RISK ASSESSMENT OF GROUNDWATER IN THE LAINGSBURG MUNICIPAL AREA

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DECLARATION

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ABSTRACT

Laingsburg Local Municipality is dependent on groundwater as the only source for water service delivery. Climate change is leading to more frequent drought and a decline in groundwater availability within the municipal area. It has been recorded that the municipality has high water losses which has had an impact on the sustainability of water service delivery. A drought was declared in 2015, and although the municipality acknowledged that there had been some rainfall in the area, it was not sufficient for the municipality to respond to the huge water demand during the 2016 summer.

This research was done to find out what effects does climate change have on groundwater in the area and more particularly as it relates to drought and other natural disasters. To this end, a literature review of previous studies undertaken in the field was conducted according to the prescribed norm and a case study was done to collect data.

The findings show that the municipality's groundwater resources are under severe strain as a result of climate change, as well as current resource management. It is therefore recommended that the municipality develop and implement an integrated adaptation plan to conserve natural resources as well as improve resource management including the use of viable alternative methods.

It is further recommended that Laingsburg Local Municipality reviews its current resource management practices and finds innovative and creative ways to bring about change. If the municipality is unable to consider and implement the proposed recommendations, for whatever reasons, it may not be able to deliver water services to its consumers in a sustainable manner. It is also clear that the municipality may also be faced with severe water shortages because the study draws clear conclusions about the decline of groundwater sources within the area under the jurisdiction of Laingsburg Local Municipality.

The researcher made recommendations to the municipality which can assist the municipality to conserve the natural resources. It includes building in-house capacity and utilisation of available resources like the War on Leaks Programme and secondments from government agencies to complement the staff component. The municipality will have to embark on vigorous awareness

programmes to change the mind-set of all stakeholders and role players within the municipal area and appoint water ambassadors to bring about a paradigm shift regarding water saving and the conservation thereof. The water tariff system must be reviewed to enable conversion of the deficient municipal budget.

The municipality must develop and implement an adaptation plan which includes replacement of ageing water supply infrastructure, which will assist the municipality to minimise water losses. The building of additional storage facilities at Soutkloof Spring as well as in Laingsburg town will assist the municipality to store water for drought conditions and the dry season. The municipality should furthermore expand the use of recycled water, which is currently used for irrigation of Lucerne to include the irrigation of sport facilities in Laingsburg. It is also recommended that the municipality investigate, plan and implement purification of recycled water for human consumption in the future.

The municipality should also undertake thorough investigation of fracking and uranium mining before supporting and approving these opportunities to improve the economy of the municipal area. Implementation of the recommendations will limit huge water losses, groundwater will be conserved and sustainability will be ensured.

OPSOMMING

Laingsburg Plaaslike Munisipaliteit is afhanklik van grondwater as die enigste bron vir die lewering van waterdienste. Klimaatsverandering lei tot meer gereëlde droogtes en 'n afname in die beskikbaarheid van grondwater in die munisipale gebied. Die studie toon dat die munisipaliteit hoë waterverliese lei wat 'n impak het op die volhoubaarheid van dienslewering met betrekking tot water. Die droogte wat in 2015 verklaar is en die feit dat die munisipaliteit erken het dat die 2016 reënval in die gebied onvoldoende was, om volhoubare water aan verbruikers te voorsien.

Hierdie navorsing is gedoen om die effek van natuurlike rampe soos droogte op grondwater in die Laingsburg munisipale gebied tydens klimaatsverandering vas te stel. 'n Literatuuroorsig met betrekking tot vorige studies op die gebied soos vereis as ‘n voorgeskrewe norm is uitgevoer en 'n gevallestudie is onderneem.

Die bevinding is dat die munisipaliteit se grondwaterbronne onder geweldige druk verkeer as gevolg van klimaatsverandering, maar die huidige hulpbronbestuur dra ook daartoe by. ‘n Plan is opgestel wat aanbevelings maak wat die munisipaliteit in staat sal stel om die nodige aanpassings te maak om veerkragtig teen die effekte van klimaatsverandering te wees en ook natuurlike hulpbronne te bewaar. Dit sluit ook verbeterde hulpbronbestuur in wat alternatiewe metodes en bronne betrek.

Daar word aan beveel dat die Laingsburg Plaaslike Munisipaliteit huidige hulpbronbestuurspraktyke hersien en nuwe maniere vind om grondwater te beskerm. Indien die munisipaliteit nie die aanbevelings aanvaar en implementeer nie, sal die munisipaliteit nie in staat wees om water op 'n volhoubare wyse aan sy verbruikers te lewer nie. Die munisipaliteit sal ook gekonfronteer word met waterskaarste soos uitgewys deur gevolgtrekkings wat die daling in die grondwaterbronne binne die munisipale gebied na aanleiding van navorsing beklemtoon.

Die navorser maak aanbevelings wat die munisipaliteit in staat sal stel om die natuurlike munisipale hulpbronne te bewaar. Dit sluit die bou van plaaslike vermoëns en benutting van beskikbare hulpbronne soos die “War on Leaks” program en sekondering van regeringsagentskappe om die personeel aan te vul. Die munisipaliteit moet

bewusmakingsprogramme van stapel stuur om die sienings van alle belanghebbendes en rolspelers binne die munisipale gebied te verander en water ambassadeurs aanstel om waterbesparing te bewerkstellig. Die watertariefstelsel moet hersien word om die munisipaliteit in staat te stel om die begrotingstekort aan te spreek.

Verder moet die munisipaliteit ‘n aanpassingsplan ontwikkel wat die vervanging van verouderde infrastruktuur insluit en dit implementeer om waterverlies te verminder. Die bou van bykomende stoorfasiliteite by die Zoutkloof waterbron asook in die dorp word aanbeveel. Dit sal die munisipaliteit in staat stel om genoegsame water te berg vir droogtes en droë seisoene. Die munisipaliteit word aanbeveel om herwinde water ook vir die besproeiing van sportfasiliteite te gebruik en nie net vir lusern nie. Verder word aanbeveel dat die munisipaliteit ‘n ondersoek loods en beplanning doen vir die implementering van die toekomstige gebruik van gesuiwerde herwinningswater vir menslike gebruik.

Die munisipaliteit moet verder ook deeglike ondersoek instel rakende skaliegas en uraan ontginning alvorens ondersteuning en goedkeuring daarvoor verleën word om die ekonomie van die munisipale gebied te verbeter. Indien implementering van die aanbevelings gedoen word, sal die grootskaalse waterverliese beperk word. Dit sal grondwater bewaar en die volhoubaarheid daarvan verseker.

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AADD	Annual Average Daily Demand
ACIP	Accelerated Community Infrastructure Programme
AMP	Asset Management Plan
BDS	Blue Drop System
BRT	Bus Rapid Transit
CBD	Central Business District
CES	Community Engineering Services
CIDB	Construction Industry Development Board
CKD	Central Karoo District
CKDM	Central Karoo District Municipality
COD	Chemical Oxygen Demand
CRC	Current Replacement Cost
CRR	Cumulative Risk Ratios
DOC	Dissolved Organic Carbon
DRC	Depreciated Replacement Cost
DC	Direct Current
DWA	Department of Water Affairs
DWAF	Department of Water Affairs Forestry
DWAS	Department of Water Affairs and Sanitation
GDIP	Green Drop Improvement Plan
GDS	Green Drop System
GPS	Growth Potential Study
HH	Household
HR	Human Resource
IDP	Integrated Development Plan
IMP	Incident Management Protocol
IMQS	Infrastructure Management Query System
IRP	Integrated-water Resource Planning
LB	Laingsburg

IPPC	Intergovernmental Panel on Climate Change
LSBA	Laingsburg Small Business Association
LED	Local Economic Development
LLM	Laingsburg Local Municipality
LM	Laingsburg Municipality
LT WC/WDMS	Long Term Water Conservation / Water Demand Management Strategy
MERO	Municipal Economic Review and Outlook
MFMA	Municipal Finance Management Act, Act 53 of 2003
MIG	Municipal Infrastructure Grant
MISA	Municipal Infrastructure Services Agency
MSA	Municipal Systems Act, Act 32 of 2000
mSCOA	Municipal Standard Chart of Accounts
NRW	Non-Revenue Water
NWA	National Water Act, Act 36 of 1998
O&M	Operation and Maintenance
OECD	Organisation for Economic Co-operation and Development
PACA	Participatory Appraisal Competitive Advantage
PDD	Peak Daily Demand
RDP	Regional Development Profile
RSA	Republic of South Africa
SDBIP	Service Delivery Improvement Plan
SEPLG	Socio-Economic Profile of Local Government
UN	United Nations
UNEP	United Nations Environment Programme
W2RAP	Wastewater Risk Abatement Plan
WCG	Western Cape Government
WDM	Water Demand Management
WC/WDM	Water Conservation / Water Demand Management
WC/WDMS	Water Conservation / Water Demand Management Strategy
WMA	Water Management Area
WMA	Water Services Authority
WSA	Water Services Act, Act 108 of 1997

WSDP	Water Services Development Plan
WSP	Water Services Provider
WWTW	Waste Water Treatment Work

CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 BACKGROUND

Laingsburg Local Municipality is known as the smallest local municipality in the country. Situated within the Central Karoo District, the municipality borders the Northern Cape Province in the northern side of the municipal area, linking Sutherland as part of the Karoo Hoogland Local Municipality. The municipality comprises of the town - which is Laingsburg CBD, the Matjiesfontein settlement and a vast farming community consisting of 250 farms. The municipal area covers an area of 8800 square kilometres with a municipal population of 8684 and 2447 all-inclusive households (Pekeur, 2014:3).

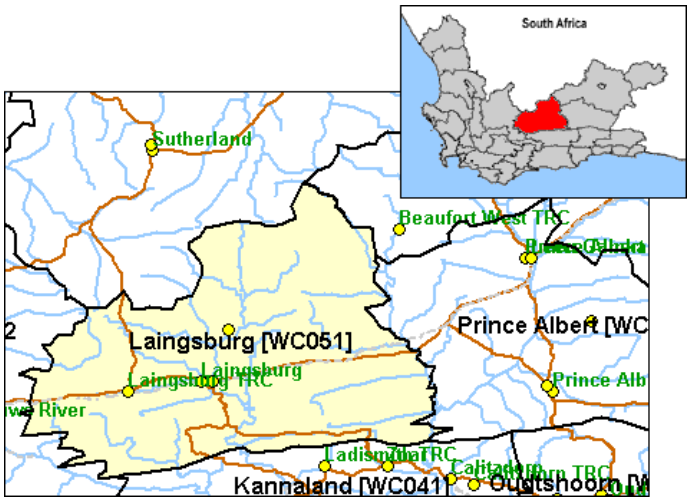


Figure 1.1. Laingsburg Municipality (Source: LLM; 2016: 28)

According to the Western Cape Government (WCG), (2014a:44) referred to in this document as the Socio Economic Profile of Local Government (SEPLG), the municipality is part of the Central Karoo which is known for moderate, severe and extreme meteorological drought, with negative effects on livestock farming. The changing climatic conditions in the area lead to declining groundwater supplies. There are notable cross-linkages between socio-economic and environmental conditions (i.e. rapidly declining dam levels, reduced household and livestock access to water, compromised vegetation cover and farm job losses). The area therefore needs an early warning system to identify and respond to adverse climatic conditions in order to minimise the impact on its socio-economic conditions.

Titus (2012:60) stated that it is believed that Laingsburg has quite a strong aquifer with a great deal of groundwater. However, this needs to be verified. He further reports that about 60% of the households have access to water. However, management and distribution of water in farming areas remains poor.

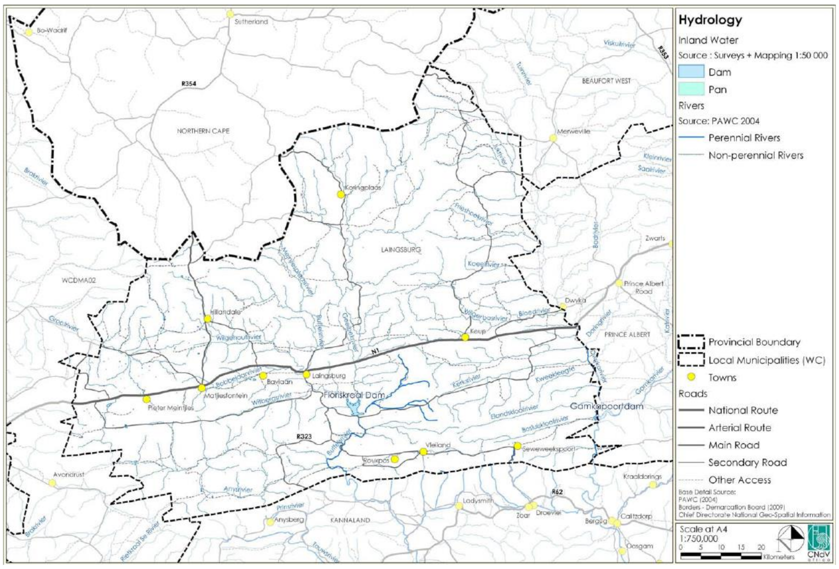


Figure 1.2 Laingsburg Hydrology: Rivers (Source: LLM; 2016: 40)

The Laingsburg Local Municipal (LLM) Region is well-serviced with water and there appears to be no foreseeable future water shortages, even considering extensions, according to the Integrated Development Plan (IDP) (2017-2012:24) (Laingsburg Municipality, 2014b). The SEPLG (Western Cape Government, 2014a: 44) indicates that:

> Laingsburg is supplied with water from the Soutkloof fountain, Soutkloof pit (a well in the river bed), the Buffels River and groundwater from boreholes in and around the town. The bulk supply network is in a good condition and is owned, operated and maintained by the Municipality. The 2010 Blue Drop Status Report (Department of Water Affairs and Sanitation (DWS), 2014a) indicates a score of 63.13% for Laingsburg and the 2009 Green Drop Report (DWS, 2014b) gave a green drop score of 76.5% which requires the municipality to improve the quality of water and wastewater to ensure a healthy and safe municipality guided by the municipality's vision and strategic agenda (Western Cape Government, 2014a:44).

SEPLG furthermore indicates that:

> Although the vegetation status of the entire Municipality is classified as 'Not threatened', meaning that there are no threats to the ecosystem's integrity. However, most of the rivers have a critically endangered status and suggest problems in the surface water catchments. The poor status of the rivers requires a major improvement in farming practices and urban effluent management near the river banks. Development in the flood lines is monitored and no residential development is allowed in these areas. Livestock grazing and watering points are managed in this zone (Western Cape Government, 2014a:46).

The municipality (LLM) is seen as a low growth municipality although it is situated on the N1 National Road, 250kms from Cape Town. The main railway line runs through the town and through a big portion of the municipal area. The municipality has no industrial activity, however, agriculture remains the biggest employment contributor within its boundaries. Statistics have shown that there is a decline in this sector, therefore the municipality and the Business Chamber are looking at ways to grow the economy. The sector that shows the biggest growth within the municipal area is Finance and Insurance which is linked to tourism and what the area can offer (WCG, 2012a: 17).

According to Titus (2012:156) there are two wastewater treatments plants, one in Matjiesfontein and one in Laingsburg, whereas wastewater treatment for Laingsburg is rated above and for Matjiesfontein below the basic RDP Standards. About 74.4% of households had access to flush toilets by means of waterborne sewerage or septic tanks in 2001. In 2007 this has increased to 91.1% (Titus, 2012:156).

The groundwater levels of the Laingsburg Local Municipality's geographical are of responsibility are threatened by climate change and the poor management of water resources. To be resilient, the municipality has to put adaptation plans in place to assist the municipality in the use of water resources in an effective, efficiently manner to ensure the sustainability thereof for future generations. The current situation inspired in the researcher to do a risk assessment in order which will enable the municipality too effectively plan and work towards municipal sustainability and economic growth.

1.2 DEFINITION OF KEY CONCEPTS

The LLM municipality must develop plans and strategies which will assist the municipality in the management and utilisation of the municipal water resources in a sustainable manner. Similarly, The Central Karoo District Municipality conducted studies to assist local municipalities in their jurisdiction to become more resilient and developmental. South Africa and other international countries also embarked on studies in Sustainable Development, Water Conservation, Scarcity of Water and the "risk municipalities" or agencies face with regards to water conservation. These studies will be a great help in conducting a study within Laingsburg Municipality. Therefore, the researcher conducted a literature research to determine possibilities in water conservation that could assist the municipality. This research will therefore be used to assist the municipality in planning and resource management, as well as inform the Municipality's Integrated Development Plan (IDP) within the next cycle, which will commence during the year 2017.

1.3 SUSTAINABLE DEVELOPMENT

Swilling and Annecke (2011) define sustainable development as "a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs". It is about taking the environment into consideration when natural resources are used and using technology in a way that adds value to these resources to ensure that it is conserved for future generations. Dresner (2002) stated that "the aim of sustainable development is to integrate environmental considerations with economic policy". This is crucial in development because the municipality will not be able to grow the economy if we do not have the natural resources.

The Brundtland Report (WCED, 1987) has stated that "Sustainable development is development that meets the needs of present generations without compromising the ability of future generations to meet their needs", therefore the Laingsburg Local Municipality (LLM) must find ways to improve resource management so that it meets the municipality's current need but ensure that it will not be depleted in the future due to the lack of resource management.

According to Metz (2010:1), climate patterns are changing which is a man-made occurrence and weather patterns are intensifying. We, as mankind, must find ways to restore or put adaptation plans in place that will prevent climate change from accelerating. Laingsburg Local Municipality is dependent on groundwater and if temperatures increase it can have an effect on the groundwater levels for current needs and future generations. Therefore, the municipality must find ways to improve water resource management or explore alternative water sources.

1.4 LEGISLATIVE FRAMEWORK

The South African Government has policies and legislation in place to ensure Sustainable Service Delivery. The Constitution of the Republic of South Africa (RSA, 1996) (previously known as Act 108 of 1996, now only referred to as The Constitution) (updated in 2015) states in Chapter 7, Section 152 that a municipality has to strive to provide services to communities in a sustainable manner within its financial and administrative capacity. In Section 153 the Constitution (RSA, 1996) states that, a municipality must fulfil its developmental responsibility by prioritising the basic needs of the community when developing its single strategic plan and budget.

Chapter 8 of the Local Government: Municipal Systems Act (32 of 2000) (RSA, 2000) gives effect to the provisions of the Constitution (RSA, 1996) in relation to the provision of services to the community by municipalities, the accessibility of these services as well as the equitable distribution thereof in a sustainable manner that is prudent, economic, efficient and effective, while taking the environment into consideration. Section 76 outlines the mechanisms for the provision of these services:

a) An internal mechanism, which may be:
    (i) a department or other administrative unit within its administration;
    (ii) any business unit devised by the municipality, provided it operates within the municipality's administration and under the control of the council in accordance with operational and performance criteria determined by the council; or
    any other component of its administration; or
b) an external mechanism by entering into a service delivery agreement with-
    (i) a municipal entity;
    (ii) another municipality;

(iii)an organ of state, including

(aa) a water services committee established in terms of the Water Services Act, 1997 (Act 108 of 1997);

[Item (aa) substituted by s. 40 of Act 51 of 2002.]

(bb) a licensed service provider registered or recognised in terms of national legislation; and

(cc) a traditionally authority;

(iv)a community-based organisation or other non-governmental organisation (NGO) legally competent to enter into such an agreement, or

(v) any other institution, entity or person legally competent to operate a business activity.

In Section 77 and 78 of the Local Government: Municipal Systems Act (32 of 2000) (RSA, 2000), municipalities are urged to review and decide on mechanisms to provide municipal services. Chapter 4 of the Local Government: Municipal Finance Management Act (56 of 2003) (RSA, 2003) outlines how public funds must be managed, guided by the Municipal Fiscal Powers and Functions (MFMA Act) (12 of 2007) (RSA, 2007). Section 20 refers to the matters to be prescribed like the annual budget in"(iv) uniform norms and standards concerning the setting of municipal tariffs, financial risks and other matters where a municipality uses a municipal entity or other external mechanisms for the performance of a municipal entities" (RSA, 2003).

The Municipal Fiscal Powers and Functions Act (12 of 2007) (RSA, 2007) regulates the exercise by municipalities of imposing surcharges on fees for Services provided under Section 229 (1) (a) of the Constitution; to provide for the authorisation of taxes, levies and duties that municipalities may impose under section 229 (1) (b) of the Constitution; and to provide for matters connected therewith (RSA, 1996). Chapter 3 of Municipal Powers and Functions Act (12 of 2007) (RSA, 2007), section 8 outlines the Norms and Standards which municipalities must adhere to. The municipality must differentiate between the different services, geographical areas, categories of users, how surcharges may increase and the setting of municipal tariffs.

The White Paper on Local Government, (RSA, 1998a) states that local government is ideally placed to analyse the local dynamics and as a collective develop the municipality and change the situation into a better state where everyone within its boundary have equal access to services. The Act (RSA, 1998a) defines developmental local government as "local government committed to working with citizens and groups within the community to find sustainable ways to meet their social, economic and material needs and improve the quality of their lives" Section 2.1 outlines services as water, sanitation, local roads, storm water drainage, refuse collection and electricity. Municipalities must prioritise the provision of these services (a basic level of services) to those who currently enjoy little or no access to services (RSA 1998). The Act also identifies new approaches to service delivery, which are basic services for all (addressing backlogs) through the following principles:

- accessibility of services (not just availability but also easy and convenient to use);
- affordability (financial);
- quality of productions and services (professionally render to service providers and consumers);
- accountability for services (appropriate mechanisms);
- integrated development and services (IDP);
- sustainability of services (ongoing service provision depending on financial and organisation systems);
- value for money (cost of inputs, quality and value of outputs);
- ensuring and promoting competitiveness of local commerce and industry (job creation and healthy competition) and;
- promoting Democracy (promotion of democratic values enshrined in the Constitution).

The Constitution (RSA, 1996) mandates local government to:

- Provide democratic and accountable government for local communities;
- Ensure the provision of services to communities in a sustainable manner;
- Promote social and economic development;
- Promote a safe and healthy environment and,
- Encourage the involvement of communities and community organisations in the matters of local government (RSA, 1998a:14)

1.5 WATER RESOURCE MANAGEMENT

Groundwater resources are decreasing due to climate change patterns specifically in the Karoo where deserts are growing bigger and the socio-economic challenges are increasing. Therefore the need for groundwater expansion and development is greater. Water resource management must also be improved, therefore LLM needs to do risk assessment and put mitigation measures in place as well as explore alternative resources to conserve the water resources in Laingsburg.

Behrens, Giljum, Kavanda and Niza (2007:445) have stated that:

> …over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, fibre and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on earth.

The challenge is to find ways to develop that ensure economic growth as well as stay in line with technology without compromising our natural resources. The Laingsburg Local Municipality (LLM) must find innovative ways to grow its economy and not deplete water resources. Stern (2006:VI) has warned that "climate change will affect the basic elements of life for people around the world which is access to water, food production, health, and the environment. Hundreds of millions of people could suffer hunger, water shortages and coastal flooding as the world warms". This will be felt especially in Laingsburg because of the socio-economic profile and its dependency on natural resources and the poorest of the poor will experience it to a higher extent.

According to Human (2013: xvii),

> Laingsburg Municipality appointed GEOSS in 2008 to perform a drilling and pump testing investigation in Zoutkloof with the main aim to supplement in the existing water supply to Laingsburg. Four boreholes were drilled, of which two were not pump - tested as the yields of these boreholes did not justify further interest.

Human (2013:9) reports that in Matjiesfontein "five boreholes are owned by Laingsburg Municipality, of which two were drilled and commissioned during 2005 as well as three boreholes drilled in 2008". Human (2013:9) states that LLM has an overall Blue Drop Score of 71.2% in 2012 and Green Drop Score of 36.9% in 2013. Human (2013:33) identified the

need for the municipality to increase their Water Quality Operational Sampling Programme and is in process of developing a Water Safety Plan.

Swartz (2014a:4) stated that Laingsburg's oxidation pond is in a fairly good condition achieving a 60% score. "The Laingsburg Wastewater Treatment Works (WWTW) is located approximately 900m to the west of the town. The Laingsburg (WWTW) consists of oxidation ponds with a design capacity of 0.06MI/d (.0219 million m^3/a) and was last upgraded in 2005". Swartz (2014a:5) furthermore mentions that Laingsburg achieved a Green Drop Score of 76.5 in 2009 and the water treatment works received and treated a total volume of 0.260 million m^3/a.

Swartz (2014b:16) provides the following for Matjiesfontein, where the Wastewater Treatment Plan is

> …a package domestic sewage plant with hydraulic flow rates estimated to peak at 52.5kL/day based on 150 litres per person per day, but containing organic content of 21 00 grams of Chemical Oxygen Demand (COD) based on the standard 60 grams per person per day. Treated effluent is irrigated on the property where possible and / or discharged into the nearby watercourse, in accordance with a fully-automated but adjustable protocol, which supplies the irrigation system at a rate of 7 m^3/hr.

According to Swartz (2014b:8) ±660 Kl/d or CD is roughly 75% of the Annual Average Daily Demand (AADD) and that approximately 90% of this is a direct contribution from connection to the sewerage system and the other 90% is contributed by groundwater infiltration. WorleyParsons RSA (2015:2.1) estimates that Laingsburg Municipality will expand from 2646 households to 2831 by 2023. The municipality has an average household size of 3.44 as per the 2011 Census data. Because it is their responsibility, the LLM should approach it as a priority to ensure that adequate and appropriate investments are made to ensure "the progressive realisation of the right of all people in this areas of jurisdiction to receive at least a basic level of water and sanitation services" (WorleyParsons RSA, 2015:3.1).

According to WorleyParsons RSA (2015:3.3), the option of groundwater mining (i.e. pumping more than the annual recharge) should be avoided at all costs. He suggests the "options of dual

reticulation where fresh water supplies are limited. The second reticulation system may carry re-used water or saline groundwater to be used for toilet flushing, gardens and laundry".

Swilling and Annecke (2011) stated that sustainable development reconciles sustainable use of natural resources like water with a pervasive and meaningful commitment to sufficiency. They assert:

> "Although the world's poor are most affected by resource depletion and negative environmental impacts, it is possible to envisage investments and interventions that result in a more sustainable use of resources and reduced impacts, without fundamentally altering the balance of power and distribution of resources between richer and poorer sectors of global society".

