A new Metro Line for Budapest: a comparison with London and Paris

Keyvan Rahmatabadi, Symonds Travers Morgan, UK
Nelly Cornet, RATP, France
Tamás Perjés, Duna-Bit Consultancy, Hungary

Introduction

Major Capital cities of the world are increasingly engaged in competition to attract larger shares of the global commercial and industrial activities as well as accommodating an increasing existing travel demand. From a regional viewpoint, the competition to attract industry and commerce is extremely intense amongst the emerging markets of eastern and central Europe.

With urban highway congestion at saturation levels in all major competing cities, together with considerations for environmental issues and the lack of physical space for further road building, city authorities are increasingly appreciating the benefits of mass and intermediate transit systems and the role that these systems can play in efficiently supplying the demand for travel within urban areas. Over the past decade in all major European cities the realisation of this important fact has resulted in extensive activities in appraisal of new systems and improvement of existing systems - although implementation has been continuously lagging behind the need due to budgetary constraints.

In some cases, schemes are primarily initiated as the utilisation of public transport services has already been stretched to capacity and demand for travel by public transport is already high. Here the problem is more visible in terms of existing demand outweighing the supply. In other cases, schemes are considered based on city's aspirations to develop particular corridors and for regeneration purposes. However, by and large all proposals claim to fulfil both roles to some degree. Whatever the primary strategic motive, it is significant that the answer to problems of accessibility is no longer seen to be provision for the inefficient private car traffic.

Following Hungary's entry to the market economy and increasing commercial activity in Budapest, sharp increases in car ownership resulted in a significant increase in urban congestion spread throughout the urban area. The first reaction of city authorities was to further accommodate the private car by providing more road space. A policy which closely resembles policies of western European cities for over 20 years prior to mid-1980's.

However, soon the restrictive costs and physical difficulties of further road space provision in conventionally dense city scape of Budapest, resulted in city authorities resorting to traffic and parking management measures to maximise the use of available road space for private car traffic, at times at the expense of worsening conditions for public transport vehicles which shared the road space with private cars.

Incorporating the scarcity of resources in the equation, attention paid to accommodating car traffic was at the expense of maintaining and improving the public transport system which resulted in the circular effect of worsening public transport system resulting in further modal switch to private cars, reducing public transport patronage and revenues and further increasing private car usage. As expenditure for providing for private cars increased, less resources became available for improvements to public transport, resulting in further deterioration of the public transport system.

The tale of demand and supply of transport in central and eastern European cities is one which has a remarkable resemblance to that of the western European cities. However, it is encouraging to see that the lessons in converting to a coherent and sustainable transport development is being learned at a significantly faster pace than in the western European cities - although the authors recognise this statement may reflect optimism on their part.

Policies of developing the public transport system at all levels coupled with endeavours to improve the efficiency of the public transport system is being recognised, in practice, as the major way forward for satisfying the demand for travel within the major urban areas of eastern and central Europe. To this end and further influenced by political will, Hungarian national and Budapest city authorities had embarked on rigorously progressing a new mass transit system which had been on both technical and political drawing boards for over 25 years.

The aim of this paper is primarily to describe the new metro system, which is being promoted by the Budapest authorities followed by an outline comparison of public transport systems in operation in Budapest, London and Paris and a general comparison of the main features of the scheme in Budapest with the new metro lines under construction in London (Extension of the Jubilee Line) and Paris (the Meteor Line).

Background to Budapest

Hungary, together with Poland and the Czech republic, is at the forefront of movement towards a full market economy in central and eastern Europe. As it adjusts to commercial demands, the economy is set to grow as a thriving emerging market. The growth in GDP in 1994 and 1995 stood at 2.9% and 1.5% respectively and the forecast trend is for continued strong growth.

The capital city, Budapest, with 1.9 million population and 1.1 million jobs is host to some 3.4 million public transport trips on a daily basis, including commuters travelling to and from the suburbs, outside the 'Greater Budapest' administrative area. Geographically the city is divided into two parts with Buda on the west bank of Danube (or Duna) and Pest on the east. Commercial and business activities in Budapest are by and large concentrated on the Pest side with Buda hosting the older, longer established activities including some of the ministries and government departments - see Figure 1.

Budapest public transport operator (BKV) operates an impressive range of public transport systems which includes diesel buses, electric (trolley) buses, trams, underground metro services and heavy rail services serving the suburbs.

Budapest boasts in operating the first underground railway system on the continental Europe. The Millennium line (Mill-Fav), also referred to as Metro line 1, opened in 1896 and is effectively a light rail system which operates over a 4.2 km route in a cut and cover tunnel and runs 425 train-set kilometres per day serving north east of the city centre.

BKV's bus services operate 183 bus routes serving 1,400 route kilometres and operating 91,000 bus kilometres per day. The trolley bus network consists of 14 routes over 70 route kilometres and operates 8,000 vehicle kilometres per day. 32 tram routes over 210 route kilometres clock around 17,000 tram-set kilometres. BKV also operates two conventional heavy rail underground metro lines on the east/west and south-east/north axis through the centre of Budapest. Suburban heavy rail services extend beyond the city's administrative boundaries bringing in passengers from suburban communities outside Budapest. There are 10 suburban routes operating over 176 route kilometres.

Budapest Metro Line 4

Metro lines 2 and 3 together provide underground urban rail services along four radial routes to the Central Business District of Budapest, serving densely populated catchment areas on their route with the Millennium line serving a mixed commercial and residential catchment area north east of the city centre.

Plans to construct a new (fourth) metro line serving the south western quadrant of the city have been on the city authority's drawing boards since the 1970s and since 1990 has become an important consideration of the Budapest municipality in their endeavours to improve the public transport supply in the south Buda corridor.

The southwest quadrant of Budapest is identified as having significant potential for commercial development. It accommodates the main highway and rail links connecting Budapest with the western European members states of the European Community through Hungary's nearest EU member neighbour, Austria. City authorities are therefore conscious of this area's need for high quality transport supply if the district is to take full advantage of its potential. On the other hand, the quality of the existing public transport services has deteriorated over the years and suffers from extensive overcrowding and poor ride quality resulting from poor track and poor highway surface condition.

The south Buda to Pest Central Business District (CBD) corridor is served by four tram routes and four bus routes, providing a very frequent service, serving a current peak hour demand of some 17,000 passengers per direction per peak hour over three river crossings. There are also a large number of other bus and tram routes acting as feeders, serving other parts of the south west corridor and serving another major commuter corridor from south Buda northwards to the central and north Buda (west bank of Danube).

All these services, particularly those serving the demand between south west of Budapest and Pest CBD are under significant overcrowding pressure. As well as the need to serve the existing demand, the progress towards exploiting the commercial potential of this area is being severely disrupted as the public transport system in the corridor comes under increasing pressure.

With the above situation prevailing, the need for a major upgrading of the public transport supply along this corridor has become increasingly evident in recent years. Although a track rehabilitation programme for some of the tram lines in the corridor has recently been completed, the need for additional capacity is clear. This resulted in the Budapest Municipality further pursuing the plans for the fourth metro line serving the south western quadrant of the capital city.

The planned terminal stations of metro line 4 are situated at the main railway station in Budapest, Keleti, east of the CBD and the last main line railway station within Budapest, on route to the west of Hungary and Austria, Kelenföldi, south west of the city. The route of metro line 4, serves the eastern and southern part of the CBD on the Pest side (east of Danube) with an interchange station connecting the proposed line to the existing metro line 3 which serves the city on a north/south-eastern axis. The line then crosses the Danube in a tunnel under the historic Freedom Bridge (Szabadság Bridge) and for the remainder of its length, runs within District XI, one of the most densely populated districts of Budapest. District XI with 170,000 residents has a population density of over 5,300 residents per km^2 which is 50% higher than the average aggregated population density for the whole city. District XI also accommodates the main university in Budapest. Figure 2 shows the proposed alignment of metro Line 4 in relation to the rest of the metro network.

The total length of the line is 7.3 km and is accessed by 10 stations (including terminal stations). The alignment is wholly underground and is planned to run in a bored tunnel up to some 45m deep with a four year planned construction period. In 1996 prices the cost of the line is estimated at a total of just over Ecu 500[1] million, including Ecu 110 million estimated rolling stock costs and Ecu 90 million for systems and signalling.

For the planned opening year of 2003 the line is forecast to carry around 430,000 passengers per day, with a maximum peak hour link loading of 18,000 passengers per hour per direction. The busiest station is Kálvin tér, where an interchange is provided with the existing line 3 resulting in 70,000 passengers boarding in both directions per day. Peak hour boardings in the peak direction at Kálvin tér is forecast to reach 8,000.

The line is forecast to carry over 8 million passengers per kilometre of track in its planned opening year which will place it amongst the most utilised metro lines in Europe. This is due to the line being relatively short with the whole of its length running through a dense catchment area with a large existing public transport demand, the majority of which is expected to transfer to the new service.

The rolling stock will be made up of 5 vehicle units with a total train-set length of 80 metres. Platforms are therefore designed to be 90 metres long.

It is planned that the rolling stock and the signalling system to be operated along the route will be able to deliver a desirable design capacity of 21,000 passengers per hour per direction, based on an operating headway of 2 minutes. With the signalling capable of handling operating headways of 90 seconds, allowing for realistic dwell times, the system will be capable of handling a peak hour crush capacity of around 32,000 passengers per direction. The maximum directional line loading in 2020 is estimated at 21,000 passengers. The system is therefore designed with reasonable spare capacity to serve the passenger demands beyond 2020.

