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This deliverable has been quality checked and approved by QCITY Coordinator
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TABLE OF CONTENTS

0. EXECUTIVE SUMMARY

The organisation of the urban landscape is closely connected to social patterns, building patterns and traffic patterns. They all have a significant impact on the sound environment. Local town planning offers many choices – in producing, increasing, avoiding and limiting noise. As summary of – only a few – important aspects of the urban organisation linked to noise, the following illustration can be used.

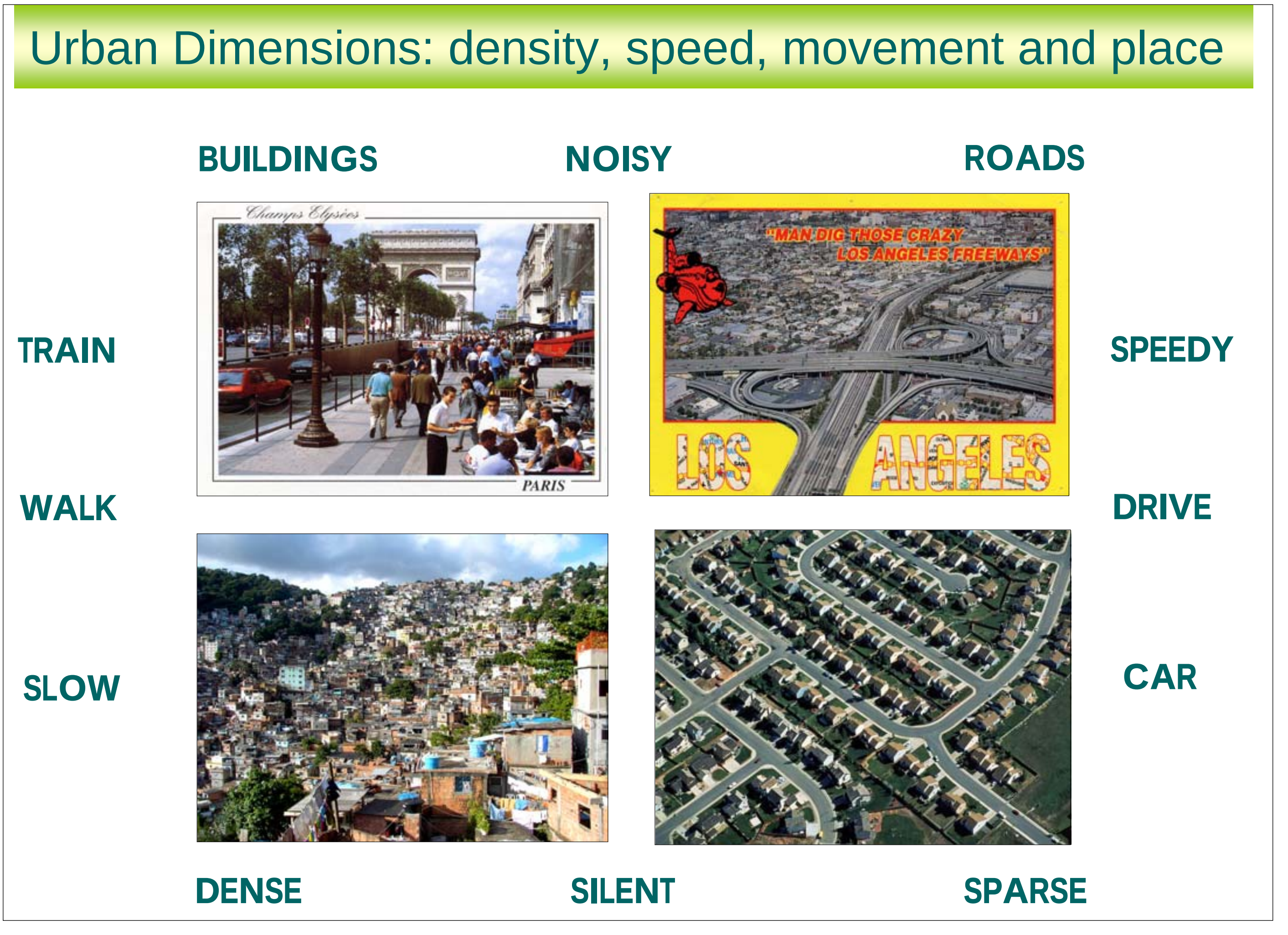

Figure 0. Top: Paris and Los Angeles. Bottom: Rio and suburban California.

0.1. OBJECTIVE OF THE DELIVERABLE

To show how: 1) local town planning, including both traffic and building layout, can be adjusted to reduce noise propagation from (car) traffic, 2) short time and long term planning strategies can be coordinated to reduce traffic generated noise in the regional scale, 3) develop evaluation models that connects and anchors the noise reduction perspective to other urban planning perspectives and goals, 4) new guidelines and recommendations regarding noise levels - related to urban quality - may strengthen and support planning initiatives directed towards reduction of traffic generated noise by a shift in travel patterns, from car/vehicle to public transport, 5) noise screening buildings can be organised and combined with efficient traffic flows and traffic safety, 6) the monetary value of noise reduction in buildings can be applied also to noise reduction on open unbuilt urban land.

0.2. STRATEGY USED AND/OR A DESCRIPTION OF THE METHODS (TECHNIQUES) USED WITH THE JUSTIFICATION THEREOF

First part: Computer simulation of traffic flows in three alternative development scenarios for a larger urban area in northern Stockholm, Sweden. Simulation of different kinds of traffic junctions and street nets, with regard to speed and congestion effects. **Second part:** Computer simulation of noise effects in the three scenarios, evaluation and change of traffic flows and organisation of buildings to further reduce noise. **Third part:** Analysis of simulation results, evaluation connected to other urban development goals and perspectives. Based on this, more general solutions and proposals are presented.

By testing different kinds of solutions in an existing area that will be the object of major traffic planning changes in the near future, it is hoped that the technical results of simulations as well as the general results can be communicated to both researchers and decision makers. Comparing alternative layouts is an effective way to illustrate choices and possibilities.

0.3. BACKGROUND INFO AVAILABLE AND THE INNOVATIVE ELEMENTS WHICH WERE DEVELOPED

The testing area, the Järva Field in northern Stockholm, has already been the object of several research projects and discussions – which has been used as input. Results from European Union research project ARTISTS (Arterial Streets Toward Sustainability, 2004) have been used and developed further. Official European Union goals for urban development (The Bristol Accord, 2005) have been included and developed further. Previous research results on noise screening buildings and street design (from Sweden and France) have been used in the three scenarios. Results presented in other reports in the QCITY project have been taken into account and developed further (monetary value of noise reduction and noise disturbance connected to type of noise source).

0.4. PROBLEMS ENCOUNTERED

The large scale testing method makes it difficult to evaluate the exact result of one specific and isolated action, such as changing the speed of a specific road or changing the height of a specific building. A more “laboratory like” testing method would have given more specific results on the local scale with clearer “cause-effect” results. It had, on the other hand, probably missed the large scale and long term effects. Micro scale testing of suggested alternative traffic junctions have not been conducted, as this would required extensive additional programming and use of other computer software.

A closer collaboration between different research groups, especially on 1) the subject of monetary evaluation of noise reduction and 2) psychological relationships regarding noise sources and level of perceived disturbances, could have generated more specific results.

0.5. PARTNERS INVOLVED AND THEIR CONTRIBUTION

KTH, Department of Urban Studies; Anders J Söderlind, Bosse Bergman:

> Analysis of relationships between noise and other urban perspectives , input for translation of present and planned road systems into simulation models, production of alternative plans A1 and A2, methods for noise screening buildings and traffic layouts, development of evaluation models, suggestions for urban quality related noise level recommendations, finalising of report.

KTH, School of Architecture; Erik Stenberg:

> Computer modelling of street systems and building layouts for three scenarios, production of alternative building and traffic principles for alternative A2, input to traffic and noise simulation, modelling of small and large scale building structures.

KTH, Department of Traffic and Location Analysis, Pia Sundberg, Staffan Algers:

> Organisation and programming for traffic simulation in computer model of test area, testing of different traffic scenarios, including congestion effects and speed, further development of relationship between new building areas and new traffic generated, input to noise simulation.

Acoustic Control Ltd; Åsa Stenman, Henrik Malker, Peter Malm, Henrik Samuelsson, Nils-Åke Nilsson:

> Organisation and programming for noise simulation in computer model of test area, testing of noise effects of different building and street layouts, input to theoretical analysis on noise acceptance and relationships between traffic flows and noise levels, input to discussion on monetary evaluation.

0.6. CONCLUSIONS

Local town planning offers a wide range of possibilities to reduce traffic generated noise in urban areas. Present practise, with noise screens and noise reducing materials/surfaces/tires, can be supplemented with more effective placing of buildings with noise screening functions, more efficient high speed and low speed roads/streets. Noise reduction strategies are more likely to be effective and more easy to finance, if designed and evaluated with respect to other aspects of sustainable development and attractivity and if combined with other functions. The noise screening building block is one example of a solution with a more positive economic result, as compared to a noise screen with only a screening function.

On the strategic level, planning that makes possible a shift from car dependant development to public transport friendly development, may have a more diffuse long time effect – in other places than the physical measures are implemented. Less car traffic in the system as a whole may be a realistic goal, but is not likely to be implemented, if present car traffic flows are being prevented or reduced by negative means. The report tries to show how an already built up area can be developed, accepting present traffic flows, to both reduce traffic generated noise in the short run and to reduce the need for car travel in the area in a long term perspective.

From a professional planning perspective, it is also proposed, that noise reduction work may be more effective and generally accepted as an important subject, if it is linked with (in both design and evaluation work) to other urban planning issues. The different proposed evaluation methods that have been produced in this work, has this goal.

0.7. RELATION WITH THE OTHER DELIVERABLES (INPUT/OUTPUT/TIMING)

Method for monetary evaluation of noise reduction measures, developed in **Work Package 4.3, QCITY Deliverable D4-5**, is commented on and discussed for further implementation.

1. THE SOUND SCAPE IN RELATION TO URBAN DEVELOPMENT, ATTRACTIVITY AND SUSTAINABILITY

1.1. INTRODUCTION

When solving one problem, one can just as well solve a number of other problems – or create unforeseen negative consequences in other fields or dimensions. This notion is central in the discussion and methodology used in this subproject – town planning measures to reduce noise propagation from car traffic, with regard to traffic planning as well as urban design. By studying different building layouts and traffic flow patterns in a specific area – a suburban district in the north west of central Stockholm – we aim at testing and answering in which ways noise reducing measures can be linked to:

- Different car traffic flow patterns in the regional scale.
- Different road and street patterns in the local scale.
- Different systems and layouts for combining and connecting high speed and low speed streets and roads.
- Different local design and organisation of buildings and constructions.

One important research hypothesis is that improvements of the urban sound/noise quality may go hand in hand with improvements of the urban environment as a whole.

In this discussion we have taken into account present **european discussions**, proposals and projects that aim at creating a more attractive, liveable, sustainable and healthy urban environment. One example of recent policy recommendations for sustainable cities is the "Bristol Accord" decided on at the EU ministers meeting in the UK in December 2005. In the evaluation part, we have examined the relationship between what is generally thought of as a "Sustainable" city – and a "Quiet" city.

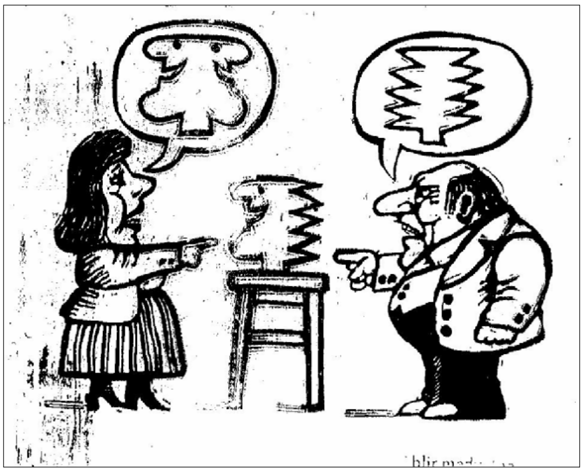

Figure 1-1. One specific design can be interpreted in many ways, depending on perspective, tools and concepts. The "good" city is defined by a multitude of actors and factors. One question in this project is how to link the broad holistic perspective with the focused perspective on sound and noise.

The testing of different urban organisations (including all aspects, from road systems to organisation of buildings) is done with the noise factor as the “bottom line”. If, for instance, two different urban designs create the same results with regard to noise/sound, the design with higher overall urban qualities is recommended. A design with higher urban qualities, but with worse sound/noise qualities, has to evaluated in a holistic way, in which short time and long time effects are compared (see Chapters 2.1, 2.5.1. 2.5.2 and 2.5.3).

In the **discussion part** of this work, on “different noise acceptance levels, related to urbanity and use” we propose however those levels of acceptable to noise could be related to the different expectations of sound quality in different situations and places. In short, in order to prevent unforeseen negative effects of noise reducing actions – sub-optimising one single aspect – a three level scheme is presented, in which some places may require “above standard” and other places “below standard” noise levels.

In the **simulation part** of this study, different factors are combined to show two principally different urban situations, based on more or less two opposite concepts for urban design and planning. The factors that differ are: car speed, number of lanes, geometry of streets/roads/junctions, differentiation of street system (structure of net), and amount and density of new buildings/constructions. This method has both advantages and disadvantages:

- It is hard to evaluate **which single action/factor** that produces which result, with regard to noise. Local effects are hard to attribute to a specific design solution, whether it might be speed, buildings, number of cars etc.
- It gives a **realistic overall view** of the performance of the two different systems - on the larger scale and including the multitude of aspects that together create the quality of an urban environment.

In order to clarify and communicate the very complex issues dealt with here, we have chosen to **illustrate** our lines of thinking with photos, diagrams and “bullet text blocks” of the following type:

- **Our basic idea**: To link noise reduction to the over all attractivity of the city.
- **The problem:** An attractive, well functioning and vital urban environment sometimes comes into conflict with questions of noise reduction.
- **The challenge:** To avoid sub-optimizing and instead present solutions that improves urban qualities in the more broad sense.
- **The question:** Is it possible to combine a denser and less car dependant urban system, without generating more noise and traffic congestion?
- **The result:** A list of building types and street designs, which both limit noise and create a better urban overall quality.

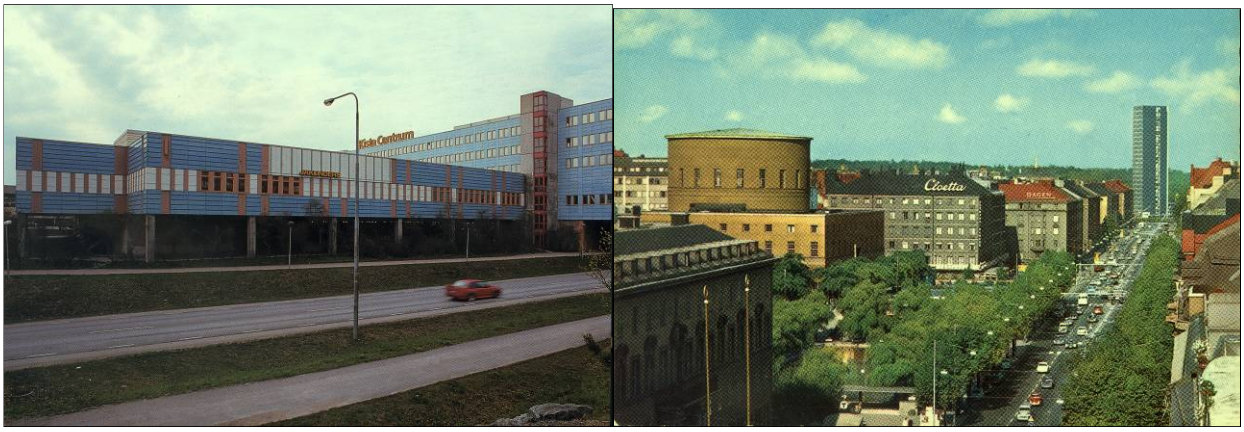

Figure 1-2. **Different soundscape related to urban qualitiy.**
Left: Testing area today, 16 000 cars, along the Hanstavägen, per day. Long distances between buildings and street. An attractive and pleasant environment?
Right: Stockholm inner city today, 44 000 cars, along the Sveavägen, per day. Buildings close to the street. A problematic and unacceptable environment?

- **How to achieve:**
  - Good preconditions for traffic flow...
  - ... and low noise disturbances...
  - ... and an attractive urban environment?

- **At first, study and influence:**
  - The need to travel by car
  - The competitiveness of public transport
  - The density/structure/functions of the city
- **Secondly, study and influence:**
  - The speed and volume of car traffic
  - Street and building patterns
  - Design of street/building/screen/surface
  - Design of car/tire/vehicle
  - Materials of street/building/vehicle/tire

1.2. DIFFERING ACCEPTANCE LEVELS FOR NOISE IN RELATION TO URBAN ENVIRONMENT

1.2.1 THE MANY ASPECTS OF "NOISE"

In urban planning, the sound quality is one among a multitude of factors that together sums up the over all attractivity and liveability of a place. The standard method of sound measurement is based upon the concept of "equivalent sound level", a logarithm mean value describing sound levels during a time period – often 24 hours of a week day (excluding week end days) and expressed in dBA. This method is best suited to describe continous noise with low variations during time – they do not describe variations during the measured time span. [1]

A rough division of sound types has to do with **time**: continuous, intermittent and impulse. The continous type is common in modern cities – the constant "sound tapestry" from a distant traffic route. In this case, the source of sound is not visible for the listener. The intemittent sound from traffic – cars, busses, lorries, passing by –is often more visually noticeable for the urban dweller. It is a question of debate and valuation whether noise disturbances of the continous or the intermittent type are harder to cope with. The impulse sound is often sudden and random. Generally, the more continous the sound is, the easier it is to accept and adopt to the level of disturbance. The time of day is also a factor with importance – high sound levels during night time are from obvious reasons harder to cope with than during day time.

Another division of sound qualities has to do with **frequency**. Generally, low frequency sound is experienced as more disturbing than high frequency sound – at the same sound level measured in dBA.

The amount of **information** contained in sound is another disputed factor. Some studies show that the information content does not influence the experience of disturbance, whilst other studies assert that sound with a high information content takes a longer time to adjust to, as compared to more "meaningless" sound[2]. The disturbance from talk is of course related to how related it is to the listeners (voluntary or involuntary listening).

A more hard to measure factor is the relation between the listener and the sound emitting **activity** – generally it is more comforting to listen to one´s own choice of music when lying sunbathing at the beach - than to the "neighbours" stereo equipment or radio... The same thing is even more obvious when sound is generated from a party in

[1] Descriptions in part from Masters Thesis at KTH: Avsteg – framsteg eller felsteg? Att planera i bullerstörda miljöer. Anna Kolm et al, 2004. (Deviations from regulations – improvement or error ? Planning in noisy environments.)

[2] Arbetarskyddsstyrelsen, 1990, Buller och bullerbekämpning, Solna. (The National Board of Occupational Safety and Health, 1990. Noise and noise control.)

an apartment house – participants appreciate the music and noise much better than not invited neighbours. This may sound like nonsence in a report on noise reducing methods in local town planning – but it is not.

1.2.2 THE CONCEPT OF "SOUND SCAPE"

In the research project "ljudlandskap för bättre hälsa" (Sound scape for better health), financed by three Swedish organisations (The Foundation for Strategic Environmental Research, the National Road Administration and Vinnova) a broader concept on sound quality is presented. Lack of noise is not seen as enough to create a health improving "silent" environment. The researchers ask for positive soud sources that can contribute to a pleasant, activating and/or soothing stay in parks and public spaces[3].

In field study, conducted in the summer of 2004, 286 visitors to four urban parks and four green field sites filled in a questionarie on the percieved sound quality, and sound level measurements were conducted. More than 80 per cent of respondents defined the sound quality as "good" or "very good" in the green field areas and an average of 60 per cent in the urban parks. In the chart below, green field sites are shown at the left top, and urban parks in the lower middle-right.

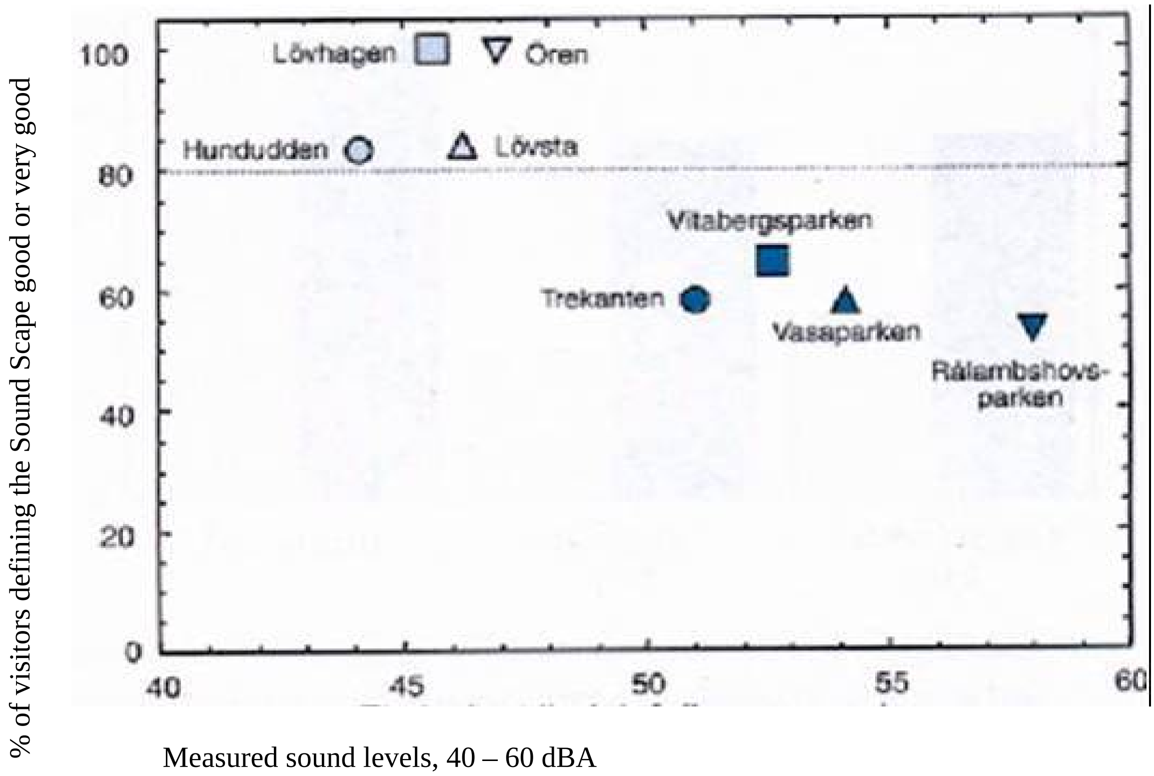

Figure 1-3. Numer of visitors(in %) in green field areas (light points, at the top) and urban parks (dark points, in the middle) that considered the sound scapes to be "good" or "very good". Measured sound levels (Laeq, 15 min) are median values of 5-7 measurements per area.

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3 Ljudlandskap för bättre hälsa, Årsrapport 2004, Mistra, Vägverket, Vinnova. (Sound Scape for better health, Annual Report, 2004)

This might not be a surprising result – natural areas out of the city are more calm and quiet, whilst urban parks are more disturbing and noicy. According to the researchers, sounds could be divided into three cathegories – natural, social, technological. The natural sounds were percieved as delightful, the social more neutral and the technological more disturbing. If the concept of “sound scape” is applied, positive sounds from water, the whistling in trees, birds song etc can not compensate for a high level of technological sound. The amount of natural sounds were about equal in the green field sites and the urban parks. The lower quality in the urban parks were attributed to the higher level of (mostly) trafic noise.

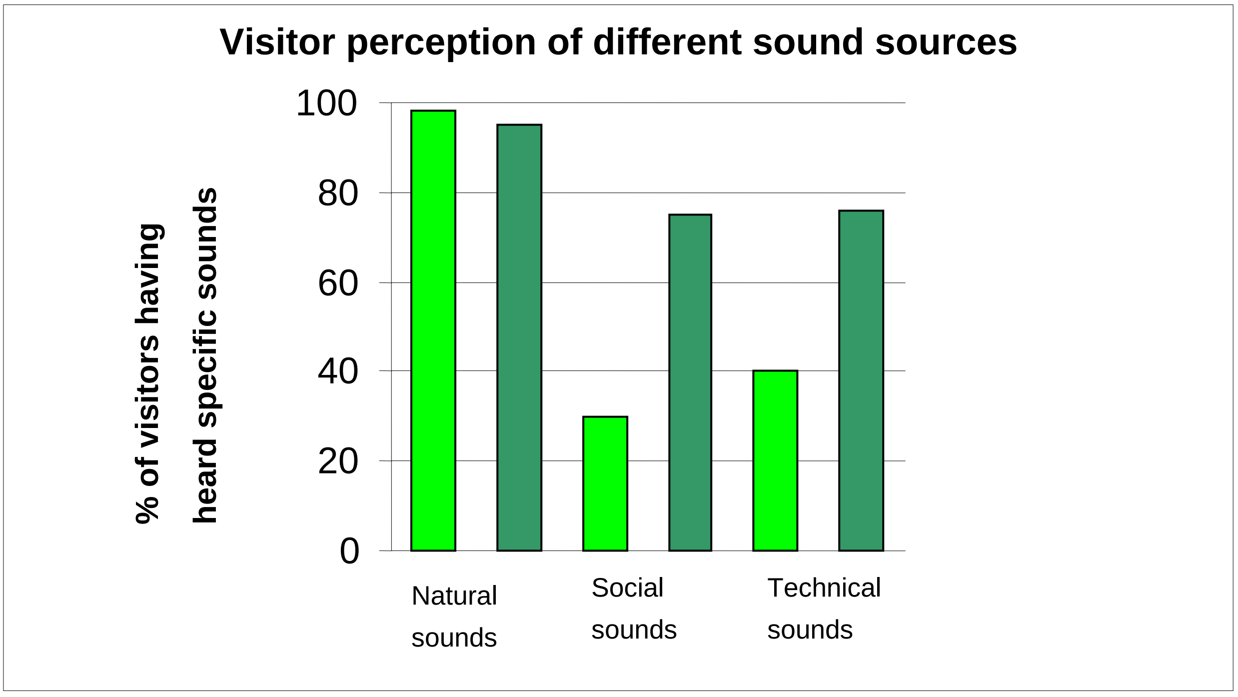

Figure 1-4. Numer of visitors (%) that have heard at least one sound source within respective sound cathegory in the four green field areas (light columns) and the four urban parks (dark columns). Note that social sounds were more noted in the four urban parks studied – and that these do not necessary have to be considered negative or disturbing.

The evalutation of the attractivity of these places were, however, only measured from the perspective of sound and noise disturbances. In the table, the amount of “social sounds” – generated by human activity, not traffic – were much higher in the urban parks. This also indicates a higher level of “social uses” and a higher level of visitors to the urban parks as compared to the gren field areas. The valuation of a “reasonable” or “good” sound level in theese two kinds of green areas, is closely linked to the activity and the pre-conceived conception of activities of the places. A higher level of sound generated by “social uses” in the urban park is not only acceptable, but maybe also an asset and something positive.

Similarly, a higher level of traffic sound/noise in the urban park, is generally not thought of as disturbing – not as much as if the same level was reached in the green field area. In a more general evaluation it would be natural to compare the quality of these two kinds of open public spaces also from other perspectives and criterias, not omitting the question of a good sound environment!

In this work, the concept of "sound scape" is used as a description of the relation between the place and the user. The task in urban planning can not be to create "quiet places", but places with a sound level and a sound picture that is percieved as positive by the general user of different urban places.

1.2.3 MATCHING THE SOUND SCAPE WITH THE PLACE

In short, to create a "good sound environment" the task could be as follows:

Match the **actvities** of the place...

... and the **design** of the place...

... with the **expectations** of the user...

1.2.4 THE WHO DEFINITIONS OF NOISE

This description of the task fits well with the definition of noise proposed by the World Health Organisation (WHO): 4

"Audible acoustic energy that adversely affects, or may affect, the physiological and psychological well being of people".

In 1999 WHO defined the following guide lines on noise, **based on health effects.** Indoor maximum level was set to 45 dBA. Outside recommended level was set to 50 dBA. Higher levels were set for industrial and shopping areas – 70 dBA equivalent level and 110 dBA maximum. For parks and recreational areas no precise levels were set:

WHO guide lines for noise levels Based on health effects		
	Equivalent level	**Maximum level**
Permanent housing		
Indoors	35 dBA	
Sleeping room	30 dBA	45 dBA
Outside	50 dBA	
Outside sleeping room	45 dBA	60 dBA
Schools, hospitals		
Class room	35 dBA	
School yard	55 dBA	
Hospital	30 dBA	40 dBA
Industry and shopping		
Industry, shopping, retail	70 dBA	110 dBA
Recreation		
Parks and recreational areas	The same as the background level in the recreational area.	

Figure 1-5. WHO, Guidelines for Community Noise.

The definitions above acknowledge **not only** the scientifically measurable levels of hazardous sound, but also the need for **higher standards** with regard to noise in, for instance, the class room at school. **Lower standards** (that is, a higher level of sound) are set and accepted for shopping areas.

Based on this, one of our hypothesis is, that noise reduction activities should always be related to the 1) activity of the place and the 2) subjectively defined "acceptance level" that differs – with regard to place and activity. The "**acceptance level**" for sound in housing could thus be set **higher** in a more dense urban setting – and **lower** in a rural setting out of town.

This line of thinking questions the logic of only one noise level for housing, as shown in the WHO table above. Especially the level set for noise outside a sleeping room – 45 dBA – could be discussed and questioned. To begin with, a high level of noise **outside** a sleeping room says nothing about the noise level **inside** the sleeping room. Secondly, it is a fact that some of the most attractive and expensive apartments in european cities – in the very city centre – have a noise level outside sleeping room windows that highly exceeds this level. And yet, theese apartments are often percieved as attractive, as theyhave a number of other characteristics than low outside noise levels. In some instances these high noise levels are closely conneced to "attractivity generating" activities, such as shopping, festivals, street music, tourism activities and the like.

This creates "two parallell bottom lines" for work with sound levels in cities:

- Limiting scientifically definable unhealthy sound disturbances.
- Adjusting sound levels to psychologically acceptable comfort levels.

1.2.5 THE BRISTOL ACCORD

In December 2005, the European Union EU Ministers stroke a deal for sustainable communities. The meeting was hosted by the Office of the Deputy Prime Minister in Bristol as part of the UK's six-month Presidency of the EU (July 1 – December 31 2005). The Bristol Accord aims at providing a new framework for EU Governments to deliver jobs, economic prosperity, social justice, and improved quality of life for Europe's 450 million citizens. The document "Creating Sustainable Communities in Europe" defined eight characteristics of a sustainable community. It is summarized in the picture below:

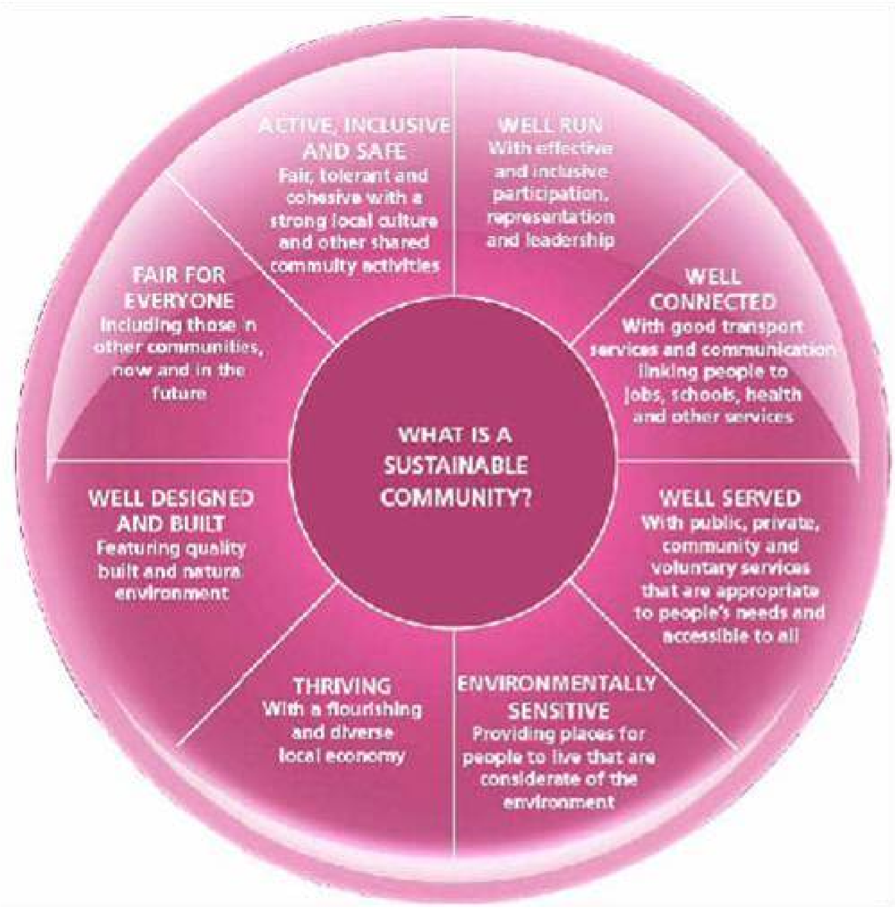

Figure 1-6. The Bristol Accord, 2005. Eight characteristics of a sustainable community.

With regard to noise generated from transportation, the sustainable community has to find a **balance point** between noise reduction measures and attractivity enhancing activities. In some cases, it is possible that a holistic approach to urban planning will create schemes in which better access with different vehicles and better preconditions for shopping and services are presented – even if this means that higher noise levels are created. Often though, technical solutions can be used to avoid “unwanted” noise related to “wanted” noise generating activities.

In the table below the eight characteristics of the Bristol Accord are presented. Below we have interpreted these with regard to the two interlinked factors – traffic and noise. The interpretations are presented as a part of a discussion to find good “balance points” betweeen different aspects of a good urban environment.

The Bristol Accord CHARACTERISTIC No 1 OF A SUSTAINABLE COMMUNITY	
ACTIVE, INCLUSIVE AND SAFE - fair, tolerant and cohesive with a strong local culture and other shared community activities	Sustainable communities offer: • a sense of community and cultural identity, and belonging • tolerance, respect and **engagement** with people from different cultures, background and beliefs • friendly, co-operative and helpful behaviour in neighbourhoods • opportunities for cultural, leisure, community, sport and other **activities**, including for children and young people • low levels of crime, drugs and antisocial behaviour with visible, effective and community-friendly policing • social **inclusion**, equality of opportunity and good life chances for all.
Our Interpretation - with regard to traffic and noise	Equal treatment of noise disturbances generated from traffic, regardless of the "social status" of the area. Easy access to leisure (etc) areas. Make sure that traffic system does not divide the city into separate "social status" areas. Low noise levels in parks, squares etc.
The Bristol Accord CHARACTERISTIC No 2 OF A SUSTAINABLE COMMUNITY	
WELL RUN - with effective and inclusive participation, representation and leadership	Sustainable communities enjoy: • representative, accountable governance systems which both facilitate strategic, **visionary leadership** and enable inclusive, active and effective participation by individuals and organisations • effective engagement with the community at **neighbourhood level**, including capacity building to develop the community's skills, knowledge and confidence • strong, informed and effective partnerships that lead by example (e.g. government, business, community) • strong, inclusive, community and voluntary sector • sense of civic values, responsibility and pride.
Our Interpretation - with regard to traffic and noise	Develop, if local inhabitants so demand, new visionary plans for neglected areas. Listen to critical voises regarding problems in the performance of present traffic systems. Cooperate closely with local citicens to reduce noise disturbances.
The Bristol Accord CHARACTERISTIC No 3 OF A SUSTAINABLE COMMUNITY	
WELL CONNECTED - with good transport services and communication linking people to jobs, schools, health and other services	Sustainable communities offer: • transport facilities, including **public transport**, that help people travel within and between communities and reduce dependence on cars • facilities to encourage **safe** local walking and cycling • an appropriate level of local **parking facilities** in line with local plans to manage road traffic demand • widely available and effective telecommunications and Internet access • good access to regional, national and international communications networks.
Our Interpretation - with regard to traffic and noise	Reduce car traffic dependancy (and with that noise levels) by better public transport. Improve parking, especially close to shopping/services. Develop more connected and integrated street networks and transport systems (bus/trains, etc)

<table>
<tr><td colspan="2">The Bristol Accord
CHARACTERISTIC No 4 OF A SUSTAINABLE COMMUNITY</td></tr>
<tr><td>WELL SERVED
- with public, private, community and voluntary services that are appropriate to people's needs and accessible to all</td><td>Sustainable communities have:
• Well-performing local schools, further and higher education institutions, and other opportunities for lifelong learning
• high quality local health care and social services, integrated where possible with other services
• high quality services for families and children (including early years child care)
• good range of affordable public, community, voluntary and private services (e.g. retail, fresh food, commercial, utilities, information and advice) which are accessible to the whole community
• service providers who think and act long-term and beyond their own immediate geographical and interest boundaries, and who involve users and local residents in shaping their policy and practice.</td></tr>
<tr><td>Our Interpretation - with regard to traffic and noise</td><td>Promote traffic systems that create good preconditions for and high accessability for establishment of local shopping and services.
Create safe and low noise areas for childrens and family life.
Follow integrated and holistic approaches in planning and design of traffic, buildings and leisure areas</td></tr>
<tr><td colspan="2">The Bristol Accord
CHARACTERISTIC No 5 OF A SUSTAINABLE COMMUNITY</td></tr>
<tr><td>ENVIRONMENT-ALLY SENSITIVE
- providing places for people to live that are considerate of the environment</td><td>Sustainable communities:
• providing places for people to live that respect the environment and use resources efficiently
• actively seek to minimise climate change, including through energy efficiency and the use of renewables
• protect the environment, by minimising pollution on land, in water and in the air
• minimise waste and dispose of it in accordance with current good practice
• make efficient use of natural resources, encouraging sustainable production and consumption • protect and improve bio-diversity (e.g. wildlife habitats)
• enable a lifestyle that minimises negative environmental impact and enhances positive impacts (e.g. by creating opportunities for walking and cycling, and reducing noise pollution and dependence on cars)
• create cleaner, safer and greener neighbourhoods (e.g. by reducing litter and graffiti, and maintaining pleasant public spaces).</td></tr>
<tr><td>Our Interpretation - with regard to traffic and noise</td><td>Reduction of traffic noise by screening techniques and reduction of total amount of vehicles.
Where applicable, conversion of high speed roads to more walking/cycling friendly streets.
Reduction of car traffic speed and, “tunneling” of necessary high volume roads.
Promote traffic patterns that allow for more dense building patterns, to facilitate public transportation and a healthy local environment.</td></tr>
</table>

The Bristol Accord CHARACTERISTIC No 6 OF A SUSTAINABLE COMMUNITY	
THRIVING - with a flourishing, diverse and innovative local economy	Sustainable communities feature: • a wide range of good quality jobs and training opportunities • sufficient **suitable land** and buildings to support economic prosperity and change • dynamic job and business creation, with benefits for the local community • a strong **business community** with links into the wider economy • economically viable and attractive **town centres**.
Our Interpretation - with regard to traffic and noise	Introduce traffic systems that gives access to under-utilized land. Apply strong noise reduction measures in public places. Create commercially attractive and easy to reach business facilities and areas.
The Bristol Accord CHARACTERISTIC No 7 OF A SUSTAINABLE COMMUNITY	
WELL DESIGNED AND BUILT - featuring quality built and natural environment	Sustainable communities offer: • sense of place - a place with a positive 'feeling' for people and local **distinctiveness** • user-friendly public and **green spaces** with facilities for everyone including children and older people • sufficient range, diversity, affordability and accessibility of housing within a balanced housing market • appropriate size, scale, density, design and layout, including **mixed-use development,** that complement the distinctive local character of the community • high quality, mixed-use, durable, flexible and adaptable buildings, using materials which minimise negative environmental impacts • buildings and public spaces which promote **health** and are designed to reduce crime and make people feel safe • buildings, facilities and services that mean they are well prepared against disasters – both natural and man-made • accessibility of jobs, key services and facilities by public transport, walking and cycling.
Our Interpretation - with regard to traffic and noise	Reduce noise by place specific and original design. Improvem silent open green spaces – by new buildings, street and landscape design. Replace “cul de sac” traffic patterns and “cars only streets” with integrated streets with mixed traffic (car/bus/walk). Promote good lighting and high visibility in streets, parks and squares. Create safe acess to buildings, squares, parks and service areas.
The Bristol Accord CHARACTERISTIC No 8 OF A SUSTAINABLE COMMUNITY	
FAIR FOR EVERYONE - including those in other communities, now and in the future	Sustainable communities: • recognise individuals' rights and responsibilities • respect the rights and aspirations of others (both neighbouring communities, and across the wider world) also to be **sustainable** • have due regard for the needs of **future generations** in current decisions and actions.
Our Interpretation - with regard to traffic and noise	Do not invest in traffic systems that presuppose a steady increase in private car use. Avoid new large scale traffic noise generating systems.

