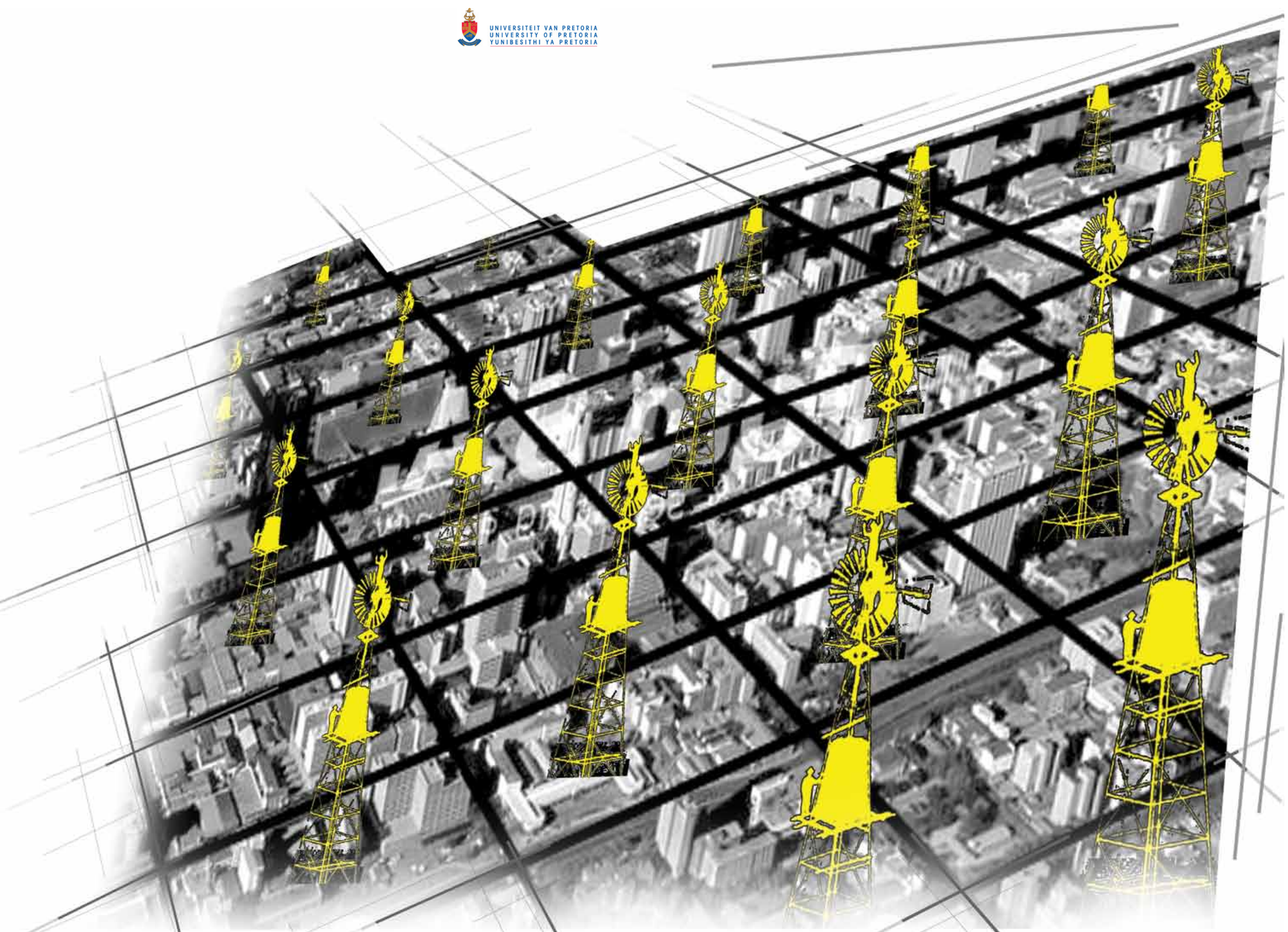
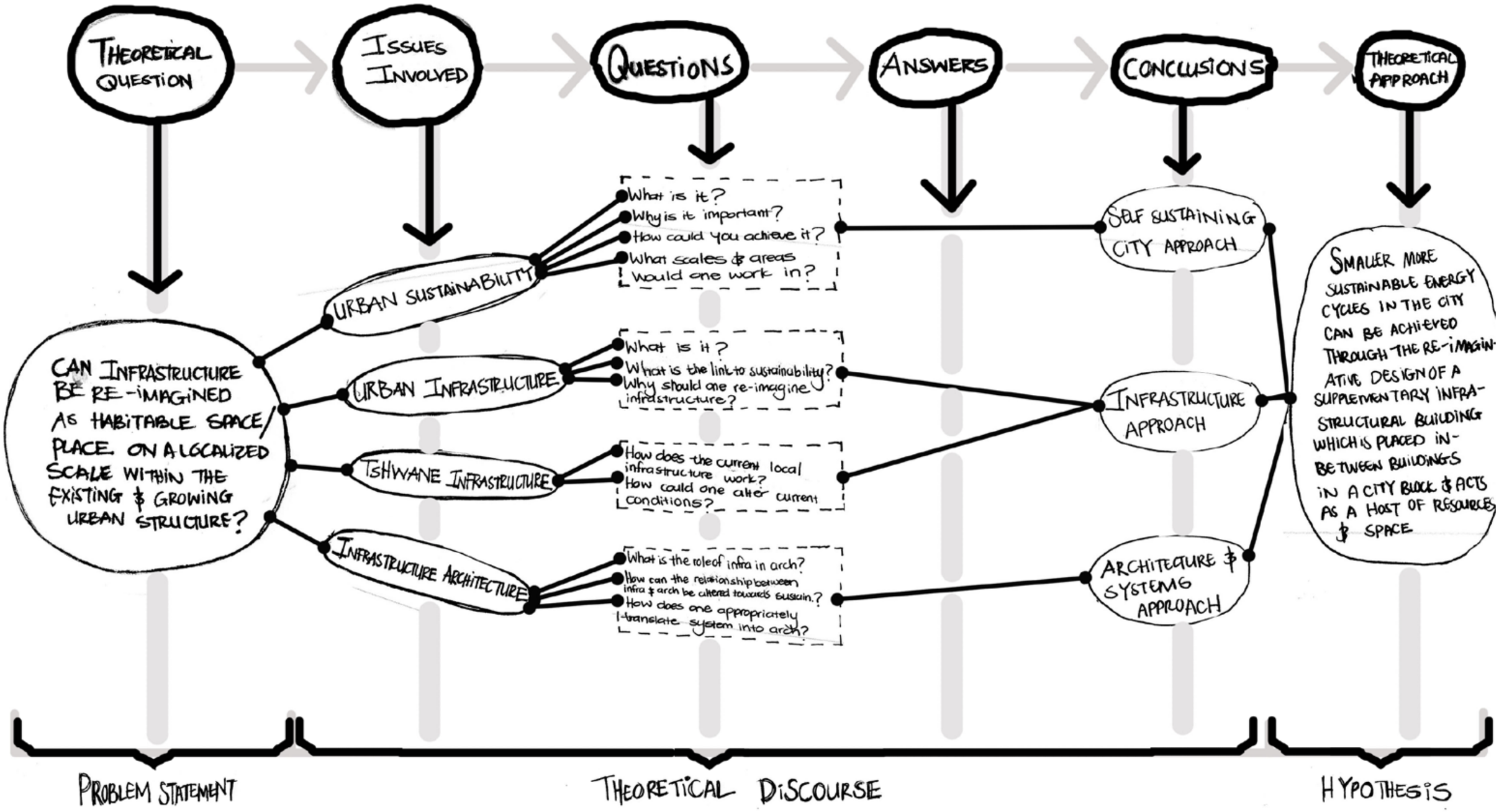
a system of thoughts composed of ideas

# [2] [Theoretical Discourse]



[Figure 2_1.] The Infra-Landscape.


THEORETICAL QUESTION
ISSUES INVOLVED
QUESTIONS
ANSWERS
CONCLUSIONS
THEORETICAL APPROACH
CAN INFRASTRUCTURE BE RE-IMAGINED AS HABITABLE SPACE/PLACE ON A LOCALIZED SCALE WITHIN THE EXISTING & GROWING URBAN STRUCTURE?
URBAN SUSTAINABILITY
URBAN INFRASTRUCTURE
TSHWANE INFRASTRUCTURE
INFRASTRUCTURE ARCHITECTURE
What is it?
Why is it important?
How could you achieve it?
What scales & areas would one work in?
What is it?
What is the link to sustainability?
Why should one re-imagine infrastructure?
How does the current local infrastructure work?
How could one alter current conditions?
What is the role of infra in arch?
How can the relationship between infra & arch be altered towards sustain.?
How does one appropriately translate system into arch?
SELF SUSTAINING CITY APPROACH
INFRASTRUCTURE APPROACH
ARCHITECTURE & SYSTEMS APPROACH
SMALLER MORE SUSTAINABLE ENERGY CYCLES IN THE CITY CAN BE ACHIEVED THROUGH THE RE-IMAGINATIVE DESIGN OF A SUPPLEMENTARY INFRASTRUCTURAL BUILDING WHICH IS PLACED IN-BETWEEN BUILDINGS IN A CITY BLOCK & ACTS AS A HOST OF RESOURCES & SPACE
PROBLEM STATEMENT
THEORETICAL DISCOURSE
HYPOTHESIS

# [2.1] URBAN SUSTAINABILITY

## WHAT IS IT?

Throughout the ages civilization has had many **threats** against which they had to construct **defence** within human settlements. Urban settlements have been designed in such a manner to deal with **animals, wars and crime** in order to protect and **fortify communities.**

In the 21st century the situation has changed, there are no more impending wars or rogue animals threatening our settlements. Our new enemy is **climate change.**

Globally, climate change is causing increasing destruction in everyday life, natural disasters are claiming millions of lives, creating food shortages and the extinction of species to name but a few catastrophes (Roaf 2005: 2).

Climate change is caused by a layer of **greenhouse gasses** (mostly a high concentration of carbon) in the atmosphere, **trapping the earth's heat,** resultantly **negatively** (that is for us humans at least) affecting climatic behaviour (Roaf 2005: 3).