[1] First Quarter 1996 exchange rates. All other figures in this paper are based on June 1997 exchange rates.

By and large, the system planned for Budapest is based on a modest design with little ambitious over-elegance. There are no plans (as yet) for costly artistic and elegant architectural wonders to function as passenger terminals. Functionality remains the only stimulus for the implementation of metro line 4 in Budapest in the endeavour to keep the costs within the minimum, and hopefully affordable, limits.

Comparison with London and Paris

In planning new public transport systems, particularly mass and intermediate transit systems, it is important to be able to put in perspective the plans, forecasts and costs against other existing systems and other systems which are also undergoing, or have recently undergone, the planning process. Comparison with similar cases elsewhere always induces interest amongst the transportation planning professionals who often use systems which are already operational or are in a more advanced stage of planning and construction as the yardstick for other projects in the pipeline.

This part of the paper undertakes an outline comparison of public transport systems in operation in the three capital cities followed by the comparison of the planned metro line 4 in Budapest against the extension of the Jubilee line in London and the new Meteor line in Paris. To set the scene, first the national and city-wide conditions are compared, followed by more specific comparisons.

Background to Capital Cities Compared

Comparing different cities is often complex as there are usually significant differences in demography and stages of social and (particularly) economic developments between them even within the same national boundaries and more so when cities in different countries are compared. Furthermore, comparison of infrastructure costs is often significantly influenced by the movement of exchange rates which is further exacerbated in the case of new market economies such as Hungary. With this in mind, the first part of the comparison section of this paper sets the scene by identifying the differences between the main economic indicators of the countries, demography and the public transport systems of Budapest, London and Paris.

Hungary is a significantly smaller country than the UK and France with a total land area of just over one third of UK and one sixth of France, and a one sixth of the population of UK and France. Hungary's GDP per head of population in 1995 stood at Ecu 3,800[2], compared to an equivalent figure for UK of Ecu 16,700 and France of Ecu 23,400, ie per head of population, Hungary generate a national income less than one quarter of UK and around one sixth of France. Average annual gross salary in Hungary stands at Ecu 3,000 against comparable figures for UK of Ecu 25,000 and France of Ecu 41,000. The rate of growth of the economy in Hungary shows signs of stabilisation following a volatile period since adopting market economy policies. Table 1 contains a summary of the national comparisons described above.

[2] Average salary statistics for 1996 converted to ecu based on 1997 exchange rate.

Table 1 General Comparison at National Level

	Hungary	*UK*	*France*
Area (km^2)	93,000	244, 000	549,000
Population (million)	10.2	58.6	58.3
GDP per Head (Ecu)	3,800	16,700	23,400
Av. Growth in GDP (1991-1995)	-2.2%	2.0%	1.1%
GDP Growth in 1995	1.5%	2.5%	2.2%
Average Annual Gross Salary (Ecu)	3,000	25,000	41,000

Sources: Central Statistic Offices of respective countries
OECD
UK Department of Trade and Industry
Economist Intelegence Unit

Note: In comparing the above figures it should be noted that currency movements in 1996 has been significant.

The capital city areas compared for Budapest and London are based on administrative areas of Budapest city and the Greater London, respectively. Providing an equivalent for Paris is somewhat more complex as the administrative area of Ville de Paris comprises an area which is significantly smaller than the Greater London area and the administrative area of Ile de France is significantly larger than the Greater London area.

To allow for compatible analysis and for the comparisons to focus on similar areas in terms of structure, we have considered an area of Paris which lies between the administrative boundary of Ville de Paris and Ile de France which is considered as the built-up area within Ile de France and is similar in structure and demography to that of the Greater London[3]. Also both areas being considered for London and Paris are approximately bounded by a major orbital motorway (M25 in London and the Francilienne in Paris). Figure 3 shows the relative size of the areas being compared.

Budapest is the smallest of the three urban areas being compared with around one third of the built up urban areas of London and Paris and less than one third of the population of Greater London and a quarter of the population of Paris. 'Greater Budapest' also has the lowest overall aggregate population density of the three cities.

Employment in all of the three capital cities is around half of the population figure with the aggregate employment density closest between Budapest and London. The aggregate employment density in Paris is some 30% higher than in Budapest or London. Table 2 provides a summary.

Table 2 Urban areas compared

	Budapest	*London*	*Paris*
Area (km^2)	525	1,578	1,525
Population (Million)	1.9	6.8	8.0
Population density (Per km^2)	3,600	4,300	5,200
Employment (Million)	1.1	3.4	4.2
Employment density (Per km^2)	2,100	2,200	2,800

[3] This definition is identical to that in "London, Paris; A comparison of transport systems" by London Research Centre and Institute d'Amenagement et d'Urbanisme de la Région d'Ile-de-France.

Public Transport Systems

As discussed earlier, urban public transport demand in Budapest is served by an impressive range of systems including, diesel buses, electric trolley buses, trams, metro and a segregated light rail type service running in cut and cover tunnel. There are also suburban heavy rail train services serving the suburbs and terminating at the edges of the city centre similar to those in operation in London and Paris which are outside of the scope of this paper and will not be compared here.

Buses and underground metro together dominate the public transport supply in London and Paris. Paris now operates one tram route[4] and London's DLR is its only Light Rail system in operation[5].

Paris also operates four regional metro (RER) routes[6] which serve the immediate suburbs of Paris carrying passengers to and through the centre of the city. London's nearest equivalent system to Paris RER is the Thameslink, although it extends well beyond the immediate suburbs of London and does not provide as comprehensive an interchange facility with the London Underground as RER in Paris. In that sense, Thameslink is therefore primarily a part of the regional railways system of south east England which also runs through the centre of the London. Comparison of Regional metro systems is excluded from this paper. Table 3 provides a basic summary.

Table 3 Urban Public Transport systems in operation

Mode	*Budapest*	*London*	*Paris*
Bus	✓	✓	✓
Trolley bus	✓	×	×
Tram	✓	×	✓
Segregated LRT	✓	✓	×
Metro	✓	✓	✓
Regional Metro	×	✓	✓

The metro systems in Budapest, London and Paris constitute a small proportion of the total public transport network with less than 2% of total public transport service route length in Budapest and 12% and 6% of total route length in London and Paris respectively. With regards to public transport vehicle kilometreage, Metro and the Millennium lines in Budapest constitute less than 5% of the total public transport vehicle kilometres[7] with equivalent figures for London and Paris being 15% and 21% respectively. Table 4 contains a summary of the extent of route kilometres and vehicle kilometres supplied by mode for each city.

[4] A second tram line (Tram Val de Seine) is planned to start operation in July 1997.

[5] Croydon Tramlink, a part segregated tram system is planned to start operation in 1998.

[6] A fifth line is currently under construction

[7] For metros, train-set kilometres are used

Table 4 Route kilometres and vehicle kilometres by mode

Mode	*No. of routes/Lines*	*Total length of all lines in mode (km)*	*Total vehicle. km per year (million km)*
Budapest			
Bus	183	1,394	27.3
Trolley bus	14	69	2.4
Tram	32	213	5.1*
Segregated LRT	1	4.2	0.13*
Metro	2	26.5	1.63*
Total		*1,707*	*36.6*
London			
Bus	481	2,920	329
Segregated LRT	1	22	1.5
Metro	11*	408	57
Total		*3,350*	*387.5*
Paris			
Bus	288	2,950	142
Tram	1	9	0.75
Metro	13**	202	39*
Total		*3,161*	*181.8*

* Estimated from vehicle unit kilometres
** Whole lines - branches are assumed as part of whole lines

As with all metro systems, although the metro network constitutes a relatively small proportion of the physical route and vehicle kilometres compared to the total public transport network, they carry a significant proportion of total public transport patronage within the urban area. In Budapest some 20% of passenger journeys and 20% of passenger kilometres is carried by the relatively modest metro network. In London 39% of passenger journeys and 61% of total public transport passenger kilometres are carried by the underground network and the equivalent figures for Paris are 54% of passenger journeys and 71% of passenger kilometres, highlighting the efficiency of metros (where there is sufficient demand) in the context of urban public transportation. Table 5 shows annual passenger journeys and passenger kilometres by mode in Budapest, London and Paris.

Table 5 Annual patronage by mode

	Budapest		***London***		***Paris***	
Mode	Passenger Journeys (million)	Passenger km (million)	Passenger Journeys (million)	Passenger km (million)	Passenger Journeys (million)	Passenger km (million)
Bus	690	3,400	1,200	4,000	840	2,030
Trolley bus	80	210	-	-	-	-
Tram	340	930	-	-	16	39
Segregated LRT	*	*	11.5	55	-	-
Metro	270*	1,130*	780	6,300	1,000	5,000
Total	*1,380*	*5,670*	*1,992*	*10,355*	*1,856*	*7,030*

* Metro and Segregated LRT (Mill-Fav) combined and shown as metro

Comparing total annual patronage by kilometre of track is a popular means of establishing the utilisation of a metro system. Using this measure in Budapest, metro lines have a significantly higher utilisation rates than the lines in London or Paris. This is because the whole of the metro lines in Budapest run through dense urban areas unlike say in London where the outer sections of long lines run through suburban and sparsely populated areas.

High utilisation of the metro system in Budapest is highlighted when comparing total patronage (boardings) on lines in London and Paris against the equivalent figures for Budapest metro lines. In Budapest similar total boardings take place over much shorter route kilometres.

On these basis the most utilised line in London is the Victoria line with total passenger trips of 440,000 per day (weekdays) or approximately 130 million passengers per year resulting in 3.1 million passengers per kilometre of track per year. An equivalent calculation for the busiest metro line in Paris (Line 1) which carries some 400,000 passengers per day results in 3.6 million passengers per kilometre of track.