The 2005 Western Cape Reconciliation Study states that water must be preserved, for instance through leak detection and repair; pressure management; use of water-efficient fittings; metering and plumbing repairs in low-income areas; use of grey water; use of well points and boreholes; metering; tariffs and surcharges/credit control; water-user education; rainwater tanks; exchange reclaimed wastewater for commercial irrigation; industrial reuse; reclamation to potable water standards; urban irrigation; dual reticulation in new housing (so that grey water can be supplied for toilets); and aquifer recharge (as quoted in Sustainability Institute & E-Systems, 2009b:30) (Swilling& Annecke, 2011).

Swilling and Annecke (2011) pointed out that:

> the most popular grand 'techno-fixes' are mass public transit systems (especially urban rail, but also Bus rapid transit (BRT); closed-loop water and sanitation systems; large-scale renewable energy systems such as Desertec–the biggest solar power plant planned by a consortium of German companies for the Sahara Desert to supply Europe via new DC ('direct current') cables; smart grids; a new generation of buildings that generate more energy than they use; and as mentioned earlier, the new autonomous sustainable cities for the elites such as Masdar, Treasure Island and Dongtan.

The Laingsburg Local Municipality must consult work which was already conducted to inform future plans and ensure sustainable development. Fischer-Kowalski and Swilling (2010:72) recommended taking into consideration the environment to become sustainable when planning

and developing policies, because the "increasing demand for resources, declining grades of several key ores, and increasing environmental impacts associated with resource use suggest that decoupling could be a timely policy response".

"In 2009, the National Department of Human Settlements introduced a national programme to bring sustainable resource-use criteria into the design of the settlement projects and houses that it subsidises across the country, with special reference to issues such as densities, orientation of the buildings, roof overhangs and insulation, installation of solar water heaters, and sustainable use of water and waste resources" (Swilling & Annecke, 2011).

Noemdoe, Jonker and Swatuk (2006:778) suggested that seasonal scarcity could be overcome if the necessary infrastructure would be put in place so that water could be accessed as and when needed. They proposed that "creating the appropriate institutions that will ensure that the management systems put in place remain functional; and initiating a dialogue amongst the various stakeholders". The scarcity of water should therefore be studied in conjunction with infrastructure, institutional capacity and the social needs of the municipal consumers.

As Ridder and Erez (1977: v) concluded that the "problem with water resources operations, design and planning is often solved by a systems approach", the current study also looked at the systems approach which can assist the municipality in water resource management. Bennison (1947:509) much earlier pointed out that "efficient development of groundwater will in the long run result in better wells, constructed under better supervision, along more standardised lines; and in so doing we will be contributing to the conservation of groundwater".

1.6 RISK IDENTIFICATION

A risk is defined by Qian, Wang and Zhang (2014:4433) as an equal to the two-dimensional combination of consequences associated with uncertainties and probability and often used as a tool to express and describe uncertainties in a risk assessment. In the case of water risks are defined as the influence of management processes, or the absence thereof, on water resources by humans.

With regard to risk, the Organisation for Economic Co-operation and Development (OECD) (2011:03) declared that;

> the awareness of risk management in government and the private sector has risen dramatically in recent years. Large-scale disasters have been recognised as challenges to public policy, usually at the national or regional level. The concept of 'global shocks' takes account of a different pattern of risk: cascading risks that become active threats as they spread across global systems, whether these arise in health, climate, social or financial systems.

According to the OECD (2011:26) "risks can accumulate, propagate and culminate in a much greater scale of effects, and the uncertainties surrounding their likelihood of occurrence", therefore it is important to identify the risks earlier on in order to make informed decisions to mitigate such risks.

Further elaboration by Qian et al. (2014:4435) on the kind of risk involved here asserts:
Risk is due to the following combined effects:

- threat of natural or human-induced events and susceptibility of a system to be affected by the external event;
- Vulnerability is a manifestation of the consequence of risk;
- Threat refers to the probability of something undesirable happening in the given time;
- Susceptibility is referred to as the inherent state of the system or the set of conditions resulting from physical, social, and economic factors that are exploited to adversely affect the system and,
- Vulnerability is defined as potential losses due to a particular hazard for a given area and reference period

Møller (2011:1) identified the drivers for risk management as "A 'progressive' argument or driver of value creation and 'defensive' arguments or drivers of value preservation" which are about finding out more about the risk and putting mitigation measures in place to adapt to the event or uncertainty.

This section reflects the studies done within field of the water conservation as well as the legislative framework pertaining to sustainable resource management.

1.7 RESEARCH PROBLEM AND OBJECTIVES

1.7.1 Problem statement

Laingsburg Local Municipality is faced with decreasing groundwater levels and an increase in demand for human consumption, as well as for economic growth.

1.7.2 Purpose of the research

The purpose of the study was to undertake a risk assessment of groundwater levels in the Laingsburg Local Municipality area and to encourage adaptation practices and strategies that can assist the municipality to remain resilient and be sustainable in terms of water supply.

1.7.3 Hypothesis

Brynard and Hanekom (1997:19) define a hypothesis as a "suggested, preliminary, yet specific answer to a problem, which has to be tested empirically before it can be accepted as a concrete answer and incorporated into a theory". It is represented as an answer to a specific question and should preferably be positive. The following hypothesis was defined for this study:

I. Implementation of a Water Resource Management Adaptation Plan will result in the sustainable use of groundwater use in the Laingsburg Local Municipal geographical area of responsibility.

1.7.4 Research objectives

According to Lourens (2007:11), an objective must be as specific as possible, it has to be relevant and it has to be unambiguous. The following epistemic objectives were used to test the hypothesis;

- assess current Water Resource Management in Laingsburg Municipal Area;
- identify risks that threaten sustainable groundwater levels within Laingsburg Municipal Area;
- analyse the policy and legislative environment for Water Resource Management;
- investigate potential adaptation processes and procedures to ensure Municipal resilience;
- recommend sustainable resource management processes to the municipality; and
- develop a Water Resource Management Adaptation Framework for the municipality.

1.8 RESEARCH DESIGN

A non-empirical research was selected on the basis of conceptual studies, municipal assessments, legislation and assessments done by government. Evaluation research was utilised to assess Water Management Practices undertaken to promote improved water resource management and prevent water scarcity. The study utilised a mixed methods approach for data collection which included a literature review and content analysis (qualitative and quantitative).

1.8.1 Research methodology

The researcher conducted the research within Laingsburg Local Municipality, which was the area under study. The researcher analysed the work done around water resource management to improve and extend local processes and practices. Structured personal interviews were conducted with key municipal personnel, such as the Head: Technical Services, professionals in the Water Resource Management & Conservation, Risk Assessment, and Infrastructure Development Departments

1.8.2 Purposive sampling

The researcher conducted semi-structured interviews with the help of an interview guide with the Manager: Infrastructure Services as well as other staff working in the water services division within the municipality. The sample of interviewees also include practitioners in the field of sustainable development, water resource management & conservation, risk assessment, infrastructure development and disaster management professionals from all spheres of government and the private sector.

1.8.3 Data collection strategies

The researcher compiled an interview guide that could stimulate the interviews and discussions with the identified people. The guide consisted of 17 questions which would give the researcher room for follow up questions. The information gathered from the interviews, content analysis and literature review was captured and analysed scientifically by the researcher to test reliability and validity which would, in future, make the utilisation of the research material and implementation possible.

1.8.4 Measuring instruments

The information from the interviews conducted was used to test the validity of risks identified on groundwater levels, water scarcity and documented processes of water management. The

input was relevant to the study to assist the researcher to do the research in a more structured way.

1.9 OUTLINE OF CHAPTERS

The chapters in this research report are structured logically in the following manner;

Chapter 1: Introduction of the study

- Background and purpose of the study
- Research problem
- Research methodology

Chapter 2: Sustainable water resource management in the era of climate change

- Sustainable development
- Climate change
- Water scarcity
- Risk management
- Water resource management (supply and demand)
- Water resource adaptation processes and procedures
- Summary

Chapter 3: Policy and institutional framework for Water Resource Management at local government sphere

- Legislative framework
- Municipal policies and frameworks
- Risk assessment
- Risk adaptation
- Summary

Chapter 4: Case Study: Water Resource Management in the Laingsburg Municipal area

- Municipal water resources
- Water resource management
- Wastewater management
- Risk assessment
- Risk adaptation
- Summary

Chapter 5: Interview sampling

- Water Resource Management
- Wastewater management
- Risk assessment
- Risk adaptation
- Summary

Chapter 6: Water Resource Adaptation Framework, Conclusions and Recommendations

- Recommendations
- Water resource adaptation processes and procedures
- Municipal guideline
- Recommendations and conclusion
- Summary

References

CHAPTER 2: SUSTAINABLE WATER RESOURCE MANAGEMENT IN THE ERA OF CLIMATE CHANGE

2.1 INTRODUCTION

This chapter provides a synopsis and contextualisation of the study. The concept of risk assessment is briefly examined from a transnational perspective, with consideration of various studies conducted in the field of groundwater conservation within the era of climate change. Focusing on the noticeable risks within the water demand management sector and the impacts of climate change on future sustainability of water sources. The outcome may lead to the sustainability of humanity, resulting from management of natural resources like water in a manner that it is conserved to ensure the continuous supply thereof (Malley, Taeb, Matsumoto & Takeya, 2008:3).

2.2 SUSTAINABLE DEVELOPMENT

According to Blewitt (2008:10), sustainable development sounds complicated but it is the belief that the future must be a place with no shortage of resources, a place where human generations have sufficient to live from and where there is no threat of scarcity of any natural resources. It requires a shared understanding of the natural world and what the demands are for water and natural resources. It should not be seen as separate worlds but as an integrated world as both are important and are interrelated. The one world is essential to the other to ensure the existence of the other. It might be complicated but it is the only way to ensure sustainability, specifically for the human generation.

Blewitt (2008:10) furthermore defined sustainable development as possible when we, as humans, admit that we are interrelated with the earth. One must come to the understanding that the world is multi-faceted, fragmented and complete requiring us to look at the world and human life in a holistic way. This is supported by Swilling and Annecke (2011) who see sustainable development as the effective use of resources to meet our needs and, at the same time conserve it for future generations so that they will be able live a good life without

shortages. Sustainable development should not be seen as a perception of people but a proactive approach of effective natural resource management.

The Bruntland Report (1987:8) identifies sustainable development as a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. This is confirmed by Swilling and Annecke (2011) that sustainable development is a key solution to minimise the effects of climate change or adaptation to climate change, which means the LLM must review the regulation, financing, monitoring and strategic management of key economic parts like water.

According to Jacobsen, Webster, and Vairavamoorthy (2013: xiii), as well as the OECD (2011: 110), sustainable resource management concerns the provision of water to a growing population and considering the environment and social needs of an urbanising world by improving the utilisation of information and actions to reduce risk of attenuation, being attentive of the reality that we are not sure and unable to replace or reverse equality of the demand and supply of water to users. Blewitt (2008: 30-33) confirms that the needs of the world's poor must also be prioritised and that it holds a threat in conservation of natural resources and the environment but we have to promote equality in resources.

Reed and De Wit (2003:9) made reference to the link between the protection of the aquatic environment and sustainability of water resources that was finally made in the early 1990 a policy on South African Water Quality Guidelines by the then Department of Water Affairs and Forestry (DWAF: 1996) to give effect to the human rights of South Africans in ensuring clean water in a sustainable way as contained in the Bill of Rights of the Constitution (RSA, 1996).

Blewitt (2008:11) documented that sustainable development requires a change of mind, a differential approach which is about being creative, the identification of potential risks, taking into account and management of the ambiguous dynamics thereof as well as utilising the opportunity to learn from life and through life in an experimental way. Therefore, LLM must become more proactive by managing water resources in a way than can ensure sustainability, specifically now that climate change is becoming more prominent.

2.3 CLIMATE CHANGE

The climate system on the earth is driven by energy received from the sun. The sun's energy is not distributed uniformly, but rather is intensive at the equator and weakest at the poles. When the balance between incoming and outgoing energy is interrupted, it changes the temperatures in climate cycles and affects climate patterns all over the world.

Climate change is a long-term shift in weather conditions identified by changes in temperature, precipitation, winds, and other indicators. It includes both changes in average conditions and changes in variability for example, extreme weather events. The causes of climate change are natural events like volcanic activity, solar output and the earth's orbit around the sun, but it also has a human influence by burning of fossil fuels, conversion of land for forestry and agriculture.

According to the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report, (IPCC, 2007:5), global average temperatures have increased since the mid-20th century, due to an increase in greenhouse gas emissions that is posing a risk to humanity and its existence. This report confirmed what Stern (2006:i-iii) concluded about climate change posing severe universal threats and demand an urgent global response in taking into account the environment in future development, as well as putting mitigation measures in place to cope with this phenomenon. Scientists looking at scientific evidence of the causes of climate change, predict how it will evolve over time with regard to the likelihood of temperature outcomes and how it will impact on the natural environment. The utilisation of such information must inform our future planning.

Stern (2006:vi) also made it clear that climate change threatens the daily life of people around the globe, specifically with regards to access to water as a basic need for survival and that there is clear warning signs identifying the severe impacts on the availability of water. One of these warming signs is evident in the melting of glaciers. The melting of glaciers increases flood risk and reduce water supplies significantly as identified in the following table:

Table 2.1: Impact of glaciers

Temp rise (°C)	Water	Food	Health	Land	Environment	Abrupt and Large-Scale Impacts
1°C	Small glaciers in the Andes disappear completely, threatening water supplies for 50 million people	Modest increases in cereal yields in temperate regions	At least 300,000 people each year die from climate-related diseases (predominantly diarrhoea, malaria, and malnutrition) Reduction in winter mortality in higher latitudes (Northern Europe, USA)	Permafrost thawing damages buildings and roads in parts of Canada and Russia	At least 10% of land species facing extinction (according to one estimate) 80% bleaching of coral reefs, including Great Barrier Reef	Atlantic Thermohaline Circulation starts to weaken
2°C	Potentially 20 - 30% decrease in water availability in some vulnerable regions, e.g. Southern Africa and Mediterranean	Sharp declines in crop yield in tropical regions (5 - 10% in Africa)	40 – 60 million more people exposed to malaria in Africa	Up to 10 million more people affected by coastal flooding each year	15 – 40% of species facing extinction (according to one estimate) High risk of extinction of Arctic species, including polar bear and caribou	Potential for Greenland ice sheet to begin melting irreversibly, accelerating sea level rise and committing world to an eventual 7 m sea level rise Rising risk of abrupt changes to atmospheric circulations, e.g. the monsoon Rising risk of collapse of West Antarctic Ice Sheet Rising risk of collapse of Atlantic Thermohaline Circulation
3°C	In Southern Europe, serious droughts occur once every 10 years 1 - 4 billion more people suffer water shortages, while 1 – 5 billion gain water, which may increase flood risk	150 - 550 additional millions at risk of hunger (if carbon fertilisation weak) Agricultural yields in higher latitudes likely to peak	1 – 3 million more people die from malnutrition (if carbon fertilisation weak)	1 – 170 million more people affected by coastal flooding each year	20 – 50% of species facing extinction (according to one estimate), including 25 – 60% mammals, 30 – 40% birds and 15 – 70% butterflies in South Africa Onset of Amazon forest collapse (some models only)	
4°C	Potentially 30 – 50% decrease in water availability in Southern Africa and Mediterranean	Agricultural yields decline by 15 – 35% in Africa, and entire regions out of production (e.g. parts of Australia)	Up to 80 million more people exposed to malaria in Africa	7 – 300 million more people affected by coastal flooding each year	Loss of around half Arctic tundra Around half of all the world's nature reserves cannot fulfill objectives	
5°C	Possible disappearance of large glaciers in Himalayas, affecting one-quarter of China's population and hundreds of millions in India	Continued increase in ocean acidity seriously disrupting marine ecosystems and possibly fish stocks		Sea level rise threatens small islands, low-lying coastal areas (Florida) and major world cities such as New York, London, and Tokyo		
More than 5°C	The latest science suggests that the Earth's average temperature will rise by even more than 5 or 6°C if emissions continue to grow and positive feedbacks amplify the warming effect of greenhouse gases (e.g. release of carbon dioxide from soils or methane from permafrost). This level of global temperature rise would be equivalent to the amount of warming that occurred between the last age and today – and is likely to lead to major disruption and large-scale movement of population. Such "socially contingent" effects could be catastrophic, but are currently very hard to capture with current models as temperatures would be so far outside human experience.					

Note: This table shows illustrative impacts at different degrees of warming. Some of the uncertainty is captured in the ranges shown, but there will be additional uncertainties about the exact size of impacts (more detail in Box 3.2). Temperatures represent increases relative to pre-industrial levels. At each temperature, the impacts are expressed for a 1°C band around the central temperature, e.g. 1°C represents the range 0.5 – 1.5°C etc. Numbers of people affected at different temperatures assume population and GDP scenarios for the 2080s from the Intergovernmental Panel on Climate Change (IPCC). Figures generally assume adaptation at the level of an individual or firm, but not economy-wide adaptations due to policy intervention (covered in Part V).

Source: Stern, 2006: VI

As the world gets warmer, the damage from climate change will increase. Higher temperatures will increase the chance of triggering abrupt and large-scale changes. Warming may induce sudden shifts in regional weather patterns of rainfall which will lead to a decrease in water availability or flooding, both of these extremes hold a treat to human existence (Stern, 2006: vi-vii). The danger of climate change is supported by Metz (2010:13) who states that even though models have limitations, there are enough grounds to consider assumptions from the

predictions about future climate change as indicators to steer planning and development. This is based on the facts of generally accepted principles of physics, the aptitude to see trends, and clear changes in current and past climates. The utilisation thereof assists us to predict how climate change will evolve in future because we do experience these extreme temperatures more than in the past. We cannot ignore it any longer if we want to continue living or become resilient and adapt to climate change and how it affects life.

Metz (2010:14) stated that clean water is of vital importance for humans as too little water means less for consumption and too much can lead to disastrous incidents like flooding which can take life. The availability or lack of fresh water can cause a variety of problems. As 20% of the world's population live in areas where glaciers or snow feed the rivers, these people will be at risk if glaciers continue to melt. A further 20% of the world population live in river basins that are likely to have increased risk of flooding by the end of the century. It is estimated that three billion people will be faced with the challenge of water availability by 2080, which is either water scarcity or plenteousness (flooding).

In the African context, more people will be affected by water scarcity as it is predicted that plus minus 250 million people will be affected by 2020 due to the effects of climate change. In South Africa, climate change is acknowledged as a key risk threatening water availability due to the shifting rainfall patterns in an already water-stressed country (RSA, 2006:29).

Fisher-Kowalski et al., (2011:92) argued that utilisation of global climate models reveals that variations in the South African climate are expected to increase within the next 50 years. It will impact on water availability on a national level as changes may include an increase in warming of between 1 and 3°C and a decrease in rainfall around of 5 to 10%. Summer rainfall will increase in the northeast and southwest but the period will be shortened. Nolan (2015:1) confirmed in their conclusion that adverse weather conditions experienced, for example ice snow downfalls, increase or decrease of water levels or extreme temperatures are factors that hold serious threats which can influence health and safety, South Africa should take this to consideration to ensure that the current water supply and demand is closely monitored in line with future needs as the country also face extreme temperatures.

2.4 WATER SCARCITY

According to Lawrence, Macdonald, Howard, Barrett and Pedley (2001:23) "groundwater constitutes some 97% of all freshwater on earth that is potentially available for human use. Groundwater is therefore of fundamental importance to human life".

Reed and De Wit (2003:56-74) identified responsibility for national government in conserving this natural resource and ensuring the provision of sufficient water in a sustainable manner to citizens as a human right. It was also identified that human need is currently defined as 25 litres per person / day and obtainable within a safe 200 meters from the home for all people in South Africa. It is predicted that the State will reach their target of access to water for all South Africans by the year 2030 but the following year the availability of water per capita will decline as the population continues to grow and water scarcity increases. Therefore "climate change is likely to exacerbate water scarcity in most areas of the country".

Reed and De Wit (2003:79) furthermore identified that arid and semi-arid areas will be heavily affected by water availability because of their dependency on groundwater. Such areas will be highly affected by scarcity of water, and the supply thereof for human consumption or to transform the social economic situation will be extremely difficult and expensive. Efforts to ensure this will include the achievement of land reform targets as set by the state, but also ensuring the sustainability of the programme.

South Africa is defined as a water-stressed area that has an uneven distribution of water availability across the country and groundwater resources that remain insufficient to meet the needs of South Africans (RSA, 2006:33). Rural areas that do not have sufficient resources or infrastructure are more heavily affected by the risk of water scarcity. It was estimated that if no mitigation measures are put in place, in line with the economic development and population growth, water shortages will result. Statistics show that a "total system yield in 2000 was 13.227 x 109m3 where total water requirements in the same year were 12.871 x 109m3". The Department of Water and Sanitation estimates that in 2025 it will be able to meet the demand, for example a "total system yield will be 14.166 x 109m3 with a total system requirement of 14.230 x 109m3" (RSA, 2006:33). The population growth increases daily in South Africa, although the water resources do not increase, therefore South Africa cannot do business as

usual but must become more effective with regards to water resource management and find alternative methods to meet future demands (RSA, 2006:33).

Various key risks causing water shortages in South Africa have been identified. Besides climate change, unchanged resource management techniques and processes, the increase of infrastructure designs and the management to ensure the supply of potable water, the water pricing structure also does not promote water saving or measures that ensure efficiency and this is coupled with limited efforts of re-use and recycling of sewerage outputs (RSA, 2006:33-34). Bad planning and lack of resource management in municipalities are also the reasons for the current state of affairs. The lack of demand management is also one of main reasons for water shortages, but residents who does not want to pay for services rendered especially when water is so important for our daily use. The culture of non-payment in municipalities also have an impact on the lack of resource management. Municipalities, service providers and consumers all played a part in the risks causing water shortages in South Africa.

These risks need to be considered seriously and preventative measures must be put in place in order to minimise the effects of water scarcity in South Africa. This is more specifically in arid and semi-arid areas where groundwater is the only source of the water and the effects of climate change is experienced more intensely. Citizens must be empowered to better understand this phenomenon arising from natural and human caused actions including their role in the phenomena of decreasing ground water.

Field (2006:766) views that the use of scarce water resources in an equitable manner in South Africa as one of the most significant challenges in the environmental setting. Water is one of the scarce natural resources along with minerals that have the potential to enable and stimulate South Africa's socio-economic development, but it has been a benefit denied to the majority of South Africans. Statutes governing the use and management of water were put in place and it is appreciated that the state has formulated laws and policies to redress the injustices of the past, but it also risks unsustainable water resources management. The fact that the demand for water is increasing for household use as well as for development purposes puts further strain on resource management. Rural areas are faced with challenges like low growth potential, limited opportunities to attract investors, lack of job opportunities as well as possibilities of shale gas drilling to address the South African energy crisis. Water is the most important

resouce for these areas to transform, but it will affect future demand for households and sustaining economic initiatives.

Bennison (1947:454) declared that the demand for groundwater resources escalated during the First World War, after water usage having increased during the industrial revolution in 1771 and even now in the era of information and communications technology (ICT) and sustainability / green technology, the utilisation of groundwater is still increasing. In both urban and rural areas where water is crucial for development, the need for a constant supply of groundwater is increasing. The revival of the economy, the creation of employment and the need for equality steer transformation in the world. This is true for South Africa and towns like Laingsburg, but it also leads to the serious increase in demands made on water resources.

It is easier to monitor surface water levels in dams and wastewater treatment plants, but in areas where groundwater measurement is complicated, groundwater flows are not tangible and it is not clear that the systematic extraction is slower than nature's ability or capability to renew. It cannot clearly be determined what the level of groundwater is, therefore the over-exploitation, the destruction of the biodiversity and the disturbance of eco-systems are at risk. Assumptions can only be made by the monitoring of consumption, prediction of seasonal demand and the cost of water management and protection. This makes it important for water authorities like Laingsburg Local Municipality to maintain groundwater for its population as a necessity of life as well as to ensure that the town develops without exposing the area to the risk of water scarcity by taking responsibility for the conservation thereof.

Querini, Tamburrino and Dell'Aquila (2004:5) concluded that the growing demand for water is predominantly related to the growing population. They therefore suggested that a new approach or model be adopted for efficient management of water resources that will enable humanity to strike a balance between availability, supply and demand. We will then be able to reduce the wasting of water resources and utilise it to conserve the environment. Arid and semi-arid areas are more susceptible to extreme recurrent droughts; water scarcity is aggravated by variability of exploitability, vulnerability and the socio-economic need of these areas.

2.5 RISK MANAGEMENT

Risk management is important in the management of resources in the era of climate change, specifically with rising demand for natural resources. Awareness thereof has been highlighted in the light of large-scale disasters globally, naturally and at a local level.

According to Querini et al. (2004:11), risk management is not being adequately developed with regard to floods and droughts, and putting adequate risk management measures in place. The cost of these types of disasters must be considered a hindrance to sustainable development. The OECD (2011:3) identified tools to identify global threats, for example; systems, models, knowledge management and the use of data that can assist Public Policy Managers worldwide to embark on ways that can assist with risk management. The OECD (2011: 3) furthermore stated that there is urgency for the identification and assessment of risks from systems that are vulnerable and at risk as well as the development of policies that encourage early detection, putting mitigation measures in place and ensure a response that does not threaten the sustainability of service delivery or the economy. Also very important is the need for explaining the seriousness of water demand management as well as providing strategic advice on preparation and responding to potential global shocks mired in uncertainty.

2.5.1 Drivers of risk

There is a need to identify the drivers of risk that influence the uncertain factor of sustainability of water resources for our current need and for future purposes. Møller (2011:1) stated the purpose for risk management and aspects of uncertainty that are identified as drivers for risk management as follows;

- value preservation;
- increasing production of risk in modern society, leading to an escalating experience of uncertainty and unpredictability;
- risk management as a mechanism of response to increasing uncertainty and;
- risk management as a mechanism to distribute responsibility and legitimacy.

Møller (2011:3) cited Kneer and Nassehi's (1997) opinion that risk management is the ability to identify the risk, the effect and impact thereof as well as the ability to control the future. Although it is not easy to anticipate when risk will become reality, to put mitigation, response or adaptation plans in place is crucial when identifying potential risks. Risk management does

not imply the possibility to predict precise incidents or accuracies and the exact causes or reasons for it, it is impossible to be 100% certain, especially now that climate change is progressing. The tools can predict weather patterns and trends to a certain extent but the increasing uncertainty and complexity are the more reason to identify the drivers of risk as well as the identification of the consequences of decisions before they are taken. The following drivers are identified;

- mobility;
- interdependency;
- centralisation;
- urbanisation and,
- behaviour.