How should a city be **fortified** against the effects of climate change? What should our communities do? What is our defence to ensure our future generations' survival and prosperity? In the 21st century our fortification is **sustainability.**

The role of sustainability is to transform settlements into self sufficient communities to lower carbon emissions, minimise resource demand and use, and to create an integral **support system** between these elements (Roaf 2005: 6).

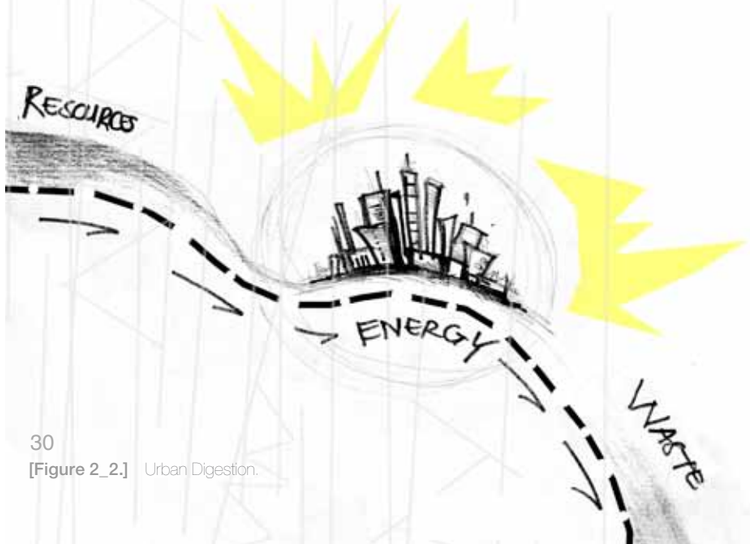
Sustainable urban development is; "a **process of change** in the built environment which fosters economic development while conserving resources and promoting the health of the individual, the community and the ecosystem" (Richardson 1989).

What is a sustainable settlement? Some people say that small European towns in the Middle Ages, or prehistoric hamlets for instance, were 'sustainable'. Both models, however, were based on the same **unsustainable** paradigm: resources were extracted from the environment, while waste was thrown back (fig. 2_2) (Ruano 1998 : 7).

Haughton (1994: 23) states that;

**"A sustainable city is "one in which its people and businesses continuously endeavour to improve their natural, built and cultural environments at neighbourhood and regional levels, whilst working in ways which always support the goal of global sustainable development."**

Thus the transformation towards a self sustaining city involves creating an urban setting where the resources which the city uses to keep going like fuels, food, water, electricity, communication distributors, transport systems, and even media is **produced by the city itself, used by the city and recycled again.** Therefore the resources cycle through the city instead of sourcing expensive resources with high embodied energy from other far away places outside the city.




[Figure 2_2.] Urban Digestion.



## SUSTAINABILITY OF THE BUILT ENVIRONMENT

So what **role** should the built environment play in this? In a global context the built environment is said to be responsible for about **50% of carbon emissions** and 70% if we include transportation associated with mobility within the built environment (Jones 2009 : 1).

One can divide the built environment into three categories; **new buildings, existing buildings and supporting infrastructures** (for transport, water/sewage, waste and energy supply) (fig. 2_3). Probably the easiest sector to deal with first is new buildings. As new buildings are likely to be around for some time it is important that they perform well in relation to $CO^2$ emissions (Jones 2009 : 2).

Many governments worldwide are developing policies to reduce carbon emissions. In Wales, the regional government has set a target for all new buildings to be **zero carbon** by 2011. The definition of a zero carbon building in its simplest form is that it **has a reduced energy demand for thermal energy and power and that the supply is from renewable energy sources, integrated into the building or nearby.**

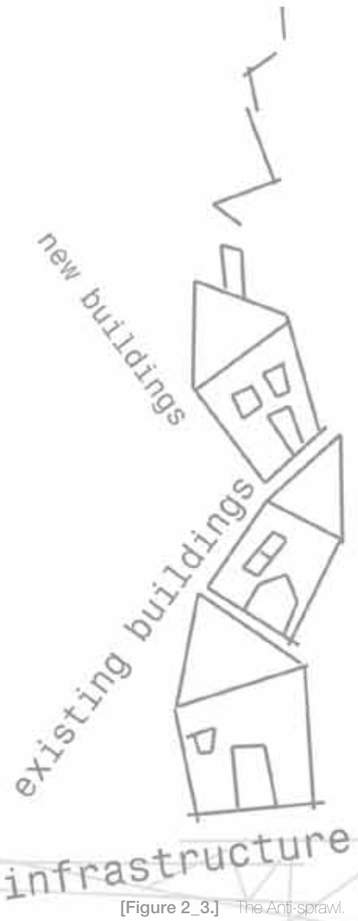
It does not normally mean green energy from large-scale grid supply, such as wind. These integrated renewable energy **systems include solar, thermal, photo voltaic, wind and biomass** (Jones 2009 : 3).

Although attention to new buildings is crucial to a zero carbon future, it is not going to reduce emissions, it will only reduce the rate of increase. The main problem area is the emissions associated with the **existing building stock.** This is **more difficult to deal with** through regulation, especially at urban scale where most emissions occur.

Many buildings are also ''hard to treat'' in terms of making them more energy efficient and in integrating renewable energy systems. Energy efficiency measures can be applied, but the **cost may be too much for many people.** It is therefore likely that **existing buildings will apply appropriate energy efficiency measures and then their energy supply must be de-carbonised at a community or grid scale** (Jones 2009 : 3).

Our **infrastructures** also have associated emissions, from **transportation, water/sewage and waste.** We must look for **reduced demand** and efficient and effective supply through **local central systems.** However, many of our grid based systems are difficult to change and work in this field may take longer.

We must ensure that when creating master plans for new developments, they should look at carbon emission reductions. **Systems that can be integrated at a reasonable extra cost for significant energy and waste reductions and the utilisation of renewables such as bio-fuels should be incorporated wherever possible** (Jones 2009 : 3).




[Figure 2_3.] The Anti-sprawl.

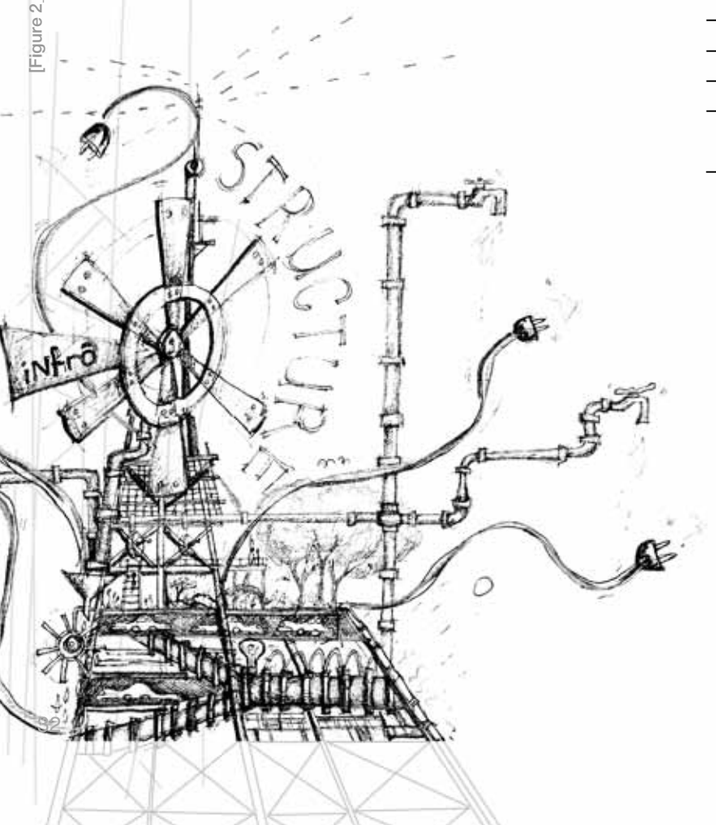
## ___HOW COULD THIS BE ACHIEVED?

The city should be sustaining its own life. Resources, infrastructure and structures should be serving a **larger contribution to society than just being transportation vessels, shelters and products of demand** – these elements should be used for **reproduction, recycling and interventions of renewal and growth** to save costs on sourcing what the city needs from miles away (Roaf 2005 : 23).

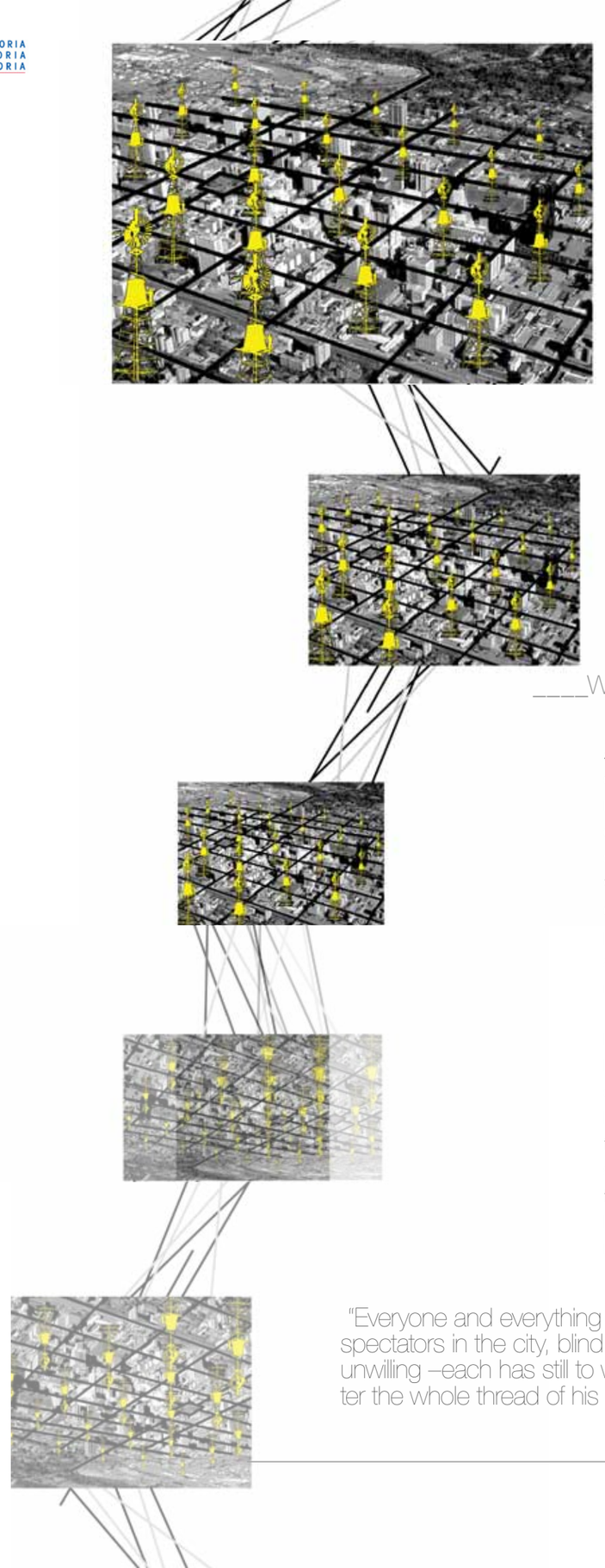
Catherine Spellman, editor of 'Re-envisioning Landscape/ Architecture' states that the very landscape of the urban environment is in actual fact **life sustaining** and that it should not be treated as a two dimensional surface which is lived upon but rather that **landscape is the infrastructure to which all other infrastructures are answerable** (fig. 2_4) (2003 : 66).

