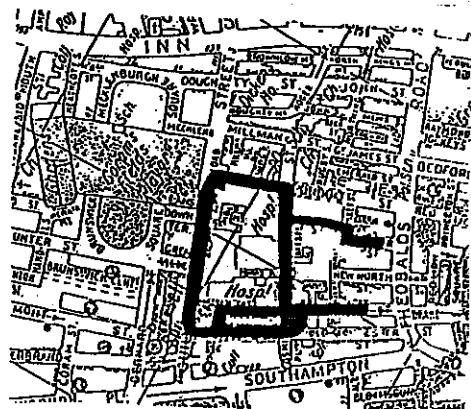
BERKELEY SQUARE - MAYFAIR  
(BEFORE)



BERKELEY SQUARE - MAYFAIR  
(AFTER)



GT. ORMOND ST. - BLOOMSBURY  
(BEFORE)



GT. ORMOND ST. - BLOOMSBURY  
(AFTER)



Table 4.4 Vehicle Following

Proportion of vehicle following runs by start point and by type of end of run

| Site              | Reason for Ending Run |                 |               |                         |                    |
|-------------------|-----------------------|-----------------|---------------|-------------------------|--------------------|
|                   | Lost                  | Through Traffic | Meter Parking | Other On Street Parking | Off-Street Parking |
| <u>Mayfair</u>    |                       |                 |               |                         |                    |
| Half Moon St.     |                       |                 |               |                         |                    |
| 1983              | 0.042                 | 0.188           | 0.167         | 0.417                   | 0.188              |
| 1984              | 0.068                 | 0.237           | 0.085         | 0.424                   | 0.186              |
| msd               | 0.086                 | 0.155           | 0.127         | 0.188                   | 0.149              |
| Deanery St.       |                       |                 |               |                         |                    |
| 1983              | 0.102                 | 0.163           | 0.102         | 0.368                   | 0.265              |
| 1984              | 0.071                 | 0.089           | 0.054         | 0.518                   | 0.268              |
| msd               | 0.108                 | 0.128           | 0.103         | 0.188                   | 0.170              |
| Conduit St.       |                       |                 |               |                         |                    |
| 1983              | 0.085                 | 0.277           | 0.085         | 0.426                   | 0.128              |
| 1984              | 0.018                 | 0.246           | 0.105         | 0.526                   | 0.105              |
| msd               | 0.087                 | 0.170           | 0.113         | 0.192                   | 0.124              |
| All Sites         |                       |                 |               |                         |                    |
| 1983              | 0.076                 | 0.208           | 0.118         | 0.403                   | 0.194              |
| 1984              | 0.052                 | 0.192           | 0.081         | 0.488                   | 0.186              |
| msd               | 0.055                 | 0.087           | 0.067         | 0.110                   | 0.087              |
| <u>Bloomsbury</u> |                       |                 |               |                         |                    |
| Judd St.          |                       |                 |               |                         |                    |
| 1983              | 0.021                 | 0.500           | 0.104         | 0.313                   | 0.063              |
| 1984              | 0.019                 | 0.482           | 0.074         | 0.278                   | 0.148              |
| msd               | 0.055                 | 0.194           | 0.111         | 0.178                   | 0.117              |
| Guilford St.      |                       |                 |               |                         |                    |
| 1983              | 0.050                 | 0.550           | 0.050         | 0.225                   | 0.125              |
| 1984              | 0.000                 | 0.414           | 0.103         | 0.379                   | 0.103              |
| msd               | 0.068                 | 0.200           | 0.103         | 0.180                   | 0.129              |
| Museum St.        |                       |                 |               |                         |                    |
| 1983              | 0.021                 | 0.417           | 0.063         | 0.438                   | 0.063              |
| 1984              | 0.103                 | 0.448           | 0.121         | 0.276                   | 0.052              |
| msd               | 0.088                 | 0.189           | 0.164         | 0.182                   | 0.089              |
| All Sites         |                       |                 |               |                         |                    |
| 1983              | 0.029                 | 0.485           | 0.074         | 0.330                   | 0.081              |
| 1984              | 0.041                 | 0.447           | 0.100         | 0.312                   | 0.100              |
| msd               | 0.041                 | 0.112           | 0.063         | 0.105                   | 0.064              |

this was found possible on only a few occasions and hence zero values, especially for walk times, rarely exist.

- (c) In Great Ormond Street the parking distribution pattern in the After survey was more closely orientated around the address than in the Before study, thus explaining a reduction in search times and a significant reduction in mean walk back times to the address.

For the areas as a whole, there was a significant reduction in Mayfair in search time but not in search plus walk time. In Bloomsbury, despite not being a clamping zone both search times and search plus walk times were significantly reduced.

The percentage reductions in times for all sites in both areas are:

- |                |                         |                                 |
|----------------|-------------------------|---------------------------------|
| (1) Mayfair    | : Search times          | 20% reduction (significant)     |
| (All Sites)    | : Search and walk times | 11% reduction (not significant) |
| (2) Bloomsbury | : Search times          | 43% reduction (significant)     |
| (All Sites)    | : Search and walk times | 45% reduction (significant)     |

Appendix 3 shows the roads in each area which were used in the survey search process in 1983 and 1984. The pattern of search in both areas is similar over the two years in terms of the area covered. Indeed in Mayfair there is a great similarity apart from slightly more searching in 1984 in the Old Bond Street area to the east and slightly less in 1984 in the Park Lane area to the west. In Bloomsbury, although the total area covered by the search process is similar between the two years there was a tendency to search only along major routes in the After study.

#### 4.2 Vehicle Following Survey

4.2.1 Types of parking space: Table 4.4 indicates the reasons for ending the vehicle following runs. Through traffic fell slightly in both areas in the After survey. Meter parking was greatly reduced in Mayfair and at one site in Bloomsbury. Yellow line parking predominated in both areas. None of the differences was significant.

