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The Notion of Adaptation

An exploration into the sustainable adaptation of our suburban development

Taryn Schefermann

0301347E

Thesis Document

This document is submitted in partial fulfilment for the degree: Master of Architecture (Professional)

at the University of the Witwatersrand, Johannesburg, South Africa, in the year 2008.

To My Parents...

for all their love, support and encouragement.

Thank you Mom and Dad for the many sacrifices that you have made to enable me to complete this degree.

This one is for you.



View of Study Area off Kloofendaal Ridge


makro

Rosalie Genevro writes “**What can architects offer**... **are visions of fundamentally new arrangements for new ways of life**. Architects must **take on the big questions** of land use patterns and transportation and space standards and hyper-consumption and waste, and challenge themselves to create positive visions of ways of living that protect the planet and still offer opportunity and comfort “,

(Buchanan, 2005: 5).

Acknowledgments

I'd like to express my deepest thanks to my supervisor, **Kirsten Doermann**, for her infectious passion and knowledgeable guidance throughout this year.

I'd also like to thank **Daniel Irurah** and **Lone Poulsen** for their invaluable time and advice regarding this thesis.

Thank you to my loving husband-to-be: **Daniel Gerlag** and the rest of my family, for all your support and prayers and a very big thank you to my **Lord Jesus Christ** who has guided, strengthened and blessed me with His grace and favour throughout this degree.

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Vanya Vucinic, (Roodepoort Museum).



Snippet of Johannesburg's Suburbia: The study area
(Google Earth 2008)

Proposition:

As current issues of resource availability, global warming and inadequate service provision cause us to tighten our belts and light more candles, some fundamental questions need to be raised about suburban development in the built environment. **How can the current and future suburban development of Johannesburg adapt to become more self-sufficient, more sustainable entities?**

Most contemporary dormitory suburbs are not self sufficient. High mobility and economic change have undermined the significance of locality in people's lives, (Barton, Grant and Guise, 2003: 2) and thus many dormitory suburbs have been birthed on the outskirts of our city. This low-rise horizontal spread in turn increases the heavy reliance on motorized transportation of our city while increasing the unconcentrated demand for water and electricity provision.

It is possible that the current insufficient and expensive service provision and the sky rocketing fuel prices that suburban residents have faced this year, may catalyze a mass abandonment of suburban areas on the outskirts of our city, for a closer more convenient location, if the current environmental, economic and social pressures are not alleviated. From this, it can be argued that the greatest weakness of this settlement may lie in its high dependence on the provision of services, substances, and economic means found elsewhere in the city. It can be suggested that human settlement has not always had this self sufficiency weakness.

How long will we allow the insecurities in our suburbs to birth more and more gated communities that create a street edge condition that is more hostile and less inviting to the pedestrian? This might not matter to the middle class of today but what of the middle class of tomorrow– when oil scarcity causes commuters to use public transportation as the more affordable option to get around? Within the suburb where every man is for himself– the undermining of the importance of public or shared space and invaluable community life might come to an end when the quality of the street edge becomes more inviting. Instead of mourning the loss of the local aspect of our neighbourhoods , how can we facilitate the resurrection of locality?

This thesis will endeavour to critically examine the growth of an existing developing suburb of Johannesburg from when humans first settled in the area until the present day. It is hoped that this examination will expose what pressures and problems have arisen in the area following its current path of development.

This thesis will propose a possible urban intervention within this suburb that may aid the existing area in becoming more sustainable by implementing sustainable urban and neighbourhood principles and by closing 'the loop' of many linear infrastructural cycles that are currently at play within the suburb.

Following this intervention, a housing development will be designed in an attempt to illustrate possible adaptations that can occur to future suburban development briefs to facilitate the future development of suburbs in a more sustainable manner. It will also demonstrate how sustainable principles and strategies may alleviate or decrease the negative effects on the environment and society. It is hoped that this architectural intervention may act as a catalyst in the area through setting an example to the local community as to how sustainable living may not be one of deprivation whilst illustrating the long term benefits attached to such a lifestyle.

It is noted that this transformation is only possible through involving many stakeholders, both from the private and public sector. This thesis endeavours to explore how 'The Architect' may be able to play a role in bringing about sustainable adaptation of suburban development by providing a service to the various stakeholders concerned.

Declaration

I, Taryn Schefermann 0301347E am a student registered for the course Master of Architecture (Professional) in the year 2008. I hereby declare the following: I am aware that plagiarism (the use of someone else's work without permission and/ or without acknowledging the original sources) is wrong. I confirm that the work submitted for assessment for the above course is my own unaided work except where I have stated explicitly otherwise. I have followed the required conventions in referencing thoughts, ideas, and visual materials of others. For this purpose, I have referred to the Graduate School of Engineering and the Built Environment style guide. I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my unaided work or that I have failed to acknowledge the source of the ideas or words in my own work.

_____

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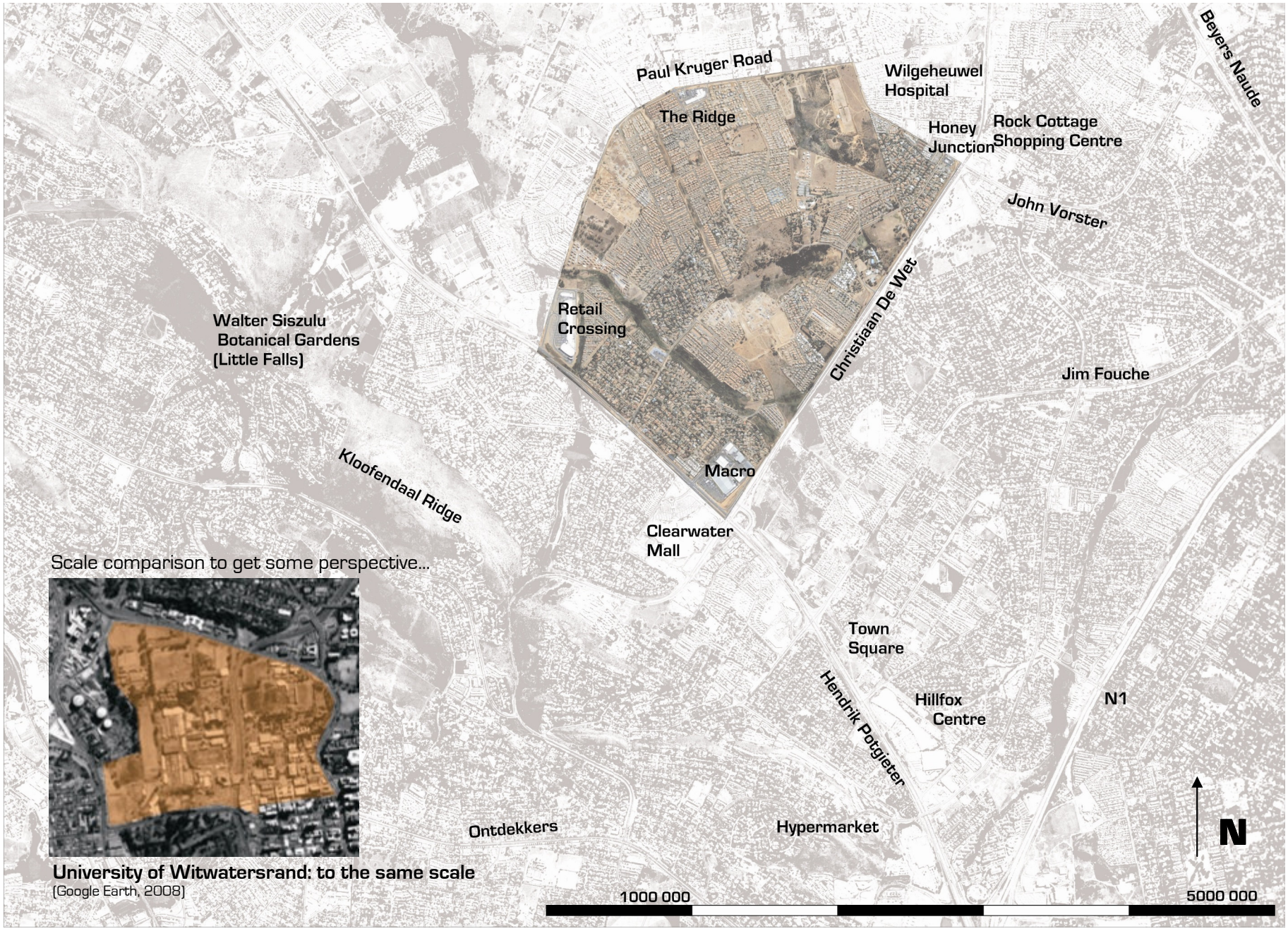

Figure 1: Aerial Photograph of Study Area in Context: Region C: Roodepoort,
(After Google Earth, 2008)

Definitions

The Study Area:

This snippet of suburbia (see figure 1) will be used to illustrate some of the issues that are raised throughout this thesis. It will also serve as the greater context for the proposed urban intervention and subsequent architectural design of this thesis.

Johannesburg is the host of many different suburbs. These suburbs range from the relatively young commuter suburbs of Boskruin and Ruimsig to the older inner city suburbs of Houghton and Melville. The outermost and consequently younger suburbs express the unsustainable characteristics of current suburban sprawl quite effectively.

This is due to their location on the outskirts of the city and the consequent daily need to commute that it catalyses. Despite the inadequate service provision and heavy traffic congestion, these dormitory suburbs are seemingly under continuous development pressure which consequently constructs, often single-class, gated communities.

Strubensvallei and its surrounding areas is one of the younger suburbs of Johannesburg and shall serve as the study area for this thesis. It was selected because it expresses many of the typical suburban unsustainable characteristics. It is a low-density, dormitory suburb and is located on the western outskirts of the city.

It is under considerable development pressure with many future development sign boards boldly declaring "Watch this space," This is surprising considering that the area is almost running on full capacity for both electricity and water supply, (Johannesburg Town Planning, Regional Spatial Development framework 2007: 7).

The study area is situated in a wetland valley that is dissected by the Wilgespruit stream which is Dutch for 'Willow Stream,' (Smith, unpublished: 41). It is furnished with much fertile soil that has accumulated from the topsoil of the higher surrounding land being washed down into the lower parts of the area over the years, (Interview with Carolina Geldenhuys, Roodepoort Museum).

Adaptation:

The action or process of fitting or suiting one thing to another; modification; to fit a new use, new conditions, etc; modification by which an organ, organism or species becomes better fitted for its environment or mode of existence,

(The New shorter Oxford English Dictionary)

Sustainability:

Supportable, manageable, rare. Able to be upheld or defended. Able to be maintained at a certain rate or level of economic activity, development, agriculture etc; not leading to depletion of resources or degradation of the environment,

(The New shorter Oxford English Dictionary)

Unsustainable:

Not sustained. Not supported materially or as valid or correct. The quality of not being sustainable,

(The New shorter Oxford English Dictionary)



"Civilized man was nearly always able to become master of his environment temporarily.
His chief troubles came from his delusions that his temporary mastership was permanent.
He thought of himself as "master of the world", while failing to understand fully the laws of nature.
'**Man, whether civilized or savage, is a child of nature- he is not the master of nature.**
He must conform his actions to certain natural laws if he is to maintain his dominance over his environment. When he tries to circumvent the laws of nature, he usually destroys the natural environment that sustains him. And **when his environment deteriorates rapidly, his civilization declines**,"
(Schumacher, 1973:84).

suburb + stimuli = abandonment?
+ principles = adaptation

Chapter 1

Introduction to the Notion of Adaptation

Survival seems to depend upon the capacity to **adapt** to changing circumstances.

It is evident that if we continue to alter and simplify the natural order of the planet "what's at risk is not the earth itself... but our own social systems and ultimately our species," (Battle and McCarthy, 2001:16-17 and 49).

It seems almost impossible to ignore the global environmental crises that our planet faces: "the destruction of the ozone layer by chlorofluorocarbons, the loss of wildlife habitat and diversity through pollution, desertification and deforestation, or the increasing levels of carbon dioxide caused by emissions from building heating and other inputs," (Energy Research Group, 1999:1).

Building societies, developers and the real estate industry are seemingly allowed to override sustainability requirements in order to satisfy short term market demands. They often, ignorantly conspire by hiding "behind the so-called do-able and the alleged 'desire' of the user,"(Barreneche, 2005: 10). The consequences of this are evident in the seemingly endless urban expansions of our cities: our suburbs.

Currently, "detached houses in new residential developments... called Chalet, Lifestyle, Ambience, Future, Residence or Metropolitan are booming. Unfulfilled longings and desires, identified by these names, in this context remain without perspectives; future demands or changes are not considered... Behind all this, paradoxically and abruptly, lies an undefined and nebulous quest for authenticity even though nobody really knows what this exactly means,"(Barreneche, 2005: 10).

Adaptation refers to the "action or process of fitting or suiting one thing to another," or "modification by which... a species becomes better fitted for its environment or mode of existence, (The New shorter Oxford English Dictionary).

Thus, **the Notion of Adaptation**, in a suburban context, refers to the modification of our neighbourhoods, our cluster developments and houses, to satisfy the conditions of the environmental, social and economic stimuli that are currently acting within the suburbs, while being mindful of the long term sustainability of such modifications, (Barton, Grant and Guise, 2003:5).

This thesis focuses mainly on the environmental issues and relevant sustainable principles that pertain to the suburbs as these have evidently been overlooked or under prioritized in suburban development in the past. However, the social and economic issues and their relative sustainable principles cannot be entirely divorced from the environmental factors as most systems are conglomerations of all three. Thus, the equally important economic and social aspects of the suburb have been mentioned and considered, but have been researched to a

lesser degree. To compensate the undermining of the importance of environmental issues, Australia and the United Kingdom (UK) have taken environmental sustainable living to new level by introducing carbon points systems and readjusting the legislation requirements for their building sectors. The Government in the UK has "committed itself to a 20% reduction target for all greenhouse gases by 2010, in parallel to its agreement to a 12,5% cut by 2012 under the 1999 Kyoto Protocol on Climate Change," (BRECSU, 2002: 5).

However, South Africa has been seemingly slow in taking initiative and planning ahead for environmentally sustainable systems to be implemented. Issues pertaining to environmental sustainability are not new and yet only in February this year was it mentioned that new buildings plans will not be approved unless they are energy efficient, (Cox, 2008: 3).

The current Growth and Development Strategy (GDS) for Johannesburg, which drives the Regional Spatial Development Framework (RSDF)- which in turn sets guidelines for our town planners, seems to focus mainly on the economic challenges we face in the great need to eradicate poverty. (see Appendix 1). Whilst the economic situation of our country is of paramount importance, should planning set aside all environmental and social considerations in pursuit of this admirable objective? This approach can be seen as rather short sighted in the face of resource depletion in the near future. Thankfully, the Johannesburg council are currently revising its policies to accommodate for the social and environmental sustainability issues that we are to face as a nation.

Thomas writes that we have entered **a new era of sustainability** which he refers to as the "New Age". (2002:9) This thesis would like to suggest that this "New Age" in architecture **involves more than** just altering one's brief for **new buildings** and systems. But that it is additionally, an era of reflection where architects, urban planners, and our society as a whole, **re-evaluate the existing approaches**, structures and systems that make up our modern world and adapt them to suit the more sustainable requirements of the "New Age".

Suburbia as we know it today, is often referred to as highly inefficient and unsustainable human settlement. However, its seems that its development has been long accepted as the norm. Its time we relook at how our suburbs can develop in a more sustainable way without loosing the essence of the suburbs which tries to simultaneously provide both the benefits of the country and the city. It is quite ironic to think that the way people live is changing at breakneck speed, but the houses most people live in have hardly changed in comparison, (Barreneche, 2005: 87).

A current challenge for the built environment is to cultivate a resource consciousness and way of life that responds to the issues our planet, our country, our city and our suburbs, face on a daily basis. "Natural structures and forms [develop] in a constant process of adaptation. **Those systems which do not adapt, disappear**,"(Battle and McCarthy, 2001:15).



Figure 3: Some of the news articles from one week in February this year
(Business Day, February 2008)

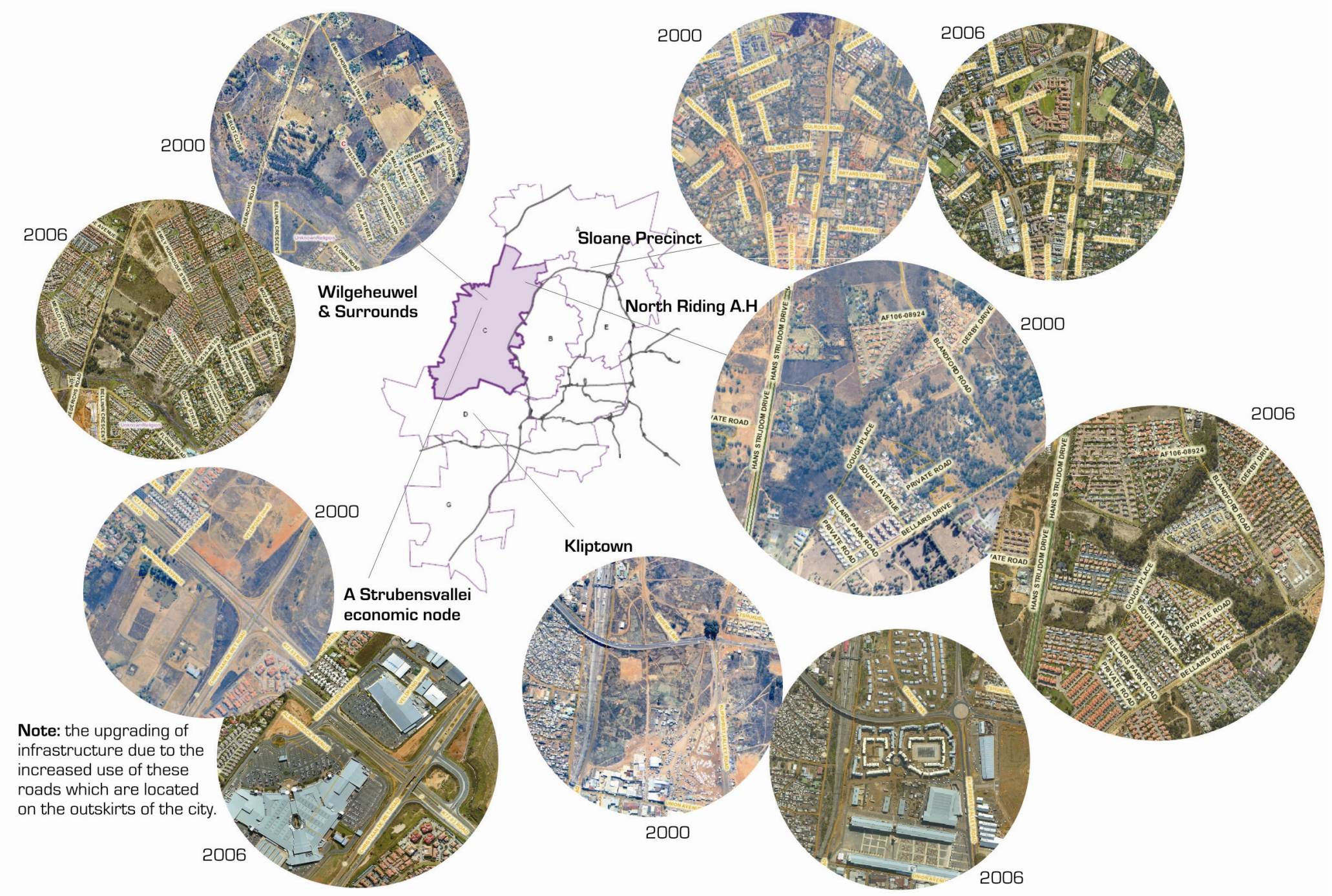

Figure 4: Rate of suburban development in Johannesburg
(Images courtesy of Johannesburg Town Planning Department)

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2.3.9 Lack of Passive Design Considerations within 'Style' Dictated Clusters

2.3.10 Contributing to the Global Carbon Cycle and Global warming Climate Changes

2.3.11 Inappropriate Construction Material Specification and Assembly

2.4 What about Future Development? The Call to adapt

Chapter 2

Suburban Development

2.1 Introduction

Directions in architecture are not readily discernible without the benefit of hindsight, (Thomas, 2002: 37).

Toffler maintains that the requirement of any civilization is energy. The initial societies of the world made use of natural kinetic energy of humans and animals as well as energies from the sun, wind and water, where possible. However, the preceding industrial societies began to use irreplaceable fossil fuels such as oil, coal, and natural gas as sources of energy. "This revolutionary shift meant that for the first time a civilization was eating into nature's capital rather than merely living off the interest it provided,"(Zeiher, 1996: 12).

"Since 1950, the world energy requirement has almost quintupled. Currently, we use up as much energy per year as nature produced over 500000 years in the form of coal, crude oil and natural gas. At the beginning f the 21st century, saving energy and reducing carbon dioxide emissions are the most critical tasks, not only for architecture," (Brauneck and Pfeifer, 2008:10).

Human settlement and suburban development seems to have lost its sensitivity in its relationship with the environment and the delicate ecosystems that it ultimately supports. In this section, the developmental history of the study area has been illustrated to substantiate this viewpoint and to illustrate the manner in which the area has been developed.

Thomas writes that "All great ages of architecture are known by their grand period titles- ours will probably be known as 'Architecture in the Age of Consumerism' arising from self-indulgent intemperance of the developed world, the declining quality of urban life globally, and a universal disregard for proper stewardship of the natural resources of the planet," (2002:9).

Rosalie Genevro writes that "the development of suburban and exurban land continues, in patterns that demand continuing use of huge amounts of energy", (Buchanan, 2005: 5). A development trend that now seems unsustainable- in a world where energy resources are becoming less available and consequently more expensive.

It is disappointing to note that natural resource issues only seemed to make the headlines when the cost of oil and electricity started to increase substantially whilst the negative environmental impacts have been around for years. Schumacher writes "call a thing immoral or ugly, soul-destroying or a degradation of man, a peril to the peace of the world or to the well being of generations; as long as you have not shown it to be uneconomic you have not really questioned its right to exist, grow and prosper," (1973:34).

Here are a few maps showing the course of development of human settlement within the study area over time.
The increase in the rate of development is evident as the figure 6 depicts the changes over a thirty eight year period, whilst the figure 7 shows changes over an eight year period. The increase in pressure on service provisions as well as the decrease of self sufficiency is also evident. This is as agricultural holdings are largely self sufficient in comparison to our current suburban dwellings, (kindly refer to Appendix 2 for a comparative Essay of the Suburban development of the study area.)

The relatively self sufficient farms and agricultural holdings (in orange) have been sliced up and converted to highly dependant cluster developments and freestanding houses. It is sad to see that the fertility of this natural wetland is no longer appreciated (no orange in figure 7).

The decrease in local working opportunities is evident as the area that once provided local opportunities to generate incomes (through farming (orange) and brick making (quarries in red)) has become progressively more dormitory in its function. Consequent of this, the prominence of the use of the car is evident as the road networks have densified and become more formalised, (see figure 7).

The ratio in green open space to buildings has significantly changed as well., (see the decrease in white spaces from figure 5 to figure 7).

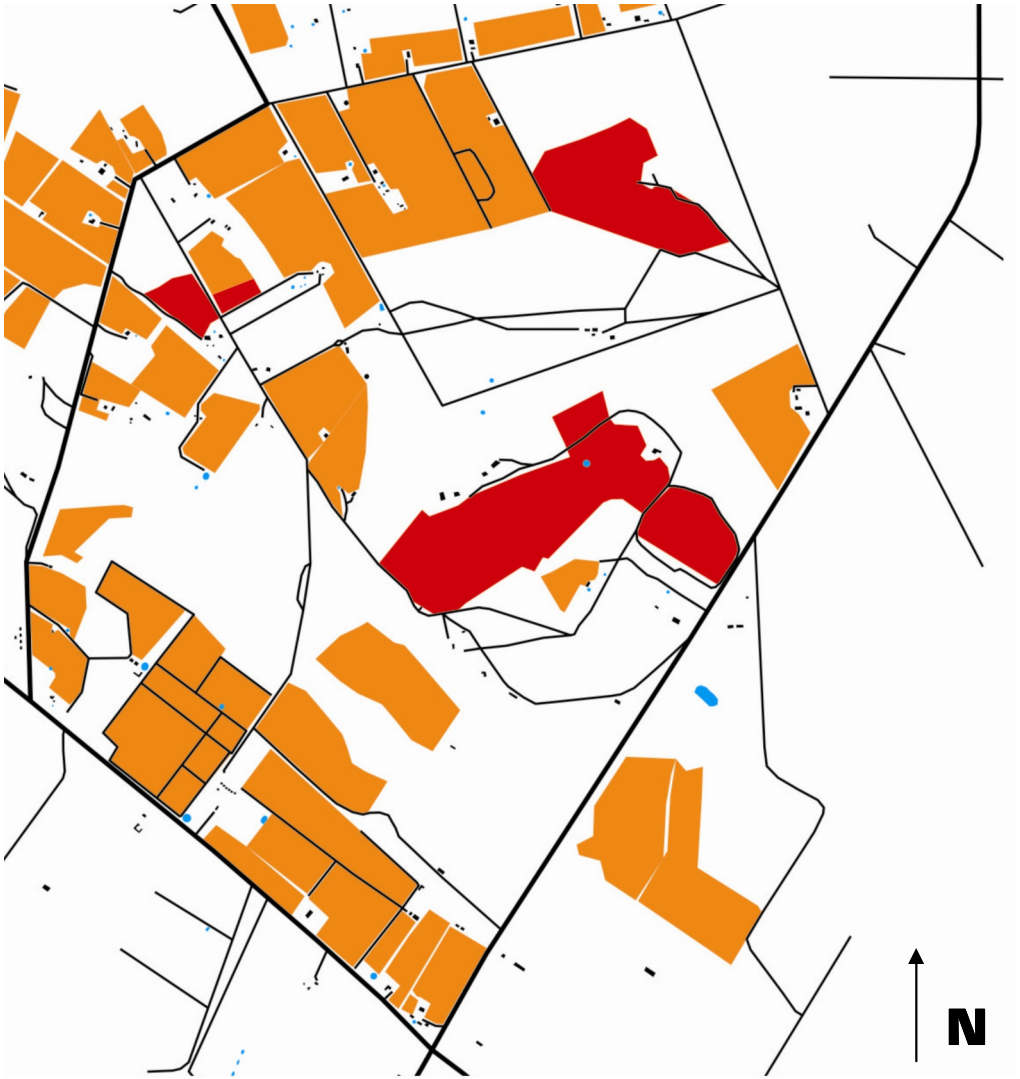


Figure 5:Human Settlement in Study Area in 1962
(after aerial photographs by Chief Director of Surveys, Mowbray, 1941)

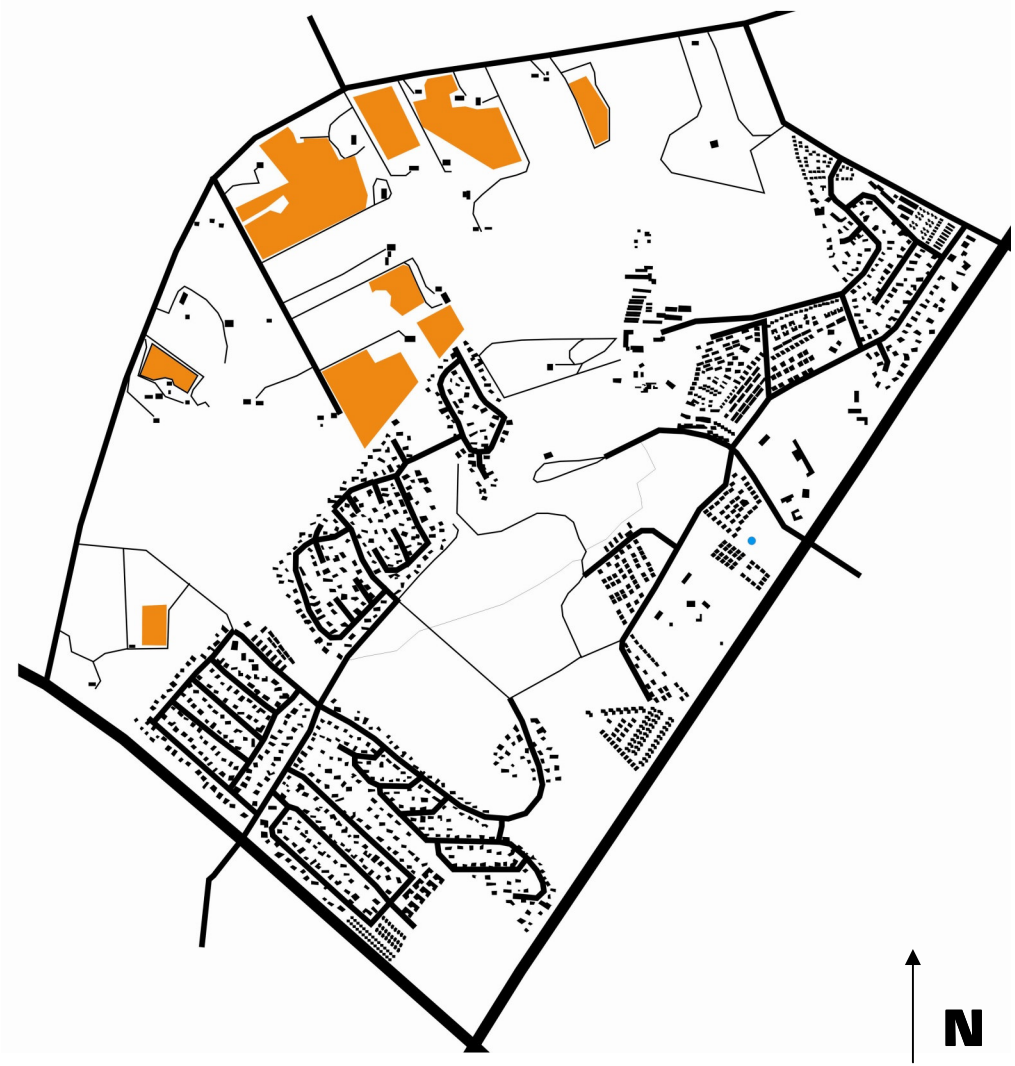


Figure 6: Human Settlement in Study Area in 2000
(after aerial photographs from Johannesburg City Council GIS)

