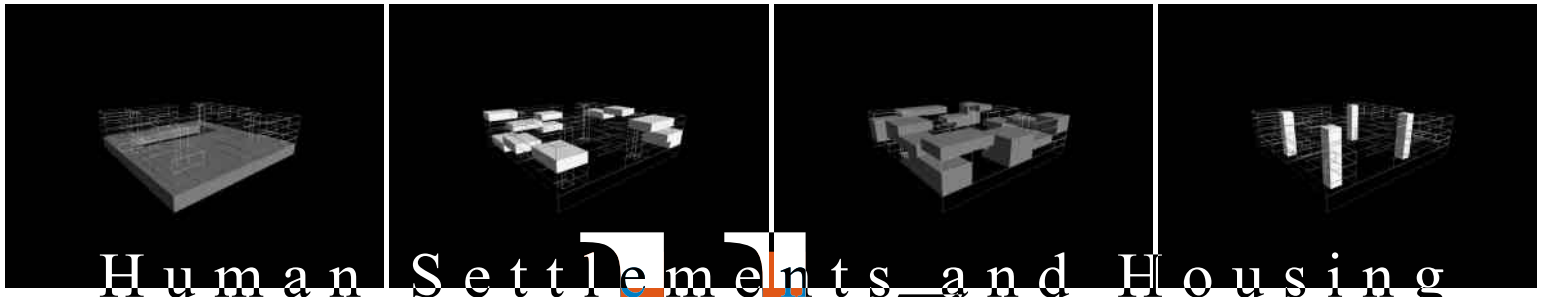
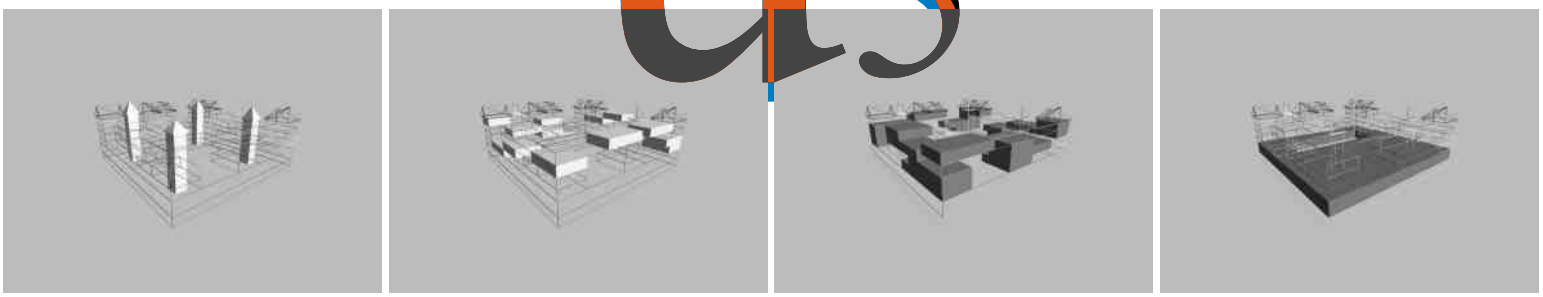


Human Settlements and Housing



A Sustainable Housing Program in Kapellgärdet, Uppsala

Responsible teachers: Dorota Wlodarczyk & Dick Urban Vestbro
Minderman Nicholas, Ruelle Delphine, Stojanovski Todor & Thitimakorn Kriangkrai

Stockholm, December 2004

Project Goal

The aim of this project is to create a sustainable community in the Kungsängen area south of the Uppsala city center. We will produce a set of directives that outline the establishment of this community according to sustainability as defined below

Sustainability

Sustainability is an economic, social, and ecological concept. It is intended to be a means of configuring civilization and human activity so that society and its members are able to meet their needs and express their greatest potential in the present, while preserving biodiversity and natural ecosystems, and planning and acting for the ability to maintain these ideals indefinitely. Sustainability affects every level of organization, from the local neighborhood to the entire globe. (The Free Dictionary, 2004b)

Our working definition of sustainability has three natures. The first is the idea that the project will be at harmony with the surrounding environment. This is almost always a challenge as the built environment, by the fact that it is human activity, is a deviation from the natural environment. The project goal is to therefore integrate nature into as many aspects of the development as possible. The second form of sustainability is in the social and cultural domain. By integrating ideals of diversity in use and occupation, as well as the creation of open spaces for interaction, the project will create a community that will flourish through the positive involvement of its citizens. The final is architectural sustainability, which is tied to both of the first two.

Environmental

The environmental sustainability if the project is implemented through a few innovative practices and many ideas that have seen positive precedence. The two most innovative are the idea of gardens within the structure and a system of incentives that encourages people to use cars only when necessary rather than penalizing them for having cars. The gardens will help the structures blend into the surrounding environment much more effectively than a normal apartment block. The transparency of the structure will also help create a more open atmosphere that will mimic a natural environment instead of a densely built city. The incentive system acknowledges that Uppsala is a somewhat isolated location, and that there are gaps in public transit, and that mobility is an important aspect of lifestyle in Sweden. Instead of penalizing people for having automobiles, we intend to reward people who minimize their automobile use. We anticipate that this method of positive reinforcement will be better received by both the residents of the development and the local government.

Another idea that is not as widely practiced but has already been implemented in Uppsala is urine separation. This technology has been implemented in two well-known developments in Sweden. Still considered experimental, our project should be crucial to the future of this technology because of the size of the population relative to other systems now in use.

The remaining environmental plans include greywater treatment, water-use reduction, composting, solar power supplement to mainline electricity, district heating from a renewable source, community gardens, and ample green space on adjacent lots.

Social/Cultural

The goals for social sustainability are equally as ambitious. Mixed-use, mixed-income development is currently the catch phrase in many western nations. This idea has existed in Europe for some time, though modern trends of use segregation started after WWII in the US have re-ignited interest worldwide as many commuter-saturated communities seek to increase vitality (and tax revenue) through addition of jobs, business opportunities, and a 'community feeling'. The greatest anticipated problem with mixed-use is the eventual domination of one group over others. We anticipate the following attributes for a sustainable residential community:

- Diversity in age, gender, and family size
- Diversity in highest attained education and income
- Diversity in race, origin, and religion

In addition, the residential community should be integrated with a sector offering job opportunities, locations for purchasing necessary goods, and facilities for day-to-day services. The one aspect missing in our plan is a school building, though the city has accounted for this by planning a school on a property it owns nearby. We feel that a school would not be sustainable at present due to the exceptionally low residential population of Kungsängen. We recommend that a day-care center be integrated into one of the commercial spaces in the development. This will make certain that this important service is offered on-site while using some of the commercial space that may not be sustainable until further residential development of Kungsängen is completed. Excess commercial space could also be used for community meeting space.

The remainder of the commercial space will be available for services and goods as determined by the property's eventual owner. It is strongly encouraged that the sustainability theme be stressed by the commercial outlets, though this should not be forced to the point at which the businesses are unprofitable or must be heavily subsidized (an economically unsustainable situation must be avoided.) It would be ideal to have a 'green goods' store as seen in Uppsala's Hågaby development, though the demand for these stores is too small to support a commercial space as large as those in our development.

Architectural

Architecture is a communicative art that situates human activity within a horizon of possibilities, the art and science of designing buildings. A wider definition would include within its scope the design of the total built environment, from the macro level of town planning, urban design, and landscape architecture to the micro level of furniture and product design. According to the earliest surviving work on the subject, Vitruvius' "De Architectura" (~25 B.C.), good buildings should have beauty (Venustas), firmness (Firmitas) and utility (Utilitas); architecture can be said to be a balance and coordination among these three elements, with none overpowering the others. (The Free Dictionary, 2004a)

Sustainability in architecture can be defined as a concept of creating built environment that meets the needs of the society and its members and preserves the nature indefinitely. The definition is very controversial because it delimits the architecture only to structure and function, because sustainability is scientific and not aesthetics concept. It is more precise to discuss about architecture with structural and functional sustainability. In this order the balance between the three elements of the

architecture would be leveled and the functional and structural principle would not be overpowered by the idea of sustainable architecture.

In some cultures, for example Macedonia, people have believed in the personification of the houses since prehistoric times. Like the people who lived in the houses, there was the belief that each home was patron to one god and one saint. The houses were built, they lived, and died. They were organic mineral creatures.
The magic starts with the laying of the first stone for the house. It includes sacrifices, feasts, songs, and prayers.
The style of the house is the unity between culture and nature. The settlement scheme follows the natural ways of water, air and sun. People say: “In the place where people live, there lives one god, but in a place shared by people and water, there are two gods”.
Settlements were built on rough terrain, never on fertile soil. The houses were built from local materials, stone and wood. There are settlements that were abandoned. But no one knows their true locations. The nature absorbed them. These settlements were built out of stone and wood with stone roads and with system of water ditches. They were complex structures, but when the houses died they left no trace. They lived perfect life with nature.

