Preface
It is imperative that the planning and policy framework process be understood. The Climate Change Response Strategy is the overarching framework for climate change actions for the Ekurhuleni city region. The Environmental Resource Management (ERM) Department will in conjunction with this process engage with key departments and develop individual Climate Change Response Plans, which will start to highlight the effects and impacts that climate change will have on the particular departments sphere of work. The relevant department will be led through a process of understanding to highlight that planning around climate change needs to be done in conjunction with current planning processes to ensure that all risk are well covered. The Climate Change Departmental Response Plan will start the negotiation process between ERM and the relevant department and will determine the relevant actions that the department will commit to, these actions will be taken up in the Environmental Cooperative Agreements that are developed and signed by the Heads of Department. In some instance departments may require specific information on a particular action and ERM will then aid in development of Sustainability Benchmark Guidelines, attached as annexures to the climate change departmental response plans, to providing best practice methods.
EXECUTIVE SUMMARY

Cities act as the concentration of economic activity within any region. Cities are therefore consumers of the vast majority of natural resources within the country and act as a major contributor to environmental degradation. Although urbanization is the driving force for modernization, economic growth and development, there is increasing concern about the effects of expanding cities, principally on human health, livelihoods and the environment. The implications of rapid urbanization and demographic trends for employment, food security, water supply, shelter and sanitation, especially the disposal of wastes (solid and liquid) that the cities produce are staggering (UNCED, 1992). This intense utilisation of natural resources has severe effects on the natural environment within the region causing it the ecosystems within the area to become severely distressed. The City of Ekurhuleni is no different in this respect. The urban landscape has highly concentrated populations that are serviced by major infrastructure, which renders them vulnerable to the impacts of climate change and environmental degradation. These impacts may be warmer temperatures, fiercer storms and increases in rainfall over shorter periods, contributing to the exposure of the society to flash floods and other natural disasters. At the same time, better urban planning, policies and service delivery infrastructure choices can reduce energy use, greenhouse gas emissions, improve the resilience of urban infrastructure to climate change, and minimize the impact of climate change on the poor, thus shaping future trends.

The Ekurhuleni Climate Change Response Strategy has being developed by the Environmental Resource Management Department to aid the organisations in dealing with the issues and impacts related to a changing climate. Ekurhuleni is regarded as the manufacturing & industrial hub of Gauteng which thus positions the city as a large emitter of GHGs. Further to this Ekurhuleni is home to the largest airport in South Africa – OR Tambo International Airport and has positioned itself to be the first Aerotropolis City in Africa. This would mean that the heart of the region would be a transport and logistics nexus lead to freight movement and thus associated emissions related to transport sector.

Addressing the effects of climate change, environmental degradation and reduction of GHG emissions not only improves the natural environment, ecosystem services and living habitat, but also helps municipalities in three dimensions of sustainability: economic, environmental, and social.

1. **Economic:** The maintenance of sprawled communities is expensive and contributes to the municipal infrastructure deficit. Taking measures towards increasing energy efficiency, water usage and protection of soils is not only about combating climate change, but also about ensuring that our communities are economically viable, well into the future. In particular research shows that the impacts of climate change are borne most heavily by the poor, thus combating climate change and its effects within EMM ensures not only economic viability but protection of the poor.
2. **Environmental**: The predicted effects of climate change include extreme weather events, increased frequency of disease, and heat stress. These will undoubtedly have severe effects on a number of sectors including agricultural, hampering consistent production and leading food insecurity. Existing water management infrastructure (i.e. storage and drainage systems) may not be well suited to changes in precipitation. Fortunately many actions which will reduce emissions can also help municipalities adapt to climate change. Some examples of actions include water conservation measures e.g. fixing leaking pipes and rain water harvesting; reducing energy use e.g. energy efficiency and solar water heating, and making municipalities more resilient in the face of droughts, and other extreme weather events.

3. **Social**: Population is an important source of development, yet it is a major source of environmental degradation when it exceeds the threshold limits of the support systems. Unless the relationship between the multiplying population and the natural life support system can be stabilized, development programmes, howsoever innovative, are not likely to yield desired results. Population impacts on the environment primarily through the use of natural resources and production of wastes and is associated with environmental stresses like loss of biodiversity, air and water pollution and increased pressure on arable land. The burning of fossil fuels not only contributes to greenhouse gas concentrations, but also releases chemicals that are detrimental to human health. Ambient air quality within the region is linked directly to industry and manufacturing, informal settlement (fires, stoves, burning of garbage) and from motor vehicles, this has serious consequences for the region and environment. Therefore, taking action on climate change often results in improved air quality and human health. Climate change and environmental degradation also has numerous socio-economic impacts including increased health care costs, social disruption, loss of income and productivity and diminished quality of life.

Climate change is not just an environmental issue and more importantly it is not an issue which should be addressed in isolation. The impacts of climate change and the varying parameters in which planning for these should occur, cut across all sectors and ultimately culminate in direct impacts on the city’s ability to deliver sustainable services.

In terms of the EMM issues pertaining to climate change risks and vulnerabilities relate to inter alia:

- Increasing temperatures impacting on social welfare and natural assets.
- Increased rainfall which could lead to infrastructure damage, particularly with regards to road infrastructure.
- Water service disruption due to increasing rainfall overburdening existing system capacity. Subsequently concerns were raised pertaining to the potential contamination to potable water as a result of ineffective and under capacitated service infrastructure.
- Increased dry spells will lead to a heightened need for water and again the over-capacitating of an already strained resource network.
- Changing weather patterns will greatly affect the agricultural sector of the EMM leading to inter alia reduced agricultural production.
The context of climate change within the Ekurhuleni city region means that significant efforts need to be made across all spheres within the organisational structure of our local government. The effect on the region is not solely isolated to disaster risk and management, but further exacerbated to the functioning of the region as an economic super force. To date, there has been little emphasis on the impact of climate change on municipal services in the day to day operation of the city. Climate change is seen as removed from the operational and implementation side of service delivery. Even within the strategic planning sphere climate change, although recognized to some extent, is not addressed through the practical and direct impacts that will result from climate variables, thus impacting on service delivery and the contribution of service delivery. Climate change is not just an environmental issue and more importantly it is not an issue which should be addressed in isolation. The impacts of climate change and the varying parameters in which planning for these should occur, cut across all sectors and ultimately culminate in direct impacts on the city’s ability to deliver sustainable services. As such Ekurhuleni has identified climate change and the possible impacts thereof as a paramount aspect of integrated planning within the region, which will be incorporated and addressed into all strategic plans for the region. This will ensure that our communities, industries and businesses have the necessary support and assurance, in order to cater for all the requirements needed in functioning as resilient global citizens.
DESCRIPTION OF THE CITY

INTRODUCTION TO EKURHULENI

The Ekurhuleni Metropolitan Municipality (EMM) was formed in 2000 from the joining of several local municipalities of the former East Rand Region (See Figure 1). EMM was established as one of eight metropolitan municipalities subsequent to the restructuring of local governments in South Africa in 2000. EMM is the fourth largest municipality in South Africa with nine local authorities and 101 wards.

EMM is also known as East Rand, the eastern region of Gauteng Province in South Africa. It consists of 192,355 hectares of land which is occupied by about 3.2 million people (Statistics South Africa, 2011), occupying approximately 900,000 households (EMM Full Term Report 2006-2011, 2011). EMM united eleven former councils into one local government authority to meet the needs of the communities in a holistic approach. The councils are Alberton, Benoni, Boksburg, Brakpan, Edenvale, Germiston, Kempton Park/Tembisa, Nigel, Springs, Khayalami Metropolitan Council and Eastern Gauteng Service Council. The municipal population makes up about one third (28%) of Gauteng’s population, with a population density of approximately 1 400 people per square kilometer (EMM, 2010). Population densities are high especially in the former “township” and informal residential areas. Approximately 22% of the population resides in informal and inadequate housing. Despite having a large percentage of the population of working age, the rate of unemployment is high, approximately 40%. The municipality, being a conglomeration of nine previously separate municipalities, has no identifiable core and also has an interesting equity profile; where ‘low development densities with historically disadvantaged communities [are] situated on the urban periphery’ (about 24% of the population live in poverty and the current estimated unemployment rate is 35%) (EMM, 2010, 9). There is currently (at the time of preparation of the 4th review) a great housing backlog with an estimated 135 000 shacks in informal settlements and 36 000 backyard shacks.

<table>
<thead>
<tr>
<th>Surface Area</th>
<th>1,924 km²</th>
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</thead>
<tbody>
<tr>
<td>Population</td>
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<tr>
<td>Population Density</td>
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<td>Proportion of Gauteng Population</td>
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<tr>
<td>Population Growth (2004-07)</td>
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<td>Main Income Areas</td>
<td>Manufacturing, Trade, Social Services</td>
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<td>Emissions per Capita</td>
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<td>Annual Budget</td>
<td>R21 Billion (+- 2.19 billion USD)</td>
</tr>
<tr>
<td>Budget for IDP Projects</td>
<td>R2 Billion</td>
</tr>
</tbody>
</table>
FIGURE 1: LOCALITY MAP OF EKURHULENI
CLIMATE
Summers in Ekurhuleni are considered mild with temperatures seldom above 30°C (EMM SOER, 2004 and EMM EMF, 2007). Ekurhuleni falls within the summer rainfall region of South Africa and the experience of hot wet summers and cool dry winters are normative. More than 80% of the rainfall occurs from October to April. Average rainfall for the region is between 715 mm to 735 mm annually. The region is prone to intense rainfall events in terms of thunderstorms, which generally fall in the late afternoons. These storms account for the major flooding and heavy rainfall events that affect Ekurhuleni and can cause much damage to livelihoods and infrastructure (Tyson and Preston-Whyte, 2000). A number of recent studies have examined daily rainfall in and around Gauteng over the past few decades to gain a better understanding of rainfall variability and change (CoJ, 2009; Dyson, 2009; Fatti and Vogel, 2009).

TOPOGRAPHY AND LANDSCAPE
The convergence of the Limpopo and Vaal river catchments is observed within the EMM region. The terrain is generally flat with elevations ranging from 1460 m to 1760 m. The following topographical features are prominent within the landscape of Ekurhuleni i.e. plains with pans; undulating plains with pans; strong undulating plains; superimposed river valley (i.e. Blesbokspruit) on plains with pans and ridges (EMM SOER, 2004 and EMM EMF, 2007).

The occurrence of groundwater in EMM is prominent, due to the underlying geology within EMM, which is dominated by dolomite of the Chuniespoort Group and tillites of the Dwyka group, both of which are formidable for the water carrying capacity, (EMM EMF, 2007).