100 000 1500 000

Agricultural land
Brick Quarry
Shopping Centre



Figure 7: Human Settlement in Study Area in 2008
(after aerial photographs from Google Earth 2008)

100 000 1500 000

Agricultural land
Brick Quarry
Shopping Centre

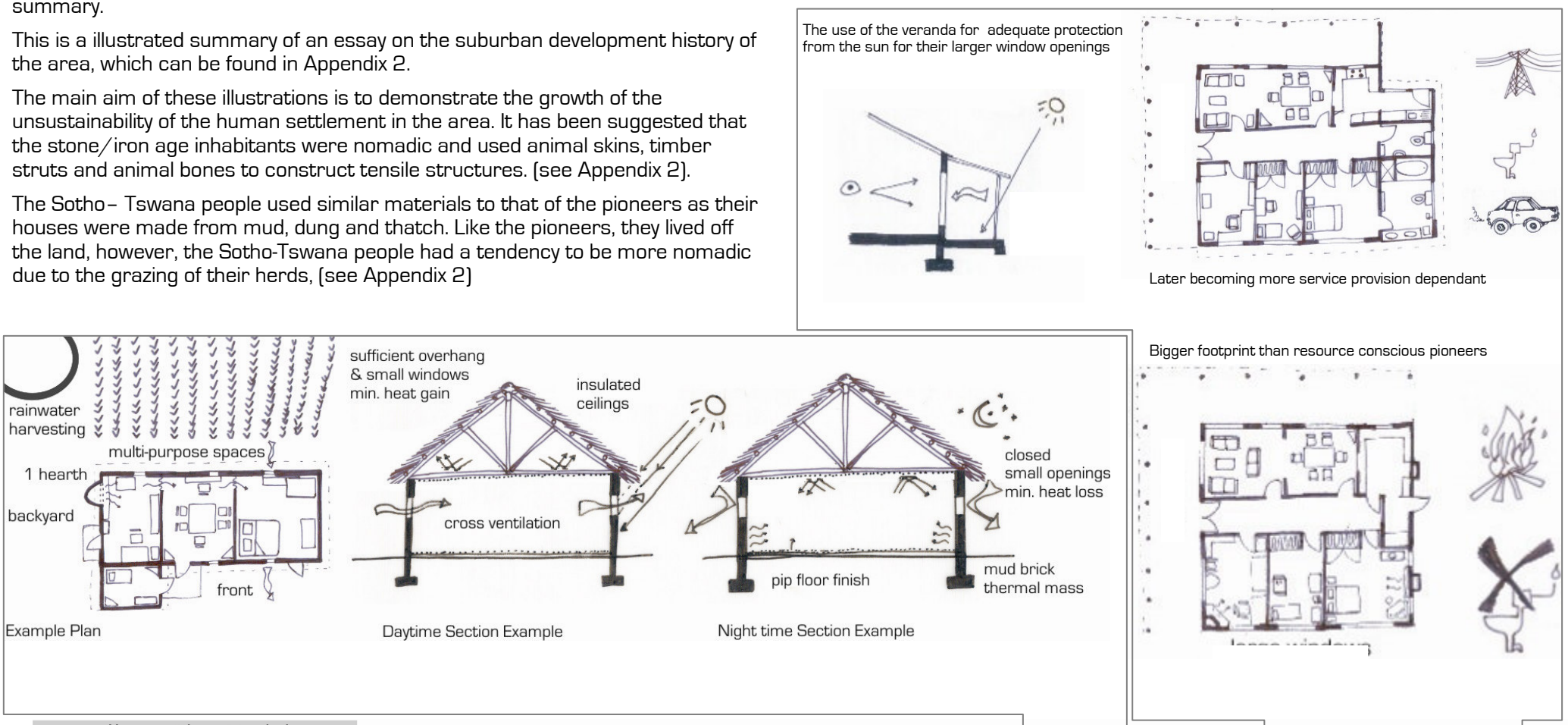
The progression of energy-use, resource dependence, waste management and way of life of the various human settlements that existed in the study area prior to the current suburbs has been researched and illustrated in this brief summary.

This is a illustrated summary of an essay on the suburban development history of the area, which can be found in Appendix 2.

The main aim of these illustrations is to demonstrate the growth of the unsustainability of the human settlement in the area. It has been suggested that the stone/iron age inhabitants were nomadic and used animal skins, timber struts and animal bones to construct tensile structures. (see Appendix 2).

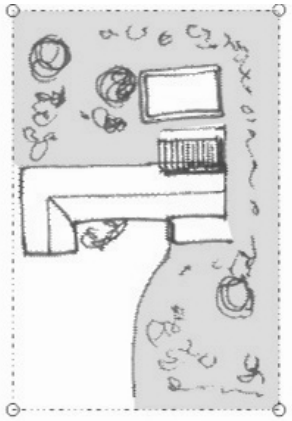
The Sotho– Tswana people used similar materials to that of the pioneers as their houses were made from mud, dung and thatch. Like the pioneers, they lived off the land, however, the Sotho-Tswana people had a tendency to be more nomadic due to the grazing of their herds, (see Appendix 2)

Figure 8: Summary Page of Suburban Development of the Study Area

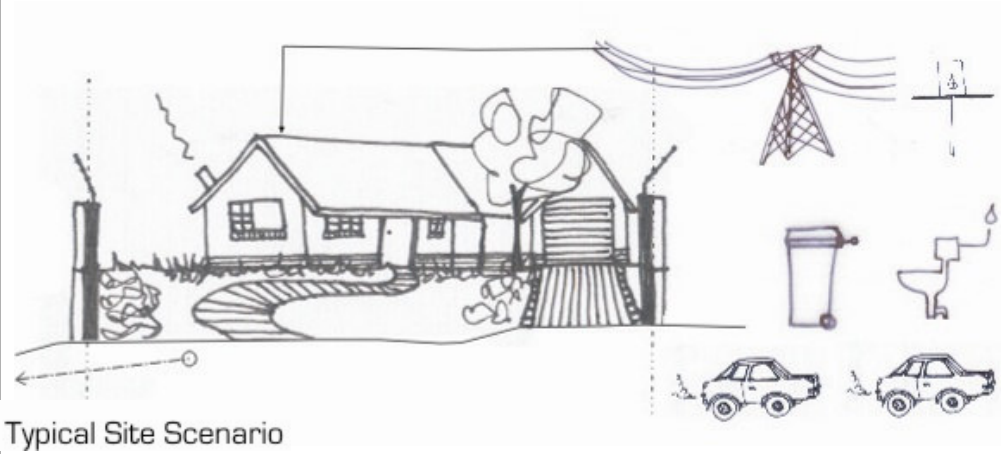




Typical Plan



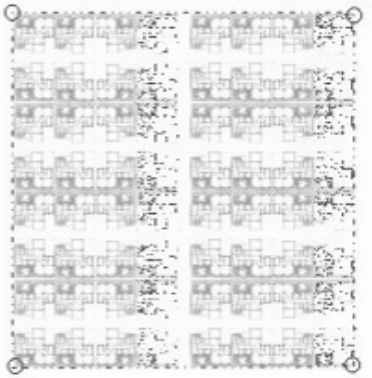
Typical Site Plan



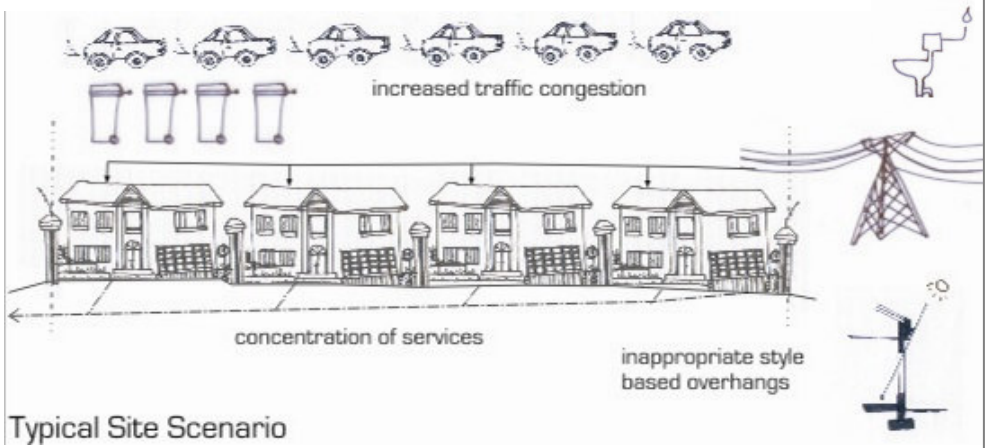
Typical Site Scenario



Typical Plan

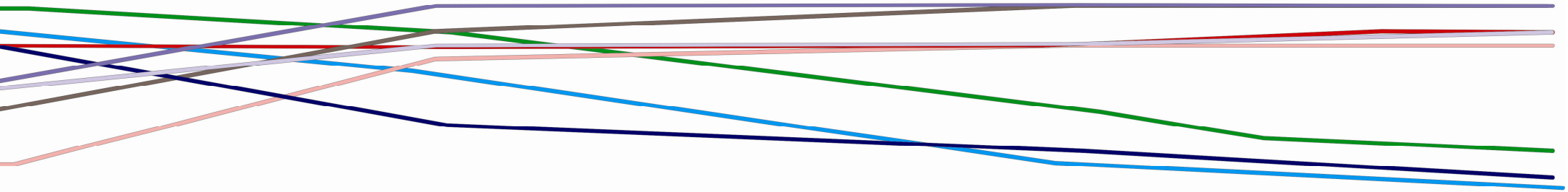


Typical Site Plan



Typical Site Scenario

Freestanding **Cluster**



2.2 Suburban Development Origins

According to Jacobs, the most important thread of influence starts, more or less with Ebenezer Howard, (1962:17).

Following this, Barry Zwicker suggests that suburbia began with the best of intentions as suburbs provided a way to deliver the dream of a family home with a manicured garden to the masses, (The End of Suburbia). Suburbia evolved from the ideals of the Garden City Movement which attempted to combine the benefits of civilised town and the open-aired country, (the Oxford Dictionary of Architecture). Ebenezer Howard's Garden City idea was conceived as an economically self-sufficient mutual aid town to be built in the countryside with all the necessary facilities to produce little beyond its own needs and was intended to eliminate the journey to work, (Frampton, 1980:28).

In 1898, he developed the Garden City idea in reaction to the appalling living conditions of the poor that lived in London's city. He aimed t repopulate the countryside by building a new kind of town which would operate as self-sufficient entity, (Jacobs, 1962:17).

Ironically, the dormitory suburbs of today are generally largely dependent on the city for all necessities whilst working residents are sentenced to several hours a week in the traffic in order to earn a living. It seems the advantages of both rural and urban are so diluted in a suburban context that they have become meaningless, (Oxford Dictionary of Architecture) and it's understandable why Jacobs wrote that "the endless new developments spreading beyond the cities are reducing city and countryside alike to a monotonous, unnourishing gruel," (1961:6-7).

Similarly, Le Corbusier wrote "Nature melts under the invasion of roads and houses and the promised seclusion becomes a crowed settlement... the solution will be found in the Vertical Garden City," which was a scheme that "accepted the Garden City fundamental image, superficially at least, and worked to make it practical for higher densities," (Jacobs, 1962: 22).

The modernist ideas of zoning and separating functions were largely stimulated by the machine age of industrialism. thinking as he separated the city into three main zones with the "automobile [playing] an integral part of his scheme," (Jacobs, 1962:23). This reliance on the machine is due to the large distances between the different zones which were by no means walk-able.

Thus, looking back at previous architectural thought, the necessity of **adapting** to one's environment and the idea of the local meeting daily needs, seemed to lose its priority after the industrial revolution where design began to rely increasingly on the art and science of technology to shrink distances and create and maintain artificial, more comfortable environments at the touch of a button.

Following this, "Early experiments into methods for warming, ventilation and

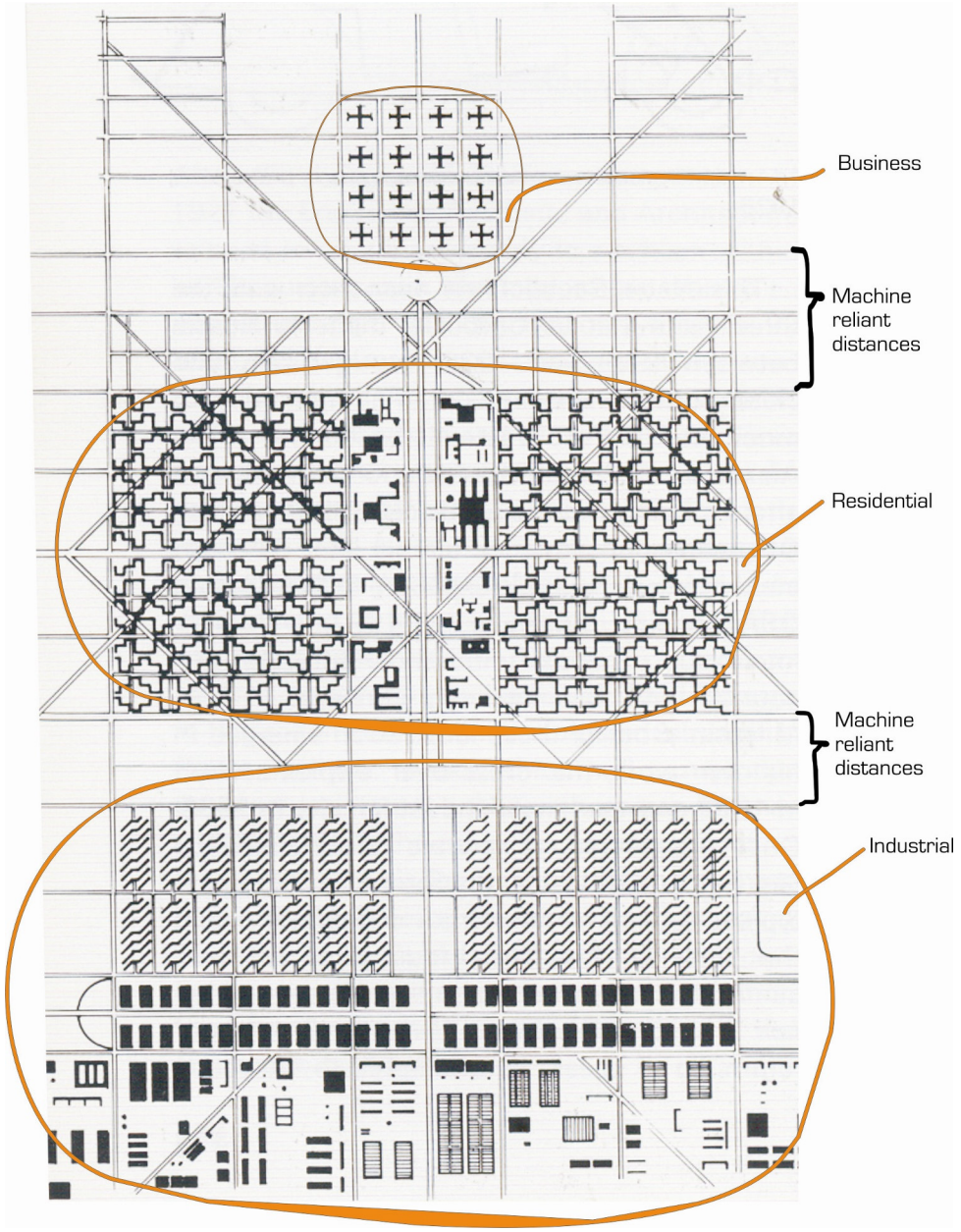


Figure 9: Le Corbusier and Jeanneret, Ville Radieuse
Plan showing zoning in parallel bands.This is an example of a machine-age city which moves away from the centralized city model to a theoretically limitless concept, (Frampton, 1980: 179). The question is... Is the key concept of this plan- which relies on the use of motorised transportation due to the separating of functions a sustainable idea? (after Frampton, 1980: 179)

artificial lighting of buildings... began before the end of the 18th century...1750 to 1900 was a critical phase in the development of new industrial methods and products and in their application... the power of steam was harnessed, coal-gas production was invented and the generation of electricity perfected... Western man... was fully entitled to say that his relationship with natural resources has been profoundly changed," (Hawkes and Forster, 2002: 12-13).

The shift in mentality is clearly reflected in what Le Corbusier stated during one of his lectures which he delivered in Buenos Aires, "...every country builds its houses in response to its climate. At this moment of general diffusion, of international scientific techniques, I propose: I propose only one house for all countries, the house of exact breathing," (Hawkes and Forster, 2002: 23).

Seemingly, technology had given developed mankind the license to ignore climate and environmental affects to a substantial degree. Air-conditioning, or "man-made weather"- as called by its inventor, Willis Carrier- seemingly liberated modern architecture from nature, (Gissen, 2002:117). This enthusiasm to depend on technology to create artificial comfort and rely on the machine for daily living has consequently facilitated the development of wholly unsustainable buildings, suburbs and cities.

2.3 Present Developments and Consequent Resource Issues

2.3.1 Urban Sprawl and Low density development

Urban sprawl is seemingly gaining momentum as developers feed off the demands for housing which are ever before us. Urban sprawl can be defined as development that rapidly occupies land which disproportionately increases the price of Greenfield sites that are situated closer to the city centres. Consequently, low to medium priced residences are being developed further out where more land is more affordable and maximum profit can be obtained by developers, (Maxwell and Huntoon, 1971:11).

Suburban sprawl began to infiltrate the study area in 1969. This involved the gradual conversion of most of the farms of the study area into suburban townships which hosted freestanding houses on reasonably large stands.

In 1969, Weltevreden farm (202-IQ) became rezoned as Weltevredenpark Township, (Smith, unpublished: 40). Thirteen years later, part of the original Wilgespruit farm (190-IQ) and Strubenridge Agricultural Holdings were renamed as the Strubensvallei Township, (Smith, unpublished: 36). Nine years later, Allen's Nek Township was established, (Smith, unpublished: 3) with Radiokop Township being established two years later in 1993. Radiokop basically kept the original name of its former agricultural holdings, (Smith, unpublished: 32). Honeydew Township was formed from the residual portion of Honeydew farm after a large portion of it was made an industrial precinct by the council, (Smith, unpublished: 18) and part of the original Wilgespruit farm (190-IQ) was established as Wilgeheuwel Township (Smith, unpublished: 41).

If one refers to figure 7, it is evident that most of the clusters in the area today, have been built in the last eight years or so.

Generally speaking, freestanding houses and cluster developments have similar resource requirements as they both depend on municipally supplied water and electricity whilst also needing municipal services for waste and sewerage removal.

However, one of the chief differences between the cluster and the freestanding dwelling is its higher density (in terms of unit per hectare) . The freestanding houses in the area carry a density of between 9– 12 units per ha, whilst the average clusters have a density ranging from 20 to 40 units per ha.

Barton, Grant and Guise maintain that , in a suburban context, 50 units per ha can be considered a medium density where 25 is considered low and 80 to100 units per hectare is considered high, (2003:114). Thus, the area is a relatively good example of low density urban sprawl. (see figure 10).

Speaking to a real estate agent, cluster developments are in greater demand than freestanding houses. This is as the cluster provides a safer and more secure environment due to the shared access point to the property which is often a high security control point.

2.3.2 Lack of Water Saving Strategies

Additionally, unlike the original farms and agricultural holdings, the typical freestanding house or cluster unit does not find rainwater harvesting a common practice and generally has a full reliance on municipal water. This is a surprising commonality as fresh, potable water is increasingly being regarded as a precious commodity.

In May of 2007, the President of the Water Institute of Southern Africa (WISA) Professor FAO Otieno in his inaugural speech stated that, "In the past 50 years, the world's population has increased more than two- and- a-half times to about 6.4 billion... The demand for fresh water has gone up by four times [and] on a global scale, it is estimated that about 3.4 trillion cubic metres of fresh water are drawn every year... The United Nations has predicted that at this rate, up to 7 billion people in 60 countries may possibly face water scarcity by the year 2050. Africa and South Africa suffer these problems to an even bigger scale. Indeed, the situation is so serious that author Dave Dempsey likened water to the "oil of the 21st century"".

The careless use of water causes a variety of environmental problems. This is with both the supply of water for use in buildings and handling of ground surfaces and waste water in built-up areas, (Energy Research Group, 1999: 41). Once water is used it must be routed through the sewers to be treated again before being released, reasonably purified, back into the natural environment. The treatment of water requires the construction and running of water plants which implies more material and energy requirements, (Energy Research Group, 1999: 41).

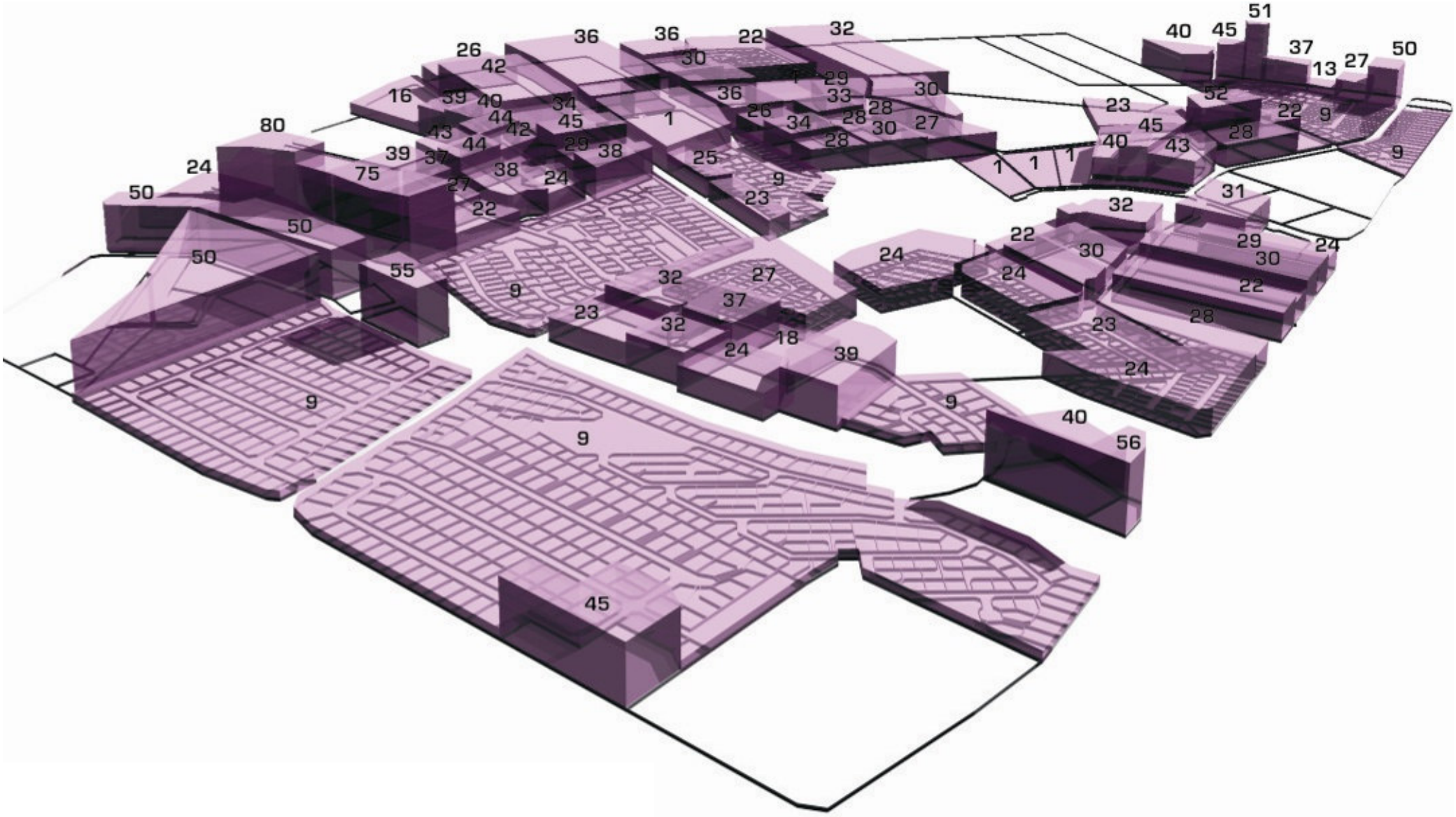


Figure 10: 3D graph of density of housing in study area
The figures are approximate and were obtained by counting the number of units on an aerial photograph and making observations in the study area.

This means that households that do not harvest rainwater or recycle their water, are wasting much energy and money as they use potable, intensely treated water to irrigate their gardens and flush their toilets which are two of the most water demanding household functions, (Interview with Ettiene Hugo, Joburg Water). Occasionally, those who are fortunate enough to have a borehole on their premises- depending on the quality of the water- use it in the household or only for irrigating the garden.



Figure 11: Drinking from a garden hose. Common practise or luxury?
Only time will tell.
(www.gettyone.com, cited March 2008)

2.3.3 Traffic Congestion and an Unsustainable reliance on Oil

Due to the general abundance of space, the typical freestanding house often offers work from home opportunities especially when an additional cottage is built on the property. This convenience is quite environmentally, socially, and economically sustainable as it can decrease one's carbon footprint quite substantially by saving on travelling time, fuel expenses and renting of other spaces.

In Johannesburg, the inadequate provision of reliable and safe public transport services to the dormitory suburbs has caused our modern commuter suburbs- which host many single-family homes- to prefer private means of transportation over public.

Echoing this, "suburbs typically have more traffic congestion and longer travel times than traditional neighbourhoods. Only the traffic within the short streets themselves is less. This is due to three factors: almost-mandatory automobile ownership due to poor suburban bus systems, longer travel distances and the hierarchy system, which is less efficient at distributing traffic than the traditional grid of streets", (www.wikipedia.org cited 18 June 2008).

Thus, the escalated use of the private motor car has birthed an incredible amount of traffic congestion. This is not only environmentally unsustainable- in terms of fuel combustion and carbon dioxide emissions- but also in terms of economically and socially unsustainable practices: such as paying a fortune for fuel, (www.dialdirect.co.za, cited 23 June 2008) to daily waste hours of valuable time in the clogged arteries of our road networks.

The separation of land uses or zoning has catalyzed a daily mass exodus from the study area to the various centres of the city such as inner city Johannesburg, Sandton, Rosebank and Midrand, (www.wikipedia.org, cited 25 June 2008). Commuting is an environmentally unsustainable practice as it not only causes large amounts of emissions that pollute the air and contribute to the global carbon cycle in the combustion of irreplaceable oil-based fuel but also, oil is a non-renewable resource and thus will eventually run out. In July last year, we experienced our first taste of what life would be like without petrol when the union workers decided to strike over failed wage negotiations. (www.fin24.com, cited 27 March 2008).

In the event of oil running out, those who are financially-able may eventually be forced to either purchase vehicles that are fuelled by other alternative technologies or **abandon** the suburbs to live closer to their place of work.

Since a single piece of suburbia only serves one type of activity, roadways are very important, as they are the only way of getting to the various things a person needs in a given day. Suburban roadways are typically much wider than in towns, with multiple lanes and few, if any, sidewalks, (www.endofsuburbia.com, cited 18 June 2008).

Suburban systems of the sprawl type are usually quite inefficient for cyclists or pedestrians, as the roads in this type of environment, are usually only designed to serve the automobiles and direct routes are usually not available due to the lack of the walk-able street grid, (www.endofsuburbia.com, cited 18 June 2008). This encourages car trips even for distances as low as several hundreds of metres (which may have become up to several kilometres due to the curvilinear, hierarchical road network).