These interpretations of the Bristol Accord, with regard to traffic and noise, will be used in the evaluation of the three alternative traffic systems and noise simulations that have been produced in this report.

The comments to these more general principles on urban development can not be said to be strictly scientific or un-questionable. But they may give a hint on the over all problematic issue on how to combine noise reduction measures with a traffic planning policy that promotes as diverse goals as economic growth, accessibility to services, safety and a less energy consuming society. The "balance point" between noise reduction and efficient traffic is actually not "a" single point, but a question of deliberation and complicated adjustment to conflicting goals and values. In the "Urban Acquis" that was presented together with the Bristol Accord, the first principle is this:

"Economic competitiveness, social cohesion and environmental quality must be balanced"

1.2.6 TRANSECT BASED NOISE GUIDELINES

The comments on the Bristol Accord will be used further on, in the presentation and evaluation of the different scenarios for the testing area north west of Stockholm, where different urban layouts are presented and compared. In this section, the discussion on "varying acceptance levels" can be illustrated by a simple figure:

Acceptance levels with regard to urban types		
High	Dense/pubic places High urbanity, Production areas Rock-conserts	Champs D´Elysées, Paris Picadilly Circus, London
Suggestion:	**"Owerstep" of present standards are allowed**	
Medium	Normal urban area	Housing area Office area Village
Suggestion:	**Present noise standards are applied**	
Low	Sparce/private places Recreation, Nature	Country side Summer house area National heritage area
Suggestion:	**Stricter standards should be applied**	

Figure 1-7 PlaceRelated sound levels. Our suggestion – for further discussion!

The suggestions above can be clarified in a table combining two aspects – level of urbanity and the relation towards the sound source. A visible sound source with a more natural relation to the activity of the place could be more acceptable – compared to the sound from an activity that does not add anything to the quality of the place. The most obvious example is the rock concert – as compared to loud rock music that is delivered from a stereo system on a natural swimming area.

Level of urbanity						
	High urbanity Dense Public	Rock Concert	Football stadium	Square in City centre (walking dominated)	Square in City centre (car traffic dominated)	
		Medieval central square				Apartment in housing area
		Public park in central urban core				Public park in housing area
	Low urbanity	Apartment in central urban core				Swimming area, beach
	Sparse Private		Golf Course	Fishing area	Church in distant countryside	Summer house in the forest
		Visible Noise source Sound related to activity				Not visible sound source Sound not related to place
		Relation to sound source				

Figure 1-8. Realtionship between urbanity and sound level tolerance. Green: Higher sound levels acceptable. Red: Lower sound levels accepted.

This discussion is linked to the previous discussion on finding balance points between:

- scientifically measurable harmful noise levels – versus subjectively defined acceptable sound levels.
- noise prevention – versus other factors defining an attractive and well functioning urban structure.

1.2.7

THE TRANSECT AND IT'S APPLICATION ON NOISE LEVELS

A simple illustration of different types of urban structures, linked to street system and density is the so called "Transect", developed and presented by the US based architectural company Duany Plater-Zyberk & Company, with owners and founders Andrés Duany and Elisabeth Plater-Zyberk. The transect have been widely used in many urban and so called "New Urbanism" planning and building projects, in the US and other parts of the world. DPZ is a leading company in the movement called the New Urbanism, which seeks to replace suburban sprawl and car dependent cities with more dense, functionally integrated and walkable communities and developments.

The Transect as a tool is presented as a natural "law" that is operating everywhere in nature. [5] A section through a place or a city often follows a gradual decrease in intensity, from the center to the outskirts. It shows, when applied to the built environment, the gradual differentiation of density, population, traffic, relationship between built/unbuilt land, etc. In this work, the Transect can be used to clarify the previous discussion on acceptance levels with regard to sound/noise in urban and rural areas. Below is a transect of a traditional urban pattern.

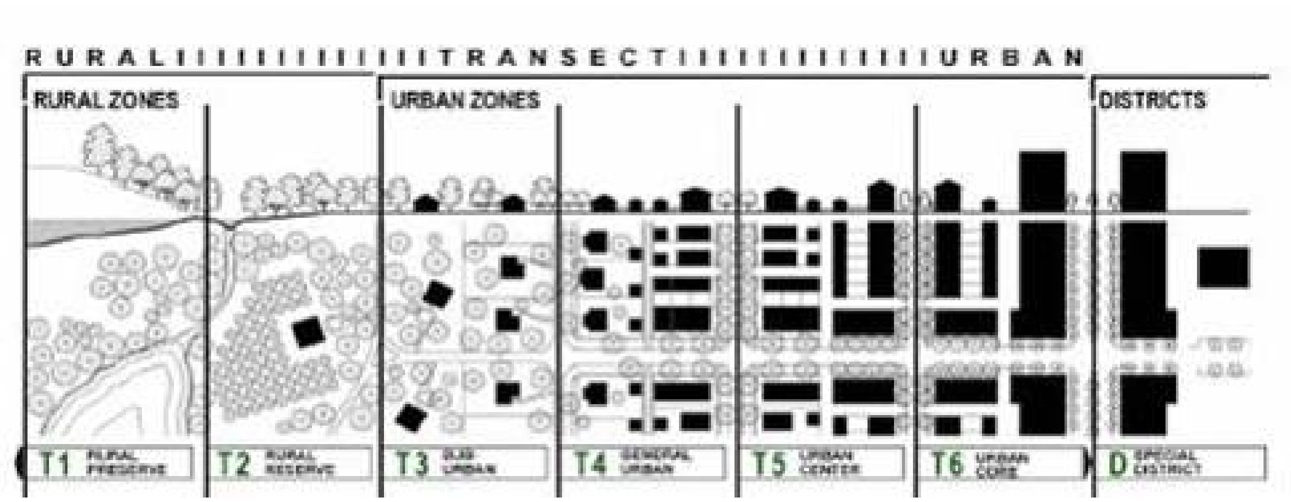

Figure 1-9. A distinct illustration of building and street pappterns on the local level has been produced by the DPZ Company,USA. This Transect shows a transport pattern which concentrates traffic flows to a central traffic flow "corridors' .

This Transect is divided in rural and urban zones as follows:

T1 – Rural Preserve
T2 – Rural Reserve
T3 – Suburban
T4 - General Urban
T5 - Urban Center

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[5] introduction to the special issue dedicated to the Transect, The Journal of Urban Design, (draft) august 26, 2002, by Andrés Duany, F.A.I.A.

T6 – Urban Core
D – Special District

A Transect of building patterns from the late 20th century, with regard to traffic pattern and building layout can be done, following the same density definitions. The world “Sprawl” that is used is a commonly used word that describes less urban and often less dense urban patterns:

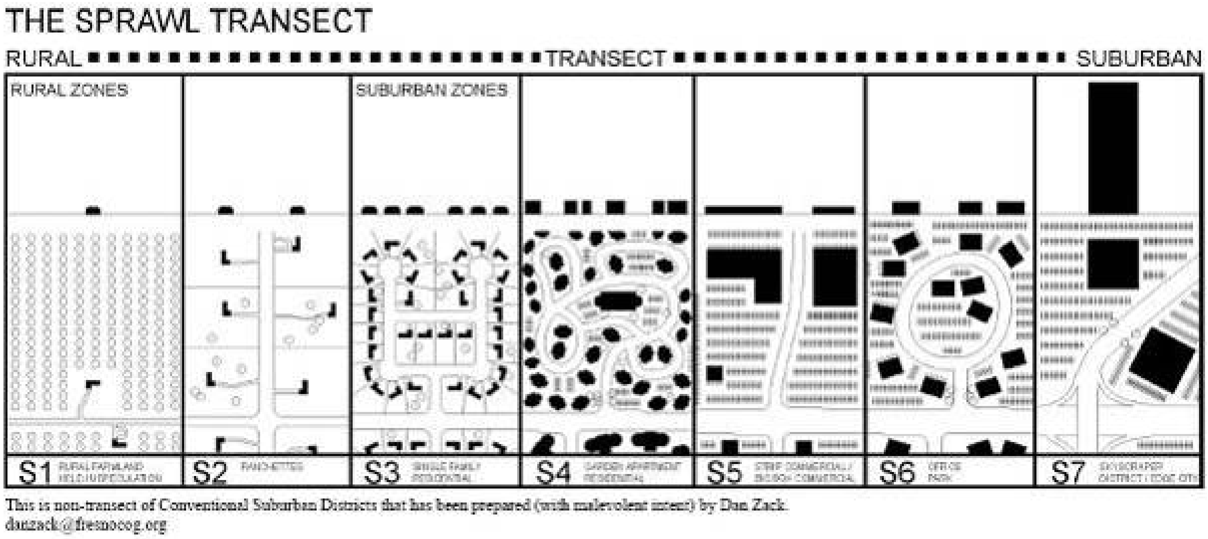


Figure 1-10. The sprawl Transect. By Dan Zack.

A clarification of the differences between these two major development types is presented in chapter 1.3 “Differing concepts for traffic planning and flows”.

With regard to noise levels, these two urban patterns may be interpreted in two very different ways:

1) **“THE SPRAWL TRANSECT IS BETTER:** Long distances between noise emitting roads and buildings give a better sound environment. Traffic flows can be handled in a very efficient way and with less conflicts between inhabitants and traffic planners. The Urban Transect, on the other hand, describes a town pattern that has devolved prior to modern high mobility societies and also creates unnessecary conflicts of interests and design solutions.”

2) **“THE URBAN TRANSECT IS BETTER:** Long distances between noise emitting roads and buildings creates a more transport intensive and energy consuming environment. It is harder to combine with high quality public transport, as one precondition for this is a rather dense urban pattern. The sprawl transect descibes a pattern of the late industrial society, before the change in work patterns, from noisy industries to more quiet office and service workplaces.”

Although the Transect is often used to promote more urban – and less “dis-urban” developments, it can be used as a neutral description tool to clarify qualities of different rural-urban types and settings. Naturally, when moving from the sparsely built rural setting, towards the more intense urban area, traffic and with that noice levels tend to increase. One interesting – and not un-debatable – question is how to define and evaluate and “permit” certain levels of noice in specific places. As has been argued here, it is hard to define a "one and only" natural sound level, even if disturbances from noise are to be fined both in the countryside and in the urban core. Some kind of correspondence between the quality of the built environment and the noise that it produces is obvious. As the next diagram shows, the factor "Diversity" changes according to different rural-urban types:

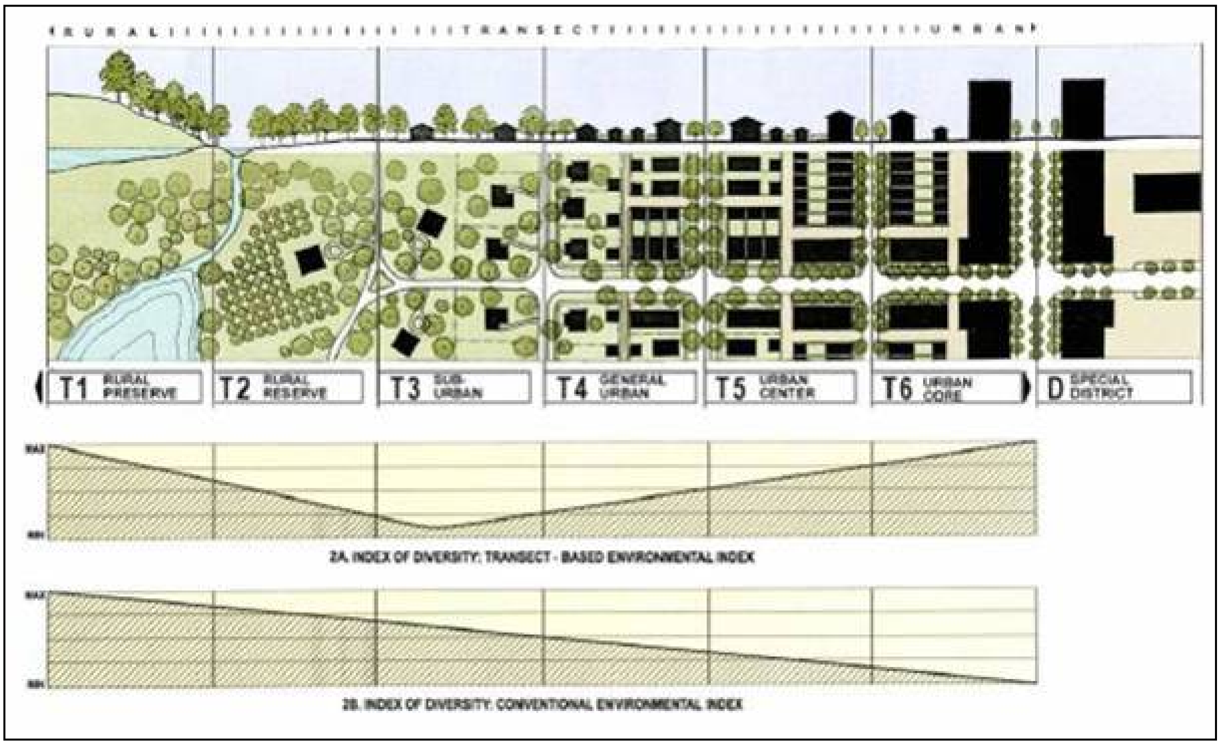


Figure 1-11. The Transect as an index of Diversity. By the DPZ Company.

The first diagram in the picture above shows high levels of diversity to the far left (natural diversity) and to the right (social diversity). The table gives the lowest points of diversity in the suburban zone. The diagram below shows a more conventional description of diversity, that only takes into account the natural diversity, thus giving higher points to the suburban than the urban environment.

The Transecot description of diversity can also be used as a model for describing different sound scapes and acceptance levels for noice. The conventional environmental index describes only biodiversity, whilst the Transect definition (see above) combines biodiversity and social diversity. Present sound acceptance levels , such as the WHO guide lines, do not take into account the setting of housing – all housing ae given the same guide line levels.

In a way similar to the discussion on diversity, it could appear natural to apply a lower acceptance of noise disturbances in more rural areas than in an urban central core. The technical and social sounds that were discussed previously in the Swedish report are of course higher in the dense urban core than in the countryside. The second diagram above could be used to illustrate naturally defined acceptence levels for noise in different urban settings:

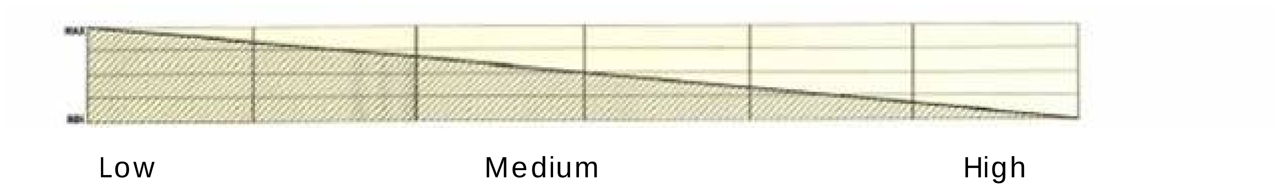


Figure 1-12. Transect based acceptance levels for noise. Our proposal – for further discussion!

Such place related acceptance levels of noise **should not** however be used as an argument for not combattning noise distrubances, wherever they appear. But they **can** be used in a discussion on priorities, cost-benefit analyses and the setting of maximum levels with regard to outdoor sound levels.

It seems reasonable to propose a more balanced view on acceptance and goals regarding noise levels – related to the over all urban/suburban situation. Based on the discussion on "acceptance levels" above, we propose that the following standards for acceptnace levels may be used. The table below is a modification of the WHO standards presented earlier. For the cathegory "D, Special District" it is hard and also inexpedient to suggest fixed levels, as theese can consist of both amusement parks, shopping areas, and recreational areas with very different characters.

Suggested Transect based noise guide lines **Based on transect based acceptance levels, compared to the WHO guide lines**									
			Suggested place related new standard						
Permanent housing		Present WHO levels	T 1 Rural Preserve	T 2 Rural Reserve	T3 Sub-urban	T4 General Urban	T 5 Urban Center	T 6 Urban Core	D Special District
Indoors	Equiv. level	**35 dBA**	**25**	**30**	**35**	**35**	**40**	**45**	**-**
	Max level	**-**							
Sleeping room	Equiv. level	**30 dBA**	**20**	**25**	**30**	**30**	**35**	**40**	**-**
	Max level	**45 dBA**	**35**	**40**	**45**	**45**	**50**	**55**	**-**
Outside	Equiv. level	**50 dBA**	**40**	**45**	**50**	**50**	**55**	**60**	**-**
	Max level	**-**							
Outside sleeping room	Equiv. level	**45 dBA**	**35**	**40**	**45**	**45**	**50**	**55**	**-**
	Max level	**60 dBA**	**50**	**55**	**60**	**60**	**65**	**70**	**-**

Figure 1-13 Suggested new acceptance levels regarding noise inside and outside of housing, related to urban type and form, based on the Transect description. Suggested changes to the WHO levels marked with colours. Green: lower noise levels sugested. Red: higher noise levels suggested.

Maximum levels are in this table set **lower** for, as an example, housing in rural preserves and reserves. Symmetrically speaking, maximum levels could be set **higher** for housing in urban centres and cores. Theese suggested new noise guide lines are applied in the evaluation section of this work, where three different traffic layouts have been simulated, with regard to traffic flows and noise.

Although it is hard to find statistical or hard core scientific proof for the assumption that it is easier to accept a high level of sound generated from car traffic along a well designed, densely built up, multi functional, densely populated and visited, people dominated urban street - as compared to an anonymous, sparsely populated, low quality, car dominated suburban thouroughfare – the discussion and the examples above do anyhow support this assumption.

Present suggested noise level: 55 dB(A)
Proposed acceptable change: +10 dB(A)
Result: maximum 65 dB(A) accepted

Present suggested noise level: 55 dB(A)
Proposed acceptable change: -10 dB(A)
Result: maximum 45 dB(A) accepted
Or improvement of urban quality!

Figure 1-14. Suggested urban quality bonus with regard to noise levels.

In short, we suggest that the **ower all urban quality** of a street environment should be taken into consideration during the evaluation of the sound quality of a street. To clarify the table above, some adjustments when it comes to disturbances from noise generated from traffic can be suggested.

A high degree of urban quality may compensate for part of the noise disturbance. A similar 'sound acceptance bonus' is in Sweden used in train traffic planning – a 60 dBA sound level emitted from passing trains are considered acceptable with regard to nearby housing developments, even if the maximum standard level is set to 55 dBA. The reason being the rather short and relatively infrequent passages of trains. This kind of 'urban quality bonus' is similarly used in the discussion on lower acceptance stadards in environments that from a psychological point of view should actually have more strict standards for accepted noise distrubances, as shown in the table above. Below we concentrate on the more dense urban situation.

An "**urban quality bonus**" may as is shown in the table below also be **negative**. In a low quality setting, it can be argued that the recommended maximum noise level should be lower than today – as compared to a high quality urban environment. For indoor environment the bonus is set lower than for the out door environment. This is to underline the possibilities to reduce noise distrurbances indoors by technical methods. This way of reasoning may give **incentives** not only to reduce noise disturbances, but also to upgrade and humanise the urban environment as a whole and to accept more dense developments along present highly trafficated routes. The suggestion here is tentative and presented for the sake of discussion. More research and investigations has to be done, before revised standards should be presented and put into action.

Note also, that this suggestion should be viewed as **the first step in a more strategic planning**, which aims at reducing traffic noise by in fact "eliminating" not only the **source** of traffic noise (that is, motorised vehicles for private transport) but more basically, the **need** for private car transport in urbanised areas.

By accepting, during a transitional time period, somewhat higher noise levels along densely built up arterial streets, it seems possible to create the preconditions for a strategic shift in transport needs and techniques – from the private car to public transport – and as a by product, from motorised long distance travel for everyday errands and needs to more walkable friendly urban areas. This possible shift is best explained by an illustration. This strategic choise is further discussed in the evaluation part of this reportof, in which three spatially different urban layouts are compared and analysed – with respect to noise and urban quality. See further **Chapter 2.1.3** and evaluations in **Chapter 2.5.2** and **2.5.3**.

Figure 1-15. . Before and after. Pictures courtesy of www.urban-advantage.com.

This suggested "Urban Quality Bonus" – can be expressed and further defined in a table. This is done with the knowledge that the definiton of "high" or "low" urban qualities is hard to measure exactly.

Suggested Urban Quality Bonus - with regard to noise levels												
Applied to housing close to high and low quality urban streets												
X dBA higher than normal maximum levels accepted in respective urban area												
				Suggested urban quality bonus								
Permanent housing		WHO standard levels		T 4 General Urban			T 5 Urban Center			T 6 Urban Core		
				Urban Quality			**Urban Quality**			**Urban Quality**		
				Low	Medium	High	Low	Medium	High	Low	Medium	High
Indoors	Equiv. level	35 dBA		-5	0	0	-5	0	+ 5	0	+ 5	+ 10
	Max level	-										
Sleeping room	Equiv. level	30 dBA		-5	0	0	-5	0	+ 5	0	+ 5	+ 10
	Max level	45 dBA		-5	0	0	-5	0	+ 5	0	+ 5	+ 10
Outside	Equiv. level	50 dBA		- 5	0	+ 5	- 5	+ 5	+ 10	- 5	+ 10	+ 15
	Max level	-										
Outside sleeping room	Equiv. level	45 dBA		- 5	0	+ 5	- 5	+ 5	+ 10	- 5	+ 10	+ 15
	Max level	60 dBA		- 5	0	+ 5	- 5	+ 5	+ 10	- 5	+ 10	+ 15

Figure 1-16. . Suggested urban quality bonus - with regard to noise levels. Our suggestion – for further discussion!

In the evaluation of the two alternative traffic system layouts in the testing area, alterantive 1 and 2, a map is shown that takes the urban quality in account. Alternative 1, the official traffic plan, has low urban qualities as it is designed merely as a transport road with little connection to the surrounding landscape and buildings.

Alternative 2 has a more urban streetscape, with sidewalks, planted trees, publicly accessible premises in the bottom floors of new buildings. The traffic flow in this alternative is organised to allow for turnoffs and stopping along the street – and does also concentrate the more distant traffic in two + two fast lanes in the middle of the street.

From this starting point, it is shown in two maps, which buildings that have an unacceptable high disturbance from the traffic – in both alternative layouts. A possible third map is also possible to produce for the areas of high disturbances if this kind of ”urban quality bonus” is applied. Note that we present theese suggestions for further discussion on strategic traffic and urban planning - and not for immediate application. Linking short time and long time actions to reduce traffic noise has always to acknowledge the underlying reasons for noise producing traffic – the high level of car traffic as both a general health and energy and economic problem.

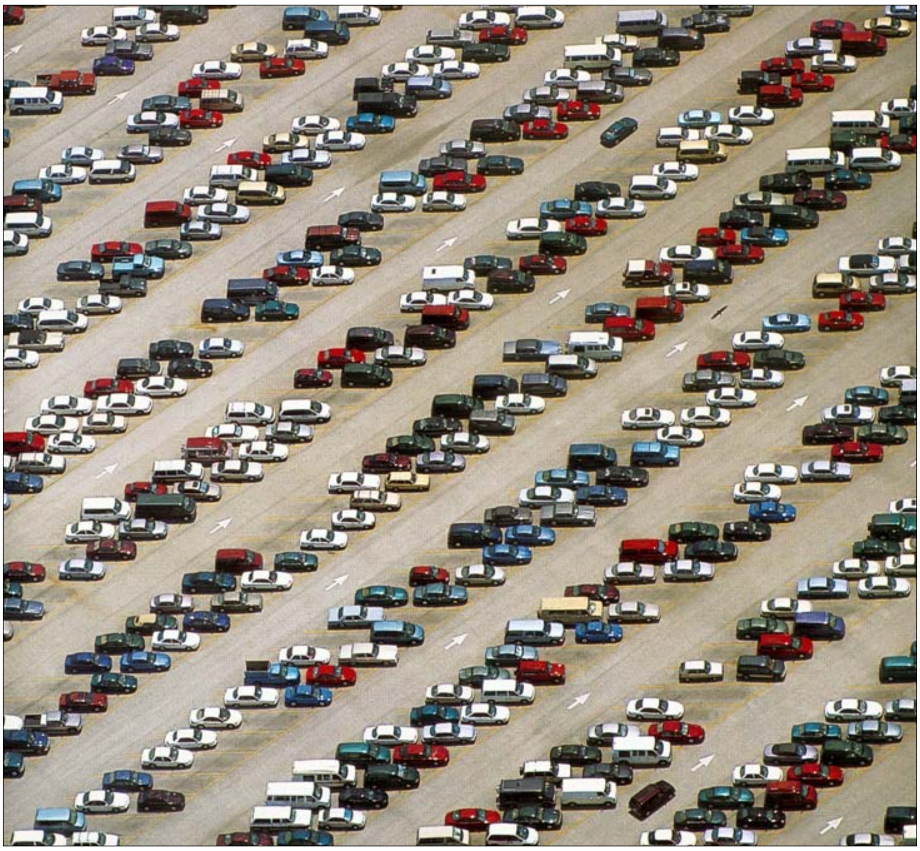


Figure 1-17. The main noise source in modern cities. Picture collected by Tigran Haas, div of Urban Studies, KTH.

1.3. DIFFERING CONCEPTS FOR TRAFFIC PLANNING AND FLOWS

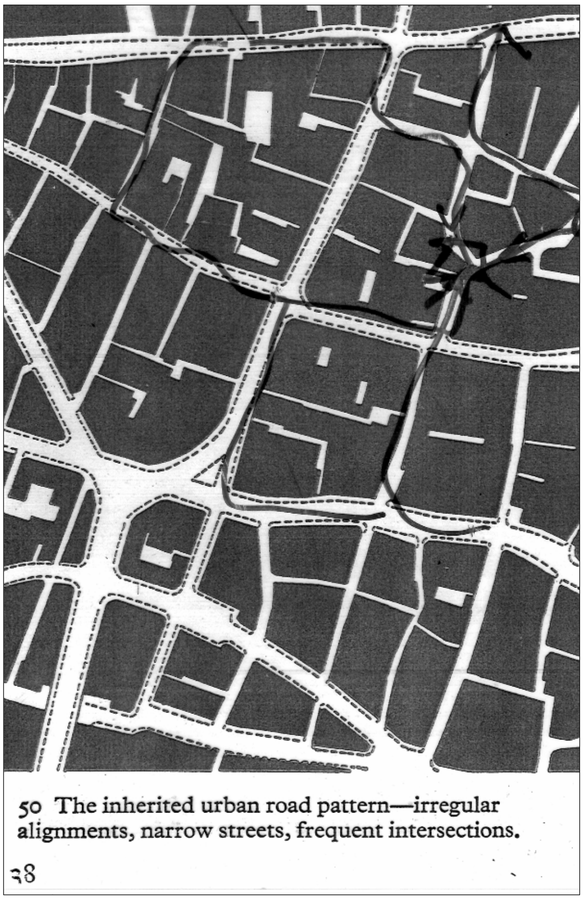
The motorised car could be said to be the single most important factor affecting the preconditions for urban development - at least since the invention of the wheel itself. In the time after the Second World War, increased mobility has, as a side effect, increased the amount of disturbances from traffic generated noise. Most planning initiatives and solutions on the subject of urban mobility have focused on traffic speed, traffic flow and on traffic safety. The issue of traffic noise has not until more recently been regarded as an important factor. In the following we will discuss some basic concepts in modern urban planning – with focus on noise effects..

In general, two clearly identifiable systems for traffic planning and traffic flows have been utilised during the 20th century in (predominantly) the western world. In large part, planning standards and methods shifted after the Second World War. The previous interconnected street system, with a number of parallel routes and frequent crossings, was replaced by a more hierarchical street and road system, designed to adapt better to the increase of car traffic and car ownership. The basic idea was to differentiate both transport systems according to type of traffic and speed, and building areas according to function and density.

Figure 1-18. The contemporary city. Low density, high speed, high noise, car dominated.

One of the more important planning guide lines from the post war period, is the report "Traffic in Towns" published in the UK in 1963. In this report, new traffic structures as well as new concepts for urban planning were presented. In short, the city – from the block scale to the regional scale – was divided in different areas according to the amount of cars (flow) and the speed of cars. The previous street system with its typical grid structure was replaced with the differentiated street system.

A main motive for this change of urban pattern was to achieve a better flow of vehicles, with higher speeds for long distance travels and to avoid the congestion that the increased car traffic generated in the older, traditional cities. A second motive was to increase traffic safety in populated areas, with less through traffic and slower speed in housing areas. Two diagrams from the report illustrate this change. To the left the old street system, to the right the new proposed.



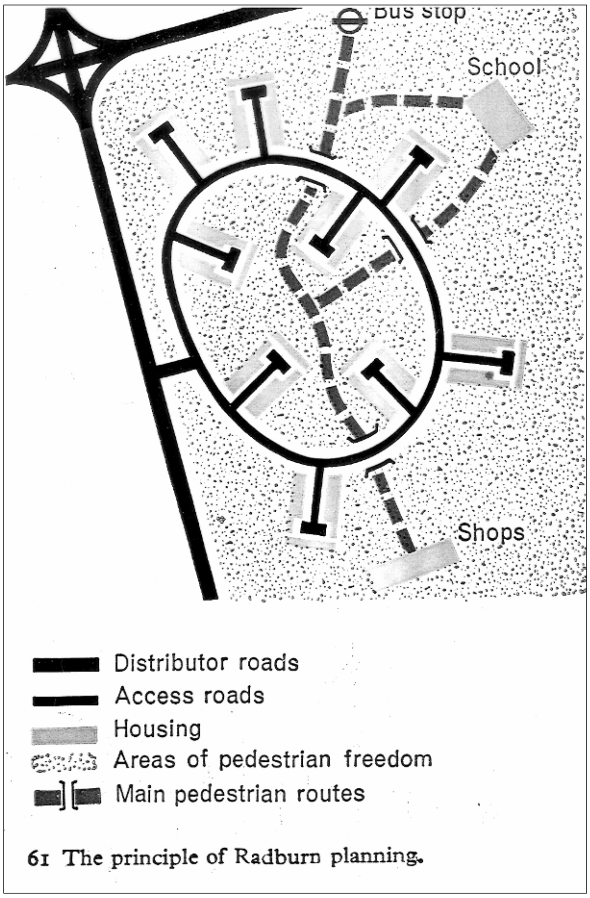


Figure 1-19. Traffic in towns: A study of the long term problems of traffic in urban areas (London, 1963).

From a noise perspective, the effects of this change in planning principles could be said to be both positive and negative. On a general level this system, adopted and designed for motorised street vehicles, gave a strong competitive advantage for the car – and disadvantage for other means of movement (train, cycling, walking). The high speeds that the distributor roads made possible has increased tremendously the general background noise levels in urban areas. On the other hand, within the neighbourhood areas with no through traffic, noise levels have been reduced.

Two simplified noise maps may clarify the old and new traffic patterns, with regard to noise levels. High noise areas marked with red, low noise areas marked with green.

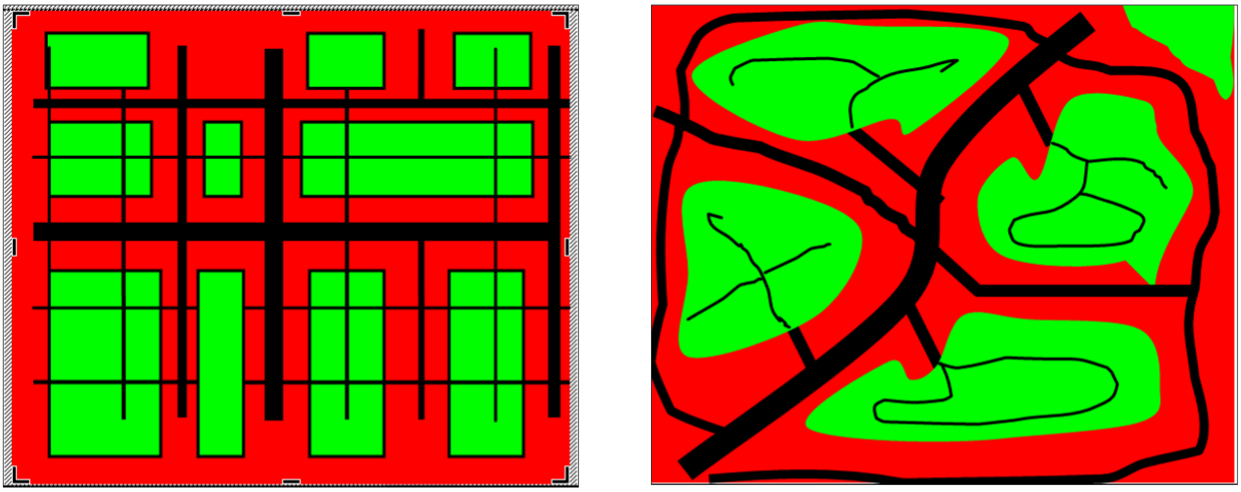


Figure 1-20. Noise effects of two traffic patterns. Diagram by A J Soderlind. Red – high noise, green – low noise. Width of lines show traffic flow intensity.

Urban areas planned and built in the post second war period are often surrounded by high capacity –and by that high noise -distributor roads. Noise levels in cities have generally increased as a result of this planning model – as noise from traffic is a result of the combination of flow (number of cars) and speed. The simple relationship is expressed in the table below.

Flow, cars per hour:	Sound levels from car traffic as a function of flow and speed. dB(A)				
1000 c/h	**66 dB(A)**	68	72	74	76
500 c/h	63	65	69	71	73
250 c/h	60	62	66	68	70
100 c/h	56	58	62	64	**66 dB(A)**
Speed, km per hour:	30 km/h	50 km/h	70 km/h	90 km/h	110 km/h

Figure 1-21. Sound levels as a function of flow and speed. Diagram by Acoustic Control.

As can be seen above, 100 cars per hour travelling in 110 km/h create the same sound level as 1000 cars per hour travelling in 30 km/h (**66 dB(A)**). See table above! It is, in this example, just as efficient to reduce the number of cars with 90 % as to reduce the speed of cars with 27 %. In practical town planning it seems easier to reduce noise from car traffic by reducing speed, rather than limiting the number of cars.

The general conclusion on combating noise disturbances from car traffic therefore is to create an urban pattern that generally:

1) Reduces **car speed.**

2) Reduces **number of cars**.

The strategy can thus be divided in two parts:

1) **in the short** run – reduce car speed on the street (combined with noise screens, new surface materials, tunnels etc)

2) **in the long run** – reduce number of cars on the street (by more public transport, higher density, dispersal of traffic to many different routes etc)

These questions have been further explored in the European Union project "ARTISTS", Arterial Streets Toward Sustainability[6]. The basic goal of this research project is to classify main streets with regard to functions and users and to explore different possible choices in the design of main streets – to create a both efficient traffic structure and a more liveable and attractive urban environment. In one project report, Stephen Marshall, University of Westminster (UK) summarises general attributes of the Sustainable Arterial Street in the following table:

Street	Arterial Street	Sustainable Arterial Street
Urban character All-purpose transport role (all modes, and giving access to land uses and buildings) public space/uses Other associations (history,identity)	Multi-functional Transport role (connecting different parts of the city) Acess (to side streets and/or land uses Urban role	Use of sustainable modes Attractive and safe place to walk and cycle Market place Public space (accessible to all) Quality of life

Figure 1-22. The two important functions of a street. From Marshall, 2004.

Marshall also gives a general description of the two spatially distinct aspects or roles of streets. The first function is the one promoted in post-war traffic planning:

- The **Arterial** role, stressing the movement function (circulation, traffic flow) and the strategic function (connecting beyond immediate locality, network).
- The **Locale** role, stressing the streets role as an urban space or place, for non-through (local) activity and urban (neighbourhood) role.

These two different aspects are specified in a table in the same report:

Arterial	Locale
Movement	Access
Circulation	Occupation
Passage	Place
Street as Link	Street as Destination
Transport-related (Transport planning, traffic engineering, etc.)	Urban-related (Urban planning, urban design, etc.)
Flow (Vehicles/People)	People Activity/Land Use
'Through' Users	'Locale' Users

[6] ARTISTS, Arterial streets Towards Sustainability, D1.1, A First theoretical approach to Classification of Arterial Streets, Stephen Marshall, University of Westminster. July 2002. European Commission Fifth Framework Programme. Key Action: City of Tomorrow and Cultural Heritage.

This classification clarifies the conflicts between **short term** and **long term** measures to reduce traffic noise by local town planning. To reduce noise from car traffic, it is very probable that the more dense and mixed city - in the long run - is the best model to provide for both lower car speed and lower number of cars (including attractive public transport which generates less noise, f expressed as “noise production” per person per distance travelled). The problem arises in the very short perspective – in which it is logical to increase distances between streets and buildings to avoid noise disturbances in the buildings themselves.

This conflict can be illustrated by describing the relationship between the level of “car generated noise” and the urban pattern and its short and long term effects. To simplify, the urban pattern generally affects noise levels on three levels:

1) The **primary** effect – related to distances between buildings and street/cars.
2) The **secondary** effect – related to vehicle speed and flow
3) The **generative** effect – related to density and other modes of transportation.

This relationship can be described with an example from Berlin:

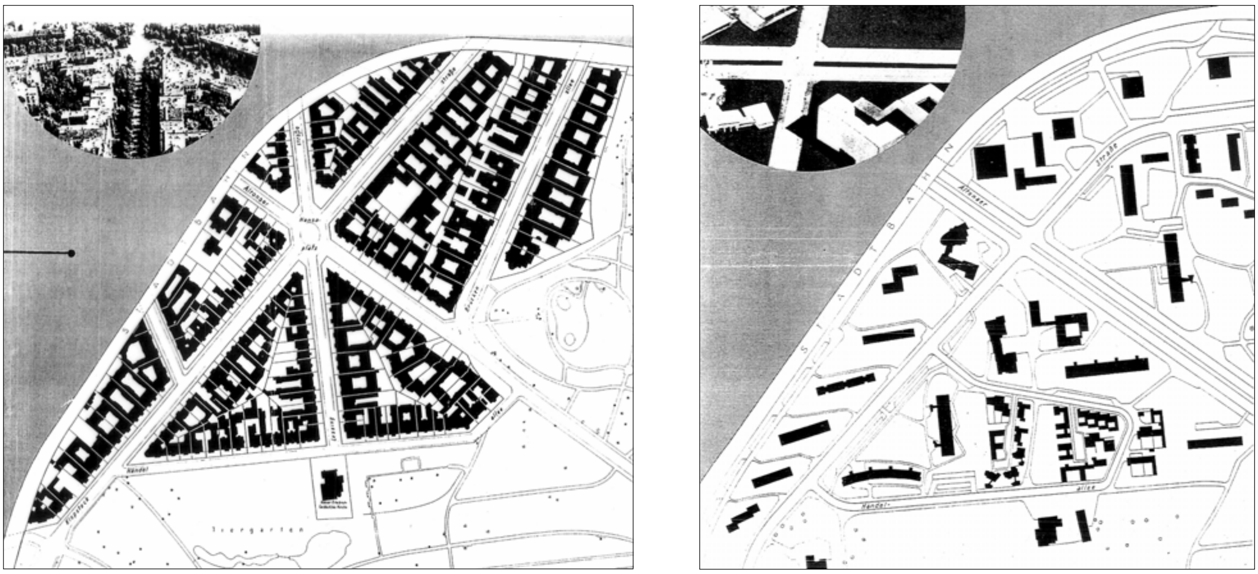


Figure 1-23. The historic and the new Hansaviertel in Berlin.

Left: the historic urban pattern with narrow streets, many intersections, low speeds, buildings close to streets.

Right: the post-war urban pattern with few and differentiated streets, few intersections, higher speeds.

The **historic pattern** of the Hansaviertel has the following noise effects:

1) Primary: The dense building pattern with short distances between noise producing vehicles and buildings, create high noise levels in the street, at facades and in buildings. The primary effect of this pattern is generally noise negative, and the natural conclusion from a noise perspective would be to move buildings further from the street or build noise screens.

2) Secondary: The narrow streets with frequent intersections and sharp corners make it generally hard to travel at high speed. Often this pattern also creates congestion, limiting the possible speed further. On this level, the historic pattern counteracts the primary effect, as slow speed also means lower noise levels.

3) Generative: The dense pattern with a high floor/space ratio generally creates a city that is possible to support with public transportation, and shorter distances between different functions (high density = low geographical spreading). On this level, the historic pattern also counteracts the primary "high noise" effect.

The **new pattern** of the Hansaviertel has the following noise effects:

1) Primary: The less dense building pattern with longer distances between noise producing vehicles and buildings, create high noise levels in the street but low levels at facades and in buildings. The division into arterial and locale streets also lower the noise levels close to buildings. The primary noise effect of this pattern is generally positive. This pattern is also more easy to combine with noise screens along arterial streets, as there is plenty of room for this between buildings and streets.