The OECD (2011:16) identified heightened mobility as risk driver linked to the increase in water demand of a growing population, in-migration, economic growth, tourism and business travelling in areas. The OECD (2011:17) also specified that interdependency of critical infrastructure and systems which enable the supply of water or the maintenance thereof is a risk driver, which means that not only the systems we utilise are interdependent but also what we use in water resource management is critical in ensuring sustainable service delivery. Information and Communications Technology (ICT) is also used as the backbone of service delivery and can be interrupted at any given time and it has a ripple effect on how business can be affected currently at this point in time as well as in the future as we become more dependent on these systems and infrastructure.

Another risk driver is centralisation of systems as recognised by the OECD (2011:17). Centralisation of systems is becoming a vital feature of efficiency to improve service delivery and cost effectiveness. The flexibility within the system or network has an impact on the service, specifically in the management of demand and the conservation of water resources. The age of infrastructure and the securing of goods, services and systems can be time consuming and one major disruption can have huge implications in a water stressed area. This instability may lead to lack of productivity, system failure and inaccessibility to water which may have consequences effects like service delivery protests. Research has shown that the some community protests are caused by lack or poor service.

Urbanisation, as identified by OECD (2011:19-21), results in high concentration of assets and resources in a relatively small, compact area and thus population growth. The risk of catastrophic events can lead to damage and loss of critical infrastructure that may result in water scarcity and the need for water resource management. More can be done to manage the risks of water scarcity and the concentration of assets and systems. Effective planning of the future demand for water, must consider the projected population growth and putting adaption plans in place to increase resilience. It also includes effective communication with citizens about the risks to provision of water, the conservation thereof, the risks they face and how they can assist in saving water.

Human behaviour, as mentioned by the OECD (2011:21), is a common factor that allows the ability to be aware of the potential risks and to learn from the past to manage the risk before it becomes a disaster and unsustainable in the future. Within the government, the operational responsibilities are in the hands of Middle Managers who often execute these duties without paying attention to the risks that exist and the impact and probability of disastrous events.

This assessment identifies various risks pertaining to provision of water (groundwater or surface water). These risks must be managed to mitigate effects of climate change in water scarce areas, therefore water resource management needs to be further studied to assist government in delivering water as a human right, as well as the economy of water delivery as an enabler for sustainability.

2.6 WATER RESOURCE MANAGEMENT (SUPPLY AND DEMAND)

Bennison (1947:472) identified the need for groundwater surveys and inventories because water is usable and expendable. It is still applicable now (in 2016 specifically) because municipalities as water regulators seldom pay attention to dropping groundwater levels and are now forced to do so due to interruption in temperatures and rainfall patterns as a result of climate change. Water scarcity increases in arid and semi-arid areas and becomes more noticeable during dry seasons; therefore there is a need to do assessments of groundwater levels and plan for the conservation for future generations. It is essential for water process controllers of the water provision divisions of municipalities to be more conscious of the water sources, studies and principles to monitor movements of groundwater. They must be aware of what the

nature of groundwater is, do research on alternative or natural restoring of sources as well quantities obtained. The following factors must be taken into consideration; i.e., rainfall penetration, natural influent and artificial influent.

Bennison (1947:478) found that groundwater, yields, pump-rates and levels are fluctuating due to the underground reservoirs (aquifers) which are subjected to over-pumping and mining of groundwater; therefore groundwater must be protected and conserved. Municipal records of groundwater levels will give a reflection of how much water is withdrawn from the source and if it is recharged faster or slower; an indication of whether it is standing as well as pumping will indicate true rises or falls of static levels. Climate also has an impact on water levels because water tables are within two or three metres of the surface and are exposed daily to high temperatures. Long dry periods in the rainy seasons also have an effect on groundwater.

Ridder and Erez (1977:1) revealed that the challenge in semi-arid areas with limited water resources is to use these water resources effectively, economically and efficiently to ensure that it is conserved. Water resources must be assessed; it is not just about the distribution of water, but how these resources can best be managed in order to conserve it for future generations. Madungwe and Sakuringwa (2007:1232) defined water demand management as an effective way of managing scarce water resources.

The Worldwatch Institute (2008:111-112) refers to the importance of handling conservations in an integrated manner. The institute defined Integrated Water Resources Management (IWRM) as a process that coordinates the improvement and managing of water, land, and related resources focusing on conservation. It is about managing the supply and demand of water in a holistic and sustainable manner. Groundwater in South Africa is not properly managed at present, which leads to significant over - exploitation of water resources in many countries, including South Africa (The Worldwatch Institute, 2008:111-112). The consequence of over - exploitation is a fall in water tables and boreholes running dry which result in an inability to provide water for human consumption, agricultural and industrial needs as well as vulnerable biodiversity and soil degradation.

Stern (2006: vii) defined adaptation to climate change as taking steps to build resilience and minimise costs. Climate change is here, and we can see the effects thereof in our own areas.

Although climate change is no longer two to three decades away, there still opportunities to protect our societies and economies from its impact. Providing adequate information and improved planning which take into consideration the environment, the use of climate-resilient techniques and approaches with regard to service delivery could ensure sustainability. The utilisation of agricultural practices and infrastructure provisions that will enable us to be more pro-active and build resilience with regard to water sources preservation of water sources for economic growth and human consumption. Fisher-Kowalski et al., (2011: xv) confirm that the Green Economy Initiative of the United Nations Environment Programme (UNEP), a UN agency that coordinates environmental activities, pursues the aim to revive the world economy by decreasing the degradation of the ecosystems. The use of water resources in an effective way reduces the possibility of water scarcity in future as well as the dependency on promoters of carbon for daily use which means building resilience and adapting to climate change.

Fisher-Kowalski et al., (2011; xvii) acknowledge that the attainment of a better understanding of the hydrological cycle, as a challenge to climate change, is the unpredictable distribution of water in both time and space. Scientists are monitoring it as groups or individuals to assist with how and when plans must be put in place to minimise the effect of climate change and water (groundwater or surface water). Heavy rainfalls and excessive droughts are clear indicators that motivate for improved water management, which is critical to ensure resilience and the wellbeing of humanity and the earth. Assessment of methods with regard to more effective ways to harvest rain water, storage, and supplementary inclusive methodologies are needed for efficient means to supply water to households, businesses, agriculture and industries. The augmented utilisation of recycled wastewater to stimulate demands or subsidise natural resources, is seen as water resource management and adaptation measures to ensure that water is available when needed and conserved for future generations.

Fisher-Kowalski et al., (2011; 4 - 53) have suggested decoupling as a water resource management tool. This means that the use of natural resources is reduced within the economy through using less without compromising the quality of the output. It is about reduced water usage, but using it in a manner that assists one to achieve the same output, be it social or economic, as previously when more water was consumed. This is applicable to South Africa as a water-scarce country, otherwise the country will not be able to have ample water resources in future. Scientists and policymakers also agree that there may be no water available for future

development, therefore Integrated Water Resource Management (IWRM) is the single solution to build resilience.

Fisher-Kowalski et al., (2011:95) quote Turton (2008:3) stating that South Africa has an average of 497 mm rainfall per annual, which means South Africa is a dry country, and 98% of available water resources have already been allocated. This indicates that South Africa does not have surplus water for future strategic development, therefore alternative ways must be found to provide water to a growing population and for economic development.
Field (2006:767-769) has identified the following three insights that stand out as crucial to the design of a water management framework.

- The first is the unity of the water cycle, a concept that links processes (precipitation, transpiration, infiltration and evaporation) with water resources (rivers, wetlands, lakes, dams, estuaries, groundwater and the sea) that confirmed that the processes and resources are interlinked and interdependent;
- The second is that the interference, interception and removal of water from the natural water cycle are largely dictated by land uses - an insight to which the National Water Act 36 of 1998 (NWA) (RSA, 1998) gives effect by including certain land uses within the definition of 'water use'. It is an insight that should prompt a much more detailed analysis of the manner in which land planning and development law intersects with water law;
- Finally, there are chilling effects of climate change on the availability of water resources in South Africa, with projections that stream flow could decrease by as much as 10% in the already water-stressed Western Cape Province by 2015, and that reduction in run-off should progress to the east coast by 2060.

Hence, effective water resource management and the supply of water can only take place if sufficient provision is made through passing of laws and subordinate statutes which regulate water usage and management effectively, efficiently and economically. The adoption of principles that can promote water conservation, adoption of plans, policies and strategies with clear objectives supported with sufficient resources that can make water resource management achievable is important. A resource classification system must be developed for all water resources in South Africa to ensure water conservation, supply and demand management. Reed and De Wit (2003; 65) further recognised the costs involved in managing water resources as

well as how the complexity thereof progresses over time. The speed at which technology evolves escalated the need for a Water Act envisaged to assist the state to provide for poorest of the poor, / in collaboration with society. The Worldwatch Institute (2008:15) reflected that water development and management must be done through an inclusive, consultative approach comprising all stakeholders; community, officials and public policy-makers. This approach will maintain effective management of networks between people, land and water with regards to water resource management.

Water as an economic value is also stressed and complimented by competing users and is seen as an economic enabler, but the absence of it can cause an economic crisis. It is also seen as a basic right for all human beings, and access to clean water at an affordable price specifically to the poor, as a human right. The ability to pay for water versus the cost or the effect of the extraction of this scarce resource must be considered together with the conservation thereof for the future. The importance of the management and utilisation of water resources as an economic enabler as well as a human right is a substantial reason to encourage the protection and preservation of water resources.

The Worldwatch Institute (2008:116) states that there is a variety of inventions that can assist in the management of water in a well-organised, creative, and maintainable way. New technologies that can assist with the utilisation of wastewater are invented on a daily basis to minimise the extraction of water. Household consumers are also embarking on water-saving technologies such as low-flush toilets, low-flow showers and faucet aerators to reduce demand and are moving away from bathing in order to conserve water. The utilisation of wastewater treatment and re-use techniques is also becoming more popular in households, businesses and industries to save water and become greener. Various opportunities have been identified and can be used to put climate change adaptation plans in place.

2.7 WATER RESOURCE ADAPTATION PROCESSES AND PROCEDURES

According to Reed and De Wit (2003:83) the long-term success of any' policy depends on strong leadership, sustained approaches and consistency. Officials who have the shared vision, responsibility and capacity to implement the policy, must develop an action plan that will assist them to reach the goal of conserving water for life, against the knowledge that 'Water is life'.

It is necessary to have clear plans stating short, medium and long-term activities, milestones and achievements which will enable the state to manage this very important natural resource. The plan must include strategies to handle difficult stages in processes and the building of partnerships and strong relationships with other sector departments, local government and other stakeholders to promote the development and implementation of water resource adaptation plans.

The UNEP (2011:8) stated that the growing need for water and threatening water scarcity can be mitigated by strong regulatory processes and an increase in investment to improve water resource management and efficient water supply. The basic ecosystem service provides freshwater which is of good quality and plentiful to meet current needs as well as the needs of future generations. This resource must therefore be managed appropriately and sufficient investment must be made to address water scarcity to restore the ecosystem of flood risk and drought risk. Supplying water without considering volumes and availability will lead to water scarcity and unsustainability with regard to global demand and supply. Therefore ways must be found to ensure transformation from old approach to conducting business by, investing in infrastructure and eco-friendly policy implementation. Fisher-Kowalski et al., (2011:96) support the notion through identifying rainwater harvesting and the utilisation of grey water for irrigation purposes as a potential solution for current challenges of growing water scarcity.

A need for an adaptation policy was identified by Stern (2006:xx1) as a way of dealing with the unavoidable impact of climate change on water and sanitation. UNEP (2011:103) identified the following opportunities to conserve water and adapt to water scarcity and climate change: a changed approach from building dams to sustain groundwater exploitation and management thereof, investing in the reduction of leakages to below 10%, reducing water consumption through the use of grey water, recycling and rainwater, instituting building standards that promote using grey water for households, gardening and food production as well as investing in technological innovations that reverse the qualitative degradation of water resources.

Querini et al. (2004:12) identified principles for the use of water resources that include coherent and flexible planning and management of resources in an effective way. It must be considered a national priority to improve the protection and preservation of water, and amounts and quality for the economy and household consumption. The development of public awareness regarding

the value of resources, making profitable investments and financing water resource management will promote sustainability and improve service delivery. The identified efforts that can be used in water demand management are the building of infrastructure and the replacement of inadequate infrastructure to reduce leaks, identify potential pollution sources and improved metering. Consumer education and encouragement of responsible behaviour will result in appreciation of water provision, and encourage re-use and conservation as a public value. Water conservation tariffs can be introduced to promote less water usage, and implementation of penalties for using more than is essential may help to create awareness on the gravity of the situation. This must, however be linked to making provision for adequate maintenance of infrastructure. The utilisation of water efficiency appliances, agricultural and industrial equipment encouraging the economical and prudent use of this scarce resource is recommended.

Madungwe and Sakuringwa (2007:1234) identified the need for strategies that motivate water demand management and an integrated approach preserving scarce water resources. Water demand management is also recognised as water strategies for life. The saving of water, the re - use of useable grey water and the treatment of wastewater for household consumption so that it can be returned to individual homes by separate reticulation and used in gardens should be encouraged. These approaches would be preferred by the regulatory authorities as they are able to retain more control.

Bennison (1947:456) argued for ways to conserve groundwater, among which is the control of leakages, flowing, restoration, recharging and re-use of water. Wastewater treatment is also a way to conserve groundwater. The treatment consists of the removal of floating and suspended solids, both fine and coarse from raw sewage, treatment by sedimentation and removal of pollutants not removed by previous processes (Querini et al., 2004:12).

Madungwe and Sakuringwa (2007:1232) also identified recycling or re-use of grey water as a water saving strategy with regard to demand management and sustainability in areas where there are increasing demands for fresh water as well as areas like Sub-Saharan Africa where water scarcity is increasing. Theoretical investigation is important and senior management must ensure that all employees understand the identified risks and that all relevant staff are part of the process when compiling plans and strategies like the Water Service Plan, so that

everyone is informed and the regulation of the supply and demand of water can be closely monitored.

Qian et al. (2014:4433) stated that various studies on water supply and demand have been undertaken, but finding a balance between water supply and water demand imposes a risk. Many researchers have tested reliability of studies conducted on the detection of the risk in water supply, determining the risk in water shortage as well as analysing the risk within the water distribution network. The criteria to evaluate natural disaster risk concern the probability of such disasters, the exposure to it and the vulnerability of people, the environment, property and the economy. Studies have concluded that risk in water resource management is due to a combination of factors. Climate change as an external event threatens natural and man-made sustainability as well as the susceptibility of a system. Vulnerability has to do with the impact that the consequence of the risk may have on the population, economy or the environment.

Water scarcity is a threat with regard to the probability of a disastrous event happening at any given time when no mitigation, response or adaptation plans are in place, whereas the susceptibility refers to the set of conditions resulting from physical, social, and economic factors that are exploited to adversely affect groundwater levels (Qian et al., 2014:445).

2.8 SUMMARY

From the literature review it can be concluded that there is a need to move away from business as usual practices which may result in water scarcity. Climate change has been debated on various platforms: resulting in acknowledgement that climate change is a fact. It is unclear on how it will evolve and what the extent of it will be. It is therefore better to put measures in place for conserving water, as the means of ensuring human life and to use it effectively to meet current needs and make provision for future.

Sustainable resource management in the era of climate change in Laingsburg is important, specifically because the municipality is dependent on groundwater for consumption as well as environmental and economic needs. An assessment needs to be done on the risks that have adverse implications on the demand and supply of the water; current water management practices and procedures that will ensure sustainable water provision.

Various water resource management practices that can be implemented within a municipal environment were identified but the cost of these changes must be considered when making recommendations to ensure the implementability. It is important for the municipality to put adaptation plans which are in line with implementable water resource management practices in place to build resilience.

This section identified theoretical findings which highlight that semi-arid regions are at risk of future water shortage. It further states that South Africa predicted water shortage in 2007 already and Water Services Authorities must prioritise sustainable resource management measures. Laingsburg as a semi-arid area is a municipality with a high risk and needs to identify proper planning and manage groundwater sources as the only water source for human and economic consumption. The municipality of Laingsburg must do a risk assessment to enable the municipality to prioritise water resource management. If the municipality does not put mitigation measures in place, the municipality will be faced with water scarcity in the future. According to findings from studies conducted the last couple of years as well as studies done by the then Department of Water Affairs (DWA) in 2006, Water Services Authorities must find ways to conserve fresh water and recycle used water as an alternative.

The next chapter offers an analysis of the local context of Laingsburg Municipality with regard to the current situation concerning the availability of water and how to mitigate the risks pertaining to the area to ensure sustainability of groundwater resource management.

CHAPTER 3: POLICY AND INSTITUTIONAL FRAMEWORK FOR WATER RESOURCE MANAGEMENT AT LOCAL GOVERNMENT SPHERE

3.1 INTRODUCTION

The purpose of this chapter is to contextualise the study. The researcher analysed the current situation of the locality, at the same time do an assessment of the risks pertaining to groundwater provision in Laingsburg. Secondly, current resource management practices is also explored to ensure whether it is sufficient to ensure sustainable water provision in future. This, together with consideration of the various studies conducted in the field of groundwater conservation during the era of climate change, led to recommendations being proposed on possible opportunities for mitigation for Laingsburg which can lead to sustainability of the water supply within Laingsburg Local Municipality.

3.2 LEGISLATIVE FRAMEWORK

Section 152 in Chapter 7 of the Constitution of the Republic of South Africa (RSA, 1996) states that a municipality must provide services like water to its consumers in a sustainable manner within its capacity, be it finance, skills or human capital etc. Chapter 8 of the Local Government: Municipal Systems Act (32 of 2000) furthermore strengthens the constitutional mandate of municipalities in providing sustainable services to their communities in an equitable manner.

The National Water Act (36 of 1998) (RSA, 1998b:3) acknowledges that water is a scarce resource which also has been unevenly distributed although it belongs to all South Africans. This is because of the injustices of the past - the discriminatory laws and practices that prevented equal access to water. It also confirms the responsibility of Water Service Authorities to manage water resources and the usage. It further recognises the protection of the quality and the management of water resources that will ensure sustainability of South African water resources, as the conservation of it will benefit all consumers and future generations. The Act further recognised the need for an integrated management approach for all aspects of water resources and that all South Africans must participate in ensuring

protection, development, conservation and management of the control of water in an effective, efficient and economic manner (RSA, 1983).

The Local Government: Municipal Systems Act (32 of 2000) (RSA, 2000), Section 76, stipulates that a municipality must utilise internal or external mechanisms that will enable it to render these services in a sustainable, prudent, economic, efficient and effective manner.. Laingsburg Local Municipality utilises internal mechanisms for the provision of water to households within the municipal service delivery areas. Sections 77 and 78 of the Loal Government: Municipal Systems Act (RSA, 2000) further urges municipalities to review its mechanisms and ensure the sustainable rendering of water on an annual basis, specifically with regard to the cost and capacity to render this service.

Chapter 4 of the Local Government: Municipal Finance Management Act (MFMA), (56 of 2003) (RSA, 2003) gives clear guidance on how public funds must be managed to ensure that services like water are provided in an affordable and sustainable manner. Furthermore, Section 20 of the Act prescribes how the Annual Budget must be compiled by means of informed norms and standards regarding the setting of municipal tariffs, the identification of financial risks and how the municipality as a Water Service Authority (WSA) functions as an internal mechanism providing water with internal controls and performance of the municipality, the department and employees.

The White Paper on Local Government (RSA, 1998a) states that a municipality is ideally placed to understand and appreciate its own situation and can bring about change in a developmental and equitable manner as an enabler to provide sustainable water services to its community. The Laingsburg Local Municipality must work with local stakeholders and role players to find sustainable practices to provide water without compromising future demands in an economic, efficient and effective manner and improve the livelihoods of all citizens.

The Water Services Act (108 of 1997) (RSA, 1997:2) provides for the rights of South Africans to have access to basic water supply but also setting norms and standards on how to provide for this human right. The provision of a regulatory framework for water services authorities or institutions was developed proclaiming their roles and responsibilities promoting sustainable resource systems, methods and practices. According to the Act, and more specifically clause

12 (1), every municipality - as a water services authority - must prepare and submit a Water Services Plan to the Department of Water and Sanitation (DWS) in draft format, as well as a final copy of the plan. The Act also requires that the municipality take reasonable steps within the drafting process to give consumers a chance to comment and influence the process (RSA, 1997:2).

The White Paper on Local Government (RSA, 1998a:19-20) outlines the obligation of a Water Services Authority to provide access to water to all consumers or potential consumers within its jurisdiction in a manner that is consistent, efficient, affordable, economical and sustainable. In the provision of water, the Water Services Authority must take into consideration all factors including alternative ways to provide water, the need for efficiency, achievement of the benefit of sale, affordability, equality and availability of resources from neighbouring Water Services Authorities. During emergency situations, the municipality / Water Services Authority must put measures in place to manage resources and put limitations of usage of water as a regulatory measure.

The White Paper on Local Government (RSA, 1998a:23-24) states that following the approval of Water Services Plans, it must be implemented and Water Services Authorities must report annually on the implementation thereof, within four months of the end of the financial year. Municipalities are allowed to enter into contracts and/or joint ventures with service providers but remain responsible for the accessibility of water to all consumers or potential consumers without risking quality or rand value. The Water Service Authority must put by-laws in place that contain the conditions according to which quality water is to be provided.

This section outlines the responsibility of Laingsburg Local Municipality as a Water Service Authority having the constitutional mandate to provide water as a human right in a sustainable manner and that the municipality must put policies, plans, frameworks and by-laws in place that will ensure water resource management and the supply of water to all its consumers.

3.3 MUNICIPAL POLICIES AND FRAMEWORKS

According to WorleyParsons RSA (2015:10) the Water Services Act (108 of 1997) (RSA, 1997) Sections 12 and 13 state that Laingsburg Local Municipality has a duty to prepare and

maintain a Water Services Development Plan (WSDP), as part of the process of preparing an IDP. The DWS has developed a new set of WSDP guidelines to guide all municipality as a WSA with the WSDP process and to provide a framework for the capturing of the data.

WorleyParsons RSA (2015:13) states that the Laingsburg Local Municipality falls within the newly established Breede-Gouritz Water Management Area (WMA). Laingsburg Local Municipality is the only WSA within the Laingsburg Local Municipality's management area and also act as the Water Services Provider (WSP). Its responsibility as WSA also extends to the rural areas within its boundaries. Laingsburg Local Municipality's management area includes the following towns and rural areas:

- Laingsburg
- Matjiesfontein
- Vleiland and
- The rural farm areas, e.g. Baviaans, Hillandale, Koringplaas, Koup, Pieter Meintjies, Rouxpos and Seweweekspoort.

From a water services perspective, the most significant challenge is the augmentation of the existing water source; ensuring adequate refurbishment and replacement of existing water and sewerage infrastructure; the installation of new bulk water and sewerage infrastructure to accommodate new housing developments; and ensuring the provision of basic services to households located on private farms. Strategies and action plans need to be developed and implemented, in collaboration with farm owners, in order for the Municipality to fulfil its constitutional obligations and responsibilities as WSA to ensure that all households are provided with at least the basic services (WorleyParsons RSA, 2015:13).

3.4 RISK ASSESSMENT

3.4.1 Global warming

WorleyParsons RSA (2015:13) has identified global warming as a risk for the Laingsburg Local Municipality. In terms of adapting to climate change, water systems will therefore need to be more robust and new / alternative sources of supply may need to be found. Increased skills and capacity will be required from Water Managers and long-term water projections will be needed. Worley Parsons RSA (2015:14) continues:

Although an overall decrease in rainfall is generally not forecast, increased variability in the climate and frequency of extreme events, as well as increased temperature and wind could have an impact on water sources, particularly surface waters.

It is therefore necessary for WSAs to develop climate response strategies and include these in their WSDPs, implement Water Conservation/Water Demand Management (WC/WDM) and reduce levels of Non-Revenue Water (NRW). Water-related climate change adaptation and mitigation planning should be incorporated into all WSDPs and IDPs. The implementation of WC/WDM is a critical element of adapting to climate change. This must be implemented by all water sector institutions and water users, and should include the optimisation of dam and groundwater operations, as well as the reduction of physical water losses and the introduction of water-efficient appliances, processes and crops.

It is therefore advisable for Laingsburg Local Municipality that a conservative approach be followed regarding the management of water sources. It is proposed that the following approach be adopted to mitigate and adapt to the impacts of climate change:

- All resources, especially surface water resources, need to be re-evaluated, especially where demand is close to the safe one in twenty year yields. It is therefore important to establish assurance of supply levels of all water sources;
- increase assurance of supply of the water resources by ensuring that there is at least 10% additional capacity (headroom), when considering the maximum 24 hour demand on the peak month of the year;
- do not undertake new developments, unless a proper investigation of the implication on water sources and sustainability in the long-term has been undertaken;
- vigorously implement WDM measures, especially in terms of the following:

    - increased water efficiency;
    - frequent monitoring of the water supply system, from the sources to the consumers;
    - regular and adequate system maintenance and repairs and;
    - diversify water resources, e.g. surface water, groundwater and wastewater re-use(WorleyParsons RSA, 2015:13).

3.4.2 Floods

Flooding in Laingsburg was also identified by Laingsburg Local Municipality (2011b:39) as a climate change threat with regard to the likelihood of floods with greater intensity and longer term impacts since Laingsburg is prone to flooding. Predictions have indicated that the impact is likely to be increased in the severity and unpredictability of weather patterns. Flooding and storms are predicted which could have devastating effects on agricultural production.

Laingsburg experienced severe flood damage in 2014 after three rivers burst their banks due to heavy rain. The town's water and sewerage infrastructure was severely damaged. The direct damage to the Municipality's infrastructure was estimated at R20 million. It was one of the worst flooding in the Karoo town since 1981. The recent floods in Laingsburg once again highlighted the importance of ensuring that all bulk water and sewerage infrastructure is properly protected against possible flooding (LLM, 2015a:25).

3.4.3 Natural environment

The Karoo is considered a wonder of the scientific world and is therefore of immense national and international conservation importance. The region is integral to the work of scientists, botanists, archaeologists, geologists, palaeontologists and ecologists from all over the world. This is mainly due to the fact that the Karoo is an ancient, fossil-rich land with the largest variety of succulents found anywhere on earth (Titus, 2012:86).