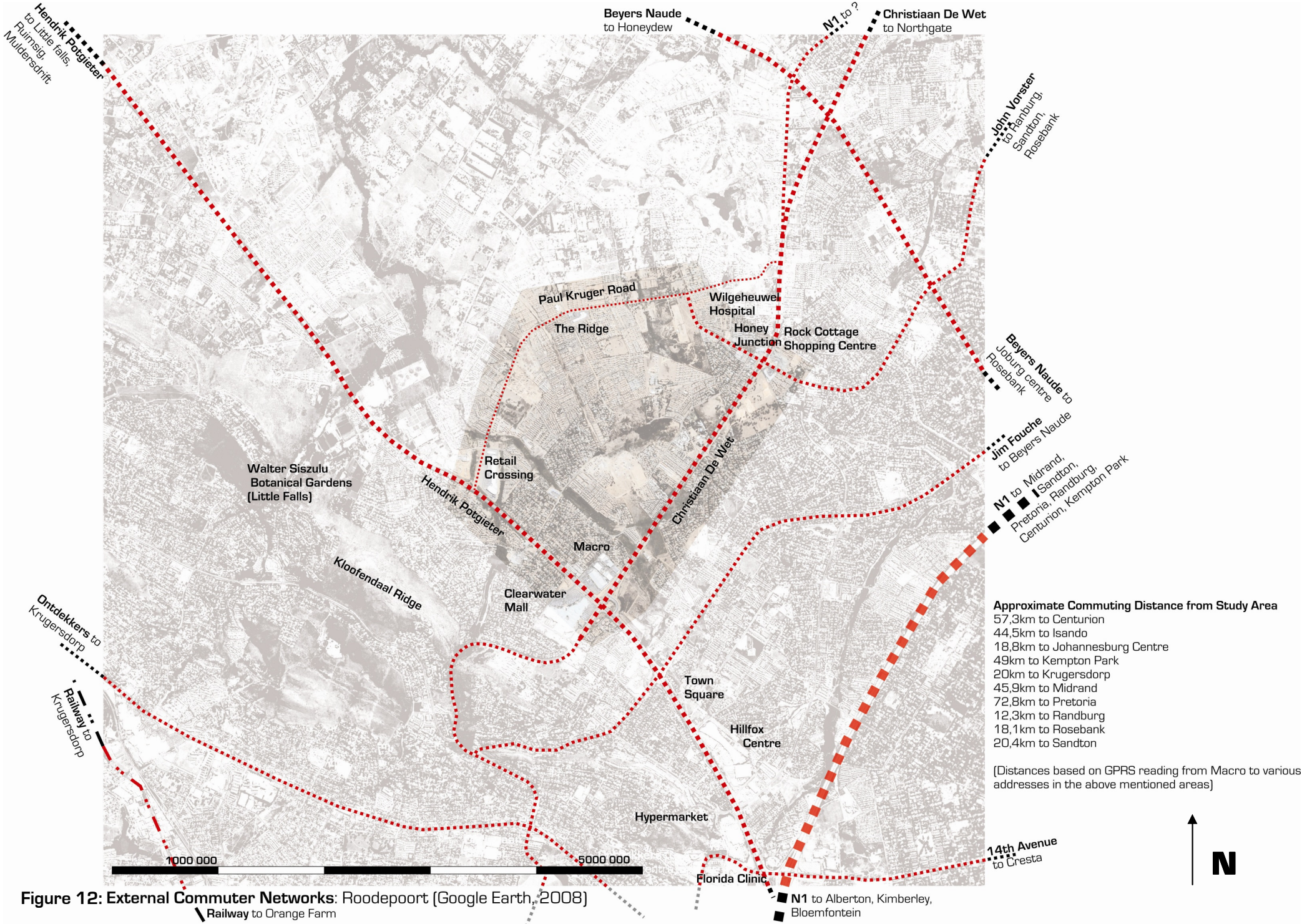


Figure 12: External Commuter Networks: Roodepoort (Google Earth, 2008)

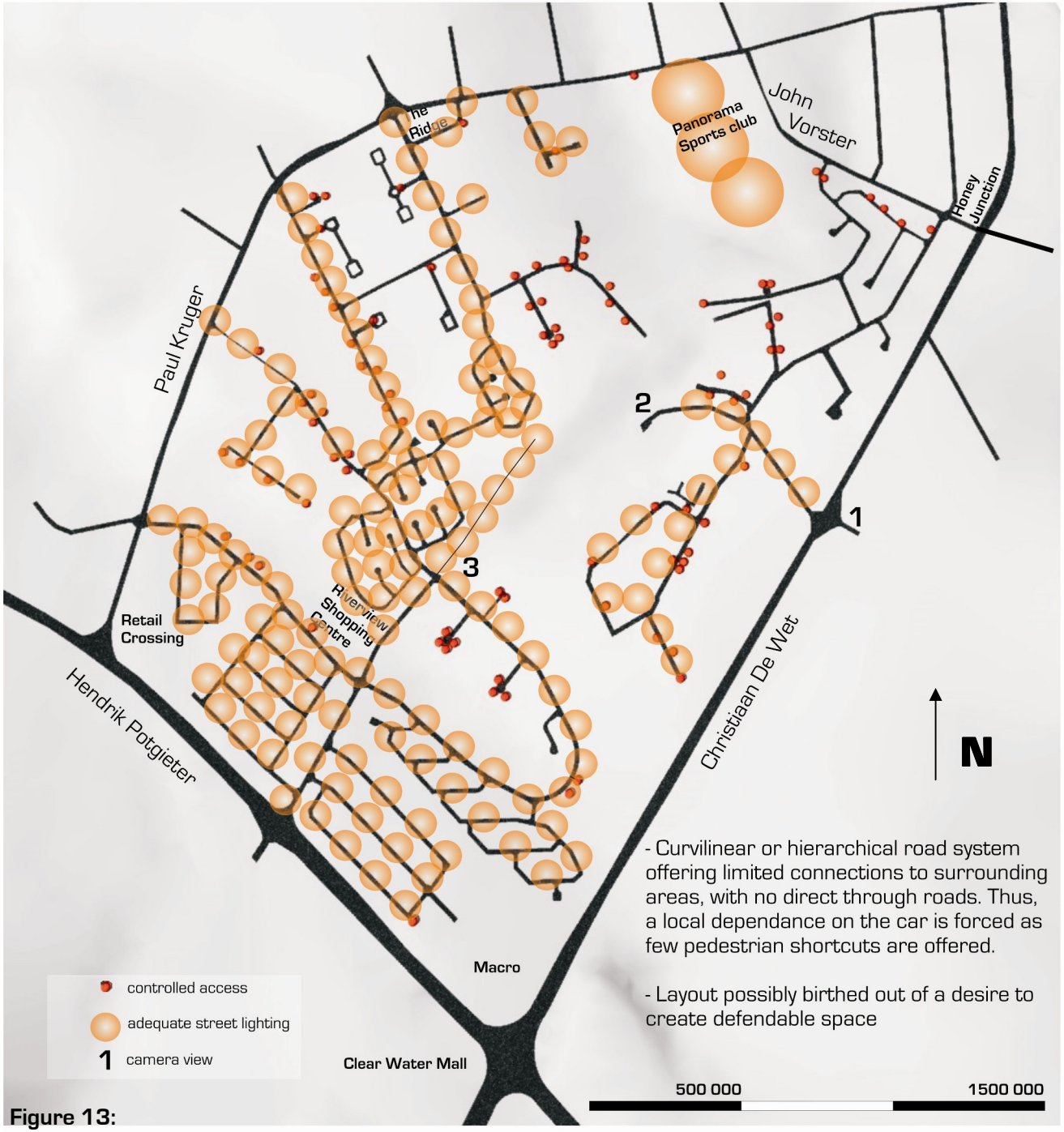


Figure 13:
Internal Road Network of Study Area



1: View down Christiaan De Wet. (lack of street lighting)



2: Top of an informal road (lack of street lighting)



3: Bottom of an informal road (adequate street lighting)

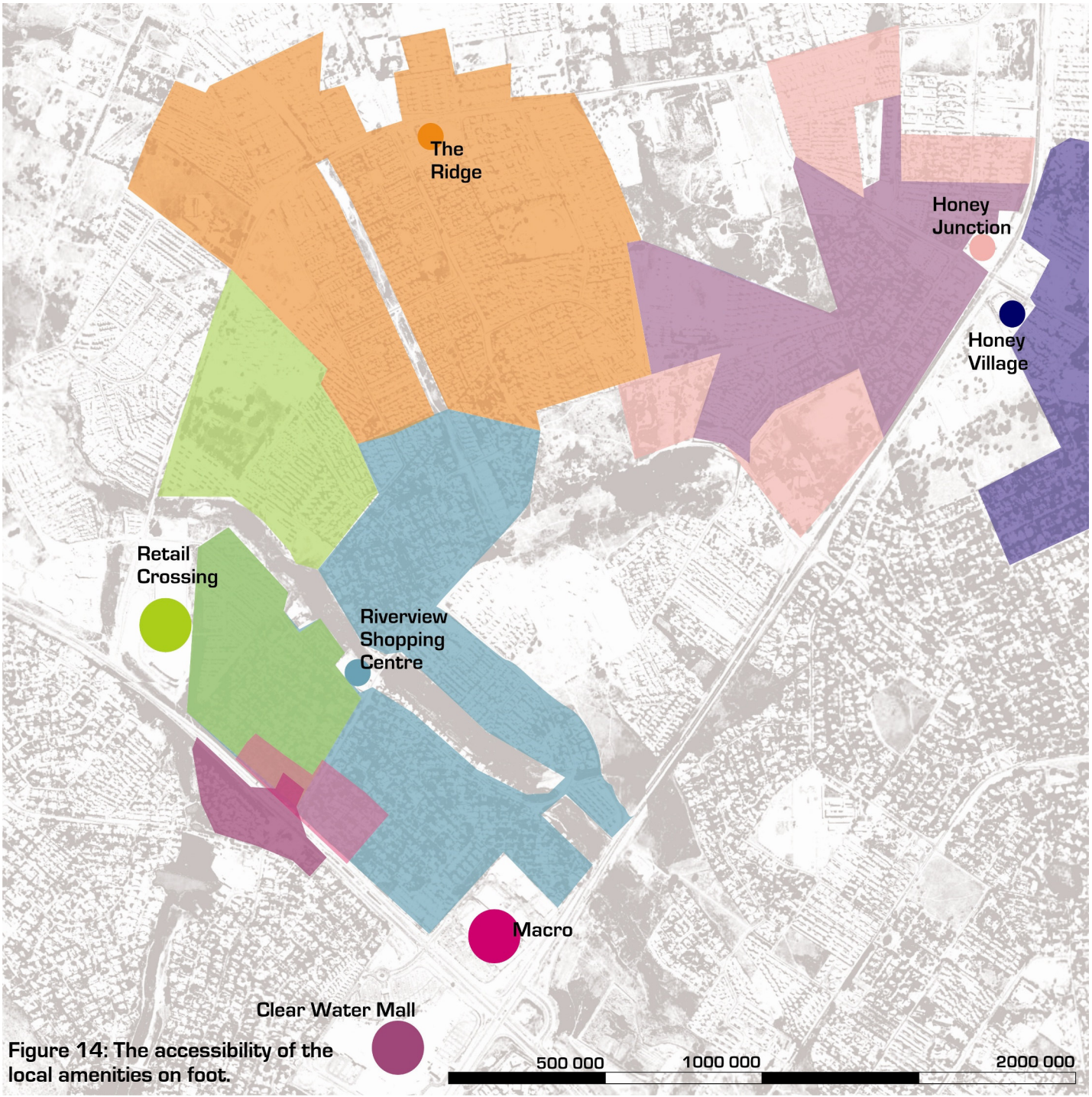


Figure 14: The accessibility of the local amenities on foot.

Figure 14: The accessibility of the local amenities on foot.

The local dependence on the car is illustrated in figure 14. The colours indicate the houses that are in a comfortable walking distance from the relative local amenities.
This distance was obtained by measuring existing routes and not as the crow flies. A comfortable distance was considered being between 750m and 1000m.
It is evident that part of the area is completely reliant on vehicular transport as no shorter, more direct routes through the area are available in this hierarchical, curvilinear road network.

2.3.4 Daily dependence on dirty, unsustainable, unreliable electricity supply

The suburban household is fully dependant on the supply of electricity for the successful operation of almost all household appliances. However, some residents opt for cooking on gas or using gas heaters whilst solar energy is occasionally used to heat household water and or swimming pools.

Earlier this year, we suffered the inconvenience of load shedding and paying higher electricity tariffs due to current power demand being greater than Eskom's supply capacity, whilst Eskom frantically rescued past discarded power stations, such as Komati, Grootvlei and Camden, from mothballs and they proposed to build more coal burning power stations, (www.engineeringnews.co.za, cited 23 June 2008). The question to be raised here is: "Is this a sustainable solution to deal with our current energy requirements?" What about our future energy requirements? Do we stop further housing developments in order to ensure sufficient energy supply to existing suburbs?

South Africa makes use of one of the dirtiest forms of electricity power generation in the world as "our per capita greenhouse gas emissions rank amongst the highest in the world [due to] most of our power [being] produced by ageing coal-fired power stations with little ability to clean their emissions," (biophile.co.za, cited 23 June 2008). Additionally, South Africa's non-renewable coal supply is limited and will eventually run out, (www.southafrica.info, cited 23 June 2008).

As a result, the government has implemented a demonstration nuclear plant - a pebble bed modular reactor (PBMR) - at Koeberg which is situated outside Cape Town. "This pebble bed nuclear reactor is considered one of the most efficient forms of nuclear power technology: smaller, cleaner, and easier to build than most others," (www.southafrica.info, cited 23 June 2008). One could suggest erecting more nuclear power stations that produce cleaner electricity and do not rely as heavily on non-renewable resources, like Koeburg.

Nuclear plants are highly energy efficient as they utilise a small amount of energy to produce a substantial amount of electricity whilst producing a relatively small amount of toxic waste. These stations have proven to be effective solutions to electricity generation in many countries, across the globe. Today, more than 15% of the world's electricity comes from nuclear power, (www.wikipedia.org cited 23 June 2008).

However, "the proposition to replace thousands of millions of tons of fossil fuels, every year, by nuclear energy means to 'solve' the fuel problem by creating an environmental and ecological problem of... monstrous magnitude. It means solving one problem by shifting it to another sphere- there to create an infinitely bigger problem," (Schumacher, 1973:15). Nuclear power is potentially very dangerous and one is not to play around with it. It must be noted that it fundamentally requires a high level of maintenance and management and cannot

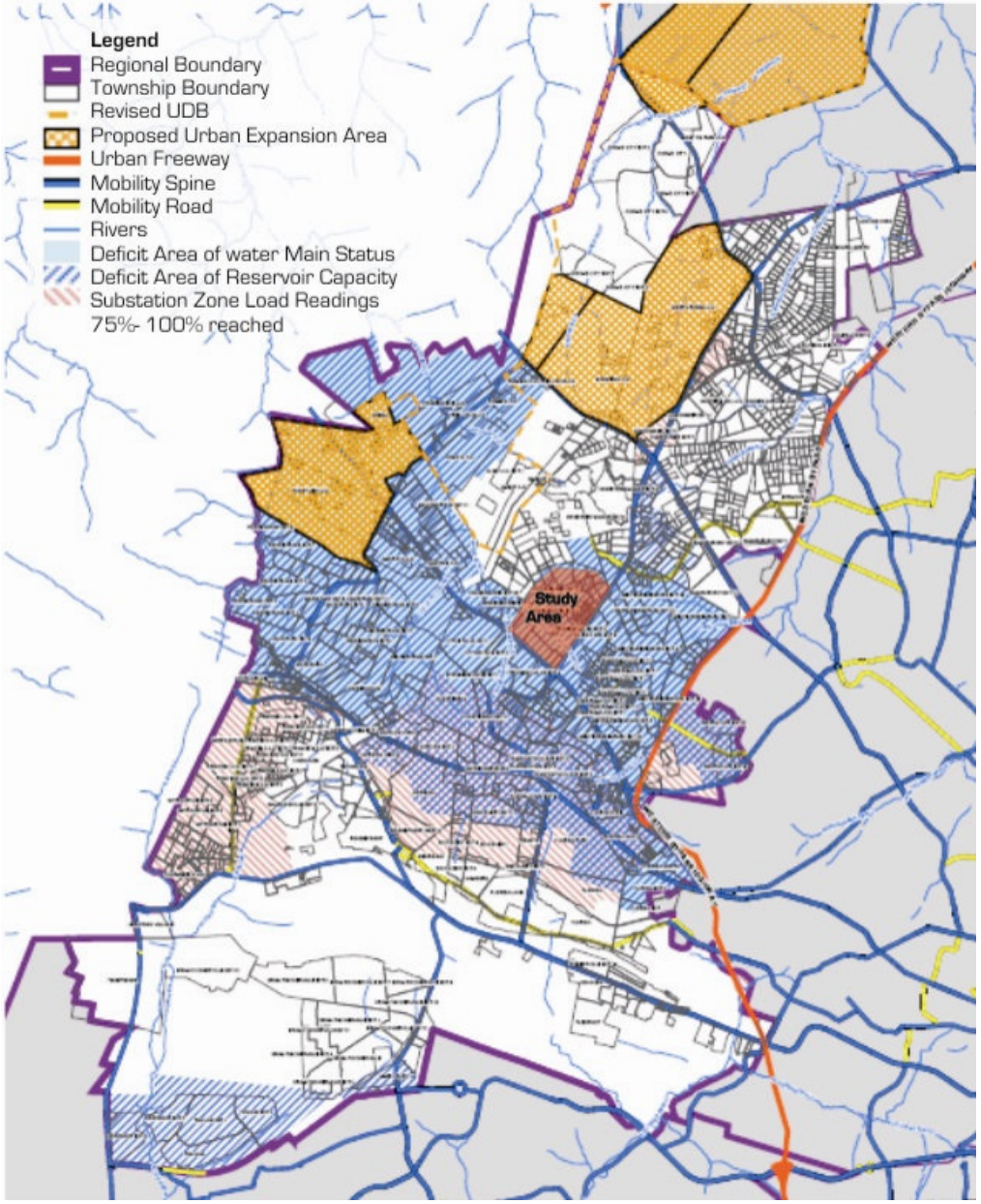


Figure 15: Region C: Infrastructure Hot Spots Map
This map illustrates how the study area, which is currently under development pressure, has already reached its full capacity water supply potential. In addition, earlier this year, one could have hatched the whole of Johannesburg in red, due to Eskom reaching its full capacity power supply potential.
(Johannesburg Regional Spatial Development Framework, Region C, 2008: 20)



Figure 16: Priorities.
Power line servitude slicing through Strubensvallei green belt

just simply be shut down if things should go wrong. One of the biggest environmental threats of this energy production is the problem of storing radioactive waste and the consequent potential for possibly severe radioactive contamination by accident or sabotage, (www.wikipedia.org, cited 23 June 2008).

Our current electricity crisis has impacted the suburban property market in a substantial way. This is due to the high dependence that the suburbs have on electricity supply. If you asked any real estate agent what mostly determines the value of a property their response will probably be LOCATION, LOCATION, and LOCATION! Normally, the status of an area lends to the value to the land. However, the effect of our insufficient electricity provision has manifested itself in the shift of the property market. The Business day stated that the buyers in the property market have been influenced by the availability of power in deciding which area to invest in. According to FNB, property buyers have started to base property value on the availability and reliability of electricity, Will location and property values continue in this manner to a point where the value of land is based entirely on reliable service and infrastructure rather than on location status? Could this lead to complete abandonment of areas due to inadequate resource and electrical service provision? What happens to those who want to remain in the outer suburban areas? **How can we prevent this energy crisis from birthing abandoned suburban areas?**

Many suburban residents, who never intended on moving, but have found themselves regularly in the dark, have turned to quick fix solutions, such as purchasing generators. The change in thought to become more energy independent can be seen as a positive fruit of the electricity crisis. However, generators require diesel to produce a minimal amount of electrical energy and they pollute their immediate environments through emitting unpleasant fumes and harmful gases whilst elevating the volume of the normal conversation to a screaming match.

2.3.5 Waste is Waste and is Destined to Waste Space

The 2002 World Summit Publication on "The Long Walk to Sustainability: A South African Perspective" it was stated that the residents of the city of Johannesburg generate approximately 1, 8 million tons of refuse annually. Of this, approximately 1, 4 million tons end up on landfill sites even though a large percentage of the waste can be recycled (page 84). These statistics are most probably higher now due to our ever growing city population.

Household waste is generally not sorted and recycled. Waste is treated as waste. Thus, waste in the study area is usually is collected by Pikitup and is destined for the Marie Louise landfill in Roodepoort, (www.pikitup.co.za, cited 26 June 2008). There is however, a local Pikitup depot for garden refuse which is a collective site to convert waste into usable fertilizer, (www.pikitup.co.za, cited 26 June 2008). Additionally, some suburbs recycle



Figure 17: Wasteland?
Public open space in study area illegally being used as a construction waste dumping site.

paper through the Mondi Recycling initiative where all "Kerbside Paper Pick-Up collections are done by small business owner drivers who are contracted to Mondi Recycling," (www.paperpickup.co.za, cited 26 June 2008).

It is imperative to adapt ones brief and way of thinking as waste in the construction sector is becoming an increasingly urgent issue due to the fact that a substantial proportion of landfill waste is debris from building and demolition works, (Energy Research Group, 1999: 4).This is disappointing when considering the amount of embodied energy they command and the reuse potential they could have if they were designed and assembled more responsibly.

Like many places in Johannesburg, if it's not destined for the landfills then it's destined to pollute the public open spaces that are currently not in use. There is a general lack of recycling in the area as according to the residents "there are no facilities provided to do so." However, some of the residents do recycle paper and there is a local Pikitup composting site for garden refuse of the local community.

2.3.6 Gated Communities: The Need for Security and its affect on the Neighbourhood Street Edge Condition

Currently, Tuscan, Bali, Georgian and many other misleading representations of foreign architectures are being made manifest through cluster developments- otherwise known as housing subdivisions or pods- that are seemingly birthed out of the capitalist drive which is spurred on by profit-making, and progress and sold in the name of comfort and security, (www.endofsuburbia.com, cited 18 June 2008). These developments are being churned out at incredible rates due to their cookie-cutter approach whereby they divide the land in a manner that maximizes financial returns and replicate the same set of plans over the landscape.

This practice has neutralized and flattened the suburban landscape to a point where architectural design surprise is hard to enjoy. This budget-strapped, time-limited approach often does not allow for the context of the site and its surrounds to be considered to the extent that a unit with living spaces that face north is considered 'luxury'.

It is no wonder, that Thomas argues that "architecture should not be a matter of economics only," (2002: 11). This is as the orientation of the complex houses are not always positioned for optimum sunlight but rather orientated to achieve maximum bulk potential of the site to achieve maximum return on the investment in the land. This prohibits the houses from enjoying the benefits of passive design- which includes natural lighting and ventilation– and often prohibits units to grow or change overtime.

Additionally, these clusters use zoning strategies that create huge single-class estates, with local employment opportunities squeezed out, social polarization and



Figure 18: Growing Insecurities in Johannesburg.



Figure 19: Curb Surfer
Frog clinging to rock after being washed away during a storm in the study area. This shows the impact of impermeable hard surfaces of the area on the rate of run off, Mozart Road.

exclusion rife, and visual monotony." (Barton, Grant and Guise, 2003: 14). However, the reality is that crime and insecurity is rife in Johannesburg. These residential developments can be seen as a response to a market that will pay any price to insure their safety and security, (www.gatedcomsa.co.za, cited 26 June 2008). The level of violence and crime in our city has cultivated a need to feel secure in many residents, (Jenkins, 1997:5). Thus, the value of new residential complex developments has risen as more people seek to live in more secure environments that have controlled access, (www.endofsuburbia.com, cited 18 June 2008).

"Several questions are asked, especially regarding the long-term impact of this type of development on the urban future. Yet, research in 2002 has indicated that it is very much an issue of balancing short-term need (crime reduction) with long-term costs and impact (impact on urban integration, urban management, etc.)," (www.gatedcomsa.co.za, cited 26 June 2008). While these developments pop up on every vacant piece of land or subdivided stand in the area, the walls of the original "1 house, 1 plot" existing typologies are growing to a height where engineering assistance is required to ensure that the structure is well-supported.

As a result, our current crime situation is inevitably breeding gated communities- which is another name for these complexes, (www.endofsuburbia.com, cited 18 June 2008). These gated communities are single function (housing) neighbourhoods only and are self-contained in order to optimize security and keep the "others" out, (www.endofsuburbia.com, cited 18 June 2008). The inside of most of these developments there does not seem to be a sense of community at all. It is not surprising that the very meaning of neighbour has become estranged and public space of these developments often mostly consists of private parking while the nostalgic notion of community gathering space rarely manifests itself within the suburb. This is as clusters usually consist of single family homes or units placed on a subdivided plot of land, with residual parking in between them, (www.endofsuburbia.com, cited 18 June 2008).

In essence, many scholars and architects do not hesitate to criticize these developments and yet do not stop and take time to develop or offer an alternative. The reality is that these developments are meeting the needs of the market and are assisting to decrease the incredible demand for housing. The sustainable benefit of these developments is that they have the potential to increase the density of our existing low density suburbs. Thus, decreasing the horizontal spread of development and the greater travelling distances associated with it whilst simultaneously promoting a more efficient concentration or grouping of services.

2.3.7 Hard Surfaces, Increased Run-off Rates and Neglected Local Water Table

The storm water management system of the study area is no longer able to cope with the amount of surface run-off that accumulates during storms. This is due to the fact that the cluster development surfaces are mainly paved, leaving little permeable surface area for the water to penetrate the soil. The storm water systems are thus under an enormous pressure as most of the original permeable surfaces of the wetland have been paved over and so are flooded with abnormal

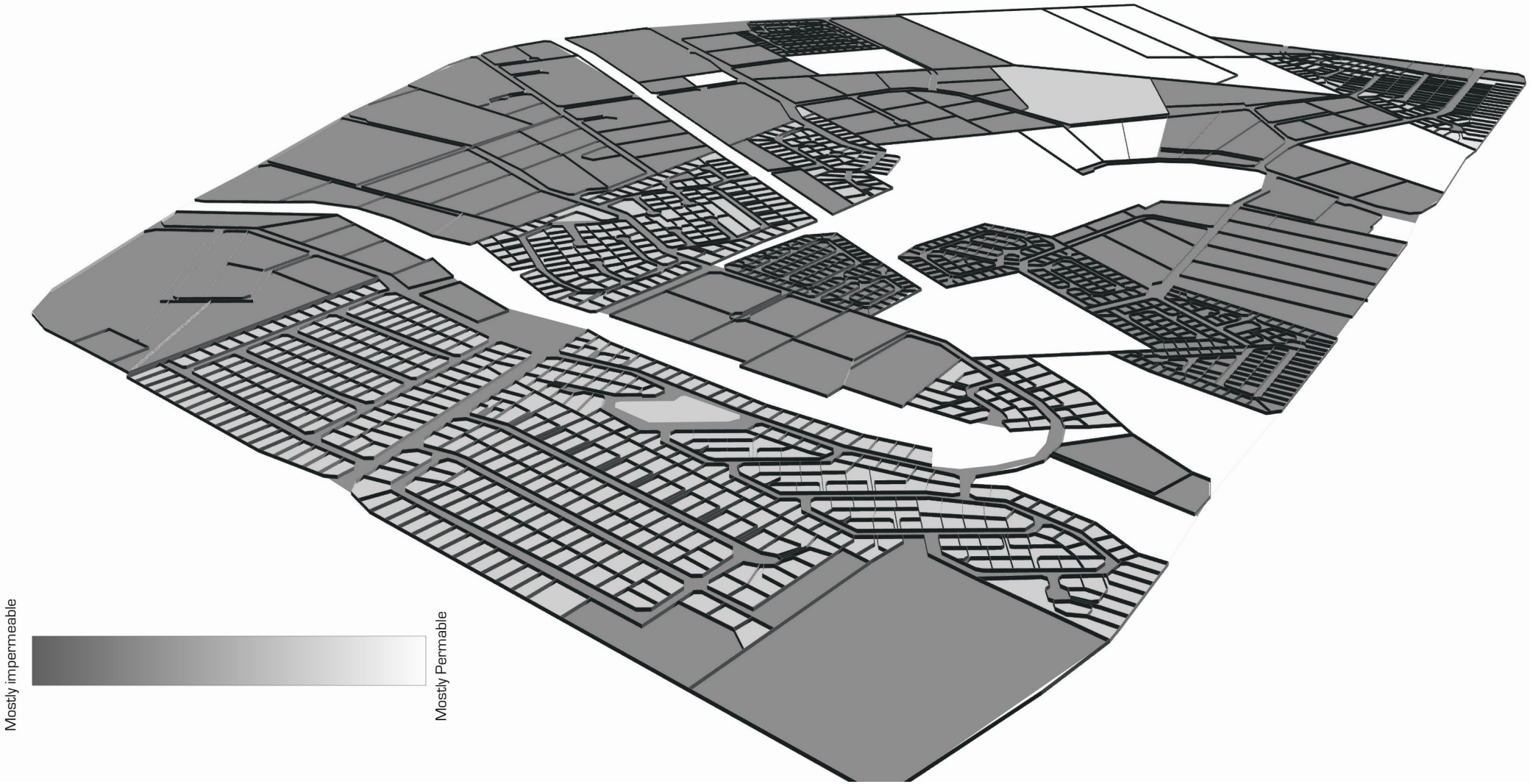


Figure 20: Rainwater Penetration
The study area was originally wetland as it lies in a valley. It is thus, meant to serve as the water catchment surface of the area. The natural water table of this wetland is lower than normal due to the majority of the surfaces having been developed with impermeable surfaces such as paving. Thus, water that would have slowly seeped into the soil, runs off these surfaces and washes into the rainwater system of the area and is taken to other parts of Johannesburg.