In Budapest the Millennium line light rail system carries 3.6 million passengers per kilometre of track per year and the equivalent figure for the two heavy rail metro lines is 6.4 and 5.4 million passengers per year per kilometre for lines 2 and 3, respectively.

Other measures of a line's 'Busyness' are passengers carried per day and directional peak hour link flows. In terms of operation, peak hour directional link flows are of higher significance as these often determine train-set and platform sizes and are used to optimise headways. The highest link flows on the Budapest metro lines 2 and 3 is 14,000 per hour per direction compared to 20,000 on London's Central Line and 19,000 on Metro Line 1 in Paris[8]. Higher directional hourly flows in London and Paris is a reflection of larger trains in London and a more frequent service in Paris. Table 6 provides a summary.

Table 6 Busiest existing Metro lines

	Budapest Metro 2	Budapest Metro 3	London	Paris
Passenger journeys (total boardings per day)	430,000	590,000	575,000 (District Line)	400,000 (Line 1)
Highest Utilisation (pass. per km of track per annum)	6.4 million	5.4 million	3.1 million (Victoria Line)	3.6 million (Line 1)
Highest link loading (Pass. per hour per direction)*	14,000	14,000	20,000 (Central Line)	19,000 (Line 1)

* Estimated from peak period data (usually over three peak hours)

Ticket prices

It is not the intention of the authors to undertake an in depth analysis of cost of travel in the three cities. However, to provide a general perspective on the cost of travel, the cheapest and the most expensive single ticket prices are compared and also expressed as a proportion of average daily wage in Table 7.

[8] All peak hour data estimated from daily and peak period statistics.

Until recently, a single flat rate per leg of a journey applied to the whole of public transport network in Budapest. In July 1996 a new system was introduced for the metro network where the fare is dependant on the number of stations travelled and number of interchanges made.

In London fares are charged based on a concentric zone system where the cost of the journey is dependant on the length of the journey based on zone bands.

Paris also has a zone system which effectively only applies to buses, tram and the Regional Railways. The whole of the metro network lies within the central zone in Paris and therefore effectively a flat rate applies to the travel on the metro.

Table 7 Comparison of ticket prices*

	Cheapest ticket	*Most expensive ticket*
Budapest		
Ticket price (in Ecu)**	0.19	0.48
Av. gross daily wage (in Ecu)†	11.5	11.5
Ticket price as a proportion of daily wage	1.5%	4.2%
London		
Ticket price (in Ecu)	1.7	4.6‡
Av. gross daily wage (in Ecu)†	96	96
Ticket price as a proportion of daily wage	1.8%	4.8%
Paris		
Ticket price (in Ecu)	1.14	1.14
Av. gross daily wage (in Ecu)†	158	158
Ticket price as a proportion of daily wage	0.7%	0.7%

Note All single fares
* June 1997 prices and exchange rates
** Great majority of travellers in Budapest purchase (or are provided with) heavily discounted period tickets compared with figures in the Table
† Estimated from annual gross salary (National averages)
‡ Up to 6 zones (Excludes 11 stations outside the sixth zone)

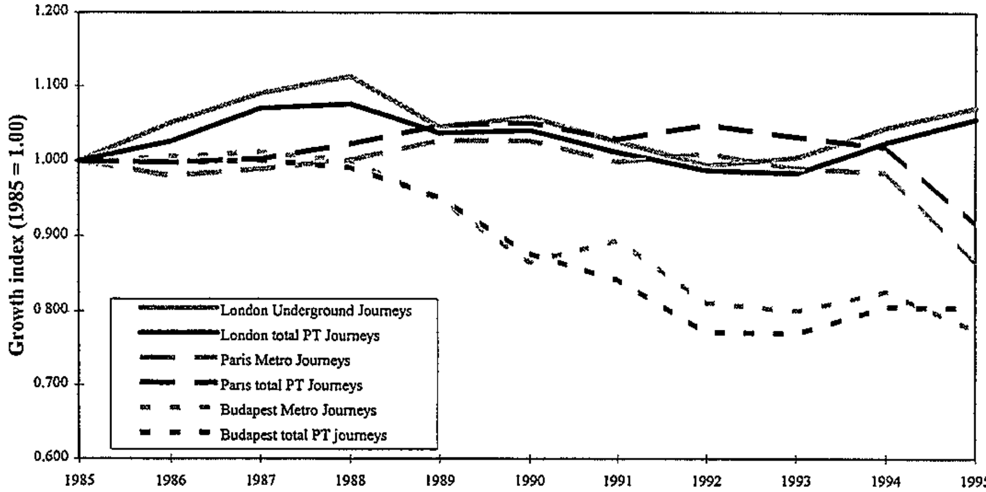
Historic Trends

Public transport usage in Budapest has been in decline since late 1980s which corresponds with Hungary's introduction to market economy and the rise in car ownership and private vehicle highway trips. However, in recent years the rate of decline has been slowing and public transport usage seems to be stabilising at around 80% of the mid 1980s level.

By comparison the trend in public transport usage in London and Paris shows relative stability until 1993/1994. Public transport demand in London has increased since 1993 by 7% over two years (1993 to 1995). This increase could be attributed to UK economy and therefore travel activity moving out of recession. By contrast, public transport patronage in Paris has fallen sharply since 1994 (by 10% in one year), which could be the result of the French economy entering a recessionary period.

Chart 1 shows patronage trends in passenger journeys. Changes in passenger kilometres also follows an almost identical trend.

Chart 1 Recent trends in Metro and total public transport passenger journeys



Proposed new Metro lines

Each one of the three cities compared are in the process of extending their existing metro networks. This section of the paper provides an outline comparison of the new Jubilee Line Extension, currently under construction in London and the Meteor Line which is under construction in Paris against the new metro line being planned for Budapest. The comparison will concentrate on patronage forecasts, operation of the lines and costs.

Jubilee Line Extension, London

The extension of the Jubilee Line is 16 kilometre long which when added to the existing section increases the whole length of the line to 37 km in total. The extension will have 11 stations and the route of the line crosses the river Thames at four locations, all in tunnels. Once complete, the total number of stations on the Jubilee line will increase to 27.

Signalling and systems are based on the leading edge, state-of-the-art technology and stations architecture and designs are of the highest quality to match.

The Jubilee line extension is primarily planned to serve and support the regeneration of the London Docklands on the east side of London and its justification is therefore heavily dependant on the development of this part of London. The extension of the Jubilee Line significantly enhances the existing public transport system serving London Docklands which includes London's newest rail based transit system (and its only fully segregated Light Rail Transit system), Docklands Light Railways.

The extension of the Jubilee Line is forecast to increase the existing number of passengers served by the line by over 300,000 to 480,000 passengers per day in 2001, growing to some 600,000 by 2020. The utilisation of the whole line is forecast to increase from 1.3 million passengers per kilometre of track to 2.4. The utilisation of the extension alone is expected to exceed 4 million passengers per kilometre of track by 2001.

The busiest section of the line is forecast to carry some 18,000 passengers in the peak hour, peak direction in 2001.

The new Jubilee Line Rolling stock will consist of six vehicle units and will be equipped with the latest train control and information systems costing around Ecu 6 million per train-set. Overall train-set length will be 108 metres.

The signalling for the existing section of the Jubilee line will be replaced with the new system, operating a moving block headway and the train operation will be fully automated. However, each train will have a driver in the cab to operate the doors and deal with emergencies.

Initially the train headways on the busiest sections during the peak period will be just over two minutes with 100 second headways planned for later years as demand increases.

The total cost of the system, excluding rolling stock, is Ecu 3.4bn[9]. Total rolling stock cost amounts to Ecu 360 million.

Figure 4 presents an schematic representation of the line.

Meteor Line, Paris

Paris' newest addition to its metro network will be completed in stages with the first stage, which is planned to start operation by the end of 1997 being the focus of this paper. The first stage is some 7.45 km long (approximately the same length as the proposed Budapest fourth metro line). For a substantial part of its route the line will run adjacent to the existing RER line A and metro line 1, on the east (north) bank of the seine.

As with the Jubilee line extension in London, the Meteor Line is planned and designed based on leading edge signalling and systems technology and architecture of station buildings is of the highest quality.

The line is primarily proposed to relieve the demand on metro line 1, the busiest metro line in Paris and RER line A. The line will also assist in regeneration of the area surrounding its southern end of its route across the Siene on the west bank.

Meteor line is forecast to carry 320,000 passengers per day by the year 2000 resulting in a utilisation measure of over 6 million passengers per kilometre of track per year. The busiest link is estimated to carry over 16,000 passengers per peak hour in the peak direction.

The rubber tyred rolling stock will initially consist of 6 vehicle units (articulated) and will be extended to 8 vehicle units after 2000 as demand increases. Cost of each train-set will be round Ecu 5.8 million. 6 car train-sets will measure 90 metres and extended 8 unit sets will be 120 meters in length.

The operation and signalling will be based on the latest state-of-the-art systems and will be fully automated with trains operating without driver. The signalling and systems are expected to handle 85 second headways at capacity conditions.

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[9] Scheme cost figures quoted here are based on figures published in Pound Sterling and converted to ecu based on June 1997 exchange rates. It should be noted that the value of Pound Sterling appreciated by some 20% against ecu in 1996.

There are plans for extending the line in both directions which will result in significant increases in the peak hour link loadings and daily passenger totals.

The overall cost of the line excluding rolling stock stands at Ecu 1bn with the trains costing a total of Ecu 0.11bn.