4.2.2 Duration of search process: Table 4.5 indicates the distribution of parking vehicles followed from each start point by duration of run. Neither the survey day nor start point had a significant effect on the mean run times in either area. In both areas there were (insignificant) reductions in the duration of runs.

In Tables 4.6 (Mayfair) and 4.7 (Bloomsbury) the mean run times are broken down by start point and by type of end of run.

In Mayfair, the only significant change between the two survey periods occurred for 'off street' parking run times where there was a reduction of 46% from the 1983 value. This resulted in a significant reduction of 18% in the mean run time for all types of run.

In Bloomsbury, there were more frequent significant differences both between sites and between types of run. A reduction in through traffic run times in Judd Street resulted in the all site run time for through traffic showing a significant reduction. There were significant reductions in the mean run times for runs originating from both Judd Street and Guilford Street. These differences result in a significant reduction in mean run times, for all run types and start points of about 17%.

4.2.3 Directness of routeing/excess distance: Directness of routeing can be expressed by the ratio:

$$\text{Directness} = \frac{(\text{shortest distance} - \text{crowfly distance})}{\text{crowfly distance}} \quad (\%)$$

In both the Before and After surveys it was found that runs in Bloomsbury were more direct than those in Mayfair. The grid pattern of roads in Bloomsbury compared with the tortuous network in Mayfair is undoubtedly responsible. Changes between surveys were not significant.



Table 4.5 Vehicle Following

Proportion of parking vehicles followed by start point and duration run

| Site              | Duration of Run (Mins) |      |                   |      |                   |                   |      |
|-------------------|------------------------|------|-------------------|------|-------------------|-------------------|------|
|                   | 0-1                    | 1-2  | 2-3               | 3-4  | 4-5               | 5-10              | 10   |
| <u>Mayfair</u>    |                        |      |                   |      |                   |                   |      |
| Half Moon St.     |                        |      |                   |      |                   |                   |      |
| 1983              | 0.27                   | 0.27 | 0.16              | 0.03 | 0.16              | 0.11              | 0.00 |
| 1984              | 0.32                   | 0.27 | 0.20              | 0.10 | 0.05              | 0.07              | 0.00 |
| msd               | 0.20                   | 0.20 | 0.17              | 0.11 | 0.14              | 0.13              | 0.00 |
| Deanery St.       |                        |      |                   |      |                   |                   |      |
| 1983              | 0.31                   | 0.19 | 0.11              | 0.14 | 0.11              | 0.11              | 0.03 |
| 1984              | 0.40                   | 0.17 | 0.13              | 0.13 | 0.09              | 0.09              | 0.00 |
| msd               | 0.21                   | 0.17 | 0.14              | 0.15 | 0.13              | 0.13              | 0.06 |
| Conduit St.       |                        |      |                   |      |                   |                   |      |
| 1983              | 0.17                   | 0.33 | 0.13              | 0.07 | 0.00              | 0.30              | 0.00 |
| 1984              | 0.19                   | 0.36 | 0.14              | 0.12 | 0.12              | 0.07              | 0.00 |
| msd               | 0.18                   | 0.22 | 0.16              | 0.13 | 0.10 <sup>+</sup> | 0.18 <sup>+</sup> | 0.00 |
| All Sites         |                        |      |                   |      |                   |                   |      |
| 1983              | 0.25                   | 0.26 | 0.14              | 0.08 | 0.10              | 0.17              | 0.01 |
| 1984              | 0.31                   | 0.26 | 0.15              | 0.12 | 0.09              | 0.08              | 0.00 |
| msd               | 0.12                   | 0.11 | 0.09              | 0.08 | 0.08              | 0.09              | 0.02 |
| <u>Bloomsbury</u> |                        |      |                   |      |                   |                   |      |
| Judd St.          |                        |      |                   |      |                   |                   |      |
| 1983              | 0.39                   | 0.17 | 0.22              | 0.04 | 0.09              | 0.09              | 0.00 |
| 1984              | 0.52                   | 0.22 | 0.11              | 0.04 | 0.07              | 0.04              | 0.00 |
| msd               | 0.27                   | 0.22 | 0.21              | 0.11 | 0.15              | 0.14              | 0.00 |
| Guilford St.      |                        |      |                   |      |                   |                   |      |
| 1983              | 0.06                   | 0.19 | 0.38              | 0.19 | 0.00              | 0.19              | 0.00 |
| 1984              | 0.27 <sup>+</sup>      | 0.35 | 0.12              | 0.18 | 0.06              | 0.03              | 0.00 |
| msd               | 0.19 <sup>+</sup>      | 0.25 | 0.26              | 0.23 | 0.08              | 0.20              | 0.00 |
| Museum St.        |                        |      |                   |      |                   |                   |      |
| 1983              | 0.33                   | 0.19 | 0.19              | 0.11 | 0.00              | 0.19              | 0.00 |
| 1984              | 0.19                   | 0.08 | 0.08              | 0.31 | 0.19              | 0.15              | 0.00 |
| msd               | 0.23                   | 0.18 | 0.18              | 0.21 | 0.15 <sup>+</sup> | 0.20              | 0.00 |
| All Sites         |                        |      |                   |      |                   |                   |      |
| 1983              | 0.29                   | 0.18 | 0.24              | 0.11 | 0.03              | 0.15              | 0.00 |
| 1984              | 0.32                   | 0.23 | 0.10              | 0.17 | 0.10              | 0.07              | 0.00 |
| msd               | 0.15                   | 0.13 | 0.12 <sup>+</sup> | 0.11 | 0.08              | 0.10              | 0.00 |

Notes: + significant change.

