DELIVERABLE 1.1.1

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PROJECT N°	**FP7-233655**
ACRONYM	**CITYHUSH**
TITLE	**ACOUSTICALLY GREEN ROAD VEHICLES AND CITY AREAS**
Work Package 1	***Acoustically green city areas - Q-Zones***
1.1	***Tools for creating Q-Zones***
	Selection of 5 reference sites for analysis
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PU	Public	✓

	Nature of Deliverable	
R	Report	**R**
P	Prototype	
D	Demonstrator	
O	Other	

SEVENTH FRAMEWORK PROGRAMME

This deliverable has been quality checked and approved by CityHush Coordinator *Nils-Åke Nilsson*

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0 EXECUTIVE SUMMARY

0.1 OBJECTIVE OF THE DELIVERABLE

The objective of this deliverable is to describe the selection of test sites for analysis of Q-zones and parks embedded in Q-zones. Q-zones is a major concept in the CityHush project. A Q-zone is an area where a low level of traffic noise is maintained by allowing only low noise vehicles to enter. The idea of WP 1 is to identify boundary conditions required to obtain Q-Zones, and to do so in a real setting. The identification of the boundary conditions requires simulations of traffic management with respect to the introduction of new vehicle technology (like electrically propelled vehicles) and policies to affect the usage of this technology (like noise charges). As traffic and other conditions may differ between European cities, five test sites reflecting different traffic conditions in Europe will be subject to simulations.

As an obvious first step in this process, these five test sites need to be selected to ensure that the simulation will be relevant as well as feasible within the project. This deliverable describes the selected test sites with respect to relevance and available noise and traffic models.

0.2 DESCRIPTION OF THE WORK PERFORMED SINCE THE BEGINNING OF THE PROJECT

To ensure feasibility of Q-zone analysis, the search for possible cities has been limited to those that have been subject to CityHush partners' noise mapping activities. The choice of cities has also been guided by availability of digital traffic network data suitable for traffic modelling.

In a second step, suitable areas within each city have been selected. Noise disturbance and potential for taking advantage of noise reductions have been important selection criteria. Another requirement has been that the Q-zone should also include a park, as the objective of WP 1.2 is to analyse Q-zone embedded parks,

The selection process has involved liaison with partners from or consultants working in the cities, as well as site visits. To supplement noise-mapping data already accessible by CityHush partners, traffic network data collection has been undertaken.

0.3 MAIN RESULTS ACHIEVED SO FAR

The following cities were selected for further selection of specific Q-zone testsites:

- Bratislava
- Bristol
- Essen
- Gothenburg
- Stockholm

0.3.1 Bratislava test site

After discussions with local representatives and a site visit, transforming the area south of the old town to a Q-zone seemed to be the most interesting Q-zone application in Bratislava. This area also includes a park-like avenue, bordering the pedestrian area of the old town. The arterial going along the riverbank is a major challenge, and different ways of handling this will be analyzed. The intended Q-zone is marked with red in figure 1.

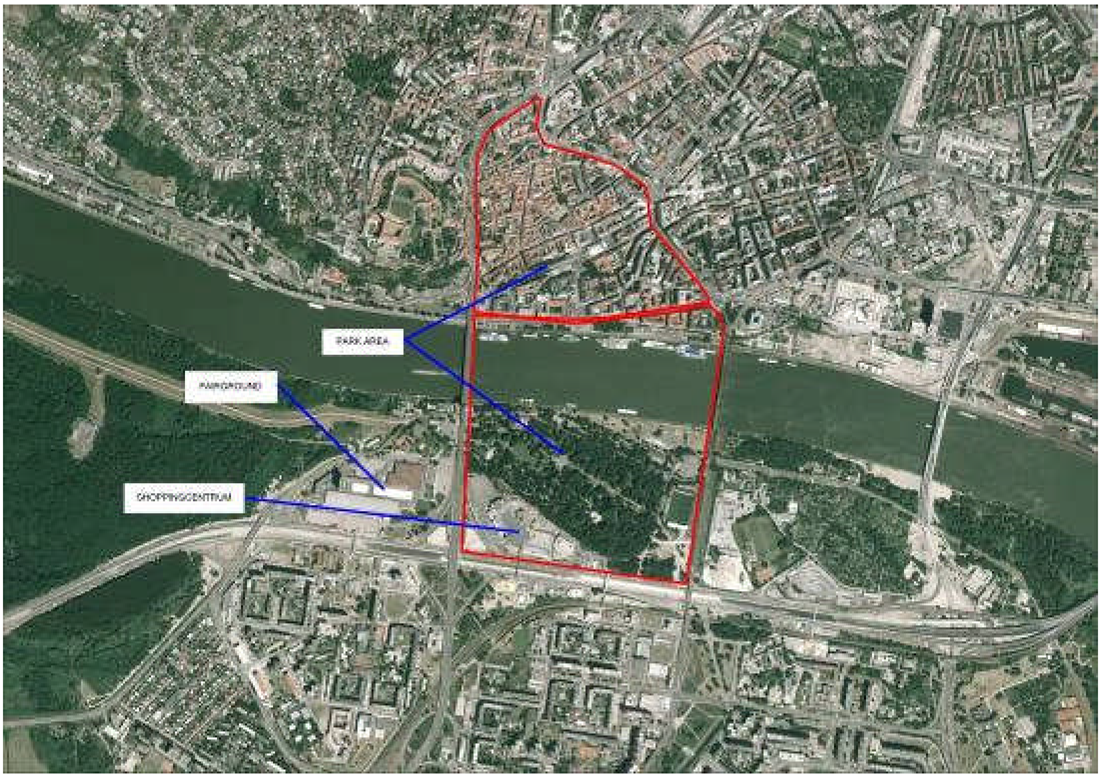

Figure 1
Intended Q-zone area

0.3.2 Bristol test site

After discussions with local representatives of the City Council and a site visit, transforming the area around Castle Park (and the opposite side of the river) to a Q-zone appeared to provide an interesting opportunity for a Q-zone application in Bristol. This is particularly the case as the area on the opposite side of the river to Castle Park is due to be redeveloped into residential flats/apartments, having previously been used as a commercial/industrial site. This area also includes a park-like avenue, bordering the pedestrian area of the old town. The arterial route going along the riverbank presents a major challenge, and different ways and options of handling this will be analyzed. The park usage is likely to consist mainly of shoppers and local workers from nearby businesses/shops. The intended Q-zone is likely to fall within the area indicated by the blue circle in figure 2.

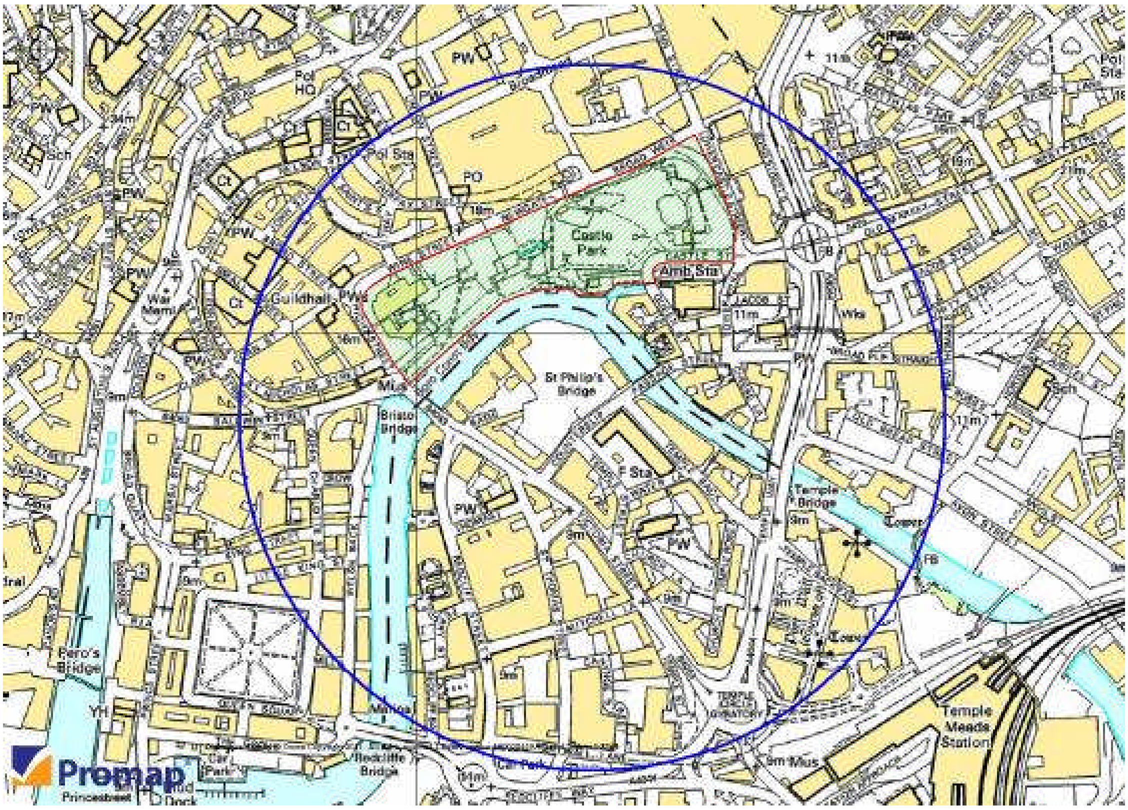

Figure 2 Map indicating Castle Park, Bristol (Q-Zone to be defined within circled area)

0.3.3 Essen Test site

Following a site visit, the park area marked with green in figure 3 and the area marked with red in figure 4 was chosen to be the intended Q-zone area in Essen.

Figure 3 Intended Essen Q-zone embedded park

Figure 4 Intended Q-Zone in Essen

0.3.4 Gothenburg test site

After discussions with the Gothenburg municipality partners, the Trädgårdsföreningen park appeared to have the highest potential to be part of a Q-zone. The intended Q-zone area is shown on figure 5.

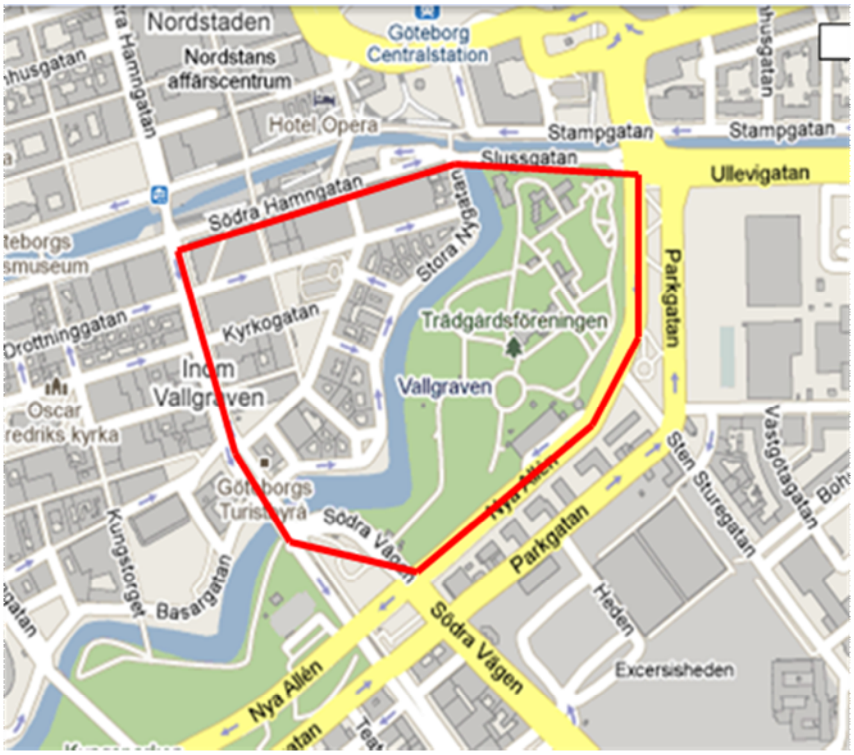

Figure 5 Intended Q-zone area

0.3.5 Stockholm test site

After discussion with the Stockholm Municipality partner, it was decided to choose the area indicated on figure 6. The area is not only disturbed by car traffic – a railway line also crosses part of the area. The area contains several parks, and is also suitable for testing smaller Q-zone sizes. A smaller zone size is shown in figure 7. A third, smaller, zone size is shown in figure 8. This will allow for analysis of different zone sizes

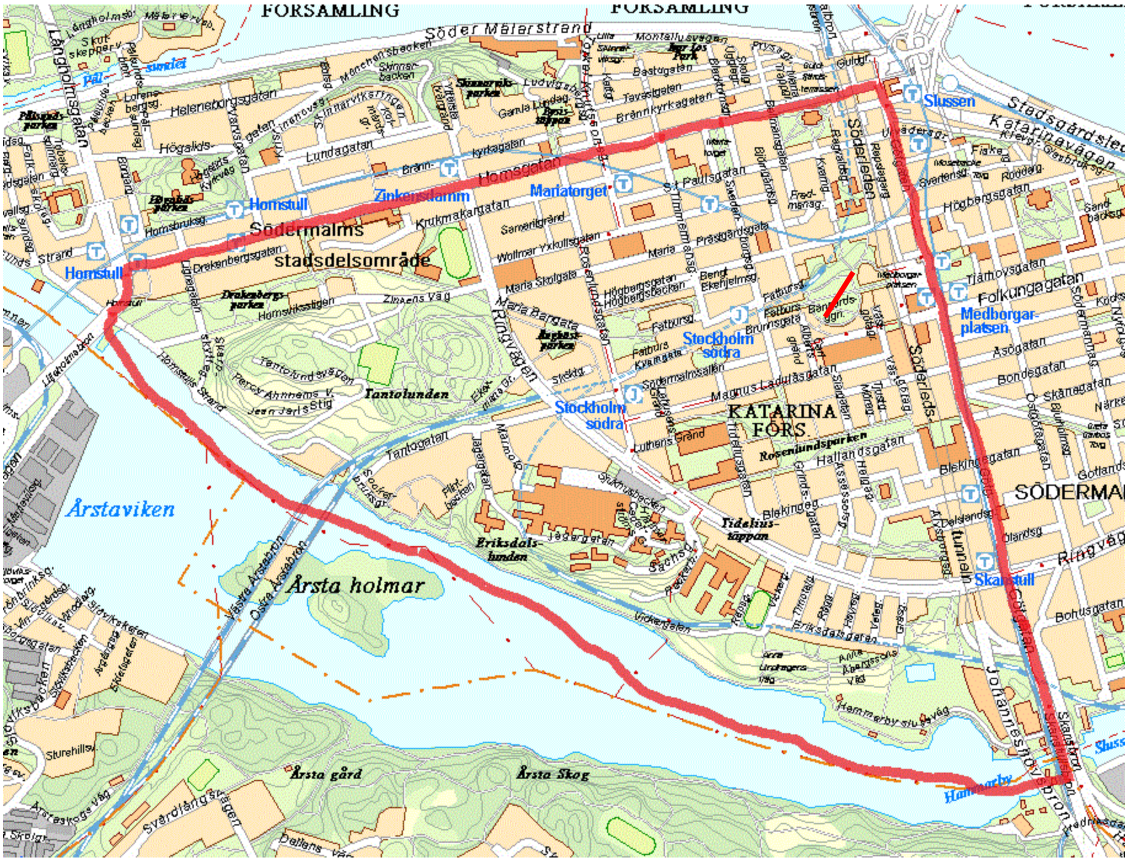

Figure 6

Intended Q-zone area

Figure 7

Smaller Södermalm Q-zone

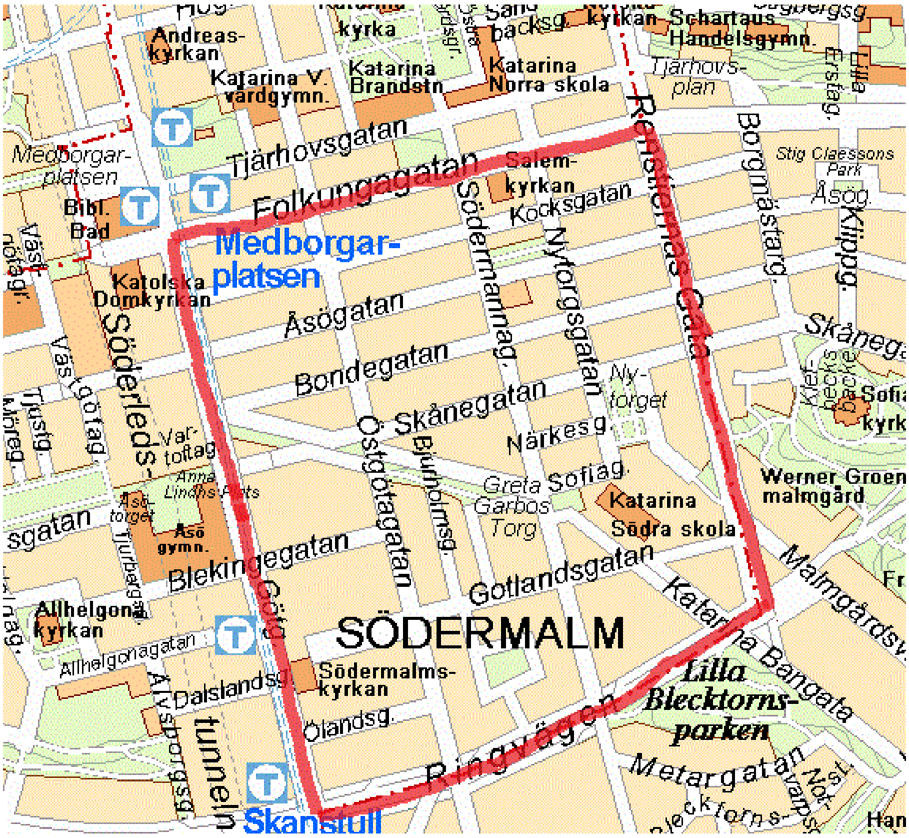

Figure 8

Smallest Södermalm Q-zone

0.4 EXPECTED FINAL RESULTS

During the analysis stage, it may well be that some redefinition of the Q-zone area will be necessary. The test site choices all present different challenges, particularly in the form of traffic constraints on major arterials. Additional measures like barriers or constrained vehicle entry that varies over the day may also have to be analyzed.

0.5 POTENTIAL IMPACT AND USE[1]

This deliverable is about the test site selection, and not the Q-zone analysis itself. Te impact of this work is to facilitate the intended Q-zone analysis of WP 1.1 and 1.2.

0.6 PARTNERS INVOLVED AND THEIR CONTRIBUTION

KTH has been responsible for the deliverable and has also contributed with the traffic model parts. ACC has contributed with noise model parts related to Bratislava, Bristol and Essen. ACL has contributed with noise model parts related to Gothenburg, SEP has contributed with noise model parts related to Stockholm. KTH, ACC, ACL, SEP and TPTA have all contributed in the site selection process.

0.7 CONCLUSIONS

Five test sites have been defined and validated with respect to relevance and feasibility of data for further analysis of Q-zone boundary conditions as well as boundary conditions and maximum noise gains for Q-zone embedded parks, which are the tasks for WP 1.1 and 1.2

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1 *including the socio-economic impact and the wider societal implications of the project so far*

1 BACKGROUND

Q-zones is a major concept in the CityHush project. A Q-zone is an area where a low level of traffic noise is maintained by allowing only low noise vehicles to enter. The idea of WP 1 is to identify boundary conditions required to obtain Q-Zones, and to do so in a real setting. The identification of the boundary conditions requires simulations of traffic management with respect to introduction of new vehicle technology (like electrically powered vehicles) and policies to affect the usage of this technology (like noise charges). As traffic and other conditions may differ between European cities, five test sites reflecting different traffic conditions in Europe will be subject to simulations.

As an obvious first step in this process, these five test sites need to be selected to ensure that the simulation will be relevant as well as feasible within the project. This deliverable describes the selected test sites with respect to relevance and available noise and traffic models.

The site selection involves a two-step decision process – the choice of a city and the choice of a particular area in the city. The choice of cities is mainly driven by the availability of simulation resources like noise mapping and traffic models, whereas relevance aspects drive the choice of a particular site in each city. Relevance aspects imply that sites with current noise problems as well as a potential to take advantage of noise reductions are sought. Sites including parks are obviously well suited in this respect, and WP 1.2 is aimed at analysing noise gains in parks by implementing a surrounding Q-zone.

Parks suffering from high noise levels are often found in central parts of a city. This highlights the conflict between accessibility and traffic noise. This conflict may make it impossible to constrain traffic on surrounding major roads throughout the day, thereby reducing the effect of traffic reductions on other streets. We may therefore need to use additional means like barriers or to let traffic constraints be in effect only in certain time intervals of the day. We believe that this reflects reality better than ignoring this conflict and will therefore be more interesting for stakeholders.

The cities that have been selected for these WP's are Bratislava (Slovakia), Bristol (UK), Essen (Germany), Gothenburg and Stockholm (Sweden). The description of the sites follows this (alphabetical) order.

The sites are presented by first giving a short general description of the city and its noise problems. On these grounds the potential for establishing Q-zones surrounding parks is discussed, and a specific site is defined. After this, the available noise and traffic models are described, including necessary adaption to the CityHush project.

2 BRATISLAVA TEST SITE

2.1 GENERAL INFORMATION CITY OF BRATISLAVA

Bratislava is the capital of Slovakia. The city covers a total area of 368 square kilometres, and has a population of about 450,000. The population density is 1,222 persons/km².

Figure 2.1 Map of Bratislava. *Map supplied by Mapa Slovakia, s.r.o.*

The city is located on both sides of the river Danube (Donau). The central part includes the old town, and is shown in figure 2.2. On this figure, smaller parks can be seen on the northern side of the river, as well as a larger green recreational area on the southern side.