3.4.4 Demographic perspective

3.4.4.1 Laingsburg

Laingsburg Local Municipality (2015a:11) stated that the primary economic base for Laingsburg town is the agricultural sector. The town serves the daily needs of the surrounding farming and residential community. With the exception of the towns' identity as a flood survivor, few other attractions, economic incentives and opportunities currently exist in the area. However, there are limited human resources present to develop the town.

Laingsburg plays an essential role as a service centre for the region by providing basic services to the surrounding farming community. Due to economies of scale and the critical threshold necessary to make businesses sustainable, the region only provides its community with a limited choice of opportunities. The town itself is therefore by-passed in favour of larger towns

for greater variety or for higher order services. A limited number of commercial enterprises have established themselves in the town with little to no private investment ensuing.

The local economy has been affected by the decline in employment opportunities and the natural increase in the growth rate of its population. The Laingsburg region has further been identified as one of the towns in the Western Cape Province with a low development potential and a high human need (Van der Merwe, Davids, Ferreira, Swart and Zietsman, 2005:67).

3.4.4.2 Matjiesfontein

Laingsburg Local Municipality (2015a:43) cited that tourism is the town's economic base, visitors and travellers visit the town for its history and unique Victorian sense of place. This causes an inflow of new money to the area. Considering its sense of place, Matjiesfontein has been granted heritage status. Major development in the area is undermined in order to retain the area's character. An additional 95 low-income houses were recently constructed by the Municipality.

3.4.5 Regional perspective

Western Cape Government (2015:51) indicated that the Central Karoo District economy grew at a faster rate than the population which has led to an increase in per capita income in the region. This indicates higher average standards of living of the inhabitants of the region. The Central Karoo District had the highest unemployment and youth unemployment rates in 2001, but this decreased significantly by 2011. The decrease can be attributed to higher levels of education and work opportunities in the Central Karoo District.

The Central Karoo District has the lowest literacy rates in the Western Cape Province, with Prince Albert recording the lowest literacy rate of 69.9%. Skills development as well as low skilled labour intensive initiatives will be necessary to stimulate employment in the region, due to the general trend towards employing skilled and highly skilled labour. Although the proportion of households that are living in poverty in the Central Karoo dropped slightly between 2001 and 2010, poverty levels are still relatively high and need to be addressed (Western Cape Government, 2012b: 10)

Even though the Central Karoo District has shown some improvement over the years with regard to its socio-economic environment there is still room for improvement with regards to

poverty reduction and skills development. The area faces a number of risks in terms of adverse climatic conditions which could impact on the sustainable development of the area. The region should therefore consider the impact of climate change in its planning and budgeting processes (Western Cape Government, 2012b:54).

3.5 WATER SERVICES OVERVIEW

The Municipal 5-year 2012- 2017 IDP (2012:55) stated that most of the municipal water is extracted from an underground water system and six water reservoirs that capture water in the Municipality. Water from Soutkloof is supplied to the New Town Reservoir where it is distributed to households. The settlement of Matjiesfontein is serviced from two boreholes. The Buffels River Pit is used as a supplementary source of water. Generally, the Laingsburg Municipal region is well-serviced with water and there appears to be no foreseeable future water shortages even considering extensions.

WorleyParsons RSA (2015:14-21) provided a local water services overview for Laingsburg and Matjiesfontein for whom Laingsburg Local Municipality act as a Water Services Authority (WSA). Table 3.1: below gives an overview of Laingsburg Local Municipality's population, households and water services levels.

Table 3.1: Water services overview

Table A.1: Water services overview																														
	2011*		2013/14		Water category										Sanitation category															
Settlement Type	Households	Population	Households	Population	Adequate: Formal	Adequate: Informal	Adequate: Sahinet Services	Water resources needs only	O&M needs only	Infrastructure needs only	Infrastructure & O&M needs	Infrastructure, O&M & Resource need	No Services: Informal	No Services: Formal	Adequate: Formal	Adequate: Informal	Adequate: Sahinet Services	Water resources needs only	O&M needs only	Infrastructure needs only	Infrastructure & O&M needs	Infrastructure, O&M & Resource need	No Services: Informal	No Services: Formal
URBAN																														
Metropolitan Area					Adequate			Below RDP					None		Adequate			Below RDP					None							
	0	0	0	0																										
Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Formal Town					Adequate			Below RDP					None		Adequate			Below RDP					None							
Laingsburg	1,512	5,667	1,567	5,873	✓		✓								✓		✓													
Matjiesfontein	95	422	97	429	✓										✓															
Sub-Total	1,607	6,089	1,664	6,302	2	0	1	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0						
Townships					Adequate			Below RDP					None		Adequate			Below RDP					None							
	0	0	0	0																										
Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Informal Settlements					Adequate			Below RDP					None		Adequate			Below RDP					None							
	0	0	0	0																										
Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Working towns & service centres					Adequate			Below RDP					None		Adequate			Below RDP					None							
	0	0	0	0																										
Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Sub-Total: (Urban)	1,607	6,089	1,664	6,302	2	0	1	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0						
RURAL																														
Rural / Farming					Adequate			Below RDP					None		Adequate			Below RDP					None							
Laingsburg Rural	804	2,200	812	2,222	✓		✓	✓		✓				✓	✓		✓		✓	✓				✓						
Sub-Total	804	2,200	812	2,222	1	0	1	1	0	1	0	0	0	1	1	0	1	0	1	1	0	0	0	1						
Informal Settlements					Adequate			Below RDP					None		Adequate			Below RDP					None							
	0	0	0	0																										
Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Sub-Total (Rural)	804	2,200	812	2,222	1	0	1	1	0	1	0	0	0	1	1	0	1	0	1	1	0	0	0	1						
TOTAL	2,411	8,289	2,476	8,524	3	0	2	1	0	1	0	0	0	1	3	0	2	0	1	1	0	0	0	1						

Source: WorleyParsons RSA, 2015: 21

The Growth Potential Study (GPS), November 2013, of the Western Cape Government determined the growth potential and socio-economic needs of settlements in the Western Cape using quantitative data (e.g. factors relating to socio-economic, economic, physical-environmental, infrastructure and institutional aspects).

Laingsburg Local Municipality has a low growth potential and has a low revenue base with a high dependency on welfare and more than 30% of households indigent and unable to pay for services.

Table 3.2 below gives an overview of the growth potential of Laingsburg and Matjiesfontein, as included in the Growth Potential Study.

Table 3.2: Growth potential rating for Laingsburg and Matjiesfontein (Growth Potential Study)

Indicator / Index (Classification)	Laingsburg (Out of 100)	Matjiesfontein (Out of 100)
Human Capital Index	45 (Medium)	32 (Low)
Economic Index	17 (Low)	16 (Low)
Physical-Natural Index	43 (Low)	26 (Very Low)
Infrastructure Index	65 (Medium)	47 (Low)
Institutional Index	44 (Medium)	40 (Low)
Growth Potential Index	39 (Low)	22 (Very Low)

Source: Western Cape Government (2015:15)

The table above illustrate the reality that the municipality's classification for growth potential is relatively low.

3.5.1 Service levels

According to the Laingsburg Local Municipality (2011b:56), 100% of the Laingsburg Local Municipal serving areas have access to water but taking into consideration the rural areas within the municipal boundary, only 60% of all the households in the whole municipal area has

access to water. The rural areas of concern are the privately owned farming areas where management and distribution of water in farming areas remains poor.

Figure 3.1 below presents an overview of the water service delivery access profile in the Laingsburg Municipal Management Area.

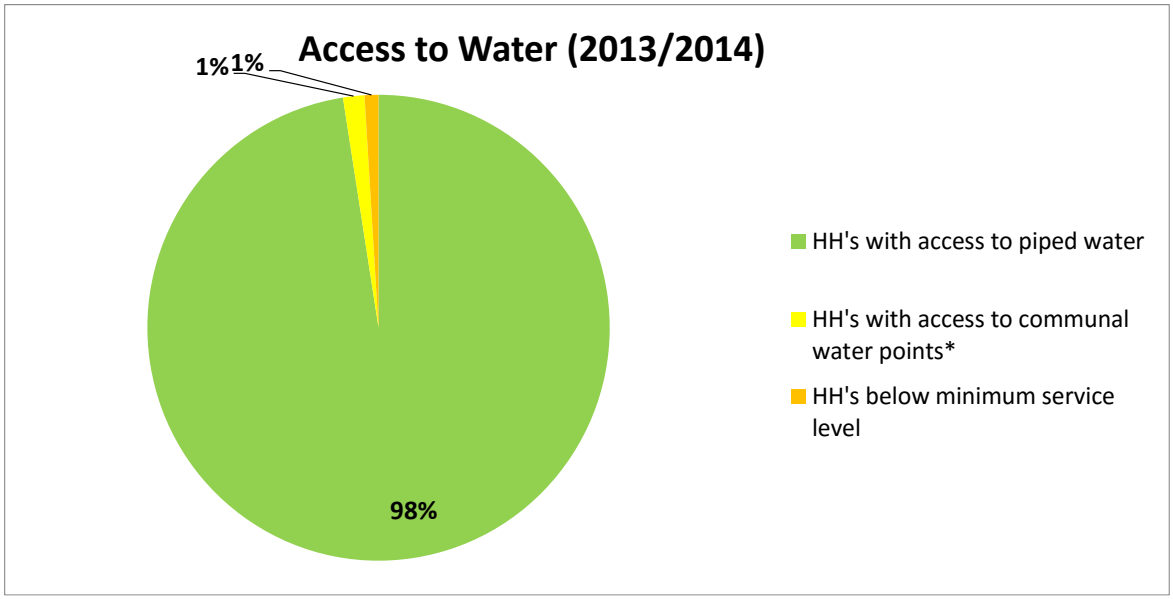


Figure 3.1: Access to water in the Laingsburg Municipal Management Area
Source: Laingsburg Local Municipality (2015b: 16)
Note: Abbreviations HH – Households

The Laingsburg Local Municipality (2011b:56) states that there are two wastewater treatment plants, one in Matjiesfontein and one in Laingsburg. Wastewater Treatment for Laingsburg is above Basic RDP standards and for Matjiesfontein it is below the Basic RDP standards.

Figure 3.2 below gives an overview of the sanitation delivery access profile in the Laingsburg Local Municipal management area, outlining that 92% of households have access to sanitation above the minimum service level standard.

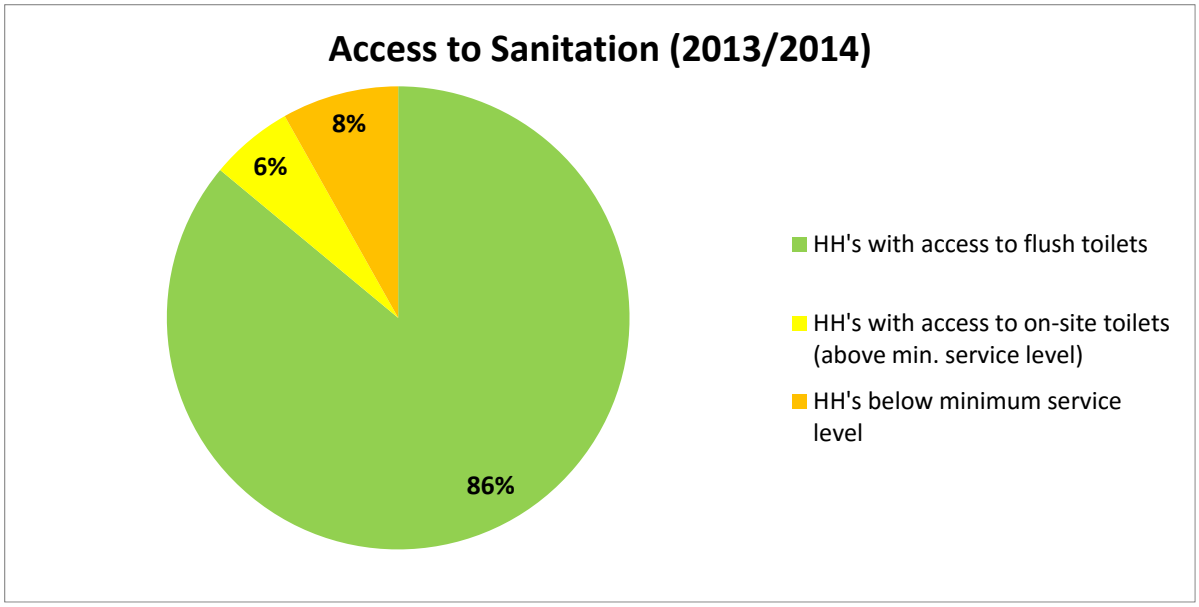


Figure 3.2: Sanitation delivery access profile

Source: Laingsburg Local Municipality (2015b, 17)

Note: Abbreviations HH – Households

However, 76 households use pit latrines below the acceptable standard. Four households also still make use of a bucket system and 43 households have no sanitation facility. At nine of the households the sanitation facility is not maintained or / not in a working order and at 17 households the sanitation facility is further than 50m away from the home (WorleyParsons RSA, 2015: -18).

Table 3.3 presents an overview of the annual number of consumer units for Laingsburg and Matjiesfontein, as taken from the financial system.

Table 3.3: Number of consumer units for the last three financial years, as taken from the financial system

Distribution System	Domestic	Business	Industry	Municipal	Gov.	Institutions	Church	Officials	Councillors	Total
2011/2012										
Laingsburg	1 162	19	1	2	5	1	9	35	1	1 235
Matjiesfontein	9	0	0	0	0	0	0	0	0	9
2012/2013										

Table 3.3: Number of consumer units for the last three financial years, as taken from the financial system										
Distribution System	**Domestic**	**Business**	**Industry**	**Municipal**	**Gov.**	**Institutions**	**Church**	**Officials**	**Councillors**	**Total**
Laingsburg	1 154	24	1	2	9	1	9	31	1	1 232
Matjiesfontein	12	0	0	0	0	0	0	0	0	12
2013/2014										
Laingsburg	1 147	38	1	2	12	3	9	33	1	1 247
Matjiesfontein	82	0	0	0	0	0	0	0	0	82

Source: Laingsburg Municipality (2015b:17)

Note: consumer units are service connections made by different end users and 71 new connections provided in Matjiesfontein during the last financial year added

Table 3.3 the above gives an indication of the various consumers units and the annual growth which should be taken into consideration in future planning.

3.5.2 Socio-economic aspects

Laingsburg Local Municipality (2014b:12) cites that the 2001 Census recorded the population in the Laingsburg Municipal management area at 6 681 persons (1 927 Households) and the 2011 Census recorded the population at 8 289 persons (2 411 Households). The population of Laingsburg Local Municipality is currently estimated at approximately 8 524 persons (2 476 Households) for 2013/2014. The estimated current population and the population growth rates for Laingsburg Local Municipality are summarised in the table 3.4 below:

Table 3.4: Projected present population and population growth rates										
Distribution System	**Census 2001**			**Census 2011**			**2001 - 2011**	**2013/2014**		**Number of Residential Consumer Units (Finance)**
	P	**H**	**P / H**	**P**	**H**	**P / H**	**Growth %/a**	**Population**	**Number of Households (Permanent)**	
Laingsburg	4 389	1 136	3.86	5 667	1 512	3.75	2.59%	5 873	1 567	1 147
Matjiesfontein	385	91	4.23	422	95	4.44	0.92%	429	97	82
Farms	1 907	700	2.72	2 200	804	2.74	1.44%	2 222	812	-
TOTALS	**6 681**	**1 927**	**3.47**	**8 289**	**2 411**	**3.44**	**2.18%**	**8 524**	**2 476**	**1 229**

Source: Laingsburg Municipality (2015b:20)

(Note: Abbreviations P – Persons, H – Households and P/H - Person / Household)

The female population in Laingsburg and Matjiesfontein is more than the male population, except on the farms where the male population is 55.18% and the female population 44.82%. The population increases occur in the younger ages (from 0 to 9 years), as well as in the working-age population (between 15 and 49 years) for the Central Karoo District. This will have particular implications for the provision of facilities and services related to children and child care, whereas the growth in the labour force will also have a direct impact on a greater need for employment opportunities (Stats SA, 2013).

According to the Western Cape Government (2014b:570) Laingsburg Local Municipality has an unemployment rate of 17.9% in spite of a comparatively low literacy rate of 70%. The municipality also has a large unskilled labour force, but its high prevalence of primary activities creates a demand for semi-skilled and unskilled labour.

According to Lawson (2013:23 -36) Laingsburg Local Municipality's highest GDP growth of 6.10% was experienced in 2008, while the lowest growth of -0.78% occurred in 2009. The Municipality's 2013/2014 Performance Report (LLM, 2013b) lists the following performance highlights with regard to the implementation of the LED Strategy.

Table 3.5: Performance highlights with regard to the implementation of the LED Strategy

Highlights	**Description**
Implemented a Participatory Appraisal Competitive Advantage (PACA) exercise	Participatory Appraisal Competitive Advantage was done in the municipal areas to inform the new LED Strategy.
Established a Business Chamber	The Laingsburg's first functional Business Chamber was established.
Established a Small Business Association	The Laingsburg Small Business Association (LSBA) was established to assist small businesses within the municipal area.

Source: Lawson (2015:20)

Best Practice Presentation at Karoo Development Foundation	Laingsburg Local Municipality presented a Best Practice in Laingsburg at the Karoo Development Foundation in Phillipstown.
Held the Ultra Karoo Marathon	A successful event was held in September 2013 which enabled economic growth in the municipal area.
Held Mayoral Golf Day	A successful event was held which led to an economic injection in the economy and funds were raised for the Municipal Bursary fund.
Held monthly Farm Markets	Monthly farm markets were held to grow the local economy.
Empowered Small Contractors	Small contractors were used within the municipality to assist them to increase their Construction Industry Development Board (CIDB) grading.

3.6 WATER SERVICES INFRASTRUCTURE

WorleyParsons RSA (2015:23) stated that Laingsburg Municipality is responsible for the operation and maintenance of the entire water and sewerage infrastructure, as summarised in the Table 3.6 below.

Table 3.6: Brief functional description of existing main infrastructure components

Component	Description of the main functional tasks
Sources: Zoutkloof Fountain, Zoutkloof Pit, Buffels River Old and New Pit, Boreholes	Bulk water abstraction
Bulk Pipelines (16.390 km)	Bulk water supply from source to town
Water Reticulation (25.745 km)	Distribution of potable water to consumers
Water Pump Stations (1)	Ensure adequate pressure and supply to specific areas
Reservoirs (6)	Balancing peak demands and providing some emergency storage
Disinfection Facility (1)	Ensure adequate disinfection of raw water

Table 3.6: Brief functional description of existing main infrastructure components	
Component	**Description of the main functional tasks**
Sewer Reticulation (24.086 km)	Collecting sewerage
Sewer Pump Stations (3)	Pumping sewerage to WWTWs
WWTWs (Oxidation Dam System and Package Plant)	Treat effluent to standards as specified in Authorisations for WWTWs

Source: Laingsburg Local Municipality (2015b:21)

3.6.1 Water infrastructure

WorleyParsons RSA (2015:23) reflected on the current and depreciated replacement cost of the water infrastructure of Laingsburg Municipality, as included in the Asset Register, and summarised in Table 3.7 below.

Table 3.7: Current Replacement Cost (CRC) and Depreciated Replacement Cost (DRC) of the water infrastructure			
Asset Type	**CRC**	**DRC**	**% DRC/CRC**
Boreholes & wells	R1 870 049	R1 437 542	76.9%
Bulk mains	R9 198 843	R7 364 509	80.1%
Dams & weirs	R769 295	R648 863	84.3%
Distribution	R10 489 742	R4 348 722	41.5%
Pump Stations	R230 591	R93 389	40.5%
Reservoirs	R4 277 237	R2 564 048	59.9%
Total	**R26 835 757**	**R16 457 073**	**61.3%**

Source: Laingsburg Local Municipality (2015a:21)

The above information in Table 3.7 indicates that 38.7% of the value of the water infrastructure has been consumed.

The following table (3.8) provides an overview of the remaining useful life and the age distribution by facility type for the water infrastructure (CRC):

Table 3.8: Overview of the remaining useful life and age distribution by facility type for the water infrastructure (CRC)					
Asset Type	**0 – 5 yrs**	**6 – 10 yrs**	**11 – 15 yrs**	**16 – 20 yrs**	**> 20 yrs**
RUL					
Boreholes & wells	R198 494	R49 117	R69 692	R270 230	R1 282 516
Bulk mains	R64 837	R649 459	R0	R0	R8 484 547
Dams & weirs	R0	R85 340	R81 650	R0	R602 305
Distribution	R2 374 913	R5 785	R0	R0	R8 109 044
Pump Stations	R63 434	R14 874	R143 517	R0	R8 766
Reservoirs	R224 327	R528 283	R175 788	R1 138 816	R2 210 023
Total	**R2 926 005**	**R1 332 858**	**R470 647**	**R1 409 046**	**R20 697 201**
Age distribution by Facility Type					
Boreholes & wells	R73 918	R959 925	R528 950	R173 552	R133 704
Bulk mains	R14 983	R1 331 325	R0	R7 165 307	R687 228
Dams & weirs	R0	R510 890	R0	R258 405	R0
Distribution	R421 253	R148 514	R1 530 900	R7 555 562	R833 513
Pump Stations	R0	R0	R230 591	R0	R0
Reservoirs	R155 413	R1 241 509	R0	R1 093 011	R1 787 304
Total	**R665 567**	**R4 192 163**	**R2 290 441**	**R16 245 837**	**R3 441 749**

Source: Laingsburg Local Municipality (2015a:21)

The average water asset renewal needs over the next 10 years is R0.426 million per year and the reinvestment required is R2.926 million in the first five years and R1.333 million in the second 5-year period (WorleyParsons RSA, 2015: 24).

3.6.2 Operation and maintenance

WorleyParsons RSA (2015:24) indicated that the Municipality's Water Quality Operational Sampling Programme includes the daily sampling of water with a handheld unit of the pH and Free Chlorine Levels at all the Municipality's reservoirs. Compliance sampling is done by an accredited external laboratory. The water quality compliance sample results are loaded onto the Blue Drop System, which indicates the compliance performance for the month for each of the distribution systems, with specific indication of samples that does not comply.

The Wastewater Risk Abatement Plan (W2RAP) is an all-inclusive risk analysis tool by which risks associated with the management of collection, treatment and disposal of wastewater, are identified and rated (quantified). The identified risks can then be managed according to the potential impacts on the receiving environment / community / resource. An Incident Response Management protocol still needs to be drafted as part of Laingsburg Local Municipality W2RAP. The purpose of an Incident Response Management protocol is to indicate the reactive procedures that will be followed when an incident occurs (Normally when malfunction of the treatment processes occur due to power failures, faulty equipment, adverse weather conditions or human error) (WorleyParsons RSA, 2015:24).

According to WorleyParsons RSA (2015:25) Operational Sampling Programmes for the Laingsburg and Matjiesfontein Wastewater Treatment Works (WWTW) are not yet implemented by Laingsburg Local Municipality. The following compliance samples need to be taken on a monthly basis at the Laingsburg WWTW: Total Bacteria, Coliforms, E.coli, EC, Dissolved Iron, Dissolved Manganese, Nitrate, pH, Turbidity, Chemical Oxygen Demand (COD) and Dissolved Organic Carbon (DOC).

The monthly compliance sample results of the final effluent sampled at the Laingsburg WWTW are loaded onto the Green Drop System (GDS), which indicates the compliance performance for the month for the Laingsburg WWTW, with a specific indication of samples that do not comply (WorleyParsons RSA, 2015:25). The municipality's Blue Drop Status has declined since 2011 when it was awarded 30% quality verification on drinking water and 35% on water safety planning resulting in a 27% Blue Drop score. The high water loss is an area of concern, together with outdated policies and plans (DWS, 2014a: 2-12).

Table 3.9: Blue Drop Performance of Laingsburg Municipality	
Municipal Blue Drop Score	**26.06 %**
Regulatory Impression: A disappointing Blue Drop score was achieved by the Laingsburg Municipality with a significant and substantial drop in the Municipal Score obtained during this assessment. Sufficient evidence could not be presented by officials for assessment by the Inspectors.	

Of great concern to the Regulator is the poor level of compliance of the microbiological quality of water provided to the community, which was also highlighted in the previous Blue Drop report. It was reported that water 2from one borehole in Laingsburg is pumped directly into the network without chlorination, and the water in Matjiesfontein is also not chlorinated, despite previous commitment by the Municipality that more efficient gas chlorination was to be installed from January 2012. Only one chemical determinant, dissolved organic carbon, has been monitored by the Municipality for which high levels of non-compliance are noted.

Despite the potential for the formation of trihalomethane compounds from chlorination of water containing dissolved organic carbon, no monitoring of these compounds has been undertaken. This needs to be addressed urgently as a high risk, to ensure that water supplied to the community meets the drinking water quality criteria to prevent health impacts.

The Water Safety Plans which were found to be so promising in the previous assessment have not been reviewed nor updated and no evidence could be presented of the implementation of any recommendations that were made.

The overall 2014 Risk Rating for Laingsburg is 61% which translates into the 7th worst performance in the Western Cape. Note that this value is based on the 3 specific areas indicated below and shows concerns (medium to critical risks) for Process Control (which risks reflect compliance in terms of draft Regulation 813) in both systems; Drinking Water Quality in both systems; and Risk Management in both systems.

Site Inspection: The site inspection impression at the Laingsburg borehole and network system was considered to be fair. A number of drinking water quality management practices still require attention. Areas for improvement are –

- Operational and maintenance logbooks not maintained, standby pump not installed, only one chlorine cylinder is on-site. Replacement cylinders may take as long as 4 days for delivery. The scale to monitor contents is not operational.
- No safety equipment is available.

Performance Area	Laingsburg	Matjiesfontein
Water Safety Planning (35%)	**12.08**	**7.53**
Treatment Process Management (8%)	**5.16**	**5.16**
DWQ Compliance (30%)	**0**	**0**
Management, Accountability (10%)	**0.75**	**1.50**

Asset Management (14%)	**3.36**	**2.31**
Use Efficiency, Loss Management (3%)	**0.99**	**0.27**
Bonus Scores	5.25	5.25
Penalties	0	0
Blue Drop Score (2012)	**27.59%**	**22.02%**
Blue Drop Score (2012)	73.3%	71.0%
Blue Drop Score (2011)	83.7%	64.8%
System Design Capacity (Ml/d)	1.8	0.3
Operational Capacity (% ito Design)	46%	100%
Population Served	6 500	500
Average daily consumption (l/p/d)	122.9	857.1
Microbiological Compliance (%)	**75.0%**	**84.6%**
Chemical Compliance (%)	**35.6%**	**15.4%**
Blue Drop Risk Rating (2012)	**90.5%**	**83.8%**
Blue Drop Risk Rating (2013)	**50.6%**	**59.0%**
Blue Drop Risk Rating (2014)	**57.2%**	**72.7%**

Source: DWS, 2014a:12

Table 3.9 above presents a reflection of how the municipality has been performing the last couple of years and shows that the municipality's performance has worsened with regard to the Blue Drop criteria used in the assessment.