The surface hydrological system consists of 6 river or spruit systems (See Figure 2). The Blesbokspruit, is a system that originates to the north of Benoni and Daveyton and flows southwards through Springs and Nigel towards the Vaal river. The eastern part of the catchment contains extensive natural wetlands, while the western part is highly modified by agriculture and human settlements. Key industrial sites including mine dumps and slimes dams, waste disposal sites, intensive agriculture, and sewage works all impact negatively on water quality. The second river system is the Klip River and its tributaries. The Riet spruit originates in the south-west of the Benoni area and joins the Klip River outside the EMM boundary. The Natalspruit, another tributary of the Klip River, rises in and around the Germiston and Boksburg areas. The upper reaches of the Klip River can be found to originate within Kathlehong. The pollution within these spruots can be attributed to human settlements, agricultural practices and industrial activities. Although these rivers join the Vaal River, they do so downstream of the Vaal dam, thus the effects of this pollution on the EMM quality of drinking water is not problematic. However, the pollution affects both the aesthetic and natural aspect of the Vaal River. The third river system includes both the Kaal and Olifant Spruists. These originate in Kempton Park and Tembisa, and flows north to join the Hennops River in Centurion. There is serious pollution in this system, which is attributed once again to human settlements and agricultural activities. The Jukskei Spruit is the fourth system and has a
number of small tributaries within the system, which drain to the western region of EMM around Edenvale. This system takes control as it leaves Ekurhuleni through parts of Alexandria. The fifth river system is the Bronkhorst Spruit, which is located in the eastern region. This area is drained by two small spruits namely Os spruit and Koffie spruit, which feed the Bronkhorst Spruit. The sixth and final system is the large Rietvlei Spruit. This system starts in the smallholdings area of Kempton Park and flows northwards past the OR Tambo International Airport to Rietvlei Dam. This dam is a high contributor of water supply in Tshwane. The primary supply of this water originates from agricultural and industrial surface runoff. The Grootvlei River in the Bapsfontein area is a tributary of this system. An impressive feature of the EMM region is the prevalence of a number of pans, which is directly linked to flat topography. They cover a total area of 3 559 ha and are mostly seasonal. A few perennial pans are found within the agricultural areas. A number of lakes are situated within the municipal region and are primarily a creation of the Gold Mines in the area. The Germiston, Benoni and Boksburg lakes are prime examples of this and are utilised as recreational parks. However, the water quality of these systems is under severe stress due to problems associated with water hyacinth, mine dust pollution and storm water drainage (EMM EMF, 2007).
The water quality is generally poor in all river/stream systems within Ekurhuleni (details provided below). The poor management of storm water, sewage treatment plant, industries and agricultural activities all contributes greatly to the negative impacts on river/stream systems.

**Figure 2: Surface Water in Ekurhuleni**
The damming of most of river and spruit systems is a common problem associated with the agricultural activities in the region. Many of the rivers have been canalised, mostly for storm water control in urban areas or for agricultural purposes. The ever-increasing human pressures in the area have caused many of the natural systems in the area to a downward cycle of deterioration.

As described above the natural systems in EMM are overshadowed by contributions from sewage works and mining. The increase in urbanisation has resulted in an increase in the surface water runoff of almost 300%. The higher river flood peaks and levels pose serious threat to all developments (mainly informal housing) within designated flood zones. Many parts of Tembisa, Katlehong, Tsakane and Nigel are at particular risk.
**Development Goals and Priorities of Municipality - GDS Focus**

**Climate Change and Cities**

Cities act as the concentration of economic activity within any region. Cities are therefore consumers of the vast majority of resources within the country and act as a major contributor to environmental degradation. This intense utilisation of resources has serve effects on the natural environment within the region causing it the ecosystems within the area to become severely distressed. The City of Ekurhuleni is no different in this respect. The urban landscape has highly concentrated populations that are serviced by major infrastructure, which renders them vulnerable to the impacts of climate change and environmental degradation. These impacts may be warmer temperatures, fiercer storms and increases in rainfall over shorter periods, utilisation and development of open spaces, contributing to the exposure of the society to flash floods and other natural disasters. At the same time, better urban planning and policies can reduce energy use and greenhouse gas emissions and improve the resilience of urban infrastructure to climate change, thus shaping future trends.

Addressing the effects of climate change, environmental degradation and reduction of GHG emissions not only improves the natural environment, ecosystem services and living habitat, but also helps municipalities in three dimensions of sustainability: economic, environmental, and social.

4. **Economic:** The maintenance of sprawled communities is expensive and contributes to the municipal infrastructure deficit. Taking measures towards increasing energy efficiency is not only about combating climate change, but also about ensuring that our communities are economically viable, well into the future.

5. **Environmental:** The predicted effects of climate change include extreme weather events, increased frequency of disease, and heat stress. Existing water management infrastructure (i.e. storage and drainage systems) may not be well suited to changes in precipitation. Fortunately many actions which will reduce emissions can also help municipalities adapt to climate change. Some examples of actions include water conservation measures e.g. fixing leaking pipes and rainwater harvesting; reducing energy use e.g. energy efficiency and solar water heating, and making municipalities more resilient in the face of droughts, and other extreme weather events.

6. **Social:** Burning fossil fuels not only contributes to greenhouse gas concentrations, but also releases chemicals that are detrimental to human health. Therefore, taking action on climate change often results in improved air quality and human health. Climate change and environmental degradation also has numerous socio-economic impacts including increased health care costs, social disruption, loss of income and productivity and diminished quality of life.
DEFINING CLIMATE CHANGE

First, it is important to distinguish the meaning of weather from climate.

Weather describes the conditions of the atmosphere at a certain place and time with reference to temperature, pressure, humidity, wind, and other key parameters (meteorological elements); the presence of clouds, precipitation; and the occurrence of special phenomena, such as thunderstorms, dust storms, tornados and others. Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Classically the period for averaging these variables is 30 years, as defined by the World Meteorological Organization. Climate in a wider sense also includes not just the mean conditions, but also the associated statistics (frequency, magnitude, persistence, trends, etc.), often combining parameters to describe phenomena such as droughts. Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.

Climate change, as defined by the United Nations Framework Convention on Climate Change (UNFCCC), is a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. It has been identified as a significant threat to human livelihoods and sustainable development in many parts of the world (IPCC, 2001). Global climate change is possibly the greatest environmental challenge facing the world this century.

THE GREENHOUSE EFFECT: NATURAL AND ENHANCED

The Earth’s climate system is powered by solar radiation (Figure 3). Approximately half of the energy from the Sun is supplied in the visible part of the electromagnetic spectrum. As the Earth’s temperature has been relatively constant over many centuries, the incoming solar energy must be nearly in balance with outgoing radiation. Of the incoming solar shortwave radiation (SWR), about half is absorbed by the Earth’s surface. The fraction of SWR reflected back to space by gases and aerosols, clouds and by the Earth’s surface (albedo) is approximately 30%, and about 20% is absorbed in the atmosphere. Based on the temperature of the Earth’s surface the majority of the outgoing energy flux from the Earth is in the infrared part of the spectrum. The longwave radiation (LWR, also referred to as infrared radiation)
emitted from the Earth’s surface is largely absorbed by certain atmospheric constituents—water vapour, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and other greenhouse gases (GHGs); and clouds, which themselves emit LWR into all directions. The downward directed component of this LWR adds heat to the lower layers of the atmosphere and to the Earth’s surface (greenhouse effect). The dominant energy loss of the infrared radiation from the Earth is from higher layers of the troposphere. The Sun provides its energy to the Earth primarily in the tropics and the subtropics; this energy is then partially redistributed to middle and high latitudes by atmospheric and oceanic transport processes.

**Figure 3:** Main drivers of climate change. The radiative balance between incoming solar shortwave radiation (SWR) and outgoing longwave radiation (OLR) is influenced by global climate ‘drivers’. Natural fluctuations in solar output (solar cycles) can cause changes in the energy balance (through fluctuations in the amount of incoming SWR).
CARBON DIOXIDE AND THE CARBON CYCLE

All living organisms contain carbon, as do gases (such as carbon dioxide) and minerals (such as diamond, peat and coal). The movement of carbon between large natural reservoirs in rocks, the ocean, the atmosphere, plants, soil and fossil fuels is known as the carbon cycle.

The carbon cycle includes the movement of carbon dioxide:

- into and out of our atmosphere
- between the atmosphere, plants and other living organisms through photosynthesis, respiration and decay
- between the atmosphere and the top of the oceans.

Figure 4 The carbon cycle - The carbon cycle, showing the movement of carbon between land, the atmosphere and the oceans. Yellow numbers are natural fluxes and red numbers are human contributions in gigatonnes of carbon per year. White numbers indicate stored carbon (The Carbon Cycle, NASA).
On longer time scales, chemical weathering and limestone and fossil fuel formation decrease atmospheric carbon dioxide levels, whereas volcanoes return carbon to the atmosphere. This is the dominant mechanism of control of carbon dioxide on timescales of millions of years.

Because the carbon cycle is essentially a closed system, any decrease in one reservoir of carbon leads to an increase in others. For at least the last several hundred thousand years, up until the Industrial Revolution, natural sources of carbon dioxide were in approximate balance with natural ‘sinks’, producing relatively stable levels of atmospheric carbon dioxide. ‘Sinks’ are oceans, plants and soils, which absorb more carbon dioxide than they emit (in contrast, carbon sources emit more than they absorb).

**INCREASES IN GREENHOUSE GASES DUE TO HUMAN ACTIVITIES**

Carbon dioxide is being added to the atmosphere faster than it can be removed by other parts of the carbon cycle.

Since the Industrial Revolution there has been a large increase in human activities such as fossil fuel burning, land clearing and agriculture, which affect the release and uptake of carbon dioxide.

According to the most recent Emissions Overview, carbon dioxide and other greenhouse gases are produced by the following activities or sources:

- stationary energy sources, such as coal-fired power stations (47 per cent)
- transport (18 per cent)
- coal mines (12 per cent)
- agriculture (11 per cent)
- land use (7 per cent)
- land change (3 per cent)
- waste (2 per cent).

Carbon dioxide released into the atmosphere from burning fossil fuels carries a different chemical fingerprint from that released by natural sources such as respiration and volcanoes. This makes it possible to identify the contribution of human activity to greenhouse gas production.
Data collected show that the concentration of carbon dioxide in our atmosphere in 2013 was approximately 395 parts per million. The level of carbon dioxide in the Earth’s atmosphere is now higher than at any time over the past 800,000—and possibly 20 million—years. Global atmospheric concentrations of the other greenhouse gases (methane and nitrous oxide) also now exceed pre-industrial values.

