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Water Reconciliation Strategy Study for the Kwazulu Natal Coastal Metropolitan Areas

First Stage Strategy: Water Requirements

MAY 2008

SUBMITTED BY:

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WATER RECONCILIATION STRATEGY STUDY FOR THE KWAZULU-NATAL COASTAL METROPOLITAN AREAS

FIRST STAGE STRATEGY: WATER REQUIREMENTS

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FIRST STAGE STRATEGY: WATER REQUIREMENTS

EXECUTIVE SUMMARY

This report documents the approach, methodology, analysis techniques and outcomes of the research into the long-term water requirements forecasting for the KwaZulu-Natal (KZN) Metropolitan areas, located around the Mgeni System. The study area also included the coastal demand centers in the Mdloti, Mvoti and Lower Thukela systems.

The objectives of the work were as follows:

- *To develop a robust population and demographic model for the study area, to serve as a key data set for the demand and return flow model;*
- *To investigate the possible correlation between economic indicators and water demand, and to make provision for this in the scenario planning process;*
- *To develop a multi-sectoral, multi-variable modelling approach that would allow for meaningful scenario planning, ie. whereby known dynamics across the study area could be incorporated into the demand forecasting process; and*
- *To develop a set of water requirement projections to the year 2030 for the study area, for subsequent use in the water resources and infrastructural planning modules.*

Dr Jeff McCarthy undertook the population and demographic study and the following were key findings from his research:

- *Overall population growth projections for the study area :*

0.7% pa : best estimate

1% pa : high road

0.4% pa : low road

- *Key growth corridors*

N2, Durban – Stanger (best estimate growth rate, North) : 1.2% pa

N3, Durban – Pietermaritzburg (best estimate growth rate, West) : 0.9%pa

- *Existing population estimates for 2005 for the study area:*

Best estimate : 5.1 million

- *Total population estimates for 2030 for the study area:*

Low Road : 5.6 million

Best Estimate : 6.0 million

High Road : 6.5 million

The population and population growth rates were utilized in the demand and return flow model, which also included a significant amount of Geographic Information System (GIS) analysis of household counts, user categories, water billings data and population dis-aggregation data from the Ethekwini Water Services GIS.

*The model is a simple water balance, matching system input volume to consumptive use, real losses and effluent return flows. The GIS analysis enables the consumer demands and effluent return flows to be built-up from a geographic base that ensures the water balance is representative of the characteristics of each sub-region, and therefore of the whole study area once aggregated up. The household (or user) categories used are illustrated in **Table i**.*

Table i: Serviced housing categories

Serviced Housing Category	*Description*
Category 1	*Fully serviced houses on large erven (erven > 500 m^2)*
Category 2	*Fully serviced flats, townhouses or cluster homes*
Category 3	*Fully serviced houses on small erven (erven < 500 m^2)*
Category 4	*Small houses, RDP type houses and shanties with water connection, but no or minimal sewage service*
Category 5	*Informal houses services only by communal taps and no water borne sewage*
Category 6	*No service from any water distribution system*
Category 7	*Other/Miscellaneous (includes hostels, military camps, etc.)*

Forty four sewage drainage areas (catchments) in Ethekwini, as well as nine in Msunduzi, were included in the demand and return flow modeling. Household demands were calibrated against measured inflow volumes, while wastewater discharges were calibrated against know effluent inflow rates to the wastewater treatment works (WWTW).

*The area units used in the Demand and Return Flow Model were the sewage drainage areas (SDA's) and the model results for these were aggregated up into results for the sewage drainage areas for the wastewater treatment works (WWTW). The WWTW SDA's used in the study are presented in **Figure i**.*

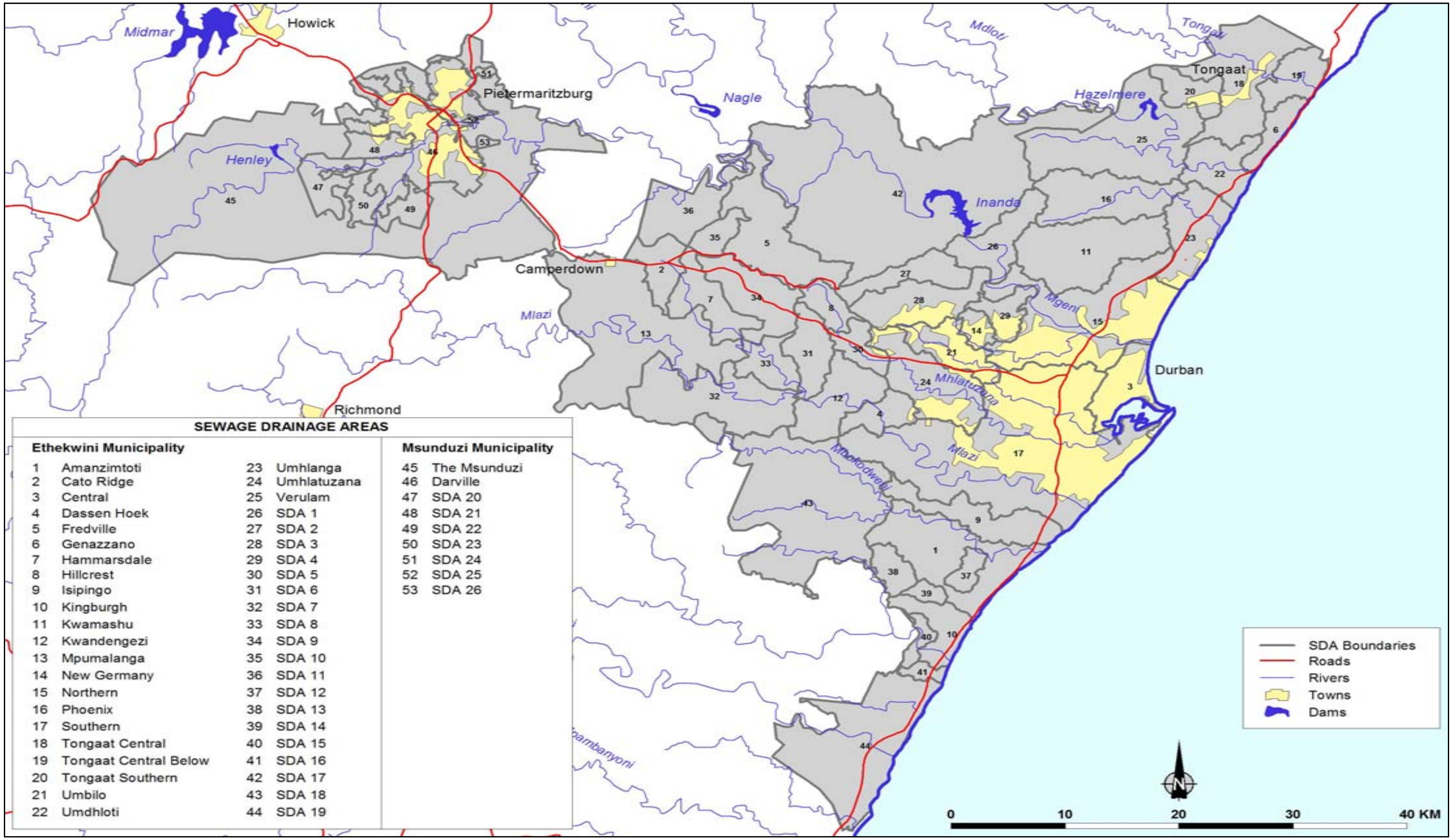

Figure i: Sewage Drainage Areas (Catchments) for the Wastewater Treatment Works

*The resultant outcome of the calibration against data from the 2006 year, were per capita consumption rates as illustrated in **Table ii**.*

Table ii: Unit consumption values for the major SDA's in the study area

SDA Name	*Unit Consumption (l/capita/day)*						
	CAT 1	*CAT 2*	*CAT 3*	*CAT 4*	*CAT 5*	*CAT 6*	*CAT 7*
SOUTHERN WORKS	*225*	*225*	*70*	*50*	*7*	*5*	*50*
CENTRAL	*320*	*320*	*170*	*80*	*15*	*10*	*80*
NORTHERN	*300*	*300*	*160*	*70*	*10*	*7*	*70*
KWA MASHU	*320*	*320*	*150*	*80*	*15*	*10*	*80*
PHOENIX	*360*	*360*	*250*	*180*	*150*	*30*	*130*
**DARVILL*	*390*	*390*	*240*	*140*	*55*	*25*	*140*

*Various water requirement scenarios were developed, allowing for migration from informal household types to formalised housing units, with their enhanced service levels, as well as area-based changes in industrial demands centered around the current airport site as well as around the King Shaka Airport site. The most important projections are presented in **Figure ii**.*

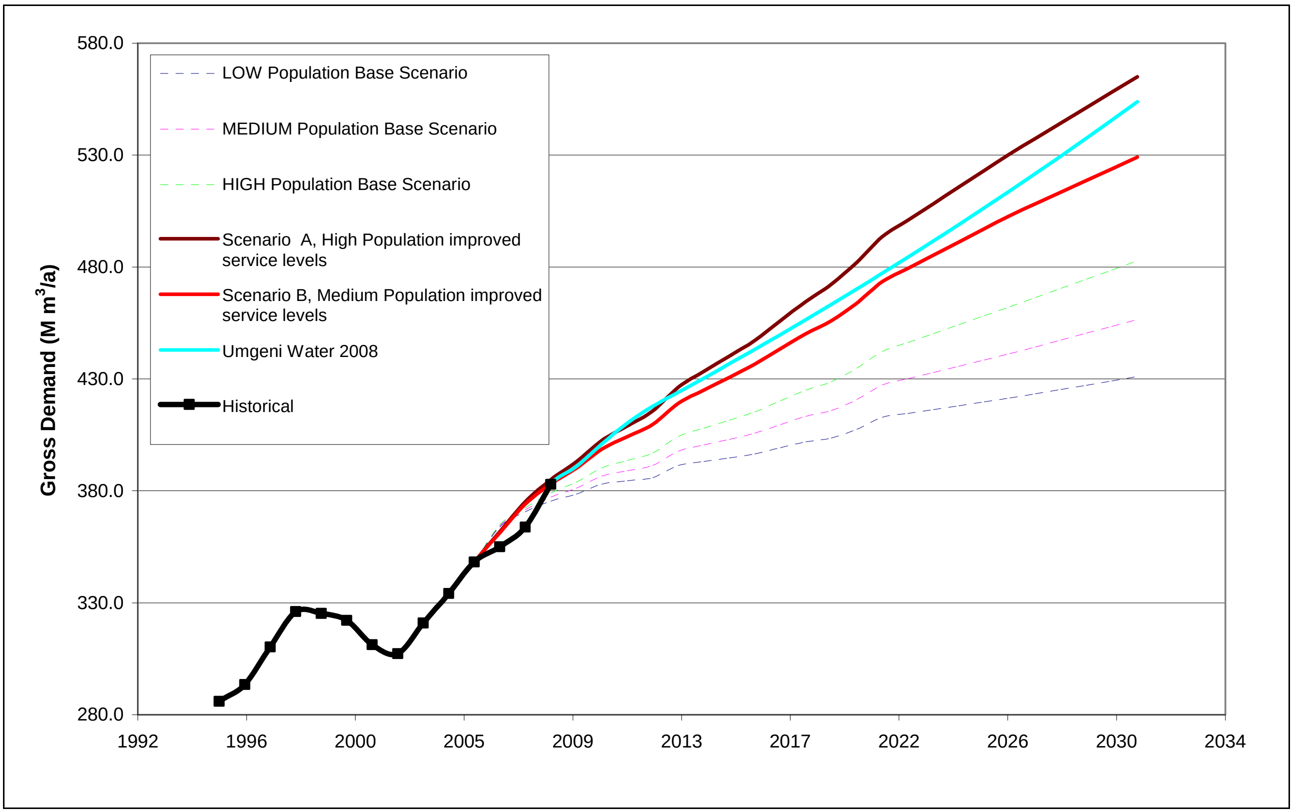

Figure ii: Summary of the Mgeni River System urban water requirement scenarios

The study concluded the following:

- *Domestic consumption comprises between 60% and 65% of the supply to Ethekwini and Msunduzi Municipalities;*
- *Overall water demand growth has been ±2.6% pa in Ethekwini since 2005, significantly exceeding the population growth rate;*
- *The biggest driver of water demand increases has been from the upgrading of service levels to the low income housing sector, rather than from the up-market housing projects.*
- *The high scenario projections for the Mgeni System including improved service levels show an increase from the current levels of ±380 million m^3/annum to ±565 million m^3/annum by 2030.*
- *The medium scenario projections for the Mgeni System including improved service levels show an increase from the current levels of ±380 million m^3/annum to 530 million m^3/annum by 2030.*
- *The low scenario projections for the Mgeni System show an increase from the current levels of ±380 million m^3/annum to ±430 million m^3/annum by 2030.*

- *The Mdloti system will come under most stress (relatively) in the period to 2014, during which time demands are forecast to more than double over current levels to ±35 million m^3/annum.*

- *The demand and return flow model was generally robust, although certain SDA correlation factors appeared unrealistic. However, their influence on the overall outcome of the demand projections was minimal.*

- *The 'per capita' consumption rates for the 7 housing categories necessary to achieve an acceptable calibration with the measure system input volume were similar to those determined on other water reconciliation strategy studies undertaken in South Africa. It must be noted that these rates are an equivalent 'system' demand per capita, and they thus appear relatively high.*

The recommendations focussed predominantly on issues to address in the re-modelling of the demands and return flows, suffice to say that the water requirements derived were suitable for further application in the subsequent modules of the study.