2) Secondary: The broad and straight streets with few intersections and clear vistas at corners (without buildings that obstruct the view) makes it generally more easy to travel at high speed. The few intersections further limits congestion and increasing possible speed further. On this level, the new pattern counteracts the primary effect, as high speed also means high noise levels.

3) Generative: The sparsely built-up pattern with a low floor/space ratio generally creates a city that is hard to support with public transportation, and longer distances between different functions (low density = high geographical spreading). The building of noise screens along major arterial streets and planning for traffic reduction on locale streets may even reinforce this urban pattern further, with higher speeds and lower density as two effects. On this level, the new pattern also counteracts the primary "low noise" effect.

This "**unforeseen noise effect**" of the post-war traffic system creates a situation with two parallel and directly conflicting strategies in noise reduction planning. Is there a combination strategy, in which both short-time and long-time effects can be made to harmonise? In a follow-up article on the EU Artists project, Stephen Marshall suggests a way of combining neo-traditional urbanism (the "historic" pattern in the example above) and transport connectivity (the "new" pattern in the example above) in an integrated street-based code for street design.

Marshall makes the following analysis of the modernist urban pattern, best summarized with the "car fractal" diagram shown in the report "Traffic in Towns". The fundamental spatial structure of the post-war urban layout is shown in a diagram with a nested hierarchy of distributor roads, framing areas for development (housing, workplaces, shopping, schools etc). From a sound perspective, the difference between the historic and the new pattern is obvious.

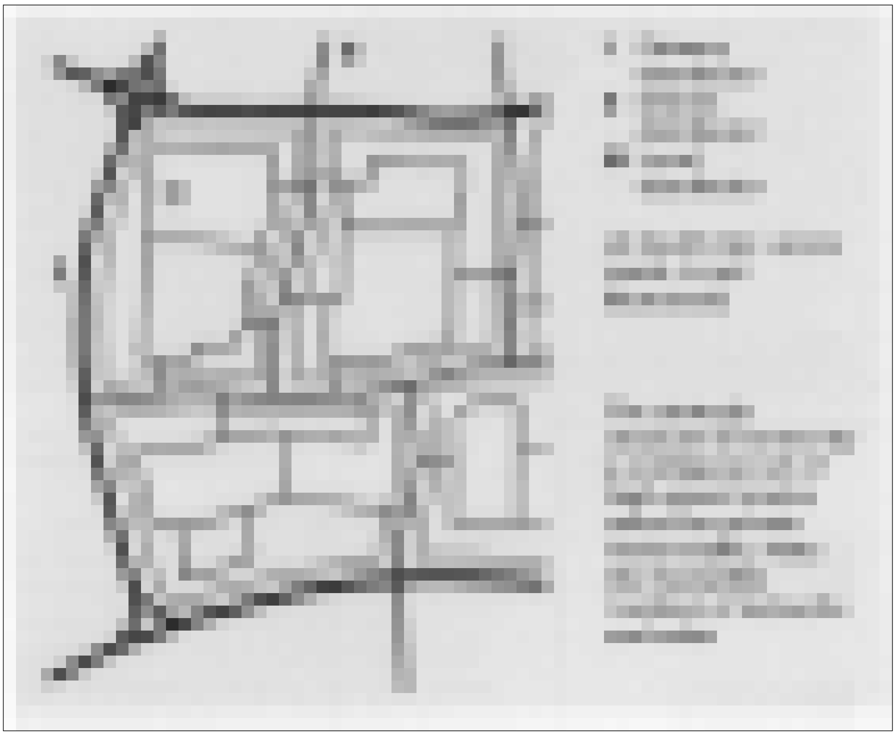


Figure 1-24. Car fractal diagram from the report "traffic in Towns", 1963, also known as the Buchanan report.

Figure 1-25. The conventional post-war suburban layout with a superstructure of high-speed distributor roads. These also produces the everyplace present "noise carpet" that charaterises most modern cities.

The fluctuating street noise from visible sources in the cramped historic street has been replaced by the uniform humming of traffic from invisible highways in almost every place. Marshall suggests that the modernist system of distributor roads should be replaced by a wider mix of routes suitable for both buildings and traffic, with a higher degree of mix of different modes of transportation. A more urban transport route could be designed to accommodate both cars and busses, cycling and walking, with more of the historic frontage development – buildings allowed close to and connecting directly to all kinds of roads. More connective street grids should be tested, as an alternative to the modernist way of separating the arterial and the locale function of streets.

In such a work, the noise factor may put a limit to the level of integration of the city's buildings/locale function and streets/arterial function. It may also create conflicts between desired goals in the short and in the long run. In the following, we will examine these questions further.

Summary:

- A basic conflict in post-war urban planning:
  - 1) Efficient traffic speed/flow/safety
  - 2) Negative noise effects
- The division of street system – building system
  - According to Traffic in Towns, 1963
- Creates two basically different street systems:
  - 1) with Arterial function (passers by)
  - 2) with Locale function (staying, being)

Challenge:

- Design strategies combining:
  - 1) Short term, local level - low car traffic noise
  - 2) Long term, regional level – low car traffic dependency

1.4. TOOL KIT FOR EVALUATION OF NOISE EFFECTS IN A BROADER PERSPECTIVE

1.4.1 MEASURING SUSTAINABILITY

To be able to evaluate – and communicate – the possible balance point between different urban aspects, a simple figure, similar to the Bristol Accord diagram, can be used. An urban environment can be analysed and discussed from the following four basic perspectives: traffic/infrastructure, economic activity, social interaction, ecological sustainability.

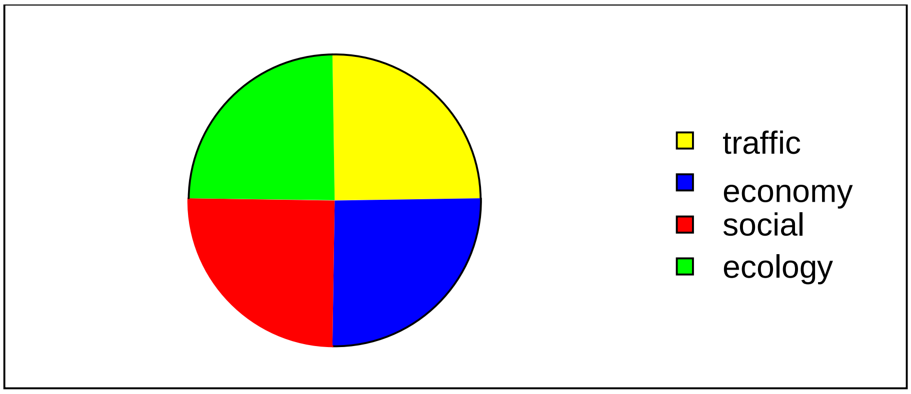


Figure 1-26. Schematic diagram of urban aspects.

This simple diagram has been used in a number of planning practises and urban workshops in Sweden. The following description of working with a "Value Rose" has been adopted from the planning book "Mission Possible". The book describes the process and the results from a number of local workshops, conducted in nine municipalities in the county of Sörmland. The project was financed by the County Administration, with the aim of inspiring to more humane, historically connected and space specific developments in the area south of Swedens capital, Stockholm[7]

1.4.2 THE VALUE ROSE

It is easy to randomly, without a plan, suggest buildings close to attractive places. To combine attractiveness with sustainability is harder – but not impossible. In order to do this it is practical to work with a "Value Rose". It consists of a circle with four different sections, describing sustainability from four different aspects. **Social sustainability** deals

[7] Det är möjligt ! Inspirationsbok för attraktiv och hållbar samhällsutvbeckling. Länsstyrelsen i Södermanlands Län, 2004. (Eng : « Mission Possible » Inspirational Handbook for designing attractive and sustainable communities, County Administration of Södermanland). Project Team: Anders J Soderlind (project leader) Johan Ohlsson (editor), Peer-Ove Skånes, Torbjörn Einarsson of Arken Architects, Håkan Jersenius of Småstaden Architects, Krister Sernbo of Ekologigruppen Planners, et al, (plans, illustrations, workshops, texts).

with the supporting and human capacity of a place - places for meetings, cultural entrenchment and social engagement.

Ecological sustainability deals with the supporting capacity of a place with regard to green thoroughfares, recycling in the production/consumption cycle and how much one has to travel to keep up with daily life.

Technical/traffic and **economical sustainability** deals with the supporting capacity of a place with regard to transport patterns and economic investments, retail, prifitability and job creation etc.. A plan for a part of a city or an entire urban district can be tested with the Value Rose. If it is easy to open up a shop (good location on a street, easy to find parking places, reasonable rent, closeness to potential customers) you put a dot far out on the circle on that aspect. If it is very difficult, you put the dot closer to the centre of the circle. Continue the evaluation with other questions. Then link together all dots with a line. Colour the area inside the line. The bigger the covered space, the more "the leaves of the rose" will unfold, the higher the supporting capacity. The concept of sustainability is like a chair - add more legs and stability will increase.

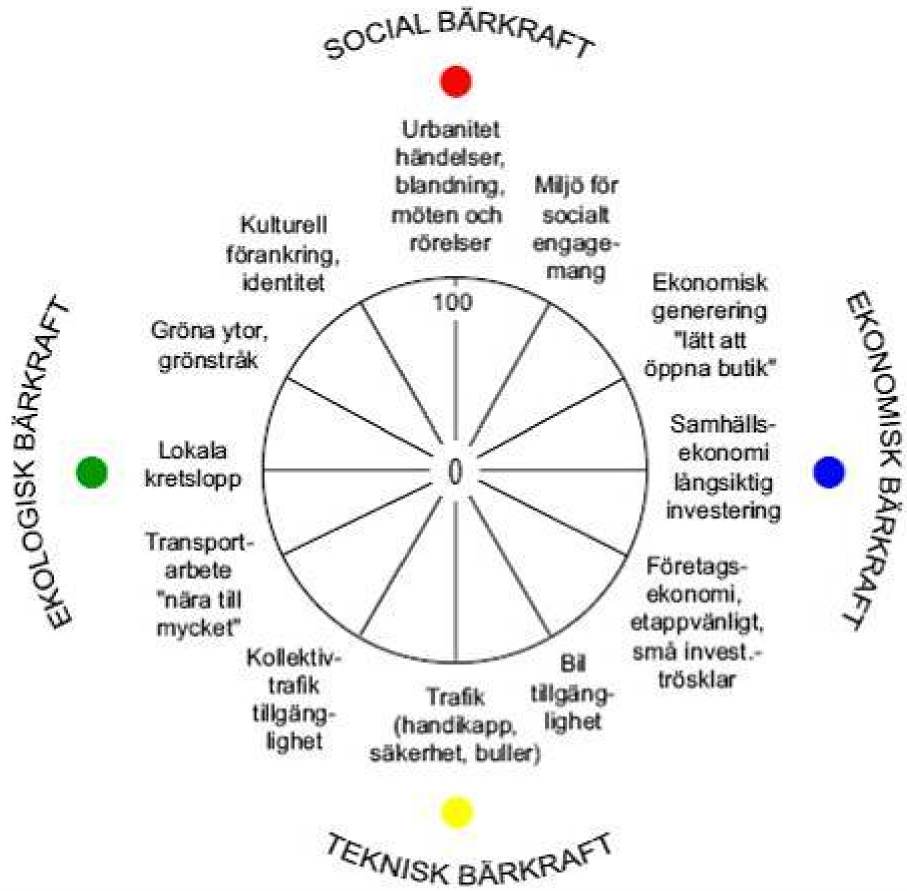


Figure 1-27. Swedish Value Rose. Copyright Arken Architects and Ekologigruppen Planners.

The Value Rose shows yet another thing. Planning is multifaceted. The entire picture is important. A city that only gets high values in some areas is hardly functional. Not in the short or the long term. This goes for a region as well.

There are many traps in designing for sustainability. The most dangerous is to focus on the specific, so that the entire picture is lost. There are reasons to discuss energy consumption, transport solutions, green structures and recycling. But if these discussions make us forget issues like social, business or cultural life, then we risk to step into the trap of sub-optimising., and the holistic idea of “sustainability” is lost.

People create sustainability. There is a need for new technical solutions but societies will never be sustainable without the single individual’s participation. Ever since the Swedish National Environment Protection Board started their campaign “Shop environmental friendly” in the beginning of the 1990´s it is obvious that peoples lifestyles affect a substantial part for of sustainability. We choose detergent, light bulbs, batteries, food and choose if to drive a car or use public transport. Planners neither want nor can decide over people’s lifestyles. But they can make sustainable lifestyles a possible choice.

The Value Rose is built on an analysis of important indicators for sustainability – or supporting capacity. The choice of indicators can be adjusted after need, some indicators are measurable (as health and noise) – others can only be judged through a value (as security). Therefore the Value Rose can never give a completely objective image, but it can clarify differences in sustainability between different planning proposals or traffic solutions – and also inform the traffic planner on consequences with regard to noise in practical planning. The supporting capacities can be described as follows:

Ecological sustainability

The ecological supporting capacity describes the ecological systems ability to survive, to maintain its biological diversity and produce. The ecological supporting capacity also entails other possibilities - to fair access of food, water and other natural resources. This capacity could to a big extent be judged on scientific grounds and measured scientifically. Important indicators are biological diversity, energy effective transports, energy systems and recycling of material goods.

Social sustainability

The social supporting capacity is concerned with prerequisites for people to meet and interact. Diversity is important: the diversity of age groups, cultures and people with different experiences. Other positive factors are good meeting places, safety, a good sound environment, clear social/real estate boundaries, places for local activities, a mix of functions, access to relaxing parks and nature. In the social sustainability perspective the possibilities to live both family and professional life is incorporated. Indicators are amongst others meeting places, local identity, security, a mix of citizens and access to recreational green structures. Even in this short description, the tight link between the ecological and the social perspective is obvious.

ECONOMICAL SUSTAINABILITY

This is to a large extent connected to the urban district's ability to generate a business life with activities and commercial service. Local business life contributes to neighbourhood activities that bring local commercial service. This requires an attractive, "business tempting" environment with a certain amount of traffic thoroughfare of people – that is, enough number of customers and/or visitors to local facilities. Economic diversity is often more sustainable than economic monopolies. This requires a diversity of prerequisites, a supply of different establishment surfaces and premises. Other aspects are the long-term social economy and the project economy/risk level of private building initiatives. Indicators are attractiveness, multiplicity of premises, thoroughfares and availability and investment thresholds.

PHYSICAL/TRAFFIC SUSTAINABILITY

This aspect deals with safety, health, noise, air pollution etc. It also deals with the support of food and water and as well as heating and electricity. Convenience and accessibility are important parts. Indicators are amongst others noise levels, air pollution, traffic safety, access for physically disabled, car and public transport accessibility. Also here, the overlapping or interaction between perspectives is clear – a well functioning traffic structure with close connections and easy access to a place, may improve both the ecological sustainability (short distances reduces fuel consumption), economic sustainability (good access is positive for business) and the social sustainability (places that are easy to go to and with a businesses and services tend to become social meeting places as well).

1.4.3 A HOLISTIC APPROACH TO NOISE, TRAFFIC AND ATTRACTIVITY

This way of reasoning is also applicable to the subject of this report – the reduction of noise disturbances in urban areas with regard to local town planning. To make the Value Rose more operative the four sustainability perspectives are here divided into three aspects each. This is an adaption of the Value Rose used in other projects – in which the perspective of Traffic takes the entire place of "Physical Sustainability" above. Note that the sound quality of an urban environment in this value rose only accounts for one third of the traffic aspects. In the same time the aspect of traffic is strongly linked to the social and the economic sustainability.

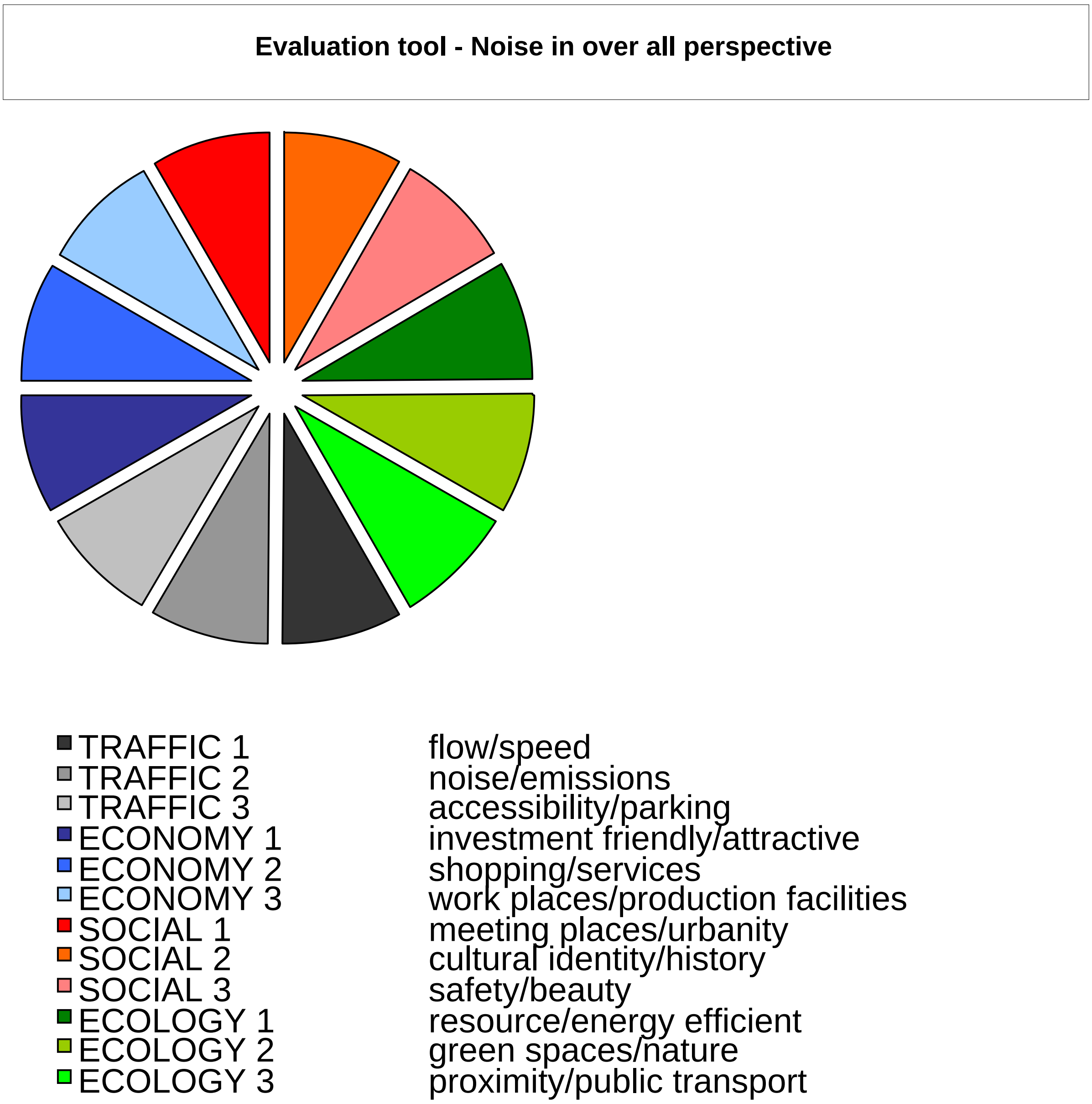


Figure 1-28. Value Rose for evaluation of different urban aspects, including traffic generated noise.

The same kind of comparison can be made, less illustrative but more specific, by using a simple table in which costs and benefits of different alternative urban layouts are compared. In the table below, costs and benefits in the twelve chosen aspects can be discussed – in words or by using numbers – to get a more holistic evaluation of a project. The Value Rose Table and the Value Rose are two illustrations of the same concept. For more detailed evaluations, it is possible to compare costs and benefits of each and every aspect, before making a general judgment. For instance, if a plan suggests a change in traffic structure, the cost and the benefit of this proposal can be compared before the result is given a specific value.

Value Rose Table				
Perspective	Aspects	Costs, negative effects	Benefits, Positive effects	Tentative Result
Traffic	Flow/speed			
	Noice			
	Access/parking			
Economy	Investment friendly			
	Shopping Services			
	Work place, Production			
Social	Meeting place, Urbanity			
	Cultural, Identiy			
	Safety			
Ecology	Resource efficient			
	Green spaces			
	Low transport/distribution needs			

Figure 1-29. Suggested Value Rose Table, for comparison of urban plans and proposals.

In the simulation part of this report, the present situation in the test area in northern Stockholm is compared with to alternative layouts and the results evaluated with the Value Rose and the Value Rose Table.

1.5. BUILDING TYPOLOGIES AND REDUCTION OF NOISE

1.5.1 NOISE BARRIERS AND TOWN PLANNING MEASURES - SOME SWEDISH EXPERIENCES

To reduce noise disturbances from car traffic, town-planning measures could be used or combined with more common measures, e.g. reduced speed limits, barriers/screens, building materials (absorption/reflection), isolation, building design smaller windows, etc. Town planning measures in this context and on this level involve at least three kinds of implementations, by which the difference between the scale of the building and block often could be difficult to separate:

- Buildings as noise barriers.
- Changes of traffic flows by new roads or new layouts of existing roads along the city-block.
- Remodelling of landscape, creating new noise absorbing or screening parts.

Starting with the first and most common measures some calculations from already studied areas will be summed up, giving an idea of the most usual practices of noise protection in Sweden and setting the frame for further examples and proposed implementations to study.

A long tradition of studies concerning the effect of noise reducing measures exists in Sweden as in many other European countries. At least from the sixties experiments and research work has parallel to real implementations in the urban landscape preserved a continuity built on previous results and with strongholds at the high schools of technology in Gothenburg (Chalmers) and Stockholm (KTH). Year 1969 the still very active nestor and front figure of noise research in Sweden, Tor Kihlman, professor at Chalmers, focused his installation lecture on the concept of a "silent side" in housing areas, meaning a bearable noise level in at least one of every apartments rooms.

Today this has become a central goal and a kind of mantra among many of the central and local planning apartments and a kind of mantra, formally used and recommended by parliamentary decision by adoption to the "barrier-model" 65/55/45. The model has made 55 db the crucial and acceptable outdoor noise-level in housing areas, acceptable if a silent side with 45 db outdoor and 30 db indoor can be reached. Above 55 db (housing) and 65 (offices, workplaces) isolation measures are needed. The studies of Kihlman and colleges, since several years also involving psychologists, are performed and annually reported under www.soundscape.nu. The report *Ljudlandskap för bättre hälsa* (in English: *Soundscape for better health*) published by Mistra, Vägverket, Vinnova, 2004, has affected the Swedish Boverket, the main authority concerning housing and planning.

The rather limited range of studied areas and types of implementations are here presented with help of the research work by Pell Nilsson at Chalmers from 1998. The work is written in Swedish and given the title *Plug-up Buildings, noise protection measures; influence on traffic/town planning and environment.* It has to be understood that in this study all the main implementations to reduce noise disturbances from car traffic either operate with noise screens, buildings as noise barriers or removed roads. They are evaluated with help of the noise barrier model 65/55/45 and contain among others the following examples:

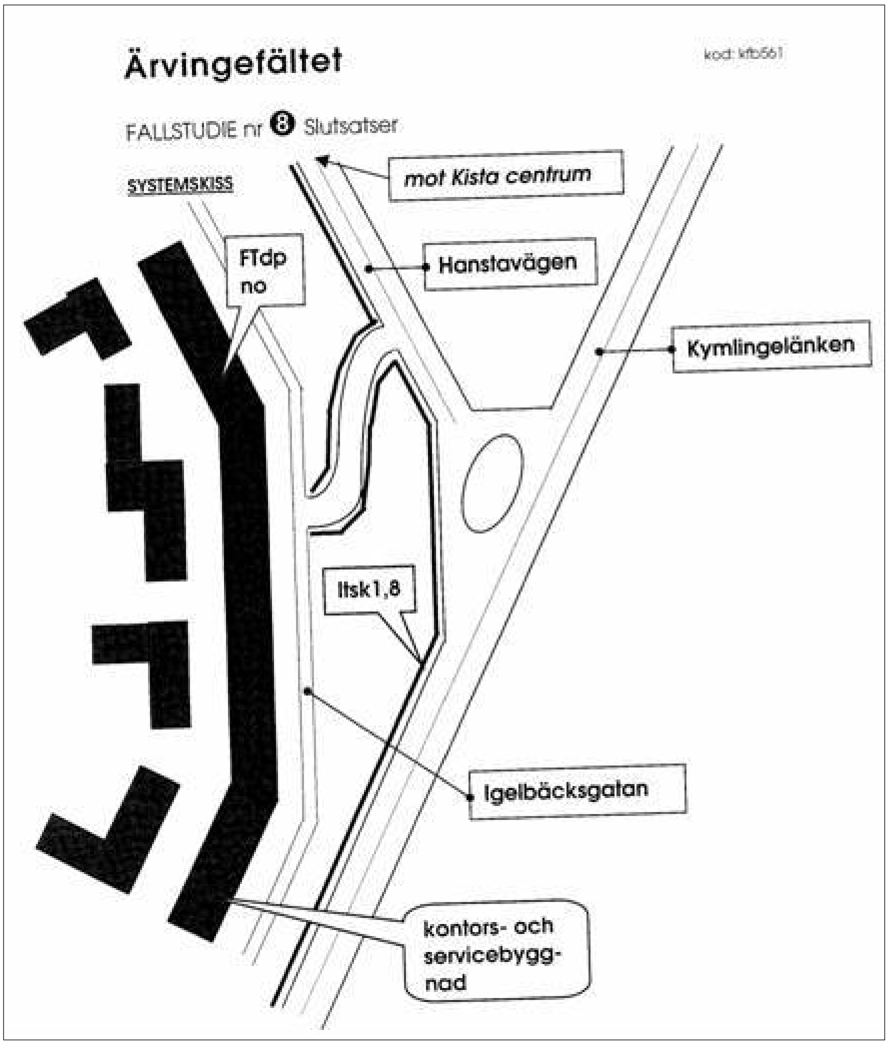


Figure 1-30. Ärvinge, Stockholm

In **Ärvinge (Kista/Stockholm)** the buildings closest to the traffic roads are raised as an 500 m long, curved office building and continuous barrier in front of a housing area and with open passageways in the bottom floor to a local speed-regulated street. The result from input data shows that the noise level in front of the facade towards traffic is <65 db and on the other side <45 db. The office building could even have been planned for housing, if the apartments had got rooms at the more silent side

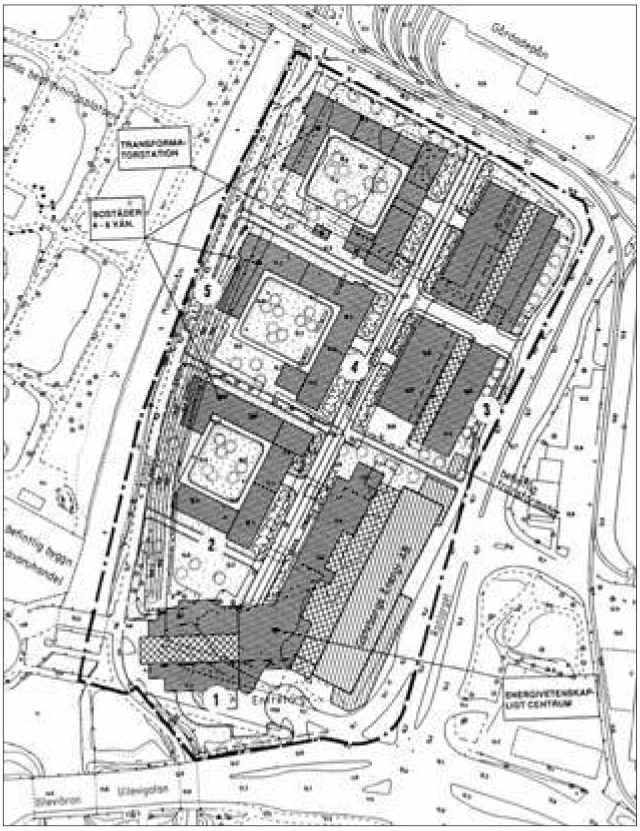


Figure 1-31. Ullevi, Gothenburg.

In the centre of **Gothenburg** close to Ullevi stadium a proposed plan using an L-shaped office-barrier of at least four stories around an inner 3-4 stories high housing area was calculated. The barrier was connected to an already existing building in the area, a high office (in the lower right corner of the plan above). The very short distances to the surrounding streets, also with trams, led to the erection of a 1, 8 m high noise wall, but the result was still a noise level larger than 65 db at the southern street-side. Special isolation measures concerning the office facade above the second floor were needed. The noise on the backside was calculated to <55 db and formed a kind of street in connection to the housing blocks that formed their own inner courtyards with the calculated noise level <45 db.

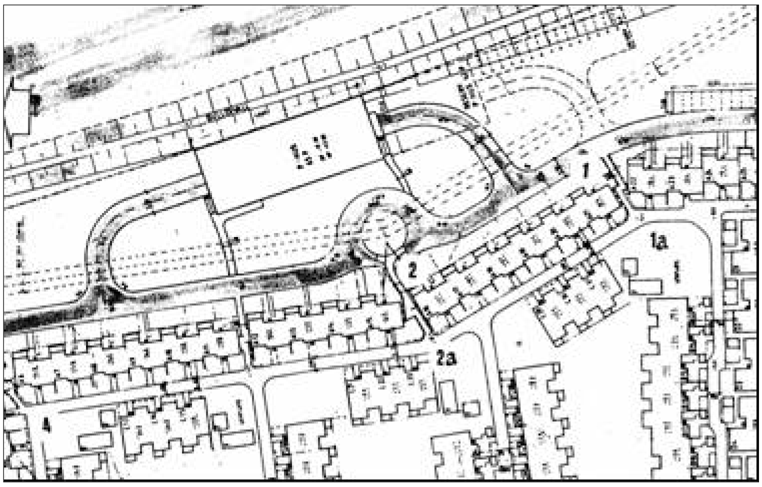


Figure 1-32. Ravalshagen, Stockholm.

In **Ravalshagen** at the main Highway E4 **in Stockholm** (upper side of the picture) a combination of a 2,5 m high embankment, a parking-house at the same level and a new row of three stories high sections of row houses were erected 150 m from the highway and in front of an existing small scale housing area. <55 db was the effect on the back side but reduced to <45 db by further measures: a wooden noise barrier on the earth-wall close to the highway and superimposed screens in the alleys between the sections in the newly built up row of houses.

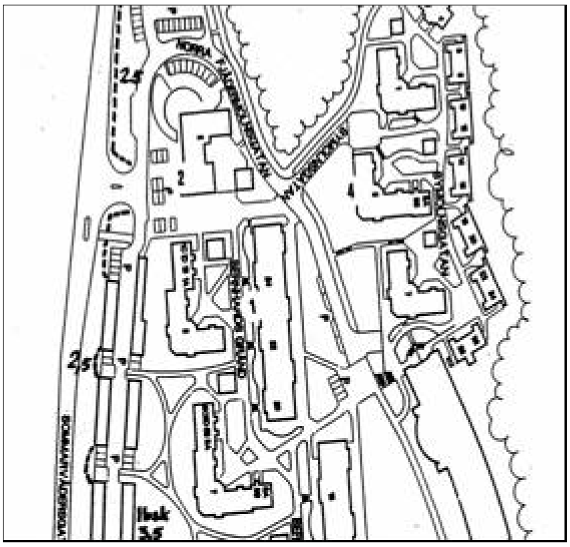


Figure 1-33. Karlaplatsen, Gothenburg.

At **Karlaplatsen in Gothenburg** a combination of noise screens, garages and L-shaped apartment buildings in 2-4 stories were erected in front of 8 stories high slabs (centre of the picture, and all measures mentioned to the left in the picture)). The terrain forms a slope that force the cars speeding up in the bottom of road in front of the main entrance to the area, making the noise levels to high above the second floor in the new additional buildings. However, in the new courtyards the level is <45 db.

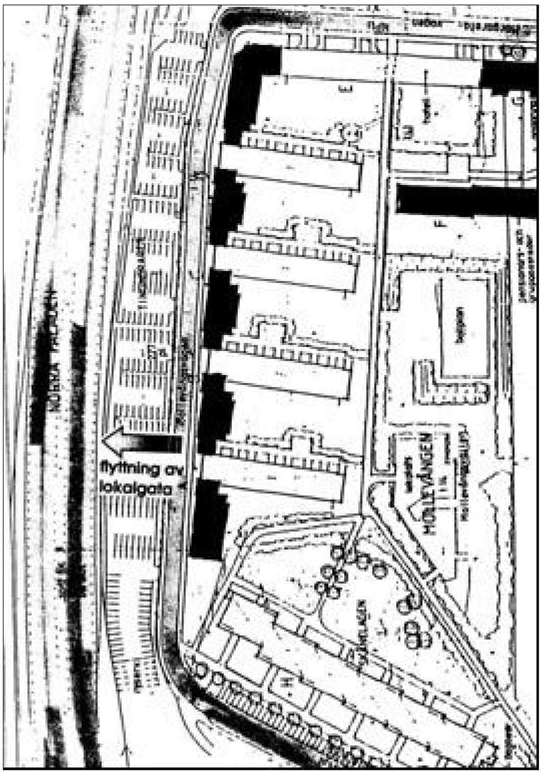


Figure 1-34. Möllevången, Lund.

In **Lund** the space between freestanding three stories high apartment houses towards the disturbing road in Möllevången (left in picture) has been used for the construction of four stories high new buildings, forming a continuous barrier for the U-shaped courtyards on the backside. Along the front of the building is a local street separated from the disturbing road by parking lots, a common layout for areas with rental housing during the 50ths and 60ths in Sweden and with the parking and sheltering area not even a part of the decided town plan and sooner handled as a kind of impediment in the hand of the municipality.

The short distance between road and facade in the example (50-60 m) gave noise levels at the courtyards < 45db, while the front facades hade a little less than 65 db at the ground floor but a higher level on the forth floor. To reach acceptable levels it was suggested that the local street for cars should be removed to a position close and parallel to the regional road and separated from it by a high noise barrier. By that the noise level towards the traffic according to calculations could be reduced to < 55 db at the ground floor and 61 db at the fourth.

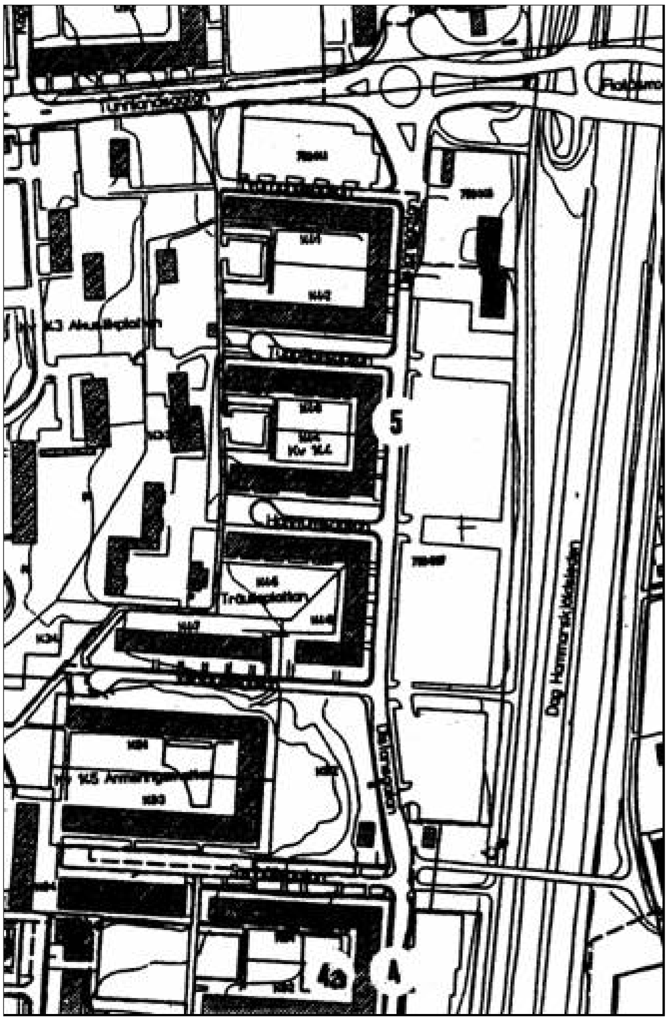


Figure 1-35. Flatås, Gothenburg.

Almost the same layout shows an area in **Flatås, Gothenburg**, but now with blocks and between them dead end streets in right angle to the parking lots and the disturbing road (to the right)135 m away from the facades. The calculations here showed the result of three different measures. A noise barrier at the road reduced the noise to > 55 db and < 65 db at the traffic side. The removal of the local street for cars to a position close to the regional road combined with both the noise screen and a lower screen along the local street hade a greater effect, resulting in a noise level a little higher than 55 db but < 55 db at the ground floor. A proposed continuous complementary building along the local road was finally calculated to give a noise level of < 45 db between the building and existing blocks.

1.5.2 BUILDINGS AS NOISE SCREENS

The calculations above is overall concerned with a kind of principal situations that don't bring up any unknown experiences concerning the noise reducing effects by town-planning measures, and they are only mentioned here to illustrate some practices that usually work rather well. Screens could easily be calculated according to position, height, length, material (reflexing/absoring in different layers), form and elements varied in size, numbers and patterns in plan and volume (terraces, set-backs, overhangs), etc. Buildings used as screens for other buildings can in this case be calculated as any constructed screen, with the mentioned possible variations of properties and of course by using the building for activities that need no noise reduction: garages, industry, and commerce.

Concerning buildings where there is a need to restricting noise propagation into the building the facade is here the main screen, with all measures mentioned above of immediate interest. Since the design and construction of the facade and its different functional elements and equipments as well as the building's form (vertically as well as in plan) and position in relation to the traffic noise play an important role, it can be appropriate to present some principal examples of noise reduction. These have been found in the report *Bruit et Formes Urbaines. Propagation du bruit routier dans les tissus urbains*, Centre d`Etudes des Transport Urbains (Ministere de l`urbanisme et du logement/Ministere des transports), july 1981.

Disposal of the building.

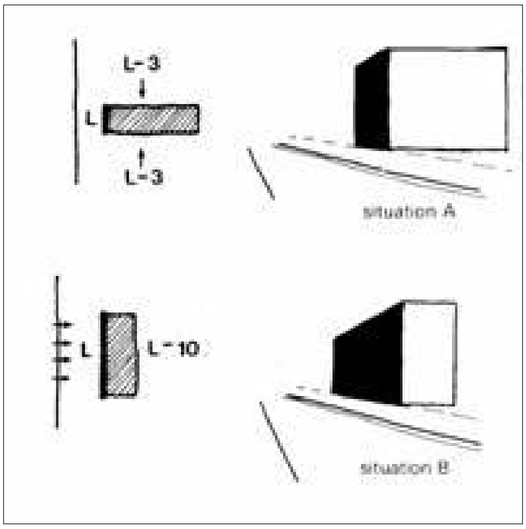


Figure 1-36. Comparing the extreme alternatives for a freestanding building, and neglecting the gables, you could say that in A 100% of the facades are exposed to L-3 db, in B 50% of the facades to L db and 50% to L-10 db.

The exposed facade as flat-screen.

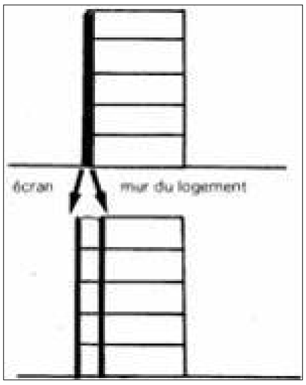
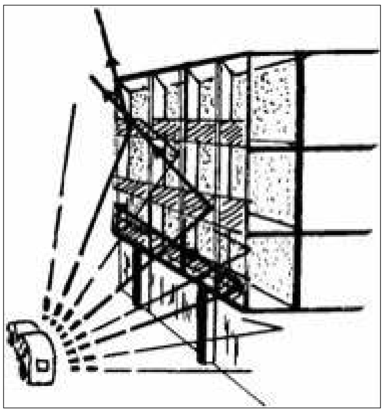


Figure 1-37. The noise is reduced by the material chosen for walls and windows and its properties, thickness, structured and patterned surface.

Dissolving the facade/screen as a straight, even and smooth surface.



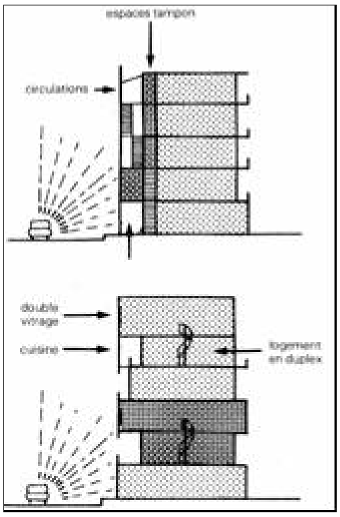


Figure 1-38. Methods to dissolve noise by soft or hard screens of buildings.

The facade could be dissolved by different elements as balconies, loggias, stairs, elevators and supporting constructions and systems (ventilation, el, lightning, etc), creating a kind of filter and space "in between", that disperse the sound (more effective with also absorbing surfaces in strategic spots, as the underside of the balconies).

