CHAPTER SIX:
PATTERNS OF PEDESTRIAN MOVEMENT IN LONDON'S RAILWAY TERMINUS AREAS

This chapter is an empirical study and statistical analysis of pedestrian movement in London's railway terminus areas. The main question is how the terminus structures as well as their local urban grid structures differently influence pedestrian movement around the station buildings. Its main objective is to examine the effect of urban spatial configuration on movement (the natural movement) in each station area whereby the influences of railway terminus as 'attractor' and 'negative attractor' first appear to predominantly exist. The empirical and statistical analyses in this chapter are to complete a series of detailed study on the urban morphological properties and their relationship on space uses of all eleven London's railway terminus areas by finally adding in precisely detailed information regarding their station-related as well as grid-related movement patterns.

The study is based on the 1988's space syntax study of King's Cross Station area (in Hillier et al, 1993) which argued that railway termini are both 'attractors' and 'negative attractors' whereby the high level of pedestrian movement is drawn toward their entrance sides while the rates tend to decrease as the non-entrance sides are approached. The diminishing movement levels occur along the routes in the rear areas where the terminus structures and railway lands severely discontinue the street network. These existing findings will be put to test upon the other London's terminus areas. The study then continues to argue that vibrant terminus areas are 'configurational attractors' whereby the dense and integrated spatial grid network, interconnecting through both internal and external spaces of the station buildings, can sustain high levels of natural movement regardless of the fluctuating 'added-on' station-related movement. These configurational attractors can then be seen as 'pedestrian nodes' in their own right whereby the attractor effects on movement might also occur at the other sides of the termini besides their front due to the influence of their entrances upon the well interconnected spatial grid network all around the buildings.

According to the above conjectures, the study in this chapter is structured into three main sections. The first section presents the empirical finding of weekday movement rates on all key routes around the terminus buildings. This is done through a descriptive review on the terminus areas' graphic map, presenting the gate observation data on pedestrian movement levels recorded along the selected routes on a weekday basis. The movement data is collected on the same basis as that of the existing King's Cross study in order to make all eleven London's station areas be possibly comparable for the discussion. The graphic representation suggests an overall pattern of daily average pedestrian movement rates around each station building. This aims to generally investigate the degree to which the terminus structures act as attractor and negative attractor in their urban context. The second section is a statistical analysis on the relationship between movement and spatial variables. It aims to identify, as best as possible, the natural movement level in the areas, apart from the movement that might be influenced by the station entrances themselves. All findings and analytical results will be discussed and concluded in the last section.

6.1: THE STATION RELATED MOVEMENT PATTERNS IN LONDON'S RAILWAY TERMINUS AREAS

Railway Termini as Attractors and Negative Attractors

Through an empirical observation, the study in this section presents an overview of pedestrian movement pattern in London's railway terminus areas, focusing on the effects that the terminus structures have on movement level within their local surrounding areas. The previous studies on King's Cross Station area's pedestrian movement and space use patterns, carried out by Space Syntax Laboratory in 1988 and 1997[1], revealed that the terminus structures influence two conspicuous movement patterns in their local surroundings (Figure 6.1 [2]). Firstly, the station entrances act as 'attractors' drawing unusual concentrations of movement in their immediate vicinity. A more striking pattern is also found as the movement levels appear to more or less fall away in all directions as gates recede from them. Secondly, it was also found that the housing estates and the King's Cross railway lands are 'negative

1 The 1988's King's Cross study is derived from: Hillier, B., et al. (1988). *The Other Side of the Tracks, The King's Cross railway lands site in its urban context.* Unit for Architectural Studies. The Bartlett School of Architecture and Planning, University College London. The study was used as a main case study in Hillier's Natural Movement theory paper to elaborate the ideas of attractor and negative attractor (Hillier, B. et al. (1993). *Natural movement: or,,configuration and attraction in urban pedestrian movement.* In ***Environmental and Planning B: Planning and Design***. vol.20. 29-66). The 1997's King's Cross Studies are: Space Syntax Laboratory. (1997b). *King's Cross - St.Pancras, report on pedestrian movement studies and review of current design proposals.* and Space Syntax Laboratory. (1997c). *King's Cross, Understanding the area. Stage one,* the Bartlett School of Graduate Studies. University College London.

2 As the 1988's King's Cross Study depicted the observed movement rates in the area in numeric figures through a series of black and white maps, the study in this chapter will use the graphic representation from the 1997's study instead, as shown in Figure 6.1. The map provides an intuitive grasp of the mean movement rates illustrated in differently coloured dots ranging in accordance with hourly rates. As the ideas of 'attractor' and 'negative attractor' are consistent in both studies, the 1997's map and its movement database is then used to present a more updated information about pedestrian movement in the area.

attractors'. The movement rates all around the site are not only extremely low but also appear to become lower as the periphery of the site is approached. In other words, these contradictory characteristics can in fact be traced from pedestrian movement pattern as the mean rates tend to fall off while receding from the attractor (the station entrances), and invertly while approaching the negative attractor (the railway land site).

According to Hillier's ideas of natural movement and movement economy, the effects of railway terminus structures on both attracting and deterring pedestrian movement are quite complex and can in fact be seen as 'station-related' as well as 'grid-related'. Railway stations, especially the termini, are by nature the attractors whereby a large number of movement are drawn toward their entrances. This type of movement can be seen as an added-on to the natural movement level that is determined by the grid configuration of the area itself. No matter how the grid structure is, the unusual concentrations of movement can be expected in the vicinity of the station entrances. This is a purely station-related effect. However, the routes where both station-related and grid-related movements add up to a high level would also attract the movement-seeking land use such as retails and businesses to develop alongside them. The routes then attract even more movement which would multiply its effect on further land use development. However, in the empirical observation it is impossible to clearly distinguish the movement types that are influenced by either station entrances, urban grid configuration, or any other attractors in the areas. In term of the 'station as an attractor' effect, the study in this section will then focus on the mean movement rates along some key routes approaching the station entrances and analyse how the concentrations of movement are within the different urban grid structures of all other London's terminus areas besides King's Cross Station's.

On the other hand, although the low movement rates within King's Cross Station area first appear to be fundamentally 'station-related' as there is no accessibility into the terminus building from its rear, the effects are in fact primarily 'spatial-related'. King's Cross' railway lands function as the urban grid barrier, the same as those of some other London's termini such as Paddington and Marylebone Stations, as revealed in the preceding chapter. In a space syntax point of view, it is argued that an interconnected grid network with homogeneously distribution of land uses allows a good flow of natural movement. The discontinuity of the grids thus means that the natural movement system in the area is disrupted. As the street grids are obstructed by the terminus structures, the dead-end routes prevent people to pass through to their destinations beyond. The spatially segregated grids, as a result of the disruption, not only draw the natural movement into the areas in a lesser degree than the integrated grid network, but they would also force people to take several more steps in their journeys in order to reach the other side of the barriers. People then tend to find the other ways to go round them before reaching the dead-ends. The movement rates thus appear to decrease as the railway land site is approached. The lack of a good level of natural movement means that a number of existing retail shops that is movement dependent could also be diminishing. At the same time, the areas could not attract any new land use either. As there is no destination in the areas, movement levels can then be even lower. In term of the 'station as a negative attractor' effect, the study in this section will then examine how the terminus structures other than those of King's Cross Station influence pedestrian movement pattern along some key routes approaching as well as crossing the railway land sites. This aims to examine the effects of the negative attractor on movement by analysing two types of routes that are different in term of their spatial connection.

6.1.1 Method of the empirical study

To examine the effects of attractor and negative attractor on pedestrian movement, the empirical observation was carried out by using the 'three minute sectional gate count' along some key routes around the terminus structures. The routes were selected and typified by their spatial relation to the attractors and the negative attractors themselves. They are the 'station entrance's approach route' (route A), the 'station non-entrance side's approach and siding route' (route B), and the 'railway lines' crossing route' (route C). Route A includes major streets and their alignments that run toward or pass all entry points of each terminus building. Entry points can be the station's direct entrances from street level, the gates to its underground tunnel or to the station's annexed building complex that directly lead station users into the station concourse. The gate observation on route A aims to record the increasing pedestrian movement rates that might be influenced by station entrances. Route B includes the lines that run toward or pass alongside the non-entrance sides of each station building, its approach railway lines and/or adjacent railway lands. Route C includes the lines that cross over or under the approach railway tracks / viaducts and railway lands. The movement levels observed along these last two types of route will be examined and compared in term of the negative attractor effects of which the terminus structures might have on obstructed and unobstructed streets.

A number of imaginary gates located at some important intersections along each route were then set up. The observer stood at each gate for three minutes and counted the total number of adult pedestrians walking pass in both directions. All selective routes and the position of altogether 573 gates in all London's terminus areas excluding King's Cross' are illustrated in Figure 6.2a-6.11a .

In order to set up the movement database of the ten London's terminus areas that can be compared to that of the 1997's King's Cross study, the observation was carried out within the same time periods as the former study. Each round of the three minute gate count was done within two hour time period for altogether three periods: 1200-1400hrs, 1400-1600hrs, and 1600-1800hrs, on a weekday basis. The observation was repeated on another weekday in order to eliminate the influence that the weather variables might have on movement patterns. However, the empirical study had been carried out during the summer season (from March to June 2000) when there had no extreme change of weather. Importantly, the sequential order of gate counts in both rounds of observation was done in reverse. For example, if the observer started counting from gate 1, 2, 3,..., to 10 in the first round, she would begin from gate 10 back to gate 1 in the second round. This is to ensure that the movement levels recorded at each gate truly represent the average rates of the whole two hour time period.

The movement database from the observation of the ten London's terminus areas including that of King's Cross Station area is all presented in form of data tables included in Appendix G . Each table is for each station area. It displays the average movement rates between both rounds of observation of each gate within each time period. The mean rates for all three time periods are calcaluted and then converted to per hour equivalent figures, displayed at the rightmost column of the tables and also illustrated in Figure 6.2b-6.11b. The hourly movement rates of pedestrian movement are plotted in the exact position of the observation gates in different colour dots ranging in the spectrum from the highest rate (5,001 or more movement per hour), shown in dark violet circle, to the lowest movement rate (0 to 100 movement per hour) in grey dot.

6.1.2 Findings of the empirical observation

Here are the empirical findings on pedestrian movement rates around the other London's terminus structures besides King's Cross'. All case studies are reviewed in the same sequential order as the previous morphological analyses in Chapter Four and Five.

6.1.2a Euston Station area

The movement rates at the front of Euston Station and the east of its railway lines are apparently higher than the area to the west of the tracks. These differences seem to correspond broadly to the difference between the 'grid integration' areas (the south and the east) and the 'line integration' area (the west). The top average rates are recorded at the gates along two major shopping streets in the area: Tottenham Court Road and Camden High Street. On Tottenham Court Road, the mean rates range from 2,467 mov/hr in front of Warren Street Underground Station to 3,207 mov/hr in front of Goodge Street Underground Station (gate 2C7-2C9). And on the section of Camden High Street between Delancey Street and Crowndale Road (in front of Mornington Crescent Underground Station), the rates are 2,367-2,700 mov/hr (gate 5A2-5A1). Extremely low movement rates ranging between 20-100 mov/hr are recorded in the proximity of Euston Station's approach railway lines, all depicted in grey dots.

It appears that the effect of Euston Station's entrances as the movement attractors is not clear as there are also other strong attractors located in the area. Nevertheless, its front entrances still draw the highest movement rates compared to the other sides within their immediate surroundings. Depicted in yellow and light green dots, the three gates located at its front have the recorded rates as high as 1,160 (4A1), 1,653 (4A2), and 1,167 (5A7) mov/hr. However, the mean rates along the station entrance's approach routes (route A) do not always increase as gates get closer to the station. For example, on Euston Road (route 3A), the mean rates fluctuate from 1,340 in front of Great Portland Street Underground Station down to 780, up again to 2,133 in front of Euston Square Underground Station, then drop to 727 and 560 mov/hr at the gates just in front of the station's bus entrance (gate 3A1-3A5). The drop at the these two gates occurs as most people tend to enter the station just before at the intersections of Euston Road and Melton Street (route 3A/6A) as well as Euston Road and Eversholt Street (route 3A/5A) through the two diagonal footpaths in Euston Square Garden. In fact, the front gate (4A4) can only draw movement of as low as 333 mov/hr, depicted as a blue dot. Continuing eastward, the movement level along Euston Road then goes up again to 887 and 1,147 mov/hr whilst getting close to St.Pancras Station (gate 3A6-3A7). On another two station entrance's approach routes: 5A and 6A, the University

College campus area to the south also draws higher rates than the gates close to the station.

Contrary to the preceptive attractor's effect on movement, the diminishing rates are recorded on Drummond Street (route A1) as the gate gets closer to the station's side entrance. The mean rate starts from 93 mov/hr in a residential area to the east of Regent's Park then goes up to 280 and slightly falls to 273 and 267 mov/hr as the station is approached (gate 1A1-1A4). On a closer examination, although the route can be used to reach its side entrance, it in fact directs toward the side of the terminus building. There is a chance that people opt to make a short cut from Drummond Street through Cobourg Street then continue their journey along Euston Street which more directly points to the side entrance. This can be seen as the movement rate on Euston Street at the gates before and after its intersection with Cobourg Street increases from 200 to 413 mov/hr (gate 2A1-2A2) as the entrance is approached.

The average movement rates drop sharply in the rear area, especially to the west of the railway tracks, to less than 100 mov/hr or less than 1 to approximately 1.5 passer by per one minute (all depicted in grey dots). The low movement area is extensive, covering much of the residential neighbourhoods at the rear of Euston Station. The low rates appear to be recorded on all railway lines' approach and paralleled routes (route B) while the rates are slightly higher on the three unobstructed lines that cross over the tracks (route 1C-3C). The negative attractor's effect along the obstructed routes is clear as the movement rates tend to more or less decrease as the railway embankment is approached. For example, the rate drops from 493-440-147 to 67 mov/hr on Crowndale Road to Mornington Terrace (gate 1B4-1B1) , from 267-87 to 47 mov/hr on Oakley Square to Mornington Circle (gate 2B3-2B1), from 100-93-67-100 to 33 mov/hr on Aldenham to Barnby Street (gate 3B5-3B1), from 53-53 to 20 mov/hr on Augustus Street (gate 4B3-4B1), and from 140-167 to 60-60 mov/hr on Stanhope Street (gate 5B4-5B1). The rates on the Pheonix Road-Brill Place alignment (route 6B) drop on two directions toward Euston and King's Cross railway land sites (207-220-187-133 mov/hr: gate 6B1-6B4). On the two lines that are paralleled to the tracks (route 7B and 8B), the mean rates are low but do not appear to follow any diminishing pattern caused by the negative attractor.

6.1.2b Liverpool Street Station area

The average movement rates recorded on some key routes around Liverpool Street Station range from moderate to high levels with only a few spots of low rates. The high rates are recorded in the areas to the south, the west (the Broadgate Complex and beyond), and the east of the station while the moderate levels are in the areas alongside the approach railway lines to the north and northeast. The highest mean rates, all depicted in purple dots, are recorded in the immediate vicinity of the station entrances on Eldon Street (3,073-4,894 mov/hr at gate 1A2-1A3), Bishopsgate Road (3,433-4,587 mov/hr at gate 9A7- 9A8), and Liverpool Street (3,013 mov/hr at gate 6A4).

The effects of the station entrances as the movement attractors are striking. Not only the high rates are recorded at the gates close to the station's entry points, located in all four directions, the movement levels appear to fall away as the gates recede from the station especially on the routes that direct toward the entrances themselves. For examples, the mean rates drop from 4,894-3,073 to 2,833 mov/hr on Eldon Street (gate 1A3-1A1), 1,947-1,800-1,667 to 1,007 mov/hr on Old Broad Street (gate 8A2-8A5), 1,627-1,440-1,067-727 to 587 mov/hr on Middlesex Street (gate 3A1-3A5), and 1,593-640-273-253-380 to 240 mov/hr on Lamb Street-Primrose Street alignment (gate 10A1-10A6) at the station's rear.

The movement attractor's effect is even more conspicuous along the routes that pass alongside the station entrances as the rates appear to fall off in both directions as gates recede from the station. For example, on Eldon Street-Liverpool Street-White Kent Road alignment the mean rate starts from 1,660 then goes up to 1,993-2,787 and reaches its peak at 3,013 at the gate in front of Liverpool Street Station's front entrance and underground station entrance (gate 6A1-6A4). Receding from the entrances, the rate then drops to 2,027-1,140-987 but again rises up to 1,140 mov/hr in the last gate as approaching Aldgate Underground Station (gate 6A5-6A8). Another station entrances' siding route is Shoreditch High Street-Bishopsgate-Gracechurch Street alignment (route 9A). The mean rate starts from 467 at the north end and keeps increasing to 473-567-940 until it reaches 1,060 mov/hr at the gate near the northeast entrance to the Broadgate Complex (gate 9A1-9A6). The rate still goes up to 3,433 in front of the two eastern entrances to the complex before reaching its peak at 4,587 mov/hr at the station's side entrance (gate 9A7-9A8). The movement level then begins to more or less fall away from 2,773-2,367-2,780-1,880 to 1,587 mov/hr as the gates recede from the station (gate 9A9-9A13).

The negative attractor's effect in Liverpool Street Station area occurs only on a few routes in the undeveloped area further down the railway lines around Shoredicth Station and the area near the north-western Broadgate Complex's service entrance. The movement rates fall away from 540-192 to 180 mov/hr on the western end section of Bethnal Green Road (gate 4B1-4B3), from 167-160 to as low as 33 mov/hr on Pedley Street (gate 7B3-7B1) and from 940-560-133 to 127 mov/hr on Christopher-Pindar Street alignment (gate 1B1-1B4). However, in a broad picture of its rear area, there are only a few grey dots marked to identify the extremely low movement rates within an extensive area of moderate movement levels all depicted in green and blue dots.

6.1.2c Fenchurch Street Station area

The average movement rates in the proximity of Fenchurch Street Station are relatively high. Only the areas alongside the railway viaducts further down the lines appear to have a record of low movement rates. The highest rates are at the three gates near the front station entrance (2,447-2,273-2,213 mov/hr at gates 4A3-1A3-1A2 respectively).

The effects of the station entrances as movement attractors are clear. Both front and rear entry points that lead up to the elevated concourse hall through a series of escalators attract a large number of pedestrians toward them. It thus seems that this small terminus is well surrounded on all sides by pedestrian bustling areas. The movement rates appear to fall away as gate recedes from the entrances on most of their approaching routes. For example, on Fenchurch Street the rate increases from 1,600 to 2,020 and reaches its peak at 2,447 mov/hr before entering Fenchurch Place (gate 4A1-4A3). Then the rate appears to fall away to 1,667-847 mov/hr as getting farther from the station before increasing again to 1,053 mov/hr in front of Aldgate East Underground Station (gate 4A4-4A6). The same pattern is repeated at Mark Lane-Billitter Street alignment (route 5A). The sequential movement levels are 1,333-2,273-800 mov/hr (gate5A1-5A3) with its highest rate recorded at the gate close to the station entrance (gate5A2). Another small approach route, Seething Lane (route 2A), also records the increasing mean rates from 1,107 to 1,360 mov/hr as approaching the station from the south (gate 2A2-2A1).

The attractor's effect of the station's rear entrance, incorporated at the ground level of an office block on Crutched Friars Street, is also clear. Although the entrance is small and rather hidden, it is well used by local office workers. The movement rates recorded on Jewry - Crutched Friars Street alignment that underpasses the railway viaducts are 1,253-1,080-1,613-1,360-820 mov/hr (gate 6A1-6A2, 3A1, 6A3-6A4) with its peak representing the gate located just before the rear entrance.

The movement rates recorded along the routes crossing under the viaduct structure (route C) are relatively much higher than the obstructed routes which ends at the railway lines (route B). On two crossing routes (route 1C-2C), not only that the rates do not necessarily fall off as approaching the railway land site but they also still maintain their moderate to high levels. On the other hand, the negative attractor's effect on movement occurs at most route B. For examples, the movement level as the railway lines are approached drops from 600-520 to 447 mov/hr on Prescot Street (gate 6B3-6B1), 67-60 to 40 mov/hr on Chamber Street (gate 4B3-4B1), 107 to 67 mov/hr on John Fisher Street (gate 2B2-2B1), 293-253 to 167 mov/hr on Shorter-Royal Mint Street alignment (gate 5B1-5B3).

6.1.2d Cannon Street Station area

The observation on average movement rates around Cannon Street Station reveals that extremely low movement rates are recorded only on the riverside dead end routes and a service road located to the east of the terminus building. The mean rates in general range from high levels, recorded along Cannon Street as well as Downgate Hill - Walbrook Road alignment that are flanked to the front and west sides of the terminus respectively, to moderate levels, along the routes located along both sides of the terminus structures.

The pedestrian movement level on all five station's approach routes (route1A-5A) is primarily influenced by the two station entrances, located on Cannon Street and Downgate Hill. The movement rate increases as gates get closer the station entrances. On Cannon Street, the rate increases from 1,007 to 2,140-2,520 and reaches its peak at 3,227 mov/hr at the gate before the station's front entrance, then falls to 2,613-2,260-1,913-1,273 mov/hr as receding from the station (gate 4A1-4A8). The same pattern is recorded on Walbrook Road - Downgate Hill alignment as the mean rate increases from 1,607 to 2,207 at the intersection before the front entrance then slightly diminishes to 2,147 at the side entrance, and dramatically falls to 487-153 and as low as 47 mov/hr at the dead end route by the riverside (gate 5A1-5A6). The other three station entrance's approach routes also share a similar pattern. The mean rate goes up from 373-433 to 647 mov/hr on Cloak Lane (gate 1A1-1A3), 380-407 to 473 mov/hr on

College Street (gate 2A1-2A3), and 940 to 993 mov/hr on St.Smithin's Lane (gate 3A1-3A2).

The average movement rates along Upper - Lower Thames Street alignment, the only route that underpasses Cannon Street Station's viaduct structure (route 1C), are moderate and do not necessarily fall off as gates approaching the railway lines. The rates fluctuate within the range of 467-927 mov/hr (gate 1C1-1C8). However, the negative attractor's effect on movement is found on all route B. The average movement rate decreases from 860 to 213 mov/hr (gate 2B1-2B2) and from 633 to as low as 13 mov/hr (gate 1B2-1B1) on the two routes approaching the non-entrance side of the station building in the east. The rate also falls from 113 to 53 mov/hr on Allhallows Lane (gate3B1-3B2) which is another riverside dead end route flanked to the east side of the railway viaducts. Although the route itself is not obstructed by the railway lines, the movement level is instead affected by the river Thames as a negative attractor.

6.1.2e London Bridge Station area

The average movement rates in London Bridge Station area in general range from moderate levels, recorded in the front area of the terminus, to low levels, in the rear. The peak rates are at the gates near the station entrances. The records are 3,467 mov/hr at the gate before London Bridge Underground Station's entrance located on Borough High Street (gate 2A2), 2,793 and 2,313 mov/hr at the other two gates before the station's front entrance itself (gate 1A7 and 1A5 respectively).

Similar to Euston Station, London Bridge Station is set back from its front major street (Borough High Street). The terminus has an entry point through an underground tunnel whose gate entrance locates along this street. Although it mainly links to London Bridge Underground Station, the route also connects to the elevated station concourse. A more direct station entrance from the street level can be approached by a large ramp. Another entrance is through a series of escalators, accessible from both ends of Joiner Street, a viaduct pathway that connects Tooley Street in the north with St.Thomas Street in the south. These entry points act as the movement attractors in a similar pattern to those of the other termini.