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Acronyms

ARV	Anti Retro Viral
DM	District Municipality
DWAF	Department of Water Affairs and Forestry
EWS	Ethekwini Water Services
GDP	Gross Domestic Product
IEC	Independent Electoral Commission
IWRP	Integrated Water Resources Planning
KZN	KwaZulu-Natal
LM	Local Municipality
MM	Metropolitan Municipality
NGO	Non-governmental Organisation
RDP	Reconstruction and Development Programme
SDA	Sewage Drainage Area
UKZN	University of Kwazulu-Natal
WDRFM	Water Demands and Return Flow Model
WC/WDM	Water Conservation and Demand Management
WMA	Water Management Agency
WSA	Water Services Authority
WSP	Water Services Provider
WWTW	Waste Water Treatment Works

Water Reconciliation Strategy Study for the KwaZulu-Natal Coastal Metropolitan Areas

First Stage Strategy: Water Requirements

1 INTRODUCTION

1.1 BACKGROUND

The imperative for the Department of Water Affairs and Forestry (DWAF) in the water reconciliation strategy studies being undertaken in key catchments and water supply systems in South Africa is the optimal use and development of the water resources, to ensure sustained water supply at reasonable rates of consumption to all user groups and communities. In order to achieve this imperative, a planning approach has been adopted to investigate system hydrology, water utilization, social and environmental factors, infrastructure requirements and resource allocation systems. The basis for the planning initiatives is a comprehensive understanding of the status quo and a sound understanding of the issues that will affect the future. In particular, the long-term water requirements presented in this report underpin the whole study, as the historic records present a view of the past and assist significantly in the development of the scenarios of future water requirements.

The South African economy is now inextricably linked to the global economy, *inter alia*, in terms of capital movements, human resources, market sentiments, and supply and demand of commodities such as oil, gold, coal and iron ore. This means that long-term planning initiatives need to take cognisance of these market forces – they can no longer be inward-focussed, traditional approaches that simple extrapolate past trends into the future. The past 24 years have seen South Africa move from a racially segregated society, battling through an intense ideological struggle and isolated from world economies (1984), through a remarkable political, social and economic revolution (1994), to being a respected emerging market, confronting a myriad of issues resulting from the inevitable vast disparity that exists between rich and poor (2008). In terms of structural, institutional and socio-political-economic factors it is therefore unlikely that the future will resemble the past in all respects and the development of scenarios should reference a range of variables and analyses of available data.

The long-term planning of water resource developments, regional water requirements and infrastructure is therefore a dynamic undertaking. The outcomes must also be reviewed at regular intervals to ensure that the proposals emanating from this planning process, are representative of current conditions and current prognoses for the future. It is this philosophy that has been adopted for the research and analysis undertaken in respect of the development of the long-term water requirements for the KwaZulu-Natal Coastal Metropolitan areas.

1.2 PURPOSE AND CONTEXT OF THIS REPORT

This report presents the findings relating to the determination of the long-term water requirement scenarios for the KwaZulu-Natal Coastal Metropolitan areas. The purpose of the report is to record the approach and methodology, water requirement modelling and study results such that a clear audit trail is possible for future review of all the supporting data, assumptions, analysis techniques and outcomes. The work is complex and empirical by nature and the report has therefore been compiled as succinctly as possible, enabling the reader to understand the processes followed, without being drawn into the complexities of GIS and demand and return flow modelling.

This report is one of a suite prepared by the Study Team for the KwaZulu-Natal Water Reconciliation Strategy Study. While to some degree a standalone document, it should be read in the context of the whole study and in conjunction with the reports on other aspects of the study.

The determination of the water requirement scenarios is fundamental to the assessment of the capacity of the water resources and infrastructure to meet these demands. For this reason, the results from this particular study have informed the bulk water and wastewater infrastructure planning module and provided a benchmark against which to review the firm yield determinations of the water resources.

1.3 STUDY AREA

The study area has been well documented in the supporting reports, but is recorded here to ensure reader is correctly informed of the area of jurisdiction of the study.

The study area extends from the Thukela River on the KwaZulu-Natal North Coast (predominantly the iLembe District Municipality), to the Mgeni System in the central zone (including the uMngeni, Msunduzi and Ethekwini Municipalities), to the Mkomazi River in the south. The study also accounts for the Mooi-Umgeni Transfer into Midmar Dam, as well as potable water transfers south from the Wiggins water treatment works to Umzinto in the Ugu District Municipality. The study area has been divided into two components, namely the total area from where water is sourced (Source Study Area) and the area to which water is supplied (Primary Study Area) as indicated in **Figure 1.1**.

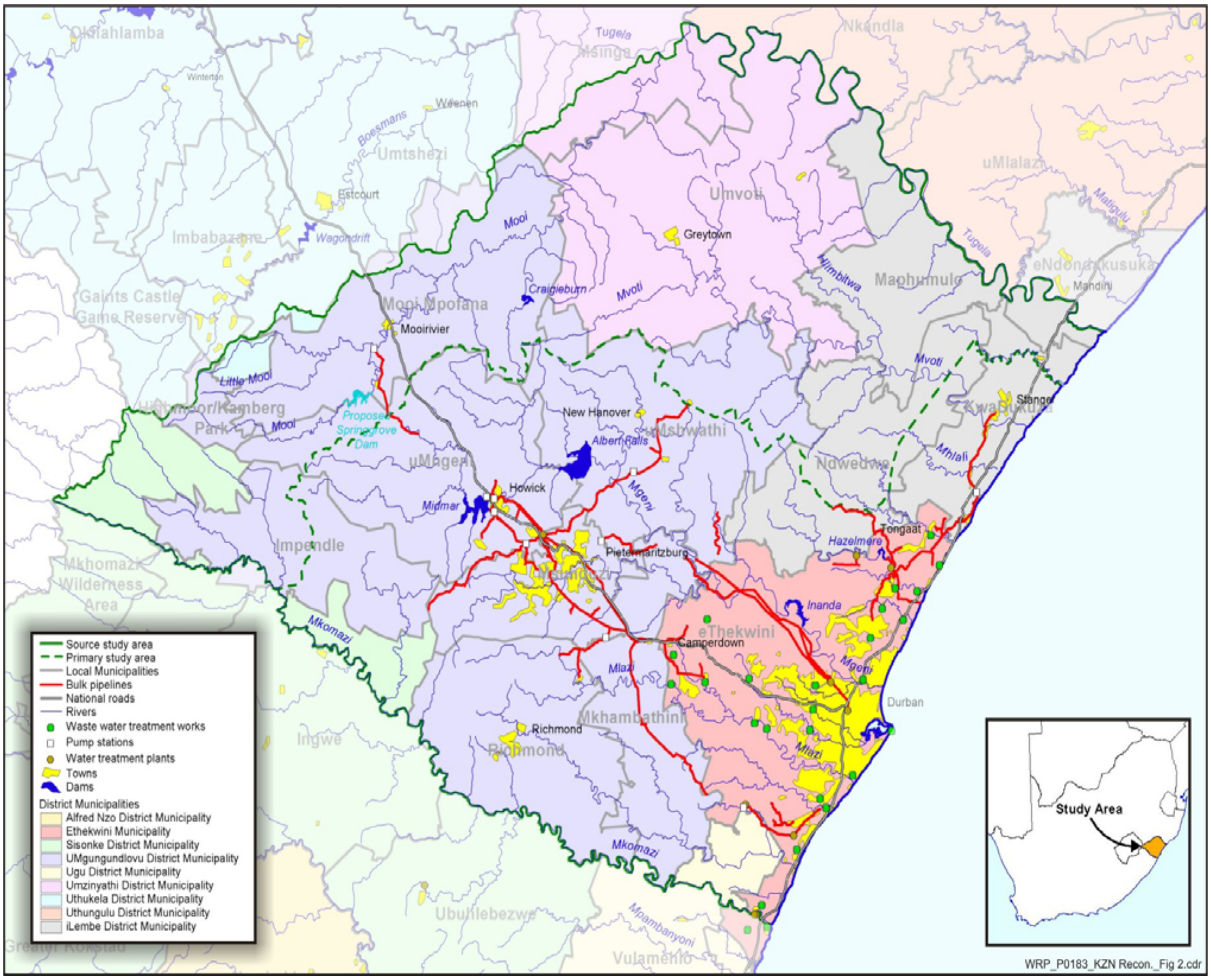

Figure 1.1: Study Area

In terms of the study area, the major focus in the determination of water requirements was on the Ethekwini Metropolitan Authority, Msunduzi Municipality, the coastal areas of the iLembe District Municipality and the relevant areas between Pietermaritzburg and Ethekwini under the jurisdiction of the Umgungundlovu District Municipality (eg. Mkhambathin Municipality around Cato Ridge and Camperdown). These areas are supplied primarily from the Mgeni, Mdloti and Thukela River systems and constitute over 95% of the total current demands. Cognizance was taken of the smaller demand centers like the uMngeni Municipality and the rural hinterland of the iLembe District Municipality.

2 STUDY OBJECTIVES

The objectives of the study were as follows:

- To develop a robust population and demographic model for the study area, to serve as a key data set for the demand and return flow model;
- To investigate the possible correlation between economic indicators and water demand, and to make provision for this in the scenario planning process;
- To develop a multi-sectoral, multi-variable modelling approach that would allow for meaningful scenario planning, ie. whereby known dynamics across the study area could be incorporated into the demand forecasting process; and
- To develop a set of water requirement projections to the year 2030 for the study area, for subsequent use in the water resources and infrastructural planning modules

3 APPROACH AND METHODOLOGY

The work was to be undertaken in the following tasks, *viz.*

- **Task 1a** : Assimilation and Review of Data
- **Task 2a** : Development of First Order Water Requirement Scenarios (2006-2030)
- **Task 3a** : Refine the Long-Term Water Requirement Scenarios (2001-2030)

A summary of the approach and methodology followed in the course of the tasks is provided in the following sections.

3.1 DATA ASSIMILATION AND REVIEW

The compilation of plausible, context-based, multi-variable water demand scenarios was key objective of the Water Reconciliation Strategy Study for the KwaZulu-Natal Coastal Metropolitan Areas. During the research for the Inception Report, an approach was been formulated that addressed five aspects critical to the water demand forecasting objectives in this study, viz.:

- Historic water demands and return flows;
- Urban development characteristics : historic and future
- Current population and demographic databases and their related projection models;
- National and local socio-economic indicators and their correlation with historic water demands and demographic trends; and

- Scenario-planning techniques, utilising the strategic foresight of representatives from the utility, agricultural, planning, industrial, commercial and public sectors to map-out a number of scenarios of water demand for the region.

In respect of these key areas of research, two specialists, *viz.* Dr. McCarthy and Mr. Coetzee, contributed to the compilation and content of this document.

Key Data and Stakeholders

Key stakeholders (ie. Ethekwini Water and Sanitation, Msunduzi Municipality, iLembe DM and Umgeni Water) were contacted in respect of the following data sets:

- Records of current and historic water demands;
- Methodologies used in previous water requirement projection scenarios;
- GIS databases in respect of land-use demarcation, sewerage catchments, potable water supply zones
- Population and demographic databases used in the course of their operations; and
- Socio-economic data used in the course of their operations.

Demographic Data

In terms of demographic data, a number of analyses have been undertaken for KwaZulu-Natal, using the 2001 Census as a basis. These are managed independently by, inter alia:

- The Ethekwini Municipality Transportation Authority (2004);
- The Corporate Policy Unit of Ethekwini Municipality;
- The Department of Provincial Local Government and Traditional Affairs;
- The Department of Water Affairs (from the Reference Framework initiative in 2006);
- The Premier's Office;
- The Department of Education; and
- Eskom.

The end objectives of these studies and the application of their findings differed from those of this project, but the work done in refining and enhancing the population data, including cross-checking it with the interim revisions published by Stats SA, was important to gain insight into actual growth rates in the region over the period from 2001-2006.

The work conducted by the DWAF Chief Directorate: Integrated Water Resources Planning (IWRP) (and specifically the work of Brendon Wolff-Piggot) on developing long-term population projection scenarios with a base year of 1995 was updated in 2007, with some major shifts in the approach to the analysis. Although the population projections for the country as a whole did not change significantly, the new work identified some major changes at local authority level. The update project also encountered major difficulties in the dis-aggregation of magisterial district level data to local authority level data. The IWRP update project has also run in parallel with the Stats SA population projection scenario work, and together, they form an important point of reference for all the water reconciliation strategy studies.

There have also been a number of post-census refinements, generally with a national focus as follows:

- The work of consulting company Global Insight for Ethekwini Municipality, including the review of General Growth Properties (GGP) and various socio-economic statistics;
- South African Revenue Services (SARS) data (at a local authority level only);
- State of the Cities report, undertaken by an non-govermantal organisation (NGO) headed by Andrew Borain;
- The work of the Bureau for Market Research, who have undertaken various surveys, including water bills issued by Local Authorities;
- The Demarcation Board; and
- The Independent Electoral Commission (IEC).

The results of all these studies were reviewed by Dr McCarthy in the development of the population and demographic data base for this study (**DWAF, 2007a**).

<u>Economic Data</u>

Mr Clive Coetzee from the Department of Economics (University of KwaZulu-Natal, Pietermaritzburg) compiles a quarterly economic review of the Ethekwini, Msunduzi and Mhlatuze (Richards Bay) Municipalities, including demographics and population forecasts. Data for variables such as the number of housing plans passed by municipalities, employment statistics, capital expenditure, business turnover, remuneration trends, interest rates, inflation data, property sales (numbers and values), rentals, retail activity trends at major retail centres, traffic counts and vehicle sales, etc. for the Pietermaritzburg, Durban and Richards Bay areas is analysed and reported on quarterly by the Department of Economics, University of KwaZulu-Natal, Pietermaritzburg. These were reviewed in the economic analyses undertaken in this study.