There is ever-increasing evidence that climate change is a physical reality. Scientific data shows that, despite the uncertainties, observable human induced climate change effects are emerging as a trend and arguments have shifted from disputing whether climate change is occurring to what the impacts might be and the extent of these impacts. Human-attributed changes to the composition of the atmosphere have begun to increase atmospheric and ocean temperatures, accelerate glacier and polar ice melt, alter the amount of precipitation, cause a rise in the sea levels, increase the likelihood of extreme weather events, induce shifts in timing of growing season and cause shifts in geographic distribution of natural species (Christensen et al., 2007 (IPCC-AR4), Cubasch et al., 2013 (IPCC-AR5); Seneviratne et al., 2012; Parmesan, 2006; Linderholm, 2006; Church and White, 2011). Increases in temperature and rainfall can also lead to direct (such as heat stroke, dehydration) and indirect (such as the spread or increase of infectious vector-borne diseases, water borne diseases or pathogens) health impacts. Africa is one of the most vulnerable continents to climate variability because of multiple stresses and low adaptive capacity (Meadows, 2006). Davis et al. (2010) indicates that by 2020 a large portion of Africa’s population will be exposed to increased water stress and yields from rain-fed agriculture could be substantially reduced in certain areas. These impacts will directly affect people’s livelihoods as well as their ability to adapt to climate change as the extent of the impact is linked to the local environmental conditions, the general health status of the community and the socio-economic status of the area. People living in informal settlements (which are densely populated, with high concentrations of poverty and limited access to employment and socio-economic services) are the most vulnerable, particularly to extreme events (flooding, drought, severe storms) and health (direct and indirect) impacts (Davis et al., 2010). The SA National Climate Change Response Strategy highlights South Africa’s vulnerabilities as being human health, maize production, plant biodiversity, water resources, rangelands and animal taxa.

**Climate Modelling**

Scientific evidence to date overwhelmingly indicates that anthropogenic induced climate change is a real phenomenon that is currently occurring, and is likely to gather momentum towards the middle of this century. Although the climate is known to vary gradually over time scales of thousands of years in response to solar radiative forcing, a reconstruction of the Earth’s climate for the past 2000 years has revealed an unprecedented change in the global mean surface temperatures over the last century (Brekke et al., 2009) and of atmospheric temperatures also that shows the Earth system is steadily heating, especially over the past few decades (Figure 5) (Trenberth et al., 2007).
Given some of the uncertainty in the projections, it is crucial that potential climate change impacts on rainfall, be modelled for different emission and economic scenarios, at the appropriate spatial scales (e.g. at the regional or local government scale) to inform decision making processes (Bates et al., 2008).

A variable-resolution atmospheric global circulation model (AGCM), the conformal-cubic atmospheric model (CCAM), was thus utilised to simulate future climates over southern Africa for the 21st century. The projections of six different coupled global circulation models (CGCMs) that contributed to Assessment Four (AR4) of the IPCC were downscaled to high resolution over southern Africa (see Engelbrecht et al. (2011) for a detailed description of the experimental design). The simulations spanned the period 1961-2100 and were obtained for the A2 emission scenario of the Special Report on Emission Scenarios (SRES). The model results yielded a few important findings that are crucial for any consideration of future water resource management. The first is that maximum surface temperatures over southern Africa are plausible to increase significantly towards the end of this century (Figure 6) – this signal is robust across the ensemble of different downscalings. Daily maximum temperatures during the summer half-year are projected to increase by more than 4oC over the northern parts of South Africa including Gauteng, for the period 2071-2100 relative to the baseline period 1961-1990. These increases are higher than the projected global increases and highlight the need for careful planning.
Higher surface temperatures are likely to result in higher evaporation and evapotranspiration. Although there are a complex set of mechanisms and regional feedback mechanisms that drive the aforementioned, some studies have indicated that a 2°C - 4°C change in surface temperature could result in a reduction in runoff of between 4 - 12% and 9 - 21% respectively if precipitation stayed constant (Nash and Gleick, 1993 and Miller and Yates 2006).

In addition to the increases in temperature, specific attention was given in this research to the predicted changes in rainfall over the country for the same modelling period. Significant changes in rainfall totals over parts of the southern African region (e.g. Engelbrecht (2011)) and the occurrence of extreme precipitation events are projected to change under climate change (Fig. 4). Significant areas of change are expected in the eastern parts of the country (Figure 4).
The ensemble-average projected change in the annual frequency of occurrence of extreme rainfall events over South Africa shows the spatial pattern of possible extreme rainfalls (Figure 7). An extreme rainfall event is defined as 20 mm of rain falling within 24 hours over an area of 0.5° x 0.5°, that is, an area of about 50x50 km². Rainfall events of this magnitude rarely occur over the South African Highveld (Dyson, 2010) and are likely to be associated with flooding over the region. A general increase in extreme rainfall events is projected for South Africa – another robust message from the ensemble of different projections obtained. Rainfall events are projected to increase over the mountainous regions of eastern South Africa in particular - including Lesotho and the Highveld regions of Mpumalanga, Gauteng and the Free State.

The increased surface temperature and the likelihood of more intense rainfall episodes possibly leading to flooding and flash flooding has direct implications on the water resource management of local governments. Associated management issues include: disaster management for especially floods but also droughts, water storage and demand changes.
SUMMARY OF OBSERVED CLIMATE TRENDS FOR SOUTH AFRICA (1960 - 2012)

Over the last five decades the following climate trends have been observed in South Africa:

- Mean annual temperatures have increased by approximately double the observed global average of 0.7°C reported by the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).
- Mean and maximum temperatures have been increasing less strongly, and some decreases in minimum temperatures have been observed in the central interior.
- There have been significant overall increases in hot extremes and decreases in cold extremes particularly in the western and northern interior of the country.
- Rainfall seasonality has shifted and rainfall intensity has increased.
- In almost all hydrological zones there has been a reduction in rainfall for the autumn months.
- Annual rainfall has not changed significantly, but, an overall reduction in the number of rainy days implies an increase in the intensity of rainfall events and increased dry spell duration.

PROJECTED CLIMATE FUTURES FOR SOUTH AFRICA (2015 - 2035, 2040 – 2060 AND 2070 - 2090) IN THE EKURHULENI CONTEXT

Climate Change projections were assessed at a national level under both the unconstrained and constrained pathways. The following climate scenarios were projected for unconstrained and constrained emission pathways respectively:

South Africa’s climate future up to 2050 and beyond can be described using four fundamental climate scenarios at a national SCALE:

1. Warmer (<4 °C above 1961 - 2000) and wetter with greater frequency of extreme rainfall events.
   - Increased spring and summer rainfall for Ekurhuleni

2. Warmer (<4 °C above 1961 - 2000) and drier, with an increase in the frequency of drought events and somewhat greater frequency of extreme rainfall events.
   - Reduced summer and spring and strongly reduced autumn
3. hotter ( > 4°C above 1961 - 2000) and wetter with substantially greater frequency of extreme rainfall events.
   - Increased spring and summer
4. hotter ( > 4 °C above 1961 - 2000) and drier, with a substantial increase in the frequency of drought events and greater frequency of extreme rainfall events.
   - Reduced summer and spring and strongly reduced autumn

**Climate Change in the Context of the EMM**

Environmental factors driving vulnerability and their potential consequence for human settlements due to climate change include:

- **Increased temperatures**: heat stress impacts on human health exacerbated by urban heat islands; loss of productivity; declining air quality in cities; and increased demand for cooling.
- **Extreme weather**: heat waves and droughts – increased water demand, water quality problems, heat-related deaths and reduced quality of life, food insecurity.
- **Extreme weather**: heavy rainfall and violent storms – water quality problems; deaths and injuries, infections and water-borne disease; damage to infrastructure and economy, loss of property.

An overview of the climate change scenario for the Ekurhuleni Metropolitan Municipality includes the analysis of rainfall patterns, precipitation, average temperature changes, and humidity. The reasons for specifically looking at these climatic variables is due to the fact that temperature is a basic climatological parameter which is used frequently as an index of the energy status of the environment, whilst rainfall and humidity are general climatic conditions.

The key documents which have been used for informing the climate change scenarios for the EMM are:

- Long Term adaptation Scenario (LTAS);
- South African Risk and Vulnerability Atlas (SARVA); and
- Climate Change and Adaptation Plan, City of Johannesburg, 2009 (used due to the close geographical link with the EMM).

Based on the approach discussed above, the following table provides a summary of the estimated climate change impacts that the EMM could be facing.
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<tr>
<th>CLIMATE VARIABLE</th>
<th>CURRENT CONDITIONS</th>
<th>2040 PREDICTIONS</th>
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</tr>
<tr>
<td></td>
<td>Autumn</td>
<td>53mm</td>
<td>64mm</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>6mm</td>
<td>7mm</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>72mm</td>
<td>94mm</td>
</tr>
<tr>
<td>EXTREME RAINFALL</td>
<td>Heavy Rainfall Intensity</td>
<td></td>
<td>+6.4% increase</td>
</tr>
<tr>
<td>HUMIDITY (for every 1°C rise in temperature the humidity will increase by 7%)</td>
<td>Annual Average Humidity</td>
<td>30-50%</td>
<td>14% increase</td>
</tr>
<tr>
<td>ADDITIONAL</td>
<td>Annual average number of extreme heat waves</td>
<td>35°C</td>
<td>+2.1°C increase in temperature</td>
</tr>
</tbody>
</table>
IMPACTS AND VULNERABILITIES

IMPACTS
Climate change is already having a significant impact on ecosystems, economies and communities.

The impacts of climate change within the Ekurhuleni region could be summarised as follows:
- Higher Temperature
- Reduction in average rainfall
- Increase in intensity and frequency of storm events
- Reduced water availability
- Strain on agricultural production

Rising average temperatures do not simply mean warmer winters. Some regions will experience more extreme heat while others may cool slightly. Flooding, drought and intense summer heat could result. Violent storms and other extreme weather events could also result from the increased energy stored in our warming atmosphere.

One of the most serious impacts of climate change is how it will affect water resources around the world. Water is intimately tied to other resource and social issues such as food supply, health, industry, transportation and ecosystem integrity.

Climate change also threatens the health of our children and grandchildren through increased disease, freshwater shortages, worsened smog and more. These impacts also pose incalculable economic risks that far outweigh the economic risks of taking action today.

VULNERABILITY
Vulnerability to climate change has been defined as:

The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

In the context of the city, the systems we are referring to are primarily municipal infrastructure, vulnerable communities, biodiversity and service delivery functions of the city.

The importance of biophysical vulnerability is acknowledged as well. Many poor people are directly dependent on ecosystems for their livelihoods. Indeed, biodiversity is the foundation and mainstay of agriculture, forests and fisheries. Natural forests, freshwater and marine ecosystems maintain a wide range of ecosystem goods and services, including the provisioning
and regulation of water flows and quality, timber and fisheries. The “poorest of the poor” are, often, especially dependent on these goods and services. For these groups, biophysical vulnerability means human and/or livelihood vulnerability.

Exposure to climate variation is primarily a function of geography. For example, coastal communities will have higher exposure to sea level rise and cyclones, while communities in semi-arid areas may be most exposed to drought.

**Effects of Climate Change related to Region within the Ekurhuleni Region**

**Drought and Water Scarcity**

The term drought may refer to meteorological drought (precipitation well below average), hydrological drought (low river flows and water levels in rivers, lakes and groundwater), agricultural drought (low soil moisture), and environmental drought (a combination of the above). The socio-economic impacts of droughts may arise from the interaction between natural conditions and human factors, such as changes in land use and land cover, water demand and use. Excessive water withdrawals can exacerbate the impact of drought.