The mean rates tend to increase as the station entrances are approached, again clearly seen on route A. The rate on Southwark Street dramatically rises from 840-1,380 mov/hr (gate 1A1-1A2) to as high as 3,467 mov/hr at the gate in front of the underground station (gate 2A2) as already mentioned before. The same pattern occurs on the London Bridge Station's Approach (the ramp) as the rate goes up from 793 and 893 mov/hr (gate 1A4 and 1A6) at both ends of the ramp to 2,313 mov/hr at the front entrance (gate 1A5). From the south, on Great Maze Pond through to the elevated walkway over St.Thomas Street as it approaches the front entrance, the rate rises from 513-1,053 to 2,793 mov/hr (gate 1A9-1A7). Similarly, the movement rate along Cotton's Lane - Joiner Street alignment starts from 407-647 then goes up to 967 and 1,327 mov/hr at both ends of the viaduct entrance (5A1-5A4).

The movement pattern along Borough High Street follows a similar pattern of Euston Road. As both termini are set back from their main streets, respectively aforementioned, the increasing pattern of movement levels as the two stations are approached is not clear. In case of London Bridge Station area, the mean rate of 2,567 mov/hr (gate 2A1) is recorded at the foot of London Bridge but the rate then drops to 1,300 mov/hr at the station front (gate 1A3). This is because the station's approach ramp instead attracts a number of people away from the main street. The rate then goes up to its peak at 3,467 mov/hr before the entry gate to London Bridge Underground Station (gate 2A2) and slightly drops to 1,540 and rises up again to 1,800 mov/hr (gate 2A3-2A4) as approaching Borough Underground Station, another attractor in the south.

However, on other two routes that are paralleled to the station's entry point (Tooley Street: route 3A and St.Thomas Street: route 4A), the diminishing pattern of movement rates on both directions as the gates recede from the station entrances is clear. On Tooley Street, the mean rates are 793-1,540-1,167-780-647 mov/hr (gate 3A1-3A5) while the rates on St.Thomas Street are 257-1,013-1,327-460-500-160-180-107 mov/hr (gate 4A1-4A2, 5A4, 4A3-4A7). Strikingly, both routes have their peak movement rates at the gates near both ends of Joiner Street (route 5A) where an entrance to the elevated concourse hall is located.

The negative attractor's effect is clear on Newscomen - Snowfield Street alignment (route 1B). The average rate diminishes from 647-513 to 247 and reaches its lowest level at 120 mov/hr as the railway structure is approached. However, the movement rate on another station non-entrance side's approach line in the north (Battle Bridge Lane or route 2B) appears to instead increase from 293 to 340 mov/hr (gate 2B1-2B2) as the terminus structure is approached. In fact, the route is almost aligned with Weston Street (route 2C) which runs underpass the viaduct structure. The movement is also influenced by the attractor's effect from Tooley Street, the major route with high movement level that connects to all riverside developments in the area.

Although the mean rates on all the railway viaducts' underpassing routes (route 1C-4C) do not always decrease as the viaduct structure is approached, the movement levels are still rather low. Apparently, most viaduct spaces at the rear of London Bridge Station have been adjusted to accommodate other functional uses or simply closed down due to their water leakage problem. These blockades including some adjacent waste pocket spaces in the area, as reviewed in the preceding chapter, instead act as the negative attractors themselves. The movement rates are recorded at as low as 47-100 mov/hr in Stainer Street (route 1C) and White Cross Lane (route 4C), all depicted in grey dots.

6.1.2f Waterloo Station area

The average movement rates in Waterloo Station area in general range from moderate to high levels. The rear of the station building especially within the immediate setting of the railway viaducts apparently has a lower level than its further surroundings. The highest level is recorded at the intersection of Waterloo Road and the Cut - Baylis Road alignment with an average rate of 2,027 mov/hr (gate 6A2). Among the top rates, only one gate is close to the street level station entrance on Waterloo Road (gate 3A1: 1,860 mov/hr). The other high rates are recorded elsewhere such as at the foot of Westminster Bridge (gate 1C1: 1,993 mov/hr), the Imax intersection (gate 6A0: 1,733 mov/hr), and along Lower Marsh Street where the morning market is located (gate 3B1 and 2C3: 1,800 and 1,700 mov/hr).

As Waterloo Station's concourse can be accessible mainly by a footbridge, a ramp or through underground tunnels, the attractor's effect on movement caused by its entry points is not clear, especially along the station entrance's approach routes. Although the recorded movement levels are high in the vicinity of the station entrances, the rates do not necessarily increase as the gates get closer to the station. For examples, the rate instead falls from 1,060 to 973 mov/hr on the Concert Hall Approach - York Road (gate 2A2-2A1), and from 607 to 1,220 then drops to 233 mov/hr on Roupell Street (gate 1A3-1A1). On Waterloo Road that flanks to the only street level entrance of the terminus, the rate starts from 1,733 at the Imax intersection then drops to 1,413 near the station entrance before increasing to 2,027 where the route intersects with the Cut - Lower Marsh Street alignment and finally falls to 707 and 407 mov/hr as receding from the station building. It appears that Waterloo Station's entrances are rather weak movement attractors within an area that has other strong attractors such as the Imax Theatre, the Southbank Centre, a street market and other retail shops. The spatial and visual connections between the entrances and the streets are made difficult by not only the level differences but also the railway lines passing at its front (to the Waterloo East Station), the taxi ramp wrapping around its front and east facades, and the office complex flanked along its west facade. The movement rates then fluctuate according to the location of other stronger attractors.

Similar to London Bridge Station, most Waterloo Station's rear viaduct spaces have been blocked off to accommodate other uses or closed down due to their water leakage problem. They are also attached by some waste pocket areas just like those of London Bridge Station. It appears that the movement patterns at the rear of both termini also share similar features. Although Waterloo Station's elevated railway structure is still criss-crossed by several routes, the rates along these crossing routes (route C) are rather low compared to those at the station's front. This can be explained as that the blocked viaduct and waste pocket spaces including other enclosed properties in the area such as Lambeth Palace, St.Thomas Hospital undermine the grid interconnection of these crossing routes and also act as the negative attractors themselves. However, the rates along these crossing routes do not necessarily fall away as approaching the terminus structures. It is clear that the negative attractors do not cause the pattern of diminishing movement levels along the routes that are not obstructed by the railway tracks. Nevertheless, they can still lower down the movement rates.

The negative attractor's effect is more clearly evidenced at the three obstructed routes (route 1B-3B). As approaching the railway structure, the rate decreases from 140 to as low as 13 mov/hr on Cosser Street (gate 1B2-1B1), from 240 to 220 mov/hr on Frazier Street (gate 2B2-2B1), and more or less in the same pattern on Baylis - Hercules Road alignment, from 1,800-353-540 down to 247 and 260 mov/hr (gate 3B1-3B5).

6.1.2g Charing Cross Station area

There is no sign of the negative attractor's effect on movement caused by Charing Cross Station's structures. The average movement rates recorded around the terminus building are relatively high. The highest rates are at the gates located on the Strand near the station's front entrances (4,693 and 4,660 mov/hr at gate 3A4 and 3A3 respectively). Other high movement levels, all depicted from red to purple dots, are also found along Villiers Street, flanking to the station's east entrance and leading down to Embankment Underground Station (route 5A), and also along Pall Mall running eastward to Trafalgar Square (route 2A).

The effect of the station entrances as movement attractors is clear on most of their approach routes. As getting close to the station, the rate rises from 673-1,627 to 2,793 mov/hr on Bedfordbury - Aldelphi Terrace alignment (gate 1A1-1A3), from 713-533 to 1,320 mov/hr on John Adam Street (gate 4A1-4A3), from 3,253 to 3,740 and 3,693 mov/hr on Villiers Street (gate 5A3-5A1), and from 267 to 420 mov/hr on Craven Street (gate 6A2-6A1). The mean rates on the Strand, another station's approach street, are relatively high all along the route as it is densely flanked with retail shops and theatres. However, it appears that the movement level is still very much influenced by the station. The mean rate increases from 4,133 to 4,573 and reaches its peak at 4,693 in front of its underground and main entrances then starts to drop slightly to 4,660 at the other entrance before dramatically falling to 500 and 993 mov/hr as receding from the station. The Pall Mall - Duncannon Street alignment is the only route that the mean rate drops to 1,867 (gate 2A4) after building up from 2,227-2,553 to 2780 mov/hr as the station entrance is approached (gate 2A1-2A3). However, this is because Trafalgar Square acts as a stronger movement attractor along that route.

The movement on Northumberland Avenue, a station non-entrance side's approach route shows no sign of the negative attractor's effect. The mean rate in fact appears to increase as the railway viaducts are approached, from 1,127-1,393 to 1,620 mov/hr (gate 1B2-1B4). However, the rate finally drops to 467 mov/hr (gate 1B5) at the end of the route but this is due to the partial obstruction of movement from the ongoing construction of the Hungerford Bridge at the time of observation.

The moderate movement levels are recorded on most routes passing underneath the railway viaducts (route C). The mean rates show now sign of the negative attractor's effects caused by the station structures. On the contrary, the movement levels tend to increase as the gates get close to the station structures, similar to those on the routes approaching the station entrances. For example, the rate starts from 773 and 927 at both ends of the observed section of Victoria Embankment (route 4C) and reaches its peak at 1,107 and 1,020 mov/hr at the gates closed to the viaduct structure. Another example is Whitehall Place - Embankment Place alignment. The rate goes up from 360-573 to 1,553 mov/hr (gate 3C1-3C3) as the railway lines are approached.

However, the dramatic increasing number of movement in this case is also because the route leads to Embankment Underground Station. It appears that the movement on these two crossing routes at the rear are still influenced by Charing Cross Station as an attractor. However, the movement rates of as low as 20 and 93 mov/hr are recorded at one viaduct's underpassing route (route 2C). This is because the route is mainly used as the Embankment Place Office Complex's service entrance and closed from public use for most of the times.

6.1.2h Victoria Station area

The average movement rates recorded at the front and sides of Victoria Station are apparently higher than those at its rear. The highest rates are found on Victoria Street, a major shopping street located to the north of the station (6,167-5,900-4,887 mov/hr at gate 3A3-3A1-3A2 respectively). The gates near the station entrances also have high movement levels ranging from 1,553-4,573 mov/hr, all depicted from yellow to dark purple dots.

The movement level along most station entrance's approach routes except Victoria Street is clearly influenced by the station as an attractor. As approaching the entrances, the rate goes up from 907 to 1,120 mov/hr on Grosvenor Place (gate 1A1-1A2), from 553-613 to 713 mov/hr on Lower Belgrave Street (gate 2A1-2A3), and from 580-1,440-1,360 to 1,553 mov/hr on Wilton Road (gate 4A1-4A4). The similar pattern is even clearer on longer routes that flank the station entrances as the mean rate tends to fall away in both directions as receding from the station building. Examples are Grosvenor Garden - Vauxhall Bridge Road alignment (route 5A) and Eccleston - Belgrave Road alignment (route 8A). The rate on the first route starts from 407-1,560 and reaches its peak at 3,347 mov/hr at the gate before Victoria Underground Station's entrance then fall away from 1,947-1,167-1,107 to 1,007 mov/hr (gate 5A1-5A7). On the second route, the rates are 193-860-1,027-2,120-860-633 mov/hr (gate 8A1-8A6) with its peak at the gate before the rear entrance located on Eccleston Bridge (gate 8A4).

Apparently, the railway embankment's approach routes (route B) are not affected by the negative attractor. Although the mean rates are relatively low, they tend to slightly increase as the railway lines are approached. For examples, the rate goes up from 100-93 to 247 mov/hr on South Eaton Place - Semley Place alignment (gate 4B1-4B3), from 260-447-400 to 460 mov/hr on Pimlico Road (gate 3B1-3B4), from 67-80 to

180 mov/hr on Alderney Street (gate 2B1-2B3). Despite approaching the railway tracks, these routes still well connect with their surrounding grids. The only route that has the movement levels diminishing as approaching the railway lines is Warwick Way (route 1B). The mean rate drops from 1,247-380-333 to 233 mov/hr (gate 1B1-1B4). Similarly, the railway lines' crossing routes (route 1C-2C) are not affected by the negative attractor. The mean rates do not necessarily diminish as the railway lines are approached but rather fluctuate according to different land uses.

6.1.2i Paddington Station area

The average movement rates recorded around Paddington Station range from moderate to low levels. The highest mean rates are recorded at the gates near the entry gates to Paddington Underground Station's entrance (2,147 and 2,193 mov/hr at gate 1A5 and 1A4 respectively). The map also shows a void in the observation area which represents the Paddington Basin area and the residential neighbourhoods to the north beyond the Westway. They are the areas where no observation was made as there is no route that directly relates to Paddington Station as well as its terminus structures.

The attractor's effects on movement along the station entrances' approach routes are rather clear. As approaching the station, the rate increases from 240-180 to 220 mov/hr on Chilworth Street (gate 2A1-2A3) and from 787 to 1,320 mov/hr on Spring Street (gate 3A4-3A3). The mean rate on Praed Street goes up from 367-947-1,107 to 2147 and reaches its peak at 2,193 mov/hr at the gate before the station entrance then dramatically drops to 893 and 987 mov/hr as receding from the station (gate 1A1-1A7). However, on London Street - Sussex Place alignment, the rate drops to 680 mov/hr at the gate near the station's east entrance (gate 4A2) after building up from 227 to 753 mov/hr (gate 4A4-4A3). It appears that Paddington Station which is set back behind a railway hotel is mainly accessible through the two underground tunnels and a ramp, all located on Praed Street.

The negative attractor's effect is evidenced even on the routes that cross over the railway lines (route C). This is because there are also other negative attractors besides Paddington Station's approach railway lines located in the area such as the Westway, the Canal Basin and the railway land site. These barriers tend to obstruct these routes even that they are not obstructed by the railway lines. The mean rates on all route B and C tend to be extremely affected by these negative attractors. On three station non-entrance side's approach routes (route 1B, 2B, 4B), the movement levels appear to more or less decrease as the station structures are approached. The rate drops from 587-173-380 to 147 mov/hr on Westbourne Terrace - Bloomfield Road alignment (gate 1B1-1B4), from 207-260 to 200 mov/hr on Harrow Road - Howley Place alignment (gate 2B4-2B2), from 293-593 to 300 mov/hr on South Wharf Road (gate 4B1-4B3). However, the rate on Cleveland Terrace slightly goes up from 387 to 453 mov/hr (gate 3B2-3B3) as approaching the non-entrance side of the terminus. On a closer examination, the route in fact directly leads to the taxi ramp which some pedestrians use to access the low-level station concourse from its west side.

Despite crossing over the railway lines, the movement rate on Porchester Road (route 3C) still drops from 273 to as low as 0 mov/hr as the route is blocked by the Westway at its north end. Likewise, the rate on Bishopbridge Road (route 2C) drops from 1,660-593-460 to 393 mov/hr as the route crosses over the railway lines to be blocked by the Westway to the north. Another example is Westbourne Terrace (route 2B). Although the mean rate goes up from 367-193-267 to 673 mov/hr (gate 1C6-1C3) at the gate just before crossing the railway lines, the level then dramatically drops to 113 mov/hr (gate 1C2) as it reaches the heavily and fast traffic Harrow Road. Despite having a pedestrian crossing, the traffic still makes it very difficult for pedestrians to cross. The mean rate finally rises up to 680 mov/hr (gate 1C1) at the last gate observed within a residential area.

6.1.2j Marylebone Station area

The mean movement rates in Marylebone Station area range from moderate level recorded around the station building in general to extremely low levels, in the immediate surroundings of its approach railway lines. The highest rates are found at the gate along Marylebone Road in front of Baker Street Underground Station (2,933 mov/hr at gate 1A6) and the gate near the station's front entrance on Melcombe Place (2,507 mov/hr at gate 2A3). The movement rates at its rear drops to as low as 27 to 60 mov/hr at the gates along the dead end routes approaching the railway embankment, all depicted in grey dots.

Although Marylebone Station is a small railway terminus, its entrances still have an effect as movement attractors on the routes approaching as well as siding it. The mean rate on its front road: Melcombe Place, goes up from 547-847 and reaches its peak at 2,507 mov/hr at the front entrance then drops to 1,187 mov/hr (gate 2A1-2A4). However, it slightly increases to 1,633 mov/hr as approaching Baker Street

Underground Station (gate 2A5). The similar pattern is also found on Marylebone Road (route 1A) although the station is fairly set back from it. The rate increases from 420-940 to 1,047 and 980 mov/hr at the gates before Harewood Avenue and Great Central Street (gate 1A1-1A4), the two routes that directly lead northward to Marylebone Station. It then drops to 833 mov/hr before rising up dramatically to 2,933 mov/hr as receding Marylebone Station and approaching Baker Street Underground Station (gate 1A5-1A6). Similarly, the rate starts from 107 mov/hr within a residential area on Wyndham Place then goes up to 267-713 and reaches its peak at 1,073 mov/hr before the station's side entrance on Harewood Avenue then begins to fall away to 333-293-300 mov/hr as the gate gets farther from the station (gate 3A1-3A7).

Even on the two non-entrance side's paralleled routes: Boston Place (route 7B) and Balcombe Street (route 8B), the movement appears to also be affected by the station's front entrance as an attractor. On the first route, the rate goes up from 27 to 107 and 247 mov/hr (gate 7B1-7B3). The mean rates on the second route are 113-240-340-167-27 mov/hr (gate 8B1-8B5) with its peak at the gate close to the station entrance (gate 8B3).

The mean rates on the railway embankment's crossing routes (route C) appear to be higher than its approach routes (route B). The negative attractor's effect is clearly evidenced along all the obstructed routes. The movement levels are not only extremely low in the proximity of the railway embankment but the falling away of movement rates as the barrier is approached is also evident. The rate drops from 1,240-1,013-513 to 60 mov/hr on Church - Lilestone Street alignment (gate 1B1-1B4), from 560-167-107 to 53 mov/hr on Broadley Terrace (gate 2B1-2B4), from 307 to 27 mov/hr on Taunton Place (gate 3B1-3B2), from 307 to 107 mov/hr on Ivor Place (gate 5B2-5B1), from 247-107 to 27 mov/hr on Boston Place (gate 7B3-7B1), and from 340-167 to 27 mov/hr on Balcombe Street (gate 8B3-8B5).

However, the movement pattern along Park Road (route 4B), a railway embankment's siding route and a local Muslim community's shopping street where their mosque is also located, shows no sign of the negative attractor's effect. The mean rates are within a moderate range of 813-1,107 mov/hr (gate 4B1-4B4), all depicted in light green and dark green dots.

6.1.3 Summary and analysis of the empirical findings: the effects of London's terminus structures as movement attractor and negative attractor.

The empirical observation on pedestrian movement level around London's railway termini revealed complicated characteristics of the terminus structures as both movement attractors and negative attractors. The findings show that although these station-related movement patterns are clearly evident in most of the terminus areas, they are obscured in some others due to some spatial and other related factors. Here is the summary and analysis of the empirical findings.

* Not all termini are strong movement attractors. The patterns of highest average movement levels recorded at the gates close to the entrances as well as the falling off rates as gates receding from them were clearly evident at all terminus areas except those of Euston, London Bridge, and Waterloo Stations. These three termini appear to be rather weak attractors. Although high levels of movement were evident in the vicinity of their station entrances, the peak rates were recorded elsewhere especially on their nearby shopping streets. It also appears that the movement rates do not necessarily decrease as receding from these station buildings. Apparently, they are the only three London's termini whose entrances have a rather complicated spatial connection with major streets. Euston Station is set back from Euston Road behind a series of gardens, plaza, a bus station and office buildings while London Bridge Station is hidden away from Borough High Street behind passing railway lines as well as building complexes. This elevated station can be mainly accessible through a large ramp at its front. Similarly, Waterloo Station's entrances are blocked by a taxi ramp, passing railway lines, and mainly approached through a footbridge or underground tunnels. While the exact location of the other termini including King's Cross Station can be detected from the accumulating levels of movement along their approach routes, the presence of Euston, London Bridge, and Waterloo Station buildings from the pedestrian's point of view is not clear. High levels of movement tend to be dissolved around these three terminus buildings without any focal point of peak rates.

* Not all termini are negative attractors. The empirical study revealed that, unlike King's Cross Station, some London's terminus structures such as those of Cannon Street, Charing Cross, Victoria, and Liverpool Street Stations do not deter pedestrian movement. Although low movement levels were recorded along some of their railway lands' approach routes or in the undeveloped areas further down their railway lines, the rear areas of these termini generally draw good levels of movement in average. In

Cannon Street and Charing Cross Station areas, low movement rates of less than 100 mov/hr. were recorded only on a few service roads at the stations' rear while the areas in general recorded moderate to high movement levels. Victoria and Liverpool Street Station areas have only a few spots of low movement rates recorded along some routes within their rear residential neighbourhoods further down the railway lines. Moreover, both termini also draw high levels of movement toward their rear entrances. The movement attractor's effects thus occur in the areas all around both station buildings, not only at their front. Additionally, unlike King's Cross Station area, these four terminus structures rarely cause the falling off movement rate pattern along their railway land site's approach routes. According to the preceding spatial analysis in Chapter Five, Liverpool Street, Cannon Street, Charing Cross, andVictoria Station's structures are well-embedded in their surrounding grid networks whereby their approach railway lines are either crossed or underpassed with several pedestrian routes.

However, Euston Station area is an exception. Although its grid network is not completely obstructed by the railway lines, there are much fewer routes, compared to Victoria Station area, that connect the residential neighbourhoods along both sides of the railway tracks together. The negative attractor's effects are clearly evident especially within the areas adjacent to the railway embankment. However, Euston Station's railway lines' crossing routes as well as the areas of Camden Town and Somers Town to the east of the tracks which include shopping, commercial, and residential neighbourhoods draw relatively high levels of movement.

Apart from King's Cross Station area, the negative attractor's effects are clearly evidenced in Paddington and Marylebone and to a lesser extent, in London Bridge, Waterloo, and Fenchurch Street Station areas. Similar to King's Cross Station, the average movement rate at the rear of Paddington and Marylebone Stations drops sharply once the urban holes, caused by their railway lines and railway lands, are approached. Movement rates at the rear of London Bridge, Waterloo, and Fenchurch Street Station buildings range from low to moderate levels. However, in Fenchurch Street Station area, the negative attractor's effects are evident only in the area further down its railway lines where the viaduct structure has been fenced off. The station's immediate surrounding grids still draw high levels of movement. In Waterloo and London Bridge Station areas, low to moderate movement levels were recorded around their rear railway viaducts although the structures themselves are not urban barriers. Despite several underpassing routes, the pedestrian connection in the areas is sparse due to the presence of several waste pocket areas including other nearby barriers (such as some large enclosed properties in case of Waterloo Station). These waste pocket spaces and private properties act as the negative attractors themselves.