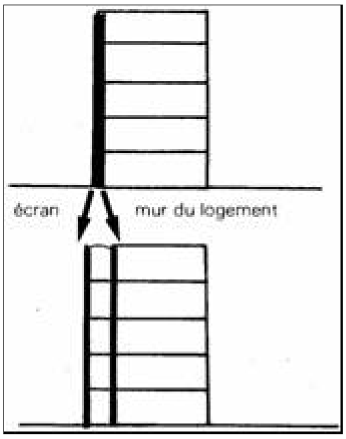


Figure 1-39. Double facades in two layers.

The consequences of the treatment above could be a doubling of facades (the exterior one wholly with glass for example), with the space in between used as a zone for communication, ventilation, etc.

Articulating the volumes of the building vertically and in plan.

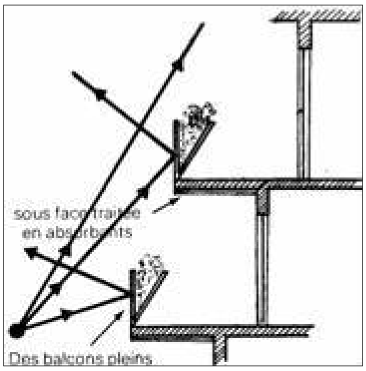


Figure 1-40. Set backs dispersing sound in different directions.

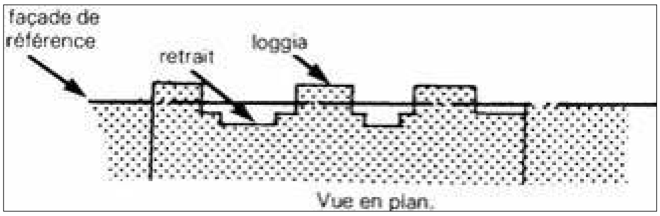


Figure 1-41. Set backs and variated facad design to disperse sound reflection.

The exposed facades of the building consist of volumes set back or projected in relation to the approximate ground plan of the building, a solution that disperses the sound.

Certain types of buildings are better adopted to weaken the propagation of noise, as the setbacks in picture number 1 - 4. The projecting parts of number 7 could with absorbents be really effective for reducing the reflection of noise to the other side of the road.

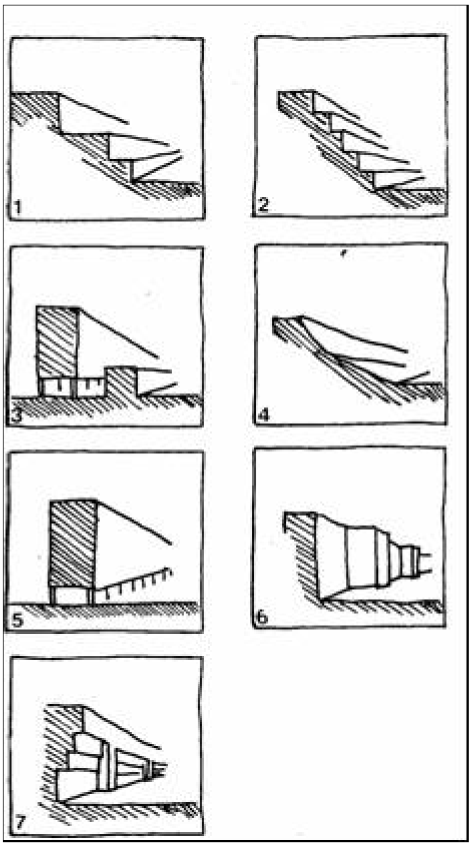


Figure 1-42. Example of set backs in building design to disperse sound.i

1.5.3 URBAN DESIGN AND NOISE REDUCTION

The question of town planning above is focused on the scale of individual buildings, which of course could reach a considerable size and length and influence the patterns of movements in the city, as long barriers of buildings do. They could for example create new streets or sections of streets along their sides and therefore also could make their functional content to an important question and at their front- or "backside" take the form of either a kind of Main Street with a variety of shops, offices, services or a kind of mega structure with flexible use. However, usually town planning measures to reduce traffic noise concerns groupings and layouts of buildings. That calls for an illustration of some better or worse solutions of a more or less typological character (the above mentioned French report is used again).

Alternative principles.

In settlements that consist of a continuous increase of building heights the lowest one closest to the road acts as screen for the one behind, that plays the same role for the next one, etc. A conventional setback-solution, where the roadside location is not the most demanded. The other principle let the building closest to the road take most of the noise, all the better as close as possible, and needs a much larger façade and surface elaborated as noise-screen or to be occupied by activities not so sensitive (to noise). A continuous building along the road of course protect buildings behind better than separated buildings with otherwise the same properties.

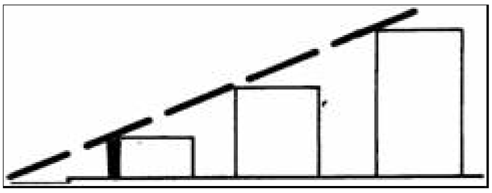


Figure 1-43. Building heights arranged to allow sound to spread long distances, in between blocks. Not recommended.

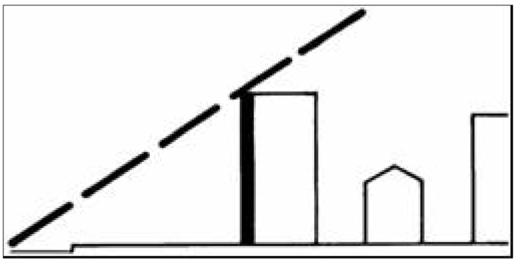


Figure 1-44. Building heights arranged to prevent sound from spreading. Recommended.

Better or worse

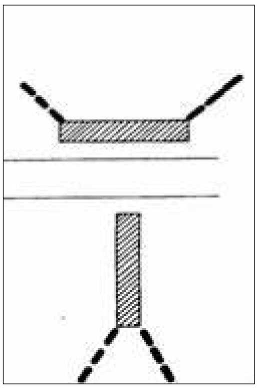


Figure 1-45. Screening as a result of building orientation.

Practically none of the facades of the building below is protected from high noise levels. In the building in the top of the illustration it is possible to give all apartments at least one silent room. The orientation alongside the street also creates a silent outdoor room, "behind" the street. This illustration can be compared with the two urban patterns in Berlin (the Hansaviertel) in the previous chapter. The open plan with "stand alone" buildings as promoted in western post-war planning has, in the perspective of noise, many problematic effects.

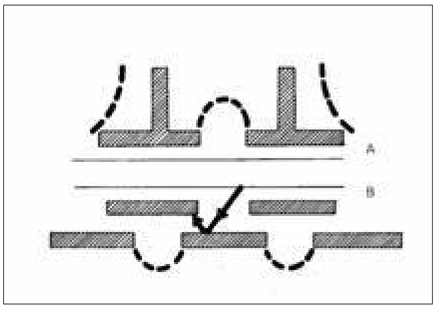


Figure 1-46. Two types of entrances or openings behind buildings.

In the figure, A is better than B. Sound is reflected between buildings in the scheme below. Sound is not reflected at openings in the scheme above in the figure.

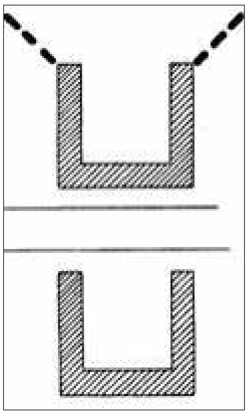


Figure 1-47. Courtyard design. Suggested above, not suggested below.

The whole courtyard is protected in the previous figure, only one side in the layout below.

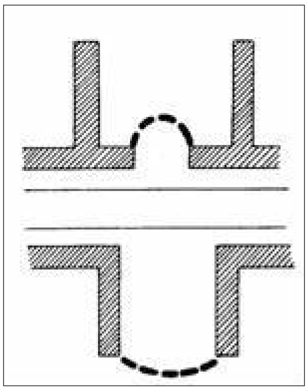


Figure 1-48. Openings layout.

The layout above is better since the lateral facades below are very exposed to noise.

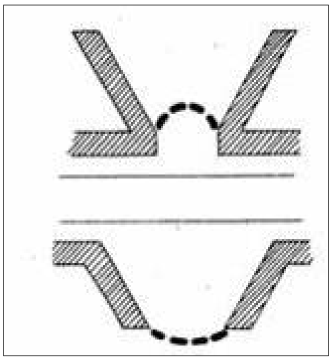


Figure 1-49. Layout of openings.

In this example the noise penetrates to the end of the configuration at the same time as it's easier to establish complementing barriers in the small entrance space above. The smaller the opening is, close to the street, the better the effect. This layout is used in the simulations in the test area in Stockholm.

Dissociation and differentiation of building patterns

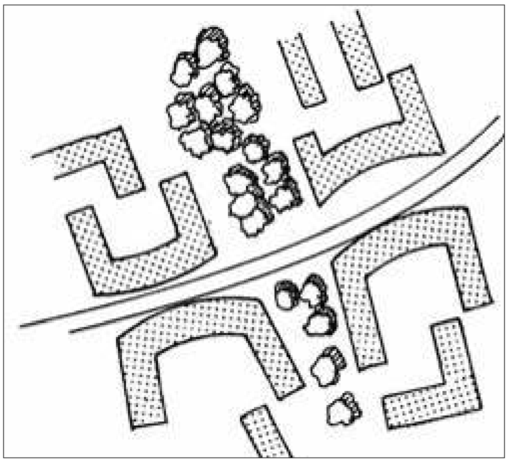


Figure 1-50. Layout of blocks close to street.

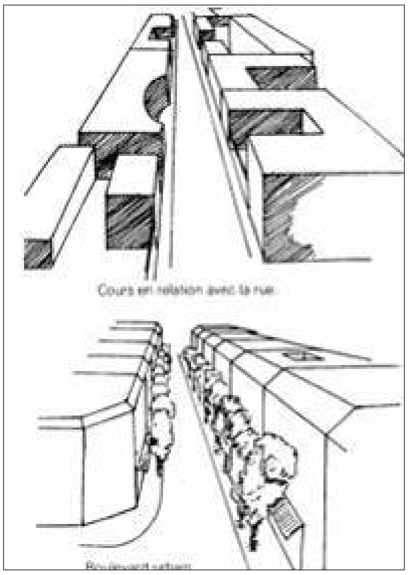


Figure 1-51. Different layouts, with irregular openings and set backs, or straight continous wall facades towards the street.

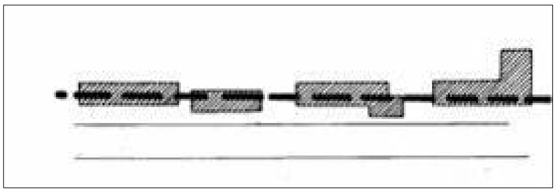


Figure 1-52. Plan of “broken up” facade layout along street. Recommended from noise perspective.

A street with the sides differentiated and broken up in small places, setbacks, green lots, irregular, curved building facades, etc disperses and weakens the propagated noise better than a conventional street corridor with continuous flat facade-screens.

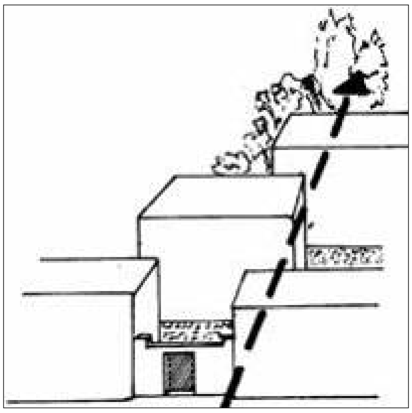


Figure 1-53. Combination layout with superimposed building blocks. Recommended.

Reducing noise propagation into areas along roads could also be done by superimposing the buildings better, in combination with measures as screens, absorbing surfaces, etc.

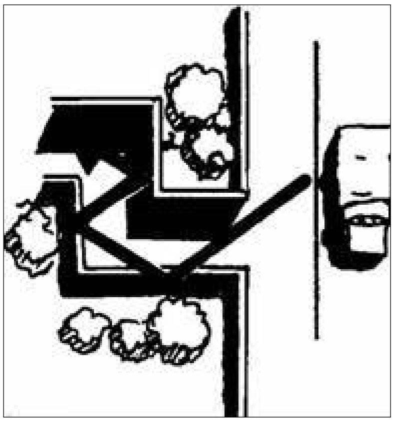


Figure 1-54. “Noise catching” entrance street. Recommended.

The choice between straight, curved or folded alleys and passageways between buildings should be done with regard to reflection of noise – that can be absorbed at critical surfaces or reduced by superimposed screens and further developed by arranging vertical changes – change of ground/street levels.

1.6. STREET TYPOLOGIES AND REDUCTION OF NOISE

In finishing these practical comments on measures reducing noise propagation, the layout of roads and streets themselves should be mentioned. The functional character of roads in relation to the traffic system of cities has already been discussed. The classification in a hierarchy according to speed is the predominant method for road/street design and planning. The hierarchy goes from the national/regional transit ways (motor-, high- and freeways), arterial roads and intraregional connections, local road- and street systems, distribution streets and lanes down to the access streets, often of the cul-de-sac-type. However, here are some solutions of physical layouts for the two first mentioned categories – high speed roads – that could be developed further.

The traffic ditch consists of a road with ramparts or high walls and noise screens, leaving all accessibility to adjoining buildings and urban areas out of question, except at larger junctions.

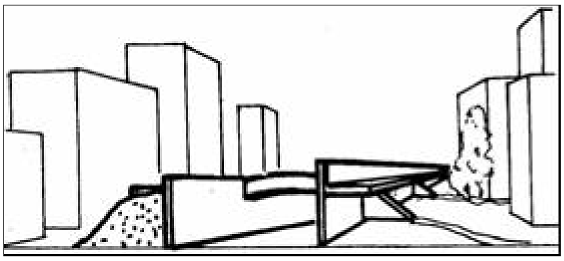


Figure 1-55. Traffic ditch.

The speed-differentiated road was first developed in the early twenty century in the shape of boulevards as well in France as in the US (avenues and so called "strips"). The central and faster lanes are along some stretches sometimes even separated from the slower lanes by trees. These could today could be changed to or complemented with noise screens. The advantage of this layout is that it combines high accessibility to the surroundings with the good flow and speed of the fast regional roads - that in themselves are attractive places for location for many companies and functions today. This layout creates a more integrated urban landscape. Effective solutions demand at least 3 + 3 lanes and another two lanes for stops and parking. To promote the flow better than the common boulevard, crossings have to be at two levels and U-turns and connections between the two sides can be made possible by fly-overs and bridges. For most people the latter solution is a visually disturbing element, that however could be reduced to rather simple, functional constructions. Two types of solutions emanate from this:

The strip: With intersections, bridges and crossing at appropriate distances. Displays, billboards, entrance- and parking-grounds could together with adjacent commercial, buildings, garages, etc serve as a noise barrier or noise-filter for a continuously rising sequence of buildings.

The level-changing highway: With intervals in which slow-speed lanes are separated from high-speed lanes vertically. This could be done by making the fast-speed lanes "dip" down into a short tunnel below ground level. The slow speed lanes, with less traffic volumes, can be more easily accommodated with a dense urban environment and gives less noise disturbance. Another choice is to elevate the high speed traffic on a bridge or otherwise elevated level. This solution is more problematic in a noise perspective, but could possibly be solved by designing the highway bridge as a tunnel above ground, or as a part of the surrounding building structures. This solution is tested in the simulation in the test area in Stockholm.

The elevated motorway is a solution that needs effective noise barriers with absorbing materials and layouts. It could also be connected to adjoining buildings and blocks at the same level (with the question of traffic security more urgent) and the areas for different uses and functions.

The interior highway runs through the interior of a building complex, making the integration of bus stops and entrances to and from garages and parking possible. The exterior noise propagation is none, but necessary to handle as an interior problem with regard to sound and vibrations.

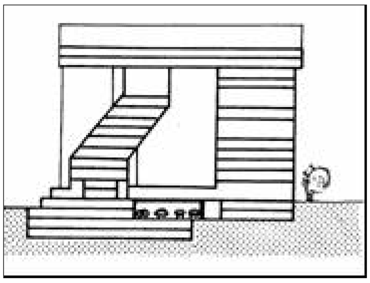


Figure 1-56. Section of interior highway.

1.7. MATERIAL AND SURFACE TECHNOLOGY

The outdoor noise level in cities and close to densely trafficked highways can depend strongly on the façade materials and their absorption capacities. Below is presented a summary of the most common reflective façade materials and their absorption capacity.

The absorption is presented as average absorption coefficient for the frequencies 250 Hz to 4 kHz. The Reflection Loss for a typical traffic noise spectrum has also been calculated and is presented in the two tables.

Reflective façade materials	Average 250-4000	Reflection Loss (road traffic spectra) dB(A)
Brick (natural)	0.04	0.2
Brick (painted)	0.02	0.1
Concrete block (painted)	0.08	0.3
Concrete (poured, rough finish, unpainted)	0.05	0.3
Steel plate	0.03	0.1
Glass (6 mm plate, large pane)	0.06	0.1
Glass (small pane)	0.03	0.1
16-22 mm wood facing (tongue-and-groove or rabbeted) on frame over 50 mm cavity filled with mineral wool	0.12	0.4
Doors (solid wood panels)	0.06	0.2

Figure 1-57. Summary of the most common reflective façade materials

The Reflection Loss is how much the sound is reduced from one reflection on that façade. It can be seen that none of the normal reflective façade materials have more than 0.4 dB(A) in Reflection Loss. From below it can be seen that it is possible to achieve Reflection Loss as high as 10 dB(A), which would reduce the traffic noise on the sidewalks significantly.

The two material marked bold are new material developed within this project, see Deliverable 4.6 Prototype of high absorbing surface.

Absorptive façade materials	Average 250-4000	Reflection Loss (road traffic spectra) dB(A)
Open brick pattern over 75mm fibreglass	0.65	5.8
LECA traffic screen (150 mm with porous concrete in grooves)	0.71	7.8

Clinker concrete, no surface finish, 800 kg/m3	0.40	3.6
Perforated metal (32 % open, over twin layer absorbent 40mm mineral wool 130 kg/m3 and 30 mm fibreglass "Piano")	0.67	8.7
Absorbing brick (new in-house design)	0.42	2.5
Perforated metal (with thin fibreglass cloth) over 80 mm air gap	0.61	10

Figure 1-58. Summary of some absorptive façade materials.

2. LARGE SCALE SYSTEM SIMULATION

2.1. DESCRIPTION OF TESTING AREA - TRAFFIC, BUILDINGS, SOCIAL PATTERNS ETC. ALTERNATIVE 0, 1 AND 2.

In this description, Alternative 0 represents the present situation, with regard to traffic structure and urban pattern. Alternative 1 represents the planned changes of major highway systems in the area, and Alternative 2 the hypothetical alternative designed in this report – in order to be able to make comparisons between different types of local town planning – with regard to noise effects. The three alternatives can be illustrated in a diagrammatic form:

Figure 2-1. Diagrams of the three tested alternative traffic layouts.

Left: present situation.

Centre: official alternative, new and improved highway system

Right: proposed dispersed traffic system.

In this work, traffic flows are simulated and measured by KTH, department of Transport and Economics, Division of Transport and Location analysis. Noise generated from road traffic is simulated and measured by Acoustic Control.

2.1.1 ALT 0: EXISTING BUILT-UP AREAS, ROADS AND TRAFFIC FLOWS.

The Järva Field housing and office area is situated North West of Central Stockholm. The area consists of six greater “urban blocks” or neighbourhoods built in the 1960´s and 1970´s, all facing the vast un built open green area of the Järva Field. It is situated approximately 5 km north-west of the old core of central Stockholm. Some of the more important regional and national highways and train lines pass through or nearby the area – with connection to the main airport Arlanda.

Two subway lines connect the area with the central city, with one station in each of the six separate urban districts. The Järva Field is one of the more important “Green Corridors” of un built open land, connecting the central parts with the country side. The six urban districts are part of Stockholm City community, but surrounded by other smaller and legally independent communities – Solna, Sundbyberg and Sollentuna.

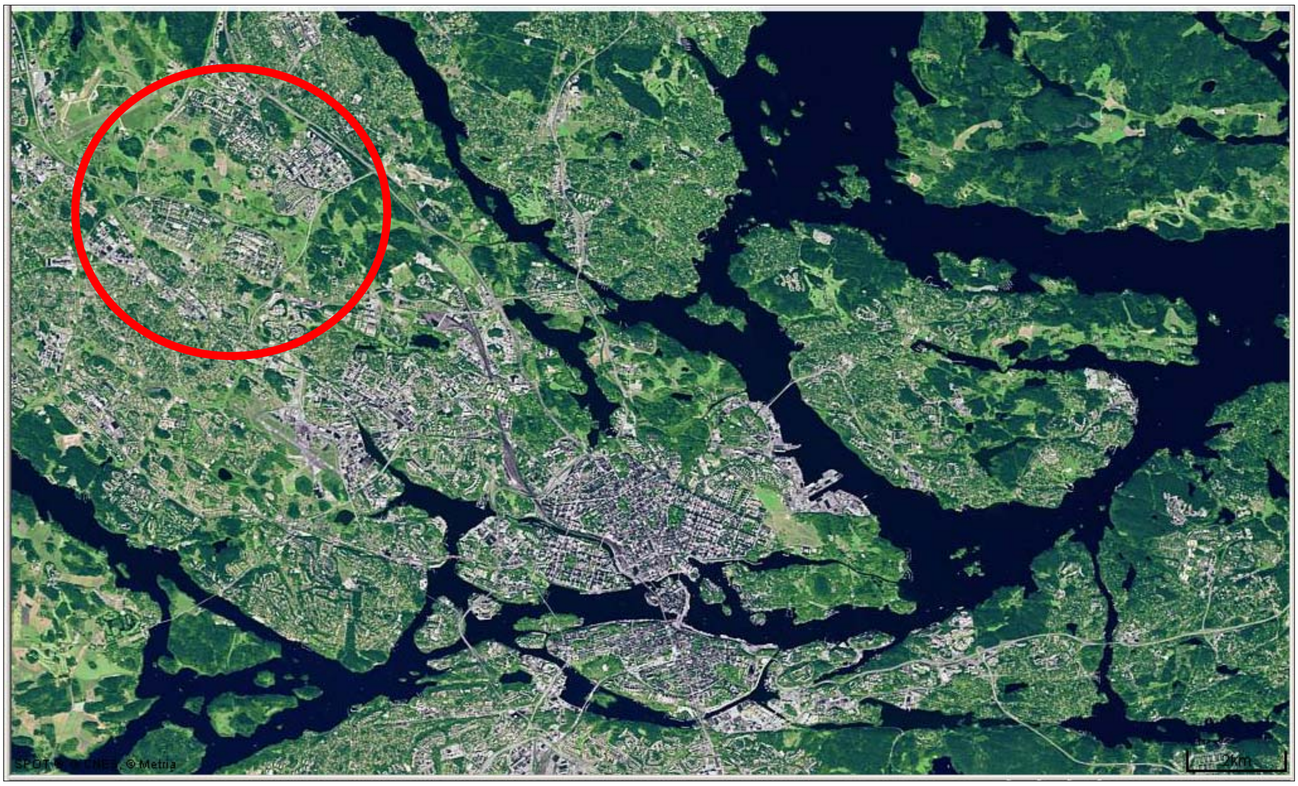


Figure 2-2. . Aerial view of central and northern Stockholm. The Järva Field marked with circle.

The traffic system in this area has the typical large scale character of post-war planning, with built up areas formed as more or less independent “islands of buildings” with no through traffic.

Figure 2-3. The traffic system around the Järva Field. Present situation. . Illustrations courtesy fo the National Road Administration.

To the **south** of the Järva Field:

Three neighbourhoods with mostly housing: **Rinkeby**, **Tensta**, **Hjulsta**. These areas are considered among the most socially/economically deprived areas in Stockholm, with low household incomes, low level of services/shopping and few workplaces.

To the **north** of the Järva field:

Three neighbourhoods with a more mixed use: **Kista** (divided into one area for working mostly targeted towards the electronic/computer businesses and one are for housing), and **Husby** and **Akalla** (mostly housing).

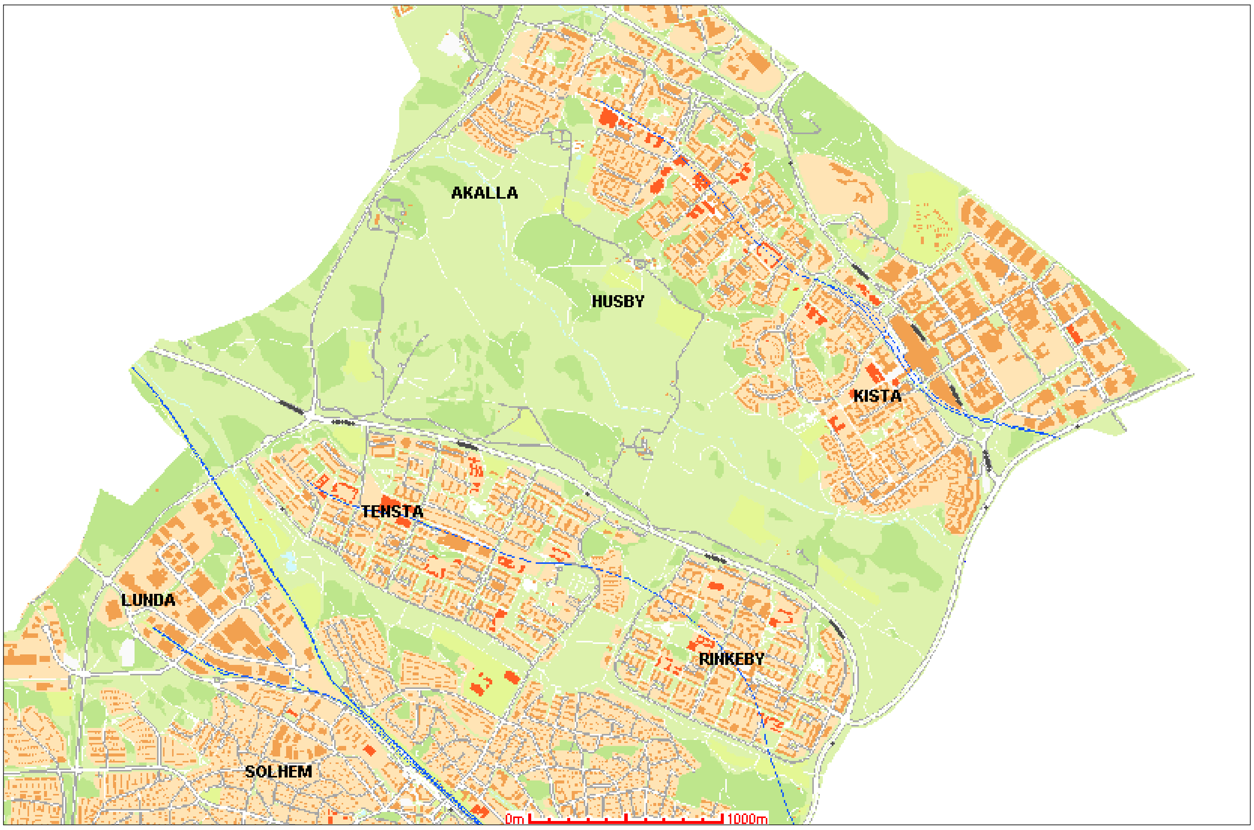


Figure 2-4. The Järva Field in north west of Stockholm. Map shows areas that are part of Stockholm City municipality. Hjulsta urban district is situated to the west of Tensta. . Illustrations courtesy of the Stockholm Urban Planning Office.

The working area in Kista is sometimes referred to as the "Silicon Valley of Sweden" with new office buildings and a newly renovated and extended indoor shopping mall, the "Kista Galleria" – one of the largest shopping malls in Sweden. The other two areas, Husby and Akalla, consist of mostly suburban housing with low attractivity and generally low income households.

The traffic system is based on the usual post war concepts of traffic differentiation and traffic separation, together with functional separation between areas for housing and work, with a few smaller and one major shopping centre (in the middle of Kista).

The southern part (Rinkeby-Tensta-Hjulsta) has a street pattern with access to housing areas from E18 (European Highway 18) which is situated outside and parallel to building areas. A few access roads lead into the area, with short "cul de sac" streets that terminate at parking areas close to housing blocks. Some local streets go across the area, with differentiated levels, to avoid conflict between car traffic and pedestrian traffic. The street system can be regarded as a large scale “net”. The accessibility with car is good related to access to apartments. Through traffic is on most places impossible. The traffic system does not allow for high speed. The system generates low noise and low barrier effects, due to car traffic within the area.

On the larger scale, the area is disconnected from other built up areas. The E18 road (70km/h) outside of the built area creates a strong barrier effect and rather high noise impacts from car traffic. The absence of through-traffic generally creates poor prerequisites for shopping, services, public spaces etc. The area can be viewed as more or less a separate “island” of housing with public services, schools and a few small shopping centres.

The northern part (Kista-Husby-Akalla) has a street pattern built up along two main local streets (50 km/h) placed close to the middle of the built up area. To these arterial roads a number of distributor roads are connected, often designed as dead ends or short loops back to the main street. Except from the office area in Kista, the housing areas have very little through traffic. This area has another highway system on the north side, the E 4, (European highway 4). Contrary to the neighbourhoods south of the field, the connection to this highway system is very weak and with no direct access points to the built up areas. This highway (E 4) has mainly an arterial function in the large/regional scale – whilst the road E 18 is the only traffic access to the built up areas.

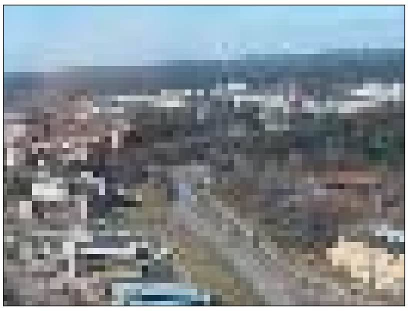


Figure 2-5. Kista housing area, left. Kista working area, right. Note that the traffic system is clearly separated from, and on rather long distance from, buildings. This gives – as was discussed in previous chapters – a good sound environment close to buildings. In the long run, this model for development is more problematic and traffic/noise generating.

As a contrast to the southern group of neighbourhoods, the Kista Area has a rather high amount of daily visitors, due to the office area in northern Kista. In the middle of Kista is situated a newly rebuilt and enlarged shopping centre with indoor shopping streets and a large central food court. Kista is also the place of a number of educational facilities, with KTH (Royal Institute of Technology) being the dominant one.

The social pattern in the areas around the Järva Field is a good example of social and economic segregation, clearly visible in the built up geography. The housing areas Rinkeby-Tensta-Hjulsta with almost only apartment blocks, is separated from the more affluent housing areas to the south, with predominantly one family homes and row houses. The areas Kista-Akalla-Hjulsta is more mixed, with higher income areas in row houses close to the field and the more lively office and shopping area in central Kista.

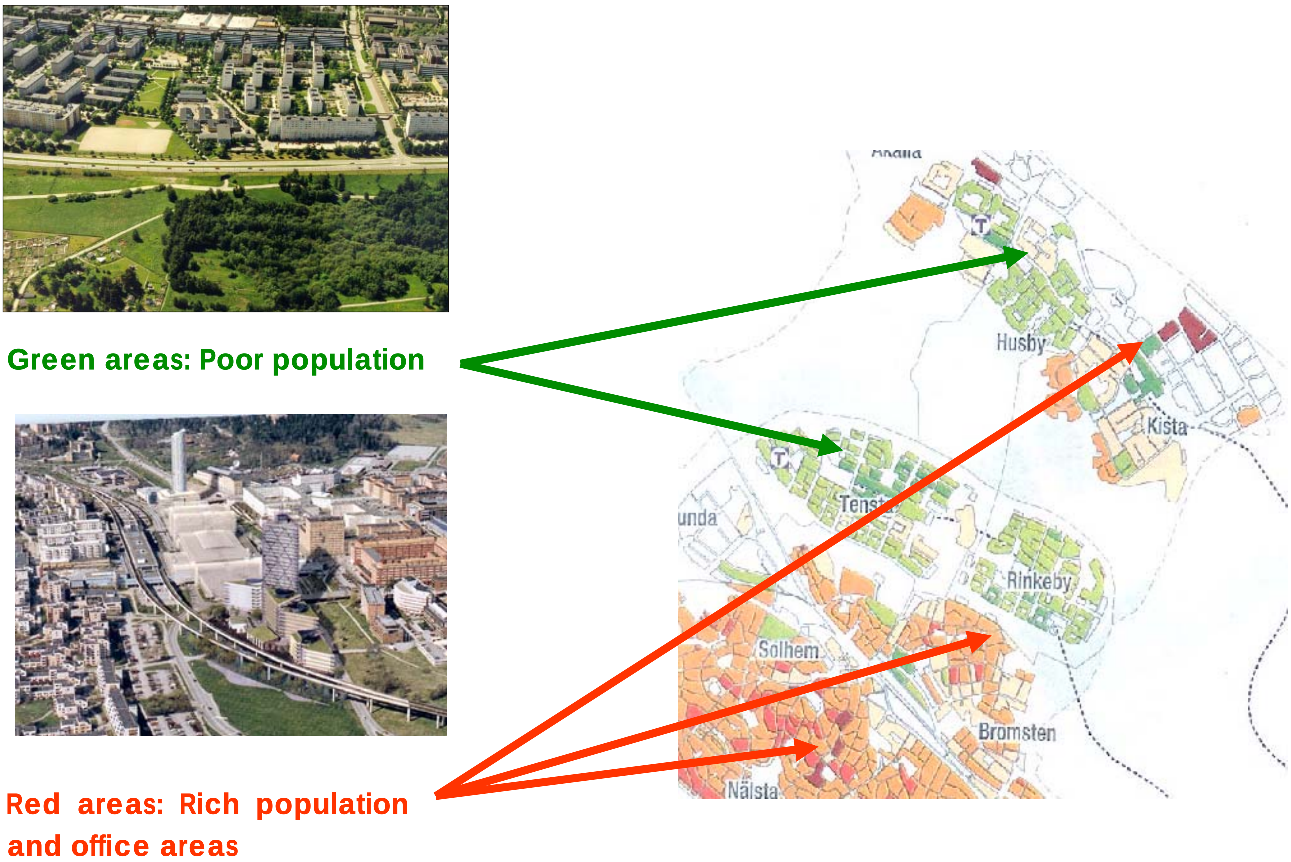


Figure 2-6. Socioeconomic map of the Järva field. Red symbolises higher income, green lower income.

Photo on top: Tensta Housing area. Photo below: Kista central area with shopping centre and offices.

The lower disturbance from noise in the northern areas, with good access to the field is worth to notify. On the other hand, the Husby area in the north, with excellent access to the filed, belongs to the less attractive areas. Attractivity in this area seems to be more linked to types of housing, with higher attractivity values (more high income groups) tied to the type of housing. One family or row houses seems to be more attractive.

2.1.2 ALT 1. ONGOING PLANNING, ROADS AND TRAFFIC FLOWS

Present official planning and projects for this area consists of a large scale project intended to create higher capacity for car traffic along the E 18 road, with more driving lanes and different levels for access to the housing areas in the southern part (Rinkeby, Tensta, Hjulsta). This new highway will be built together with noise screens to prevent disturbances in the housing areas and partly towards the Järva Field. Inside the area, a number of infill projects for new housing have just been completed. To the east of Rinkeby, a completely new urban district is planned in the community of Sundbyberg, with office blocks closer to the main streets, apartment blocks and low scale housing in the inner parts.

The northern area is planned for more office blocks and housing and a more integrated internal traffic system. The Stockholm Urban Planning office aims for a denser and mixed use developments in Kista with streets organised more in the form of an inner city grid.

Figure 2-7. Planned new highway along the Järva Field (blue) with planned new connecting highway system (yellow). Illustrations courtesy of the National Road Administration.

The proposal replaces the present 11 signalled level crossings with five new circulation places with fly ower junctions or underpasses. The connecting highway to Kista is designed in three levels to allow for high speed – and replaces the present signalled crossing with frequent long queues and traffic jam.

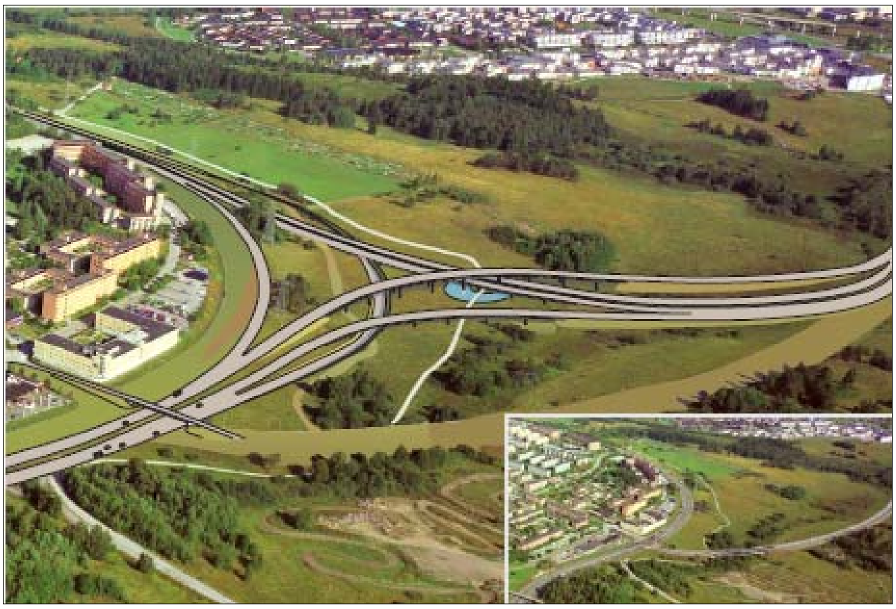


Figure 2-8. Planned new traffic junction at Rinkeby. Inserted picture: present situation. . Illustrations courtesy of the National Road Administration.

At Rinkeby and Tensta respectively, the highway will be decked over, in the form of "built up roofs over tunnels" stretching 300 meters each, to reduce disturbances and give better access to the field. It will be possible to build new buildings on top of these decked tunnels.

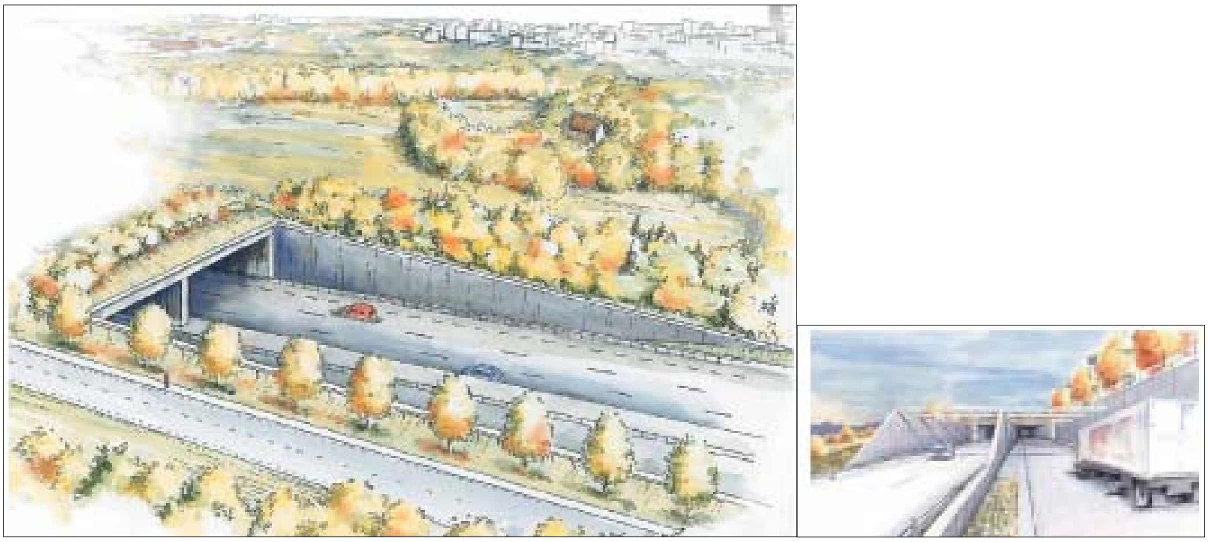


Figure 2-9. Covered tunnels between housing areas and the Järva Field. Illustrations courtesy fo the National Road Administration.

The housing areas Rinkeby-Tensta-Hjulsta will be connected by a local street that goes parallel to the new highway.

Figure 2-10.Present and planned traffic design at Tensta (in this report: Alt. 0 and Alt 1). Illustrations courtesy of the National Road Administration.

As mentioned earlier in this report, there exists a conflict between short run and long run solutions – in reducing disturbances from traffic noise. The proposed traffic plan increases in high extent traffic flows and traffic safety. In some respects in reduces noise disturbances, by screening and tunnels. In the long run, and in the overall strategic perspective, it might have the opposite large scale and regional effect. By improving the competitiveness of the private car, as compared to travel with public transport, it may in a broader systems perspective, increase traffic generated noise - in this area as well as in other parts of the city.