IPCC Working Group II noted that, in Africa, “by 2020, between 75 million and 250 million people are projected to be exposed to an increase of water stress due to climate change” (Adger, Aggarwal, Agrawala et al., 2007) (high confidence). In Asia, “Freshwater availability in Central, South, East and Southeast Asia, particularly in large river basins, is projected to decrease due to climate change which, along with population growth and increasing demands arising from higher standards of living, could adversely affect more than a billion people by the 2050s.” Any reduction in the availability of freshwater resources caused by climate change will be particularly problematic for those who live in areas already suffering water scarcity or water stress – with poorer groups likely to be most affected (Romero Lankao, 2006).

Many cities and their water catchments will get less precipitation (and have more constrained fresh water sources) – which is particularly problematic for growing cities and large cities already facing serious problems obtaining sufficient fresh water supplies. At least 14 African nations are already facing water stress or water scarcity and many more are likely to join this list in the next 10 to 20 years (Muller 2007). There is already a failure to manage water resources well in much of this region, independent of climate change – where around half the urban population already lacks adequate provision for water and sanitation, although this is linked far more to inadequate governance than to water shortages.

**Flooding**

Urban areas always present some risk of flooding when rainfall occurs. Buildings, roads, infrastructure and other paved areas prevent rainfall from infiltrating into the soil – and so produce more runoff. Heavy and/or prolonged rainfall produces very large volumes of surface water in any city, which can easily overwhelm drainage systems. In well-governed cities, this is rarely a problem because good
provision for storm and surface drainage is easily built into the urban fabric, with complementary measures to protect against flooding – for instance the use of parks and other areas of open space to accommodate floodwaters safely from unusually serious storms. In most cities, there is also scope for land-use management and incremental adjustments to increase flood-water management capacity. But in poorly-governed cities, this does not happen. Most residential areas have no drainage system installed and rely on natural drainage channels - and it is common for buildings or infrastructure to be constructed that actually obstructs these drainage channels. In many areas in Ekurhuleni, a significant proportion of the population is not served by adequate solid-waste collection services. In neighbour hoods with inadequate solid-waste management or drain maintenance, garbage and plant growth can quickly clog drains, leading to localized flooding with even light rainfall. There is also a growing documentation on the inadequacies in drainage and flood protection for urban centres in Africa and Asia and of the trend towards increased numbers of deaths and injuries from flooding in urban areas. Floods are already having very large impacts on cities and smaller urban centres.

**Heat Waves**

Cities such as Ekurhuleni will experience more heat waves. Even small increases in average temperature can result in large shifts in the frequency of extremes (Kovats and Aktar 2008). For larger, higher density cities, the temperatures in central “heat islands” can be several degrees higher than in surrounding areas; in tropical cities, the temperature difference can reach 10 degrees by the end of the night (ibid). Many cities will face more problems with certain air pollutants as concentrations of air pollutants change in response to climate change because a portion of their formation depends, in part, on temperature and humidity. This has particular importance for Asia and Latin America, which have most of the cities with the highest levels of air pollution. There is less information on the impacts of heat stress in Africa or Latin America but studies undertaken in North America, Asia and Europe found that heat waves are associated with marked short-term increases in mortality (Confalonieri et al., 2007). The European heat wave of 2003 claimed 20,000 lives, mostly among the poor and isolated elderly. In Andhra Pradesh, India, a heat wave killed more than 1,000 people – mostly labourers working outside in high temperatures in smaller urban settlements (Revi, 2008). In regard to urban heat islands, higher temperatures occur in urban areas than in outlying rural areas because of diurnal cycles of absorption and late re-radiation of solar energy and (to a much lesser extent) heat generation from built/paved physical structures. These increase the frequency and severity of heat-stress events in cities and can affect the health, labour productivity and leisure activities of the urban population. There are also economic effects, such as the additional cost of climate-control within buildings, and environmental effects, such as the formation of smog in cities and the degradation of green spaces – and increased greenhouse gases if additional demand for cooling is met with electricity generated from fossil fuels.

There is some evidence that the combined effects of heat stress (e.g. urban heat-island effects) and air pollution may be greater than the simple additive effects of the two stresses (Patz and Balbus, 2003). There are again different vulnerabilities to the health impacts of climate-related extremes and air
pollution within urban areas. Local factors, such as climate, topography, heat-island magnitude, income, access to health services and the proportion of elderly people, are important in determining the underlying temperature–mortality relationship in a population (Curriero et al., 2002).

**Bushfires**
According to research, the risk of bushfire is likely to increase by up to 50 per cent. With climate change, these conditions are projected to increase, resulting in a 10 to 50 per cent rise in the frequency of days with a very high to extreme risk of bushfire. The report also expects the fire season to be extended in most regions, although before the extent of the increase can be predicted further research is needed into the El Niño weather cycle, ignition rates, fuel accumulation, and moisture and carbon dioxide levels.

**Biodiversity**
Climate change is emerging as a serious threat to native species and ecosystems and is expected to be an on-going challenge to the effective conservation of these assets.

Rising temperatures and flooding/drought, as well as climate-induced changes in fire regimes, water quality and ocean chemistry, will have wide-ranging impacts on biodiversity and will intensify existing threats such as habitat loss, weeds, pest animals and drought.

Species that have survived previous climatic shifts by evolving, moving or modifying their behaviour may find it more difficult to use these coping strategies when the change is rapid, especially if their habitat is degraded or lost.

The most vulnerable ecosystems include those that are coastal, alpine, rainforest or fragmented terrestrial, or those that are in areas vulnerable to fire or low freshwater availability.

Species that could become endangered or extinct include those living near the upper limits of their temperature range (for example, in alpine regions); those with restricted climatic niches; and those that cannot migrate to new habitats because of habitat fragmentation or lack of alternatives. For those species capable of dispersal, action is required to ensure that there is sufficient remnant habitat, that invasive species are controlled, and that links (including dispersal vectors) exist between habitats.
SECTORAL ANALYSIS OF THE DIRECT AND INDIRECT IMPACTS OF CLIMATE CHANGE

WATER
• Alteration of water quality which has implications for aquatic plants and wildlife;
• Increased demand for water
• Increases soil erosion and runoff;
• Increased flooding;
• Increased damage to water infrastructure;
• Alters ground water recharge;
• Variation in water availability

AGRICULTURAL
• Increased water demands for irrigation;
• Increase in spread of pests and pathogens;
• Increased discomfort levels and heat stress for livestock;
• Increased discomfort levels and reduced productivity for the labour force;
• Increase in winter temperatures and a decrease in the number of chill units in a year;
• Increase in extreme precipitation events which can cause crop damage

HUMAN HEALTH
• Increase in heat related illness;
• Increase in vector-borne diseases;
• Increase in trauma due to loss of property (through increased flooding and fires)
• which impacts psychological and mental health;
• Increase in health effects associated with population displacement;
• Increased demand on health care facilities and emergency services

BIODIVERSITY AND ECOSYSTEM
• Biome shifts, with an expected increase in the savanna area and a reduction in the grasslands;
• Shifts in climate envelope suitable for various species, which may cause extinction
• of some species, but increase in others;
• Increased disturbances which can lead to an increase in alien species;
• Wetland degradation due to changing water temperatures and water quality

HUMAN SETTLEMENTS
• Increase in the urban heat island effect;
• Increase in infrastructure damage due to flood and storm surges;
• Increase in damage to communication and energy networks;
• Increase in damage to property;
• increase in income loss due to increased breaks in service deliveries cause by flooding, hail storms or fires;
• Increased loss of subsistence crops
BUILDING RESILIENCE AND CLIMATE PROOFING THE CITY

In order to build resilience in the city to the impacts and effects of climate change, issues related to adaptation and mitigation needs to be undertaken. The following sections provide a framework for actions around climate change adaptation and mitigation which are relevant within a local government city region context.

It is imperative that the planning and policy framework process be understood. The Climate Change Response Strategy is the overarching framework for climate change actions for the Ekurhuleni city region. The Environmental Resource Management (ERM) Department will in conjunction with this process engage with key departments and develop individual Climate Change Response Plans, which will start to highlight the effects and impacts that climate change will have on the particular departments sphere of work. The relevant department will be led through a process of understanding to highlight that planning around climate change needs to be done in conjunction with current planning processes to ensure that all risk are well covered. The Climate Change Departmental Response Plan will start the negotiation process between ERM and the relevant department and will determine the relevant actions that the department will commit to, these actions will be taken up in the Environmental Cooperative Agreements that are developed and signed by the Heads of Department. In some instance departments may require specific information on a particular action and ERM will then aid in development of Sustainability Benchmark Guidelines, attached as annexures to the climate change departmental response plans, to providing best practice methods.

ADAPTATION

DEFINE

Adaptation is the adjustments that society or ecosystems make to limit negative effects of climate change. It can also include taking advantage of opportunities that a changing climate provides.

Some co-benefits of adaptation:

- **Addressing physical risks to property, employees and communities**, with potential legal implications
- **Maintaining access to key resources** such as water and food
- **Maintaining or enhancing employee health and well-being**
- **Promoting sound infrastructure planning** in relation to the location and design of new developments
- **Minimising excess strain on existing municipal services**, including water management, disaster management and health services
- **Ensuring sustainable service delivery** to communities
• Supporting **stable environments for economic growth, investment and community development**
• **Improving local governance** and participatory decision making
• Supporting better **community resource management**
**ACTIONS**

1.1.1. Water sector

**Water monitoring**
- Monitor stream flow particularly for improved infrastructure planning and development
- Monitor water quality
- Improve the groundwater monitoring system
- Monitor the AMD

**Increase water storage capacity**
- Promote the use of rain water harvesting systems in households and businesses

**Water conservation**
- Conduct awareness and education campaigns for water conservation
- Encourage the use of water conservation technology e.g. low flush toilets, low flow shower heads
- Encourage rainwater harvesting for flushing toilets, car washing, and irrigation
- Identify water losses in the water supply system to the municipality and implement a programme of fixing leaks and other losses from the water supply chain
- Improve residential, industrial, commercial and shopping centre water usage by regulation of installation of low usage taps. Use incentives, and water-wise campaigns

**Improve flood/storm surge control**
- Maintain and upgrade stormwater infrastructure
- Consider permeable pavements, green roofs and rain tanks to increase on-site retention of storm water;
- Build retention dams to accommodate the overflow and assist with managing storm water;
- Promote the planting of indigenous trees around river banks to control runoff

**Water demand management**
- Implement Water Demand Management and Water Loss Strategies
- Monitor unlawful water use
- Support new technologies to utilize grey water and rain water

**Conserve and restore aquatic ecosystems**
- Preserve wetlands
- Protect and rehabilitate aquatic systems
- Implement policies that prevent development on wetlands
- Conduct awareness and education campaigns