Allied to the population and socio-economic research, the urban and rural development characteristics for the region were considered when analysing the output of the population projection models. Current indicators show a marked increase in the number of housing units (nationally), as well as commercial developments, at a higher rate than the increase in population. The significance of understanding population migration characteristics has also been identified, emphasizing once again the importance of regional development and planning data.

In the study area specific to this project, all WSA's contracted with Umgeni Water are required to provide demand projections each year, according to the Bulk Supply Agreements. However, with the exception of Ethekwini Water Services (who currently submit a 12- and 18-month forecast annually), Umgeni Water undertake the water demand forecasting task on behalf of the WSA's,. There is therefore a comprehensive database of monthly Umgeni Water sales to the WSA's, as well as Umgeni Water's and Ethekwini Water Service's water demand projections. The Umgeni Water data comprises the abstractions from the Midmar, Nagle and Inanda Dams (Mgeni System) and the Hazelmere Dam (Mdloti System), as well as their sales of potable water to the WSA's (ie. Umgungundlovu DM, Msunduzi Municipality, Ethekwini Municipality, iLembe DM and Ugu DM).

In terms of GIS data sets, the Ethekwini Water and Sanitation data was used for analysing sewerage catchments, reservoir supply zone and land-use maps. The population data was not available at a ward level, but the Ethekwini Transport authority data was to be used for the dis-aggregation of population to the sewerage drainage catchments.

A number of other issues emerged in the research for the Inception Report and were considered in the analysis of the population projections, *viz.*

- The impacts of inward/outward migration;
- HIV/Aids;
- The marked rate of increase in housing, with much lower rates of increase in population;
- The time-lag in increase in water demands with urban expansion;
- The seasonal fluctuations in water demand due to the influx of tourists/visitors to the coastal resorts; and
- The growing influence of the N3 and N2 <u>corridors</u>, instead of particular <u>nodes</u>.

Reference to research undertaken of these issues supported the development of a comprehensive understanding of the data sets, approach and methodologies necessary for the development of rational scenarios for the medium- and long-term water demands in the study area.

3.2 DEVELOPMENT OF FIRST ORDER WATER REQUIREMENT SCENARIOS (2006-2030)

3.2.1 Approach: Overview

The approach to the development of the first order water requirements encompassed the following:

- The baseline year used was 2001, being the year of the last comprehensive national census;
- Consultation with key stakeholders to ensure that reference was made to the most recent data sets (population, demographics, historic water demands, land-use, urbanisation, socio-economic indicators, etc.);
- Analysis of current data in terms of previous projections, and the assessment of the degree of correlation. This improved levels of understanding of the trends in all historic records.
- Development of water demand scenarios, which included the views of key sectors and reflected realistic possibilities for the region, in terms of historic water demands and demographic, economic, geographic and climatological factors; and
- Use of an interactive model, developed on a framework of dis-aggregated population projections, water demand scenarios, progressive land-use demarcations and sewerage catchments. The model referenced population distribution and unit water demand rates for a range of land-use categories.

In line with modern planning techniques, a scenario planning approach to the water demand projections was proposed. This approach is significant from two perspectives, *viz.* that it considers more than one variable simultaneously, and that it determines a future state or condition according to conditions deemed to be prevailing at that time (ie. not based specifically on the current status quo). However, the scenario planning approach must be informed by data sets beyond simply historic water demands and return flows and population projections. Workshops were convened to include the insight and views of the key stakeholder groups. The scenario planning approach is discussed in more detail in subsequent paragraphs.

<u>Approach A: Population, Demographic and Land-use Analysis</u>

The approach adopted for the demographic, urban and regional development analyses was as follows:

1. It was assumed that demographic trends of the past will inform and influence those of the future, subject to certain known factors of change such as those influencing mortality, fertility and migration; and high, low and medium projections spatially disaggregated to Local Authority and Ward levels were developed on this basis. The STATS SA population projection scenario as previously used by DWAF constituted one of the basic or foundation

methods for making projections, although the data could be augmented by spatially disaggregated time series data available for the longer term (50 years) at magisterial district level, and for the shorter term (circa. 10 years) at the municipal Ward level.

2. The main deviations that might be expected from the ‘projectionist’ approach above were the significant new trends in the locality of jobs and homes in the decades to come, that differ from the characteristics of the past. There is now agreement that the N2/N3 highways and associated rail corridors are exerting as much influence upon the spatial distribution of growth in KZN as the previous nodal influences, and this needs to be factored into the scenarios. Their influence was assessed on combinations of insights derived from (i) provincial planning officials (ii) senior private developers and real estate agents (iii) senior private planning practitioners and (iv) closest available national and international precedent/s.

Approach B: Assessment of Relevant Economic Indicators and their use in Developing Water Requirement Projection Scenarios

It has become increasingly evident in the assessment of water demands and the development of future demand projections, that historic trends are insufficient and often inadequate predictors of future values. Current research in South Africa shows that economic indicators such as GGP, the number of new housing and commercial units built, job opportunities, income levels and regional housing development projects, can have a signficant impact on increasing water demands. The approach to this proposed component of the study was therefore as follows :

- Select the economic and socio-economic variables that, according to theory and experience, have a significant correlation with water demand;
- Selected the variables for use in the analyses;
- Data collection, verification of source and confidence levels, and analysis;
- Apply/run a mathematical model and determine the cross-correlation matrices for the selected variables,;
- Evaluate the model output and make appropriate changes if needed;
- Develop scenarios for each variable for application in the scenario planning phase.

The analysis would also give some indication of the significance value of the selected variables (as discussed earlier). Whereas population data has a direct correlation to baseline (lifeline) water demand, industrial and commercial triggers may be more significant and could be applied as such in the scenario planning models.

Approach in Respect of the Scenario Planning Process

It is internationally recognised now that the planning process for any business or operation has to account for complexity, uncertainty and rapid changes in the external environment. Conway (Swinburne University of Technology), has proposed that the failure of traditional strategic planning is due to a lack of "foresight capacity", ie. the capacity to develop and maintain a systematic view of the future (**Conway, 2004**). This implies that a range of issues and their future prognoses should be continuously monitored and evaluated, to guide strategy formulation, decision-making and implementation. It is also implicit therefore, that any strategy should incorporate options that are, in their own right, the result of systematic research of future possibilities, outcomes and impacts. Global events such as war, oil price changes, third world market perceptions and fluctuating commodities prices can have profound, immediate impacts on the local economies (not least that of South Africa) that require fundamental changes to any operating strategy that may have been formulated for an enterprise.

The scenario generation approach thus addresses these aspects of planning, and was informed by the data compilation and analysis work described in the previous sections, as well as the output from key stakeholder workshops. The critical component however, is that each data set will have researched "the future" and its prognoses – the data is not simply a projection of historic trends.

Conway has defined the planning process in **Figure 3.1**, termed the Strategic Foresight Framework, in which the 'Strategic thinking' modules address future possibilities and options.

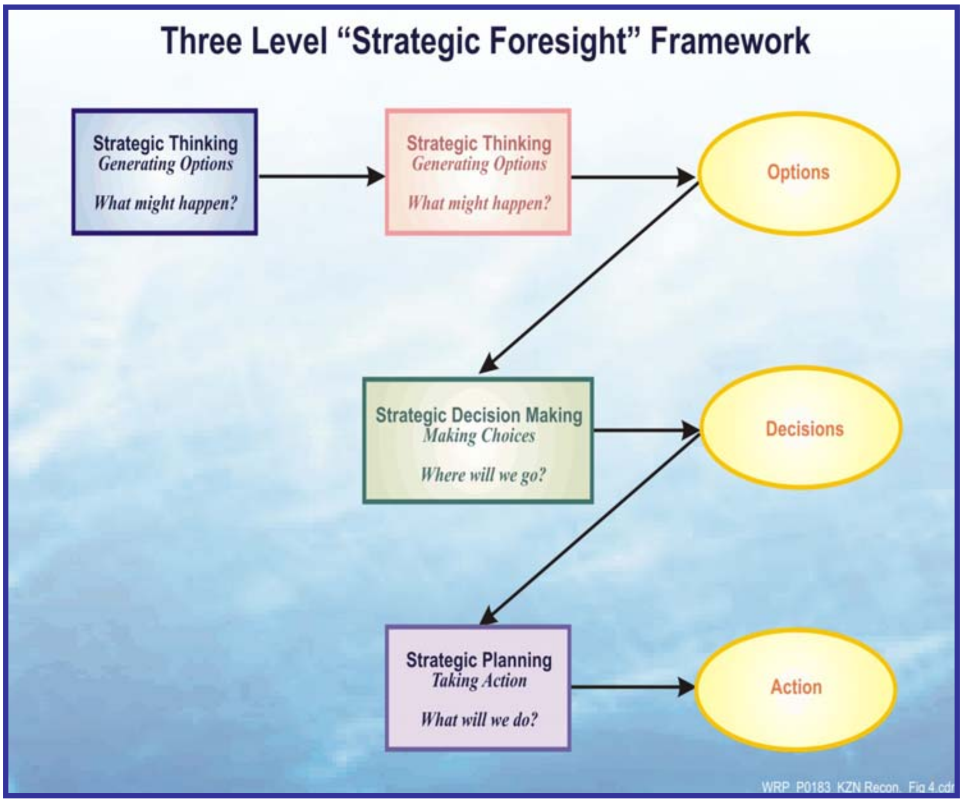

Figure 3.1: Strategic Foresight Framework (Conway, 2004)

The generic foresight process has been further described by Voros (**Voros, 2003**) to provide a framework for understanding how foresight contributes to the strategy formation and planning process. This is depicted in the **Figure 3.2**:

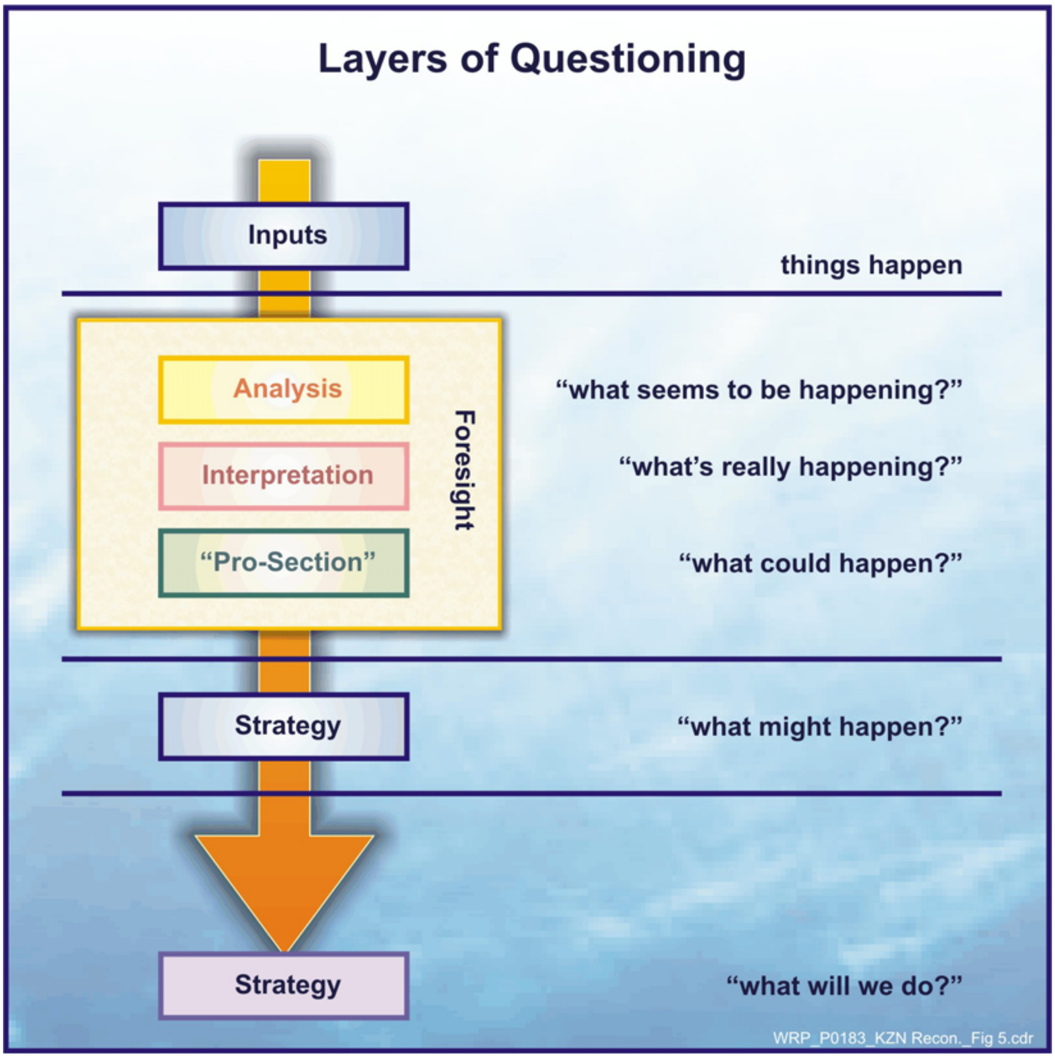

Figure 3.2: Strategy Formation and Planning Process (Voros, 2003)

This figure clearly emphasizes a multi-variable, systematic consideration of the present and future and how an understanding of these issues "plugs-in" to the "strategy". The development of a strategy to ensure that the future water requirements are met is not part of the scenario generation process *per* se, but is the overall objective of the study.

