

**AN ASSESSMENT OF ENVIRONMENTAL SUSTAINABILITY IN LOW-INCOME
SETTLEMENTS: THE CASE STUDY OF QADI TOWNSHIP IN KWANYUSWA**

By

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Submitted in fulfilment of the requirement for the Degree of Master of Housing, School of Built
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DECLARATION

- I hereby confirm that the work in this research is originally my own.
- This work does not contain any other person's writing.
- All the sources used in this study have been carefully and properly acknowledged.
- The words of the sources have been re-written but the general information attributed to them has been properly referenced; where their exact words have been used, their writing has been placed in italics and inside quotation marks, and referenced.
- No similar work has been submitted in any university for any academic qualification.

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Psalms 18:32 It is God who arms me with strength and makes my way perfect.

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DEDICATION

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ABSTRACT

Keywords: *sustainability, sustainable development, environmental sustainability, natural capital, quality of place, greening, low-income housing, low-income settlement, water efficiency, energy efficiency, waste management.*

Environmental sustainability has a significant contribution to the conservation of natural capital. In low-income settlements it improves the quality of place by providing a clean environment and minimising environmental threats. During the life-cycle of low-income settlement where housing is used as a product, natural resources such as water and energy are consumed as inputs while waste is generated as an output. Environmentally sustainable low-income settlements are therefore necessary for controlling the consumption of resources, manage waste, minimise environmental impacts and provide a clean environment. It is against this background that the study assesses and suggests greening, water efficiency, energy efficiency and waste management as strategies to conserve natural capital, address environmental impacts and ultimately improve quality of place (QoP) in low-income settlements. The study therefore explores the effectiveness of these elements on creating environmentally sustainable low-income settlements based on the interpretive paradigm. It has used both qualitative and quantitative data methodologies relying on interviews, questionnaires and observations and secondary data to evaluate the uncontrolled negative impacts and unintended environmental threats brought about by low-income settlements. It examines the influence of conserving natural capital in improving QoP while assessing the elements that can create environmentally sustainable low-income settlements. Finally it outlines the strategies that can be adopted to strengthen the conservation of natural capital and improve the quality of place within low-income settlements. It was discovered by the study that poor management structures and budget constraints are contributing factors to unpleasant environmental conditions and poor quality of place within low-income settlements.

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ACCRONYMS AND ABBREVIATIONS

CSIR	Council for Scientific and Industrial Research
DHS	Department of Human Settlements
DoH	Department of Housing
ECN	European Counter Network
EPA	Environmental Protection Agency
GBCSA	Green Building Council of South Africa
GM	General Manager
LPG	Liquefied Petroleum Gas
PV	Photovoltaic
QoP	Quality of Place
SALGA	South African Local Government Association
UN	United Nations
WCED	World Commission on Environment and Development

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CHAPTER 1: INTRODUCTION

1.1. Background

Customarily an environmentally sustainable human settlement refers to a clean environment, free of unanticipated environmental threats. A clean environment has an influence on the quality of place (QoP) of a settlement, its comfort and maintenance (Zahibi, et al., 2012). From an environmental perspective, Ayatac & Turk (2009) point out that QoP is determined by environmental protection such as conservation of biodiversity and protection from toxins and waste. Water and energy efficiency, adequate services and infrastructure are also determinants of QoP. Landforms such as rivers, valleys and trees improve QoP and contribute to pleasant environmental conditions of a place. Quality housing and building serve as security and protection for those using it where environmental management ensures that there is effective maintenance of such conditions and of QoP (Ayatac & Turk, 2009).

CSIR (2010) adds that environmental sustainability contributes to the maintenance of QoP of low-income settlements. The quality of place can improve the quality of life when housing is provided together with supporting services and infrastructure suitable to the natural environment (CSIR, 2010). Not only is an environmentally sustainable low-income settlement necessary for supporting peoples' livelihoods through diverse opportunities such as maintaining a food garden, recycling waste and attaining various resources of water and energy, it also decreases unintended environmental threats brought about by housing as a process or housing as a product (CSIR, 2010). In essence it improves a settlement's QoP.

Environmental sustainability is based on preserving, conserving, maintaining and managing natural capital. Natural capital is the stock of environmental goods and services such as water, air quality, waste assimilation and soil generation (MacDonald, et al., 199). In a settlement natural capital contributes to improving environmental services and supplying adequate natural goods (Collados & Duane, 1999). If QoP is determined by the design and management of space, then a well-maintained natural capital improves QoP. As such environmental threats are alleviated while pleasant conditions are introduced (Zahibi, et al., 2012).

With regard to these factors, housing is crucial to the environmental setting in order to minimise degradation of natural goods and services. Zahibi et al., (2012) argue that minimising degradation of natural goods and services can be achieved through design and management of space. The design perspective is a characteristic of functionality aesthetics and orientation whereas the management perspective is the maintenance and sustainable use of natural goods and services such as water, energy, vegetation, and waste (Zahibi, et al., 2012). In addition Zahibi, et al. (2012) conclude that in responding to environmental sustainability, settlements must have: an environmentally sound housing design which adheres to temperature regulation, resistance of a house to harsh environmental conditions, efficient use of water and energy resource which aids natural capital by reducing its consumption, increased pockets of vegetation to improve air quality and restore the environment from the disturbances caused by the process of constructing housing (Sowman & Urquhart, 1998), efficient waste management services to ensure that waste is properly disposed and minimise pollution (Sowman & Urquhart, 1998) . Zahibi et al., (2012) assert that failure to maintain these conditions in a settlement can result in major environmental threats hence an environmentally unsustainable settlement.

Low-income housing is government subsidized housing that is provided to the low-income groups which are the poor and disadvantaged. According to Department of Human Settlement (DHS) (2004) low-income groups are people that earn a monthly income ranging from zero to R3500 a month. The purpose of low-income housing is to provide maintainable, habitable, stable and sustainable residential environment for the poor and disadvantaged (DHS, 2009). Goepel (2007) recognises several challenges continuously existing within low-income settlements, resulting from housing as a process whereby housing material dilapidates into the environment. Housing as a process draws on the relationship between housing and the environment during construction. It captures integration, design, ecology, quality, innovation, empowerment and sustainability (Sertich, 2014). Challenges are also noted with housing as a product whereby households accumulate waste and cause environmental pollution (Goebel, 2007). Housing as a product refers to the finished building; the building components clustered together to form a house in a specific area, land and environmental setting. It has unending

processes that occur in improving its conditions and using it for household activities (Sertich, 2004).

Goebel (2007) further states that, oftentimes, during the construction of South African low-income housing cheap materials such as corrugated iron or fibre cement tiles are used. This material provides inefficient insulation and ventilation. The effects of poor ventilation and insulation in summer are excess heat at night; and high indoor temperature which causes discomfort. In cold seasons it attracts less heat release at night to warm the house (Aldawi, et al., 2013). The implication is more costs on energy to warm or cool the house. Goebel (2007) argues that this is an indication of inefficient use of resources. It therefore results in high energy consumption. Moreover low-income settlements are provided with a single type of source of energy and water. This increases consumption of resources in a short period of time which indicates poor maintenance of resources (Sowman & Urquhart, 1998). Such conditions are an indication of poor maintenance of natural capital (Goebel, 2007).

Tissington (2011) and Charoenkit & Kumar (2014) argue that while some low-income settlements have moderate vegetation, waste management is generally made inadequate and thus becomes inefficient. This is due to the limited capacity of the waste collection service provided by the local municipality which sometimes cannot meet the increasing demands for waste collections as a result of rapid population growth and urbanization (Tissington, 2011). Therefore inappropriate disposal of waste and high levels of pollution become visibly dominant (Charoenkit & Kumar, 2014).

These challenges are most likely to result from poor management structures responsible for advocating the choice of building material, adequate waste management systems, vegetation management and efficiency of water and energy (Goebel, 2007). Charoenkit & Kumar (2014) argue that these circumstances reveal the negligence of environmental threats existing in low-income settlements. Furthermore it reflects ineffectiveness of the strategies that are used to address unintended environmental threats and maintain the quality of place within low-income settlements. In the same way, the environmental management approaches available for low-income settlements may not be clearly applied to eliminate unintended environmental threats

and address unpleasant environmental conditions found in low-income settlements (Charoenkit & Kumar, 2014).

This research endeavours to assess unpleasant environmental conditions and environmental threats within low-income settlements. It does this through assessing the conservation maintenance and management of natural capital. In this study the concept “environmental sustainability” refers to well-maintained natural capital or conservation of natural capital. The scope of the study has been confined to management aspects that determine QoP which are greening, water efficiency, energy efficiency, and waste management.

1.2. Motivation of the Research

The study is motivated by the depletion of natural capital, uncontrolled environmental threats, unpleasant environmental conditions and poor QoP within low-income settlements. Housing can be viewed as a process, a product or both. As a process it captures the ongoing construction of houses and improvement of a settlement, and as a product it captures the use of a house and life-cycle of houses within a settlement. During the construction phase it applies to the process of housing as natural capital is indirectly exploited and the natural goods and services are diminished. (CSIR, 2000; Navarro, 2014). In terms of the on-going use of housing as a product the consumption of natural goods and services to deliver domestic activities can result in unintended threats to the environment such as waste and pollution within a settlement. As a result the life supporting systems that produce goods and services needed for human life such as food such as clean air may also depleted (CSIR, 2000; Navarro, 2014).

Low-income housing is government’s initiative for providing a shelter to the poor and disadvantaged (DHS, 2004). The provision of this type of housing must be environmentally sensitive in order to continuously maintain natural capital. Housing as an on-going process both during construction and the lifecycle of the structure must be in harmony with the environment; having minimal negative impacts in order to boost natural capital (Zahibi et al., 2012). However the environmental changes brought about by low-income settlements often create challenges in the success of eliminating unpleasant environmental conditions and controlling environmental threats (Goebel, 2007).

This study therefore suggests the strategies, approaches and tools that can be used to address environmental challenges, reduce the depletion of natural capital, control unintended environmental threats, and enhance self-sustained communities. The strategies are adopted from the aspects of managing place which are greening, water efficiency, energy efficiency, waste management, within the use of housing as a product.

1.3. Research Problem

The problem of the study is the depletion of natural capital within low-income settlements. In a settlement, the conservation of capital has a positive influence in improving QoP. Housing as a process draws the relationship between housing and the environment during construction (Navarro, 2014). Nevertheless the process of construction continues due to policy expectations and poor quality of housing product services. This exerts more demand on the natural environment resulting in waste generation (Tissington, 2011). Housing as a product captures the use of the final output from the construction process. During the life-cycle of housing waste is generated from domestic activities during which water and energy are consumed and waste is an output (CSIR, 2000; Navarro, 2014).

Goebel (2007) argues that the post-apartheid provision of housing to the poor in South Africa focused on addressing the inequalities of apartheid, increasing opportunities and increasing the involvement of the private sector. Therefore high mass of housing was built to meet these objectives. However problems unfolded with such type of housing. Pascals (2007) argues that these houses were of a poor quality since they were built on quantity than quality. They had poor services which resulted in uncontrolled waste, exposed soil which enabled runoff to cause soil erosion and there was often lack of access for clean water.

In 2004 the South African national government introduced a new strategy to housing delivery which was based on sustainable human settlements. This approach to housing was adopted from the international framework for sustainable development (Keivani and Werna, 2001; Irurah and Boshoff, 2004). However at that time South Africa had not developed a framework for sustainability and human settlement. Housing provision using this strategy was therefore

not a success due to lack of strategic planning (Keivani & Werna, 2001). As a result the environmental concerns of the low-income housing lifecycle have been neglected.

It is on these grounds that the current study emphasizes the uncontrolled negative environmental impacts and unintended environmental threats brought about by low-income settlements. Furthermore, it evaluates influence of conserving natural capital in improving QoP, suggests elements that have a potential in creating environmentally sustainable low-income settlements and emphasises the importance of these elements in improving QoP and addressing environmental impacts.

1.4. Hypothesis

The study highlights the importance of managing natural capital in order to improve low-income settlements' QoP (CSIR, 2000). Improving QoP can be achieved by effective management of the natural capital which may be greening, intensifying vegetation, water efficiency, energy efficiency and waste management (CSIR, 2000). The hypothesis of the study is therefore: greening, water efficiency, energy efficiency and waste management imply the conservation of natural capital and can improve QoP within low-income settlements and reduce unintended environmental threats.

1.5. Aim

The aim of this research is to assess and suggest strategies that can be used to conserve natural capital, address environmental threats and ultimately improve QoP during the on-going use of housing as a product within low-income settlements.

1.6. Objectives

The objectives of this study are:

1. To evaluate the influence of the conservation of natural capital in low-income settlements.
2. To evaluate management practices that strengthen natural capital conservation.
3. To identify the unintended environmental threats caused by activities occurring within low-income settlements.
4. To evaluate the threats that compromise the quality of place in low-income settlements.

5. To outline the strategies of addressing the environmental threats in low-income settlements.
6. To recommend approaches that can be used to improve environmental conditions in low-income settlements.

1.7. Research Question

The main question of this research is: What strategies can be adopted to conserve natural capital, address environmental threats and improve QoP during the on-going use of housing as a product within low-income settlements.

1.7.1. Sub-Questions

The sub questions of the research are:

1. What is the influence of conserving natural capital within low-income settlements?
2. What management practices strengthen the conservation of natural capital?
3. What are the unintended environmental threats that are caused by activities occurring in low-income settlements?
4. Which threats compromise the quality of place in low-income settlements?
5. What is the approach used to address unintended environmental threats in a settlement?
6. What strategies can be used to improve the environmental conditions in low-income settlements?

1.8. Concepts and Theories

There are 4 theories that inform the study and the various concepts that were used by the study. These theories guide all the aspects of the research, and provide an overview of various arguments around environmental sustainability and housing. They are liberal theory, neo-liberal theory, neoclassical and evolutionary theory. Liberal views are based on housing as a verb (process) and the process of housing construction (Soliman & de Soto, 2004). For human settlement, housing becomes an unending process that occurs within the environment which allows the indirect exploitation and use of natural capital (Collados & Duane, 1999). The Neo-liberal theory stresses that government housing is unaffordable and ineffective since it always

depends on the availability of subsidies, and thus shifts focus from government to the private sector; allowing it intervene in the construction of houses. Intervention of the private sector means sufficient funds and sensitivity to the environment as opposed to state housing (Marais, et al., 2008). The neo-classical theory suggests that environmental degradation results from shortages in the production of environmental goods and services. This is perceived as a result of poorly performing markets. In this regard the poor markets fail to capture the right prices of environmental goods and services (Adaman & Ozkaynak, 2002). The evolutionary theory acknowledges that aspects of change in sustainability are qualitative and quantitative (Mulder and van den Bergh, 2001). It centres more qualitative aspects of the environment that sustainability is dependent upon in order to improve and manage the environment, and provide services such as clean air, water and efficient energy (van den Bergh and Hokes, 1998). The issues around housing and the environment in these theories have been further explored in chapter 3.

1.9. Definition of Terms

1.9.1. Sustainability

Sustainability refers to the ability to maintain a unit or a process over time (Jenkins, 2009). It can be divided into three components: economic, social and environmental sustainability. It is based on the maintenance of all life-supporting systems among the environmental, social and economic pillars of the system (Mulder & Van Der Bergh, 2001)

The concept of sustainability encompasses the ways in which environmental impacts compromise and lower the conditions of a stable and healthy economic, ecological, and social system (Mulder & Van Der Bergh, 2001). Sustainability is the goal of sustainable development: the continuous mission that is aimed at improving the quality of life without degrading the life-supporting systems for future generations (Moreli, 2011). It involves equity and justice for all in the access and accumulation of resources needed to support life. Sustainability is therefore the root of the concept of sustainable development (Mebratu, 1998).

Sustainability has significantly evolved; it started in the 20th Century as an economic growth and development paradigm where economic growth was central to development (Mebatru, 1998).

Environmental degradation resulted in the unity of antagonistic movements to form one environmental movement. The sustainability movement was thus based on common ideas to address resource and environmental degradation arising from economic and population growth (Irurah & Boshoff, 2003). The United Nations Conference on Human Environment that was held in Stockholm in the year 1972 became the first effort to raise sustainability issues on a global scale (Adams, 2008). The impacts of development on the environment such as resource degradation were later realized and resulted in incorporating the environment into development (Irurah and Boshoff, 2003).

1.9.2. Sustainable Development

Sustainable development has various definitions, from different organisations. However these definitions are almost the same and are concerned with the present and future generation. The World Commission on Environment and Development (WCED) (1987) defines sustainable development as development that allows the fulfilment of present generations' needs, while those of the future generations are not compromised. However the WWF (1993a) defines sustainable development as the improvement of quality of life within the ecosystem's carrying capacity. The World Wide Fund (WWF) (1993b) defines sustainable development as an approach to improve the quality of life whilst making sure that future generation will also be able to improve theirs. Sustainable development has three pillars which are environmental, economic and social (WCED, 1987)

1.9.3. Environmental Sustainability

Environmental sustainability is a subset of sustainable development. It generally refers to the preservation of natural capital and deals with the maintenance and conservation of natural capital from which goods and services are derived (Goodland, 1995). It is defined as "a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity." (Moreli, 2011, p. 21). The concept *environmental* is strongly linked to the environment in a relationship with the people; which generally are the impacts of humans to the environment (Moreli, 2011). *Sustainability* generally refers to something that is good and

well maintained, whether it is directly linked to the environment or not (Moreli, 2011). For instance, environmental sustainability can be indicated by pleasant environmental conditions.

Environmental sustainability deals with the maintenance of the environmental life-supporting systems that contain the stock of natural capital and actions to maintain these systems (Goodland, 1995). It also encompasses the flow of materials that people use such as flow of energy and resources such as water, food, medicine and air (Moreli, 2011). This flow of materials is found in the life-supporting systems such as forests, ocean, lakes etc. The implication of the absence of environmental sustainability is the inability of the environment to prolong life-supporting systems (Goodland, 1995).

1.9.4. Natural Capital

The natural capital refers the stocks of natural goods and services such as land, air, water and all living organisms. It can be divided into two types which is non-renewable resources such as oil, fuels and minerals and renewable resources such as ecosystems food, climate regulation waste assimilation and energy (Collados & Duane, 1999). The goods and services that natural capital provides us with are used for our well-being and sustaining human life. They also provide economic opportunities (IISD, 2015)

1.9.5. Quality of Place (QoP)

Quality of place refers to the physical characteristics, size and type of a given place (CSIR, 2000). In an environmental perspective, the quality of place is determined by design and management of space which can be environmental protection such as: conservation of biodiversity, saving water and energy, availability of open spaces, protection of the environment from waste and toxins, availability of adequate services and infrastructure, buildings, the presence of natural features and landforms such as rivers, valleys and trees, and quality housing that can withstand natural disturbances; serve as protection and security for the people living in it (Ayatac and Turk, 2009).

1.9.6. Greening

Greening is the process of growing vegetation with the aim of providing or intensifying vegetation in a place. Greening can occur in the form of corridor vegetation, gardens or parks

(CSIR, 2000). In the process of greening, indigenous trees must be given first priority since they are adaptable to specific environmental conditions (Sowman and Urquhart, 1998). Within a settlement the areas with intense vegetation are important for recreation, temperature regulation and source of nutrition and air quality as well as the generation of income (CSIR, 2000).

1.9.7. Resource Efficiency

Resource efficiency generally refers to delivering more activities by consuming fewer resources. Efficiency is basically making most of what you have using less. Therefore, resource efficiency requires using a wide range of resources such as variety building material, more than one energy source and water sources in order to avoid dependence on one type of a resource and minimising consumption of that one resource (ECN, 2013).