Table 4.6 Vehicle Following Survey - Mayfair

Mean run time (minutes) by start point and by end of run

| Reason for Ending Run     | Start Point      |      |      |                |      |      |                |      |      | All Start Points |      |                   |
|---------------------------|------------------|------|------|----------------|------|------|----------------|------|------|------------------|------|-------------------|
|                           | Half Moon Street |      |      | Deanery Street |      |      | Conduit Street |      |      | 1983             | 1984 | msd               |
|                           | 1983             | 1984 | msd  | 1983           | 1984 | msd  | 1983           | 1984 | msd  | 1983             | 1984 | msd               |
| Through Traffic           | 7.39             | 6.66 | 2.17 | 6.27           | 7.67 | 3.78 | 5.93           | 5.04 | 1.80 | 6.46             | 6.14 | 1.29              |
| Meter Parking             | 2.44             | 1.33 | 2.99 | 4.17           | 2.58 | 3.96 | 3.41           | 3.32 | 3.12 | 3.18             | 2.63 | 1.63              |
| Other On-Street Parking   | 2.61             | 2.20 | 1.17 | 3.39           | 2.31 | 1.75 | 3.17           | 2.30 | 1.20 | 3.04             | 2.28 | 0.77              |
| Off-Street Parking        | 2.35             | 1.59 | 1.53 | 1.99           | 1.71 | 1.25 | 3.17           | 1.49 | 2.00 | 3.04             | 1.63 | 0.80 <sup>+</sup> |
| Mean for each start point | 3.47             | 3.25 | 1.13 | 3.59           | 2.67 | 1.20 | 3.90           | 3.01 | 0.97 | 3.65             | 2.98 | 0.62 <sup>+</sup> |

Notes: + significant change (msd = minimum significant difference)

Table 4.7 Vehicle Following Survey - Bloomsbury

Mean run time (minutes) by start point and by end of run

| Reason for Ending Run     | Start Point |      |                   |                 |      |                   |               |      |      | All Start Points |      |                   |
|---------------------------|-------------|------|-------------------|-----------------|------|-------------------|---------------|------|------|------------------|------|-------------------|
|                           | Judd Street |      |                   | Guilford Street |      |                   | Museum Street |      |      | 1983             | 1984 | msd               |
|                           | 1983        | 1984 | msd               | 1983            | 1984 | msd               | 1983          | 1984 | msd  |                  |      |                   |
| Through Traffic           | 5.19        | 3.97 | 1.20 <sup>+</sup> | 5.64            | 5.05 | 1.20              | 5.73          | 4.78 | 1.23 | 5.51             | 4.59 | 0.68 <sup>+</sup> |
| Meter Parking             | 0.52        | 0.98 | 0.76              | 4.44            | 1.28 | 3.52              | 2.51          | 3.52 | 2.66 | 1.91             | 2.13 | 1.55              |
| Other On-Street Parking   | 2.50        | 1.75 | 1.37              | 2.89            | 2.26 | 1.16              | 2.69          | 3.55 | 1.62 | 2.67             | 2.50 | 0.80              |
| Off-Street Parking        | 2.57        | 1.46 | 1.48              | 2.62            | 1.49 | 2.01              | 1.39          | 1.48 | 3.15 | 2.27             | 1.48 | 0.81              |
| Mean for each start point | 3.67        | 2.71 | 0.92 <sup>+</sup> | 4.53            | 3.23 | 0.95 <sup>+</sup> | 3.89          | 4.04 | 0.98 | 4.00             | 3.32 | 0.55 <sup>+</sup> |

Notes: + significant change (msd = minimum significant difference)

A more useful statistic is that of excess distance, which may be used to investigate the degree of searching for a parking space. A comparison is made between the actual distance travelled and the shortest practical distance. The expression is:

$$\text{Excess Distance} = \frac{\text{Actual Distance} - \text{Shortest Distance}}{\text{Shortest Distance}} \quad (\%)$$

This ratio can be used to estimate the extent to which searching has taken place. 40% has been taken as the threshold above which searching is deemed to have taken place. Table 4.8 shows the proportions searching for different types of parking space. Although changes are not significant there have been opposite shifts in the proportions searching for meter spaces in Mayfair and Bloomsbury. In 1983, 22% of those parking at meters were deemed to have searched for the space in Mayfair. This declined to 7% in 1984 with a corresponding increase in Bloomsbury from 10% to 18% over the same period.

For off-street parking and all other on-street parking there was a similar decline in both areas.

Overall less searching was observed in the After study, in both areas, apart from far meter spaces in Bloomsbury. While the 40% threshold is inevitably somewhat arbitrary, changes in the threshold had no effect on the direction or significance of the changes.

#### 4.3 Business Survey

Tabulations of the survey results are included in the associated technical note. The general impression is that results across the two areas are similar, respondents perceiving transport and traffic problems to be some of the most serious problems affecting business operations and considering parking problems to be the most serious of these. The main results were:

Table 4.8 Vehicle Following

Proportions searching for different types of parking space

| Site                | Proportion<br>1983 | Proportion<br>1984 | Min. Sig.<br>Diff.     |
|---------------------|--------------------|--------------------|------------------------|
| <u>Mayfair</u>      |                    |                    |                        |
| Off Street          | 0.07               | 0.06               | 0.13                   |
| Meters              | 0.22               | 0.07               | 0.24                   |
| All Other On Street | 0.18               | 0.12               | 0.12                   |
|                     | —                  | —                  | —                      |
| All Parkers         | 0.16               | 0.10               | (0.09) Not Significant |
| <u>Bloomsbury</u>   |                    |                    |                        |
| Off Street          | 0.09               | 0.00               | 0.17                   |
| Meters              | 0.10               | 0.18               | 0.26                   |
| All Other On Street | 0.19               | 0.11               | 0.14                   |
|                     | —                  | —                  | —                      |
| All Parkers         | 0.15               | 0.10               | (0.11) Not Significant |

- (1) Approximately 76% of respondents in Bloomsbury and 82% in Mayfair considered their business operations to be affected to some degree by traffic/transport problems.
- (2) Of those claiming to be affected, 90% in Bloomsbury and 100% in Mayfair mentioned parking as one such problem.
- (3) 20% of respondents in both areas felt that there were ways in which their businesses could benefit from stricter enforcement of regulations.
- (4) 80% of respondents thought that stricter parking controls might adversely affect trade.
- (5) 85% of suppliers thought that stricter enforcement of parking regulations would be beneficial.