* The negative attractor's effects occur especially along the obstructed routes. The empirical study clearly showed that the patterns of low movement levels and falling off rates mostly occur along the railway land sites' approach routes (route B), not on their crossing routes (route C). In all terminus areas, it thus always appears that movement levels on the railway lines' crossing routes are relatively higher than those of the obstructed ones. Movement rates along the crossing routes also do not decrease as the gates get close to the railway lines. In some of the crossing routes at Liverpool Street, Victoria, and Charing Cross Station areas, movement levels even increase as they are affected by the nearby station entrances. Moreover, in Liverpool Street and Victoria Station areas, movement rates do not fall off along some of their railway embankment's approach routes (route B) as well. Apparently, although these routes lead to the railway lines, they still well connect with other routes in the areas.

* The common effects of attractor and negative attractor on movement can be deviated if there are some other strong attractors also located in the station areas. Fluctuation in movement levels can occur along both station entrances' and railway lines' approach routes (route A and B respectively) if there are some major retail shops, market, or underground train station entrances, etc. located along them. Examples can be clearly seen in Victoria, Euston, Waterloo, and London Bridge Station areas. Victoria Station appears to draw a large number of pedestrians toward their entrances, evidenced as an accumulating movement pattern toward the station on all approach routes except on Victoria Street. The route is a major shopping street whereby the highest rates are recorded at the gates further along the route, not the one close to the station entrance. Similar to Euston, Waterloo, and London Bridge Stations, movement levels fluctuate along the observed routes by sharply increasing as the gates are close to underground train station entrances, retail shops, or market space.

In summary, it thus appears that pedestrian movement in London's railway terminus areas is very much affected by the terminus structures through their roles as movement attractor and negative attractor. However, the findings add up to the existing King's Cross study by pointing out that not all London's termini are strong attractors and negative attractors and this is due to the urban grid configuration of the terminus areas including the spatial relationship between the station entrances and their surrounding grids. In case of the station areas where the terminus structures are well embedded within the interconnecting grid networks such as Liverpool Street, Victoria, Cannon Street, and Charing Cross Station areas, the attractor's effects would occur both at the stations' front and rear sides. The negative attractor's effects in these areas are evident in a less degree and only in some locations further down the railway lines where the street grids are obstructed.

In case of the station areas where the terminus structures, railway lands, or other urban barriers such as waste pocket spaces, enclosed private properties, etc. cause degrees of disruption to the urban grids such as Euston, Fenchurch Street, Waterloo, London Bridge, Paddington, Marylebone, and King's Cross Station areas, the negative attractor's effects are clearly evidenced especially in the locations where their urban grid networks are interrupted. It can also be said that all station areas consist of several sub-areas which are distinctively affected by the terminus structures and thus have different levels of pedestrian space use. The next section will turn to an examination of the grid-related movement in all sub-areas around London's terminus structures.

6.2: THE URBAN GRID-RELATED MOVEMENT PATTERN IN LONDON'S RAILWAY TERMINUS AREAS

The Statistical Analysis

To examine the relationship between urban grid structure and pedestrian movement in each terminus area, the analysis in this section is based on a series of scattergram plotting spatial integration values against movement rates observed in all sub-areas around the station structures. The spatial variables of all observed routes, derived from the axial map of the catchment area of all London's terminus areas (illustrated and analysed in Section 5.3.2), as well as the pedestrian movement rate database, from the empirical observation (presented in the preceding section), are altogether displayed in a single station-based data table in Appendix H .

All gates are categorised by two factors. First is the degree to which they locate within the proximity of the station entrances. The gates which locate in front of or nearby the entrances are categorised as 'entrance' gates while the ones further out along the observed routes are 'street' gates. All gates are also ranged according to their location within sub-areas around the terminus structures. They are categorised into the gates located within 'north', 'east', 'west', or 'south' sub-areas. In some cases where there are more than one sub-area within any of the direction, the gates are further ranged into 'sub-area: a, b, c,...'. For example, in Charing Cross Station area, all entrance and street gates located to the north of the station are further categorised into sub-areas 'north-a' and 'north-b'. The allocation of gates in all sub-areas around each London's terminus building is depicted in Appendix I (Plate I.1-I.11).

6.2.1 Methods of the statistical analysis

Statistical analysis techniques have been used to understand and examine the fundamental relationships between the different parameters measured for the morphological analysis of public spaces, and to determine which of these factors are most significant in predicting the performance of public space. Here is a brief description of the key techniques used in this study.

'Regression analysis' is the standard technique that is used to predict a single dependant variable from the knowledge of one or more independent variables. 'Simple regression' is used when the analysis involves only a single independent variable, and 'multiple regression', for two or more independent variables.

In this study, the linear relationship between spatial and movement variables will be evaluated. A linear regression simply means that the functional relationship between Y (the dependent variable in the vertical axis in the scattergrams) and X (the independent variable in the horizontal axis) can be expressed by a linear equation. In the case of simple regression, the equation[3] is: $\mathbf{Y = b_0 + b_1 X}$. Where 'b_0' is the intercept on the 'Y' axis and 'b_1' is the gradient of the line. These parameters are known as the regression coefficients, displayed at the top of the scattergram. Using a mathematical procedure[4], these values can be used to calculate a regression line shown in the scattergram. The regression analysis calculates the linear coefficient of determination (R-squared value), which is a measure of the strength of the linear relationship between X and Y values. The greater the proportion of explained variation, the stronger the degree of the linear relationship. An example of regression analysis is shown below in Plate 6.1 .

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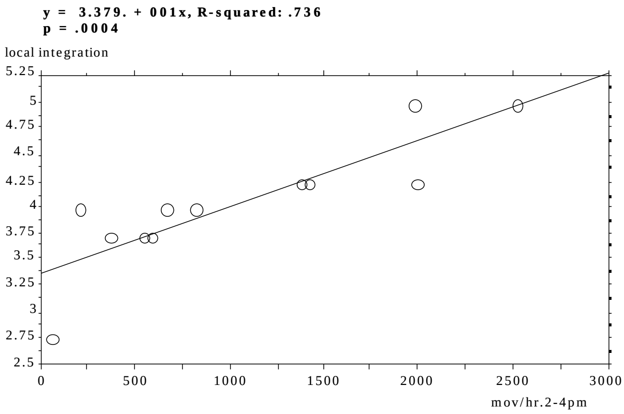
3 Hair, J.et al. (1992). Multivariate Data Analysis with Readings. New York: Macmillan Publishing Company.

4 The statistical analysis in this chapter was done using the 'New Statview 512' software.

Plate 6.1: Regression analysis



In the example where the movement rates is plotted against the local integration values, the even distribution of points along the regression line indicates a good linear relationship. The R-squared = 0.736 means that 73.6% of the variability of Y is explained by X. The regression analysis also calculates a probability value (p-value). P-value importantly tells how strong or weak the evidence is the support the results, where the smaller the value, the stronger the evidence. Results with p-value of more than 0.05 are generally not considered because they are regarded as statistically insignificant.

While the coefficient of determination value in simple regression tells how strong the relationship between a dependant variable and an independent variable, the same analysis from multiple regression analysis is used to express the strength of the relationship between a set of independent variables in order to predict the values of one dependent variable.

'Stepwise regression' is a statistical techniques that is used to sort from a large number of independent variables which one(s) are significant and which not significant in predicting the variation of one dependent variable. The results are given by listing which predictors should be deleted and which should be added to the regression model.

For the statistical analysis in this section, the main objective is to examine the relationship between urban grid configuration and pedestrian movement in each sub-area around the terminus structures. The strong relationship would mean that the level of movement is determined by the grid structure itself and thus can in fact be identified as the level of natural movement in that sub-area. In order to identify this grid-related movement level, the station-related effect on movement caused by the station entrances must then be eliminated as much as possible. This can be done by excluding the gates located close to the station entrances (categorised as 'entrance' gates in the table) in the regression analysis. Although it is noted from the preceding section that the unusual concentrations of movement caused by some station entrances can in fact be detected even in the locations further out along their approaching routes, the exclusion of the entrance gates is the best way to reduce, if not all removal, such attractor effect in this statistical analysis.

Furthermore, the attractor effect can be further minimised by examining the movement levels around the termini during the time when the station entrances have the least influence on movement, that is the station's non-peak period (2-4pm), or the period in between the lunch peak (12-2pm) and the evening peak (4-6pm). The stepwise regression analyses presented below in Table 6.1-6.3 also confirm the mean movement rates of the 'street' gates in all eleven station areas during the 2-4pm time period as the only dependant variable among all four time periods (12-2pm, 2-4pm, 4-6pm, and the mean rate of 12-6pm) that gives the significant prediction to all three spatial variables (global integration, location integration, and connectivity).

Table 6.1: Stepwise Regression analysis global integration values and time-periodwise movement variables

Integration N vs. 4 independent variables

F to Enter	4
F to Remove	3.996
Number of Steps	1
Variables Entered	1
Variables Forced	0... 0

Variables in Equation

Parameter:	Value:	Std. Err.:	Std. Value:	F to Remove:
INTERCEPT	1.556			
mov.2-4pm.	1.784E-4	2.197E-5	.325	65.984

Variables Not in Equation

Parameter:	Par. Corr:	F to Enter:
mov.12-2pm.	-.012	.08
mov.4-6pm.	-.009	.05
μ.mov.ALL	-.009	.047

Table 6.2: Stepwise Regression analysis local integration values and time-periodwise movement variables

Integration 3 vs. 4 independent variables

F to Enter	4
F to Remove	3.996
Number of Steps	1
Variables Entered	1
Variables Forced	0...0

Variables in Equation

Parameter:	Value:	Std. Err.:	Std. Value:	F to Remove:
INTERCEPT	3.381			
mov.2-4pm.	.001	7.445E-5	.387	98.077

Variables Not in Equation

Parameter:	Par. Corr:	F to Enter:
mov.12-2pm.	-.027	.401
mov.4-6pm.	-.003	.006
μ.mov.ALL	-.013	.097

**Table 6.3: Stepwise Regression analysis
connectivity values and time-periodwise movement variables**

Connectivity vs. 4 independent variables

F to Enter	4
F to Remove	3.996
Number of Steps	1
Variables Entered	1
Variables Forced	0... 0

Variables in Equation

Parameter:	Value:	Std. Err.:	Std. Value:	F to Remove:
INTERCEPT	7.529			
mov.2-4pm.	.005	4.926E-4	.379	93.369

Variables Not in Equation

Parameter:	Par. Corr:	F to Enter:
mov.12-2pm.	-.044	1.068
mov.4-6pm.	.002	.002
µ.mov.ALL	-.015	.125

The stepwise and simple regressions (Table 6.4 and Plate 6.2) further confirm that the local integration (int-3) generally outperforms the other spatial variables to predict movement levels in all eleven London's terminus areas. This means that pedestrian movement around the termini is most influenced by how the grids are distributed to benefit the local scale of movement in the station areas. The case by case regression analysis presented follow on will then use the local integration values to examine the relationship between urban grid configuration and pedestrian movement.

**Table 6.4: Stepwise Regression analysis,
mean movement rates (2-4pm) and three spatial variables**

Movement rate (2-4pm.) vs. 3 variables

F to Enter	4
F to Remove	3.996
Number of Steps	2
Variables Entered	2
Variables Forced	0 ...0

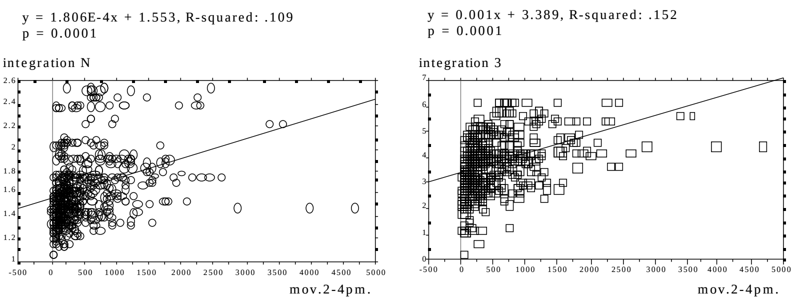
Variables in Equation **STEP 2:**

Parameter:	Value:	Std. Err.:	Std. Value:	F to Remove:
INTERCEPT	-497.222			
int3	159.902	26.9	.306	35.335
intN	227.747	93.834	.125	5.891

Variables Not in Equation

Parameter:	Par. Corr:	F to Enter:
conn	.065	2.46

**Plate 6.2: Scattergrams of mean movement rates (2-4pm)
and the two spatial variables in equation**



6.2.2 The regression analysis

Plate 6.3-6.13 is a series of scattergram plotting local integration against movement rates (2-4pm) of the 'street gates' in eleven London's terminus area, with the integration values read from their large catchment areas. Starting from Euston through to Marylebone Station areas, the regression analyses are reviewed in the same order as all the preceding analyses with all scattergrams presented within the fixed frame of both axes throughout. The first scattergram of each plate combines all sub-areas of the station area while the others that follow plot each of the sub-areas separately. In order to easily identify the sub-areas that yield good levels of movement, the sub-area scattergrams in each case are orderly arranged according to the areas' mean movement rate, from the highest to the lowest. Here is the area by area statistical analysis.

6.2.2a Euston Station area

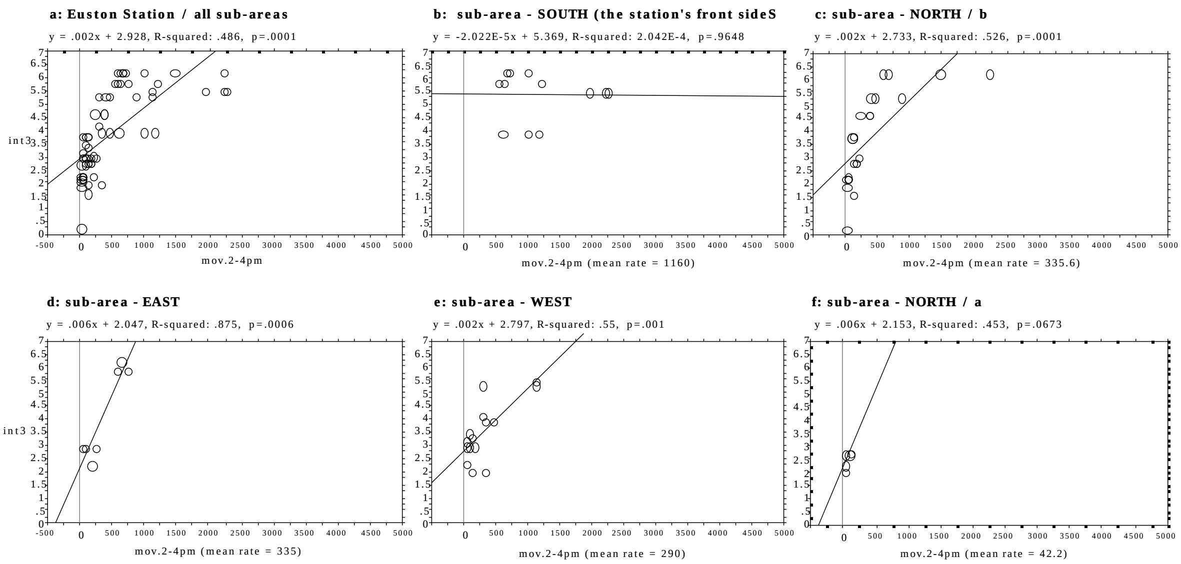
The strength of the scatter of Euston Station area (Plate 6.3a) with its R-squared value of 0.486 suggests that the relationship between integration and movement in the area is rather strong. A good correlation read from the analysis of the whole station area also means that its sub-areas are structured within a more or less single urban grid framework, attracting different levels of movement ranging from the busy office and university area at the front and Camden Town's retail and commercial area at the rear to quiet residential areas alongside its approach railway lines.

Although the station's front side (6.3b sub-area: south) attracts the highest mean movement rates, the correlation is rather weak. The area consists of several integrators which run north-south through the University College London's campus. This large institution is single-use and, similar to a railway station, functions as an attractor which seems to attract a number of university students for all day long. Additionally, retail shops as well as other commercial and business uses on both Tottenham Court Road and Euston Road also have an influence on movement as attractors. There is then no clear relationship between urban grid structure and movement in the area.

The scattergram of the other surrounding sub-areas reveals a strong correlation (6.3c-f). It thus confirms that the mean movement rates of these areas can be read as the natural movement levels, or the amount of movement that is influenced by the urban grid structure itself. However, it appears that the surrounding grid networks of Euston

Station, except that of the front, attract only moderate movement rates. The commercial area of Camden Town located to the northeast (6.3d sub-area: north/b), the residential areas of Somers Town (6.3c sub-area: east) and Regent's Park (6.3e sub-area: west) have mean movement rates ranging from 290 to 335.6 mov/hr. The residential area located to the west of the approach railway lines (6.3f sub-area: north/a) attracts the lowest movement level of only 42.2 mov/hr in average.

Plate 6.3: EUSTON STATION AREA
Regression analysis of local integration and movement.

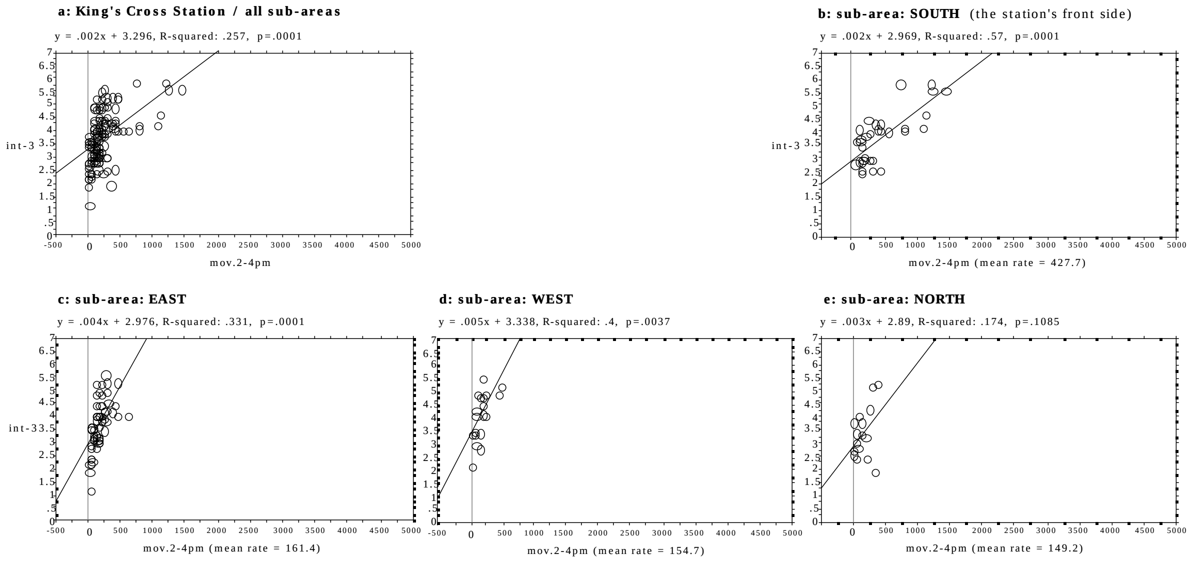


6.2.2b King's Cross and St.Pancras Station area

The combined scattergram of King's Cross Station area (Plate 6.4a) reflects several splits and a weak correlation, representing several sub-areas separately located around the large urban hole that its terminus structures and railway lands have caused. Separately analysed, all sub-area scattergrams except that of the Agar Grove residential area located to the north (6.4e sub-area: north) show stronger correlations. The station's front side (6.4b sub-area: south) draws the highest mean rate of 427.7 mov/hr. which is also confirmed to be the grid-related movement level by a strong correlation of its scattergram (with an R-squared value of 0.570).

The sub-areas on both sides of the railway lands (6.4c sub-area: east and 6.4d sub-area: west) draw movement rates of only 161.4 and 154.7 mov/hr. respectively. Both areas show a fair relationship between movement and integration, with R-squared values of 0.331 and 0.400 respectively. They include several housing estates located at the outer rim of the King's Cross railway land site and it is clear that their natural movement levels are rather low. The north sub-area (6.4e) draws the mean rate of as low as 149.2 mov/hr. However, its correlation is rather weak as the area consists of both housing estates and light industrial use which are not homogeneously distributed in the area.

Plate 6.4: KING'S CROSS STATION AREA
Regression analysis of local integration and movement.



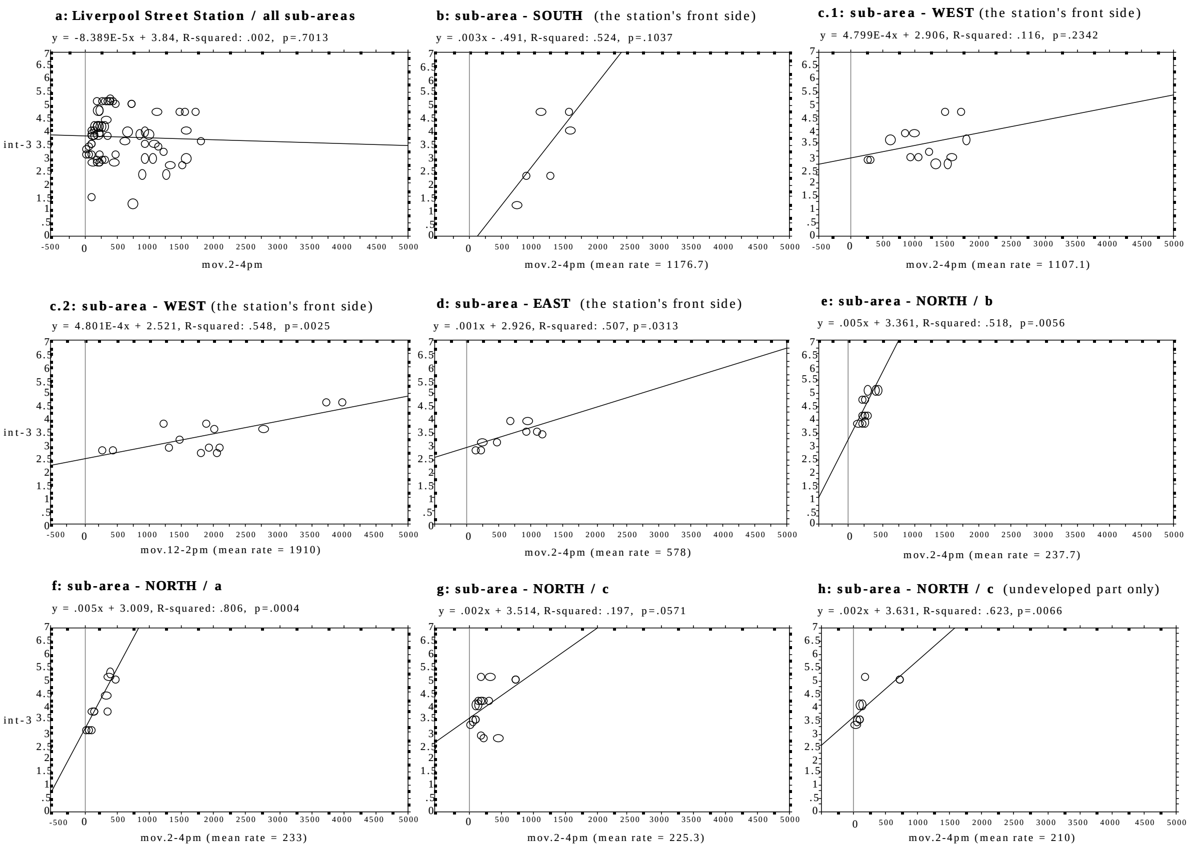
6.2.2c Liverpool Street Station area

Liverpool Street Station area consists of several distinctive sub-areas as shown in several splits in its combined scattergram (Plate 6.5a). Separately plotted in Plate 6.5b-g , most sub-area scattergrams show much better R-squared values than the combined one. Only the residential area located between the approach railway lines and the Spitalfield market (6.5g sub-area: north/c) shows a rather weak correlation between integration and movement.