1.9.8. Human Settlement

Human settlements are cities, towns or villages together with their communities (UN Habitat, 1976). These cities or villages enable us to live in a way that does not contradict the conditions of sustainability and the principles of sustainable development (UN Habitat, 1976). They must have institutional, social and economic systems that will ensure their existence is continued and maintained. Furthermore they must adhere to the environmental conditions of a place they are in (UN Habitat, 1976).

1.9.9. Low-income Housing

Housing is a building or structure built for people to live in with their families. South African low-income housing is government subsidised housing that is provided to the poor and disadvantaged through the Housing White Paper and Breaking New Ground Policy (DoH, 1994). According to the National Housing Code (2009) low-income settlement must be located within or have various land uses such as recreation, clinics, schools and commercial use.

Low-income housing is developed in order to: create, promote and maintain habitable, stable and sustainable residential environments, ensure usable and vibrant households and settlements, and allow convenient access to economic, social, health and educational opportunities and all other amenities that residents can have access to (DHS, 2009). The aim of

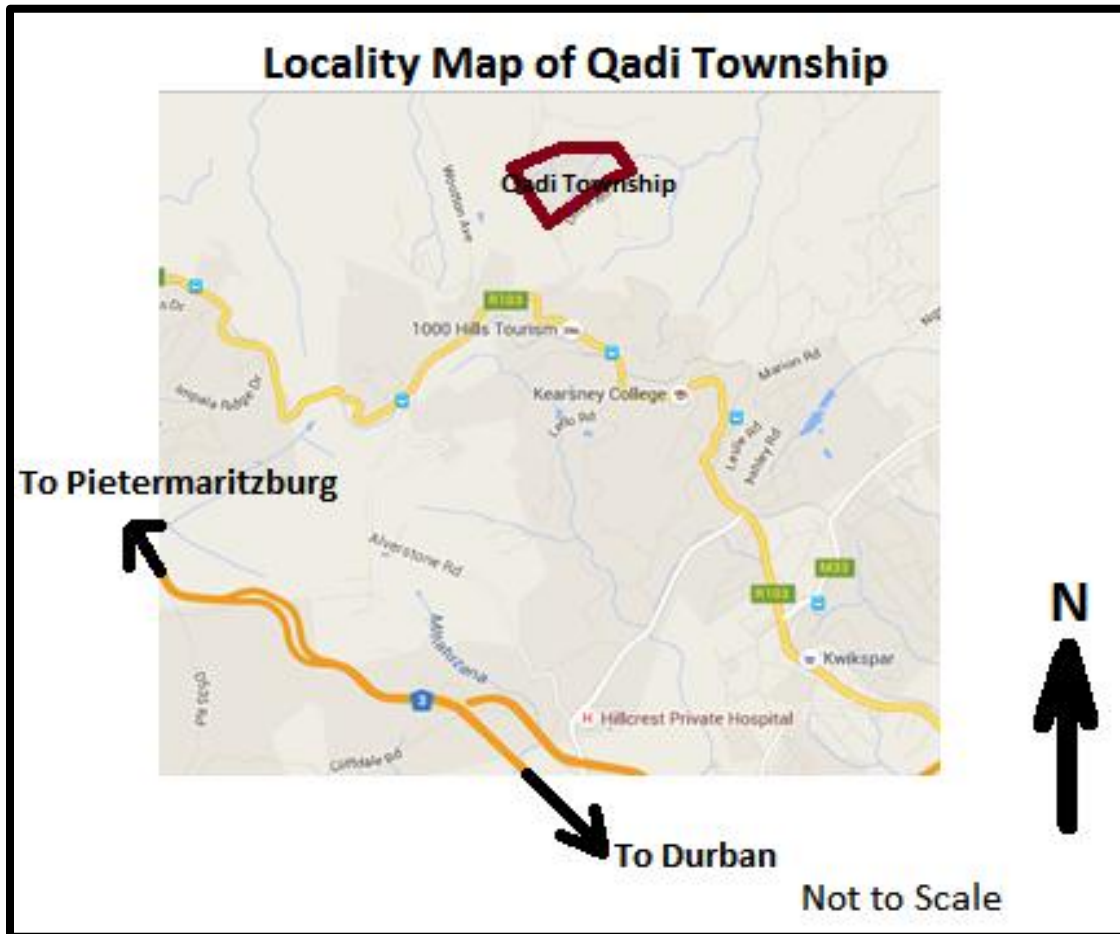
providing low-income housing is for citizens of South Africa to have access to a permanent residential structure with secure tenure, sufficient protection, services, facilities and infrastructure, water, and electricity (DHS, 2009).

1.10. Research Methodologies and Materials

1.10.1. Description of the Study Area

The research study area is the settlement of Qadi Township located in MaQadini area. MaQadini is a peri-urban area that falls within both the Durban Metropolitan Area under the authority of eThekweni Municipality and traditional leadership (Cross, 2002). MaQadini lies on the fringes of west of Durban, 35 kilometres from the CBD. It occurs west of Inanda Dam and north-west of Pinetown as shown by figure 1. It occupies most of the central ground between UMgeni and UMLazi Rivers. The nearest towns to this peri-urban area are Botha's Hill and Hillcrest (Cross, 2002).

Figure 1: Locality Map of Qadi Township



Source: Google Maps (2015)

Qadi Township is a low-income settlement that lies within MaQadini area and was developed in 2004 by QDT and DHS. It is situated in ward 108. The types of land use in the area were residential, commercial, educational and health land uses. The township was a vast grassland with areas of wetlands and gum trees before the township was developed. There is still some gum trees that were preserved. There is a river which flows through the area and wetlands as well at the edge of the area.

MaQadini is a the peri-urban area that falls within Durban Metropolitan City; to access local government services, parts of this area referred to izigodi (valley) remain under tribal organisations. However, due to the Municipal Demarcation legislation, the Durban metro

region diminished the tribally structured territories located to the south and west of the city (Cross, 2002).

1.10.2. Research Design Methodology

The research was conducted in Qadi Township. The study area was selected because the researcher is familiar with the place and was motivated by the depletion of natural capital within which is the reduction of vegetation and exposure of the ground soil.

The study was conducted based on the interpretive paradigm. The interpretive paradigm makes emphasis on the people's experiences on a particular subject where there are no correct or incorrect answers (Thomas, 2010). This research paradigm allows people to express their realities on social issues. It makes use of observation where the observed data is collected while its meaning is interpreted. During the conduction of the study the researcher does not stand outside, but becomes a participant observer (Thomas, 2010). The relevance of this paradigm to the research study is that the study is concerned about the state of the environment in low-income settlements and seeks to understand peoples' perspectives on the factors that may trigger in sustaining the environment in low-income settlements and make sense on the data obtained from their views and based on available literature

This study adopted a mixed research method using both qualitative and quantitative research design methodology approaches. However qualitative method was dominant. Qualitative methodology designs usually make emphasis of observations on aspects, perceptions and the understanding of the individuals' social life on situations surrounding them (Glatthorn & Joyner, 1998). Quantitative methodology is useful in grouping and analysing data using statistics analysis which is a clear summary of the data findings. Therefore it yields easy interpretation of data.

1.10.3. Sample Selection

In qualitative research methodology only a sample which is a portion of the population is selected for the research (Williams, 2015). This study employed random stratified and judgmental sampling. A random stratified sampling method enables the researcher to select a sampling frame of individuals. It produces accurate and precise data because it produces

characteristics in the sample that are proportional to the overall population (Williams, 2015). Judgemental sampling allows a researcher to do a selection based on his or her knowledge and judgement (Kothari, 2006). This method enabled the selection of 3 key informants based on the suitability of their professional position in responding to the research questions. . The key informants comprised of the civil servants in the low-income sector. These were the community leaders and professionals who had first-hand knowledge about the community, low-income housing and/or environmental sustainability. They provided an insight on the nature of problems around housing and the environment. In other cases they also gave recommendations.

A sample of 30 household individuals from low-income settlements was chosen using random stratified sampling. The area was divided into three stratas; namely A,B and C. In each strata 10 houses were selected. From the first house selected in each strata, every eighth house was selected until the last house. Household individuals selected were those that live within the settlement and spend most of their time in the household environment. The respondents chosen were from the age of 18, the legal age taking responsibility of a low-income house, to the age of 60 which is considered as retirement age in South Africa. Age has implication for willingness of conserving natural capital. Furthermore only households that have stayed within the settlement for a year or more were selected. The researcher considered this timeline as sufficient to observe the environmental changes within the environment from all climatic conditions.

Three key informants were selected based on their roles on the creation of low-income settlement and that of Qadi Township. They have been selected according to their roles and professions in the sector and the community. These are:

- Qadi Development Trust (QDT) Chairperson
- Ward Councillor
- DHS West Local Area Project Manager

1.10.4. Data Collection

The research relied on both primary and secondary data. Primary data was obtained from the Qadi Township residents and the key informants. It allowed the researcher to get an insight of attitudes, actions and thoughts of individuals towards the influence of natural capital maintenance within the settlement. It made use of interviews, questionnaires and observations. Before the interview or questionnaire survey was conducted a consent form was presented to the respondents which included both key informants and residents. This was done in order to ensure confidentiality and freedom to refuse to participate or withdraw from the research. Interviews were administered to key informants only and the questionnaires were administered to both key informants and residents. Semi-structured interviews were used as an effective way to allow the respondents to freely express their feelings on the questions asked (Babbie, 2005). The researcher asked questions and wrote the responses down while recording as recommended by Babbie (2005).

Questionnaires are effective on saving time and are easily understandable and capture only the required data (King & Horrocks, 2010). Since the majority of the residents did not understand English well, the questionnaires were administered to them using isiZulu which is the language they understood better. Questionnaires composed of closed questions which save time and open-ended questions which allow respondents to express their views. Observations were helpful in cases where information could not be acquired through interviews and questionnaires.

Observations express the data and information that cannot be expressed by words (Babbie, 2005). For the study, observation contributed in expressing data that was not captured by the questionnaires. Observations focused on the quality of place from an environmental perspective within Qadi Township. The type of observation method that was used is participative observation. In this type of observation the researcher was the observation participant with the respondents. The researcher viewed and interpreted the activities and conditions occurring in Qadi Township and recorded the interpretation narratively. Such ensured that the researcher captures the data that could not be expressed through

questionnaire surveys. Secondary data included books, journals, internet materials, articles, dissertations, and case studies.

1.10.5. Data Analysis

The primary data collected from the study was analyzed using quantitative and qualitative methods. Statistical and thematic analyses were used to interpret the data. Thematic analysis enables the grouping of data into themes in a summary of tables. The themes in the study were formulated from the research objectives and research questions. In each survey the questions within each theme captured data on greening, water efficiency, energy efficiency and waste management. The recording of views of the respondents was done in a table form using the Likert scale. King & Horrocks (2010) acknowledge the Likert scale for measuring responses of individuals. It captures the agreements or disagreements of individuals and measures their level. The tables revealed the views of the respondents towards the subject of the theme. These views were narrated and interpreted. They were also analysed using statistical percentages which measured respondents' views.

1.10.6. Limitations of the Research

Some of the key informant participants were not available for interviewing at the period when data was collected and this prolonged the time that was set for collecting data. Moreover conducting a survey of the participants from the study area was challenging because they were busy with household chores and it took much longer to finish each questionnaire. In addition it was challenging finding a suitable translation for technical terms that were used in the questionnaire. These limitations were however well-managed for the success of the research.

1.11. Ethical Considerations

The study has maintained privacy and the right of the respondents to human dignity as to respond to the importance of ethical consideration. The approval of the study was obtained from the University of KwaZulu Natal's, Humanities and Social Sciences Research Ethics Committee (HSSREC). This consent form presented to the respondent ensured the confidentiality of the respondent. It emphasized that the respondent was not forced participate in the study, the participation was completely voluntary and withdrawal from the study could

be done at any time. The researcher entered into the agreement with each participant to ensure that limited access into private information was maintained. All data records (written note and voice records) gathered in this study will be disposed through the use of standardized university procedures. All original copies were handed to the supervisor and after 5 years will be destroyed. The student will retained the soft copy. The research will be made available to any participant who would like a copy.

1.12. Chapter Outline

This dissertation comprises 5 chapters. Chapter 1 provided the direction of the dissertation by providing the background of the study and introducing the problem of the research, aims, objectives and research questions. It also presented a background of the study area and the research methodology design and tools that were used. Chapter 2 presented the literature review which had four major components which are low-income housing as a product, environmental conditions and challenges in low-income settlements approaches towards conserving natural capital during the use of low-income housing as a product, the contribution of, greening, water and energy efficiency and waste management in conserving natural capital and improving QoP. In chapter 3 the research theoretical framework is provided. This section provided all the theories and concepts adopted by the research and their relevance to conserving natural capital in low-income settlements. Chapter 4 presented summary of research findings in tables, discussion of findings and interpretation, answers the research questions, and fulfils the aims and objectives of the study. Chapter 5 outlined a summary of findings and presented recommendations based on the challenges revealed by the study.

1.13. Conclusion

This chapter has introduced the importance of conservation of natural capital within low-income settlements and the environmental challenges of conserving natural capital within low-income settlements. It is from this background that the research has presented detailed analysis of concepts of conserving natural capital, relevant theories and has engaged societal perspectives on the issues introduced by this chapter through relying on primary data as well.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This chapter provides all the critical summary of literature that informs the study. The critique is a summary of environmental sustainability issues around low-income settlements. Housing as a product is broadly defined so that the importance of natural capital management structures is shown. The environmental conditions existing within low-income settlements and monitoring tools to alleviate environmental threats are discussed. The maintenance of natural capital is narrowed down into five elements which are: greening, energy efficiency, water efficiency and waste management. These elements unfold as environmental changes occur during the use of housing as a product. They are used as management structures for the maintenance of natural capital and improvement of QoP. The key terms; low-income housing, natural capital, QoP, greening, water efficiency, energy efficiency and waste management in this section have been broadly and critically discussed. Lastly there is a conclusion section which provides a summary of all the issues drawn from this section.

2.2. Definition of Housing

Simpson & Weiner (1989) define housing as buildings or shelter for human habitation. It is designed to meet certain federal regulations such as clean environment for individuals and families to live in. Different housing situations vary for individuals and may depend on age, family, and geographic location (Business Dictionary, 2015). While some people may live in rented apartments some may live in houses with or without a mortgage and in an estate and/or mansion. Since housing covers land, protects the people in it, and supports livelihoods, it is made of multiple components both on the inside and outside. The outer components are aimed at protecting internal components (Business Dictionary, 2015). Although the study captured the maintenance of natural capital during the use of housing as a product housing as a process has also been briefly discussed

2.2.1. Housing as a Process

Housing as a process draws the relationship between housing and the natural environment during construction. During the unending construction process integration, design, ecology, quality, innovation, empowerment and sustainability become important (Sertich, 2014).

Integration draws on all the housing engagement around socio-cultural, economic and political dynamics around livelihoods (Sertich, 2014). For instance the infrastructure, services and facilities that are provided with housing create economic opportunities to improve livelihoods. This is considered to improve integration within social, economic and political dimensions (Burgess, 1978).

Design is relevant to the environmental context of the area such as climate, topography and soil. It is important that the design of housing at all times responds to the environmental context. This improves housing adaptability to the environment (Brown & Bhatti, 2003). Environmental sound designs are incorporated through ventilation, insulation and environmentally suitable building material. The negative environmental impacts that occur during construction of houses are therefore minimized. The preservation of natural resources becomes optimal since it enhances environmental protection and mitigation of impacts (Zahibi, et al., 2012). Quality draws on the material used to build the house. Evaluation of the house is done before and after building. Construction operations must ensure healthy partnerships among all the sectors involved in the process of housing so that agreements are reached on the choice of quality material (Sertich, 2014). Innovation is relevant to the technology that is installed in housing to solve problems. Alternative materials can be substituted to increase the efficiency of resources (GBCSA, 2015).

2.2.2. Housing as a Product

Housing as a product refers to the finished building; the building components clustered together to form a house in a specific area, land and environmental setting. This product becomes fixed to a certain area since it cannot be moved. It is therefore attached to land regulations and the changes on the environment (Sertich, 2014).

Housing as a product has certain attributes which make it different from clothes or cars or fancy goods. It has a very high capital value and its production time is far longer than that of most other commodities since it must always be well-managed (Barton, 1977). As a product housing has a purpose it serves, the need it fulfils and the problem it solves. These functions are determined by the tangible and intangible features such as design, resources for household

activities and material used to build (Soliman & de Soto, 2004). The purpose of a housing product determines the processes that occur in it and within the settlement and environment. As a product housing can therefore be used for making means of survival, protection, dignity, security of tenure and sense of belonging (Booth, 1982).

The institutional arrangements responsible for housing provision determines the viability and innovation of a housing product used in housing to solve problems. Viability is about the housing conditions that enable survival and benefit of the product such as availability of water and energy for household activities. The housing product impacts on the surrounding entities such as health, educational, economic, safety and cultural facilities as well as the environment. These entities in turn impact on the existence of housing and the environment (Booth, 1982). As a product housing is affected by the processes of environmental change such as climate and the availability of resources for household activities. These changes can either improve or compromise housing. Therefore the maintenance of natural capital is one of the ways which contribute to adequate natural services and goods required for households. It is important that the management structures for these changes are put in place (Parrott, 1997)

2.3. South African Low-income Housing

According to DHS (2009) the low-income residential environment must be provided with services, facilities and infrastructure to promote usable and vibrant households. Furthermore it must allow convenient access to economic, social, health and educational opportunities and all other amenities that all residents must have access to (DHS, 2009). Goebel (2007) argues that the background of creating low-income settlement lacks environmental aspects. The idea behind low-income housing is capitalist based. It has often been focused on the economic and social perspectives such as: secure tenure, basic services and affordable mortgage finance, and increasing delivery in order to eradicate the backlogs (Goebel, 2007). Subsequently modification from the initial housing policy strategy to “a comprehensive plan for the development of sustainable human settlements” in 2004 was more or less driven by the same ideas of basic services, tenure and economic opportunities (Tissington, 2011; Goebel, 2007).

Irurah & Boshoff (2003) also add that the likelihood that low-income housing as a product may compromise the environment to some extent may have been neglected. As a result the creation of low-income settlements has failed to account for the unintended environmental threats that result from using housing as a product. Secondly the contribution of maintaining natural goods and services that are brought about by a clean environment has been neglected (Gunnell, 2009). Negligence of the environment results in unpleasant environmental conditions within low-income settlements such as pollution. As a result housing as a product in low-income settlements may continuously have uncontrolled environmental threats (Irurah & Boshoff, 2003; Goebel, 2007).

2.4. Low-income Settlement as an Environmental Issue

Generally the environment is a composition of physical, biological, social and economic elements around us. These elements constantly undergo changes and they impact on each other in different ways (Sowman and Urquhart, 1998). The natural environment consists of certain elements such as biodiversity, vegetation, fuels, water, air etc. One element depends on the other and there must always be a balance between these elements so that the environment is stable. This balance can be achieved through minimizing as much threats towards the environment as possible (Saini, 2011).

Housing is an environmental issue because the process of housing occurs within the environment. The components that are required to construct a house are extracted from the environment (Saini, 2011). Household activities required for daily living within a settlement occur within the environment. In order for some of these activities to be executed an accumulation of natural environment resources is required; as a result natural capital is indirectly exploited. In order to recognize the importance of the conservation of natural capital, the implication of housing as product on the environment must be well understood (Saini, 2011).

2.4.1. Housing as a Product within the Environment

Environmental sustainability emphasizes balance and maintenance of natural life-supporting systems for the satisfaction of our needs. Therefore shelter provided in the form of low-income

houses must be in harmony with the natural environment (Agenda 21, 1992). There are significant and immediate negative environmental impacts drawn from housing as a product (National Housing Forum, 1997; Parrot, 1997). Negative impacts such as vegetation removal, careless resource consumption, waste generation, and pollution become noticeable (NHF, 1997).