Comparing the business and supplier responses, it was noticeable that the suppliers were more likely to be seriously affected by transport problems generally and more likely to consider the on-street parking situation important to their operations. They were also more willing to accept that stricter enforcement might be of benefit to them.

## 5. CONCLUSIONS

### 5.1 Survey Methods

The prime objective of the study was to develop survey and analysis techniques to aid in determining the costs of non-compliance with on-street parking regulations. Two techniques, the park and visit survey and the vehicle following survey have been adapted for this purpose, and found to be effective. Further discussion of the methods and their associated analysis procedures is to be found in May and Turvey (1984a).

The business survey was of value in demonstrating the considerable concern about parking problems among the business community and particularly its suppliers. It also indicated a considerable willingness on the part of respondents to be involved in further surveys of the effects on business of enforcement action. Unfortunately it was not possible to take advantage of this proffered co-operation.

### 5.2 Some Effects of Non-Compliance

The before study provides information on parking conditions in Mayfair and Bloomsbury before the introduction of wheel clamps. Particular points of note taken in the order in which they are identified in Table 1.2 are:

- (i) around 15% (+ 7%) of parkers in both areas apparently searched for parking spaces; this probably adds about 10% to the vehicle kilometres in Mayfair, and about half that amount in Bloomsbury, where through traffic predominates.

- (ii) fixed route speeds, of 14.3 km/h ( $\pm$  2.13 km/h) in Mayfair and 14.4 km/h ( $\pm$  1.03 km/h) in Bloomsbury, were extremely low, indicating substantial congestion.
- (iii) while reasonable illegal spaces could be found, on average, within a few seconds, the time taken to find a vacant meter averaged 5 min 10 sec ( $\pm$  99 sec) in Mayfair and 3 min 13 sec ( $\pm$  61 sec) in Bloomsbury.
- (iv) adding the time taken to walk back to the destination gave an average access time for legal parkers of 12 min 52 sec ( $\pm$  245 sec) in Mayfair, and 7 min 47 sec ( $\pm$  153 sec) in Bloomsbury. To these should strictly be added the time to walk back to the car on the return journey; these give totals of over 20 minutes for Mayfair and over 12 minutes for Bloomsbury. These represent substantial increases in total journey time, and ones which are usually ignored in the assessment of traffic management measures.
- (v) 100% of business respondents in Mayfair, 90% in Bloomsbury, and all the suppliers approached considered that parking problems affected their businesses.

While the cause of these findings cannot be associated wholly with poor compliance, it seems likely that it is a major contributor to the low travel speeds. It is worth noting, however, that an increase in compliance, if it did not increase meter availability, could result in a substantial increase in searching and in the time spent gaining access to premises in Central London.

### 5.3 Some Effects of the Introduction of Wheel Clamps

Comparison of the Before and After studies provides an indication of the possible effects of the wheel clamps experiment. Again, using the order of Table 1.2, the changes of note are:

- (i) A reduction in the percentage of drivers searching for parking in both Mayfair and Bloomsbury (from 15% to 10%, though not statistically significant).

- (ii) A significant increase of fixed route speed of 24% ( $\pm 14\%$ ) in Bloomsbury, which was, because of the wide confidence levels for Mayfair, not significantly different from the (insignificant) 15% ( $\pm 31\%$ ) increase in Mayfair.
- (iii) Significant reductions in the average time taken to find a meter of 20% (to 4 min 7 sec) in Mayfair and of 45% (to 1 min 47 sec) in Bloomsbury.
- (iv) Average time taken to find a meter and walk back falling by a statistically insignificant 11% to 11 min 25 sec in Mayfair, and by a significant 45% to 4 min 18 sec in Bloomsbury. Adding the return walk time would give new total access times of just under 19 minutes in Mayfair and 7 minutes in Bloomsbury.
- (v) There was a 22% increase in meter availability in Mayfair, but an increase of only 1% in Bloomsbury; neither was significant.

While it was not possible to measure changes in business attitudes, it was interesting to note that while 80% of businessmen were concerned that stricter enforcement might reduce trade, 85% of suppliers anticipated an improvement in operating conditions.

It is, of course, not possible to ascribe the changes above to the introduction of wheel clamps. In particular it is interesting to note that in all cases, except for meter availability, the improvement in the Mayfair clamping zone has at least been paralleled by an improvement in the Bloomsbury control zone. It would ideally have been appropriate to check the consistency of the above findings with the consultants' findings on travel times and meter availability. Unfortunately this was not possible during the period of the study.



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APPENDICES

- APPENDIX 1 : The Business Questionnaire  
(Before Survey)
- APPENDIX 2 : Parameters of the Fitted Exponential  
Forms for the Park and Visit Survey  
Search and Search Plus Walk Times  
(Before and After Studies)
- APPENDIX 3 : Park and Visit Survey  
Roads Used at Any Time in the Fixed  
Route and Search Process  
(Before and After Studies)

APPENDIX 1

THE BUSINESS SURVEY QUESTIONNAIRE (1983)

# Appendix 1: Business Questionnaire

Name of firm :

Address of firm :

Type of firm :

Name of respondent :

Position of respondent within the firm,  
(owner, manager, etc.) :

Background information.

1. How long has the business been trading from these premises ?

2. Does the business have any other premises which are an integral part of the operations carried out here (in terms of supplying or receiving goods etc.) ?