Tables 8 and 9 provides summary comparison of the main points compared, including information on the Budapest fourth metro line which was described earlier in this paper.

Figure 4 presents an schematic representation of the line.

Table 8 New Metro lines, Patronage*

	Budapest Metro 4	London JLE (Extension only)	London JLE (Whole line)	Paris Meteor
Passengers carried (total boardings per day)	430,000	320,000	480,000	320,000
Highest Utilisation (pass. per km of track per annum)	8.8 million	4.0 million	2.3 million	6.4 million
Highest link loading (Pass. per hour per direction)*	18,000	18,000	18,000	16,000

* All figures estimated from published data

Note Budapest Metro line 4 forecasts are for 2003, Jubilee line forecasts for 2001 and Paris Meteor line forecasts for 2000

Table 9 New Metro lines, scheme statistics and costs

	Budapest Metro 4	London JLE	Paris Meteor
Length (km)	7.3	16	7.5
No. of Stations	10	11	7
No. of river crossings	1	4	1
No. of interchanges with existing lines	2	8	3
Approx. platform lengths	90m	120m	130m
Scheme costs in Ecu (excluding Rolling Stock)	0.5 bn	3.4 bn	1.0 bn
Cost per kilometre (million Ecu)	68.5	212.5	134
Total rolling stock costs (million Ecu)	110	360*	110
Approx. Cost per train-set (Million Ecu)	5.8	6.0	5.8

* Cost of new Rolling stock to serve the whole route

Conclusions

High project costs together with budgetary restrictions dictates that promoting mass transit systems, anywhere in the world, can only be contemplated where there are significant grounds for the project's justification. Promoters need to be able to demonstrate that the system is imperative for its stated purpose and will be utilised to its limits.

Robust patronage forecasts on their own are not sufficient for implementation. As well as robust economics, availability of funds (affordability) and (perhaps the most important of all) political will are also amongst the most important requirements for commitment to constructing such high cost projects.

Examples cited in this paper confirm that projects which are proposed or are under construction have demonstrated the need by producing high utilisation, backed up by robust assessment. Although not explored in this paper, all the schemes also showed healthy economics.

Budapest Metro line 4 is a significant undertaking which promises to rank amongst one of the busiest metro lines in Europe. Budapest municipality and the Hungarian government's commitment to a public transport project of this scale demonstrates a major act of faith in urban public transport at a time when car ownership and private vehicle traffic is increasing at a substantial rate.

Plans for the Budapest metro line 4 are based on modest designs with functionality as the only driving factor. Proposals for the line concentrate on serving the transport purpose and avoids costly and elegant extras in an endeavour to keep costs to a minimum and within budgetary restrictions.

Furthermore, encouraging and improving transport facilities within the main corridor to the western Europe is likely to advance efficient trading between Hungary and western Europe. This is an important consideration at a time when Hungarian economy is emerging as a stable market economy.

Initiatives of this nature from the emerging markets of central and eastern Europe, therefore, need to be encouraged by international aid and funding agencies if the momentum in developing the public transport system as the major supplier of urban travel demand, is to be maintained and if endeavours towards achieving a sustainable transport strategy is to succeed.