Thus the city should be able to harvest and produce its own resources from the **urban landscape** if it is utilised correctly. Spellman is of the opinion that in order for this to be possible the city should be regarded in a different manner, envisioning:

_ **networks** not boundaries
_ **relationships and connections** not isolated objects
_ **interdependence** not independence or dependence
_**natural and social communities** not just individuals
_**transparency or translucency** not opacity
_**flux or flow** not stasis
_**permeability** not walls
_**mobility** not permanence
_**relinquishing control**, not dominating nature
_**catalysts, armatures, frameworks, punctuation marks,** not final products, master plans or utopias (Spellman 2003: 232).




[Figure 2_4.] The infra-tower

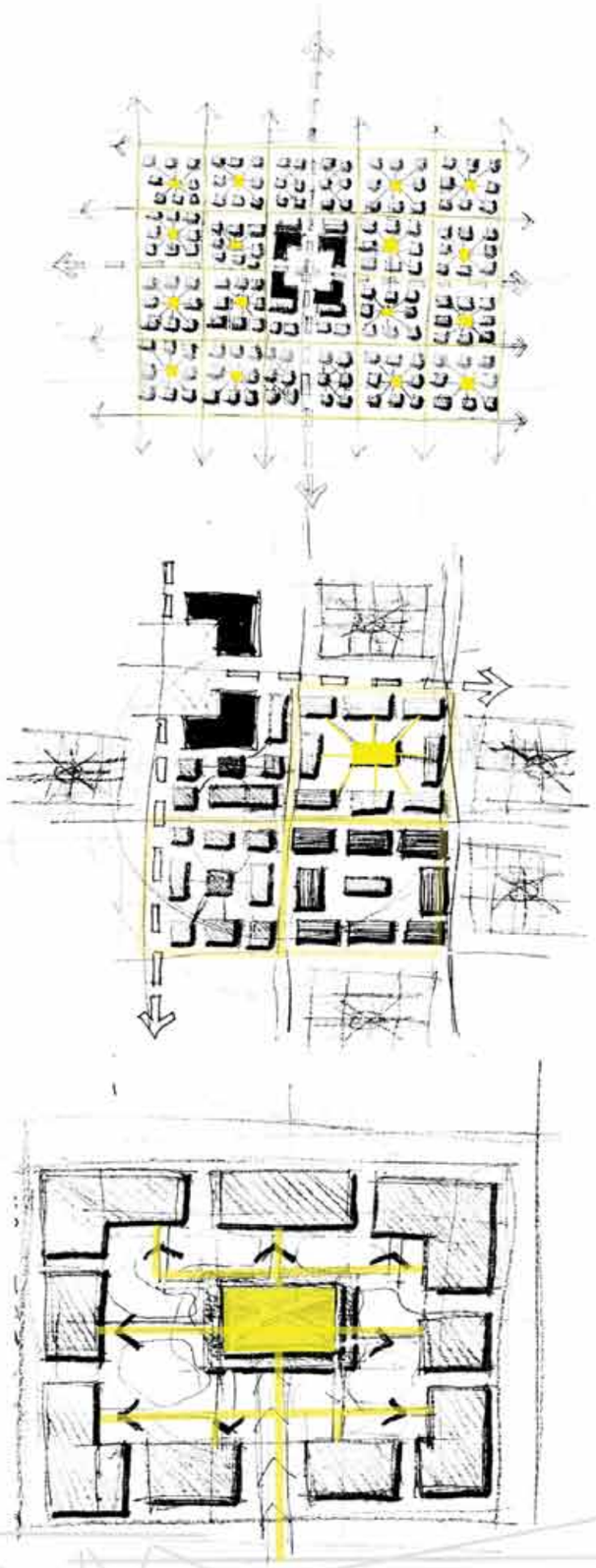


## ____WHAT SCALES & AREAS WOULD ONE FOCUS ON?

According to Michael Ruano, author of 'Eco Urbanism', the development of multidimensional sustainable human communities happens within harmonious and balanced built environments, by firstly starting to **localise resource use**, we should start looking at what we can **recycle on a local scale** within the city instead of bringing new things from outside the city. This can be approached by recycling resources and applying smaller **systems in smaller areas** which are linked but are on a more practical, manageable and human scale (Ruano 1998: 10).

Part of a sustainable approach is that in the cities, people have to tie together and start functioning as **sustainable communities,** the scale of community formation is governed by **contact,** people join as groups with other people whom they have something in common with (like living in the same area) and even more so if they are familiar to each other (like frequent passersby between buildings and streets) thus a city block can very easily start functioning as a community (Community scale, 2006).

"Everyone and everything is intertwined in the city, there are no more spectators in the city, blind or seeing, inven-tive or unthinking, joyous or unwilling –each has still to weave in, ill or well, and for worse if not for better the whole thread of his life" (Geddes 1968 : xxiv).



[Figure 2_5.] Host Growth. Illustration of how the infratecture is imposed on all city blocks to create a self sustaining city.

# ____CONCLUSIONS

_Sustainability is urban settlement's fortification tool for future development and survival.

_Sustainability is about a support system between people, resources and the environment.

_Change should start happening on a community scale.

_A sustainable city produces, uses and recycles its own resources.

_New buildings should be zero carbon buildings, thus it has reduced energy demand and uses energy from a renewable source.

_Existing buildings' energy supply need to be de-carbonised at community or grid scale.

_Must reduce demand and have efficient effective supply of infrastructure services( transport, water/sewage and waste) at a local central system scale.

_Infrastructure should be serving renewal and growth and should not just be acting as a vessel of transport, shelter and products of demand.

_The urban landscape should be regarded differently in order to sustain the city.

_Scales of interventions should be tangible, human contact scale.

# [2.2] URBAN INFRASTRUCTURE

## WHAT IS IT?

**Infrastructure** is the basic physical and organisational structures needed for the **operation of a society** or enterprise, the **basic, underlying framework or features of a system or organization**. The term typically refers to the technical structures that support a society, such as roads, cables, wires, pipes, bridges, canals, reservoirs and sewers that support economy and society.

Infrastructure development and management are important in urban and rural areas at the **local**, state, regional, national or international levels (University of Colorado, 2000).

From a **sustainability** stance however, the investigation will be limited to those infrastructural services concerned with the **usage and wastage of non-renewable energies** which each respective building needs; **water supply, electricity supply, sanitation services and waste removal, as well as user needs like access, movement systems, social space, legibility and thresholds.**

## WHAT IS THE LINK TO SUSTAINABILITY?

From the understanding that our resources are non-renewable the **consumption and production thereof needs to be addressed**, thus **looking at the systems which supply, resource generation and harvesting thereof in order to provide and produce resources in a more sustainable manner** would be good place to start.

The **link between the production, processing, usage and wastage of resources is the infrastructure** which produces and supplies as well as deals with the waste. If one considers infrastructure as the tool which enables consumption, could it not then also be considered as the tool which controls consumption?

## WHY SHOULD ONE RE-IMAGINE INFRASTRUCTURE?

Our current infrastructure **needs to change** because it is **not functioning as a sustainable system,** whilst one which relies on a number of **non-renewable energies**. The question is how do we go about this change? It is not sufficient to just change the system of service to meet new criteria, but the **user is free to continue to use and waste as they did before,** disregarding the inevitable crisis.

Thus changing the system in a imaginative manner not only solves the problem, but **captures the attention of the user,** creates an awareness, draws the user in and stirs the way they adapt themselves to these new conditions.