The municipality performed better in the Green Drop assessment. Green Drop criteria are designed to assess the standard operating procedure of the municipal wastewater services. Wastewater treatment poses key risks in preventing pollution of water resources. The Department of Water and Sanitation states (Green Drop Report, 2014b:27):

> Wastewater risk abatement planning and implementation is part of this set of Green Drop criteria and is using the Cumulative Risk Ratios (CRR) to track progress on a year-to-year basis. This allows the Regulator to have insight into the treatment component of the municipal, private and public wastewater treatment business.

The municipality received 87% as a risk rating and slowly but gradually improved to achieve 59% in 2013 when the municipality recorded the highest score since the start of the process in 2014(DWS, 2014b: 2-7) This is illustrated in Table 3.9.

Table 3.10: Green Drop Performance of the Municipality	
Wastewater Risk Rating (2014)	**88.2%**
Wastewater Risk Rating (2013)	**58.8%**
Regulatory Impression: Laingsburg Municipality was allocated 36.9% for their single system during the 2013 Green Drop audits. This has deterioration from the 56.3% achieved in 2011. More concerning to the Regulator is that this trend is continuing and in the 2013-14 Green Drop Progress Reporting their wastewater Risk Rating increased from the 2013 value of 58.8% to 88.2%. The DWS is understandably disturbed about this deterioration. The Municipality needs to urgently address the flow metering at the works and should ensure that flow is measured there. The necessary competencies for supervisory, process controllers and maintenance staff should be built. The non-compliant wastewater quality being irrigated should be addressed. The Municipality is advised to use the tools provided by the DWS, such as the W2RAP and Green Drop Improvement Plan (GDIP), to address these concerns and to improve the wastewater services, CRR and GD scores in the upcoming GWSA 2015.	
Technology Description	**Laingsburg**
Technology (Liquid)	Anaerobic ponds / Facultative ponds
Technology (Sludge)	One Specified
Key Performance Area	**Laingsburg**
(A) ADWF Design Capacity (MI/d)	**1.7**
(B) Operational flow (% of Design Capacity)	**151% (NI)**
(C) Annual Average Effluent Quality Compliance (2012-2013)	**32.3%**
• 1) Microbiological Compliance (%)	**61.5%**
• 2) Physical Compliance (%)	**32.4%**
• 3) Chemical Compliance (%)	**24.5%**
(D) Technical Skills (Reg 813)	**No**

Source: DWS, 2014b:27

Risk identification was done for the whole municipality and wastewater was among the risks identified. The findings indicated that the Wastewater Risk Abatement Plan (W2RAP) and a Green Drop Improvement Plan (GDIP) would be developed in the 15/16 financial year (DWS, 2014:6).

3.6.3 Associated services

All the schools, clinics and the one hospital in Laingsburg Local Municipality's management area are supplied with higher level service of water and sanitation.

3.6.3.1 Water services institutional arrangements

WorleyParsons RSA (2015:32) explains that Laingsburg Local Municipality is the WSA for the entire Municipal Management Area and no external bulk Water Services Providers are used. An Indigent Policy, a Tariff Policy and Credit Control and Debt Collection by-laws and Water Services by-laws are in place.

WorleyParsons RSA (2015:33) identified the Service Delivery and Budget Implementation Plan (SDBIP) as the process plan and performance indicator / evaluation for the execution of the budget. The SDBIP is being used as a management, implementation and monitoring tool that assists and guides the Executive Mayor, Councillors, Municipal Manager, Senior Managers and the community. The plan serves as an input to the performance agreements of the Municipal Manager and Directors. It also forms the basis for the monthly, quarterly, mid-year and the annual assessment report and performance assessments of the Municipal Manager and Directors.

At a technical, operations and management level, municipal staff is continuously exposed to training opportunities, skills development and capacity-building in an effort to create a more efficient overall service to the users. Submissions were also made to the DWS for the classification and registration of the Process Controllers and Supervisors at the various plants. A skills audit is conducted during each year which leads to various training programmes in order to wipe out skills shortages and to provide employees with the necessary capacity (WorleyParsons RSA, 2015:33).

According to WorleyParsons RSA (2015:33), Laingsburg Local Municipality has limited personnel and operational budget capacity to ensure adequate rehabilitation and maintenance

of their existing infrastructure. Most of the maintenance work carried out is re-active, due to the limited financial resources available to the Municipality.

3.6.3.2 Social and customer service requirements

WorleyParsons RSA (2015:33) has pointed out that Laingsburg Local Municipality has not instituted a comprehensive Customer Services and Complaints system. A Logbook system is in use, according to which a complaint is recorded and transferred to the correct person to address it. The system is not able to provide performance information on the time it takes to address a problem or respond to a complaint or query. Although all the complaints are recorded in the monthly report to Council, there is no system of recording complaints electronically according to the different types of complaints. This means that it is not possible to overview the different type of monthly complaints received and addressed by the Municipality.

Laingsburg Local Municipality works towards addressing all public complaints within 24 hours on week days and within 72 hours on weekends, but burst pipes and "no water" complaints are repaired and fixed within 12 hours, by standby teams over weekends (WorleyParsons RSA, 2015:33).

3.7 WATER SERVICES PLANNING

Laingsburg Local Municipality compiled annual Water Services Audit Reports for the 2012/2013 and 20132013/2014 financial years. The Water Services Audit Report gives an overview of the implementation of the Municipality's previous year's WSDP and can be seen as an annexure to Laingsburg Municipality's Annual Report (WorleyParsons RSA, 2015:33).

Laingsburg Local Municipality's WSDP process entails the establishment of computer models for the water systems and the sewer systems in Laingsburg Municipality, the linking of these models to the stand and water meter databases of the treasury financial system, evaluation and master planning of the networks and the posting of all the information to the Infrastructure Management Query System (IMQS). The Water and Sewer Master Plans lists the analyses and findings of the study on Laingsburg Municipality's water distribution and sewer drainage systems (WorleyParsons RSA, 2015:33).

According to WorleyParsons RSA (2015:33) the latest Water and Sewer Master Plans, which were available for inclusion in Laingsburg Municipality's WSDP, are as follows:

- Water Master Plan, Laingsburg Municipality, February 2007, Community Engineering Services (CES)
- Sewer Master Plan, Laingsburg Municipality, February 2007, CES

The other Water Services Planning studies completed over the last number of years are as follows:

- Water Meter Audit and the Development of a Meter Maintenance and Management Strategy, 2 June 2010, KV3 Engineers.
- Rural Service Level Survey, Laingsburg Municipality, 2 June 2010, KV3 Engineers.
- Long-Term Water Conservation and Water Demand Management Strategy, Final Draft, June 2011 (WorleyParsons RSA, 2015:33).

3.8 RISK ADAPTATION

WorleyParsons RSA (2015:24) specified that the Water Safety Plans for Laingsburg and Matjiesfontein are not yet in place. A consultant was recently appointed to assist the Municipality with the drafting of their Water Safety Plan. An Incident Response Management Protocol and Emergency Response Plans also need to be put in place.

3.8.1 Conservation and demand management

Laingsburg Local Municipality was assisted, as part of the 2012/2013 Water Services Audit Process, with the development of detailed water balance models for Laingsburg and Matjiesfontein. All bulk water meter readings are recorded in the models and it will assist the Municipality to monitor water usage and Non-Revenue Water (NRW) for Laingsburg and Matjiesfontein more actively in the future (WorleyParsons RSA, 2015:27).

According to WorleyParsons RSA (2015:27) the Municipality also completed a detailed Water Meter Audit of all their bulk and consumer water meters during 2009/2010. The Municipality continued over the last three years to address the shortcomings identified as part of the detailed Water Meter Audit process. Two hundred and fifty eight (258) pre-paid water meters were replaced during the 2012/2013 financial year.

Laingsburg Local Municipality is currently busy with a "War against Leaks" project with their indigent households, which was started on the 20th of January 2014. For this intervention, 33 youths from the community were trained over a six-week period to repair household leaks in Laingsburg and Matjiesfontein. The training was completed on the 28th of February 2014 and the inspection of the properties in Laingsburg and Matjiesfontein for leaks started on the 3rd of March 2014. The repair work started on the 14th of May 2014 and leaks had been repaired at 685 of the 710 households by the time of the survey (WorleyParsons RSA, 2015:27).

Limited financial and personnel resources have prevented the Laingsburg Local Municipality from focusing on the installation of water efficient devices (WorleyParsons RSA (2015:28) and it is obvious that retro-fitting of plumbing fittings will provide significant water saving opportunities. It is important for the Municipality to raise awareness regarding conservation products and the installation of these products to reduce the water demand and the percentage Non-Revenue Water (NRW) in the future. Such measures may also significantly reduce the hydraulic loading in the wastewater system as an added benefit.

The schools in Laingsburg Local Municipality's management area are not yet targeted with awareness around water education programmes and water conservation. While the Municipality realises the importance of good communication with the public and involving community members on a regular basis, the Municipality currently does not have a community awareness programme relating to Water Conservation and Water Demand Management regulations (WC/WDM) in place. Also schools in the municipality's management area have not been involved in programmes around water education and water conservation (WorleyParsons RSA, 2015:28).

WorleyParsons RSA (2015:28) reported the main water demand management interventions undertaken by Laingsburg Local Municipality over the last years as follows:

- Water Master Plans are in place for Laingsburg and Matjiesfontein.
- Water Balance models were developed for Laingsburg and Matjiesfontein and all the bulk water meter readings are recorded in the models.
- Municipality completed a detailed water meter audit and continue with the replacement of old or faulty water meters and pre-paid water meters.

WorleyParsons RSA (2015:28) also reported growth in the average annual bulk water demand of 4.14% over the period 2003/2004 to 2012/2013, although total water requirement for Laingsburg Local Municipality for 2013/2014 was 27.2% less than the total water requirement for 2012/2013. There was also a drop in the total bulk water requirement during 2010/2011, due to the drought in the area.

The long-term WC/WDM Strategy of Laingsburg Local Municipality (June 2011) indicated the priority areas and estimated potential savings achievable through the implementation of various WC/WDM measures in the municipality's management area presented in Table 3.11 (WorleyParsons RSA, 2015:28).

Table 3.11: The estimated potential water savings achievable through the implementation of the WC/WDM Strategy

WDM Measure	Laingsburg		Matjiesfontein		Total	
	kl/d	Percentage	kl/d	Percentage	kl/d	Percentage
Efficient water use	200	11%	0	1%	200	11%
Water loss management	334	19%	11	36%	345	19%
Pressure management	177	10%	0	0%	177	10%
Large users: Schools	6	0%	0	0%	6	0%
Re-use of wastewater	0	0%	0	0%	0	0%
Total water sales	608 kl/d		1 kl/d		609 kl/d	
Total bulk supply	1 750 kl/d		30 kl/d		1 780 kl/d	
Total estimated savings	**717**	**41%**	**11**	**37%**	**729**	**41%**

Source: Laingsburg Local Municipality (2015b:26)
(Note: The percentage in the above table refers to the percentage of the total bulk water supply per year as included in the Strategy)

According of WorleyParsons RSA (2015:28) Laingsburg Local Municipality is committed to implement the newly developed WC/WDM Strategy in order to reduce the percentage of Non-Revenue Water (NRW) for Laingsburg and Matjiesfontein. No WC/WDM projects are included in the Municipality's approved 2014/2015 Capital Budget. Some of the current WDM activities implemented by the municipality, for example the replacement of meters, repairing

burst pipes, etc. are funded through the Municipality's Operation and Maintenance (O&M) Budget. The only funding support available to Municipalities for WC/WDM initiatives from National and Provincial Government is through the Accelerated Community Infrastructure Programme (ACIP). The funding is very limited for the Western Cape Province however, and Laingsburg Local Municipality did not receive any funding for the 2014/2015 financial year. This Municipality's budgets are too limited to fund specific Water Demand Management (WDM) initiatives from their own budgets.

3.8.2 Water resources

According to WorleyParsons RSA (2015:33), the following water sources currently supply the town with bulk water:

- Zoutkloof Sources: Zoutkloof Fountain, Zoutkloof SAR Borehole and the Zoutkloof Pit in the Wilgenhout River;
- Dr van Heerden van Riebeeck Road Borehole (Old Town Borehole, direct supply to Goldnerville network); and
- Buffels River Old Pit No. 1 (Direct supply into network) and Buffels River New Pit No. 2 (Supply New Town reservoir).

The yield from the Zoutkloof Fountain is adequate to meet the water requirement of Laingsburg during winter. During summer months, however, the bulk of the town's water supply is supplied from the Zoutkloof Fountain and the Zoutkloof SAR Borehole, with an occasional supply from the Zoutkloof Pit situated approximately 250m downstream of the fountain. The Zoutkloof automatically supplies water when the Zoutkloof Fountain is not able to supply the required water demand. The water supplied by the Zoutkloof Fountain is captured in a covered lined canal in the bed of the Wilgenhout River. The Dr van Heerden borehole is located on the eastern bank of the Buffels River and is used during peak demand to supplement the Zoutkloof sources. The two Buffels River Pits are also used regularly (WorleyParsons RSA, 2015:33).

Laingsburg Local Municipality appointed the Global Earth Observation System of Systems (GEOSS) in 2008 to perform a drilling and pump testing investigation in Zoutkloof. The main aim was to supplement the existing water supply to Laingsburg. Four boreholes were drilled. Two were not pump-tested because the yields of these boreholes did not justify further interest, but the remaining two boreholes, (LB bh 3 and LB bh 4) were deemed acceptable to contribute

to the Laingsburg water supply. However, boreholes are not yet used to supply water to the town as the Municipality still has to install the required pumps and pipework (WorleyParsons RSA, 2015:33).

The water sources supplying water to Matjiesfontein are two boreholes owned and operated by Matjiesfontein Village (Pty) Ltd (Hotel) and five boreholes owned by Laingsburg Local Municipality, of which two were drilled and commissioned during 2005 as well as three boreholes drilled during 2008. The two boreholes (PKE 1 and PKE 2) drilled during 2005 have primarily been used for the irrigation of the sports field. Declining yields resulted in Borehole PKE2 not being utilised anymore however. Borehole PKE 1 also struggled to keep up with the demand of filling the reservoir and neither one is currently operational, as the municipality has removed the pumps. Three new boreholes (MF bh2, MF bh4 and MF bh5) were drilled during 2008 and Matjiesfontein is currently supplied from the Matjiesfontein Village (Hotel) boreholes and the municipal borehole MF bh4.

Figure 3.3 and table 3.12 below present a summary of the annual bulk water supply to Laingsburg and Matjiesfontein for the various financial years.

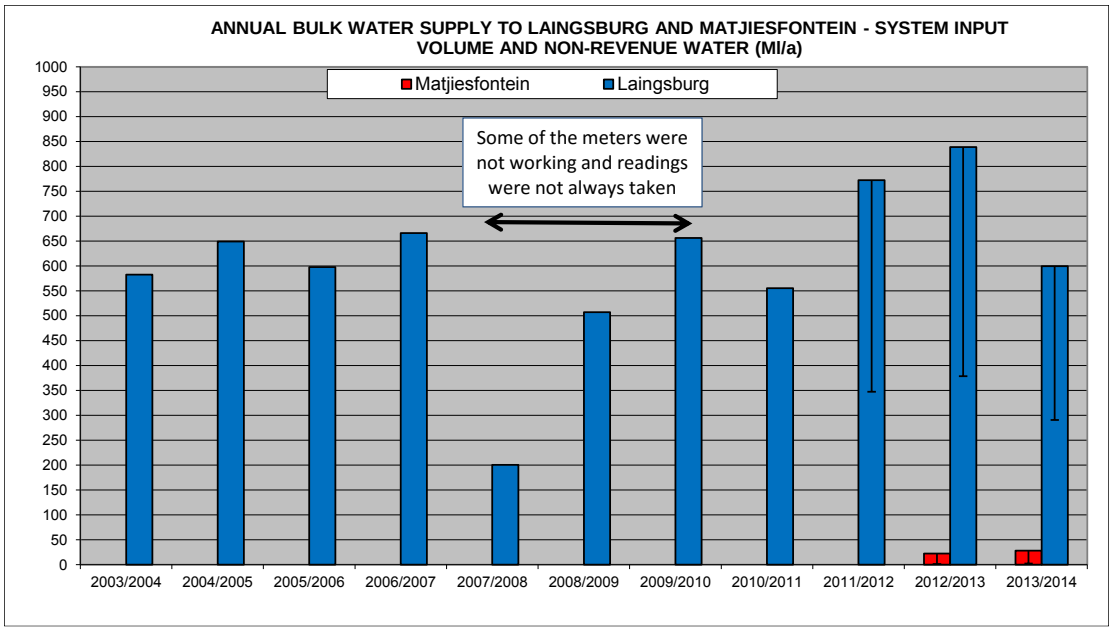


Figure 3.3: Annual bulk water supply
Source: Laingsburg Local Municipality (2015a:28)

Table 3.12: Treated water supplied to Laingsburg and Matjiesfontein								
Distribution System	**Source type**	**Safe Yields (Mℓ/year)**	**Current Use 13/14**	**Record : Prior (Ml/a)**				
				12/13	**11/12**	**10/11**	**09/10**	**08/09**
Laingsburg	Zoutkloof	420.480	406.550	415.000	762.162	539.678		
	Buffels River	204.984	192.288	367.710				
	Dr Van Heerden Borehole	31.536	0.572	56.250	9.957	15.739	41.218	66.532
	LB bh3 & LB bh4	78.840	-	-	-	-	-	-
Matjiesfontein	Boreholes	115.121	27.817	22.340				

Source: Laingsburg Local Municipality (2015a:28)

Table 3.12 states that there is an increase in water usage and the more boreholes was utilised during the 2013/14 financial year to meet the demand for treated water.

3.9 GROUNDWATER INFRASTRUCTURE (BOREHOLES)

WorleyParsons RSA (2015:44) specified that it is critical for Laingsburg Local Municipality to monitor the static water level (i.e. the level prior to commencement of pumping for the day) in each of their production and monitoring boreholes on a monthly basis (at least). The daily rainfall for the area should also be recorded. This monitoring data should be processed, analysed and reported on by an experienced hydrogeologist in order to ascertain whether the resource is being sustainably utilised or whether groundwater mining is taking place. It is important for the municipality to focus on aquifer protection, groundwater monitoring and well field management, in order to meet the town's future water requirements.

3.10 WATER TREATMENT WORKS

WorleyParsons RSA (2015:45) reported that the water is currently only disinfected in Laingsburg at the New Town Reservoir, prior to distribution to the end users. The water in Matjiesfontein is not yet disinfected. The DWS's 2013 Blue Drop Progress Report highlighted

that the microbiological quality compliance of both systems was still of major concern for the DWS, as no improvement had been observed. The Laingsburg system indicated a decrease in microbiological water quality compliance from 77.3% to 42.1%. The Matjiesfontein system indicated an increase in microbiological quality compliance from 63.6% to 75.0%. This is still far below the requirements of the South African National Standard (SANS) 241. The microbiological quality compliance for 2013/2014 for Laingsburg was 79.8% and for Matjiesfontein 100.0%.

It is recommended that the water of Matjiesfontein should be disinfected prior to distribution to consumers, in order to ensure that microbiological compliance, according to SANS: 241, is achieved and maintained.

All potable water supplied to the consumers in Laingsburg also needs to be adequately disinfected prior to distribution to consumers. The recommended Operational and Compliance Water Quality Sampling Programmes, as included in the WSDP need to be implemented (WorleyParsons RSA 2015: 45).

3.11 RESERVOIRS

WorleyParsons RSA (2015:45) stated that the condition of most of the reservoirs in Laingsburg is good and the reservoirs are well maintained. The Municipality plans to replace the Matjiesfontein steel reservoir with a new 0.250 Ml concrete reservoir in 2015/2016. With a total storage capacity of 21 hours of the Peak Daily Demand (PDD), the current total storage capacity for Laingsburg is insufficient however.

Storage capacity for Matjiesfontein will be adequate, with the construction of the new 0.250 Ml reservoir. The future required reservoirs and the current storage factors, based on 1 x PDD (24 hours storage capacity), are as shown in Table 3.13:

Table 3.13: Future reservoir storage capacities required			
Town	**Existing Storage Factor**	**Recommendations included in the Water Master Plan**	**Estimated 2014 Cost (Vat Incl.)**
Laingsburg	0.91	New 1.5 Ml reservoir (LLW B3 Water Master Plan). MIG Technical Report was prepared for the construction of a new 2 Ml reservoir	R5 004 100
Matjiesfontein	2.00 (New 0.25Ml reservoir)	MIG Technical Report for the construction of a new 0.250 Ml concrete reservoir	R1 165 600

Source: Laingsburg Local Municipality (2015a:42)

3.12 WATER PUMP STATIONS AND WATER RETICULATION INFRASTRUCTURE

According to WorleyParsons RSA (2015:45) the operational staff indicated the following two operational problems within the reticulation system, at the time when the Water Master Plan was compiled.

- Low pressures in the higher Goldnerville area, Laingsburg.
- Pipe breaks in the fragile Matjiesfontein network.

The existing Laingsburg and Matjiesfontein Water Distribution Systems have insufficient capacity to supply the future water requirements for the fully occupied scenario and additional future development areas. The proposed changes to the existing distribution zones are as follows:

- The new Goldnerville reservoir initiates the new Goldnerville upper reservoir zone that serves the new developments in that area.
- The higher Goldnerville residential area will be served from the new Goldnerville upper reservoir.
- A new Matjiesfontein distribution pipeline is required to reinforce water supply within the Matjiesfontein water network (WorleyParsons RSA, 2015:45).

3.12.1 Water quality

The Municipality monitors the pH and Free Chlorine Levels at all their water reservoirs daily. The Water Quality Compliance Sampling Programme is actively implemented in order to promptly identify water quality failures and to react accordingly. The water quality results are loaded onto the DWAS's Blue Drop System (BDS) via the internet. Once entered, the data are automatically compared to SANS241. This real-time system allows immediate intervention to rectify any problems.

To date, it has not been necessary to take any steps to inform the consumers of any health risk regarding the potable water supplied by Laingsburg Local Municipality. Safety Management Procedures still need to be developed to inform the Municipality's consumers about any potential health risks regarding the water quality, should it become necessary. The Microbiological and Chemical Compliance for the last twelve months for the Laingsburg and Matjiesfontein systems, as included in the DWAS's 2012 Blue Drop Report, was as follows:

Table 3.14: Percentage microbiological and chemical water quality compliance

Compliance	**Laingsburg**	**Matjiesfontein**
Microbiological Compliance	77.3%	63.6%
Chemical Compliance	99.9%	99.9%

Source: Laingsburg Local Municipality (2015a:29)

3.12.2 Effluent quality

The effluent quality compliance sample results are loaded onto the DWS's Green Drop System (GDS) via the internet. The overall percentage compliance of the final effluent samples taken over the period July 2013 to June 2014 at the Laingsburg WWTW are summarised in Table 3.15 (Measured against irrigation standards).

Table 3.15: Percentage chemical, physical and microbiological compliance of the samples taken at the Laingsburg WWTW

Determinant	**Category**	**Compliance %**	**Irrigation Limits**
Coliforms	Microbiological	63.6%	< 100 000 for irrigation up to 0.5 Ml/d
COD	Chemical	27.3%	400 Irrigation up to 0.5 Ml/d

pH	Physical	72.7%	6 - 9 for irrigation up to 0.5 Ml/d
Conductivity		100.0%	200 Irrigation up to 0.5 Ml/d

Source: Laingsburg Local Municipality (2015a:29)

Table 3.15 gives an indication of chemical, physical and microbiological compliance. The chemical oxygen demand achieved a 27.3%, which are used for irrigation purposes.

3.12.3 Industrial consumers

The only wet industry in the Laingsburg Local Municipality's management area is the Laingsburg abattoir. The Municipality's tariff structure for the discharge of effluent by industrial consumers does not make provision for nutrient loads and volume to be taken into account. There is no limit on the permitted volume of effluent that can be discharged into the sewer system, but the concentration limits for the various parameters are included in the Municipality's Water Supply By-laws (Acceptance of industrial effluent for discharge into the sewage disposal system). The By-law includes the following sections with regards to the discharge of industrial effluent:

- application for disposal of industrial effluent;
- unauthorised discharge of industrial effluent;
- quality standards for disposal of industrial effluent;
- conditions for disposal of industrial effluent;
- withdrawal of written permission for disposal of industrial effluent;
- measurement of quantity of industrial effluent discharged; and
- quality standards – Acceptance of industrial effluent for discharge into the sewage disposal system (Laingsburg Local Municipality, 2011a:48).

3.13 FINANCIAL ASPECTS

3.13.1 Capital budget

The total capital requirement for the 2014/2015 financial year amounted to R11.979 million. The capital budget is funded by means of grants from National government to the amount of R11.281 million and own funding to the amount of R0.698 million.

3.13.2 Operational budget

Table 3.16 provides a summary of the total operating costs and income for water and sanitation services for the various years:

Table 3.16: Summary of Operational Budget for water and sanitation services for the last four years				
Expenditure / Income	**Financial Year**			
	13/14	**12/13**	**11/12**	**10/11**
Water Services				
Expenditure	R3 223 357-68	R2 203 718-84	R1 481 931-20	R5 014 776-73
Income	-R679 609-42	-R916 773-09	-R1 493 363-97	-R1 404 725-76
Surplus / Deficit	**R2 543 748-26**	**R1 286 945-75**	**-R11 432-77**	**R3 610 050-97**
Sanitation Services				
Expenditure	R2 056 310-57	R1 736 474-12	R2 480 567-93	R966 123-61
Income	-R1 755 598-63	-R1 633 416-51	-R1 532 433-00	-R1 251 240-71
Surplus / Deficit	**R300 711-94**	**R103 057-61**	**R948 134-93**	**-R285 117-10**

Source: Laingsburg Local Municipality (2013a:10)

Table 3.16 outline that the municipality has recorded a deficit on the water services budget for the last two years and that there is a need to improve budgeting and planning.