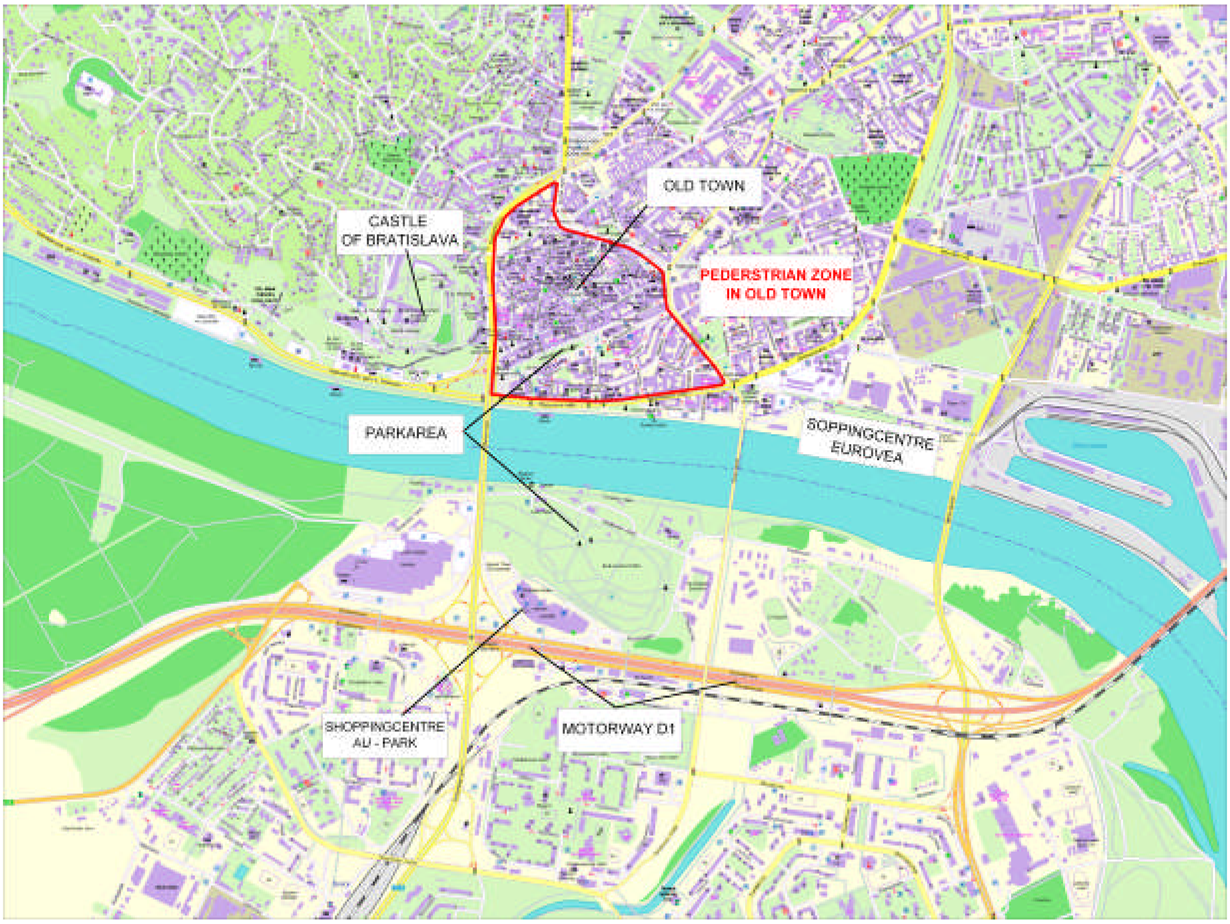

Figure 2.2 Central part of Bratislava. *Map supplied by Mapa Slovakia s.r.o.*

The old city centre is already largely a pedestrian area. Pedestrian areas are indicated by the checked areas in Figure 2.2. A more detailed view of the old city centre can be seen in Figure 2.3.

Figure 2.3 Pedestrian areas of the old city centre in central Bratislav a. *Ortofotomap supplied by EUROSENSE/Geodis Slovakia.*

2.2 TEST SITE SELECTION

2.2.1 Noise conditions

For Bratislava, noise mapping has been undertaken for the whole Bratislava Conurbation area in the year 2007 (Fig 2.4). From this map, it can be seen that the central parts suffer from high noise levels. Figure 2.5 shows the central parts of the city. Major roads along the riverbanks cause large noise disturbances in the central areas south of the old town. These disturbances also extend to the other side of the river, where a green recreation area is situated.

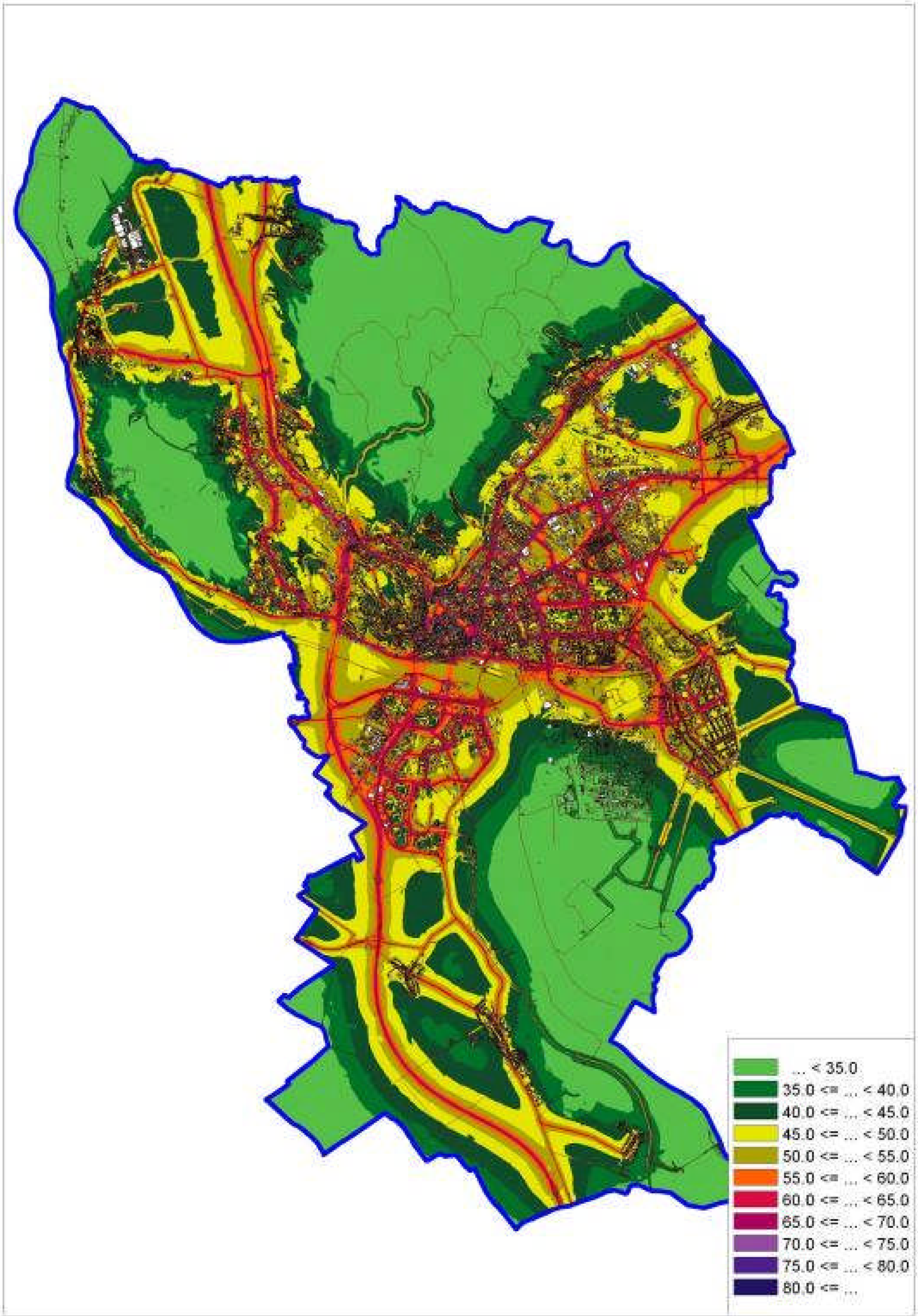

Figure 2.4 Road Noise map for Bratislava (dB(A) L_{den} noise levels)

Figure 2.5 Road Noise map for central Bratislava (dB(A) L_{den} noise levels)

2.2.2 Potential for Q-zones

The City of Bratislava is already planning for and developing areas along the Danube River. The Danube embankment offers excellent possibilities to create an enjoyable recreation environment, and reshaping of the dockland areas to a mix of commercial and residential land use is under way. These developments are located east (the Eurovia project) and west (the River Park project) of the area south of the old town.

2.2.3 Selected Q-zone area

After discussions with local representatives of the City of Bratislava and a visit to the site, transforming the area south of the old town to a Q-zone seemed to be the most interesting Q-zone application in Bratislava. This area also includes a park-like avenue, bordering the pedestrian area of the old town. The arterial going along the riverbank is a major challenge, and different ways of handling this will be analyzed. The intended Q-zone is marked with red in figure 2.6.

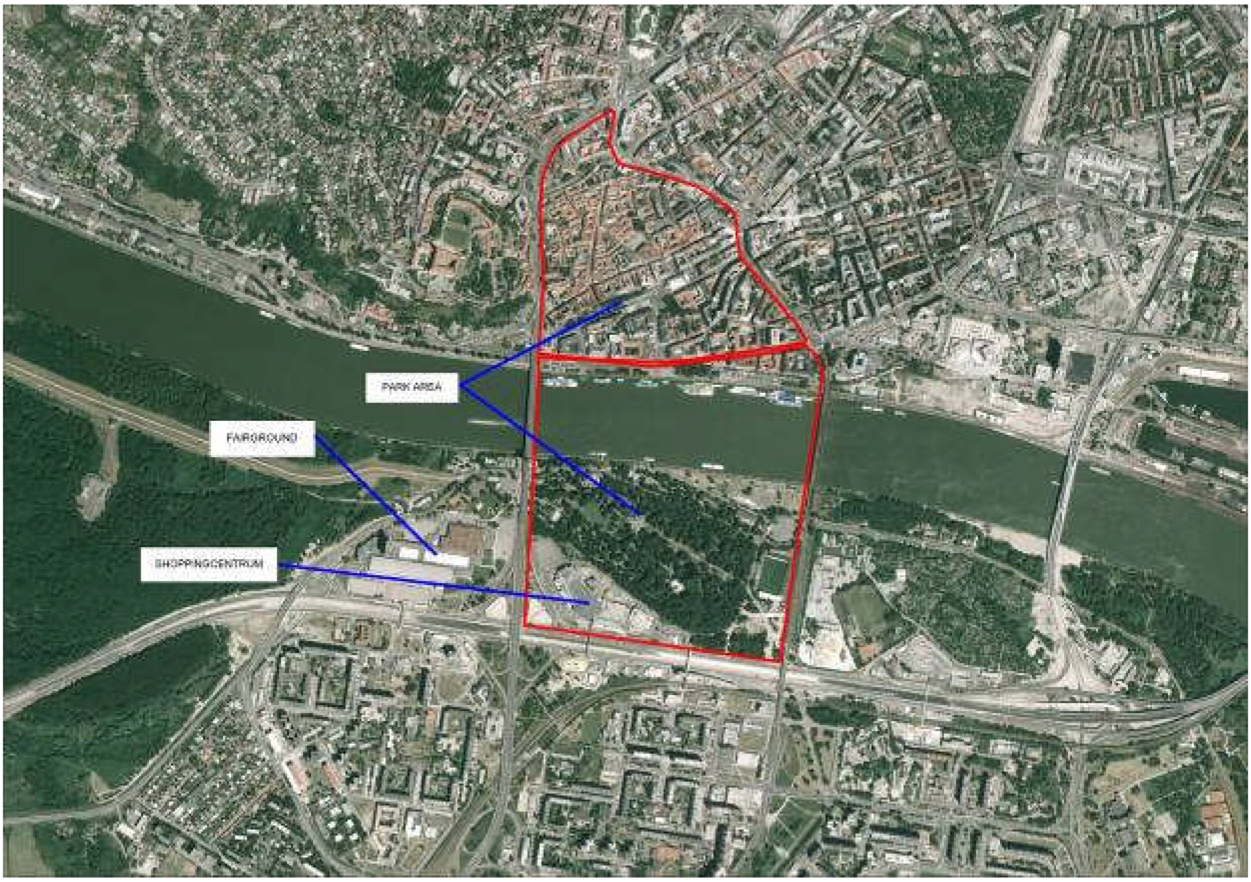

Figure 2.6 Intended Q-zone area (red line). *Ortofotomap supplied by EUROSENSE/Geodis Slovakia*

2.3 AVAILABLE NOISE MODEL

2.3.1 Digital terrain model

The terrain model is important for noise calculation and to determine the ground type i.e. soft or hard, for the determination ground attenuation. Also the shielding effects of hills and embankments are considered within the calculation of noise levels.

Figure 2.7 shows a visualization of the elevation model in which the area height is represented by colour.

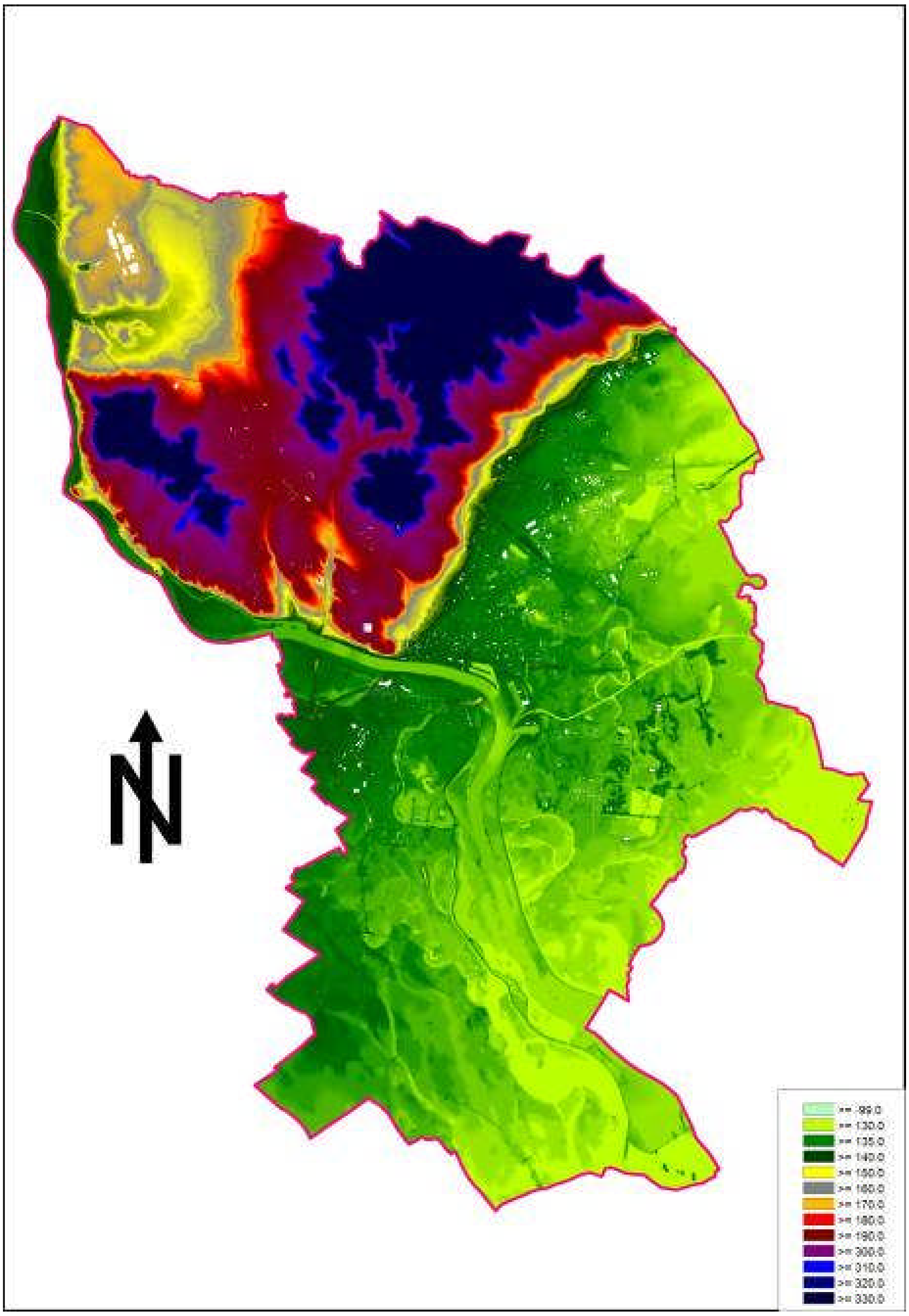

Figure 2.7 Topography map for the City of Bratislav a

The lowest point of the investigation area is located approximately 125 m above sea level and the highest point is more than 420 m absolute altitude. The DTM model was created from the photogrammetric data with CadnaA software.

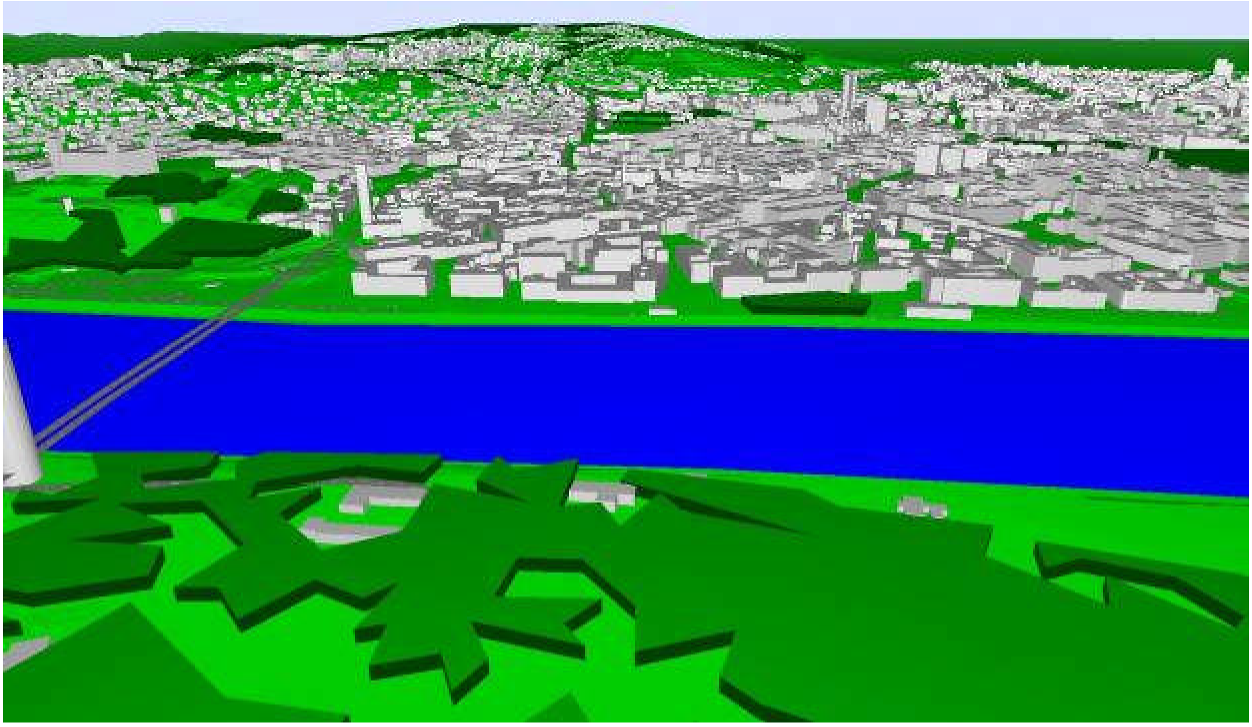

Figure 2.8 3D model of selected Q-Zone area (*data from photogrammetry adapted in CadnaA*)

2.3.2 Road and traffic information

The traffic model noise calculations for Bratislava take account of all roads with traffic. The traffic flow on particular road sections was set using a mathematical model applied in the PTV Visum program.

Total length of roads studied is about 1,922km. The most important roads in terms of the highest traffic flows are:

- North-west highway D1 connected to highway D2 with directions to Czech republic and Hungary

2.3.3 Rail and tram information

The noise map which was processed in 2007 also took noise from railways and trams into consideration. In Bratislava 177 km of train lines were studied as well as 73 km of tramlines.

2.3.4 Noise barriers

Altogether there are 21,456 meters of noise barrier installed in the Bratislava area. The total length of noise barriers alongside roads is 20,655 meters. The barriers are mainly installed along highways and major access roads to the city.

The location of barriers along the motorway corridor and the main train lines are shown in the figure 2.9.

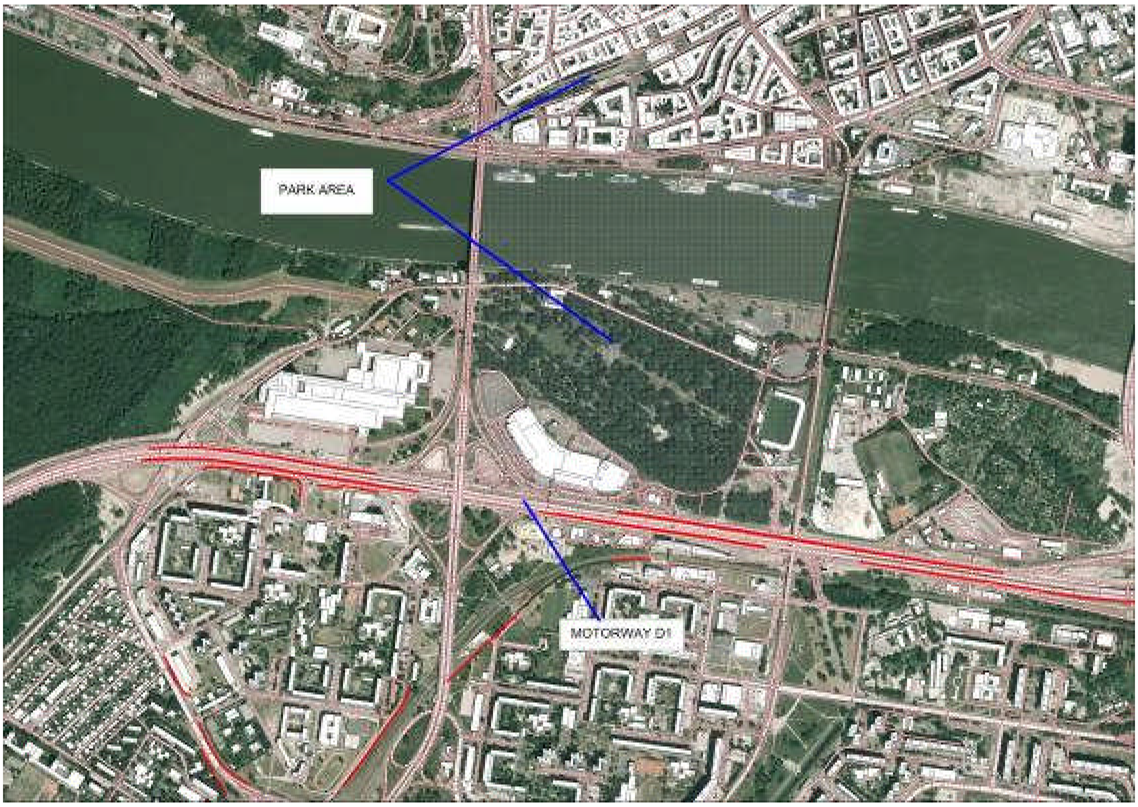

Figure 2.9 Noise barriers (red line) along the D1 motorway (near the Q-Zone area).