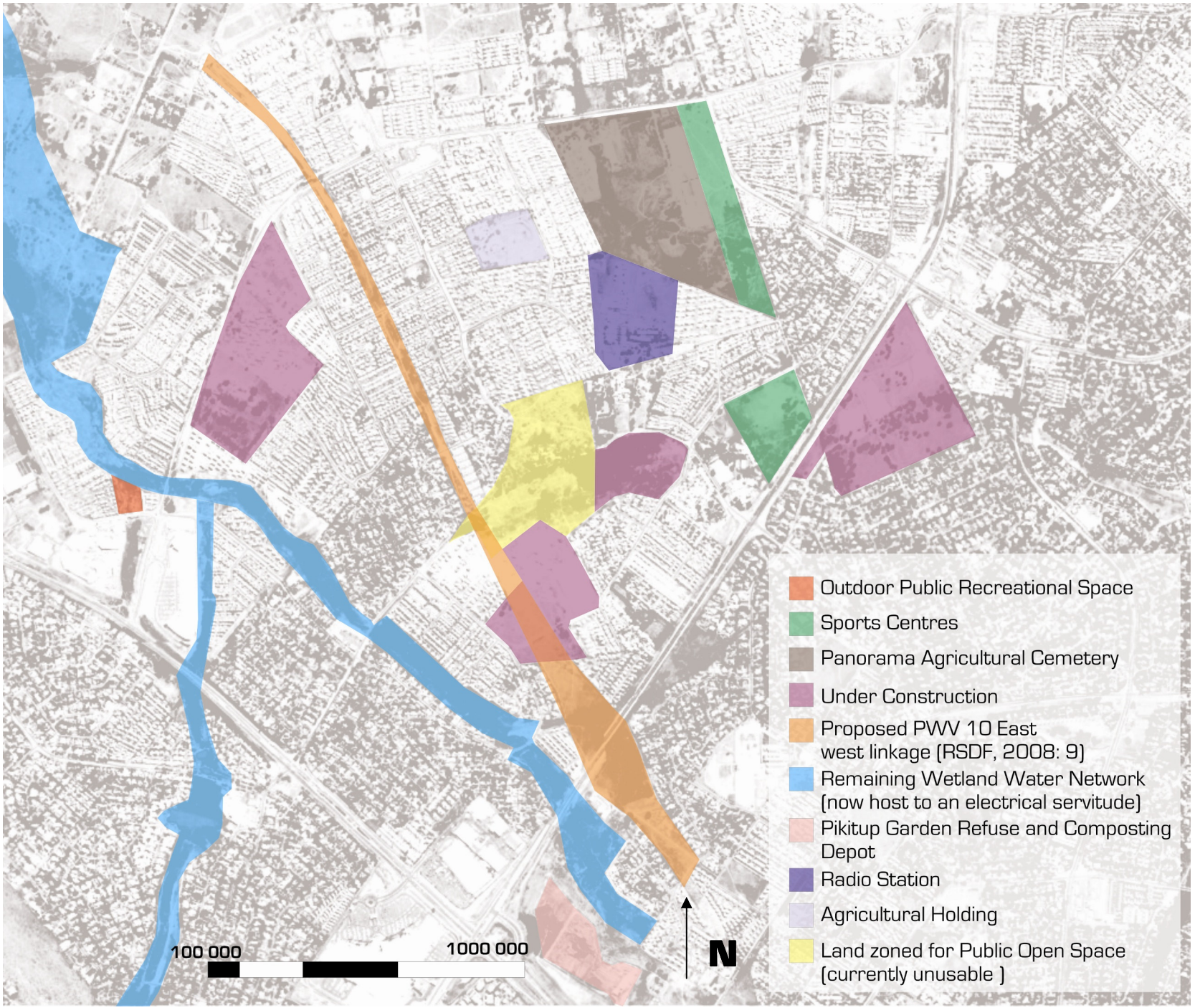


Figure 21: Current green spaces in the study area

It is evident that the area is still host to some outdoor spaces that have permeable surfaces.
These spaces act as the lungs and sponges (ground water absorption points) of the area.
However, it is evident that very little land is accessible for public recreational use. This is concerning considering the ratio of people to outdoor space within the area, due to the cluster developments not providing adequate outdoor space.

The current land zoned for public open space (indicated in yellow) is not easily accessed and forms the backside of most of the development that frames it.
Thus, it has no passive surveillance, leaving the park feeling less safe and user friendly.
Furthermore, it is starting to be used as a dumping site for building refuse and is gradually being eaten away by encroaching developments.
It can be suggested that this piece of land is invaluable to the area and should be preserved if it is to remain the largest and therefore key green open spaces within the area.

amounts of water which would have been absorbed before the development took over. These harder surfaces not only increase the amount of run off- due to the soft surfaces they replace- but also increase the rate of flow of surface run-off, (Energy Research Group, 1999: 58).

Impervious urban surfaces- such as tarred roads, paved driveways and parking lots- speed up rainwater run-off. This reduces natural evaporation and consequently causes soil erosion in landscaped area. Subsequently, more construction occurs as storm water management systems requiring more drains, culverts and embankments are required in order to prevent flooding, (Energy Research Group, 1999: 41).

Maintaining the natural water-table of an area is fundamental in ensuring the continual support of the local ecology by providing the hydration, minerals and nutrients within the soil to its inhabitants. The natural ground water table of the study area has decreased over the last ten years due to a substantial amount of impermeable surfaces that have been iced over the land. This has caused this natural wetland to be significantly drier as the natural ground level has not been able to be recharged by the surface water, which consequently affects the natural local ecology, (www.wikipedia.com, cited 26 June 2008).

Large amounts of unabsorbed rainwater is either being channelled into storm water drainage systems which take it to other parts of Johannesburg, or robbing the land of its fertile topsoil through uncontrolled erosion. Hence, natural ecology that hasn't yet been washed away suffers any way as the natural water table is not being maintained.

2.3.8 Lack of Public Recreational Space

A lack of green outdoor space might mean less maintenance but also increases need for local parks and outdoor recreational spaces- especially when one has a pet that needs to stretch its legs. It is surprising that currently in the study area– which largely consists of cluster developments that host little or no garden spaces– there is only one outdoor, public recreational space for the residents to enjoy which is inadequately proportioned to meet the needs of the residents (see figure 21).

2.3.9 Lack of Passive Design Considerations Within 'Style' Dictated Clusters

It is observed that the selected 'style' or theme of the complex most often dictates the location and size of the fenestration and the roof overhangs. Thus, this approach often results in inappropriately short roof overhangs- trimmed with the usual plastered cornicing- allowing large amounts of direct sunlight and radient heat in summer into the interior of the house, through the large windows that boastfully look out over a view- or the roof and wall of the unit next door. Consequently, the tenants move in and the first item on their shopping list becomes blinds to block out the harsh exterior light. Not soon after these are installed do they realise that the lighting problem may have been resolved but the heat is still unbearable. So they sin and install air-conditioning that chews up electricity that could have been allocated elsewhere, whilst contributing to the global carbon cycle, www.planetfriendly.net/airconditioning.html, cited 26 June 2008).

2.3.10 Contributing to the Global Carbon Cycle and Global Warming Climate Changes

It can be argued that the global carbon cycle is currently out of balance which is consequently increasing the likelihood of rapid global climate change," (Gissen, 2002:45). Buchanan writes that one could possibly suggest that industrialization has brought much of the destruction on our planet because of its intense dependence on the burning of highly pollutant non-renewable resources such as coal and oil, (2005:31). This dirty process has been identified by many scientists as a likely cause for the acceleration of global warming affects. It can be suggested that our dormitory suburbs are daily contributing a substantial amount of carbon dioxide emissions to the global carbon cycle due to the heavy dependence on commuting and dirty electricity produced from coal.

"The phrase 'global warming' has become a familiar catch phrase to many people. Many opinions have been expressed concerning it, from the doom-laden to the dismissive," (Houghton, 2004:1). One could suggest that this conflict of various theories could be as a result of our limited understanding of climate development and the delicate balances between the various systems of our planet.

The undoubted truth of 'global warming' is that it is an effect operating within the earth's atmosphere. The earth's atmosphere reaches about 800 hundred kilometers into space from the earth's surface and it consists of five layers of gases that insulate the planet in order to maintain its warm temperature, (Roleff, 1997: 12). Roleff likens these gases to the windows of a greenhouse as they allow sunlight to reach and warm the earth's surface and its surrounding air whilst retaining most of the solar generated heat. This process is known as the greenhouse effect which is vital for the continuation of life on earth, (1997: 12). Roleff claims that "Without the greenhouse effect, the planet would be inhospitable to life because the earth's surface temperature would be cooler by 63F [or 1120°C]," (1997: 12). As with all things of life- too much of any good thing can have detrimental effects.

Are we really facing a crisis?

Thomas writes that "there is considerable scientific evidence that the earth's temperature is rising and will continue to do so as a result of human activities," (2003: 5). During the 1970's, a number of scientists became concerned about the greenhouse effect when they realized that the average surface temperature of the earth had risen nearly 17°C during the twentieth century, (Roleff, 1997: 12). Lemonick wrote in a report on global warming for the International Panel on Climate Change (IPCC) that the Earth's atmospheric

temperatures may increase by nearly 106° by the year 2100, which could consequently cause disastrous climate changes such as flooding and droughts, (Roleff, 1997:31).

2.3.11 Inappropriate Construction Material Specification and Assembly

The relevance of resource issues of sustainability seems to be snowballing in our global society, especially in the built environment. "The construction of buildings is consuming some three billion tons of raw materials each year. By most estimates new construction accounts for 40 percent of the raw stone, gravel and sand used each year; 40 percent of the processed materials such as steel; and one-quarter of the world's wood harvest. **Together new and existing buildings account for two-fifths of the world's annual energy use, one-sixth of its water consumption, and one-half of its waste stream," (Gissen, 2002:115).**

Our construction materials have widely varying environmental impacts: some such as oil, hardwood timber from non-sustainably managed sources or copper are drawn from limited stocks of non-renewable resources whilst others such as limestone or sand, are generally more abundant but their extraction, processing and transportation to site can carry higher embodied energies and cause significant environmental degradation, (Energy Research Group, 1999: 4).

Most suburban houses in the study area consist of building materials that are not locally sourced and carry considerably high embodied energies. Irurah defines embodied energy as "the accumulative energy which is consumed and thus dissipated during the production stages of a product starting from the origination of raw materials (cradle) through processing and fabrication, to decommissioning and disposal after the product's life cycle is over (grave)," (2002: 91). In the context of architecture, embodied energy can be defined as the energy consumed by all of the processes connected with the creation of a building, from extracting the natural resources to product delivery. This includes the energy required to transport the materials and machinery used, Milne (2005:01).

Currently, most of the conventional building materials, such as glass, clay bricks, mortar, steel and concrete, specified in the building industry carry a high embodied energy due to their energy intensive processing, fabrication, transportation, (www.sustainablebuiltenvironments.com, cited 26 June 2008). Following this, specifications of finishes can cause the building's embodied energy to increase over time due to the maintenance they require to keep them aesthetically pleasing. An example of this can be stucco plaster which requires a fresh coat of paint every few years- which carries an embodied energy of its own.

Consideration must be given to the impact of extraction, manufacturing, transporting, and assembling, repairing, disassembling, recycling and final disposal of building materials, (2004:25). This consideration forms part of the life cycle of a building and its materials. Current conventional detailing of how materials should be put together is considerably inefficient and unsustainable when considering the life cycle of building materials after demolition. This is as most components are fixed in such a way that the process of detaching or disassembling them for reuse is too time and energy consuming that it is considered not feasible.

An example of this is the conventional brick wall. Bricks, especially clay kiln-fired face bricks, carry a significant embodied energy as well as a large carbon footprint. Thus, it would be an environmentally beneficial practise to reuse them if a building is destined for demolition. However, due to the conventional way of fixing bricks together with mortar, a masonry brick wall is much more conveniently demolished and sent to a landfill than disassembled and recycled, (www.sustainablebuiltenvironments.com, cited 26 June 2008).

Face brick seems to be the most commonly specified construction material in the study area. This could be due to the low maintenance properties of this wall finish.

Embodied Energy	MJ/kg	MJ/m³
Aggregate	0.10	150
Stone (local)	0.79	2030
Concrete block	0.94	2350
Concrete (30Mpa)	1.30	3180
Concrete precast	2.00	2780
Brick	2.50	5170
Cellulose insulation	3.30	112
Steel (recycled)	8.90	37210
Steel	32.00	251200
Plywood	10.40	5720
Glass	15.90	37550
Fibreglass insulation	30.30	970
Zinc	51.00	371280
Brass	62.00	519560
PVC	70.00	93620
Copper	70.60	631164
Paint	93.30	117500
Linoleum	116.00	150930
Polystyrene Insulation	117.00	3770
Carpet (synthetic)	148.00	84900
Aluminium (recycled)	8.10	21870
Aluminium	227.00	515700

Figure 22: Table of Embodied Energy of Materials

Note: the mega joule per kilogram rating of a material can be misleading as materials differ in weight. However the embodied energy per cubic metre is more indicative of the resultant embodied energy of a building. (After Holtzhausen, 2004).

While compiling a comparative research report on the embodied energy of bricks last year it was deduced that face brick carries one of the highest embodied energies in comparison to other brick types.

Schumacher writes about the 'economics of permanence' and how "scientific and technological 'solutions' which poison the environment or degrade the social structure and man himself are of no benefit, no matter how brilliantly conceived or how great their superficial attraction," (1973:27). He continues to suggest that "We must look for a revolution in technology to give us inventions and machines which reverse the destructive trends now threatening us all," (1973: 27). It is imperative that we adapt and find alternative ways to sustain our lifestyles by becoming more energy efficient and independent from nature's limited reserves.

2.4 Future Development? The Call to Adapt

Schumacher wrote in his book entitled Small is Beautiful, that "**modern man doesn't experience himself as part of nature but an outside force destined to dominate and conquer it**. He even talks of a battle with nature, forgetting that, if he won the battle, he would find himself on the losing side. Until quite recently, the battle seemed to go well enough to give him the **illusion of unlimited powers**, but not so well as to bring the possibility of total victory into view. This has now [in 1973] come into view, and many people, albeit a minority, are beginning to realise **what this means for the continued existence of humanity**," (1973, 11).

It is clear that our current high dependence on non-renewable resources is unsustainable. This is proving problematic in maintaining and developing our modern hi-tech society which has- up until now- been sustained by a cheap and reliable supply of electricity and oil. The challenge these days should not only be about how to erect the biggest power station in the shortest time or trying to determine how many generators one would need to run a household. The challenge should be to assess how we can best solve our resource problems without causing further damage to the delicate balances found in nature.

The realization that we need to stop taking advantage of the environment- all in the name of comfort, progress and profit has progressively been brought about through the media. In the last quarter of the 20th Century, the assumption that the progress of technology would continue indefinitely has been seriously challenged. This has been catalyzed by the scientist's growing awareness of the limits of the earth's fossil fuel resources, and then by the realization that the continued consumption of these resources at was having an irreversibly destructive effect on the world's climate, (Hawkes and Forster, 2002: 36).

A preponderance of uninformed choices has led to the slow unravelling of the earth's delicate web of life, (Gissen, 2002:115). **We, the professionals of the built environment, have an immense direct and indirect influence on the conditions of our environment of today, and our environment of tomorrow.** Reiterating Gissen's opinion, **our decisions, irrespective of how conscious they are, will inevitably carry an environmental consequence that can unravel the earth's delicate web of life.**

It seems that in the near future the development of our world may be driven by sustainability. We need to **adapt** our modern drive of capitalism to make way for sustainability to take the lead so that the delicate systems of our planet and our society don't crash, (Schumacher, 1973: 11). One is not suggesting that sustainability cannot be profitable but what is being motivated is that profit cannot and will not be the only sought after outcome in the future. It is becoming progressively clearer that one of the greatest investments one can make may be in one's environment.

To conclude, Schumacher defined our due **adaption** when he stated that "we often hear it said that we are entering the era of the 'Learning Society'. Let us hope this is true. We still have to learn how to live peacefully, not only with our fellow men but also with nature and, above all, with the Higher Power which has made nature and has made us; for, assuredly, we have not come about by accident and certainly have not made ourselves."

Our survival depends on it.

Thomas maintains that climate change affects us all and we should all act to reduce its impact," (2003: 5). This statement describes the consciousness that climatic change is an all encompassing issue and no one can afford the luxury of being excluded from its consequences. As we enter the 21st century, serious questions are beginning to emerge about the sustainability of our suburban way of life. The prospects of the suburbs need to be questioned as the planet approaches a critical era flavoured with a global demand for fossil fuels that is beginning to outstrip supply, (www.endofsuburbia.com, cited 18 June 2008).

The necessity of changing man's course of development to a more sustainable one is not to be disputed. However, the way forward for development demands attention. How do we **adapt** existing suburban development to be more sustainable whilst **adapting** one's brief for future suburban developments?

The pending question in the context of Johannesburg is: If global warming effects increase and the supplies of non-renewables such as coal and oil run dry, will our adjustable louvers, solar panels and cooling towers in our suburban dwellings be enough to assist our city and suburbs in functioning efficiently without affordable

Figure 23: Collage of Clusters Developments Within the Study Area.

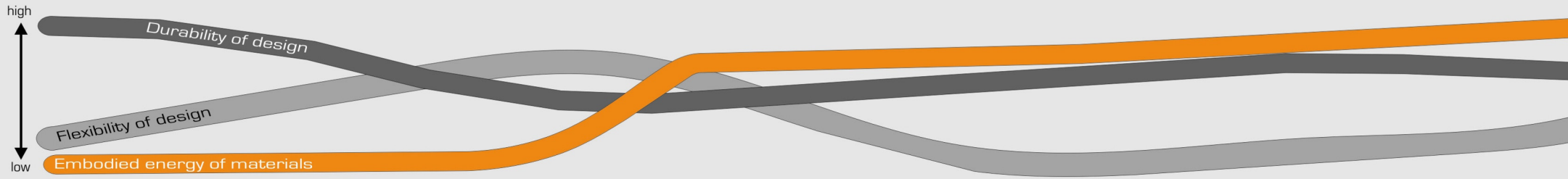


fuel for private motorized transportation, with sky-rocketing food prices and a decreased supply of expensive electricity- to name a few current and prospective tribulations? Or will we need to take **adaptation** to the next level? It is suggested that sustainable **adaptation** needs to be explored in the context of our suburbs on not merely an architectural level- by simply implementing green principles- but also on an urban or suburban scale where issues pertaining to energy supply and municipal services can be addressed on a local basis.

Issues pertaining to air pollution, resource and energy-use and efficient management of water and waste need to be addressed in our suburbs in order to prevent mass abandonment as well as the destruction of our irreplaceable planet.

We need to **adapt**.

Graph of the Amount of Durability, Flexibility and Embodied Energy in Materials Over Time (in reference to typical designs of each period mentioned below)



Main Stem of Western Architectural History and Major Influences

Technical and Technological Influences- Escalating Energy Demands, Resource Depletion - Global Warming

Manuel Labour and Crafts

Egyptian 50C- 1C BC	Greek 30C-1C	Roman 1C BC- 4C BC	Early Christian 4C-12C	Byzantine 4C-15C+	Romanesque 8C-12C	Gothic 12C-16C	Renaissance 15C-18C	Baroque 18C-19C
Timeless legacy of eternal pyramidical royal burial chambers. Temples of massive walls, sturdy closely spaced columns and flat roofs. Machineless technical craft. Astronomical Knowledge	Clear-cut architectural style through love of precise forms. Structures limited to short spans. Outdoors favoured as expressed in the agora	Crafted exponents of classical orders. Abundance of marble and stone- terracotta and brick use- development of concrete and the vault with Estruscan arch. Regional climate influenced diversity	Recycled ruins of Roman buildings and adaptation of fragments quarried from the past	Architectural forms usually domical on square or polygonal plans- shaded colonnades. Clay bricks, rubble for concrete, finished in marble	New construction principle- structural equilibrium. Heavy cross-vaulting evolved into lighter 'rib and panel'. Glass in general use during the 9th C- small fenestration in south and large in north	Throughout Europe climate varied influencing the choice of etailing- use of materials varied- pointed arch became the structural 'truth'	Classical orders ruled. Walls of ashlar masonry laid horizontally, often rusticated- openings with semicircular arches- roofs vaulted with no ribs	Freedom demanded from orthodoxy of plan, design and ornament. Columns crafted with twisted shafts, surmounted by clumsy curved pediments
Culture founded on deities- spiritual belief. Human resource exploited by overlords to build massive royal monuments. Mathematical skills, metaphysical, geological and climatic perceptiveness	Symmetry of philosophical thought- artistic sense of harmony and simplicity- worship of deities- colonization. Buildings were public monuments	Romans were empire builders with administrative skills- colonization through conquest- spread of influence of pantheon f deities under the Emperor- love of justice expressed through basilicas. Amphitheatres for contests between man and wild beasts	Emperor Constantine- Christianity modelled on Roman basilicas for worship thereby retaining some pagan features	Christianity became the state religion of the Roman Empire and power moved to Byzantium, Greece, thereby influencing architectural style	Decline in Roman power. Civil government and military protection. New states and nations formed in previous colonies in western Europe. Rise of religious enthusiasm and churches, feudal tenure	Rise in monastic communities- the power of the Pope supreme- the Church became wealthy and clergy proliferated. Growth of towns, commercial activity and rivalry- wealth	Religious and social activity in Europe affected by invention of printing, use of gunpowder, mariner's compass and immigration of Greeks into Europe. A spirit of enquiry and freedom of thought, energized by intellectual vigour- Classical styles triumph again	Reaction to blind worship of Vitruvian rules. A new freedom and desire for originality of style and carved ornament. The movement commenced in Italy

Social, Cultural, Economic, Political Influences- Environmental Pressures- Decline in Urban Quality of Life

Despotic Rule/ Dynastic Power

Technical and Technological Influences- Escalating Energy Demands, Resource Depletion - Global Warming

Information and Other Advanced Technologies

Neo-Classical 1750-1900	Art Nouveau c1880- c1910	European Expressionism 1910-1925	Bauhaus 1919-1932	Modern Movement C1920 +	International Style 1925-	Post Modernism c1980	New Age 2000 + (Adaptation time)
Steam power, the iron frame, trade with the New World. Technical transformations and development in structural engineering 1775-1939	Extensive use of the tensility of iron with glass in public and domestic architecture freeing space with iron superstructures over wall enclosures	Promotion of glass to 'elevate culture' leading strides in development of glass technology	A culture of teaching of craft for designing for mass production- collaboration with existing industrial enterprises for mutual stimulation	First serious confrontation of art with the machine characterized by the 'Depreciation of material that results from the treatment by machine'	Skeleton construction enveloped by a curtain wall, typified by the tower block on podium	Non-canonic variety of solutions, adherence to irrational, elitst and exhibitionist designs wit little regard for affordability, sustainability or structural rationality	Protection of natural world and global resources and development committed to an environmental ethos
Territorial transformations 1800-1909: Urban development upgrading to utopian communities. Rising bourgeoisie	Style inspired by William Blake Arts and Crafts tradition- cultural acceptance of the use of the machine in design and expression of symbolism are striking	Collective of European architects believed that 'to raise our culture to a higher level, we are forced... to change our architecture' by introducing glass architecture. Free form and rational prefabricated construction shown as incompatible	Proclamation of the Weimar Bauhaus programme by Gropius envisaged the encompassing of architecture, sculpture, and art like the 'crystal symbols of new faith'	Architectural ideology of unadorned 'form follows function', 'less is more'- purism in simplicity, machine aesthetic, anti-metaphor- utopian with architect as saviour/ doctor	Prime architectural symbol no longer the dense brick but the open box- free plan flexibility. Rudiments and initial principles of modern architecture betrayed	Reaction to the Modern Movement as practiced by later exponents. Replaced by a culture of individuality of self-indulgent, eclectic manifestations. No declaration of intent regarding pressing contemporary	Architecture to be reclaimed by society at large to meet changed cultural and environmental paradigms

Social, Cultural, Economic, Political Influences- Environmental Pressures- Decline in Urban Quality of Life

Old and New Democracies/ Anarchy/ The Sovereign Individual

[Time line after Thomas 2003:39]



Figure 25: Don't worry... there's a light at the end of this tunnel
(www.bludav2.storage.msn.com, cited 22 September 2008).

The Way Forward Contents

3.1 Introduction to Sustainability

3.2 Suburban Sustainability on an Urban Scale

3.2.1 The Eco System Approach

3.3 Suburban Sustainability on an Architectural Scale

3.3.1 Passive Design Principles

3.3.2 Resource Managment

Chapter 3

The Way Forward

3.1 Introduction to Sustainability

"Despite over-exposure, and the consequent danger of the phrase loosing resonance, **sustainable development remains a valid and challenging goal**," (Barton, Grant and Guise, 2003:5).

So..."What is sustainable design?" one might ask. Many people have various misconceptions about what it means to be referred to as "green" or sustainable. Sustainability is not about hugging trees and sniffing illegal substances whilst prancing around merrily in a field of spring flowers and eating vegetables all day. It does not promote an architecture of deprivation either: It is not about sacrificing your comforts, living in caves and tree houses and taking short, cold showers all in the name of saving the environment.

Before one can seek to be sustainable one needs to be informed of the extent of the damage we are causing to our irreplaceable planet through our carbon emissions. The analysis of one's carbon footprint has emerged in order to create awareness by determining one's lifestyle's environmental demands and use of non-renewable energy sources. Thomas writes that "the challenge is to reduce it over time and increase our 'footprint' of the ambient energy source," (2003: 9).

Food & Trees for Africa (FTFA) is organisation who has been talking of the need to address this through conserving, planting and maintaining trees since they were established in 1990. The FTFA carbon calculator is the first South African calculator of its kind and was developed by PriceWaterhouseCoopers who are the first African company accredited to do carbon auditing. The purpose of the calculator is to create awareness around lifestyle choices, events, venues, office buildings, business processes, industries and the contribution to climate change. Creating awareness based on a credible baseline is the first step in reducing your footprint as "If you do not know how large your footprint is, how can you evaluate your reduction"? (www.trees.co.za, cited in April 2008).

Sustainable design on both urban and architectural levels can be considered vital for this century as well as for the future. Thomas argues that "our health, welfare and future depend on it," (2003: 11). Sustainable architecture can be described as an architecture of community as everyone needs to get involved in order to successfully maintain a sustainable society (Thomas, 2003: 11).

Sustainability is about achieving a balance: the search for sustainable development that is represented by the trefoil diagram which does not signify a weak trade-off between social economic and environmental priorities, but rather requires finding solutions that combine all three, (Barton, Grant and Guise, 2003: 5).