The strength of the scatter of all three sub-areas located to the front and sides of the station (6.5b-6.5d sub-areas: south, west, and east) confirms that their grid structures have very much influence on movement. Their good correlation confirms that the mean movement rates of as high as 1176.7, 1910, and 578 mov/hr. respectively can be read as the natural movement level in the areas. However, it is noted that the local integration values of the observed routes in Broadgate Complex area (6.5c sub-area: west) appear to correlate well with the movement rates recorded during the lunch time period (12-2pm) instead of the mid-afternoon (2-4pm), shown in comparison in 6.5c/1 and 6.5c/2 . This is because the area has been developed as a mix-use complex of office, retail, and public spaces whereby its main users are local office workers who flock into the area mostly during their lunch break.

The other three undeveloped sub-areas located to the north along the approach railway lines (6.5e-6.5g sub-area: north/a,b,c) attract moderate levels of movement (233, 237.7, and 225.3 respectively). The first two show a strong correlation confirming that their movement levels are urban grid related. The weak correlation is evidenced in the third sub-area. Its location is to the north of the Spitalfield Market (6.5g sub-area: north/c). This area in fact consists of both undeveloped and developing parts. The undeveloped part located alongside the railway lines is mainly occupied by existing council flats and dilapidated warehouses while the developing part is extended northward from the adjacent Spitalfield office and residential development complex. When excluding these new spaces, the correlation gets very much improved (from 0.197 to 0.623) as shown in comparison in 6.5g-6.5h .

Plate 6.5: LIVERPOOL STREET STATION AREA
Regression analysis of local integration and movement.

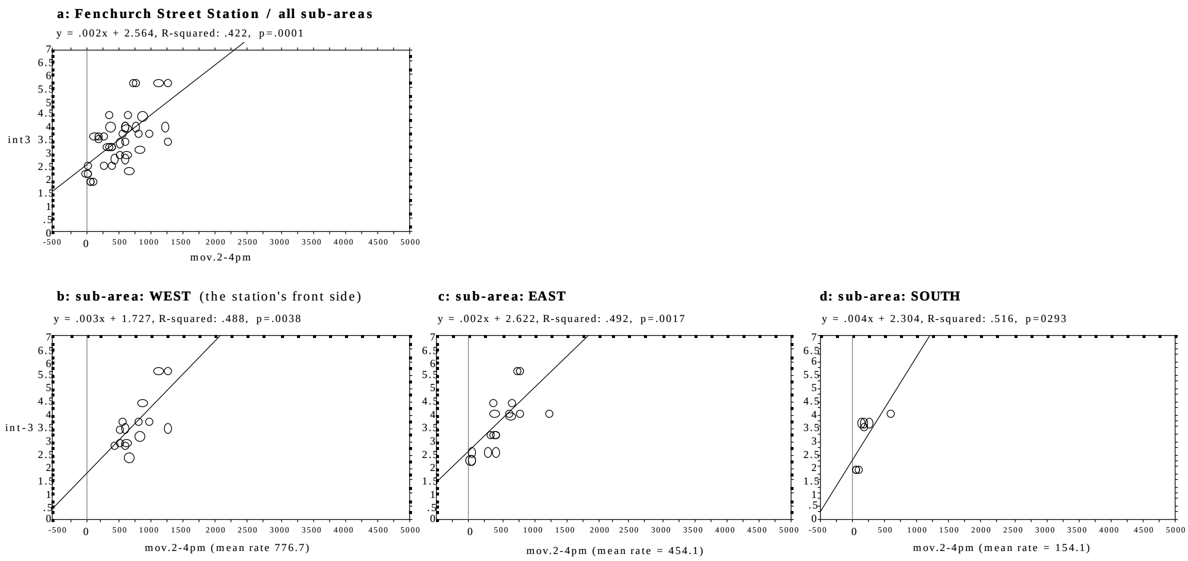


6.2.2d Fenchurch Street Station area

The strength of the scatter in the combined scattergram of Fenchurch Street Station area (Plate 6.6A) confirms that this small and elevated terminus structure imposes very little effect upon its spatial context as the station's surroundings are structured as a more or less single area within a main urban grid framework. With an R-squared value of 0.422, it appears that pedestrian movement within the area is generally very much influenced by the urban grid structure. However, the station area can also be read as three distinctive sub-areas divided be the railway viaduct structure, attracting different levels of movement in average. The sub-area scattergrams (6.6b-6.6d) all show a strong correlation which means that the movement levels are all grid-related.

The highest mean rate (776.7 mov/hr.) is evidenced in the station's front area (6.6b sub-area: west) which is the business and commercial area included in the City of London. The Whitechapel area located to the north of the approach railway lines (6.6c sub-area: east) attracts relatively less but still high level of movement (454.1 mov/hr). The residential area located in between the railway viaduct structure and St.Katherine's Dock area (6.6d sub-area: south) draws the lowest movement level with its mean rate of only 154.1 mov/hr.

Plate 6.6: FENCHURCH STREET STATION AREA
Regression analysis of local integration and movement.

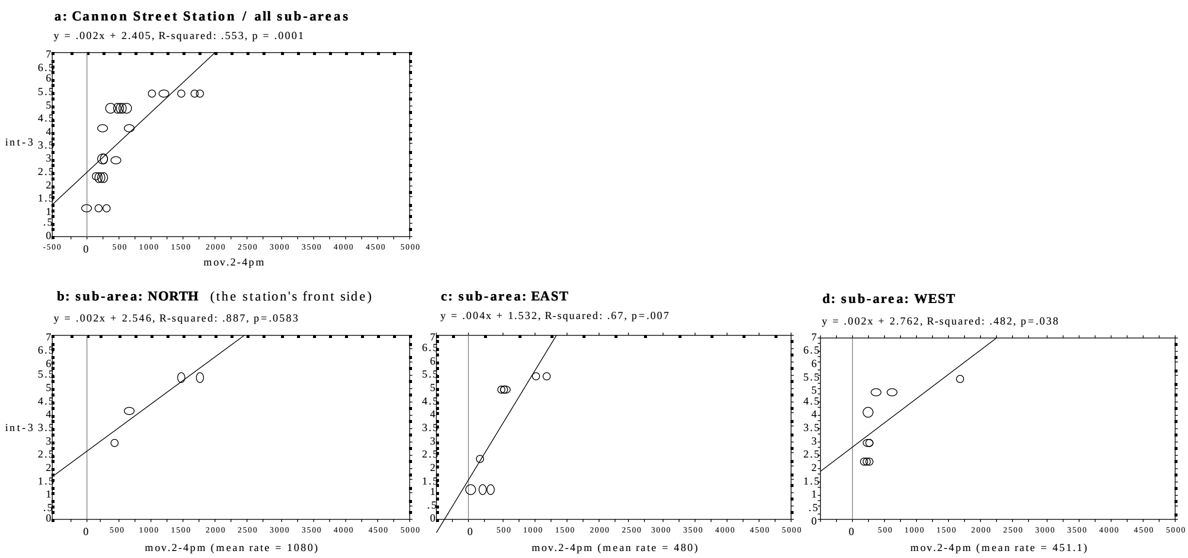


6.2.2e Cannon Street Station area

The strength of the combined scattergram of Cannon Street Station area (Plate 6.7a) suggests that its sub-areas are more or less structured within a single urban grid framework. Similar to Fenchurch Street, Cannon Street Station is a small and elevated terminus structure which imposes very little effect upon its surroundings, also with a topographical advantage of the site just beyond the River Thames' bank.

All three sub-areas located to the north, east, and west of the station draw relatively high movement rates in average (6.7b-6.7d). They are all included within the City of London area and mainly occupied by commercial and office buildings, some with ground floor retail areas. It is also confirmed that their mean movement rates can be read as the natural movement levels as all of the sub-area scattergrams show strong correlations with the R-squared values of 0.887, 0.670, and 0.482 respectively. However, the highest movement level of 1080 mov/hr is found at the station's front side (6.7b sub-area: north) while the east and west sub-areas (6.7c-6.7d) are relatively quieter but still attract movement of as high as 480 and 451.1 mov/hr. respectively.

Plate 6.7: CANNON STREET STATION AREA
Regression analysis of local integration and movement.

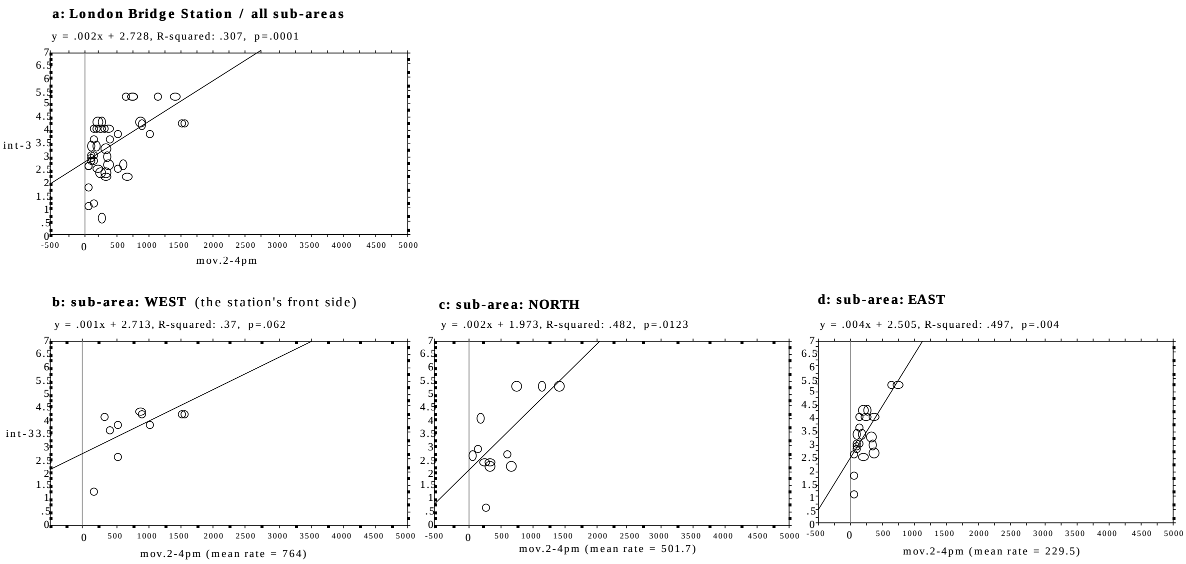


6.2.2f London Bridge Station area

The combined scattergram of London Bridge Station area shown in Plate 6.8a reflects several splits, representing several distinctive sub-areas located around the terminus structures. Considering all three sub-areas separately, the station's front side draws the highest mean rate of 764 mov/hr (6.8b sub-area: west). However, its scattergram shows a rather weak relationship between movement and integration, with an R-squared value of only 0.370. This can be explained as the front area also includes several other strong attractors which make the relationship between urban grid configuration itself and movement unclear. It has a combination of high street retail and office spaces, market, hospital and a much quieter residential area located behind busy streets. It also has an influence of the underground train stations' entrances of both London Bridge and Borough Stations.

Both scattergrams of the sub-areas: north and east (6.8c-6.8d) show a strong correlation with R-squared values of 0.482 and 0.497 respectively. However, only the north sub-area which is occupied by both existing and new office and commercial developments attracts a high mean rate of 501.7 mov/hr. The east sub-area is a residential area mainly filled with council flats located alongside the railway viaducts. The area attracts movement of 229.5 mov/hr in average. However, the strong correlations suggest that both can be read as their natural movement levels.

Plate 6.8: LONDON BRIDGE STATION AREA
Regression analysis of local integration and movement.

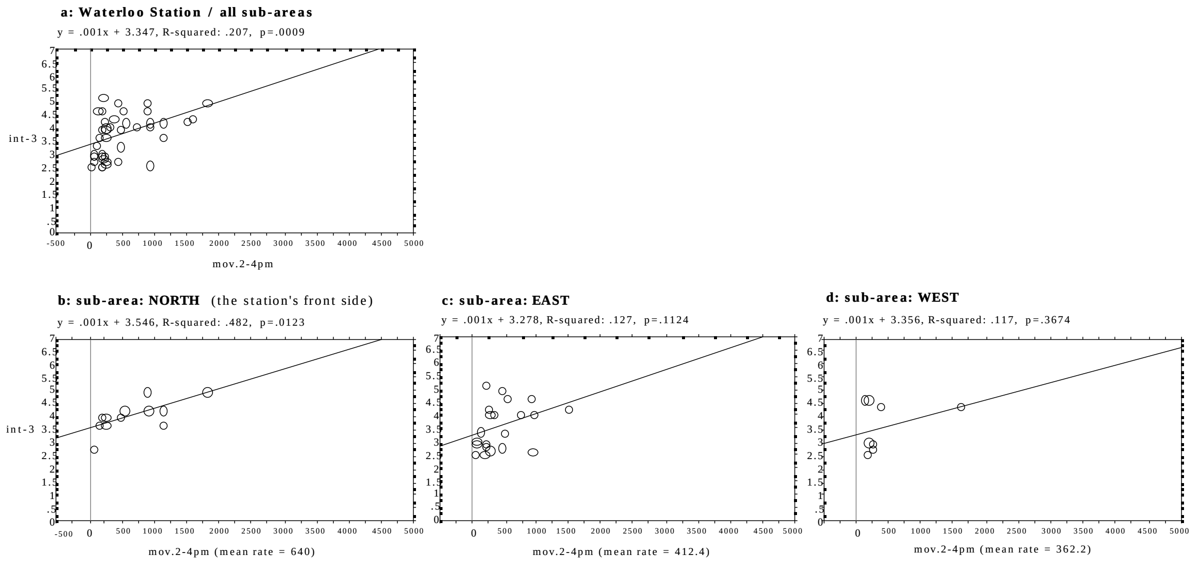


6.2.2g Waterloo Station area

The weak correlation of the combined scattergram of Waterloo Station area (Plate 6.9a) suggests that the area generally consists of several sub-areas. Similar to most other London's termini, the station's front side (6.9b sub-area: north) draws the highest movement rate in average (640 mov/hr). The strength of the scatter with an R-squared value of 0.482 suggests that this mix-use area of retail, business, and residential spaces located to the north side of the terminus is well structured with a homogeneous distribution of land use despite the existence of the railway viaduct structure of Waterloo East Station.

As the urban grid at the station's rear is not completely disconnected, the sub-areas located alongside the approach viaduct structure (6.9c sub-area: east and 6.9d sub-area: west) appear to draw movement levels of as high as 412.4 and 362.2 mov/hr. respectively. However, their scattergrams show a rather weak correlation which suggest that the movement in both sub-areas is not well related to their grid structures. The east sub-area consists of blight housing estates and a morning market street which can turn very quiet during the afternoon period. The west sub-area is confined by several enclosed private properties with some of their internal routes being auto-oriented and not very well used by pedestrians.

Plate 6.9: WATERLOO STATION AREA
Regression analysis of local integration and movement.

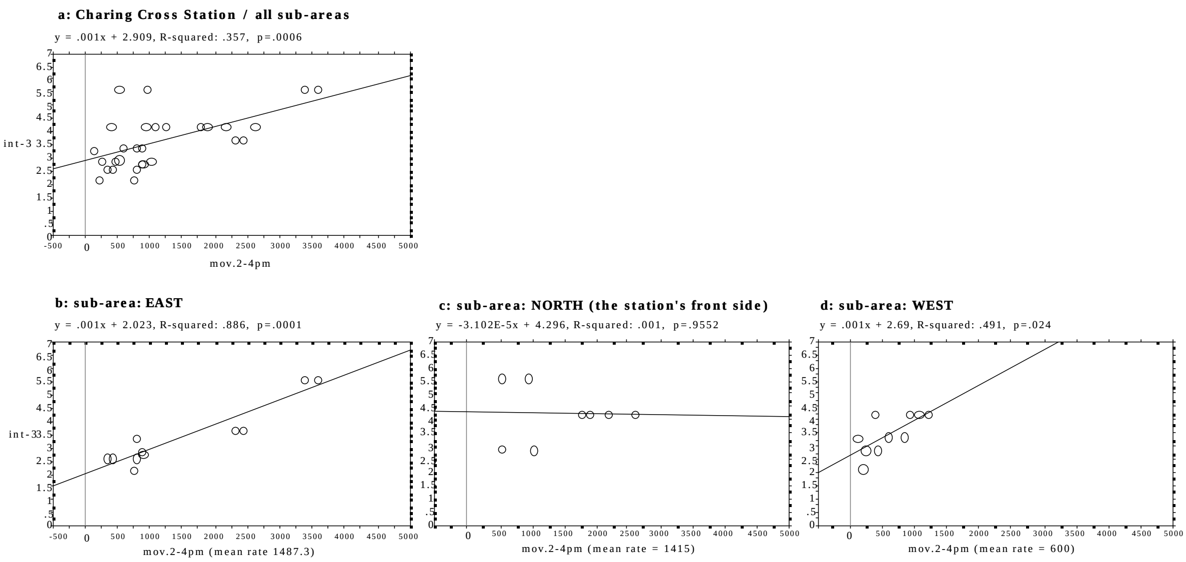


6.2.2h Charing Cross Station area

The combined scattergram of Charing Cross Station area shown in Plate 6.10a reflects several splits and a weak correlation between integration and movement rates, representing several distinctive sub-areas surrounding the terminus structures. Although the station is a small and elevated terminus located just beyond the River Thames' bank, its location is close to other major attractors such as the Trafalgar Square and retail, commercial and entertainment areas of the West End. Thus, there is no clear relationship between its urban grid structure and movement in general.

Both sub-areas located to the station's front and east sides (6.10c sub-area: north and 6.10b sub-area: east) draw movement rates of as high as 1415 and 1487.3 mov/hr. respectively. However, the front area reflects a very weak correlation as it includes several major streets in the West End area which are largely occupied by attractors such as retail shops, art galleries, and institutions. The east sub-area which is mainly occupied by office and some retail spaces shows a stronger correlation which legitimates its high mean movement rate as the natural movement level. The west sub-area (6.10d) occupied by residential and some institutions is relatively quieter but its strong correlation (an R-squared value of 0.491) confirms that its mean movement rate of as high as 600 mov/hr. is largely influenced by its urban grid structure.

Plate 6.10: CHARING CROSS STATION AREA
Regression analysis of local integration and movement.

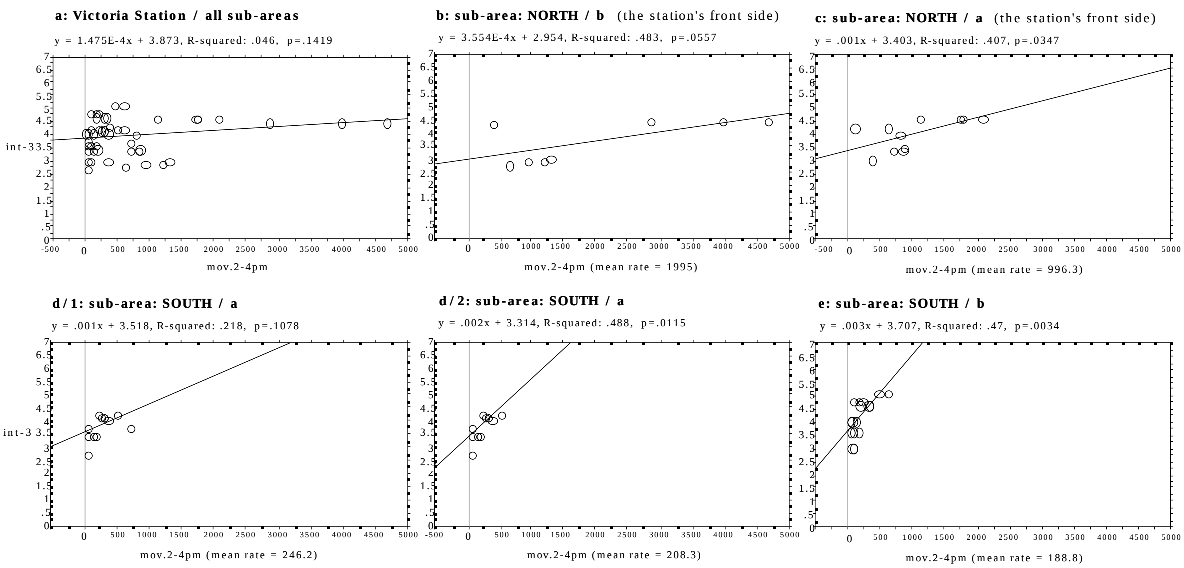


6.2.2i Victoria Station area

Victoria Station is a large ground-level railway terminus whose structure creates several distinctive sub-areas around it as shown in a weak scatter and correlation of its combined scattergram in Plate 6.11a . All sub-area scattergrams show much better R-squared values. The high mean rates of 996.3-1995 mov/hr. are found in the station's front which consists of two sub-areas located to the east and west of the terminus building (6.11b sub-area: north/a and 6.11c sub-area: north/b). Both are mix-use areas of commercial, business, entertainment, and residential whereby their high levels of movement are considered to be largely grid-related according to their rather strong R-squared values of 0.483 and 0.407 respectively.

Separately plotted in 6.11d-e (sub-areas: south/a and south/b respectively), the other two sub-areas located alongside its approach railway lines which are mainly occupied by residential use with some small retail shops attract only moderate levels of movement of 246.2 and 188.8 mov/hr. respectively. However, only the area to the east of the railway embankment (6.11e sub-area: south/b) shows a strong relationship between movement and its grid structure in its scattergram with an R-squared value of 0.470. The area to the west has a rather weak correlation shown in its scattergram in 6.11d/1 (sub-area: south/a). However, when the entrance space to the Victoria Coach Station is excluded as shown in comparison in 6.11d/2 , the correlation gets very much better with the R-squared value improves from 0.218 to 0.488.

Plate 6.11: VICTORIA STATION AREA
Regression analysis of local integration and movement.