Acknowledgement

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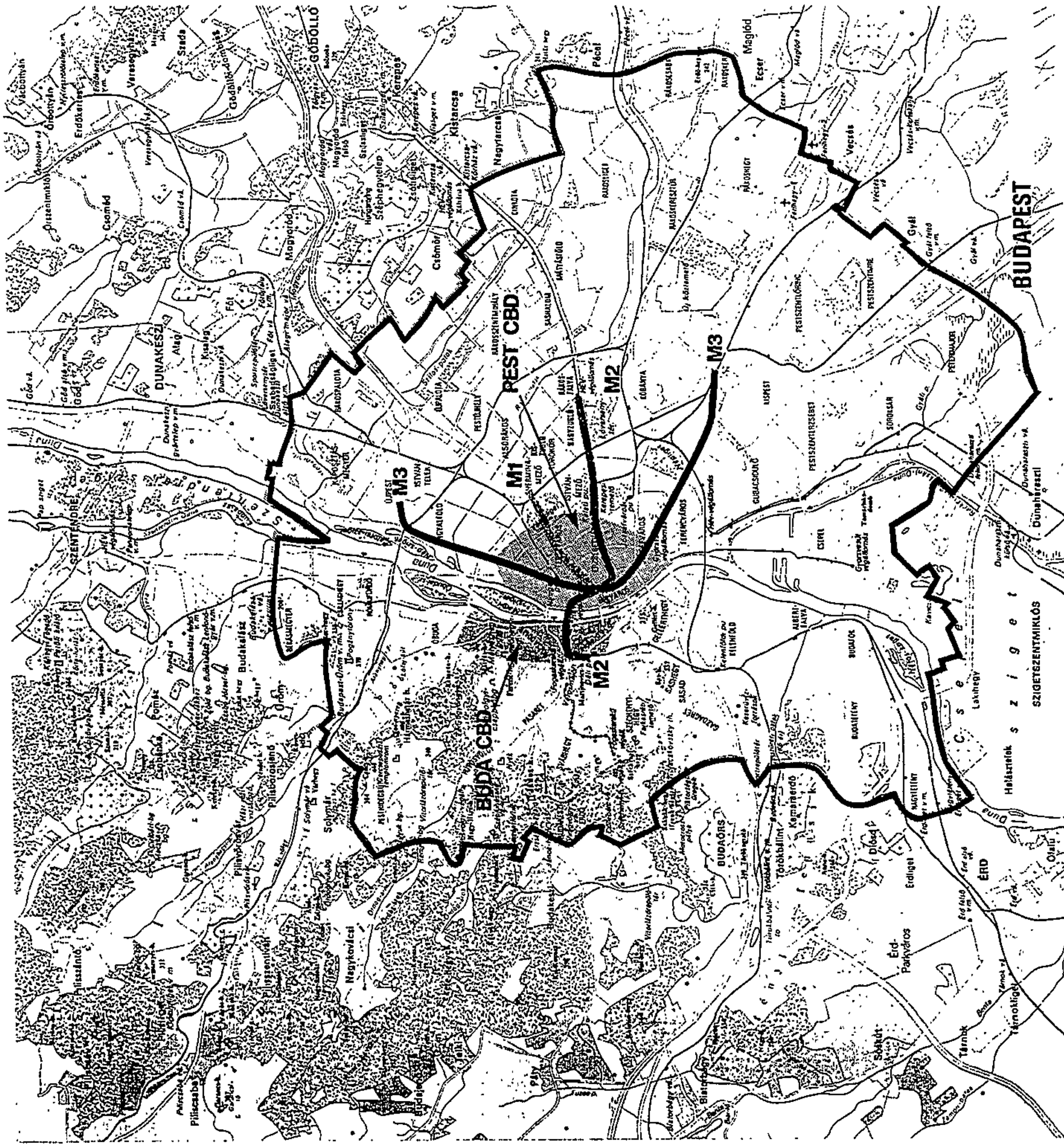
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