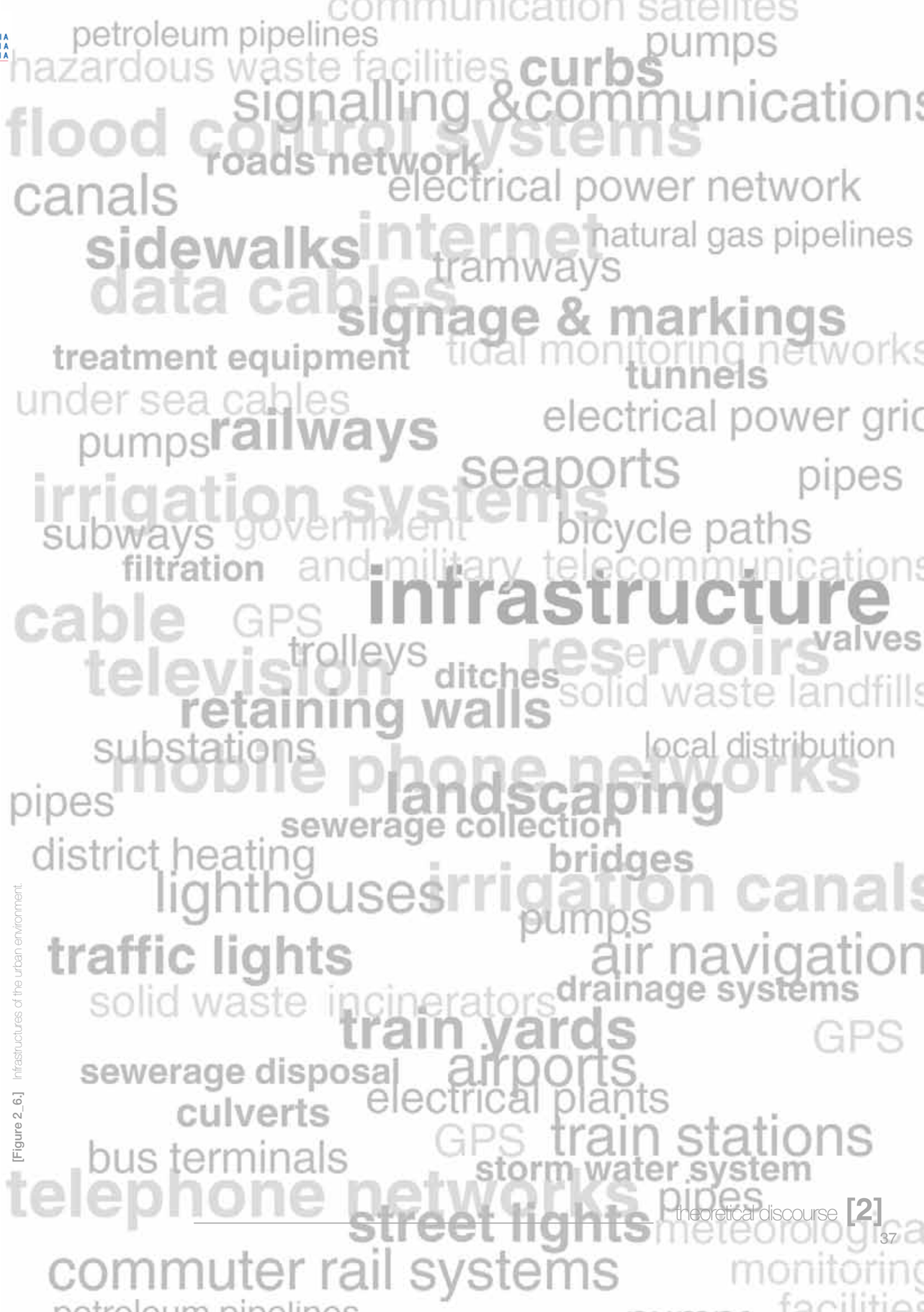
Thus a re-imaginative application of infrastructure has the **potential to bring about behavioural change.** A lot of creative and alternative possibilities are missed because of the **pragmatic engineering of infrastructural design** in the Urban Landscape.

Ecological and functional processes in the urban environment have been separated from design, instead of natural phenomena such as erosion, succession or water cycles being used to generate, the design of the landscape infrastructure has become the negating party. **We need infrastructure that goes beyond technical considerations,** to embrace ecological sustainability and with a **connection to place, context and culture.**

As in most Urban settlements, the infrastructural grid is the **core of the city's shape and space giving elements** and thus the **core of the city's transformation opportunities** of becoming an integrated urban landscape (Waldheim 2006 : 165).

Developing infrastructure's **potential as public spaces**, which carry an aesthetic expression of their own, has plenty of potential to **transform pragmatic necessities into urban amenities**. It is exactly along these margins where public space can unfold its neglected potential as a space of diversity, because public space is a spatial conception, a phantasmagoria, regardless of its functioning as urban public space or public space defined by landscape.

It is **capable of an 'in-between' state, of tolerating a clash** and it provides contemporary urbanism a presence as a fragile state of **superimposition.** The ambiguity of public space between the poles of mobility and locality, and its disability to allocate itself to one or the other, and as well its disability to achieve reconciliation or compensation among the two poles and to escape the 'in-between' state, makes it an archetype for the phantasmagoric view of the 'urban' city (Hauck 2010).




[Figure 2_6.] Infrastructures of the urban environment.

# [2.3] TSHWANE INFRASTRUCTURE

## HOW DOES THE LOCAL INFRASTRUCTURE CURRENTLY WORK?

**“…urban centres are relative intensifications of processes that stretch across the Earth’s surface…”**

**(Waldheim 2006 : 78)**

Globally vast networks **connect** users in almost every building with more or less **distant** power stations, sewerage works, reservoirs, transport grids and global communication systems. Enormous regional, national and international networks and **powerful institutes have been constructed to suck resources into and extract waste from cities,** and to exchange communication from predominantly urban centres across the world (Graham 2001: 13).

Tshwane Metro Municipality currently serves **2.2 million people** from 76 municipal wards, including Centurion, Crocodile river, Pretoria, Akasia, Soshanguve, Ga-Rankuwa, Mabopane, Winterveld, Temba, Hammanskraal, Mamelodi and Atteridgeville. Municipal services including **health care services, housing, environmental management, public spaces, refuse removal, water treatment, street-scape services, roads, storm water, waste management, agriculture, town planning, water and electricity supply** are offered by the local municipality (Tshwane 2004: 5).

The ‘Tshwane State of the Environment Report 2004’ declared that population growth and urbanisation can lead to **greater pressure on environmental resources and the capacity of the infrastructural system** (Tshwane 2004 : 13). Research was performed on the current municipal services of **electricity and water supply and sewage and waste removal**, via interviews held with individuals working for Tshwane Metro Municipality in the respective departments. Here follow the findings:


[Figure 2_8.] Tshwane service area.

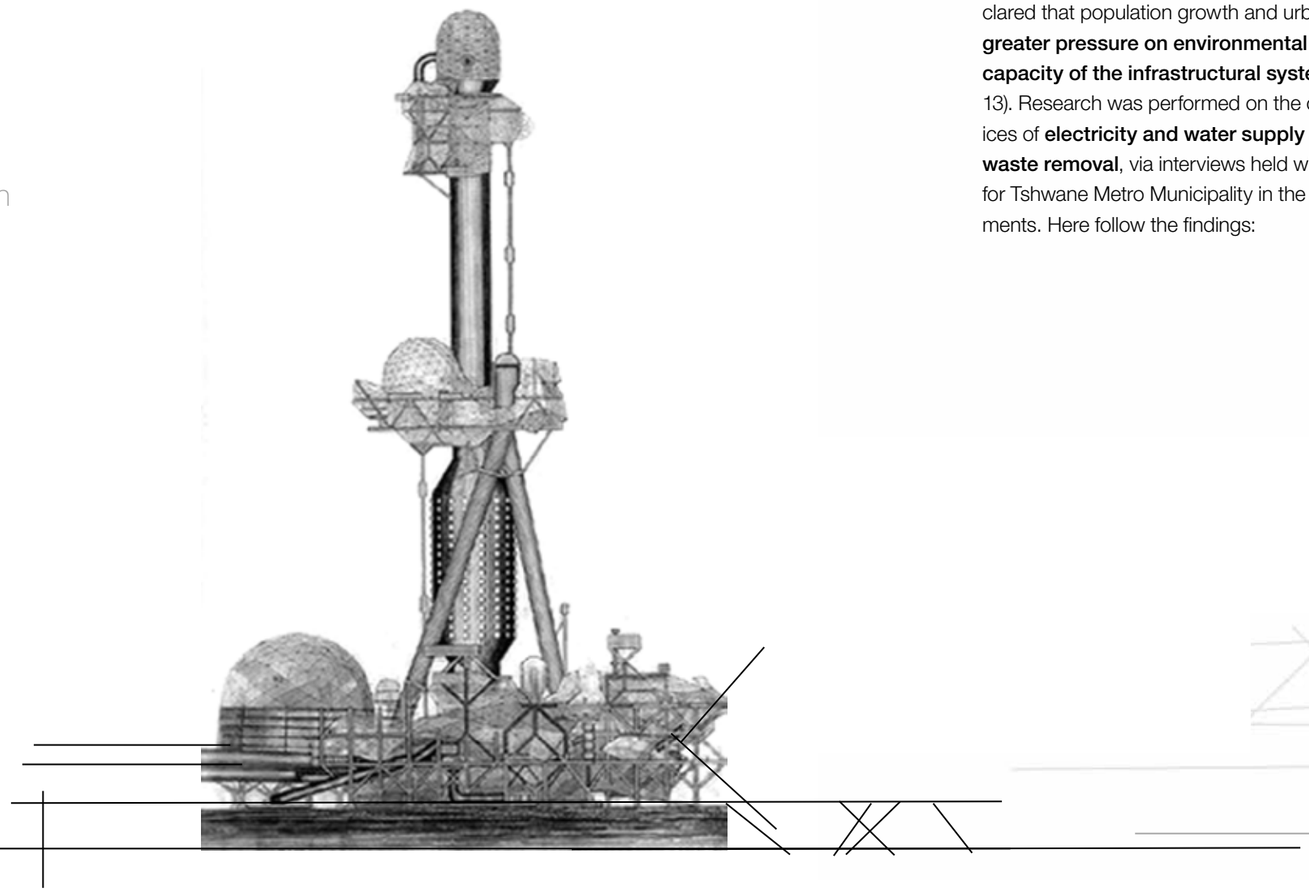
## ___CONCLUSIONS

_Infrastructure is the basic underlying framework of a system of organization.

_This study will be focused on the infrastructures which create direct links to architecture; water/sewage, waste, electricity and transport.

_Infrastructure is the tool which could control consumption.

_Re-imagining infrastructure has the potential to bring about behavioural change as well as the potential to act as public space in an ‘in-between’ state.