Minimising environmental threats can be done through environmental rehabilitation where the environment is slightly restored whenever environmental impacts have visibly compromised the settlement vegetation. This can be done by increasing green spaces through planting and growing vegetation suitable to the environment and through agricultural practice and conservation of indigenous plant species (Parrot, 1997). Domestic activities such as cooking, washing, cleaning etc. occurring as household activities within of low-income settlement can generate solid and liquid waste. If this waste is not properly managed it can cause pollution (Cosmato, 2010). It is also important that waste is minimised and well managed so that it does not lead to the contamination of environmental resources and this can be done by the reuse of waste (CSIR, 2013). Lastly there must be available proper environmental management structures, services and strategies suitable for the settlement environment that so that the maintenance of pleasant environmental conditions and control of potential environmental threats are ensured. It is important for low income settlements to be provided with such services because low-income groups cannot afford some of them (CSIR, 2000).

2.5. Environmental Conditions within Low-income Settlement

According to Gunnel (2009) the built form, which is housing and buildings, contributes to significant environmental degradation. Housing requires the use of the world's freshwater and energy but in turn produces outputs which may have negative impacts to the environment. Prior to this, the low-income built form also contributes to environmental degradation (Gunnel, 2009). This section presents the literature on the environmental conditions existing within low-income settlements which are unpleasant for natural capital and how they manifest themselves into poor quality of place in terms of greening, water energy and waste.

2.5.1. Greening Conditions within Low-income Settlements

Greening is a process of planting vegetation in an effort to improve landform, air quality and protecting the soil. It can be done in the form of planting trees, food gardens or both (CSIR, 2000). Parkinson (2003) argues that the landform in low-income settlements is often very poor. There is moderate vegetation cover around the area. During habitation vegetation is important for the absorption of gas emissions and in turn increases fresh air. GBCSA (2012), stresses that low-income households rarely have food gardens. GBCSA (2012) further stresses that within these settlements there are minor efforts and attempts at home for gardening and agricultural practice due to lack of or no information on how the process may be executed. In addition there is a lack of resources. Due to these factors temperature regulation may not be effective during hot and cold seasons (GBCSA 2012). In areas where there is removal of vegetation the soil is exposed and susceptible to erosion by water or wind. As a result the flow of runoff increases during rainy seasons (Parkinson, 2003). Such negative impacts coupled with often inadequate drainage systems exacerbate soil erosion. Therefore restoration of the environment through greening must be considered from time to time. All together, these factors combined, result in environmental degradation and they compromise the quality of place (Parkinson, 2003).

2.5.2. Energy Conditions within Low-income Settlements

According to SALGA (2014) poor insulation and ventilation result in extreme temperature fluctuations and excessive levels of humidity. The absence of insulation ceiling in low-income houses causes the interior to become too hot during hot seasons and too cold during cold periods. This results in high energy consumption to regulate indoor temperature (SALGA, 2014).

Furthermore the dependence on one energy source in most low-income settlements results in excessively high consumption and demands of electricity, which is considered expensive for the disadvantaged (SSN, 2015). This may result in tampering with switch boards to illegally connect the expensive electricity for energy (Sowman & Urquhart, 1998). Lemaire (2015) further adds that the electricity installed in low-income settlements is inadequate; there is only one plug point found in the electrical switch board and one electrical bulb. Consequently this results in inappropriate connections to the rest of the house and may put the life of residents in danger

(Lemaire, 2015). The use of fuels such as paraffin results in excess greenhouse gas emissions. This is also indicative of inadequate services since there are no other clean sources of energy provided for low-income household activities (GBCSA, 2012). The high costs of energy may result in difficulties in accessing electricity, where in fact there should be other clean sources which are also easily accessible. Not only may other sources be readily accessible but they may also minimise costs, increase efficiency and avoid high consumption of electricity as a source of energy (Lemaire, 2015).

2.5.3. Water Inefficiency within Low income Settlements

In low-income settlements water is provided by the municipality. Water service is installed through a single tap in each house or water standpipes in each street (Zunguzane et al., 2012). In other settlements, a ration of 200 litres of free water is provided in each house for all domestic activities per day (Tissington, 2011). If the water is free, residents may often use it recklessly knowing they do not have to pay for it. Therefore they may not necessarily recognise the importance of saving water and hence they may not even initiate individual water saving methods. As a result this may cause high consumption of water. In addition it may exacerbate the already scarce water conditions not only within the settlements but in the broad environment since South Africa is a water scarce country (Tissington, 2011; Zunguzane et al., 2012).

2.5.4. Inadequate Waste Management within Low-income Settlements

GBCSA (2012) points out that most of low-income settlements are often provided with poor and inadequate waste management services. The contributing factor to this poor service is drawn from the continuously reduced capability of municipalities to provide adequate infrastructure and services due to increasing populations and urbanisation (Tissington, 2011). Insufficient waste services and management result in inappropriate waste disposal, accumulation of waste within the environment and pollution. All of these conditions compromise the quality of place. If there is a river stream, waste may accumulate in the river stream and result in water contamination. Contaminated water is not only inaccessible for residents but also threatens the life of aquatic organisms (GBCSA, 2012).

2.6. The Benefits of Conserving Natural Capital to Low-income Settlements

Environmental sustainability is a condition in the environment that allows the use of resources, goods and services within the capacity of the ecosystems and their regeneration (Moreli, 2011). It is based on the implications that there must be a balance between production and consumption of the natural capital goods and services needed for human life. Thus, it is based on maintaining and conserving natural capital (Goodland, 1995). The availability of natural goods and services can be constrained if the consumption and production balance is not reached. The life-supporting systems such as water, air, energy and forests, from which natural capital goods and services are accumulated must be maintained so that there are no shortages of resources (Goodland, 1995).

An environmentally sustainable settlement is one which is characterized by activities that produce waste and pollution that the natural environment can absorb, prioritizes conservation of renewable and non-renewable resources, promotes recycle and reuse of resources, and yields minimal negative environmental impacts (Mebratu, 2007). This means that the lifecycle of housing as a product will not collapse the environment; there is efficient use of water and energy for household activities, and there is adequate management of waste to control pollution (Sowman and Urquhart, 1998).

2.7. The Importance of Conservation of Natural Capital for QoP?

The natural capital is the stock of all natural goods and services which is natural resources such as water, geology, land and energy (Collados & Duane, 1999). From the natural capital a wide range of ecosystem goods and services for human life to continue is derived. Some of the goods and services from natural capital that are mostly used for human life are fuel, building material, water, energy, medicine, forests, climate regulation and natural flood defence. These goods can be regarded as renewable or non-renewable resources (Natural Capital Forum, 2015).

Like any other capital, when too many resources are drawn from the environment, a debt which needs to be paid fully is created. In the environment this for instance is done by replanting a forest after cutting of trees, or allowing groundwater to replenish after extraction (WWF, 1993). However there are other resources that cannot be renewed such as oil. Poorly-

managed natural capital becomes an ecological liability. This occurs from over exploitation of natural resources. It results in biodiversity loss, reduces ecosystem productivity and exacerbation of extreme natural disasters. As a result human life becomes difficult to maintain (NCF, 2015). Nature is therefore priceless, although it has social and financial values. There must be a well-managed natural capital so that the settlements are continuously environmentally sustained (NCF, 2015).

Ayatac & Turk (2009) argue that in a settlement one of the outcomes of a well-managed natural capital is the improvement and maintenance of high quality of place. Generally QoP is concerned with various elements in a settlement such as accessibility of place, sense of place, size and type of place, users of place and natural characteristics of a place (Ayatac & Turk, 2009). However from an environmental perspective QoP would be concerned with the natural and physical characteristics of place, type of place and users of place. The natural and physical characteristics of a place refer to rivers, mountains, vegetation, soil, buildings, landscape and infrastructure (Wesener, 2011). The type of place refers to land use of that place; it can be residential, commercial or industrial. The users of a place are the people using a specific place for their daily activities (Wesener, 2011). Maintaining a good quality of place therefore depends on the interaction of the users of a place with the physical and natural attributes of a place which include the stock of natural goods and services.

In order for the environment to best preserve its distinguished natural features in a settlement, housing must respond to nature. The creation of a settlement is an on-going process that has no beginning or end. In process of creating a settlement the quality of place is best achieved in the construction process during site-making and during the functioning of the house (CSIR, 2000). On an on-going settlement making it can be achieved by creating a diversity vegetated space for fresh air and absorption of greenhouse gases, food provision and medicinal use, ensuring there are additional sources of water, energy, and providing adequate services to control waste (CSIR, 2000). In its functional stage, when housing is used as a product it can be achieved by maintaining all these conditions so as to avoid threats towards the environment. These actions do not only conserve capital in a settlement but also create more choices of living

for the community while the negative impacts towards the environment are minimised (CSIR, 2000).

These settlement conditions reveal a well-managed natural capital and control of unanticipated threats towards the environment. They improve settlement viability and quality (CSIR, 2000; NCF, 2015). Furthermore there is careful consideration of all the services and infrastructure that are provided to accommodate resource efficiency and waste management, as well as restoring the environment during the unending use of these services. As a direct influence from these conditions the quality of place is improved (Ayatac & Turk, 2009). For this study, greening, energy efficiency, water efficiency and waste management were assessed and suggested as the approaches and contributors for achieving conservation of natural capital, minimising environmental threats and improving QoP.

2.8. Approaches for Maintaining Natural Capital and Improving QoP

2.8.1. Importance of Greening within Low-income Settlements

Greening is the process of planting vegetation cover with an aim of increasing vegetation pockets within an area. Vegetation protects the house against soil erosion and wind (Saini, 2011). Not only does vegetation protect the house, during the lifecycle of housing household activities may produce greenhouse emissions into the atmosphere. Plants are well known for the absorption of carbon dioxide and taking out oxygen; therefore in a settlement they absorb greenhouse gases and increase air quality (Denison et al., 2011). As a result, the conservation of vegetation for the improvement of QoP is important in low-income settlements. Other advantages of vegetation that are discussed in this section are the provision of medicine and nutrition and increasing water quality.

2.8.1.1. Improving Air quality

Since plants generally give out oxygen and absorb carbon dioxide increasing vegetation cover within low-income settlement assists in the absorption of greenhouse gases produced from domestic activities and energy consumption. As a result pollutants are reduced, fresh and clean air quality is increased. Vegetation also traps dust and all other particulate matter thus purifying air (GBCSA, 2012). In the process of greening, indigenous trees must always be

prioritised since they are adaptable to the environment and they require affordable low-maintenance (Given and Meruk, 1998). Different type of vegetation can be planted in settlements, e.g. shrubs, trees, crops. Depending on location and type of soil, greening can be done in the form of parks, corridors or home gardens (Bilgili & Gökyer , 2012).

2.8.1.2. Protecting the House

Trees have the ability to protect the house from strong winds depending on the orientation of the house and the type of vegetation. They act as windbreaks, impeding wind from the ground and deflecting it over and away from the house (USDA, 2007; Denison et al., 2011). In this regard the roof of low-income houses may be protected from being ripped off if there is vegetation around the house. Moreover this process lowers the chills brought by the wind during cold periods (Powell, 2015). Vegetation also protects the house from fires. Fire resistant shrubs are useful for this and they can be planted around the house (Sowman and Urhuhart, 1998).

2.8.1.3. Protecting the Soil

Vegetation protects the soil from water runoff thus preventing erosion. It does this by stabilising the soil and tightening soil particles; binding them together so that they efficiently absorb water (Gillaspy, 2015). The velocity of water runoff is slowed down as water gradually infiltrates the soil. This prevents the building up of water runoff and contributes to the water table and groundwater (Menashe, 1998). The effects of soil erosion such as flooding can be hazardous if they are ignored. These effects may result in the dilapidation and damage to the house, which in most cases may need rebuilding or renovation (Gillaspy, 2015). Therefore, introducing vegetation in low-income settlements protects the house, increases its quality while improving the quality of place of a settlement.

2.8.1.4. Nutrition and Medicinal Provision

Vegetation also contributes to food production through agricultural practice. This can be done in the form of gardens for vegetables, fruits and medicinal crops and/or trees. In this manner vegetation provides excess natural capital goods and services which is medicine and nutrients. Moreover it provides healthy food for the disadvantaged residents at a much easily accessible and affordable rate (Given and Meruk, 1998). Low-income households may not have enough

space to grow food crops such as fruits and vegetables to feed the household or for other types of gardens (Cervantes-Goroy & Dewbre, 2010). An agricultural practice suitable to the settlement can be adopted to grow food and produce it in a sustainable manner (Sowman and Urquhart, 1998).

2.8.1.5. The Significance of Water Quality within Low-income Settlements

In waterways, vegetation acts as evaporation ponds. It extracts chemicals used in fertilisers such as phosphorus and sulphur from water and keeps them out of water thus increasing water quality and well-being of aquatic animals (Dosskey, et al., 2010). When there is heavy rainfall, the velocity of the flow in rivers is high, therefore vegetation absorbs the force in the flow and reduces the erosion in the river banks (Dosskey, et al., 2010)

2.8.2. Water Efficiency

In low-income settlements water is used for domestic activities mainly washing, cleaning, cooking and drinking. Water is also used for sanitation and other purposes. Other low-income settlements, however, have been provided with Ventilated Improved Pit (VIP) toilets or Urine Diversion (UD) toilets. This is an efficient way to save water used for flushing. Moreover the financial costs for maintaining sewerage in these VIP toilets are much lower than those of flushed toilets (Tissington, 2011).

Generally in any type of a settlement clean and safe water is essential for domestic activities and for the maintenance of life. Low-income settlements go hand in hand with basic services of water, such as taps and water tanks per house at the rates that will be affordable to pay for. Some low-income households are provided with free water service in the form of a tank that has a capacity of 200 litres of water per day (Tissington, 2011). Interventions for water conservation are essential for the maintenance of the natural capital within low-income settlements. This reduces the costs that must be covered to pay for using water and optimises water efficiency. The water saving methods that the study argues are relevant to increasing efficiency are rainwater harvesting and water recycling. These methods are not only presumed to reduce costs for water but also conserve water as a natural capital (Denison et al., 2011).

2.8.2.1. Rainwater Harvesting

South Africa is a water scarce country; if water saving methods are not adopted, the demand of water may exceed the supply (DWA, 2011). In South Africa all households depend on dams for water supply. However in some parts of South Africa ground water is supplied. For low-income settlements that are located in dry areas and away from dams, a stand of water pipes is provided to supply for 25 households per section (Sowman and Urquhart, 1998). It is for these reasons that low-income residents are encouraged to harvest water using the tank system. The tank system is installed through a roof gutter system which collects water and stores it in tanks. Apart from the roof gutter system, rainfall water can be harvested using other methods, depending on the number of people that must be supplied with it (Denison et al., 2011). The equipment used in this system can be expensive but the water comes free, therefore it is worth installing as a service for low-income settlements. It is important that this alternative of water conservation system is readily available for low-income settlements since the low-income groups cannot afford it individually (Tissington, 2011). Moreover it may be useful in case of water disruptions such as water shedding which is a current crisis in our country.

2.8.2.2. Water Recycling

Water recycling is another measure used to conserve and use water efficiently. Recycled water can be reused for different purposes. Nevertheless, if not carefully monitored, recycled water may cause a health hazard (Denison et al., 2011). It is therefore important that an appropriate system is adopted to recycle water. Water from bathing, washing dishes and clothes, cleaning etc. can be filtered and used for garden irrigation, flushing or other purposes (Denison et al., 2011). There are several systems designed to recycle water. They range in size, depending on the number of people using it. The number can range from 4-6 in a household. However grey water recycle-systems can be expensive to install. This may be the reason that low-income settlements are not provided with it (The Mvula Trust, 2015; Sowman & Urquhart, 1998). There is however an alternative domestic grey water system that can be adopted using cheaper materials. The materials are a cleaned oil drum with a gradation of particles ranging from pebbles to sand. The particles can isolate clean water and release it out to be reused for

irrigation, flushing or other purposes for which it is desired (The Mvula Trust, 2015; Sowman & Urquhart, 1998).

2.8.3. The Significance of Energy Efficiency within Low-income Settlements

In order to achieve and maintain sustainable low-income settlements energy is one of the essential natural resources after water. It makes sustaining of life easier and some of household activities cannot be performed without it. The form of energy that is usually provided for low-income settlements is electricity (Department of Energy, 2012). However, electricity has been a continuously scarce resource. In the pursuit of energy efficiency, dependence on other sources is therefore required. Given the critical condition of electricity in South Africa this may be a useful way to conserve electricity and provide other sources of clean energy for low-income settlements, thus maximising energy efficiency (Yelland, 2009). Such form of energy can be substituted for other household activities that depend on energy, while other activities can be performed using electricity.

2.8.3.1. Electrical Energy

Among all the varieties of energy, electricity is considered to have less negative environmental impacts, affordable and safer than liquefied petroleum gas (LPG), paraffin, wood and batteries (GBCSA, 2012). This is because other forms of energy may cause health and environment hazards through high levels of air pollution. In low-income settlements LPG and paraffin are mostly used when there is no electricity. This is because they are easily affordable and accessible for most low-income households. However some low-income households continue to use them as a source of energy other than electricity (Tait, Merven and Senatla, 2013). This is perpetuated by the high costs of electricity and the electricity crisis that South Africa is facing. The capacity of electricity has failed to meet increasing demand of energy (SALGA, 2014; Yelland, 2009).

2.8.3.2. Renewable Energy

Renewable energy is another source of energy that is used for the generation of electricity and that is closely related to naturally occurring and non-depletable sources of energy. Types of renewable energy sources are solar, wind and biomass. They produce electricity, gaseous and liquid fuels as well as heat energy (DME, 2003). The burning of wood is also renewable, but if it

is burned rapidly the resultant smoke can emit pollutants into the atmosphere (SALGA, 2014). The form of renewable energy that may be used for low-income housing is solar energy and biogas system. However the biogas system is too expensive to install and maintain and it requires careful monitoring and management. Therefore, solar power is considered ideal (GBCSA, 2012).

In the generation of electricity using solar energy, solar power is used. This depends on the sun's energy and rays to regulate temperature for the generation of electricity. The system used to generate electricity from the sun is called photovoltaic (PV) system (DME, 2003). The system has panels that are installed on the roof of the houses directly towards the sun and convert the sun's rays into electricity. It is essential that they face due north for the efficient incoming of the sun's rays. Solar panels can therefore be used as an alternative renewable source of energy in low-income settlements in order to conserve the scarce coals also used for generating electricity thus increasing efficiency (SALGA, 2014).

2.8.4. The Significance of Waste Management within Low-income Settlements

Infrastructure and services are fundamental supporting systems of low-income settlements and for the continuous operation of domestic activities whilst controlling waste generated by these activities (CSIR, 2000). The provision of waste services within low income settlements is very important because it controls the generation of waste (CSIR, 2000). Waste management services ensure that: the environment is protected against waste; there is reduction of pollution and environmental impacts are minimised.

It is important that there are strategies developed for the management and control of waste. In low-income settlements waste is usually individually managed or municipal managed or both (Tissington, 2011; Sowman & Urquhart, 1998). With individual management, it is the responsibility of household residents to collect waste in their environment. During individual waste management, waste is usually collected, disposed in an excavated hole and incinerated. Municipal waste management involves waste collection services through waste collection vehicles in each house (Tissington, 2011).

Developing appropriate and acceptable waste management systems for low-income settlements is important for controlling pollution. Like any other settlement, low-income settlements also produce domestic waste. It is important that solid and liquid waste are properly managed to avoid a health and environmental hazard (CSIR, 2011). As a result this prevents inappropriate disposal of waste. Waste management in such settlements must accommodate the settlement in terms of affordability and maintenance (CSIR, 2011). This section of the study focuses on managing household and settlement waste relying on collection services available in the settlement and waste recycling.