Figure 2.10 shows the structural design of the barriers along the motorway D1.

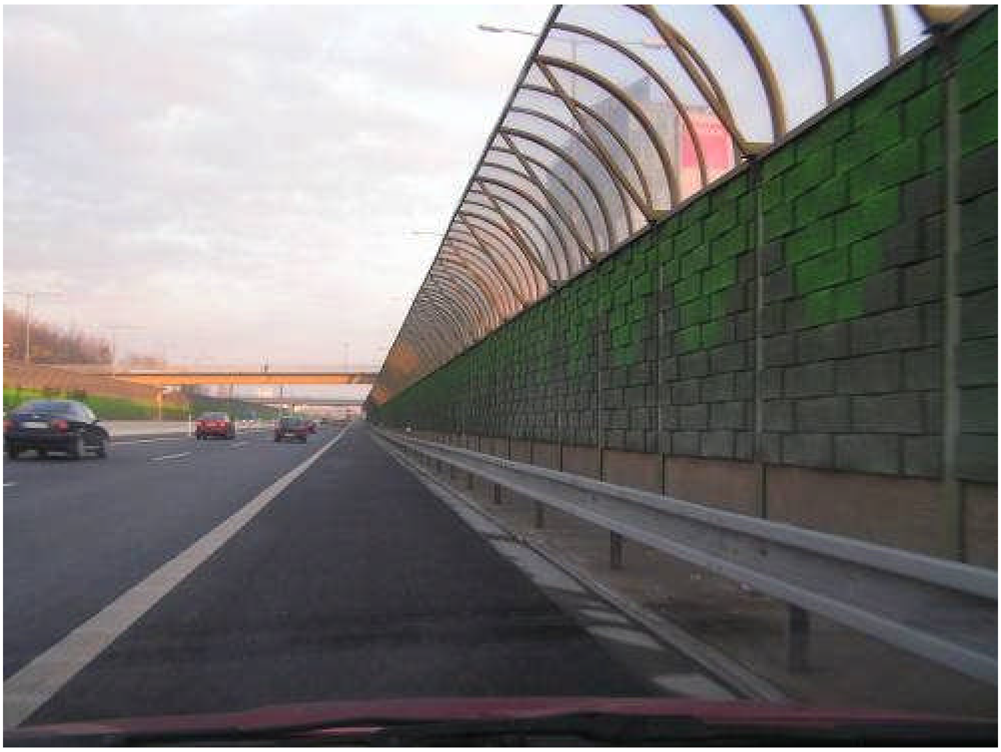

Figure 2.10 Noise barriers along the D1 motorway.

Figure 2.11 shows the construction noise barriers around the major road.

Figure 2.11 Photo showing noise barriers alongside a major road.

2.3.5 Buildings and inhabitants

The city of Bratislava has about 450,000 inhabitants. There are about 34,200 buildings of which about 26,150 are residential (approx. 76,5%). In total, there are 183,500 flats and residential units.

2.4 AVAILABLE TRAFFIC MODEL

2.4.1 Network model

A Visum application exists for Bratislava. It was developed in context with the noise mapping, and comprises of the municipality of Bratislava. Data from this application has been made available to the CityHush project The network contains 302 zones, 3,833 nodes and 10,472 links.

The application only considers car traffic. Network Information on buses etc. is not available. Public transport bus, tram and train lines are also not included in the database.

The network is shown in figure 2.12 as a Visum screenshot.

Figure 2.12

Visum network for Bratislava municipality

Figure 2.13 shows the network for the central parts of Bratislava. All streets are included in the network. Pedestrian streets are coloured in red.

Figure 2.13

Visum network for central Bratislava

2.4.2 Demand models

Traffic is assigned on an all day basis. Congestion is accounted for by using a general volume-delay function at all regular links (i.e. not connectors).

Travel demand is constrained to one vehicle type. An OD matrix for the all day traffic has been developed using a gravity model calibrated with traffic counts from 130 count locations. There is no specific trip generation model and no specific mode choice model.

2.4.3 CityHush adaptation

The network and the OD matrix have been exported from the Visum system to the Emme system. Since all streets are already contained in the network, there is no need to enhance the network. The zoning system may need some additional detail in the central area.

The assignment is based on time, and as the simulation scenarios will imply fees on specific links, a conversion from monetary units to time units is necessary to reflect the impedance on such links. This conversion will be done using the Heatco recommendations on values of time for Slovakia (Shires and de Jong 2006). As these recommendations concern the mean value of time, assumptions on the distribution of the mean value are needed to reflect differences in the willingness to pay noise charges. These assumptions will be based on recent value of time research.

The fact that only car traffic is included in the traffic models means that policy simulations will affect car traffic only. Effects on other noise sources will have to be calculated on an ad hoc basis using information from previous noise mapping in Bratislava.

3 BRISTOL TEST SITE

3.1 GENERAL INFORMATION ON THE CITY OF BRISTOL

Bristol is the largest city in South West England. The city covers a total area of 332 square kilometres, and has a population of about 421,000. The population density is 1,268 persons/km². Figure 3.1 shows Bristol and the surrounding area.

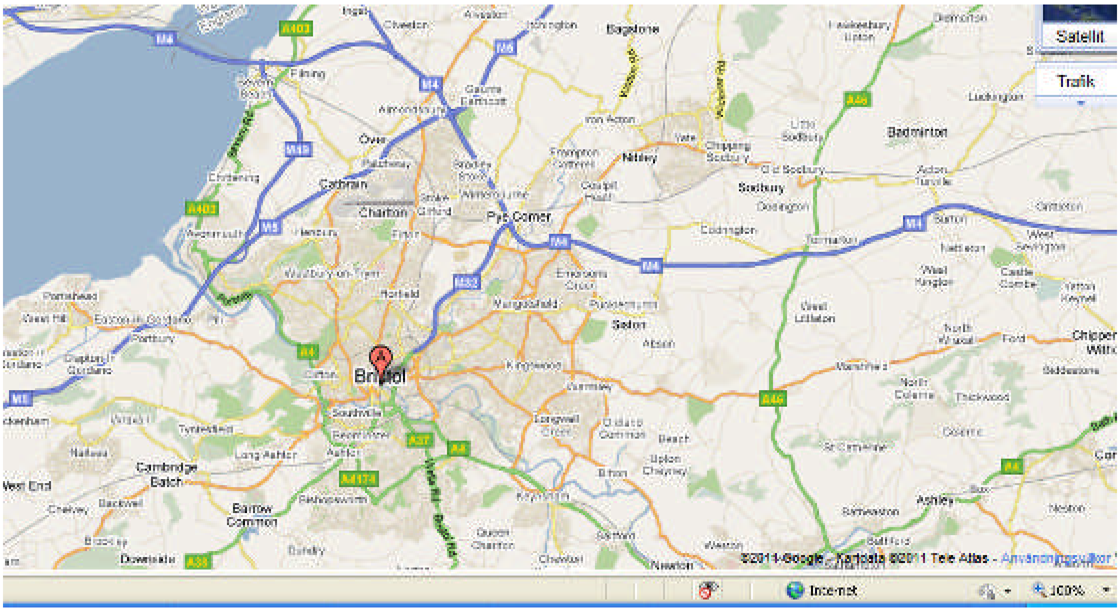

Figure 3.1 Bristol and surrounding area

The city is located close to the mouth of the river Severn. The river Avon runs through the central part of Bristol as is shown in Figure 3.2. On this figure, larger parks can be seen situated on the northern side of the river, as well as a smaller park in the Old City area.

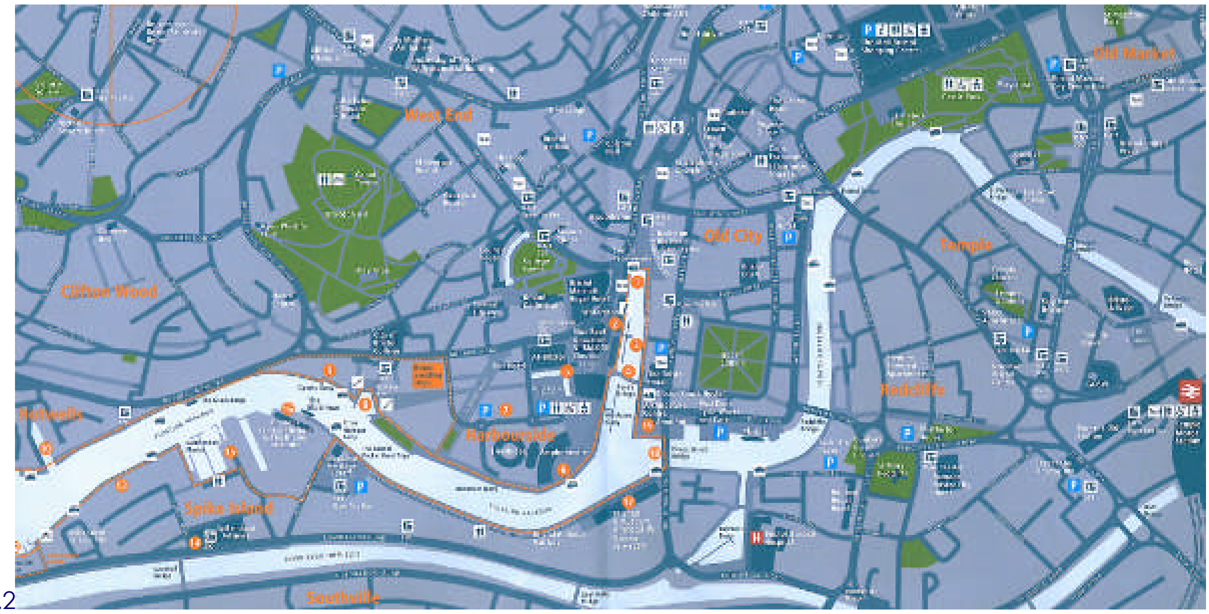

Figure 3.2 Central Bristol

3.2 TEST SITE SELECTION

3.2.1 Noise conditions

For Bristol, noise mapping was undertaken for the whole Bristol area in 2006 and 2007. The noise conditions for the agglomeration of Bristol are presented on the resulting noise map (Figure 3.3). Traffic from the M32 motorway results in high noise levels within the central parts of the city. Figure 3.4 shows the central parts of the city.

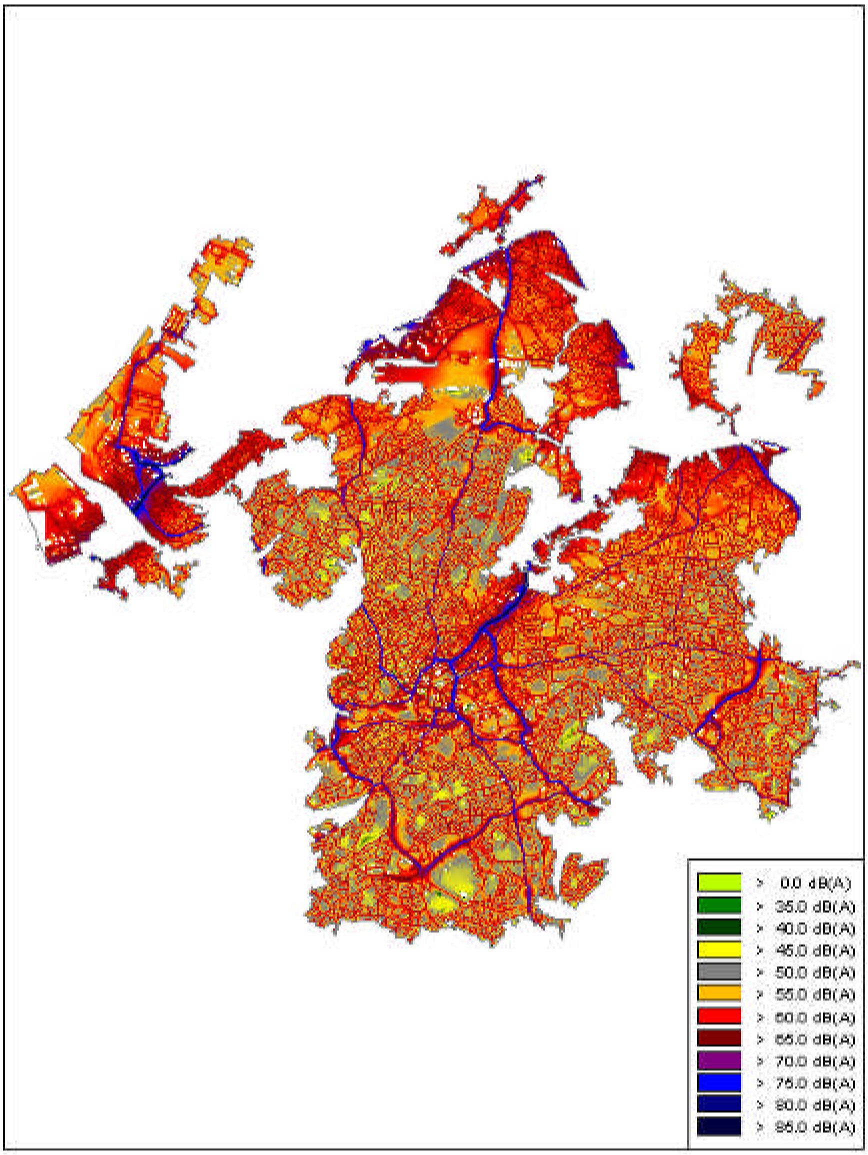

Figure 3.3

Noise map for Bristol agglomeration showing L_{den} (from Noise Mapping England Project)

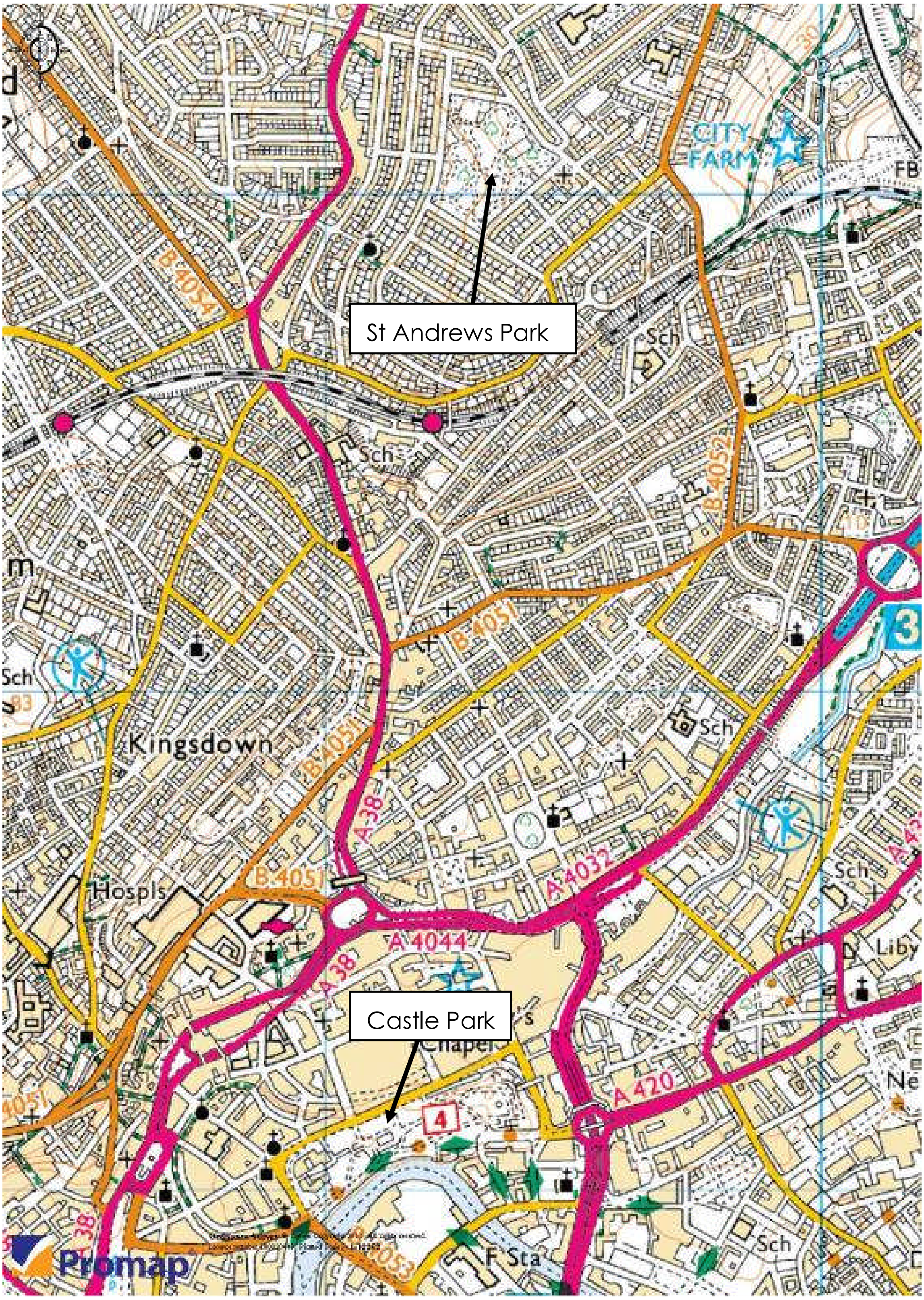

Figure 3.4 Noise map showing central area of Bristol and embedded parks

3.2.2 Potential for Q-zones

The City of Bristol is very hilly, when moving away from the river valley. This means that the landscape often provides natural noise barriers. With respect to park areas, it is mainly those in the central parts that are subject to noise disturbance. The two main park candidates for a Q-zone area that emerge following a site visit are St Andrews Park in the Montpelier area and Castle Park in the Broadmead area. The Redcliff area facing Castle Park on the opposite side of the river is partly a residential area and partly an industrial area. Creating a Q-zone in this area would enable the area to be developed into an attractive residential neighbourhood.

3.2.3 Selected Q-zone area

Castle Park:

After discussions with local representatives of the City Council and a site visit, transforming the area around Castle Park (and the opposite side of the river) to a Q-zone appeared to provide an interesting opportunity for a Q-zone application in Bristol. This is particularly the case as the area on the opposite side of the river to Castle Park is due to be redeveloped into residential flats/apartments, having previously been used as a commercial/industrial site. This area also includes a park-like avenue, bordering the pedestrian area of the old town. The arterial route going along the riverbank presents a major challenge, and different ways and options of handling this will be analyzed. The park usage is likely to consist mainly of shoppers and local workers from nearby businesses/shops. The intended Q-zone is likely to fall within the area indicated by the blue circle in Figure 3.5.

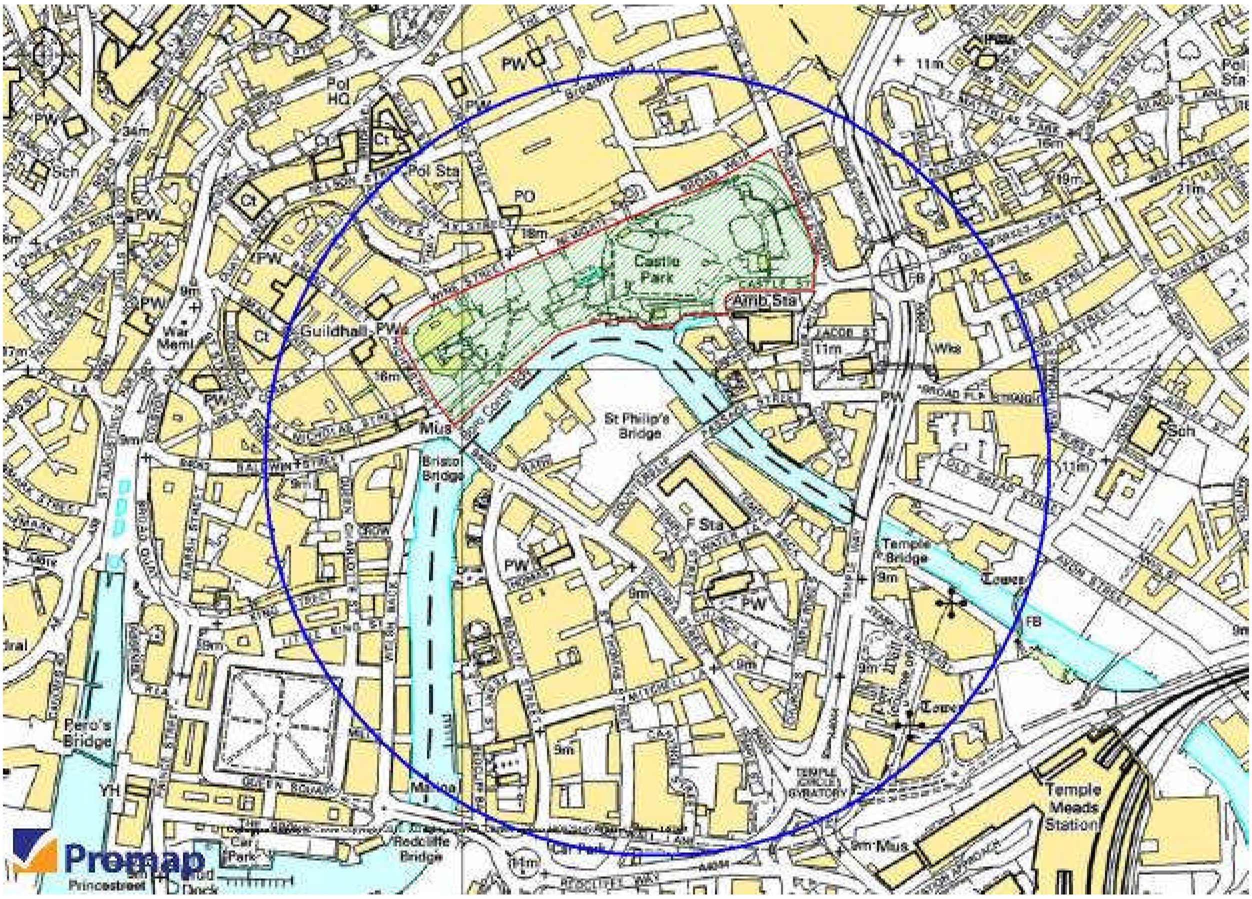

Figure 3.5 Map indicating Castle Park, Bristol (Q-Zone to be defined within circled area)

St Andrews Park:

Another potential site located north of Castle Park is St. Andrews Park, which has different characteristics to Castle Park as the area surrounding it is predominantly residential, also the park has a sloping orientation, which again could result in interesting challenges with respect to establishing a Q-Zone and embedded park. The usage of this park in comparison to Castle Park will also differ in that it appears to mainly target family usage. This area potentially lends itself better to the provision of a Q-Zone (with an embedded park) as the road layout surrounding the park has potential options for redirection of traffic onto nearby larger roads with greater traffic capacity. The intended Q-zone is likely to fall in the area indicated by the blue circle in Figure 3.6.