From the definitions of architecture and sustainability, sustainable house is a building which meets the needs of the tenants and preserves the nature indefinitely. Sustainable house is a building that has balance between aesthetics principle, functional and structural sustainability. That balance can be found in traditional architecture
However, some also stress the importance of tenant preference as an aesthetic principle. According to Hundertwasser, (1990) every man has the right to express his fantasy and to create his home environment:

> A person in a rented apartment must be able to lean out of his window and scrape off the masonry within arm's reach. And he must be allowed to take a long brush and paint everything outside within arm's reach. So that it will be visible from afar to everyone in the street that someone lives there who is different from the imprisoned, enslaved, standardized man who lives next door.

The Five Skins
Friedensreich Hunderwasser

There are few social and climatic principles of sustainability in housing architecture that are applied in the housing program, community and roof gardening as way of beautification and capture of rainwater, usage of local and recyclable materials in the buildings, influence of the local traditional architecture on the concept of indoor and outdoor gardens and towers, and thicker northern walls as climatic concern in preserving thermo dynamical balance between the unit and the environment.

As previously outlined, the site for the housing program is situated in Kungsängen. It is part of Uppsala with a history of mixed use, but today the use is mainly industrial. There is a small housing area from the 1920s in the north part of Kungsängen which is

Nord Mills, Kungsängen

of historical value. The industry character of the neighborhood is mainly based on the dominant brick architecture of the Nord Mills factory. The site for the housing program borders the Nord Mills in the north. On the east side it borders rail line that serves Nord Mills and a few other industries on a regular basis. On the west side the site borders the river Fyris. The existing buildings are part of a lumber yard. There are no roads penetrating the building site. The main automobile communication with the city center is the Östra Ågatan; there is also a pedestrian path that follows the river Fyris toward the city center.

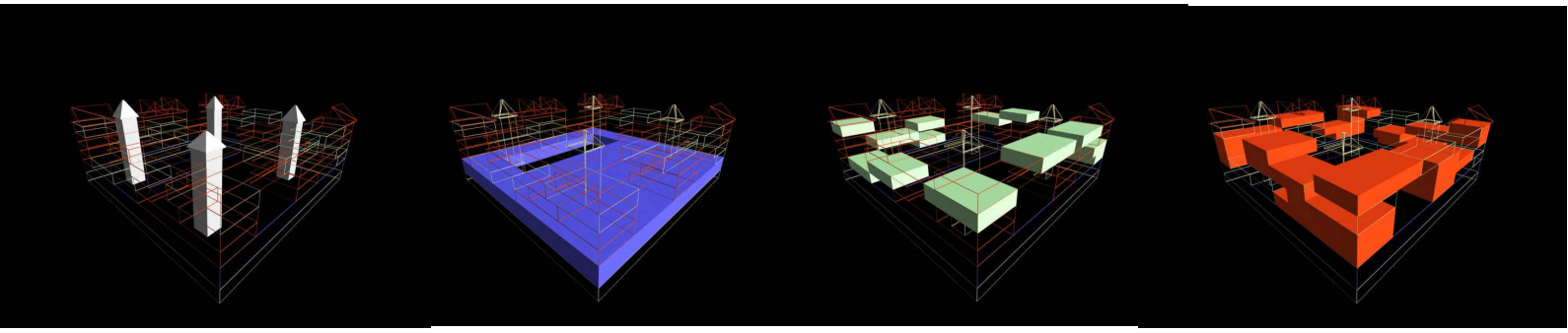
Housing from the 1920s, Kungsängen

Architectural Goals

Build a community of 500 residents with 50-55 units per building
To construct space for commercial and community services
To combine different concepts, from tenant preferences, architectural experimenting
To integrate a natural setting into the built environment
To allow for innovative and practiced eco-friendly technologies

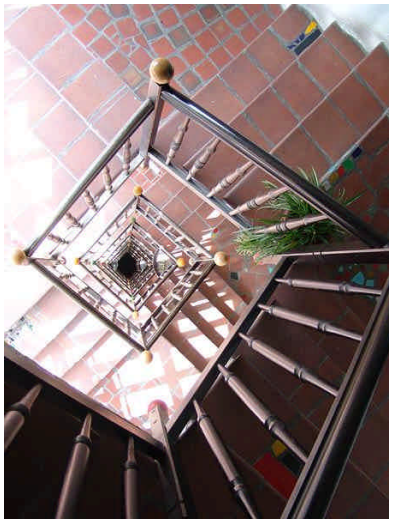
Vision

This plan primarily details the vision for the complex. The plan may be changed in details, though we believe that the idea, as a whole, should not be significantly altered. The general concepts regarding the construction of the building (directly following) will help create a structure that will blend into the setting well while still allowing flexibility for the development scheme for surrounding sites. This plan also allows for building layout decisions to be made by a consulting architect, the owner, or the future tenants.



Architecture of the blocks

The unique blocks are formed by positioning ‘units of function’. ‘Units of function’ are one, two, or three levels volumes that have different purposes, such as housing, commercial, services or gardens. These units can either be positioned according to the tenants’ preferences or positioned randomly and later are chosen by the tenant. All the units must have all the characters of a good architecture like accessibility, comfort, views and security. The building consists of two parts: the base and the spatial plots. The base is the solid part of the building. It is comprised of the vertical communication, the towers, and the ground and underground floors. The base of each building is built with solid materials with a long life span. The base also forms a chain of gardens, which will be watered by natural precipitation. In the base the housing units are positioned only by tenant preferences, in the direction of securing high quality architecture and longer tenure. The base holds the service, commercial and machine units. The central building will have two floors of

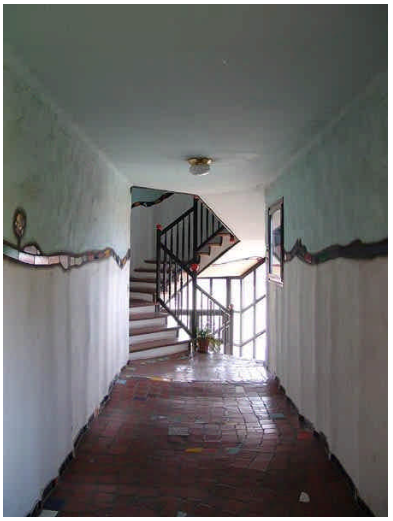


Tower, Hundertwasser House
Wien, Austria, 1983–1985
Friedensreich Hunderwasser

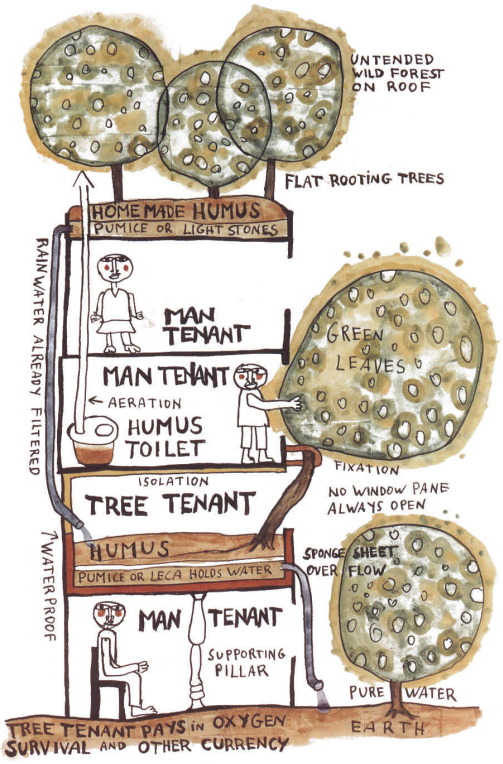
Bridge, Casa Mila , Barcelona 1906-10
Antonio Gaudi

commercial services while the north and south structures will only have one floor of commerce, leaving space in the base layers for residential units.

The spatial plots are more flexible units with a less formal arrangement in comparison to the base sections. Access to these units is directly through the towers through corridors to the towers. If tenants are present during the building process,



Corridor, Hundertwasser House
Wien, Austria, 1983–1985
Friedensreich Hunderwasser

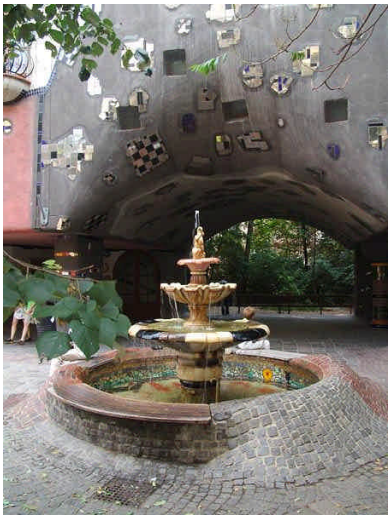


Tree Tenant
Friedensreich Hunderwasser

they should be allowed input on factors such as the architectural style, color, area, volume, and dimensions of their unit. The beauty of this system is that numerous tastes can be integrated for those present during the early stages of the process.