2.8.4.1. Collection Services:

Collection of waste can be arranged by the municipality through collection vehicles in every house or street. This may either be included in the rates that the household members pay monthly or come as a free service (Tissington, 2011). Municipal waste management provides may be outsourced or in-house waste collection services. The outsourced service is a normal construction truck that collects waste every week from every household. The in-house service is a waste collection designed truck that collects waste every day in each household (Sowman & Urquhart, 1998). In cases where this service is not readily available or the community cannot afford it, community based waste management or individual waste management can be initiated instead (van de Klundert & Lardinois, 1995).

2.8.4.2. Waste Recycling

Waste recycling involves collecting waste such as glasses, plastics, bottles and papers by recycling companies through designated trucks (van de Klundert & Lardinois, 1995). This can create job opportunities and income generation for the community while environmental quality is increased. The rest of the waste that is not recycled could be carefully monitored in terms of disposal in order to avoid damage to the environment (CSIR, 2011). Community based waste management involves forming Community Based Organisations (CBO's) in the aim of self-servicing to manage waste. This is highly effective in low-income settlements since marginal services are often provided (van de Klundert & Lardinois, 1995). Apart from the effects of waste management to the environment which are clean air quality, water quality and pollution

reduction, there is also alleviation of environmental threats and well-maintained natural capital leading to the improvement in the quality of place.

2.9. Tools for Monitoring the Environmental Threats within Low-income Settlements

The study has used two organisations that have given tools for monitoring and reducing unintended environmental threats within low-income settlements. These organisations are the Green Building Council of South Africa (GBCSA) and the Council for Scientific and Industrial Research (CSIR). CSIR has released a red book which has the guidelines for creating human settlements while GBCSA created a green star tool which assesses environmental attributes of buildings. These tools and guidelines are useful in achieving greening, energy efficiency, water efficiency and waste management thus making low-income settlements environmentally sustainable.

The CSIR Red book gives a description of the attributes of sustainable settlements in terms of environmental conditions. According to CSIR (2000), in order for settlements to operate efficiently they require a range of resources that must be used with special attention. These resources are water, man power, energy, infrastructure and services. It is the people that live in a settlement that improve the settlement's environment through social, cultural and recreational opportunities that they create from natural capital and share as a group (CSIR, 2000). Subsequently, the quality of place depends upon natural elements such as green spaces for shade, wind protection and food, parks for recreation, source of energy and water, controlled waste and services. These elements do not only provide a clean and environmentally sustainable settlement but also provide the community with various choices of living conditions (CSIR, 2000).

CSIR (2000) also argues that a settlement must be able to adapt to the natural landscape it is located within and this depends on the natural resources it has. The availability and maintenance of natural capital consequently depends on sustainability. Sustainability of a settlement has two dimensions; the one that is entitled to a relationship between the built and

natural environment, and the one entitled to the quality of place that a settlement reflects. Achieving environmental sustainability within the settlement lies on:

- Working in harmony with the natural environment, and avoiding breakdowns to its systems.
- Recycling and reusing waste as much as possible to avoid pollution.
- Availability of adequate services to control environmental threats (CSIR, 2000).

Therefore an environmentally sustainable settlement will result in high quality of place and the end-user (resident) can make use of its benefits and those of pleasant environmental conditions (Zunguzane et al., 2012).

Additionally to the recommendation made by CSIR the department of Human settlements commissioned CSIR to update Human Settlement Atlas by demonstrating sustainable low-income settlements as well as decreasing the dependence of low-income settlements on municipal services. As a result a pilot study of 441 houses was done in Western Cape Overstrand Municipality to demonstrate energy efficient and sustainable low-income settlements. CSIR installed innovative technology in the roof assembly of the houses it built during the construction of the super-structure and sub-structure, the wall finishing and the service structures (CSIR, 2010). Energy efficiency was incorporated through installation of standard, commercial solar water heater on top of the roof. This ensured the provision of home owners with hot water whilst reducing dependence on municipal services (CSIR, 2010).

Energy efficiency was further improved through maximisation of insulation. Generally low-income houses have no ceilings and thus no insulation. This results in huge variations in indoor temperatures, where the house is too cold during winter and too hot during summer. In this way the thermal performance of the house is significantly improved (CSIR, 2010). For the improvement of water efficiency a water tank was installed next to the house for harvesting rainwater off the roof. As part of monitoring sustainability CSIR committed itself to evaluate the performance improvement of these houses in terms of energy efficiency, greening and water efficiency after a period of 1 year (CSIR, 2010).

This is evidence that CSIR has not only made requirements of sustainable human settlements on the Red Book but have also demonstrated how such can be achieved and how they can be monitored overtime. CSIR has also worked hand in hand with DHS in creating sustainable human settlements programme for the department through the Redbook. However the Redbook sets a vision for South African Sustainable Settlements. It is general to the reader and user such as architects and engineers and department. It is not made as a basic requirement that is incorporated in the housing policy so as to guide implementation. Therefore it is not all housing projects that the DHS commission CSIR to be involved throughout the housing process and its life-cycle as a product (CSIR, 2010).

The GBCSA (2015), on the other hand, provided the basis for the provision of environmentally sustainable houses through green buildings. The Green Building Council of South Africa is a non-profit company that deals with the greening of South Africa's commercial property. It promotes buildings to use resources efficiently and address climate change while creating productive environments (GBCSA, 2015). It has various tools that are used to enhance green buildings. This study focuses on the green star tool.

The green star is an environmentally based tool used for assessing the interior and exterior of office, retail, multi-unit residential, public, and education buildings. In terms of low-income settlements as part of the residential units, the green star tool may be used to assess environmental attributes (GBCSA, 2015). The multi residential development unit green star tool is used for developments that are common property with three or more dwelling units, shared services, and infrastructure (GBCSA, 2013). The development types it focuses on are apartments, flats, townhouses, semi-attached housing, gated communities, and self-catering student residence (GBCSA, 2015). Apartments and semi-attached housing can be part of low-income housing; the study suggests this tool for assessing and monitoring environmental attributes of low-income housing.

In assessing the environmental attributes of buildings, the green star uses different categories. These are energy, water, management, emissions, land use and ecology, transport, innovation, indoor environmental quality and material (GBCSA, 2015). The building is accredited for each of

these categories. For a building to get accreditation it must at least be a five star in terms of categories. At the end of the design phase the green star grants accreditation of the green building according to the environmental attributes and categories shown in table 1 for that particular building (GBCSA, 2015)

Table 1: Green Star Categories

Management	Indoor Environmental Quality	Energy
Green Star SA Accredited Professional	Ventilation.	Conditional Requirement.
Commissioning	Daylight Thermal Comfort	Greenhouse Gas Emissions
Occupant Users' Guide	Hazardous materials	Energy sub-metering
Environmental Management	Internal Noise Levels	Lighting Energy Use
Waste Management	Volatile Organic Compounds	Maximum Electrical Demand Reduction
Airtightness Testing	Formaldehyde Minimisation	Hot Water Energy Use
Common Property Rules	Private outdoor space	Common Property Services Energy Use
	Universal Access	
Transport	Water	Materials
Car Parking Provision	Occupant Amenity Water	Recycling waste storage
Fuel Efficient Transport	Water Sub-Metering	Building Reuse
Cyclist facilities	Landscape Irrigation	Recycled Content and Material
Local connectivity	Fire system water	Concrete
	Potable Water Efficient Appliances	Steel
	Pool Eater Efficiency	Sustainable Timber
		Dematerialisation

		Local Sourcing
		Efficient Dwelling Size
		Masonry
Land use & Ecology	Emissions	Innovations
Conditional Requirement	Gaseous ODP	Innovative Strategies and Technology
Topsoil	Refrigerant GDW	Exceeding Green Star SA Benchmark
Reuse of Land	Insulant ODP	Environmental Design Initiatives
Reclaimed Contaminated Soil	Watercourse Pollution	
Change of Ecological Value	Discharge to Sewer	
Urban Heat Island	Light Pollution	
Outdoor Communal Facilities	Boiler and Generator Emissions	
Urban Consolidation		

Source: GBCSA (2015)

GBCSA has demonstrated such attributes through a pilot project in Cator Manor low-income housing. The project selected 30 low-income households for improving environmental attributes. A set of broad interventions to make low-income environmentally sustainable was implemented through solar heaters, insulated ceilings, efficient lighting, insulation cookers, rain water harvesting tanks food gardens and cleaning of a polluted stream (GBCSA, 2012). Solar water heaters delivered hot water inside houses without the dependence on electricity using about 85% of South African products. This reduced the emissions of greenhouse gases associated with importing such products. The insulated ceilings were installed to improve the thermal performance. Not only was thermal performance improved but also the reduction of energy consumption to control indoor temperature (GBCSA 2012). Efficient lighting was implemented through the installation of compact fluorescent light bulbs. Such light bulbs are known for saving energy compared to the normal used incandescent light bulbs (GBCSA, 2012).

Rainwater harvesting were installed to save tap water, provide water in cases of drought or interruption in water services. Due to limited space in low-income households recycled car tyres and 2l containers were used to establish home gardening to those interested. Fruit trees and other indigenous plants were also planted. In order for these plants to be maintained training on permaculture and food gardening was provided for the community (GBCSA, 2012). These interventions increased comfort inside homes, saved energy and increased its affordability, reduced carbon emission and boosted water security. As a result the quality of place was improved while improving the quality of life as well.

2.10. Conclusion

This section explored that during the lifecycle and functioning of low-income settlements resource efficiency is the element for the control of natural capital consumption within low-income settlement. The presence of vegetation protects the house, provides free nutrition and medicine and the quality of place is improved. Therefore the role of vegetation in the process and product of low income housing must always be considered. Energy efficiency creates innovative ways for other clean and affordable resources of energy. Water recycling and saving methods within low-income settlement assist in conserving the scarce resource of water and increase efficiency. Managing waste for housing product reduces waste using collection services and recycling waste. For the maintenance of such conditions, GBCSA and CSIR have contributed by providing tools for evaluating, assessing and monitoring environmental attributes.

CHAPTER 3: THEORITICAL AND CONCEPTUAL FRAMEWORK

3.1. Introduction

Theories are credible studies that seek to explain, predict and understand scenarios while challenging the existing knowledge which is constrained to critical assumptions. They represent what goes on inside the head of a researcher whereas observations represent what goes on in reality (Simon & Goes, 2011). It is on such grounds that this study was formulated. The theoretical framework guides the logic of the study and provides a supportive rationale for it. It does this by pointing out the limits of the study and the key factors influencing it (Labaree, 2013). In this study four theories were used to interpret the findings of the secondary data. This chapter provides a selection analysis of perspectives and concepts of sustainability, sustainable development, and environmental sustainability relevance to the use of housing as a product within the environment

3.2. Sustainability

The concept of sustainability encompasses the ways in which environmental impacts compromise and lower the conditions of a stable and healthy economic, ecological, and social system (Mulder and van Den Bergh, 2001). It is the unending mission that is aimed at improving the quality of life without degrading the environmental life-supporting systems. It involves equity and justice for all in the access of resources needed to support life (Moreli, 2011).

Sustainability first emerged in an aim of finding the suitable manner for consuming resources (Russell 1995). Various arguments arouse around the concept of sustainability. Some theorists argued that environmental degradation was affecting production, while some argued that it is not environmental degradation that determines the availability of resources but immense technology; as human knowledge advances, decision making improves and resources also increase (Russell, 1995).

Irurah & Boshoff (2003) maintain that sustainability has strongly evolved. It started in the 20th Century as a paradigm approached antagonistically. The antagonistic approaches were divided into two: the first was based on economic growth. This approach was rooted on the beliefs that economic growth is central to sustainability, therefore achieving sustainability lies in increasing

economic growth and increased economic outputs. The second approach was based on standards of living where high standards of living indicated sustainability. In both these approaches minimal attention was given to the environmental impacts (Irurah & Boshoff, 2003)

Realisation of environmental degradation resulted in unity of antagonistic movements to form one environmental movement where several organisations were formed rooted on one goal. This movement was based on common ideas to address resource and environmental degradation arising from economic and population growth (Drexhage & Murphy, 2010). The movement stressed that unless there is control of population and economic growth, the environment will eventually put limits to development and human survival (Irurah & Boshoff, 2003). Within this unity of the environmental movement, efforts were made to prepare action for environmental degradation. These efforts resulted in the United Nations Conference on Environment and Development (UNCED) which was held in Stockholm. At this conference it was realised that a framework is needed to sustain the environment and control degradation (Adams, 2008) .

Following from the UNCED, was the 1987 World Commission on the Environment and Development (WCED) conference titled “Our Common Future”. The WCED was created as an independent figure by the United Nations General Assembly to progress the understanding of interrelation between economics and the environment (Creech, 2012). It was realised that the environment does not exist separately from our daily activities and needs. It must at all times be considered as an inclusion in human concerns. It is where we all live and call home. Development is a tool we use to improve our lives within it, therefore the two are inseparable (WCED, 1987). Through the WCED sustainable development resulted as a framework that can be used to integrate environmental, economic, social pillars and achieve environment, social and economic sustainability where:

- **Environmental Sustainability:** is based on stable resource base, preserving the natural capital, maintaining environmental quality such as clean water and air, environmental protection; waste management, and resource efficiency (Satton, 2004).

- **Economic Sustainability:** is based on continual production of goods and services, a financial stable system, state control of debts and all economic and efficient markets (Harris 2000).
- **Social Sustainability:** Is based on social cohesion; social welfare, integration of factors such as health, adequate services, infrastructure and facilities, even distribution of resources; stable political system, security, gender equity, transparency, participation and accountability (Dempsey, et al. 2011).

3.3. Sustainable Development

After the WCED report sustainable development was adopted by different organisations and sectors such as the World Bank, World Trade Organisation, Wildlife World Fund, non-government organisations (NGO) and local and international governments (Sneddon, Howarth and Norgaard, 2006). The WCED (1987) defines sustainable development as the development that allows the fulfilment of present generations' needs while those of the future generations are not compromised. However there have been other definitions of sustainable development from other organisations. Adams (2008) argues that these definitions are often strongly rooted on the satisfaction of needs and concerns for future generations. The World Wildlife Fund for Nature (1993) defines sustainable development as the improvement of quality of life within the ecosystems carrying capacity. The National Commission on the Environment (1993) defines sustainable development as an approach to improve the quality of life whilst making sure the future generation will also be able to improve theirs. Sustainable development has three pillars which are environmental, economic and social pillars. In sustainability the three pillars integrate to produce a sustainable system and each pillar represents a component of sustainability (Irurah and Boshoff, 2003).

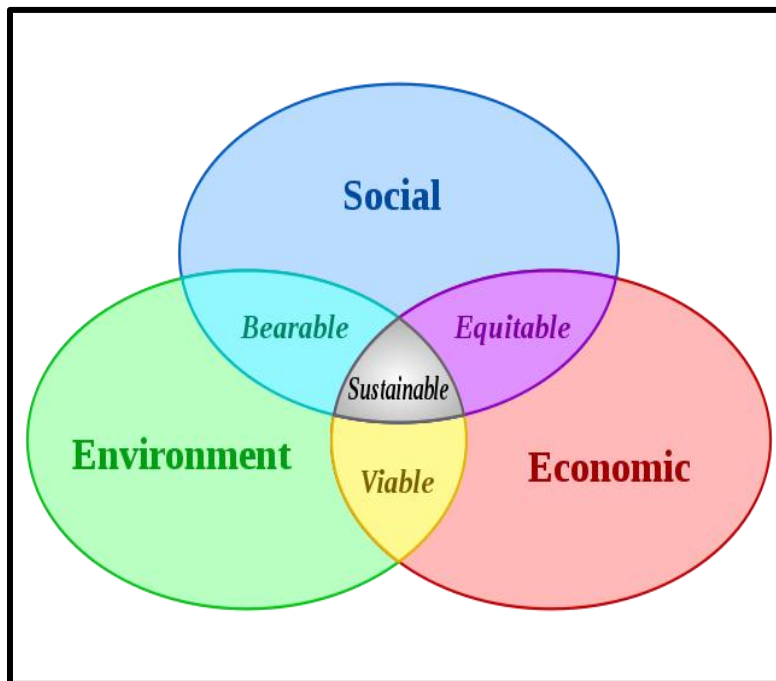
Sustainable development seeks to ensure that these pillars remain mutually compatible during all development processes (Adams. 2008). Keeping the three pillars mutually compatible with each other assist in creating actions and interventions that address development challenges. The integration of the three pillars can be diagrammatically represented by various models. This

study selected two models which is the Venn diagram and the concentric or nested circles (Helleman, 2012).

3.3.1. Different Models of Sustainable Development

The Venn diagram on figure 2 is the popular model for the conceptualisation of sustainability. It has been adopted by the UN and several other international organisations (Helleman, 2012). In this model the three pillars of sustainability occur in three distinctive circles representing each pillar. Where all of the three pillars integrate represents sustainability (Mann, 2009). The extent to which each pillar impacts on each other expresses the relationship they have with each other where the system can either be bearable, equitable, viable or sustainable which is the main goal (Helleman, 2012).

Figure 2: Sustainable Development Represented in Venn Diagram



Source: Helleman (2012)

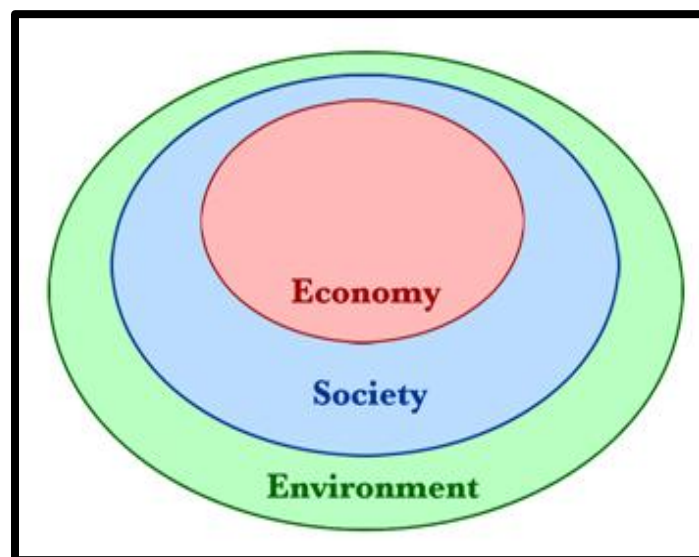
However the other regions of the pillars occur exclusively separated and are not wholly part of the system which Mebratu (1998) recognises as weak sustainability. Mann (2009) also argues

that this model implies weak sustainability since it maintains that degradation of one pillar is compensated by the improvement of the other, suggesting a possibility of replacing natural capital with human capital.

Although sustainability means the integration of the three pillar, the model on the Venn diagram suggests that they are independent and are unrelated which contrasts with the idea behind sustainability which is integration (Moir & Carter, 2012). Therefore, addressing issues related to each pillar using this model becomes challenging and instead technological solutions are applied and this appears to be weak sustainability. This model fails to engage with issues at a deeper level and engage with the whole system (Mebratu, 1998).

The shortcomings of the Venn diagram resulted in emergence of other various diagrams although this study focuses only on one which is the concentric circles as illustrated in figure 3 (Mann, 2009). This model is strongly associated with strong sustainability. It maintains that the economy only exists in the context of society and all economic activities are constrained by the natural resources. Moreover the economic activities such as exchange of goods are based on social interactions (Moir & Carter, 2012)

Figure 3: Sustainable Development Represented in Concentric Circles



Source: Helleman (2012)

Lozano (2008) criticises this model for failing to consider the spatial existence of societies, economics and environments which are controlled by different policies and perceptions. In this regard the three regions cannot be considered as a unified system. This model also maintains that all the three systems are dependent on each other but in reality the environment can exist without societies and the societies can to some extent persist without economy (Lozano, 2008).