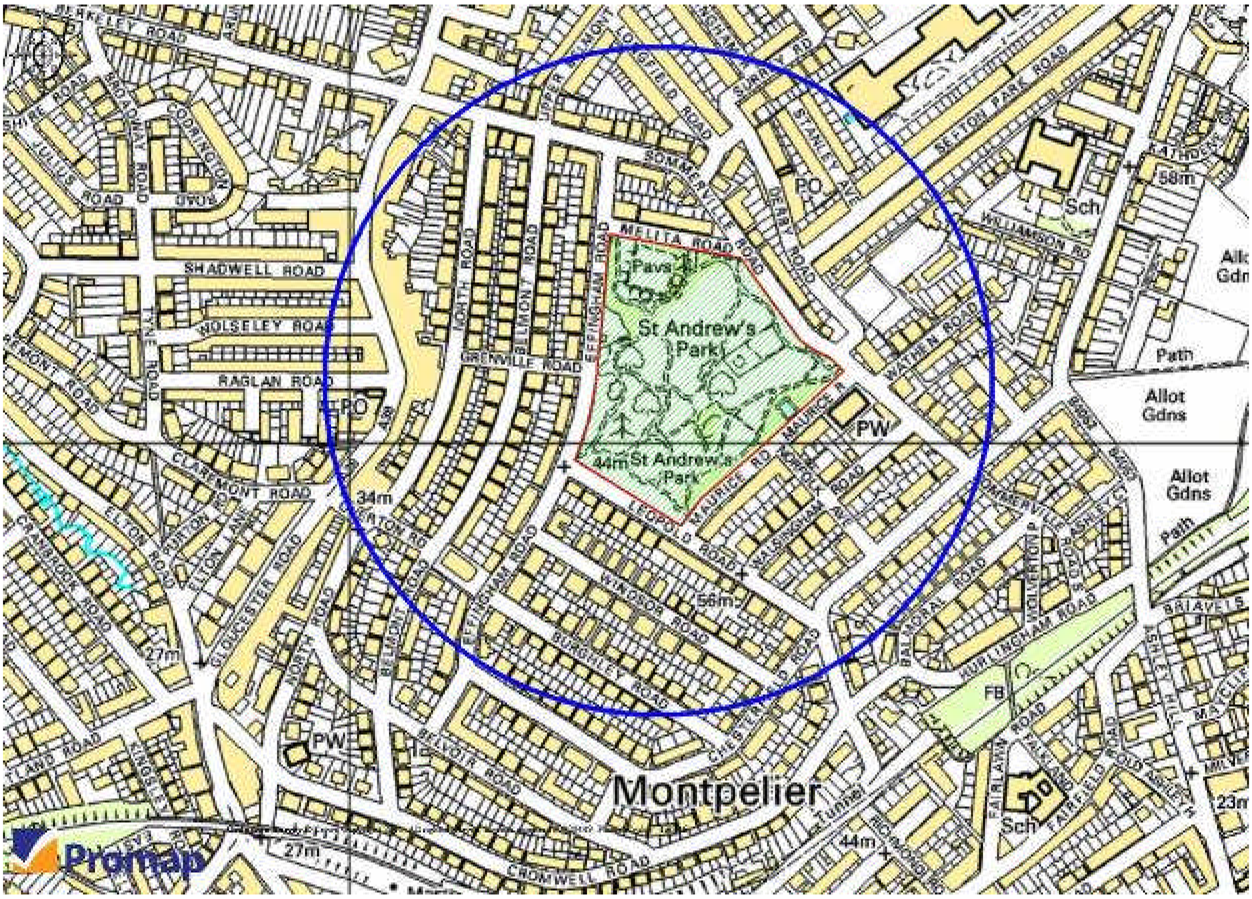

Figure 3.6 Map indicating St Andrews Park, Bristol (Q-Zone to be defined within circled area)

3.3 AVAILABLE NOISE MODEL

3.3.1 Digital terrain model

The terrain model is important for noise calculation and to determine the overall ground attenuation characteristics. Also the hillside situation and shielding from topographical features etc can be taken into account.

Figure 3.7 shows a visualization of the elevation model in which the area height is represented by colour.

The ground model dataset has been checked following the transfer from ArcView (shp) into CadnaA (cna).

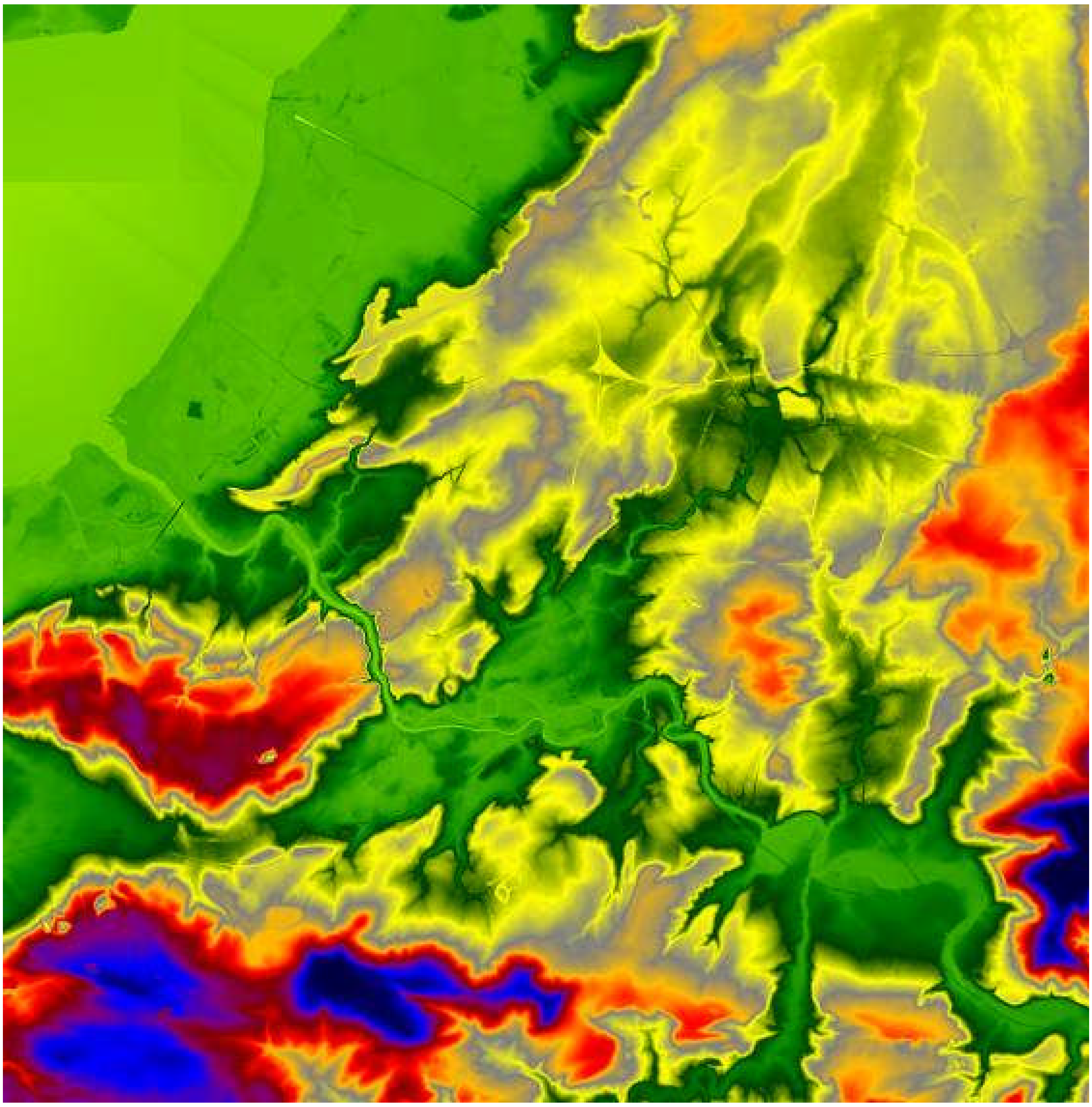

Figure 3.7 Topography for Bristol

3.3.2 Road and traffic information

The traffic model of Bristol considers all major roads, irrespectively of their traffic load. In the available model all roads with a traffic flow of greater than 185 vehicles / 18 h vehicles were considered. The following illustration shows the regarded road system for the whole of Bristol City:

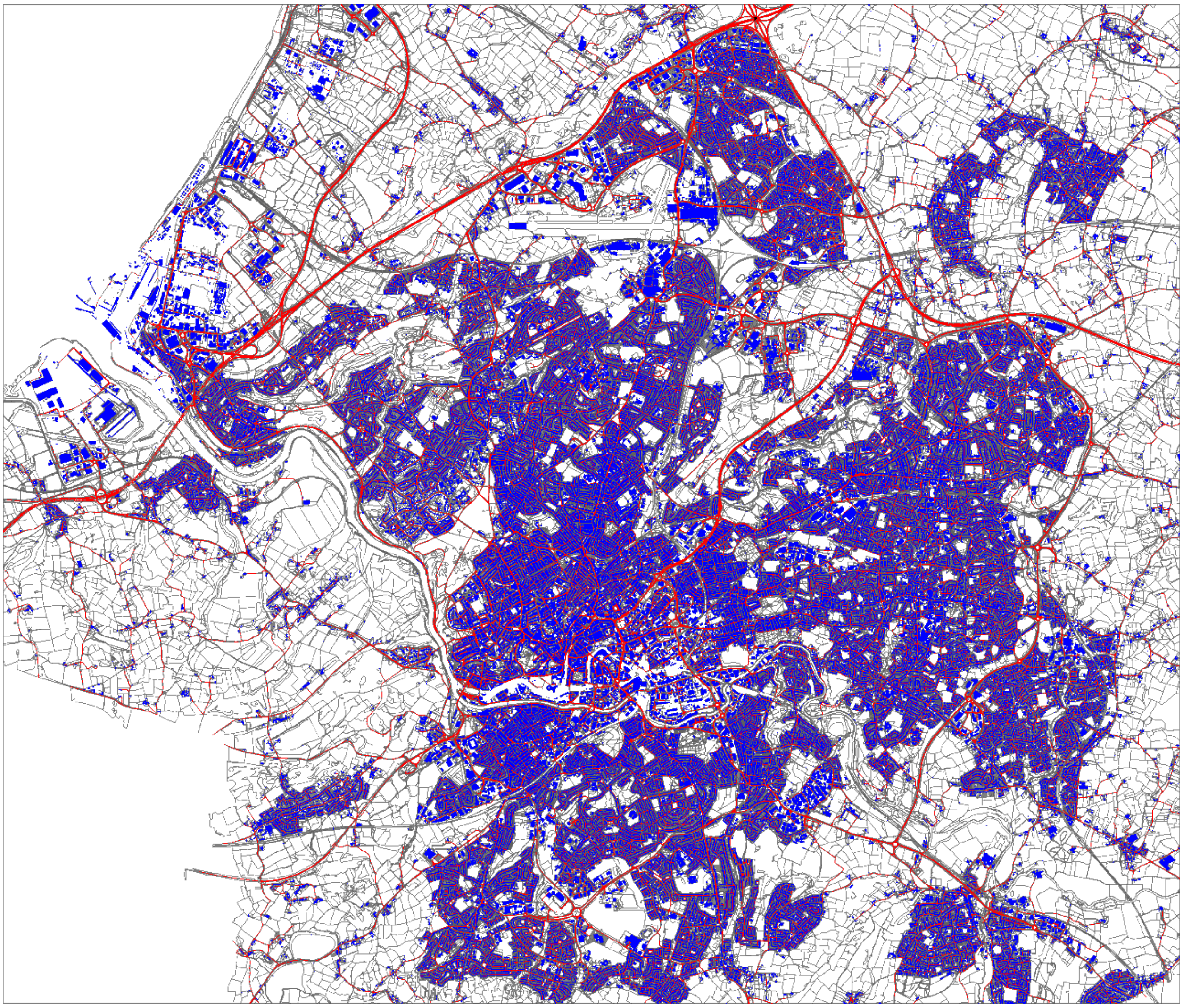

Figure 3.8

Roads, buildings and noise barriers of Bristol

In relation to the 'Noise Mapping England' project about 2775 km of roads were studied. The most important (most travelled) roads as part of the CITYHUSH project and in relation to the embedded parks and surrounding Q-Zones are as follows:

- A38 (which affects both parks)
- A4044
- Sommerville Road (along north-east boundary of St. Andrews Park)

The relevant traffic parameters were obtained from Bristol City Council.

Information provided by the Highways Agency on speed limits and road surface types were carried over into the model, where this data was not held by Bristol City Council

The road network dataset was checked for completeness following transfer from ArcView (shp) into CadnaA (cna). This ensured the correct transfer of all roads without any loss of data.

This check was carried out for motorway and non-motorway roads separately.

Besides the quantity checking, several components e.g. number of vehicles , traffic speed, surface type and curb to curb distance were also reviewed to ensure that they are within sensible limits and had transferred correctly into CadnaA.

All calculation settings were double checked to ensure a maximum of correctness to the interim noise model results which are then transposed to L_{DEN} etc.

The calculation method in CadnaA is according to CRTN.

The correctness of the calculation according to CRTN was tested and confirmed by DataKustik, the developers of the CadnaA program.

3.3.3 Rail and tram information

Bristol does not have a tram system, however one of Bristol's main railway stations is located near to the edge of the potential Q-Zone surrounding Castle Park.

3.3.4 Noise barriers

The noise barrier data was imported into CadnaA, the noise barrier dataset was then checked for quantity to ensure the complete transfer of data. All barrier heights were reviewed to ensure they were within sensible limits and had imported correctly, i.e. checked for negative and extraordinarily high values.

3.3.5 Buildings and inhabitants

The City of Bristol has about 421,000 inhabitants. There are about 284,000 buildings in Bristol. The height and the usage (residential building, school, hospital, commercial use) for each of these buildings was known.

The building datasets were checked for completeness following the transfer of building data from ArcView (shp) into CadnaA (cna). This ensured that all buildings were transferred correctly without any loss of data.

Secondly, the height of the buildings was also checked. This means that the lowest and the highest value from dbf file were compared with the lowest and highest value from cna file. Having this information enables the production of 3D maps such as the one shown in Figure 3.9, it is also possible to overlay noise data, as shown by the coloured grid.

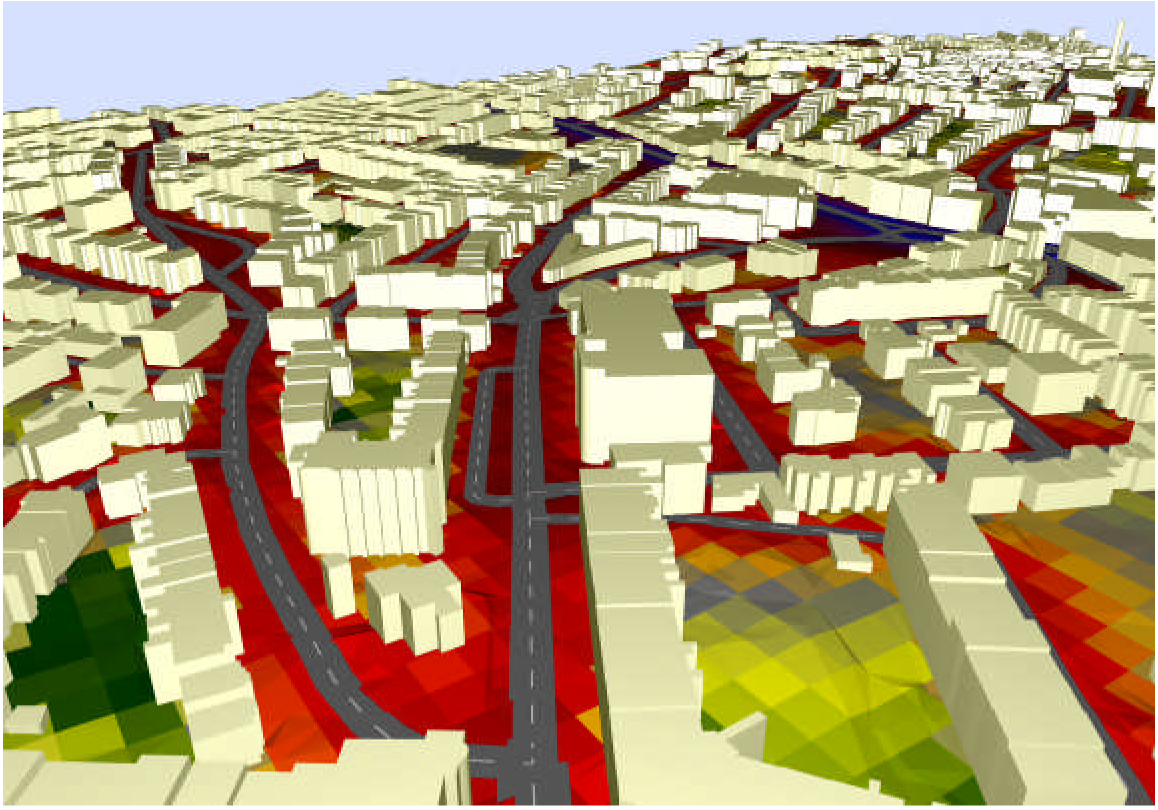

Figure 3.9 3D detailed map of Bristol, showing coloured noise grid

3.4 AVAILABLE TRAFFIC MODEL

3.4.1 Network model

Different traffic models exist for Bristol. For the CityHush project, data from a Saturn software application has been made available. The application was used in context with previous noise mapping, and comprises the city of Bristol. The Saturn application concerns car and HGV traffic. The network contains 263 zones, 1580 nodes and 3,400 links. Public transport was not included in the Saturn application.

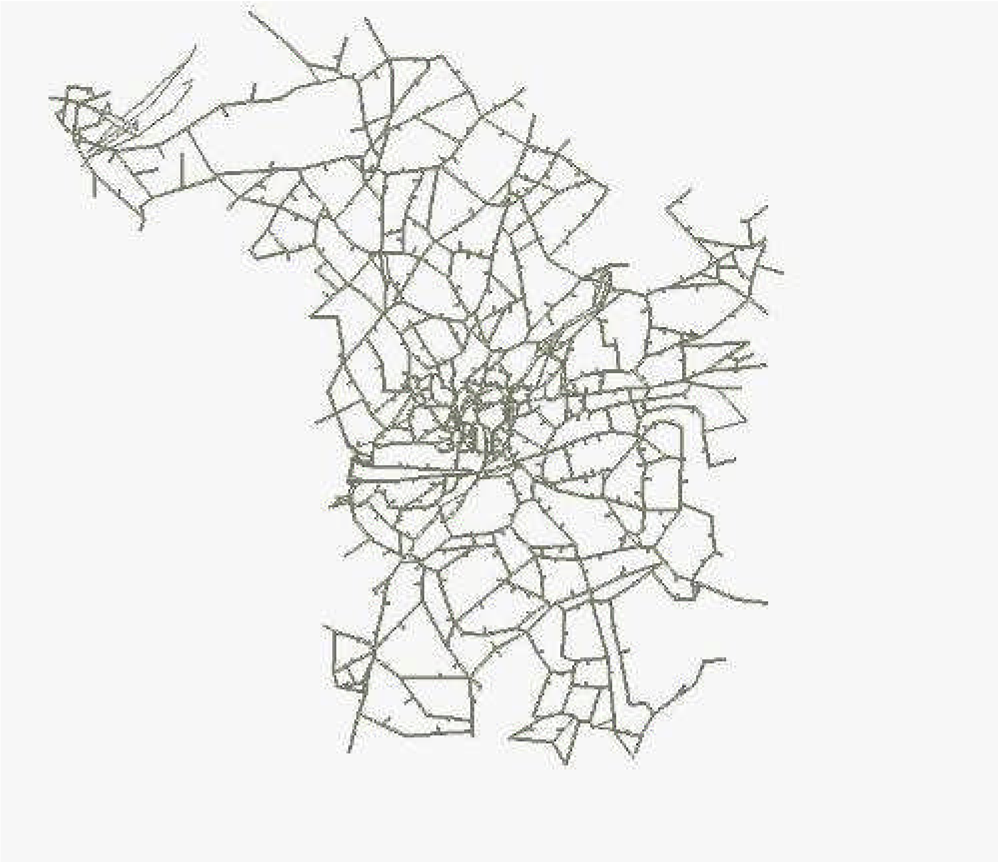

Figure 3.10
Emme network for Bristol

Figure 3.11 shows the network of the central parts of Bristol. All streets except very minor roads are contained in the network. The intended Q-zone area is marked with blue.

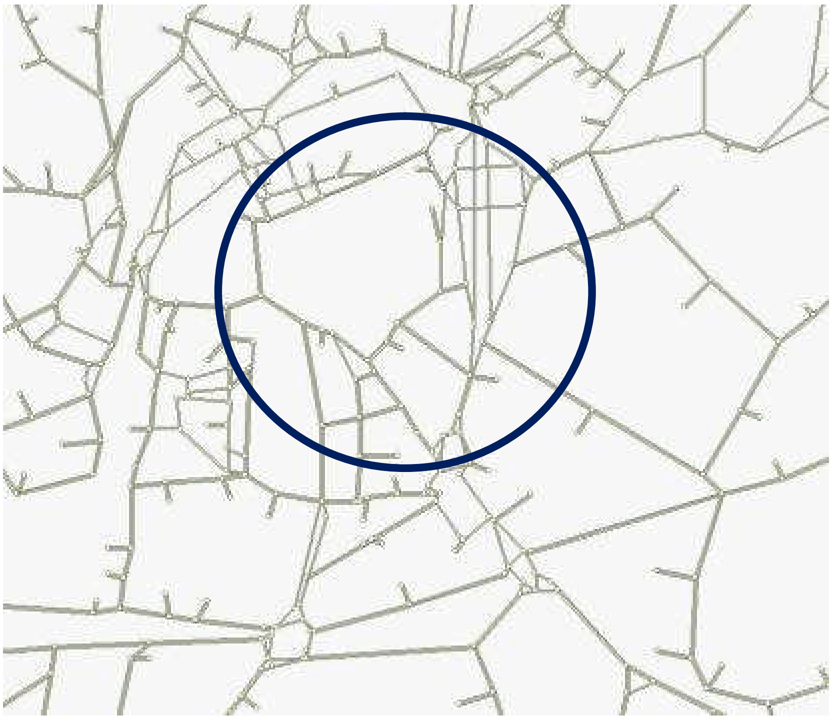

Figure 3.11
Emme network for central Bristol (circle indicates approximate position of Q-Zone)

3.4.2 Demand models

In the Saturn application, traffic assignment is done for the AM peak hour. Congestion is treated by using link specific volume-delay functions for all regular links (i.e. not connectors).