Urban Regulations

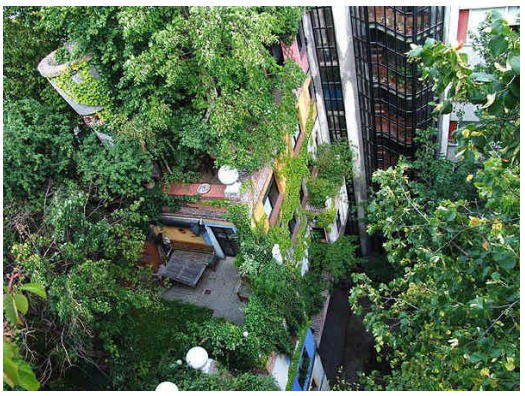
By orienting the project toward tenant preferences, the urban regulations are concentrated on the maximum volume of the block and urban quality issues. This in no way indicates that the entire area will be built (as discussed below.) The volume of the block is limited by the regulation lines. There are two types of regulation lines, the main regulation lines as ground floor limits and the secondary regulation lines as drop-out (protruding alcove) lines in the higher floors' limits. The thickness of the block represented by the main regulation lines is 9m. The towers, the vertical communications are placed in the limits of the inner block secondary regulation lines.



Urban Space, Hundertwasser
House Wien, Austria, 1983–1985
Friedensreich Hunderwasser

The drop-outs in the upper floors may not exceed more then 15% of the area of the façade. At least 30% of the volume of the entire block must be filled with gardens units. The pores will provide additional views and circulation of air in the inner space of the block. The pores can be flexible. They could open or close, for example open gardens in summer and greenhouses in winter, depends of the climate. Consideration must be made for wind and sunlight in the placement of the gardens (to minimize shady spots) and closed and open gardens (to avoid a 'wind-tunnel' effect.)

The height of the block is limited by both the number of floors and the maximum height of the block. The ground floor must be at least 4m high. The inner (courtyard) space of the block is used for bi-level community gardens. The inner garden and the other semiprivate spaces must have high quality urban and architectural values.



Roof Gardens, Hundertwasser
House Wien, Austria, 1983–1985
Friedensreich Hunderwasser

Pedestrian road down Fyris River, Kungsängen

Site Analysis

Many of the aspects of the site analysis are discussed in greater detail in respective sections of the report. This section summarizes all the ideas integrated into the design for the project.

Natural Features (topography, vegetation, wildlife, geology)

- Fyrisån to the west
- Present vegetation is of no value; trees will be located throughout the site, community gardens will allow resident input
- Geology is glacial till and post-glacial clay. Not adverse building conditions due to local familiarity
- No known wildlife

Emissions

- Possible odors from treatment plant to south, vehicle emissions not significant due to low traffic volume and consistent speed on roads
- Potential for increased auto emissions from Östra Ågatan should it become a reliever route; mitigation not possible at present due to uncertainty

Townscape

- Plaza at southern limit of plot will act as focal point of intersection of two avenues
- Buildings will act as landmarks due to innovative architecture
- Parkland will be further developed along river
- Paths will be included in river parkway and along east plot line

Communications

- Östra Ågatan as an alternate for overcrowded Kungsgatan
- No new through streets in plan
- Dedicates pedestrian and cycle paths N-S; passageways between buildings E-W (allowing for expansion as dedicated paths in future)
- Traffic patterns analyzed (see appendices A-1 and A-2)

Spatial Allocation and Offered Services (See appendices B-1 to B-6)

- Primarily residential: 50-55 units per building in three buildings
- Residential divided roughly equally between high-income family, low-income family, and student living quarters.
- On-site childcare in one building

- Commercial space: one floor in extreme buildings and two floors in center
- Garden space: 30% of basic building volume (may be open or enclosed)
- Recreational space offered along river parkway and on plaza
- Possible community room in surplus commercial space

Microclimate

- Passages between buildings will be shaded most of the year
- Courtyards may experience high winds, depending on placement of open and enclosed garden spaces
- Shade in courtyard and interior units reduced by building transparency
- Solar panels oriented southward

Target Groups

The target resident groups of this program are high and low income families as well as students living in a semi-private setting. More details of this will follow in the discussion of social aspects. Due to the flexible nature of the housing units, this project should be accessible to all people. The modular style will accommodate needs governed by disability, family size, and family structure.

Social and Economic Aspects

The goal of our housing complex is to serve as a socially sustainable community as well as a cornerstone for the new community growing in Kungsängen. The decision was made early in the process to incorporate commercial and residential housing into the plan. The hope is that the development maintains vitality through not only those who live there, but those who visit the commercial venues on-site. Another aspect is the blending of income-level of those residing in the complex. By integrating apartments intended for higher wealth and lower wealth alike, the mixture of different classes and cultures will foster a community with better social understanding. As a side effect, it is hoped that the mixture will also help those who are less-educated regarding issues of ecology will learn more by living next to those who have a broader understanding of environmental issues. A special aspect of Uppsala is the large student population from the university. We have decided that students should be a part of our community and suggest that a few of the larger apartments in one building instead be divided into semi-private flats for student living. This emphasizes the ability for apartments to be used for various purposes without significant inconvenience.

Ownership and Resident Tenure

In order to maintain the sustainability of the residential community, it is recommended that the units be distributed between rental and owner-occupied housing. We believe that the flexibility and lower up-front cost will be beneficial for students and lower-income families, thus making this facility attractive. It is understood, however, that higher-income families are looking for housing and an investment at the same time. In order to make this development competitive, it is imperative that steps be taken to ascertain that these people will also favor living in the complex. This demographic is also important, as their longer-term residence will help maintain a ‘continuity’ of sorts. They will become involved and help train new residents in how some of the more innovative elements of the project function. The hope is that everyone living here will WANT to be here. This will provide an unparalleled living experience and a strong community.

Long-Term Development

Our development is a part of the earliest stage of development in Kungsängen. Once completed, it will be 'an island' among a number of industrial buildings. It is expected that the quality of housing, the ecological aspect, and the location near the river and city center will make this area attractive despite its temporary home in an industrial park. The plan is that the entire area will eventually be built for housing and the majority of the industries will move to new locations. At that point, as stated earlier, it is expected that our development will be the cornerstone of Kungsängen by both location as well as design. While designing the plot, options have been integrated to insure flexibility. The hope is that future developments will easily be integrated into the plan and that nothing constructed, as a part of this plan will conflict with future constructions. An example of this is the boulevard leading to the parking structure. If, in the future, the railroad tracks are removed, the boulevard can be continued northwards to provide relief for Östra Ågatan should it become overcrowded. If it is preferred to instead convert this land to a pedestrian mall, the boulevard-style construction will continue to allow access to the parking structure without destroying the 'green' feel.

Ecology, Preservation and Outdoor Space

The only present asset to this plot is the river. The river is primarily a concern because it will be susceptible to impacts from the structures due to proximity. Conversely, industry currently occupying the space is of no significant value. The previously mentioned 1920's buildings are nearby (~400 meters) though not yet historically designated. Our plan does not integrate these buildings because there are numerous developments expected between this plot and the historical buildings. Architecturally this plan is different in order to give the historical structures a more prominent role through their distinctive style. Among these are the Nord Mills granaries which could remain in the area should Nord Mills eventually leave Kungsängen. Since our project will be completed long before the vacancy of these buildings, it is nor necessarily relevant to consider them as more than nearby landmarks.

By placing community gardens along the riverway, it is expected that the river path will be a lively area where people can walk, cycle, or simply enjoy the scenery. The gardens will also act to eliminate views of cars and reduce noise to those walking along the paths, while still affording a view over the river to those living in the complex. The forest area across the river also has some ecological and recreational significance, though it is also beyond the limits of this project. Ecologically it is important to maintain passageways for fauna and flora, even through urban centers. Recreationally, it is considered in so much that the residents of this area will have both the river parkway and the forest at their disposal. For this reason the design of the parkway was chosen to be more open to facilitate activities that cannot be conducted in the forest.

The plaza at the southern extreme also follows the idea of an open area, as well as serving as the intersection of the greenway along the river and the wide avenue, Kungsängsesplanaden. This area will be a focal point of the Kungsängen development once completed.

Soil, Fauna and Flora

The soil in the project area is not unusual within the context of Swedish construction. Therefore it is not of exceptional concern. With regard to soil contamination, it is suspected that there are heavy metals in the soil on site due to previous and current land uses. In order to achieve a high-quality living area that is safe for all residents, this soil must be decontaminated.

Our proposal for soil decontamination first specifies that all procedures will occur off-site. This is primarily with intention of making certain that no accidental spills could reach the river or (re-)contaminate clean soil in the area. The excavation of the lower-level parking structure also indicates that the majority of the contaminated soil will be removed from the site anyway.

There are three possible solutions for removal of heavy inorganics (heavy metals) from soil. The first is landfilling. This is simply the removal of soil and placement in a sequestered sanitary landfill. This solution is adequate for very small amounts of contamination and in nations where landfill space is inexpensive.