Yes (go to 3)  
No (go to 5)

3. Where are the other premises located ?

4. and what is their connection with the operations carried out here ?

5. Does the business own or operate any vehicles (including private cars used on company business) ?

Yes (go to 6)  
No (go to 8)

6. How many vehicles does the business own or operate and of what type are they (show card A)?

|              |                  |   |   |   |   |   |
|--------------|------------------|---|---|---|---|---|
| Private cars | Company owned    | A | B | C | D | E |
|              | or Operated cars |   |   |   |   |   |

7. During the day where is each of these vehicles parked. What sort of parking is this (show card B) and how far is it from these premises ?

| Type of vehicle | Types of parking space | Distance from premises. |
|-----------------|------------------------|-------------------------|
|-----------------|------------------------|-------------------------|

Vehicle 1

Vehicle 2

Vehicle 3

Vehicle 4

8. How often does the business receive supplies of goods :

(a) delivered by a supplier ?

(b) brought to the premises by an employee ?

9. Where are the goods off-loaded and, if this is not on site, how are they brought from there to the premises ?

10. Who are your main suppliers, and from where are deliveries made/goods fetched ?

|          |                 |                       |
|----------|-----------------|-----------------------|
| Supplier | Source of goods | Delivered or fetched. |
|----------|-----------------|-----------------------|

11. Excluding trips to fetch supplies, how many trips are made from these premises each week on company business ?

What proportion of these are made by private transport ?

15. How seriously do transport or traffic problems affect the operation of your business at these premises? (C)
- extremely  
very  
fairly  
not very  
not at all (90 to 20)
16. Which other problems affect the operation of your business more seriously than transport?

12. Excluding trips to deliver supplies, how many trips are made to these premises each week on business (by representatives, regional managers etc)?

What proportion of these are made by private transport?

What sort of parking space do they use (show card B) and how far are these from the premises?

Number of trips      Parking type      Distance from premises.

13. How many people work at these premises

(a) full time (over 30 hours per week)?

(b) part time (8 - 30 hours per week)?

What proportion of these come to work by car?

What sort of parking space do they use (show card B) and how far are these from the premises?

Number of employees.      Parking type      Distance from premises.

14. How many clients/customers do you have on a typical day?

What proportion of these come to these premises by car?

What sort of parking space do they use (show card B) and how far are these from the premises?

Number of customers.      Parking Type.      Distance from premises.

Looking in more detail at transport and traffic problems:

17. .... what do you see as the main transport or traffic problems associated with the operation of your business at these premises ?
- 1.
  - 2.
  - 3.
  - 4.
  - 5.
  - 6.
20. How important is the on-street parking situation to the operation of your business at these premises ?
- (a) extremely
  - (b) very
  - (c) fairly
  - (d) not very
  - (e) not at all (go to Q.25).

18. .... taking each of these in turn, how seriously are your business operations affected by these problems ? (C)
- extremely    very    fairly    not very    not at all
- problem no. 1.
  - problem no. 2.
  - problem no. 3.
  - problem no. 4.
  - problem no. 5.
  - problem no. 6.

19. ....and, for each, what effects does it have on business operations ?

effects

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

21. In what ways is the on-street parking situation important to the operation of your business at these premises ?

22. .... what do you see as the main problems of on-street parking associated with the operation of your business at these premises ?

- 1.
- 2.
- 3.
- 4.
- 5.

23. .... taking each of these in turn, how seriously are your business operations affected by these problems ? (read list).

| problem No. | extremely | very | fairly | not very | not at all. |
|-------------|-----------|------|--------|----------|-------------|
| 1.          |           |      |        |          |             |
| 2.          |           |      |        |          |             |
| 3.          |           |      |        |          |             |
| 4.          |           |      |        |          |             |
| 5.          |           |      |        |          |             |

24. ....and, for each, what effect does it have on business operations ?

effects

- 1.
- 2.
- 3.
- 4.
- 5.

25. What do you see as the main problems of on-street parking associated with the supply of goods to these premises by your suppliers ?

- 1.
- 2.
- 3.
- 4.
- 5.

26. ....taking each of these in turn, how seriously are your suppliers affected by these problems ?

extremely very fairly not very not at all

- problem no. 1.
- 2.
  - 3.
  - 4.
  - 5.

27. Can you suggest the name and address of a major supplier whom we could approach to discuss these problems ?

Thinking, for the moment, only of this business

28. ....are there any ways in which you think that this business might benefit from stricter enforcement of parking regulations ?

29. ....are there any ways in which you think that this business might suffer from stricter enforcement of parking regulations ?

30. ....overall, as far as this business is concerned, do you think that stricter enforcement of parking regulations would be :

- (a) a good thing
- (b) a bad thing
- (c) neither good nor bad
- (d) don't know.

31. ....do you think that your trade/turnover might be affected by stricter enforcement of parking regulations ?

Yes No

32. ....and, would you be willing to help us assess any such effects by providing us with further information in the future ?

Yes No.

Thank you for your assistance.