**Climate monitoring**
- Develop links with water research institutes to ensure early preparation for extreme events (such as flooding);
- Maintain meteorological monitoring at the air quality monitoring station so as to provide additional climate data in the area
1.1.2. Agricultural

**Improve food security**
- Preserve agricultural land
- Promote food gardens in residential areas
- Support the Agricultural Hub activities
- Low income housing development should incorporate communal food gardens
- Protect and develop productivity of agriculture potential land through promotions and incentives

**Improve crop Management and yields**
- Promote the use of crops with higher heat tolerance, better WUE and shorter growing periods (e.g. cabbage, short season maize)
- Promote the use of crops which can take advantage of higher ambient CO2 conditions
- Promote diversification: mixed crops or mixed crop and livestock farming

**Improve control on flood water**
- Promote natural vegetation buffers along rivers on farms
- Decrease wind erosion and flood runoff by using belts of natural vegetation (not alien species)

**Improve Groundwater Management**
- Improve the groundwater monitoring system
- Investigate the long-term costs and benefits of groundwater extraction for irrigation purposes

**Improve water use efficiency**
- Promote the use of mulching and crop residues
- Increase efficiency and flexibility of irrigation

**Improve Sustainable farming**
- Promote crop rotation
- Promote the recycling of nutrients and energy on farms
- Promote conservation and climate smart agriculture by incentivising conversion through conditional subsidies and rebates
- Conduct an awareness campaign explaining conservation agriculture and the conversion steps

**Increase shading/ natural cooling**
- Promote planting of indigenous trees to improve shading or natural cooling
- Ensure there is an early warning system in place
- Provide early warnings of eminent disasters, particularly to vulnerable communities (link to Disaster Risk Management Adaptation Table)
### 1.1.3. Human health

#### Improve monitoring of health impacts
- Conduct public awareness campaigns on health risks due to increased temperatures and appropriate response actions
- Observe and monitor human health impacts relating to extreme events
- Monitor the incident and distribution of disease vectors

#### Reduce air pollution
- Adapt passive energy measures and non-polluting renewable energy sources to reduce air emissions from fuel combustion (links to next phase of project on mitigation strategies)

#### Improve health care services
- Maintain and upgrade all health care services to deal with heat related and vector-borne diseases
- Maintain health care emergency services

#### Increase resilience in rural areas
- Increase access to basic water and sanitation

### 1.1.4. Biodiversity and Ecosystems

#### Conservation of open areas and wetlands
- Promote the conservation of urban parks and open areas
- Identify further parks and protected areas, taking connectivity into account
- Use land-use planning provisions to prevent further fragmentation of protected areas so as to maintain connectivity between core biodiversity and ecosystem services areas
- Maintain corridors to facilitate dispersal and migration
- Identify habitats of significant value for consolidation through purchase or conservancies
- Protect grassland areas
- Protect wetlands

#### Rehabilitation of natural ecosystems
- Promote the planting of indigenous plant and tree species to green the urban and peri-urban areas (see Human Settlement Adaptation Table)
- Conduct alien eradication campaigns
- Conduct information and awareness campaigns to inform the public about alien species
- Rehabilitate degraded land such as landfill sites, riverine areas, Mine Residue Areas
- Restore and rehabilitate degraded wetlands
1.1.5. Human settlement

**Improve infrastructure**
- Promote rainwater harvesting water storage to slow water surges
- Maintain and upgrade stormwater infrastructure
- Maintain and improve natural barriers for storm water surges (such as wetlands in more rural areas, indigenous trees in urban areas)
- Promulgate by-laws related to green servitudes such as storm water management and open space guidelines
- Consider permeable pavements, green roofs and rain tanks to increase on-site retention of storm water
- Support new housing schemes which introduce innovative water conservation, water efficiency and sanitation measures, as well as energy efficient technologies

**Reduce heat island effect**
- Promote planting of indigenous trees in urban areas;
- Develop a formal process for evaluating green infrastructure
- Promote the reduction of radiation absorbance by buildings and pavements through the use of ‘cool’ building materials.
- Promote roof top gardens (including vegetable gardens)
- Protect open areas and parks in urban areas

**Improve landuse planning**
- Regulate and enforce sustainable land-use planning and spatial development

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1.1.6. Disaster risk and early warning

**Improve climate monitoring and early warning detection systems**
- Early warning system development to identify risks
- Monitor and record changes in temperature and the “urban heat island” phenomenon
- Conduct a detailed GIS mapping project to identify hazard and areas that are at risk

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1.1.7. Waste

**Improve waste collection**
- Maintain and improve infrastructure for waste collection
- Improve waste collection services in all areas

**Monitor landfills**
- Monitor landfill sites and ensure operators have licenses

**Improve use of urban plant and tree waste**
- Engage with waste collection companies and municipal park services to adapt their current practices for collecting and disposing of woody biomass
- Establish and support recycling and garden waste drop off centres
- Provide facilities for small entrepreneurs to collect and package woody bio-waste from central depots
Reduce and recycle waste

- Include recycling options into Integrated Waste Management Plan which is part of the Integrated Development Plan
- Require business and industry to produce recycling plans as part of their broader environmental strategy
- Implement registration of recyclers
- Promote recycling by providing suitable storage bins or facilities for different types of waste
- Support paper recycling pick-up (from offices and houses) programmes and paper banks at schools, offices, complexes
- Support recycling initiatives in the form of bylaws that facilitate the location, operation and use of these facilities
- Provide economic incentives to avoid, minimize and recycle
- Enforce sorting of waste at source
- Municipality should be mandated to use locally-produced recycled paper and to investigate the purchase of other recyclable items for use in municipal departments
- Promote composting of plant and food material
- Conduct public awareness campaigns in residential, commercial, industrial and shopping complexes
- Collect information on recycling material types and quantities for the municipality
- Support and develop waste collection cooperatives so that informal waste collectors can integrate, improve and regularize their operations
- Encourage waste avoidance through immaterialization of products and services through digitalization
- Promote and regulate reusable shopping bags, unpackaged products and packaging reuse
Mitigation

**Define**

Mitigation refers to any strategic intervention and/or anthropogenic action taken to remove the greenhouse gases (GHG) released into the atmosphere, or to reduce their amount, to reduce any risk and hazards of climate change to human life and environment. The reduction of emissions.

Some of the co-benefits of mitigating climate change:
- **Reduced air pollution** (and less strain on the local health sector) from efficiency gains and improved transport systems
- **Job creation**, especially in the development of public transport and renewable energy
- **Improved energy security** through energy efficiency and renewable energy
- **Financial savings** through energy conservation measures, particularly for municipal infrastructure

**Actions**

1.1.7.1. Energy sector

<table>
<thead>
<tr>
<th>Renewable energy supply (Energy Supply)</th>
<th>Develop a plan to subsidise the installation of solar systems for water heating in residential areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Collaborate with institutions doing research and innovation in renewable energies</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy efficiency</th>
<th>Conduct energy audits in all government facilities to monitor energy use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Implement awareness campaigns to sensitize users of government buildings on how to optimize energy efficient operation</td>
</tr>
<tr>
<td></td>
<td>If government buildings are old make recommendations for retrofitting</td>
</tr>
<tr>
<td></td>
<td>Install smart meters in all public buildings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water heating efficiency (Energy Efficiency)</th>
<th>Establish a task team to conduct audits of hot water use and geyser capacities in all public buildings (owned or rented)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engage with small and medium hospitality establishments to encourage group participation in Solar or heat pump procurements</td>
</tr>
<tr>
<td></td>
<td>Participate in public information campaigns around the economic and climate protection advantages of heat pumps</td>
</tr>
</tbody>
</table>

| Combined heat and power generation (Energy efficiency) | Promote the installation of co-generation plants in industry. (Issues could be addressed through Forums). |
| Energy efficient Lighting (Energy efficiency) | • Implement energy efficient lighting and smart controls in all government buildings  
• Install automated lighting control devices in all government buildings (administrative buildings, hospitals, clinics, schools)  
• Support initiatives to design, manufacture and market energy efficient lighting  
• Install energy efficient lighting in street lamps  
• Use motion sensors in areas that are not continuously occupied  
• Install energy saving light fixtures on high illumination trunk roads  
• Install energy efficient light bulbs in public areas  
• Install energy efficient light bulbs in traffic lights |
| Energy efficient Appliances (Energy efficiency) | • Procure office equipment that have certified energy conservation performance  
• Conduct public awareness campaigns on energy efficient appliances  
• Encourage innovation in designing smart-compatible appliances |
| Energy efficient transformers and motors (Energy efficiency) | • Promote the installation of energy efficient electric motors and transformers |
| Smart energy Controls (Energy efficiency) | • Install smart metering devices and public display  
• consoles to monitor energy consumption |

1.1.7.2. Transport sector improvement

Public Transport | • Ensure public safety for commuters  
• Development of an IRPTN network for EMM  
• Promote the use of public transport by increasing frequency and reliability (including rail)  
• Regulate and implement further preferential bus and taxi lanes  
• Work with other municipalities and GDARD to create financial policies allowing for integrated regional transportation ticketing across municipal boundaries and allow for mode switching  
• Refurbish and maintain railway stations and precincts  
• Ensure effective railway ticketing to ensure revenue collection  
• Promote the use of rail for heavy freight  
• Develop a Non-Motorised Transport Plan (NMTP) for EMM  
• Purchasing of Green Busses and Greening of EMM fleet  
• Identify and develop suitable park and ride facilities at key public transport interchanges  
• Identify Traffic free zones in EMM and bicycle/running lanes. |
### Industry and commerce

| GHG emission monitoring       | Implement reporting of GHG emissions by companies in the industrial sector |
| Emission reductions          | Incentivise cleaner production technologies by giving recognition to the relevant industries |
| Energy efficiency            | Promote the installation of energy efficient electric motors and transformers |
|                              | Promote new building standards that require all buildings to incorporate energy efficient measures |

### Infrastructure

| Densification and multifunctional landscapes | Promote development of high density and mixed development zones, with delineated areas to encourage the use of public transport |
| Energy efficient buildings                | Evaluate all government buildings for retrofit status, potential and requirements, then set priorities to implement such retrofitting where applicable |
|                                         | Address government procurement policies to add a “green” scoring into point system for awarding tenders for retrofitting and new buildings |
|                                         | Promulgate regulations that require implementation of energy efficient measures contained in SANS 204 standard for all new buildings and structural renovations of existing buildings |
|                                         | Enforce the new energy efficient components of building codes |
|                                         | All new subsidized housing must incorporate basic passive energy saving features e.g. north-facing orientation, ceiling insulation |
|                                         | Develop contract specifications for new buildings to incorporate energy performance over a defined period as a key deliverable of the contract |

| Waste-to-energy                  | Promote the utilization of methane from anaerobic digesters |
|                                  | Promote the adoption of waste-to-energy technologies |
|                                  | Provide incentives for power generation from waste |
|                                  | Support LFG flaring from small landfills where it is uneconomical to capture the gas |
|                                  | Promote biogas technology at WWTPs to enable self-sufficient energy supplies at these sites |
Energy efficiency in wastewater treatment

- Conduct an energy audit at all wastewater treatment plants
- Regular maintenance of pumps and motors
- Promote the use of high-efficiency motors
- Replace oversized motors with the correct size motors
- Introduce solar water pumping systems to suitable applications that only require pumping during the day
- Promote combined heat and power (CHP) generation
- Implement a variable speed drive programme for appropriate motor technology
- Install control mechanisms to control the speed of aerators
- Installation of automatic controls

CLIMATE CHANGE IMPLICATIONS FOR EKURHULENI

ENVIRONMENTAL DEGRADATION AND EFFECTS

In Southern Africa we are well aware of the weather events that can affect urban areas and informal settlements within the region. While droughts and floods have long been distinctive features of the climate of Southern Africa, the frequency and magnitude of these events, may change due to the effects of climate change (Engelbracht et al., 2009; Hewitson & Crane; 2006; New et al., 2006; and Muller, 2007). These are likely to increase vulnerability and risk for city dwellers (Satterthwaite et al., 2007). Communities that are already vulnerable to the effects of heavy rainfall events are likely to be worst affected by an increase in frequency and intensity of these events (Adger, 1996). The concentration of people in urban areas often exacerbates vulnerability (Bates et al., 2008). Scientists, both locally and internationally, are therefore increasingly exploring the possible links between climate change and climate variability.