The second is soil washing. This involves the use of water-based detergents in a solution. The soil is soaked in the solution for some time, allowing the metals to transfer (often by ionic exchange) to the solution. The soil and solute are centrifuged, leaving clean soil behind. The solution is then precipitated and the residue containing the metals is landfilled. The volume to the landfill is greatly reduced, though much more potent than the disposed material in the first option.

The final option is quite similar to the first, with the substitution of acid for the water/detergent solution. The removal of metals is more complete in this method, though the risk of residual acid in soils is inherent. This method is normally employed in finer-grained soils (i.e. clays) where bonding of metals and soil particles can be considerably stronger than in silts and sands.

In both of the latter methods a water rinse is applied to the soil before returning it to use.

We initially preclude the use of the landfilling method because landfill space is at a premium in Sweden. We also believe the environmental impact of this method to be high because of the 'wasted' soil that could be re-used but will instead sit, more or less eternally, in a contaminated state.

Our preferred method is the water-based washing method. This will have the lowest impact on the environment as well as a lower cost (~1700SEK/ton). The hope is that a biodegradable detergent could be used, such that only the metals remaining in the residue will pose a hazard.

We caution, though, against using this method without first conducting a small-scale test. The soils in Uppsala are often composed of large amounts of clay, which could reduce the amount of metals removed such that the acid wash method will be necessary. This option poses a greater environmental risk because it involves the use of acids that could create an environmental hazard at the decontamination site. The cost of this method can be considerably higher, up to 4000SEK/ton, largely dependent

on the amount of soil (more contaminated soil lowers the unit price because of the apportionment of large up-front equipment costs.)
(information on methods summarized from Remediation Technologies Screening Matrix and Reference Guide [Federal Remediation Technology Roundtable])

The wildlife and vegetation in the area are not expected to be impacted by this development. Very little vegetation exists on the building site; it is dominated by pavement and building space. The river parkway is currently composed of grass and a few trees that are anticipated to be preserved during the renovation of the park space. No known wildlife exists, with a possible exception for pests.

Transport System

The development of transport has a great importance, as it is a mean to achieve other policies:

- social justice and equality (transport accessibility for everybody)
- for leisure
- for employment (if it is easier to get to and from work)
- for regional development (with an efficient infrastructure)
- for environment and health (by developing environmental friendly transport)

A sustainable transport system contains three main aspects (Ministry of Industry, Employment and Communication, 2002):

- "satisfy the basic needs for communication and development[…] in a safe way for the individual and the ecosystem and which promotes equality within and between the generations"
- "offers good value for money, functions in a fair and efficient way", with "different types of transport opportunities"
- "restricts emissions and waste to a quantity that the earth can absorb" and "keeps the consequences of use of land and noise to the minimum"
- Location from the city center: as Uppsala is a small city, the area is not far from the center. It can be accessible by bus and more efficiently in a sustainable way by bicycle or by walk.
- The actual road will remain but another road will be built behind the buildings: this one would be almost only used mainly for access to the garages.

Why not giving access to the garages on the existing road? The aim is to keep the area between buildings and riverfront as attractive and safe as possible.

Use of Private Cars

Assumed frequency of car ownership: we keep the standard figure of 0.8 cars per household. With around 50 apartments in each of the 3 buildings that leads to 40 private parking places in each building with a total of 120 parking places. The parking garage will be located in the underground: so it is hidden from the view and it does not create a visual barrier by parking the cars outside.

In return, we would like to implement an innovative system to encourage public transport.

According to statistics, an average person in Sweden travels 40 kilometers per day (Berg, 2002) on average, with the majority of trips made by car. Understanding that

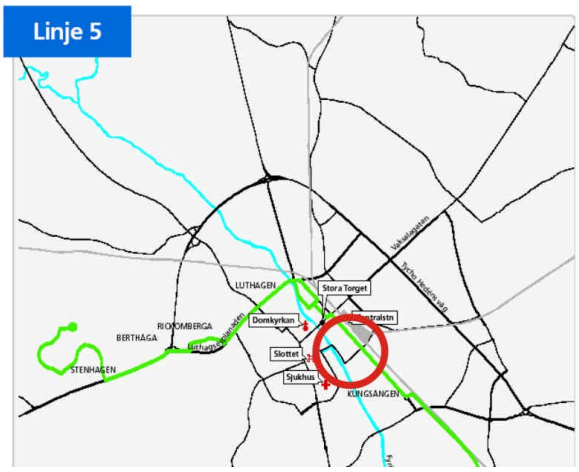
there are relatively few low-density or even smaller cities in which a person can live without a car, we have integrated the normal number of automobile parking places into the plan. As stated earlier, we instead intend those residing in the complex to take advantage of the alternative facilities available. These are primarily cycling, walking, and a bus system partially fuelled with renewable energy.

To encourage these other modes of transit, we suggest the implementation of an incentive system for those who chose to reduce their automotive dependence.

- Program goals: (anticipated outcomes)
  - Incitement measure for the use of public transport
  - Not a restrictive but rather a voluntary system for private cars
  - Change in consumption habits: influence private cars owners to change their mode of transport (at least for some of their journeys)
- Implementation process:
  - Every car owner of the area will monitor their vehicle usage by voluntary odometer readings. Occasional audits may also be used to insure that those using the system are reporting honest statistics. Assuming that a person normally travels 40 km/day i.e. 1200km/month, a 33% reduction (800km/month or 2400 km/quarter) will result in an incentive. Suggested incentives include a rebate toward a bus pass or cycling shop, etc. to encourage alternate modes. The reward should be carefully considered such that people are not encouraged to get a car and not use it simply to attain the discount (i.e. the discount per year should be less than the average annual cost of car ownership).

Public Transport

Public transit in Uppsala is based on a bus network; there are a number of buses in the fleet that are fuelled with biogas. (AB Uppsalabuss[a])



From http://www.uppsalabuss.se/PDF/NYA_LINJEKARTOR/linje5.pdf

Our proposition is to slightly re-route the buses traveling on line #5 in the area indicated by the red circle. The proposal would insert one or two stops in the project area so that each of the building would be in a reasonably walking distance from the access to public transport. The frequency of this route is around one bus every 10 or 20 minutes during the daytime. It would be undesirable to implement a higher frequency as it could

cause excessive noise and traffic in the area. This route provides connections to most other routes in the city center, which is less than five minutes away. (AB Uppsalabuss, 2004a) (AB Uppsalabuss, 2004b)

As previously outlined, this public transport improvement will be combined with efforts to try to change habits concerning the use of private cars. It is through these actions that a better traffic system can be developed.

Pedestrian and bicycle paths

The planned pedestrian network leads through entire area and gives access to courtyards and water front side. The possibility of a system of bridges between the buildings enabling good communications and a stronger sense of community is integrated into the proposed plan. A minimum of one bridge leading to the sports field across the river will create a pedestrian friendly atmosphere along the river; the possibility of a second bridge exists, though it may delayed and implemented as a part of future projects.

The intention is that the whole area will be accessible by walking. Shops, sport activities, natural areas, structured parks, residence, and most other necessary services will be within an easy walk or provided on-site with easy pedestrian access.

A bicycle path separated from the roadway will be created along the river parkway (near to the pedestrian path). This path will lead from the end of the river parkway at the southern extent of this project to the city center, where it will connect with other cycling paths. An off-road path was chosen for safety and to create a better environment for recreational cyclists.

The option of a cycle path on the east side of the project area also exists. This creates a second, possibly less congested path as well as a 'second front' to the development.

Road Network

No changes in the road network are anticipated due to this project. There is a possibility that, due to increased traffic loads, the number of cars on Östra Ågatan could increase if it becomes a reliever route for Kungsgatan (~500m east.)

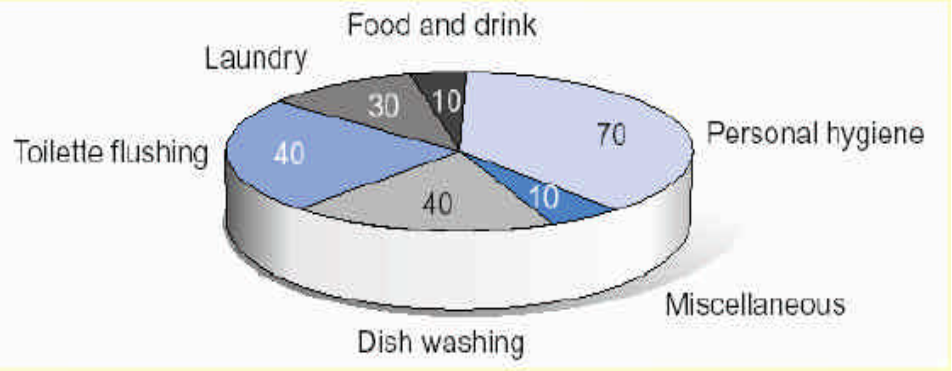
Water Systems: Water Conservation

The water consumption is estimated to 200 liters per household per day (l/d) in Sweden (for personal hygiene, washing, washing up and cooking). Estimates varied between 160l/d and 200l/d, we will consider the maximum number as it was the most common.