Travel demand includes separate matrices for private cars and trucks. The Saturn application does not include mode or destination choice effects.

3.4.3 CityHush adaptation

The network and the OD matrix have been exported from the traffic model to the Emme3 system. There is no need to enhance either the network nor the zoning system.

As the simulation scenarios will imply fees on specific links, a conversion from monetary units to time units is necessary to reflect the impedance on such links. This conversion is included in the data base for private cars and trucks separately. For private cars, a further distribution of the demand into user classes with different values of time (reflecting different willingness to pay noise charges) will be done, building on recent value of time research.

The traffic simulations will affect private cars and trucks. Effects on other noise sources will have to be calculated on an ad hoc basis using information from previous noise mapping in Bristol.

4 ESSEN TEST SITE

4.1 GENERAL INFORMATION CITY OF ESSEN

The City of Essen is located in Germany in the federal state Nordrhein-Westfalen. The total area of investigation covers 210 km² and has a population density of 2,750 inhabitants per km².

Figure 4.1 Essen.

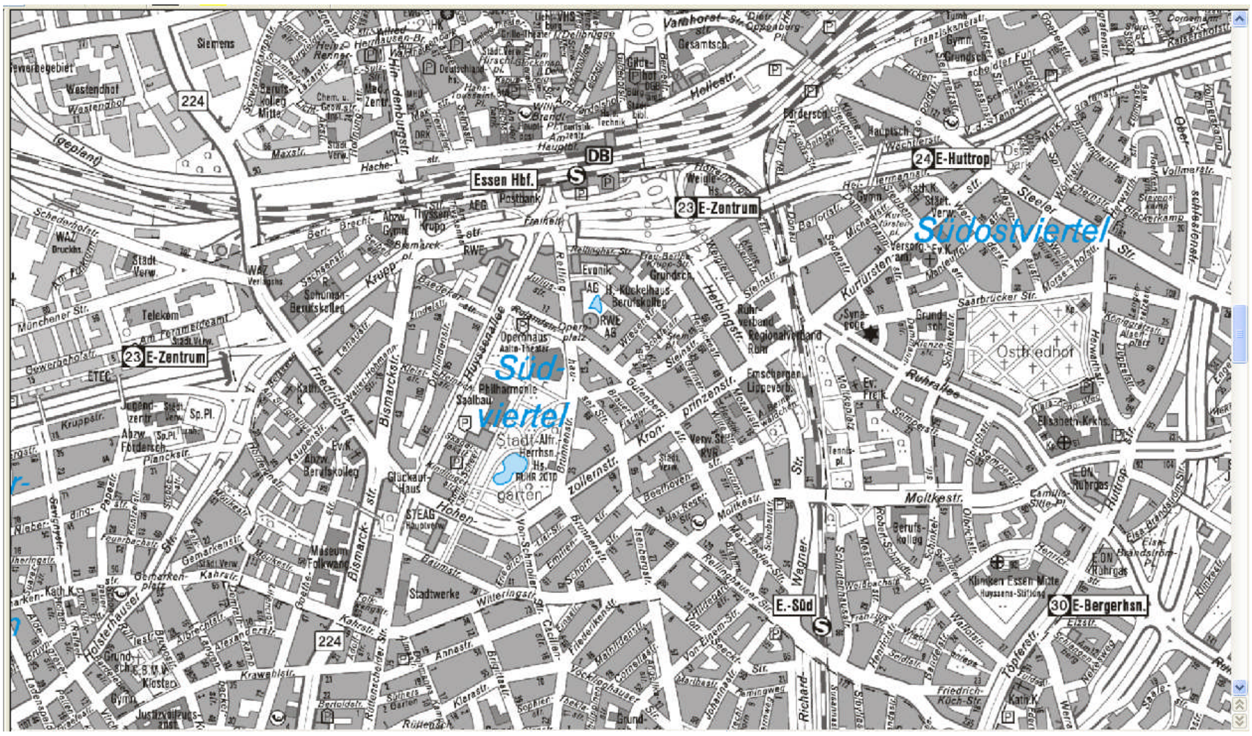

Figure 4.2
Central part of Essen.

4.2 TEST SITE SELECTION

4.2.1 Noise conditions

For Essen, general noise conditions are presented on the noise map (Figure 4.3). Traffic from the motorway M32 results in high noise levels within the central parts of the city. Figure 4.5 identifies more detailed noise conditions for the central parts of the city.

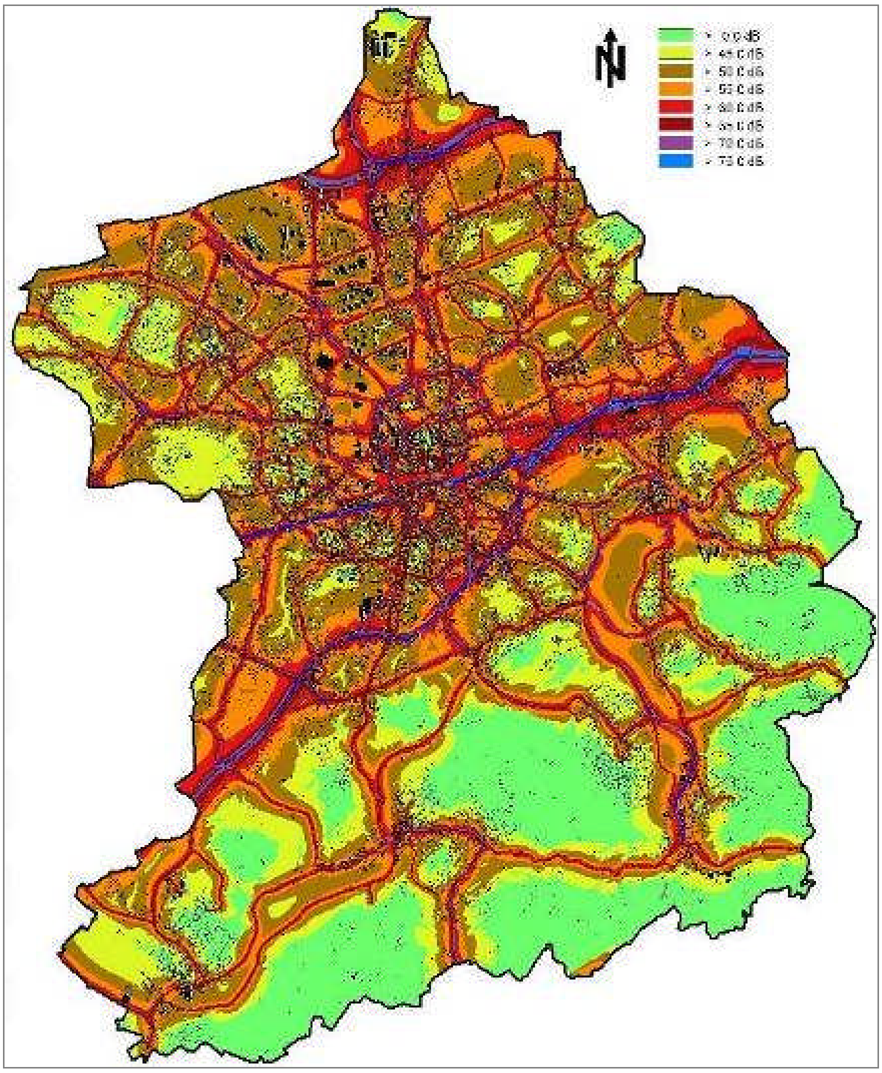

Figure 4.3

Noise map for Essen (dB(A) L_{den} noise lev els)

In the noise calculation program the results for the current situation for tram and road traffic noise are presented as modelled noise contours at the surface height of 4 metres and also at façade noise levels. The following illustrations provide an impression of the computed parameters:

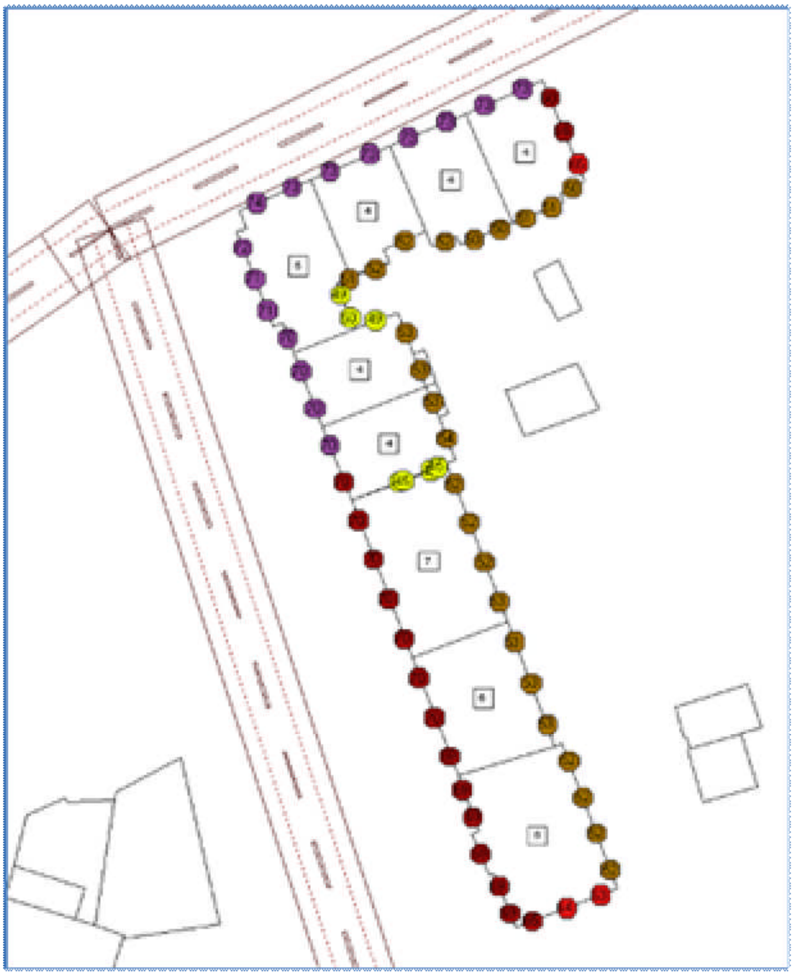

Figure 4.4 Façade noise levels on a block of buildings

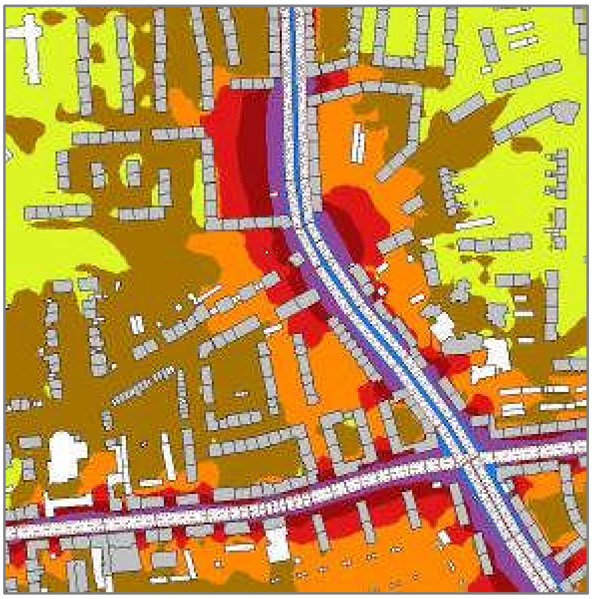

Figure 4.5 More detailed noise map showing an area of Essen

It is also possible to calculate additional scenarios as required.

For all residential buildings the facade levels were calculated, see Figure 4.4 above, which gives an example of a building over the defined limits, Figure 4.6 below identifies those locations alongside the transport network where noise levels exceed 70 L_{DEN} and 60 L_{NIGHT}.

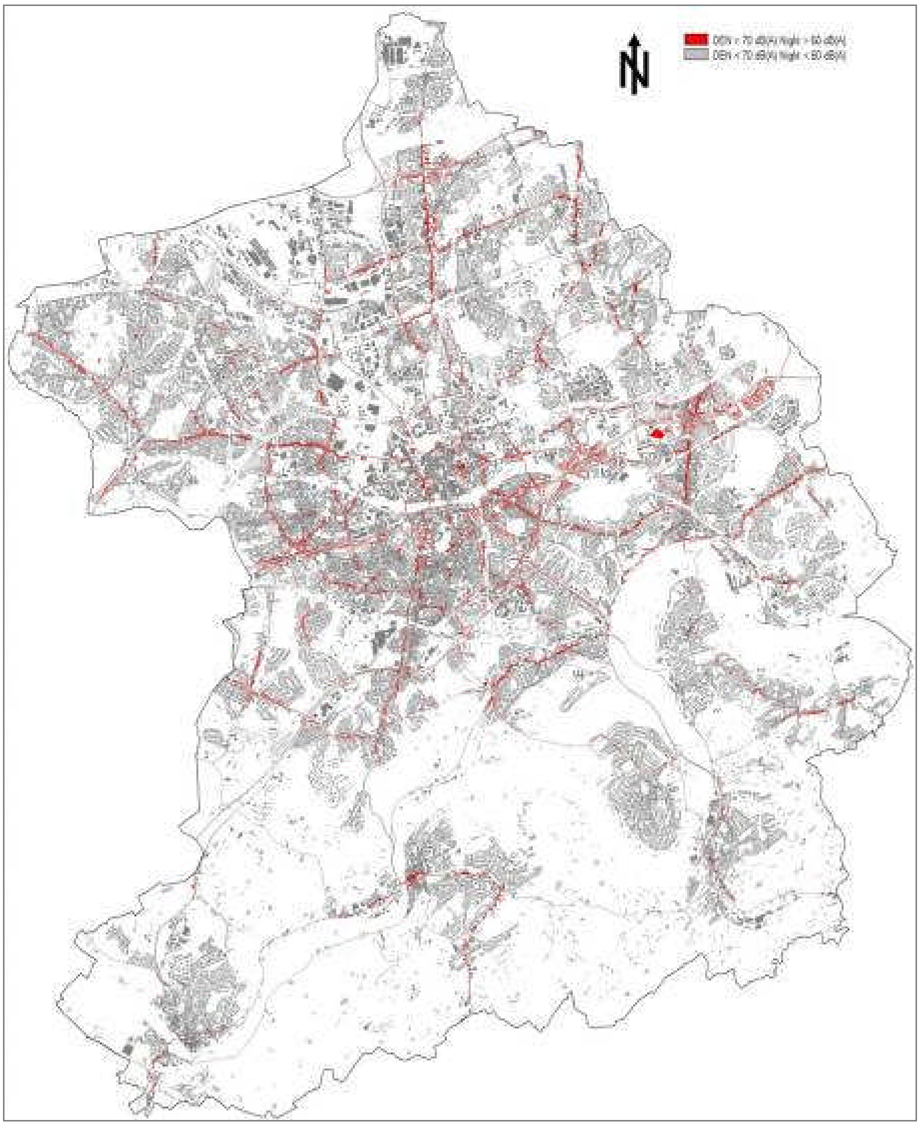

Figure 4.6

Residential buildings along main roads with facade levels exceeding limiting values

In total, there are 31,380 inhabitants in approximately 8,170 buildings where façade noise levels exceed 70 dB(A) for the whole day(DEN) from road traffic noise. At night 32,100 people in 8,500 buildings are exposed to façade noise levels over the 60 dB(A) level.

4.2.2 Potential for Q-zones

The central parts of Essen contain relatively few parks. The most obvious candidate for an embedded park is the Stadtgarten (fig 4.7). The park is surrounded by commercial and residential areas. A tramway line runs along the northern side of the park. From the noise map shown in Figure 4.8 it can be seen that road traffic is the dominant source of noise along all sides of the area.

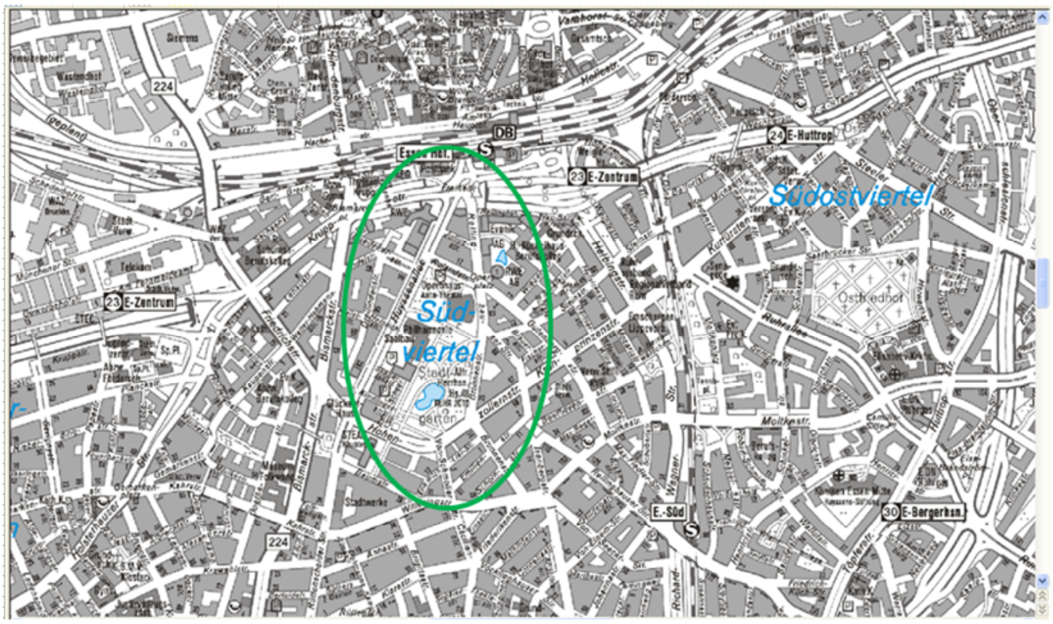

Figure 4.7
Stadtgarten park in central Essen

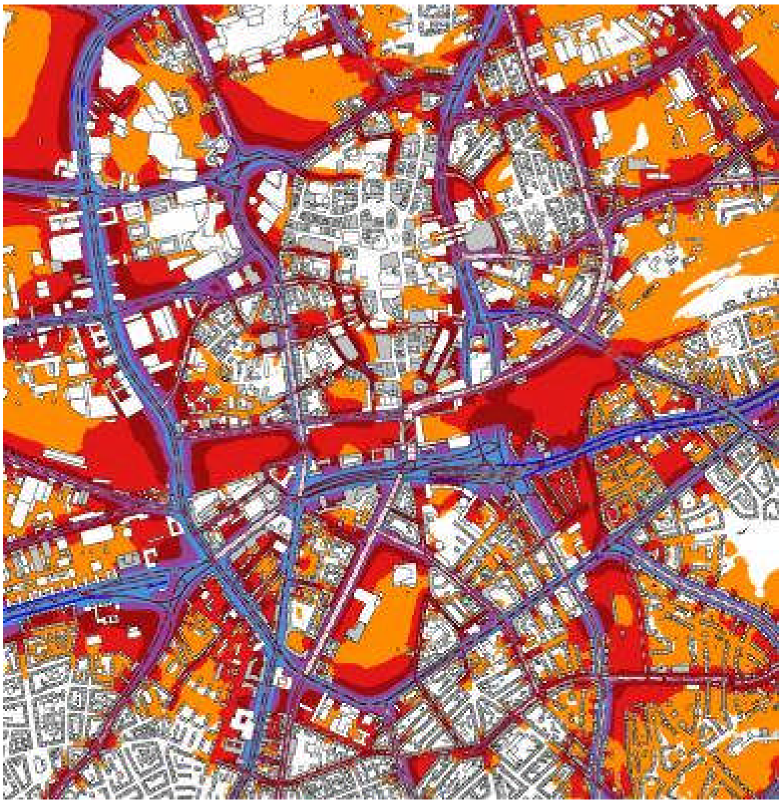

Figure 4.8
Noise map for central Essen

4.2.3 Selected Q-zone area

Following a site visit, the area marked with green in fig 4.9 was chosen as the intended Q-zone area for investigation.

Figure 4.9 Intended Q-Zone in Essen

Figure 4.10 Intended Essen Q-zone embedded park

4.3 AVAILABLE NOISE MODEL

4.3.1 Digital terrain model (DTM)

The terrain model is important for noise calculation and to determine the ground type i.e. soft or hard, for the determination ground attenuation. Also the shielding effects of hills and embankments are considered within the calculation of noise levels.

Figure 4.11 shows a visualization of the elevation model in which the area height is represented by colour.