Both on the **local** level – with regard to the urban environment – and on the **regional** level – with regard to the generative effects on travelling patterns and choice of transport mode – this official traffic plan differs not much from the concepts presented by in the previously mentioned traffic planning guideline, the report “Traffic in Towns”.

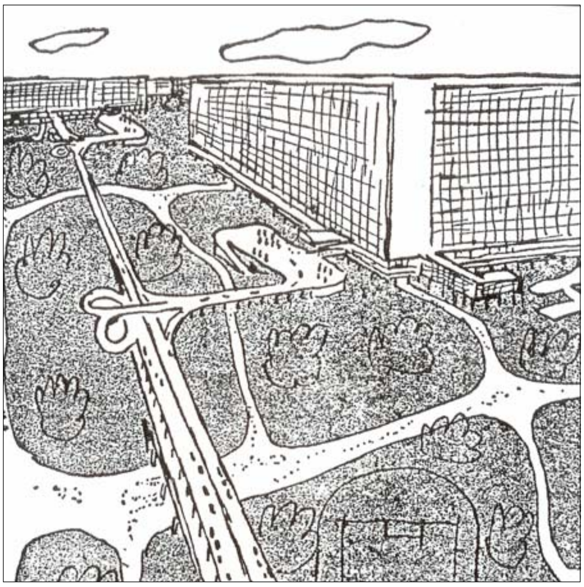


Figure 2-11.Similar layouts for urban between development, from different time periods.

Left: Architect Le Corbusiers vision for a city with elewated highways. From “Le Maison des Hommes”, 1936.

Right: illustration of traffic junction on the Järva Field with a view towards Rinkeby housing area, The National Road Administration, 2004.

The basic concept is close to those that were presented as early as in the 1930´s, by for instance the visionary urban planner Le Corbusier. The question to answer is, if there are other layouts and technical solutions that could **combine** a good sound environment and efficient traffic flows with an overall attractive and sustainable urban form – and this in both the long and short time perspective. To study these questions, an alternative plan has been designed, for comparison and evaluation.

2.1.3 ALT 2: PROPOSED INTEGRATED TRAFFIC AND BUILDING STRUCTURE

The proposed alternative traffic and building plan is designed to differ as much as possible from Alternative 1 (the official plan), to make comparisons meaningful and to generate new knowledge. However, one condition has to be fulfilled – **the alternative has to be realistic when it comes to traffic flows**, both with regard to number of cars and speed of cars. An alternative plan that halts local traffic flows and creates less noise disturbances by forcing the traffic to choose other routes, around the testing area, is easy to present. But it would not be meaningful or creative; as such a concept would only move the problems of traffic and noise from one place to another. The traffic simulation model used is not confined to the testing area, but simulates traffic flows in the entire Stockholm area. The alternative traffic pattern has been tested a number of times and adjusted according to these results, to avoid this kind of “overspill” to other areas.

In the following **Chapter 2.2** and **Chapter 2.3** comparisons of the three alternatives are done in a more systematic way, with regard to traffic flows and noise effects. In this section, the basic principles and ideas behind the alternative plan is presented. The plan is based on the following points:

1. The Noise Screening Building
2. The Multiple Node Traffic System
3. The Brussels Urban Highway
4. The Improved Urban/Nature Interface
5. The Gradual Car/Public Transport-Shift

Figure 2-12. Overview of Alternative 2. New building blocks (yellow) around the urban park serve as effective noise screens – and add economic value by new possible development. Plan developed for this research project, labelled "STHLM NOW" (Stockholm North-West) by Erik Stenberg and Anders J Söderlind, KTH.

1 The Noise Screening Building

As discussed in **Chapter 1.8**, the orientation and design of individual buildings, streets and traffic junctions, offer a number of possibilities to reduce both production and transmittance of traffic noise. New noise screening buildings, formed as blocks that are closed towards the main streets are added into the area. To provide for silent inner yards and large open areas with a minimum of noise, buildings blocks are placed along the main arterial street, the E 18.

Proposed buildings close to noise emitting main streets are preferably used for offices, shopping and other work/public related use. On higher floor levels, with set back facades, it is possible to arrange for housing as well.

Towards the open park, with excellent low noise levels and attractive views, housing and hotels are preferred. Entrance streets between blocks are narrow and curved, to function as “noise locks”.

In separate reports in the QCITY project, by Acoustic Control, technical solutions are presented that show methods to combine a more dense traffic/urban pattern, without sever negative noise effects. In Work Package 4.4, different technical solutions are presented:

1) Prototypes for high absorbing building surfaces.
2) Prototypes for low improved noise barriers for the use along tram lines.
3) Acoustic galleries with office buildings with “overhangs” over noisy main streets.

Together with other material solutions, such as “silent asphalt”, the proposed alternative plan may be more in line with present recommended noise levels.

Generally speaking, the noise screening building, placed directly along an urban street with high noise levels is rarely used in temporary planning. Regulations and planning standards on noise, traffic safety, air quality, accessibility, traffic flow, health, fire prevention, etc all tend to increase distances between buildings and streets/roads – thus limiting the potential of effective noise screening buildings. Free standing noise screens, which do not contribute in the same way to a liveable and attractive urban street environment, are much more common in contemporary planning. The alternative plan is designed to elucidate and evaluate a more active and hopefully more efficient use of noise screening buildings.

2 The Multiple Node Traffic System

In order to limit traffic concentration and the risk of congestion along main streets, a secondary street system is introduced in the existing housing areas, providing for shorter distances for local traffic, the possibility to choose between several alternative routes (especially during peak hours) and better preconditions for shopping/commercial and public services.

Figure 2-13.Traffic plan Alternative 1. With the new mixed use area in Sundbyberg in lower left corner.

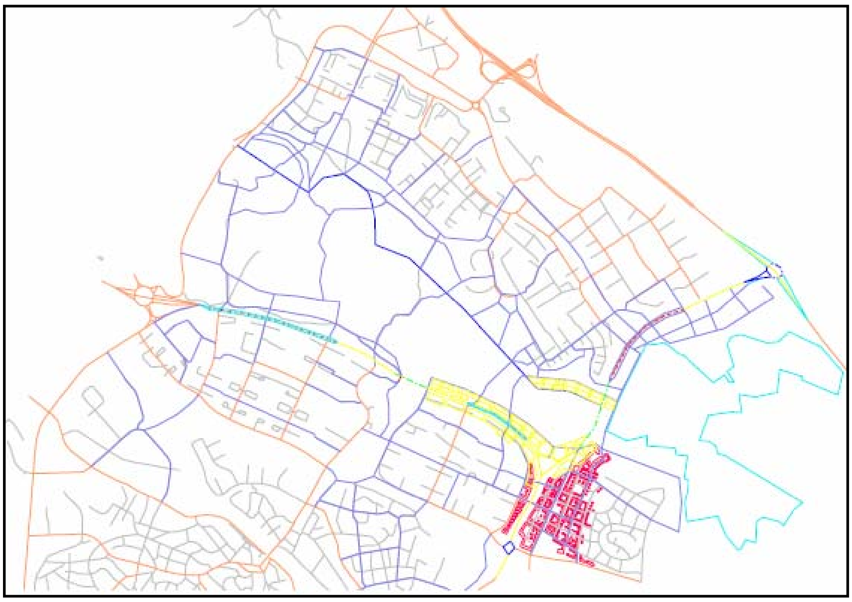


Figure 2-14. Traffic plan Alternative 2. Existing and new streets connected to a multiple nod system. The first part of new blocks between E 18 and the Järva Field marked with yellow.

Rinkeby and Tensta are connected by two new continuous streets with rather low speeds and with new links to the housing and working areas further south. These new “short cut streets” creates more through traffic within the built up areas, but the combination of lower speeds and shorter travelling distances reduces the present dependence on a few large scale streets or highways. The reason for this change of local street system – from present cul-de-sac streets to a more urban street net with more frequent crossings – is not based on traffic flow considerations alone. A common experience in traffic planning is that a higher degree of through traffic generates better preconditions for local shopping as well as commercial and public services.

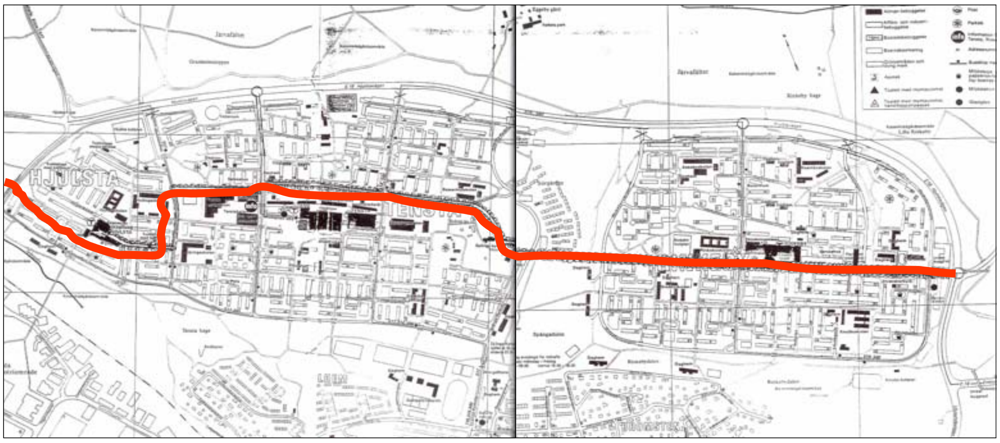


Figure 2-15. Possible new interior street, connecting Rinkeby and Tensta-Hjulsta housing areas. Illustration courtesy of Stockholm Urban Planning Office.

In the evaluation part, this is noted as a clear conflict between opposite goals. Higher noise levels are an unintended effect of traffic patterns designed for higher levels of local commerce and urban functions. The noise simulation maps give a sharp illustration of this conflict. Local streets with 55 dB(A) or above in the alternative plan, could in a different perspective be interpreted as streets with better preconditions for shopping/services.

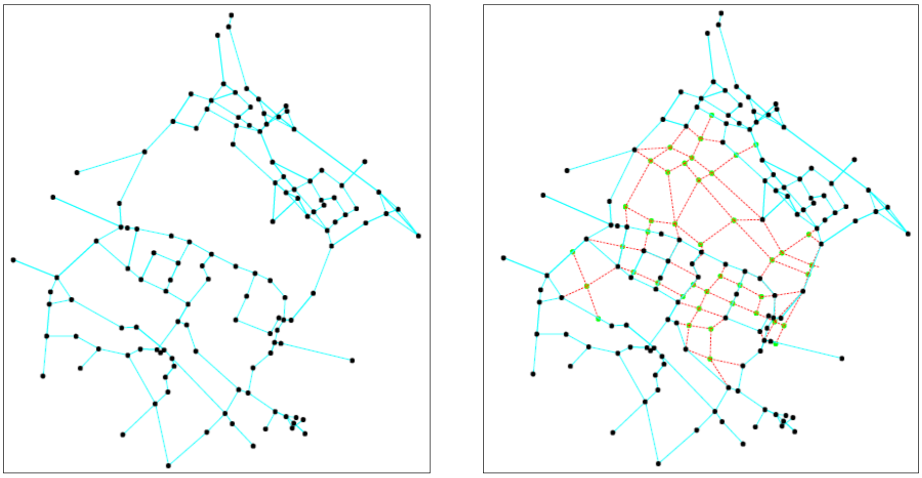


Figure 2-16.Present (A0) and proposed (A2) street node system. Layout principle for traffic simulation, KTH dept of Traffic and Location Analysis.

According to the present official plan, the entrance to Kista office area is designed as a large scale traffic junction. The alternative plan works with three different entrance streets to Kista. This solution may create both easier orientation and higher traffic safety, as these kinds of access roads into the built up areas are designed for lower speed than traditional fly over or under pass access roads. Due to the lower speed and dispersion of traffic on many different entrance streets, the noise effects are not as negative as was first expected.

3 The Brussels Urban Highway

The new planned highway, E 18, is a high capacity road with a regional function that can not be questioned. Local traffic is in that plan not connected to the highway, except at the five new traffic junctions. Local traffic in Rinkeby-Tensta-Hjulsta is in that plan organised as a separate system. In the alternative layout, a combination solution is tested, with four high speed lanes in the middle and two low speed lanes, one along each side of this “urban highway”.

At three points, a different method of bridging over the highway is tested. The official plans two “covered tunnels” are replaced, at other places, with short sunken tunnels for high speed traffic, with two lanes in each direction. The two remaining low speed lanes, one in each direction, continue on ground level. This creates a traffic pattern that at intervals mixes local and regional traffic. Access to the built up areas, without conflict with high speed through traffic is possible at these three points. The low speed lanes allow for traffic to cross traffic in the opposite direction, with high traffic security and with a relatively low level of traffic noise. The critical point, from a sound perspective, is here the section of the urban highway where high speed traffic dips down and below the surface. It is believed that sound absorbing materials along the walls may have a good effect. The areas above these “sunken tunnels” are suitable for easy access parking, trees and minor service buildings and may serve as a public space, connecting the two sides of the urban highway. As access speed is slower in this design, compared to the official plans access roads with fly over junctions, it seems reasonable that noise and visual disturbances will be lower.

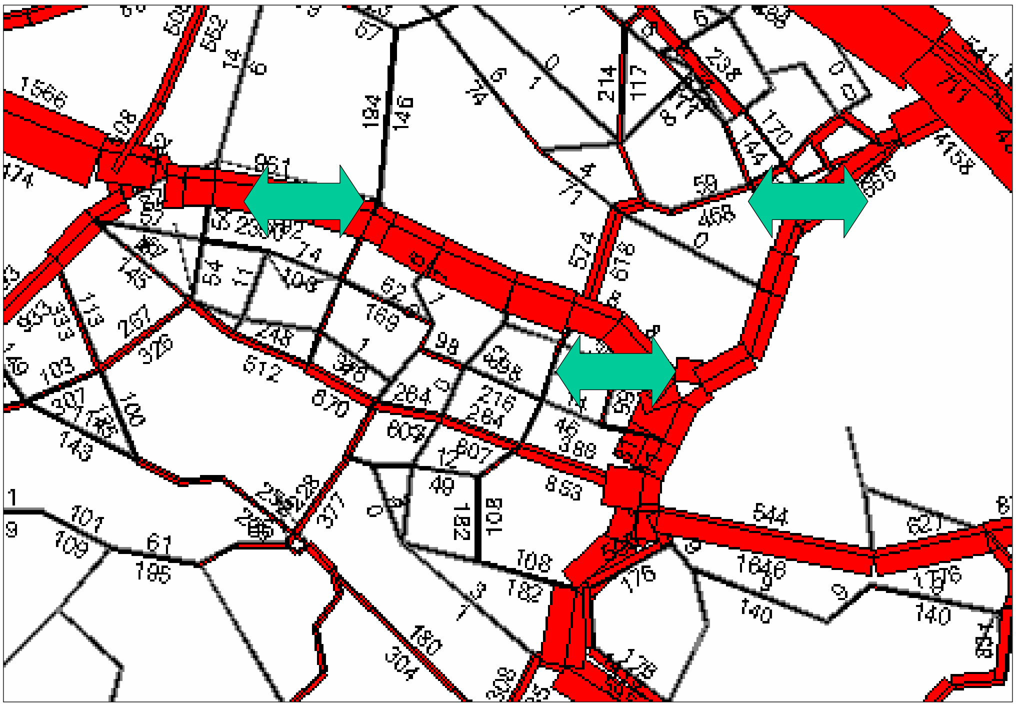


Figure 2-17.A combination of high speed regional flow streets (7o km/h) in tunnels and low speed local connecting streets (50 km/h) are tested in the abnove three locations.

The short tunnels are placed along the housing areas Rinkeby and Tensta and at the entrance to Kista office area. Along other sections of this alternative E 18, the six lanes goes on ground level, which only makes turn off and parking possible along the right side of the street – no crossings are allowed in these sections. All streets have parking pockets along the driving lanes, for short time parking, taxi access, bus stop and "drop off, drop in".

Figure 2-18.Central Brussels, Belgium.

Left: Local street on ground level with slow traffic, parking and pavement.

Center: Central high speed lanes, going down in short tunnel.

Right: Open area for parking, level crossings etc on top of short tunnel.

This layout is directly inspired by the short tunnels for high speed traffic that is found in many areas of central Brussels, thus the name "Brussels Urban Highway". In Stockholm this solution is in part realised in the end of the main urban street Sveavägen. Close to the central square Sergels Torg, traffic is divided in two levels, with regional traffic in a system of tunnels below ground and local/access traffic on the surface.

4 The Improved Urban/Nature Interface

From an ecological and health related perspective the existence of and accessibility to high quality urban parks and natural spaces with a minimum of noise disturbances is important. In the alternative plan, one goal has been to discuss the quality versus the quantity of open green fields. The building pattern, with relatively high new building blocks placed in the existing field close to the E 18; reduce the amount of open urban spaces. In the same time it improves access to the remaining parts of the Järva Field and minimises noise disturbances.

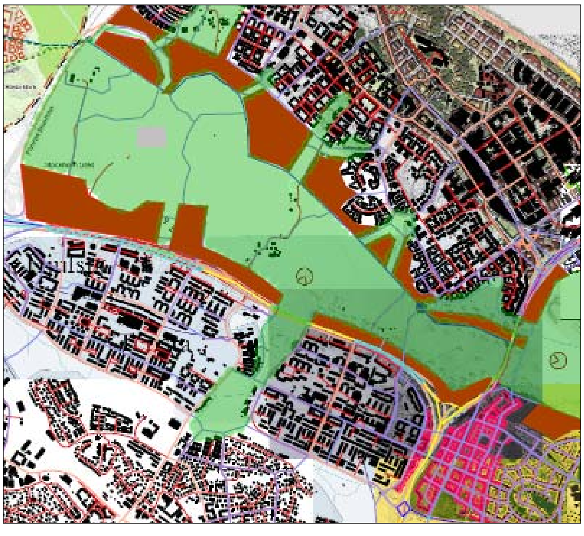


Figure 2-19. New building areas in The Järva Field, marked with brown colour.

In the northern part of the field, an opposite layout is tested. The present interface between housing and open field has no streets and traffic and therefore no noise disturbances. In order to provide for both more building blocks in this area, and to create a similar “traffic short cut” for local movement, a new slow speed street in tested, as a boarder between building area and field area. The speed limits of this new local street have been modified in order to create a relatively low number of passing cars.

Three new local streets also cross the open field, along existing historical roads and foot paths. These serve as “urban short cuts” that connect the districts on the opposite side of the Järva Filed. In some extent they relieve the pressure on the main streets and are especially suitable for bus traffic. The noise effects are however negative and counteract part of the positive effects of noise screening buildings.

Figure 2-20. Examples of more urban interface between buildings/streets/park.

Left: Tengerlunden in central Stockholm, Sweden.

Right: Central Park, Manhattan, USA.

The official plan has been designed to optimise noise reduction by local screens etc. The alternative plan has, due to budget and time restrictions, NOT been optimised for noise reduction in the same way.

Such measures have been discussed and could include local low screens, “silent asphalt”, absorbing materials, partially “sunken streets” across new streets across the field and low earth walls along the new local street along the north part of the field. Such actions would improve the quality of the open field and also create new economic and social values in the alternative plan.

In the evaluation part, is discussed if it is possible and suitable to access a specific monetary value to reduction of noise on open urban land. This evaluation is done on a tentative basis, as a follow up of the method for cost-benefit analysis with regard to noise reduction and rent levels for buildings.

5 The gradual car/public transport-shift

The strategic goal of the alternative plan is to present a realistic example of development that can reduce the increase of private car traffic on the regional scale by opening up a new area for dense urban development that is public transport friendly and walkable.

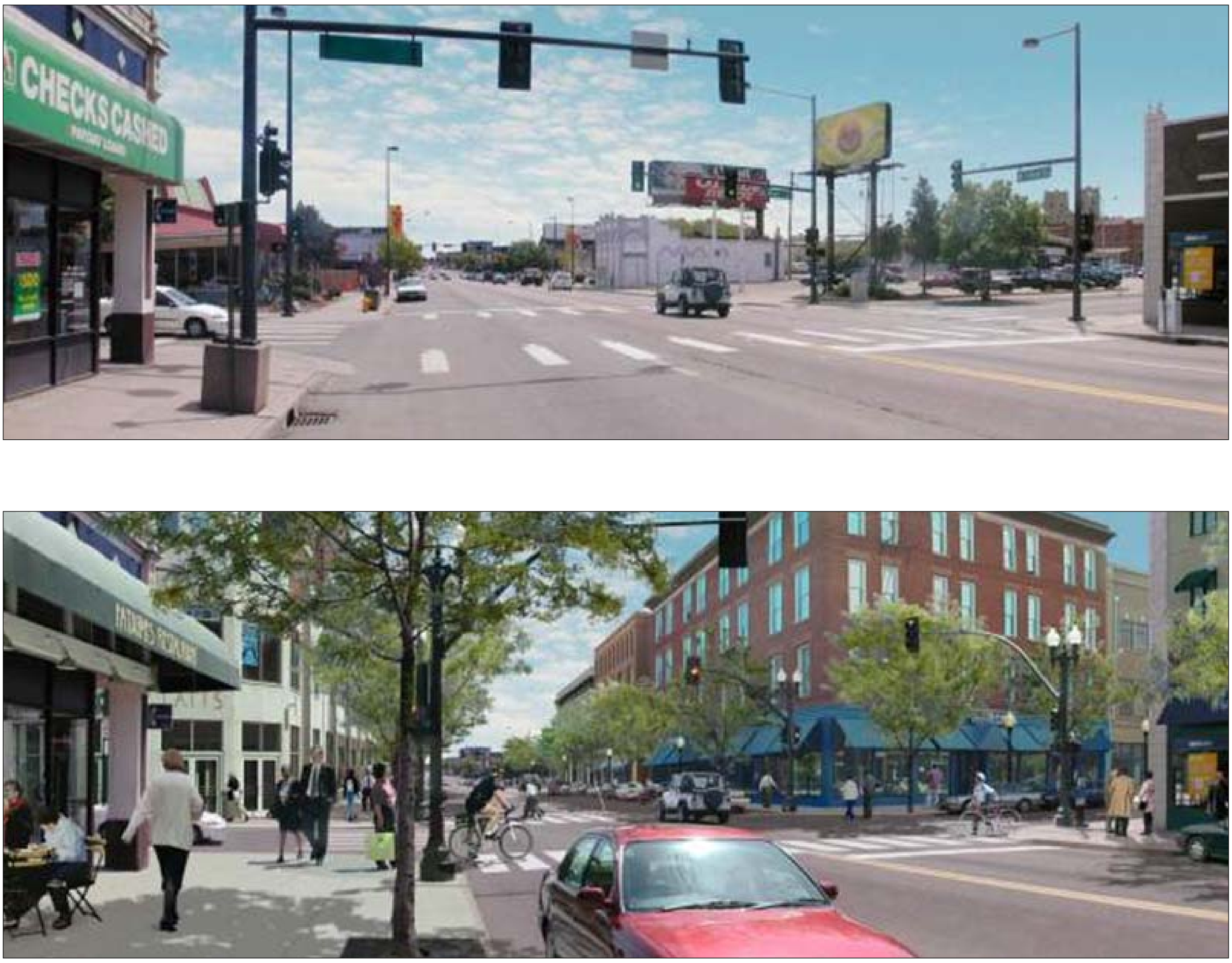


Figure 2-21. Before and after. Densifying of arterial street with high speed, low walkability and sparse development. Picture courtesy of www.urban-advantage.com.

The proposed new buildings around the field can accommodate 30 000 persons (living or working). If the plan was carried out according to intensions (mix of uses, high density, new bus lines) it would have positive effects on noise disturbances, traffic congestion, exhaust emissions, energy consumption, etc – on the **regional** scale – as the pressure for and the incentives to build less dense and car oriented new housing and working areas further out in the region would then be lower.

As mentioned in Chapter 1.1, an evaluation of noise effects has to compare the:

- The **local**
    - short and
    - long time effects

as well as

- the **regional**
    - short an
    - long time effects.

The local short time effects are further evaluated and illustrated in Chapter 2.2.

The local and regional **long time** effects are harder to evaluate and would need further simulation work. It is however probable that the new developments proposed would make it economically realistic to reinforce the present public transport system in the area (two parallel, not connected, subway lines on each side of the field) with new bus lines and an officially long discussed but not yet decided on new light rail system across the field.

The proposed **Transect based noise guide lines** (**Chapter 1.2**) is developed to make such a strategy possible. See also the evaluation section (**Chapter 2.5**).

2.1.4 WORKING METHOD FOR COMPARISON AND EVALUATION

In all three alternatives noise levels are simulated and compared. In some important places, so called "Hot spots", noise effects are analysed more in detail, as the result of different locations of buildings, building heights, content, material of facades, streets, boulevards, strips with speed differentiation, fly overs, partial tunnels etc. Noise reducing solutions of a more technical kind are not included in this report, but are presented in other deliverables. More general local and regional effects of the alternatives are then compared.

2.1.5 DESCRIPTION OF COMPUTER SOFTWARE AND RESULTS FROM SIMULATION OF TRAFFIC FLOWS AND SPEED

2.1.6 IMPLEMENTATION OF THE ALTERNATIVES IN A TRAFFIC MODEL

In this section the traffic modelling software I s described, as well as results. In chapter 2.2.13, Appendix A, simulations of off peak hours are described.

2.1.7 THE TRAFFIC MODEL USED

To model the traffic conditions of each town planning alternative the transportation modelling system Sampers (Beser and Algers 2002) was used. It contains a multimodal travel demand model system, which is integrated with the analysis package Emme/2 (Inro, Canada).

In Emme/2 links and nodes make up the traffic network. Regular nodes and links describe junctions and main roads respectively. Furthermore there are centroid nodes and connector links. A centroid node represents an area that generates or attracts trips representing e.g. dwellings and working sites. Connectors are fictive links that connects trips between the traffic zones and the road network and the public transport system. A connector can be seen as a representation of one or several local streets.

A simulation results in an equilibrium solution where no one can reduce his or her travel cost by changing route and which is consistent with the mode and destination choice. The most detailed model results are vehicle flows per category per link for different time periods (in QCity, morning peak hour and off peak hour), and transit loads for the same periods. A deeper description of the Sampers system and how it is applied is found in Deliverable D2.4.

2.1.8 Modelling the Different Town Planning Alternatives

For alternative 0 we used an application of the Sampers system including Stockholm County. The model was then used by making adjustments in Emme/2 to describe alternative 1 and 2.

All scenarios were assumed to take place "today", thus parameters in Sampers related to national factors such as economic development and changes in petrol taxes were the same for all three alternatives. In addition, the public transport system existing in alternative 0 was also used in alternative 1 and 2.

2.1.9 Alternative 0

Alternative 0 describes the traffic system, as it exists today. The part of the road network modelling Järva is illustrated in the following part. Black lines are regular road links; blue lines are links open for buses only. Red lines and points are connectors and centroids respectively. Note that railroads are not illustrated in the figure though they are included in the model.

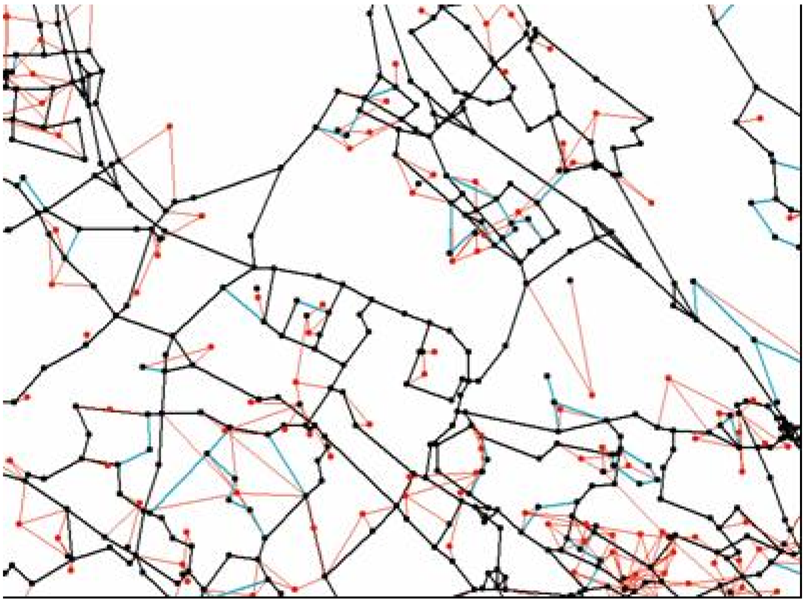


Figure 2-22. Model network of alternative 0.

2.1.10 Alternative 1

By studying shape files created from drawings new nodes and links were added in Emme/2 to model alternative 1. This illustrates the rebuilt network where each line in most cases represent a two way street. As the traffic model is macroscopic which means that it works on a high aggregation level, only links describing the new main roads were created. In addition each link was given attributes representing planned number of lanes and road type. Moreover forbidden turns were specified for each on and off ramp junction and changes on existing roads were implemented.

The new housing area Stora Ursvik was modelled by changing the socioeconomic parameters of a centroid placed near the location of the new area and additional connectors were added. It was assumed that the area has the same distribution of age, gender, number of cars etc. as a centroid describing a housing area in Aspudden south of Stockholm and working site types similar to a centroid describing parts of Älvsjö south of Stockholm. In total the area is modelled to have 7 000 inhabitants and 3 000 working sites.

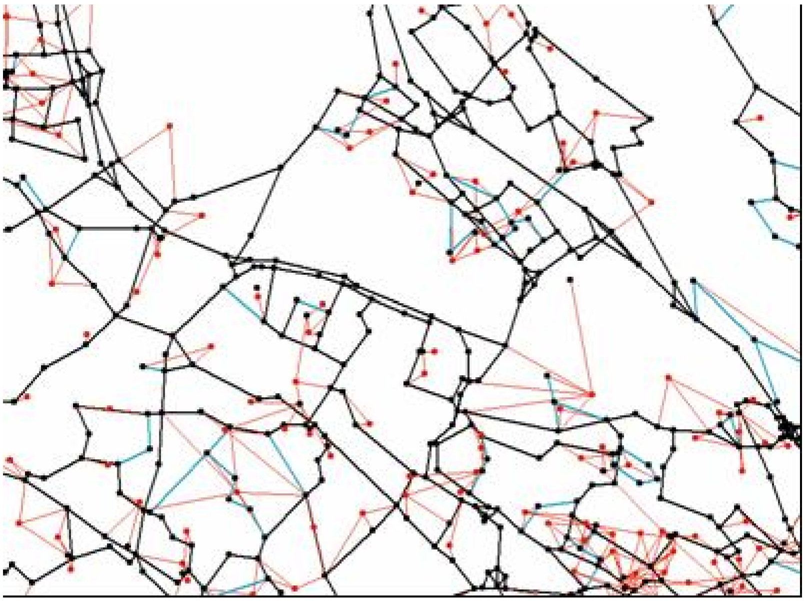


Figure 2-23. Model network of alternative 1.

2.1.11 ALTERNATIVE 2

The new roads and traffic solutions were modelled and parameters changed on existing links according to the hypothetical town plan in Alternative 2. Stora Ursvik was implemented in the same way as in alternative 1. In addition, to further open up the areas Akalla and Tensta, buss links were modelled to also allow car traffic.

The new estates on Järvafältet were modelled by adding centriods and connectors. The socioeconomic data of each zone were changed and calculated in accordance with the existing area they were assumed to resemble and the total number of inhabitants and working sites defined.

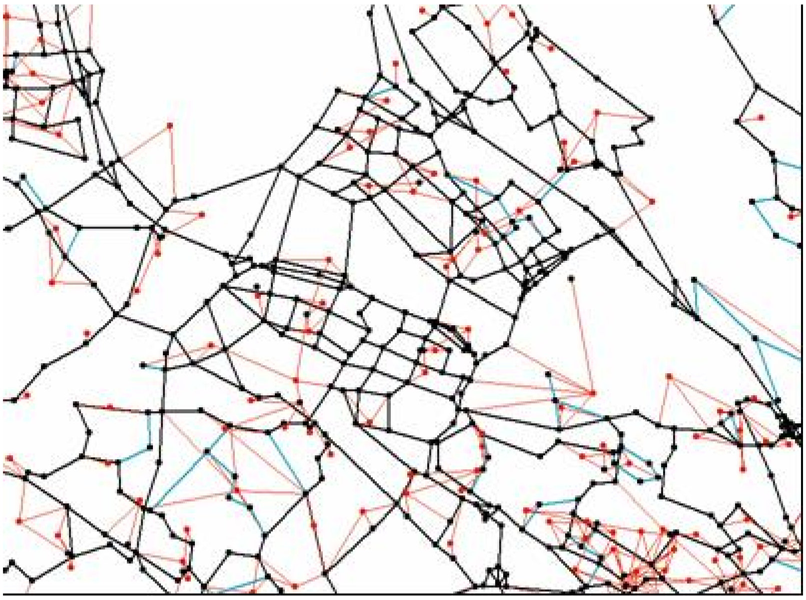


Figure 2-24. Model network of alternative 2.

2.1.12 TRAFFIC MODEL RESULTS

The following paragraphs present the simulation results of the morning peak hour period for each alternative. This period has the highest traffic volumes and shows therefore the characteristics for each alternative in the clearest way. Off peak hour results show the same flow pattern but with lower traffic volumes and as a consequence higher speed on links that are congested in peak hour. The off peak results are found in Appendix A. Off peak hours simulation. Auto volumes on connector links are not presented.

2.1.13 ALTERNATIVE 0

below illustrates the morning peak hour volumes of alternative 0. It shows that the most loaded roads are the motorway E4, E18/Hjulstavägen, Akallalänken, Bergslagsvägen, Kymlingelänken and Enköpingsvägen. Exact traffic volumes are given on selected links and will be compared between the three alternatives. For roads running east and west the first number represents the flow towards west and the last number the flow towards east. For roads running north and south the first figure represents flow running south and the last flow towards north. This convention is also used in showing the traffic speed and in the following illustrations of alternative 1 and 2. Notable is the speed on E18/Hjulstvägen, which is much lower on the east direction towards Stockholm centre than the opposite direction.

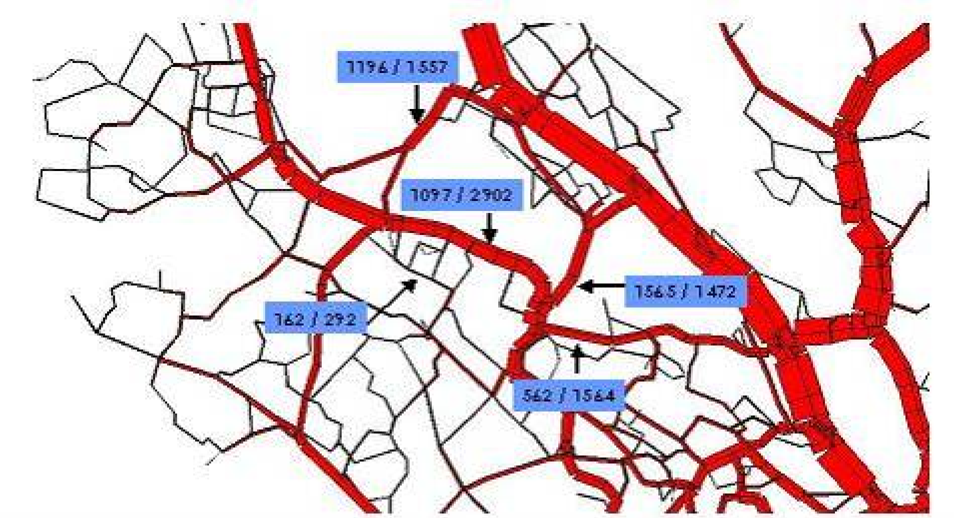


Figure 2-25. Traffic volume morning peak hour, alternative 0.

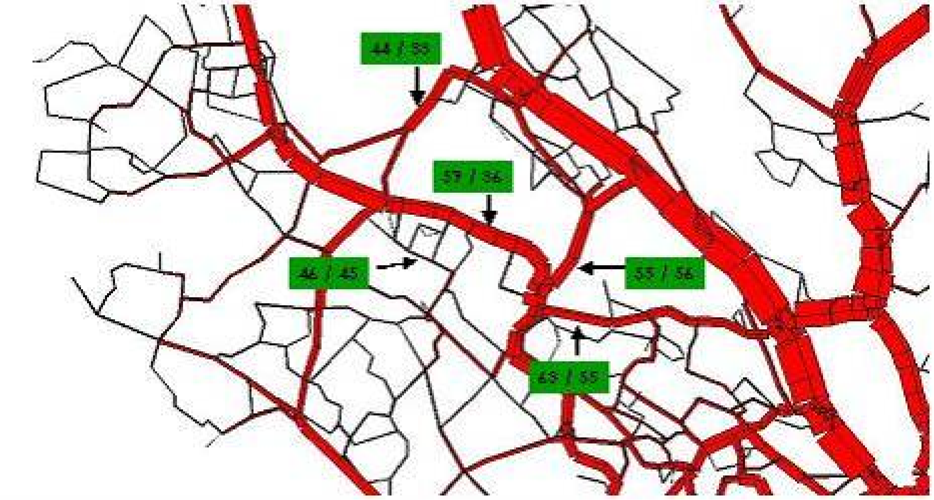


Figure 2-26. Speed [km/h] and flow pattern in peak hour traffic, alternative 0.

2.1.14 ALTERNATIVE 1

This alternative illustrates the traffic flow for alternative 1. As expected there are higher volumes on Kymlingelänken compared to alternative 0. It is a total increase of approximately 1300 vehicles and the volume on Enköpingsvägen has decreased by the same amount. The total volume on the rebuilt E18 including both the motorway and the inner local street is around 4600 vehicles, which is 600 higher than in alternative 0. The volume on motorway E4 between Enköpingsvägen and Kymlingelänken has increased by about the same amount though (not shown in the picture).

There are small variations in volume on the local street Tenstavägen which is due to the location of the new on – and off ramp. Moreover the new inhabitants and working sites in Stora Ursvik give contributions to the volumes of roads near the area. On roads further away the contribution is minor. The exact figures have not been calculated.

Average speeds on the selected links are shown in the simulation beolw. As expected the speed on Enköpingsvägen is reduced due to the new speed limit. A reduction also appears on Kymlingelänken caused by the decrease in traffic volume. Noteworthy is that the speed on E18 has not changed significantly. This is because the road is still a large through route.

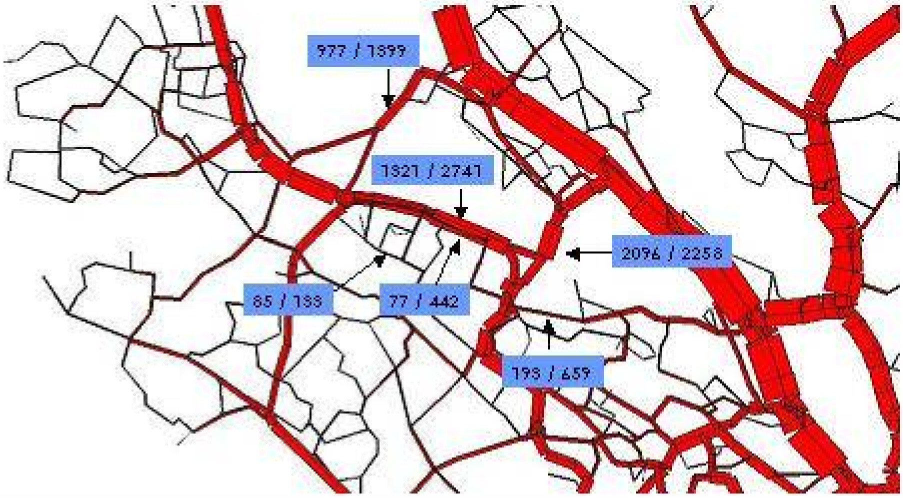


Figure 2-27. Traffic volume morning peak hour, alternative 1.

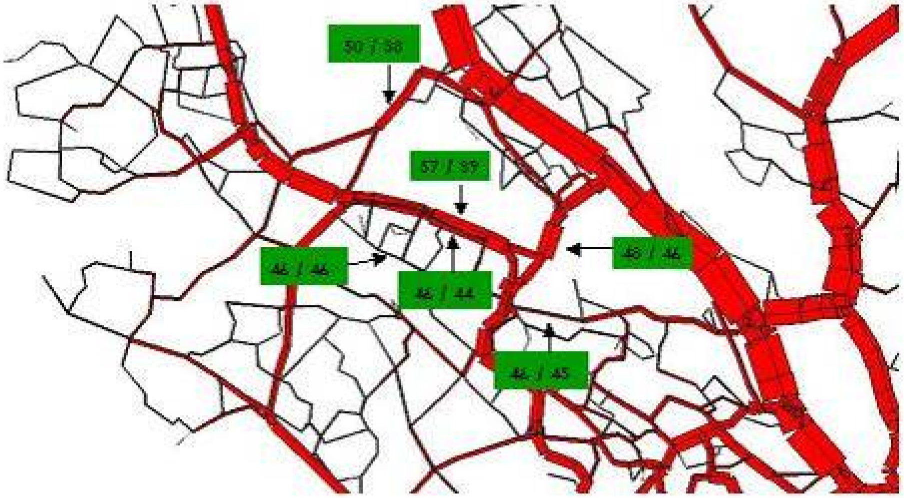


Figure 2-28. Speed [km/h] and flow pattern in peak hour traffic, alternative 1.