The overall Scenario Planning approach is best described in the **Figure 3.3**:

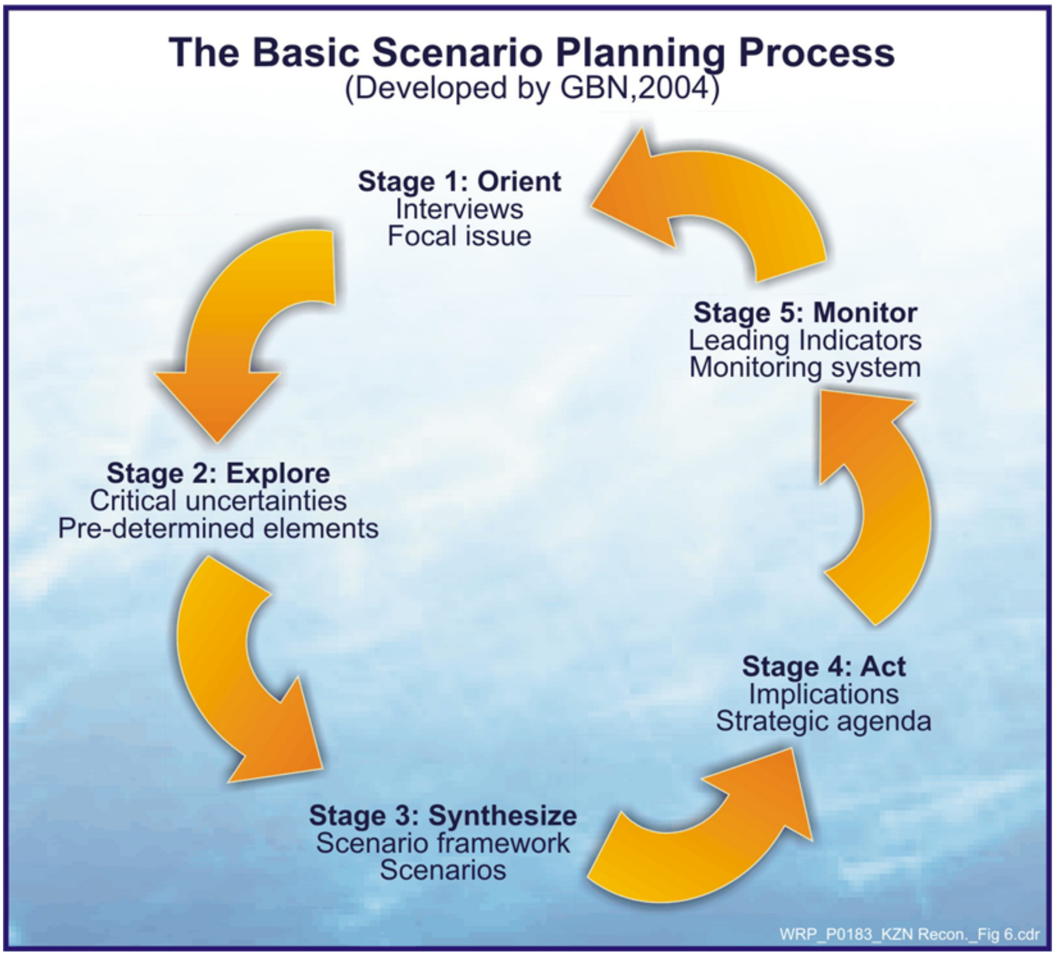

Figure 3.3: Overall Scenario Planning Process

In terms of this project, the approach defined above needs to be contextualised to achieve the required deliverables. This is discussed further in the methodology section, suffice to say that key stakeholders with sector interests in future scenarios of their own (eg. SAPPI and paper demand, Eskom and electricity demand, etc.) were represented in the workshops to ensure that the scenarios for future water requirements are not contradictory in their alignment with other sector positions. The principles as described above were adopted by the project team in preparing for the scenario workshop, to guide the planning of the discussions. In addition, the demographic studies undertaken by Prof. McCarthy included a number of sessions with the author of this report, where socio-political-economic scenarios for the study area were discussed.

Given the time horizon of the scenarios (ie. up to 2030) it was important to involve the potential Catchment Management Agency (CMA) Stakeholder Sectors in the Mvoti to Mzimkhulu WMA in the scenario generation process. It is these stakeholders who will develop the Catchment Management Strategies and Plans from at least 2010 onwards and it is important to align this reconciliation process with the future catchment management processes. The stakeholders will be the same, therefore buy-in, credibility, and governance (including enforcement of codes of conduct and allocations) will all be enhanced by involving the same inclusive group of stakeholder sectors.

3.2.2 Methodology: Overview

In order to retain focus within the following investigation modules, it was important that the framework within which the demographic, socio-economic and scenario planning work was undertaken was understood. Firstly, the demographic and socio-economic studies were integrated in the assessment of data for use in the water balance model. Secondly, both dealt with two components of the water requirements projections, ie. the direct demand (of the population / households) and the indirect demand of commerce, industry and agriculture. The relationship between these two components is variable and in some cases, complicated - there is considerable elasticity in water demand, responding to a myriad of variables, which needs to be synthesized and analysed. The demographic and economic analyses were important contributions to the workshops looking at the generation of water requirement scenarios.

Methodology A: Demographics

The methodology addressed the following :

- Consultation with DWAF (particularly the IWRM Directorate) and local and regional authorities about all relevant data sources;

- Compilation of all available data sources on demographic and urban and regional development trends for the study areas, providing for as much spatial dis-aggregation as is possible (at least to the level of the sewerage drainage areas (SDA's)), and the assessment of the strengths and weaknesses of these data. (A critical component of the scenario planning approach is to identify appropriate variables and to conduct a significance assessment of each. This assessed the range of value of each variable, its estimated impact and the integrity (inherent confidence level) of the baseline data.);

- Incorporation of the more reliable data sources into a common GIS system, and creation of overlays that allowed the data to be assimilated into spatial units (catchments, etc) that were of specific use in the water demand and return flow model;

- Generation of population projection scenarios for period 2006-2030 at yearly intervals (maximum interval of 5 years) for the spatial units defined by the model set-up, including the dis-aggregation by income group categories.

- Review of the proposed population projections in the context of the current STATS SA, DWAF IWRM, Provincial Government, Local Authority and Eskom projections;

- Presentation of results to the Scenario Planning workshop, and revision of the scenarios where necessary;

Methodology B : Economic Indicators

The study included a review of relevant literature, with specific focus on the relationship between economic indicators and water demand. The intention was to give direction to the selection of economic and socio-economic variables for the model, the forecasting techniques to be used and the appropriate testing of the models.

The literature reviews also made it possible to compare the results of the study with the results of other studies.

The analysis primarily made use of regression and time series techniques in the modelling process, utilising data specific to the region (eg. numbers of new houses built, gross geographic product, bulk sales of Umgeni Water) and national data (eg. Gross Domestic Product (GDP)).

The diagram below (**Figure 3.4**) graphically illustrates the methodology that was employed in the this study module.

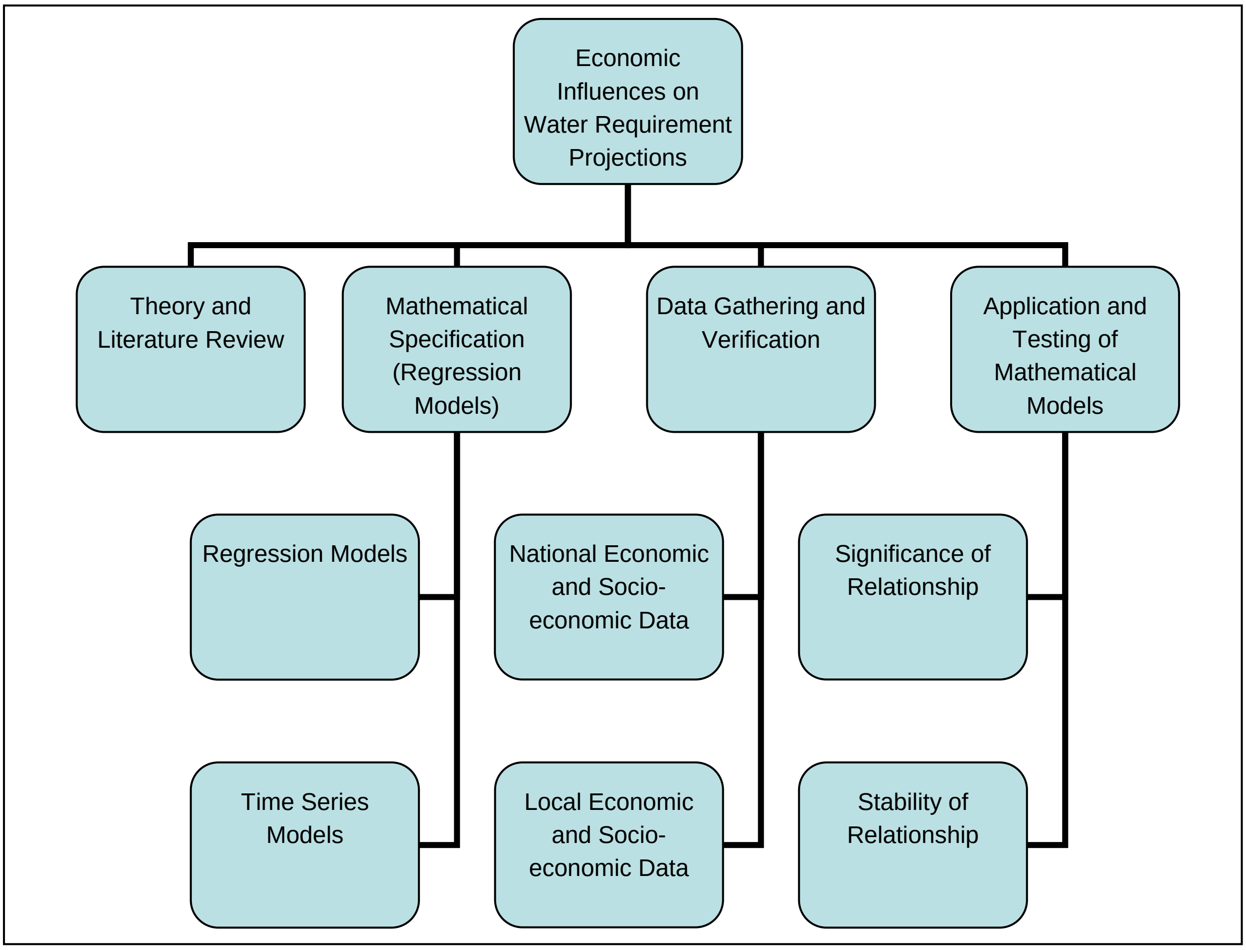

Figure 3.4: Economic Indicator Determination Methodology

It must be noted that both national economic and socio-economic variables (data) and local economic and socio-economic variables were used in the forecasting and estimation process.

In South Africa, data on national economic and socio-economics is readily available; however data on similar variables on a local level is almost always non existent or outdated. This study thus attempted to identify and test national economic and socio-economic variables that could be used as indicators of local water demand and consumption. The data was obtained from official sources like the Bureau for Market research, SA Reserve Bank and Statistics South Africa. This study also made use of local economic and socio-economic data bases (generated from local sources), to ensure that the local variances off national norms were accounted for. Some data was sourced from municipalities, e.g. number of consumers per user-category (as per the Vaal River Reconciliation Strategy Study) and the unit consumption per user category. This data will also be required for different time periods.

The study also made use of local data that had been generated during a similar study (regional energy demand forecasting) for Eskom.

Thus, the main aim of this component was to determine with an acceptable degree of certainty, the economic relationship between national and local economic indicators and regional water demands.

Methodology C: Scenario Planning

At the outset, it is noted that there are a range of specialist studies in this project looking at the utilisation of different resources (sea water and groundwater as well as inland surface runoff), interventions to reduce water demands and interventions to increase water-use efficiency. While issues such as water conservation and demand management have a critical role to play in the future, it was not the intention to debate them in the scenario planning workshop, as the prupose of the workshop was to develop scenarios for future direct and indirect water requirements, across all sectors. The Reconciliation Strategy will determine where the resources are developed, how the water is conveyed, treated and consumed (water-use efficiency) and what is done with the return flows.

In consultation with key sector stakeholders, a workshop was convened to develop the various scenarios for the study area, and the impact on population, demographics and ultimately, water demands. Sector specialists were consulted during this process, as well as representatives of the stakeholder group. The objective was to develop scenarios (eg. the high, middle and low road type) which reflect the future outcomes or possibilities for a range of variables, that all correlate realistically with each other. It is critical therefore that each scenario has an “audit trail” to its derivation, such that the output of a water demand curve for example can be re-analysed at a later date with new or updated data.

In simple terms, the study team presented their work on population and demographics, economic indicators and the review of historical water demand as a background to the workshop. The representatives at the workshop thereafter had the opportunity to comment on this output and debate the relationship of it to their sector outlook and scenarios. Salient issues considered in the scenario planning are therefore:

- Demographics, including all related issues of health (HIV Aids) and security
- Economics
    - Pricing and cross subsidization;
    - Economic viability of water trading (eg. previously disadvantaged agriculturalists to lease their entitlement to high value industrial & domestic users);
    - High & low economic growth (*cf.* work of Mr Coetzee and Eskom, Chambers of Business Durban & Pietermaritzburg, etc.), with reference to the national and local economic indicators modelled.
- National and global scenarios for issues such as the oil price, war in the Middle-East, and economic growth in China and the USA, and their impact on local industry (indirect water demand) and ultimately on local households (direct water demand). Sectors which play a major role in the local economy and which are running their own scenarios for future business prospects are, *inter alia*, electricity supply (Eskom), forestry, sugar, motor manufacturing cluster, tourism, freight and logistics, Durban harbour (new container depot), King Shaka Airport and the Dube Trade Port.
- Political factors:
    - Redistribution of land and water in terms of the National water Act;
    - Department of Agriculture scenarios for food production; food security; redress; irrigation "greening the province". (Consider the case of the Makhatini Flats irrigation on the uPhongola River.)
    - Estimates of scale of redress and where redress is going to come from in already over allocated catchments. Will it be from confiscation; trade; buy-outs; additional use from rivers & dams?