Increased development of the region creates hard impenetrable surfaces, which increase the amount of runoff and thus the potential for flooding. Flooding risks are influenced by local factors such as topography, drainage, population distribution, infrastructure and rainfall (Douglas et al., 2008; Satterthwaite et al., 2007).

In 2009, a statistical analysis was conducted on historical weather data from the OR Tambo weather station. Significant trends were identified in the frequency and intensity of thunderstorms for 1960-2009. This preliminary assessment concurs with possible climate change projections that suggest that heavy rainfall events may become more frequent and intense (Fatti and Vogel, unpublished).
Southern Africa has a highly variable climate, particularly between droughts and floods (Reason et al. 2004). Information used for storm water drainage systems planning and infrastructure design depend on the historical range and averages in rainfall variability. An increase in intensity and frequency of storms is likely to have an effect on surface runoff and flooding as well as the spread of waterborne disease. Projected future changes in rainfall variability, thus need to be taken into account when designing infrastructure (Denault et al., 2006). For example, an increase in rainfall intensity requires an increase in storm water drain capacity which then reduces flooding (Bates et al., 2008). More extreme wet and dry cycles as projected for much of South Africa will require a far more in depth and planned response to disasters, water storage and provision, storm water design, road infrastructure development, development within dolomitic areas, etc. than is currently in place. Although total rainfall is likely to remain similar for parts of South Africa, the temporal distribution is likely to change and this will affect infrastructure and planning.

Global climate projections provide little practical guidance for city and regional planners as the projections give no insight into how climate changes will affect local scale climate, drainage or flooding (Denault et al., 2006). To minimise the risk of increased flooding, factors such as transport networks and storm water infrastructure need to be improved (Bates et al., 2008). The cost of these improvements is likely to be high, particularly in areas where infrastructure is already insufficient in dealing with current flood risks. Despite these costs, the benefits of anticipatory planning and development far outweigh the cost of repairing damage incurred by flooding events (Bates et al., 2008; Stern, 2008).

Another perceived impact is an increase of temperatures within the region. These increases are likely to increase the rate of evaporation, which means that more water will be lost through this means and it needs to be accounted for in the planning process. Further the demand on water provision will be higher during these events and this should also be significantly addressed in planning. Suggestions have been made to increase the use of underground reservoirs, as they are far less susceptible to water loss through evaporation. However, as we have seen in parts of the region, overuse of ground water resources will lead to inconsistencies in the geotechnical structure of the underline geology and result in sinkhole formation.

The redefining of the weather patterns within the region will have considerable impact on a number of sectors. For instance, the agricultural sector will have conditions which will be unfavourable for production. Thus the affect on food security within the region is a critical challenge. This will also be further hampered by global effects of climate change on food production and the increase economical value attributed to import/export cost related to food production.

The context of climate change within the Ekurhuleni city region means that significant efforts need to be made across all spheres within the organisational structure of our local government. The effect on the region is not solely isolated to disaster risk and management, but further exacerbated to the functioning of the region as an economic super force. The vision of the region to develop into Africa’s firsts Aerotropolis means that functioning and infrastructural fabric needs to cater for all aspects of “change” and be resilient to any change. As such Ekurhuleni has identified climate change and the possible impacts thereof as a paramount aspect of integrated planning within the region, which will be
incorporated and addressed into all strategic plans for the region. This will ensure that our communities, industries and businesses have the necessary support and assurance, in order to cater for all the requirements needed in functioning as resilient global citizens.

The following principles need to be applied with regards to Climate Change within Ekurhuleni:

**Identify and reduce impacts to climate change:**
- identify those sectors that may be vulnerable to the impacts of climate change e.g. energy intense industries, agriculture, human settlements;
- evaluate the risks associated with vulnerable sectors;
- ensure that the risk are minimized by enhancing disaster management programmes and effective mitigation and adaptation strategies for those sectors; and
- reduce risk to flash flooding by improving storm water management systems and rehabilitating/maintaining open areas to attenuate flood water.

**Reduce greenhouse gas emissions through:**
- the promotion of green technologies in the industry;
- reduction of methane from landfill sites and agricultural sector;
- the promotion of green building;
- the promotion of public transport; and
- the promotion of alternative energy production i.e. solar, wind, biogas etc.

**Improve energy efficiency through:**
- the promotion of green technologies in the industry;
- the promotion of green building, solar technologies and alternative energy; and
- the promotion of public transport.

**Improve water efficiency through:**
- the promotion of green building, rainwater collection of flood attenuation on-site;
- the better control of storm-water systems; and
- the promotion of water recycling technologies.

**Reduce waste:**
- Promotion of reduce, reuse and recycling methods in order to reduce waste at landfill sites; and
- promotion of waste exchange programme between industries, manufactures and businesses.

**Ekurhuleni’s key commitments**

As part of the delegation and input to COP17 Durban 2011, Ekurhuleni became a lead signatory to the Durban Adaptation Charter for local government. The charter looked at several key aspects of local government’s position with respect to climate change. As a signatory to the Durban Adaptation Charter, Ekurhuleni joined the international community in calling upon local and sub-national governments to commit and upscale action to accelerate their adaptation efforts by committing to the following:
1. **Mainstreaming adaptation as a key informant of all local government development planning**
2. **Understand climate risks through conducting impact and vulnerability assessments**
3. **Prepare and implement integrated, inclusive and long-term local adaptation strategies designed to reduce vulnerability**
4. **Ensure that adaptation strategies are aligned with mitigation strategies**
5. **Promote the use of adaptation that recognises the needs of vulnerable communities and ensures sustainable local economic development**
6. **Prioritise the role of functioning ecosystems as core municipal green infrastructure**
7. **Seek the creation of direct access to funding opportunities**
8. **To develop an acceptable, robust, transparent, measurable, reportable and verifiable (MRV) register**
9. **Promote multi-level and integrated governance and advocate for partnerships with sub-national and national governments on local climate action**
10. **Promote partnerships at all levels and city-to-city cooperation and knowledge exchange**

**Declaration**

In terms of the above focus areas, Ekurhuleni therefore undertakes to implement a strategy to fight against climate change, by:

- Adapting global objectives, defined by international negotiation and the scientific community
- Implementing a climate response plan for each key department, outlining concrete actions, in order to reach a local objective. The creation of this climate plan must begin with a detailed understanding of the department’s role and objectives.
- Regularly measuring and reporting reductions in emissions of greenhouse gases in order to assess and evaluate the efficiency of the climate plan’s actions, using truthful and reliable techniques;

**THE EKURHULENI+ CHALLENGE: A CULTURE OF SUSTAINABILITY**

**Recognising** that the perpetuation of the health and well-being of Ekurhuleni’s people is rooted in the health and well-being of our natural environment and economy.

**Understanding** that living in a changing environment requires balancing and integrating human needs and aspirations with the ability of our natural systems to be replenished and our quality of life is physically and spiritually linked to the land.

**Affirming** that we will increase our stewardship efforts, enhance them through synergies to be found with each other, and accept the responsibility to care for Ekurhuleni.

Further **affirming** that our journey to sustainability will be guided by respect for culture, diversity, beauty and history of our communities.

**Appreciating** the many government, private sector and community leaders across our region who are taking action to build a more sustainable and resilient Ekurhuleni.
**Representing** that the strength of our commitment as demonstrated in this partnership, both unprecedented and essential to Ekurhuleni’s future, by working together, we can and will reach a shared destination – an economy, environment and community worthy of future generations.

**Deceleration of Commitment**

We the Elected and Appointed Executives of the Ekurhuleni region jointly commit to build a more secure, sustainable and resilient future for Ekurhuleni and pledge to achieve the six targets of the Ekurhuleni+ Challenge by 2030, which include:

1. **Clean Energy:** 30 percent clean energy – a mix between renewables and energy efficiency
2. **Local Food:** Improve local food production and harness the agricultural potential of the region. At least 20 percent of the food consumed in the region is grown locally.
3. **Natural Resource Management:** Reverse the trend of natural resource loss by increasing freshwater security, watershed and wetlands protection, community based wetlands management, invasive species control and natural species restoration.
4. **Waste Reduction:** Reduce the solid waste stream prior to disposal by 50 percent through source reduction, recycling, bioconversion and landfill diversion methods.
5. **Smart Sustainable Communities:** Increase livability and resilience in the built environment through planning and implementation in all areas of local governance
6. **Green Workforce and Education:** Increase local green jobs and education to implement these targets

In order to implement the Ekurhuleni+ Challenge, we further agree to:

- Establish and expand our partnership between government agencies, non-profit organisations, private sector and local communities to promote and coordinated and integrated action.
- Share experiences, tools and techniques among Ekurhuleni’s officials, practitioners and community leaders.
- Increase long term financing mechanism for conservation and sustainability programs essential to reaching our 2030 targets
- Review and report progress to achieve the Ekurhuleni+ challenge annually to our respective legislative bodies.
**Human Health and Social Well Being**

Human health and social well being is a significant priority for Ekurhuleni. Cities impact on health in many ways. In the areas of the environment and health, problems of emission reduction, supply of clean drinking water, sewage and rubbish disposal, food security and poverty reduction are the most important. Vulnerability of the urban population to natural disasters and diseases, especially HIV/AIDS and atmospheric pollution has also been recognized. Although, data about pollution levels are fragmentary, the air and water quality in many cities threatens the health of millions of city residents (UNEP, 1994). The complex health challenges facing South Africans in general are compounded by poverty and poor living conditions. The unhealthy environment and overcrowded housing in the informal settlements expose the urban poor to high rates of infectious diseases such as pneumonia, tuberculosis and diarrhoea. Although it is clear that cities in the developing countries act as nodes through which development occur, it is important to note that rapid urbanization poses particular risks that affect sustainable livelihoods of millions of people. The effects of climate change will exacerbate factors that will increase the vulnerability of society. These factors may have direct effect e.g. risk attributed to disasters or indirect effect such as those that arise from food insecurity and depth of poverty. The commitment of Ekurhuleni is to ensure that region and society have greater resilience to these effects. It is imperative that there is adequate access to all necessary services. That the impacts of climate change associated with water scarcity, vector borne disease and disasters are appropriately planned for and that strategies address these are developed to ensure appropriate adaptation.