The usual distribution of household water usage is:

We have decided to act on three primary issues where the consumption is highest: personal hygiene, toilet flushing and dish washing. The summation of these stands for 75% of the total use of water per day.

In order to achieve the goal of 20-30% water conservation, we took the example of Uppsala's Hågaby Village. The first step will be to outfit the taps in the kitchen and bathroom with flow limiters (theoretically giving a 30% reduction of flows.) The



From http://www.watersave.uk.net/Presentations/Gilbert_Svensson.pdf

second step is water savings through toilets. The integration of the urine separation system discussed later will include the installation of special toilets. These will have two 'flush options': low flow (2 liters) and high flow (4 liters); this will reduce by nearly 50% the amount of water consumed by toilets.

This table outlines the itemized and overall water conservation.

water use per household (liters/day)		**reduction expected**	**consumption after reduction**
toilet flushing	40	35%	26
dish washing	40	30%	28
personal hygiene	70	30%	49
total of water use	150	30%	103

The technologies used lead us to water savings of around 30% for the considered items. It stands for around 23,5% of saving on the global consumption, which achieves our objective (between 20 and 30%).

Water Systems: Grey Water Treatment

Toward sustainable housing

Water is one of the most valuable nature resources due to its necessity for daily life. Water usage is a topic that should be of discussion in all new developments as water use in many places is exceeding aquifer re-charge and other natural supply replenishment processes. Grey water recycling is one of many developed technologies to conserve or reuse the household wastewater.

Consider how much water can be saved if each of us recycled our greywater; varying figures estimate that 50-80% of home water-use is greywater from showers, baths, laundry and kitchens that can safely irrigate a home, small commercial garden, orchard or landscape with simple on-site appropriate treatment (Kaufman).

It is possible to recycle water from baths and sinks for toilet flushing. This is known as greywater restoration and involves the collection of wastewater, which is then filtered and pumped into storage tanks. On a more simple level the use of water butts and permeable surfaces can reduce the need to use tap water for gardens (Falk and Rudlin, 2000).

Wastewater and greywater recycling are emerging as integral parts of water demand management, promoting the preservation of high quality fresh water as well as reducing pollutants in the environment and reducing overall supply costs. Greywater represents the largest potential source of water saving in domestic resident. For example, the reuse of domestic greywater for landscape irrigation makes a significant contribution towards the reduction of portable water use (Al-Jayyousi, 2003).

Looking in the picture bellows, it is presenting that in private sector housing, savings of 45 liters of drinking and wastewater per person / per day are possible, and these can rise above 60 liters per guest / per day in hotels (Lindstrom, 2000).

The aim of this chapter is to apply a greywater reuse system in sustainable water management for sustainable housing, which have significant advantages according to ecological as well as to economical aspects.

What is grey water?

As stated earlier, greywater is the household water from showers, sinks, washing and general use; everything except toilets. This water comprises a sizeable portion of the wastewater stream. The difference between greywater and blackwater is that since greywater does not carry 'humanure' from toilets, greywater can be cleansed and used for irrigation much faster and safely (Kaufman).

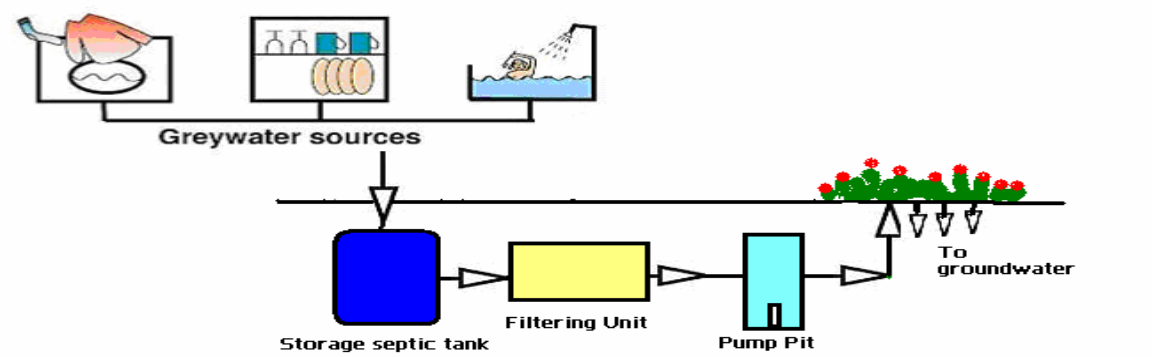
Greywater can be used in groundwater recharge, landscaping, and plant growth. The fact that greywater is usually generated by the use of soap or the soap products for body washing, indicates that its quality varies according to source, geographical location, demographical and level of occupancy. Greywater is relatively low in suspended solids and turbidity, suggesting that the greater proportion of contaminants is dissolved (Al-Jayyousi, 2003).

Important concepts

Greywater reuse should fulfill four criteria: hygienic safety, aesthetics, environmental tolerance, and technical and economical feasibility. Options of making safe use of greywater as a source of irrigation are many and diverse. The simplest greywater treatment consists of directly introducing freshly generated greywater into an active, live topsoil environment. Many new technologies have been developed to treat greywater apart from collecting rainwater technique such as basic two-stage system

and biological system are the good ways to reduce water consumption (Al-Jayyousi, 2003).

Buried underground in the garden (see below picture), water recycling equipment, filtering units, and storage tanks - water from the house is recycled and used to irrigate the garden. The system features are storage tank, household plumbing units, a pipe to send water to the garden, water from the washing machine, and the garden being watered (Krikke, 2004).



Water Systems: Urine separation

Introduction

There have been many applications of human or animal urine in history. The historical cycle between agricultural produce and animal and human excreta is well known. Human urine is a potential source of phosphate. The average human produces about 500 liters of urine per year. The separated urine can be used directly as fertilizer or the phosphorus can be precipitated and applied in other forms (Wilsenach). Urine separation methods have been well-developed and are being tested at full scale in Sweden. For instance, in 1995, the urine separation toilets were installed in Understenshöjden in the south of Stockholm and Palsternackan estate within Stockholm (Johansson and Nykvist, 2001).

Recycled human waste is an affordable and environmentally sound alternative to chemical fertilizers. Applying human waste to crops is safer than spraying with chemical fertilizers because it diverts raw sewage from rivers, reduces sewerage load in treatment plants, and can help improve agricultural production. It also costs only a fraction of sewage treatment plants. It contains approximately 70% of the nitrogen and 50% of the phosphorus and potassium in all household waste and wastewater fractions, while the flow of urine is comparatively small (UNDP Equator Initiative).

Separating the urine, which only accounts for about 1 % of the total wastewater flow, and using it as fertilizer makes it possible to utilize most of the nutrient content of wastewater. Urine separation cannot replace other treatment methods but is a complement that provides a possibility to recycle a larger proportion of the nutrients in wastewater (Johansson and Nykvist, 2001).

The main purpose is to apply the system to recycle nutrients from human waste back into the environment and into productive systems such as farming fertilization for sustainable housing.

Urine separating system

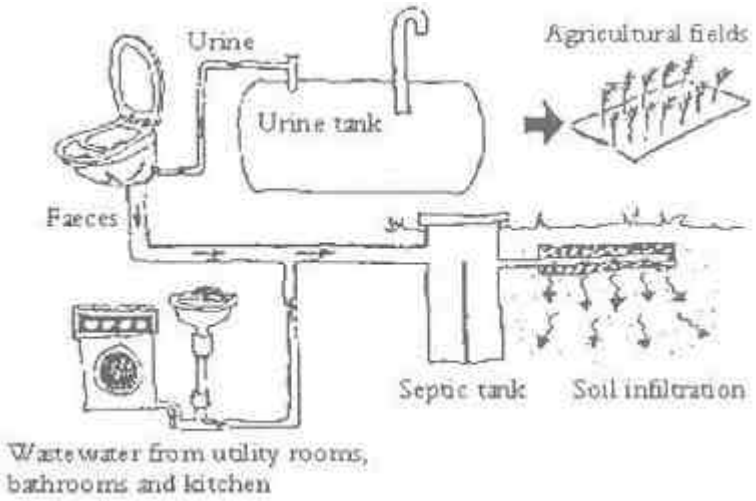


Illustration: ©A.Hanæus, 1996
Design of a urine separating system with soil infiltration for treatment of feces and greywater. From Hanæus and Johansson, 1996.
Source: UNDP Equator Initiative: Divide and Spray – Sweden

The figure illustrates the urine separation system that can be applied into this housing project. The urine separation is based on toilets equipped with two bowls, a front one for the collection of urine and a rear one for feces. It is possible to equip both dry sanitation toilets and water closets this way. The collected urine is led through a sewer system to a storage tank. There is a risk of cross contamination of the urine with feces; this is more likely to occur with diarrhea or improper use of the toilet. For this reason, the urine is stored for a long enough time to kill all harmful bacteria. (UNDP Equator Initiative).