3.3.2. Sustainable Development in South Africa

Since its first emergence by the WCED, the implementation of sustainable development in South Africa has been inadequate. There have been several programmes and policies formulated to effect sustainability on improving people's lives (Sneddon, Howarth and Norgaard, 2006). In South Africa implementation has been done through aligning sustainability goals with government planning, evaluation, and monitoring implementation systems (DEA, 2011). It is believed that this alignment can be integrated into all spheres of government from national, provincial, local up to municipalities, and civil societies (DEA, 2011). Although this is a good strategy but the detail of the "how" part of this strategy is not clearly stated. Furthermore, the responsibilities are given to all sectors but the tools and resources that are needed are not specified in terms of how they can be accumulated (Sneddon, Howarth and Norgaard, 2006). The effects from such phenomenon are inadequate implementation of sustainability let alone environmental sustainability (Sneddon, Howarth and Norgaard, 2006). As a result the implementation of environmentally sustainable low-income houses has been a challenge

Capacity to support implementation such as financial resources is needed. Moreover the political context is also important for the implementation of sustainability, this is for governing decision making around sustainability (Robinson, 2004). All the decisions that entail sustainable development are influenced by the political context (Drexhage and Murphy, 2010). Oftentimes the implementation of sustainable development is done just to impose a political idea and fulfil its goal rather than to effect change in development (Adams, 2008). In South Africa alone the capacity to implement sustainability remains critical in all sectors especially the public sector (DEA, 2011).

The efforts that have been made by South Africa to implement sustainability are often market-oriented. They are based on the status of the market and economy. This puts a price on environmental degradation (Abaza and Baranzin, 2002). If the environment is degraded there are costs that are paid by those responsible. This gives the implication that it is acceptable to degrade the environment as long as one can afford the costs (Robinson, 2004). There are also plans and strategies of implementation. However they are quite unconsolidated, they lack the aspects of constituency of government channels thus they fail to address implementation (Abaza and Baranzin, 2002). Poor decision making and unstable political systems have bad influence on the implementation of sustainability (Abaza and Baranzin, 2002). The action plans of implementation made by political leaders are often based on their hidden agendas such as preparing campaigns for election. They are created as a way to attract peoples support. When the campaigning is over, the plans are not necessarily put into action (Drexhage and Murphy, 2010).

Lack of infrastructure is also an influencing factor to inadequate implementation especially in developing countries (Mc Neil, 2007). One of the implementation actions for sustainability has been done through Agenda 21. Many of the developing countries have not been able to live up to the commitments they made in Agenda 21 and Rio Declaration (Mc Neil, 2007). Although the strategies and plans were stated but the infrastructure and tools needed to fulfil those plans was not accumulated, especially in developing countries such as China, India and South Africa (Mc Neil, 2007). This is due to the shortage of the resources needed. There has not been research on how the tools for implementation could be acquired and how to use them effectively and efficiently (Mc Neil (2007).

3.4. Theoretical Framework

Although most researchers believe that housing lacks academic disciplines, and thus should not be theorised, theories of housing have been known to capture the transition between users and providers of housing (King, 2012). It is the application of theories that is important, not their creation. In this regard, theories must not be used as an approach to achieve environmentally

sustainable settlements but must be used to guide policy making. Policy thus would engage in the manner that theories have evolved so that their policy can be suitable to their context and to the environment (King, 2012).

King (2012) asserts that it is advisable to engage with concepts and theories from different disciplines such as environment, sociology, economics and politics. This is for conceptualising housing according to theories and concepts prevalent in each discipline, since it affects and is affected by these areas. This study, however, conceptualised housing based on environmental sustainability and engaged with theories around these concepts.

The study selected four theories which are liberal, neo-liberal, neo-classical theory and an evolutionary theory. These theories give an emphasis of accumulation of natural capital for the functioning of low-income settlements and maintaining natural capital within that process. They reveal the manner in which sustainability is perceived, the way in which it is reflected in the system and the approaches used for it to effect change.

3.4.1. Liberal Theory

Liberal views were promoted by John Turner in opposition to the Marxist views that are rooted on housing as a product for the reproduction of labor. Turner's ideologies are based on housing as a process and not product (Soliman & de Soto, 2004). They are based on the freedom from the state in building houses. The neo-liberal view stresses that housing is a broad phenomenon that occurs at a micro and macro level (country or city level) and the state must not put itself into this system (Sandhu & Korzeniewski, 2004). As a process housing becomes a dynamic and unending process which considers the needs of housing for residents. Additionally, the value of the house depends on companionship for building the house. As a result housing becomes a product transpired by the beneficiary (Soliman & de Soto, 2004).

Liberal views stress that a small residential unit such as a shack can be turned into a building consisting of various housing units (Soliman & de Soto, 2004). However this development depends on the capacity of the household and the availability of resources such as natural resource and human resource; therefore it occurs in stages. The Liberal theory uses the

concept of self-help housing where people help each other to build houses without state intervention (Burgess, 1978).

In liberalism everyone is equal and has a right to build houses and use natural resources without the state making certain regulations that place obstacles in the building process. This allows people to consume natural resources at a rate suitable to meet their needs which may result on damages to the environment if not well managed (de Shalit, 1995). The liberal view fails to extend people's notions and attitude towards the environment where in fact they should be part of sustainable use of natural resources for household activities. This does not only control consumption but also creates sustainable use of natural resources.

Liberals maintain that whenever the state intervenes it is limited to a series of environmental policies (de Shalit, 1995). Such a platform is not enough to pass information to the grassroots. Creating environmental awareness to the people should be done extensively through communal workshops and forums. This method enables the grassroots to engage with the information being given to them and asks questions when there is lack of understanding on certain concepts. This process creates easy access to information (Nour, 2011). Li & Reuveny (2007) argue that although this process may appear to be alluring, personal willingness is also a contributing factor. In order to accept an environmental idea one must be open to new ideas, be willing to effect change and be tolerant to constructive criticism.

Furthermore, freedom from the state may seek to please a certain group of people which is the people engaging on self-help housing; where they progressively assist each other to build their houses (Li & Reuveny, 2007). Due to the fact that progressive upgrading and self-building is beneficial to a certain group, others may be a reluctant to control the use of natural resources and minimising environmental degradation. To this group the idea of conserving natural resource benefits the environmental system while the social system collapses (Li & Reuveny, 2007). However, in essence the idea of rejecting state intervention compromises and degrades the environment. As a result environmental sustainability is not achieved under these conditions (Parkin, et al., 2003).

3.4.2. Neo-Liberal Theory

Neo-liberalism is based on the principles of maximising markets, limited state control and free trade. It emerged in the 1970s but became a dominant philosophy in the 1980s led by the World Bank. The maximisation of markets and limited state control allows private ownership of property. It allows the owner to deplete natural resources and oppose environmental policies that are aimed at protecting the environment (Haque, 1999). Initially the state welcomed John Turner's proposals because of cheap housing maintenance. However due to Turner's failure to consider housing value in the market, his ideas were revised and modified into the neo-liberal theory (Harvey, 2005). Policies formulated under the neo-liberal system are driven by profits more than any other variables. Maximisation of profit requires the use of natural resources. With reference to housing these resources are mainly water and energy. Maximisation of profit can thus result in massive environmental destruction. The higher the profits made by the private sector the greater would be resource depletion. Therefore, consumption of natural capital is not balanced with its production. Not only is there depletion of resources but there are also major negative environmental impacts arising from the greenhouse emissions of producing materials. If this is continuous, eventually ecosystems from which natural goods and services are acquired would diminish (Haque, 1999).

South Africa adopted liberalism in informal settlement upgrading programmes, private sector provision of housing markets, sites and service and provision of services and infrastructure by the private sector (Harvey, 2005). This move reflects a capitalist approach and was aimed at mobilising private markets than conserving natural resources while empowering the people. It allowed the private sector to exploit the environment leaving nothing but major threats and debt for the public. As a result the low-income groups cannot afford costs of having a home (Haque, 1999). When maintenance of natural resources is not catered for it leaves negative environmental impacts such as waste. Several housing projects implemented through this philosophy in the late 1980s and currently usually experiences failure due to inadequate sanitation services, polluted rivers and soil erosion (Goebel, 2007).

3.4.3. Neo-classical Theory

The Neo-classical theory started in the early 1960's as an effort to bring technological change to growth. It aimed at optimising production so that economic growth can increase. It emphasises the relationship between economics and the environment. The neo-classical view identifies environmental degradation as a problem strongly linked to environmental economics (Henning 2008). It suggests that environmental degradation results from shortages in the production of environmental goods and services.

This theory considers the overuse of resources for any development as a direct result from lack of well-defined property rights (Adaman & Ozkaynak, 2002). The lack of well-defined of property rights causes the natural goods and services to have lower prices. If everyone has free access to properties where natural goods and services are acquired, environmental degradation will be the consequence. This is because there is no careful consideration of the environmental effects caused by resources accumulation such as pollution. Eventually environmental degradation results in high costs of restoring the environment (Medalye, 2008). With such factors the neo-classical theory predicts that eventually environmental degradation leads to a collapse in the whole system. In restoring the system resource efficiency may be maintained in two ways. The first one is clearly defining property rights (Draagulanescu, 2013). This increases the costs of natural services and goods. The second one is to introduce regulations that will prohibit or limit environmental degradation. This can be done in the form of compensation for causing damages to the environment. The latter has resulted in precautionary and polluter pays policies (Draagulanescu, 2013).

The neo-classical theory treats natural capital as a financially replaceable capital. It focuses on economic growth and obstacles towards it where the biggest obstacle is environmental degradation (Adaman & Ozkaynak, 2002). Hanley, et al. (2007) argue that this theory creates well defined property policies to protect the environment from degradation where the property owner has to make a financial compensation. This does not protect the environment but rather helps identify the person responsible for degradation. If the polluter can afford to compensate for degradation they are most likely to continue degrading it because they do realise the damage they cause to the environment. Therefore environmental exploitation and

degradation would be continuous (Hanley, Shrogen and White, 2007). Furthermore, Neo-classical views promote inequality. While the polluter has financial power to exploit the environment the poor are also affected by degradation caused and become short of natural resources for survival (Draagulanescu, 2013).

In addition, the neo-classical theory is based on beliefs that environmental degradation occurs when the costs of applying environmental policy are too high and there is a market failure (Nelson & Winter, 1974). In this regard more effort is put on mobilising the markets for economic growth than controlling accumulation of natural capital to avoid degradation towards the environment (Hanley, et al., 2007). The neo-classical theory perceives environmental degradation as the main cause for market inefficiency. However Edargo (2015) argues that market efficiency can be achieved by avoiding environmental degradation in the first place instead of using money to compensate for it

The beliefs that the application of technological innovation can sustain resources and natural capital needed for economic growth is based on weak sustainability. Taxes charged for environmental degradation are rather used for investment than for the restoration and rehabilitation of the environment (Hanley, Shrogen and White, 2007). Weak sustainability occurs when natural capital is replaced by economic capital as opposed to strong sustainability where natural capital is considered irreplaceable and thus is well-maintained. Therefore environmental economics is not ideal for sustaining the economic growth using natural capital because it results in its depletion (Mulder and van den Bergh, 2001).

3.4.4. Evolutionary Economics Theory

The evolutionary theory is based on views that development and environmental change should be seen as evolutionary processes. It acknowledges that aspects of change in sustainability are qualitative and quantitative (Mulder and van den Bergh, 2001). In order for development to occur good environmental quality and adequate natural resources are needed. Technology plays a role by making the system sustainable while institutions cater for all decision making that concerns sustainable development (Mulder and van den Bergh, 2001). This theory emphasises more qualitative aspects of the environment that sustainability is dependent upon.

This is done in order to improve the environmental quality such as clean air, water and efficient energy (van den Bergh and Hokes, 1998). It focuses on understanding the processes involved in economic and ecological systems. These two systems are perceived as mutually occurring systems that are affected by change (van den Bergh and Hokes, 1998). Moreover it is believed that integrating the two can create solutions that would address uncertainty, confusion and the complexities involved in sustainability (Edargo, 2015)

The evolutionary theory perceives sustainable development as a process of change where the environmental status (quality) is largely dependent on the availability of resources (quantity) (Mulder and van den Bergh, 2001). It is based on an approach where decisions concerning the environment are looked at from the base elements of the environment (van den Bergh and Hokes, 1998). Therefore achieving economic sustainability in the long run is dependent upon the availability of resources. If natural resources are depleted the economy will not be sustained and peoples' social needs will not be fulfilled. This theory is also based on careful and responsible use of natural resources. Achieving economic growth lies upon the maintenance of life-supporting systems from which natural resources are obtained (OLTRA, 2008).

The evolutionary theory can be easily manipulated for personal purposes because it relies on models that are based on historical trends to make development and environmental predictions (Nelson & Sidney, 1982). These models require thorough trend analysis which can be time-consuming. Relying on evolutionary ideas is not only time consuming but predictions may be too generalised since they only depend on history. In cases where a solution is needed immediately to make a decision this theory becomes ineffective (van den Bergh and Hokes, 1998).

In evolutionary theory human behaviour is based only on environmental morals and ecological science but not on personal choice, decision and complex behaviours. Not everyone will make decisions based on maintaining natural capital and life-supporting systems (Li & Reuveny, 2007). People have a free will to the choices and decisions they make. Therefore the evolutionary theory uses unrealistic assumptions (van den Bergh and Hokes, 1998). The assumptions made on human behaviour reflect how the theory has neglected uncertainty.

Furthermore the theory focuses on the natural selection and not on human rationality, plans, choices and aspects that are not part of the evolutionary process. With such assumptions on human behaviour, this theory fails to maintain natural capital (Nelson & Sidney, 1982; Li & Reuveny, 2007).

3.5. Conclusion

This chapter has assessed various theories and concepts. It introduced the concepts and ideologies that this study is constrained to and which guide it. The various theories that were critically discussed reveal the manner in which sustainability is approached as a whole and the manner in which consumption of natural resources occurs within the various ways of providing housing. It is from this background that the study has compared and contrasted the reality of these philosophies and concepts to the observations that were revealed by data presented in chapter 4.

CHAPTER 4: PRESENTATION OF DATA AND DISCUSSION OF FINDINGS

4.1. Introduction

This section presents the data from field work. It first introduces the background information which entails the context of the study area and analyses the data that was collected from the field and the views that were given by the respondents. The respondents composed of residents and key informants. The views of the residents were analysed on a table based on themes that were captured by research objectives as well as in accordance with the challenges that were revealed and identified by the study. The theme tables recorded the views of residents. They were summarised into four sections: a column of residents in a group of five which adds up to 30 residents, columns with a Likert scale which measures the responses of residents, a total in the end of each column of Likert scale measurement and a total percentage. The percentage was calculated by dividing the total of residents which is 30 by the responses in each column under the recordings in the Likert scale. The calculated percentages were discussed, compared and contrasted to the key informants' views. Key informants were categorised into 3; tribal authority, local governance, and departmental with municipal structures as key informant 1, 2 and 3 respectively. The views were also interpreted in terms of theoretical framework that was adopted by the study.

4.2. Field Work Experience

The interviews and questionnaires were executed orally with the key informants and residents. For the key informants appointments were made over the phone. Once the time and date convenient for the key informants were set, a venue agreed upon by the researcher and the key informant was chosen to undertake the interview. Before the interview started, a consent form was presented for the respondents to sign. All the key informants were pleased to sign the form and they freely mentioned and wrote down their names on the forms. However, some of the residents were somehow reluctant to sign the consent form with their names. Two consent forms were signed by the respondents. The other form was left for the respondent while the other one was taken by the researcher. It is only the key informants that were interviewed while the residents were engaged with using questionnaire surveys.

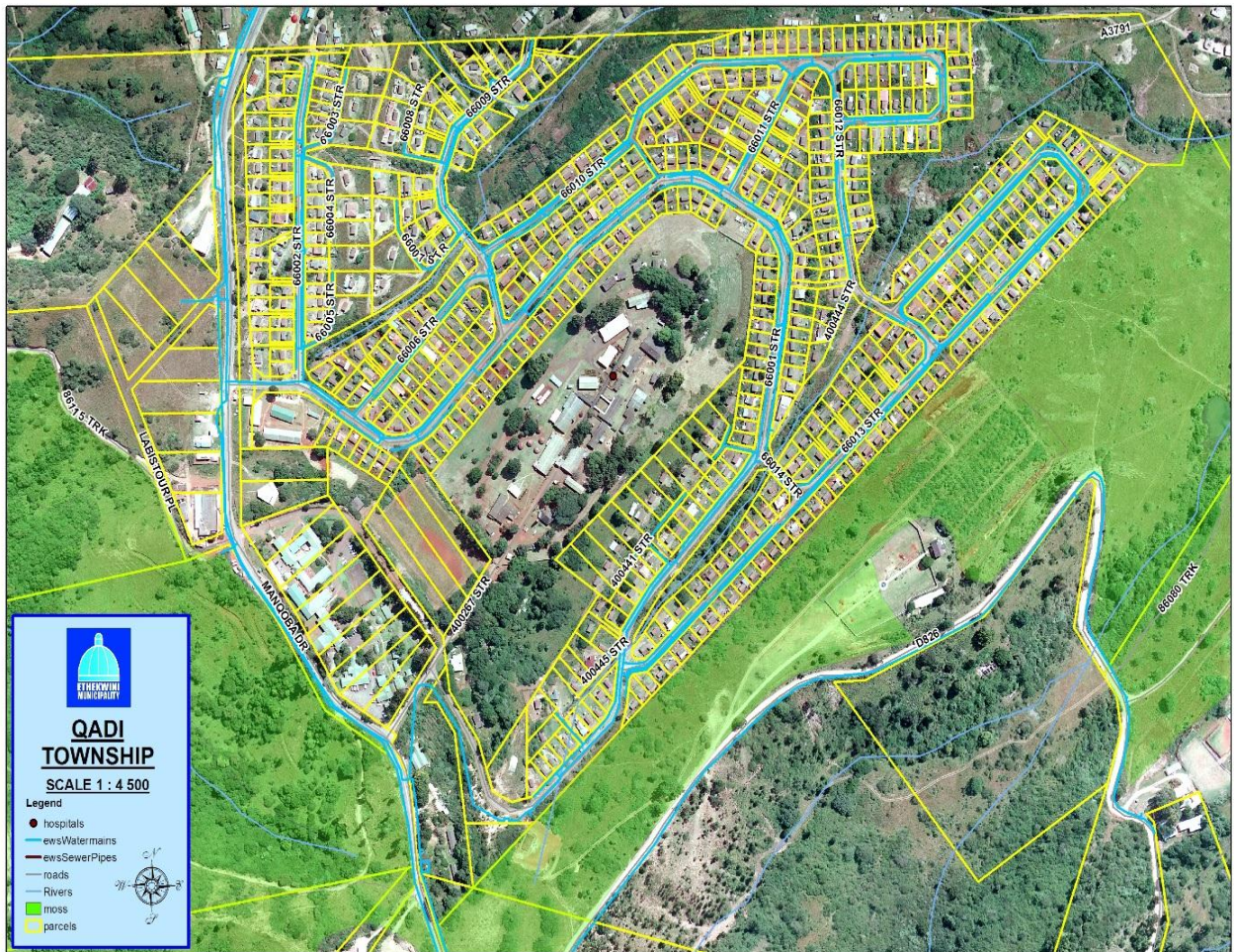
The first interview was conducted with the Chairperson of the QDT, who is also the tribal facilitator and secretary of the MaQadini Tribal Court. The aim of the interview was to obtain background information on the QDT, its role on the development of Qadi Township, the establishment of the Qadi Township, and all the stakeholders that were involved in the settlement development. The second interview was conducted with the Ward Councillor. The aim of the interview was to gather background information on KwaNyuswa and the township as well as development of Qadi Township and the political status of the area in terms of authority. Further discussions were based on obtaining permission to collect data on the study area. The third interview was conducted with the project manager of all the western wards of the EThekwini Municipality. The aim of the interview was to also gather background information of the Qadi Township and of KwaNyuswa. Questionnaires and interview with the key informants were conducted at the same time and this was administered by the researcher. The questionnaires had five sections comprising open and closed questions. These sections were used as themes in the data analysis section using statistic and thematic analysis. Questionnaires for the residents were also administered by the researcher with the help of a gate keeper.