3.13.3 Tariff and charges

Laingsburg Municipality's current (2013/2014) water and sewer tariffs are based on the following:

- A five (5) block step rising tariff structure with the first 6 kl/month being free for all consumers
- A five (5) block step rising tariff structure for drought periods is also in place.
- The tariff structure includes a fixed monthly availability fee for all consumers.

- There is a fixed sewerage charge per month for all residential consumers. Various other fixed monthly sewerage charges are applicable for the "commercial" and "other" consumers.
- Tank removals are charged per load, with different costs for Laingsburg, Matjiesfontein and the rural areas. The fixed charge per load removal is also different for week days and weekends.

Laingsburg Local Municipality currently provides the first six (6) kilolitres of water free to each and every household. The Municipality's tariffs support the viability and sustainability of water supply services to the poor through cross-subsidies (where feasible). Free Basic Water and Sanitation services are linked to Laingsburg Local Municipality's Indigent Policy and all indigent households receive free basic water and sanitation services, which are funded from the Equitable Share (Laingsburg Local Municipality, 2014b:70).

Installing meters and implementing an adequate billing system is central to managing services effectively and building relationship of understanding and mutual trust between the provider and consumer. Laingsburg Local Municipality's overall debtor's payment percentages, as included in their 2013/2014 Performance Report (LLM; 2013b), were 95.3% and 94.4% during 2012/13 and 2013/2014 Financial Years, respectively

3.14 ASSET MANAGEMENT ASSESSMENT

WorleyParsons RSA (2015: 7) identified that it is important for Laingsburg Local Municipality to differentiate between budget allocated towards the operation and maintenance of the water infrastructure and budget for the replacement of infrastructure. A budget of approximately 2% of the total asset value per annum should be allocated towards the replacement of existing infrastructure. In the case of operations and maintenance of the system, a budget of approximately 1% to 2% of the value of the system is typically required to ensure that the system remains in good condition.

The Municipality further needs to develop an Asset Management Plan (AMP) from their Asset Register. It is essential for Laingsburg Local Municipality to protect their assets by ensuring that an appropriate Maintenance and Rehabilitation Plan (AMP) is developed and implemented. The objective of an AMP is to support the achievement of the strategic goals of

the Municipality and facilitate prudent technical and financial decision-making. It is also a vehicle for improved internal communication and to demonstrate to external stakeholders the Municipality's ability to effectively manage its existing infrastructure as well as the new infrastructure to be developed over the next 20 years (LLM, 2014a: 3).

WorleyParsons RSA (2015:47) furthermore stated that priority should be given to rehabilitating existing infrastructure as this generally makes best use of financial resources and can achieve most rapidly an increase in (operational) services coverage's. The preparation of maintenance plans and the allocation of sufficient funding for maintenance are required to prevent the development of a large backlog.

This plan must be based on the principle of preventative maintenance in order to ensure, as far as this is practical, that damage to assets is prevented before it occurs. Laingsburg Local Municipality must ensure that the maintenance and rehabilitation plan is part of the Water Service Development Plan and that the plan is implemented. Assets must be rehabilitated and / or replaced before the end of their economic life and the necessary capital funds must be allocated for this purpose. The potential renewal projects for water and sewerage infrastructure need to be identified from the Asset Register. All assets with a condition grading of "Poor" and "Very Poor" need to be prioritised. The condition of the existing infrastructure is not yet adequately assessed in the existing Asset Register (LLM, 2014a:19).

According to the Municipal Risk Register (2015:7) a Water Safety Plan still needs to be drafted for Laingsburg and Matjiesfontein. A detailed risk assessment needs to be executed as part of the process. This step of the Water Safety Plan establishes the risk that the water quality standard will not be met as well as the consequences if the standard is not complied with. A list of potential hazards and hazardous events need to be compiled and worked through with the Water Safety Plan Team. The impact of each of the hazards or hazardous events needs to be characterised by assessing the severity of the likely health outcome and the probability of occurrence.

According to WorleyParsons RSA (2015:49) an Improvement / Upgrade Plan needs to be compiled for all significant existing risks where the existing controls are not effective or absent. Each identified improvement needs to be linked to one of the Water Safety Plan Team members

for taking responsibility for implementation, together with an appropriate time frame for implementation of these controls. The Supporting Programmes also need to be looked at. Supporting Programmes are activities that ensure that the operating environment, the equipment used and the people themselves do not become an additional source of potential hazards to the drinking water supply.

An Incident Management Protocol (IMP) and Emergency Response Plan also need to be compiled. The Incident Management Protocol should clearly specify the responsibilities for co-ordinating measures to be taken, a communication plan to inform / alert users of supply and plans for providing / distributing emergency supplies of water (WorleyParsons RSA 2015:47).

According to WorleyParsons RSA (2015:47) it is important for Laingsburg Local Municipality to classify all treatment works and operators along the lines of the regulations by establishing a programme for certification of works, operators, technicians and managers. The process will include reviewing the skills needed and aligning resources to these needs as well as reviewing total staff numbers necessary to meet all the objectives in the National Water Act (36 of 1998b) (RSA, 1998b).

It is also important for the Laingsburg Municipality to establish a mentoring role for operators to ensure an adequately trained and classified workforce with dedicated training programmes for supervisors and operators. Budgets need to be secured to address the shortfall of skilled staff, rethink methods to retain qualified personnel and plan for succession and clear career paths for experienced staff. A source of specific resources of skilled operators, technicians and managers will be established through such a programme (WorleyParsons RSA, 2015:47).

The Municipality's existing Water Quality Operational Sampling Programme as cited by WorleyParsons RSA (2015: 47) includes the sampling of the pH and Free Chlorine Levels at all the Municipal reservoirs daily. The Laingsburg Local Municipality further needs to conduct operational monitoring of process indicators according to the minimum requirements specified in SANS 241 (2011) for characterising raw water quality, on-going levels of operational efficiency in a water treatment system and acceptable final water quality to the point of delivery. It is important for the municipality to compile and implement an Operational Monitoring Programme, which includes the following:

- daily sampling of Conductivity, pH and Turbidity of all raw water sources used;
- daily sampling of Conductivity, pH, Turbidity and Free Chlorine of final water for Laingsburg and Matjiesfontein;
- weekly sampling of E.coli and Heterotrophic plate count of final water for Laingsburg and Matjiesfontein; and
- sampling of pH, Turbidity, Free Chlorine, E.Coli and Heterotrophic plate count fortnightly in the distribution systems of Laingsburg and Matjiesfontein.

A further recommendation is that Monthly Water Quality Compliance Sampling Programme of the Laingsburg Local Municipality should include the sampling sites and monthly determinants to be monitored presented in Table 3.17.

Table 3.17: Recommended monthly water quality compliance sampling programme

Recommended Sample Sites	**Determinants to be sampled monthly**
Main Reservoir Laingsburg	pH, Conductivity, Turbidity, Free Chlorine, Nitrate, Nitrite, Fluoride, Sulphate, Ammonia, Chloride, Sodium, Zinc, Iron, Aluminium, Manganese, E.coli / Total Coliform, Total plat Count
Goldnerville Reservoir	
Bergsig Tap	
School Reservoir	
Matjiesfontein Tap	
Matjiesfontein Reservoir (Once constructed)	

WorleyParsons RSA (2015:47)

The number of monthly microbiological compliance samples taken in Laingsburg is adequate, but one additional sample needs to be taken in Matjiesfontein.

3.15 SUMMARY

The Laingsburg Local Municipality as a Water Service Authority adheres to the legislative requirements listed in this chapter, but the municipality still has to put policies like Water Safety Plans, Demand Management and Water Conservation in place in order to ensure that the municipality addresses the risks in Laingsburg. The municipality as a low capacity municipality is unable to attract suitable skills and retain skills to ensure resources are managed in a sustainable manner.

The Municipality achieved low ratings in the blue and green drop assessments, which highlights the gaps in resource management and the quality of resources for consumption as well as economic growth. A need for an integrated resource management system to address the challenges and the conservation of resources in identifying implementable practices in the effective use of municipal resources (which includes human capital and skills development programmes) has also been identified.

The municipality is at risk of being heavily impacted by flooding or slow onset droughts. The flooding in 2014 which resulted in the district being declared a disaster area due to millions of Rands' worth of flood damage, which was followed immediately by a drought declared in 2015 in the Central Karoo District and the Western Cape Province government leading in millions of economic losses for the province and South Africa. Boreholes run dry during this period put enormous strain on the Zoutkloof Fountain which clearly states that groundwater levels in Laingsburg municipal area are declining, which threaten the sustainability of the municipality. It is therefore imperative for the municipality put climate change adaptation plans in place to ensure resilience because global warming will intensify, and Laingsburg will be vulnerable to the effects thereof.

Water infrastructure provision and planning are crucial for the existence of the Municipality and its people and it calls for greater asset management. The Municipality must therefore develop an AMP with action plans for appropriate maintenance and rehabilitation informed by the Municipal Asset Register as well as proper integrated planning for future developments and the increasing demand for water taking into consideration alternative or new technologies.

CHAPTER 4: CASE STUDY: WATER RESOURCE MANAGEMENT IN THE LAINGSBURG MUNICIPAL AREA

4.1 INTRODUCTION

The Laingsburg Local Municipality is a Water Services Authority responsible for the provision of potable water for the citizens of the Laingsburg Municipality. The municipality relies on groundwater in a semi-arid desert area where the management of natural resources is of the outmost importance at a time of climate change. With a staff component of 70 permanent employees, the municipality is the smallest municipality in the Western Cape Province and in South Africa. Infrastructure Services is the most important department delivering basic services as mandated to local government through the Constitution (RSA, 1996) with the rest supporting directorates with the municipality. The Infrastructure Services directorate consist of 30 employees, with seven of them in the water division, responsible for wastewater and water management.

4.1.1 Laingsburg Hydro census

The Laingsburg Local Municipality has eight groundwater abstraction points of which only six are being used, three of these points are located in the Town well-field, which is essentially based in the Buffels River. The Soutkloof well-field, some 15 km to the north-west of Laingsburg has five production boreholes (Lasher & Conrad, 2011:4).

Lasher and Conrad (2011:4) state that the closest spring to Laingsburg is the Soutkloof Spring. The spring emerges from the alluvial aquifer along the Wilgehout stream roughly 9.4 km northwest of the town of Laingsburg. The spring flows along a channel under normal slope and adds to the Municipal water supply. The municipality assessed the municipal boreholes in 2010 and an overall evaluation of the surrounding area was done for possible causes of pollution. The Town well-field is made up of three boreholes. The boreholes situated in the Town well-field are the only boreholes at risk of contamination because of the three petrol stations in the Central Business Area of the town along the N1 road which is within 100 meters from these boreholes (Lasher & Conrad, 2011:15).

Lasher and Conrad (2011:16) further identify a possible risk of contamination upstream of the boreholes in the Town well-field where several agricultural activities and the use of fertilisers and pesticides are common. Although the national and international standards are adhered to when utilising the fertilisers and pesticides, the minor likelihood does exist that the Town well-field downstream may be affected. The nitrate content, where measured, is low but it is advised that continuous groundwater chemistry should be scrutinised.

The municipality's main water source is the Zoutkloof spring situated 30 kilometres outside Laingsburg on the municipal farm. The water flows directly from the fountain to the Zoutkloof farm reservoir; from there it flows to the Zoutkloof Reservoir just above the New Town precinct which was built after the devastating flood in January 1981. At this reservoir the water is purified by means of chlorine.

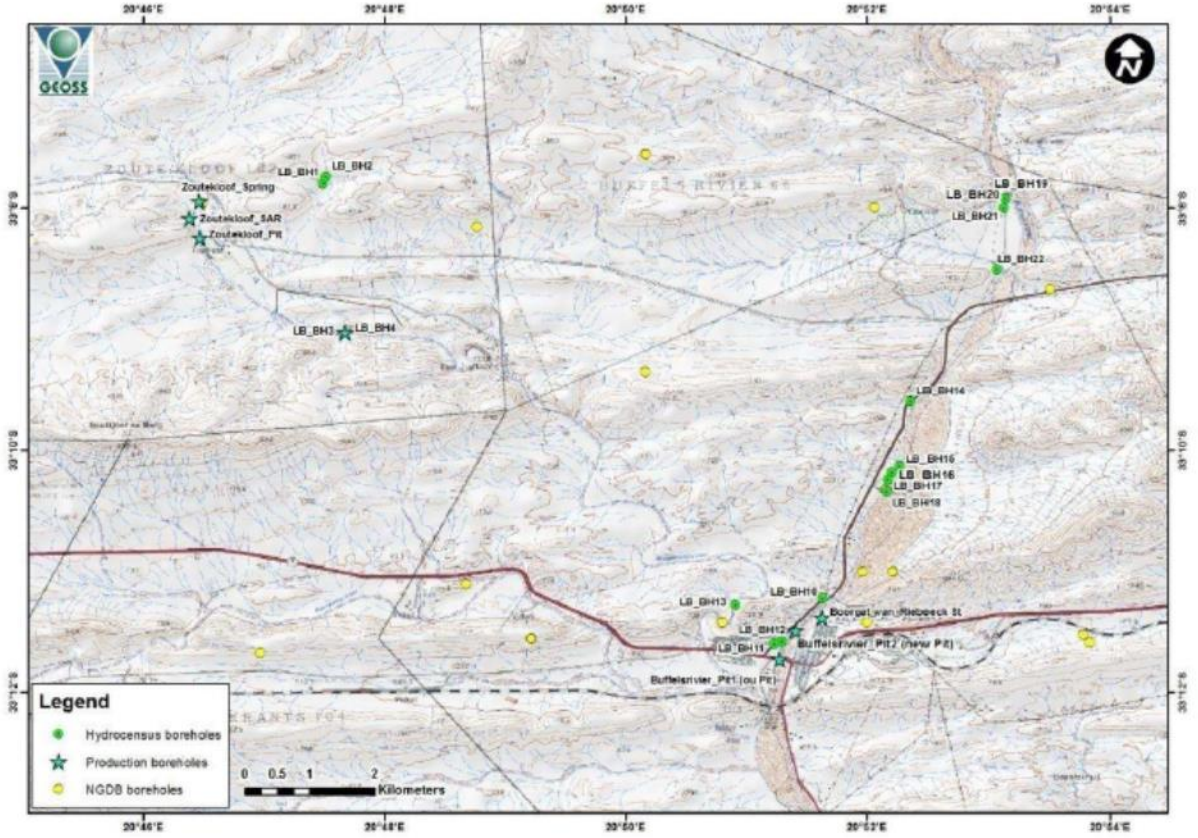


Figure 4.1: Map Laingsburg Production Boreholes
Source: Lasher & Conrad (2011:36)

Matjiesfontein as the other town under the municipality has four production boreholes which are located in the mountainous area, to the south of the town. The utilisation of these boreholes permits the Municipality to meet the present and perhaps the future water demands. The

Laingsburg Local Municipality has made a request for 718 408 m3/a plus 97 761.6 m3/a to be abstracted from the Laingsburg and Matjiesfontein aquifers respectively.

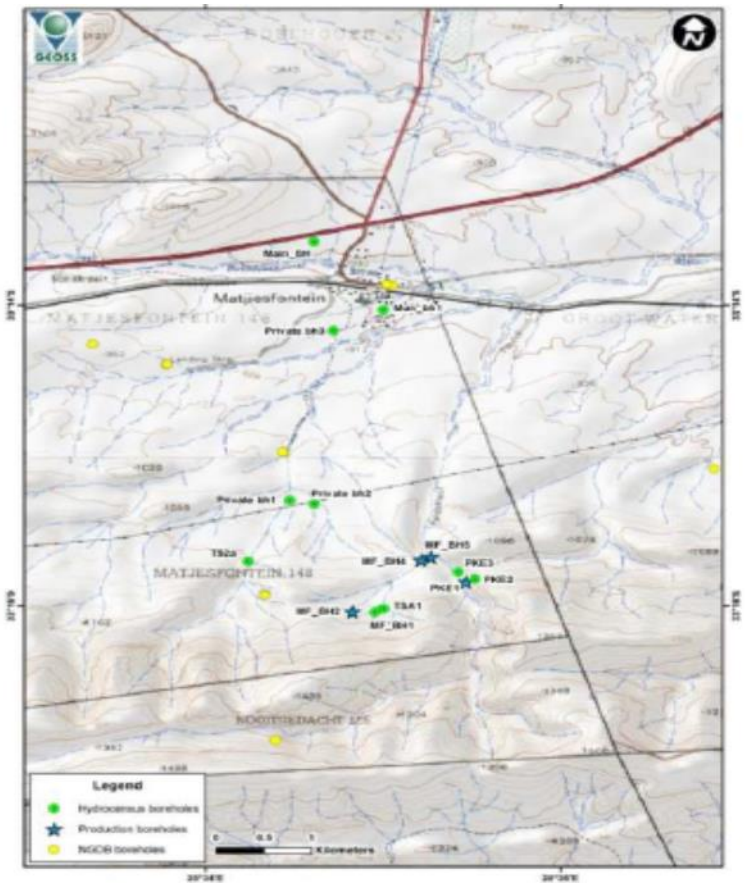


Figure 4.2: Map of Matjiesfontein Production Boreholes
Source: Lasher & Conrad (2011:43)

According to Lasher and Conrad (2011: i) Laingsburg municipal area extracts water from the primary alluvial aquifer and the secondary fractured rock aquifer. The municipality has tested these boreholes for sustainability and for the extent of influence. The boreholes are being pumped at the calculated sustainable yields and are functioning efficiently based on previous monitoring results.

Lasher and Conrad (2011:iii) foresee no threats to the boreholes from septic systems in the municipal area and stated that the overall water quality of these sources is either "good" or "marginal" and is Class I and Class II respectively. Class I water is suitable for use but occasional instances of undesirable effects may occur whereas Class II water is conditionally adequate. The municipality add chlorine to improve the quality of the water.

Lasher and Conrad (2011:17) recorded that the municipal groundwater levels of the Laingsburg production boreholes are being monitored on a continuous basis. The boreholes are equipped with Solinst data loggers which register and record water levels every 30 min. The statistics from these loggers are downloaded and are interpreted by a geohydrologist on an ad-hoc basis. The municipality's management receives recommendations such as yield adjustments and pumping and resting durations to help with maintenance of these aquifers. Comparing the data with past trends clearly show that the water levels are declining, which poses a risk to the municipality as the demand is increasing. The municipality does not monitor the water quality of these boreholes.

The chlorine is used because it stays in the network and when a pipe burst occurs the network is exposed to germs, but the chlorine which is in the network, cleans it immediately as soon as it is repaired to mitigate the risk of pollution and diseases harmful to humans and animals. The water is then distributed to the New Town, Bergsig, Bo Dorp, Ou Dorp and Onderdorp. The water flows to the Goldnerville Reservoir where it is distributed to the Goldnerville and Acacia Park Precincts. During summer there is a need for more water, therefore the municipality utilises a Buffels River borehole to fill the reservoir. The chlorine in the network purifies the water as soon as it gets in the system. A chlorine house is constructed at each reservoir and these are used to reticulate the water pumped from the boreholes into the reservoir before it is distributed to households.

Visual assessment of the Soutkloof spring flow seems to be deteriorating. Zoutekloof SAR and Zoutekloof Pit are located about 264 m and 530 m downstream of the Zoutekloof Spring respectively. Zoutekloof SAR extracts water from the unconfined secondary aquifer. The CSIR (1997: 25) has indicated that water abstraction from this borehole may not have any impact on the spring as it geologically is located in the overlying unconfined groundwater aquifer.

Zoutekloof Pit is located in the alluvial aquifer; the chances of it affecting the spring are improbable given that the radius of influence after pumping the borehole for one day is only 74 m. It is therefore anticipated that the weakening of the flow may be caused by the fact that the Laingsburg area had low rainfall over the past few years and recharge to the aquifers has been limited. Water level monitoring at the Borehole Van Riebeeck Street indicates that the

yield at which the borehole is pumped is too high and it is not well managed. The Municipality should therefore ensure that the appropriate yield of the borehole is determined and this should be adhered to before the groundwater aquifer is damaged and rendered useless (Lasher & Conrad, 2011:18).

Wastewater treatment is done to the South of Laingsburg at the Oxidation Ponds. The Municipality uses a purifying system consisting of various ponds that filter the wastewater until it can be used again. The purified water is not re-used in households but is used by the emerging farmers for irrigation of lucerne near the oxidation ponds.

The Municipality developed a sewerage plant at Matjiesfontein during the low-cost housing development project in Matjiesfontein. Purification is also used here and the recycled water is used to irrigate the Matjiesfontein Sports Facility. The municipality thus made provision for infrastructure to articulate and to re-distribute water to conserve water resources for household use. The municipality would have preferred to do the same in Laingsburg but the lack of infrastructure prevents the utilisation of treated wastewater for irrigation of parks and open spaces including the sports field and the golf course.

Lasher and Conrad (2011:31) concluded that the apparent decline in groundwater levels is due to the low rainfall in the Laingsburg Local Municipality area (The long-term mean annual precipitation for quaternary catchment J11E is 188 mm/a). Unrestrained abstraction can result in a further reduction of the aquifer. Serious long-term effects for other groundwater users and water resources in the area are predicted, but if it is properly monitored and managed the aquifer could sustainably supply the towns with water.

A Laingsburg Water Safety and Security Plan Project Team consisting of eight internal members assembled from all of the water supply operations and maintenance managers and supervisors of the Laingsburg Local Municipality and one external member to make assessments of the municipal resources and management practices, conducted a risk assessment and introduced mitigation measures (Swartz, 2014a:3-4).

The assessment identified a challenge of frequent interruption in the water supply to Bergsig when the pipe through the Wilgehout River breaks during high flows in the river of which a

permanent pipe crossing was recommended to ensure that the risk is removed (Swartz 2014a, 12). Laingsburg Local Municipality (201: 2011) confirms that the municipality approved a Water Supply by-law in 2010, focusing on Water Services and Sanitation Services. The by-law is outdated and must be reviewed in the light of the more recent challenges like climate change. It should take in consideration that groundwater has become a scarce water resources and the conservation thereof can secure the sustainability of the municipality.

4.2 MONITORING

The Geoss Groundwater Assessment done in 2011 indicated that water levels of the Laingsburg groundwater production boreholes are monitored on a continued basis. The boreholes are furnished with Solinst data loggers programmed to record water levels every 30 minutes. The data is downloaded and interpreted on an ad hoc basis by a geohydrologist who makes recommendations to the management of the municipality on aspects such as groundwater abstraction yield amendments and pumping and resting durations to assist with effective maintaining of the aquifer. Comparison with earlier data sets has unmistakeably revealed that the groundwater water levels are declining. The current yield of boreholes unfortunately is not known because the boreholes are not furnished with water flow meters. The Laingsburg Local Municipality furthermore does not monitor the water quality of the water abstracted from these boreholes (Lasher & Conrad, 2011:17).

Figure 4.3 illustrates the whole municipal water provision network including, the fountain, boreholes, pits and reservoir and how it is distributed to the various points.

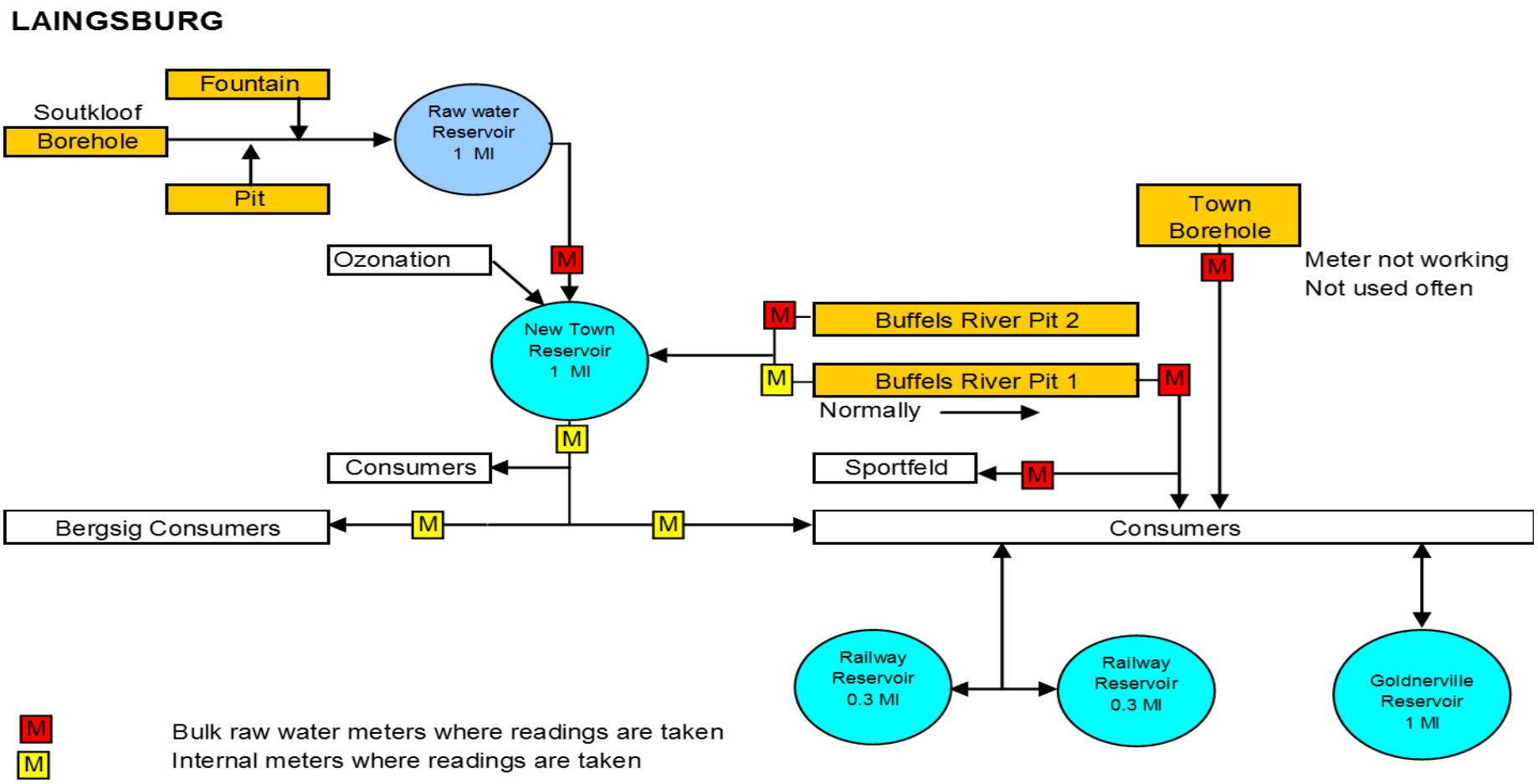


Figure 4.3: Laingsburg water distribution network

Source: Laingsburg Local Municipality (2014a:23)

The water distribution network illustrated in Figure 4.3 outlines where the Laingsburg Local Municipality is sourcing and storing water and how it is treated and where it is distributed to consumers, as well as how untreated water goes into the system and is being treated at various points. It also illustrates that these waters are metered and how water is used for irrigation of public places like sports facilities.