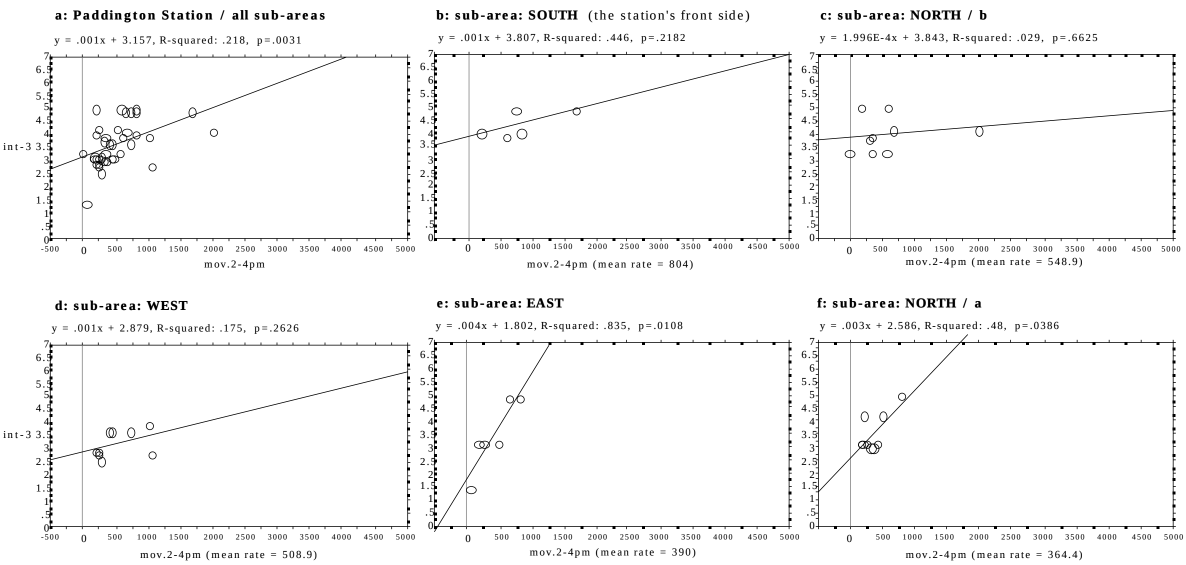
6.2.2j Paddington Station area

Several splits in the combined scattergram of Paddington Station area (Plate 6.12a) reveal that there are sub-areas located around its terminus structures and railway land site. The strong correlation of the scattergram of the station's front side (6.12b sub-area: south) confirms that its mean rate of 804 mov/hr., the highest level among all of its surroundings, is largely grid-related. Another two sub-areas located to the north side of the terminus structures (6.12e sub-area: east and 6.12f sub-area: north/a) also show a strong correlation of 0.835 and 0.480 respectively in their scattergrams. The east sub-area is mainly occupied by a hospital complex while the north/a sub-area is largely residential. However, both areas draw only moderate levels of movement of 390 and 364.4 mov/hr.respectively.

The higher mean rates are evidenced in the other two sub-areas located to the south of the terminus structures (6.12c sub-area: north/b and 6.12d sub-area: west). They attract pedestrian movement of as high as 548.9 and 508.9 mov/hr. respectively. However, both scattergrams reveal a rather weak correlation. Both areas include some retail spaces of the Bayswater area which make the relationship between movement and their urban grid structures rather uncleared.

It is noted that there is no movement being recorded in the Paddington Basin area as the area was totally closed for the ongoing construction of the new development complex. Although the sub-areas around the terminus structures still appear to attract moderate to high levels of movement in average, similar to the King's Cross railway land site, the movement level within the Paddington Basin site itself was pedestrian deserted for most of the times, according to the initial urban condition survey.

Plate 6.12: PADDINGTON STATION AREA
Regression analysis of local integration and movement.

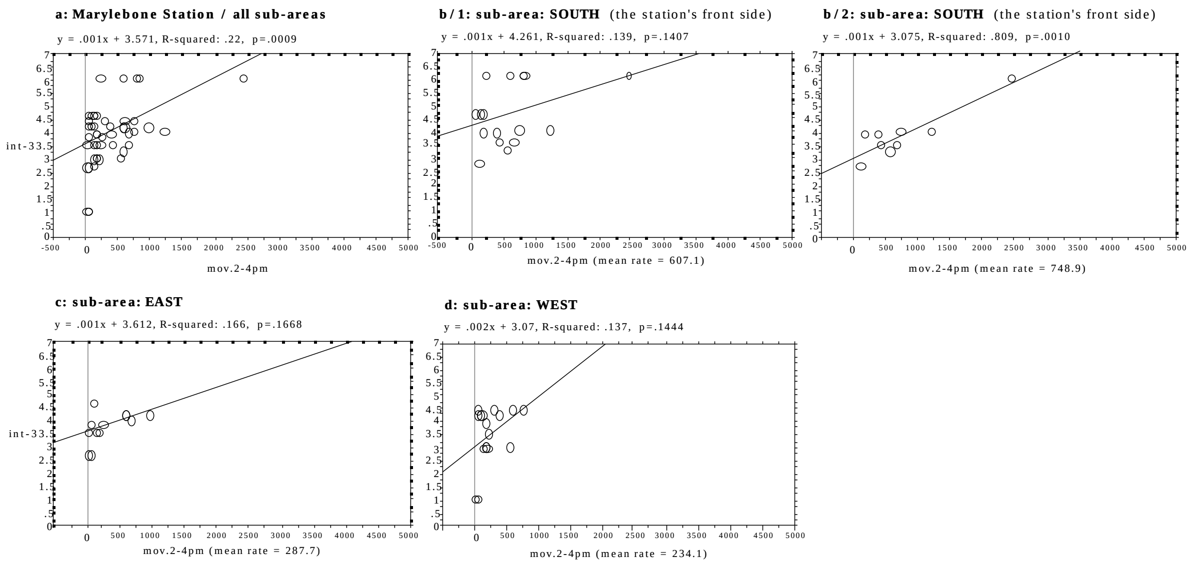


6.2.2k Marylebone Station area

Both combined and sub-area scattergrams of Marylebone Station area (Plate 6.13a-d) reveal a weak relationship between movement and its urban grid configuration. The whole area appears to be influenced by several other attractors besides the station building itself. The station's front side (6.13b/1 sub-area: south) includes major retail and commercial streets such as Marylebone Road and Upper Montague Square. Excluding these spaces (6.13b/2), the correlation gets very much better with the R-squared value improves from 0.139 to 0.809. The area also attracts the highest mean rate of 748.9 mov/hr.

The other two sub-areas located alongside the approach railway lines (6.13c sub-area: east and 6.13d sub-area: west) attract relatively lower movement levels in average (287.7 and 234.1 mov/hr. respectively). However, their weak correlations reveal that there is no clear relationship between movement and the urban grid configuration of both areas. The east sub-area includes several dead-end routes mostly occupied by residential use. The area also includes a major Muslim community's retail street (Park Road) with their local mosque. The west sub-area is mostly filled with rather enclosed and blighted housing estates.

Plate 6.13: MARYLEBONE STATION AREA
Regression analysis of local integration and movement.



6.3: DISCUSSION AND CONCLUSION

Although the empirical analysis of average pedestrian movement levels on a weekday basis in London's terminus areas suggested that movement patterns are primarily determined by the termini themselves, the follow-on statistical analysis revealed that movement drawn into the sub-areas located around the terminus structures also have a strong relationship with their urban grid configuration. Strong correlation in most sub-area scattergrams justifies that the movement levels are largely determined by the local structures of urban grid network themselves. The station-related and the grid-related movement patterns then appear to be two layers of movement, adding up into different levels in all sub-areas around the terminus structures.

However, the summary of the empirical findings (presented earlier in Section 6.1.3), pointed out that even the station-related effects on movement are also shaped by the areas' spatial structure. In a broad summary, although the observation results support the existing space syntax studies in that, similar to King's Cross Station area, the other London's terminus structures also act as both movement attractors and negative attractors, there are empirical evidences suggesting that these two contradictory station-related effects do not occur in the same degree within all terminus areas. In fact, both attractor and negative attractor effects are very much influenced by the grid structures of the terminus areas. The attractor effects can be shaped by the spatial relationship between station entrances and streets while the negative attractor effects, by the degree of spatial barrier the terminus structures cause to their urban settings.

Thus, it appears that how the terminus structures as well as the grid structures of their urban settings affect pedestrian movement are both found to be spatial related. In order to answer more clearly the main question of this chapter about the nature of station-related and grid-related movement characteristics in each London's railway terminus area, it is then useful to discuss how both types of movement can be distinguished within each group of the station areas that share similar spatial properties. Through the station categorisation established earlier in the preceding chapter (Section 5.4.1), both effects can be identified as follows:

* For Liverpool Street Station area, the only successful case that is placed in the first category, the empirical study revealed that the attractor effects occur all around the station building. This is not only because the terminus has its entry gates in all

directions[5], but also that its surrounding grid structure provides several approach routes toward the station. As presented in the preceding chapter, the station's internal space and external structures are very well embedded within the dense and integrated grid network. How the urban grid structure largely overcomes the terminus structures and becomes well integrated locally and globally means that it enhances the route choices people can make to access the station from different locations. High levels of movement including the pattern of increasing rates as the station is approached are evident in all directions. As the nature of barrier is largely eliminated in the area, the negative attractor effects are thus very limited to only a few undeveloped locations further down the railway lines where some grids are still interrupted.

Despite the elimination of the amount of movement that might be attracted or generated by the station entrances[6], high levels of movement are still evident in most of the sub-areas immediately flanked to the station building[7]. Locating to the east, south, and west of the terminus, these developed sub-areas have the mean movement rates of as high as 578, 1,176.7, and 1,910 mov/hr. respectively. It also seems that the latest developed Broadgate Complex flanked to the station's west side whereby a spatially integrated route is created to directly link the station's internal space with the complex draws the highest mean rate (1,910 mov/hr.). The other three sub-areas located to its north have moderate levels of 210-233 mov/hr. They include the areas that are undeveloped and not fully developed whereby the approach railway lines still act as a barrier to some routes. According to the regression analysis, strong correlations of all sub-area scattergrams confirm that these movement levels are largely influenced by the sub-areas' local grid structures. In other words, the mean movement rate of each sub-area can be justified as its average 'natural movement' level. However, although the rear sub-areas of Liverpool Street Station appears to draw relatively lower natural movement levels than those of the front and sides, they still benefit from the attractor effects due to the presence of the station's rear entry gates as mentioned above. Thus, it can be said that Liverpool Street Station are surrounded in all directions by the sub-areas with high levels of movement. In three of them (located to the front and the sides), the high rates are sustained by their

5 All entry gates to Liverpool Street Station include the entrances that are either directly accessible from streets or through the station's annexed building complex.

6 As already described in details in *Section 6.2.1: Methods of the statistical analysis*, this is done by excluding all the entrance gates of each sub-area in the regression analysis.

7 According to calculation of mean movement rates of all 'street gates' in each sub-area.

urban grid structures themselves while in the other three (located to its rear), they are added up by both grid-related and station-related movement levels.

* For the four station areas of the second category, all but Euston Station area (means Cannon Street, Charing Cross, and Victoria Station areas) recorded moderate to high levels of movement in average according to the empirical observation. Although the internal spaces of these stations are not well embedded in their spatial settings, their external structures do not impose themselves as severe urban barriers. Their surrounding grid networks are well integrated though not well related with the stations' concourse spaces. Similar to Liverpool Street Station area, there are only a few spots of low movement rate being recorded in these three terminus areas and the negative attractor effects are also rather limited. Victoria Station is the only terminus in this second group that can be accessible from all sides. The attractor effects are thus clearly evident all around the station building. The negative attractor effects in Victoria Station area do not necessarily occur on all the routes approaching the non-entrance sides of the station. If the routes are not the dead-ends and still connect to some other routes, even though they run toward the railway lines, they do not record low movement levels and the rates do not always decrease as the barrier is approached. In Cannon Street and Charing Cross Station areas, the attractor effects are also evident in almost all directions. In the first case, its east side entrance attracts and generates a large number of movement into the side and rear areas. In the latter case, it is mainly due to the presence of the Embankment Underground Station at its rear. The negative attractor effects in both areas are limited because there are very few number of routes obstructed by the railway lines. Not only that the terminus structures are all elevated on viaducts, but both station areas are also restricted by the River Thames at their rear. Thus, their grid structures are very little affected by the termini.

In case of Euston Station area, although its urban spatial structure in general is well interconnected by a major grid network, the rear residential areas alongside the railway embankment are linked by only a few routes. There are several routes that are either limited or dead-ended by the railway lines. The negative attractor effects are clearly evident and extensively cover most of the rear sub-areas, especially the one located to the west of the railway tracks whose grid structure has a 'line integration' characteristic and is relatively less spatially integrated (see Section 5.3.2a). The attractor effects are not clear in Euston Station area. As its main entrances are set back from the front major street (Euston Road) and there are some other strong attractors in the area, the movement rates do not necessarily increase as the station is approached and the highest levels are not recorded at the gates near the station's entrances.

The regression analysis of Cannon Street and Charing Cross Station areas suggested that all of their sub-areas sustain high levels of natural movement in average (451.1-1487.3 mov/hr.). Only the front side of Charing Cross Street Station where its high mean rate is found to also be influenced by other attractors in the area such as retail, commercial, and entertainment spaces (resulting in a weak correlation). In Victoria Station area, strong correlations confirmed that its sub-areas draw a mix of moderate and high natural movement levels. Similar to Liverpool Street Station, the sub-areas located to the front of Victoria Station draw high natural movement levels in average (996.3-1,995 mov/hr.) while its rear sub-areas have relatively lower levels of only 188.8-208.3 mov/hr. Although these three terminus areas share similar spatial characteristics, it is clear that the first two terminus structures impose themselves as urban barriers in a lesser degree than that of Victoria Station. The mean natural movement levels of the rear sub-areas of Cannon Street and Charing Cross Stations appear to be relatively higher than those of Victoria. In case of Euston Station area where the terminus structures cause a relatively more impact as an urban barrier, one of its rear sub-areas draws natural movement level of as low as 42.2 mov/hr. in average. The area is where the negative attractor effects are extensively evident. The only sub-area that has a high mean movement rate is the one located to the station's front (1,160 mov/hr.). However, as confirmed by weak correlation of its scattergram, such high rate is also due to the presence of other strong attractors in the area.

From the above review of station-related and grid-related movement patterns in all four station areas of the second category, it is clear that in the cases where the terminus structures impose less interruption to the urban grids such as Cannon Street and Charing Cross Station areas, high natural movement levels are recorded all around the terminus buildings. The attractor effects also appear to generate an add-on movement level into the areas. The presence of Embankment Underground Station at the rear of Charing Cross Station thus makes the areas as the most vibrant station area among all in the second group. This is because it generates a large number of movement into the area where high levels of natural movement are already sustained all around the terminus building. In case of Victoria Station area, the degree of barrier is greater than Cannon Street and Charing Cross Station areas as the railway lines run through a vast residential area. Despite a few crossing-overs, there are still some routes that are shifted or disconnected by the terminus structures. Victoria Station area is relatively quieter in its rear sub-areas compared to those of the first two cases as the grid structures sustain only moderate levels of natural movement. However, its rear entrance draws high levels of movement adding on in its surrounding. Euston Station's structures impose themselves as the most severe urban barrier of all in the group. One of its rear sub-areas has extremely low natural movement level. The set back of its main entrances from Euston Road in addition to the presence of other strong movement attractors within its front area make the station-related as well as the grid-related effects unclear. Nevertheless, the area recorded the highest level of movement in average.

* Although all three terminus areas in the third category: Fenchurch Street, Waterloo, and London Bridge Station areas, share similar spatial characteristics, similar to those of the second category the varied degrees of spatial barrier the terminus structures impose upon its urban surroundings and the different locations of their station entrances in relation to main streets influence distinctive patterns of station-related and grid-related movement in the areas. According to the empirical study, Fenchurch Street Station area is the only case that has relatively high levels of movement being recorded all around the building with the attractor effects occurred in the proximity of both its front and rear entrances. The negative attractor effects are rather limited as they are evident on the obstructed routes, mostly located only further down the railway lines where the railway viaduct spaces are blocked or attached with some waste pocket areas.

In cases of Waterloo and London Bridge Station areas, the observation study revealed similar movement patterns. Both areas recorded moderate movement levels at their front and side with high rates focusing at the station entrances. Low rates are evident extensively at their rear. The attractor effects in both station areas are unclear. Similar to Euston Station, both termini have their entrances set back or hidden from major roads. Some other strong attractors such as retail shops and other Underground station entrances (in case of London Bridge Station) or retail shops and a market space (in case of Waterloo Station) located on the front main routes appear to attract higher rates than the stations themselves. Thus, it seems that the movement rates do not always increase as the stations are approached. As their viaduct spaces allow most routes to pass through, the negative attractor effects caused by the terminus structures are not clearly evident at the rear of both termini either. Nevertheless, low levels of movement are still recorded in the areas. In fact, the negative effects are instead caused by the waste pocket spaces and enclosed private properties next to some blocked viaducts. Due to the presence of these other 'barriers', it is clear that the grid structures at the rear side of London Bridge and Waterloo Stations are relatively less interconnected and more sparse than those of their surroundings.

It thus seems that the different station-related movement patterns in Fenchurch Street, Waterloo, and London Bridge Station areas are spatial related. Although all three terminus structures are similarly elevated on viaduct structures which allow most urban grids to be largely interconnected, the first terminus and its approach railway lines affect relatively very little to the spatial setting. The latter two stations are very much larger in size and also entangled with the railway lines both at their front and rear. Additionally, some of their rear viaduct spaces are blocked or attached with waste pocket spaces or enclosed private properties. This occurs in a lesser degree in Fenchurch Street Station area. Waterloo and London Bridge Stations' structures thus appear to impose a greater degree of spatial barrier to their urban settings compared to Fenchurch Street Station.

The regression analysis confirms that Fenchurch Street Station is surrounded by two sub-areas (located to its front and side) that sustain high levels of natural movement in average (454.1-776.7 mov/hr.). The attractor effects also add up a large number of movement into both sub-areas. Only the residential sub-area located to the south of its fenced off railway viaducts draw relatively less natural movement level of only 154.1 mov/hr. Although Waterloo Station is surrounded by three sub-areas that draw rather good levels of movement in average (362.2-640 mov/hr.), only the mean rate of its front sub-area located beyond the Waterloo East's railway lines to the north is justified to be the natural movement level by a strong correlation of its scattergram. The mean rates of the other two sub-areas located alongside its rear viaduct structures are found to be weakly correlated with their grid configuration. Despite the elimination of movement influenced by the station entrances, the areas are still very much affected by other strong attractors such as retail shops and a market space. Some of the viaducts' underpassing routes in the areas are also rather auto-oriented and less used by pedestrians. These factors make the relationship between movement and the sub-areas' grid structures unclear. In a slightly distinctive manner, London Bridge Station area is flanked by three sub-areas with moderate to high movement levels in average (229.5-764 mov/hr) of which all are confirmed to be influenced by their grid structures themselves. However, the scattergram revealed that the movement rates in its front sub-areas are also influenced by other attractors as mentioned above.

Consisting of the sub-areas that sustain high natural movement levels, Fenchurch Street Station area then appears to be the most vibrant area of all in this third group. In addition to that, both of its front and rear entrances also attract and generate a large number of movement adding onto the surroundings. It is clear that its terminus structures affect very little to their urban settings as a spatial barrier. London Bridge Station area seems to slightly outperform Waterloo Station area as its surrounding sub-areas clearly sustain better levels of natural movement.

* For the other three cases included in the fourth category: Paddington, Marylebone, and King's Cross Station areas whereby the terminus structures and railway lands impose themselves as severe urban barriers, the empirical study revealed that only low to moderate movement levels are recorded within the areas in general. High rates are focused only in the close proximity of their entrances then sharply decrease within only one or two blocks away. Extremely low rates of less than 100 mov/hr. are extensively recorded at the rear side of King's Cross Station especially around its railway lands. Although such low rates are not extensively evident in Marylebone and Paddington Station areas, the pattern of decreasing movement rates occurs both at the rear and sides of the terminus buildings on all of the non-entrance side approach routes. In Paddington Station area, this kind of negative attractor effect also occurs even on its railway lines' crossing-over routes because they are obstructed by the other barriers in the area (the Westway and the heavily trafficked Harrow Road to the north of the railway lands). In all three terminus areas, the attractor effects are clearly evident in all stations' approach routes which mostly locate only at their front. Apparently, all of the termini provide no accessibility from their rear areas.

The regression analysis revealed that the sub-areas located to the front of all three termini draw relatively high natural movement levels in average (427.7, 748.9, and 804 mov/hr. for King's Cross, Marylebone, and Paddington Stations respectively). The other sides of King's Cross Station draw movement levels of only over 100 mov/hr. However, only the two sub-areas located alongside the railway land site to its east and west that the movement rates are justified as the natural movement levels. The north sub-area scattergram reveals no strong relationship between movement and its urban spatial structure due to the clear separation of residential and light industrial land uses. The two sub-areas located to the north of Paddington Station's structures (the residential area to the north of the Westway and the Queen Elizabeth Hospital area) appear to sustain moderate natural movement levels (364.4-390 mov/hr.). The other two sub-areas located to the south of the terminus structures draw relatively higher movement levels in average (508.9-548.9 mov/hr.). However, the relationship between movement and their spatial grid structures are unclear as such high rates are also found to be influenced by the retail and commercial area of Bayswater. The sub-areas located alongside Marylebone Station's approach railway lines draw moderate movement rates of 234.1-287.7 mov/hr. However, their scattergrams show no strong correlation. Apparently, the west sub-area includes a large and enclosed residential property which is rather separated from its surroundings while the east sub-area includes a Muslim community's retail street where an Islamic mosque is also located. It appears that the non-homogeneously distribution of land use and the presence of other strong attractors in the sub-areas shift the correlation and make the relationship between movement and the spatial grid structure itself rather unclear.

Although all three terminus areas are severely scarred by the terminus structures, their adjacent railway lands, including some other barriers, it is clear that King's Cross Station area appears to be the worse case due to the size of barrier it includes. This is confirmed by the fact that only its front side where the grid structure is well integrated can sustain a good level of natural movement. According to the regression analysis, Paddington Station area appears to outperform Marylebone Station area as most of its sub-areas are shown to be able to sustain moderate to high natural movement levels. However, although it appears that some of the sub-areas in both terminus areas are still able to draw good levels of natural movement, they in fact locate around the urban holes where no movement is recorded at all. In this respect, the Paddington Station's railway lands which include most of the Paddington Basin area plus the vacant areas below or adjacent to the Westway's elevated structure create a relatively larger urban void than what the railway lines and the adjacent enclosed residential properties do to Marylebone Station area.

In conclusion, the discussion on the nature of both station-related and grid-related movement in London's terminus areas through the station categorisation suggests that some patterns can be commonly identified within the group that shares similar spatial characteristics. The urban grid configuration of the station areas, that is mainly determined by how the terminus structures are spatially embedded within their settings and how the settings are embedded within their larger urban grid networks, appears to be the crucial factor that determines both movement types. The areas whereby the terminus structures are well embedded within the integrated spatial grid structures are found to be able to sustain good levels of natural movement, a key factor for 'urbanity', in most if not all of their sub-areas. The negative attractor effects, a key factor for 'disurbanity', are also found to be limited in the station areas whose urban grids are less disconnected or disrupted, by either the terminus structures themselves or other spatial barriers.

The degree of the attractor effects is determined by the number of station entrances including their location in relation to the main streets. The termini that can be accessible from all around could well attract and generate a large number of movement into their surroundings. However, this type of movement is considered as an 'add-on' of the natural movement. Its level can fluctuate during different times of the day while the natural movement level is sustained by the grid structure. If the entrances locate along the main routes, the pattern of increasing movement rates as the termini are approached tends to be more conspicuous than the termini whose entrances are rather set back or hidden from the main streets. The clear pattern of the attractor effects might help people, especially the first time station users, to easily identify the location of railway termini in the city by following the unusual concentration or build-up of movement level .

Each terminus area appears to have its own unique combination of these spatial factors, resulting in a rather distinctive overall movement pattern as a collective outcome of station-related and grid-related movement levels. In addition to that, movement can also be influenced by other strong movement attractors and urban barriers located in the area. Because of different station layouts and locations in the city, all station areas are thus rather unique with distinctive characteristics of pedestrian space use evidenced in their surrounding sub-areas.