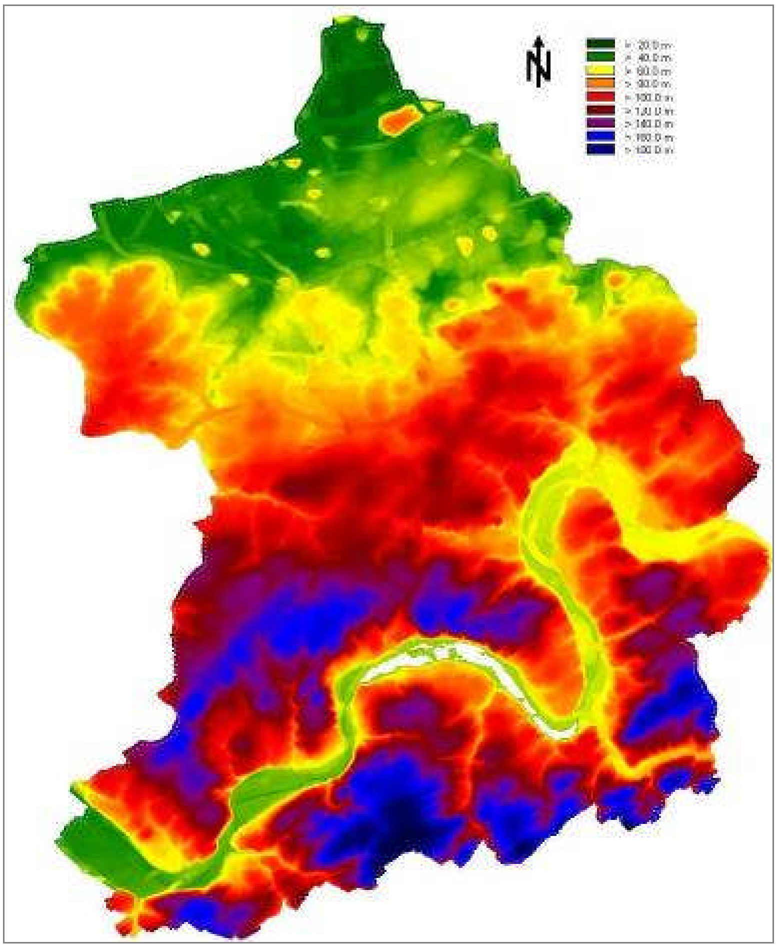

Figure 4.11 Topographic map of the City of Essen

The lowest point of the investigation area is located 20 m above sea level and the highest point is at 205 m absolute altitude.

4.3.2 Road and traffic information

The traffic model of Essen considers all major roads and contains also community roads with daily traffic flows exceeding 1500 vehicles per day. The following illustration shows the road system for the whole of Essen City which has been utilised for the study:

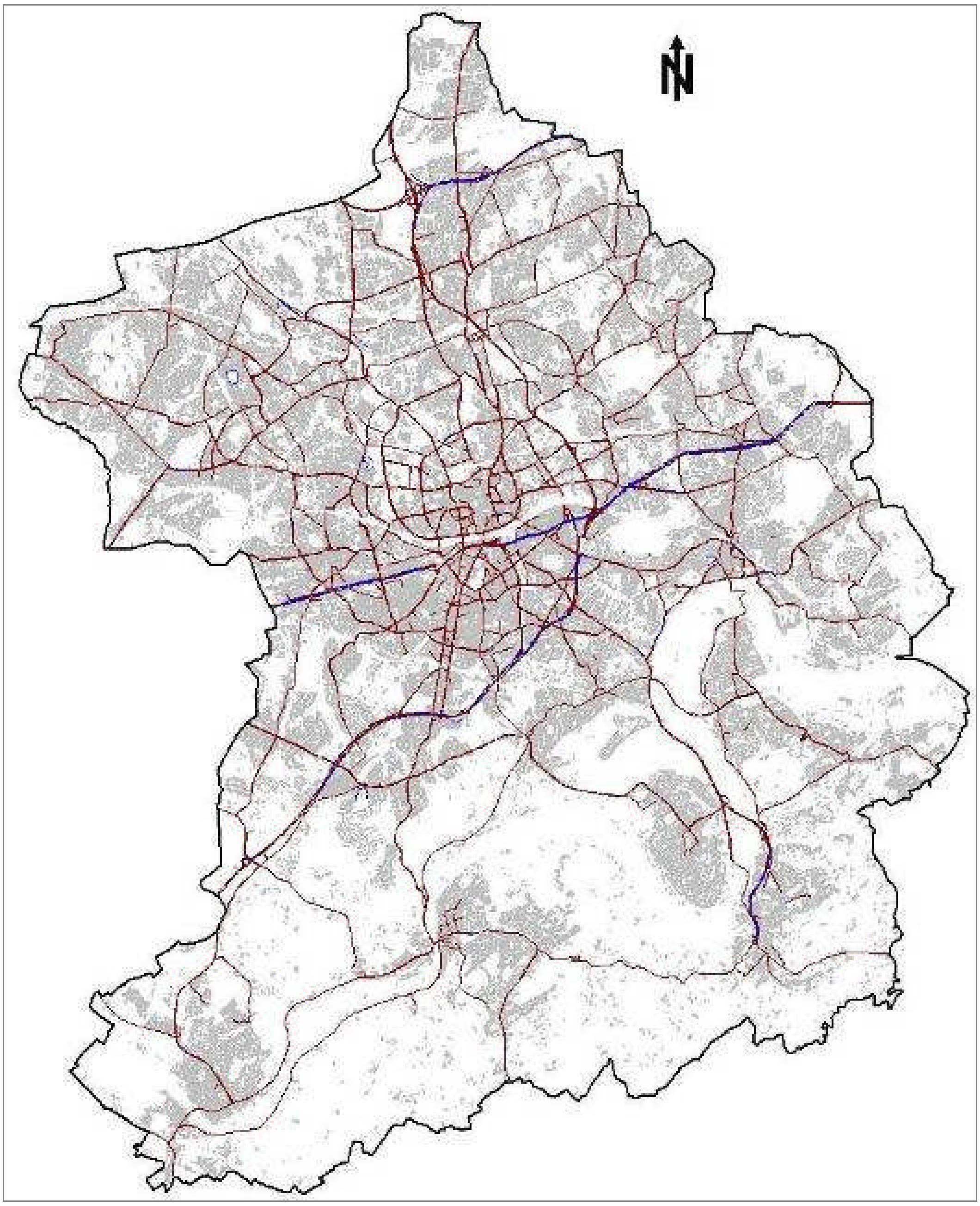

Figure 4.12
Roads, buildings and noise barriers of Essen

All together about 730 km of roads have been studied. The most important (highest traffic flows) roads are:

- West-east direction: BAB 40
- Southwest – east direction: BAB 52
- In the north: BAB 41

The relevant traffic parameters e.g. traffic flow, heavy vehicles, speed, etc. were obtained from the city administration.

The daily traffic flow was distributed for the day times, evening and night. The heavy vehicles contribution was known exactly for most of the roads for the whole of the time. However, for those roads which had no data the standard parameters from the German directive VBUS were used as default values.

Information provided by the city administration on speed limits and road surface types were utilised in the model.

4.3.3 Rail and tram information

In Essen the data for trams and subways is available. The noise from subways where they run over ground was taken in to consideration. These are presented with $L_{m,E}$ in the model. Exact parameters (number of trains, length, speed etc.) are also presented.

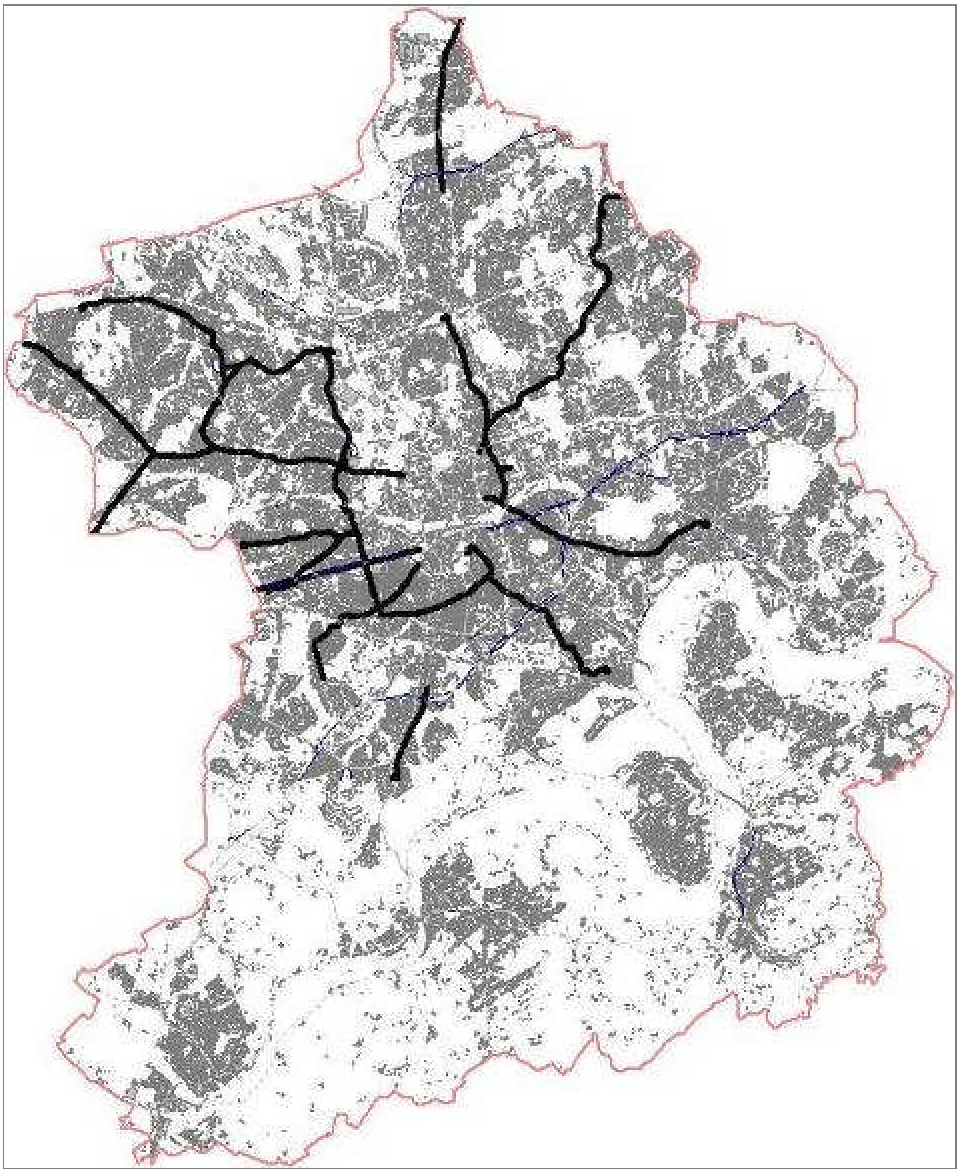

Figure 4.13
Tram and subway lines in the city of Essen

4.3.4 Noise barriers

The DTM also included data with respect to natural noise protection embankments/barriers.

The location of the built noise barriers (shown by blue lines) is evident in Figure 4.12. Most of the protection barriers are along the motorways as well as partly around cemeteries. Figure 4.14 shows a cemetery with noise protection.

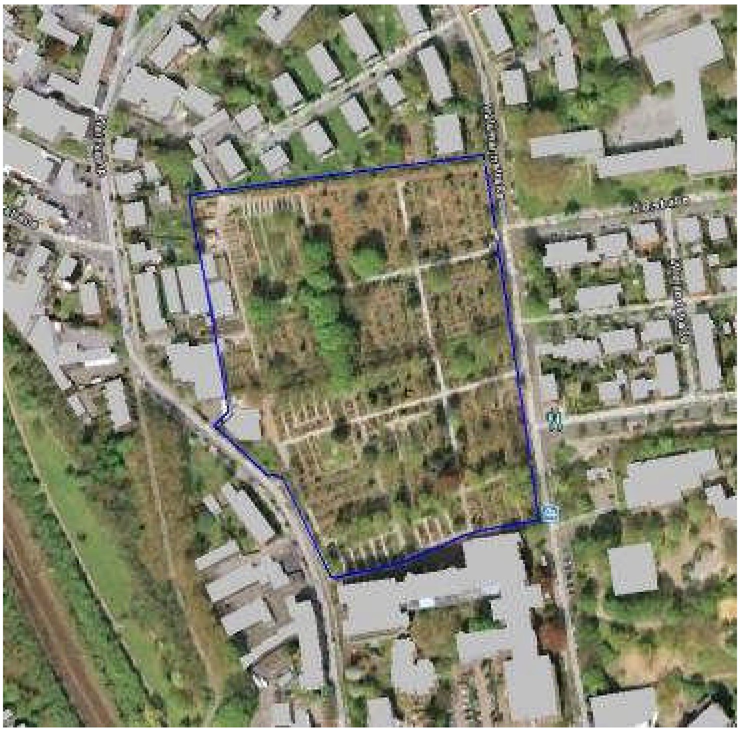

Figure 4.14
Noise barrier around a cemetery

The noise barrier data was entered in to the model with its exact geometry, as well as height and absorptive properties. If the walls/barriers were on bridges, they were shown as an elevated wall, to make sure, that the road or railway under the bridge had the correct sound propagation.

4.3.5 Buildings and inhabitants

The city of Essen has about 591,100 inhabitants. There are about 171,400 buildings of which about 94,600 are residential buildings (approx. 55%). The height and the usage (residential building, school, hospital, commercial use) for each of these buildings is known.

Additionally, there is noise modelling for certain industrial plants where for each the sound power level data is available. However as the industrial plants result in a relatively small contribution of noise to the overall noise levels they have not been considered further in this study.

4.4 AVAILABLE TRAFFIC MODEL

4.4.1 Network model

For Essen, data from a traffic model application of the PSV system has been made available. The application contains car traffic in Essen and the surrounding region. For analysis within the CityHush project, the data has been converted to the Emme network assignment software.

The network is shown in Figure 4.15 as an Emme screenshot.

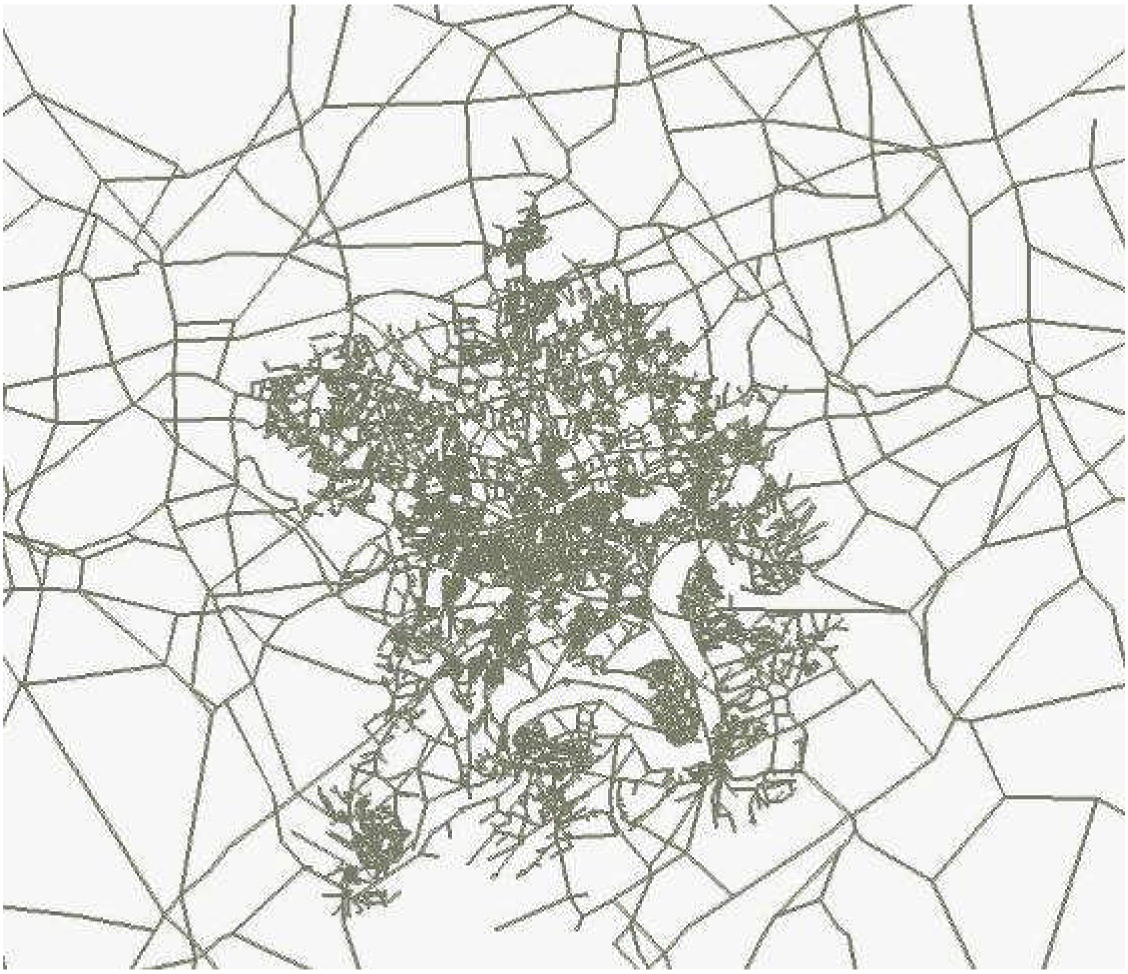

Figure 4.15 Emme network for Essen

Figure 4.16 shows the network of the central parts of Essen. All streets are identified within the network. The intended Q-zone area is marked with red.

Figure 4.16
Emme network for central Essen

4.4.2 Demand models

In the PSV system, traffic assignment is done on an hourly basis. Congestion is treated by using link specific volume-delay functions for all regular links (i.e. not connectors).

Mode and destination choice is not treated in the current application. An Origin-Destination car matrix is available.

4.4.3 CityHush adaptation

The application has been transformed to an Emme application. No further detail is required for the CityHush application. The assignment is based on time, and as the simulation scenarios will imply fees on specific links, a conversion from monetary units to time units is necessary to reflect the impedance on such links. This conversion will be done using the Heatco (Shires and de Jong 2006) recommendations on values of time for Germany. As these recommendations concern the mean value of time, assumptions on the distribution of the mean value are needed to reflect differences in the willingness to pay noise charges. These assumptions will be based on recent value of time research. Effects on other noise sources will have to be calculated ad hoc using information from previous noise mapping in Essen.

5 GOTHENBURG TEST SITE

5.1 GENERAL INFORMATION ON THE CITY OF GOTHENBURG

Gothenburg is the second largest city in Sweden. The urbanised area covers a total area of 412 square kilometres, and has a population of about 510 000. The population density is 1 200 persons/km².

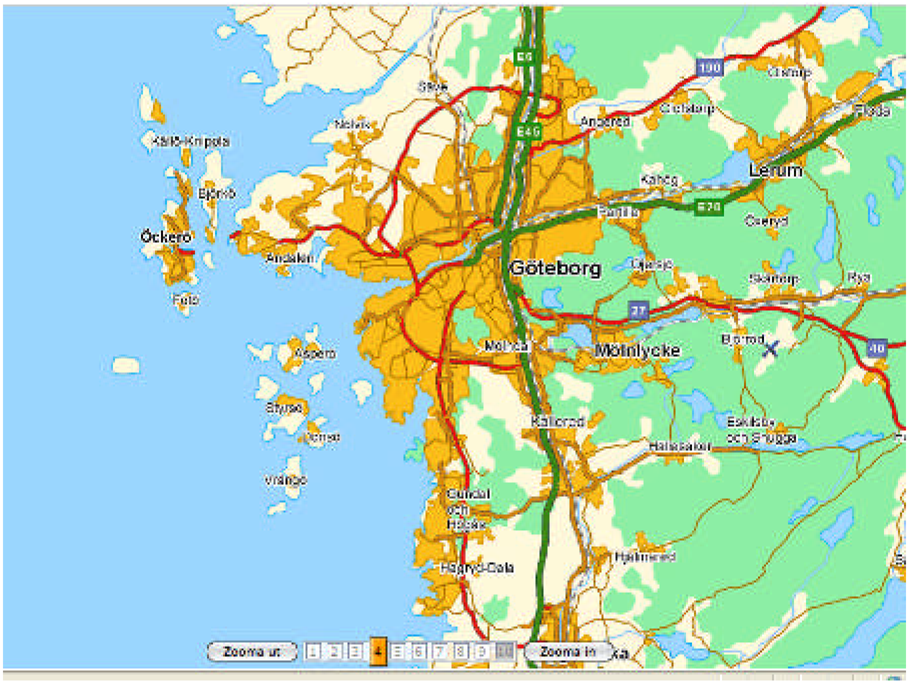

Figure 5.1 Gothenburg.

The city is located on the Swedish west coast around the mouth of the river Göta Älv. The central parts are built close to the river, and surrounded by canals. Gothenburg has a large harbour and much of the space along the river is used for harbour related activites.

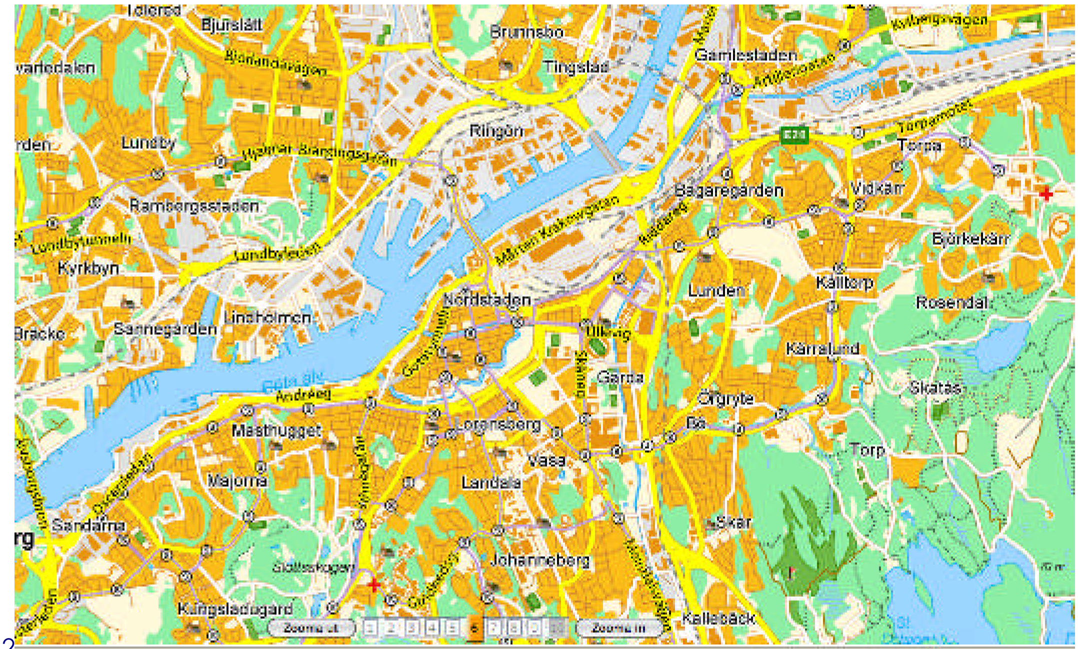

Figure 5.2

Central part of Gothenburg.

5.2 TEST SITE SELECTION

5.2.1 Noise conditions

For Gothenburg, noise mapping has been undertaken for the whole Gothenburg area in the year 2007. The Gothenburg noise conditions (Leq 24 h) are presented on the resulting noise map (Figure 5.3). Traffic from the motorway E6 brings high noise levels to the central parts. Figure 5.4 shows noise conditions for the central parts of the city.