4.3 CONCLUSION

Laingsburg Local Municipality is a Water Service Authority and is responsible for the provision of water to its residents. It is the responsibility of the municipality to provide water to the town of Laingsburg as well as the settlement at Matjiesfontein. The Municipality has infrastructure in place to render the services and has staff responsible for the management of this natural resource. A management and implementation plan is in place although there are areas that can be improved.

CHAPTER 5: INTERVIEW SAMPLING

5.1 INTRODUCTION

The interviews took place over a period of one month, starting the 5th of September 2016 with the last interview on the 7th of October 2016 with prior identified individuals working in the field of water and more specifically groundwater. Data were captured, analysed and an assessment was made to inform the research. The interviews focused on the current drought the municipality was facing, the high percentage of unaccounted water loses, the drilling of new boreholes in 2015 and the utilisation thereof. Also the staff sufficiency of the water services division, the level of skilled experience as well as current resource management within the municipality were investigated. The implementation of recommendations from a policy or strategy perspective and what impact it may have on sustainable resource management, is also explored. The external interviewees like the water and groundwater specialists, the Manager Infrastructure, the Councillor responsible for Infrastructure Services and the officials working within the water and wastewater division within the municipality were explicit with regards to the sustainability of groundwater in the era of climate change and the impacts of resource management and more frequent droughts effecting Laingsburg as a small Karoo town.

5.2 INTERVIEW SAMPLING

The end result of interviews was informed by the interview guide which consists of plus minus 17 questions. The interview guide is included with this study as Addendum A. The study results found that the interviewees were busy but they made time available to participate in this study because they understood the importance thereof? The interviews were scheduled with interviewees beforehand but it took longer than anticipated. Interviewees who were unable to avail time requested the questionnaire and completed it in their own free time and emailed it back to the researcher. Individuals felt that climate change and more specifically droughts have an impact on groundwater.

They also felt that the percentage of unaccounted water can become problematic and threaten the sustainability of the municipality as a Water Service Authority. They were also of the view

that if the municipality can manage to limit the unaccounted water to more acceptable levels the municipality can easily provide water for current need as well as for future needs.

All interviewees stated that the municipality water services divisions is understaffed and the level of skill is low and training as well as additional staff is needed to be able to effectively manage this scarce natural resources. A need for a water engineer were highlighted that will assist the municipality to improve resource management. The engineer will also assist with the conservation of groundwater extraction and at the same time manage the demand and supply for household and business requirements.

The findings will be discussed under the following 5 themes.

5.3 WATER RESOURCE MANAGEMENT

The study outlines that the LLM municipality does have a Water Services Development Plan in place as well as various other supporting documents in place, but the staff component responsible for the provision of water is not efficient and their level of skill is not sufficient to fully manage the water resources. A need for further capacity in the form of additional trained staff and training of the current staff component was highlighted by all interviewees. The current resource management team also identified that there is areas that require improvement and intervention within current management processes.

The LLM municipality has been assisted by the Department of Water and Sanitation (DWS) through its War on Leaks Programme to minimise the huge water losses but was unable to make an impact. The programme did assist residents to fix leaks at household level but the amount of unaccounted water did not show a decrease. Interviewees made mention that the programme could have worked better if it was utilised on the bulk water network. The municipality in cooperation with the Department of Water and Sanitation (DWS) are rolling out the programme again with the training of locals as water agents to assist the municipality, but interviewees suggested that the participants be used in all divisions to address the problem.

The LLM municipality does not have a water engineer who can assist with monitoring of groundwater levels and the over-extraction of water from boreholes. Many a times officials

only find out that the boreholes are running dry when it is too late because of lack of skills and knowledge of groundwater resource management. The Zoutkloof spring providing the bulk of water is not managed as it should be because it is not maintained on a regular basis by means of cleaning and effectively utilising the water when the Zoutkloof Reservoir is full as overflow water flows away. Officials are of the view that the spring's lifespan is not threatened and the better you maintain it the more water the spring releases.

According to the municipal complaints system, 20% of complaints by consumers were related to the quality of the water. Especially the high chlorine smell of water as well as the milky form of tap water and that it has been stand for a couple of seconds before it can be consumed, were mentioned. The municipal council also had queries on the water quality and demanded tested results from the infrastructures services department. Regular testing reports were made available to the council as well as to the community to monitor the compliance levels to the green and blue drop status of the municipality. The water quality met the compliance levels for human consumption but the infrastructure services department was requested to improve water management and to improve the quality of water.

A need for more storing facilities were identified at Zoutkloof, Bergsig and Goldnerville to store the water that is not captured and stored on a regular basis.

5.4 WASTEWATER MANAGEMENT

Wastewater is being purified through a natural plant and is utilised for irrigation purposes only. In Laingsburg it is applied for the use of emerging farmers utilising it for a local lucerne production downstream of the sewage plant. The Matjiesfontein sewage plant's purified water is used for the irrigation of the Matjiesfontein sports facility.

Interviewees felt that the purified wastewater might even be used for human consumption if the purification process can be improved. A general view of the interviewees; that instead of only using the recycled water for lucerne irrigation it can be also be used for the irrigation of sports facilities in Laingsburg including the town's golf course.

The interviewees also highlighted that the cost implications for the further purification process as well as infrastructure to irrigate the sports facilities and golf course might be too high for the Municipality as statistics already indicate that municipality's water provision budget is under severe strain recording a deficit on the operational budget. The municipality however must look at the possibility of investigating the opportunity to conserve water resources and ensure sustainability of groundwater in this global trend where groundwater resources are depleted and the increase of uncertainties for future generations and increased water demands.

5.5 RISK ASSESSMENT

The uncertainties of the effects of climate change and economic development pose a risk for the human race. A small town like Laingsburg that only played a small part in the degradation of the earth and the over utilisation or exportations of our natural resources in trying to bridge the economic gap between the rich and poor without success.

Figure 5.3.1 outlines the risk assessment from the consultation process to monitoring and evaluation.

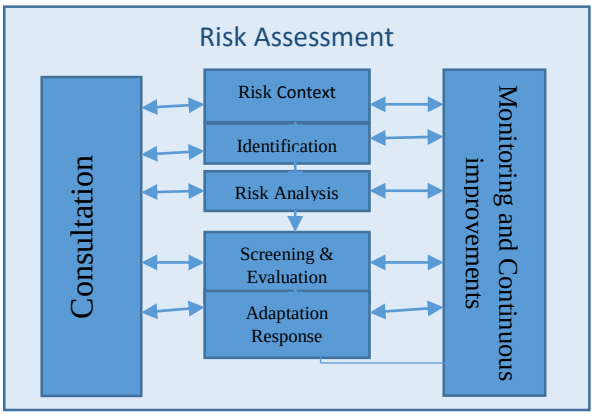


Figure 5.3.1 Risk Management Process
Author (2016)

The above figure illustrates the process of risk management to achieve adaptation. Starting from consultation and improvement on a continuous basis through understanding the risk context, and identifying risks and doing an analysis to fully understand the impact and the likelihood of the risk and the impact it will have on groundwater. Continuous screening and

evaluation of corrective measures which will lead to resilience or adaptation of the Laingsburg community.

The study identified various risks to the sustainable provision of water to the Laingsburg community and businesses. The first risk which was identified was the over-extraction of groundwater resources without knowing before it is too late. Secondly, the identification of economic potentials like gas extraction in the Karoo (fracking) which include an area in Laingsburg as well as the mining of uranium in the area and the transportation to Beaufort West as the hub for uranium mining in the Karoo.

The possibility of pollution of groundwater by means of gas and uranium mining and uranium dust falling from trucks infiltrating the ground and groundwater. Although Shell Petroleum insist that the technology and material used in fracking are completely safe, it still poses a risk of groundwater pollution.

The utilisation of water in fracking poses a risk on the water in the area, as a huge amount of water is needed during the fracking process before the gas can be released from underneath the layers where groundwater is stockpiled. The used water will also be extracted from the fracking and needs to be recycled to store without the possibility of polluting existing groundwater aquifers. The risk of using potable water for the abstraction of gas poses a risk on water availability for future demand and the existence of water for human consumption.

Thirdly the inability of LLM to account for water losses counting for more than 50% of water. This poses a risk of water scarcity in future because of the noticeable more frequent severe droughts that are occurring. Interviewees have responded that these drought situations will impact negatively on the availability of groundwater and the drought which was declared in 2015 by the Municipality, the district, the Western Cape Province Government and national government was proof enough when boreholes run dry and water usage restrictions were enforced during the festive season starting in December each year.

The aging infrastructure was pointed out by one interviewee as also a risk to conserving the groundwater and can also be one of the reasons why the water losses are so high and if it is not replaced might become a bigger problem in future. The Municipality's small budget for water

highlighted that there is a deficient and that might pose further risk to improve the resource management processes and to ensure sustainable resource management.

5.6 RISK ADAPTATION

LLM has a Water Services Plan, a by-law and other plans and strategies in place to address certain aspects of sustainable resource management but it is not sufficient to ensure that the municipality can cope with its current capacity and available resources. One interviewee stated that the municipality has an approved Long-Term Water Conservation / Water Demand Management Strategy (LT WC/WDMS) but it is not implemented. The interviewee further stated that adequate Human Resources and financial budget must be made available to implement it to ensure that the municipality is resilient to global warming, climate change and occurring droughts.

Other interviewees also alluded to the fact that the capacity within the municipality is not adequate, that the level of education is not very high and that there is a need for a water engineer who can assist the water services division to monitor groundwater levels and water quality because this is not easy as surface water monitoring and proper groundwater monitoring would ensure that groundwater is not over extracted from sources and that it is conserved for future purposes.

One of the interviewees stated that if the municipality can manage to curb water losses to excepted levels it will assist the municipality to cope during disasters like droughts, than the possible water scarcity will not occur and the effects of climate change will not be significant for the next few years. The more regular maintenance of resources will also assist the municipality to monitor water resources and be on alert when resources are decreasing to put mitigation measures in place that will ensure that the municipality is able to meet the demand of consumers without compromising the local economy.

Interviewees agreed to the fact that recycled or purified water might be a solution in times when groundwater is decreasing and when faced with water scarcity. Another element of sustainability which can be implemented in the medium-term is to use recycled water for irrigation in Laingsburg for sports facilities and the golf course. The interviewees also

mentioned that the possibility of a sewage plant on the Goldnerville side where most of the population are situated should be investigated and a business case built and funding sourced. The municipality will then have to need to build a sewage line back to the Central Business District (CBD) where the main sports facility and golf course are situated. This will enable the municipality to use the water resources on a sustainable basis. Interviewees further stated that the municipality can on the long-term even further purify the recycled water so that it can be used for human consumption.

The financial situation as the smallest municipality in the country was recorded negatively in the municipality's annual report indicating a deficit in water service delivery budget. Interviewees stated that this could be changed with an increase in tariffs excluding the availability fee as well as introducing a differentiated model with regards to usage of water during summer. The municipality will then be able to break even and more can be done to improve the maintenance of water resources.

The capacity problem identified throughout the interview process require Human Resources (HR) to enrol water services staff in training to ensure that staff is capacitated. They will be able to improve the resource management and maintenance of water as well as wastewater management. One of the interviewee's mentioned that the municipality might receive a water engineer that will assist them to monitor groundwater resources more effectively and assist the municipality to introduce integrated resource management processes that will improve how the municipality is currently operating within the division.

The municipality can further utilise the participants of the War on Leaks programme much better than the previous round. During the previous round the participants were utilised to fix leaks at household level assisting households to conserve water. The interviewees felt that this time around they should be used to assist the current staff component to work with them in all areas especially on the bulk network. This will assist the staff to manage the maintenance and resource more effectively. These participants will then also be more equipped as they will obtain skills through skills transfer and not only by theory taught in the classroom.

The aging water and sanitation infrastructures are a universal problem in South Africa and the LLM like all other municipalities must start to use the replacement fund and or the surplus made at year end to start replace the old underground infrastructure on an annual basis so that

the aging infrastructure can be addressed through a multi-year project as no solutions were identified to address the challenges faced by almost all municipalities in the country. The Laingsburg Local Municipality with its financial constraints can then implement a multi-year project and at the same time address the possible leakages on the bulk water network from the Zoutkloof spring to the household level.

The planned economic opportunities for the area which can boost the economy that include fracking and uranium mining may pose possible risks to the groundwater resources. Some of the interviewees did not understand what it entails but it came out that if the implementers stay within environmental parameters the situation can be monitored and effects thereof can be mitigated. If the planned initiatives are rolled out the municipality as the water services authority must closely monitor progress and groundwater levels. The municipality must measure and regulate the performance of service providers' not exceeding environmental restrictions and stay within regulations. The municipality must also make sure that by-laws and policies are in place to address areas where implementers do not adhere to prescriptions or restrictions and that the municipality can hold them accountable for not abiding to rules and regulations.

5.7 MUNICIPAL GUIDELINE

The purpose of this guideline is to provide and assist the municipality with reliable and clear guidance for building drought resilience with regard to groundwater management and conservation. The guidelines were informed by specialists in the field of groundwater within Western Cape Province in South Africa. Interviews were conducted with officials of the Department of Water and Sanitation, Geohydrological and Spatial Solutions International (Pty) Ltd. (Geoss), WorleyParsons, Groundwater Driller, a MISA Water Engineer and municipal officials who included the Manager of Infrastructure Services to ensure that the best practical experience would inform these guidelines. The guidelines draw on experience in the water sector to provide clear direction so that the municipality can advance to the adaptation process with a reasonable and fully comprehensible method.

The guidelines was developed to assist LLM through various stages in the adaptation process, from the initial phase until it is implemented, monitored and reviewed for further improvement. These guidelines do not analyse the science but it does recognise the impact that global warming, climate change and drought have on groundwater resources. The guidelines can be used as the basis for an adaptation strategy as the municipality currently does not have such a strategy in place.

The guideline is intended to assist the Infrastructure Services department in Laingsburg Local Municipality and, more specifically, the water services division that focuses on water and wastewater within the municipality.

The structure of the guidelines is such that it allows the municipality to use sections of the guidelines or the whole set of guidelines to inform adaptation processes or inform future strategic decisions. It is informed by the study that was undertaken and should be read alongside all the chapters in this study. Information derived from the literature review and interviews and studies conducted by the municipality makes clear recommendations which inform an adaptation strategy which can assist the Municipality to conserve groundwater as the main water resource and render sustainable integrated water resource management services.

5.8 CONCLUSION

The Laingsburg Local Municipality can definitely improve the current water resource management process which will assist the municipality to deliver on its vision and cross-cutting strategic objectives of rendering a service which is of a good quality but at the same time affordable as well as value for money.

The municipality has a unique situation as part of the war on leaks programme and with secondments from MISA, but it can be addressed through the use of current resources in an innovative way and if the municipality is willing and able to address these challenges. It can be done without waiting for a financial injection from donors that may never come.

The staff component understands their situation and they are willing and able to bring about change with the assistance of management and the community as a whole. The biggest

challenge is obtaining funds to implement the recommendations of interviewees but also using the stakeholders, partnerships and resources that are already available within the municipal environment.

The municipality cannot do anything to stop climate change but it is able to put measures in place that will assist them to become more sustainable and conserve the groundwater sources on a daily basis and not only when faced by drought situations. If the municipality build more water storage facilities, for instance reservoirs, at the Zoutkloof spring and in town there will be sufficient water available during dry seasons or when the municipality is facing drought situations.

The replacement of aging water and sanitation infrastructure, additional water storage facilities, the minimisation of water losses, installation of a sewage plant in the Goldnerville area, the utilisation of recycled water in the municipality for irrigation of sports facilities and the golf course, the implementation of an integrated water resource management programme, the increase of water tariffs and the increase of municipal capacity through the obtaining secondments or placements to transfer skills to staff. The extra human capital within the municipality will assist the municipality to be able to use resources in a sustainable manner. This will enable the municipality to conserve groundwater resources for future generations. The municipality must ensure that an adaptation plan is put in place to cope with possible water scarcity in future. This will assist the municipality to put mitigation measures in place and adapt to climate change.

CHAPTER 6: WATER RESOURCE ADAPTATION FRAMEWORK, CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

The study of groundwater resource management in Laingsburg Local Municipality outlined that the municipality has an approved long-term Water Conservation / Water Demand Management Strategy in place but the staff working within the municipality is not aware of it. The study also mentioned that the biggest challenge why this strategy has not been implemented is the current municipal financial constraints and the inability to attract funds to implement the policy. However, the interviewees made clear recommendations on how the municipality can improve the current situation. The interviewees also suggested that an Integrated Water Resource Management (IWRM) process must be put in place. This will assist the municipality and its residents to be resilient, and adapt to climate change and the inevitable.

6.2 RECOMMENDATIONS REGARDING RISK ASSESSMENT OF GROUNDWATER IN THE LAINGSBURG MUNICIPAL AREA

The interviewees recommended that LLM must ensure that groundwater resources are conserved for future needs and generations. The interviewees felt that if the municipality does not do something now, water scarcity will be inevitable and the municipality will definitely become unsustainable and that the municipality will have to change the current business process and the way the municipality is doing business.

The Municipal Long-term Water Conservation / Water Demand Management Strategy (Laingsburg Local Municipality, 2011a: 28) makes the following recommendations;

a) reduce and maintain low water losses through active control of leaks theft in water reticulation system;
b) reducing and maintaining low levels of water losses through water pressure management in reticulation system;
c) rehabilitation and replacement of components of network system;
d) preventative maintenance;
e) active leak control;
f) develop a uniform operational and maintenance policy;
g) reduce and maintain low water wastage;

h) increase use of alternative water resources;
i) ensure the efficient use of water in new developments;
j) ensure and maintain adequate information / policies to support decision-making;
k) ensure all decisions are supported by Integrated-water Resource Planning (IRP);
l) ensure adequate financial resources and processes to finance WC/WDMS and minimise commercial and metering loses;
m) ensure adequate human resources and human resource processes;
n) ensure adequate stakeholder by-in and commitment; and
o) monitoring the impact of WC / WDMS measures.

The following recommendations were derived from the interview process:

i. Motivate for the secondment of a water engineer at Municipal Infrastructure Services Agency (MISA) of the LLM
ii. Training and skills development for municipal staff
iii. Metering of unmetered ervens or properties
iv. Utilisation of War on Leaks Programme to assist municipal staff
v. Regular monitoring of water network and natural resources
vi. Daily cleaning of Zoutkloof Spring and equipment
vii. Building of extra storing facility at Zoutkloof spring;
viii. Building of extra storing facility in Goldnerville;
ix. Utilisation of recycled water for sports facilities and golf course
x. Building of sewage plant at the Goldnerville side from where irrigation can be done
xi. Replacement of aging water and sanitation infrastructure through municipal replacement fund or annual surplus of the municipality
xii. Development of by-laws and policies that conserve groundwater
xiii. Regulating economic projects ensuring that it does not pollute groundwater

The recommendations from both strategies are applicable to the Laingsburg Local Municipality situation and will assist the municipality to become sustainable and will enable to cope with global warming, climate change and local drought disasters. Most of the interviewees were not aware of the WC / WDMS and identified a need for an adaptation strategy which will assist the internal teams to be informed and be hands-on in handling of drought disasters.

The information which came out of the interviews is also captured in the WC /WDMS and is therefore complementary. Two of the interviewees made mention of the WC /WDMS and said that the reason why the WC /WDMS was not implemented was because of lack of financial assistance and the low income base of the municipality as well as the deficit water budget of the municipality as well as the high compliance cost which has to be done on a monthly basis. In the light of the above recommendations the following water resource adaptation processes and procedures should be implemented within the municipality to ensure resilience.

6.3 WATER RESOURCE ADAPTATION PROCESSES AND PROCEDURES

Adaptation to climate change is crucial. As something that may be inevitable, drought situations are not the responsibility of Laingsburg Local Municipality as the Water Service Authority only, but require actions from all its communities, individuals, groups and businesses. Adaptation linked to groundwater dependency requires the management of natural resources, the replacement and maintenance of infrastructure, the monitoring and effective planning and utilisation of water by consumers. All stakeholders must take responsibility and co-create or co-operate in realising mutual but collective goals in conserving the water resources and finding ways to adapt a lifestyle of saving water and protecting groundwater sources even when there is no drought.

LLM, in putting adaptation plans in place to cope with drought situations and water scarcity must understand the environment, the capacity and what implications it has on the sustainability of the municipality. The following framework illustrates the manner in which the Municipality must operate to ensure that groundwater availability is not jeopardised for future generations.

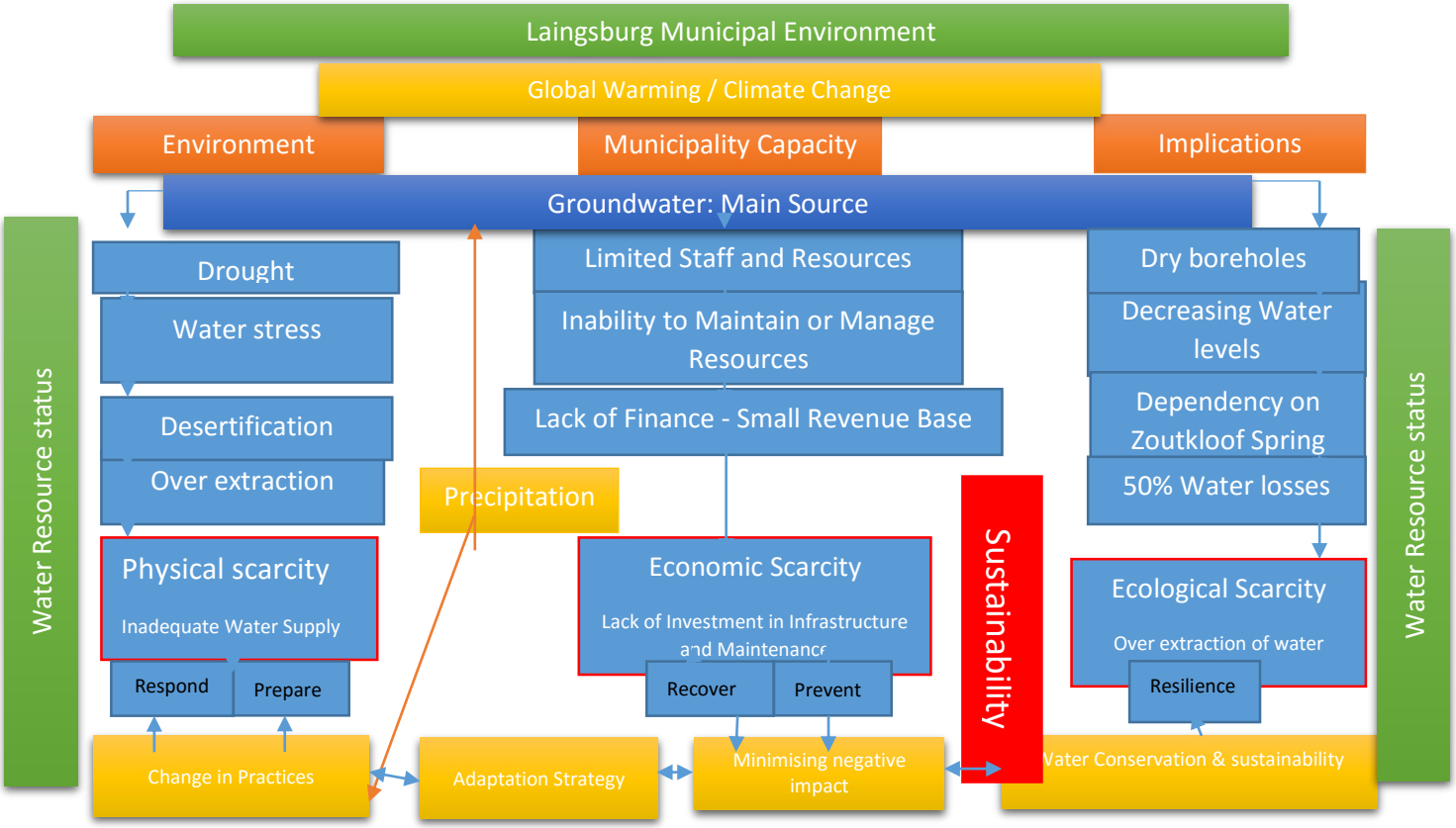


Figure 6.1 Groundwater Adaptation Framework
Source: Author, 2016

Figure 6.1 illustrates the processes LLM will have to follow to ensure that the municipality is able to cope with groundwater decreases and water scarcity caused by a drawn-out drought situation.

The municipality's resources situation is stable at the moment, but the municipality might still face water problems during the summer of 2016 because the municipality did not get sufficient rain to recharge the current boreholes that normally assist during summer time when the demand for water is very high and the municipality cannot manage to fill up reservoirs and supply water to consumers and visitors.

Adaptation starts with a change of attitude from all stakeholders from the municipality to the consumers and businesses using it. A change in management approaches and processes will assist the municipality to improve the groundwater resource management. It will assist the

municipality to minimise the negative impacts of climate change. This will assist the municipality to conserve water and achieve sustainable water provision.

The municipality has a Water Conservation / Water Demand Management Strategy in place, it was approved by the Council in July 2011 but it has never been implemented. The municipality however has appointed staff in the water and wastewater division but it is still not sufficient. The appointed staff members have not received training; therefore capacity in the municipality, especially in the water services division, remains a challenge. As there is not sufficient capacity in the municipality, MISA has appointed an engineer who is currently assisting the municipality to find the cause of the high water loss. The reason for water loss has however not been identified yet.

The municipality's Infrastructure Services Department must review the WC /WDMS in line with this research study and identify processes and procedures which can be implemented in the short, medium and long-term to become more sustainable. The following Water Resource Adaptation processes and procedures must be put in place in order for the municipality of Laingsburg to become resilient and sustainable in these daring times because climate change does have an impact on the groundwater levels of the municipality, because less rainfall reduces the recharge rate of aquifers. Less rainfall during drought situations will also result in the municipality to become dependent on their groundwater requirements. The dropping of static water levels of boreholes indicates over-abstraction.