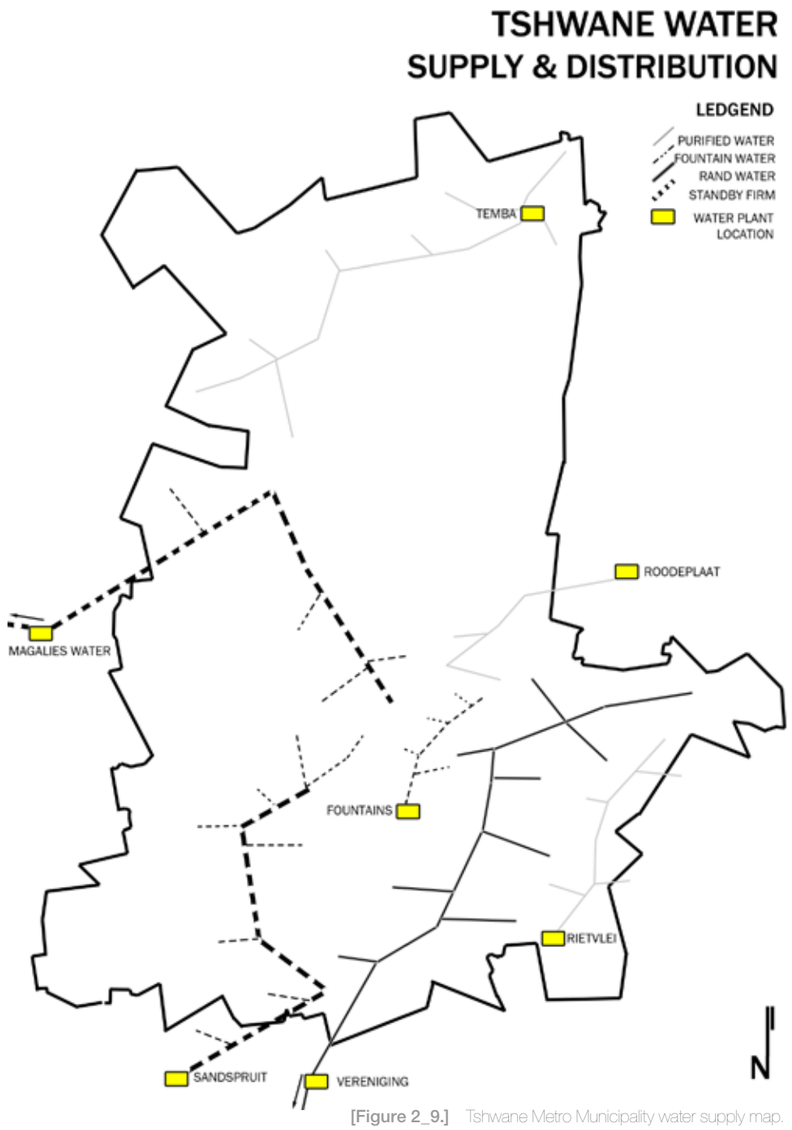


[Figure 2_7.] Serve City, Archigram,

## __WATER SUPPLY

**W**ater demand from especially the residential sector is ever **increasing,** an annual increase of **55%** was recorded in 2003. Water demand projections have been based on the Rand Water historic water demand trend that takes notice of water demand management (Water Situation Assessment Model).

It was estimated that the current demand of 574 Mℓ a day would increase to approximately 800 Mℓ a day by 2020, which represents **an increase of 40%, or an average annual increase of 2,1%** (Tshwane 2004 : 96).




[Figure 2_9.] Tshwane Metro Municipality water supply map.



Interview: Mr. Diederick J. Lues, Water conservation Manager, Tshwane Metro Municipality
Department of Water Affairs.

**1. Where does Tshwane's water come from?**

87% comes from Rand Water (Vaal dam)
8% From springs and boreholes
5% from the Rietvlei water treatment plant

There are three boreholes at Fountains Valley which supply part of the 8% water which come from springs and boreholes. Rietvlei dam in combination with Roodeplaat dam and Themba supply purified water via the Rietvlei puricifation plant. Part of the 87% which comes from the Vaaldam is also supported by two standby firms, Magalies Water and Article 21 company, Sandspruit Works, which supply the far North areas of Tshwane with water.

**2. Does the water get purified/treated and where?**

Rand Water purifies the water from the Vaal dam at Vereeniging. Roodeplaat, Rietvlei and Themba's water is treated at the respective plants. Sandspruit works and Magalies water is purified at source as is the fountains water.

**3. What is the cost per unit? What is a unit?**

1 unit = 1000 L = R11
Kilo = 1000
Mega = 1000 000
The price works at an increase scale and industrial and residential tariffs differ, in rural areas the 1st 5 kilo liters is free.

| INDUSTRIAL | RESIDENTIAL |
|---|---|
| 0 – 10 Kilo Liter = R 9-02 | 0 – 6 Kilo Liter = R 4-27 |
| 10 – 100 Kilo Liter = R 8-55 | 7 – 12 Kilo Liter = R 6-10 |
| 100 - > Kilo Liter = R 7-97 | 13 - 18 Kilo Liter = R 8-00 |
| | 19 - 24 Kilo Liter = R9-25 |
| | 25 – 30 Kilo Liter = R10-57 |
| | 31 – 42 Kilo Liter = R11-44 |
| | 43 – 72 Kilo Liter = R12-24 |
| | 72 - > Kilo Liter = R13-10 |

**4. How much water does Tshwane consume per day?**

710 Mega liters per day

**5. Will our water supply be enough for the next ten years?**

It depends on the rain, we cannot predict what the rainfall would be in the next ten years. Right now we have no water restrictions and we purchase 'limitless' supply from Rand Water.

**6. Would it impact the department much if more people started to collect and supply their own water?**

At the moment the impact is very small, if any, but in the end if less people purchase municipal water it would just mean we have less funding for municipal projects. We do not work for a profit all the money goes into maintenance and projects, so if there is less income we will have less or smaller projects.

**7. If all the water in the Vaaldam was finished in ten years, because of population growth and climate change what would the municipality do?**

We will try other alternatives, making use of more boreholes, purification of sewerage water like in Namibia and try other sources/ other dams and if it is an immediate crisis we will move large tankers with water into neighbourhoods and people will receive water rations (Lues 2010).

## ____CONCLUSIONS

_Water demand especially from the residential sector is annually increasing by 2.1% per anum and will be double the current amount in 2020.

_Most (87%) of Tshwane is dependent on water from the Vaal dam.

_Tshwane is currently purchasing 'limitless' water supply and the interviewee has no idea whether the future climatic conditions will cause water shortages.

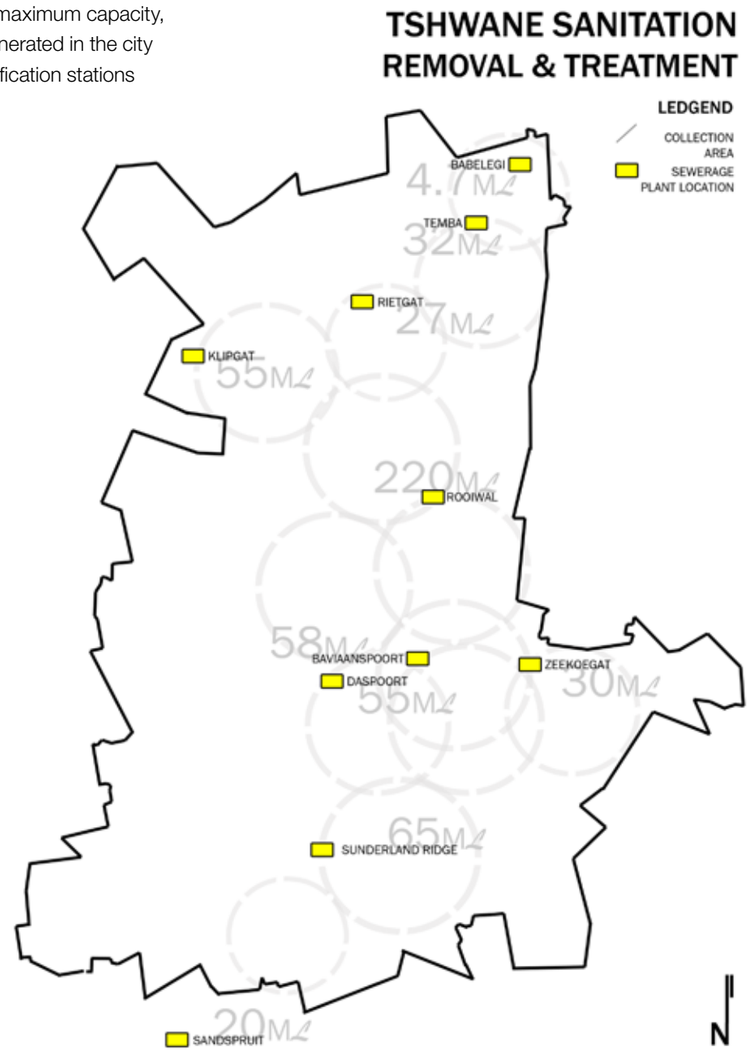
_If more people privately start collecting their own water, the municipality will have less funding for maintenance and projects, thus privatisation in water supply might risk the municipality's ability to maintain the current supply.

_The Department of Water Affairs does not really have a realistic strategy to provide water for the future in case of water shortages.

## SANITATION SERVICES

The waste-water system, similar to the water system, consists of a **bulk system** and an internal system. Both these systems are the property of the CTMM. Waste water is discharged to **ten waste-water care works through approximately 290 km of bulk outfall sewers.** The bulk system is generally in good order with spare capacity available. However, some sections of the system have reached **maximum** capacity and will need to be upgraded soon (Tshwane 2004 : 45).

In the city, there are two purification stations that currently operate above their maximum capacity, namely Sunderland Ridge, with a total of 1,33% above its maximum capacity (about 600 kℓ per day), and Zeekoegat, with a total of 24,33% above its maximum capacity (about 7,3 Mℓ per day). **In total, the city generates 355,9 Mℓ of effluent waste water per day.** Of this, a total of 7,9 Mℓ is above the maximum capacity, which means that 2,22% of the effluent generated in the city is above the maximum capacity of the purification stations (Tshwane 2004 : 45).




[Figure 2_10.] TTshwhane Metro Municipal Sewage service area.
Digital image by Author, 2 April 2010.

Interview: Mrs. Dorcas Monageng, Functional Head, Tshwane Metro Municipality Department of Sanitation Management.

**1. Where does Tshwane's sewerage go to?**

There are currently 12 sewerage treatment plants which all have different capacity. As new area extensions are built, new sewerage plants are built to serve them:

| | | |
|---|---|---|
| _Sandspruit | - | 20 Mega liters per day |
| _Klipgat | - | 55 Mega liters per day |
| _Rietgat | - | 27 Mega liters per day |
| _Zeekoegat | - | 30 Mega liters per day |
| _Baviaanspoort | - | 58 Mega liters per day |
| _Rooiwal (3 works) | - | 220Mega liters per day |
| _Sunderland Ridge | - | 65 Mega liters per day |
| _Babelegi | - | 4.7 Mega liters per day |
| _Daspoort | - | 55 Mega liters per day |
| _Temba | - | 32 Mega liters per day |

**2. Does all the sewerage go to sewerage plants?**

Yes, there is nowhere else for the sewerage to go, and no other use for it, very few people have French drain systems.