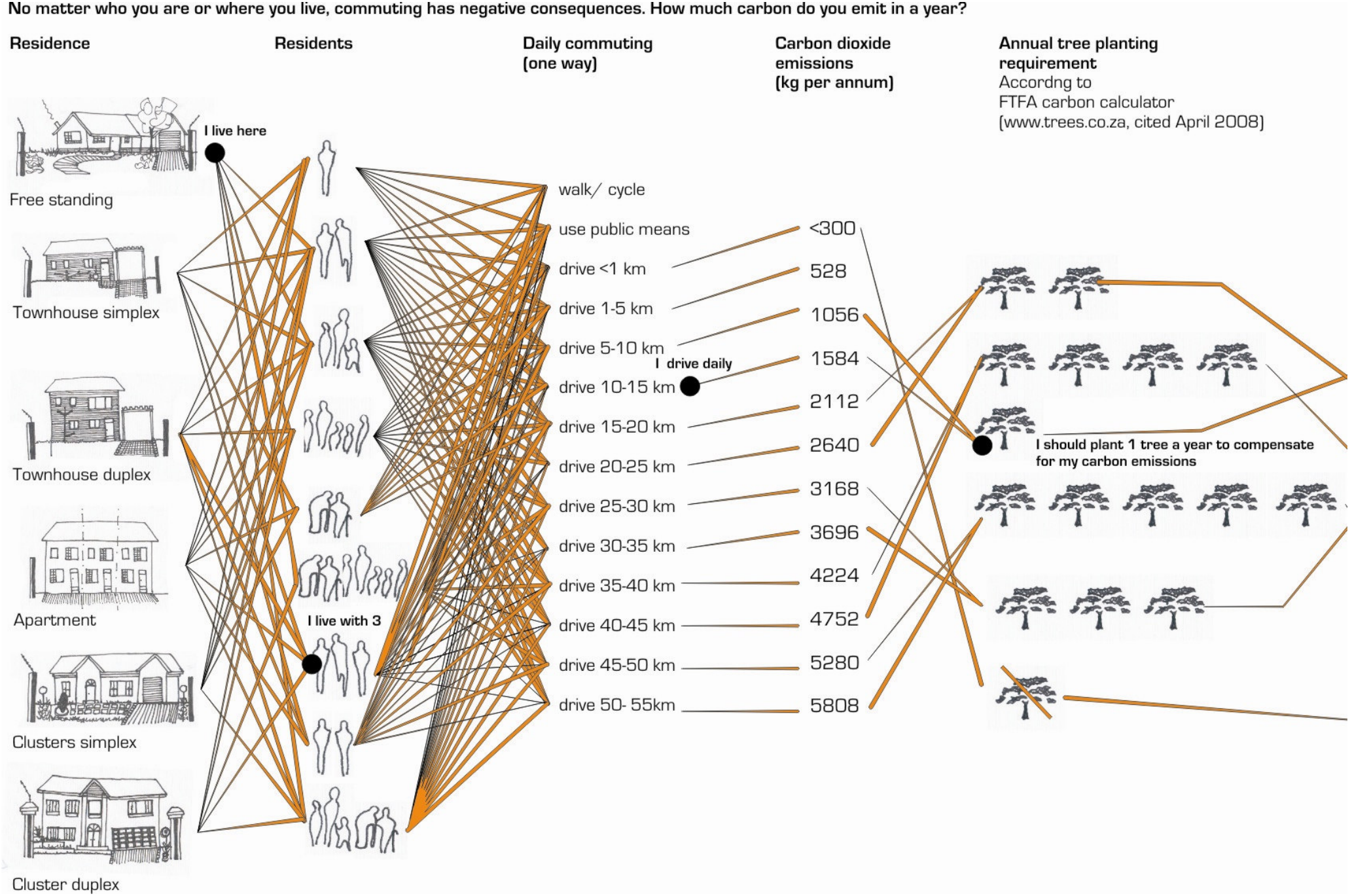
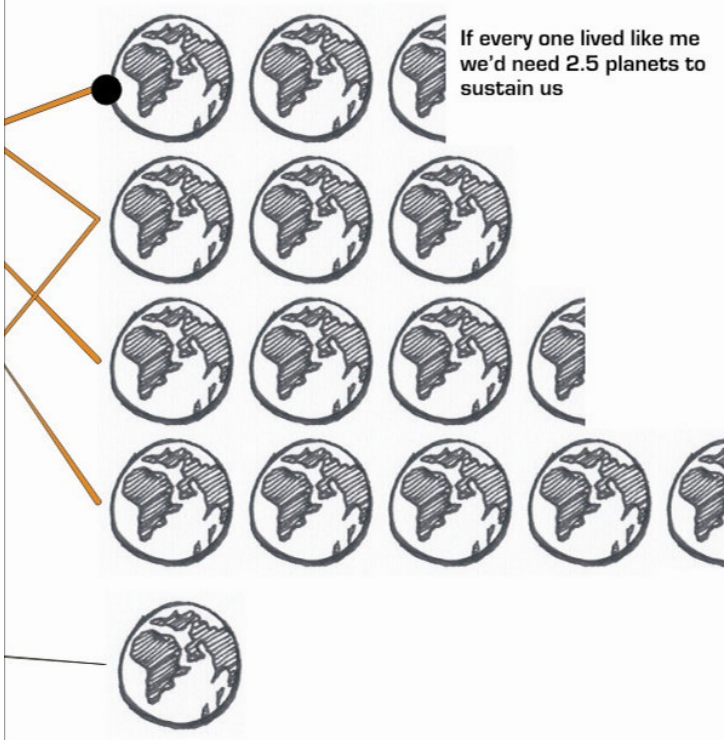


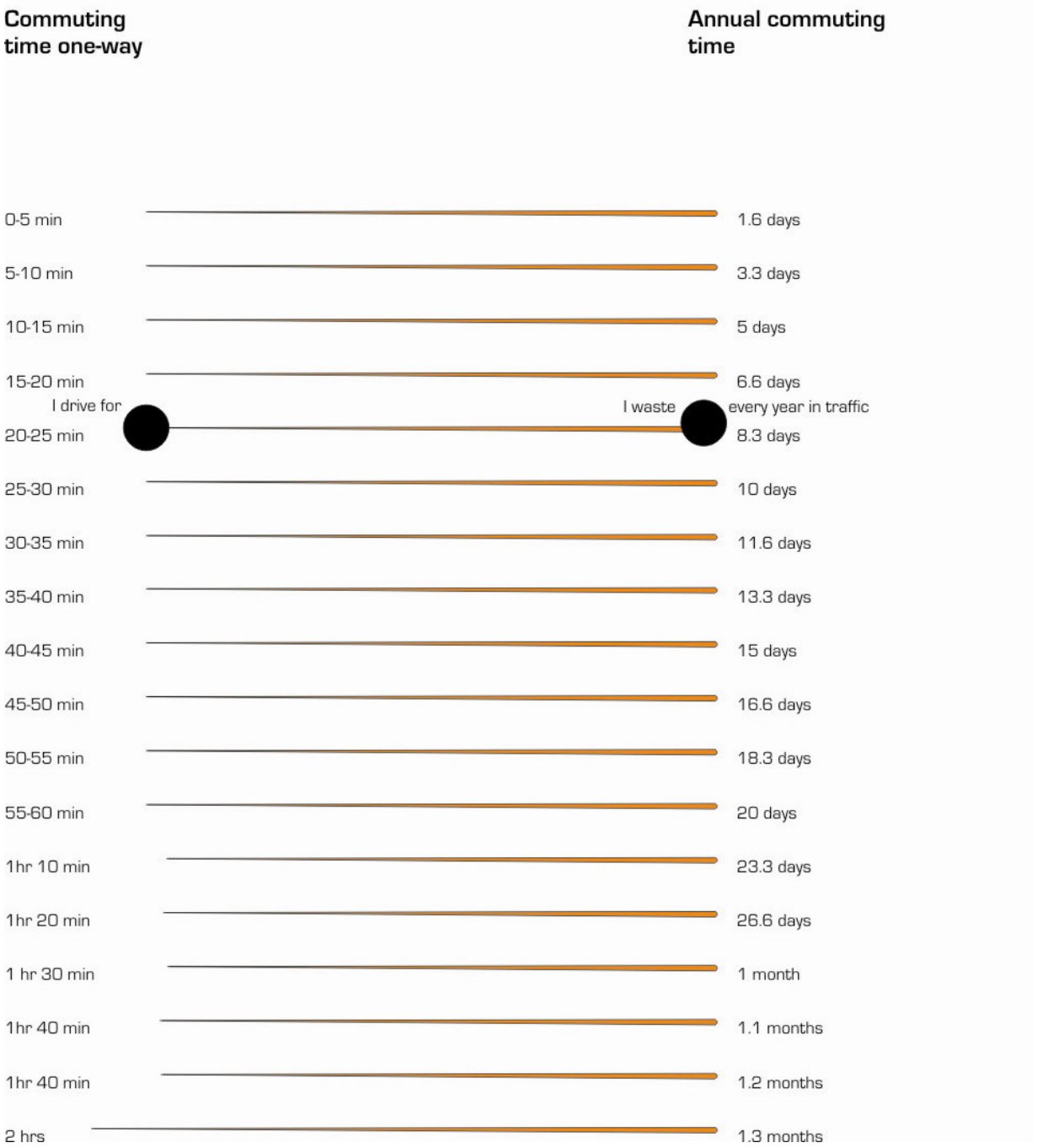
Figure 26: Brief Carbon Footprint Analysis

How many earths required to sustain this lifestyle if every one lived like this
Earthday Network Ecological Footprint
(www.earthday.net, cited April 2008)



...What about you?

How much time do you waste in traffic a each year? Wouldn't it be great to work closer to home?



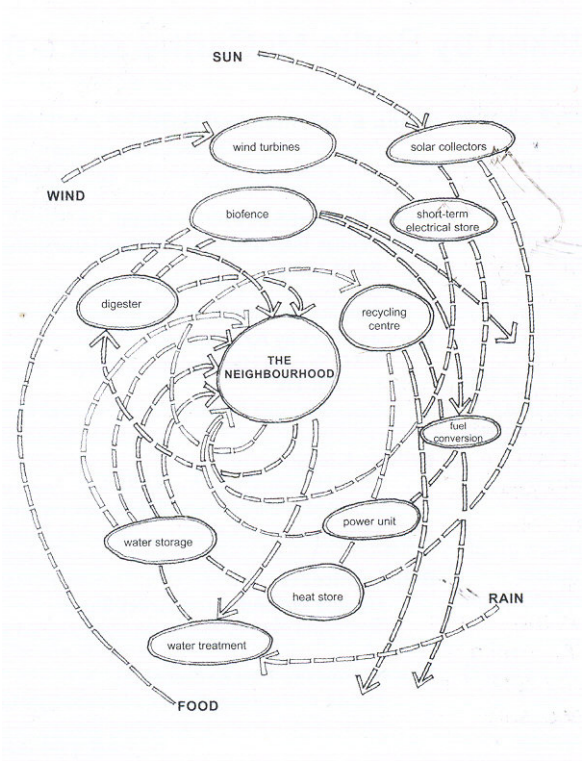


Figure 27: The Neighbourhood
Both sustainable urban master plan and building design requires a wide variety of issues to be integrated in order to produce a sustainable goal, (Battle and McCarthy,2001:125).

"The value of a built environment now extends beyond simplistic accounting of its financial value– an educated public demands not only quality but also social and environmental responsibility. The development of solutions arises out of the overlapping and integration of disciplines and expertise."
(Battle and McCarthy, 2001:125)



Figure 28: The Trefoil Diagram of Sustainability
After Barton, Grant and Guise 2003:5 and www.copeland.gov.uk, cited February 2008)

To recapitulate, professionals of the built environment have an immense indirect influence on the conditions of our environment today, and the environment of tomorrow. Their decisions, irrespective of how conscious they are, will inevitably carry an environmental consequence. For realistic and informed decisions to be made, it is imperative that these designers gain significant insight to the relative environmental impact of the various options available to them. (Anink, Boonstra and Mak,1996:8)

It is arguable that a sustainable balance can and must be achieved on both an architectural and urban (or suburban) level to be efficient and stable. Otherwise, one scale's unsustainable attributes may undermine the other scale's sustainable aims and efforts. It can be said that the building is not an object in isolation, but rather a collection of subsystems that together form part of a larger system. Sustainable design ranges from the microcosm of designing small objects in subsystems, through to the macrocosm of designing buildings, cities and the earth's physical surface, (www.wikipedia.com, cited August 2007).
Thomas writes that a critical analysis of where architecture stands needs to examine how we create our living environment so as to respond to threats to health from urban stress and pollution, to environmental destruction, social and

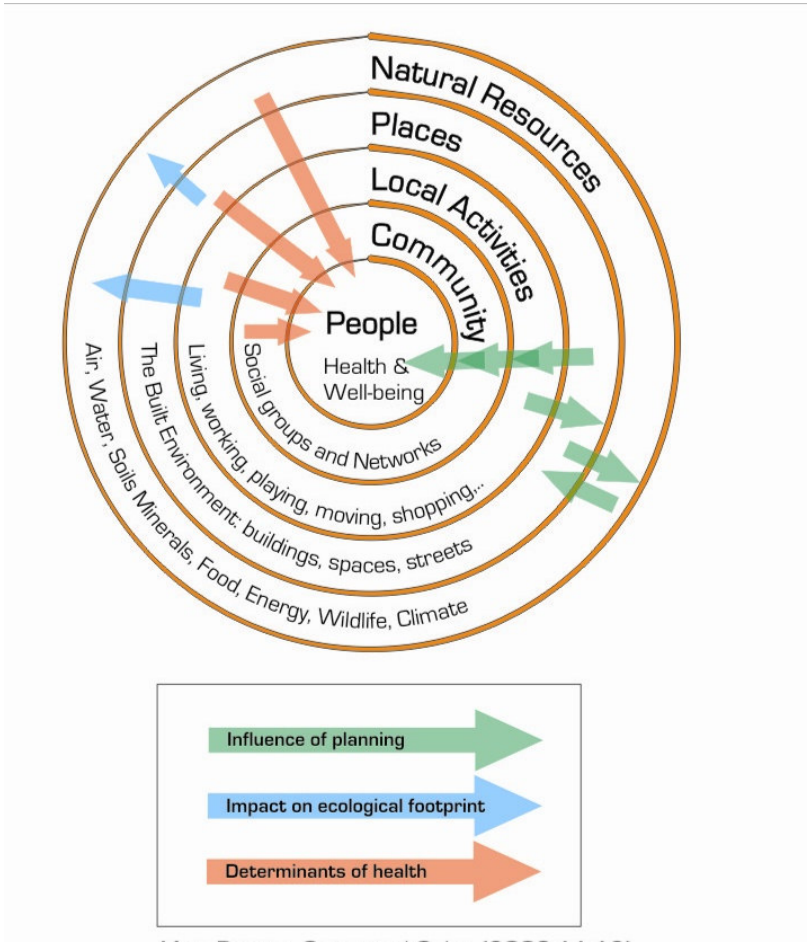


Figure 29: The Neighbourhood Ecosystem
After Barton, Grant and Guise (2003:11-12)

human dysfunction. (2002: 43). There is an overlapping of the sustainable aims of both scales. Sustainable architectural design involves passive design principles, embodied energy of building materials, and resource management whilst sustainable urban strategies of the suburb are also involved in resource management in the neighbourhood ecosystem model. Sustainable principles will now be discussed on both an urban and an architectural scale.

3.2 Suburban Sustainability on an Urban Scale

Urban form can be seen as a result of the complex interaction of interdependent pressures and influences: climatic, social, economic, political, aesthetic, strategic, technical and regulatory, (Energy Research Group, 1999: 47). Many planning decisions have an all-encompassing and long lasting effect on social cohesion and general quality of life of both the city dweller and the global environment, (Energy Research Group, 1999: 47). It can be suggested that this applies to the suburban dweller as well.

The magnification of the issues of conservation of fossil fuels and energy resources and the need for more environmentally friendly sources of energy happens on an urban scale. Energy efficiency forms part of an integrated search for sustainable development which recognises the impact of cities on air, land water, fauna and flora and the human race, (Energy Research Group, 1999: 47).

Susan Henshaw Jones wrote, “Any viable solutions must be conceived in the broadest possible way... most modern development is large scale, however- mixed -urban complexes, shopping centres, office parks and so on- and it is in this realm that environmentally conscious building practices can have the greatest impact, (Gissen, 2002: 6)

The Energy Research Group maintains that sustainable urban planning strategies can facilitate a healthier environmental, social and economic environment. Additionally, strategies can be implemented to decrease the amount of daily energy consumption of people, (1999:5). Barton, Grant and Guise argue that “The ecosystem approach [to suburban neighbourhoods] provides a coherent philosophy to underpin the principles of planning for health and sustainability,” (Barton, Grant and Guise, 2003:10).

3.2.1 The Ecosystem Approach

This ecosystem approach shows the importance of recognizing the diverse needs in a locality. This includes “different ages and life stages, different income levels, varied ethnic, household and family groupings, different cultures, lifestyles and levels of mobility- and to encompass not only the needs of residents but workers, providers, visitors, those running businesses and those just passing through,”(Barton, Grant and Guise, 2003: 11). They maintain that there is no such person as an ‘average’ neighbourhood user but rather, there are many people with specific demands: kids... elderly couple next door...” (2003: 11).

Additionally, Barton Grant and Guise suggest that the ecosystem model can be broken up into five main determinants. They rightly suggest that people are

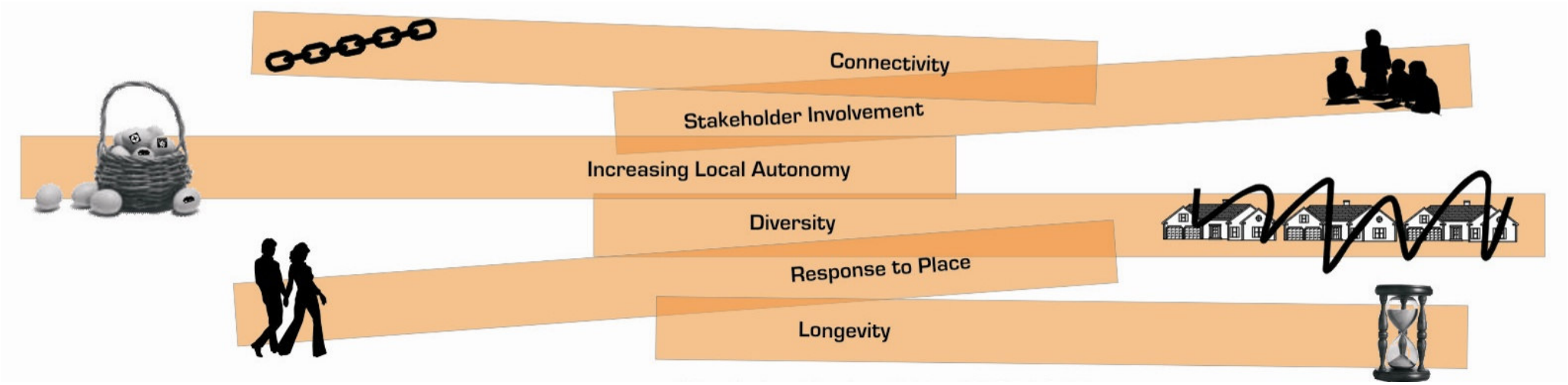


Figure 30: The Ecosystem Approach Principles
After Barton, Grant and Guise (2003:14-15)

responsible for satisfying their own needs; however the spatial or urban design of the suburban fabric or neighbourhood can either support this self reliance or restrict and frustrate it. Thus the fundamental design aim should be to create an environment of choice- "providing a congenial and sustainable habitat for everyone while protecting it from destructive forces," (Barton, Grant and Guise, 2003:11). **There are six robust principles that Barton, Grant and Guise have identified to assist one in applying the ecosystem theory.**



Stakeholder Involvement: This principle encourages the designer to consider all of the main stakeholders' opinions from public, private, and community sectors- when their interests are at stake. (Barton, Grant and Guise, 2003: 14).



Diversity: This principle is a response to the failures of conformity which is especially evident in the latest suburban developments. This includes diversity of housing typologies and tenure with the aim of promoting social inclusion, diversity of local work and service opportunities, (Barton, Grant and Guise, 2003: 14).



Increasing Local Autonomy: This involves ensuring that the neighbourhood is relatively self-sufficient by providing for the everyday needs of its inhabitants. This could include the implementation of energy generation and waste management centres within local communities, (Barton, Grant and Guise, 2003:15). Increasing the local autonomy can encourage a broad spectrum of local employment for both skilled labour and professionals, (Energy Research Group, 1999: 50). William Mc Donough suggests that we could learn from the delicate balances and systems of nature, where one organism's food is another one's waste, (Gissen, 2002:6). Gissen says "we should not see energy supply as a linear process from fuel to power stations to our cities - we should see our cities as power stations in themselves, self sufficient in terms of electricity and heat, but also capable of supplying energy to surrounding towns," (2002:45). This brings one to the idea of locally implementing alternative sewage treatment works, or biogas digester systems, within the suburb that can use sewage to generate electricity and produce usable gas.

Biogas typically refers to methane that has been naturally produced by the fermentation of organic matter including manure, wastewater sludge, or municipal solid waste, under anaerobic conditions (in the absence of air), (www.biophile.co.za, cited June 2008). This methane can be used in its gaseous form or converted into electricity. Thus, the demand for electricity supply, the inconvenience of power outages and increased electricity rates can be reduced with the implementation of bio-digesters into the suburbs, thereby supplying the community and the grid with additional electricity. This increasing of the local autonomy ultimately makes the suburbs more self-sufficient entities that are less dependant on other parts of the city to meet their daily needs.

The use of biogas is encouraged because it burns with a clean flame and thus produces little pollution. However, the consequent advantages of using a biogas digester to convert human waste into an easily accessible alternative energy source do not stop at cheaper and cleaner power. The maintenance and

regulation of the digester may also provide local employment whilst the digester also provides enriched liquid manure which is an effective fertiliser for both home and commercial vegetable gardens, and in turn, can increase income savings in reduced food bills, (www.biophile.co.za, cited June 2008).

Another way of using waste as a resource is through recycling a portion of household waste that would have otherwise taken up space in a landfill. Since 1998, Pikitup has developed five buy-back recycling centres and have formed partnerships with Mondi Recycling, Collect a Can. Glass Recycling Association and the Plastics Federation. The buy-back recycling centres accept recyclable waste such as paper, glass, plastic, cans and aluminium, thereby diverting them from the landfills. Separating recyclable material can provide local employment and money generating opportunities, thus increasing the local autonomy. Additionally, "communal provision at neighbourhood or block scale may make separation, collection and re-use of solid waste more economic," (Energy Research Group, 1999: 53). Thus, increasing local autonomy supports accessible employment, choice of local facilities, the opportunity for healthy exercise and the development of local community networks, (Barton, Grant and Guise, 2003:15). This principle can be seen as a reversal of the separating of land-uses mentioned earlier.



Figure31: A Suburban Scale Bio-gas Application: The world's largest fuel cell demonstration project under way in a Seattle suburb
The fuel cell, located at the South Treatment Plant in Renton, WA, breaks down millions of gallons of sewage and can consume about 154,000 cubic feet of biogas a day. Thus, it can produce up to 1 MW of electricity a day "which is enough to power 1,000 households," (www.forester.net, cited 17 September 2008). (dnr.metrokc.gov, cited 17 September 2008)

Lynedoch EcoVillage, which is situated in Stellenbosch, South Africa, demonstrates these three principles. I had the brief privilege of staying in the Lynedoch EcoVillage for a week of last year. It is the first ecologically designed socially mixed intentional community in South Africa.

"The most significant aspect of the Lynedoch case is that it provides a working example of an *integrated sustainable development*.. *Integrated* because it connects social, economic and ecological objectives and because it incorporates technologies that span the energy, water, sanitation, and building materials fields; *sustainable* because of the commitment to a long-term vision of social, economic and ecological sustainability; and *development* because of the anti-poverty and local economic development objectives," (Annecke and Swilling, unpublished: 2).

Diversity: The EcoVillage comprises of a preschool; primary school; a large all-purpose hall; offices and classrooms of the Sustainable Institute; the converted old Drie Gewels Hotel which is now 18 residences which serve as accommodation for participants of the programmes of the Sustainable Institute as well as a conference venue for general use; and a mix of subsidized and commercially priced residential sites, (Annecke and Swilling, unpublished: 3).

Additionally they have developed an It centre which links the primary school, the Sustainability Centre and the University of Stellenbosch and it has been developed for the use of the children, university students and the community members, (Annecke and Swilling, unpublished: 14).

The aim of the development was to focus on the reduction of water consumption in each dwelling by treating both black and grey waste water on-site and by re-using the treated water. Additionally, its aim was to reduce household energy consumption, eliminate the need for solid waste removal from the site, raise the density of the site by shrinking the average size erven in ways that do not discriminate between rich and poor and maximise the economic benefits of a socially mixed development, (Annecke and Swilling, unpublished: 8).

There are five pre-designed housing types that have been developed for the scheme which range from freestanding dwellings to semidetached and terrace housing, (Annecke and Swilling, unpublished: 10).

It was during my brief visit that I first encountered the idea of using human waste to generate biogas as well as the alternative methods of using, treating and reusing water on the site. All on-site service infrastructure is managed and maintained by LHOA in accordance with the Western Cape's Land Use Planning Ordinance and the Municipal Systems Act, (Annecke and Swilling, unpublished: 7).

Local Autonomy: A dual water supply system which involves both municipally supplied potable water and recycled water supply has been implemented. The potable water is directly supplied to each unit with one meter for the whole development. The recycled water is supplied to each household for the flushing of

Figure 32: Collage of Lynedoch images.

The Renovated old Drie Gewels Hotel

A Double Storey Houses in the Scheme built with ecobond bricks

Room in old Drie Gewels Hotel



Their more permeable coarse road surfaces
These roads reduce the rate and amount of run-off and allow the water to percolate back to the ground water reserve.

Aerial Photograph of Lynedoch EcoVillage.
On the site of old Drie Gewels Hotel which is 200m away from the Lynedoch Station on the main train line between Cape Town and Stellenbosch, (Annecke and Swilling, unpublished: 1).
(After Google Earth 2008)

The Main Building: The Sustainability Institute

toilets and for irrigation. Each household has two water meters installed and is billed on a monthly basis by LHOA who then pays the municipality and finances the operation and maintenance of the on-site water recycling systems, (Annecke and Swilling, unpublished: 8).

There are two household effluent treatment systems demonstrated on the site. Both of them are rapid, odour free, fly free environmentally appropriate filtration systems that do not require the use of chemicals and no storm water, black, or grey waste water will leave the boundary of the site except via the groundwater flows and evaporation, (Annecke and Swilling, unpublished: 9).

Septic tanks receive household effluent from up to three ervens. Here, the solids are deposited whilst the effluent proceed to a Vertically Integrated Constructed Wetland at the lower end of the site. On arrival (on the top of the wetland) the treatment of the effluent is aerobic but then becomes progressively anaerobic as the effluent sinks down through multi-layered filter to the bottom. It is interesting to note that it is the anaerobic process which removes pathogens and nutrients from the water that enables the water to be reused within the house for the purposes of toilet flushing. The water is then piped into a dam and later pumped up into storage tanks at the top of the site to be redistributed for irrigation and the flushing of toilets, (Annecke and Swilling, unpublished: 9).

Another system, which uses a Biolytic Filter, services the Guest House and Main Building which is home to the Sustainable Institute. Here, the black and grey effluent is directly channelled into the filter which is an engineered micro-ecology consisting of a peat filter inoculated with earth worms which effectively deals with the solids in an aerobic environment. Thus, the resultant treated water contains nitrogen and phosphorus which can be used as a natural fertiliser for developing a nursery or other agricultural irrigation purposes. Pathogens are removed when the effluent passes through an ultra-violet light, (Annecke and Swilling, unpublished: 9).

Additionally, a Biogas digester has been installed for demonstration purposes. It collects all the grey and black water of the houses and produces methane gas with the addition of the kitchen organic waste. The gas accumulates at the top of its brick dome where it is released via a pressure valve and supplied back into the houses to be used as cooking gas.

Additionally, each building has a conventional supply of electricity and all buildings make use of solar water heaters that are fitted with thermostats that switch to electricity supply during days when the sunlight is insufficient. Furthermore, all stoves are low pressure gas hobs and all artificial lighting is achieved through the use of low energy lights, such as Compact Fluorescent Lights (which only require

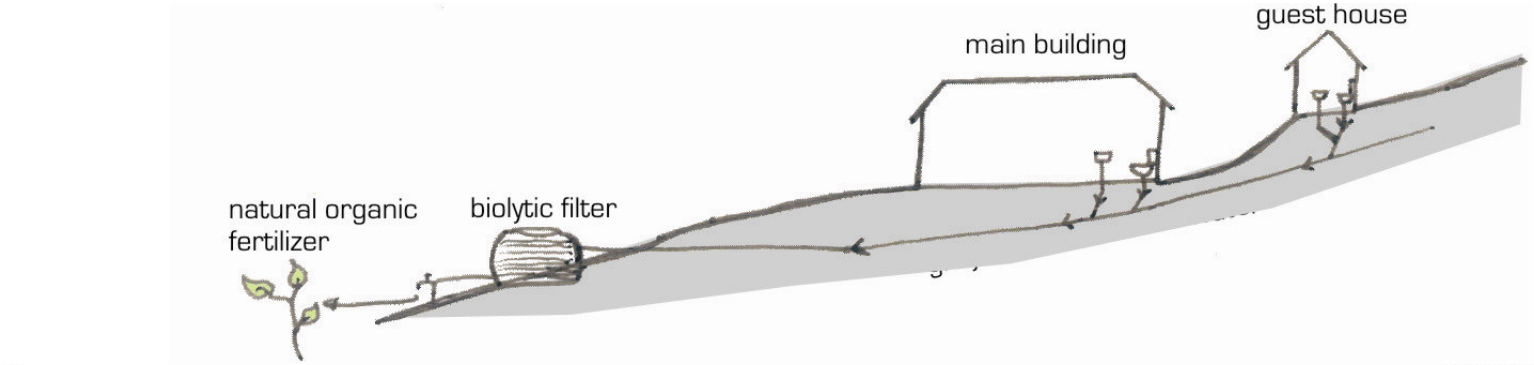


Figure 33: Diagram of Biolytic Filter System at Lynedoch EcoVillage
(After information from Annecke and Swilling, unpublished: 8).