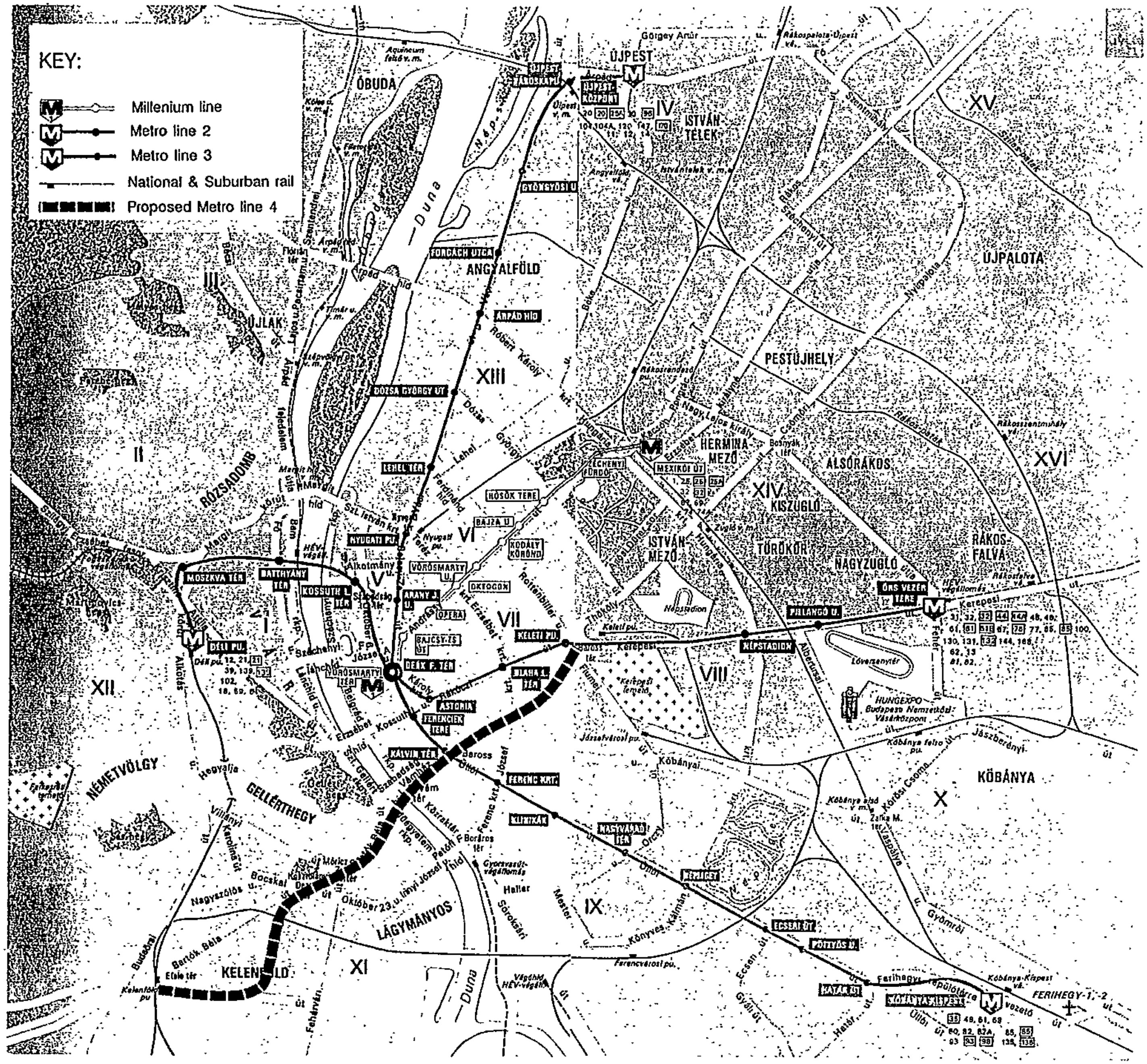
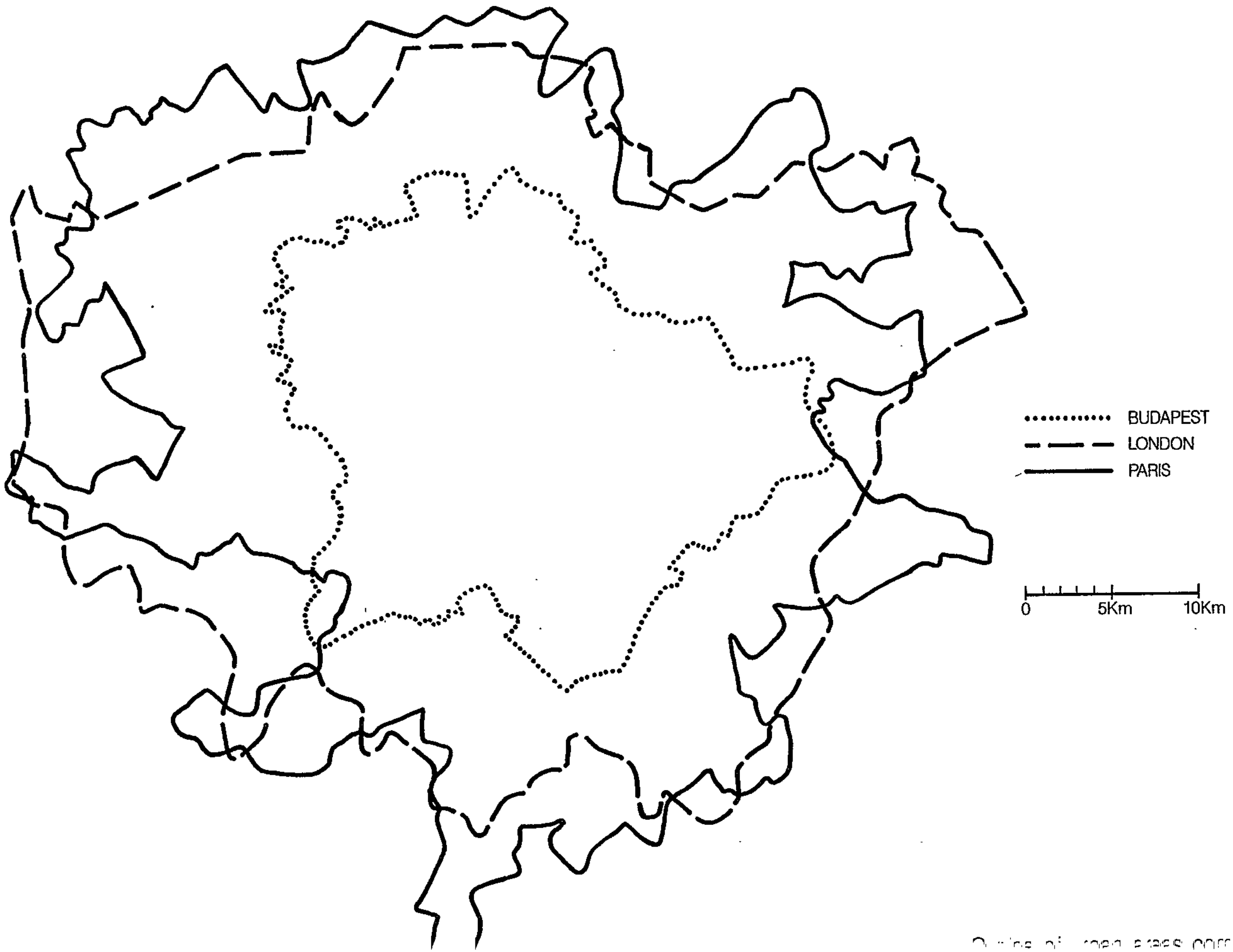
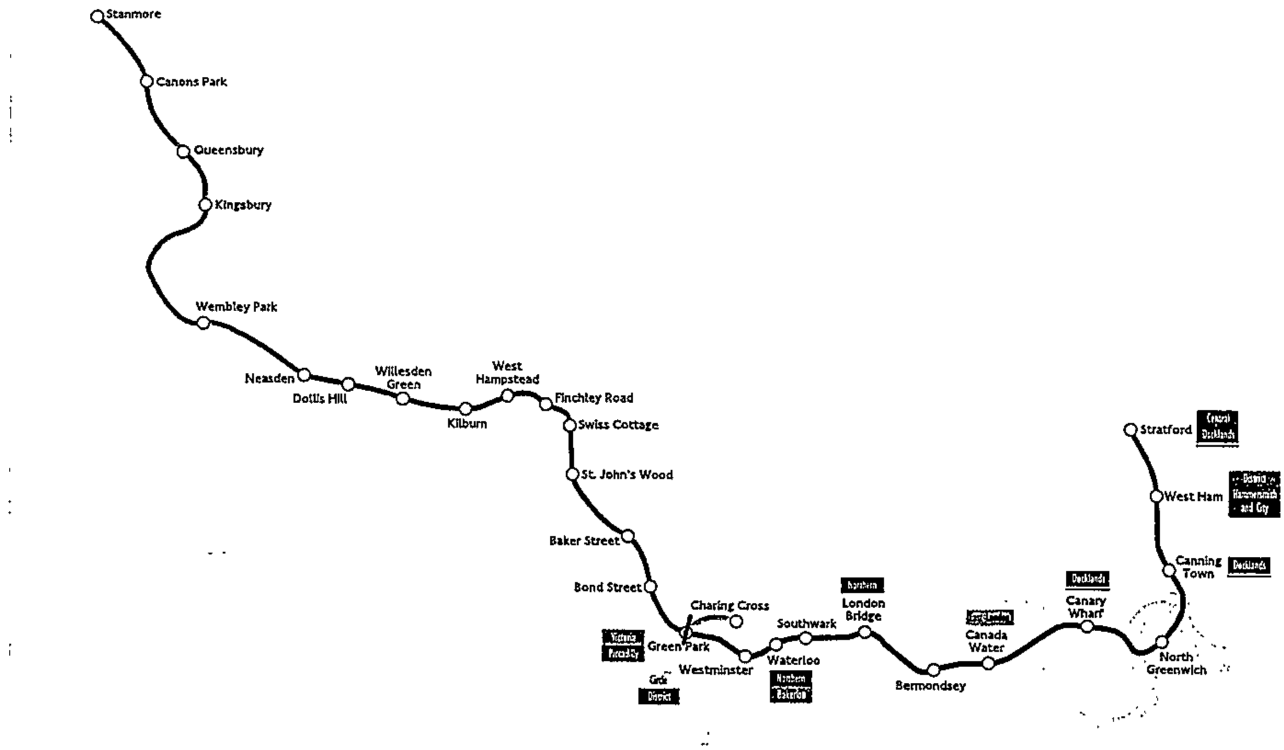
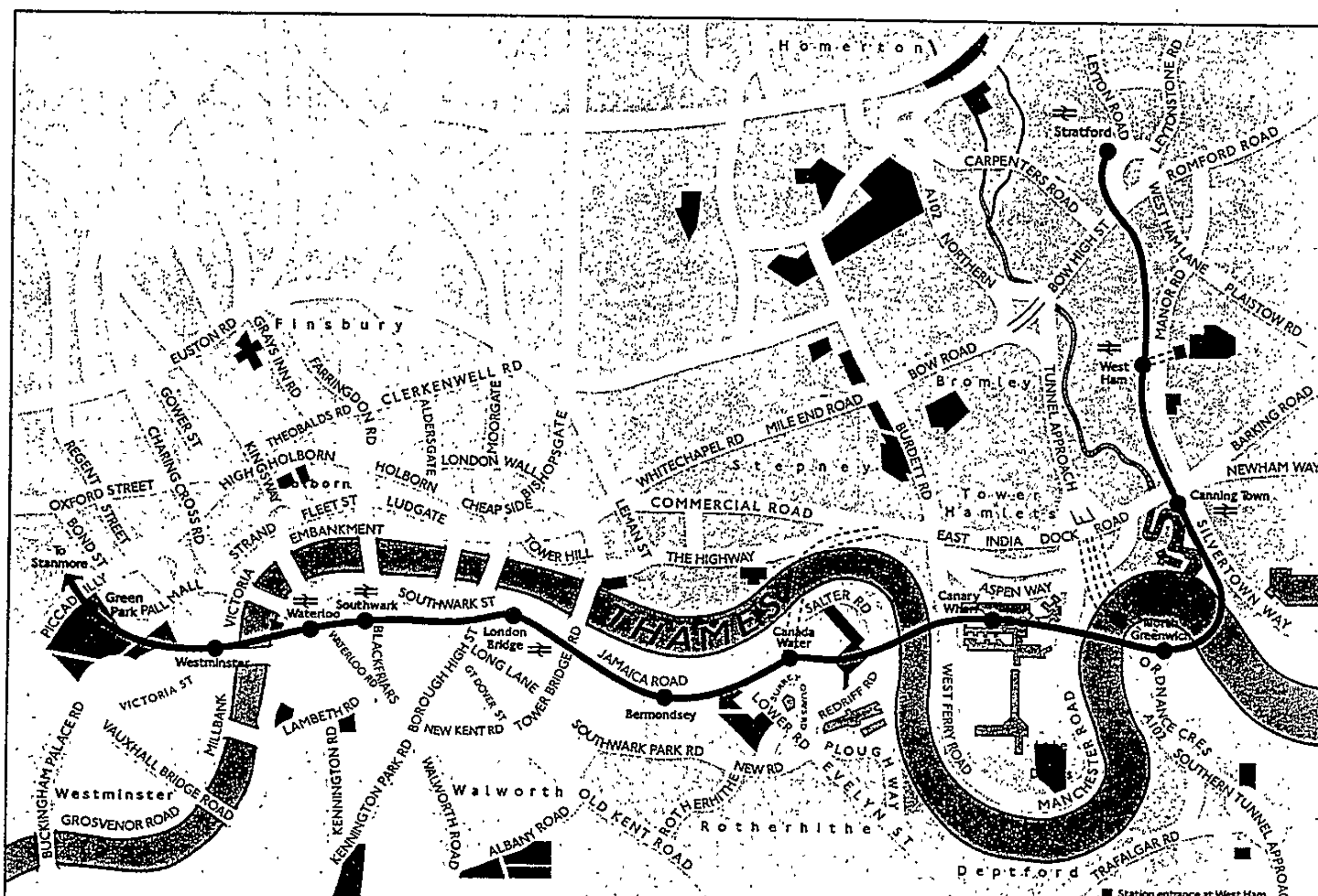