The urine is collected in the front of the toilet and led through a tube down to a storage tank. When tank is full, a lorry comes and collects the urine by sucking it out using a pipe. The urine is then taken to be stored in special tanks where it is monitored. The present recommended storage time for source-separated urine is a minimum of six months. This is to ensure that all the bacteria have been killed. The feces fall straight down into a bucket under the toilet seat. The system is usually combined with separate, on site treatment of greywater (UNDP Equator Initiative).

This ecological sanitation system has many advantages such. For example,
1) ecological toilets can be easily installed inside the houses and on any floor, 2) they do not smell or produce flies, if the are properly managed and 3) there are a great advantage when they applied on a large scale i.e. no water is required for flushing, transportation and dilution of human excreta (UNDP Equator Initiative).

Solid Waste Systems

Solid waste in our development will be handled in a way similar to the rest of Uppsala. The primary reason for this is because the infrastructure already exists and because the development is in the city center, making some alternative methods more challenging.

Trash Pre-Sort

In general, Sweden recycles roughly 86% of household waste. (Svenska Renhållningsverksföreningen) The waste stream has, for many years, been dictated by a trash pre-sort system dependent on participation of individual households. Our hope is that the percentage of landfilled or incinerated trash in our development is 10% or less of the total waste stream. While this is not significantly above average, it takes into account the fact that it is not feasible to recycle some wastes either due to restrictively high technology or low amounts of specific wastes in the waste stream. The plan to achieve this elevated recycling participation shall be through a public relations campaign at the opening of the development, as well as a special 'Welcome Pack' consisting of materials from the local trash and recycling authorities for all those who move in after the initial opening. The high performance of pre-sort in the past leads us to believe that this system will be relatively successful as pre-sort is already a part of many people's lives.

Compost

Uppsala does not have a community-wide composting system (Uppsala Kommun VA-och Avfallskontoret, 2003); they encourage residential communities or individuals to collect compostable goods and supervise their own program for management of biodegradable goods. We intend to implement a composting system for out complex. The composted soil will be used in gardens on the plot and excess donated to other organizations.

The preferred composting system will be an active (turned) system in a set of drums. These would be placed behind the northernmost building. The drum system will increase the speed of the decomposition process, produce high quality compost, and reduce the possibility of odor problems. The primary concern is capacity, which will dictate at least three large devices or numerous smaller ones, depending on models available. (University of Florida Institute of Food and Agricultural Sciences [a]) In order to insure that the composting is effective, the complex will need a few 'compost wardens' to make certain that the bins are turned and that the composition is optimal. Proper composting will be a part of all PR campaigns and will, in its most basic forms, explain the scientific necessities of good composting. According to the University of Florida, a carbon-to-nitrogen ratio of 30:1 produces the best conditions. (University of Florida Institute of Food and Agricultural Sciences [b]) Using the 'Virtual Pile' plug-in, it was observed that normal table scraps, fruit scraps and coffee grounds produce compost at near optimal composition. In the case of low carbon content, newspaper or paperboard may be added. Balancing excess carbon is done with addition of green plants or grass clippings.

Heating

One of the greatest sources, if not the greatest source of over-consumption in Sweden is electricity. A large portion of wasted energy is in resistance heating of living units. This process has exceptionally low energy efficiency, especially when considering

energy losses in transmission of power over great distances from power stations to individual homes. In order to avoid this, our structures will be connected to Uppsala's district heating system.

The efficiency of this system is an unparalleled option in our case. The development benefits from its proximity to the city center, where the infrastructure already exists and the population densest, resulting in the lowest infrastructure cost per residential unit. The use of a central plant means that efficiency is higher because greater benefit for lesser cost can be realized from large-scale structures. Furthermore, the Uppsala heating plant uses biomass for heat production, reducing dependence on imported fuels as well as reducing transport of fuel is the biomass is locally produced. It is quite apparent that the costs of implementing a self-sufficient system could be both cost prohibitive and environmentally detrimental when such a good option already exists.

Electricity

With regard to electricity, the most important factor will be to reduce usage of electricity. There are many campaigns throughout Sweden to help. By referring people to resources (to be included in move-in packet) they can learn of energy reduction processes including energy-efficient lighting and purchasing 'energy star' appliances. (Eskiltuna Energi och Miljö)

Additionally, our structures will produce electricity themselves. With the average Swedish household using between 7,000 and 14,000 kilowatt-hours per year (kWh/y), (Eskiltuna Energi och Miljö) we wish to produce no less than one-fourth of the electricity on-site. Our design, outlined below, may produce up to 35%, which is more than acceptable. The goal is that the production will never fall below 25% of total complex consumption.

We will employ a new type of photovoltaic converter that has shown consistent efficiency of approximately 20%. With this system, the solar cells will produce about 170 kWh/y per square meter of surface area when facing south. With about 400m^2 of south-facing roof space per building and three buildings, the minimum power produced (204 MWh/y) should represent about 35% of the complex's total power consumption of 572 MWh/y.[1] (Alm, et.al, 1998)

[1] Calculations are as follows: *Annual Production* 170kWh/y/m^2 x 1200 m^2=204,000 kWh/y or 204 MWh/y *Annual use* (occupied units, accounting for vacancies) x (above median for conservative estimate) gives 52 units x 11,000kWh/y/unit=572,000kWh/y or 572 MWh/year. Percentage= 204/572x100˜35.6%

Possible Implementation Issues

The issues surrounding this development fall into two categories. The first is the voluntary status of many of the programs, while the second is the changes in behavior that this program will evoke. A minor role may be played by resistance to the innovative architecture of the structure.

Concerning the choice of a voluntary system to encourage the use of public transport, there is a possibility that people do not see the value in changing to other transit modes. This may be remedied by changing the incentives. The voluntary waste systems may see similar hindrances either due to lack of education about the methods or lack of interest. With the expectation that those residing here are doing so voluntarily, it is anticipated that this will not be a significant problem. Further education may be necessary at times when high turnover has reduced the number of 'veteran' residents to help guide the processes.

Education will be a key to helping change peoples' habit without resistance. This too is voluntary in nature, again presenting a problem if lack of volunteers is also a problem. Fortunately, the Uppsala area is academically oriented and Swedish citizens, in general, are very well educated about the environment and current ecological issues. Education sessions would detail such local factors as the car monitoring system and information about the way the housing area has been built, as well as the global effects that lifestyle changes will have. This should sufficiently motivate those who are otherwise unwilling to participate.

The proximity of the industrial area could also be a problem and a sort of barrier, which could cause some people to hesitate before moving to the development. Also a concern is occasional odors from the treatment plant nearby. The long-range plan for removal of the treatment plant removes the proem of the latter. To combat the former problem, the development has been surrounded by parks and emphasizes its proximity to the river. The architectural style will also be helpful due to the integration of green areas and the concept's allowance for views of the waterfront from all of the buildings.