Before the questionnaires were conducted with the residents and key informants the consent form was presented and read to the respondents and they were asked to write their initials and surname. Initials and surnames were chosen rather than signing because some residents were not familiar with using signatures. The consent form explained the details of what the research was about and its contribution towards the settlement and the rights of the respondents to withdraw from the survey if they felt uncomfortable. For residents, the first section of the questionnaire had instructions and a table with details of the respondent which composed of settlement strata, individual number (house number), date, time and length of stay in the settlement. The details of the respondents assisted in avoiding conducting a survey with the residents that have stayed in the settlement for less than a year. Some of the residents were pleased to sign the consent form and take the questionnaire survey although a small number felt uncomfortable at times.

4.3. Background of the Study Area

According to Mr Gasa, who is the QDT chairperson, Qadi Township is commonly known as Mandela Park, Elokishini (township) or Shiyabazali. The name Mandela Park was given by the people due to the belief that the houses in the township were from Mandela. Dr Nelson Mandela is the first black president and the fact that the initial development started while he was the president at that time resulted in this name. The Shiyabazali name means leaving one's parents. Shiyabazali is based on the initial purpose of developing the Qadi Township. The township was developed as an initiative to address overcrowding around the area of KwaNyuswa; in the homes of the poor and disadvantaged. Therefore it is the children of the poor that occupied these houses that were built in the township and parents were left behind. Most of these habitants were unemployed adults who had children (Gasa, 2015).

Figure 4: The Map of Qadi Township



Source: City Engineers (2015)

Qadi Township in figure 4 occurs within KwaNyuswa in the MaQadini village. It is accessible via Mangoba Road which is a distributor road to the Old Main Road. On the western side, the township is bounded by a node composed of the Holy Stutt Clinic, Empliweni Primary School, Valley Hardware and a small taxi rank. On the south-eastern side it is surrounded by Metropolitan Open Space System (MOSS). MOSS is an area designated as an undevelopable area of high biodiversity. In Qadi Township MOSS is large peri-urban area with a beautiful and hilly landscape (The Official Website of Ethekweni Municipality, 2015). On the northern side there are settlements of self-built houses. Central to this settlement is a TB hospital called Don Mckenzie Hospital and a soccer field proximal to it. Outside this area on the eastern side are the cemeteries which are only used by some of KZN's royal families.

Pictures of the area were also taken in the field. The picture in figure 4 on the left side shows the overview of the western area with the Don Mckenzie hospital where there is intense vegetation. This overview is clearly observed when passing by Manqoba Road. The picture on the right shows part of the study area facing Manqoba road.

Figure 5: Overview of Qadi Township



Source: Author (2015)

Mr Phewa who is the councillor in KwaNyuswa said that Qadi Township was developed in 2004 by the QDT and Department of Human Settlement. QDT is a Non-Profit Organisation (NPO) that was established from a communal land committee. Mr Gasa confirmed that this committee was seeking to claim land in order to implement a low-income housing project. Therefore it ought to obtain funds for the project. In order to access funds the committee formed a trust called QDT. Back in 1993 the QDT consulted with the Valley Trust that owned the land that the committee proposed for the housing project. The Valley Trust facilitated all land claims and donated the land to the QDT.

Mr Gasa further stated that in 1996 the QDT sent its application for funds to the local government through the Department of Housing. This application was forwarded to the national government and funds of R10 million were received to start the housing project. Although Mr Gasa maintained that the houses were developed using the trust funds which

were obtained from government, Mr Phewa maintained that the houses were built by the government; the trust identified the need and was a helping hand. Both these key informants maintained that in the year 2000 the registration for houses was initiated and the details were sent to Pietermaritzburg for processing of title deeds. In the same year the storm water pipes installation, Urine Diversion (UD) toilets construction and installation of road signs were done. In mid-2004 construction of low-income houses started until the year 2005. After the installation of sewer pipes, waste mains, water pipes and electrical reticulation were completed, the services and infrastructures were handed over to the municipality for maintenance. When the housing project was completed, the DHS sent building construction inspectors to inspect the houses and no defaults were found. The people were allocated houses according to the standards stated in the Housing National Code.

4.4. Analysis of Findings

The questionnaires had five sections with open and closed questions. For residents the first section which was referred to as section A composed of respondent details which is residents' age and whether or not they were heads of their respective households. The age of the respondents supposedly had implications on their knowledge of conservation of natural capital and preference in the quality of place. The perception on natural capital was found to be different for young adults and the elderly. In some households there was sharing of household heads, therefore the research accommodated those respondents as well. Other section were as follows:

- Section B: Influence of Preservation of natural capital in low-income settlement
- Section C: Consumption of natural capital within the settlement
- Section D: Unintended environmental threats compromising QoP of the settlement.
- Section E: Strategies and Approaches of controlling and addressing Environmental Threats.

For the key informants the first section (section A) composed of respondent details which are their name, position, organisation or department. The following section composed of the

general questions which were designed to understand the key informant’s role in the creation of low-income settlements whether they were part of the development of Qadi Township or not. Other section were as follows:

- Section C: Influence of Preservation of natural capital within low-income settlement
- Section D: Consumption of natural capital within the settlement
- Section E: Unintended environmental threats compromising QoP of the settlement.
- Section F: Strategies and Approaches of controlling and addressing Environmental Threats.

The data was analysed using the themes that were used as sections of the questionnaire. The themes aimed at asking the research question using the main subjects on literature which were greening, water, energy and waste. The statistical analysis was used to group, summarise and measure residents’ views. The percentage became an easier and effective representation of the residents’ views on each subject matter. Within the key informants, two were local under the local governance and tribal authority while the other one was under the departmental and municipal authority. These were stipulated as key informant 1, 2 and 3 respectively.

4.4.1. Natural Capital in low-income Settlements

Table 2: Residents’ Understanding of Conservation of Natural Capital in Low-income Settlement

Respondents’ understanding of conservation of natural capital within settlement					
Respondents	<i>Very Limited</i>	<i>Limited</i>	<i>Fair</i>	<i>Strong</i>	<i>Very Strong</i>
5	✓	✓	✓✓	✓	
5			✓	✓✓✓✓	

5		✓	✓✓	✓	✓
5			✓✓	✓✓✓	
5			✓	✓✓	✓✓
5		✓	✓✓✓	✓	
Total out of 30	1	3	11	12	3
Percentage out of 100%	3.33%	10%	36.67%	40%	10%

Source: Author (2015)

From the findings shown on table 3 most residents understood what natural capital is and some its elements. They were aware of the environmental conditions existing within the settlement. This was gathered when residents were given a list of elements and asked to choose whether they were part of natural capital or not and when they were asked about the influence of these elements in their environment. They considered soil, water, air quality, vegetation and fuels as part of natural capital. However some felt that fuels were not part of natural capital because their extraction results in pollution. Residents also considered soil erosion as uninfluential in conserving natural capital and as such showed their extended understanding of the influence of natural capital within the environment.

Only 10% of responses showed a clear understanding of conservation of natural capital, whether extracted or not and its effect on low-income settlement in terms of quality of place. This accounted mostly for the elderly than young adults due to the fact that the elderly spend more time at home than the young. The highest percentage (40) in the table accounted for those residents that understood what natural capital is with regards to their settlement and its importance in improving the quality of place. However this percentage did not understand conservation of natural capital and its impact on the broader environment. Other residents were aware of what natural capital is but were not sure whether some elements were part of natural capital or not. The percentages 3.3% and 10% of respondents were respectively found to have very limited and limited knowledge of natural capital and elements. 3.3% accounted for residents that did not understand what natural capital is and the elements of natural capital

whether given options to select from or stating the elements by themselves, whereas 10% accounted for residents that selected wrong elements that represented conservation of natural capital. Therefore this portion failed to understand the influence of natural capital in their settlement

Nevertheless key informants had varied views on understanding natural capital. Key informant 1 at tribal level regarded natural capital as a very important part of nature that maintains a settlement. In local governance point of view, understanding the conservation of natural capital was somewhat limited. Based on key informant 2’s point of view, conserving natural capital appeared to be a constraint to development than increasing the efficiency of resources. This came out when key informant 2 was asked about understanding of the influence that conserving natural capital has in low-income settlements. At a department and municipal level key informant 3 had a very strong understanding of the importance of conserving natural capital. This is because of the professional level and influence key informants 3 works under which normally is reviewing policy and implementing low-income housing and ensuring sustainable low-income settlements.

4.4.2. Management Strategies to Strengthen Natural Capital Conservation

Table 3: Residents’ Views on Management Strategies to Strengthen Conservation of Natural Capital

Management Strategies to Strengthen Conservation of Natural Capital					
Respondents	<i>Very Inadequate</i>	<i>Inadequate</i>	<i>Fair</i>	<i>Adequate</i>	<i>Very Adequate</i>
5		✓✓	✓	✓✓	
5		✓	✓✓✓	✓	
5		✓	✓✓✓	✓	
5		✓✓✓	✓✓		
5		✓✓✓	✓✓		

5	✓✓✓	✓	✓		
Total	3	11	12	4	0
Percentage	10%	36.37%	40%	13.33%	0%

Source: Author (2015)

In Table 3, management for conserving natural capital was divided in terms of greening, water efficiency, energy efficiency and waste management. The management focused on by the study were those which came as a free service to the settlement or paid for by residents and those that the residents individually intervened. Residents were asked to rate the adequacy of waste management services, and efficiency of water service and energy service they were provided with. They felt that the management structures were adequate but 13.3% managed on their own whenever services appeared to be inefficient or inadequate. This is the portion of residents that accepted what was offered as a service within the settlement and if not satisfactory they found temporal solutions such as burning waste. Within this portion some residents made use of the provided management services and also put on effort to complement services such as rain harvesting, greening through planting and recycling waste by using some as compost. These were residents whose views showed that management structures were effective. The highest percentage (40) accounts for residents that felt that management structures were fairly effective to conserve natural capital. 36.37% of residents felt management structures were ineffective and forcing them to manage the environment on their own whereas some of them do not clearly know how this can be done. 10% of residents felt that management structures through services were very inadequate and were driving the settlement environment to be severely damaged.

Key informants' views on management structures also had varied responses. Key informant 1 at tribal level stated that some of the management structures that strengthen natural capital in terms of greening, energy, water and waste were still not put in place to effect significant environmental change. This was based on the inadequate services which were provided for low-income settlement such as outsourced waste collection services. Key informant 2 felt that the conservation of natural capital is a constraint to harvesting the resources needed for

household use, hence the services being provided were quite effective to conserve natural capital. Key informant 3 acknowledged the lack of municipal capacity to meet demands for conserving natural capital while on department level as well as partnerships with other departments there was insufficient budget to strengthen the management structures. Key informant 3 also stated that conserving natural capital was an issue calling for strengthening local government leadership.

4.4.3. Environmental Threats Compromising QoP

Table 4: Residents’ Views on Unintended Environmental Threats that Compromise QoP

Activities Resulting on Environmental threats that compromise QoP within the settlements					
Respondents	<i>Very Least</i>	<i>Least</i>	<i>Fair</i>	<i>Frequent</i>	<i>Very Frequent</i>
5		✓✓	✓✓	✓	
5		✓✓✓✓		✓	
5		✓✓✓	✓✓		
5		✓✓✓✓	✓		
5		✓✓	✓✓	✓	
5		✓	✓✓	✓✓	
Total	0	16	9	5	0
Percentage	0%	63.33%	30%	16.67%	0%

Source: Author (2015)

Unintended and intended environmental threats that were unleashed through data collection were vegetation removal, inappropriate waste disposal and soil erosion and they are shown in table 4. Among all residents that the survey was conducted with, none revealed complete satisfaction with their environmental conditions. Most residents (63.33%) felt that their

environment did not have environmental threats. This was especially because they were provided with waste management services, water and energy which helped them with their household activities and controlled waste. 30% of residents felt that the existing environmental threats within their settlement were fair, bearable and could be alleviated if their local authorities work together. Few residents (16.67%) recognised the environmental threat as a major issue that calls for urgent solutions. These residents were those that were found to stay proximal to the riverbed where people often dispose waste, or proximal to mass grave sites. These residents oftentimes experienced unpleasant smells and pollution especially during windy periods.

Based on environmental threats key informant 1 and key informant 3 believed that the environmental threats existing within low-income settlement were a major problem whereas key informant 2 believed environmental threats were well managed. All the key informants maintained that enough has been done according to their roles to control environmental threats. However, residents have always been reluctant on taking personal responsibility to eliminate these threats. They further stated that the presence of environmental threats depended on the willingness of the community to clean and cater for their environment. Key informant 3 also added that some communities were environmentally cleaner than others while some were worse. Key informants' 2 and 3 views showed that people have been taught to cater for their environment through media and municipal booklets but, despite all such efforts, people's morals and willingness cannot be changed. Key informant 1 added that it is the youth that appeared more problematic in causing environmental threats than the elderly. This is because they hardly read the municipal booklets and pay attention environmental awareness portrayed through media; they prefer the entertainment aspect of the media.

4.4.4. Controlling and Addressing Environmental Threats

Table 5: Residents' Views on Strategies to Control and Address Environmental Threats.

Strategies of Controlling and Addressing Environmental Threats					
Respondents	<i>Very Ineffective</i>	<i>Ineffective</i>	<i>Fair</i>	<i>Effective</i>	<i>Very Effective</i>
5		✓✓✓✓	✓		
5		✓✓✓✓	✓		
5		✓✓✓✓	✓		
5		✓✓✓✓✓			
5		✓✓✓	✓✓		
5		✓✓✓	✓✓		
Total	0	23	7	0	0
Percentage	0%	76.67%	23.33%	0%	0%

Source: Author (2015)

The strategies that were considered by the study included monitoring and alleviation of environmental threats, engaging with the community to achieve success in implementing strategies and addressing all conflicts that may arise. The strategies for controlling environmental threats involved the provision of services to alleviate threats and the passing of information to the community members on how they can alleviate threats individually. Strategies included giving the community training on saving water, energy, growing and planting vegetation and managing household waste. Based on the data represented in table 5 23.33% of residents felt that strategies that control environmental threats were fair because they appreciated the awareness done through free municipal booklets and the media. They felt that to some extent it showed that at least something was being done. However 76% of residents regarded strategies as ineffective. They maintained that they were not involved in the issues pertaining their settlement whether they were environmentally based or not. Whenever

they raised their concerns, their leaders have continuously failed to take the time to listen. As a result they have sought for better means to address environmental threats individually.

Key informant 1 and 3 recognised that there were still gaps which called for strongly involving the communities on strategies to control environmental threats and the main contributing factor to this was said to be budget constraints. Key informant 3 also added that that an extra budget is needed to conduct workshops and forums that teach community members their societal and moral importance of conserving natural capital. Key informant 2 felt that there were enough strategies done to control environmental threats. He maintained that as the councillor he has provided adequate and effective strategies for communities to ensure a clean environment.

4.5. Discussion of Findings

When respondents expressed their views on the subjects that were asked challenges were identified from their views. These challenges were lack of understanding natural conservation, water and energy inefficiency, poor quality of place, poor environmental management structures, budget constraints and other external findings that contribute to unpleasant environmental conditions.

4.5.1. Lack of Understanding on the Influence of Conserving Natural Capital

The views of the residents reflected that they had limited understanding of what natural capital is. Some confused it with nature in general such as animals and plants. In this regard they failed to understand the implications of conserving natural capital within the settlement. Key informant 1 and 3 had a clear understanding of the importance of natural capital and sustaining it. However, key informant 2 maintained that conserving natural capital was a barrier to development.

According to residents there were no means or initiatives of their authorities at the department, municipality or tribal level on alerting them of the importance of natural capital in terms of water, energy, waste and vegetation. They stated that the booklets and information on the media were not based on solid, clear and easily understandable information but rather on awareness from a crisis such as saving energy, saving water, whilst there was no awareness

made based on vegetation. The residents also maintained that there were no community workshops or forums where they were given an opportunity to learn about the environment and share their ideas. Key informants argued that the information that is provided is enough and there is limited budget to go the extra mile and engage with the community through workshops.

4.5.2. High Consumption of Water and Energy Resources due to Inefficiencies

4.5.2.1. Water and Energy Inefficiency

Residents regarded water as a resource to be used for domestic activities but it has no influence in conserving natural capital. Instead it is a natural capital available to be used for human life. The importance of saving water was revealed to be an issue of caution due to the current drought crisis. The awareness on the drought crisis has made most residents panic and began to regard water as a resource that is very important and should be conserved.

As much as the drought crisis has created more caution on saving water and residents' views showed that ways of saving water were mostly done in terms of not misusing it such as leaving the tap open. Water recycling was hardly considered as means to save water and a small portion of residents harvested rainwater seasonally. These ideas of saving water were based on willingness and information from the media. Some residents considered recycled water unhygienic, while some reused it on small scale such as cleaning with water that was used for washing clothes.

The 200 litres per day that is provided for each household in the settlement is another way of reducing consumption of water. This has resulted in low water consumption. However some residents waste the already restricted water. Natural watercourses that were observed to be polluted by waste were perceived as least important by most residents. They did not regard this water as necessarily important except for residents that lived next to wetlands. The free water service was a contributing factor to wasting water since it is not paid for by residents; thus, individuals did not worry about the high costs. This concludes that saving water and using it efficiently is largely dependent on the residents' choice.

Residents viewed energy as a very important element for their daily domestic activities where price and not efficiency was regarded as an important factor. The concerns on energy were based on affordability since some low-income groups had difficulty affording it. Attempts to save energy were based on avoiding high costs than increasing efficiency. Although there was panic over the issues of load shedding, having clean sources of energy was not regarded as a solution. This reflected a very high dependence on electricity as a source of energy. Wood and paraffin were used as other sources of energy but this is because they were readily available within the settlement whenever there was load shedding and unaffordability of electricity. This concludes that low-income settlements are in need of energy efficiency.

The use of other sources of energy such as paraffin appeared to have minor effects to pollution and greenhouse gases into the atmosphere because these sources are used as back up sources. Therefore air quality was not highly compromised, and this had minor effects on compromising QoP within the area. The effects of using electricity had no recognisable effects on the settlement environment but rather on the broad environment. SALGA (2014) states that, for every kilowatt of electricity generated, greenhouse gasses are emitted into the atmosphere, compromising air quality in the environment. Therefore high dependence on electricity has profound negative impacts on the broad environment than on the settlement.

4.5.3. Poor Quality of place

4.5.3.1. Moderate Vegetation Cover and Extensive Soil Erosion

According to most of residents' views there was not enough vegetation within the settlement. This was based on their own personal observation. Understanding the influence of vegetation in conserving natural capital to some extent was not well understood. Residents considered vegetation as a recreation element used for beautifying land and provide shade and cool air during hot season. It was not regarded as an element of natural capital that increases air quality, protects the soil from eroding and reduces air pollutants. A small portion of residents admired that vegetation had the ability to protect the house from wind. Again, this was also perceived in terms of the benefits it brings to the people rather than an element that improves the quality of place and sustains the environment.

Findings showed that the use of vegetation within the settlement in terms of recreation and obtaining food or medicine was fairly minor. There was a small proportion of households with trees or food gardens. The few households that had attempted growing vegetation failed because it either did not grow well or the livestock fed on it. Proximal to the settlement were neighbouring settlements with livestock consisting of cows and goats. These animals wandered around the township looking for food. This had been a significant contributing factor preventing people from planting and growing vegetation of any form. Those who were successful either fenced their homes or had sufficient information on how to maintain it.