Interview comments:-

APPENDIX 2

PARAMETERS OF THE FITTED EXPONENTIAL FORMS FOR  
THE PARK AND VISIT SURVEY SEARCH AND SEARCH PLUS  
WALK TIMES (BEFORE AND AFTER STUDIES)

TABLE 1 : SEARCH TIMES

TABLE 2 : SEARCH PLUS WALK TIMES



Table 2 Fitted Exponentials (Cumulative Proportion Against Search and Walk Time)

| Area       | Site           | Feb 1983<br>(Before Survey) |                        |        | Feb 1984<br>(After Survey) |                        |        |
|------------|----------------|-----------------------------|------------------------|--------|----------------------------|------------------------|--------|
|            |                | $\beta_0$                   | $\beta_1$              | $r^2$  | $\beta_0$                  | $\beta_1$              | $r^2$  |
| MAYFAIR    | Grosv. Sq.     | -0.239<br>(0.027)           | -0.0022<br>(0.00017)   | 0.8628 | -0.256<br>(0.037)          | -0.0016<br>(0.00013)   | 0.8222 |
|            | South St.      | -0.0992<br>(0.049)          | -0.00217<br>(0.00015)  | 0.8700 | 0.0937<br>(0.0306)         | -0.00315<br>(0.00011)  | 0.9581 |
|            | Berk. Sq.      | -0.099<br>(0.0212)          | -0.00238<br>(0.000082) | 0.9621 | -0.293<br>(0.039)          | -0.0015<br>(0.00017)   | 0.7053 |
|            | Grosv. St.     | -0.1295<br>(0.0128)         | -0.00121<br>(0.000038) | 0.9746 | -0.056<br>(0.024)          | -0.00208<br>(0.000089) | 0.9469 |
|            | Total          | -0.23<br>(0.05)             | -0.079<br>(0.006)      | 0.9311 | -0.271<br>(0.06)           | -0.089<br>(0.008)      | 0.9119 |
| BLOOMSBURY | Gt. Ormond St. | -0.207<br>(0.026)           | -0.00182<br>(0.000078) | 0.9396 | -0.133<br>(0.031)          | -0.0034<br>(0.00014)   | 0.9369 |
|            | Malet St.      | -0.281<br>(0.027)           | -0.0029<br>(0.00012)   | 0.9379 | 0.278<br>(0.089)           | -0.0048<br>(0.00029)   | 0.8597 |
|            | Cartwright Gdn | 25.825<br>(7.055)           | -0.154<br>(0.039)      | 0.2751 | 14.312<br>(2.951)          | -0.103<br>(0.0185)     | 0.4027 |
|            | Montague St.   | 0.1404<br>(0.043)           | -0.00301<br>(0.00014)  | 0.9374 | 0.2598<br>(0.0351)         | -0.0048<br>(0.000112)  | 0.9759 |
|            | ** Total       | -0.209<br>(0.03)            | -0.13<br>(0.005)       | 0.9869 | 0.063<br>(0.05)            | -0.235<br>(0.006)      | 0.9917 |

Note: Figures in brackets are standard errors.

\* Cartwright Gardens not exponentially distributed.

\*\* Cartwright Gardens not included.

Table 1. Fitted Exponentials (Cumulative Proportion Against Search Time)

| Area       | Site           | Feb 1983<br>(Before Survey) |                      |        | Feb 1984<br>(After Survey) |                      |        |
|------------|----------------|-----------------------------|----------------------|--------|----------------------------|----------------------|--------|
|            |                | $\beta_0$                   | $\beta_1$            | $r^2$  | $\beta_0$                  | $\beta_1$            | $r^2$  |
| MAYFAIR    | Grosv. Sq.     | -0.263<br>(0.028)           | -0.0049<br>(0.00042) | 0.8293 | -0.2267<br>(0.0318)        | -0.0056<br>(0.00037) | 0.8759 |
|            | South St.      | -0.061<br>(0.019)           | -0.0046<br>(0.00013) | 0.9760 | -0.0270<br>(0.020)         | -0.0094<br>(0.00023) | 0.9777 |
|            | Berk. Sq.      | -0.170<br>(0.016)           | -0.0045<br>(0.00013) | 0.9748 | -0.3145<br>(0.038)         | -0.00510<br>(0.0006) | 0.7052 |
|            | Grosv. St.     | -0.162<br>(0.017)           | -0.0032<br>(0.00013) | 0.9545 | -0.1839<br>(0.021)         | -0.0053<br>(0.00024) | 0.9375 |
|            | Total          | -0.227<br>(0.019)           | -0.197<br>(0.006)    | 0.9963 | -0.321<br>(0.15)           | -0.246<br>(0.05)     | 0.8591 |
| BLOOMSBURY | Gt. Ormond St. | -0.253<br>(0.023)           | -0.0050<br>(0.00019) | 0.9513 | -0.1346<br>(0.023)         | -0.0107<br>(0.00035) | 0.9609 |
|            | Malet St       | -0.263<br>(0.028)           | -0.0061<br>(0.00026) | 0.9368 | -0.0642<br>(0.051)         | -0.0129<br>(0.00054) | 0.9276 |
|            | Cartwright Gdn | 1.079<br>(0.168)            | -0.0349<br>(0.00268) | 0.7975 | -0.2731<br>(0.123)         | -0.0199<br>(0.0026)  | 0.5723 |
|            | Montague St.   | -0.0099<br>(0.018)          | -0.0068<br>(0.00015) | 0.9829 | -0.0662<br>(0.025)         | -0.010<br>(0.00023)  | 0.9782 |
|            | ** Total       | -0.25<br>(0.043)            | -0.317<br>(0.014)    | 0.9922 | -0.093<br>(0.09)           | -0.57<br>(0.031)     | 0.9885 |

Note: Figures in brackets are standard errors.

\* Cartwright Gardens not exponentially distributed.

\*\* Cartwright Gardens not included.