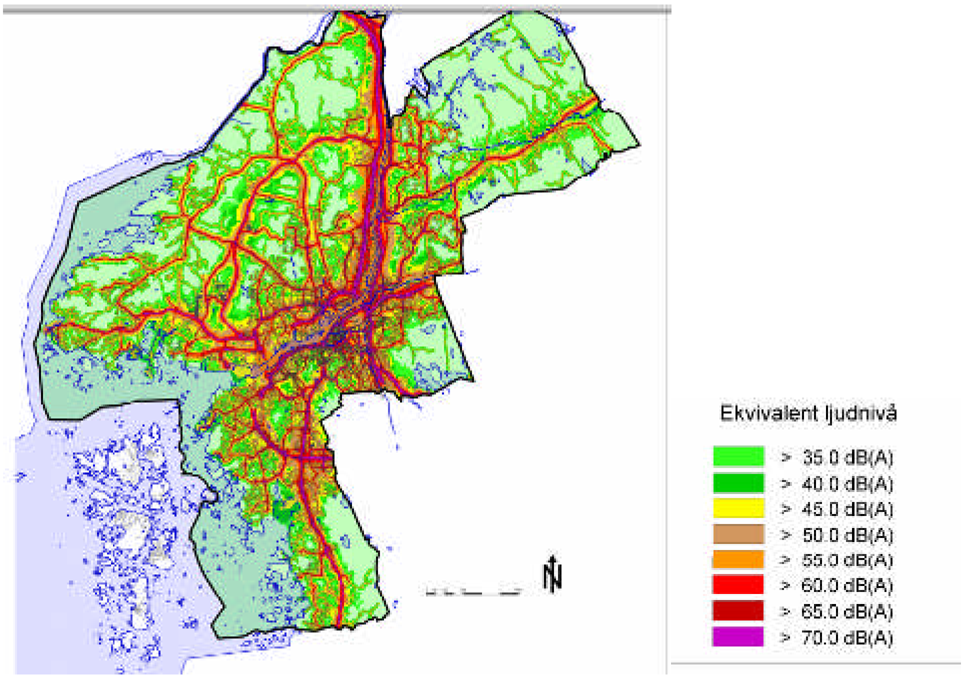

Figure 5.3

Noise map for Gothenburg (dB(A) L_{eq24h} noise levels)

Figure 5.4

Noise map for central Gothenburg (dB(A) L_{eq24h} noise levels)

5.2.2 Potential for Q-zones

The central parts of Gothenburg contain several park that are hit by noise disturbance. Parks have been subject to investigations with respect to use and environmental status. The Cityhush Gothenburg municipality partner suggested thee main alternatives for a park surrounded by a Q-zone emerged as shown In Figure 5.5,

Figure 5.5

Parks in central Gothenburg

The Trädgårdsföreningen is the largest park, It is shown in more detail in Figure 5.6, where also noise level measurements are reported (shorter intervals).

Figure 5.6
Noise levels in the Trädgårdsföreningen park (dB(A))

According to the investigation, the park is used for a number of different recreation purposes like resting, walking, playing, experiencing water and flowers and also for cultural events. The two other parks are smaller and not as much used as the Trädgårdsföreningen.

5.2.3 Selected Q-zone area

After discussions with the Gothenburg municipality partners, the Trädgårdsföreningen park appeared to have the highest potential to be part of a Q-zone. The intended Q-zone area is shown on Figure 5.7

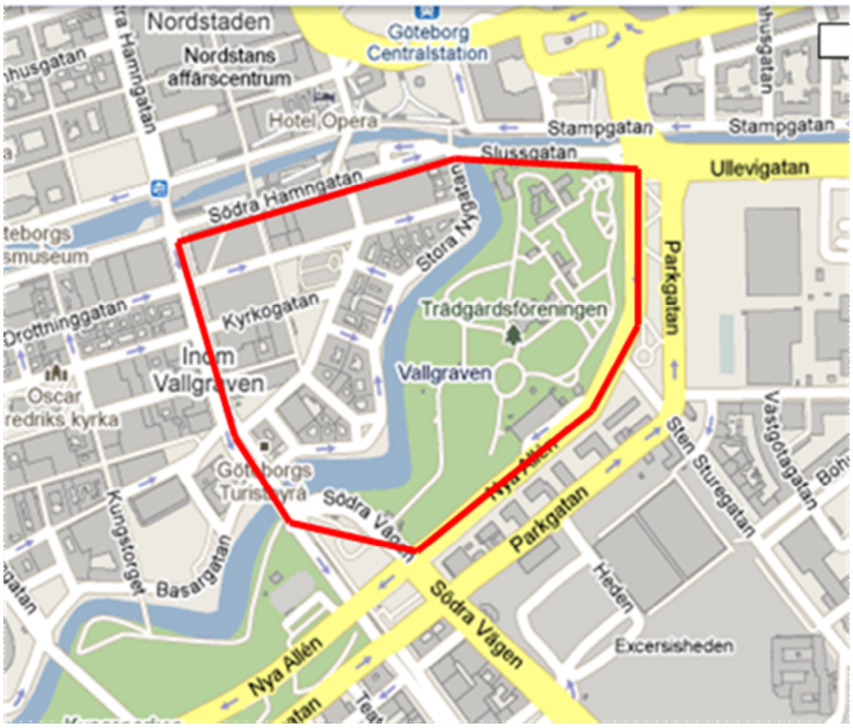

Figure 5.7

Intended Q-zone area

5.3 AVAILABLE NOISE MODEL

5.3.1 Digital terrain model

A new terrain model was supplied by Gothenburg municipality and has been adapted for noise mapping purposes.

Figure 5.8

The Gothenburg data terrain model

5.3.2 Road and traffic information

In the noise mapping of Gothenburg a lot of the inner city roads had estimated numbers on traffic and heavy vehicle percentages. For CityHush an updated traffic model has to be used for sufficient accuracy. The latest measured traffic flows will be supplied by Gothenburg municipality and introduced in the model.

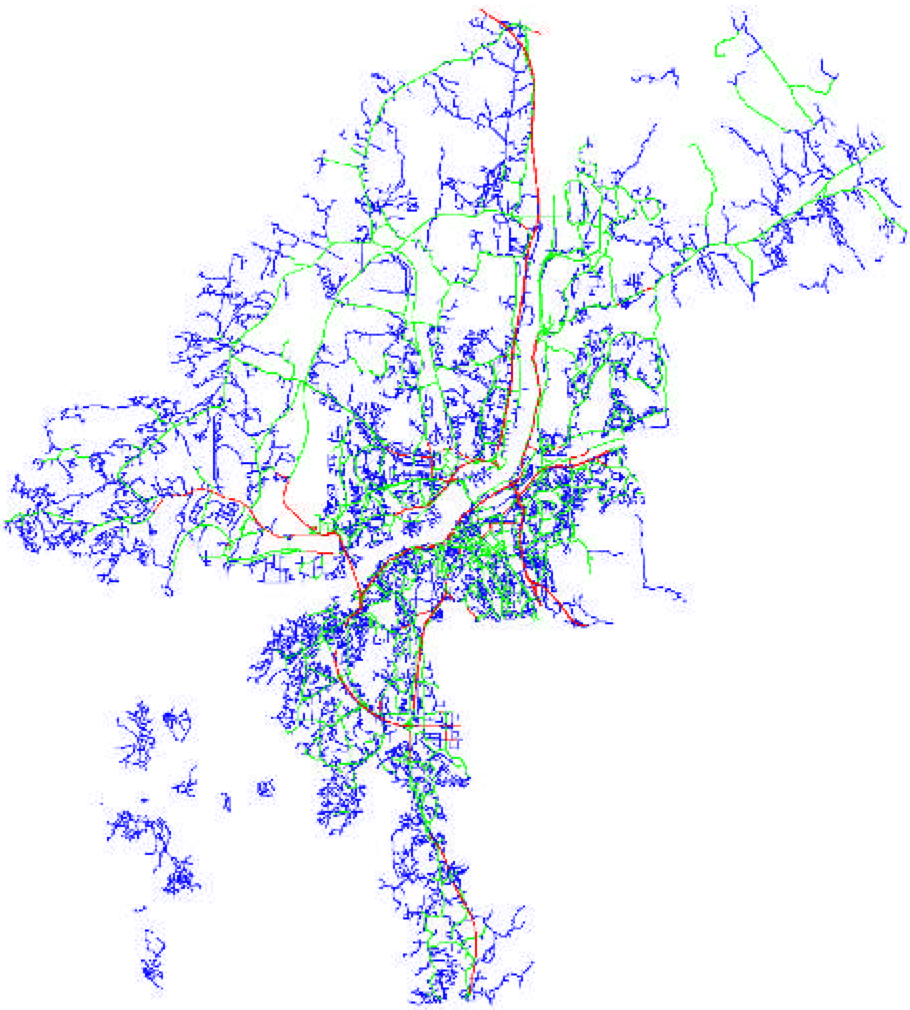

Figure 5.9

Gothenburg roads used in previous noise mapping, blue roads have estimated traffic, green roads have measured traffic below 1000 cars/hour, red roads have measured traffic above 1000 cars/hour

5.3.3 Rail and tram information

Tram and rail information will be used where applicable and is available on the Gothenburg tram system and for national rail traffic.

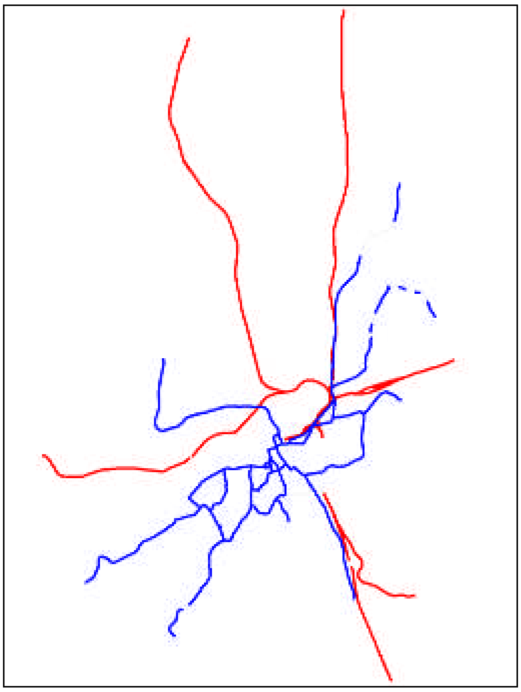

Figure 5.10 Gothenburg tram (Blue) and Rail system (Red)

5.3.4 Noise barriers

Location and height of existing noise barriers is included in the material from the previous noise mapping. Updates will be made from the data supplied by Gothenburg municipality.

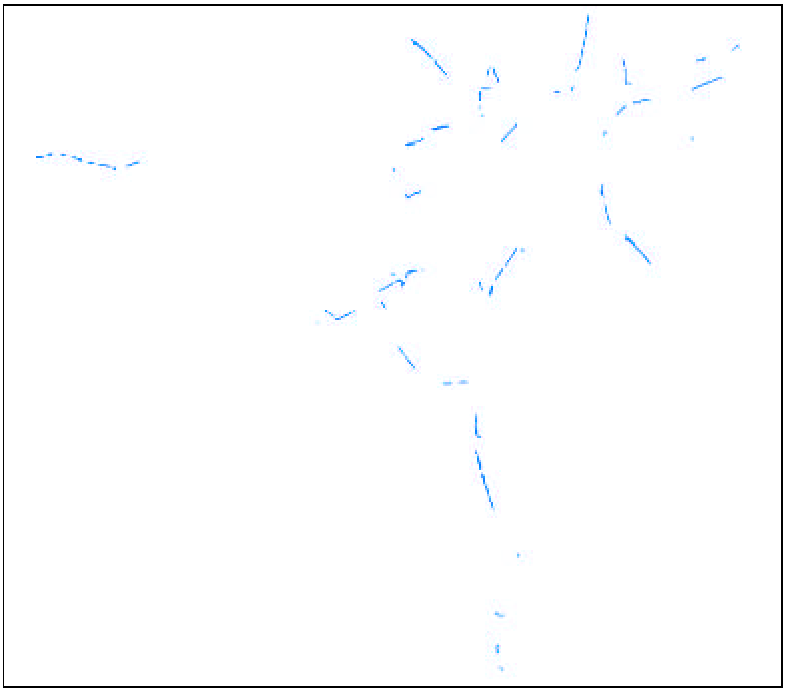

Figure 5.11 Noise barriers in Gothenburg

5.3.5 Buildings and inhabitants

Information on inhabitants and buildings is available from the noise mapping material.

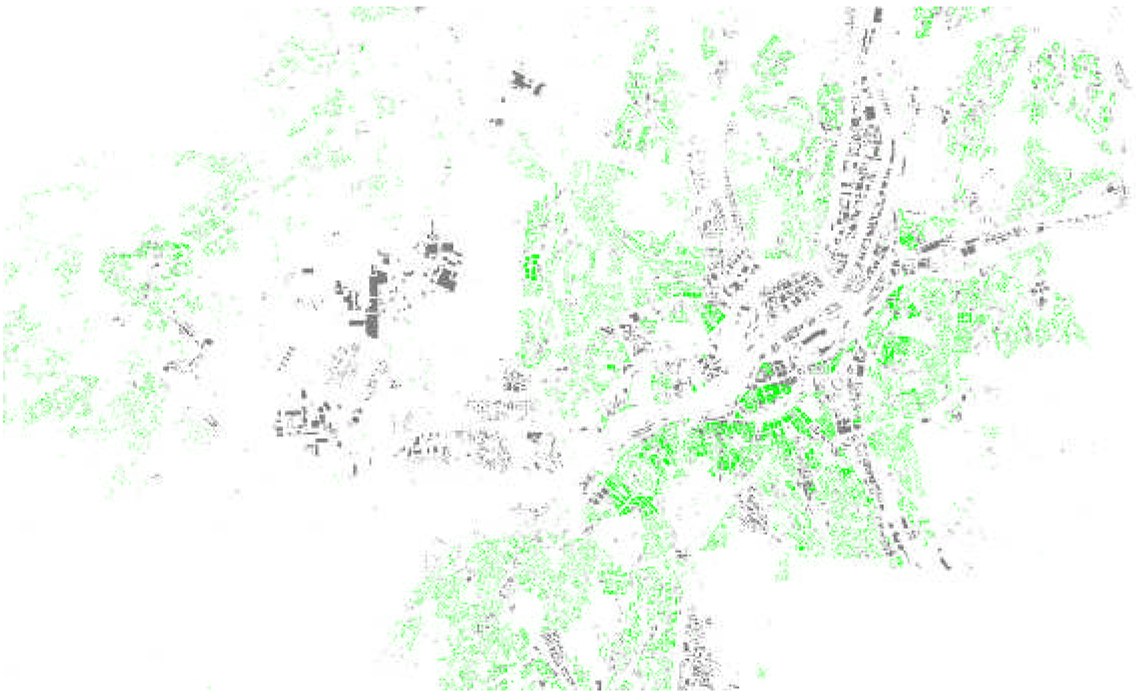

Figure 5.12

Buildings and inhabitants in Gothenburg. Dwellings are green and other buildings grey

5.4 AVAILABLE TRAFFIC MODEL

5.4.1 Network model

Gothenburg Is included in the national Sampers forecasting system. The Emme network assignment model is integrated in the Sampers system. For CityHush, the Sampers regional model for the Western part of Sweden is used. It contains 2700 zones and 65 000 links. Public transport lines are also included in the model.

The network is shown in Figure 5.13 as an Emme screenshot.

Figure 5.13
Emme network for Gothenburg

Figure 5.14 shows the network of the central parts of Gothenburg. All streets except very minor roads are contained in the network. The intended Q-zone area is marked with red.

Figure 5.14
Emme network for central Gothenburg

5.4.2 Demand models

In the Sampers system, traffic assignment is done for the morning peak hour and one midday hour. Congestion is treated by using link specific volume-delay functions for all regular links (i.e. not connectors). Multiclass assignment is used, in order to regard different values of time.

The travel demand models I Sampers include mode and destination choice models.

5.4.3 CityHush adaptation

More detail needs to be added to the central part of the network for links as well as zones. The assignment is based on time, and as the simulation scenarios will imply fees on specific links, a conversion from monetary units to time units is necessary to reflect the impedance on such links. This conversion will be done using the Sampers system values of time.

6 STOCKHOLM TEST SITE

6.1 General Information on the City of Stockholm

Stockholm is the capital of Sweden. The municipality of Stockholm covers an area of 188 square kilometres, and has a population of about 840,000. The population density is 4,500 persons/km².

Figure 6.1 Stockholm.

The city is located on the border between the Mälar Lake and the Baltic Sea. It contains many islands connected by bridges. The inner city is shown in Figure 6.2.

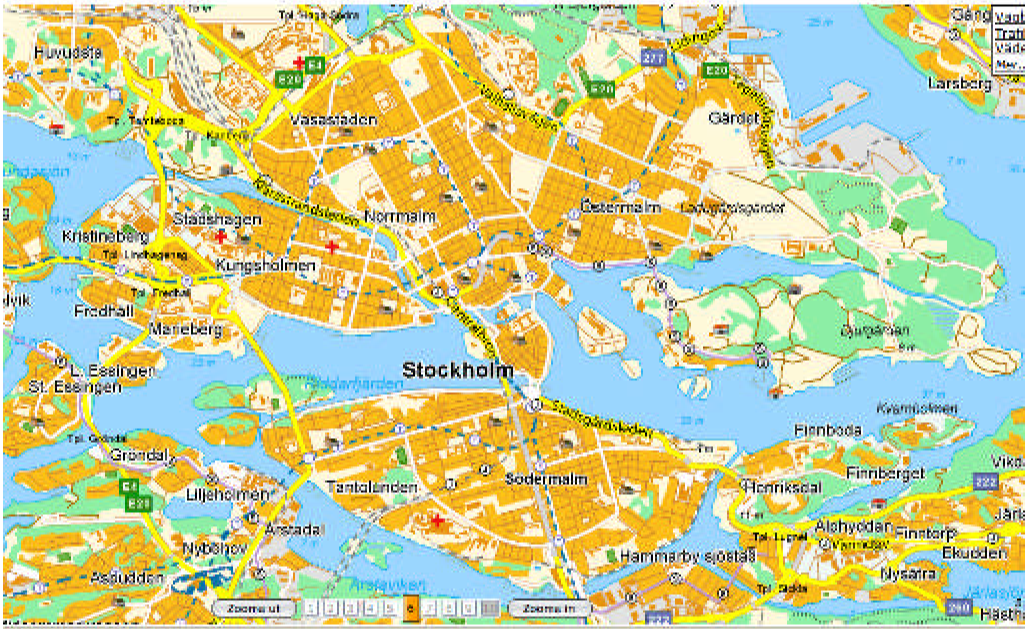

Figure 6.2

Stockholm inner city.

6.2 TEST SITE SELECTION

6.2.1 Noise conditions

For Stockholm, noise mapping has been undertaken for the whole municipality, and was finished in the year 2006. The Stockholm noise conditions are presented (in Leq 24h) on the resulting noise maps (Figure 6.4). Figure 6.5 shows the central parts of the city.

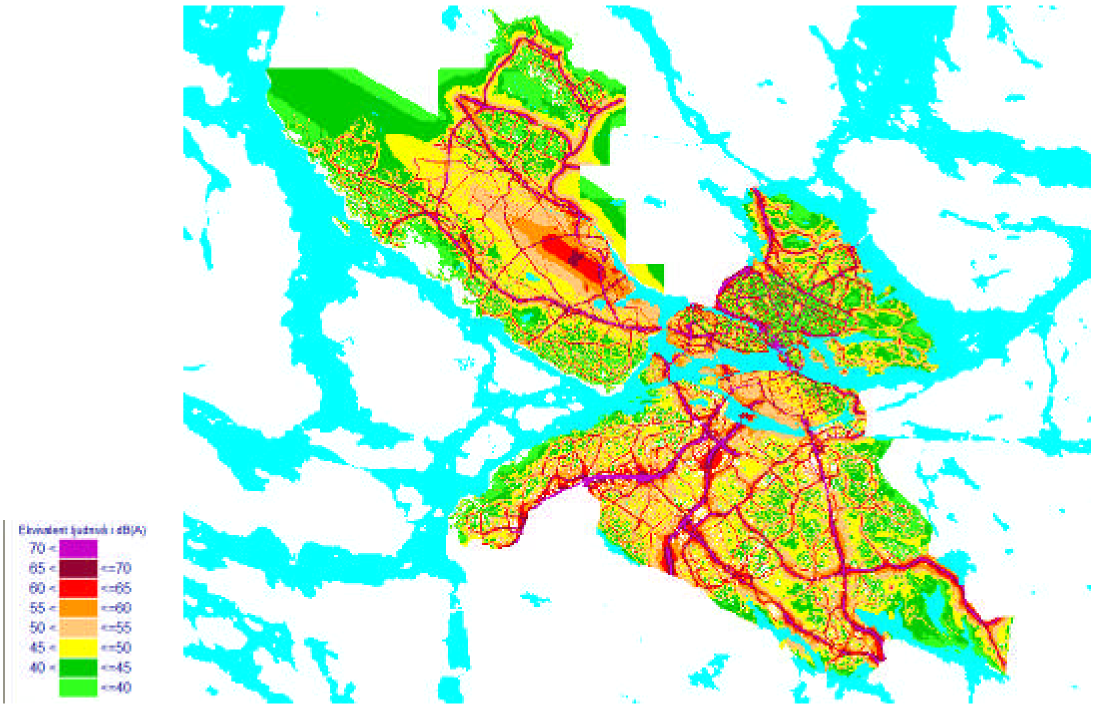

Figure 6.4

Noise map for Stockholm (noise levels in L_{eq24h})

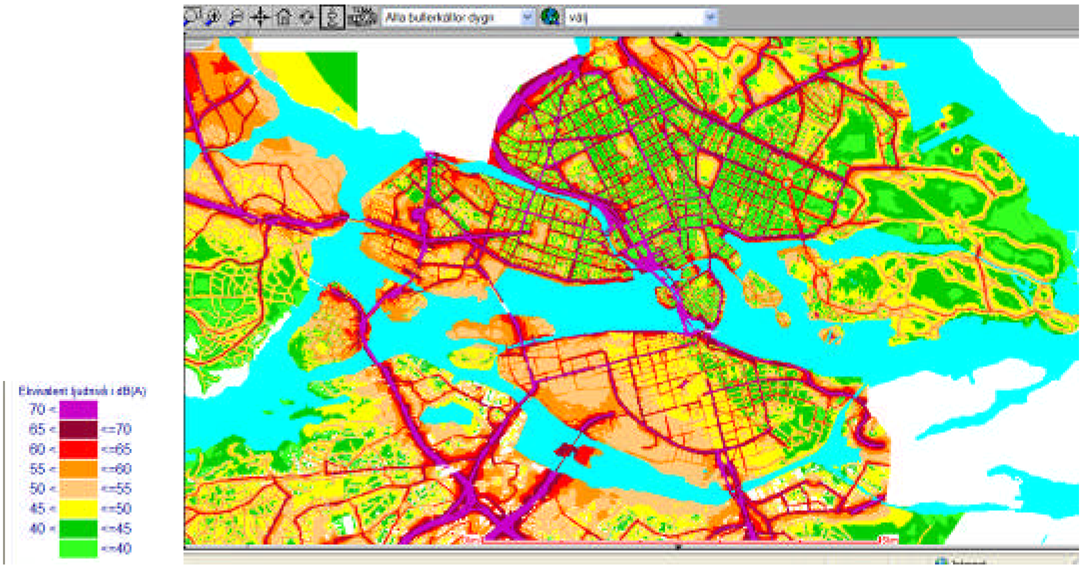

Figure 6.5 Noise map for central Stockholm (noise levels in L_{eq24h})

6.2.2 Potential for Q-zones

The western part of the Södermalm island is more severely hit by noise disturbance than many other parts of the inner city. This area also contains larger and smaller parks that would benefit from being included in a Q-zone. As there are several possible parks to include In a Q-zones, this area provides an opportunity to study different zone sizes which is one of the WP objectives. Another reason to choose Södermalm is that there is a discussion on extending the current ban on studded tyres on Hornsgatan (red in Figure 6.5) to a larger part of the island.