**3. What happens to the sewerage at the plants?**

We clean the water according to minimum requirements, we take out harmful materials (solids bigger than 25mm) and chemicals and then the water is pumped into the rivers. The solids are dried out and burned in an incinerator, the incinerator uses methane gas which is produced in the anaerobic digesters.

The sludge from the anaerobic digesters is pumped into drying beds where it is left to dry out, the dried out sludge is used by the parks department to make compost for their gardens. The water is sent through a biofilter where organisms digest the organic matter then the micro organisms (harmful bacteria) is killed with either UV or chlorine gas. The water is then clean enough to be received in the public streams.

**4. Where does Tshwane's treated water go?**

The rivers flow north-west towards the Brits area, the water is not drinkable but not harmful (Monageng 2010).

## CONCLUSIONS

_22% of Tshwane's effluent waste is above maximum capacity, thus the processed waste is either not cleaned properly before being placed into the rivers because it is being rushed through the system, or there is an overflow situation at some of the plants.

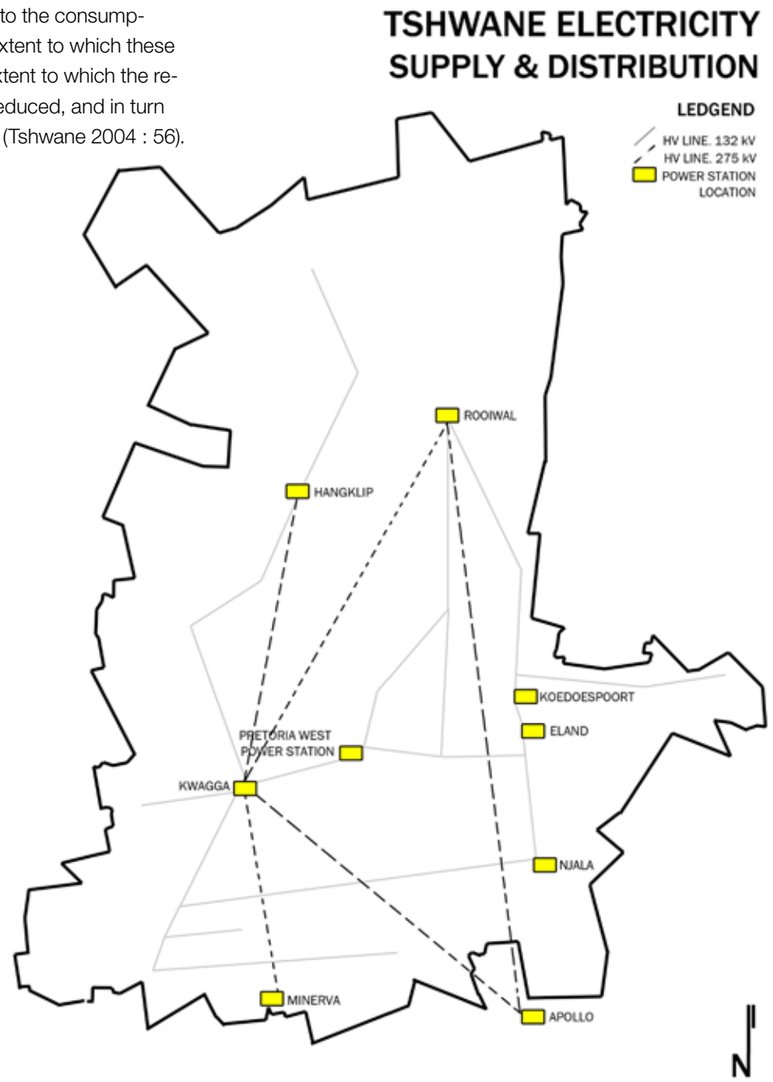
_Purification plants only purifies water to minimum requirements, it is not placed back into the system again, thus the maximum potential of the water is not reached. The water does not reach the user again, the process is stopped halfway through.

_Water from purification plants is placed back into rivers but is not drinkable, thus rivers which feed rural areas are transporting undrinkable water from the cities which can cause health risks.

## ____ENERGY SERVICES

**E**lectricity is the main form of energy used in the Tshwane metropolitan area. The area has a well-defined electricity infrastructure that makes it easy for consumers to use. Legislation prescribes that proclaimed stands must be supplied with electricity service points. Consumers are charged for this service even if they are not connected to it. They can use **another energy source only as a secondary source for heating or cooking.** Electricity is suitable for lighting and electric appliances.

Electricity is sourced from **Eskom and from two power stations** owned by the CTMM. As these two power stations are under the direct control of the Municipality, it can ensure that the generating process adheres to strict environmental standards. During the transfer process from the place where the energy is generated and distributed to the consumption points, **energy losses** occur. The extent to which these losses can be curbed determines the extent to which the required energy to be generated can be reduced, and in turn the negative impact on the environment (Tshwane 2004 : 56).




[Figure 2_11.] Tshwhane Metro Municipal Electrical service area.



Interview: Mr. Willie Naude, Electrical distribution manager, Tshwane Metro Municipality Department of Energy supply and distribution.

**1. Where does Tshwane's electricity come from?**

Tshwane Metro Municipality purchases electricity from Pretoria West power station, Rooiwal power station, and 3 Eskom import stations; Kwaga, Njala and Koedoespoort stations which respectively receive electricity from Kabora-bassa (the hydro electricity plant in Mosambique) which gives electricity to Appolo power station and Appolo gives electricity to Njala power station and Minerva power station gives electricity to the Kwaga plant.

**2. How is the electricity made?**

The electricity at Kaborabassa is made with hydro electricity technology but all the other plants still burn coal to make electricity.

Electricity is made and put into the main grid at 275 kilovolt (1000 volt), it is then transformed to 132 kilovolt at large substations to be supplied to industrial areas and again transformed by mini substations to smaller grid cyclical systems for residential areas at 11 kilovolt. One 11 kilovolt grid can supply 50 – 60 houses with electricity.

**3. How much does the electricity cost per unit? How much is a unit?**

I unit = 1 kilowatt hour = R1 (new 2010 tariff)

**4. What is Tshwane's daily electricity consumption?**

1300 Megawatt

**5. If there was a way that Tshwane municipality could supply electricity for smaller areas which can be generated in these areas would this alternative be considered?**

No, it would be too expensive and a safety risk (Naude 2010).

## ____CONCLUSIONS

_Energy losses occur during transfer between the place of production and user, thus the less distance between user and source- the less losses will occur.

_Most of the energy supplied to Tshwane is produced with coal, coal is a nonrenewable resource which causes pollution during production and will not be as freely available in the future. Thus we are dependent on a finite system.

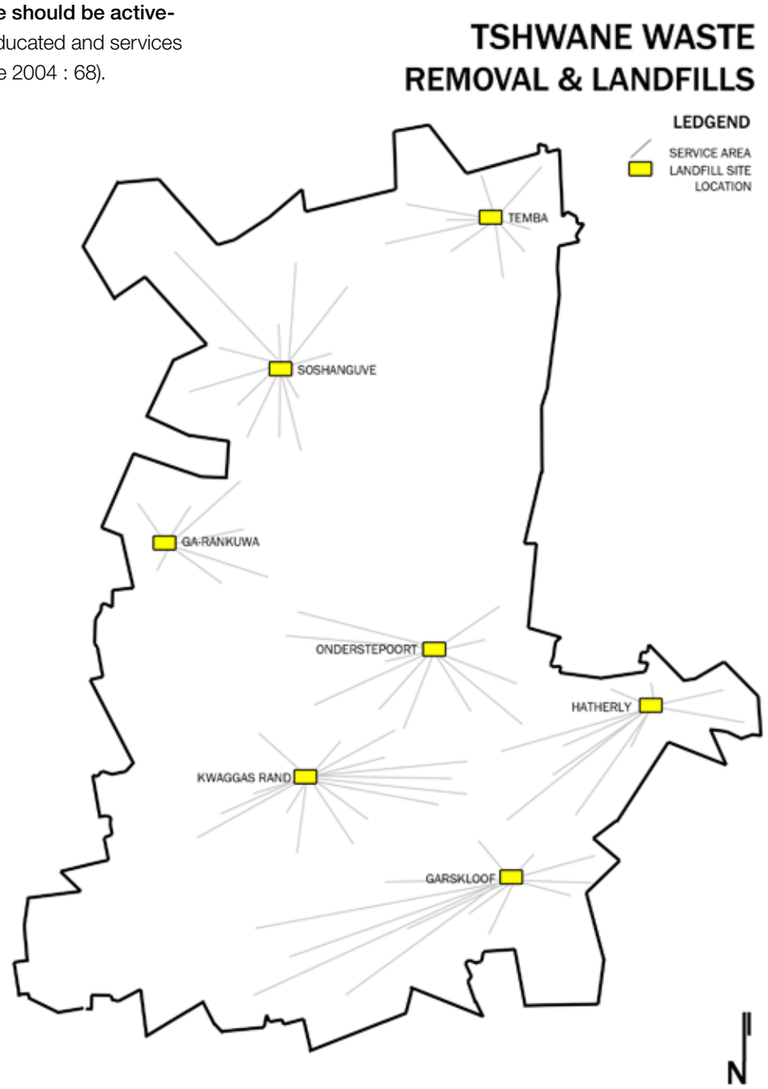
_Smaller electricity supply cycles and generation is seen as a safety risk, thus if energy is generated and supplied within communities there needs to be strict safety precautions and regulations.

_ Tshwane has no current strategy to replace non-renewable resource use to produce energy.

## ____WASTE REMOVAL SERVICES

**W**aste disposed of at the CTMM's landfill sites amounts to about 2 242 000 m³ a year. Cover material used amounts to about 559 000 m³. Only 22 387 m³ **(1%) of the waste is being recycled**. Tshwane has 11 landfill sites and a number of garden-refuse sites where **more than a million tons of solid waste is dumped each year**. Inadequate sites in the formerly disadvantaged areas have either been phased out or replaced, or have been extensively upgraded.