2.1.15 ALTERNATIVE 2

Alternative 2 shows as expected a more sparse flow pattern, illustrated below. The model outputs is a result of the many elements added and changed to build alternative 2. It is not possible to determine which contribution each solution gives to the model results. However with knowledge about the transport model and the implementations made an analysis can be made on an overall approach.

There is a general increase in traffic caused by the new housing areas and working sites. New possible route choices lead to increased volumes in the areas Rinkeby, Tensta, Akalla and Kista. For example the town planning creates new access roads to the working sites Kista and Lunda, illustrated in green in the noise simulation maps. This gives a reduction in traffic volumes on the route marked in orange and on Kymlingelänken. A comparison between all scenarios shows that alternative 2 has the lowest flow on Kymlingelänken, however with the highest speed as a result of this. (Speed results are shown below).

The volume on E18 has reduced by approximately 600 vehicles compared to alternative 0. We also see a reduction in flow on Akallalänken compared to both alternative 0 and 1. This is mainly due to the increased number of alternative routes across the area and changes in speed limits. Moreover volumes and speed on Enköpingsvägen are at the same levels as in alternative 0.

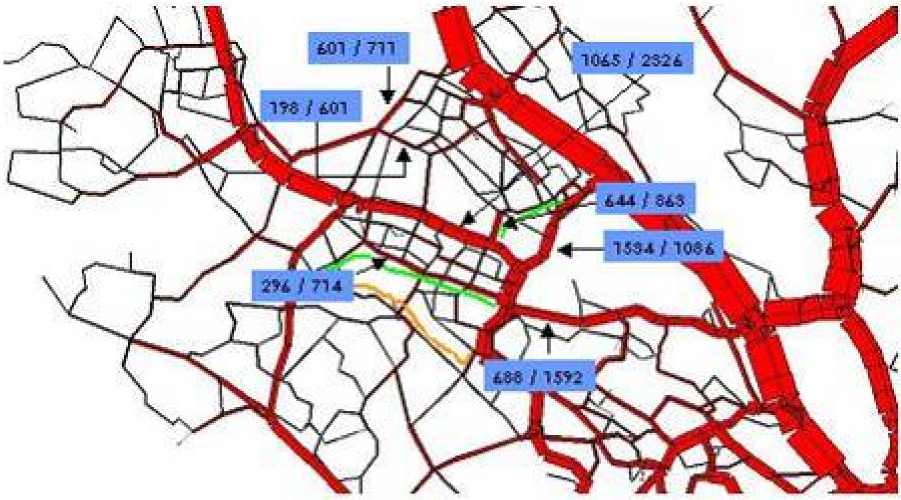


Figure 2-29. Traffic volume morning peak hour, alternative 2.

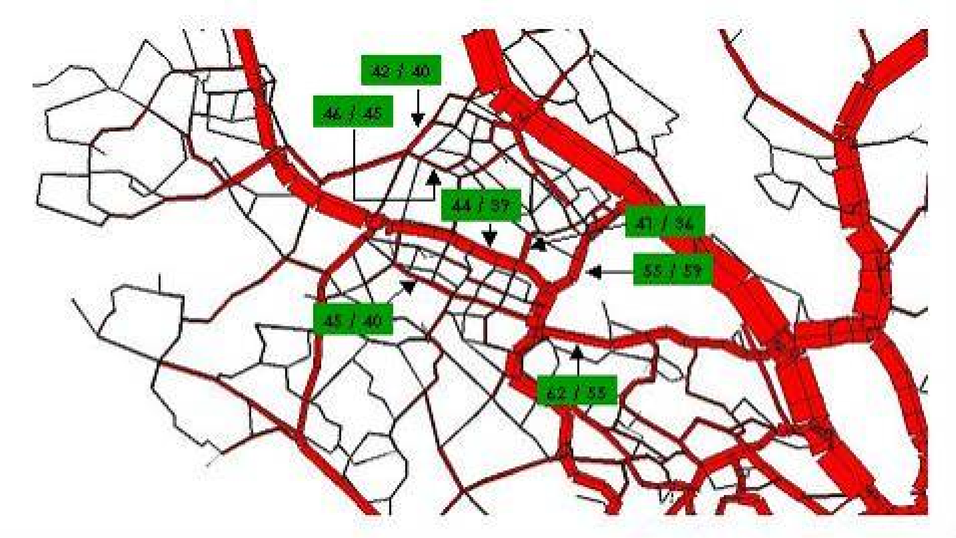


Figure 2-30. Speed [km/h] and flow pattern in peak hour traffic, alternative 2.

2.1.16 CLOSE UP RESULTS ON RINKEBY

Below follows figures illustrating results in a close up view of the Rinkeby area. Since overall evaluations already have been made it is left to the reader to make comparisons between the three alternatives in this regard.

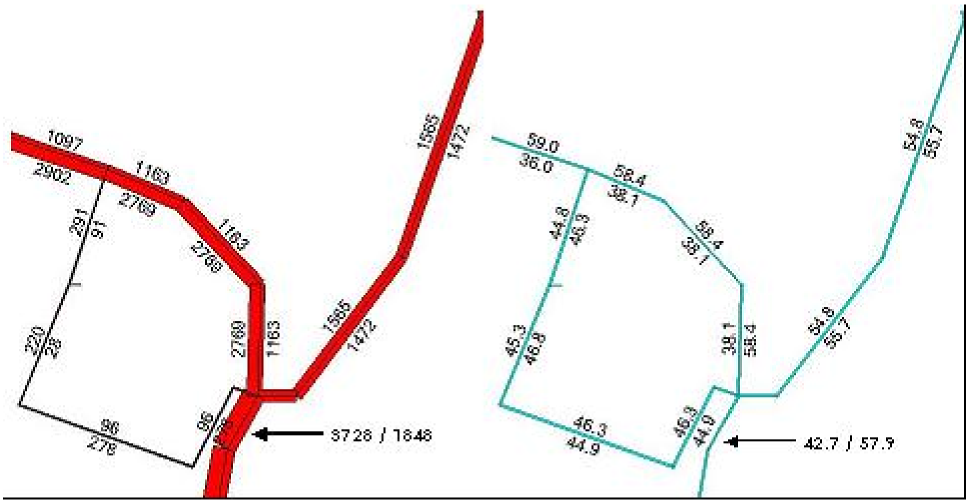


Figure 2-31. Traffic volume and speed at Rinkeby, alternative 0.

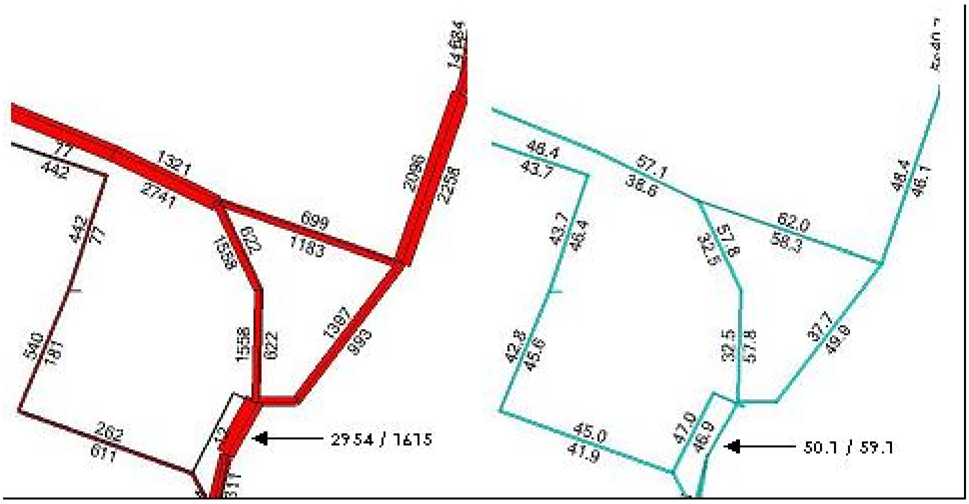


Figure 2-32. Traffic volume and speed at Rinkeby, alternative 1.

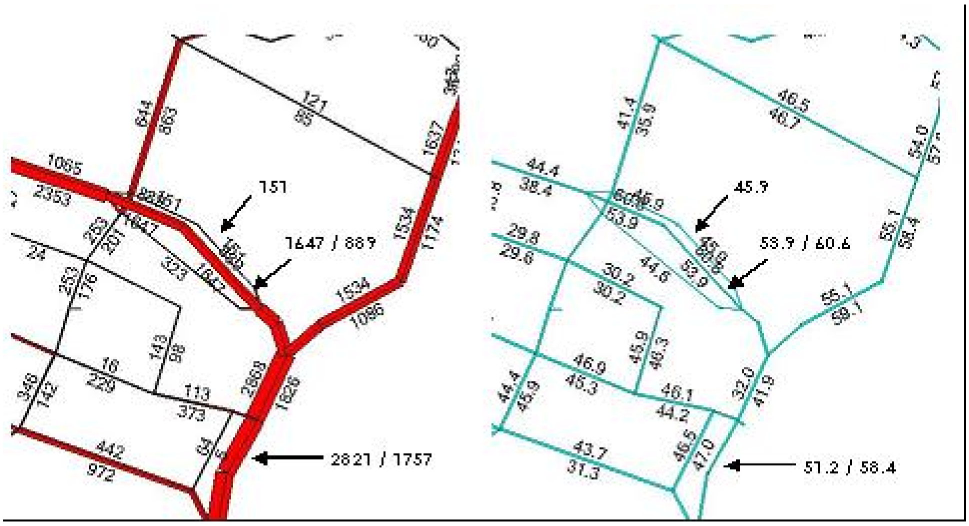


Figure 2-33. Traffic volume and speed at Rinkeby, alternative 2.

2.1.17 ADAPTING TRAFFIC FORECASTS TO NOISE MAPPING SOFTWARE

In order to use the outputs of the traffic model as input to the noise mapping software CadnaA an interface has been developed in WP 2.3. This method handles both differences in network representation and aggregation levels of traffic data. The interface is described exhaustively in deliverable D2.4, here only follows a brief description.

For each traffic scenario analysed a key between the model links and the roads described in the related shape file is created. The key makes it possible to connect model outputs to the shape files attribute list and consequently import traffic data to CadnaA.

The peak hour and off peak hour simulation results were recalculated to represent daytime traffic. Evening traffic and night time traffic was not considered. Traffic data calculated and used as input to CadnaA is traffic flow, speed and share of heavy vehicles.

References

Beser, M. and Algers, S., (2002) 'Sampers – The New Swedish National Travel Demand Forecasting Tool', in Lundqvist, L. and Mattson, L. –G (eds), *National Transport Models – Recent Developments and Proscpects, Advances in Spatial Science*, Springer-Verlag, Berlin, pp. 101-118.

Deliverable 2.4 QCity, Sundbergh, P. and Alger, S., (2006) 'Traffic control measures for vehicles: Basic Concepts'

2.1.18 APPENDIX A. OFF PEAK HOURS SIMULATION

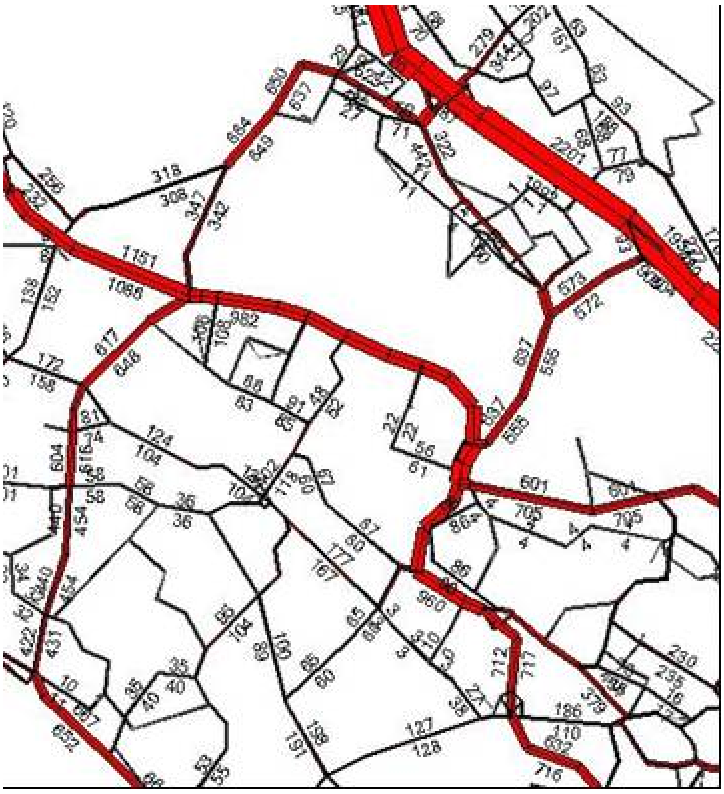


Figure 2-34. Traffic volume alternative 0, off peak hour

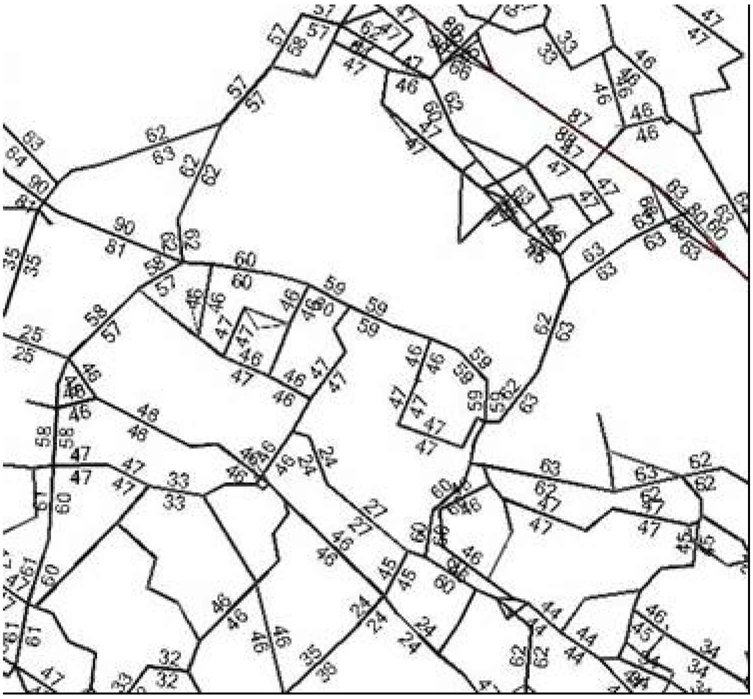


Figure 2-35. Speed alternative 0, off peak hour.

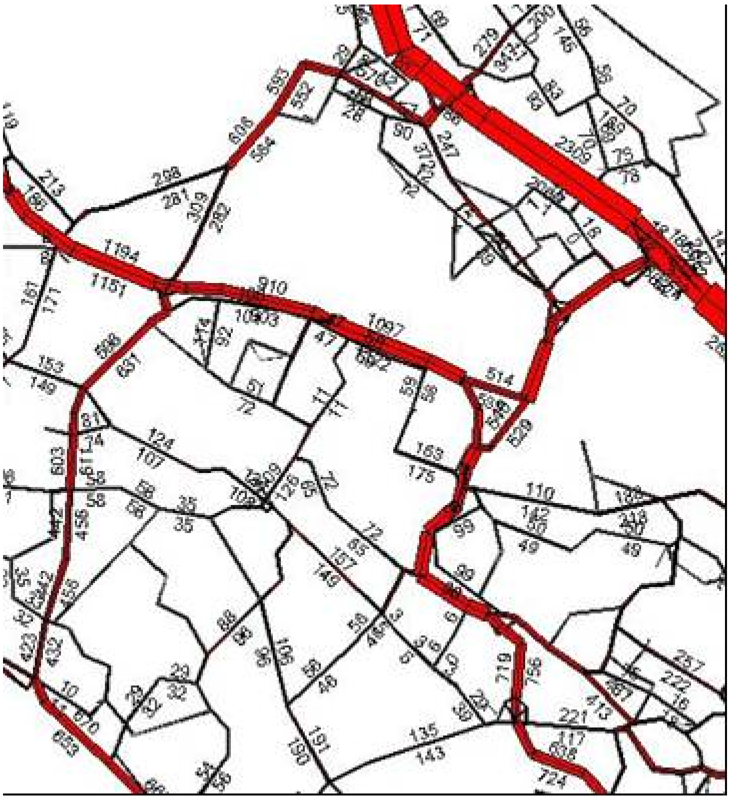


Figure 2-36. Traffic volume alternative 1, off peak hour

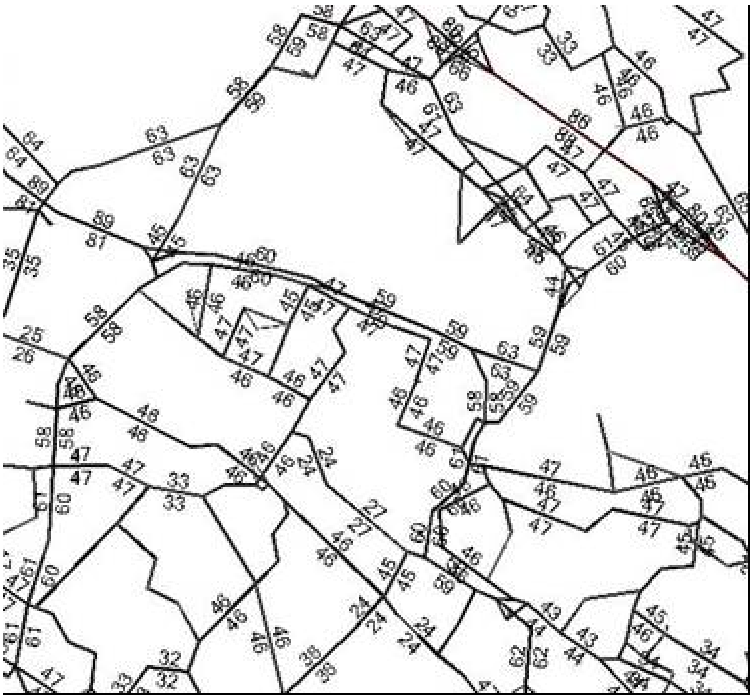


Figure 2-37. Speed alternative 1, off peak hour

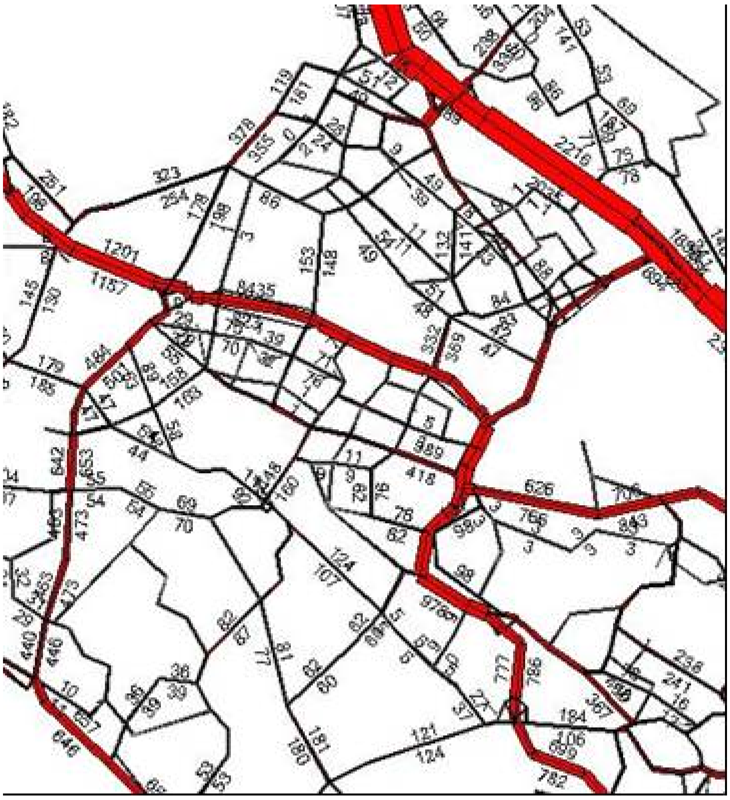


Figure 2-38. Traffic volume alternative 2, off peak hour

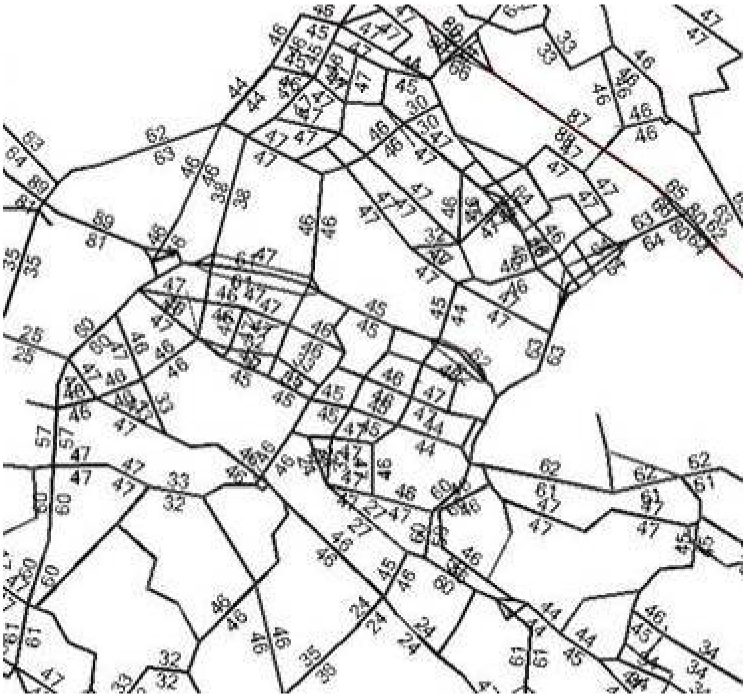


Figure 2-39. Speed alternative 2, off peak hour.

2.2. DESCRIPTION OF COMPUTER SOFTWARE AND RESULTS FROM SIMULATION OF TRAFFIC NOISE

2.2.1 THE NOISE CALCULATION SOFTWARE USED

When creating noise maps CadnaA (developed by Datakustik GmbH, Munich) will be used. CadnaA is a commercial software, continually updated and improved with the latest prediction methods and calculation algorithms.

Calculations will be performed according to official Nordic prediction methods for respective source. For road traffic noise the Nordic prediction method for road traffic noise, rev. 1996, will be used.

The CadnaA software automatically manages the effects of ground absorption, screening, reflections etc. according to the official prediction method.

Calculations demand a 3 dimensional map (Data Terrain Model, DTM) as well as data for the different kinds of sources, e.g. the amount of traffic on a specific road or the sound spectrum for a specific source.

The terrain model is built with contour lines defining the height along the line. Locations of larger wooded areas, lakes shore lines, locations of buildings and screens as well as their height are then implemented to complete the digital terrain model (DTM).

The roads are fitted to the DTM. The bridges and overpasses are taken into account by letting the road “float” at the defined height. No sources are placed when roads are in a tunnel.

More information about CadnaA can be found on the webpage www.cadna.de.

2.2.2 ALTERNATIVE 0

Alternative 0 is a model of the area as it looks today. The 3 dimensional DTM, which can be seen in the figure below, is built up using contour lines, ground absorption, buildings, foliage and roads containing information about the traffic density. Data for the noise calculations are given from the traffic simulations.

Figure 2-40. 3-D model containing roads, buildings, contour lines, ground absorption and foliage for alternative 0 calculations in CadnaA

2.2.3 ALTERNATIVE 1

In alternative 1 new road-sources were created and new attributes were given from the traffic simulations. New housing in “Stora Ursvik” is also added.

Figure 2-41. 3-D model containing roads, buildings, contour lines, ground absorption and foliage for alternative 1 calculations in CadnaA

2.2.4 ALTERNATIVE 2

New housing in the areas north of Enköpingsvägen and west of Kista is implemented. A number of new road-sources are created as links between Kista and Rinkeby. The new sources are given attributes from the traffic simulations.

Figure 2-42. 3-D model containing roads, buildings, contour lines, ground absorption and foliage for alternative 2 calculations in CadnaA

2.2.5 NOISE MODEL RESULTS

As the simulated traffic data is implemented into the ground model, some interesting remarks can be made about the calculated sound levels. The paragraphs below show the results and the differences between them. All results are calculated using a 2 x 2 m grid located 4 m above the ground

2.2.6 ALTERNATIVE 0

The result below show the calculated noise levels as for today.

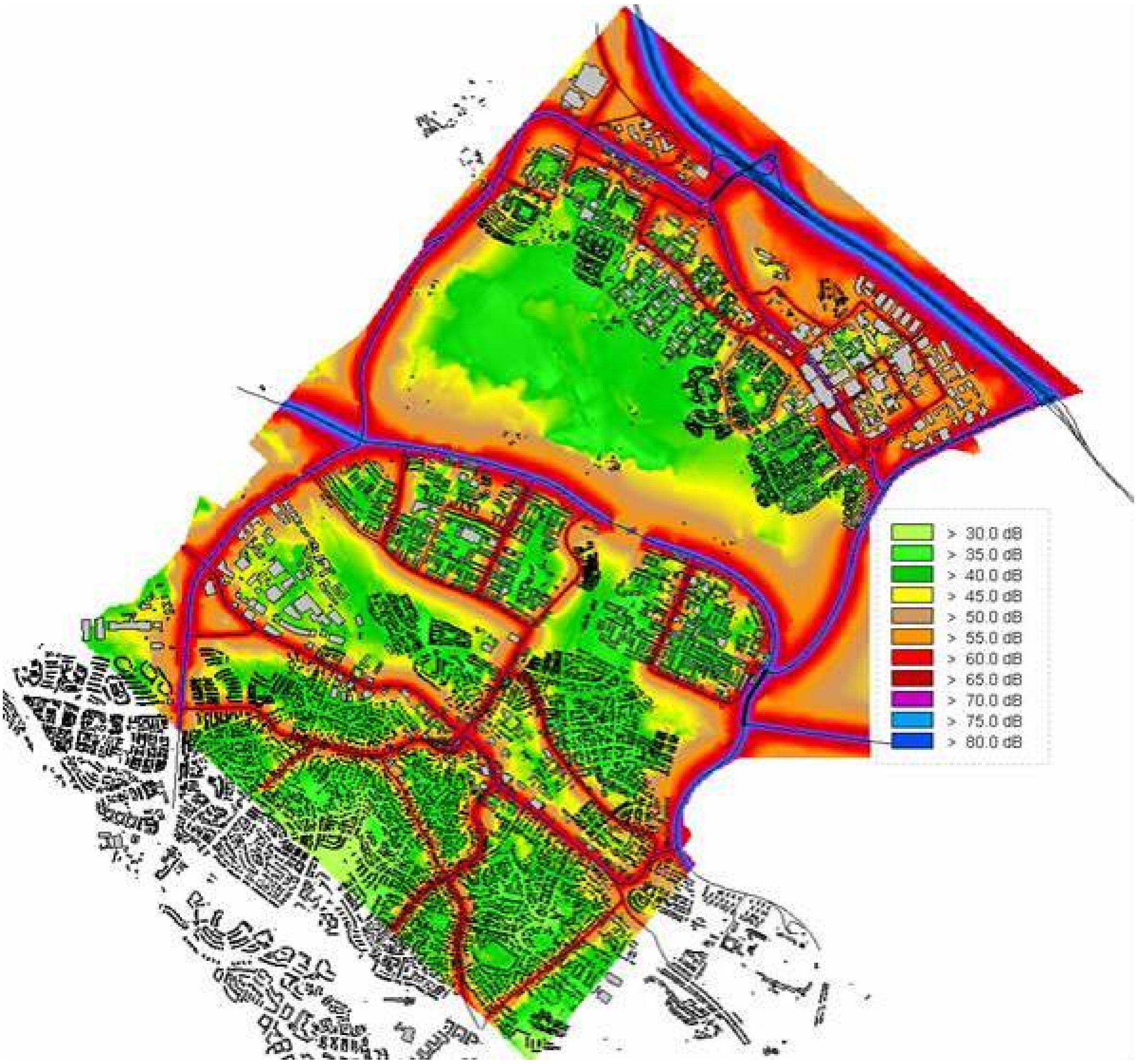


Figure 2-43. Equivalent sound pressure level calculated for alternative 0 as today.

2.2.7 ALTERNATIVE 1

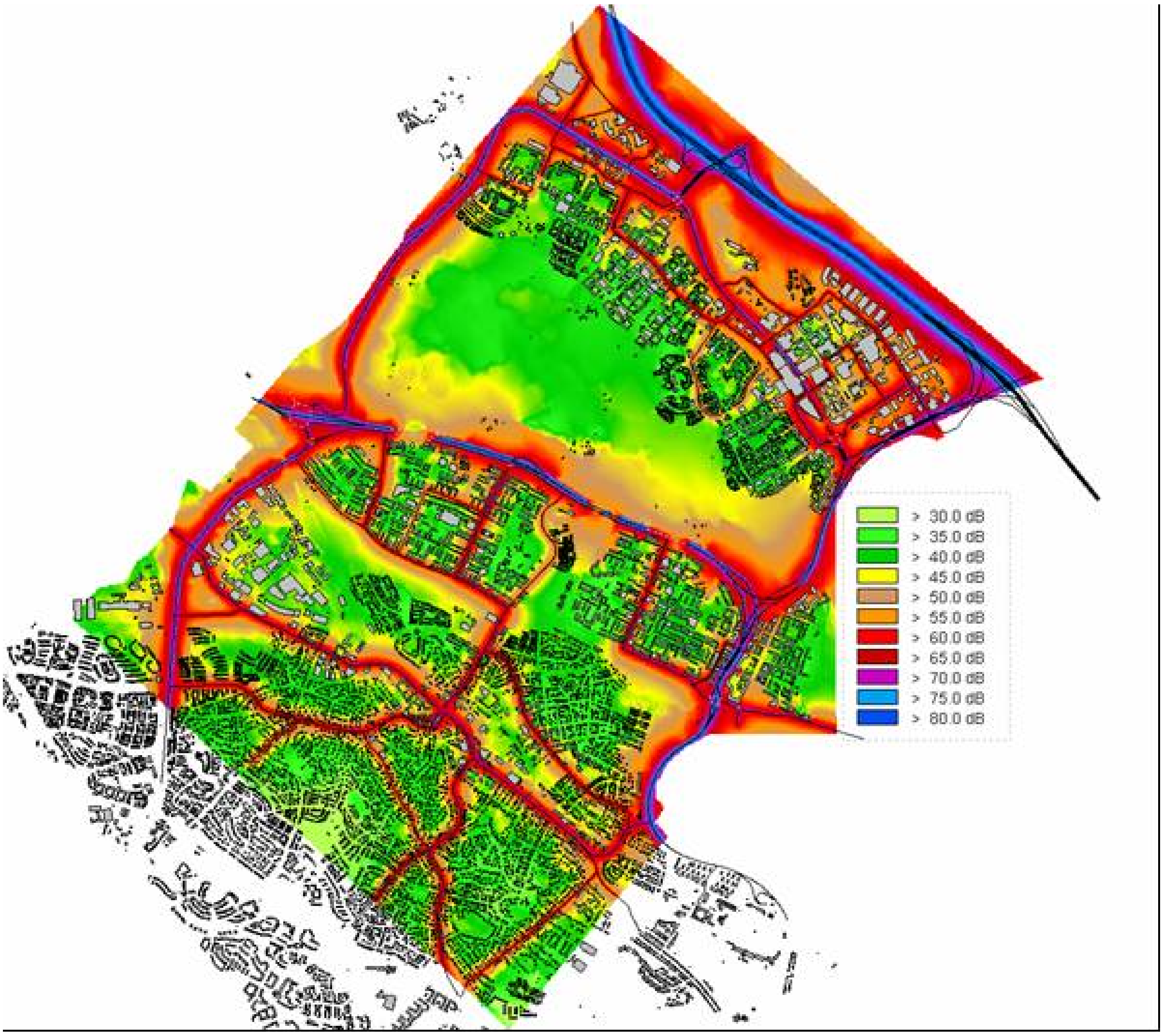


Figure 2-44. Equivalent sound pressure level calculated for alternative 1

Comparing alternative 1 and alternative 0 is calculated it can be seen that the levels have decreased substantially around one of the main roads through the area, E18 Enköpingsvägen, even though the amount of traffic have increased. The only dramatic increase in noise levels is noticed at the junction between E18, Enköpingsvägen and Kymlingelänken, even though the amount of traffic have increased (the explanation for this is the new tunnels along some short stretches). The calculations also show a decrease of noise levels around the new housing in “Stora Ursvik” (the added area far east in the middle). One reason for this is the screening effect caused by the new office buildings along the road.

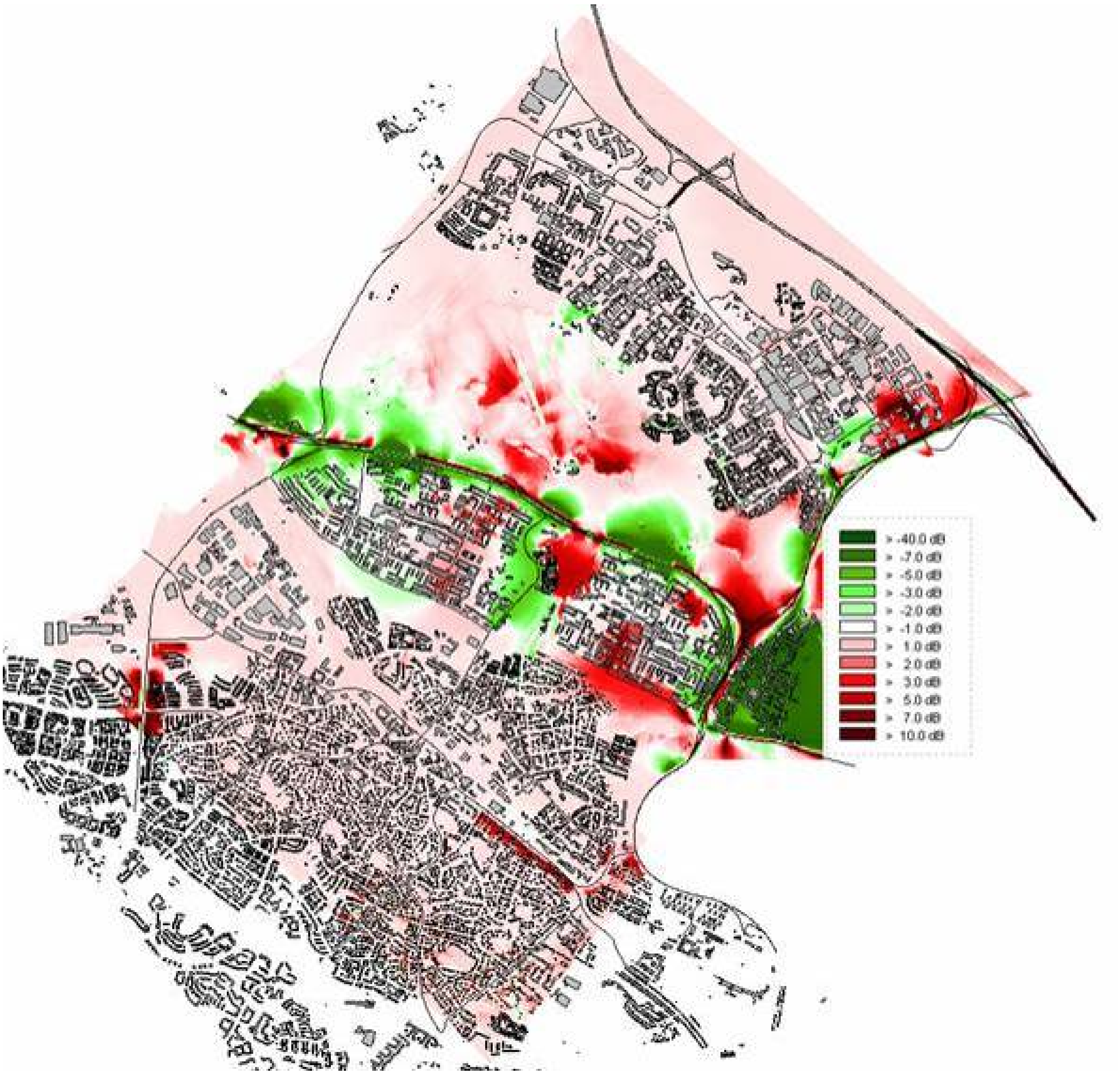


Figure 2-45. Difference between alternative 1 and alternative 0 calculated in dB-units. Green colour indicates a reduction of the equivalent sound pressure level.

2.2.8 ALTERNATIVE 2

This alternative includes more access roads between Akalla/Kista and Rinkeby/Tensta. This leads to higher noise levels around the southern part of the new housing in Kista. The amount of traffic on E18 Enköpingsvägen have decreased, thus also the sound levels.

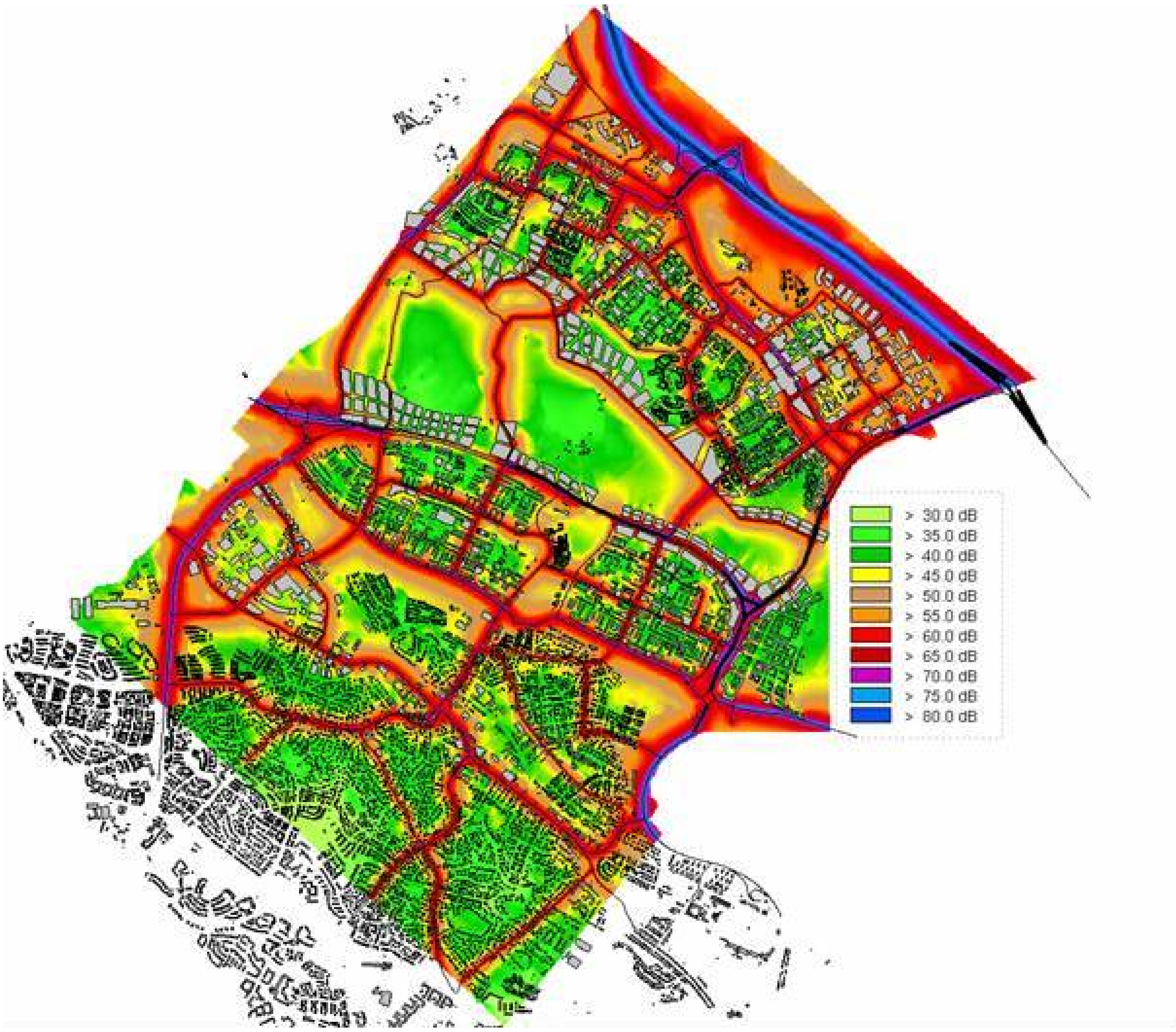


Figure 2-46. Equivalent sound pressure level calculated for alternative 2

The difference between alternative 2 and alternative 0 however show an increase of noise levels in some of the populated areas due to many new streets and roads and increased traffic density at some points. The new housing blocks, just north of E18 (Enköpingsvägen) serve as noise screens giving a reduction of the traffic road noise for the area north of E18.