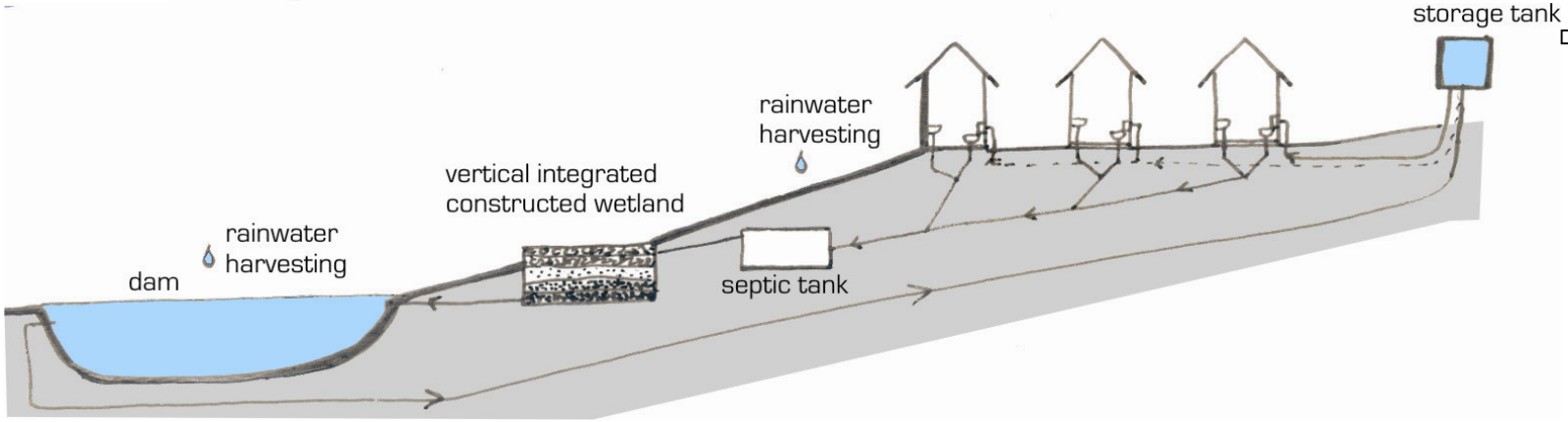


Figure 34: Diagram of Vertical Integrated System at Lynedoch
(After information from Annecke and Swilling, unpublished: 8).

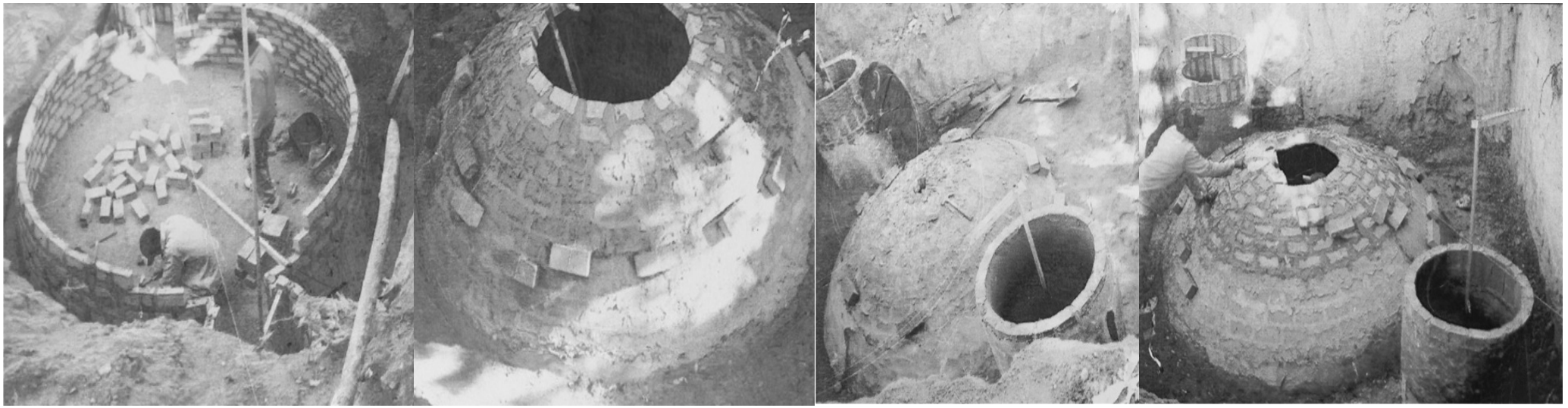


Figure 35: The Construction of the Lynedoch Biogas Digester
The biogas digester usually has five key components: the dome-shaped underground digester body, the gasholder, the slurry inlet, the slurry outlet, and the gas use point. The gas pressure is created by the weight of the gasholder thus: the greater the weight, the greater the pressure. A biogas digester functions as follows: Human effluent from the sewer is piped into the digester where bacteria transform the waste into biogas. The methane gas rises into the gas holder where it is contained by a water seal. The gas is then piped via the outlet point on a pressure-fed system to a generator, to be available on demand, (www.biophile.co.za, cited June 2008).
(Photograph of photographs on their information board, 2007)

11KW), or Low Energy Diodes (LEDs) (which only require 2KW) as opposed to the normal 60KW or 100KW incandescent bulbs , (Annecke and Swilling, unpublished: 9-10).

Waste management on the site requires the user's to separate their refuse into two separate containers for either organic waste or solid waste which is then separated further at a depot. From the recycling depot, the refuse collection is entirely managed by the LHOA who sells the solid waste to recyclers or retains it for productive re-use which means that at most only 5% should reach the landfill site, (Annecke and Swilling, unpublished: 10).

The internal roads are constructed as gravel wearing coarse surfaces and no kerbs were provided to compliment the natural character of the site as well as to reduce costs, (Annecke and Swilling, unpublished: 10).

Stakeholders: have been considered on a variety of levels and governance plays an important role in the EcoVillage. This refers to management and control of activities on the site. They have a Code of Conduct which defines the way the community would like to live on a daily basis. This code "governs matters such as litter, waste disposal... the number of pets each owner is allowed, noise pollution, traffic control, building extensions, use of energy and water, use of organic waste, safety and security matters... use of the community hall, conflict resolution, air pollution, external appearance of buildings, procedures for managing community events... behaviour of temporary residents... and the right to privacy in a context that is already inundated by visitors," (Annecke and Swilling, unpublished: 12).

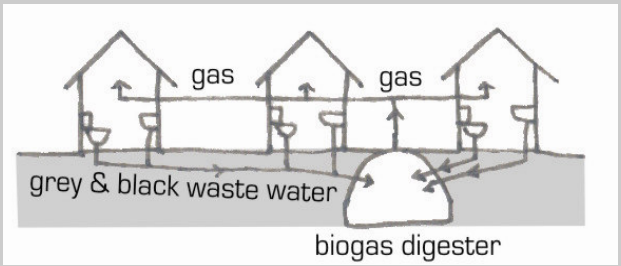
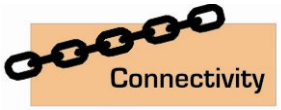


Figure 36: Diagram of Bio-gas system at Lynedoch
(after information from Annecke and Swilling, unpublished: 9-10)

It is important to note that Lynedoch EcoVillage will never need to face the burden of capital costs for bulk sanitation or operating costs for such a service which are normally indirectly through rates. It has been calculated that the low-income households will save up to 90% in their normal monthly water bill whilst the middle-income households will save up to approximately 70%. Additionally, the installation of the solar geysers has reduced the normal electricity consumption by 60%, (Annecke and Swilling, unpublished: 8 and 9). Furthermore, the Lynedoch programme has discovered that it is possible to give low income buyers a high value asset at a massively discounted price, "without over-burdening middle income buyer". savings on electricity cabling infrastructure by specifying that there would be no geysers, electric stoves and electric street lights in Lynedoch EcoVillage have translated into a lower monthly repayment for those paying via bonds or loans, (Annecke and Swilling, unpublished: 10 and 15).



Connectivity: Promoting connectivity within and between neighbourhoods to encourage vitality, viability and increased choice in the way one can move through the area. This linking of places and activities can assist in their success. This includes the resource management, provision of social and leisure facilities, permeability of the street network, interdependence of adjacent neighbourhoods and the networks of wildlife and water corridors, (Barton, Grant and Guise, 2003:14).

Densification is closely related to connectivity. Higher density residential development is often encouraged in close proximity to public transport access. This is an effective way of connecting many people with many places. However, even though higher densities are a means of providing services more efficiently and better accessibility, it can have negative impacts such as a lack of public space and inadequate management of waste which can result in pollution, (Energy Research Group, 1999: 50).

Low density may result in larger houses with the inherent possibility of working from home and private green space but its horizontal spreading generally carries the unsustainable consequence of inefficient use of transport, space and fossil fuel which brings about more pollution, (Energy Research Group, 1999: 50). The private car is the most wasteful user of energy and source of emissions today. Thus, sustainable design needs to be combined with measures to reduce and restrict its use. Success of this of this depends partially on "public policies for traffic calming, parking restrictions, road pricing, bus or taxi priority and other factors which [usually] lie outside of the control of the architect" , (Energy Research Group, 1999: 51).

However, connectivity can also refer to the technologies of networking and the internet which link places together at a touch of a button, thus enabling many occupations to be less location specific. Thomas argues that the need for intensive concentration of business activity in the typical CBD's will be challenged by New Age communications technology to decentralize into more stress free environments for workers, (2002: 17). The idea of satellite offices is seemingly becoming more popular for information based companies with the traffic congestion and fuel issues of today.

It seems that, "computers [may] provide the convenience of reliable communication with corporate headquarters anywhere in the world and the luxurious advantage, for information based employees, of living in sylvan surroundings, with only occasional trips to the city for office conferences, dining and entertainment," (Gissen, 2002:78).

In Johannesburg, companies such as DAC Systems (a software development company based in Midrand) have already implemented these strategies. Some of their employees, who live in the suburbs of Bryanston, work from home for the majority of the week to reduce the time wasted in traffic as well as their travelling expenses in commuting through to Midrand, (Interview with Gary Carter, Financial Director and Chairman of DAC Solutions).

Could this strategy of decreasing mass commuting and traffic congestion instigate the municipal installation of municipal broadband deployments within suburbs that is free and accessible to all? Overseas, a " municipal broadband deployment [is] broadband Internet access service [that is] provided, either fully or partially, by local government. The means of connection include unlicensed wireless (Wi-Fi), licensed wireless (such as WiMAX), Line-of-Sight, and Fiber Optic technologies. The most widely used type of broadband is Wi-Fi, with reports of around 350 citywide projects in the United States being launched within the past few years," (www.wikipedia.org, cited 26 June 2008).

Additionally, other suburban residents have already started using the South African equivalent of car pools to make our current fuel situation more affordable. This involves colleagues, friends and family members living in the same area sharing the petrol-price burden by taking turns to use their cars, and hence their petrol, (www.dialdirect.co.za, cited 23 June 2008).

Connectivity in neighbourhoods should encourage multi-purpose trips by hosting multipurpose buildings and spaces with mixed civic, office, retail, leisure and residential uses, (Energy Research Group, 1999: 50). Echoing the idea of increasing the local, in a suburban context, this can refer to decreasing the "dormitory" aspect of the suburb by incorporating more mixed-use typologies that contribute to the 'localness' of the area. Could this possibly bring back the relevance of walk-able and cycle-able distances, thus linking activities and uses without a dependence on the machine? According to Wikipedia, suburbs can be improved by " increasing the connectivity of the area through implementing more directly routed foot and cycle paths," (www.wikipedia.org cited 18 June 2008). From this, could we maybe witness the death of the car dominated road and the birth of a new street lifestyle- providing it cultivates an environment of safety and security?



Response to Place: The central facet of connectivity is to create a connection to place. Here, the local ecological and cultural characteristics of a place are considered. It encourages capitalization on the specific environmental resources of the area, such as streams for example and it builds new developments that reflect the best aspects of what already exists, therefore cultivating 'local distinctiveness', (Barton, Grant and Guise, 2003: 15).

An important aspect of sustainable urban planning is the provision of green spaces at a number of scales. These range from play spaces, public parks and gardens to multipurpose open spaces. By providing these open green spaces, one can reduce air pollution, maintain the local water table of the area through providing attenuation dams, create wildlife zones and additionally contribute to the

social, physical and psychological health of individual and the community, (Energy Research Group, 1999: 52). Additionally, rainwater retention can mitigate the lowering of the water table, reduce demand for municipal pipe work and waste treatment, and reduce shock loads on treatment plants, (Energy Research Group, 1999:5).

Maintaining the water table of an area is fundamental in ensuring the continual support of the local ecology by providing the hydration, minerals and nutrients within the soil to its inhabitants. The natural water table and ecology of an area can be maintained through implementing sufficient storm water management systems that include permeable ground cover and attenuation dams which allow rainwater to percolate back into the soil, (Energy Research Group, 1999: 53). This could be achieved by providing suburbs- that have many paved complex developments - with sufficient green open spaces that have inherently soft surfaces, whilst changing the brief for future developments to incorporate more permeable surfaces.

Additionally with the 'sense of place' principle in mind, it is important that one addresses the barriers or the edge conditions of the houses and gated communities of our suburbs . With Mumford and Bauer's popularized ideas "such as: the street is bad as an environment for humans; houses should be turned away from it and faced inward towards sheltered greens... good city planning must aim for at least an illusion of isolation and suburban privacy", (Jacobs, 1962:20). This seems like one big recipe for the death of all street life and it seems to have manifested in our Johannesburg suburbs to a considerable degree. Its no wonder our suburban streets are not as inviting as those of the older neighbourhoods in the inner city who were built around the time when pedestrians were abundant because the public transport was reliable and the streets were 'safe'.

Alan Jacobs writes about how streets should be far more than just a pragmatic and functional space. They should be functional spaces that offer an experience, (Jacobs, 1993:3-4). The car dominance of our suburbs seems to have undermined the sense of place of our sidewalks. However, the heavy car reliance of our suburbs is not the sole instigator of this problem. The concerns of security and privacy issues have caused people to turn their backs on the street, build higher walls and not allow for passive surveillance which generally gives a place a sense of safety and security. Jacobs echoes this when she writes that "public peace... is not kept primarily by the police, [as] necessary as police are. It is [however,] kept by an intricate, almost unconscious, network of voluntary controls and standards among the people themselves; and enforced by the people themselves," (1962: 31).

Jane Jacobs writes that it does not take many incidents of violence on a city [or suburb] street to make people fear the streets. And as they fear them, they use them less which makes the streets still more unsafe, (1962: 30). Hence, lack of this sense of safety has robbed our streets from all pedestrian life and consequently robbed the suburban dweller from enjoying the experience of the neighbourhood street. How can they be designed or treated or even dissolved in a way that still offers the privacy and security that they provide? Can this be used as a tool to revitalise and restore a sense of place to our suburban sidewalks. If one proposes that public recreational space in the neighbourhood and public transport should be more frequently used, then this is the challenge that one faces.

The walk-ability of a street is also dependant on the density of the suburban fabric. Within the study area walk-able distances are less frequent with the hierarchical road network, the neighbourhood blocks being consequently bigger with large cluster developments and gated communities that offer no through roads. Jane Jacobs writes that streets and opportunities to turn must be frequent, (Jacobs, 1962: 179). Thus, this principle, hand in hand with the principle of connectivity encourages the offering of alternative routes and options in which to navigate through the neighbourhood.



Lastly, longevity or adaptable: This refers to the fact that people and places change. This principle evolves the neighbourhood's ability to evolve steadily and 'naturally' over time. It is argued that sustainable urban development patterns rely on the intensification and renewal of the existing fabric, (Energy Research Group, 1999: 50).

The Decentrists, who developed Ebenezer Howard's Garden City concept further, claimed that planned communities should be islanded off as self contained units that " must resist future change," (Jacobs, 1962: 20). However, in order to be sustainable an area needs to be able to change to cope with changing conditions or decay. This includes promoting adaptable building forms, extendable buildings and streets, encouraging gradual renewal, evolving heritage- instead of it mothballing- keeping transportation options open, making space for future development and avoiding fixed edges and barriers, (Barton, Grant and Guise, 2003:15).

Melville: one of the few areas of the Northern Suburbs to have cafes, restaurants and shops lining the streets.



Figure 37: Melville is one of the older neighbourhoods of Johannesburg. It was proclaimed on 5 October 1896, and is named after the land surveyor, Edward Harker Vincent Melvill, (ww.wikipedia.org cited 18 September 2008). It has a fantastic **sense of place** and is punctuated with pedestrian activity. The streets feel relatively safe due to the constant passive surveillance of the mixed activities of the suburb's street edges. It is evident by looking at the street grid network that it has a high sense of **connectivity** with the grid offering many multi-destinational routes. (ww.wikipedia.org cited 18 September 2008). In the sketch below pedestrian life and passive surveillance is encouraged through mixed-use programs and activity.

Melrose Arch's safe and lively streets in Johannesburg



Figure 38: "Melrose Arch is Johannesburg's newest neighbourhood, a gated urban community purpose-built to ensure safety on the streets, (www.cntraveller.co.uk, cited 18 September 2008). It is evident that they have installed a sense of safety through providing passive surveillance along the street edge. Whether it is necessary to go as far as turning the entire neighbourhood into a 'gated' community is debatable. Either way, it can be said that they have been successful in creating a **sense of place**– no matter how artificial it might be. (www.farm1.static.flickr.com, cited 18 September 2008)

Neighbourhood Design: Ashton Green



Figure 39: Ashton Green is a new neighbourhood extension project to the north-west of Leicester being developed by EDAW.

Local Autonomy: It is a 100ha community village project that will incorporate higher density housing, workplaces, schools, open spaces and neighbourhood facilities, (Baron, Grant and Guise, 2003: 180).

Stakeholders of the community are participating in the process of the village design. Targets have been set for energy and water consumption as well as waste management, local food allotment provision and biodiversity with a focus on nature conservation.

Connectivity is ensured through a network of roads that offer alternative , more direct paths through the grid. This offers a wider choice of how to move through the area– one can walk, cycle or drive.

The key Urban design principles that have informed the spatial framework and design codes include creating a **sense of place, diversity** of densities and tenures and "developing financial viability and market appeal," (Barton, Grant and Guise, 2003:180).

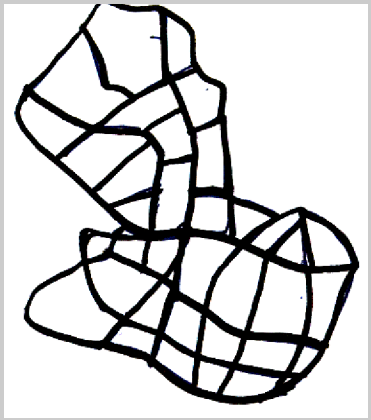


Diagram of Connectivity

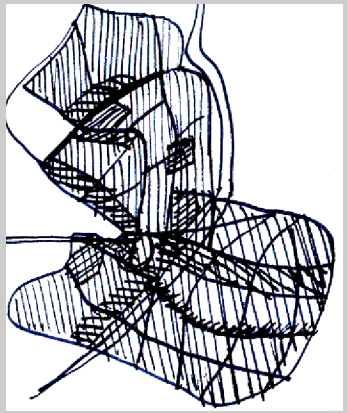


Diagram of Local Autonomy

Latitude: 26° South,		Solar Times	06:00	08:00	10:00	12:00	14:00	16:00	18:00
Longitude: 25,5° East		Clock Times	06:18	08:18	10:18	12:18	14:18	16:18	18:18
Summer Solstice	21-Dec	Azimuth	112E	101E	91E	0	91W	101W	112W
	21-Dec	Altitude	10	35	63	88	63	35	10
Equinox	21 Mar/ Sep	Azimuth	90E	76E	53E	0	53W	76W	90W
	21 Mar/ Sep	Altitude	0	26	51	65	51	26	0
Winter Solstice	21-Jun	Azimuth	NONE	55E	34E	0	34W	55W	NONE
	21-Jun	Altitude	NONE	14	32	40	32	14	NONE

Figure 40: Johannesburg Solar Details
After Napier (2001: 4.10)

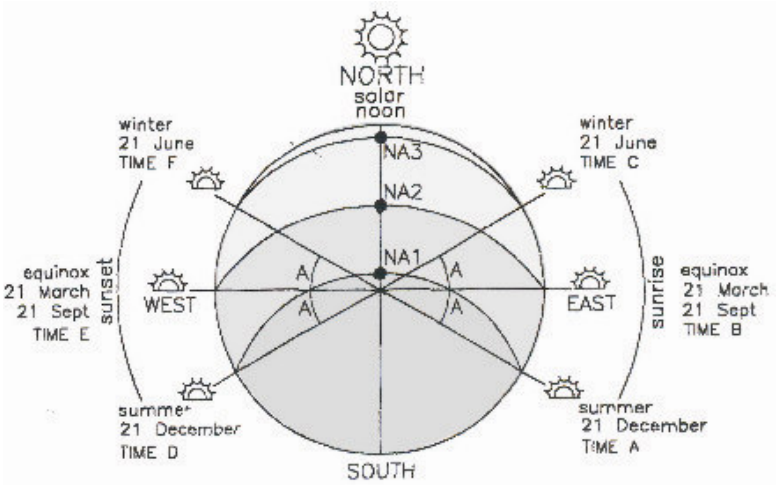


Figure 41: Cardinal Solar Seasonal Times and Angles
(After Napier 2001: 4.7)

How can the street edge of a gated community or a house be designed so that it can adapt as an when the need arises? Can the edge of a development be animated with a variety of adaptations rather than designed spaces that are static and fixed to a particular function? These questions will all be explored in the design intervention to follow.

3.3 Suburban Sustainability on an Architectural Scale

Buchanan describes sustainable architecture in his book entitled "Ten Shades of Green" using ten design principles. These principles have been simplified into two main concerns or topics. These are namely, passive design principles and the efficient selection and management of resources.

Energy in the form of electricity, gas or oil is used within three broad sectors: buildings 50%; transport 25%; industry 25%. The underlying principle of any energy strategy must be to firstly reduce the demand and secondly to provide the energy required from a renewable source thus creating a self sustaining... even self sufficient... system," (Battle and McCarthy, 2001:91). The main aim of passive design is to achieve a low energy- high performance drive which focuses on harnessing the benefits of natural lighting and ventilation whist striving to create and maintain redefined comfortable standards, (2005:39). According to Olgay, "the comfort zone can be described as the point at which man can spend the minimum energy adjusting to his environment," (Energy Research Group, 1999:26). Thus, it can be seen as a strategy to reduce non-renewable energy-use and can consequently decrease the running costs of a home substantially.

Congruently, "the reduction of energy consumption in the running of buildings is the most important factor in sustainability, as it can have secondary effects of reducing carbon dioxide emissions, which cause global warming and climate change," (Energy Research Group, 1999: 4).

3.3.1 Passive Design Principles

People spend 80-90% of their lives inside buildings. Thus, conditions inside a building can clearly affect not only the comfort but also the health of the occupants and users, (Energy Research Group, 1999:36). Battle and McCarthy maintain that the human body is extremely sensitive to variations in light, heat, sound, touch and airborne smells, but perception varies dramatically from person to person, (2001:35). Thus, "Comfort is subjective and depends on age, gender, culture and who's paying the bill," (Energy Research Group, 1999:26).

In practice, designers aim to provide conditions that are acceptable to the majority of uses. It is common practice to design accepted fixed design temperatures, but research has shown that people are not passive in relation to their thermal environment. This is as they will seek out comfortable conditions (this includes shade, sun and shelter) and or change their position activity and clothing to make themselves more comfortable. Thus, spaces should be designed with an allowance for adaptation of both the building and its users. The two main comforts that can be focused on in passive design are Thermal and Visual comfort, (Energy Research Group, 1999: 26-28).

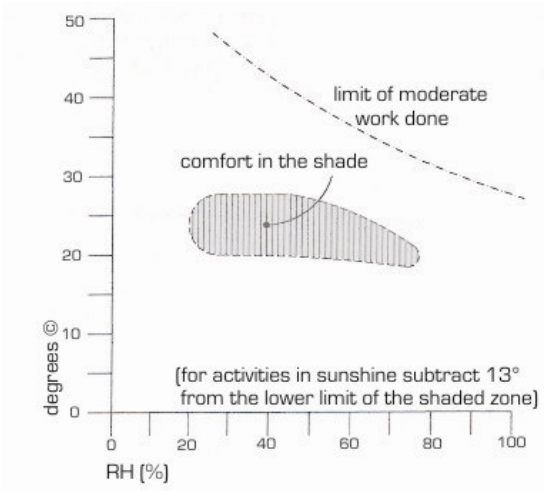


Figure 42: Comfort Zones: Balance of Temperatures and Relative Humidity
(After Napier 2001: 2.4)

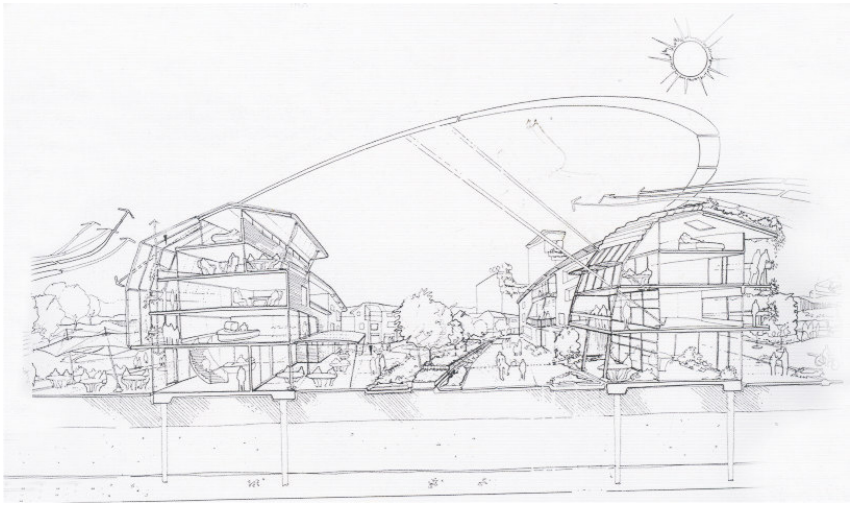
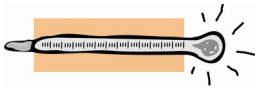


Figure 43: Solar Utilization
(Battle and McCarthy, 2001: 123)

Climate plays an important role in deciding which passive design strategies should be implemented within a building. Johannesburg enjoys a dry, sunny climate, with the exception of occasional late afternoon downpours in the summer months of October to April. Temperatures in Johannesburg are usually fairly mild thanks to the city's high altitude, with the average maximum daytime temperature in January of 26 °C which drops to an average maximum of 16 °C in June. Winter is the sunniest time of the year, with cool days and cold nights. The temperature occasionally drops to below freezing at night which causes frost. Very cold southerly winds with clear skies are caused by the regular cold fronts that pass over Johannesburg in winter. The annual average rainfall is 713 millimetres, which is mostly concentrated in the summer months. However, infrequent showers can occur through the course of the winter months, (www.wikipedia.org, cited 26 June 2008).



Thermal comfort can be defined as a sense of well-being with respect to temperature, (Energy Research Group, 1999:26). Passive cooling can be achieved in a number of ways. The most efficient way of protecting the building from unwanted radiant heat- caused by direct sunlight exposure- is to shade its windows and other apertures. The degree and type of shading required is dependent on the position of the sun and the geometry of the building, thus it is useful if the shading devices used are adjustable, (Energy Research Group, 1999: 3). In addition to this, various natural ventilation design strategies can be implemented in both plan and section of the building design.

Following this, the stack effect is a passive design strategy that relies on the fact that warmer air is less dense than cooler air, (Energy Research Group, 1999: 4). Thus, exterior cooler air enters into the building through lower openings whilst the hotter interior air escapes from higher outlets.