Proposed alignment of Budapest Metro 4
FIGURE 2

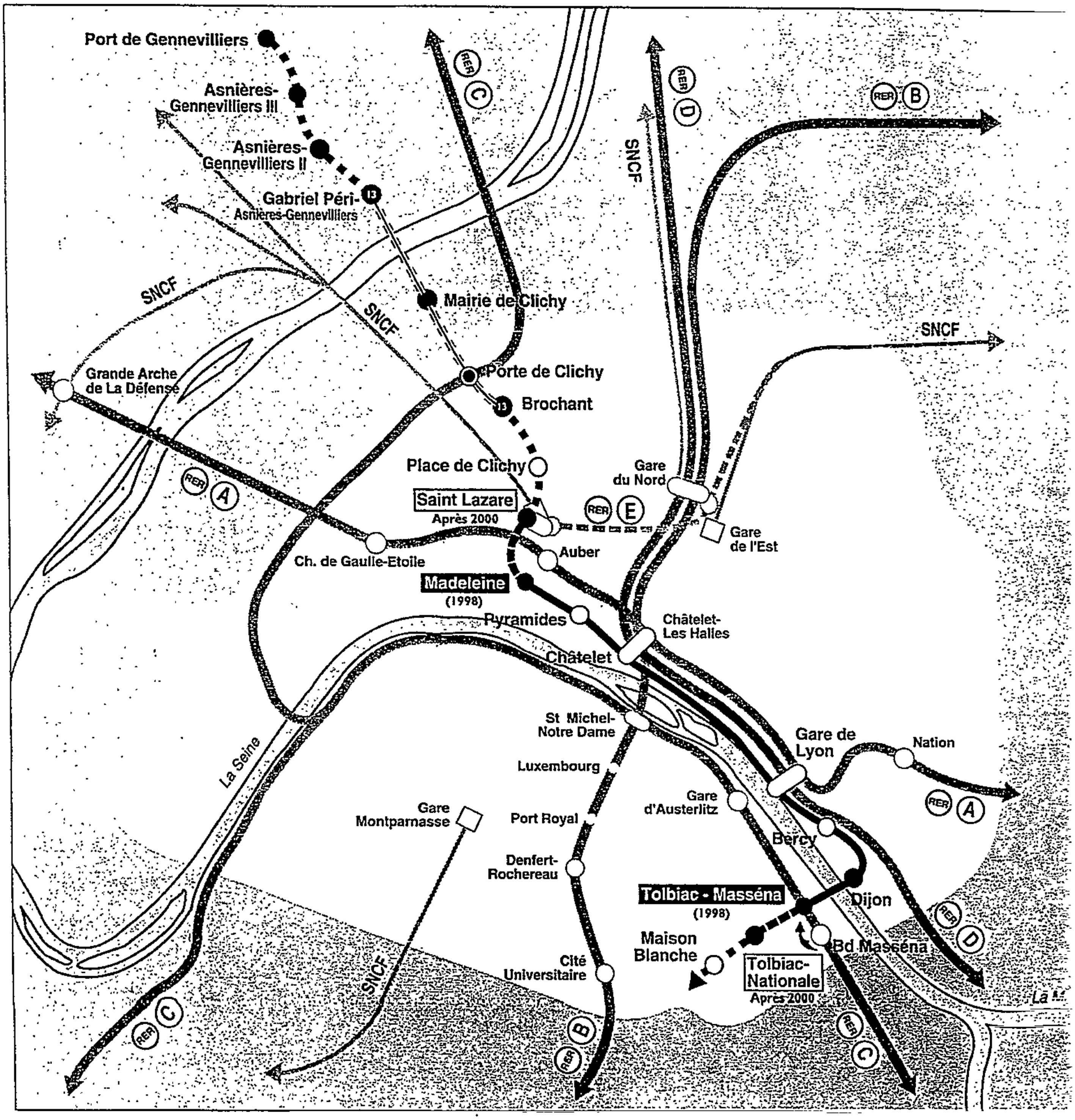


Outlines of urban areas compared

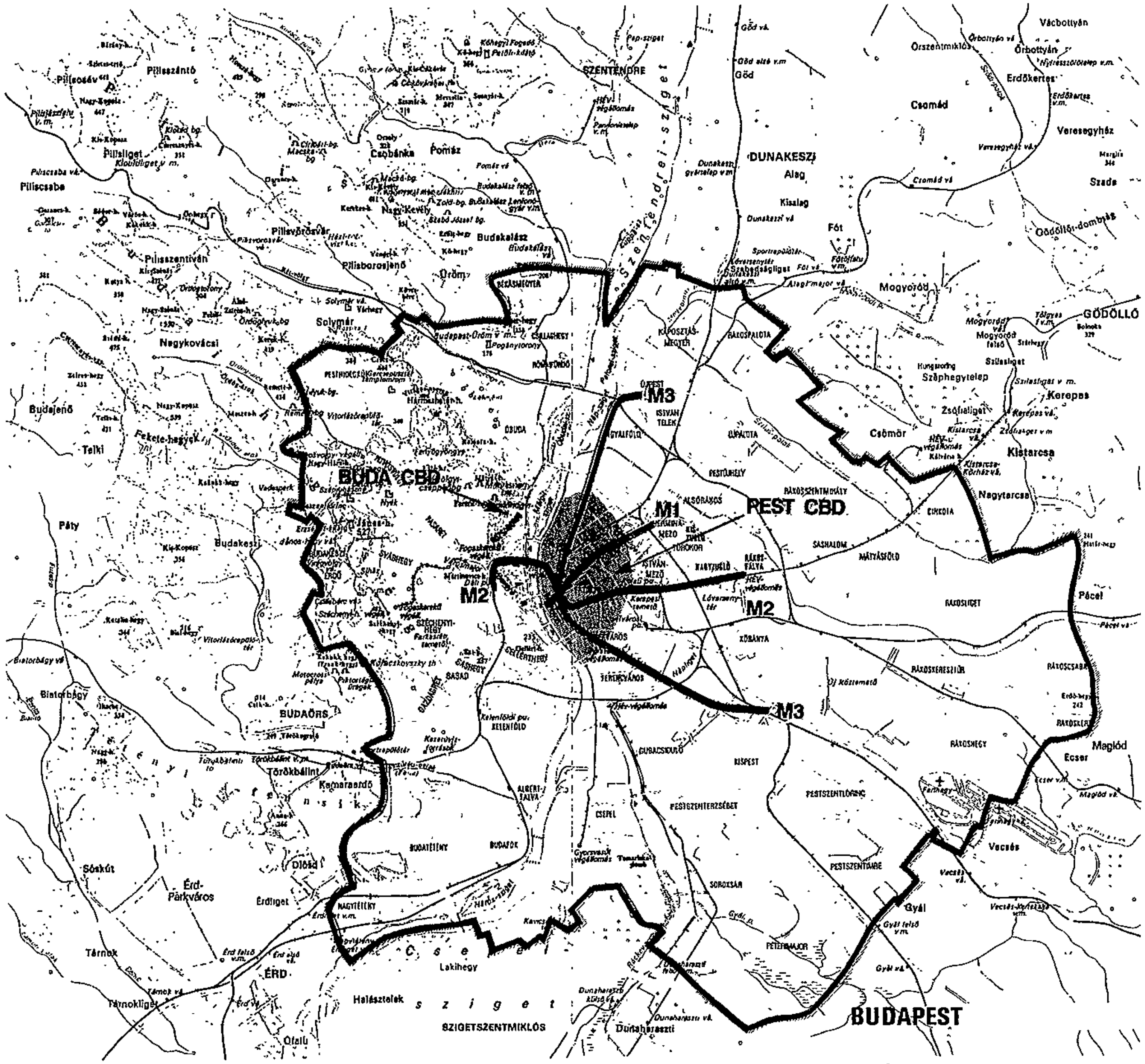




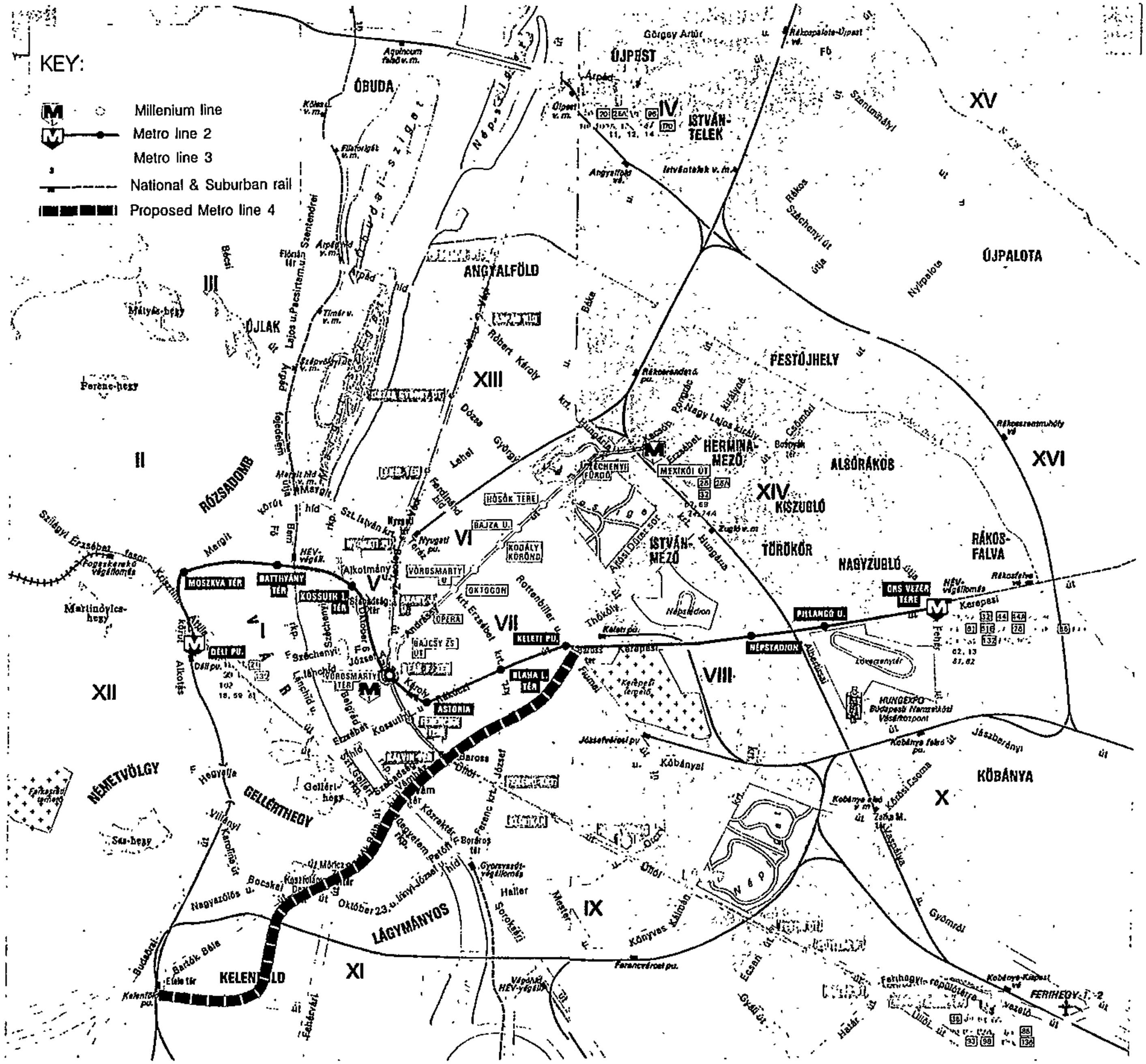
Jubilee Line Extension alignment
FIGURE 4