Liverpool Street Station area appears to be the only case that possesses all crucial spatial factors. Its large scale urban development embeds the station's internal space and most of its external structures and creates a spatially integrated development complex that helps eliminate the nature of barrier once imposed by the terminus structures and railway lands. The new development also provides altogether eleven entry gates to the station buildings from all directions. The attractor effects occur all around the terminus building, generating a large number of movement adding onto its surrounding sub-areas that mostly sustain high levels of natural movement. The area has different levels and combinations of station user and urban dweller but would never been left vacant throughout different times of the day. King's Cross Station area appears to be a bold example of how the lack of these crucial spatial factors leads to a deserted railway lands flanked by the sub-areas which mostly sustain very low natural movement levels.

This chapter provides the precise examination on the nature of station-related and grid-related pedestrian movement patterns in all London's terminus areas and crucially confirms how both are spatial related. The next chapter will bring altogether the analytical findings from all chapters to be critically discussed in order to answer the thesis question. Supporting by the morphological and empirical studies, the last chapter will review how each terminus area possesses the physical and spatial characteristics that 'contribute' or 'undermine' the creation of the railway terminus building as a place out of a transport node. It will also further explore the spatial potential of the unsuccessful or undeveloped terminus areas and make a suggestion of how to turn them into places including the spatial potential of the already successful case to be further developed into a live centre, as defined by Hillier (2000).

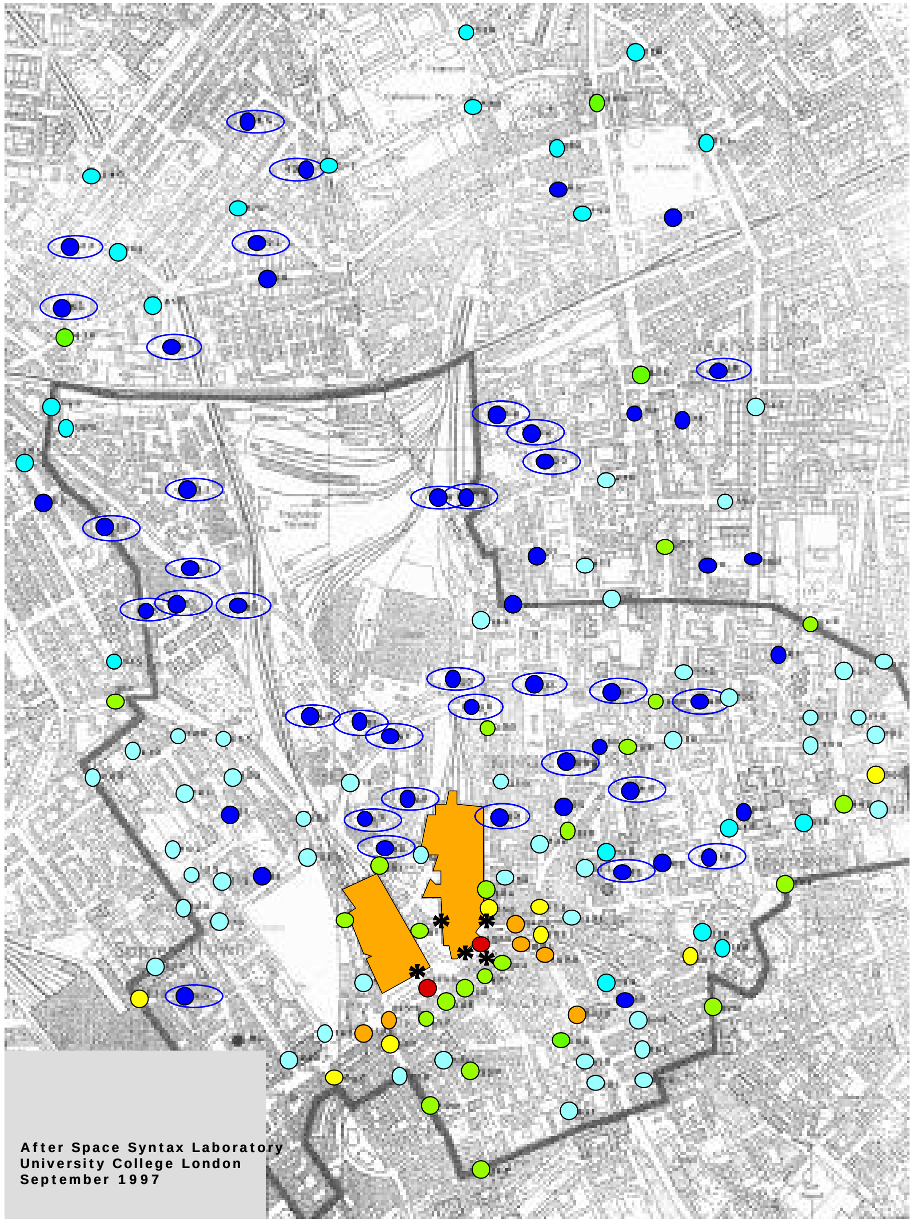


Figure 6.1: KING'S CROSS - ST.PANCRAS STATION AREA
mean pedestrian flow rates (12:00-18:00)

✱ station entry point

Hourly Rate

- 1501 or more
- 1001 to 1500
- 501 to 1000
- 251 to 500
- 101 to 250
- 0 to 100
- less than 60 pedestrians per hour

KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame

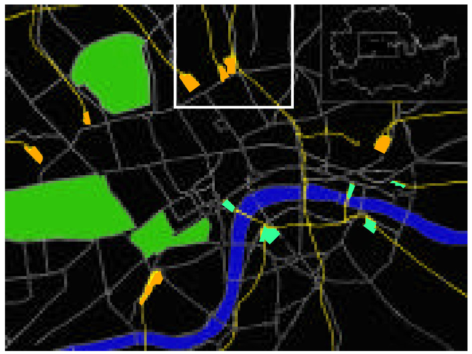
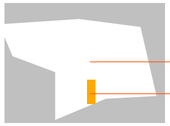


Figure 6.2a: EUSTON STATION AREA- Key pedestrian routes around the terminus structures and the allocation of gates for movement observation



the terminus area

the terminus building

station entry point

route A: station entrance's approach route

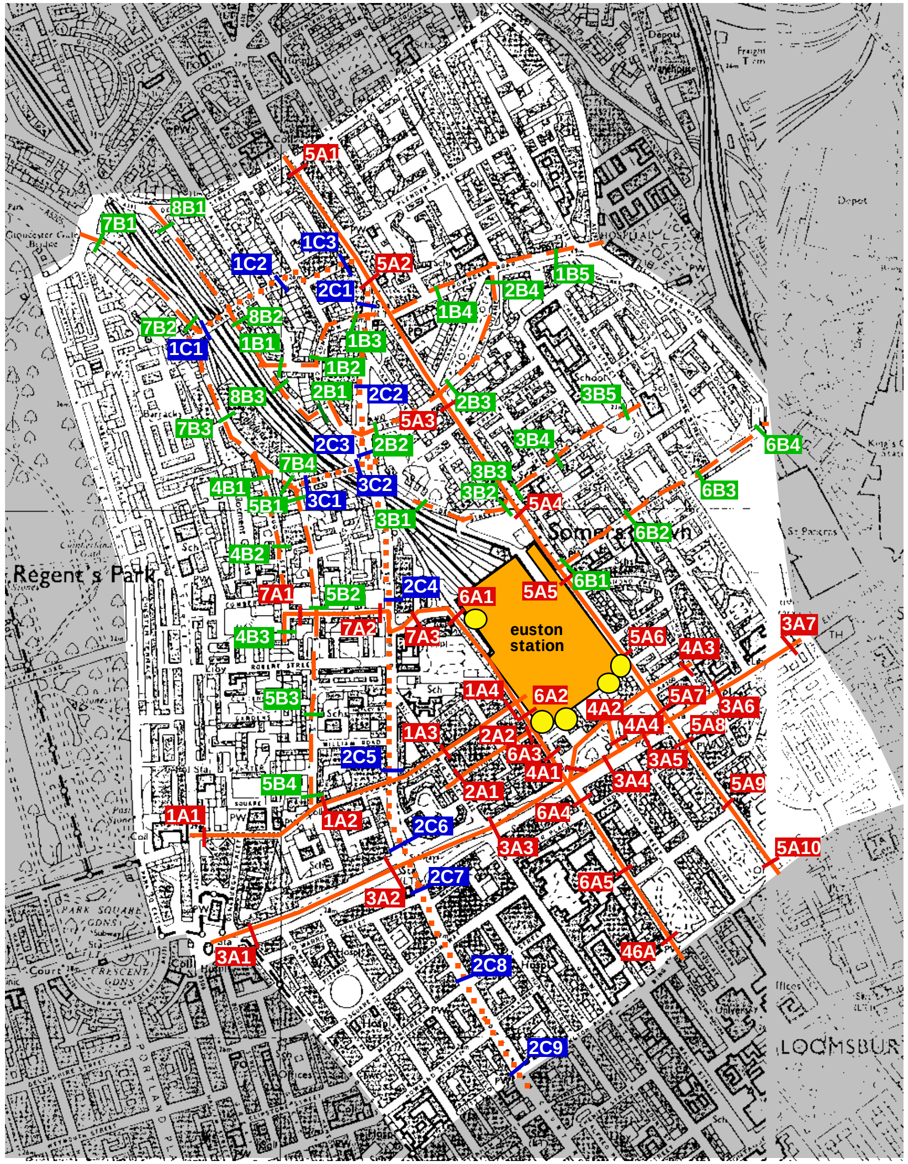
route B: station non-entrance side's approach/siding route

route C: railway lines' crossing route

1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C



KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame

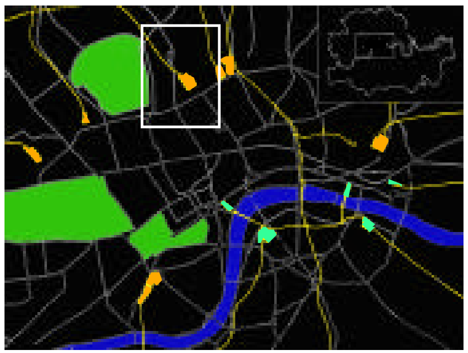


Figure 6.2b: EUSTON STATION AREA
Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

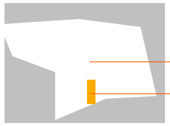
Hourly Rate

- 5001 or more
- 4001 to 5000
- 3001 to 4000
- 2501 to 3000
- 2001 to 2500
- 1501 to 2000
- 1001 to 1500
- 501 to 1000
- 251 to 500
- 101 to 250
- 0 to 100

* station entry point

route A: station entrance's approach route
route B: station non-entrance side's approach/siding route
route C: railway lines' crossing route

Figure 6.3a: LIVERPOOL STREET STATION AREA- **Key pedestrian routes around the terminus structures and the allocation of gates for movement observation**



the terminus area

the terminus building

station entry point

route A: station entrance's approach route

route B: station non-entrance side's approach/siding route

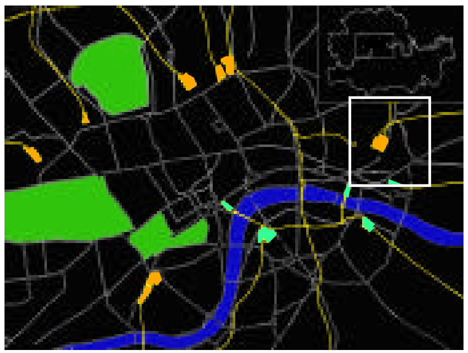
route C: railway lines' crossing route

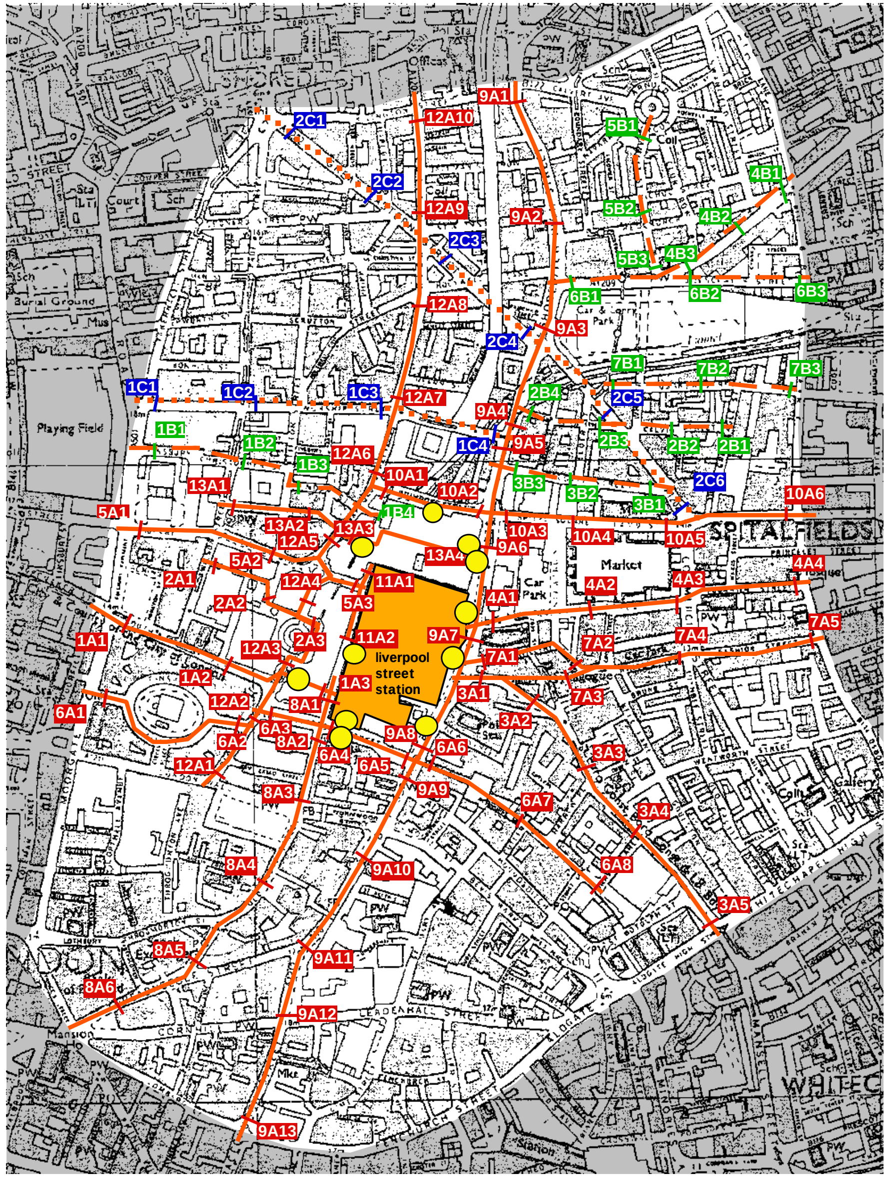
1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C

KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame





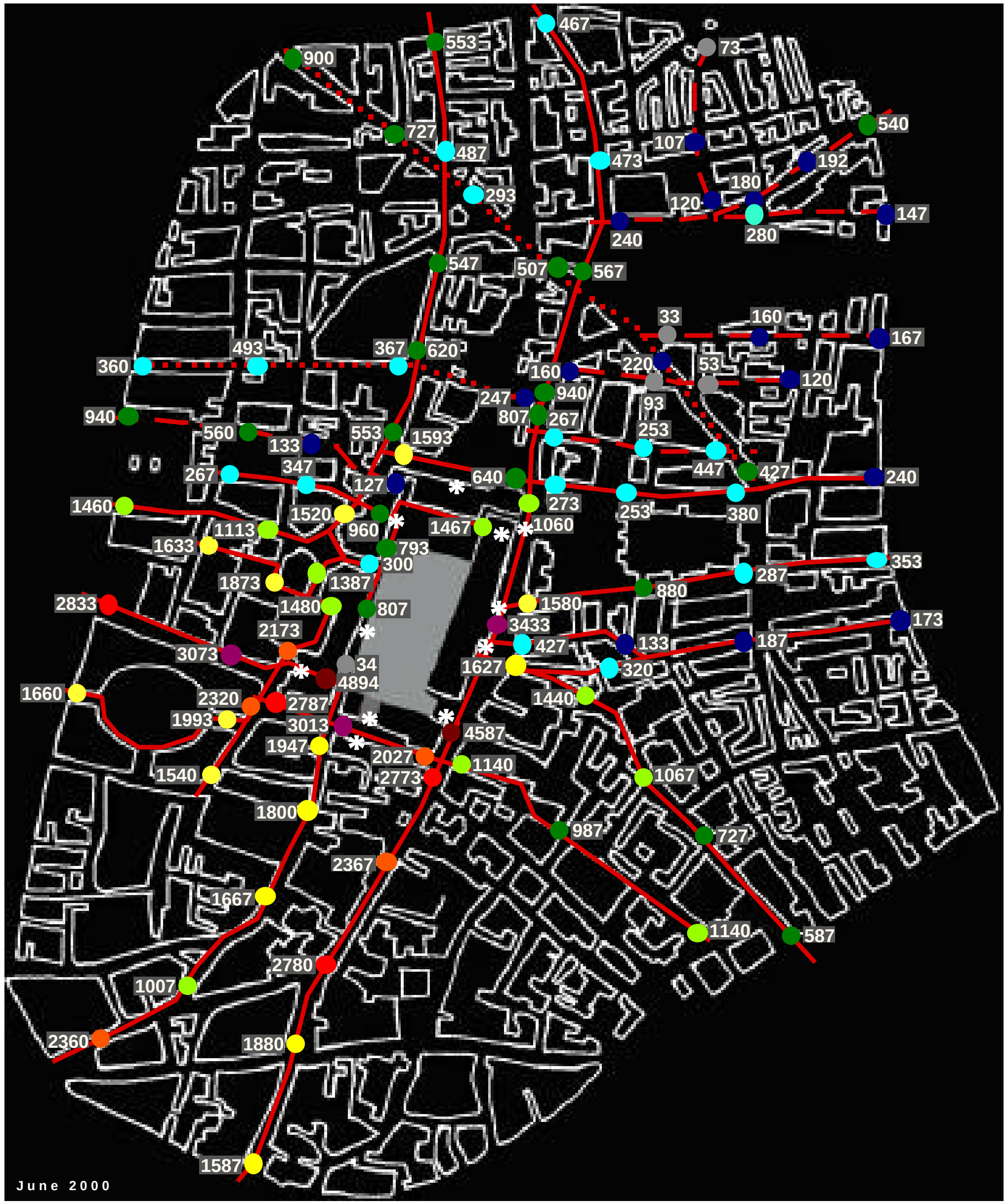


Figure 6.3b: LIVERPOOL STREET STATION AREA
Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

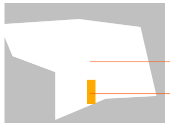
Hourly Rate

- 5001 or more
- 4001 to 5000
- 3001 to 4000
- 2501 to 3000
- 2001 to 2500
- 1501 to 2000
- 1001 to 1500
- 501 to 1000
- 251 to 500
- 101 to 250
- 0 to 100

* station entry point

route A: station entrance's approach route
route B: station non-entrance side's approach/siding route
route C: railway lines' crossing route

Figure 6.4a: FENCHURCH STREET STATION AREA- **Key pedestrian routes around the terminus structures and the allocation of gates for movement observation**



the terminus area

the terminus building

station entry point

route A: station entrance's approach route

route B: station non-entrance side's approach/siding route

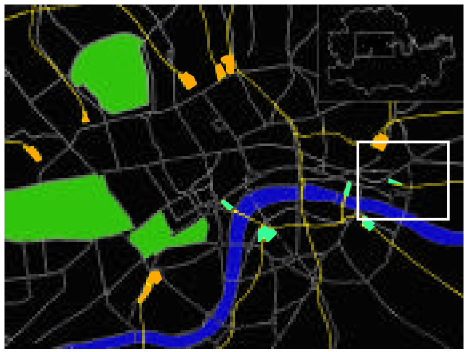
route C: railway lines' crossing route

1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C

KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame



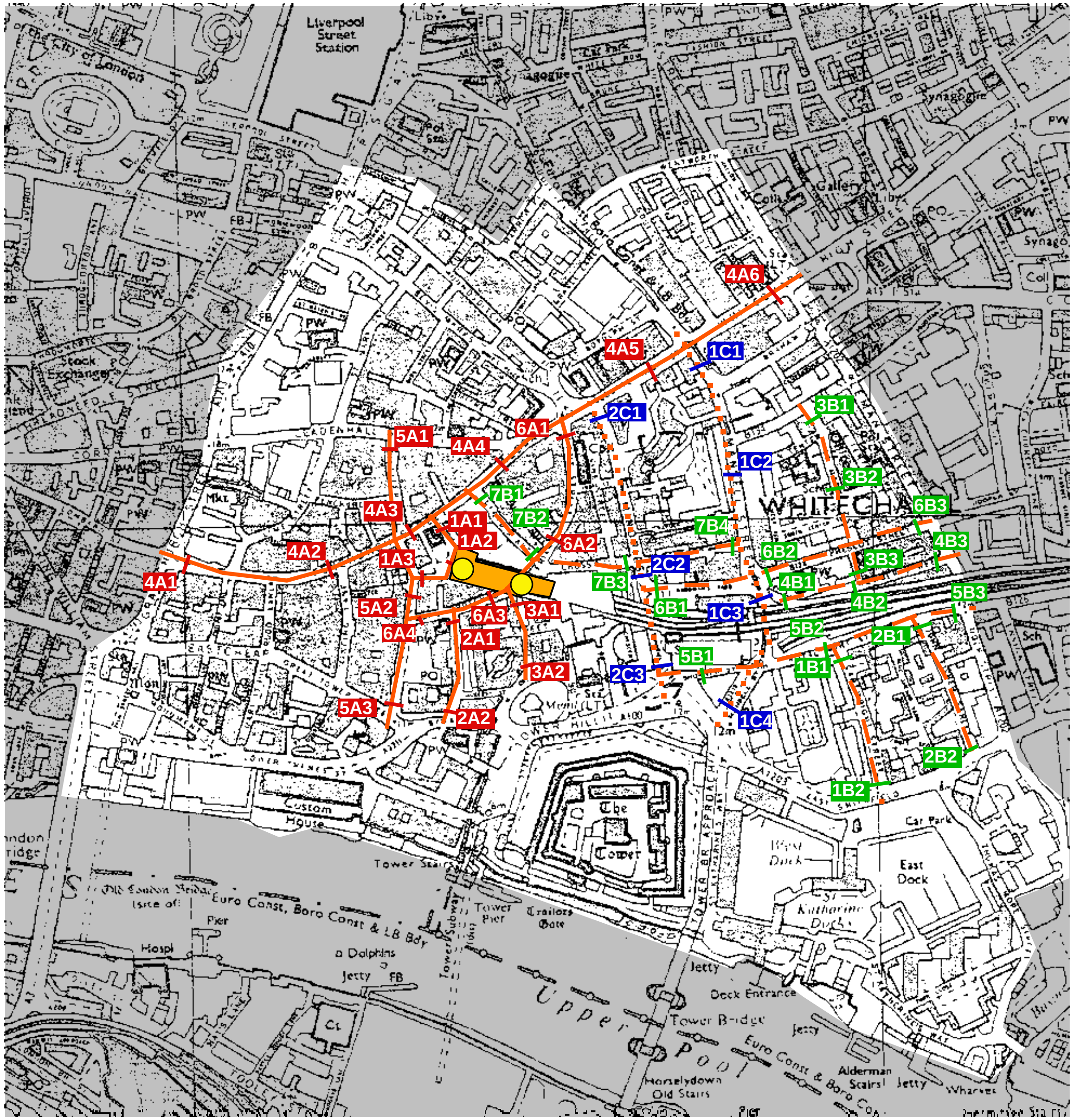


Figure 6.4b: FENCHURCH STREET STATION AREA
Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