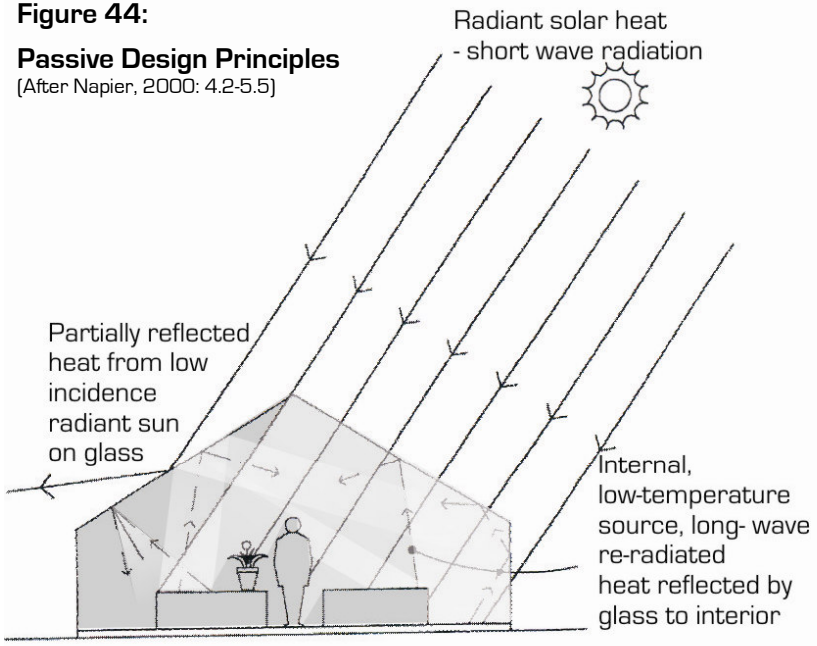
Additionally, the double skin is another ventilation strategy but it is most effective in cold temperate climates. It uses solar energy in winter to act as a thermal buffer between the interior and exterior which reduces space heating requirements whilst offering effective solar penetration and acoustic insulation. This warm blanket of air can be used to preheat a fresh supply of air, thus saving energy expenditure and the resultant emissions. In summer the double skin can be opened to allow natural ventilation, (Gissen, 2002:42).

Another form of a double skin is the Trombe wall which involves using a high thermal mass skin (such as concrete) to maximize solar energy absorption, (Gissen, 2002:43). Other strategies include using the Earth's natural geothermal temperatures to naturally cool or heat air by burying pipes or constructing concrete, notched labyrinths which draw air through underground corridors to preheat or precool air, (Gissen, 2002:43). Additionally, evapourative cooling can be used to significantly reduce air temperature at the cost of a slight rise in humidity. Cross ventilation is another method of naturally ventilating a space and often makes evapourative cooling a successful intervention, (Gissen, 2002:42).

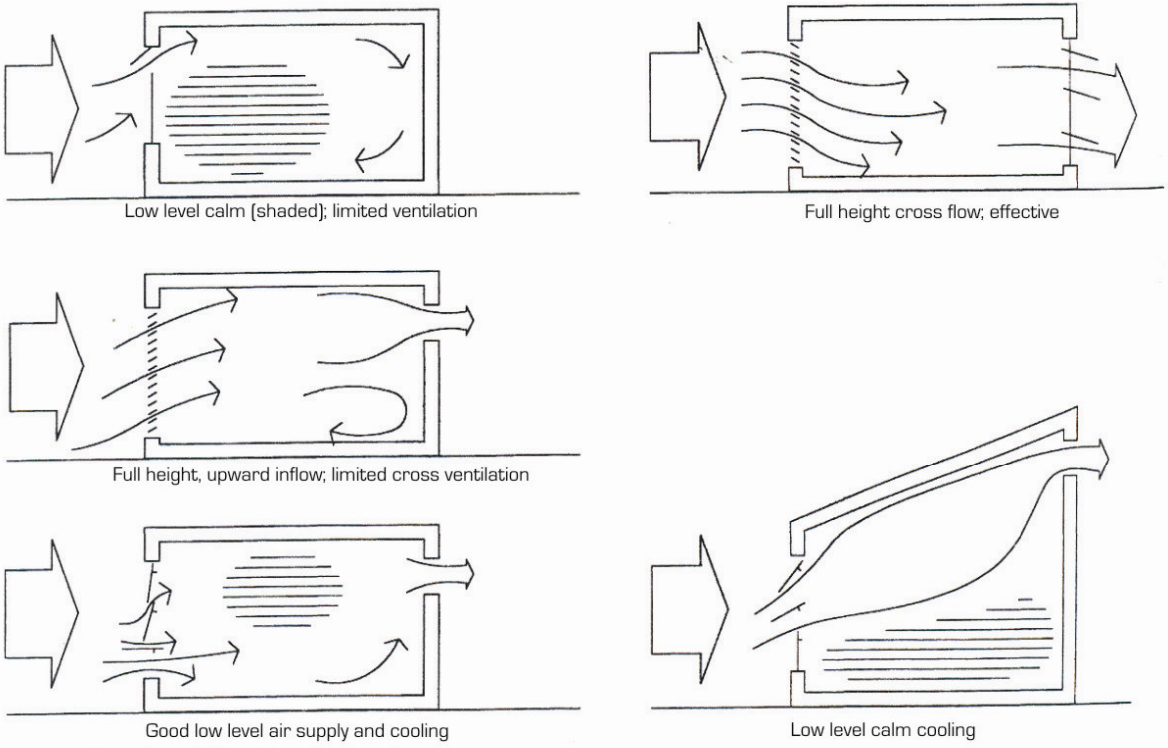
Additionally, the increase of internal temperatures can be reduced by using efficient appliances and lighting which can minimize the internal heat gain. Passive heating during the cooler evenings can be achieved through specifying materials

Figure 44:

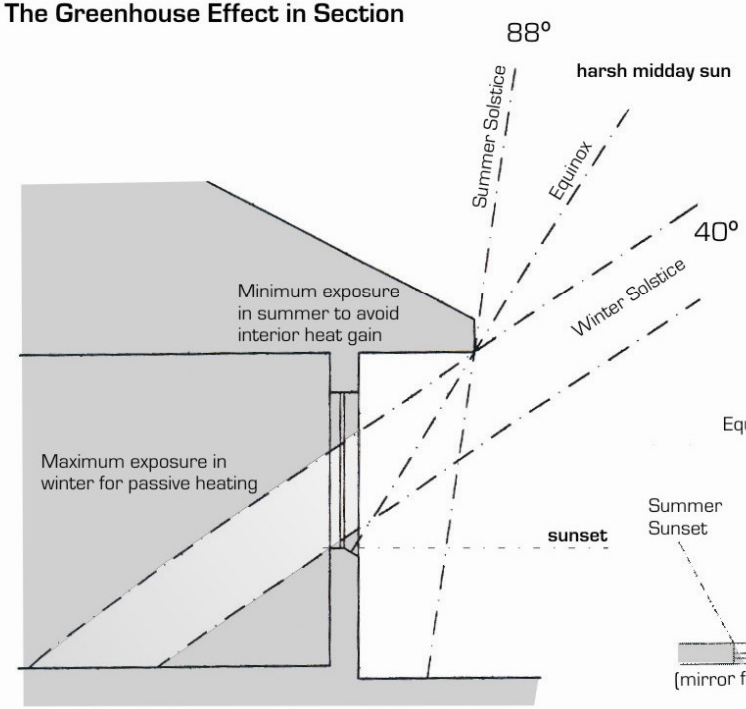
Passive Design Principles
(After Napier, 2000: 4.2-5.5)



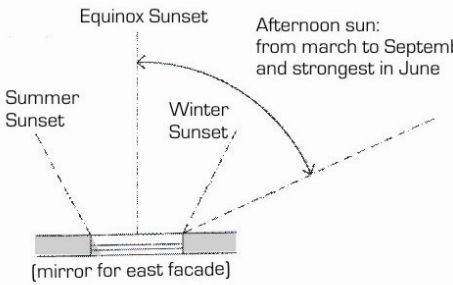
The Greenhouse Effect in Section



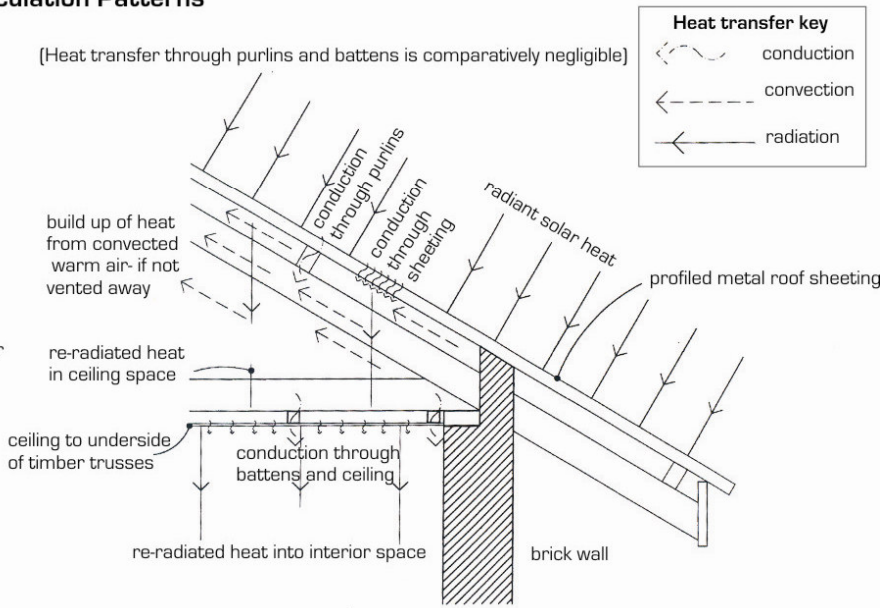
Cross Sectional Air Circulation Patterns



Northern Facade Sun to be Controlled in Section



West Facade Sun to be Controlled in Plan



Heat Transmission through conventional metal sheeting roof without insulation

that have a high heat storage capacity, or thermal mass, on the northern and western sides of the building. This is as these materials tend to absorb and release solar radiant heat and relatively slowly, (Energy Research Group, 1999: 3).

Passive heating and cooling strategies have many advantages however, the acoustic quality of a space may be affected by noise discomfort of external, internal and building service sources which may conflict with natural ventilation requirements. Nevertheless, it is important to ensure adequate air change rates, efficient air distribution and control of interior pollution in order to maintain an acceptable indoor air quality. This is so one can avoid stuffiness and unpleasant odours and ensure user comfort, (Energy Research Group, 1999:29).



Visual comfort refers to one's ability to see well as well as one's scope of sight. The source of light in a space may be natural, or artificial or a combination of both. Comfortable lighting conditions in a space are dependent on quantity, distribution and quality of light. The quantity of light needed in a space is determined by the activities of a space. Distribution of light in a space is often more important than quantity. This is as the perception of brightness is influenced by the evenness of lighting levels. The quality of light refers to direction, colour and variation over time. Daylighting provides excellent quality in terms of direction and both colour appearance and colour rendering, thus people enjoy daylight and sun light and the views that come with them, (Energy Research Group, 1999:28).
Buchanan's nineth principle motivates that the building should provide a healthy, naturally lit and ventilated environment. He claims that this in turn can increase the productivity of its occupants and can cultivate a sense of community, (2005:39). This is as the provision of natural daylight in the interiors of buildings to reduce or eliminate daytime use of electric lights can offer substantial energy savings and consequent environmental damages whilst generating healthier, more productive and more pleasant living conditions, (Energy Research Group, 1999:3). Strategies to bring sunlight into a space include using atria, light shelves, roof monitors and clerestory lighting, (Energy Research Group, 1999:3). Passive lighting can also be achieved through installing daylighting products which are currently available on the market, for example, the solatube.

"We need to go further than simply reducing energy consumption and emissions. For some time, the environmental community has promoted the three R's: Reduce, Recycle and Reuse," (Gissen, 2002:43).This statement brings one to the topic of resource management.

3.3.2 Resource Management

Resource management involves the careful **selection and assemblage of building materials** as well as a **systematic approach** which involves the effective co-ordination of various management systems of waste, water and energy consumption.



Building Materials: In a conventional building, the amount of energy consumed in use (and its source) is the fundamental consideration from an environmental point of view. However, this situation is changing as buildings become more energy-efficient (Energy Research Group, 1999: 40). This is as from non- sustainably managed materials to energy intensive extraction and manufacturing processes "materials have widely varying environmental impacts" (Energy Research Group, 1999:4).
Contrary to current common practise, building materials should not only be selected based on their aesthetic attributes and their cost. Environmentally-responsible specification of building materials and components includes the consideration of other extrinsic and intrinsic requirements during the specification process, (Energy Research Group, 1999: 40). These requirements include whether they are appropriate to the climate and can provide the climatic response required; whether they are of local origin; whether they carry a low embodied energy and small carbon-footprint; whether they utilise local skills for construction or assemblage; whether they can be recycled and whether they are structurally appropriate for the task at hand, (Battle and McCarthy, 2001: 95).

Congruently, Buchanan's maintains that the life cycles of building materials and the embodied energies they carry, as well as the building's total life cycle cost:

Lynedoch Ecovillage

Figure 45: Ecobond Double Storey Brick House at Lynedoch. Some of the houses have been constructed out of adobe brick which are 300mm wide clay and straw sundried bricks. Thus the houses have a considerably low embodied energy and carbon footprint. (Annecke and Swilling, unpublished: 11). This double story house was constructed out of Ecobond bricks. Ecobond is a strengthening agent that– that when mixed with local soil and compressed– can produce high-strength, durable roads, bricks and slabs. It is non-toxic, low cost and inherently carries a low embodied energy. It is socially sustainable as it encourages labour intensive construction programs. (www.ecobond.co.za, cited September 2008).



from construction, running, maintenance and demolition costs; to the costs to the environment and society are important factors to consider, (2005:39).

For example, the environmental impact of the transport involved is enormously different when deciding between a brick manufactured 10km or 1000km away, (Energy Research Group, 1999: 4). From this, it is suggested that the use of local materials can substantially reduces the embodied energy of a building's materials which thus reduces the negative impact that the building has (directly or indirectly) on the environment. However, a material produced within the region of the site may be produced less energy efficiently than one produced further away.

On the other hand, a material carrying a high embodied energy may still be specified as its other extrinsic properties can cause an equal or higher saving in energy consumption over a few years of use. Thus, it is important to consider all the characteristics of a material in order to make an informed design decision as the choice of materials and components of a building can play an important role in determining the energy performance of a building. (Energy Research Group, 1999: 40).

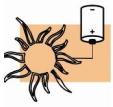
Systematic Approach

Systems and programmes such as waste production management, and regulating of consumption of natural resources, which includes fossil fuels and water; as well as the consideration of vegetation and its soil are as important as reducing the building energy consumption, (Energy Research Group, 1999:4).



Waste Management: Buchanan suggests that buildings should strive to "consist of permanent yet flexible, multipurpose spaces and recyclable materials and energies where possible whilst decreasing the amount of pollution it generates," (2005:39).

Following this, "household and commercial refuse, street litter, construction debris, industrial process and other wastes together with sewage sludge present environmental problems," (Energy Research Group, 1999: 41). A change in the user's mindset towards household waste is required. This is as not all household waste is waste but has the potential to be a resource as well. The EU Waste Management Strategy lists a four stranded waste management system: reduce waste at the source; sort wastes, re-use or recycle and finally dispose of waste safely if it can no longer serve a purpose, (Energy Research Group, 1999: 41). Furthermore, Buchanan maintains that buildings should make use of renewable resources in place of exhaustible ones, (2005:39).



Renewable Resources: There are many alternative renewable energy products on the market today that make use of the sun's radient heat and solar rays. Each hour the earth receives more energy than the world can use in a full year. Out of this abundance of incoming energy, South Africa has one of the highest levels of solar radiation in the world. The solar radiation of South Africa ranges from around 1450 kWh/m2 to about 1950 kWh/m2 per year, compared to Europe which on average is 910kWh/m2 per year. In March this year the Department of Minerals and Energy told Parliament's Portfolio Committee on Minerals and Energy that by 2010 all electric geysers will have to incorporate solar heating in all new houses valued at over R750 000, or larger than 300 square metres. This would also apply to commercial buildings, hostels, resorts and shopping centers, (www.pdcsolar.co.za, cited 18 September 2008).

This is as conventional geysers use the greatest amount of electricity in a home while solar geysers use the free radiant heat of the sun to heat water. Thus solar geysers can save a considerable amount of electricity during their life time and consequently reduce both carbon emissions and running costs of the building, (www.pdcsolar.co.za, cited 18 September 2008).

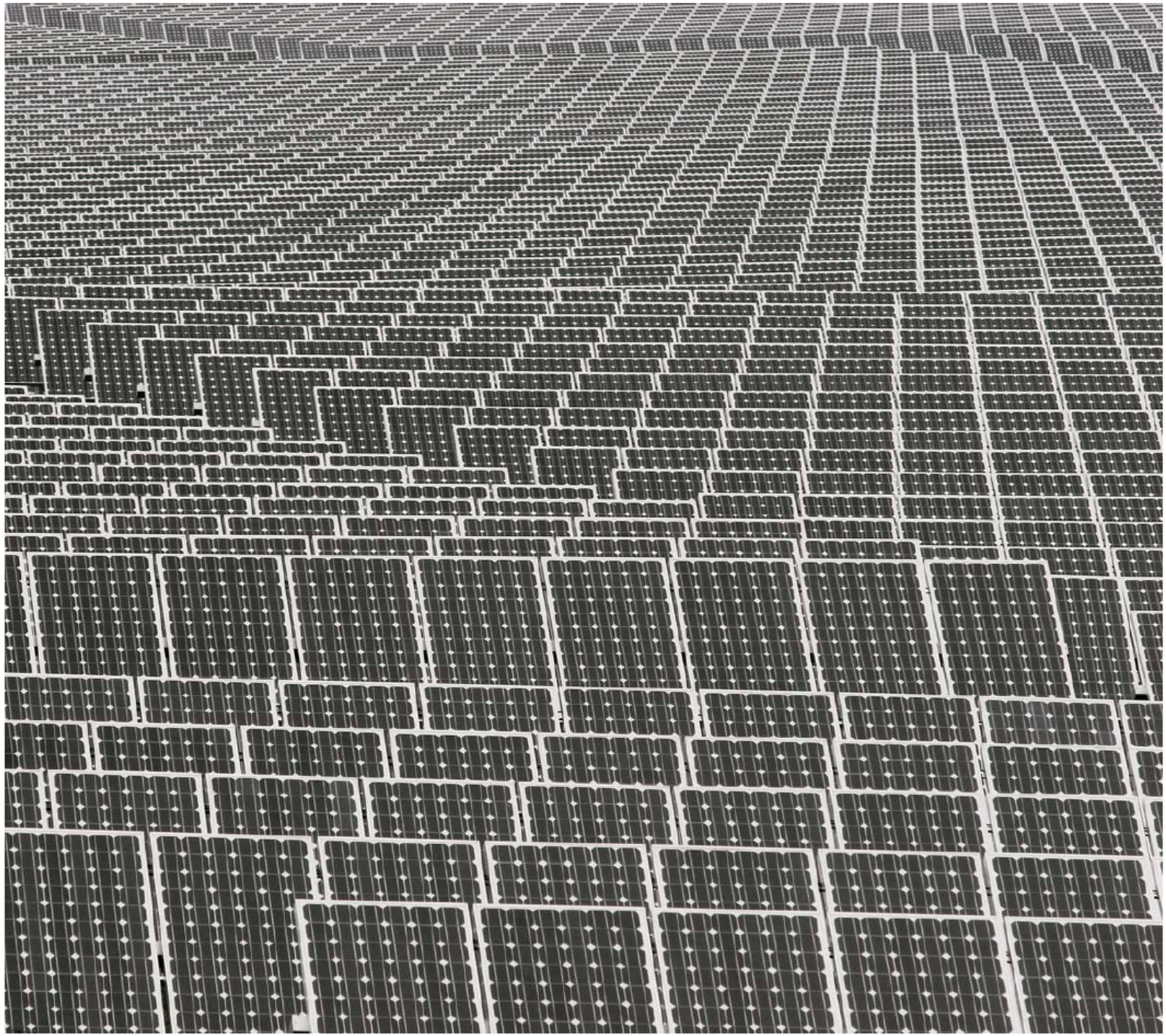
Additionally, solar energy can be used to generate electricity through the use of photovoltaic technology. In the past, economies of scale have been a problem as many photovoltaic cells or panels are required to produce an effective amount of electricity, (www.abc.net.au, cited 18 September 2008). However, companies like Real Energy, in California, have overcome this through renting the roofs of suburban buildings from the owners to generate cleaner electricity. They achieve this by installing their own photovoltaic system on the roofs which convert solar energy into usable electricity which then is fed make onto the national grid, (www.abc.net.au, cited 18 September 2008).

Furthermore, wind turbines can be used to convert the wind's kinetic energy into electricity. However, in 1998, Norway commissioned a study of wind power in Denmark and concluded that it has "serious environmental effects, insufficient production, and high production costs," (www.aweo.org, cited 18 September 2008).



Vegetation: "We need to create a new kind of architecture that actively treats its waste products and cleans the air of our cities," (Gissen, 2002:43). Thus, plants can scrub the air of pollutants and carbon dioxide whilst producing revitalizing oxygen. Along with the benefits of air treatment, deciduous creepers can provide a seasonal advantage over artificial shading (in passive design) as they shed their leaves in winter- allowing maximum solar heat gain whilst protecting the building from excessive solar heat gain in summer through their dense foliage. Plants also reduce noise pollution, acoustic reverberation and can play a part in insulating a building in winter, (Gissen, 2002:44). The fostering of indigenous flora and fauna and topsoil can conserve and cultivate environmental diversity and provide natural outdoor shelter from noise, wind and the sun, (Energy Research Group, 1999:5). Thus, providing green outdoor living spaces can greatly improve quality of living. One's carbon footprint can be reduced substantially by eating foods that are produced locally, (www.carbonfootprint.com, cited 18 September, 2008).

Figure 46: An 11 Megawatt Photovoltaic Power Plant
The problem of economies of scale. (www.blog.thesietch.org, cited 18 September 2008)



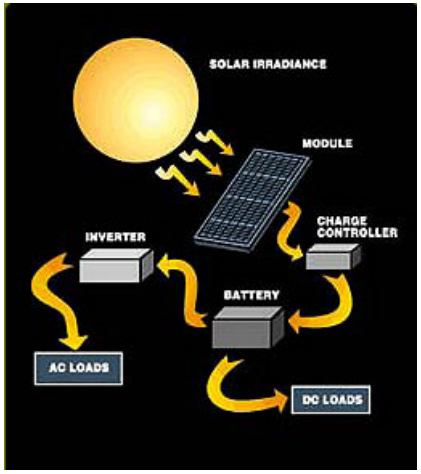


Figure 47: How Photovoltaic Fuel Cell Technology Works
Solar radiant heat gets absorbed by a module which then gets transferred into a charge and stored in a battery. From there, DC current is available. However, an inverter is required to obtain AC current. (www.gammasolar.com, cited 18 September 2008)

Water Conservation: Large or small scale rainwater harvesting systems can also assist in reducing the amount of runoff while saving precious potable water. This can be achieved through the implementation of a dual water supply system where harvested rainwater and recycled grey water can substitute the municipally-supplied potable water in the flushing of toilets (saving up to 40% in potable water consumption) and irrigating gardens (which could save up to 60% in potable water consumption in higher income households), (Annecke and Swilling, unpublished: 8). In housing, much water is consumed by appliances that are generally not specified by the architect. However in all building types, the architect can specify dual flushing water closet cisterns, treatment and reuse of grey water on site as well as harvesting, storage and treatment of rainwater on site, (Energy Research Group, 1999:5).

Achieve Higher Density: Row Housing as a sustainable typology

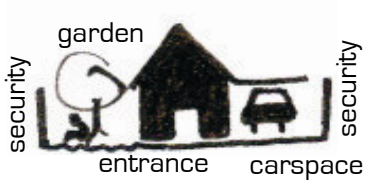
Row housing is a housing typology concerned with " individual houses [that] can be joined on two or three sides, thereby creating dense developments suitable for sustainable housing structures," (Brauneck and Pfeifer, 2008:7).The row house typology does not necessarily have an immediate positive connotation. One generally thinks of worker's cottages from the beginning of Industrialisation which served more to increase the profits of the enterprise than to fulfil the needs of the occupants, at least viewed from today's perspective, (Brauneck and Pfeifer, 2008:16).

The strength of the row house as a housing typology lies in its economical design which involves the joining of units and consequent sharing of walls. This leads "to a well balanced ratio of living space, surface area and volume, which in turn creates advantageous characteristics in terms of energy efficiency," (Brauneck and Pfeifer, 2008:16).

In conversation with suburban dwellers, most of them live in the suburbs to fulfil their desire to live the American dream that Barry Zwicker describes in his movie entitled, "The End of Suburbia." This dream, mentioned previously, is illustrated briefly below.

High priority in Johannesburg: **security**

Own **private**: garden, entrance and carspace.

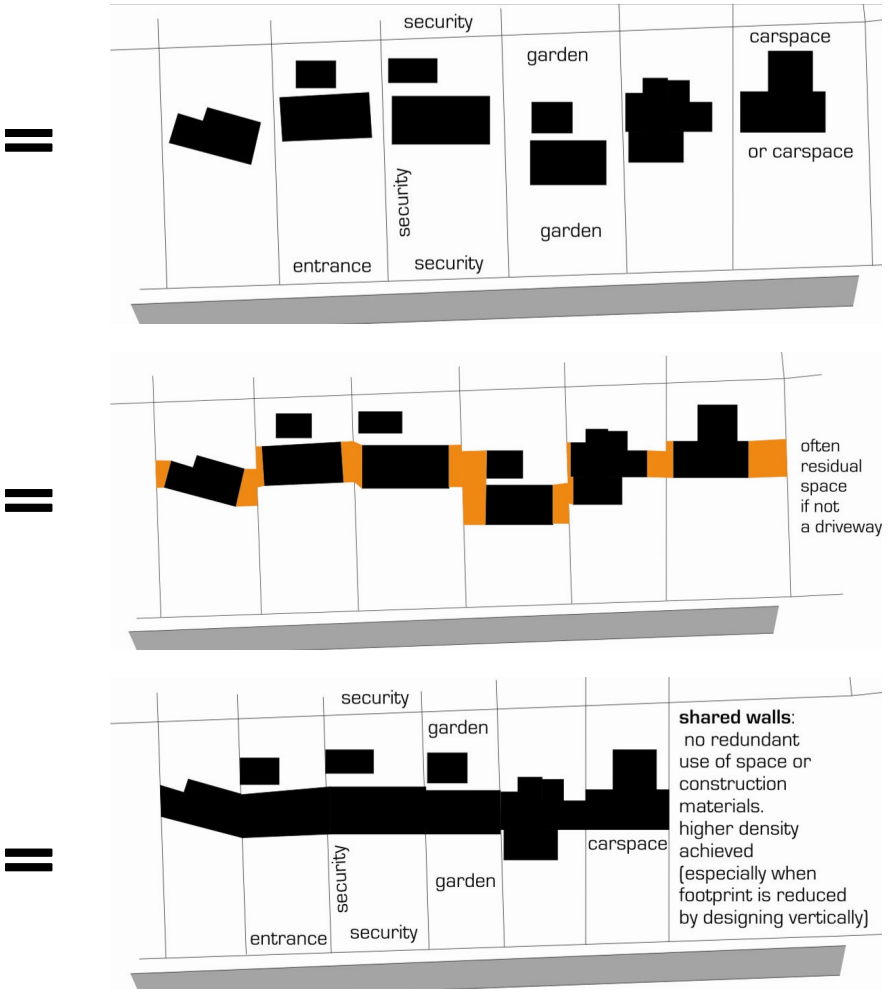


So... how can the suburban dream become more sustainable? Can it?

One of the fundamental unsustainable characteristics of the suburb is the fact that it is low density sprawl. It can be suggested that the American dream of freestanding villas placed in manicured rolling gardens could be the chief instigator of this.

Figure 48: Typical Suburban Freestanding Houses that represents the American dream.
In Johannesburg's suburbs.
(After Google Earth 2008)





However, is one suggesting that people may no longer enjoy the suburban lifestyles that they have grown accustomed t or strive for? Not at all.

It suggested that all of the above mentioned 'dream requirements' can be met more efficiently through implementing the row house typology within a suburban development scheme, whilst simultaneously achieving a higher density and passive design principles. Thus, making the suburbs more environmentally and socially sustainable, by decreasing sprawl; decreasing the need to commute far; decreasing carbon emissions and the loss of green field sites. (please see graphic explaining this suggestion below).

Further more it can be suggested that by increasing the number of shared walls in a housing development, one can decrease the amount of construction materials used, thereby decreasing the overall embodied energy and carbon footprint of the development. Thus, making suburban development even more environmentally and economically sustainable.

Borneo Sporenburg: The higher density housing development demonstrates that family housing is not incompatible with dense urban areas, (www.cabe.org.uk, cited 19 September 2008).

The project, run by West 8, consists of 2500 low-rise dwelling units, with a density of 100 units per hectare, that are set on the two peninsulas of Borneo and Sporenburg in the eastern part of the Amsterdam docks, The Borneo Sporenburg plan divides the low-rise buildings into three zones with architecturally distinctive high-rise residential buildings creating significant landmarks within the harbour landscape, (www.cabe.org.uk, cited 19 September 2008).