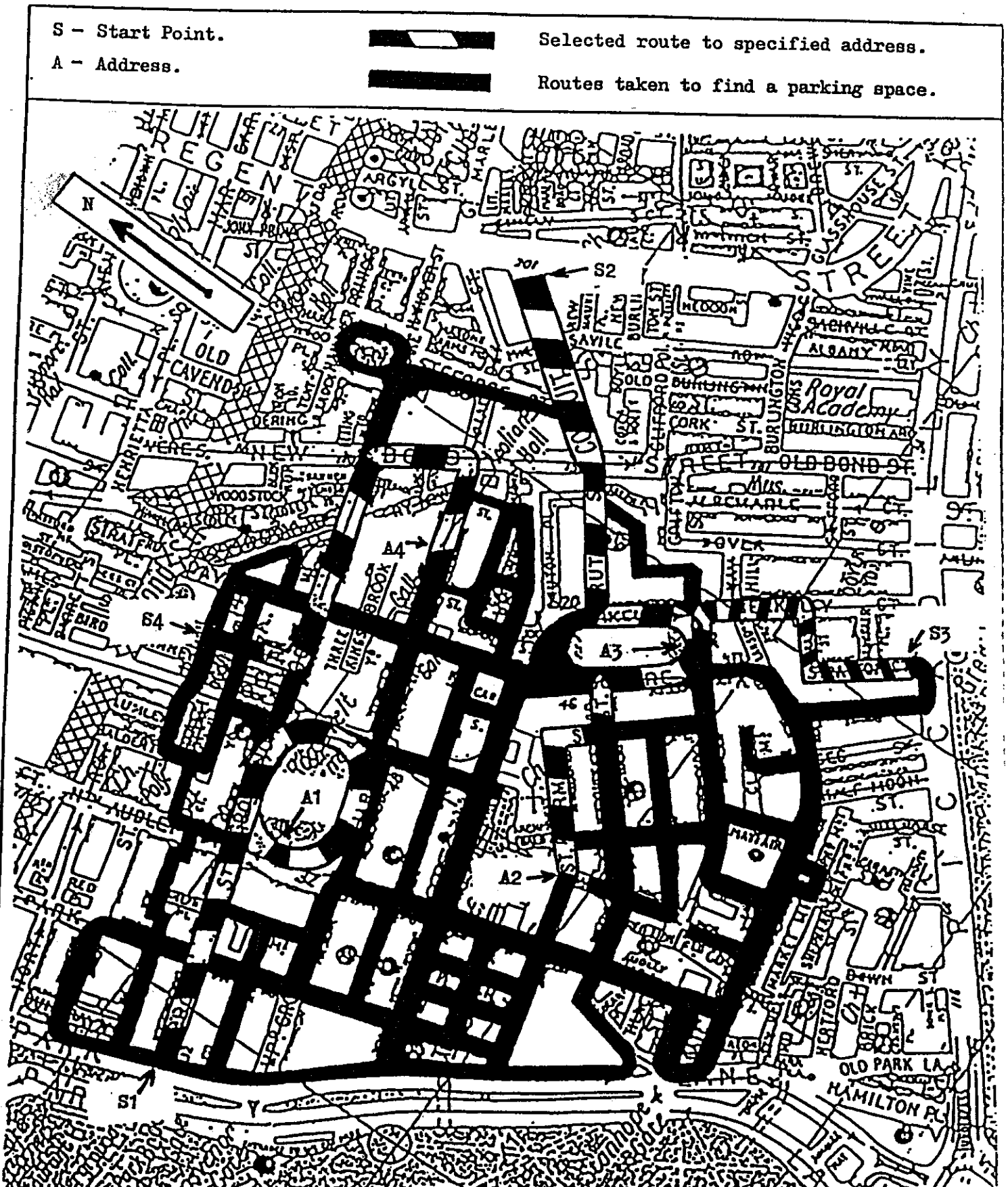
APPENDIX 3

ROADS USED AT ANY STAGE OF THE PARK AND VISIT SURVEY

- FIGURE 1 : MAYFAIR; BEFORE STUDY (1983)
- FIGURE 2 : MAYFAIR; AFTER STUDY (1984)
- FIGURE 3 : BLOOMSBURY; BEFORE STUDY (1983)
- FIGURE 4 : BLOOMSBURY; AFTER STUDY (1984)