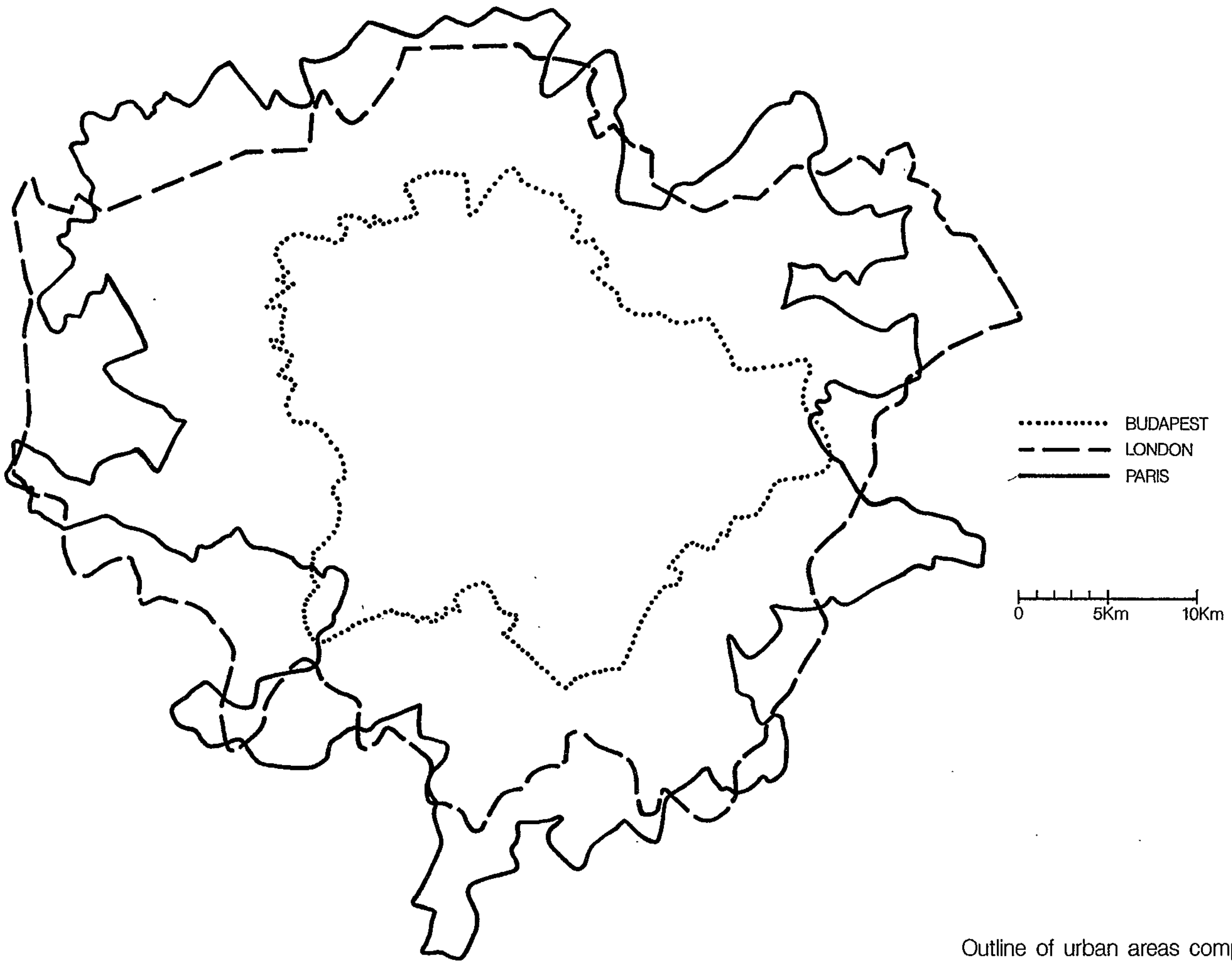
Meteor line alignment
FIGURE 5



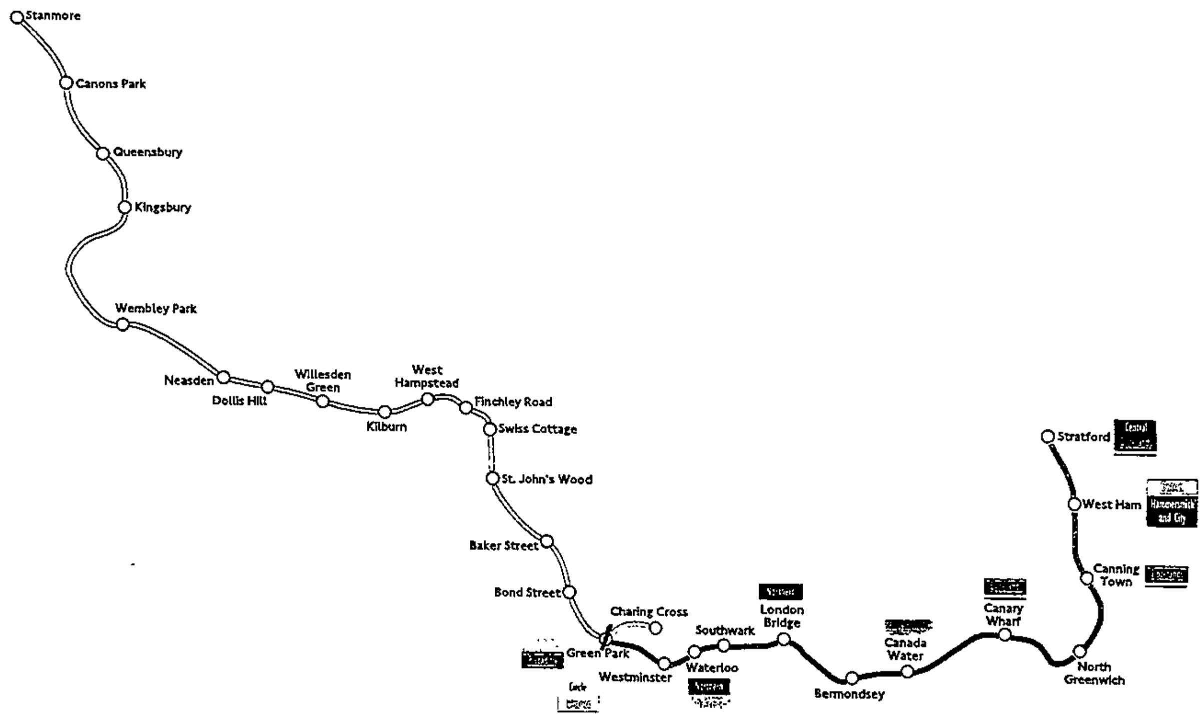
Budapest and its Metro network
FIGURE 1

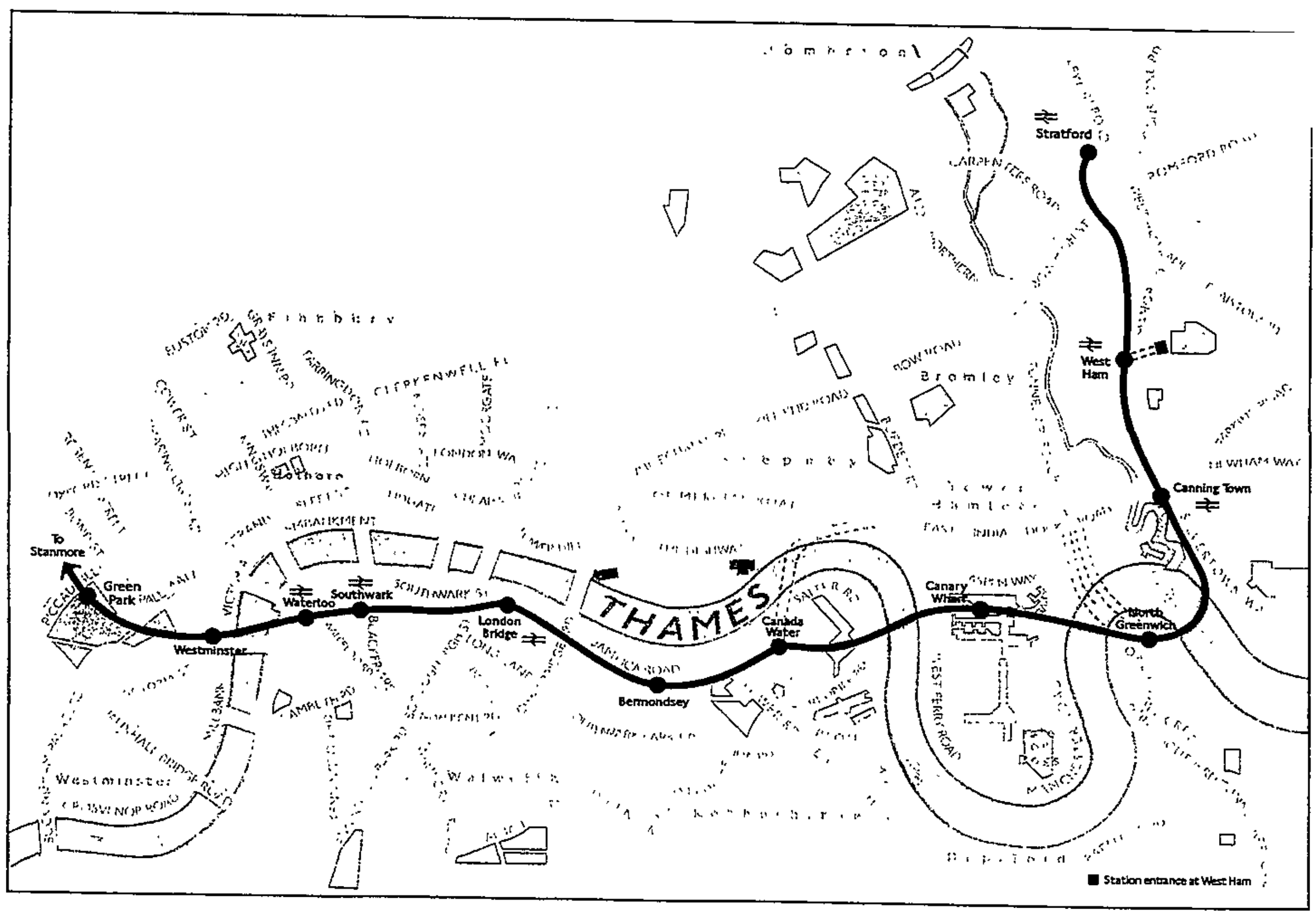


Proposed alignment of Budapest Metro 4

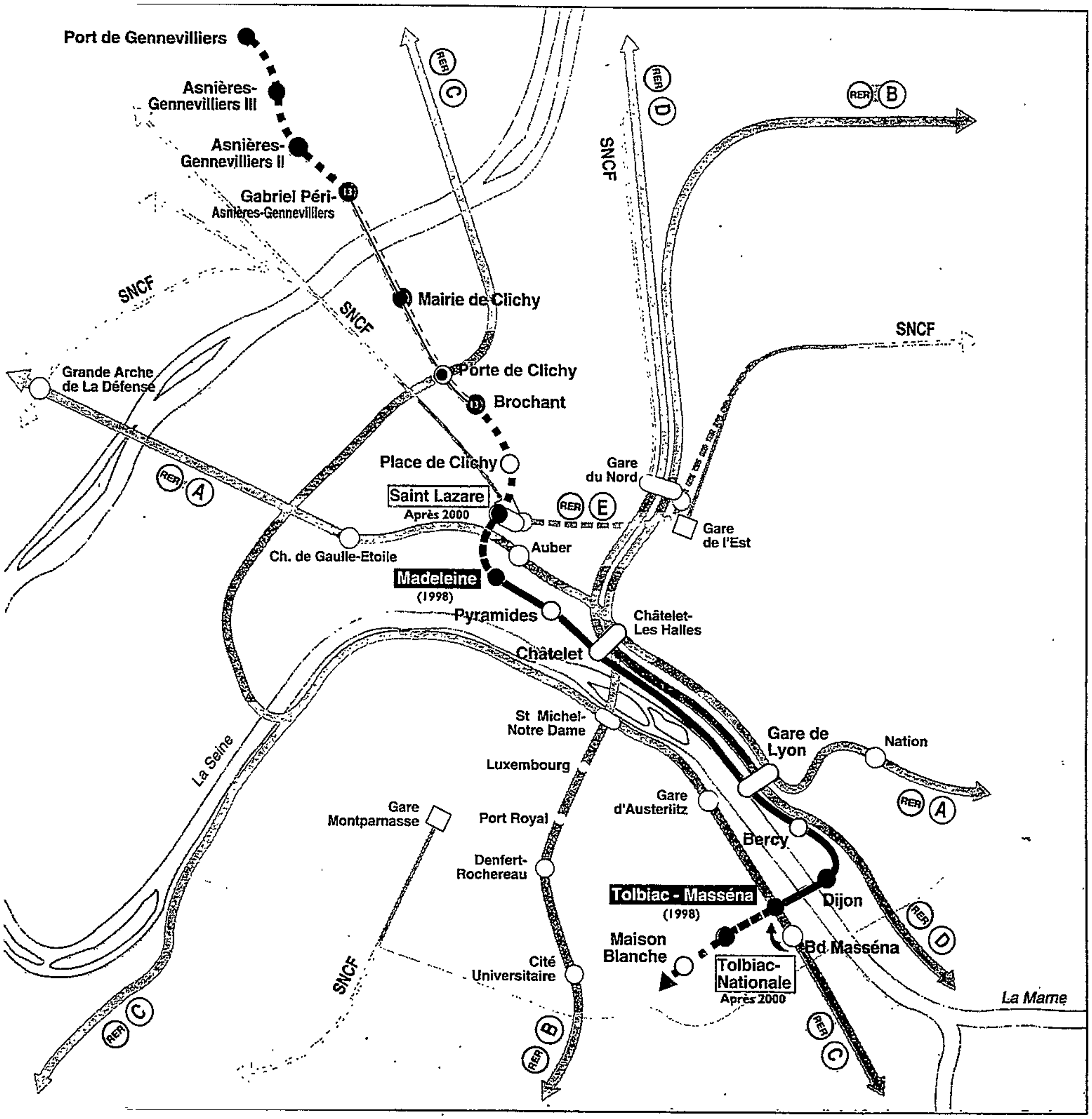


Outline of urban areas compared





Jubilee Line Extension alignment
FIGURE 4



Meteor line alignment
FIGURE 5