"For a new interpretation of the traditional Dutch canal house, West 8 suggested new types of three-storey, ground-accessed houses deviating from the usual terraced house in being strongly oriented to the private realm by incorporating patios and roof gardens. By repeating this type in a great variety of dwelling modes and with maximum architectural variation, an animated street elevation emerges with a focus on the individual. At a larger scale, a delicately balanced relationship exists between the repetition of the individual dwellings, the roofscape and the great scale of the docks", (www.west8.nl, cited 19 September 2008).



Figure 49: View of units from waterfront
(www.west8.nl, cited 19 September 2008).

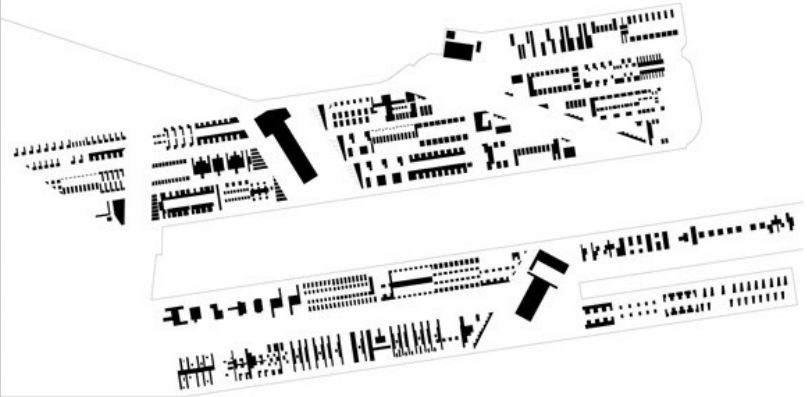


Figure 50: Figure ground study of the development
(www.west8.nl, cited 19 September 2008).

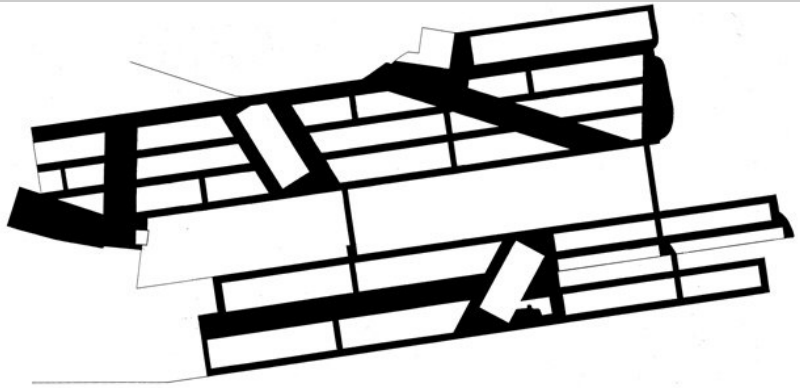


Figure 51: Closer View of Row Housing Strips
(www.west8.nl, cited 19 September 2008).

In brief, the project "reverses the predominant social trend towards a dense urban core inhabited by childless couples, singles and the extremes of high and low income, and a low density suburban fringe occupied by middle-class families," (www.cabe.org.uk, cited 19 September 2008).



Figure 52: Aerial photo of Borneo Sporenburg
(www.west8.nl, cited 19 September 2008).

For the purposes of this thesis, three row house types were analyzed to see which type would best suit the objectives that this thesis endeavors to obtain. The three types differ in the placement of the internal circulation which affects the overall planning of each unit. This thesis is greatly concerned with trying to design for maximum daylighting for all living and sleeping spaces whilst implementing passive thermal control principles.

Precedent One

Longitudinal Staircase

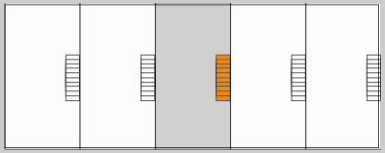
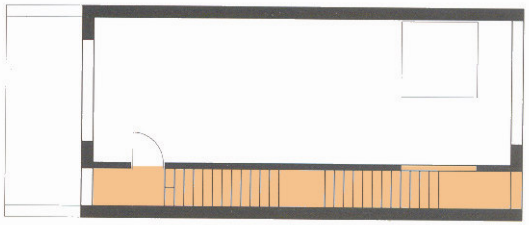
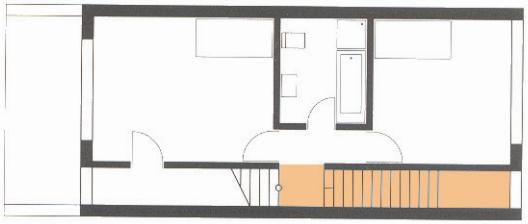


Figure 53: Voltstraat Row Housing in Tilburg was designed by Rijnvos Voorwinde (completed in 1996).

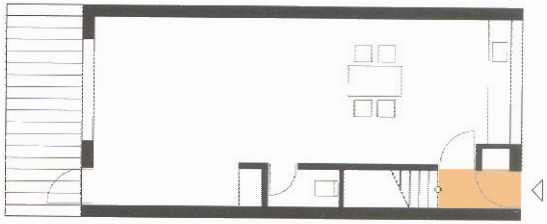
(after Brauneck and Pfeifer, 2008: 20).



Second Floor



First Floor



Ground Floor

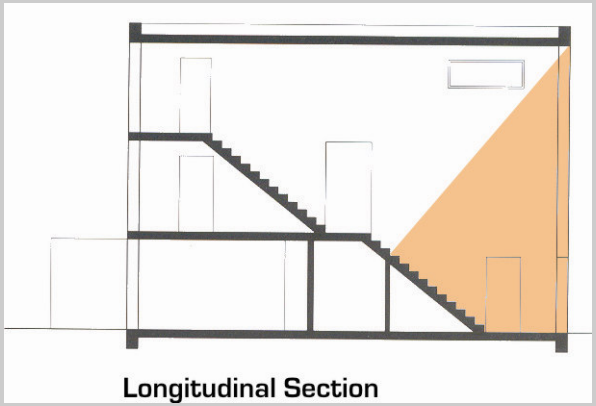
N

(after Brauneck and Pfeifer, 2008: 40).

This is a three storey unit with an east–west orientation. The longitudinal staircase is the most common form of arrangement due to the fact that the row house is often deeper than it is wide. Depending on the width of the floor plan, the staircase is located either along the party wall or between room axes," (Brauneck and Pfeifer, 2008: 20).

The long single flight staircase is orientated to be an attractive feature of the house whilst separating the main internal circulation from the rest of the house. "This element allows for a generously sized continuous living space on the ground floor free of any circulation zones," (Brauneck and Pfeifer, 2008: 40).

The disadvantage of this circulation system is that if one wanted two bedrooms on the second floor, one would need to include a long hallway, (Brauneck and Pfeifer, 2008: 40).

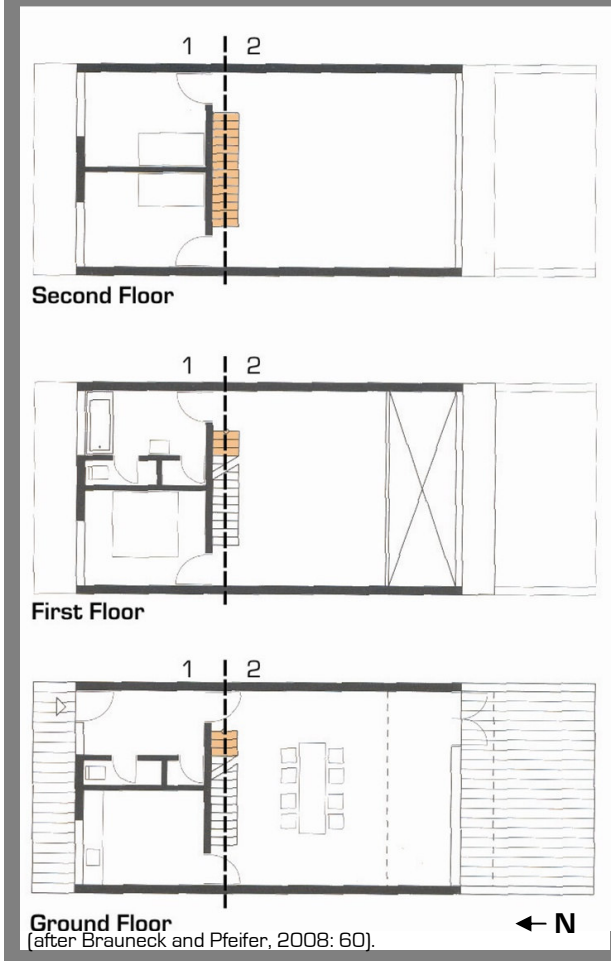


Longitudinal Section

The orientation of the house doesn't allow maximum northern light (or in this case southern) exposure to all living spaces.

However, even if the unit was orientated North-South half the light would be wasted on the circulation strip and the rooms at the southern end would be cold and not as well lit (as demonstrated in the section.)

(after Brauneck and Pfeifer, 2008: 40).



(after Brauneck and Pfeifer, 2008: 60).

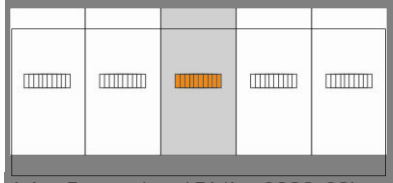
Precedent Two

Transversal Staircase

Figure 54: Betzenberg Park Row Housing in Kaiserslautern was designed by AV1 (completed in 2000).

This is a three storey unit with an north-south orientation. The transversal staircase divides the unit into two zones with the kitchen and bathrooms on the north and the entrance and living spaces on the south.

The width of the unit is variable however the staircase dictates the minimum width possible. Brauneck and Pfeiffer maintain that this "house type is highly modifiable as it can be a two storey, three bedroom unit or a three storey unit with additional rooms or a roof terrace.,



(after Brauneck and Pfeifer, 2008: 20).

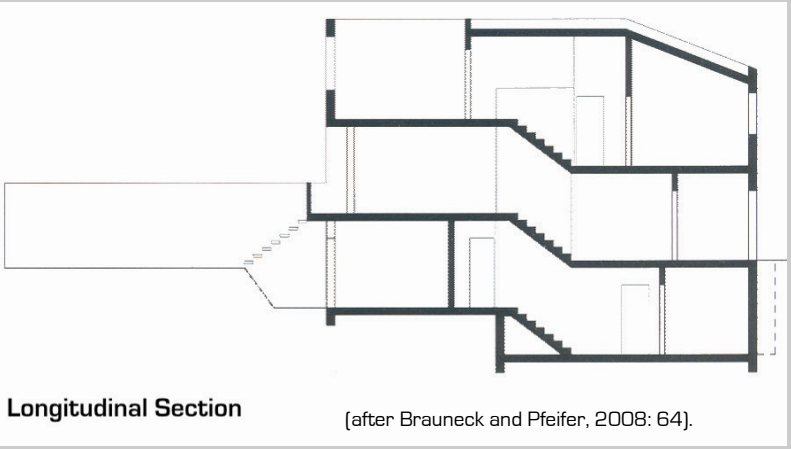
Precedent Three

Longitudinal Split Level Staircase

Figure 55: Kirchholzle Park Row Housing in Schopfheim was designed by Gunter Pfeifer (completed in 1990).

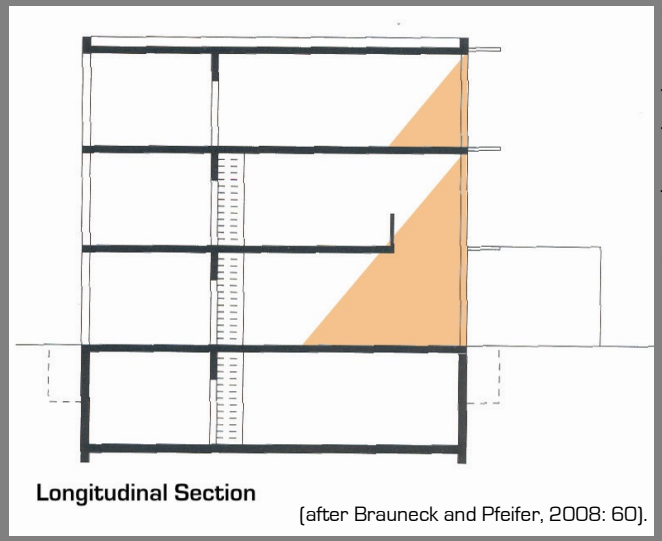
This is a three storey unit with an east–west orientation. The longitudinal split level staircase facilitates a shift in levels in the longitudinal direction of the house which "creates a dynamic spatial atmosphere," (Brauneck and Pfeifer, 2008: 20).

This split-level unit type is characterized by "its intelligent embedding into the topography," (Brauneck and Pfeifer, 2008: 64).



(after Brauneck and Pfeifer, 2008: 64).

Longitudinal section showing spatial flows and the dynamic shift in the vertical (after Brauneck and Pfeifer, 2008: 64).



(after Brauneck and Pfeifer, 2008: 60).

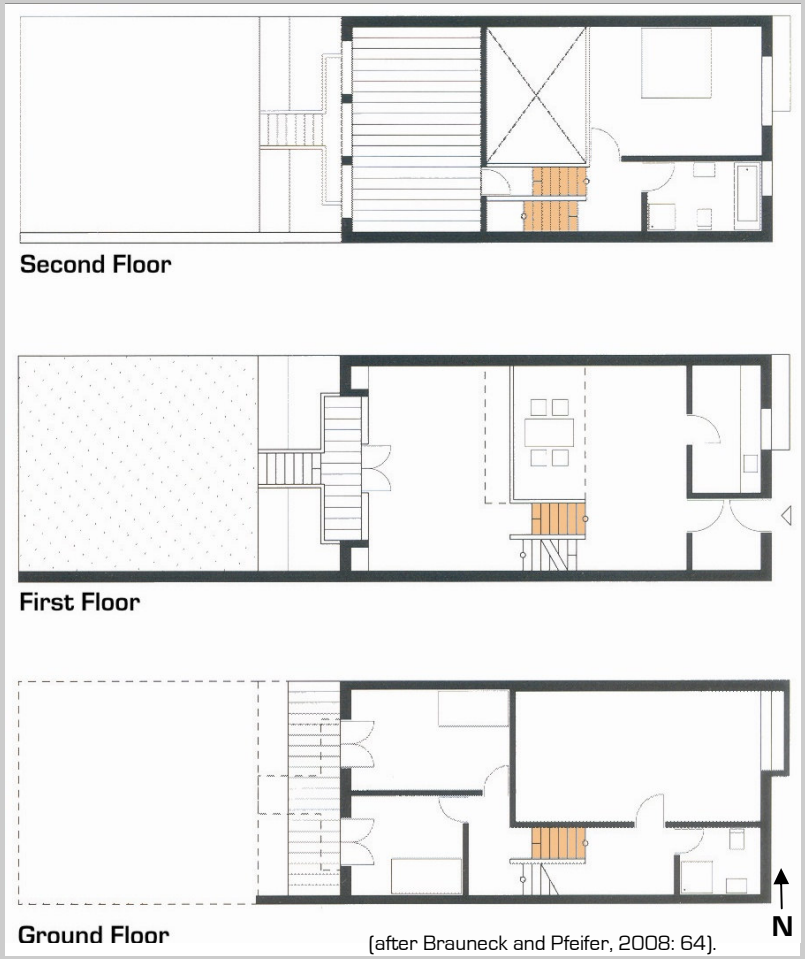
(2008:60).

This type of row house can function as a single sided unit that is orientated towards the north and can have a smaller house depth, (Brauneck and Pfeifer, 2008: 20).

In this type it is possible for the position of the staircase to define the proportions of the individual levels of the unit while voids between the offsets can create both visual connections and offer daylighting to the centre sections of the floor plan, (Brauneck and Pfeifer, 2008: 20).

In this particular case, a void provides daylighting and ventilation from the roof terrace down into the living space which gives the internal spaces a larger feeling . Additionally, the bedroom on the upper floor is well lit as well, (Brauneck and Pfeifer, 2008: 64).

To conclude, it can be suggested that precedent two and three present more opportunities for daylighting and natural ventilation due to the transverse split of the unit that is caused by the location of the stair . Precedent 2 has the ability to grow over time. Thus, it will play a significant inspirational role in the planning of the housing units in this thesis.



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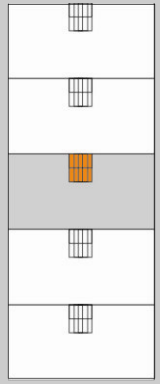


(after Brauneck and Pfeifer, 2008: 20).

Beddington Zero Energy development (BedZED)

Beddington Zero Energy Development (BedZED) is the main precedent of this thesis as it reflects most of the principles that have been explored.

Design by: Bill Dunster Architects in collaboration with ARUP & Partners and Glen Carter of (co- developers BioRegional Development Group) from 1998.

Client: The Peabody Trust which is London's largest and longest established housing association, (BRESCU, 2002: 33).

Location: On the Hackbridge/ Beddington Border in London Borough of Sutton

Brief Introduction:

BedZED is Britain's first urban carbon-neutral development which has proven the zero-carbon target for all new buildings to be feasible. It explored the possibilities of "neighbourhood renewal" on a Brownfield site that was once a sewage works, (BRECSU, 2002: 23 and 26).

The aim of the project was to "encourage the kind of holistic strategies essential if architects, developers and planners are to: reconcile higher-density living with an improved quality of life; protect agricultural and green belt land from urban development; reduce the global environmental impact of urban regeneration in the United Kingdom; support local economies and communities and source good materials and energy within the local bioregion," (BRESCU, 2002:3).

It is a mixed-use, holistic, sustainable urban development that consists of sustainable architecture and systems which have proven to be no more expensive than conventional architectural design, (BRECSU, 2002: 28). It provides housing; business and employment opportunities as well as educational value whilst reducing waste pollution and implementing more energy efficient transportation systems, (BRECSU, 2002: 7). The developer's main objective was to "enable people to live sustainably without sacrificing a modern, urban and mobile lifestyle," (BRECSU, 2002: 3). They focussed on environmental, social and economic issues whilst simultaneously meeting a target to decrease carbon dioxide emissions from energy consumption, (BRECSU, 2002: 3).

Sustainable Principles and Strategies Used:

The site acts like a mini neighbourhood and includes 120 workspaces per hectare and over 4000 square metres of green open space per hectare. The units were planned so that no building would steal sunlight from its neighbour and the planning of the units was informed by the orientation of the sun, thus (being in the Northern Hemisphere) the dwellings were in the southern face whilst the workspaces enjoyed the northern light. Additionally the workspaces have long skylights which provide adequate daylighting into the interior which reduces the need for daylighting, (BRESCU, 2002: 12).

They achieved a density of 50 dwellings per hectare but the design allows for a density of 80 units per ha, (BRESCU, 2002: 9).

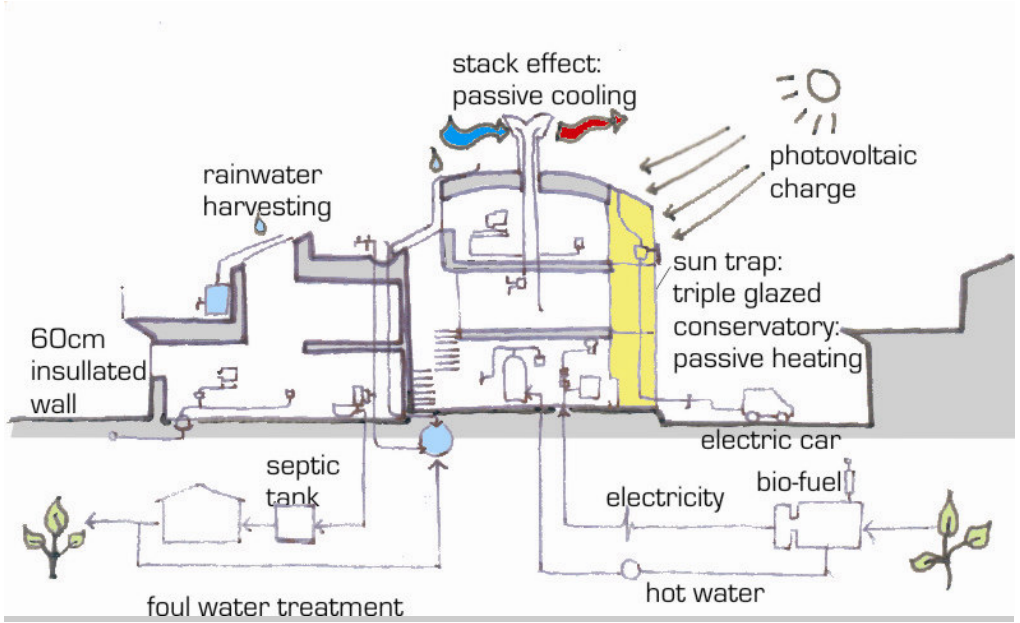


Figure 56: Typical section through BedZed row house
(After www.sd-commission.org.uk, cited March 2008)

All the roofs, walls and floors are heavily insulated and the stack effect is achieved by the specially designed rooftop wind cowls which use the wind to draw warm stale air up from the interior and direct fresh air downwards over a passive heat exchanger, (BRESCU, 2002: 12).

Additionally, the concrete ceilings, walls and tiled floors act as thermal mass passive heaters which provide enough heat storage to prevent overheating in summer and store warmth in winter while releasing heat slowly during overcast days. The windows are triple-glazed with low emissivity glass and are well sealed. Each unit has an unheated double glazed sun space which has windows that can be opened out in summer to form open-air balconies, (BRESCU, 2002: 12).

They used locally sourced materials which meant that the local community benefited from the development financially.

Local Autonomy

The provision of workspaces and local employment within the neighbourhood reduces the need to travel by providing opportunities to live and work on site, (BRESCU, 2002: 15).

Stakeholder Involvement

It has made plans to install information and communication technology (ICT) to all workspaces and homes.

Connectivity

The neighbourhood enjoys walk-able distances to amenities and the roads have been designed to be well lit and express the pedestrian as the priority with reduced speed limits, dropped kerbs for prams

and wheelchairs and natural surveillance provided by the surrounding houses. All dwellings have been allocated a cycle storage space as the site has an easy access to Sutton's cycle network. The complex is also located on a main road which provides access to public transport networks. Consequently, this development reduces air pollution, increases safety of the roads and decreases the combustion of non-renewable oil-based fuels, (BRESCU, 2002: 16).

Following this, a carpool system has been planned to service the complex where residents, businesses and employees can hire a vehicle by the hour to enjoy extra flexibility without the extra expense of owning a car. However, residents who'd prefer to retain their private car are encouraged to change to an electric vehicle, (BRESCU, 2002: 16).

Provision of parking has been approved by the local council to be less than the required ratio, thus one parking per dwelling has been provided. The parking has been laid with porous block paving over gravel to minimise surface run-off and is not allocated to the dwellings, thus allowing empty space for employees to park during the day and saving on space redundancy, (BRESCU, 2002: 17 and 21). Rainwater can filter through to and return to the groundwater through the parking whilst the runoff of the sky gardens, roads and pavements is drained to the front of the site to form an attenuation dam that serves as a "wildlife-friendly water feature," (BRESCU, 2002: 21).

They reduced the consumption and waste of natural resources by implementing water saving strategies which include rainwater harvesting for the flushing of toilets and irrigation and pre-fitting energy and water efficient appliances into each dwelling. The rain water harvesting tanks are fitted into the foundations of the buildings. Additionally, water-saving dual-flushing toilets have been installed and single bedroom dwellings are fitted with showers rather than baths which in turns save energy, space, cost and water. The kitchens are fitted with highly visible water meters to increase the user's awareness of their water consumption, (BRESCU, 2002: 20).

Additionally, they made use of renewable energies such as biomass for heat and power and photovoltaic cells to charge their electric cars. Furthermore, "wherever possible, BedZED uses natural, recycled or reclaimed materials, products with low embodied energy, and those not associated with habitat destruction, (BRESCU, 2002: 22).

The kitchens have been fitted with a set of containers for different types of waste and multi-material recycling points have been provided on the site. They had biodiversity measures and provided private gardens for most of their gardens, (BRESCU, 2002: 3).

Diversity

They included a mixed tenure of two-thirds affordable housing or social housing. The residents to enjoy lower fuel costs and have included community facilities within the neighbourhood which include a healthy living centre, sports facilities, entertainment and retail, (BRESCU, 2002: 3).



Figure 57: Beddington Zero Energy Housing Development

Response to Place ?

They have included an outdoor recreation community space with a sports field., highlighted in orange. However, the spaces between the buildings seem to have not been considered and do not seem to create a sense of place for the community to enjoy.

Longevity ?

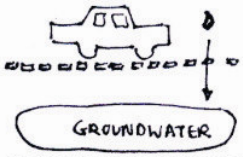
What about the ability to change over time? The adaptability of the buildings is not evident in their design.
(After Google Earth, 2008)



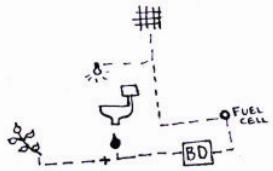
Figure 58: View from above of BedZED Energy Housing Development
They have provided local vegetable growing spaces but it seems they do not have outdoor community gathering or recreational spaces between their buildings. Blame it on the weather?
(Photo by Bill Dunster, www.leonardo-energy.org, cited June 2008)

Summary of Lessons Learnt from Precedents...

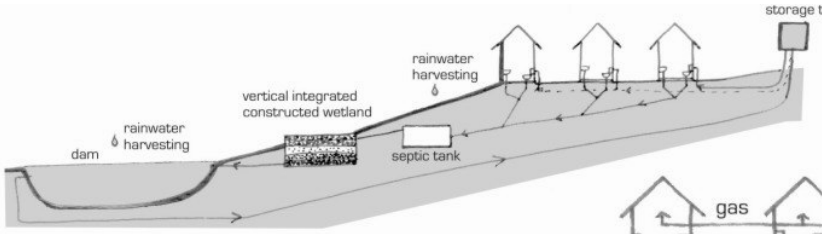
From Lynedoch Ecovillage...



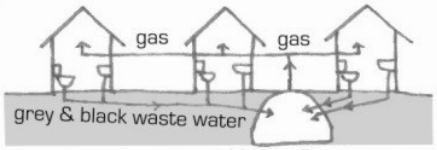
maintaining natural water table



waste = resource

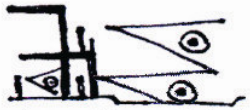


on-site water treatment



on-site waste treatment and energy production

From Melville and Melrose Arch...

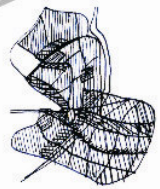


passive surveillance and mixed use edges

From Ashton Green Neighbourhood design...

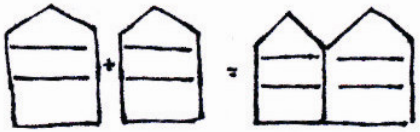


road network offering more direct routes and more options on how to move through the area

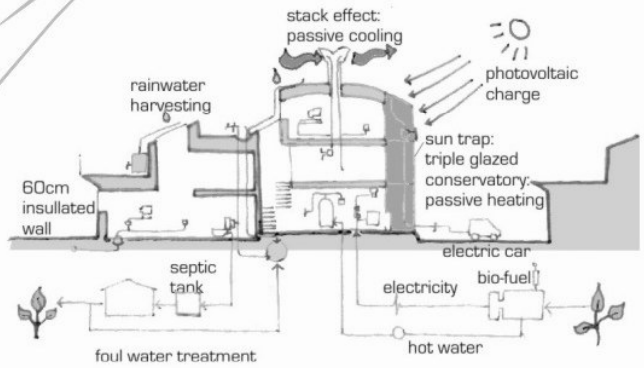


Mixed use neighbourhood - not dormitory

From Borneo Sporenburg...

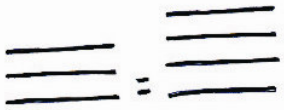


application of high density row housing principles in family housing context

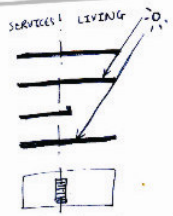


A systematic approach and passive design principles

Betzenberg Park Row House in Kaiserslautern...



Idea of being able to grow over time



Orientation of staircase for daylighting planning

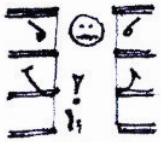


Mixed use spaces with passive surveillance on the streets

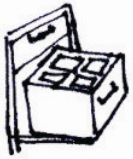


Recycling Network

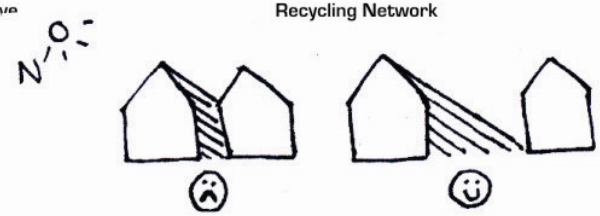
From Beddington Zero Energy Development...



Learn from lack of human scale in development



Recycling sorting bins within kitchens



High density with maximum exposure to winter sun

Due to the size of this thesis file it has been divided into 2 parts.

Please see the file entitled: **"The Notion of Adaptation Part Two - Design"** for the design section of this thesis book

Chapter 5
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