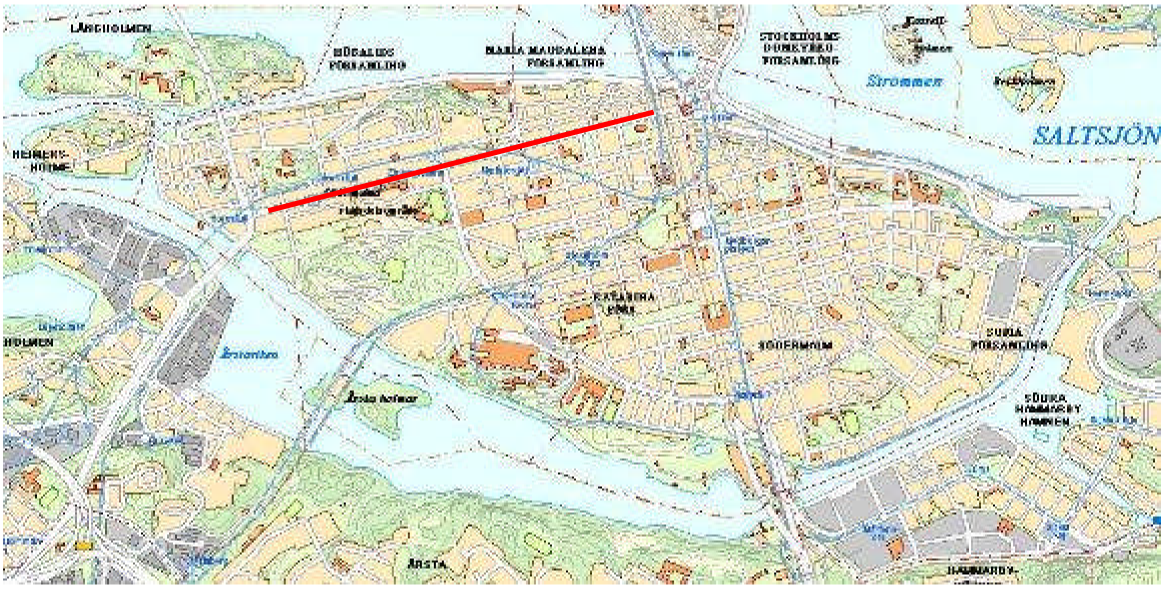

Figure 6.5 Södermalm island

6.2.3 Selected Q-zone area

After discussion with the Stockholm Municipality partner, it was decided to choose the area indicated on Figure 6.6. The area is not only disturbed by car traffic – a railway line also crosses part of the area. The area contains several parks, and is also suitable for testing smaller Q-zone sizes. A smaller zone size is shown in Figure 6.7. A third, smaller, zone size is shown in Figure 6.8

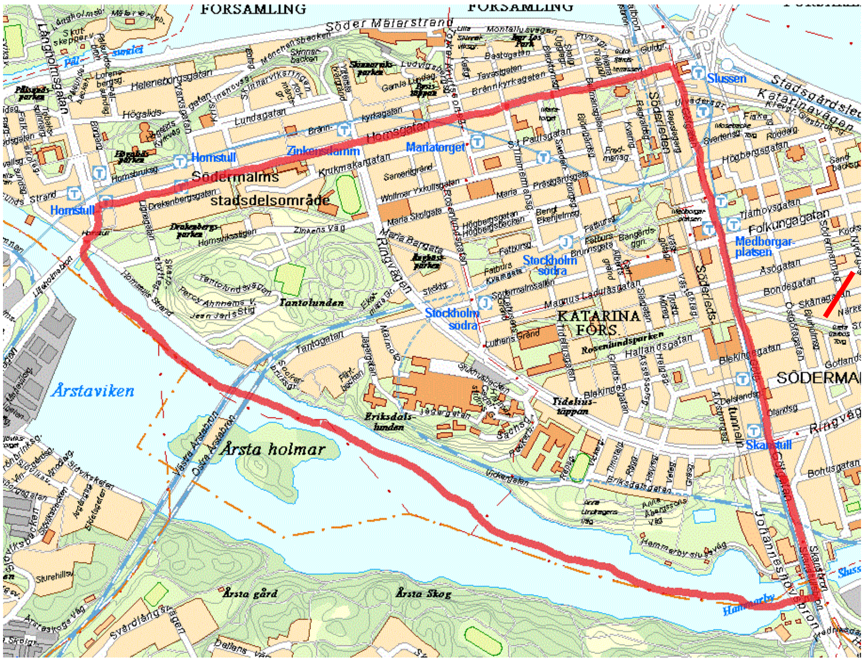

Figure 6.6

Intended Q-zone area

Figure 6.7

Smaller Södermalm Q-zone

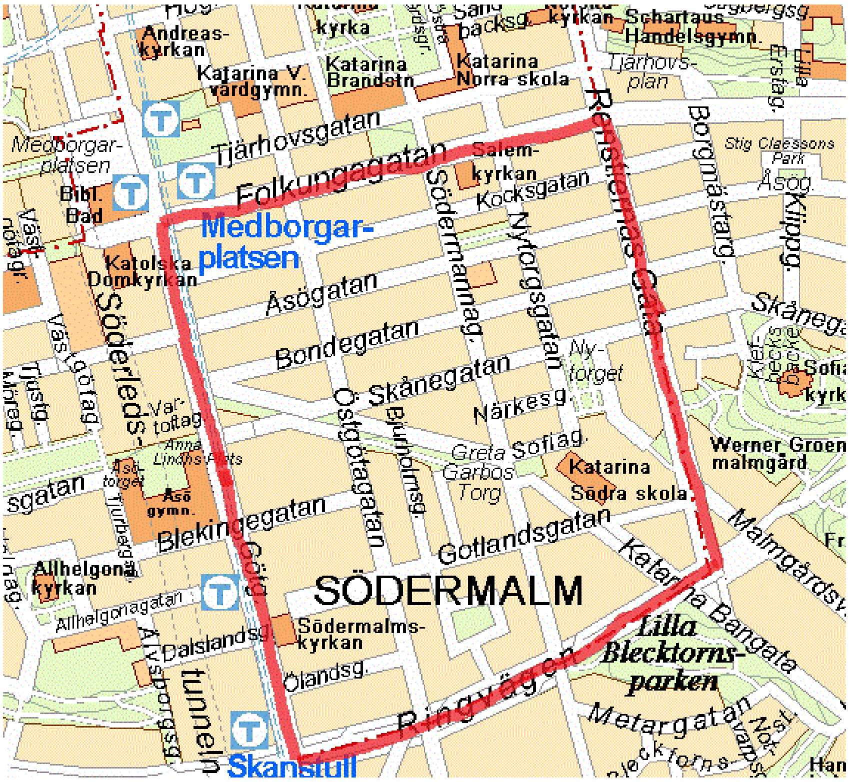

Figure 6.8

Smallest Södermalm Q-zone

6.3 AVAILABLE NOISE MODEL

6.3.1 Digital terrain model

A digital terrain model was created when the noise mapping was done. The relevant part of the city is shown in Figure 6.9.

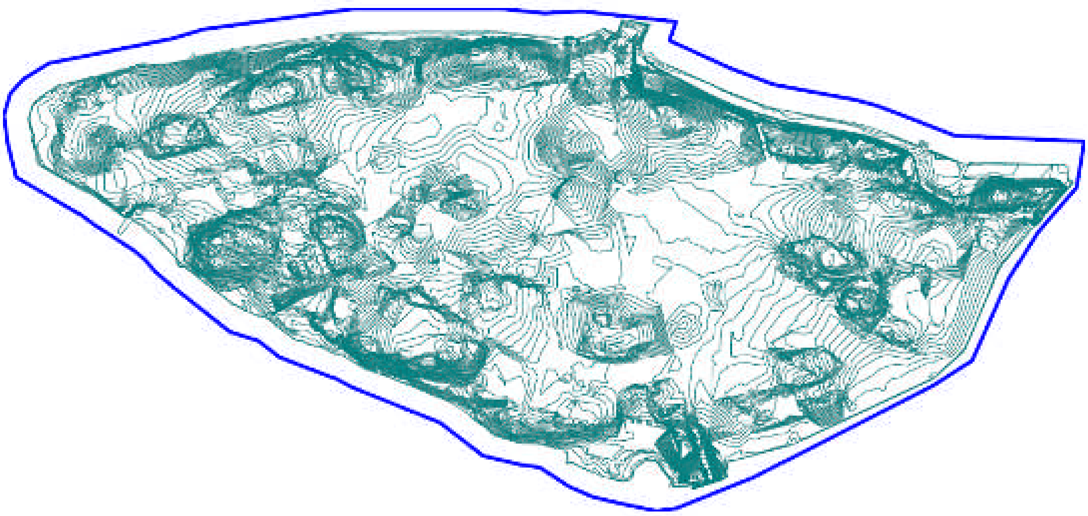

Figure 6.9

The digital terrain model for the island Södermalm

6.3.2 Road and traffic information

The roads that were used in the noise mapping are shown in Figure 6.10. The figure also shows the speed that was used for each link.

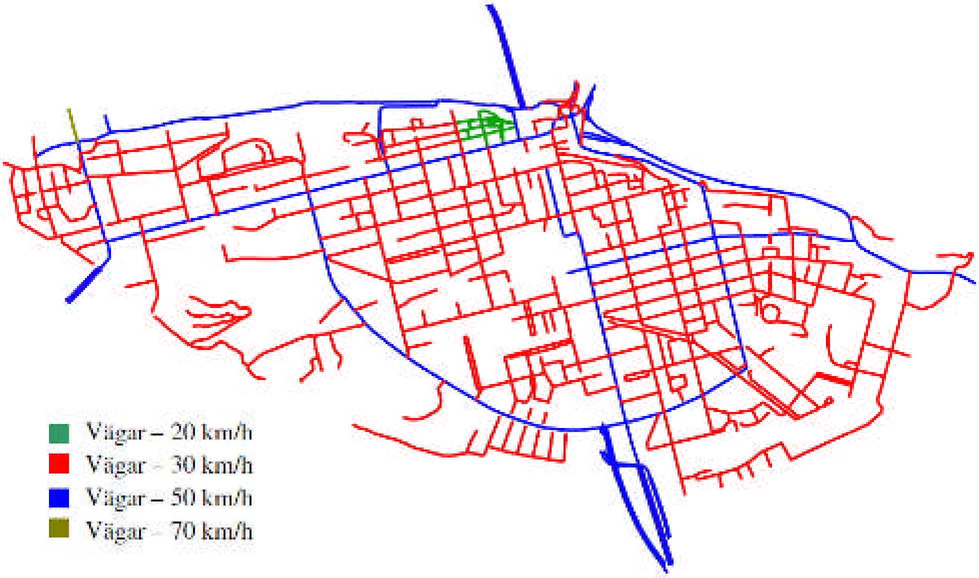

Figure 6.10 Roads used for noise mapping

6.3.3 Rail and tram information

The parts of Södermalm island affected by rail and tram noise can be seen in Figure 6.11.

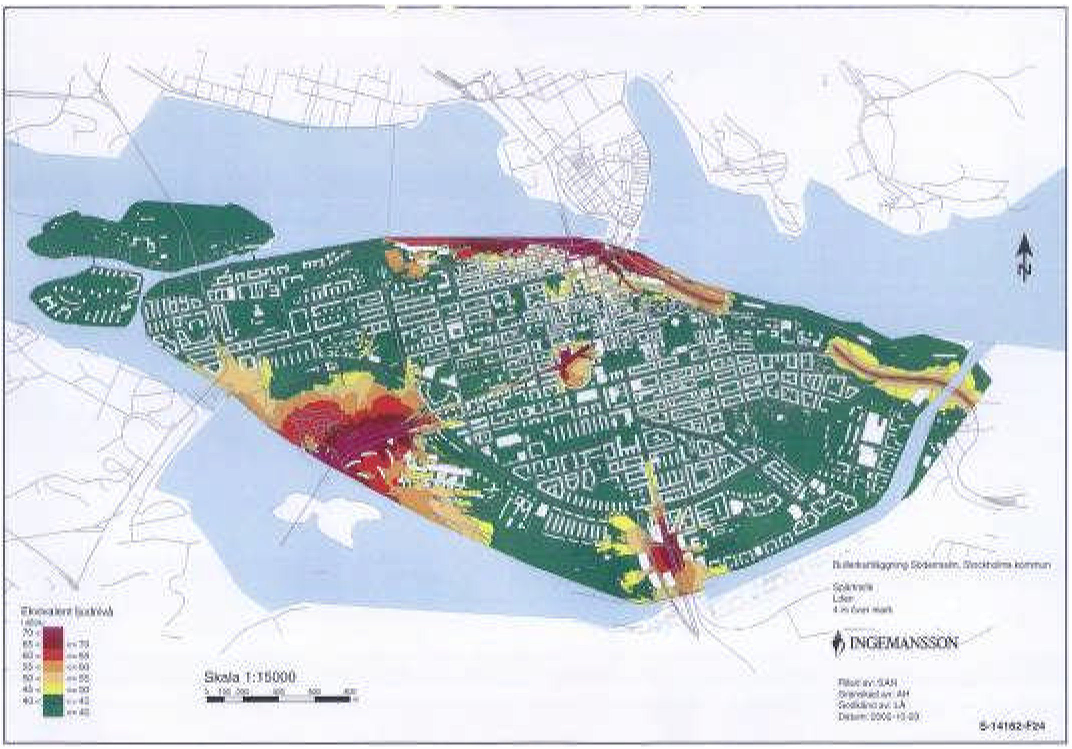

Figure 6.11 Rail and tram noise

The roads that were used in the noise mapping are shown in Figure 6.10. The figure also shows the speed that was used for each link.

One national railway line is relevant for the selected part of the city. It enters the island in the southeast via two parallel bridges, and then goes into a tunnel. The trains leave the tunnel in the central northern part of the island and enter a bridge. This line is causing the noisy spots in the southeast and the north. It also causes the central noisy spot, due to an opening in the tunnel. That opening will be closed by 2017 when a major reconstructing for the commuter trains will be finished.

One eastbound regional railway line starts in the northern central part. It causes the noise in the east and contributes to the noise in the north.

Two subway lines cross the island, leaving their tunnel in the north and in the south. Therefore they create the noise in the south and contributes to the noise in north.

6.3.4 Noise barriers

Noise barriers are included in the Stockholm noise mapping. For the island of Södermalm only one noise barrier is relevant. It is located at the central railway line, in the southeast of the island. That noise barrier was not erected (or at least not included) when the noise map in Figure 6.11 was created.

6.3.5 Buildings and inhabitants

The buildings included in the noise mapping are shown in Figure 6.12. There may be slight differences between this map and Figure 6.11. The railway noise mapping was made earlier.

Figure 6.12

Buildings included in the noise mapping

In the noise mapping the number of exposed inhabitants was calculated according to the European Noise Directive. For the entire city the number of people exposed to more than 55 dB(A), LDEN from road traffic was 271,415. For the island of Södermalm the number was 40,624. The corresponding number for rail and tram traffic were 49,819 for the city and for Södermalm 2 382.

6.4 AVAILABLE TRAFFIC MODEL

6.4.1 Network model

Stockholm Is included in the national Sampers forecasting system. The Emme network assignment model is integrated in the Sampers system. For CityHush, a version containing 1,500 zones and 30,000 links was used. Public transport lines are also included in the model.

The network is shown in Figure 6.13 as an Emme screenshot.

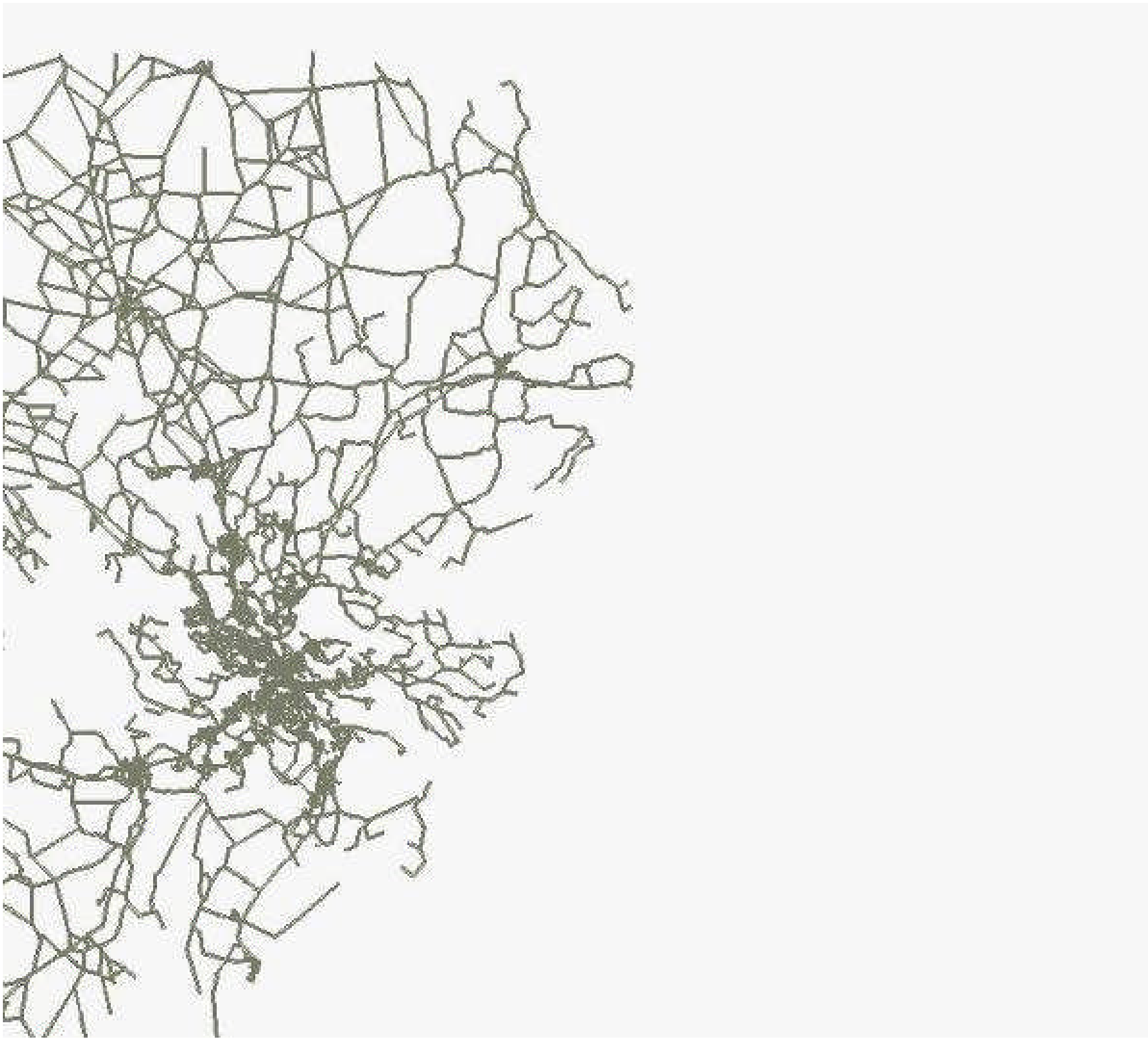

Figure 6.13
Emme network for Stockholm

Figure 6.14 shows the network of the central parts of Stockholm. All streets except very minor roads are contained in the network. The intended Q-zone area is marked with red.

Figure 6.14
Emme network for central Stockholm

6.4.2 Demand models

In the Sampers system, traffic assignment is done for the morning peak hour and one midday hour. Congestion is treated by using link specific volume-delay functions for all regular links (i.e. not connectors). Multiclass assignment is used, in order to regard different values of time.

The travel demand models I Sampers include mode and destination choice models.

6.4.3 CityHush adaptation

More detail needs to be added to the Södermalm part of the network for links as well as zones. The assignment is based on time, and as the simulation scenarios will imply fees on specific links, a conversion from monetary units to time units is necessary to reflect the impedance on such links. This conversion will be done using the Sampers system values of time.

7 REFERENCES

Shires, J.D., and de Jong, G.C. (2006) An international meta analysis of values of time. Annex A to the Heatco Deliverable 5 Proposal for Harmonised Guidelines FP6-2002-SSP-1/502481

Emme 3 Travel demand forecasting software. Developed by Inro company, Canada. www.inro.ca

Visum. Travel demand forecasting software. Developed by PTV AG, Germany. www.ptvag.com

Saturn. Software for Simulation and Assignment of Traffic to Urban Road Networks. Developed by Atkins, UK. www.saturnsoftware.co.uk

Cadna. Noise mapping software developed by DataKustik company, Germany. www.datakustik.com

ArcView. Geographic Information System. Developed by Esri, USA. www.esri.com

PSV. Travel demand forecasting software developed by SOFTWARE-KONTOR HELMERT GMBH, Germany. www.software-kontor.de