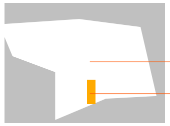
Hourly Rate

- 5001 or more
- 4001 to 5000
- 3001 to 4000
- 2501 to 3000
- 2001 to 2500
- 1501 to 2000
- 1001 to 1500
- 501 to 1000
- 251 to 500
- 101 to 250
- 0 to 100

* station entry point

route A: station entrance's approach route
route B: station non-entrance side's approach/siding route
route C: railway lines' crossing route

Figure 6.5a: CANNON STREET STATION AREA- **Key pedestrian routes around the terminus structures and the allocation of gates for movement observation**



the terminus area

the terminus building

station entry point

route A: station entrance's approach route

route B: station non-entrance side's approach/siding route

route C: railway lines' crossing route

1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C

KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame

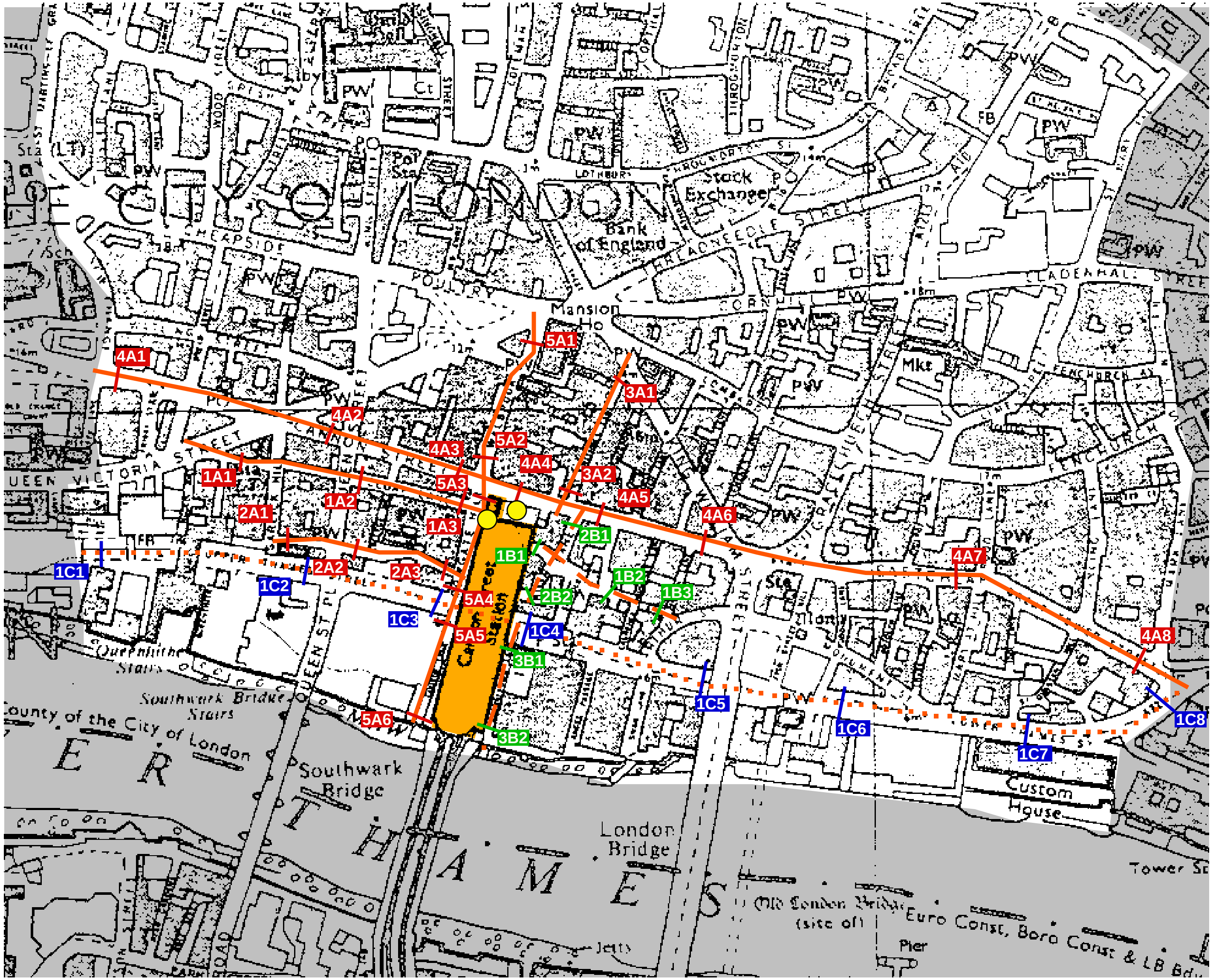


Figure 6.5b: CANNON STREET STATION AREA
Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

Hourly Rate

	5001 or more
	4001 to 5000
	3001 to 4000
	2501 to 3000
	2001 to 2500
	1501 to 2000
	1001 to 1500
	501 to 1000
	251 to 500
	101 to 250
	0 to 100

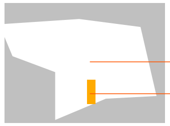
✱ station entry point

route A: station entrance's approach route

route B: station non-entrance side's approach/siding route

route C: railway lines' crossing route

Figure 6.6a: LONDON BRIDGE STATION AREA- **Key pedestrian routes around the terminus structures and the allocation of gates for movement observation**



the terminus area

the terminus building

station entry point

route A: station entrance's approach route

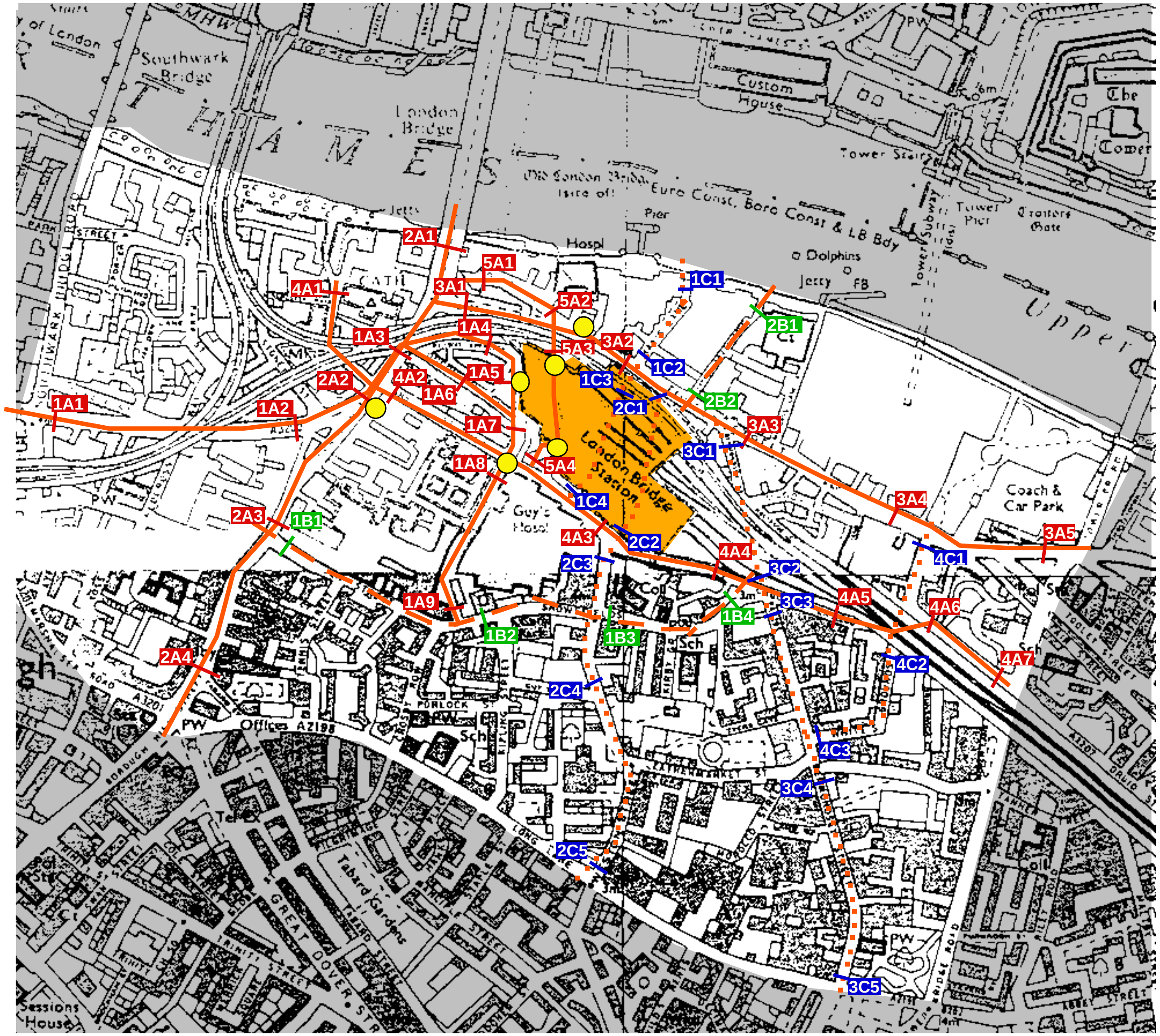
route B: station non-entrance side's approach/siding route

route C: railway lines' crossing route

1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C



KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame

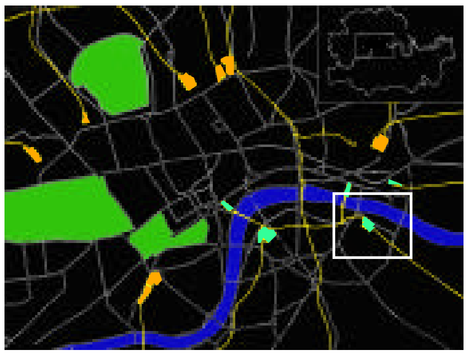


Figure 6.6b: LONDON BRIDGE STATION AREA
Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

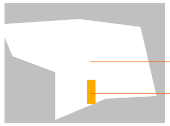
Hourly Rate

- 5001 or more
- 4001 to 5000
- 3001 to 4000
- 2501 to 3000
- 2001 to 2500
- 1501 to 2000
- 1001 to 1500
- 501 to 1000
- 251 to 500
- 101 to 250
- 0 to 100

* station entry point

route A: station entrance's approach route
route B: station non-entrance side's approach/siding route
route C: railway lines' crossing route

Figure 6.7a: WATERLOO STATION AREA- **Key pedestrian routes around the terminus structures and the allocation of gates for movement observation**



the terminus area

the terminus building

station entry point

route A: station entrance's approach route

route B: station non-entrance side's approach/siding route

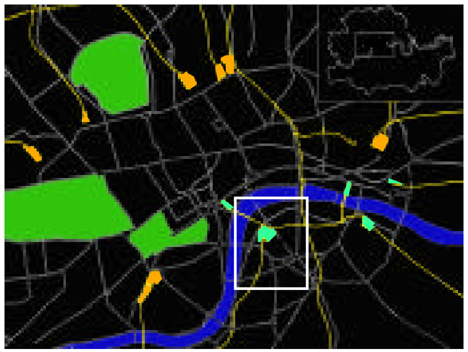
route C: railway lines' crossing route

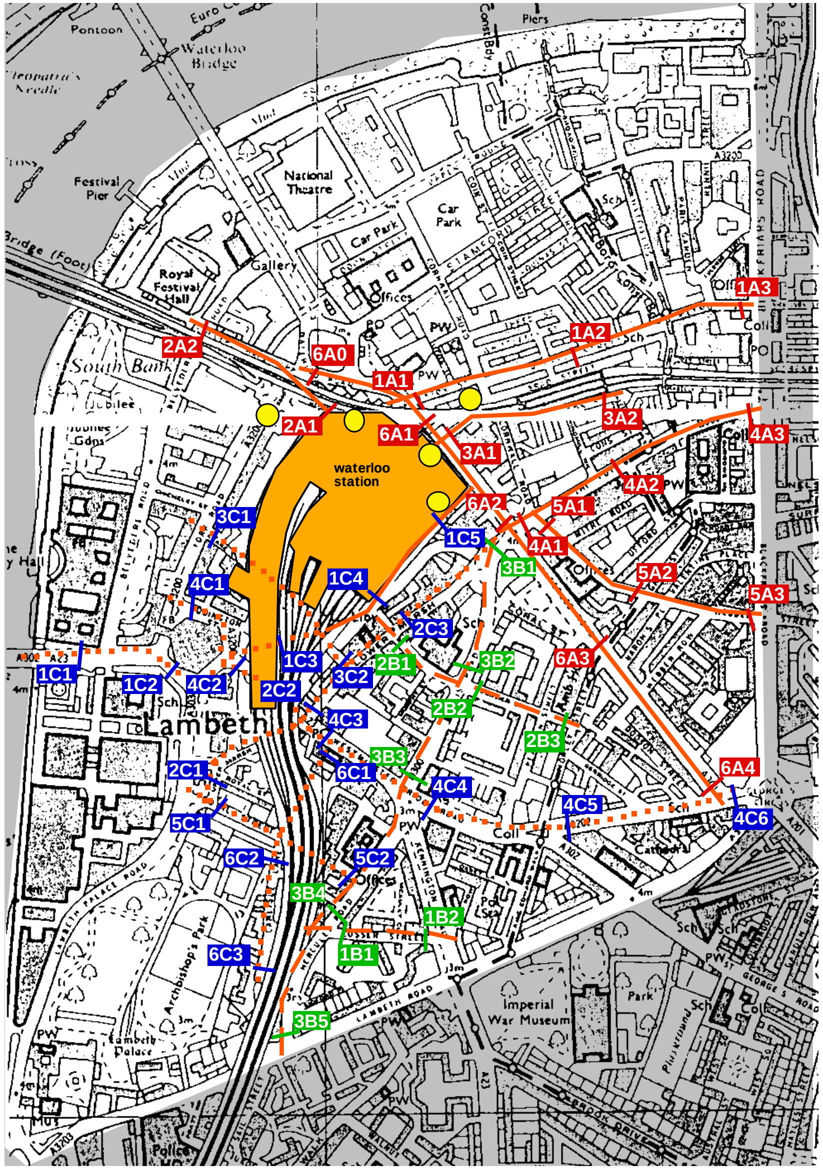
1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C

KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame





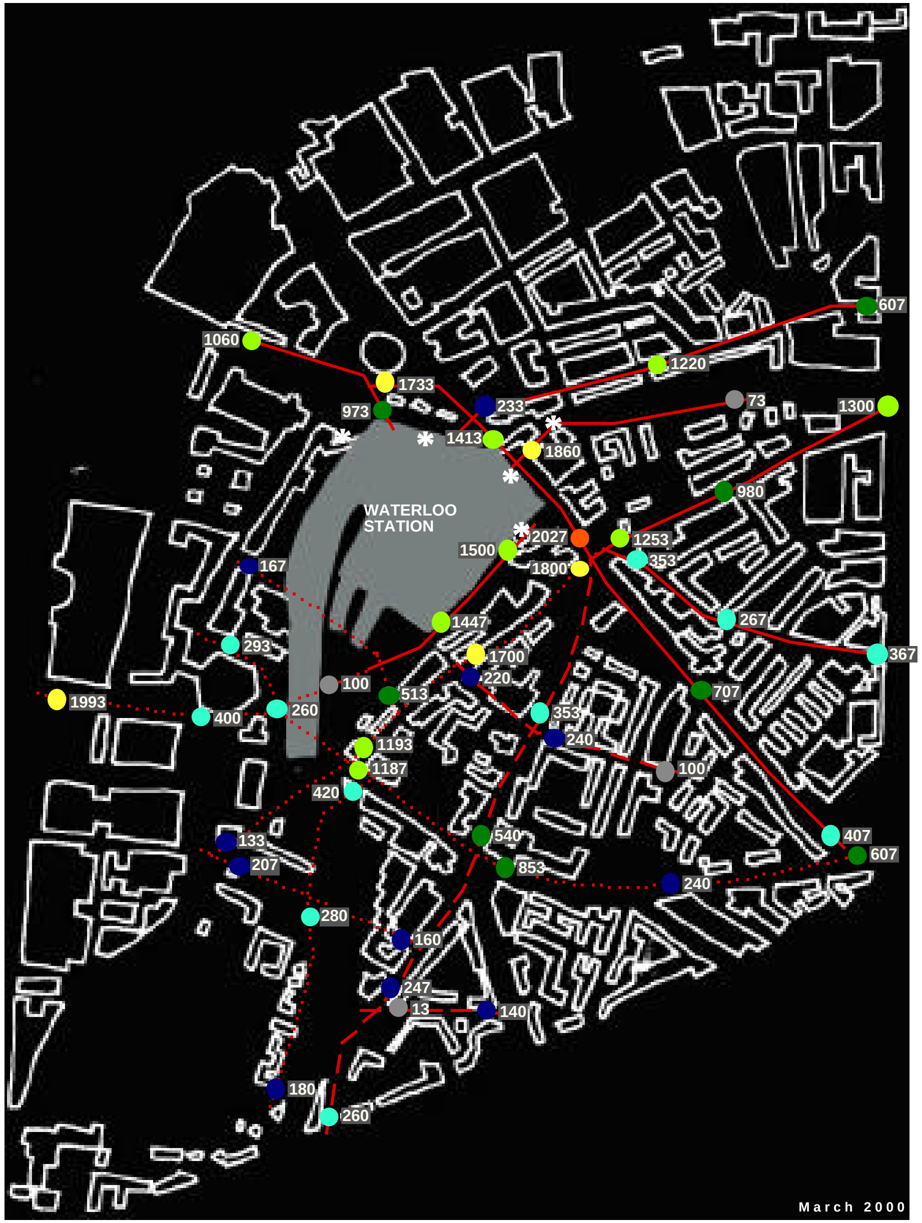


Figure 6.7b: WATERLOO STATION AREA: Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

Hourly Rate	
	5001 or more
	4001 to 5000
	3001 to 4000
	2501 to 3000
	2001 to 2500
	1501 to 2000
	1001 to 1500
	501 to 1000
	251 to 500
	101 to 250
	0 to 100

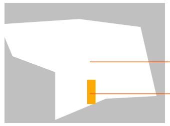
✱ station entry point

route A: station entrance's approach route

route B: station non-entrance side's approach/siding route

route C: railway lines' crossing route

Figure 6.8a: CHARING CROSS STATION AREA- Key pedestrian routes around the terminus structures and the allocation of gates for movement observation



station entry point

route A: station entrance's approach route

route B: station non-entrance side's approach/siding route

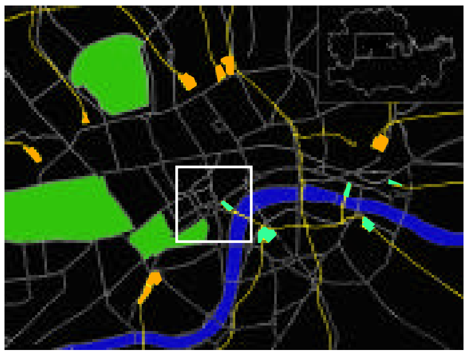
route C: railway lines' crossing route

1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C

KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame



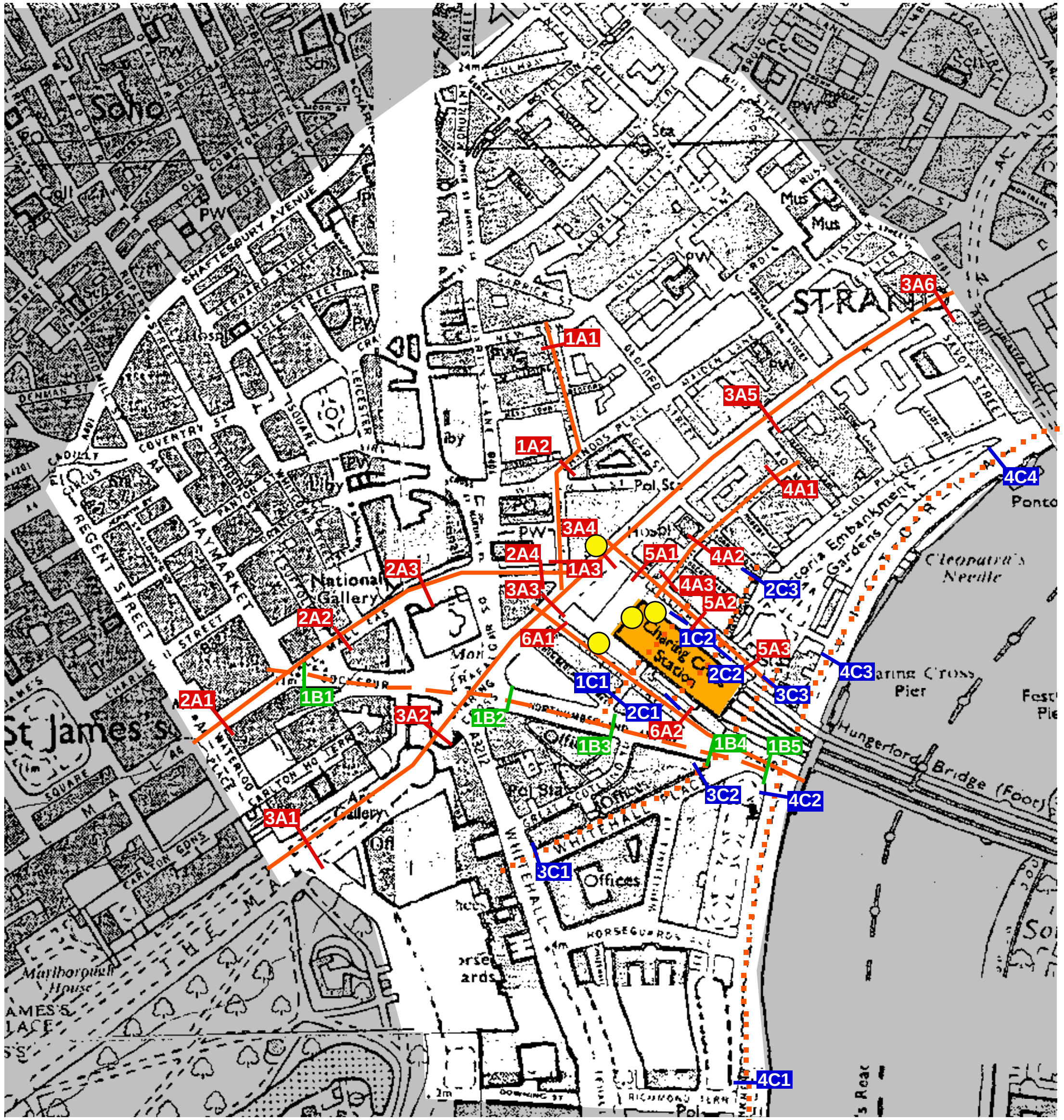


Figure 6.8b: CHARING CROSS STATION AREA
Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

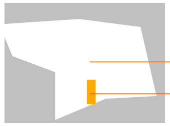
Hourly Rate

- 5001 or more
- 4001 to 5000
- 3001 to 4000
- 2501 to 3000
- 2001 to 2500
- 1501 to 2000
- 1001 to 1500
- 501 to 1000
- 251 to 500
- 101 to 250
- 0 to 100