In endeavouring to achieve ownership of the scenarios by the catchment stakeholders, it was imperative that the scenario planning process embraced the direct and ongoing involvement of them. They will be responsible for using and communicating the scenarios throughout their organizations, and who, through the workshops, should contribute to the review of the scenarios.

The initial scenario workshop was a one-day event. This required up-front work in identifying the participants and ensuring that they were adequately informed of the objectives and format of the workshops.

The paragraphs above give a comprehensive description of the data compilation, data analysis, model development and predictive components of the water demand forecasting. The approach includes the input of key stakeholders, as their view of the future should not be in conflict with the planning of the water industry, and *vice versa*. Significant technical input was required to incorporate the output of the various analyses into the Water Demand and Return Flow model (WDRFM), which was developed for DWAF as part of the Crocodile (West) River Return Flow Assessment Study (**DWAF, 2004**). Running concurrently with the data analyses, was the reviewing of mapping and development of the sewerage drainage catchments, and alignment of these with the demographics, land-use, water-use assessments, etc.. In using the scenario planning approach for future water requirements, the aim was to move away from simple %-type growth scenarios and to use multi-variable inputs that are considered realistic and possible for the study area. The scenario planning approach will enable the outcomes from this project to be continuously assessed at time intervals in the future.

3.3 REFINING OF THE LONG-TERM WATER REQUIREMENT SCENARIOS (2006-2030)

As described in **Section 3.2**, a framework for the water requirements forecasting was developed which was based on demographic, economic, development and infrastructural variables. The issue of repeatability is critical to the approach and methodology adopted, enabling the ongoing review and refinement of the input data, analysis models and outcomes.

The strategy for the long-term forecasts may change the weighting factors for certain variables (eg. climate change impacts), but the underlying approach and methodology will remain the same. In the long-term forecasts, the impact of changing economic conditions can be as profound as the impact of drought cycles, so there will be more emphasis on the sensitivity of the scenarios to these factors. In addition, the long-term impact of water demand management interventions (eg. reducing water consumption practices at water-intensive industries) will have a much bigger impact in the long-term than the short-term and must be taken into consideration.

Health issues such as AIDS and TB also manifest more significantly in the long-term, and will need to be addressed.

Once all the additional inputs have been assessed (eg. issues requiring further investigation which may have been raised at the first workshop), a second workshop will be convened to consider the final water requirement scenarios for the period to 2030.

4 PREVIOUS AND CONCURRENT WATER DEMAND ESTIMATIONS

4.1 DWAF

The Department of Water Affairs and Forestry (DWAF) undertook a number of water resources studies of the Umgeni, Mlazi, Lovu and Mdloti river systems in the early nineties. The focus of this work was on developing baseline hydrology records and undertaking the system yield analyses for a number of target water demands. Subsequent, more detailed system yield analyses of various inter-basin transfer options were led by Umgeni Water, utilising a range of target demands.

Water requirement forecasting followed a linear, trend-based approach.

4.2 UMGENI WATER

Umgeni Water has been at the forefront of the water requirement forecasting in the study area since their inception. This was borne out of necessity as the only bulk water services provider in the region and their largely autonomous role prior to the promulgation of the Water Services Act in 1997 (Act 108 of 1997). The Water Services Act re-defined the roles of the metropolitan (eg. Ethekwini Municipality), district (eg. iLembe District Municipality) and certain local municipalities (eg. Msunduzi Municipality), as Water Services Authorities. In terms of the Water Services Act, Umgeni Water is a Water Service Provider (WSP) responsible for supplying bulk water to its customers in terms of the water requirement forecasts presented to them. In practice, Umgeni Water managed the water demand forecasting process, in discussion with the Local Authorities.

The process was based on customer projections, customer consultation, the review of trends from the historic records and experience. Umgeni Water also undertook a number of detailed analyses of development projects in the region and the impact of them on demands and the timing of infrastructure augmentation.

The trend-based projections provided a guide to consultation, but is limited in that it in effect only references one variable, that being the historical record. In addition, the impact of reducing water demands through proposed interventions by the Local Authorities had to be accounted for at face value. This led to significant under-estimations of actual demands, as the target reductions and estimated increases were not realised (refer to **Figure 4.1**).

Umgeni Water has recognised these short-comings and has expressed interest in the possibility and practicalities of using a multi-variable approach to water requirement forecasting.

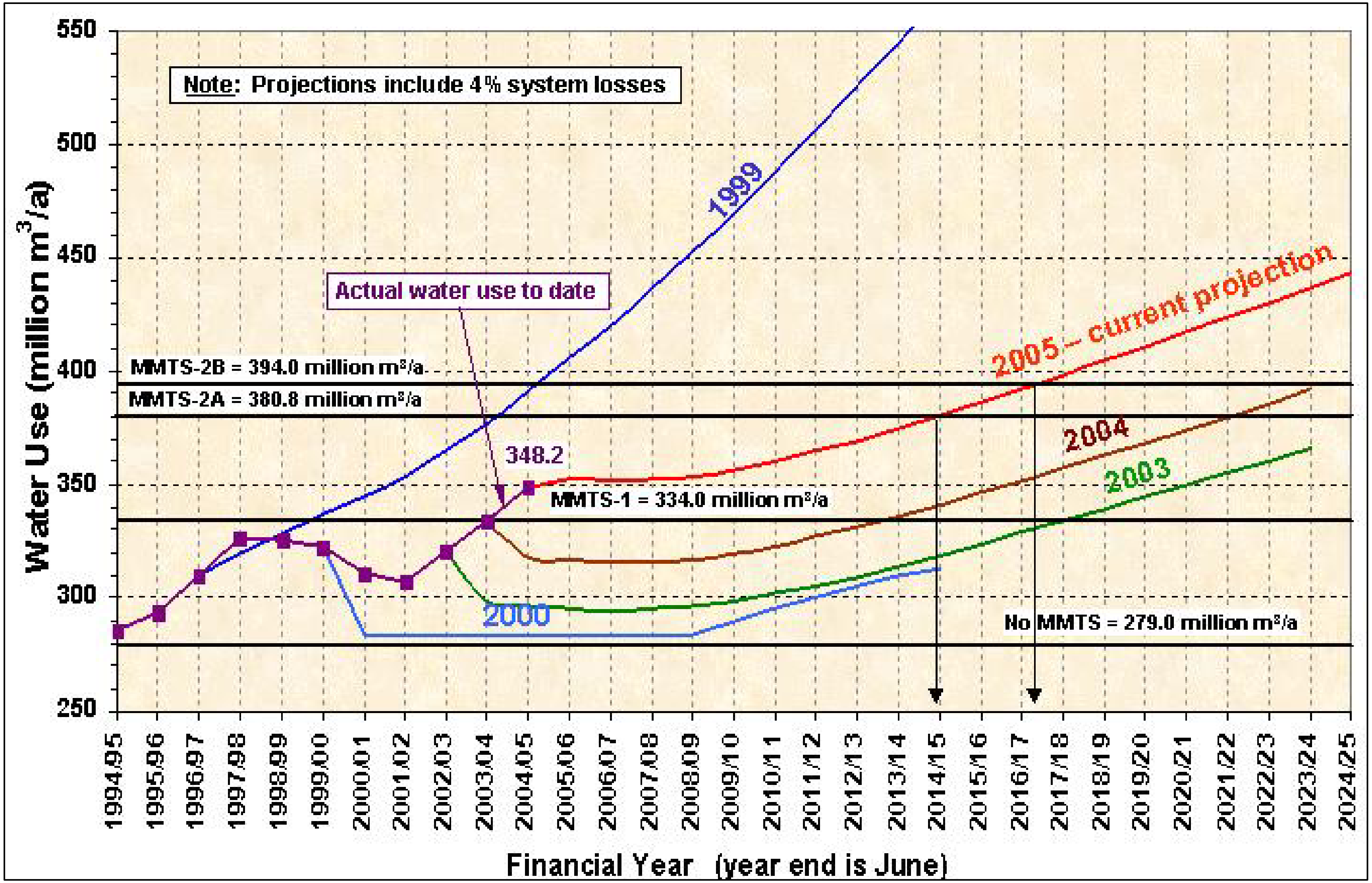

Figure 4.1: Mgeni System "Medium" water use projections (current and historic) and 1:100 year stochastic system yields (July 2005 update)

4.3 ETHEKWINI WATER SERVICES

In accordance with the bulk service provider contract with Umgeni Water, Ethekwini Water Services (EWS) are required to submit their water demand forecasts for a 12- and 18-month window to Umgeni Water by October each year. Prior to 2005, a consultative approach had been facilitated by Umgeni Water, utilising the Umgeni Water demand-trends model and insight from EWS on the net effect of new demands and demand reduction initiatives.

EWS commenced a new approach to water demand forecasting in September 2005 which sought to identify specific, area-based demand triggers, as well as to evaluate water conservation and demand management interventions on the basis of measured results.

The results of this approach have brought a degree of stability and realism to the forecasts, although there remain factors to address in what is a very dynamic economic and development environment.

4.4 ILEMBE DISTRICT MUNICIPALITY

The Ilembe District Municipality (DM) is important to mention here due to the extreme pressure being placed on water resources and supply infrastructure within the municipality. The decision to proceed with the King Shaka Airport near Tongaat has triggered a number of developments in the region, primarily industrial and commercial, although interest in residential developments has also increased. There is also increased economic activity in KwaDukuza and increasing numbers of people taking up residency in Ballito and commuting to work in Durban. In terms of high-end consumers, the Siza Water supply concession has therefore experienced significant increases in water demand growth.

The iLembe DM therefore commissioned a review of their bulk water supply and sanitation masterplan, to augment the quantification of the services backlogs in the municipality (**DWAF, 2007b**).

The approach adopted for the water requirement projections was based on the Census population data, assumed population growth rates and assumed per capita consumption rates. This data was used largely for the Mvoti and Thukela supply systems, while the detailed development planning database compiled by Umgeni Water was used for the Ilembe DM areas supplied from Hazelmere Dam on the Mdloti River.

5 ANALYSIS OF POPULATION GROWTH, DEMOGRAPHICS AND ECONOMIC INDICATORS

5.1 BACKGROUND

It became apparent in the research for the Water Requirements module of this project that additional specialist were required in respect of two aspects, *viz.* population and demographics, and the analysis of economic indicators impacting on water requirements. The development of water requirement scenarios for the period to 2030 was dependent on sound demographic data and the work of Dr Jeff McCarthy on the Census data for KZN and his intimate knowledge of the sub-regional dynamics and development planning, made him a key specialist for the project team. Primarily, Dr McCarthy's objective was to develop a high, middle and low-road population projection for the whole study area, but distinctly disaggregated down to the primary systems or supply nodes in the system, ie. those areas supplied from the existing water treatment works, ie. Midmar, DV Harris, Durban Heights, Wiggins, Amanzimtoti, Ogunjini, Hazelmere, Tongaat, and KwaDukuza (Stanger).

The idea of researching the relationship between socio-economic indicators and water demands stemmed from the multi-variable approach to the forecasting and the need to ascertain if there was a strong correlation between water demands and the state of the economy. Mr Clive Coetzee from the School of Economics, University of KwaZulu-Natal (Pietermaritzburg Campus) was contracted to undertake this research.

5.2 POPULATION GROWTH AND DEMOGRAPHIC ANALAYSIS

Factors Influencing The Population Projections

In terms of the most recent evidence of all, the StatsSA July 2007 Mid-Year Estimates seem plausible – indicating the KZN total population at very near to 10 million in 2007 which in turn suggests very slow, population growth from the 1996 and 2001 Census estimates of 8.3 million and 9.4 million respectively. There are several reasons for this. StatsSA July 2007 update shows the SA population growth rate as a whole declining from 1.25% pa in 2001 to 0,97% pa in 2006 – and if projected forwards this suggests a national population steady state by 2014. Moreover, StasSA July 2007 update shows KZN is declining fastest (mainly due to the very high HIV rate). Also fertility rates are declining at about 10% over five years; and life expectancy in KZN between 2001-2006 is projected by the July 2007 StatsSA update at 47 yrs; and for 2006 -2011 45 yrs (compare this to W.Cape equivalents of 67 yrs, and 64 yrs to see how pronounced the AIDS impact is here). The implied very low natural population growth projected for eThekwini is corroborated by declining occupancy rates of houses/dwelling here (i.e. declining numbers of persons per dwelling over time). This has a profound bearing on the fundamental 'human need' component of water demand in the study area.

In terms of the prognosis for the future, it is assumed that the recent historic trends (from 2001) will be repeated, ie. that eThekwini will absorb about one third of provincial population growth, and the rest of the study area an additional 17% to make up half of provincial total; but all of this within the context of slowing population growth provincially to steady state by at least 2014 (the national scenario) and probably sooner (because of high HIV rates in KZN).

However it is not just AIDS, but also relatively slow economic growth in the province which will likely lead to there being comparatively slow population growth in the future. Indeed, the signs of KZN's potential economic growth slowness in the future were already there in the past when the various national metros were compared for economic growth for the last industrial inter-censual interval - eThekwini's recorded economic growth rate was below Cape Town and the East Rand (Ekurhuleni) for example.