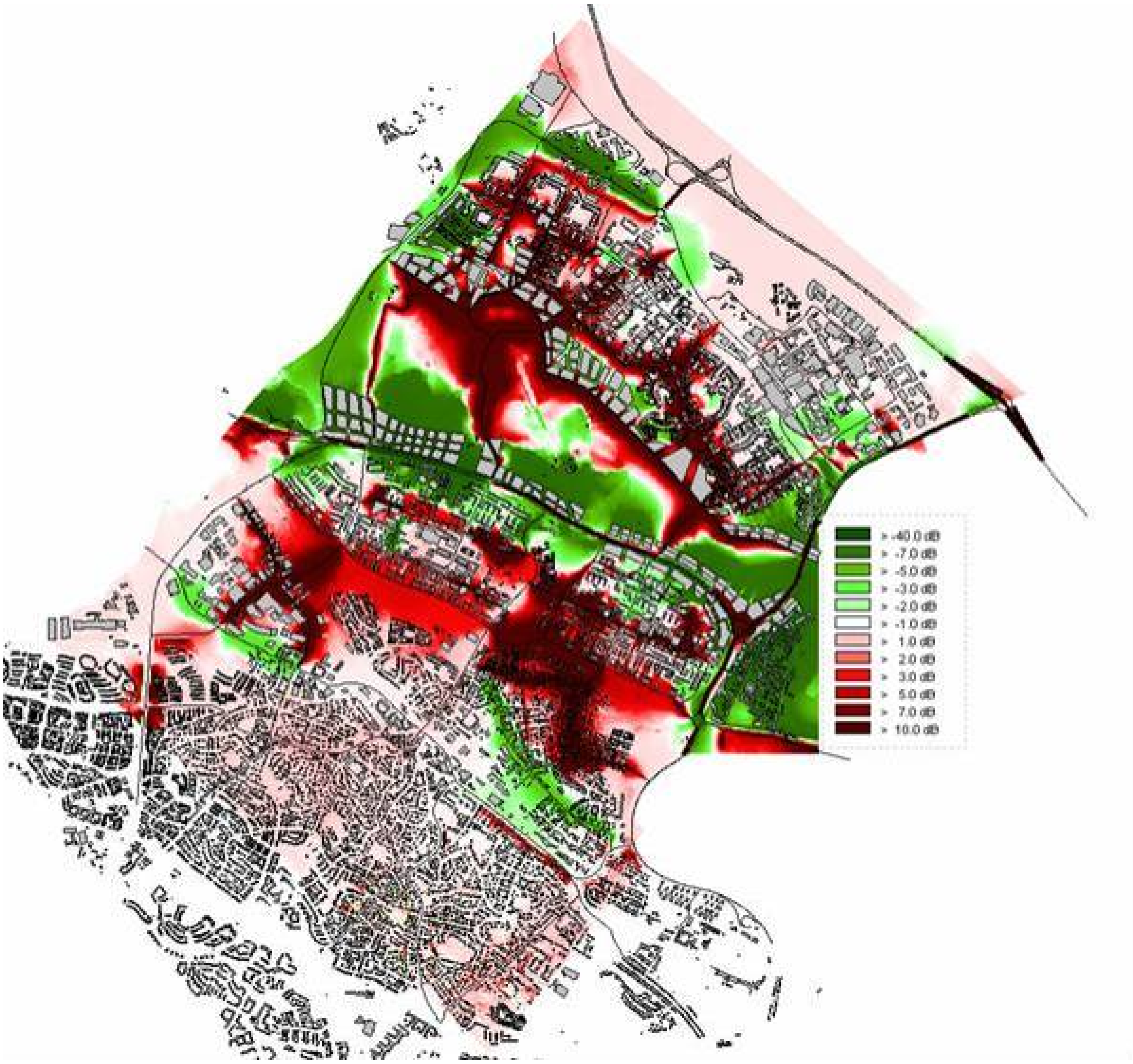


Figure 2-47. Difference between alternative 2 and alternative 0 calculated in dB-units. Green colour indicates a reduction of the equivalent sound pressure level.

2.2.9 RESULTS IN TOTAL

The difference between alternative 2 and alternative 1 shows a lower noise level around the new housing north of E18 Enköpingsvägen. To the opposite the noise levels south of Kista show an increase in alternative 1 compared to alternative 2.

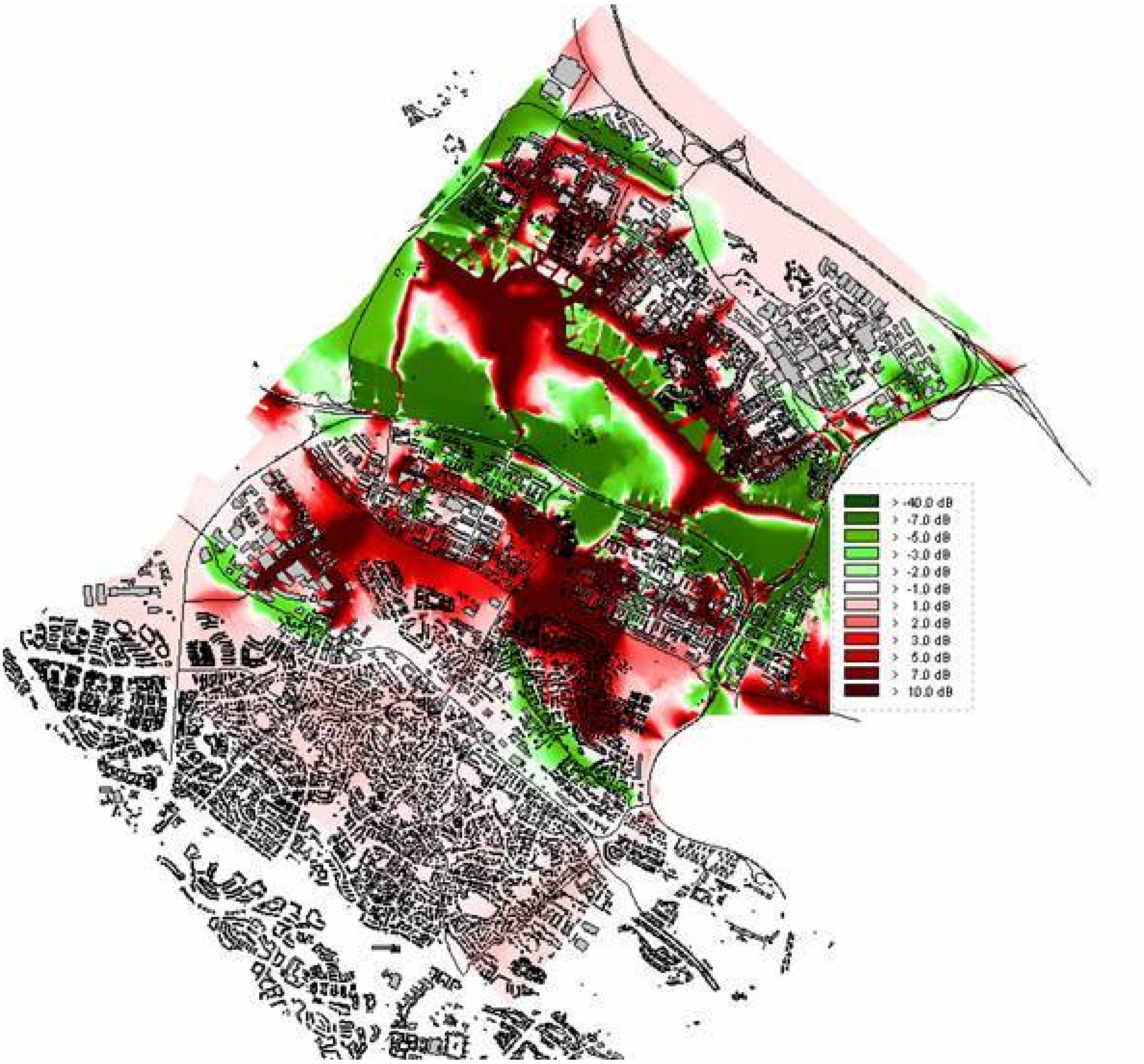


Figure 2-48. Difference between alternative 2 and alternative 1 calculated in dB-units. Green colour indicates a reduction of the equivalent sound pressure level for alternative 2 relative alternative 1.

These results are interesting but it does not tell anything about the noise levels that the inhabitants of the new housing are exposed to. To visualise this a map for each scenario are constructed to show where people are exposed to levels above 55 dB(A).

Figure 2-49. Areas where people in alternative 0 are exposed to levels above 55 dB(A). Green colour means an equivalent sound pressure level below 55 dB(A).

Figure 2-50. Areas where people in alternative 1 are exposed to levels above 55 dB(A). Green colour means an equivalent sound pressure level below 55 dB(A).

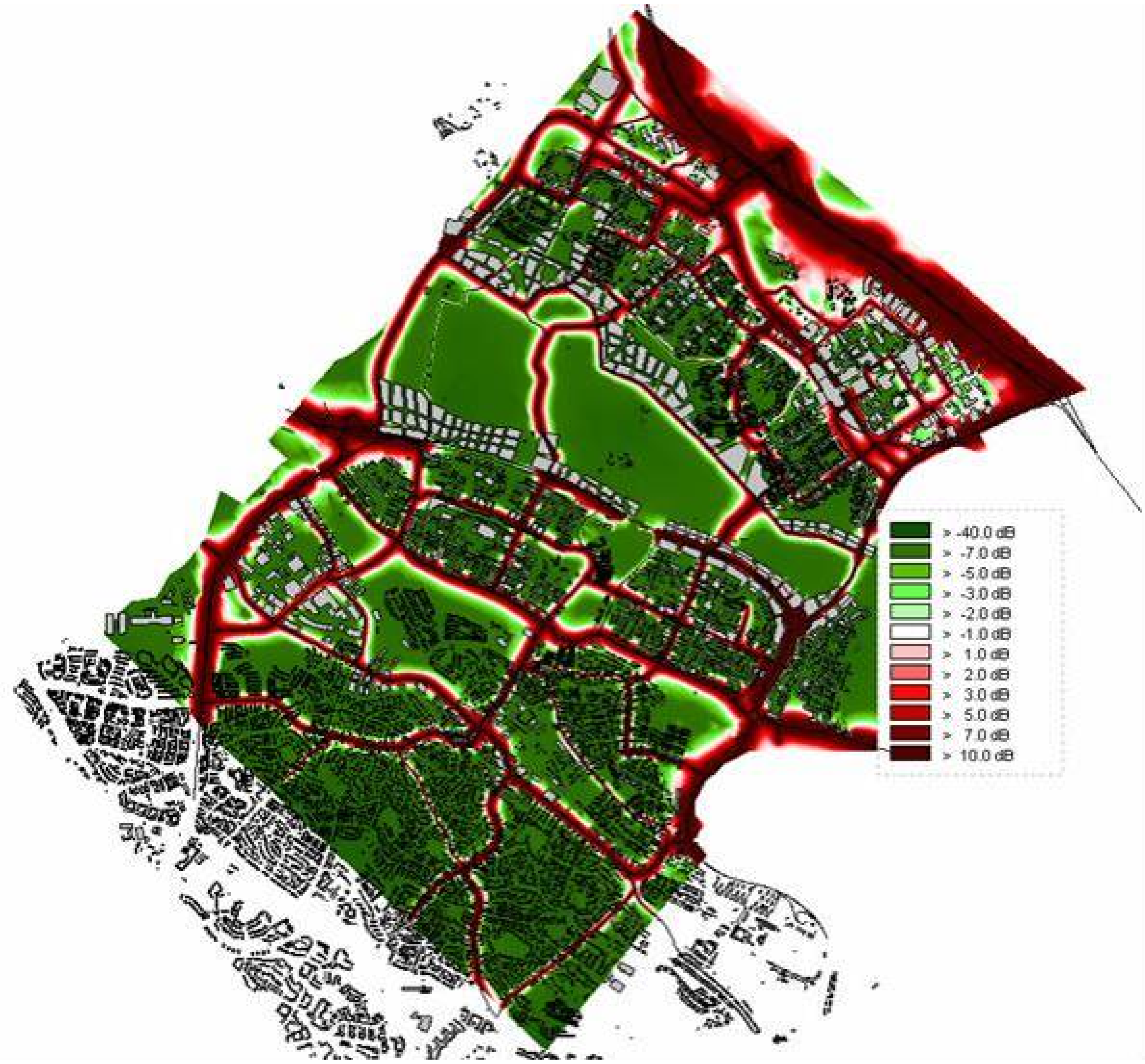


Figure 2-51. Areas where people in alternative 2 are exposed to levels above 55 dB(A). Green colour means an equivalent sound pressure level below 55 dB(A).

2.3. COST-BENEFIT ANALYSES OF NOISE REDUCTION MEASURES IN TESTING AREA

The method is an effective tool to evaluate noise reduction measures and highlight the cost-effect relations. The method is presented in D4.5.

The noise levels in different scenarios are used to calculate how much a specific measure is monetary worth. The method uses parameters such as floor/ground ratio, rental/m2/year and the rental change with respect to changes in noise level. These parameters are then used along with the actual noise level for the different scenarios to calculate a value representing the noise reduction measure taken.

2.3.1 TESTED SCENARIO

Applying the cost-benefit method to a large area with substantial changes is road layout and town planning presents some difficulties. For example, the noise levels in a specific point can be significantly changed to the worse due to changes in road layout even if the new road position is the overall better choice. This results in an increase in rental deprivation rather than the opposite.

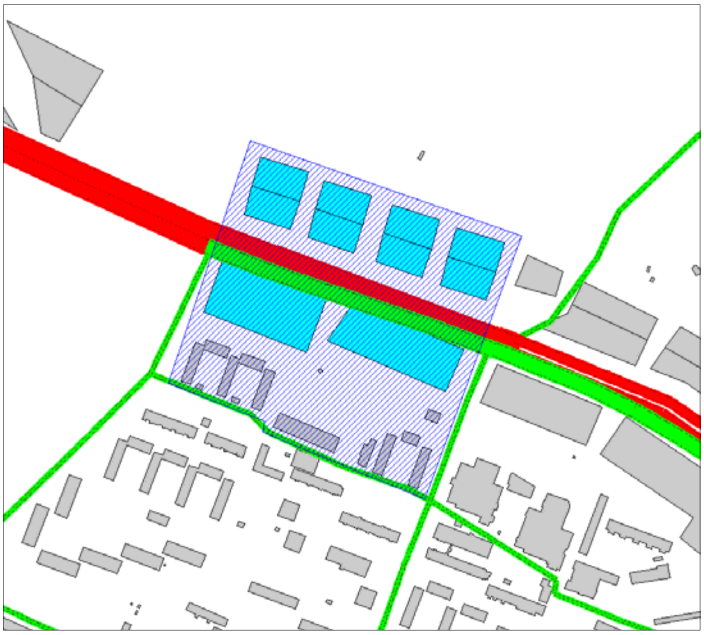


Figure 2-52. The area selected from Järvafältet includes new houses (blue) as well as new roads (red).

In these particular scenarios, alternative AJ0, AJ1 and AJ2, the future predicts more traffic, new roads as well as buildings used to shield the surrounding areas from the increased traffic noise, as a consequence, setting the parameters for the cost-benefit analysis in this case is proven to be extremely difficult.

In a relative large area, such as the whole perimeter of Järvafältet, no consideration is taken to the areas kept “noise free”. Therefore a small area around Enköpingsvägen was chosen as a demonstrative example. Grids calculated for alternative AJ0, AJ1 and AJ2 was use in the analysis. The example includes new buildings, new roads and an increase in traffic volume. No quiet areas behind the new houses were included in the analysis, thus generating a more accurate result. This particular area was chosen to have similar road layouts between the alternatives.

2.3.2 ENCOUNTERED PROBLEMS

One should not underestimate the difficulties in setting the parameters. The floor/ground ratio was set to 0.8 as in D4.5. Setting this parameter should in some way include the new buildings as well as the old. The rental/m2/year naturally differs between the new and the old buildings. The parameter was set to the same used for the old buildings, namely €80/m2/year. The rental abatement was set to 1 dB per percent in the region between 55-70 dB(A) according to D4.5.

The grids calculated for the three alternatives also present problems. The grid is calculated beneath the new buildings, thus giving a greater difference in noise levels than in strict scenarios without new buildings.

2.3.3 RESULTS

Considering the problems stated above the results show quite realistic values. The difference in rental abatement between AJ0 and AJ1 is €160 000 and between AJ0 and AJ2, €170 000. The true complications now lay in translating these sums into actual changes in the town plan.

The cost-benefit method has in this case been used in an inappropriate way by evaluating areas with changes in town planning, road layout etc. As described in D4.5 the method is an excellent way to evaluate the benefits in implementing specific noise reduction measures.

2.4. CONCLUSIONS, RELATED TO URBAN AND TRAFFIC SYSTEM LAYOUT

The scenarios have shown how road systems affects noise propagation into built up and open areas. In this section effects are discussed following this agenda:

Effects on the Urban Scale
Evaluation according to the Bristol Accord Sustainability Criteria's
Evaluation with use of the Value rose
Discussion on further development of Cost-Benefit Analysis

2.4.1 TOWN PLANNING STRATEGIES FOR FURTHER REDUCTION OF NOISE PROPAGATION : THE URBAN SCALE

The following illustration used in the European Union project ARTISTS shows the manifold of demands that different users can make on the same street environment. Low noise disturbance is an important but not superior demand.

Figure 2-53. Devon County Council (1991). Traffic Calming Guidelines.

Traffic flows and congestion effects, before and after.

The traffic system of A1 compared to A0 will probably have the intended effects. It will intensify the westward traffic to E 18 and its new part, The Kymlinge Link, where the speed during peak hours however will be lower than today. The traffic on the old part of E 18 further to the east will be strongly reduced, as well as along the north-south Link. The "cutting off", of the present level crossings entrances into Rinkeby and Tensta south of E 18, probably helps to limit the calculated substantial increase of traffic flow. At the same time it will create a more local and isolated traffic pattern that will force inhabitants to making detours. The system is designed to reduce congestion generating crossings, but will, due to traffic movements in themselves, not have the high speed and congestion free function as could be expected (see example of traffic simulations, Chapter 2.2.11, Close up results on Rinkeby).

The traffic system of A2 compared to A0 is quite different, with several possibilities for crossing in different directions. It gives higher accessibility to E18 for the inhabitants in Tensta-Rinkeby. The traffic on E 18 is therefore calculated to become slightly lower than in A0. It will, as a positive effect, allow for higher speed on The Kymlinge Link close to Kista working area. New flows in the east-west direction on the new opened interior streets contain smaller flows than expected. The new road along the northern boarder of the Järva Field has, probably due to speed restrictions in the simulation, a very traffic flow. Further simulations could probably show how this street could be designed to relieve the pressure on major streets in the northern working/housing area. In this simulation, the northern street mainly has a function to provide access to new housing/working blocks.

New roads crossing the field have in this simulation a substantial flow, while traffic on The Akalla Link in the west is heavily reduced. The A2 traffic junction in the south of the test area, close to Rinkeby and the new officially planned housing/working area in Sundbyberg community is designed as a large scale roundabout. This could be compared to the three level junctions in A1. To evaluate the possible congestion effects in the local scale, further testing would have to be made with micro scale simulation software.

Noise disturbances, generally, before and after.

The noise map of A1 shows, generally, a reduction of noise in many parts along the field as a result of tunnels and buildings. A slight increase in the middle parts does not raise the level to more than 40 dB(A). Noticeable increases will occur around the two main junctions in the north and south end of The Kymlinge Link. At the planed traffic junction close to Hjulsta in the north, outside of the testing area, noise levels are very high. This area could also be an interesting spot for future development but has not been part of this project.

The noise map of A2 shows, generally, with its addition of new roads and streets a large increase in noise propagation, despite the new noise screening buildings between E 18 and the field. The new streets crossing the Järva Field reduces significantly the noise reductions generated by noise screening buildings. The new connected streets through the present housing areas also increase noise levels, but at a rather moderate level. The areas in the north of the Järva Field have, due to new proposed development, significantly higher noise disturbances.

"**Hot Spots"**

The noise reducing potentials of a more dense development pattern and a more urban street pattern could be evaluated in more detailed way. We have labelled these as "Hot Spots", for further detailed evaluation and discussion. To be able to evaluate the results, a more detailed study of traffic flows has to be conducted, with different computer software – microsimulation. Time has not admitted such a work in this deliverable. As an example, some Hot Spot areas are presented briefly.

Hot Spot 1) – Traffic junction E18-Kymlinge Link

The large scale roundabout solution close to Rinkeby shows a combination of higher and lower noise levels, that correspond to the previously suggested "**Transect based noise guide lines**" (**Chapter 1.2.6**). As can be seen below, noise levels are considerably l higher in A2 along the E18, compared to A1. Noise levels are in the same time considerably lower in A2 in the Järva Field close to the large scale roundabout, compared to A1. If applied, the idea of the "**Urban Quality Bonus**" could make the A2 solution acceptable from a noise perspective:

- A **higher** noise level than the WHO recommendations along the urbanised E18 Urban Highway

Is accepted...

- In exchange for a **lower** noise level in the adjoining open green park area.

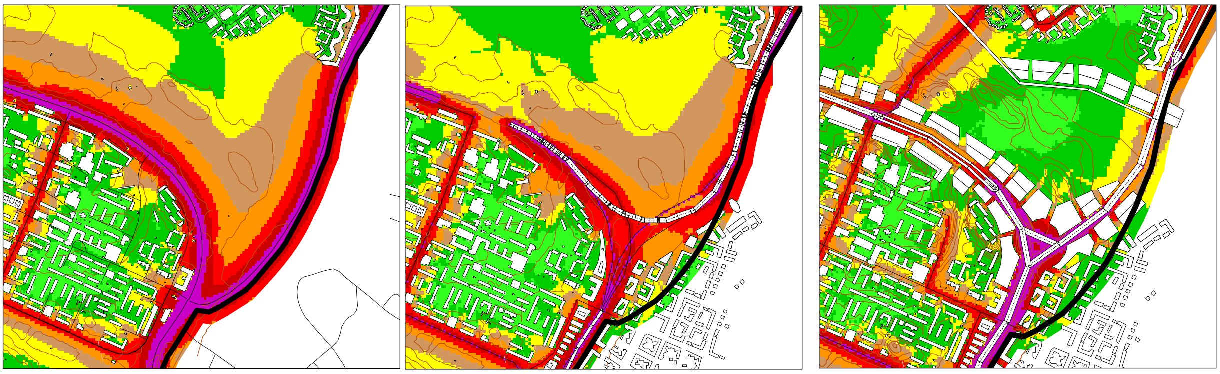


Figure 2-54. example of Hot Spot Study area. Alt 0, Alt 1, Alt 2.

Other Hot Spots that could be studied furhter are, for example:

Hot Spot 2) The Kymlinge Link

Noise levels on the Kymlinge Link, towards Kista working area is, due to the "Brussels Urban Highway" design lower in A2, compared to A1. If traffic flows, with three parallell entrance/exit roads to the working area are realistic, has to be studied more closely, with micro simulation computer models.

Hot Spot 3) New connecting streets over the Järva Field.

In the conducted noise simulations, new connecting streets have not been designed to reduce noise in the field. Small scale simulation would be possible, with added low screens and sunken street levels (reference: partly sunken streets in Central Park, Manhattan) and earth works.

Hot Spot 4) Brussels Urban Highway design at Tensta

The more precise design of entrances to high speeds tunnels offers a range of testing of geometric and material connected solutions. In the reference objects referred to, in Brussels, noise levels are sometimes disturbingly high. A combination of screens and absorbing materials should be tested and evaluated.

Hot Spot 5) New connecting local streets

As the overall noise maps show, the new connecting street nets in the present housing areas increase noice levels. To reduce negative impacts, a combination of new buildings, fine tuning of speed limits and street material, would be appropriate.

2.4.2 CONCENTRATION OF TRAFFIC FLOWS – NOTES ON A THIRD POSSIBLE ALTERNATIVE

During the simulation work, a combination alternative has also been discussed but not tested. This alternative solution combines part of the A1 traffic system with part of the A2 building pattern. In the following this possible alternative (that could have been labelled A3) is described.

The traffic layout of A1 concentrate the traffic but could also be supplemented with better noise screening developments along main roads and open areas such as buildings, screens, walls, relocated local roads, continuous screens, embankments, walls etc close to the road. Urbanists and town planners that have as a goal to bring urbanism on a level with the developing culture of mobility, such as Francois Ascher and Rem Koolhaas, may propose a policy for reducing noise levels **without** changing the basic traffic system. Concentration of regional traffic to a limited amount of high speed arteries could in this perspective be combined with the reinforcement and intensification of specialized areas, mainly equipped for commuters and passer-bys in the regional system with good access from the road. Since four or three decades this has obvious also to a large extent been the result of the more or less spontaneous development along urban highways, a development that almost everywhere is a hot target for regulating initiatives, also in Stockholm (planning, jurisdiction, popular opinions).

In most cases, the goal has also been to check, moderate and even inverse the process, especially when it comes to retailing. i.e. in general a rather defensive position towards roadside investments. Such a policy could of course, and will probably in a more moderate and not totally defensive way, be adopted in A1. However, to demonstrate the possibilities of the proposed scenario it is also necessary to look at the possibilities of the outlined proposition above, i.e. the ambition to encourage and facilitate the concentration of firms and functions to specialized nodes along the highways, and also giving place to, if possible, public transportation.

How does this affect noise propagation more than buildings unintentionally being noise barriers themselves? The point is that with the municipalities and stakeholders supporting and promoting the development of roadside functional zones, investments could more easily be combined with a wide range of screening measures elements combined with more practical functions - buildings, landscaping, signs, billboards or whatever - and, if reasonable, also securing good contacts with housing areas near by. In these functionally better defined roadside areas it is in other words a better chance that noise barriers will be architecturally integrated in the environment with the help of also private investments, e.g. display boards and walls given noise protective properties. At the same time, according to the function of the areas of course, this perspective of urban development also could lead to the development of new nodal points for surrounding areas, complementary to or creating problem for existing service centres.

To sum up, one goal of the urban policy could surely be that regional routes and their closest areas more than today are stimulated and allowed to become the main addresses for a manifold of specialized functions and clusters and even transformed to

- ***shopping areas*** - *malls, shopping centres*
- ***service nodes -*** *with hotels, petrol stations, restaurants, tourist offices*
- ***transport and logistic centres*** - ***amusement parks,*** *dancing palaces, cinemas*
- ***sport fields*** *with arenas, courts, training camps*
- ***health centres industries***
- ***dirty works***
- ***display corridors, etc.***

Several of these places or areas could easily be closed around the roads as dense corridors. This is however not the most attractive option. As an alternative, it could have been possible to choose a few some “spots” along E18, where the propagation of noise into housing areas could be reduced by this kind of urban nodes that are served by the road as it is planned in A1. This alternative, that could have been labelled “Alternative 3” has however not been tested in traffic and noise simulations.

2.5. EVALUATION BASED ON THE BRISTOL ACCORD URBAN GOALS

In our comments and interpretations of the Bristol Accord a number of suggestions on traffic systems and noise disturbances were presented. In this section we use these interpretations for an evaluation of the **three different traffic system layouts** – and their respective effects on **traffic** and **noise**. The Bristol Accord interpretations are shown to the left, with short comments on the three alternatives in the columns to the right.

To present a more convenient and easy to read evaluation, points are given on each aspect – every alternative can be given a minus (-1) a neutral point (0) and a plus (+ 1). The text on each aspect is discussed in brief and given a point. The numbers of points in each of the Eight Characteristics of a Sustainable Community (collected in the eight squares) are added together in the right columns.

> **Example:** The first square evaluates the ACTIVE, INCLUSIVE AND SAFE aspect:
>
> **Alternative 0**, present situation, is described in words only – and is given 0 point (alternative zero = alternative to compare with)
>
> For **Alternative 1** the evaluation is: +1, 0, -1, 0. Which adds up to: **0 points** (neutral).
>
> For **Alternative 2** the evaluation is: 0, +1, +1, -1. Which adds up to: **+1 points**.

The eight different Bristol Accord Goals for Urban Development are in this way possible to summarize with numbers – and a **total sum** is presented in the end of the following tables.

Note that this evaluation is based on **estimations** – as are our interpretations of the Accord itself. The results should therefore be taken as an **illustration** of possible effects, given that the reader is in somewhat agreement with the following:

1) The Bristol Accord gives a neutral and fair description of urban development goals.
2) The interpretations of the Accord, on the two questions on traffic an noise, are neutral och fair.
3) The evaluation of the two alternative layouts is neutral and fair.

The Bristol Accord interpretation	Comments on layout alternatives			Tentative Points		
	A 0	A 1	A 2	A 0	A 1	A 2
1) ACTIVE, INCLUSIVE AND SAFE						
• Equal treatment of noise disturbances generated from traffic, regardless of the "social status" of the area. • Easy access to leisure (etc) areas. • Make sure that traffic system does not divide the city into separate "social status" areas. • Low noise levels in parks, squares etc.	High noise levels in low class housing areas. Bad access. Very strict divisions between social areas. Generally silent internal parks and squares. Noisy large park.	+1, Some investments to reduce noise in low class areas. (could be given zero points...) +1, Somewhat better access. -1, even higher division than today in separate areas. 0, Large park more silent. Some areas more noisy.	-1, Both work and housing areas get more noise from local traffic. +1, improved access to large park. +1, more connected street net, interior as well as external- -1, More noise in large park. More noise in internal squares.	0	+1	0
2) WELL RUN						
• Develop, if local inhabitants so demand, new visionary plans for neglected areas. • Listen to critical voices regarding problems in the performance of present traffic systems. • Cooperate closely with local citizens to reduce noise disturbances.	Plan developed before inhabitants had moved in... A above. As above.	-1, very little communication, low amount of "visions" -1, local critique of present situation in neglected areas not taken into account. -1, low amount of cooperation, top-down-planning.	+1, more visionary plan in neglected areas. +1, local demand for integrated streets has been taken into account -1, low amount of cooperation, top-down-planning.	0	-3	+1
3) WELL CONNECTED						
• Reduce car traffic dependency (and with that noise levels) by better public transport. • Improve parking, especially close to shopping/services. • Develop more connected and integrated street networks and transport systems (bus/trains, etc)	High local access to subway, less good bus transport. Hard to find and few parking places. Very differentiated street net.	0, no planning for streets with better bus connections. 0, as today. -1, less integrated street network is proposed.	-1, higher access for cars and with that higher noise levels. +1, better car access to shopping and services. +1, more integrated street network, more direct bus routes are made possible	0	-1	+1

4) WELL SERVED						
• Promote traffic systems that create good preconditions for and high accessibility for establishment of local shopping and services. • Create safe and low noise areas for children and family life. • Follow integrated and holistic approaches in planning and design of traffic, buildings and leisure areas	Traffic system of today creates low accessibility for local shopping and services. Safe areas with low amount of through traffic of cars. Area planned on ideas of dis-integration of functions - strong division of traffic and buildings.	0, as today. +1, local improvements, by screens and tunnels. 0, as today	+1, substantial improvement of accessibility. -1, through traffic gives higher noise and less safety. +1, more integrated approach, streets and buildings planned to interact more than today	0	+1	+1
5) ENVIRONMENTALLY SENSITIVE						
• Reduction of traffic noise by screening techniques and reduction of total amount of vehicles. • Where applicable, conversion of high speed roads to more walking/cycling friendly streets. • Reduction of car traffic speed and, "tunnelling" of necessary high volume roads. • Promote traffic patterns that allow for more dense building patterns, to facilitate public transportation and a healthy local environment.	No screening techniques applied when area was built. High speed roads separated from safe walking and cycling paths. Tunnels not built from the outset, due to lack of funding. Rather high density in over all area, high level of public transportation from the outset.	+1, new screens built along major highway close to housing. 0, no conversions made. 0, higher car traffic speeds on highway, buildings above road. 0, new traffic pattern does not allow for more buildings or more travellers with public transport.	+1, screens and noise reducing buildings proposed. +1, interior streets converted for slow and mixed traffic. 0, higher car traffic speed on highway, tunnelling of high volume road. +1, large amount of new buildings made possible by changes of traffic pattern.	0	+1	+3
6) THRIVING						
• Introduce traffic systems that give access to under-utilized land. • Apply strong noise reduction measures in public places. • Create commercially attractive and easy to reach business facilities and areas.	When built, traffic system gave access to buildable land. Low traffic flows secured low noise in public places. Business and service facilities hard to reach, except"on foot".	0, no more land accessible by proposed plan. +1, low traffic and noise volumes in public spaces. 0, no improvement or new areas proposed for business services etc.	+1, traffic system opens up new land for new buildings. -1, traffic systems create more noise in public places. +1, present and new areas made more accessible for business/services.	0	+1	+1

7) WELL DESIGNED AND BUILT						
• Reduce noise by place specific and original design. • Improve silent open green spaces – by new buildings, street and landscape design. • Replace "cul de sac" traffic patterns and "cars only streets" with integrated streets with mixed traffic (car/bus/walk). • Promote good lighting and high visibility in streets, parks and squares. • Create safe access to buildings, squares, parks and service areas.	Elevated walking paths and bridges above car streets. No specific planning for silent areas. Cul-de-Sac street patterns and cars only streets built from the outset – to promote traffic safety. No specific measures. Traffic separation gives high security for walking access.	+1, screens and new roads improve noise situation. +1, noise disturbances in large park are reduced. 0, no change of traffic pattern. 0, no specific measures. +1, higher safety along highway, no changes internally.	+1, Noise reduction by new buildings along high volume roads/streets. 0, large park in part more silent and in part noisier. +1, cul de sac traffic system replaced with more integrated and mixed use streets. 0, no specific measures. -1, less safe access, as a result of new integrated streets.	0	+3	+1
8) FAIR FOR EVERYONE						
• Do not invest in traffic systems that presuppose a steady increase in private car use. • Avoid new large scale traffic noise generating systems.	Area planned for good access with subway and high level of car use. Present highway creates a high level of local noise.	-1, plan increases the attractivity and competitiveness of private car use. +1, the new traffic system generates generally less noise in over all perspective.	-1, plan increases the attractivity and competitiveness of private car use. -1, new roads and changes of present streets creates generally more noise in the area.	0	0	-2
TOTAL SUM EVALUATION				0	+3	+6

This "total sum evaluation" gives a positive result for both alternatives:

+ 3 for Alt 1 and +6 for Alt 2.

The numbers given do not express exact values, but illustrates one important thing:

Alternative 1 gets higher scores on questions of **noise reduction and safety**.

Alternative 2 gets higher scores on questions on **development and access to services/business**.

This inherent **conflict** between two perspectives in town planning is thus highlighted.

One conclusion is that planning for a sustainable and attractive urban environment can not avoid value judgments or choices between competing goals and planning concepts.

A number of conflicting aspects have to be considered to avoid optimising one aspect at the expense of other aspects – what is generally called ”the danger of sub-optimising”.

NOTE:

Alternative 1 has been designed to **optimise for noise reduction** – by the use of screens and tunnels. This applies for the main artery road, the E 18.

Alternative 2 has **not been designed to optimise for noise reduction** –except for the main artery road, the E 18. New streets, across the Järva Field and inside/between existing building areas have no design elements for noise reduction. This could be done, by screening, differentiated levels and by sound absorbing facades and road material

2.6. TENTATIVE VALUE ROSE ANALYSIS

EXAMPLE OF PREVIOUS RESEARCH WORK, WORKSHOP RESULTS

The Value Rose represents a more holistic - and in the same time more subjective - method to evaluate urban projects. It is more suitable to use during discussions, preparations and workshops designed to prepare and communicate planning projects – but may also be used for ”post festum” evaluations. This evaluation of the two alternative layouts in the test area should be seen as a complement to the evaluation above (Bristol Accord Evaluation) – with the aim of contributing to a more holistic perspective on town planning and noise reduction measures.

As is said in chapter x of this report, the value rose handles very different perspectives and aspects of the urban environment. A strictly objective and scientific evaluation method to compare different town planning measures and concepts is not possible, as measurable and **un-measurable** aspects are mixed. The analysis of the two layouts in the test area is however worth doing, as an analysis of a design often offers an opportunity to improve and change the chosen design. The use of a value rose in a previous project in the test area is first presented and analysed. After that, an evaluation of the alternative layouts in this project is conducted.

Workshop results in 2005

In 2005, a workshop arranged for the National Road Administration was organised by researchers at KTH and the consultancy firm Inregia. The area chosen is close to the same as is used in this QCITY project:

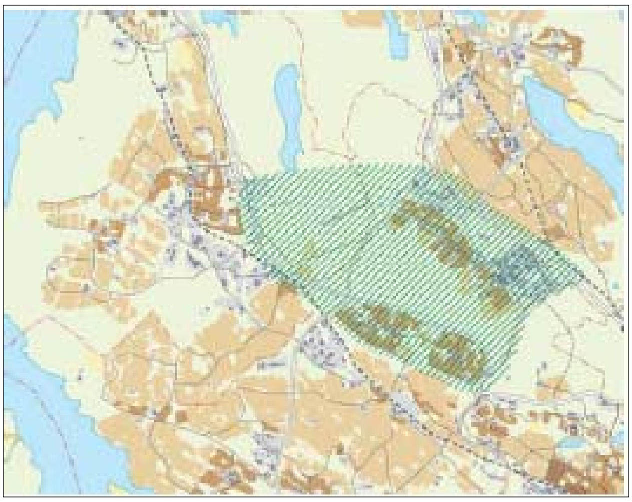


Figure 2-55. Workshop area, around the Järva Field.

The participants in the workshop - around 30 persons, representing planners, citizens, environmentalists, architects, traffic experts etc, tried to add new structures to the existing, with the aim of testing if the present infrastructure – transport systems and sewage/electricity etc – could be used for a rather low cost project for new housing and workspaces in Stockholm. The theme of the workshop was ”traffic sparse growth” – meaning to investigate places and methods to create more dense urban areas without the need for new and expensive infra structure investments.

Figure 2-56. Workshop for the National Road Administration, future structures around the Järva Field.

The figure below shows an assessment of the **present** situation made by the participants.

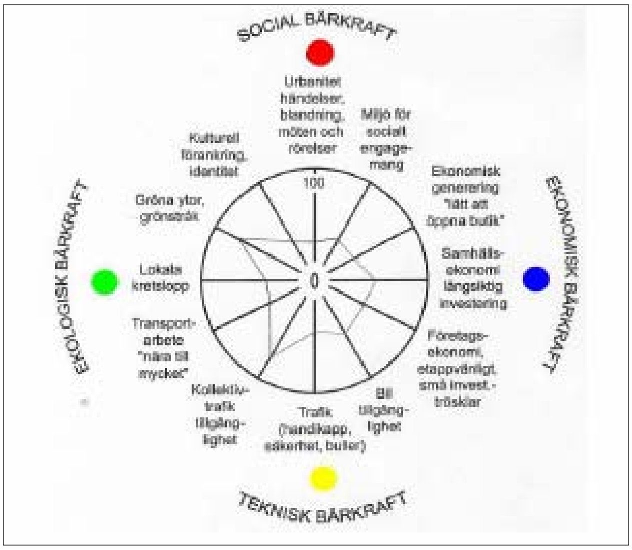


Figure 2-57. Value Rose of present situation showing rather low points given to the social (red), economic (blue) and technical/traffic (yellow) aspects. Higher values given on the present environmental (green) aspects.

This picture can be translated into numbers. In the columns on costs and benefits some comments are shown. The value rose is translated so that the maximum value is 10 and the minimum is 0 in the table:

Value Rose Table – present situation				
Perspective	Aspects	Costs, negative effects	Benefits, Positive effects	Tentative Result
Technical	Public transportation	Few bus lines	Good subway	8
	Traffic safety, noise, disabled persons	Noise from highway	Not much interior traffic	4
	Vehicle friendly, car accessibility, parking	Hard to find the way	Lots of parking	5
Economy	Business economy, profitability, low investment risks	Low attractivity, run down area	Lots of unbuilt land	5
	Public sector economy, long term investments	Run down infra structure	Run down services	5
	Economic generative places, easy to open a store	Bad situation for shops	-	4
Social	Places for social involvement, responsibility	Centralised ownership, low involvement	Interest in changes from population	4
	Urbanity, meetings, mixture, complexity	Few meeting places	Culturally mixed population	3
	Close cultural ties, identity	Low identity	-	4
Ecology	Green areas, parks, nature	Bad access to green areas	Large green areas	7
	Local eco cycles, renewal of resources	-	Re use of buildings possible	4
	Low transport dependency, close to everything, complexity	Few workplaces in area	-	4

Figure 2-58. Numeric presentation of Value Rose evaluation of present situation.

In the workshop in 2005, different scenarios for the future were presented. One of the future scenarios, rather similar to Alternative 2 in this QCITY study, proposed more dense new building in the edges of the large open green field and new connecting streets between and inside the different housing areas.

Figure 2-59. Work shop result. New buildings marked with Styrofoam blocks. Green dots mark landscaping where streets are tunnelled or built over to increase access to the Järva Field.