The high quantity of waste generated per capita in Tshwane (1, 07 tons per capita per annum) leads to **pressures on water, air and land quality**. (Comparison with other cities/ countries: Thailand (0,23 tons per capita per annum, Singapore 0,7, Suret City in India 0,2 and Ireland 0,57) The problem is further aggravated by extensive illegal dumping and littering. **The principle of reduce/re-use/recycle should be actively promoted**. Communities should be educated and services expanded to un-serviced areas (Tshwane 2004 : 68).




[Figure 2_12.] Tshwhane Metro Municipal Waste removal service area.

Interview: Mr. Frans Dekker

**1. Where does Tshwane's waste go?**

It is transported daily to either of Tshwane's seven Landfill terrains;

_Kwaggas Rand
_Onderstepoort
_Ga-rankuwa
_Soshanguve
_Temba
_Hatherly
_Garskloof (only garden waste)

**2. What do they do with the waste?**

There is no specific formal recycle programme, waste gets dumped on specific heaps at the landfill sites, individuals sort through the waste for recyclables before the municipal trucks remove them or just as it gets dumped at the landfill sites. The waste is left to dry out, compacted and then buried on the landfill site.

**3. How many trucks go out to collect waste every day?**

There are different types of waste collection, there is special order collection which is usually for industries, then there is daily collection at places like restaurants, malls and hospitals and then there is residential waste removal once a week for each area. But our entire fleet consists of about 180 vehicles.

**4. How many petrol is used by these trucks per day?**

The trucks use about 2.5L per kilometer, and each truck travels about 75km per day so 187.5 L per truck X 180 = 33750 L for the entire fleet per day.

**5. If there was a way that waste could be dealt with on site would the municipality consider this alternative?**

There is currently already a 'Waste minimization plan' which just needs to be approved and implemented but is taking very long because of political reasons. It is basically based on a recycling system which focuses on 'separation at source'. (Dekker 2010)

## ____CONCLUSIONS

_Currently 1% of the annual waste is being recycled, thus there is a lot of lost potential in our local landfill sites.

_Bulk waste produced per annum is placing pressure on water, air and land quality, even exceeding amounts which countries like Thailand and Ireland produce.

_180 waste removal vehicles drive around every day using 33 750L of petrol whilst picking up the metro's wastes, thus adding to pollution via the transportation thereof.

_A 'separation at source' recycling strategy is in process of being implemented, thus future change in the waste system will take place in how buildings and collection is currently functioning.

## ____HOW CAN ONE ALTER THE CURRENT CONDITIONS?

One can investigate the current **production** of resources and try to **make the processes more sustainable:** water purification, sewerage treatment, electricity generation and waste dumps are usually supplied from big industrial plants outside the city. **If the plant operates on a more sustainable manner** (eg. replacing a coal generated electricity plant with a nuclear plant) one could argue that the problem is solved, but the resources then still needs to travel all the way in and out of the city thus still using a lot of energy to reach the user.

Another proposal would be to **adapt the user**, making every individual recycle their waste, collect rain water, cycle and purify sewerage, use methane gas, solar power or little futuristic nuclear power generators and sustain their own needs, but the question would be, would **everyone** do this? **Does everyone have the access to money or technology to do this?** Would you find some opportunist trying to make money out of people by selling off their energy? Even the privatisation of energy and water supply would make it even **more difficult to acquire.** This could cause **economically strong areas** to become little utopias and other **underprivileged areas to struggle just to generate their minimum requirements** and will probably not bother doing anything other with their waste then create their own local dump site. **Retrofitting** every single existing building, putting water tanks and harvesting surfaces for water and solar power on every imaginable surface (something which could look quite horrible but in a few instances has been executed tastefully), maybe even incinerating waste and recycling grey water is a very popular option. This also involves **renovating/altering buildings** for better cross ventilation and natural lighting to **cut back on energy usage,** replacing toilets, shower heads and taps as well to save water.

Although this has already been done to some buildings, it involves a lot of **money** and initiative from the owners of buildings which, if not under law, **might never happen to the majority of existing buildings.** This is currently our most **realistic** approach towards making buildings more sustainable and, while it is a very isolated solution focused on making **individual** buildings sustainable within an **unsustainable urban landscape – this is what current technology allows**. Again privatised buildings are upgraded as 'sustainable' and the rest is left to depend on the inevitable diminishing resource services.

Then there is the option to **bring the cycle to the site**, to divide the overall production, harvesting and treatment system into **smaller systems.** Numerous smaller systems which are linked to neighbouring systems provides more manageable almost object-like scale systems which decreases the stress on a giant overall system and also reduces the consequences of malfunctioning (Marley 2003). Instead of being dependant on a distant system core which functions as a massive centralised system, **smaller localized on site infrastructural systems** are applied to serve the buildings. A centralised system cannot adapt to the smaller scale changes in the city but smaller systems **allow flexibility,** adaptability and growth more easily.

We can divide the city into smaller quadrants which can function with smaller systems of which some are connected to the whole while others serve smaller areas and systems. Thus resources can be recycled to create 'mini-Infrastructure'. Within these divisions, areas can be grouped together to be connected to a **'host'** which can be conceptualised as a 'Supplementary Infrastructural' building designed to accommodate the specific area's current and future resource needs.

## ____CONCLUSIONS

_The production method and choice of resources could be changed towards more sustainable means.

_One could downscale the cycle to such extent that every individual is responsible for the production and gathering of their own resources.

_Every single building could be retrofitted and renovated if we have the available funds.

_One could bring resource generation to the site.

[Figure 2_13.] TRetro-fitting Pretoria towards sustainability

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## INFRASTRUCTURE ARCHITECTURE

### WHAT IS THE ROLE OF INFRASTRUCTURE REGARDING ARCHITECTURE?

Architecture and infrastructure are **codependent**. Architecture cannot exist without infrastructure and infrastructure would not exist without architecture. Infrastructural veins stretches across the globe to serve cities where population demand pulls resources from far away to sustain the urban fabric.

As densities grow, the **urban footprint expands** and infrastructure follows. When addressing the sustainability of the existing fabric and re-imagining the **relationship** between architecture and infrastructure, which currently is not a very sustainable liaison, one first needs to understand the relationship between architecture and infrastructure.

Infrastructure can be seen as the way in which architecture **connects** to the resources, systems, economies and ecologies around it. According to Jacob, contemporary architecture is like an iceberg. That's to say most of it is **hidden below** a datum. Below this, there is a mass of stuff that **keeps the visible peak afloat.** The invisible part of this iceberg-architecture-metaphor - by far the largest - is a strange mixture of the practical and the conceptual. Down here is a **submerged structure,** a kind of armature of engineering and culture that gives architecture its **shape.**

Like a patient on a life support machine, architecture is **sustained** by the wires and tubes that are plugged into it. But where one stops and the other starts is increasingly difficult to determine. **Infrastructure and architecture bleed into one another** (Jacob 2009).

[Figure 2_14.] Deep Machine

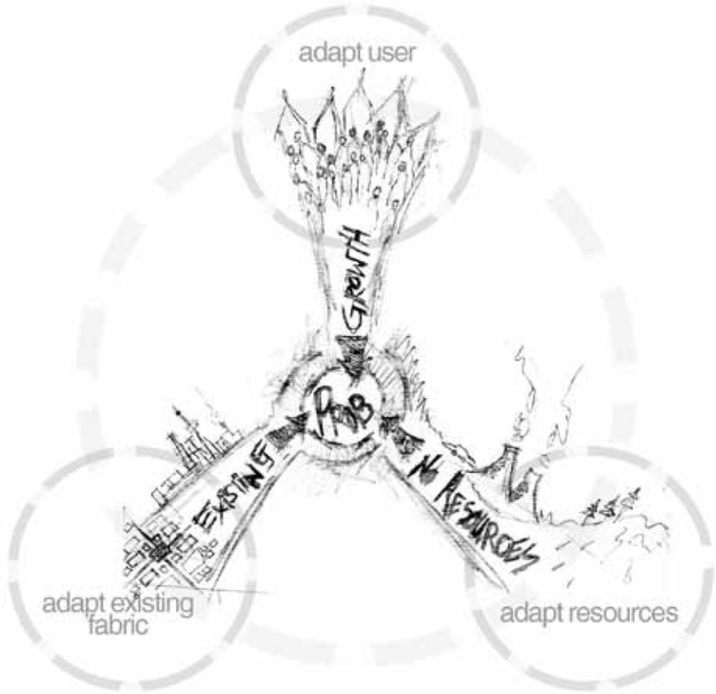


### HOW CAN THE RELATIONSHIP BETWEEN INFRASTRUCTURE AND ARCHITECTURE BE ALTERED TOWARDS MORE SUSTAINABLE MEANS?

From a sustainable approach we endeavour to meet means with needs, thus the possibility and opportunity of not just a new space (if needed) with the help of the system would eliminate the need to go and construct a new separate space as well. Dealing with infrastructural spaces in an urban context always has to involve dealing with their perimeters as well. Infrastructures, with the political-technical aim of supplying energy, resources, access and mobility to a certain space, do not structure it evenly, but create **spaces of centrality** and subsequently spaces that have a more lateral character.

If the margins of these political-technically conceived space configurations are permeable and accessible – hence they allow a public acquisition of the commodities or services the infrastructural space is supplying – they generate public spaces and activate spaces **in-between** the infrastructural component and its environment. This adds to the **economic sustainability** of a project, saving cost and construction material and energy by building one project instead of two.

Thus architecture cannot just remain architecture and infrastructure cannot just remain infrastructure. The systems of space, energy, movement and support becomes **shared facilities which supports and complements each other.** Why should we create a wall and place energy inside if we could have an energy wall? Why should we have a tank in the ground if the grid could be the tank? The **weave of systems into architecture** can take up a whole new meaning.




[Figure 2_15.] System cycling and connecting

Second, altering architecture so that it does not **need** as much resources as it normally demands from infrastructure - this implies how much it uses, what and how it uses it. By changing the way resources which infrastructure supplies to architecture is **generated**, more sustainable means can also be achieved through minimising the amount of energy used and pollution caused. Then also changing the non-renewable resources **to renewable resources which can be recycled on site or even within architecture** would make an enormous difference. Supporting **community sustainability** by promoting **interdependence, shared facilities and creating small scale centralised facilities within the architectural realm.**

### HOW DOES ONE APPROPRIATELY TRANSLATE INFRASTRUCTURAL SYSTEMS INTO ARCHITECTURE?

Infrastructure is **absent** from architectural representations in the urban context and architectural media. In its planning, it tends to be **hidden** below ground, behind earthworks, walls and fences. It is discreetly routed to **minimise its visual presence** in the landscape. Infrastructure acts as a kind of uninhibited version of architecture - uncivilised, unsocialised, inarticulate, yet driven with a primal urge to **create structures of unprecedented scale** and ambition. It realises the most extreme architectural fantasies that our conscious thinking would not permit (Hauck 2009).