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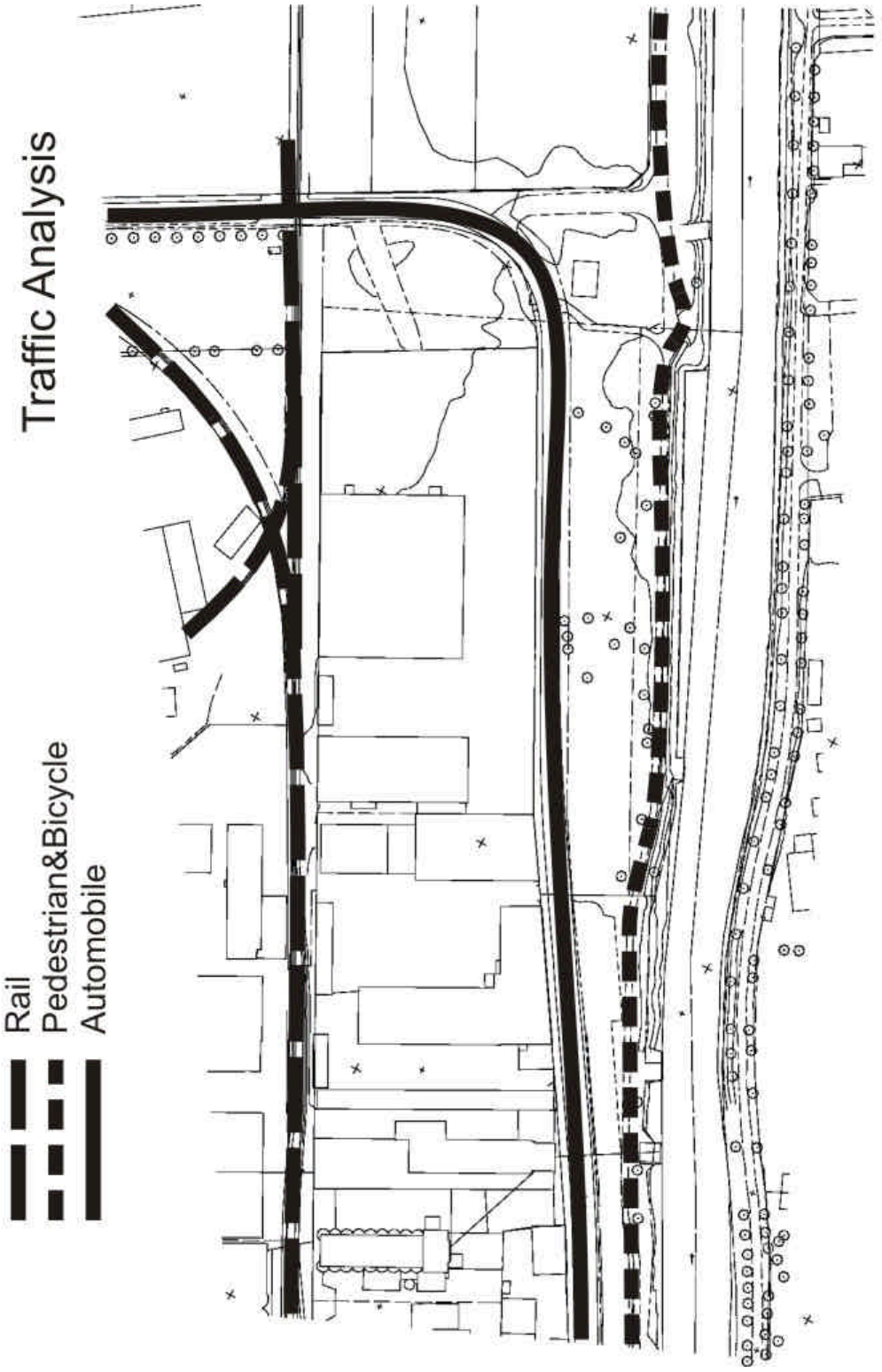
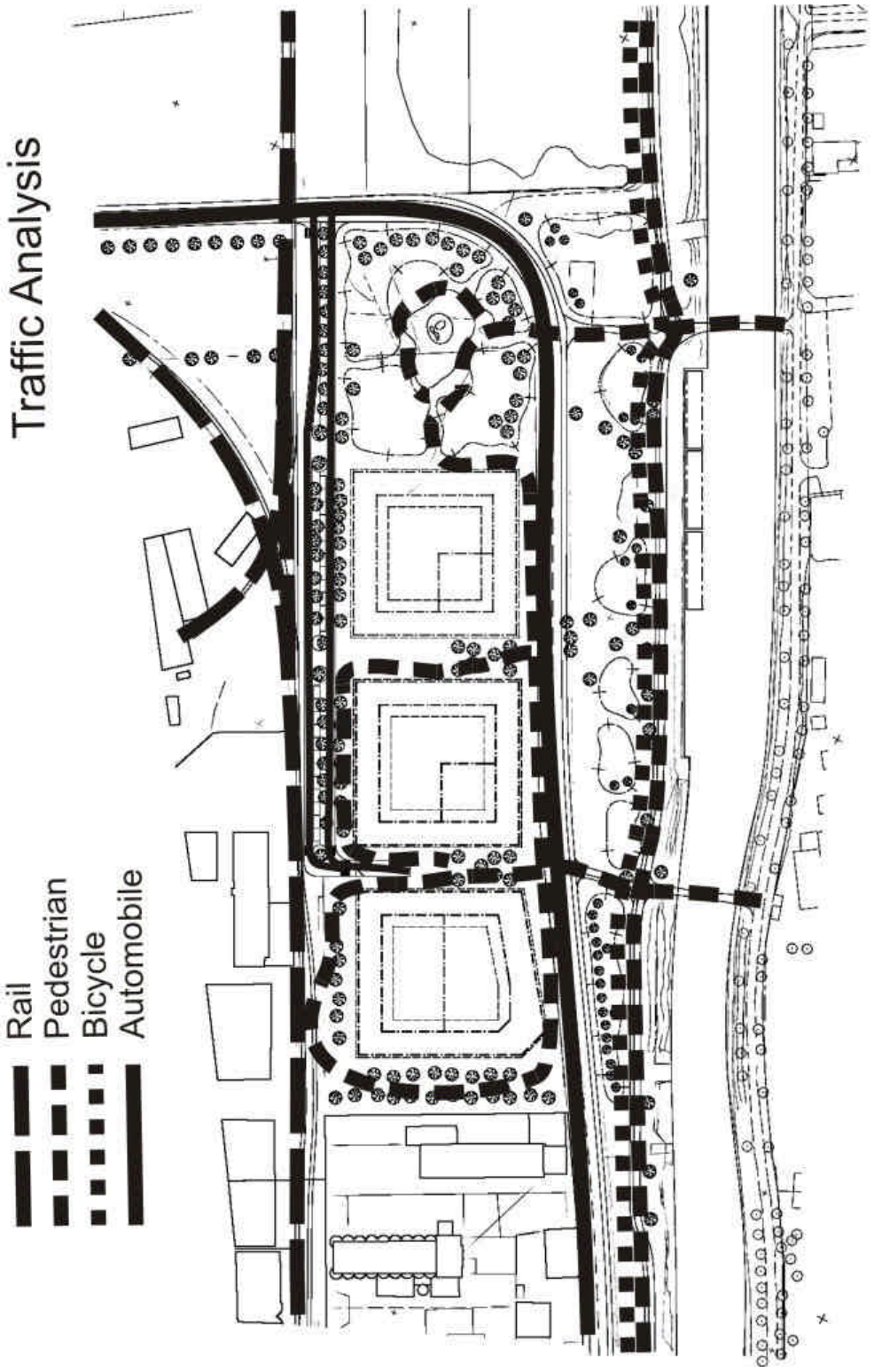
Appendix A-1: Present Traffic Patterns



Appendix A-2: Traffic Patterns After Project Implementation



Appendix B-1


LEVEL -1
SCALE 1:1000
100m
0m
Parking Places
Vertical Communications
Water Treament
Waste Treatment

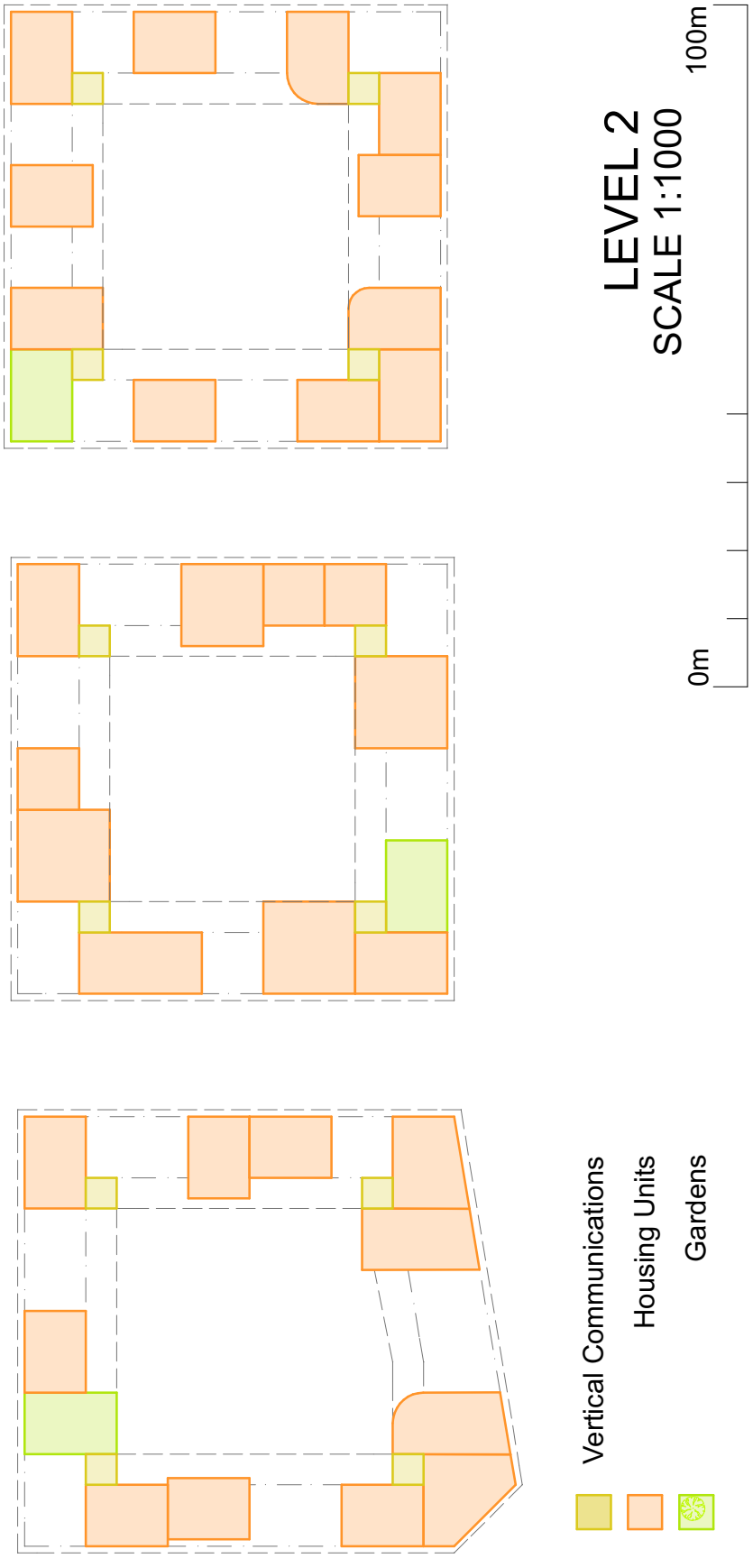
Appendix B-2


LEVEL 0
SCALE 1:1000
0m
100m
Östraågatan
Commercial Units
Vertical Communications
Gardens