Moreover, following the census, eThekwini had the slowest recorded 1996-2001 inter-censual population growth of all the major SA metros.

This analysis of the StatsSA data was viewed against the data published in the report "ETHEKWINI DEMOGRAPHIC PROJECTIONS" for the Ethekwini Transport Authority in August 2004 by Stephen Kramer of Aidsintelligence. This work highlighted and accounted for the significant influence on inward migration into the Ethekiwini Municipality from hinterland towns and rural areas, as well as the impact of Anti Retro Virals (ARV's) on reducing AIDS mortality rates.

According to Kramer/eThekwini:

"The population of Ethekwini is expected to grow by just over 1% per annum over the next 26 years. This growth takes place against a backdrop of decreasing fertility, rapid inward migration from rural Kwa-Zulu Natal, and mortality that is affected by HIV and will fluctuate depending on access to anti-retroviral therapy."

Dr McCarthy suggested that the declining population in the rural areas, will limit the extent of inward migration. Dr McCarthy has also countered the emphasis on the north and central areas for growth by highlighting the influence of the N3 corridor on population growth in the west.

Population Projection Scenarios

The essence of the low, high and middle road population projections for the Study Area are suggested here to be:

- Low Road – Zimbabwe style political and economic decline, and AIDS projections for the entire period based upon current trends to 2030 – resulting probable absolute declines in population numbers and possibly even declines in water consumption. Demographically, this scenario is still a growth scenario, about a 40% margin below our median growth projections for 2030.

- High Road - HIV solutions involving full, subsidized anti-retroviral rollouts, and an economy growing strongly especially in the metros, based perhaps on a continued global commodities boom which also accelerates local production, consumption and affordability of ARVs. This scenario is projected as 40% above our median projections for 2030.

- Middle Road scenario – this would be somewhat lower than the Kramer/eThekwini "best estimate'', partly because a reduction in the expected migration rates from the hinterland, and partly because we are assuming a larger study area than eThekwini, which includes parts of KZN which have recent histories of static to negative population growth (e.g. Ndwedwe, Maphumulo).

In terms of geographic distribution, the future will not be entirely like the past, as eThekwini planners amongst others recognize. Historically, from the sixties to nineties the central and inner west and south were the strongest growth performers. More recently (the last ten years), eThekwini's outer west and north have moved faster than its centre and south in rates of both economic and population growth (for different reasons in each case); and Msundusi/Pietermarizburg and KwaDukuza/Ballito have each boomed.

It is assumed that the national and international access afforded to the north coast by the new international airport will further bias economic and population growth northwards within the study area, and significantly over historical performance levels – especially in KwaDukuza (although this is more debateable in northern eThekwini where the airport itself and its noise zones may curtail residential growth). Elsewhere, it is assumed the future will be somewhat like the recent past. More specifically, for purposes of geographic allocation/projection we assume initially four sub-regions (**Figure 5.1**), which comprise:

- **Inner** - approximately incorporating Umhlanga, Durban North, KwaMashu, Pinetown, Bellair Rossburgh, Chatsworth, Mobeni (low 0% p.a. growth; middle 0,2% p.a. growth; high 0,4% p.a. growth)

- **South** - South of Mobeni including Umlazi, Amanzimtoti, Illovo, Mgababa, Umkomaas (low 0,2% p.a. growth; middle 0,4% p.a. growth; high 0,6% p.a. growth)

- **North** - including Umdloti and northwards including Pheonix, Inanda, Verulam, Tongaat, and KwaDukuza (low 0,8% p.a. growth; middle 1,2% p.a. growth; high 1,6% p.a. growth)

- **West** of Kloof, including Hillcrest, Mpumalnga, Fredville, Cato Ridge, Camperdown/Mkhambathini, Msundusi/Pietermaritzburg and uMngeni Municipality. (low 0,6% p.a. growth; middle 0,9% p.a. growth, high 1,2% p.a. growth)

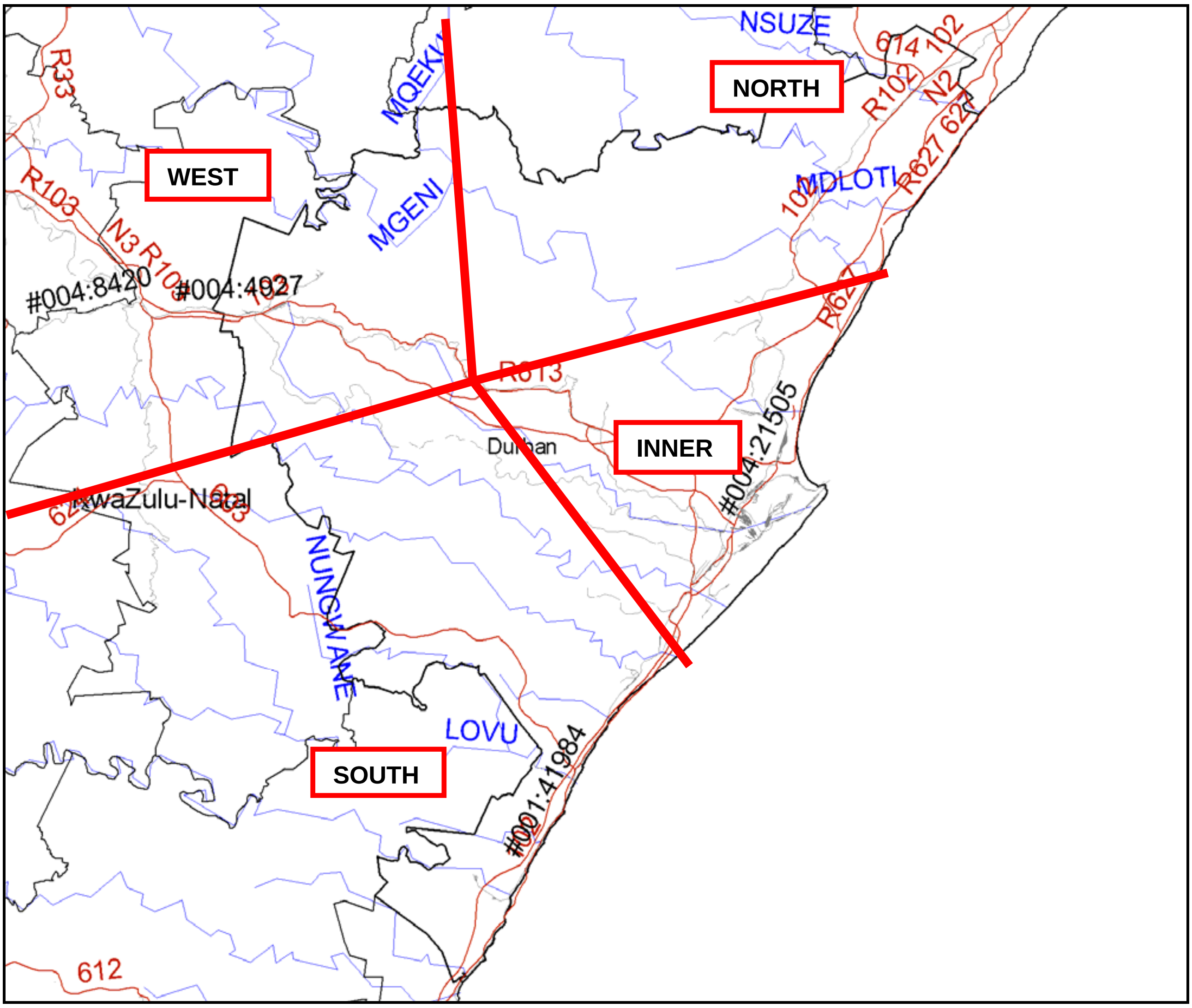

Figure 5.1: Map of sub-areal components

These demographic sub-regions are served by the existing water treatment works as follows:

- Inner is served by Durban Heights and Wiggins;
- South is served by Wiggins and Amanzimtoti;
- North is served by Ogunjini, Hazelmere, Tongaat, and KwaDukuza (Stanger).; and
- West is served by Midmar and DV Harris.

The First Stage Population Projections are shown in **Table 5.1**.

Table 5.1: First Stage population projections

Year	Inner	South	North	West	TOTAL
2001	1 mill	1,3 mill	1,3 mill	1,3 mill	5 mill
2005	1 mill low 1 mill med 1 mill hi	1,3 mill lo 1,3 mill med 1,3 mill hi	1,3 mill lo 1,4 mill med 1,4 mill hi	1,3 mill low 1,4 mill med 1,4 mill hi	
2010	1 mill low 1 mill med 1 mill hi	1,3 mill lo 1,4 mill med 1,4 mill hi	1,4 mill lo 1,5 mill med 1,5 mill hi	1,4 mill lo 1,4 mill med 1,6 mill hi	
2015	1 mill low 1 mill med 1,1 mill hi	1,3 mill lo 1,4 mill med 1,4 mill hi	1,5 mill lo 1,5 mill med 1,6 mill hi	1,4 mill lo 1,5 mill med 1,6 mill hi	
2020	1 mill low 1 mill med 1,1 mill hi	1,4 mill lo 1,4 mill med 1,5 mill hi	1,5 mill lo 1,6 mill hi 1,7 mill hi	1,5 mill lo 1,5 mill med 1,6 mill hi	
2025	1 mill low 1,1 mill med 1,1 mill med	1,4 mill lo 1,4 mill med 1,5 mill hi	1,6 mill lo 1,7 mill med 1,8 mill hi	1,5 mill lo 1,6 mill med 1,7 mill med	
2030	1 mill low 1,1 mill med 1.1 mill hi	1,4 mill lo 1,5 mill med 1,5 mill hi	1,6 mill low 1,8 mill med 1,9 mill high	1,5 mill med 1,7 mill med 1,8 mill hi	5,6 m low 6,0m med 6,5m hi*

*NOTE : Because the rounding summing across the rows will not necessarily exactly equal the totals in the right hand column

Projections including administrative breakdowns are shown in **Table 5.2**.

Table 5.2: Projections including administrative breakdowns

Year	Inner Ethekwini only	South Ethekwini only	North (Med) **Ethekwini** *Ilembe other*** ***KwaDukuza***	West (Med) **Ethekwini** *Mkhambathin* ***Msunduzi***	TOTAL
2001	1 mill	1,3 mill	1,3 mill	1,3 mill	5 mill
2005	1 mill low 1 mill med 1 mill hi	1,3 mill lo 1,3 mil med 1,3 mill hi	**1,1 m med** *0,2 m med* ***0,1 m med***	**0,7 mill med** *0,1 mill med* ***0,6 mill Med***	
2010	1 mill low 1 mill med 1 mill hi	1,3 mill lo 1,4 mil med 1,4 mill hi	**1,1 m med** *0,2 m med* ***0,2 m med***	**0,7 mill med** *0,1 mill med* ***0,6 mill med***	
2015	1 mill low 1 mill med 1,1 mill hi	1,3 mill lo 1,4 mil med 1,4 mill hi	**1,2 m med** *0,2 m med* ***0,2 m med***	**0,8 mill med** *0,1 mill med* ***0,6 mill med***	
2020	1 mill low 1 mill med 1,1 mill hi	1,4 mill lo 1,4 mil med 1,5 mill hi	**1,2 m med** *0,2 m med* ***0,2 m med***	**0,8 mill med** *0,1 mill med* ***0,6 mill med***	
2025	1 mill low 1,1 mill med 1,1 mill med	1,4 mill lo 1,4 mil med 1,5 mill hi	**1,2 m med** *0,2 mill med* ***0,3 m med***	**0,8 mill med** *0,1 mill med* ***0,7 mill med***	
2030	1 mill low 1,1 mill med 1.1 mill hi	1,4 mill lo 1,5 mil med 1,5 mill hi	**1,3 m med** *0,2 m med* ***0,3 m med***	**0,9 mill med** *0,1 mill med* ***0,7 mill med***	5,6 m low 6,0m med 6,5m hi*

* **NOTE** : Because the rounding summing across the rows will not necessarily exactly equal the totals in the right hand column

** **NOTE** : Refers to parts of iLembe DM other than KwaDUkuza that fall in urbanised study area, and mainly includes Ndwedwe

5.3 ECONOMIC INDICATORS ANALYSIS

Overview

Water forecasting and estimation is based on the assumption or requirement that there exists a significant and stable relationship between water demand or water consumption and certain economic and socio-economic variables. These economic and socio-economic variables can therefore also be used as indicators of future water demand and consumption if such a relationship indeed exists.

A number of studies internationally have been conducted with regards to water demand forecasting and estimation. This study will therefore not develop a new approach to water demand forecasting and estimation, but will closely follow existing and internationally best practice approaches to water demand forecasting and estimation. The key references were as follows:

- DEMAND ANALYSIS AND FORECASTING (Handbook for the Economic Analysis of Water Supply)
- DEVELOPMENT OF PROBABILISTIC WATER DEMAND FORECAST FOR THE SAN DIEGO COUNTY WATER AUTHORITY (Planning and Management Consultants, Ltd., November 2000)
- WHAT ARE THE LIKELY FUTURE TRENDS IN WATER DEMAND, AND WHAT CAN BE DONE TO MANAGE DEMAND MORE EFFECTIVELY, AND TO INFLUENCE THE BEHAVIOUR OF CONSUMERS AND OTHERS? (Memorandum by Arup and Leeds University)
- FORECASTING WATER DEMAND: TORONTO WATER EFFICIENCY PLAN (Water and Energy Services)
- WATER WORKING GROUP, UNIVERSITY OF CALIFORNIA, BERKELEY (Peter H. Gleick, 2000)
- WATER DEMAND FORECASTING IN THE PUGET SOUND REGION: SHORT AND LONG-TERM MODELS (Ani E. Kame'enui, 2003)

Through a modelling process (as described in **Section 3.2**, Methodology B) it is possible to identify appropriate economic and socio-economic variables that can be used as indicators. The modelling process will also allow us to determine the nature of the relationship that indicators have with water demand and consumption.