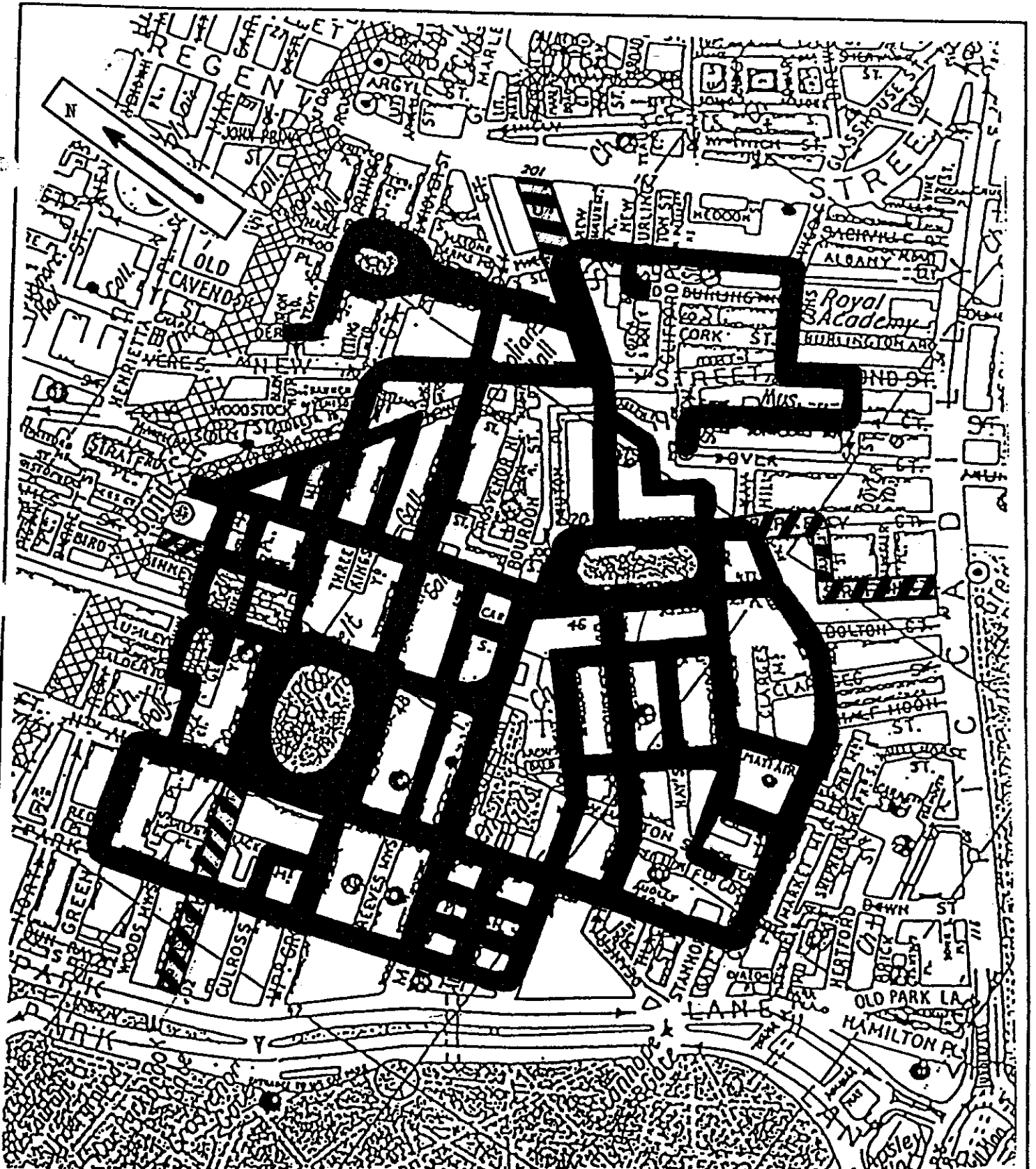
Appendix 3 : Figure 1

Mayfair Before



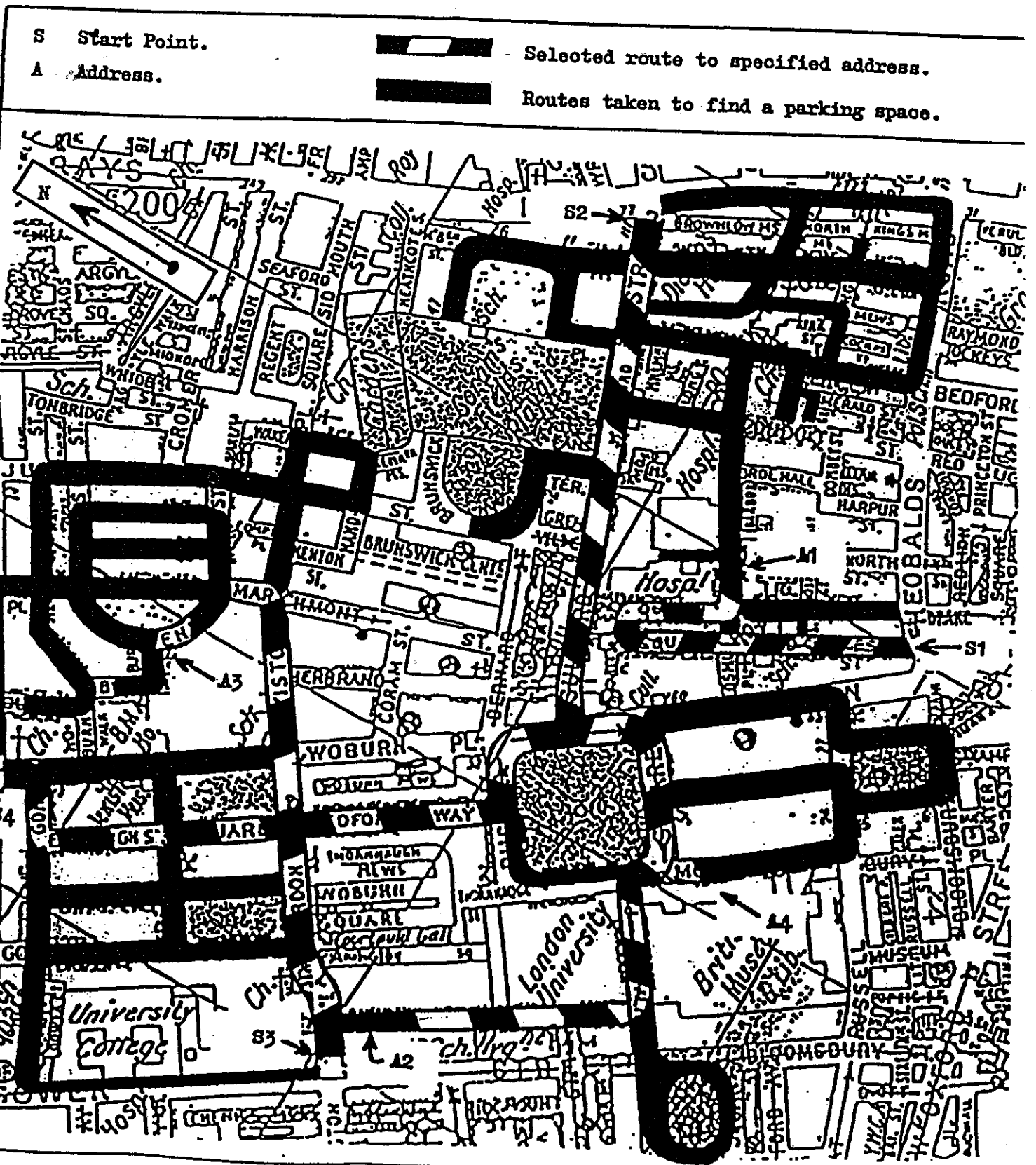
Appendix 3 : Figure 2

Mayfair After



Appendix 3 : Figure 3

Bloomsbury Before



Appendix 3 : Figure 4

Bloomsbury After