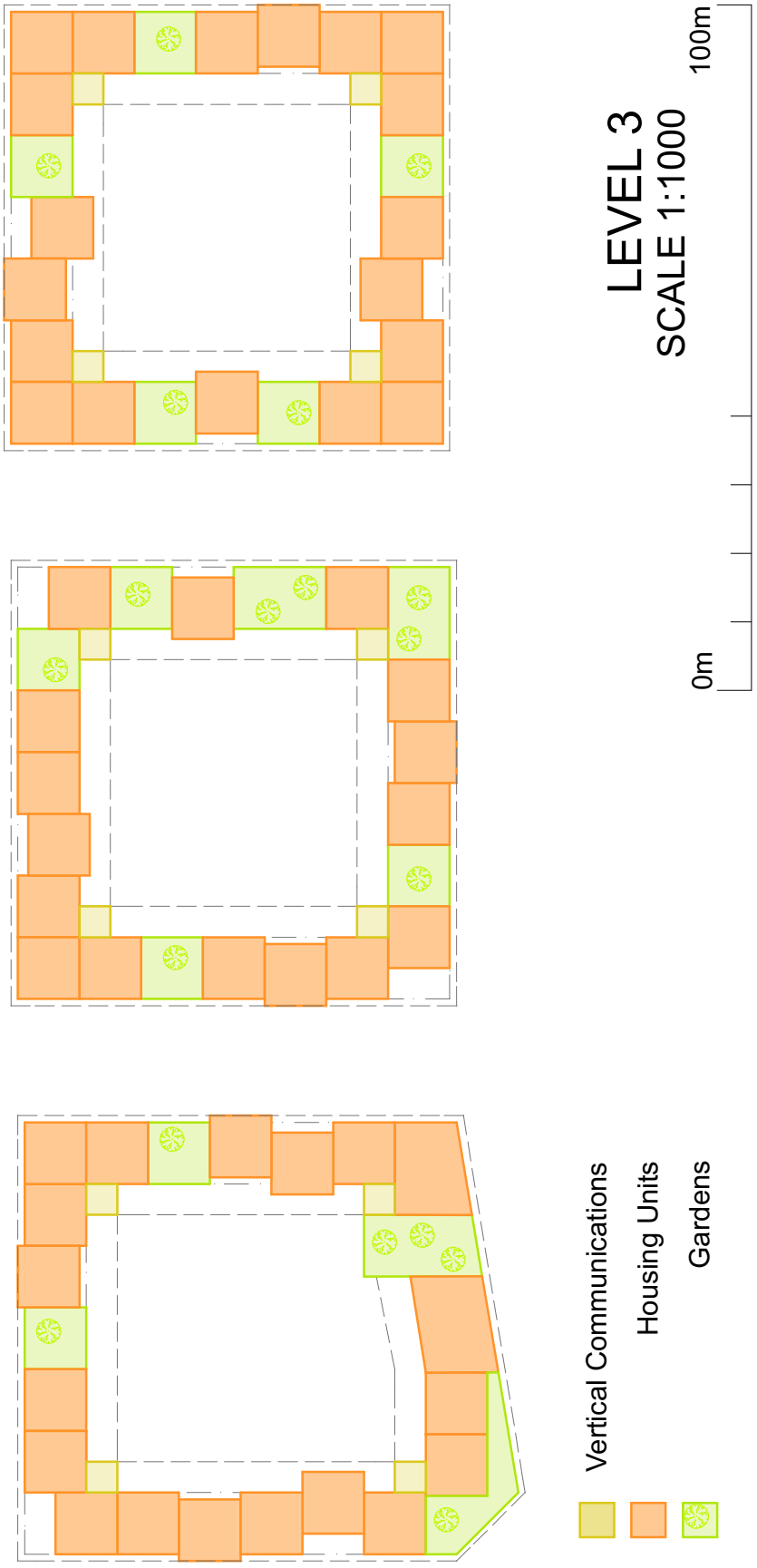
Appendix B-3


LEVEL 1
SCALE 1:1000
0m
100m
Commercial Units
Vertical Communications
Housing Units
Gardens

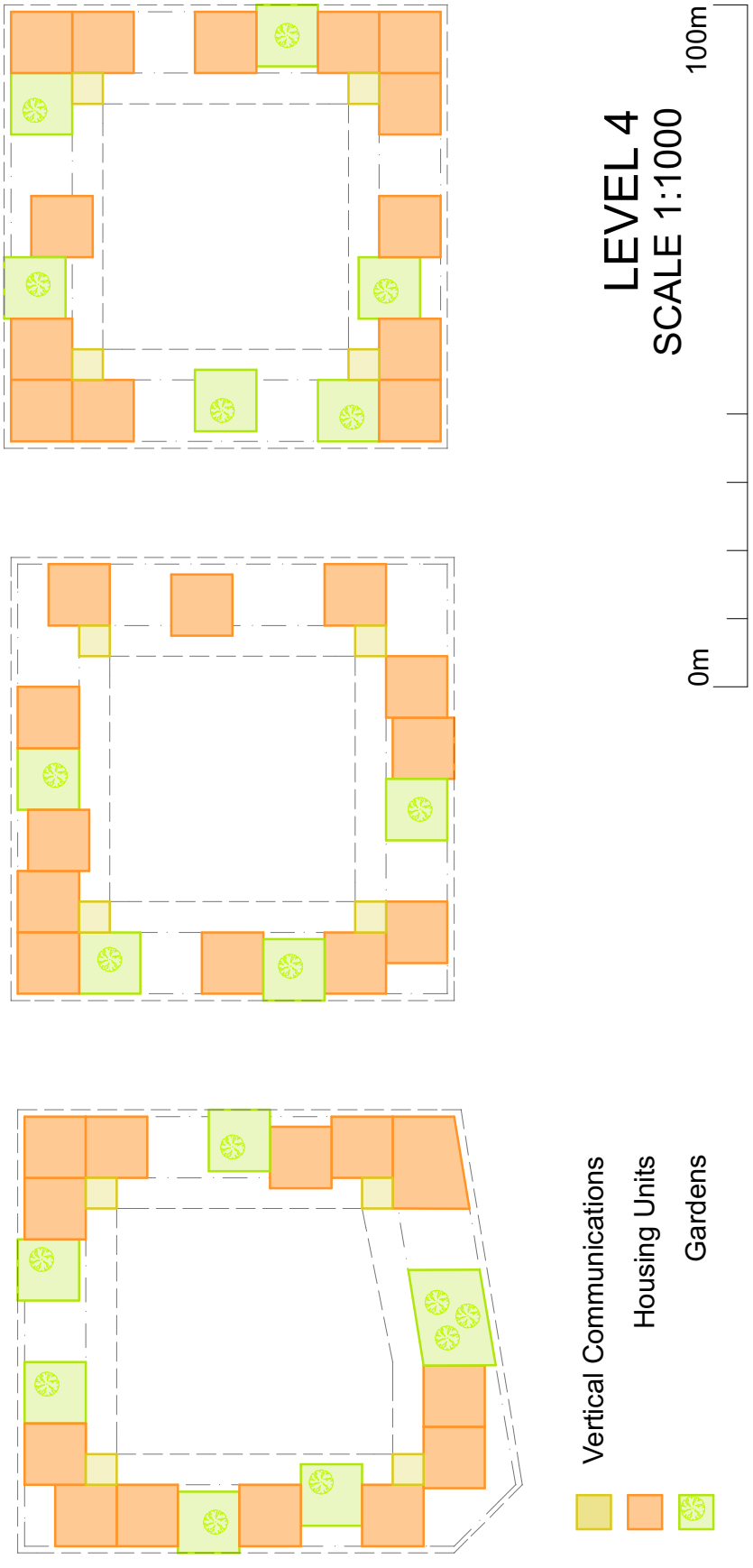
Appendix B-4


LEVEL 2
SCALE 1:1000
100m
0m
Vertical Communications
Housing Units
Gardens

Appendix B-5


LEVEL 3
SCALE 1:1000
0m
100m
Vertical Communications
Housing Units
Gardens

Appendix B-6


LEVEL 4
SCALE 1:1000
100m
0m
Vertical Communications
Housing Units
Gardens

Appendix C: Ground Plan