6.3.1 Environment

Water is not a luxury, but a necessity and a human right for all South Africans, it signifies dignity. Although it is so important, this natural resource are regarded by society as it will never be depleted. This perception must be changed and more must be done to ensure the conservation thereof.

Laingsburg Local Municipality is solely dependent on groundwater for water service delivery, but the conclusion that 50% of water is unaccounted for, raises red flags regarding the management and conservation thereof. A municipality like Laingsburg is faced by drought on a regular basis and the last drought declaration as recorded in 2015 was a wakeup call, when the municipality faced challenges to provide water to its consumers and businesses. The municipality's water resources were stressed and it resulted in desertification, specifically in

the agricultural sector and even within the municipal service boundaries where the municipality could not water public areas like sport facilities.

This disastrous event was caused by the lack of sufficient groundwater distraction monitoring as well as inappropriate or lack of regular and applicable water resource management. It resulted in over extraction of groundwater and boreholes running dry and the additional stress on the Zoutkloof spring. If the municipality does not change current water management practices, the municipality will face physical scarcity of water and inadequate water supply to its consumers.

6.3.2 Municipal capacity

The municipality reviewed the municipal organisational structure and managed to approve two new positions for work within the water services division, adding up to five staff members. The two positions were filled, so there are no vacancies in the water services division, but there a need for more staff remains. The skills level of the new employees is also not adequate for the field of work, and the municipality has not trained the staff to strengthen the capacity within the division. It was also recorded that the budget of the division did not break even in the last three years, but reported a deficit. Financial resources therefore are insufficient for improving current resource management processes and procedures.

The lack of skills, too few staff and the inability to manage this natural resource effectively and maintain infrastructure have led to the situation where the municipality's groundwater abstraction is under severe pressure. The resources must be managed, but the lack of capacity and resource will prevent the municipality from being able to manage water resources effectively. The situation of the Laingsburg Local Municipality will not change overnight as the economic situation is a reality, but it needs to be addressed to conserve the resources of the municipality. The lack of investment in infrastructure and maintenance requires innovation to ensure the rendering of sustainable water related services.

6.3.3 Implications

The environmental concerns of LLM and the current municipal capacity result in huge challenges which the municipality cannot handle on its own or with its own capacity. The current state of affairs in the Laingsburg Local Municipality is the consequence of not having implemented the Water Conservation / Water Demand Management Strategy which was

approved in 2011. The situation has escalated since then; therefore the municipality is confronted with decreasing groundwater levels, boreholes running dry, a 50% water unaccounted for and high dependency on the municipality's main water resource, the Zoutkloof spring. Laingsburg is facing an ecological problem which requires breaking away from business as usual and implementing adaptation methodologies.

6.3.4 Change in practices

A paradigm shift is inevitable, therefore the municipality must find ways to address challenges even if the municipality's capacity is low. Finding innovative ways is an option to ensure that the municipality brings about change. The War on Leaks programme and the relationship with the Department of Water and Sanitation (DWS) and Municipal Infrastructure Services Agency (MISA) can be used to address the capacity challenges.

The utilisation of participants of the War on Leaks programme to assist with maintenance and monitoring at household level and bulk network level assist the municipality to improve resource management. The existing partnerships with DWS and MISA can be used to obtain scarce skills like groundwater technicians and groundwater engineers to assist to put implementable programmes and business processes in place and transfer skills to staff to effectively maintain and monitor the water services division.

The Corporate Service's Human Resource Management unit of LLM must roll out urgent training for staff to ensure that they are willing and able to maintain and manage water resources in an effective way. This is crucial for the municipality to be able to cope with global warming and decreasing groundwater levels.

6.3.5 Adaptation strategy

Climate change is a universal problem and nothing can be done to rectify the situation. Humanity can only slow down effects by considering the environment in current and future development. Laingsburg Local Municipality will have to find ways to adapt to this reality or otherwise face unsustainability and water scarcity.

Adaptation strategy is a way to ensure that LLM and its residents continue as usual without any water scarcity. The adaptation strategy will ensure that the municipality can manage its resources and maintain infrastructure and ensuring that groundwater is not over extracted and

it is conserved for the future without jeopardising current needs. The strategy must entail short, medium and long term objectives, implementing what won't cost too much within the current resources and plan for medium-and long-term goals.

6.3.6 Minimising negative impact

Climate change cannot be reversed, neither can anyone stop drought. Laingsburg Local Municipality may be certain that there will be a flood every few years and that there will be drought. The municipality's Disaster Risk assessment has therefore identified drought as a most likely occurrence that will have a negative impact on the environment, human life and the economy.

Although groundwater levels are decreasing, the municipality can still ensure that water resources are conserved through various programmes and projects. Most of the initiatives can be implemented in the short-term with the resources that are available. It starts with training, awareness programmes, tariff increases, incentive schemes, limiting of water loss, reporting of water theft, maintenance of resources, replacing of faulty meters, replacing aging infrastructure or building additional water storage facilities.

This cuts across all objectives of an adaptation strategy and will assist the municipality to use water more sparingly or limit water loss and store water that is currently flowing away, specifically at the Zoutkloof spring. The municipality will be able to supply in the current water need, conserve groundwater and ensure sustainability of the municipality as a water service authority and a municipality.

6.3.7 Water conservation and sustainability

Adaptation to change is not always easy, but with the groundwater adaptation process, one is forced to accept the reality and to start putting measures in place which will enable one to live with changing climate patterns, troubling times and challenging scenarios. A paradigm shift is sometimes needed to bring about change. A change management strategy is most of the time needed to speed up the pace before time runs out and one cannot do anything to the situation and is forced to deal with the consequences.

The decreasing groundwater levels and drought conditions that Laingsburg Local Municipality has to manage requires a Change Management Strategy to change processes, procedures, technologies, attitudes, business processes and human behaviour. The municipality will be

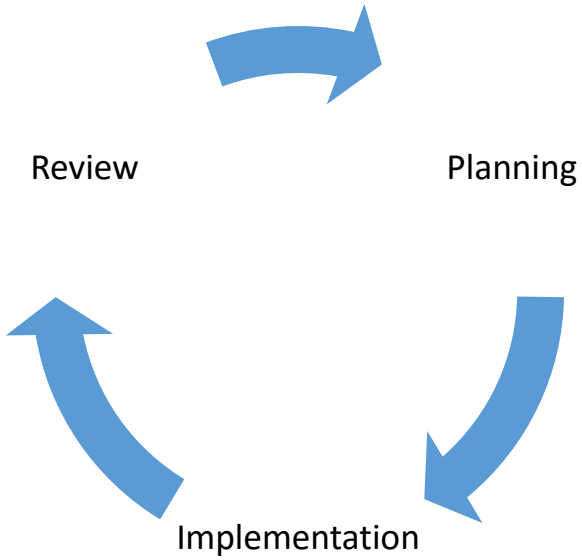
able to minimise the impact of drought and the municipality together with its residents will be resilient and able to cope during dryer periods without water shortages. Resilience does not involve the municipality only, but requires all stakeholders and role players to work together to save water, use it sparingly, and fix leaks and burst pipes as soon as possible.

6.4 MUNICIPAL GUIDELINE

Weaknesses in the current system were identified by 99 percent of interviewees and they also used the opportunity to identify possible solutions and make recommendations on how to improve the current system of water conservation and water demand management.

6.4.1 The adaptation decision framework

The municipality's decision-making power resides in the municipal council. Whatever the municipality plans to implement, must be captured in the municipality's Integrated Development Plan (IDP) as the single strategic plan of the municipality. If the Infrastructure Service Department fails to include a project in the IDP, the implementation of any adaptation projects will not be funded. The municipality will also struggle to source funding because any funding that needs to be secured, has to be captured in the municipal IDP. The adaptation framework comprises three phases: Planning, Implementation and Review. Figure 6.1 illustrates that it is a process which must be reviewed on a continuous basis and is informed by monitoring and evaluation.



The implementation framework for the drought adaptation decision in Laingsburg Local Municipality is aligned with the activities captured in Figure 6.2 that must be undertaken on a continuous basis or the municipality may reach a state of unsustainability.

Figure 6.2: Implementation framework

Source: Author, 2016

Figure 6.3: Groundwater adaptation decision framework
Source: Author, 2016

The guideline is informed by conclusions made throughout this study as well the recommendations made in studies done previously. The guideline was informed by recommendations made by interviewees as well as strategies and plans compiled by the municipality to address water losses. It will also assist with the improved water resource management as well as the repair and maintenance of water infrastructure. A groundwater adaptation activity proposal is attached as annexure 1 and can inform future actions taken by the municipality to ensure sustainable resource management.

6.4.2 Conclusion

The conclusion from this research study is that global warming threatens humanity and that effects of this are experienced by everyone around the globe. The researcher found that climate change and, more specifically increasing temperatures, has a huge effect on surface water as well as groundwater.

The investigation was undertaken to determine what the effect of climate change is on groundwater in semi-arid areas like the Laingsburg Local Municipality in the Central Karoo. The researcher conducted research by consulting existing studies in the field of groundwater conservation under changing climatic conditions linked to climate change. Further investigation was done to find out whether more frequent droughts linked to climate change have an impact on groundwater availability and whether it can lead to water scarcity as well as unsustainability.

The researcher undertook a case study of the Laingsburg Local Municipality that is solely reliant on groundwater. During the course of the year and a half during which the study was conducted, the municipality faced a challenging drought with no rain for two years and the municipality, the Western Cape Provincial Government and National Government declared drought disaster areas including Laingsburg and other areas in South Africa that faced drought conditions. The 2015 droughts in South Africa resulted in the unavailability of water for household and economic consumption in the Laingsburg Local Municipality area. LLM implemented demand management measures and could provide water for household consumption and could make more water available for other uses, including for the economy after a two-week process.

The municipality struggled to fill the water reservoirs because of the number of travellers through the town who used rest rooms, but once the roads became less busy, reservoirs could be filled and more water became available. The municipal boreholes ran dry during the period of drought and the Zoutkloof Spring was the only source providing water at that stage. The municipality further implemented differentiated usage tariff increases to force garage owners to pay higher tariffs for high water consumption.

The researcher conducted a study in the municipal environment and on the municipal capacity to effectively manage the groundwater resource and continuous repair and maintenance of infrastructure following reported figures indicating that the municipality was unable to account for 50% of water loss over the preceding years. The municipality also reported a negative budget that recorded a deficit leading to the water division's unsustainability. The staff component was found to be insufficient and unable to do regular maintenance or monitor natural resources to accurately record groundwater levels and the volumes of water extracted to meet the demand.

The study was further researched by means of interviews with specialists working in the field of water conservation and resource management from government officials, municipal officials, government agencies, water engineers, consultants to groundwater drillers working within the Laingsburg Local Municipality area to understand groundwater studies and tap into their knowledge to find solutions to the challenges raised. These interviewees managed to identify the risks the municipality is facing with regard to water scarcity and the dropping groundwater levels under drought conditions. The interviewees also made recommendations concerning the current business process followed by the Municipality.

A risk assessment was done and risks like water scarcity, decreasing groundwater levels, the limited municipal financial resources available, the aging water and sanitation infrastructure and 50% water loss that pose a risk to the municipality were identified. Possibilities of fracking within the municipal environment and need for water to discharge the gas trapped between the layers below the groundwater level, as well as the possibility of polluting the water if gas contaminated the natural resources on which the municipality is dependent were considered. Other issues concerned the question of where the huge quantities of water needed for gas extraction will come from, with Laingsburg already facing decreasing groundwater, and the possible re-opening of uranium mining that might involve transporting it to Beaufort West, with uranium dust falling from vehicles, contaminating the soil and infiltrating the groundwater sources to endanger the water resources.

The municipality uses wastewater which is purified for irrigation of lucerne plantations and the Matjiesfontein sports facility. Hence the researcher concludes that currently recycled water can be better utilised by also watering sports facilities in Laingsburg, including the golf course. If the municipality is to become a sustainable Water Service Authority, it must investigate a further purification process so that purified water can be used for human consumption because groundwater sources are decreasing. This would support groundwater sources like boreholes and the Zoutkloof Spring before they are fully exploited and run totally dry. If the municipality can manage to increase tariffs and minimise water losses to less than 18%, the municipality can apply for funding to construct a recycling plant. This will improve resource management processes and conserve groundwater.

In the midst of the 2015 drought, LLM drilled five boreholes of which two were unsuccessful. The three boreholes that produced sufficient water did not comply with SANS standards, hence

the water cannot be used at present as the municipality does not have a water purification plant. It is recommended that the municipality make financial provision for the future so that water from the new boreholes may be added to the water that currently is SANS compliant. The municipality will then be using resources more efficiently and render a sustainable service with adequate water for economic development.

The aging water and sanitation infrastructure of the municipality needs to be replaced. The municipal replacement fund could be implemented for this over a period of years. The replacement of bulk pipelines will assist the municipality to minimise water loss, and the replacement of faulty meters as well as the metering of unmetered areas will also minimise the water loss. The new municipal Standard Chart of Accounts (mSCOA) financial system must be linked to every meter of the municipality's bulk and household meters in order to accurately record water usage and account for every drop of water. The continuous monitoring and analysing of water usage statistics will assist the municipality to track illegal connections and regulate it to assist the municipality to bring the water loss to under the 18 percentage mark. This will enable the municipality to apply for funding to implement projects that will assist the municipality to implement the long-term WC /WDMS which a 20 year plan.

The utilisation of quick wins like the utilisation of the War on Leaks programme which can be used to assist permanent staff to improve repair and maintenance as well as monitoring of water resources on a daily basis as well as fixing households leaks is important. The municipality has applied for a water engineer at MISA for the utilisation of the specialist to put business processes in place for repair and maintenance, as well as integrated resource management which can be implemented by staff. The municipality could use the opportunity to obtain much needed skills by means of skills transfer.

The municipality could conduct awareness programmes to change the behaviour and mindsets of local inhabitants. This will motivate consumers to use water sparingly, especially if incentives for installing water saving equipment are available. A differentiated tariff system will also assist the municipality to improve water conservation.

While undertaking this investigation, the researcher observed that the staff in the Water Service Division was not included when plans and strategies were developed but just continued with their daily chores. The telemetric system is in the office of the Infrastructure Manager and the

responsible staff does not have access to this system to improve monitoring of groundwater levels. If they had been more involved they could have done more to ensure sustainability. They also require more training, especially new staff appointed over a year ago and who were not trained.

The following recommendations are made to improve groundwater conservation and sustainability in the Laingsburg Local Municipality area:

- research must be considered when municipal IDP is developed and the programme must be reviewed on an annual basis;
- the Guideline be used to develop a Groundwater Adaptation Strategy;
- the municipality must utilise the War on Leaks programme participants to support the water services division;
- the municipality must utilise the MISA water engineer applied for to develop an integrated resource management programme and tap into the specialist skills to transfer skills to staff;
- embark on an awareness programme to partner with consumers to save water;
- implement an incentive scheme to motivate the installation of water saving equipment and technology;
- review the water tariff system in cooperation with the consumers;
- implement a differentiated tariff approach to minimise water usage;
- training the staff component, especially newly appointed staff in water control and management of groundwater;
- replace faulty meters;
- investigate metering areas with no meters;
- calibrate bulk meters;
- upgrade the telemetric system and make the system available to the Water Service Division;
- utilise recycled water for watering the sports facility and golf course in Laingsburg;
- establish a Goldnerville sewerage plant for irrigation purposes;
- invest in a water purification plant to make use of water that does not comply with SANS Standards at present;
- invest in a wastewater purification plant to use recycled water for human consumption;
- build an additional Zoutkloof Reservoir to capture water that runs away;

- add a Bergsig water reservoir for additional storage; and
- promote water saving technologies and equipment in new developments.

It also has to be taken into consideration that the municipality can only implement a few projects over a multi-year period or within the five-year IDP cycle. It will not be implemented in one five-year term either, but the municipality should implement the quick wins and find innovative ways to address challenges in order to achieve sustainable water provision and water conservation.

6.5 SUMMARY

This study can be used to inform future plans to ensure that Laingsburg Local Municipality conserve groundwater resources and become resilient toward the effects and impacts of climate change. The most important fragments of this study are the fact that Laingsburg Local Municipality is negatively affected by climate change and that the Municipality is prune to droughts.

Resource management is partially blameable for a decrease in groundwater levels with 50% of water flowing away or being stolen and it has been happening for years. Lack of financial planning to maintain and replace old water infrastructure was also highlighted for the current state of affairs. Inadequate monitoring of natural resources like boreholes is also one of the main reasons for boreholes running dry in dry seasons. The staff component is also to small and their level of skills is very low leading to a small pool of knowledge and experience which can be used to effectively manage the water services division.

The study made clear recommendations on how to improve the current practices and conserve water natural resources for future generations without compromising current economic needs. Recommendations were made to implement short, - medium-and long term actions. Short-term actions include the utilisation of the War on Leaks programme and the secondment of an engineer from MISA to improve water resource management. A vigorous community awareness programme to educate the community to save water and become water ambassadors for the municipality as well as starting to effectively monitor resources form the source to

distribution levels. The participation in the Integrated Development Planning of the municipality to ensure that water projects are prioritised.

Medium-Term actions include implementing improve resource management practices and the replacement of aging water infrastructure by means of multi-year project using the municipal replacement fund and surpluses recorded at year end. Training of staff and the transfer of skills to permanent staff to broaden the skills base. The review of the municipal organisational structure making provision for more staff and the making provision to employ some of the War on Leaks participants within the municipality. Conducting feasibility studies and Environmental Impact Assessments (EIA's)for prioritised IDP projects so that projects can be implemented on the long-term. The review of the water tariff model with the community to break even or raise revenue from water to improve water services practices.

Long-term projects like building additional storage capacity being constructed as well as a development of a waste water purification plant and the utilisation of purified water for irrigation and human consumption release stress from natural water resources. Improvement of the water treatment plant which will enable the poor quality of water found during the 2015/6 drilling process.

Upon the implementation of these initiatives the municipality of Laingsburg Local Municipality will mitigate the risks of water scarcity in future and ensure long-term sustainable water supply with the help of all stakeholders. Prospecting of fracking and uranium mining in the municipal area must be close monitored to take informed decisions. The municipality must also ensure that mining is strongly regulated to ensure that groundwater sources are conserved and not compromised for economic growth. The whole of Laingsburg town and Matjiesfontein will be resilient to climate change and can cope during droughts and dry seasons.

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ANNEXURE 1

Proposal for Groundwater Adaptation Activity

No.	Objective, Process / Procedures	Time Frame	Responsibility
1.	Reduce and maintain low Levels of water loss through reticulation system	Short Term	Municipality
	• Utilisation of War on Leaks Programme to provide additional human resource to bridge the gap; • Enrolling staff and War On Leaks programme participants for training; • Applying for a Water Engineer through MISA to assist staff component and transfer skills; • Frequent monitoring of water supply system , from source to consumers; • Replacing of faulty meters and installing meters to measure non-revenue water; • Financial system alignment with all meters to accurately record usage; • Regular and adequate system maintenance and repairs; • Upgrade the telemetric system and make the system available to senior staff working in the water division; • Leak detection for households through War on Leaks Programme; and • Replacement of Aging Infrastructure through replacement fund.	Short Term Short Term Short Term Short Term Short Term Short Term Short Term Short Term Short Term Medium and Long-Term	Municipality

2.	Reduce and maintain low levels of water wastage and inefficient water demand by existing consumers	Short Term	Consumers
	• Household Leak Detection and repair by War on Leaks Programme; • Identification of areas for interventions and a differentiated approach; • Review the outdated municipal by-law connected to law enforcement procedures; • Awareness Programmes (Conservative Approach); • Increase in Tariffs linked to usage; • Alternative programmes to use grey water or water saving techniques; • Consumer Water Audits; • Reporting and Complaints System; and • Water Conservation for new developments	Short Term Short Term Short Term Short Term Short & Medium Term Short Term Short Term Short Term Medium Term	War on Leaks Programme Municipality Municipality Municipality Municipality Consumers Consumers Consumers Consumers and Municipality
3.	Increase use of alternative water resources	Medium & Long-Term	Municipality & Consumers
	• Irrigation of Sports Facilities and Golf Course with recycled water; • Grey Water promotion; • Promote rainwater harvesting; • Sewage plant on Goldnerville side of Town; • Re-cycled water pipeline; • Utilisation of boreholes with needed treatment for human consumption or for irrigation purposes; • Investigate purifying wastewater for human consumption; and	Medium & Long Term Short Term Short Term Long-Term Medium & Long-Term Medium & Long-Term	Municipality Municipality & Consumers Municipality & Consumers Municipality Municipality Municipality & Consumers

	• Purification Plant and distribution for human consumption.	Long-Term Long-Term	Municipality
4.	Ensure the efficient use of water in new development	Short Term	Municipality
	• Regulation and enforcement to prevent water wastage and promote alternative sources; • Awareness, Education and Training for new consumers; • Incentive scheme / Rebate for water conservation; • Promotion of grey water usage / Plans; • Water efficient plans (Bathrooms, Toilets, Kitchens & Pools); • Water efficient gardens and Rainwater tanks; and • The development of new engineering standards.	Short Term Short Term Short Term Short Term Short Term Short Term Medium Term	Municipality Municipality Municipality Municipality & Consumers Consumers Consumers Municipality & Consumers
5.	Ensure and maintain adequate information /policies to support decision-making	Short Term	Municipality & Consumers
	• Replace faulty meters; • Install meters where water is not measured; • Upgrade of the municipal Telemetric System; • Telemetric System installed within the Water Division and not only in Manager Infrastructure Services office;	Short Term Short Term Medium Term Short Term; Short Term Short Term	Municipality

	• Upgrade Municipal Financial System (Integrated System); • Implement an effective monitoring system to manage the supply and demand; • Customer Satisfaction Surveys to inform planning and decision-making; • Quarterly water audits • Review the WC /WDMS on an annual basis; and • Complication of a multi-year action plan.	Short Term Short Term Short Term Short Term	
6.	Ensure adequate financial resources and processes	Medium & Long-Term	Municipality
	• Review the WC /DWMS; • Conduct Study on what resources is available and how it can be used to improve the current process; • Conduct study on what resources are available from other stakeholders like DWA and MISA; • Investigate a Water Services Engineer on a Shared Services Model with other municipalities within the district; • Review the Municipal Water Tariff System (Availability and usage tariff) in co-operation with consumers, once off or price hype on an annual basis; • Incentive Scheme to motivate water conservation; • Introduce an informative billing system;	Short Term Short Term Short Term Short Term Short Term Medium Term Ongoing Ongoing Ongoing Ongoing Short Term Short Term	Municipality Municipality Municipality Department Local Government, Central Karoo District Municipality & LLM Municipality & Consumers Municipality & Consumers Municipality Municipality Municipality

	• Ongoing meter replacement system; • Regular testing of meters on accuracy; • Monthly monitoring of meter reading and spot checks; • Management of large consumer meters; • Reduction of illegal connections; • Job Creation to address high indigents; and • Introducing FLISP or GAP Housing to broaden municipal Income.	Short Term Medium Term	Municipality Municipality Municipality Municipality & DWS Municipality & Business Chamber Municipality, Department of Human Settlements
7.	Expansion of current Resources / Storage Facilities	Medium & Long Term	Municipality
	• Building an Extra Reservoir at Zoutkloof Farm • Building of a Reservoir in Bergsig • Building of a Reservoir in Goldnerville • Provision of Rainwater Tanks in Matjiesfontein • Investigate a purification Plant for human Consumption • Planning and Budgeting a Wastewater Purification Plan • Building a wastewater purification plant in Laingsburg	Medium Term Long-Term Long-Term Medium Term Medium Term Medium Term Long-Term	Municipality

ADDENDUM A

Interview Guide

MPA: Risk Assessment on Groundwater in LLM Area

2016

1. **According to the SEPLG (2014) Laingsburg Municipality is part of the Central Karoo and is negatively impacted by climate change which means that the municipality will face more severe or extreme meteorological droughts. The Municipality, Central Karoo DM and the Western Cape declared a drought in 2015**. Does it have an impact on the groundwater levels of the municipality as it is the main water resource of the municipality?

2. Do you think the municipality may face water scarcity and unsustainability in future?

3. **The municipality is also unable to account to 50% of water loses as stated in their 2014/15 Annual Report**. What could be the possible reasons?
   a) Will the municipality be able to address this water loses using current management processes.
   b) What would you suggest the municipality do to minimise water loses?

4. **Laingsburg Municipality is the smallest Municipality in South Africa and so is it budget and capacity. Groundwater measurement is not as easy as surface water.** What would you suggest the municipality do to ensure that this natural resource is not depleted?

5. What other options can the municipality pursuit to change current resource management?

6. **The Municipality have been a beneficiary of the War on Leaks programme for the last 3 years.** Does the programme add value to the current situation?

a) Will the programme be able to assist the municipality to minimise the high water loses in the municipality?

7. **The population grows slowly with 2% per annum, and economic growth is lowest in the Central Karoo District. The Municipality is identified as one of the areas for fracking and Uranium mining, it will improve the municipal economic situation but** what impact will it have on the groundwater resources?

8. What are the potential risks faced by municipalities like Laingsburg with regards to groundwater availability / water scarcity to sustain current and future needs of the municipality?

9. What can be done to minimise these risks?

10. **The municipality's waste water is currently used for irrigation of Lucerne plantation near the oxidation ponds and the sports field in Matjiesfontein**. Is there a possible opportunity for the municipality re-use it?
    a) What will the cost implications be on an already stressed municipal budget?

11. **The municipalities Green Drop and Blue Drop status has dropped the last few years**, what is the main reasons?
    a) What can the municipality do to change the current outcome?

12. **The municipality are reliant on the Soutkloof Fountain / spring and a few boreholes. The municipality also drilled 5 holes 2016 to increase water availability in the current drought situation**. Were the municipality able to find sufficient, potable water?
    a) What does the municipality plan with the new bore holes, current resources and used water?

13. Do you think the municipal current water resource capacity and management is sufficient?

14. What can the municipality do to improve water resource practices and capacity?

15. Does the municipality has a Groundwater Adaptation Plan or framework in place?

a) What should be included in these plans to ensure sustainable water resources in Laingsburg?

16. **The municipality's tariff system is in place but the municipality makes a deficit on water services and sanitation services (Expenditure and revenue**). What is the reasons for these deficit?
    a) What can the municipality do to change the current situation?

17. What can be done to minimise the impact of climate change on groundwater within Laingsburg Municipality.