Thus, the main aim of this study is to determine with a high degree of accuracy the short run and long run economic relationship between national and local economic indicators and water demand and consumption.

It must be noted that both national economic and socio-economic variables (data) and local economic and socio-economic variables (data) will be used in the forecasting and estimation process.

In South Africa data on national economic and socio-economics is readily available; however data on similar variables on a local level is almost always non existent or outdated. This study will thus attempt to identify and test national economic and socio-economic variables that can be used as indicators of local water demand and consumption. The data will be obtained from official sources like the SA Reserve Bank and Statistics South Africa. This study will also make use of local economic and socio-economic variables. A database of local data has been generated and will be used. The database has been generated from local sources. Some data will have to be supplied by the municipalities, i.e., numbers of users per category of users and the volume of water consumption per category of users. This data will also have to be supplied for different time periods.

The study will also make use of local data that has been generated during a similar study for Eskom.

<u>Output from the Economic Indicators Analysis</u>

A range of analyses were undertaken with a specific focus on the demands of the two largest local authorities supplied by Umgeni Water, *viz.* Msunduzi Municipality and Ethekwini Municipality. A selection of the results and discussion is presented below.

From **Figure 5.2** it is clear that water consumption in the Pietermaritzburg area has increased at a faster rate than in the Durban region. The cumulative increase for Pietermaritzburg is about 30% against a cumulative increase of about 8% in Durban. The difference in volatility in water demand in the two cities is very evident. The fluctuations are also a function of monthly meter reading adjustments and metering period variations.

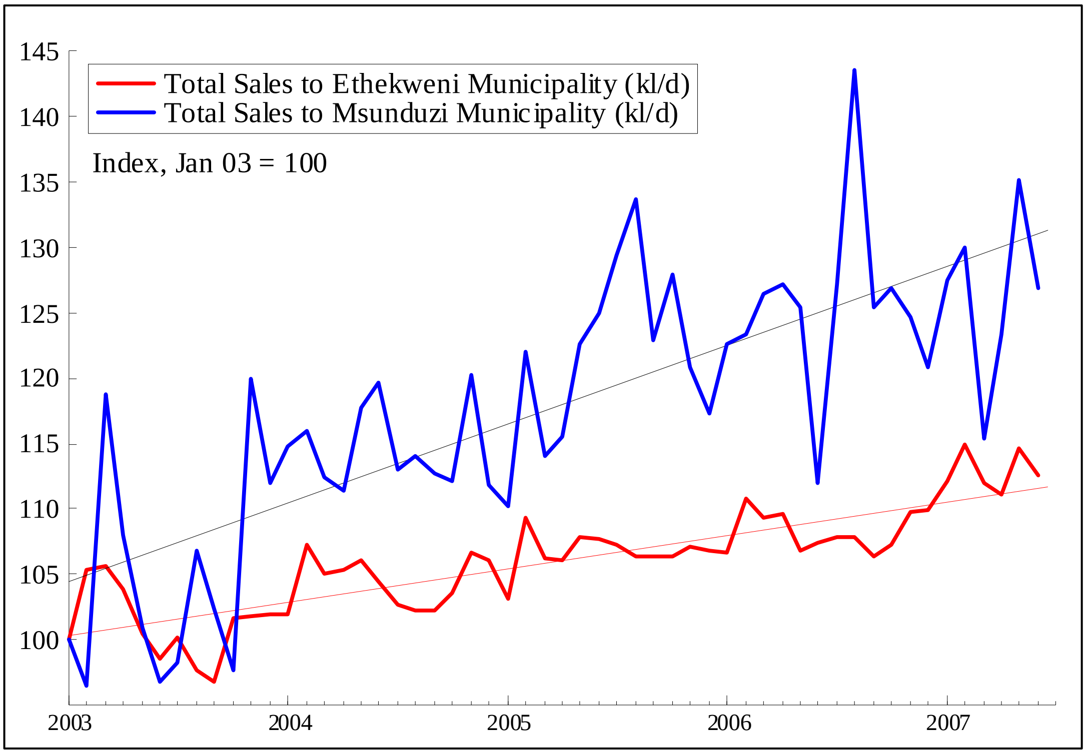

Figure 5.2: Durban and Pietermaritzburg water consumption, Index Format

The use of local economic indicators would in most cases be a much better indicator of water demand/consumption than national economic indicators, because economic decisions are made based on the prevailing economic conditions of the local economy. Local economic conditions would thus have a much greater impact on water demand/consumption than national economic conditions.

However local economic indicators are in very short supply and in most cases outdated. A database of local economic indicators has however been compiled for the Durban-Pietermaritzburg region. The local economic variables that will be employed include the following:

- Number of new job postings
- Number of new building plans approved
- Total number of new vehicles sold
- Total electricity consumption
- Retail activity
- Total additions to business space
- Economic Performance Index
- Average daily maximum temperature

- Average daily minimum temperature
- Average monthly rainfall

All the above variables were first transformed into Index format with a base year of January 2003. This was done to ensure easy comparisons between the different variables. **Figures 5.2 – 5.7** display the relationships between water consumption and the stated local economic variables. The particular correlation coefficients are included in each graph.