**Actions:**

1. **Ensure that all household within the region has access to clean and safe drinking water**
2. **Ensure that all household in the region have access to electricity**
3. **Identify alternative energy sources for cooking and heating within informal settlements to aid in improving the air quality and safety issues**
4. **Scale up disaster response plans to deal with food security issues, health pandemics, water shortages, heat waves, floods, droughts and vector borne and infectious diseases**
GREEN AND CLEAN ENERGY

Energy plays a crucial role when it comes to climate change, especially in South Africa where our emissions account for about 40% of Africa’s emissions and where SA produces 0.99 carbon emissions per unit of GDP compared to just 0.45 in OECD countries and 0.55 for all developed countries (UNEP, 2011). This means that just on energy alone there is a huge opportunity to mitigate climate change. To ensure that the issue of energy and climate change is addressed adequately, there must be an increase of funding with respect to renewable energy production projects and further a review of the SDBIP targets which are not adequately addressing the green economy and potentials within this sphere.

Although energy generation and supply is a systemic National issue to be governed this level, it is imperative that Ekurhuleni as local governments commits to identifying means to aid in clean energy and identifying technologies to reduce energy consumption. It is an aim of the municipality to reduce energy consumption within its internal operations by at least 25% over the next five years. This will be used as a catalyst to show the commitment of local government to energy efficiency. Our hope is that the strides of local government in this respect will spark local industries to participate and join efforts to ensure that the region is energy secure well into the future.

Actions:

1. Create inventory of all municipal energy consumption and reduce by 35% over 5 years and 50% over 10 years.
2. Put mechanism in place to reduce energy consumption within the region on household and commercial level.
3. Develop clean energy production mechanism (wind, solar, waste) within Ekurhuleni to supplement National supply
4. Design incentives and rebate programmes for industries and manufactures to become more energy efficient
**WATER FOR ALL**

Water is a shared resource and needs all the divisions and government departments to deal with a long term solution to have communities and cities living in a sustainable manner. The scarcity of water as a resource in the world may eventually lead to the doom of civilization. People of this earth need to take this topic very seriously so that we can protect humanity from the effects of climate change and must all have one goal, to “SAVE THE PLANET”.

Behavioural change is the cornerstone of Water Demand Management to ensure that the little water that is available is appropriately utilised so that future generations can benefit from that as well. Keep in mind that there is no other planet we inhabit except for this one. The concept of doing more with less should be operationalized “CONSUME LESS WATER”. It is therefore of utmost importance that Ekurhuleni focus and promote methods and techniques such as, rain water harvesting, flood attenuation, water recycling, grey water reuse and other similar initiatives. This will ensure that Ekurhuleni positions itself as a region with water security into an uncertain future.

The term “water quality” is used to describe the microbial, physical, chemical, toxological and radiological properties of water. All indications are that the water quality is deteriorating, mainly due to industrial pollution, treated waste water from sewage treatment plants and mining operations. Informal settlements near aquatic systems also exacerbate the problems, causing littering and dumping in river and stream beds. Poor stormwater management also impacts negatively on streams. Only a few of the stormwater control systems include retention ponds and pollution control litter traps. Regular stormwater management audits should be undertaken at construction sites, slimes dams, feedlots and livestock sheds. Regular clearing of dirt road shoulders, kerbs and drains could also alleviate the problem. A problem common to all areas is the degradation and erosion of stream and river banks. All sectors should be alerted to this problem. Loss of soil, loss of riparian vegetation, loss of aquatic habitats and loss of biodiversity should also be addressed. The ingress of polluted surface water into mines and the groundwater is also a potential significant problem that needs to be addressed further, as Acid Mine Drainage is already a serious consequential effect. (EMF, 2007)

The Water and Sanitation infrastructure construction methods should be done in such a manner that it is resilient and can withstand the effects of climate change i.e. flooding and increasing temperatures.

The past few years the city of Ekurhuleni has experienced high rainfall, which led to flooding, damages to the municipal infrastructure and private assets such as vehicles, homes and most heartening the loss of lives. Thus it is the commitment of Ekurhuleni that all departments should consider implementing green house gas emission reduction and climate proofing measures for infrastructure and municipal assets.

**Actions:**

1. **Improve and invest in infrastructure to reduce loss of water within the municipal supply system**

2. **Investigate means to reduce pollution and improve water quality within the region**
3. **Develop a rain water harvesting industry and design a programme for all residential, commercial and industrial customers**

4. **Identify and promote technologies to reuse grey water and recycle water**

5. **Increase investment in waste water treatment technologies to ensure stricter public health and that environmental disasters concerns are averted**

6. **Invest in research and development of ground water resources and identify means to ensure that this viable resources is adequately managed and equitably accessed within the region**
WASTE – MINIMISATION EFFORTS AND RECYCLING

Waste minimization involves efforts to minimize resource and energy use during manufacture. For the same commercial output, usually the fewer materials are used, the less waste is produced. Waste minimisation usually requires knowledge of the production process, cradle-to-grave analysis (the tracking of materials from their extraction to their return to earth) and detailed knowledge of the composition of the waste.

Recycling of used materials (waste) into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from landfiling) by reducing the need for "conventional" waste disposal, and lower greenhouse gas emissions as compared to virgin production. Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse, Recycle" waste hierarchy. The municipality is looking at putting together a proposal that will see waste separation at source. This will allow greater potential for recyclable material to be extracted and reused before it reaches the landfill site.

**Actions**

1. Develop recycling at source programmes for the municipal region
2. Assist with the development of a programme to remove organic waste from the waste stream at landfill sites
3. Investigate and develop clear policy to facilitate energy recovery from appropriate waste streams, ensuring that all programmes are registered for carbon-offset funding
AIR QUALITY AND GHG REDUCTION

A key commitment of the Ekurhuleni Metropolitan Municipality is improvement of ambient air quality and the reduction of GHG emissions within the region. The two largest contributing sectors to poor air quality are the industry and manufacturing sectors and the transportation sectors. The Air Quality legislation has strict controlling mechanism to ensure that these sectors adhere to an acceptable standard of emissions. It is thus imperative that the municipality impose these stricter controls, thus ensuring that the targets indicated below are achievable.

Sources that have been found to be significant in terms of their contributions to ambient air pollutant concentrations and associated health risks include:

1. Household - fuel burning – particularly coal and, to a lesser extent, wood burning. Household fuel burning is predicted to be a very significant contributor to fine particulate concentrations within densely populated areas.
2. Industrial and commercial fuel burning – particularly uncontrolled coal-fired boilers in close proximity to residential areas. These sources contribute significantly to ambient sulphur dioxide and PM10 concentrations.
3. Vehicle exhaust emissions – including both petrol and diesel vehicle emissions. Road traffic is the most significant source of NOx, CO and VOC emissions and is anticipated to contribute significantly to ozone formation. (NOx and VOCs are both important precursors of photochemical products.)
4. Johannesburg International Airport – despite contributing only a small fraction of the total emissions, the airport is a significant source of low level, concentrated NOx emissions. The airport is anticipated to contribute to NO2 guideline exceedances in the vicinity of the airport.
5. Unrehabilitated mine tailings impoundments – significant source of nuisance dustfall and potentially contribute significantly to airborne concentrations of fine particulates.
6. Large industries associated with various stack, vent and fugitive emissions. These industries were not adequately quantified during the baseline assessment due to the unavailability of current and comprehensive source and emissions data for such operations.

The air quality improvement targets outlined in the table below, are aligned with the National Outcomes targets. The percentages indicated below are based or interpreted on consistent compliance to ambient standards and frequency of exceedence. Improved or clean air is defined to be the air compliant to the ambient standard which in the rating of National Framework complies to Green indicator/colouring.

**Actions**

1. Update the GHG inventory for Ekurhuleni to identify all key emissions
2. Identify alternate sources of heating and cooking mechanism in informal settlements to ensure improvement in ambient air quality
3. To promote cleaner production and continuous improvement in best practice as it pertains to air pollution prevention and minimisation.

4. Impose stricter controls on industry and manufacturing to ensure that they compile to National legislation

5. Identify gaps in current Air Quality Management Plan and structured key objectives to achieve the targets below:

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<tr>
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<th>GDS 2012-2025</th>
<th>GDS 2025-2030</th>
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<tr>
<td>PM10/Particulate Matters targets/reduction 50%</td>
<td>PM10/Particulate Matters targets/reduction 90%</td>
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<tr>
<td>Oxides of Nitrogen (NO2-NOx) target 50%</td>
<td>Oxides of Nitrogen (NO2-NOx) target 90%</td>
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<td>Carbon monoxide target 60%</td>
<td>Sulphur dioxide target 80%</td>
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<td>Sulphur dioxide target 60%</td>
<td>Carbon monoxide target 80%</td>
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<tr>
<td>Ozone target 70%</td>
<td>Ozone target 90%</td>
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<tr>
<td>Carbon dioxide target 34% and related green house gases methane, CFCs etc</td>
<td>Carbon dioxide target 80% and related green house gases methane, CFCs etc</td>
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**Conservation of Biodiversity**

A large percentage of South Africa’s biodiversity is represented in this small area of the Gauteng province. The number of species per unit area is exceptionally high. This biodiversity is, however, threatened by high levels of industrial, economic and urban development activities.

Natural resources from wetlands are often central to the livelihoods of people and natural biodiversity. These resources include water for agricultural, industrial, mining and domestic use for both local and down stream users. At the same time, these wetlands and the resources that they supply are coming under increasing pressure (e.g. through extensive conversion to settlement and urban development). Ekurhuleni is renowned for the number of fresh water systems within our vast region. The fresh water pans, rivers and lakes within the region are landmarks of our geographic location and must be maintained as functioning ecosystems as they play a vital role in the regulation of water and the harboring of biodiversity.

The interactions of physical, biological and chemical components of a wetland, such as soils, water, plants and animals, enable the wetland to perform many vital functions, for example: water storage; storm protection and flood mitigation; shoreline stabilisation and erosion control; groundwater recharge (the movement of water from the wetland down into the underground aquifer); groundwater discharge (the movement of water upward to become surface water in a wetland); water purification through retention of nutrients, sediments, and pollutants; and stabilisation of local climate conditions,
particularly rainfall and temperature. In addition, wetlands have special attributes as part of the cultural heritage of humanity: they are related to religious and cosmological beliefs, constitute a source of aesthetic inspiration, provide wildlife sanctuaries, and form the basis of important local traditions.