Poor vegetation cover meant that the area was susceptible to soil erosion. Within the settlement it was observed that not only was there moderate vegetation cover but there were also poor soil conditions in some parts. Moderate vegetation cover had therefore resulted in extensive soil erosion especially on steep areas of the settlement. Some areas were affected more than others due to their steep slopes. It was observed that areas located next to Manqoba Road had extensive erosion due to the absence and overflowing of storm water drains in the road. Soil erosion resulted in small elongated soil openings called rills within residents environment and compromised QoP.

Figure 6 shows a series of areas observed with soil erosion in an anticlockwise direction. Picture 1 from the left shows evidence of soil erosion on parts of the settlement that had exposed ground and lacked ground cover. During high rainfall, runoff increases and cause soil erosion. Picture 2 shows evidence of soil erosion on steep areas. This is because runoff obtains high speed due to slopes and aggressively erodes the soil. The eroded soil avalanches down to the road causing it to be muddy as shown in picture 3. Sometimes when there is high rainfall there is soil debris that avalanches into residents' environments shown by picture 4, and becomes a hazard to the house. In referring to picture 5, some residents tried opening a passage to regulate the water away from their houses. However, this was not effective because this passage also became full of all the particles that eroded from the road.

Figure 6: Evidence of Soil Erosion



Picture 1



Picture 2



Picture 5



Picture 4



Picture 3

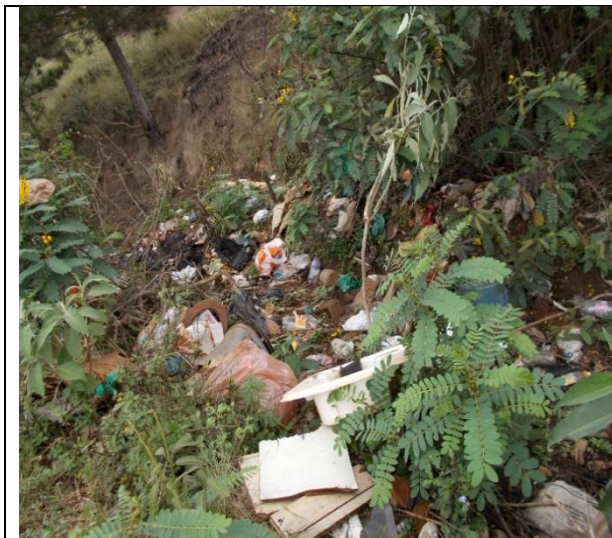
Source: Author (2015)

4.5.3.2. Pollution of Riverbed and Wetland from Domestic Waste

Observations showed waste in a dry riverbed that only flows perennially during high rainfalls. Inside the dry riverbed domestic and construction waste were observed. This waste was disposed by residents that stayed proximal to the riverbed as shown by figure 5, picture 1. Questions regarding waste disposal were directed to the resident as an observant participant. It was found that collection service does not take other types of waste such as glasses and sanitary waste. Whenever this kind of waste was collected into refuse bags for collection the

collection service rejected it. Sometimes such waste cannot be burned and was thus disposed in the riverbed in order to avoid having the dogs strewing it all over the settlement environment. Such disposing of waste on the riverbed resulted in downstream pollution of a wetland as shown by figure 5 picture 2. The polluted wetland and soil erosion decreased the quality of place. Moreover this water in the wetland was no longer accessible for those who needed it due to pollution coming from upstream. It could not even be used for washing clothes due to solid waste particles.

Figure 7: Disposal on the Riverbed and Wetland



Picture 1



Picture 2

Source: Author (2015)

4.5.4. Poor Environmental Management Structures

4.5.4.1. Poor Water Services

Observations also revealed that some of the areas within the settlement had exposed water pipes as shown by figure 8. Although no one within the township had livestock, the neighbouring area had. The livestock fed on the vegetation that residents had which may be trees or gardens. Not only does the livestock destroy vegetation, it may also damage the exposed water pipes which would result in bursting of water. Exposed water pipes reflect underperformance of water management services.

Figure 8: Exposed Water Pipe



Source: Author (2015)

Apart from water pipes, waste management and greening services were also very poor within the settlement. There were no greening services found to be a service provided to plant and maintain vegetation within the settlement. It was also observed that waste that accumulated in riverbed was neglected because waste management was only done in the form of household waste collection services and there were no monitoring services that were put in place to ensure continuous maintenance of the whole environment.

4.5.4.2. Inadequate Waste Services

According to the key informants waste management within low-income settlement is still a problem and has been well defined terms of efficiency. Locality, municipal abilities, and residents' willingness are essential factors for its efficiency. Urban areas tend to have efficient waste management services than peri-urban and rural areas. This is because in most peri-urban and rural areas the waste collection services are not readily available, waste is rather managed individually by households. When a low-income settlement is developed and provided with this service it is likely to be an outsourced service at a small scale. The outsourced service however is also used for other neighbouring settlements. As a result it becomes inefficient. The DHS working with municipalities has reached out to people through media and booklets to minimise

littering and inappropriate disposal of waste. However communities have not appeared to take such awareness serious. Therefore residents' willingness also counts for managing settlement waste.

4.5.4.3. Absence of Landscaping Vegetation and Maintenance Services

According to key informant 2, vegetation is the most important element in the environment especially for protecting the soil. However, it can be an obstacle for the development of housing, therefore it is removed for the creation low-income settlements. Vegetation can be restored after the creation of low-income settlement but in most low-income housing projects there is not sufficient budget to accommodate the vegetation restoration process. Therefore the conservation of natural capital may thus be regarded as a development barrier for the process of housing whereas for the product of housing there is often not enough budget to intensify it.

Vegetation is important for the protection of the soil from erosion and is one of the cheapest ways to reduce erosion. Within low-income settlement, intensification of vegetation is not a permanent procedure; instead it is project that is based and depends on partnership between DHS and Department of Agriculture. Working with other departments to create human settlements is not strong enough and largely depends on budget availability.

4.5.5. Challenges of Budget Constraints

All the key informants maintained that the biggest challenge in conserving natural capital is budget constraint. Budget is limited to only building low-income houses and providing water and energy and waste management depending on locality. Moreover these services are not all the same for low-income settlements. For rural and peri-urban low-income housing outsourced or no waste services are provided. Electricity and energy are provided depending on the availability within that area. Other aspects of the environment such as greening, solar energy and rainwater storage are not inclusive of the services that are provided due to the limited budget. Key informant 3 added that whenever these services are provided they are project based and not provided in all low-income settlements.

The aim of changing the housing department from DoH to DHS was to also recognise the importance of other departments on implementing housing and creating partnership so that there is integration in the creation of low-income settlements. Partnership between DHS and other departments such as department of agriculture has appeared to be not strong enough. As a result having other services within the settlement becomes a challenge when other departments are not strongly involved. The limited budget coupled with weak partnership with other departments or organisations perpetuates the poor environmental conditions, poor strategies to control environmental impacts and weakens management structures available for conserving natural capital within low-income settlements

4.5.6. Other Findings

These are the challenges that were not covered by the scope of the study but were also found to be contribution variables to unpleasant environmental conditions.

4.5.6.1. Sewerage Services

When all residents were asked about other services, specifically sewerage services, all the residents' views revealed dissatisfaction from the sanitation services they were provided with which was a single urine diversion (UD) toilet in each house. They all considered them as unhygienic and defiling to their dignity. These toilets have two separate sections inside the toilet seat; the one where the user is supposed to urinate and the one for passing stool. For each use of passing stool, a mass of soil is thrown. This is intended to dry out the waste as time goes on. At the back of the toilet there is a removable wall section for the removal of the dried waste (Bio-Activator, 2015). Some of the residents complained that it is impossible to successfully aim for the section where the urine is supposed to go whether they are sitting on the toilet seat or standing. Children also have difficulty using these toilets. The urine section therefore becomes full of faeces and toilet paper which residents have to remove and filter manually. All the residents stated that these toilets also had a terrible smell more than the self-built pit toilet. As a direct result this unpleasant smell gets worse during hot seasons.

4.5.6.2. Shallow Graves

From observations it was noted that there were parts of the settlement that were proximal to graves for mass burial. Mass burial graves are the graves that are used to build multiple

unclaimed bodies in one location on a wide but shallow opening (Morgan, 2004). Residents living next to this area were interviewed and pointed out that they live next to shallow graves. In windy periods the soil from these graves reaches their homes and this creates a discomfort given that this soil might be infectious from dead bodies.

4.6. Interpretation of Findings

This section interprets the challenges which are lack of understanding the conservation of natural conservation, poor quality of place, poor environmental management structures, and poor approaches to pass information to the community based on the theoretical frameworks chosen.

The implications of these findings to theory are that the low-income settlement appears to be created based on the neo-liberal theory. This theory employs a deliberate strategy where government and the private sector combine their financial and political power to bring change. In order to spread knowledge and information they utilise all the major communication institutions of a modern society which is media and education. Their purpose is to shape community beliefs, values and behaviour rather than engaging with the community to bring change. These beliefs and values of the system may contradict community or individual beliefs which results in conflict. As a result citizens cannot regard the knowledge they obtain from government as useful.

All the key informants' understanding of controlling water and energy consumption is through payment by household individuals. According to their views paying for water which maintains the bulk services is a way of managing consumption and conserving water. Although their responses revealed that all low-income settlements are provided with a water service they pay for, this was not true on the ground. These findings can be linked to the neo-classical theory where natural resources are regarded as financially replaceable resources. The idea of viewing payment of water as a conservation measure means that as long as one has money to cover water service bills they have access to water. This allows careless use of water and excludes the disadvantaged and the poor that the low-income settlements are provided for, because they may not afford to pay for water and energy.

Poor environmental conditions such as water and land pollution also have implication for the neo-classical approach. The resident as the owner of the house and environment has freedom to pollute the environment given that the area is theirs. If the waste in the riverbed and wetland were to be removed there would have to be payment of the service that removes waste from that environment. This approach does not alert people on the damages they cause to the environment but rather gives them freedom to pollute the environment given that should they require to alleviate the environmental threats they would have to pay.

The constraints on budget are inherited from the fact that South Africa is a developing country with limited resources to facilitate development. As a developing country it is considered disastrous to adopt the neo-liberal system because of the poor performance of economy. In South Africa Agenda 21 has given the key elements outlined by the WCED on *Our Common Future* for approaching sustainability and sustainability projects have been executed through this Agenda. It is undoubtedly clear that it has been difficult living up to the commitments South Africa made in Agenda 21. Although the strategic plans are clearly stated, the infrastructure and tools needed to fulfill those plans have not been accounted for. Furthermore it has to be acknowledged that in developing countries there are difficulties in accumulating resources. This is due to shortages of natural and human capital. Therefore the challenges around achieving sustainability and sustainable settlements must be expected.

4.7. Answering the Research Question

Based on the findings the influence of conserving natural capital is captured and reflected when one understands what natural capital is; its components and its contribution to natural resources needed for domestic household. It is likely that when a person has limited or no clear understanding they would not engage on conserving natural capital. This was found from the residents and some key informants' views and responses

When the management structures designed to strengthen natural capital are not put in place or clearly implemented due to budget constraint there will most likely be damage of the environment. The people living in low-income settlements use the environment as input for their household activities. As a result the outputs are released to the environment as waste,

emission or any other minor or major environmental impacts. Failure of having adequate management structures has a direct influence on the strategies and approaches needed to manage natural capital and protect the environment. These were the findings that the study revealed using Qadi Township as a study area.

The purpose of the study was to assess and suggest strategies that can be used to conserve natural capital, address environmental threats and improve QoP in terms of greening, water efficiency, energy efficiency and waste management within low-income settlements, using Qadi Township as a study area. Whilst the study used Qadi Township it must be acknowledged that low-income settlements on other areas may have different conditions. Therefore the findings of the research may not be generalizable.

CHAPTER 5: RECOMMENDATIONS AND CONCLUSIONS

5.1. Introduction

The conclusion presents the issues that were revealed in chapter 4. The summary is based on the issues and challenges that were found. The challenges discovered by the study were: limited understanding of the influence of conserving natural capital for low-income settlements, high consumption of natural capital due to resource inefficiency and severe environmental threats from poor management structures responsible for strengthening natural capital. Such conditions compromise QoP in low-income settlements. The recommendations suggested for maintaining natural capital, controlling environmental threats and improving QoP are outlined on the recommendations section.

5.2. Summary of Findings

5.2.1. Understanding the Influence of Conserving Natural Capital

The study revealed that maintaining natural capital is effective when there is clear understanding and strong knowledge of what natural capital is, its contribution to human life and its effect to improving QoP. With sufficient understanding one will know what to conserve, sustain and what is critical to preserve at any given stage. The study shows that understanding the conservation of natural capital was stronger for key informants than the residents. This is because the key informants have academic background of environmental legislation and are responsible for environmental protection during the creation of low-income settlements. However, the local governance point of view maintained that environmental protection is a development constraint. If the residents do not recognise development within their settlement or feel that it is not enough they will be more likely to restrict their support for the leader. Such views on the conservation of natural capital have influence on the poor environmental conditions within low-income settlements. It is likely that the people on the ground may also view development and not environmental protection as empowerment whereas in fact both should be viewed as empowerment.

It is therefore important that the residents have strong understanding because they consume natural capital through daily household activities. There should be a balance between the

production of natural capital and its consumption. The study revealed that the understanding that the residents have is constrained to the information they obtain from the media and municipal booklet and supportive departments. The information is not entitled to their cultural and moral understanding thus they do not strongly relate to the conservation of natural capital. All these issues create poor maintenance of natural capital and environmental sustainability which compromises QoP.

5.2.2. Resource Inefficiency

The study found that due to the current water and energy crisis, the residents appeared to be more concerned about their source of energy and water. Their understanding of water efficiency was narrowed into saving the tap water they obtain and rarely relying on rainwater harvesting. Additionally the tank system was not appreciated due to the closing down of the previous 200l tank system. It appeared that within the settlement people found objects that were hazardous to drinking water such as dead animals. It is for this reason that tank water was regarded as unsafe for use. Therefore high consumption of tap water was found. The key informants' views were that installation of the tank system depends on the location and budget availability. However it is also influenced by residents' views.

In terms of energy, extremely high consumption was discovered. It was observed that there were no sources of renewable energy except for wood. Moreover residents regarded only electricity as their reliable source of energy. Even though it is highly expensive, it was regarded as an easily accessible source with no complications except load shedding. In this way, implementing other sources of energy would be a challenge in terms of the willingness to use. Budget appeared to be the constraint to the installation of renewable energy on the key informants' views. Moreover key informant 3 stated that it would outweigh Eskom by creating loss of profits, unaffordability of electricity and consequently weaken other means of energy efficiency.

5.2.3. Management Structure for Maintaining Natural Capital

The severe environmental threats observed within Qadi Township were inherited from poor management structures responsible for the maintenance of natural capital and improvement of

QoP. They also revealed that residents had lack of understanding environmental sustainability and unwillingness to maintain natural capital. However, other environmental threats reflected residents' powerlessness on controlling the efficiency and effectiveness of environmental management structures that were put in place.

In terms of waste management key informants maintained that it is the responsibility of both the service provider and residents to ensure clean settlements. Inadequacy of the service and unwillingness of the residents were found to create severe environmental threats. It was established that water, energy, greening, waste and management services were inadequate. Water and energy services provided only one source of water and energy which resulted in extreme consumption. There were no greening services to ensure that there is increased vegetation and maintenance of the existing one. Waste collection service was inefficient because it did not collect all type of waste such as sanitary waste, thus resulting in inappropriate disposal.

According to the key informants this was also a budgetary issue and it was beyond their control or power. In terms of waste management the community appeared to get the blame because the key informants felt they also held the responsibility to clean the environment they live in.

5.3. Recommendations

Based on research findings, discussions and interpretation, strengthening management structures and involvement of other organisations within low-income housing were purposed as recommendations. The recommendations were explored from both primary and secondary data.

5.3.1. Strengthening Management Structures

According to Agenda 21 (1992) management structures within low-income settlement are important for improving infrastructure development while ensuring that the impact of that development is minimised. Therefore, management structures also improve the conservation of natural capital, maintenance of a clean environment and alleviation of environmental threats. The study suggested waste management, greening, water efficiency and energy efficiency as part of the components that represent the conservation of natural capital. It was

shown by the study that within Qadi Township, as a low-income settlement there, is a single source of energy (electricity) and water (tap water) provided. Other sources of energy and water that were available were those initiated by individuals such as paraffin, wood and rainwater. Moderate vegetation was also observed due to the absence of services that were responsible for growing vegetation within the settlement. Waste management was done by collection services through outsourced services designed to collect within peri-urban low-income settlements.

Strengthening management structures has implications for improving waste management, maximising efficiency of water and energy and increasing vegetation. In terms of waste management, if the collection service does not collect other type of waste, it is recommended that there are collection services for sanitary waste and recyclable materials. If the municipality does not provide such services, the community can initiate this by putting aside an area to place recycled material that the recycling companies can collect. The same can be done for sanitary waste. The provision of recycled and sanitary waste material services reduces inappropriate disposal of such waste in valleys or rivers. Pollution is therefore also reduced. In terms of greening, it is recommended that the parks and recreation division from the municipality increase vegetation in all low-income settlements. This division must increase and maintain vegetation within the settlement as well as involving the community by giving workshops on how people can green their homes. Increasing vegetation would not only provide fresh air but also protect the soil from erosion and houses from eroded soil debris. Apart from electricity and tap water other sources of energy and water must be provided to increase efficiency. Maximising efficiency of energy and water saves the already scarce electricity and water. Such can be done through the provision of the equipment for cleaner sources such as solar energy and rainwater harvesting. Maximising efficiency also increases water storage for future use, which in turn enhances sustainable use of water. The summarised implications of strengthening management structures are:

- Effective management of natural capital within low-income settlements.

- Evaluation and monitoring negative environmental impacts within low-income settlements.
- Prevention of environmental damage within low-income settlements.
- Increasing the availability of resources for household activities.
- Improving environmental conditions within low-income settlement.
- Increasing affordability of environmental management services for low-income groups.
- Creating a clean and safe environment for low-income households

5.3.2. Involvement of Other Organisations in Low-income Housing

The study shows that the poor performance of management structures is influenced by shortages in the budget allocated to low-housing. Agenda (1992) acknowledges that local government lacks direction with regards to the tools required for settlement management. As such this is a major problem which weakens natural capital.

It is recommended that this challenge is overcome by involving different NGO's, NPO's, trusts and councils in the creation and management of low-income settlements. Tissington (2011) argues that it is the role of national government to make addition or eliminate tools for housing policy and implementation. This is usually done during policy review in a period of every ten years. The study recommends GBCSA and CSIR as tools to be adopted by government in order to improve low-income settlement QoP while conserving natural capital. These councils are well known for their involvement and contribution to several low-income settlements in South Africa. Furthermore, they have contributed in the design phase and management phase of low-income settlements through several pilot projects (GBCSA, 2015; CSIR, 2000). Most of these projects serve as demonstrations of how low-income settlements should portray in terms of sustainability. CSIR focuses more on the design phase but also contributes to the construction and management phase, while GBCSA focuses more on the management phase based on environmental aspects and attributes within residential environments. CSIR has even published a book which stipulates guidelines for settlement making while the GBCSA has a greenstar tool which can be used to rate environmental attributes of low income settlements. Both these

councils promote sustainable low-income settlements and it is recommended that they are added as tools for housing policy and implementation.