✱ station entry point

route A: station entrance's approach route
route B: station non-entrance side's approach/siding route
route C: railway lines' crossing route

Figure 6.9a: VICTORIA STATION AREA- **Key pedestrian routes around the terminus structures and the allocation of gates for movement observation**



the terminus area

the terminus building

station entry point

route A: station entrance's approach route

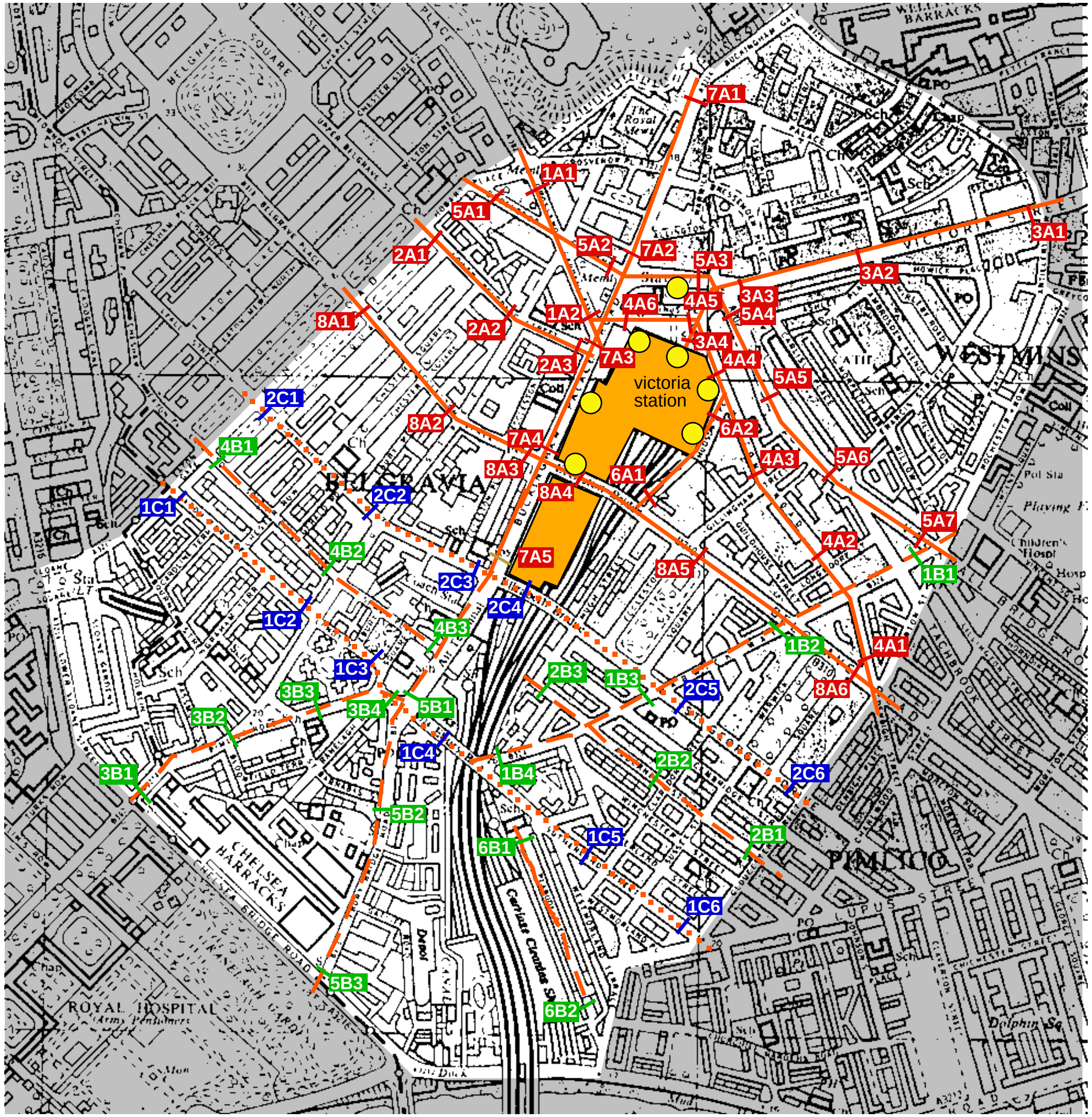
route B: station non-entrance side's approach/siding route

route C: railway lines' crossing route

1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C



KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame

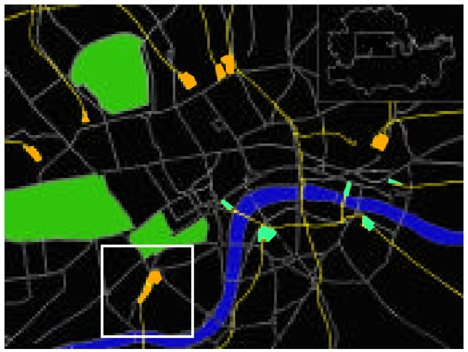


Figure 6.9b: VICTORIA STATION AREA
Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

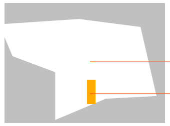
Hourly Rate

- 5001 or more
- 4001 to 5000
- 3001 to 4000
- 2501 to 3000
- 2001 to 2500
- 1501 to 2000
- 1001 to 1500
- 501 to 1000
- 251 to 500
- 101 to 250
- 0 to 100

✱ station entry point

route A: station entrance's approach route
route B: station non-entrance side's approach/siding route
route C: railway lines' crossing route

Figure 6.10a: PADDINGTON STATION AREA- Key pedestrian routes around the terminus structures and the allocation of gates for movement observation



the terminus area

the terminus building

station entry point

route A: station entrance's approach route

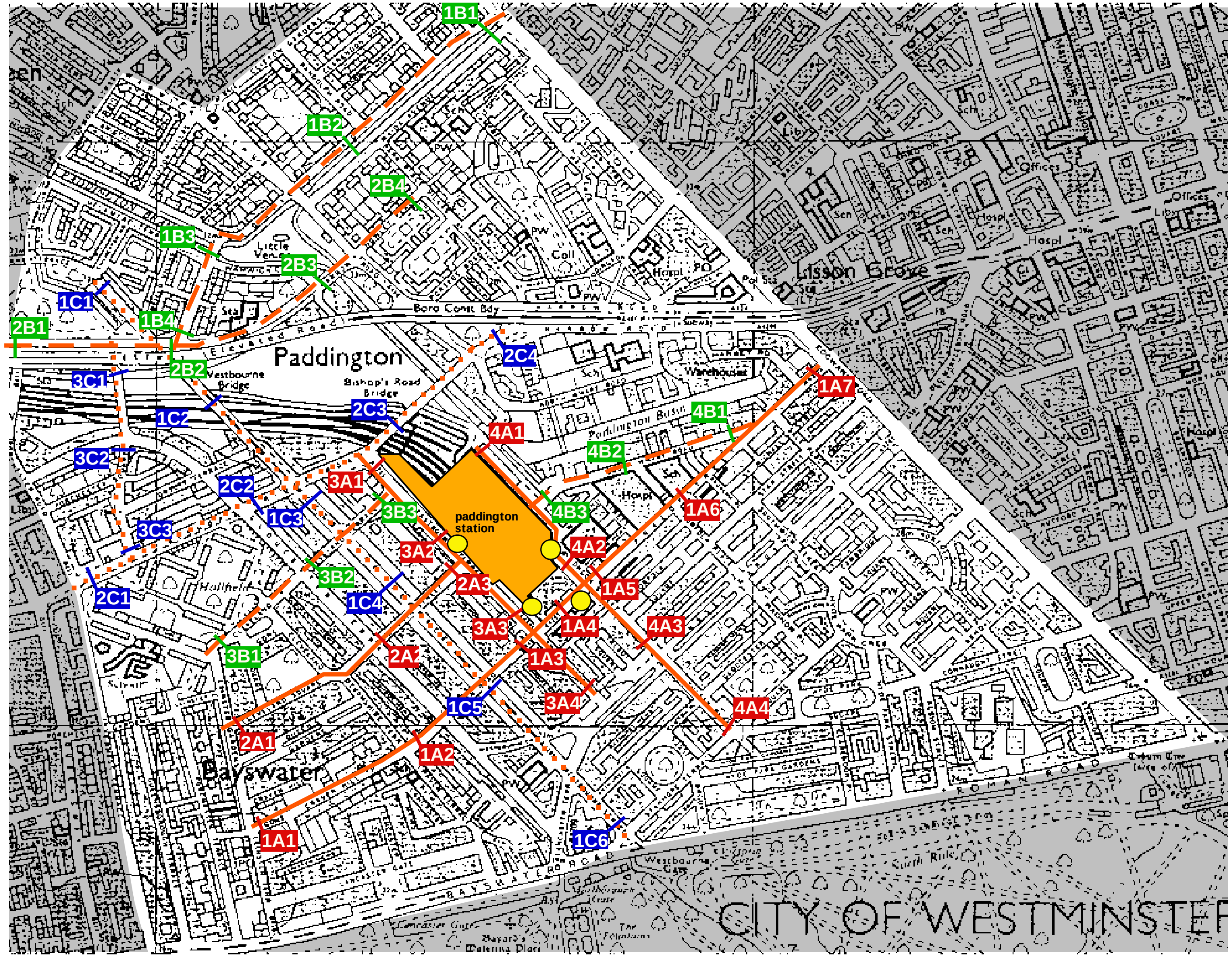
route B: station non-entrance side's approach/siding route

route C: railway lines' crossing route

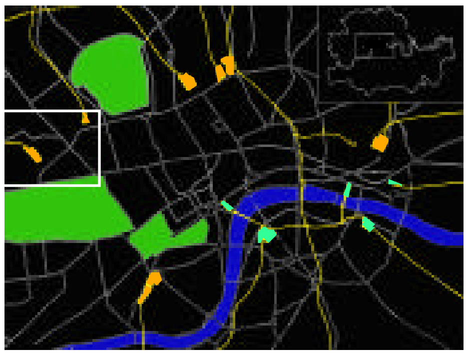
1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C



KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame



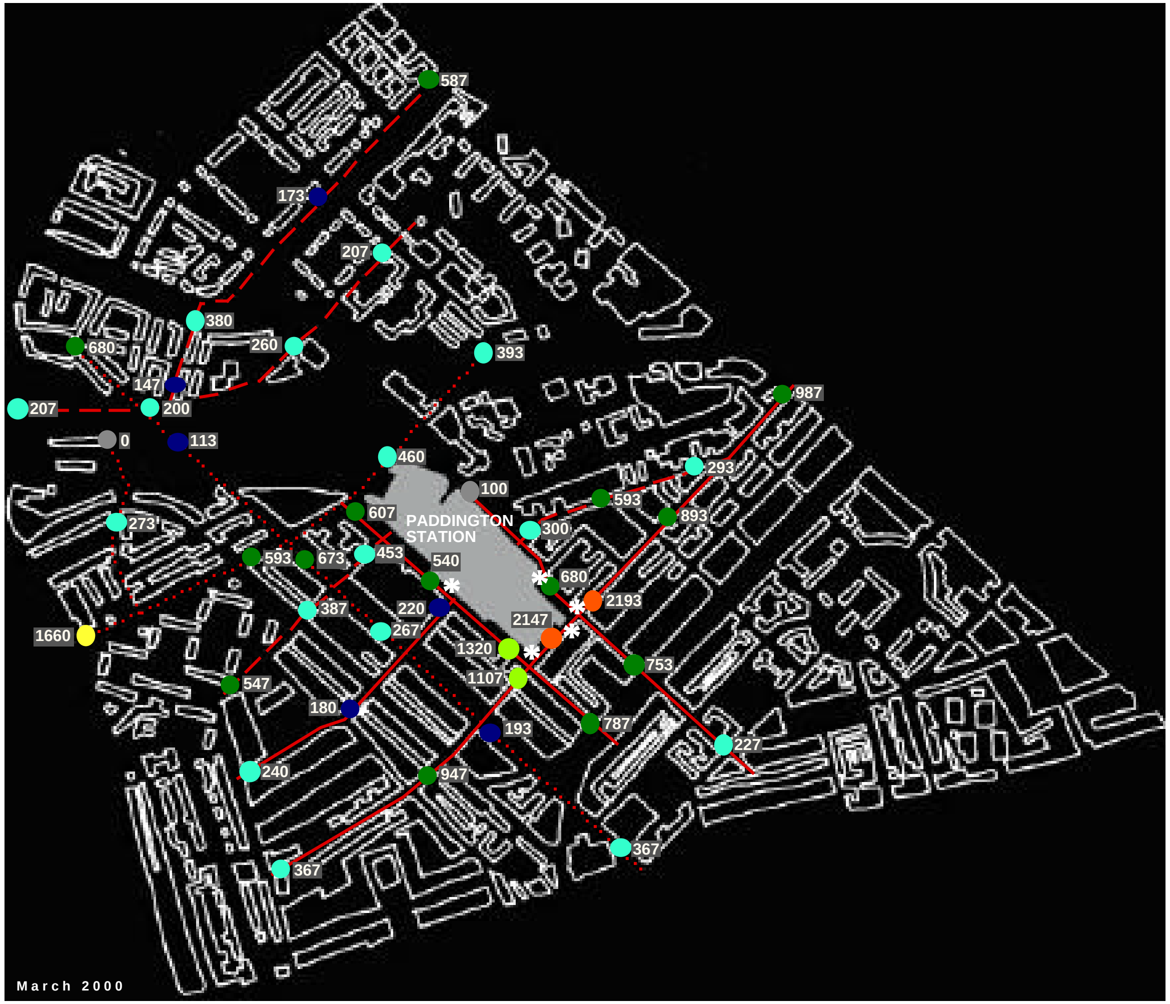


Figure 6.10b: PADDINGTON STATION AREA:
Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

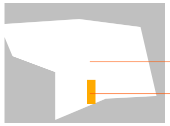
Hourly Rate

- 5001 or more
- 4001 to 5000
- 3001 to 4000
- 2501 to 3000
- 2001 to 2500
- 1501 to 2000
- 1001 to 1500
- 501 to 1000
- 251 to 500
- 101 to 250
- 0 to 100

* station entry point

route A: station entrance's approach route
route B: station non-entrance side's approach/siding route
route C: railway lines' crossing route

Figure 6.11a: MARYLEBONE STATION AREA- **Key pedestrian routes around the terminus structures and the allocation of gates for movement observation**



the terminus area

the terminus building

station entry point

route A: station entrance's approach route

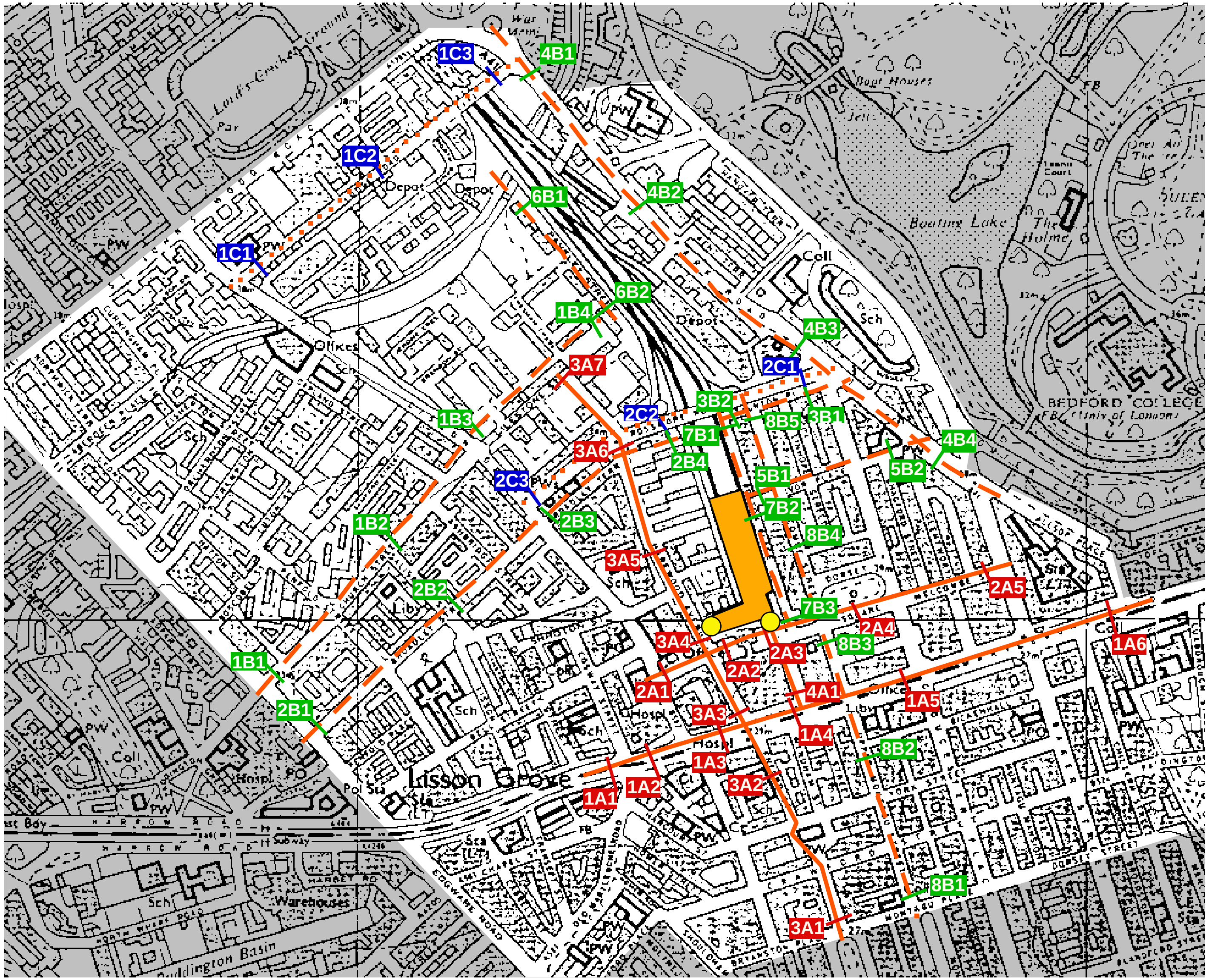
route B: station non-entrance side's approach/siding route

route C: railway lines' crossing route

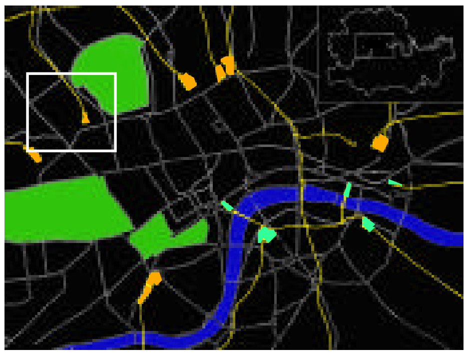
1A1 Position and serial number of gate on route A

1B1 Position and serial number of gate on route B

1C1 Position and serial number of gate on route C



KEY MAP: central London and its mainline railway termini, showing the area of enlargement in white frame



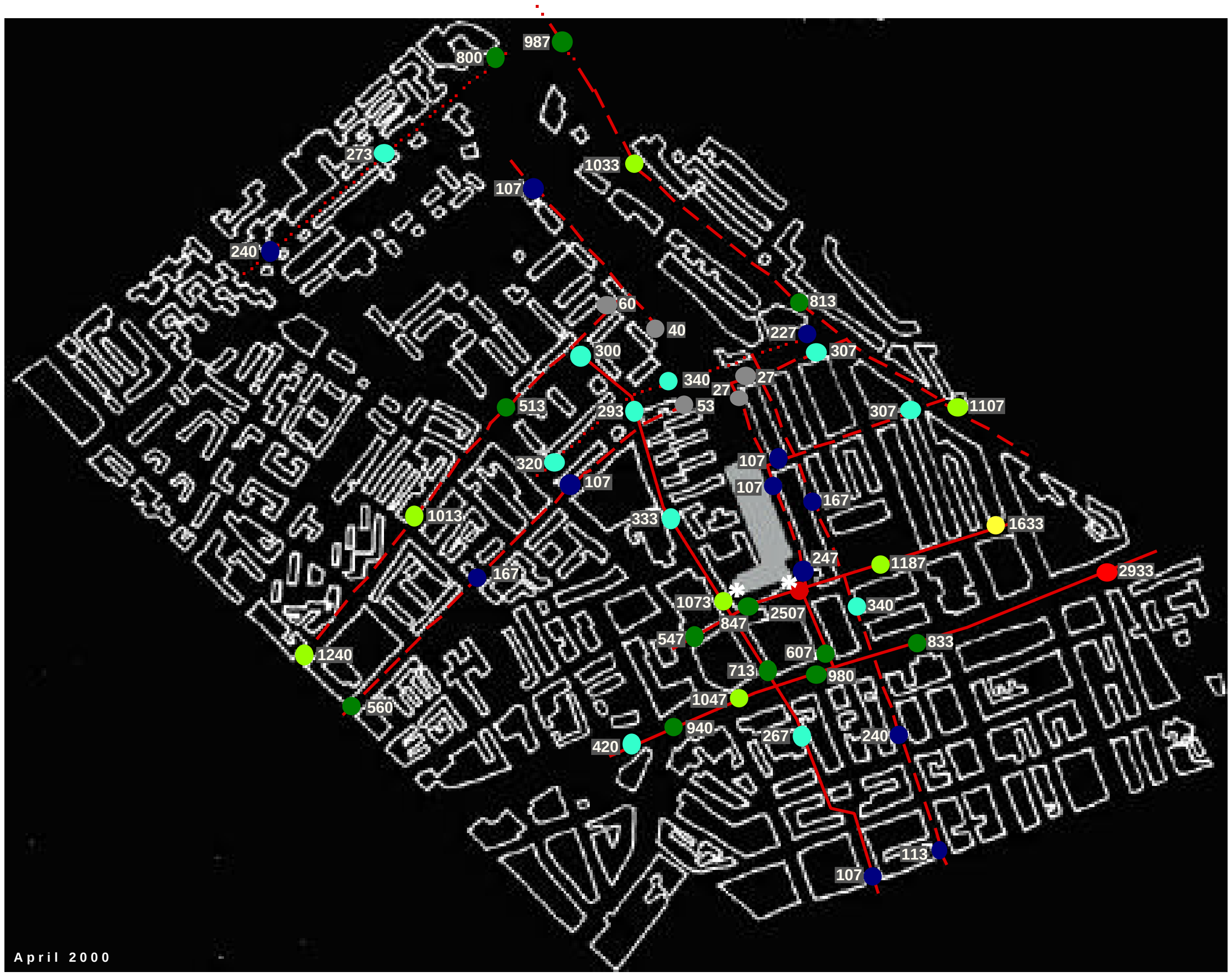


Figure 6.11b: MARYLEBONE STATION AREA
Mean Pedestrian Flow Rates (weekday - 12:00 to 18:00)

Hourly Rate

- 5001 or more
- 4001 to 5000
- 3001 to 4000
- 2501 to 3000
- 2001 to 2500
- 1501 to 2000
- 1001 to 1500
- 501 to 1000
- 251 to 500
- 101 to 250
- 0 to 100

* station entry point

route A: station entrance's approach route
route B: station non-entrance side's approach/siding route
route C: railway lines' crossing route