The rationale is to ensure that the services we currently enjoy i.e. water purification, bird life and recreation is not hampered by the effects of climate change. While it is understood that these ecosystems are specifically vulnerable to the effects of temperature and rainfall changes, the exact effects are not clearly ascertainable. It is thus imperative that the wetlands and ecosystems within the region are recognized as an integral functional part of the biodiversity within the region, supporting and interacting with all life forms. Further, that these systems are rehabilitated, maintained and conserved. It is therefore the goal of Ekurhuleni to ensure that all wetlands within the region are resilient to the impacts of climate change and Ekurhuleni is committed to ensuring that the biodiversity supported within these regions are preserved and protected.

**Actions**

1. The protection of biodiversity in the open space system, creating the open space system as a formal conservancy
2. Align municipal development proposal for development of land surrounding the open space system to incorporate and take ownership of these areas and acting as stewards for these areas
3. Create a conservation unit for the metropolitan region to deal with protection of the sensitive environment and ensure that these area are rehabilitated and maintained
4. Align the EMM biodiversity conservation targets with that of the provincial (GDACE) and national (DEAT) targets
5. Develop the open space system within the region to address the needs of biodiversity and fulfil the recreational requirements of humans
6. Ensure that all municipal greening within the region is with indigenous plants and trees
7. Reduction of water use for greening by imposing environmental sensitive methods and technologies
8. Ensure that grass cutting is limited to areas of recreational use and that natural areas be maintained as such. Develop a programme to educate the community and sensitise them to the value of natural areas and the rationale behind not cutting the natural vegetation
MINING AND ITS LEGACY
The legacy of mining and poor past land use planning driven by mining as an imperative goal, has severely impacted upon the productivity of land and has rendered large areas unusable. Mining contributes only 2% to Ekurhuleni economy. However the implications and environmental degradation and costs for rehabilitation that mining scars the region with is much higher than the contribution to the region’s economy.

Mining in the areas has a significant impact on the quality (especially acidification) of groundwater as well on fluctuations of the water levels in the area. Inadequate information in this respect is available at this stage to make definite recommendations. There is a need to investigate the matter further and if the relevant information cannot be obtained from the Department of Minerals and Energy, extensive further studies may be necessary. The potential impact of radon gas emissions and the general toxicity of soils should be investigated where it is proposed to reuse old slimes dam sites before plans for the re-use of such areas are formulated.

A large number of the mines within Ekurhuleni are no longer operational and most of the mining footprint in the area is made up of mine tailings and waste dumps. Mining acts as a driver that exerts pressure on natural habitat and biological diversity, in the following ways:

- Open cast mining and quarrying, require the complete clearance of vegetation, they change surface topography and the drainage characteristics of soils (even when reasonable rehabilitation is implemented), leading to the loss of habitats and of populations of plant and animal species.
- Underground mining causes surface subsidence, which leads to land degradation. The sector encourages an influx of job seekers, with the same consequences as for human settlement pressures.
- Large volumes of bulk waste products, in the form of tailings and waste rock dumps, require large areas of land for disposal, leading to habitat destruction.
- Water falling on these waste disposal sites leaches toxic substances into the soil, seepage of which contaminates ground and surface water, leading to poor water quality. This causes changes in species composition and loss of natural indigenous riverine biota.
- Underground mining dewater aquifers and the excess water in the mines has to be pumped and disposed of into surface water bodies, thus increasing flows in such receiving water bodies. There are also water quality changes associated with mine water.
- Changes in water quality and quantity of surface and ground water exert pressure on the riparian vegetation and biota is dependent on the natural water bodies and wetlands. This leads to loss of biodiversity, changes in species composition and numbers and, where contamination or toxicity is severe, to physiological deformities and even mortalities. Changes in water quality resulting from contaminated run-off also increases the possibility of exotic invasion in wetlands.
Actions

1. **Initiatives to better control mining activities and address the rehabilitation of degraded mining areas**
2. **The need for co-operative governance with respect to mining**
3. **Explore ways to find to get the mine dumps and undermined land rehabilitated within the region.**
**GREEN ECONOMY**

The definition of a green economy is based on six main sectors:

1. Renewable energy (solar, wind, geothermal, biogas, and fuel cell)
2. Green buildings (green retrofits for energy and water efficiency, residential and commercial assessment; green products and materials)
3. Clean transportation (alternative fuels, public transit, hybrid and electric vehicles, car-sharing and car-pooling programs)
4. Water management (Water harvesting, greywater and rainwater systems, low-water landscaping, water purification, stormwater management)
5. Waste management (recycling, municipal solid waste salvage, brownfield land remediation, Superfund cleanup, sustainable packaging)
6. Land management (urban agriculture, habitat conservation and restoration; urban forestry and parks, reforestation and afforestation and soil stabilization)

Ekurhuleni aims at devising a strategic plan that will identify areas to link up with the National and Provincial programmes on the Green Economy and the spheres mentioned above. In order for the concept to be successful, Ekurhuleni understands that commitment from all spheres is necessary. A major priority is to ensure that there is access to job opportunities created within this sector and that Ekurhuleni empowers its youth to have the skills and access to those jobs.

As part of National commitments Ekurhuleni will look to local business in aiding them to devise a campaign which will actively promote retrofitting by companies and households to reduce energy use, especially in commercial buildings. Ekurhuleni will further look at undertaking a specific “lights-off after hours” campaign in buildings and workplaces and educate communities on the importance of energy efficiency.

**Actions**

1. **Identify a Green Job Strategy for the region which will look at funding mechanism and identify necessary skills that can be developed to aid in a green manufacturing sector**
2. **Ensure that the principles of a green economy is carried through all aspects of service delivery for the region**
3. **Develop a Green Economy policy for the municipality**
**Development of Green By-Laws and Imposing Green Building Principles**

Ekurhuleni has embarked on a study to revise the environmental by-laws within the region. The focus is to ensure that the governing legislation for the region is founded in principles sustainability. The new by-laws will look at imposing on the residents higher standards of energy and water efficiency, waste minimisation and recycling and transportation. The by-laws over time will make it a requirement of every resident and industry to retro-fit green technologies that will aid in meeting the National target for energy reduction.

A key area of concern for Ekurhuleni is the amount of energy and greenhouse gas emissions accounted for by the built environment. In some countries this accounts for 40% of total energy use. The adherence to green building principles will ensure that the new developments within the region adhere to the highest standards available and have the least reliance on energy and water. The concept of “green buildings” dictates that the design is to be energy and water efficient, use non hazardous materials and provide healthy productive environments. Green buildings can reduce their consumption of energy to less than half of what a conventional building does, with similar reductions in potable water usage, runoff to sewer and solid waste. This form of practices will reduce operating costs and further alleviate the demand on energy and water in an ever increasing populous.

**Actions**

The principles of green building that will be imposed on new developments through development guidelines and building control regulations will include the following aspects:

1. **Sustainable/durable/low maintenance building design and operation:**
   - Building must be sturdy and disaster resistant;
   - Design and build for long service life;
   - The building must be “future proof” – access channels all around the structure to easily upgrade and add future technology;
   - Capable of being “stand-alone” without connections to gas mains or electric utility.

2. **Energy efficiency and conservation:**
   - Work towards eliminating dependence on external sources of energy;

3. **Site/land management, reclamation and conservation:**

4. **Water efficiency, management and conservation:**

5. **Improved indoor air quality:**

6. **Improved outdoor air quality:**

7. **Material resource management, recycling and conservation:**
   - Maximum use of renewable building materials such as timber, thatch and wool;
   - Minimum use of non-renewable, energy intensive building materials like steel, brick, vinyl, aluminium;
   - Use materials found on site or close to the site;
   - Locally source materials and components in order to minimise transportation impacts and create local jobs;
   - Re-use of building materials and products.
CONCLUSION AND WAY FORWARD

The ultimate goal for Ekurhuleni is its evolution to a sustainable green city in which definitive use is made of available resources such as land, water and other natural resources. In this scenario the consumer / EMM resident will be well informed and educated in the need to preserve our natural resources in order to meet current as well as feature demands. They will require a level service in line herewith. The council policy will have to be amended and alternative methods of service delivery in line with National and International standards for Green technology and Green economy will have to be implemented (see recommended activities in the previous pages). The end result should lead to a functional and liveable, compact high density city in which a high level of recycling and re-use of resources are implemented creating a “circular metabolism” for the city.

Although cities are realizing the critical importance of acknowledging and integrating various sustainability principles into municipal planning spheres, it is evident that they will continue to face external shocks and stresses regardless. Rising energy prices, the rapid depletion of natural resources, carbon constraints, increasing urban populations and aging service delivery infrastructure contribute to the manner and the capacity of cities to pro-actively and effectively address sustainability. Cities face a myriad of potential future shocks—sudden, major breakdowns—and stresses—slow, insidious cracks. To meet these challenges, cities must become more resilient.

Climate change poses immediate and long-term challenges across a spectrum of development sectors. In this regard addressing the impacts and effects of climate change will require a holistic and integrated approach. Metropolitan Municipalities will play a critical role in strengthening social, biophysical and economic systems.

The promise of a greener, greater Ekurhuleni will only be met if we recognize the seriousness of the challenges before us and our responsibility to meet them. A comprehensive climate change strategy requires equal attention to both mitigating GHG emissions and building climate resilience. Together, our efforts to address climate change on both fronts will allow us to remain strong for many years to come.

Reducing the risks posed by climate change will not be achieved through a single plan or action—it must be achieved through an ongoing planning process that is responsive to the latest scientific information and a thorough understanding of the potential costs and benefits of our actions. Our strategy will remain flexible so it can be adapted to changing needs, but we are taking steps now that have tangible benefits today and will have even greater benefits as the climate changes.

The context of climate change within the Ekurhuleni city region means that significant efforts need to be made across all spheres within the organisational structure of our local government. The effect on the region is not solely isolated to disaster risk and management, but further exacerbated to the functioning of the region as an economic super force. To date, there has been little emphasis on the impact of climate change on municipal services in the day to day operation of the city. Climate change is seen as removed from the operational and implementation side of service delivery. Even within the strategic planning sphere climate change, although recognized to some extent, is not addressed through the
practical and direct impacts that will result from climate variables, thus impacting on service delivery and the contribution of service delivery. Climate change is not just an environmental issue and more importantly it is not an issue which should be addressed in isolation. The impacts of climate change and the varying parameters in which planning for these should occur, cut across all sectors and ultimately culminate in direct impacts on the city’s ability to deliver sustainable services. As such Ekurhuleni has identified climate change and the possible impacts thereof as a paramount aspect of integrated planning within the region, which will be incorporated and addressed into all strategic plans for the region. This will ensure that our communities, industries and businesses have the necessary support and assurance, in order to cater for all the requirements needed in functioning as resilient global citizens.