Furthermore, for low-income groups, an environmentally sustainable settlement is more than just the conservation of capital (Sowman and Urquhart, 1998). The presence of intense vegetation means fewer costs on measures to prevent soil erosion. Water and energy efficiency means reduced costs on water and energy which implies environmentally sustainable use of resources. Controlled waste means a clean environment and reduction of diseases from pollution. It is from such grounds that partnership between these organisations and DHS is recommended. In all low-income housing projects and the already created low-income settlements such partnership would enhance environmental sustainability through:

- Strengthening management structures
- Improving environmental sustainability of low-income settlements
- Improving environmental attributes of low-income settlements
- Controlling waste and pollution
- Improving QoP within low-income settlements and
- Reducing the costs of living within low-income settlements

5.4. Conclusion

In chapter one the research introduced the overview which includes background, aims, objectives, questions and research methodology. Chapter two presented the literature on the influence of greening, water efficiency, energy efficiency and waste management towards conserving natural capital and tools were suggested by the research. In chapter three a general overview of the theories and concepts relevant to the study was presented. Chapter five presented data findings in a summary of tables, Critical analysis and interpretation were also done in that chapter. The study has shown that there are several barriers towards the influence of conserving natural capital within low-income settlements. During the use of housing as a product such barriers result from: lack of understanding what natural capital is, its contribution to low income settlements, budget constraints to preserve natural capital and poor environmental management structures. While individuals living in other types of settlements

may be able to manage such challenges, conserving natural capital is important for low-income settlements because it creates various household opportunities such as food, affordable water and energy, and alleviation of poor environmental conditions such as soil erosion.

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APPENDIX 1

Key informant Content Form



School of Built Environment and Development Studies

Discipline of Housing: Masters Dissertation

Researcher: Ms Sithabile Mnyandu 0717710259/ snestha@ymail.com

Supervisor: Mrs T. Judith Ojo-Aromukodu 0312602427 / ojoaromukodu@ukz.ac.za

Research Office: Ms Phumelele Ximba 0312603587/ ximbap@ukzn.ac.za

Content Form

My name is Sithabile Mnyandu (student number 208507414). I am doing a Masters research on a project entitled: An assessment of environmental sustainability in low-income settlements: the case study of Qadi Township in KwaNyuswa. The subject was identified given the negligence of threats to the environment of low-income settlements. The research will therefore provide the framework regarding how environmental sustainability can improve the environment, conserve natural capital and in turn quality of place in low-income settlements. This project is supervised by Mrs T. Judith Ojo-Aromukodu. The project is also administered by the Humanities & Social Sciences Research Ethics Administration of University of KwaZulu-Natal at Westville Campus. In the event of any problems or concerns/questions about my rights as a study participant then you may contact Miss Phumelele Ximba on the contact details given above or alternatively on:

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

Fax: 27 31 2604609

Thank you for agreeing to take part in the project. Before we start I would like to emphasize that:

1. Your participation is entirely voluntary;
2. You are free to refuse to answer any question;
3. You are free to withdraw at any time.

A decision not to participate will not result in any form of disadvantage. However benefits derived from this interview will assist in making recommendations to the creation of environmentally sustainable low-income housing. The interview will be kept strictly confidential and will be available only to members of the research team. Interview notes and questionnaire responses where possible will be stored in their original form for a period of at least five years from the completion of the research as stipulated by the UKZN institution. It will be important to maintain data in its original form particularly if published results are challenged by others. After this time data will be destroyed by shredding or incineration so as to ensure that your identity whom may not wish to be made public is protected. Written and audio recordings may be made during this interview.

DECLARATION

I, _____, [full name(s) of respondent] hereby confirm that I understand the contents of this document and the nature of the research, and hereby consent to participate. I understand that I am at liberty to withdraw from the research at any time, should I so desire.

Additional consent, where applicable

I hereby provide consent to:

Audio-record my interview / focus group discussion YES NO

Video-record my interview / focus group discussion YES NO

Use of my photographs for research purposes YES NO

Participant signature: _____

Date: _____

APPENDIX 2
Residents Content Form



School of Built Environment and Development Studies
Discipline of Housing: Masters Dissertation

Researcher: Ms Sithabile Mnyandu 0717710259/ snestha@gmail.com

Supervisor: Mrs T. Judith Ojo-Aromokodu 0312602427 / ojoaromokodu@ukz.ac.za

Research Office: Ms Phumelele Ximba 0312603587/ ximbap@ukzn.ac.za

Ifomu Lokuqukethwe

Igama lami ngingu Sithabile Mnyandu (inombolo yomfundi **208507414**) (inombolo yocingo **0717710259**) Ngenza ucwaningo ngohlu osihloko salo sithi “An assessment of Environmental sustainability in Low-income Settlements: The Case Study of Qadi Township in KwaNyuswa.” Inhloko yalolucwaningo ikhonjwe yizimo eziyizinkomba zokunganakwa kwe emvelo ezindlini zomxhaso zase Ningizimu Afrika. Ucwaningo luletha umqolo mayelana nokuhlengwa kwemvelo Kanye nokongiwa kwesitokwe semvelo okunomthelela omuhle ekwenzeni isimo sendawo sibe sezingeni eliphezulu emphakathini yalabo abanezindlu zomxhaso. Lomklamo uholwa ngu Nkk T. Judith Ojo-Aromokodu. Umklamo uphinde uphatwe yihhovisi locwaningo eNyuvesi yaKwaZulu-Natal elibizwa nge Humanities & Social Sciences Research Ethics elitholakala eWestville Campus. Uma unezinkinga noma imibono ngemibuzo engikubuza yona, amalungelo akho njengomphenduli kanye nawami njengomcwaningi ungathinta u Phumelele Nkz Phumelele Ximba kule mininingwane enikezwe ngaphezulu, noma umthintew kule mininingwane

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

Fax: 27 31 2604609

Siyabonga ngokuba yingxenye yalolu cwaningo, ngaphambi kokuba siqale, ngingathanda ukugcizelela loku

1. Ukunhlanganyela kwakho kulolu cwaningo kungukuzenzela ngokuvolontiya.
2. Ukhululekile ukuba unqabe ukuphendula imibuzo.
3. Ukhululekile ukuphuma kulolucwaningo noma ngabe yinini uma unesifiso.

Ukungavumi kwakho ukuthi ubeyinhlanganisela yalolucwaningo angeke kube nasici kuwena. Kepha okuzuzwe kulolucwaningo kusosiza ukuba kuthasisele umgomo nepolisi lezindlu. Ingxoxo ephakathi kwethu ngalololu cwaningo izogciwa njengemfihlo futhi izophathwa amalunga ocwaningo kuphela. Kubalulekile ukugcina ulwazi lwalolu cwaningo lungashinhiwe, ukuze kunanele kulabo abafisa ukuphonsa inselelo ngemiphumela yalo. Imibuzo ebuziwe kanye nezimpendulo kuzogcinwa iminyaka eyisihlanu emva kokuba lolu cwaningo lufeziwe, njengokubeka komthetho wesikhungo seNyuvesi yaKwaZulu-Natali. Emva kwalesi sikhathi ulwazi olukulolu cwaningo luzoshabalaliswa ngokugaywa ukuze kuqinisekwe ukuthi igama lakho aliveli kulolucwaningo.

ISIVUMELWANO

Mina _____ (amagama aphelele ophendulayo) ngiyaqiniseka ukuthi ngiyakuqonda okuqokethwe yilombhalo nesimo socwaningo, ngithi ngiyavuma ukuba yinhlanganisela nengxenye yako. Ngiyaqonda ukuthi ngikhululekile ukuyeka ukuba yingxenye yalolucwaningo noma ngabe yinini uma ngifisa.

Isivumelwano esengeziwe

Ngiyavuma ukuth:

Ukuqhophisa inkulumo YEBO/ CHA

Ukurekhoda ngokuthwebula Inkulumo YES/ NO

Isiginesha yomphenduli: _____

Usuku: _____

APPENDIX 3
Key Informants Interview Survey

Personal Details of Respondent

1. Name.....
 ...
2. Position.....
3. Organisation.....
 ...
4. Department.....

Venue	
Date	
Time	
Years in Service	

1. What is the formal name of the name of the settlement?

2. What is the name(s) the settlement is usually called by the people?

3. How was the development of the settlement initiated?

4. Who were the stakeholders involved in its development?

5. What was your role in the development of the settlement?
6. What was the procedure for implementing housing?

7. Were there any concerns on the environment during the development of the settlement?

.....
.....
.....
.....

8. Please tell me about the facilities and services within and next to the settlement relevant to the settlement development

- Don Mckenzie Hospital:

.....
.....
.....

- Empilweni Primary School:

.....
.....
.....

- Holy Stuart Clinic:

.....
.....
.....

- Soccer Field

.....
.....
.....

APPENDIX 4

Key Informants Questionnaire Survey

Instructions

- Please answer all questions
- Please select one answer
- Please tick to select your answer
- Please explain if other is selected and an answer

Section A: Personal Details of Respondent

5. Name.....
6. Position.....
7. Organisation.....
8. Department.....

Section B: General Questions

1. What is your role in the creation and development of low-income housing?
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.....
.....

2. Were you involved in the development of Qadi Township low-income settlement in KwaNyuswa? (tick one)

Yes	<input type="checkbox"/>
No	<input type="checkbox"/>

3. If answered yes what was your role?
.....
.....
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Section C: Influence of natural capital preservation in low-income settlement

1. What do you understand by the conservation of natural capital?
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2. Would you consider the following as part of natural capital?

<i>Soil</i>	<i>Vegetation</i>	<i>Water</i>	<i>Air Quality</i>	<i>Fuels</i>
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3. Please describe the environmental conditions commonly existing within low-income settlement.

Environmental Conditions	<i>Very Good</i>	<i>Good</i>	<i>Fair</i>	<i>Bad</i>	<i>Very Bad</i>
Waste Management					
Water Quality					
Air Quality					
	<i>Very Intense</i>	<i>Intense</i>	<i>Moderate</i>	<i>Least</i>	<i>Very Least</i>
Soil Erosion					
Vegetation					

4. What would be the effect of each condition in the conservation of natural capital?

Effect to conservation of natural capital	<i>Waste management</i>	<i>Water Quality</i>	<i>Air Quality</i>	<i>Soil Erosion</i>	<i>Vegetation</i>

5. To what extent do these conditions influence the conservation of natural capital?

Environmental	<i>Very Influential</i>	<i>Fair</i>	<i>Uninfluential</i>	<i>Very</i>

Conditions	<i>Influential</i>				<i>Uninfluential</i>
Soil Erosion					
Vegetation					
Waste Management					
Water Quality					
Air Quality					
Soil Erosion					
Vegetation					

Section D: Consumption of natural capital within low-income settlements

1. What source of water is provided for low-incomes settlements?

<i>Stand Pipe</i>	<i>Tap</i>	<i>Tank</i>	<i>Recycled</i>	<i>Other</i>

2. Please support your answer with an explanation.

.....

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.....

3. What source of energy is provided for low-income settlement?

Electricity Reticulation	<i>Solar Energy</i>	<i>Biomass Energy</i>	<i>LPG</i>	<i>Paraffin</i>	<i>Wood</i>	<i>Other</i>

4. Please support your answer with an explanation.

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.....

.....

5. Are there initiatives done to plant and grow vegetation within low-income settlements?

Yes	
No	

6. How does this affect the low-income settlement environment?

<i>Positively</i>	<i>Negatively</i>

7. How is low-income waste disposed?

7.1. In designated areas

7.1.1.

Designated Area			
Who is responsible for this service?	<i>Municipality</i>	<i>Beneficiary</i>	<i>Other</i>

7.1.2.

Designated Area					
How efficient is this service?	<i>Very Efficient</i>	<i>Efficient</i>	<i>Fair</i>	<i>Inefficient</i>	<i>Very Inefficient</i>

7.1.3.

Designated Area		
Please explain how this affect the environment?	<i>Positively</i>	<i>Negatively</i>

7.2. Pit disposing and burning

Pit disposing and Burning			
Who is responsible for this service?	<i>Municipality</i>	<i>Beneficiary</i>	<i>Other</i>

7.2.1.

Pit disposing and burning					
How efficient is this service?	<i>Very Efficient</i>	<i>Efficient</i>	<i>Fair</i>	<i>Inefficient</i>	<i>Very Inefficient</i>

7.2.2.

Pit disposing and burning		
Please explain how this affect the environment?	<i>Positively</i>	<i>Negatively</i>

8. Are sewerage services provided in low-income settlements?

Yes	No

9. If answered yes please proceed up to 7.3.

9.1.

Who is responsible for this service?	<i>Municipality</i>	<i>Beneficiary</i>	<i>Other</i>

9.2.

How efficient is this service?	<i>Very Efficient</i>	<i>Efficient</i>	<i>Fair</i>	<i>Inefficient</i>	<i>Very Inefficient</i>

9.3.

Please explain how this affect the environment?	<i>Positively</i>	<i>Negatively</i>

Section E: Unintended environmental threats compromising QoP within low-income settlements

1. Is the vegetation within low-income settlements maintained? Please support your answer with an explanation.

<i>Explanation</i>	<i>Yes</i>	<i>No</i>
Support your answer with a reason		

2. Do low-income groups housing beneficiaries pay for water? Please support your answer with an explanation

<i>Explanation</i>	<i>Yes</i>	<i>No</i>
Support your answer with a reason		

3. Do low-income housing beneficiaries pay for electricity? Please support your answer with an explanation

<i>Explanation</i>	<i>Yes</i>	<i>No</i>
Support your answer with a reason		

4. How often does littering occur within low-income settlements? Please provide your answer with an explanation.

<i>Explanation</i>	<i>Very often</i>	<i>Often</i>	<i>Fairly</i>	<i>Seldom</i>	<i>Very Seldom</i>

Support your answer with a reason					
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Section F: Approaches and strategies of controlling and addressing environmental threats

- Has there been training provided for low-income settlements residents on how to plant and grow vegetation in their homes?

<i>Yes</i>	<i>No</i>

1.1.

If answered yes, was it helpful? Please provide an explanation for your response	<i>Yes</i>	<i>No</i>

1.2.

If answered no, do you think it would be helpful? please provide an explanation for your response	<i>Yes</i>	<i>Yes</i>

2. Are low-income residents provided with rainwater storage services?

<i>Yes</i>	<i>No</i>

3. If answered yes, how does this service operate?

.....

.....

.....

4. Has there been training provided for low-income settlements residents on how to save water?

<i>Yes</i>	<i>No</i>

4.1.

If answered yes, was it helpful? Please provide an explanation for your response	<i>Yes</i>	<i>No</i>

4.2.

If answered no, do you think it would be helpful? please provide an explanation for your response	Yes	Yes

5. Has there been training provided for low-income settlements residents on how to save energy?

Yes	No

5.1.

If answered yes, was it helpful? Please provide an explanation for your response	Yes	No

5.2.

If answered no, do you think it would be helpful? please provide an	Yes	Yes

explanation for your response		
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Additional Notes

- Please express any additional comments or suggestion based on the study and questionnaires

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Thank You!

APPENDIX 5

Residents Questionnaires

Instructions

- Please answer all questions
- Please select one answer
- Please tick to select your answer
- Please explain if other is selected and an answer

Settlement Strata	
Individual number	
Time	
Date	
Length of Stay in the settlement	

Section A: Respondent Personal Details

1. Please tick your age

18-34	<input type="checkbox"/>
35-59	<input type="checkbox"/>
>60	<input type="checkbox"/>

2. Are you the household head or owner of this house?

Yes	<input type="checkbox"/>
No	<input type="checkbox"/>
Other	<input type="checkbox"/>

Section B: Influence of natural capital preservation in low-income settlement

1. What do you understand by the conservation of natural capital?

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.....

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2. Would you consider the following as part of natural capital?

<i>Soil</i>	<i>Vegetation</i>	<i>Water</i>	<i>Air Quality</i>	<i>Fuels</i>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. Please describe the environmental conditions of the settlement you live in.

Environmental Conditions	<i>Very Good</i>	<i>Good</i>	<i>Fair</i>	<i>Bad</i>	<i>Very Bad</i>
Waste Management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water Quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<i>Very Intense</i>	<i>Intense</i>	<i>Moderate</i>	<i>Least</i>	<i>Very Least</i>

Soil Erosion					
Vegetation					

4. To what extent do these conditions influence the conservation of natural capital?

Environmental Conditions	<i>Very Influential</i>	<i>Influential</i>	<i>Fair</i>	<i>Uninfluential</i>	<i>Very Uninfluential</i>
Soil Erosion					
Vegetation					
Waste Management					
Water Quality					
Air Quality					
Soil Erosion					
Vegetation					

Section C: Consumption of natural capital within low-income settlement

1. What is your source of water and what do you use it for?

Source	Use			
	<i>Domestic Use</i>	<i>Agricultural Use</i>	<i>Industrial Use</i>	<i>Commercial Use</i>
Stand pipe				
Tap				
Tank				
Recycled				
Other				

2. What is your source of energy and what do you use it for?

Source	Use				
	<i>Cooking</i>	<i>Lighting</i>	<i>Warming/ Cooling</i>	<i>TV/Radio</i>	<i>Other</i>
Electricity Reticulation					
Solar energy					
Biomass Energy					

LPG					
Paraffin					
Wood					

3. Have you planted trees in your environment?

Yes	
No	

4. How has this affected your environment?

<i>Positively</i>	<i>Negatively</i>

5. How do you dispose your waste

5.1. In designated areas

Designated Area			
Who is responsible for this service?	<i>Municipality</i>	<i>Myself</i>	<i>Other</i>

5.1.1.

Designated Area					
How efficient is this service?	<i>Very Efficient</i>	<i>Efficient</i>	<i>Fair</i>	<i>Inefficient</i>	<i>Very Inefficient</i>

5.1.2.

Designated Area		
Please explain how this affect the environment?	<i>Positively</i>	<i>Negatively</i>

5.2. Pit disposing and burning

Pit disposing and Burning			
Who is responsible for this service?	<i>Municipality</i>	<i>Myself</i>	<i>Other</i>

5.2.1.

Pit disposing and burning					
How efficient is this service?	<i>Very Efficient</i>	<i>Efficient</i>	<i>Fair</i>	<i>Inefficient</i>	<i>Very Inefficient</i>

5.2.2.

Pit disposing and burning		
Please explain how this affect the environment?	<i>Positively</i>	<i>Negatively</i>

6. Are there sewerage services provided for you?

Yes	No

7. If answered yes please proceed up to 7.3.

7.1.

Who is responsible for this service?	<i>Municipality</i>	<i>Myself</i>	<i>Other</i>

7.2.

How efficient is this service?	<i>Very Efficient</i>	<i>Efficient</i>	<i>Fair</i>	<i>Inefficient</i>	<i>Very Inefficient</i>

7.3.

Please explain how this affect the environment?	<i>Positively</i>	<i>Negatively</i>

Section D: Unintended environmental threats compromising QoP within low-income settlements

1. Do you cut trees? Please support your answer with an explanation.

<i>Yes</i>	<i>No</i>

2. Do you pay for water? Please support your answer with an explanation

<i>Yes</i>	<i>No</i>

3. Do you pay for electricity? Please support your answer with an explanation

<i>Yes</i>	<i>No</i>

4. Do you litter waste within the settlement or in your environment? Please provide your answer with an explanation.

Yes	No

Section E: Approaches and Strategies of controlling and addressing environmental Threats

1. Have you attended any training on how to grow your own vegetation?

Yes	No

- 2.

	Yes	No
If answered yes, was it helpful? Please provide an explanation for your response		

a.

If answered no, do you think it would be helpful? please provide an explanation for your response	Yes	Yes

3. Do you use rainwater?

Yes	No

4. How do you store it?

.....

.....

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5. Have you attended any training on how you can save water?

Yes	No

5.1.

If answered yes, was it helpful? Please provide an explanation for your response	Yes	No

5.2.

If answered no, do you think it would be helpful? please provide an explanation for your response	<i>Yes</i>	<i>Yes</i>

6. Have you attended any training on how you can save energy?

<i>Yes</i>	<i>No</i>

6.1.

If answered yes, was it helpful? Please provide an explanation for your response	<i>Yes</i>	<i>No</i>

6.2.

If answered no, do you think it would be helpful? please provide an	<i>Yes</i>	<i>Yes</i>

explanation for your response		
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Additional Notes

- Please express any additional comments or suggestion

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Thank You!