An evaluation of this scenario was made with the Value Rose. New streets, connections, buildings and infrastructure added, improved the situation in many respects:

Based on this figure an evaluation showing results with numbers can be made.

The points in the table below show an evaluation in which:

- the same number equals no change
- lower points a worse situation
- higher points indicates a better situation.
- changes compared to present situation are shown and added up to a final sum.

Perspective	Aspects	**Present situation**	**New situation**	
		Points	Points	Change
Technical	Public transportation	8	9	+ 1
	Traffic safety, noise, disabled persons	4	7	+ 3
	Vehicle friendly, car accessibility, parking	5	8	+ 3
Economy	Business economy, profitability, low investment risks	5	8	+ 3
	Public sector economy, long term investments	5	7	+ 2
	Economic generative places, easy to open a store	4	6	+ 2
Social	Places for social involvement, responsibility	4	6	+ 2
	Urbanity, meetings, mixture, complexity	3	7	+ 4
	Close cultural ties, identity	4	9	+ 5
Ecology	Green areas, parks, nature	7	7	0
	Local eco cycles, renewal of resources	4	6	+ 2
	Low transport dependency, close to everything, complexity	4	8	+ 4
Sum change		**(57)**	**(88)**	**+ 31**

Figure 2-60. Value Rose table, numeric evaluation.

TENTATIVE VALUE ROSE ANALYSIS OF A0, A1 AND A2

EVALUATION OF THREE ALTERNATIVE LAYOUTS IN THE TEST AREA IN STOCKHOLM

The evaluation above is an **illustration** of a **tentative** method. A similar evaluation can be made of the present situation in the test area and the two alternative layouts.

The Value rose has here been slightly modified. Traffic is chosen as one of four main perspectives.

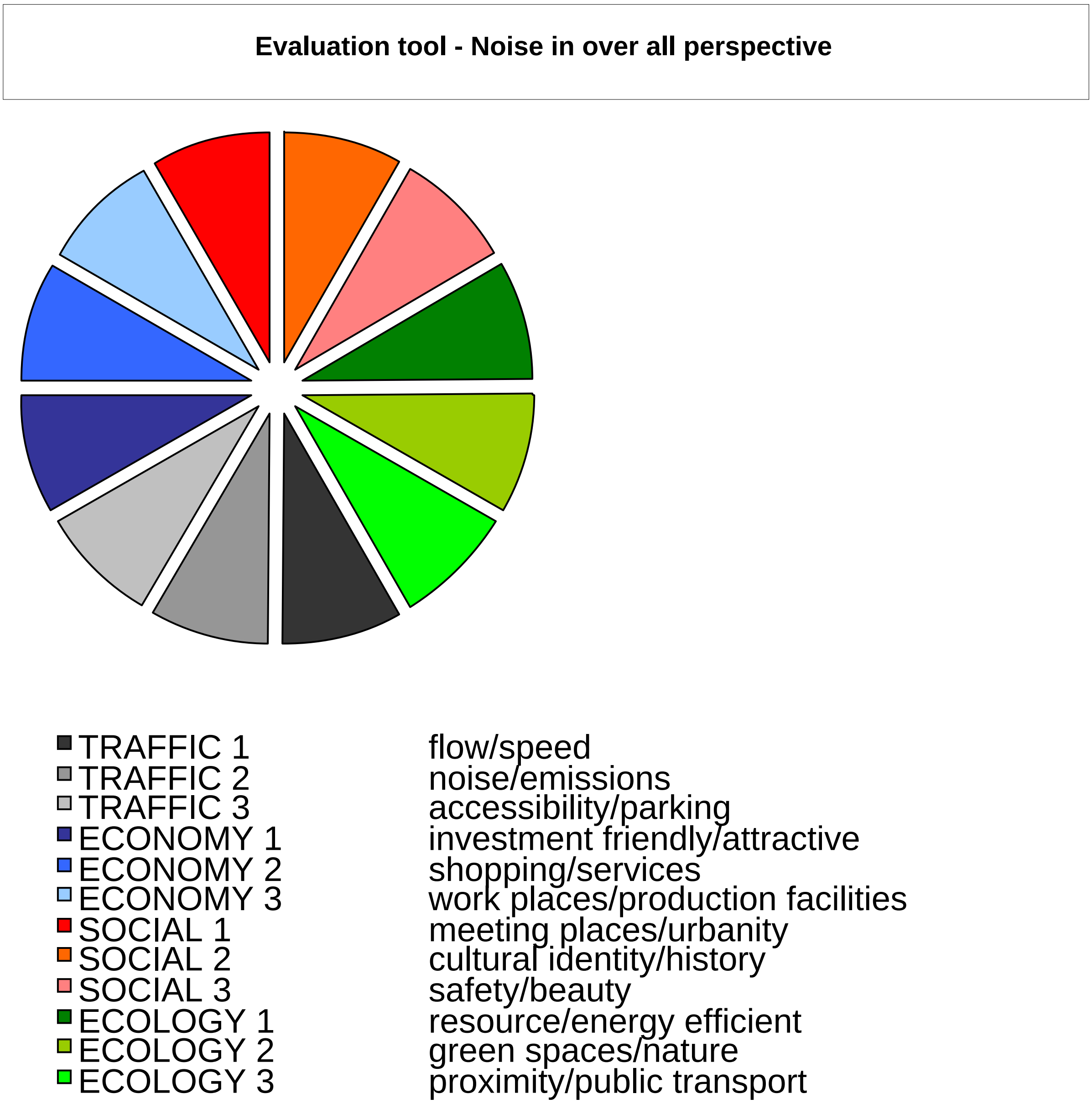


Figure 2-61. Tentative Value Rose evaluation tool.

The points given in the table are a result of discussion within the research group, based on the traffic and noise simulations conducted.

NOTE: The points and aspects here are not the same as in the workshop evaluation.

Value Rose Table – comparison of 3 alternative layouts						
Perspective	Aspects	Alt 0	Alt 1		Alt 2	
		Points	Points	Change	Points	Change
Traffic	Flow, speed	5	7	+2	8	+2
	Noise, emissions	4	6	+2	3	-1
	Acessability, parking	5	6	+1	7	+2
Economy	Investment friendly, attractive	5	5	0	8	+3
	Shopping, services	5	4	-1	7	+2
	Work places, production	4	5	+1	6	+2
Social	Meeting places, urbanity	4	3	-1	6	+2
	Cultural identity, history	3	3	0	5	+2
	Safety, beauty	4	3	-1	6	+2
Ecology	Resource, energy efficient	7	7	0	7	0
	Green spaces, nature	4	5	+1	2	-2
	Proximity, public transport	4	4	0	6	+2
Sum		**0**		**+ 4**		**+16**

Figure 2-62.. Numeric representation of Value Rose evaluation.

A Values Rose evaluation of the three alternative layouts may look as below:

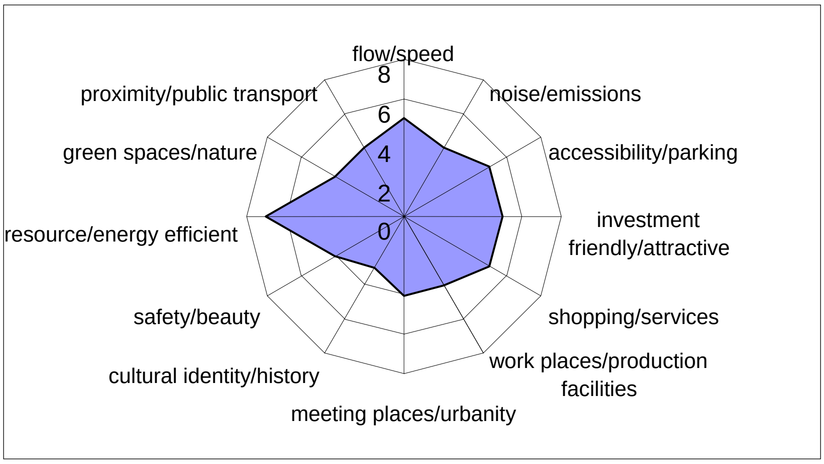


Figure 2-63. Alternative 0, present situation.

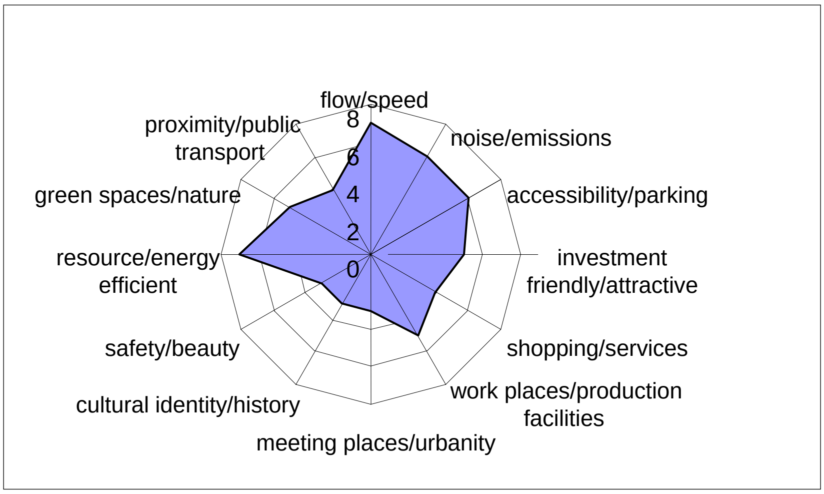


Figure 2-64. Alternative 1, official plan.

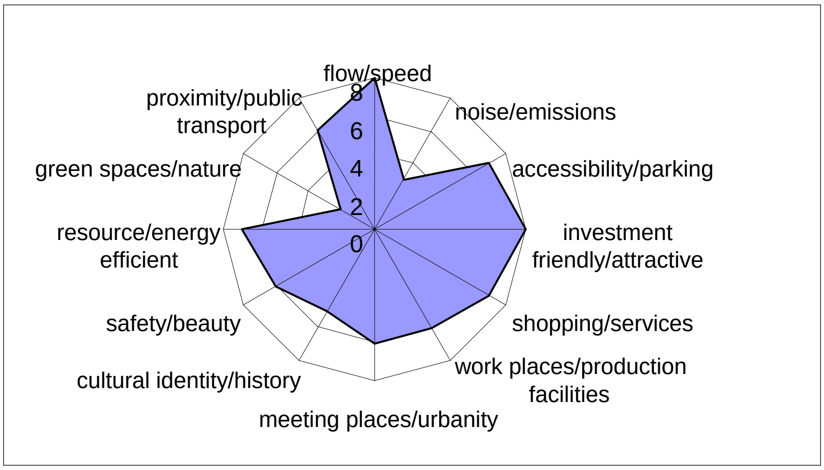


Figure 2-65. Alternative 2, hypothetical plan.

This evaluation method is more holistic than the previous evaluation that used the EU Bristol accords aspects that focused on traffic and noise only. To clarify the relationship between noise reduction and a good sound level environment, the following relationships can be highlighted. A better sound environment – which is the main perspective of this report, relates in positive and negative ways with the 12 aspects:

Improvement of aspect corresponds to:	lower sound levels(+)	higher noise level (-)	hard to say (?)	Comments:
Flow, speed		-		Better flow and higher speed may sometimes give less traffic
Noise, emissions	+			High emissions often = high noise levels
Acessability, parking		-		High acessability with cars = more noise. Accessability with bus/train = less noice
Investment friendly, attractive			?	Depends of type of investment
Shopping, services		-		Shopping in central areas does not create a lot of noise. Shopping in external centres = high traffic noise
Work places, production		-		Office work places = silent, production places = transport and high noise
Meeting places, urbanity			?	Some attractive urban meeting places creates a lot of noise from traffic
Cultural identity, history	+			Cultural heritage is seldom noise producing
Safety, beauty	+			Safety = less traffic, beauty = less noise and traffic
Resource, energy, efficient	+			Sometimes high density areas create more noise than suburban less dense areas
Green spaces, nature	+			Green spaces demand low noise levels to be well used
Proximity, public transport	+			Public transport = low noise dense building = sometimes more noisy environments
Sum	6 +	4 -	2 ?	

Figure 2-66. Summary table, evaluation of alternative layouts.

2.7. TENTATIVE COST-BENEFIT DISCUSSION

This outline for further development of land use evaluation with regard to unbuilt open land and addition of new buildings, is presented for further discussion only.

The following discussion on development of the ACCON method for monetary evaluation of noise deduction is presented in text only. It has not been possible, within the time budget of this subproject, to make actual measurements in the test area of the value of noise reduction on unbuilt land, as this requires a substantial input of work hours. The method presented may however be used together with the ACCON tool (se below). The monetary value of new buildings on unbuilt land is presented for further discussion. A rough estimation is presented.

In this section, the results in **Work package 4.3, QCITY Deliverable D4-5** is taken into account and developed further. [8] In the presentation, the research partner **ACCON** describes the redefined definition of deliverable as:

”**Proposal of an adequate performance evaluation tool for Noise action Plans.**”

The work/task is described (by ACCON) as:

”Definition of an adequate performance tool from receiver point of view including both physical descriptor, cost ratio and population assessment procedures.”

The approach chosen is that noise is only one – and often not the most important – aspect in city planning, and that many concepts of noise reduction influences other properties of the urban environment that also are important. The method proposed is to take into account the decrease of rental rates for buildings and dwellings if noise levels are increased. Within the 55 – 79 dB(A) bracket, a reduction of about 1 % of renting price for dwellings is assumed for each decibel increase of noise.

From this monetary definition of a relationship between attractivity and noise, follows of course also that a **reduction** of noise with 1 decibel corresponds to an **increase** of (potential) rent levels with 1 %. The possible rent level can, in this context, be defined as the Real Estate Value (REV) of a building, expressed as cost for rental per square meter per year. REV = cost / floor area / year.

The ACCON method for calculating the cost-benefit of noise reduction measures can be considered as an practical tool for evaluation of – and a help in choosing between different possible – noise reduction projects in practical planning. A further development of this tool also seems possible and practical. The method as presented in Deli D 4-5 is only targeted towards evaluation of noise reduction measures in **already built up areas**, as it is linked to the values of already built dwellings. It can be developed to take into account also:

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[8] Performance Evaluation Tool for Noise Mitigation Measures, Wolfgang Probst, ACC.

1) **The value of noise reduction measures on unbuilt land**, for example urban parks, gardens, recreational areas, urban sport fields and play grounds.

MOTIVE: If the present ACCON tool is used to compare two different areas suitable for noise reduction measures, it will generally give priority to densely built housing areas. A proposal to reduce noise generated from road traffic in a public area, such as an urban park with a low amount of dwellings close to a highway or a main traffic artery, will according to the tool generate a very low benefit in the form of higher rent levels for dwellings – even if the cost for a noise screen is rather low (as the monetary benefit per definition is zero). Therefore we suggest that the tool – used as a method to **compare** different noise reducing projects - should be developed, by assessing a value also on open ubuilt land.

2) **The value of noise reduction measures that include new buildings,** which may function as a form of screening walls.

MOTIVE: The present ACCON tool may give more guidance in practical planning, if the effects and values of new constructions are included. It may then be used to evaluate different methods – and costs – to reduce noise from traffic. More expensive methods to reduce noise – as construction of new buildings – can by this be given a monetary value with regard to noise levels.

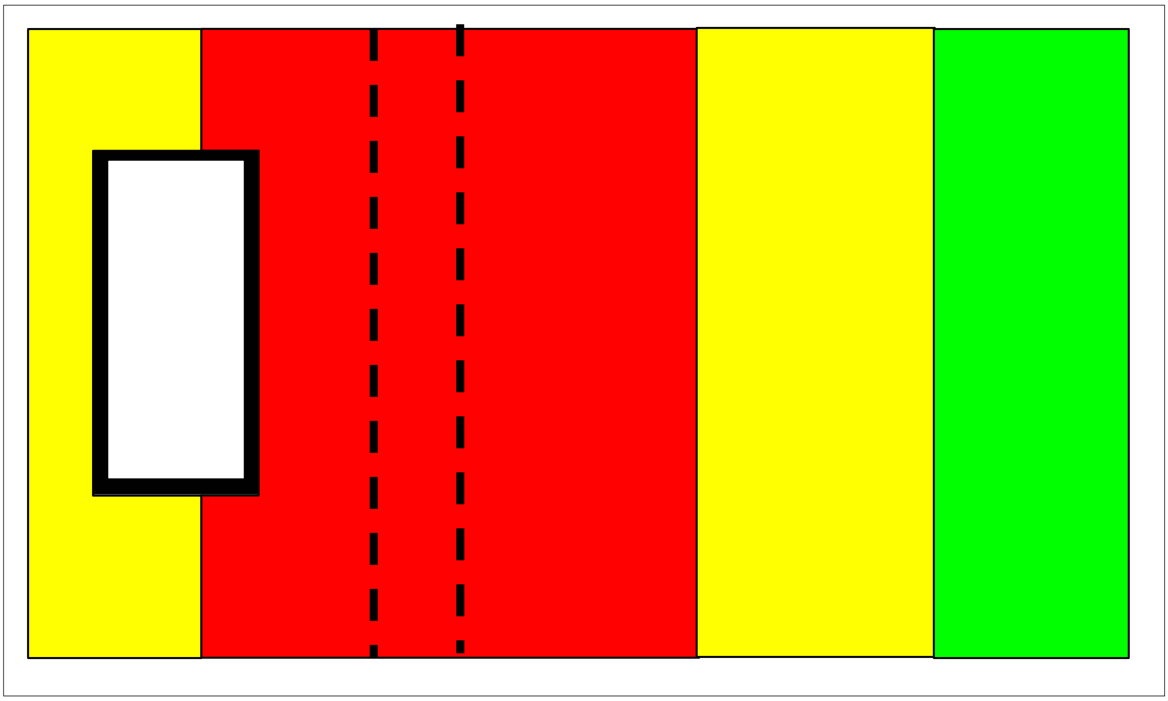
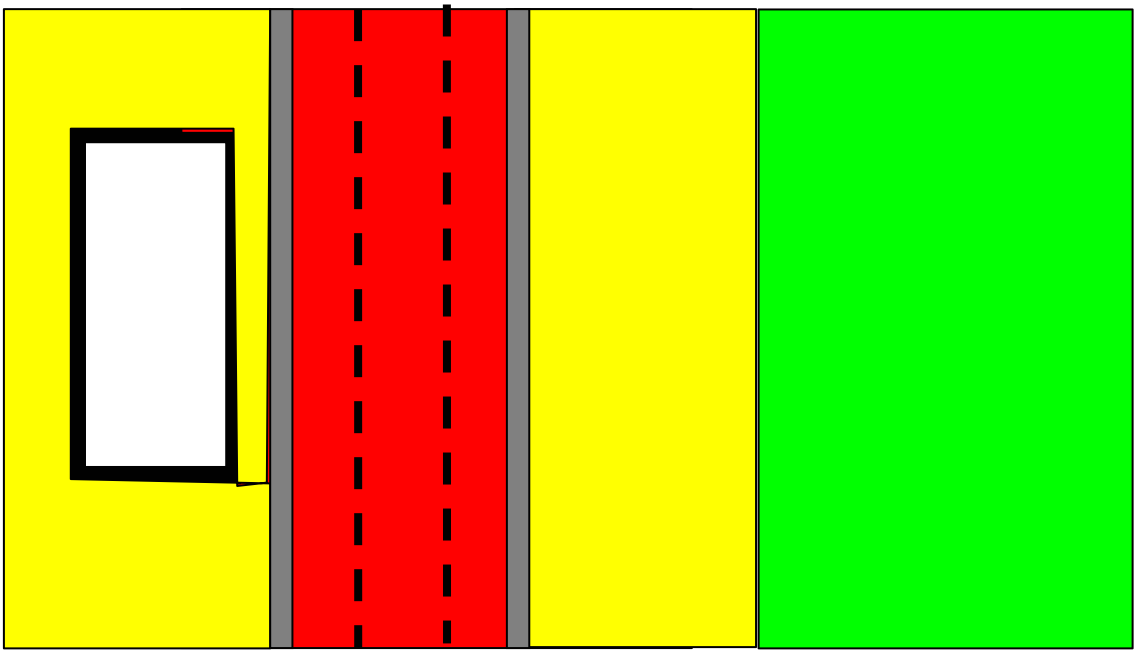


Figure 2-67. Example of test area.
Red: high noise levels. **Yellow**: medium. **Green**: low noise levels. Dotted parallel lines show street with traffic generating noise.

The monetary value of noise reducing screens along both sides of the street, may be estimated in the following way:



Noise reduction 10 dB(A) = Increase of real estate value of 10 %

Proposal:
Real Estate Value (REV) is used to define Urban Park Value (UPV)

Example:
REV 10 Euro/sqm: UPV 1,0 Euro/sqm (0-25 m from building)
UPV 0,5 Euro/sqm (26 - 100 m from building)
UPV 0,2 Euro/sqm (100 - 300 m from building)

Figure 2-68. Summary of monetary value of noise reduction – close to buildings and on unbuilt open land – that is NOT used for new development.

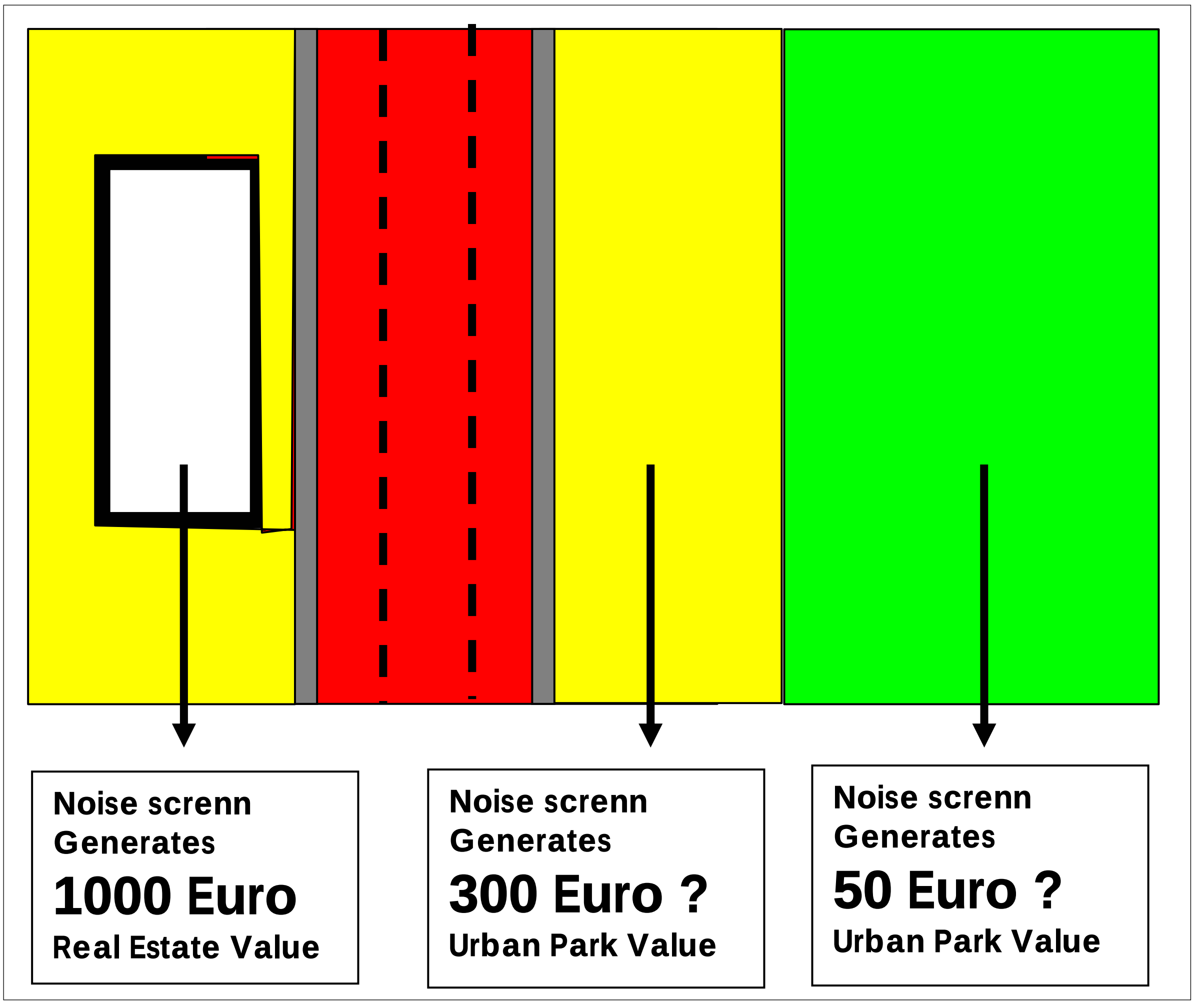


Figure 2-69. Example of possible result of monetary evaluation. Values in Euro are only examples.

In this example the ACCON method may give a value of 1000 Euro, as a result of higher real estate values of the building, when a noise screen is built.

The proposed **addition** to this method gives a value ALSO to a screen that reduces noise on the other side of the street, on the unbuilt open land. The screen along the building generates of course more money, but the method may be used to motivate also the building of a noise screen towards the urban park side of the street.

This wy of reasoning could also be applied to he test area in northern Stockholm. An evaluation of the monetary value of

1) unbuilt land
2) and of new buildings

in this area would give a more complete picture – than only assessing the monetary value of noise reduction measures for the existing buildings in the area. In Alternative 2, new building blocks are illustrated with yellow in the picture below:

Figure 2-70. New building blocks along the Järva Field (Yellow). New connecting streets (Red).

A step-by-step evaluation in the test area,, with the focus on noise reduction, would include the following points:

Calculation of Real Estate Values of a) **present housing** and b) **unbuilt land**.

REVY. Value of existing **dwellings** is estimated. A medium of rental costs in existing buildings in the area can be calculated as swedish krona per square meter housing area per year. This is considered as the Real Estate Value per Year – REVY.

UPVY. Value of **unbuilt land** is estimated. In a range of 0 – 100 meters from buildings, the attractivity value is set to 10 % of the REVY. In a range of 100 – 300 meters it is set to 5 %. This is considered as the Urban Park Value per Year – UPVY. This is of course a rough estimation of the value of unbuilt land close to dwellings, that is only used as a basis for comparison of different layouts and plans. The value set to unbuilt accessible open land follows however the notion that one family homes built on large building sites are more expensive (have higher rent levels) than the same kind of buildings on smaller plots. The value of a park in a more dense area (inner city environment) is also expressed in the value of individual apartments. In short, this value acknowledges the importance of the quality of the surroundings in an urban area – expressed in the saying"a room with a view". Open unbuilt land further away than 300 meters from buildings is in this calculation not given any monetary value.

NOTE: The distance factor is chosen to describe the assumption that open and reasonably silent unbuilt land is more easy to access and use if this land is located close to inhabited areas, as roads and public transport tend to be located in built areas. A definition of what constitutes a "built area" is not presented here, even if it would be possible to make a more exact description (choosing floor/ground ratio figures). For the estimations made in the test area, the definition is clear – "built land" means the densely populated areas around the Järva Field. Unbuilt land more than 300 meters from "built land" is not considered close and more hard to access, for both inhabitants and visitors.

Production of Noise Maps for comparison of alternative layouts.

1) Noise Map of Alternative 0 (base situation) is produced, limited to areas with noise levels between 55 – 70 dB(A). These areas are defined as the Cost Benefit calculation Land, CBL-0. The land area is divided into 10 x 10 meter squares.
2) Noise Map of Alternative 1 is produced, . CBL-1.
3) Noise Map of Alternative 2 is produced. CBL-2.

Estimation of changes of Urban Park Values per Year, UPVY, as a result of changes in Noise Disturbances.

Unbuilt land of present situation (CBL-0) is compared to alternatives (CBL-1 and CBL-2). The medium change of Noise Levels in each square of 10x10 meters is estimated. Unbuilt land (in CBL-0) that is being used for new buildings (in CBL-1 or CBL-2) is given the noise pressure of 40 dB(A) – a rather conservative estimation of the effect of changing an out door environment to an indoor environment. This means that new buildings in the alternative layouts are considered as part of the CBL areas.

Differences in dB(A) in each 10x10 meter square are expressed with the values of + dB(A) (lower noise level) and of – dB(A) (higher noise level). The new UPVY of Alternative 1 and Alternative 2 is calculated by using the ACCON estimation of a straight 100 % proportionality between change of dB(A) level and change of REVY. In this context, the dB(A) change of unbuilt land corresponds also to a 100% change of the medium PEVY on land 0-300 meters from (new and existing) buildings. Note that as UPVY is set to 10% and 5% of the Real Estate value per Year, depending of the distance to buildings, the changes of value on unbuilt land as a result of changes of noise, is much lower than the change of Real Estate Values in existing buildings.

Example:

REVY and UPVY in CBL-0 is calculated as follows: Medium rent level in the existing housing areas (in Rinkeby and Tensta) is today 750 – 850 sv krona per year. 800 krona/sqm/year gives a rough estimation of UPVY of 80 krona per sqm in areas 0-100 meters from buildings, and 40 krona per sqm in areas 101-200 meters from buildings. The medium noise level in a 10x10 m square of unbuilt land (in CBL-0) is compared to the noise level of the same square in, to begin with, Alternative 1 (CBL-1). If the noise level is 5 dB(A) **lower** in the chosen square, the value of the unbuilt land is increased with 5 %. An unbuilt 10x10 m square close to existing buildings will thus have an increase of value, from 80 krona to 84 krona per sqm (80 + 0,05 x 80 = 84). If the noise level is 10 dB(A) **higher** on the same part of unbuilt land (as could be the case in Alternative 2) the value of the change is negative and the calculation will give a reduction of value to 72 krona per sqm (80 – 0,10 x 80 = 72).

In real money, this means that this specific 10x10 m square (with the area of 100 sqm) has a value of 80 x 100 = 8 000 krona.

An **improvement** with 5 dB(A) will change the value to 8 400 krona and the benefit thus **+ 400 krona** (new value – existing value = change of value); 8400 – 8000 = + 400).

A "**worsening**" of the situation with a 10 dB(A) higher noise pressure can be expressed in the same way: 7 200 - 8000 = **- 800 krona**.

If the 10x10 m square compared is between 100 and 300 meters from buildings, the calculation of 5 dB(A) lower noise levels will give the value 42 krona per sqm (40 + 0,05 x 40 = 42) and the calculation of 10 dB(A) higher noise levels will give the value 36 krona per sqm (40 – 0,10 x 40 = 36).

The monetary changes in these cases will be:

42 – 40 = 2; +2 x 100 = **+ 200 krona**.

36 – 40 = -4; -4 x 100 = - **400 krona.**

Valuation of land that is built upon. In the same way, a 10x10 m square that in the CBL-0 is unbuilt land and in for example CBL-2 is built land will give the following calculation example: The medium dB(A) level in the chosen 10x10 m square in CBL-0 is 60 dB(A). As this 10x10 m square is built upon in CBL-2, the medium dB(A) is set to 40 dB(A) as a default. The change of noise is expressed as: new noise level - existing noise level = change of noise level: 40 dB(A) – 60 dB(A) = 20 dB(A).

The improvement of 20 dB(A) gives a rise of land value (UPVY) with 20 %. The value of the land is in the same way increased with 20 %. The land in the existing situation has, as explained above, a value of 80 krona per sqm. The change of UPVY is: 80 x 1,20 – 80 = 96 - 80 = 16. The 10 x 10 m square has thus increased its value by 16 x 100 = 1 600 krona.

Over all monetary valuation. Changes – comparisons made with the base alternative (existing situation) - in both Alternative 1 and Alternative 2 in all chosen 10x10 m squares can be calculated and the real money values added together. By this simple method two (or more) alternative layouts can be compared and the value of unbuilt land can be given a monetary value.

NOTE: the monetary values assessed to unbuilt land close to buildings are rather conservative, due to the fact that the existence of low noise levels in areas around buildings already in the ACCON model are in part accounted for (low noise levels close to facades indicates an over all low noise picture). But, investments in noise reduction also indirectly affects buildings that are not directly affected by these measures – a pleasant noise environment 100 och 200 meters from a building also creates a higher attractivity to the same buildings – and for visitors as well. The discussion above on UPVY is basically an attempt to argue for the value of a ”sound” sound environment on behalf of the public sphere and public places – as well as for housing.

NOTE also: The ACCON model only discusses the monetary value of changes in noise levels for buildings **used for housing**. we have followed this basic procedure, even if it could be said that improvement of noise levels also might improve real estate values of commercial buildings – but probably to a lower extent. Taking the”public open land” into account in part compensates for this. In the case of unbuilt land being replaced with buildings, as described above, we have given the same default value (40 dB(A)) for all kinds of buildings, housing and commercial alike.

Estimation of monetary value generated from new buildings.

To further complement the ACCON tool, it is also appropriate to estimate certain monetary values to new buildings that are proposed in an area. This could be done by checking the present rental levels – preferably from newly built apartments - in the area that is evaluated, and putting this into the equation. As real estate values differ from time to time and from usage to usage, we will here propose that a cost-benefit analysis is done, on the basis of the net profit generated from new buildings.

As a basis for this discussion, it is important to note that rent levels in new buildings as a rule tend to be higher than in existing or old buildings. The estimation of possible rent levels can be based on a recent example. In the test area, the north west part of Stockholm, a newly produced apartment of 87 sqm, owned by the public housing company Svenska Bostäder (Eng. ”Swedish Housing”) is rented for 8 500 krona per month.

This example gives an **average rental level per sqm** of **1 172 krona** (8 500 x 12 / 87 = 1172). This is considerably lower than the rent levels in the already existing and around 40 years old apartment buildings that dominate the areas around the Järva field. New buildings, according to this estimate, have a real estate value of 1,46 of existing buildings (1172 / 800 = 1,46). A conservative estimation of possible rent levels – and by that, real estate values, of the new buildings that are shown in Alternative 2 – will follow this figure. Generally though, a mixed use as is discussed in Alternative 2, with premises for shopping and offices, will if the environment is perceived as attractive and easy to access, generate higher rent levels.

The monetary value generated from new buildings has to be compared to the – possibly – more expensive solutions with regard to streets, roads, infrastructure, parking, etc, that would be needed in the test area. An estimation of these costs are at this stage not possible. What remains to be discussed is then the possible profit that new buildings can generate. One simple calculation can be done. According to the Swedish organisation Svenskt Fastighetsindex (Swedish Index on Real Estate Values) the total yield from real estate investments, was 12,7 % in 2005. Real Estate Values have increased 7 % in a year – with the highest yield from retail buildings (17,3%) and the lowest from office buildings (11,3%). A very **conservative estimation** of a profit of **6 %** of generated rents from new buildings – that is, **half** of the general real estate yields in Sweden 2005 - would in this area and in this case, give a profit of around 70 krona per sqm – if housing and commercial real estate are treated alike. This figure is based on the rent level of 1 172 krona per sqm for new housing in the area (1 172 x 0,06 = 70,32).

Based on this **very rude figure**, the net profit (benefit!) of new buildings can be given a number, in the overall area or in smaller chosen areas. As an over all rule, each person in an apartment building corresponds to 25 sqm of floor area. For a mixed type of commercial use, with more dense occupation in offices and fewer working persons per sqm in shops and retail, the same figure can be used (1 person = 25 sqm). In the overall plan for Alternative 2, we have estimated 17 000 people living and 13 000 people working. This gives 30 000 persons in new buildings and equals a built floor area of 750 000 sqm.

The **net profit per year** can be estimated to about **50 million krona.** (750 000 x 70 = 52 500 000). This, again a very rough figure, shows that the new building opportunities in themselves could motivate an extra investment for more expensive street designs and infrastructure of about **500 million krona** (half a billion krona) based on the assumption that profits generated should cover the extra expenses within a ten year period. This sum, for parts of or for the entire area, may be added to the monetary evaluation of Alternative 2.

With a **higher estimation** of net profit from new buildings – the Swedish real estate yields in Sweden being above 12 % in the year 2005 – the figures above would double. Net profit of new buildings would then be around **100 million** krona. This would, in turn, give a rough figure of about **1 billion krona** in profit in a 10 years time. How much of this, that in reality would be able to cover the costs of a more urban street layout, is really hard to estimate.

Conclusion

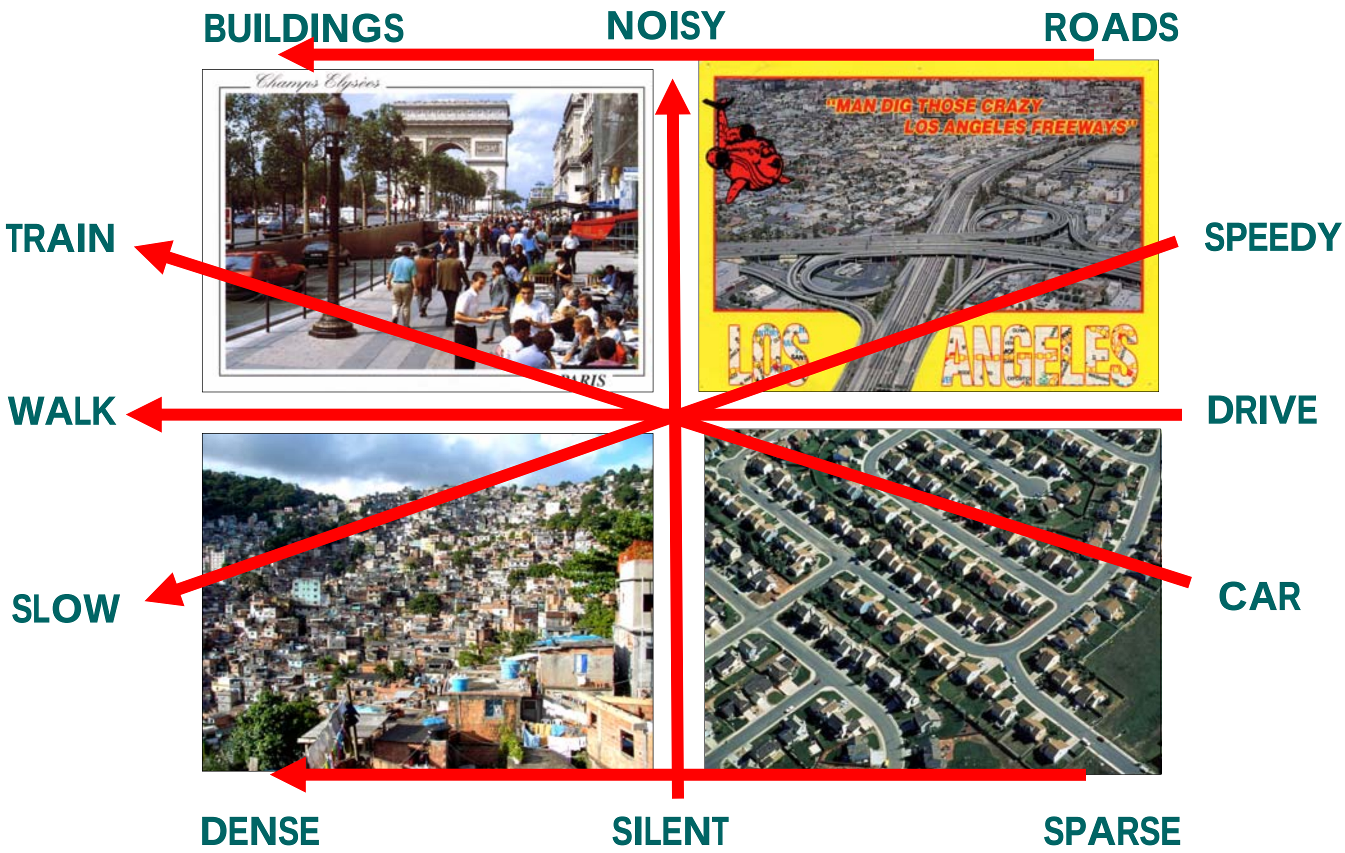
The monetary discussion in this section point towards a general conclusion – that a more urban street net, at least in this specific place and considering the shortage of housing in the Stockholm region, is not unrealistic from an economic point of view. Obstacles to an implementation of Alternative 2 deals more with political considerations, technical practicalities and traffic planning concepts in general.

2.7.1 CONCLUDING ILLUSTRATION OF POSSIBLE GRADUAL SHIFT, REDUCING THE SOURCE OF URBAN NOISE.

Figure 2-71. Envisioning change.

Three steps of urban development, reducing urban noise by shifting from car dominated to public transport and walkable neighbourhoods. A possible long term outcome of Alternative 2.
Source: www.urban-advantage.com

A final comment: To reduce the negative noise effects from vehicle traffic, a number of parallel strategies can be adopted. The arrows below show parallel paths towards QUIET CITY TRAFFIC. All these strategies have not been tested or discussed in this report. But we hope that this deliverable will in some extent be useful to put the question of noise reduction higher on the agenda of other areas of planning, building and technical innovation.



Quiet City	**Noisy City**
Buildings define spaces	**Roads** define places
Walking priority	**Driving** priority
Train transportation	**Car** transportation
Dense development	**Sparse** development
Slow movements	**Speedy** movements