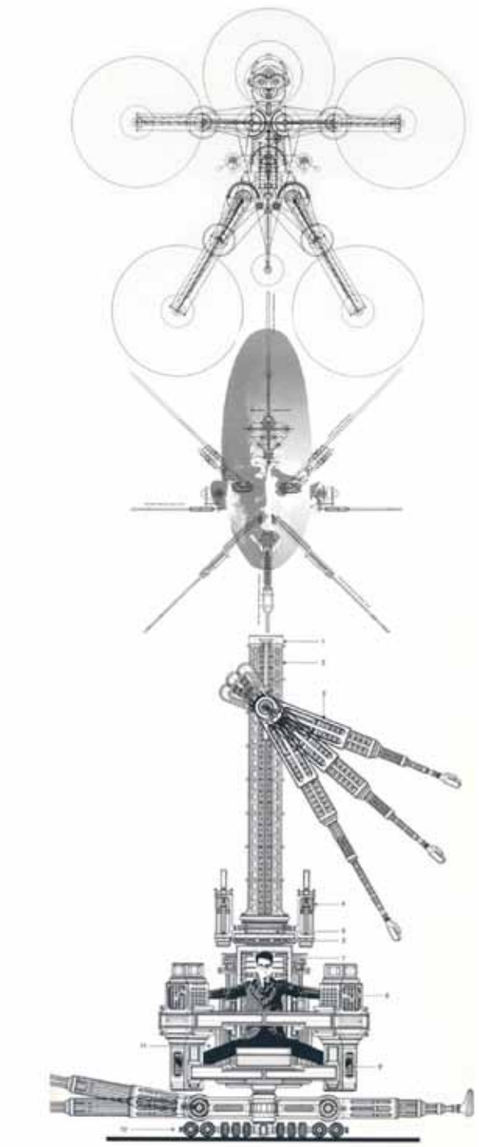
**H**igh Tech architecture applied the **aesthetic of infrastructure to architecture** and it grew out of a set of ideas explored by Reyner Banham which argued for an architecture of **mechanic qualities** - exemplified by gadgets and gismos - in 'Architecture of the Second Machine Age'. Inspired by the industrial revolution, these ideas provided the structure that **Archigram** later carried on in their visions of ultra **mechanised environmental architecture**, and these in turn led to the imagery of engineering and infrastructure becoming part of architectural language. But the process of aestheticisation sheds the real **significance** of infrastructural networks. If we were to reassess a contemporary relationship between architecture and infrastructure, we might set out in the opposite direction. Rather than import the aesthetics of machine/ infrastructure to architecture, we might **export architectural thinking to infrastructure** (Jacob 2009).

Marshal McLuhan suggested that we might understand media infrastructure as an **extension of our bodily selves.** He suggested, for example, that communication technologies are extensions of our own nervous systems - that radio is an extension of our hearing, TV an extension of our vision. If McLuhan is right, perhaps all infrastructure might be thought of as an extension of our bodily make up. Hauck states that **perhaps these networks of pipes and cables are a mapping of our own biology onto geology - a globally scaled anthropomorphic projection** (Hauck 2009).

In this way, we could imagine the Pompidou or Lloyds buildings unravelled and **strung out across the ground,** into trenches below the sea, across borders and linking continents. But imagine not just their physical fabric but their **culture and extended architectural heritage** wrapped up in these buildings forming a linear construction that strings out a narrative of abstract ideas over topography, across borders and through regions: Rogers, Archigram, Banham, Pevsner, the Bauhaus, Arts and Crafts and so on in mile after mile of unwound architectural ideology as infrastructure (Jacob 2009). **Consolidating, recontextualising and expanding the cultural under standing of infrastructure is more than appropriate in an age of mega-projects.**

When envisioning these infrastructural systems as architecture, one should note that we have gone beyond the paradigm when the **boundaries of architecture, and architectural thinking, stop at the building skin.** Design thinking comprises far more than the accommodation of function or even the skilful manipulation of data: it encompasses the **ability to be visionary and to contribute to urban livability**, especially through the creation of a new generation of public works.

Thus the system does not work from the outside in, the system physically is the outside and the inside. A new urbanist theory termed 'Landscape Urbanism' argues that landscape, rather than architecture, is more capable of organizing the city and enhancing the urban experience. The theory states that the 'landscape' consists of a series of man made and natural systems and networks which stretches across the globe. The Urban Landscape is an intersection point where a concentration of these systems and networks occur, it consists of physical and metaphysical 'structures' as well as the actions, spaces and rituals for which they are built to serve within the 'Scape' (Waldheim 2006: 40).



**[Figure 2_16.]** TFrançois Dallegret, Cosmic Opera Suit ,1962.

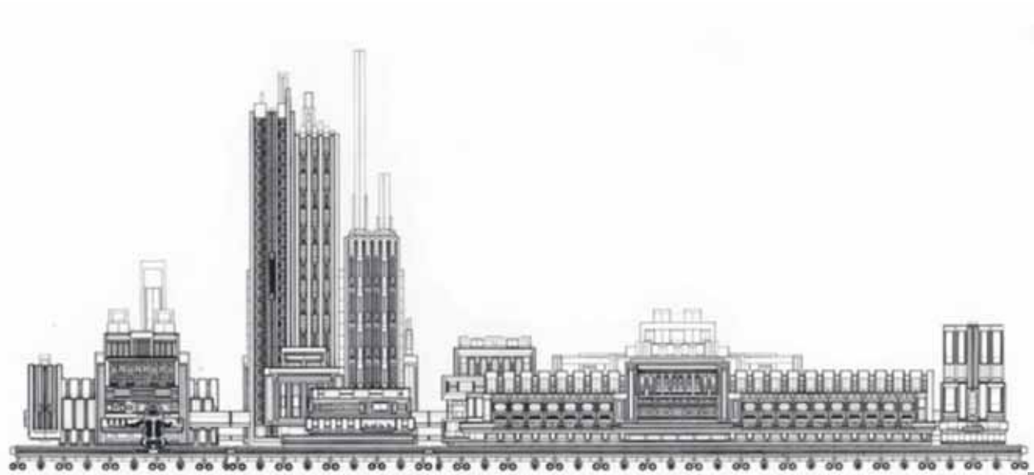
## _____WHAT IS SYSTEMS ARCHITECTURE?

"A systems architecture is the conceptual design that defines the structure and/or behaviour of a system. An architecture description is a formal description of a system, organized in a way that supports reasoning about the structural properties of the system. It defines the system components or building blocks and provides a plan from which products can be procured, and systems developed, that will work together to implement the overall system". (Marley 2003)

**N**o generally established definition of which aspects constitute a system architecture, exists. Various groups define it in different ways, including:

_ The **basic organization** of a system, represented in its **components**, their relationships to each other and the environment, and the ideologies governing its design and development.
_ It is a combination of the design architectures with **resources** and their life cycle processes.
_ An interpretation of a system in which there is a **mapping of functionality onto surfaces** (the spatial values) and the functional values onto components, a mapping of the software architecture onto the hardware architecture.
_ An assigned **arrangement** of physical elements which provides the design solution for a consumer resource or life-cycle process intended to satisfy the prerequisites of the functional architecture (Marley 2003).

"Systems architecture can best be thought of as a representation of an existent (or to be created) system, and the process and discipline for effectively implementing the design(s) for such a system" (Marley 2003).



**[Figure 2_17.]** François Dallegret, Relation-public-ornatic,1963.

# ___CONCLUSIONS

_A system needs to be organised in a certain practical manner which gives a set of restrictions, structure or structura properties to the architecture.

_When a system has been laid out, it provides a plan from which development can sprout in numerous determined locations.

_The system deals with components, resources and characters which has specific life cycles which needs to enter and exit, and in some instances, re-enter.

_Human interaction takes place with these systems because of its relationship with architecture.

_A system is arranged to satisfy the function of the architecture.

_The system produces the architecture whilst the architecture justifies the system's presence.

_Numerous smaller systems which are linked to neighbouring systems provide more manageable almost object-like scale systems which decreases the stress on a giant overall system and also reduces the consequences of malfunctioning.

[Figure 2_18.] Feats





# [2.5] ___CHAPTER CONCLUSION

## SEWING THE BITS TOGETHER

The aim of the project is to **create a host structure which serves the existing urban fabric** as an infrastructure of place, space, resources and services. Ultimately the host should contribute to the perpetual life and quality of the area in order to create a sustainable community and built environment.

In order to achieve a sustainable project, a support system between people, resources and the built environment should be established. This can be achieved by **using the built environment to 'generate' resources** for the community whilst serving as a public entity on an everyday based human scale.

To start off, the foundation of the project is infrastructure. Infrastructure is defined as the basic underlying framework of a system of organization. **Thus it is necessary to plan and calculate the required infrastructural systems' layout and design so that this can serve as the plan structure from which the rest of the project can grow.**

**For the host structure to function optimally, it is placed in an 'in-between' condition in a block core** in order to reach all the involved user buildings efficiently. As stated, this should be an imaginative endeavour which serves the block as public space and brings about behavioural change.

After investigating the current municipal services system, the following should be considered:

_ On-site **water harvesting should be implemented** for use. The local municipality has no backup plan for future water shortages.

_ As many of the municipal sewage purification plants are currently over their daily capacity it would be better to **treat sewage on site.**

_ Because the municipal electricity is produced with non-renewable resources and energy losses do occur during transferral, it would be better to **generate electricity on site with the help of renewable resources.**

_ It is already encouraged by Tshwane Metro Municipality that waste should be recycled and processed on-site. Thus **generating, recycling and digestive systems integrated with the design is required.**

**The organizational system of infrastructure creates the architecture whilst the architecture justifies the system's presence. The building as an infrastructure serves as an extension of the landscape and thus an extension of the public realm.**