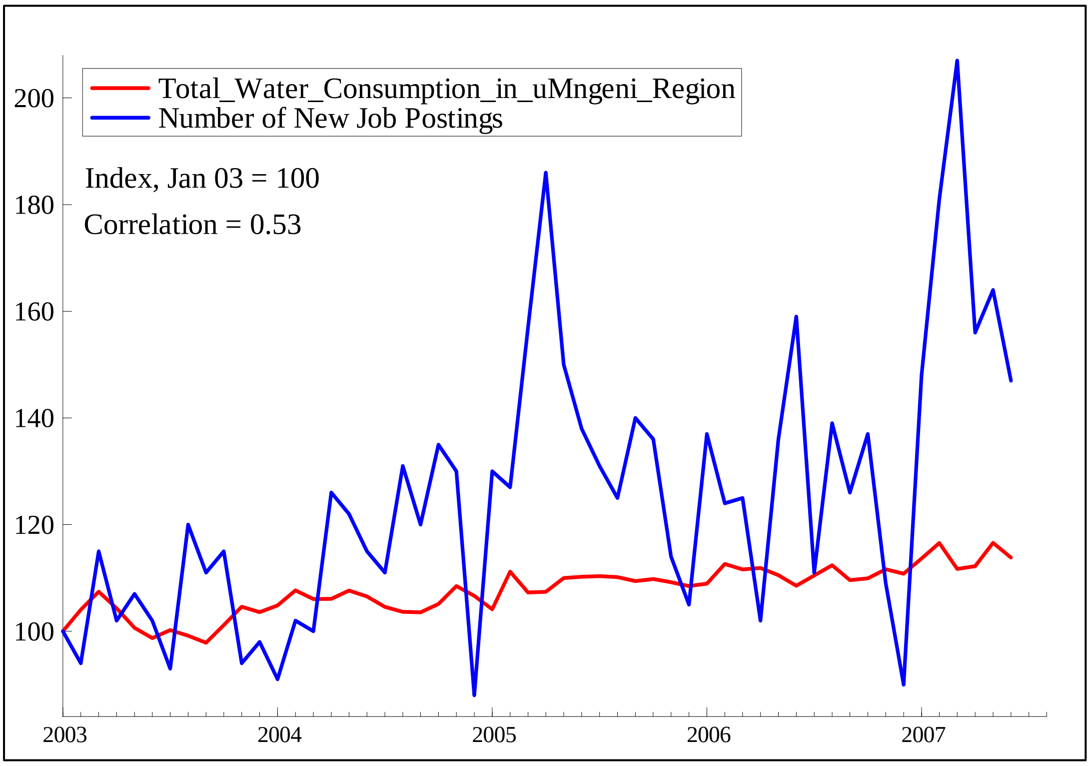

Figure 5.3: Total water consumption vs. Number of New Job Postings

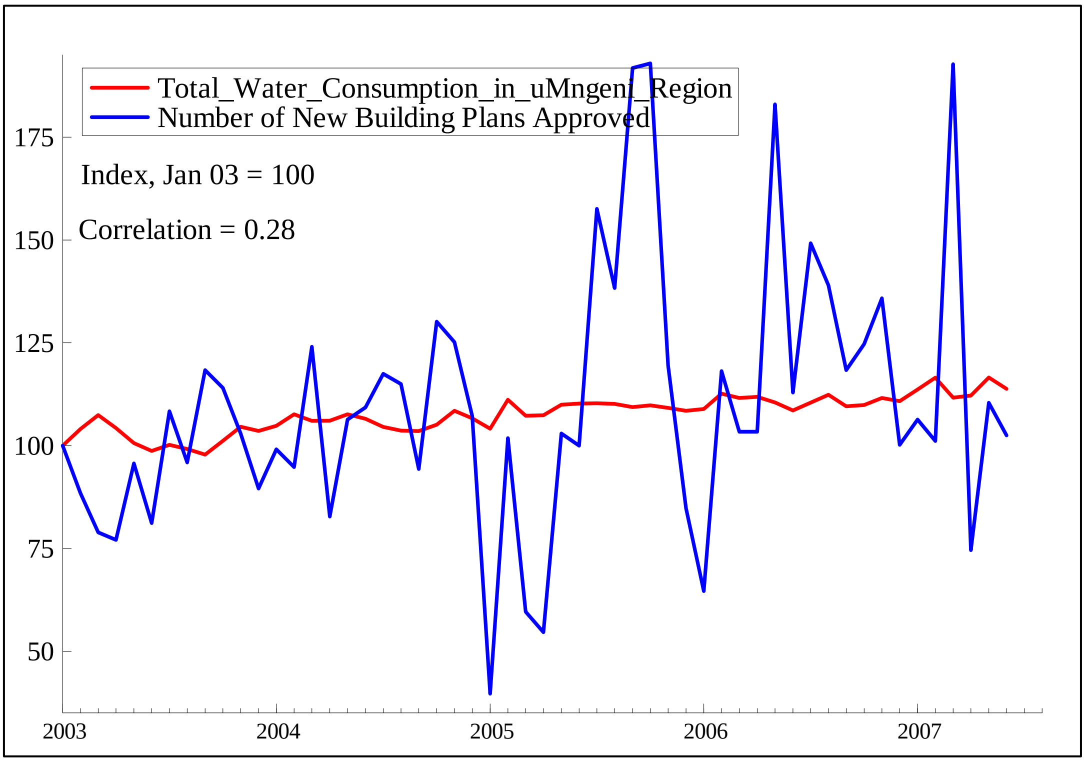

Figure 5.4: Total water consumption vs. Number of New Building Plans Approved

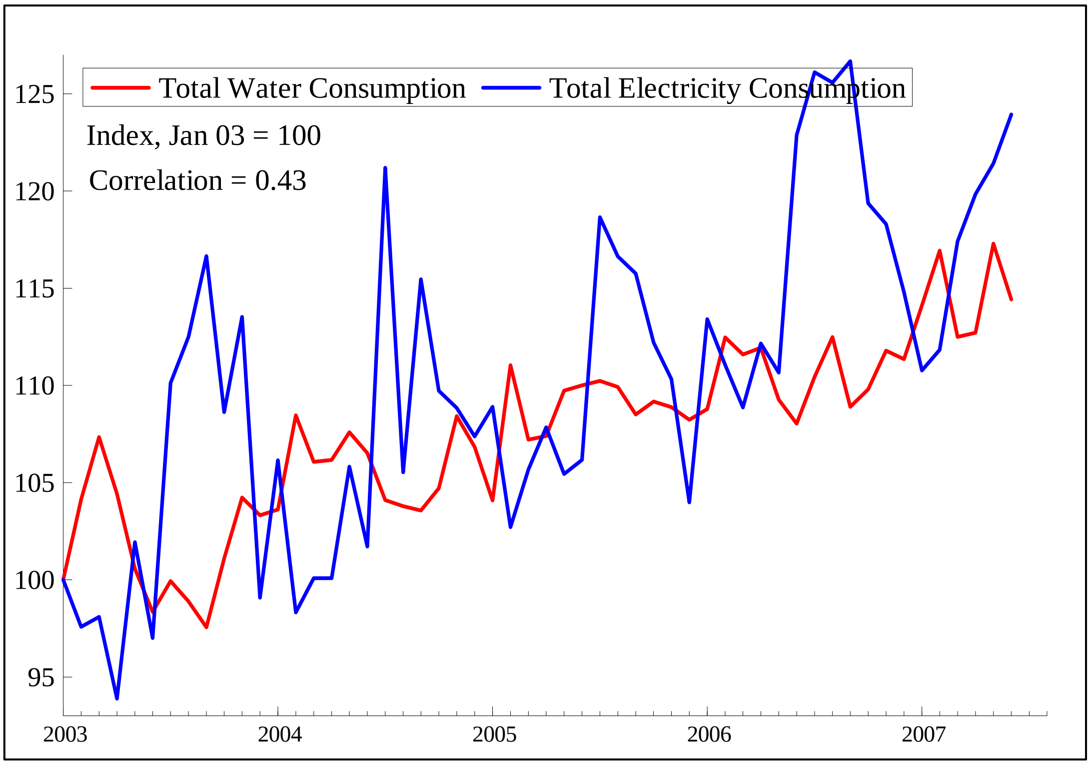

Figure 5.5: Total water consumption vs. Total Electricity Consumption

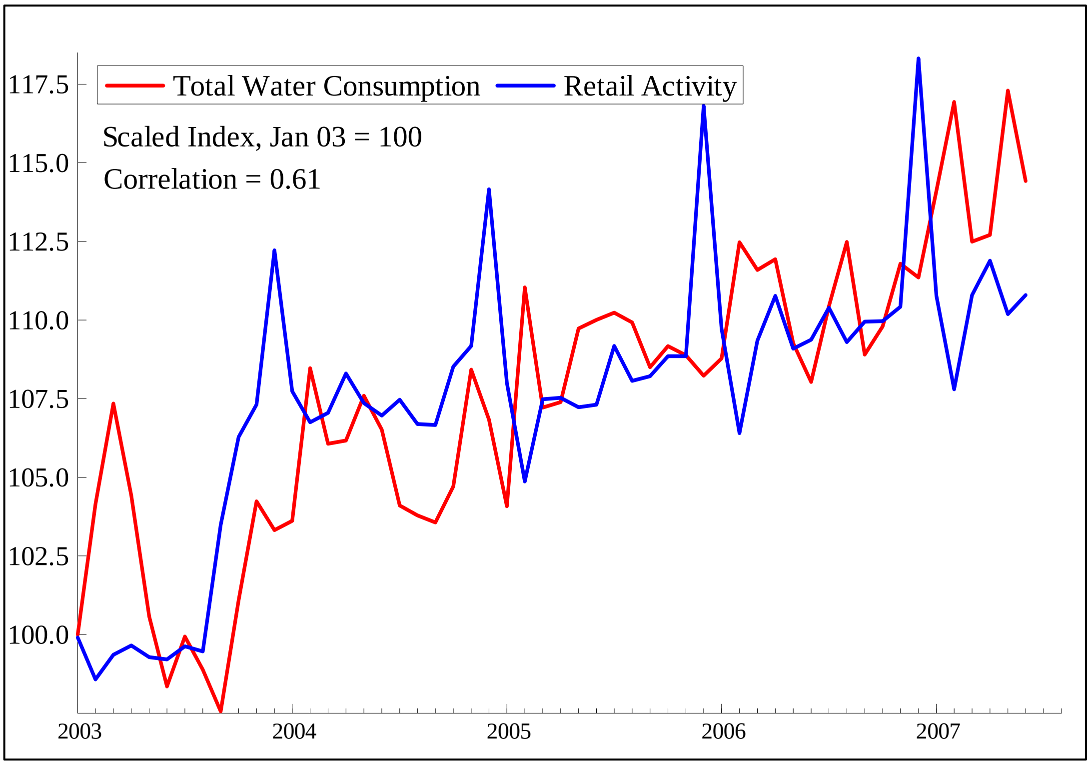

Figure 5.6: Total water consumption vs. Retail Activity

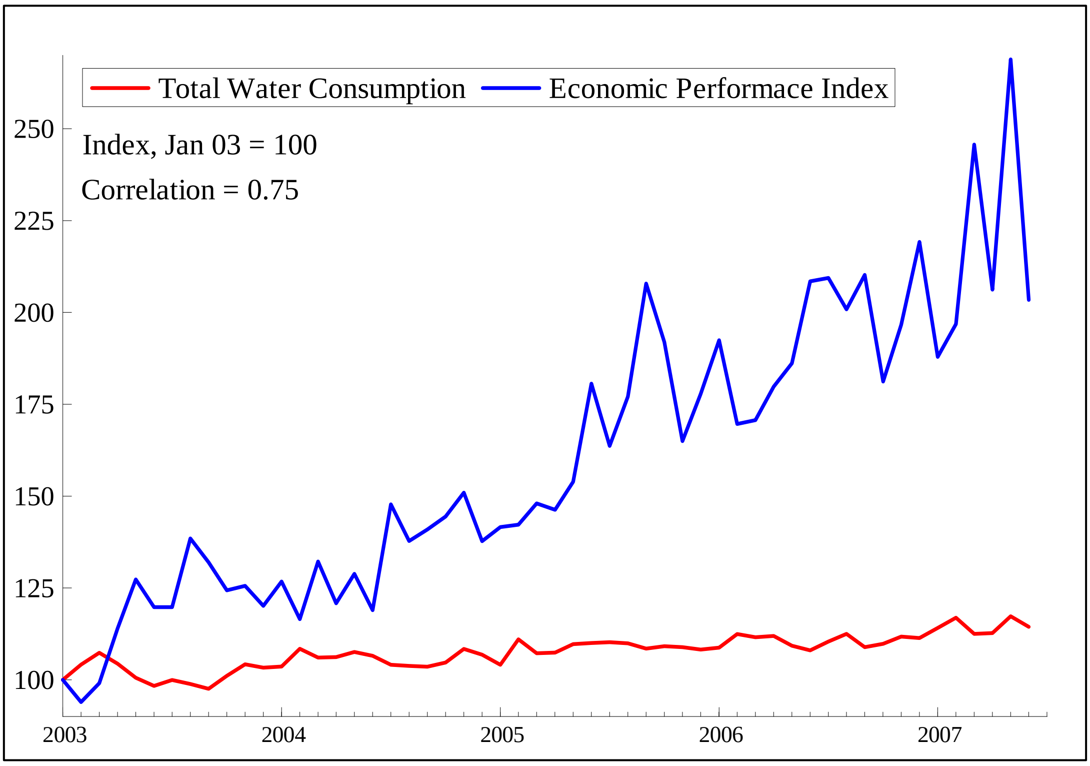

Figure 5.7: Total water consumption vs. Economic Performance Index, Normal index

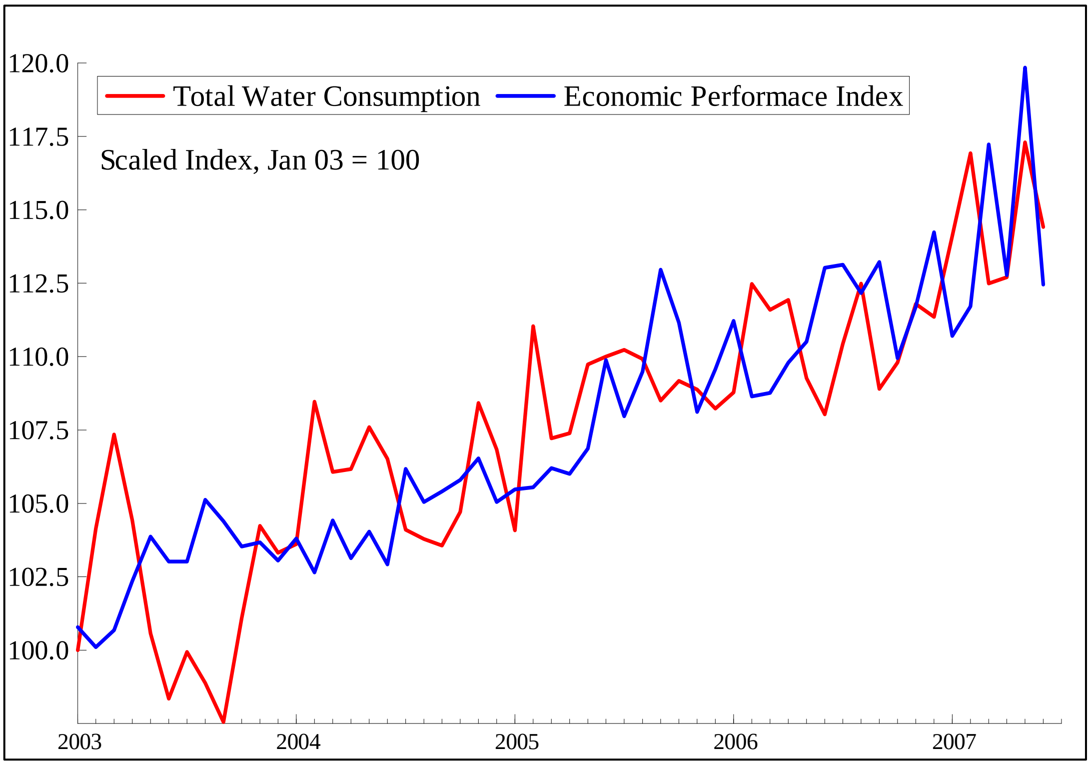

Figure 5.8: Total water consumption vs. Economic Performance Index, Scaled index

Analysis of the finding

Table 5.3 supplies the correlation coefficients in order of the strength of the different relationships. From the table it seems that the majority of local economic variables have fairly insignificant relationships with water consumption. It ia apparent that only the first three variables that have any significant relationship with water consumption.

Table 5.3: Correlation Coefficients

Local Economic Variables	*Water Consumption*
Total Number of New Vehicles Sold	0.81
Economic Performance Index	0.75
Retail Activity	0.61
Number of new Job Posting	0.53
Total Additions to Business Space	0.52
Total Electricity Consumption	0.43
Number of New Building Plans Approved	0.28
Average Daily Maximum Temperature	0.26
Average Monthly Rainfall	0.13
Average Daily Minimum Temperature	0.12

Although the majority of correlation coefficients indicate fairly insignificant relationships there is a high probability that the coefficients are actually biased. The main reason for this is that correlation coefficients measure the co-movements of trends only and do not suggest anything about economic relationships or the causality of the relationships. Overall however, there was no significant correlation (other than obvious relationships) between water demand growth and economic indicators. The obvious relationships between water demands and a growing economy (increases in the standard of living), are addressed by allowing rates of consumption to vary in the demand and return flow model.

Determining the correlation coefficients is only a very small part of econometric analysis and therefore in building a structural model. The next step would be to build disaggregated regression models. The primary reason for using disaggregated models is that there exist unique relationships in each of the main types of water demand, for example the factors that influence domestic water demand might not be significant in influencing industrial water demand, etc.

The approach would thus be to build a structural model for each of the main types of water demand and to forecast each of these different types of water demand. The sum of the forecasts would then suggest total water demand.

This approach is dependent on the availability of disaggregated data and in the absence of such data it would be very difficult (even impossible) to build any significant structural models. The only alternative is to use the models as suggested by the literature review.

Despite the difficulties of building predictive models of sectoral water demand, the prospects for continued water demand growth across all sectors in the study area in the longer term appear positive, driven by economic growth. There is evidence that coastal regions can expect to be the major beneficiaries of globalisation and the new global trade order. Global economic growth remains favourable with the Chinese and Indian economies the fastest growing economies. The demand for commodities will therefore remain strong. The province of KZN with its relatively good infrastructure and two harbours is well placed to capitalize on its new found opportunities. The growth of the province will mainly be concentrated in the Durban-Pinetown, Pietermaritzburg and Richards Bay/Empangeni regions. The three centers will also experience an inflow of people from the rural areas where the remainder of the population will continue to be dependent on agriculture.

The availability of cost effective and efficient water and related infrastructure within and between the three growth corridors at present is under pressure. Water usage (by households, industry and commerce) has increased dramatically over the past couple of years because of the growth of the "city" economies and the fact that the number of households with access to water has increased. Disposable income of households increased above inflation and business investment has accelerated. Water demand is also becoming more concentrated along the three main corridors as economic activity becomes more concentrated within the three main cities. The demand therefore for cost effective and efficient water and related infrastructure within and between the three growth corridors will probably increase by about 3% to 5% per annum over the next 10 to 15 years.

<u>Implications for Water Demand in the Study Area</u>

The national forecasts suggest more of the same, i.e., the past trends will very much continue into the future. The forecasts also suggest no major shocks and/or changes in the trend behaviour of the economic variables.

It is thus possible and reasonable to assume that water demand and consumption in the uMngeni region will increase by between 2.5% and 3.5% per annum over the medium to long term.

6 URBAN WATER REQUIREMENTS AND RETURN FLOW MODEL

6.1 DESCRIPTION OF THE MODEL

The model utilised in balancing water demands and return flows is presented in **Figure 6.1**. The model is a simple water balance, matching system input volume to consumptive use, real losses and effluent return flows.

6.2 INPUT DATA

The unit areas analysed in the model are the Sewage Drainage Areas (SDA's), representing the catchment areas draining to each waste water treatment works. The lack of suitable data sets for iLembe DM (KwaDukuza) meant the northern areas demand requirements were developed using the Umgeni Water development planning and scheduling model. The key focus area of the model was however the EWS system, for which the most detailed data sets were available. In the data preparation phase, certain significant tasks were undertaken. The key inputs for the Ethekwini Municipality were the following, specifically for the 2006 year against which the calibration was to be determined:

- the monthly and annual Umgeni Water bulk sales meter records and the bulk meter supply zones in GIS;
- the monthly and annual EWS inflow records to each waste water treatment works (WWTW) and the sewage drainage catchments (SDA's) in GIS for each WWTW;
- 2006 population data for the Ethekwini Municipality, revised by the Thekwini Municipality and dis-aggregated to small hexagons at a resolution less than the Wards;
- EWS billings data and User-Types, split into domestic and non-domestic customers, and
- Spatial distribution of informal dwelling units (actually service points in the informal areas) in GIS (a point shape file).

In terms of the demands and return flow model, the user categories are presented in **Table 6.1.** The EWS user categories were in turn matched with those in **Table 6.1**. The EWS customer meter database is also linked to the cadastral data in GIS, thus enabling the number of connections per category per SDA to be determined. The number of informal units per SDA was estimated using the 'point service points' data.

The EWS population data (dis-aggregated into small hexagons) was summed in GIS for each SDA, and distributed on a pro-rata basis to the number of dwellings in each category in each SDA.

Table 6.1: Serviced housing category definitions

Serviced Housing Category	Description
Category 1	Fully serviced houses on large erven (erven > 500 m^2)
Category 2	Fully serviced flats, townhouses or cluster homes
Category 3	Fully serviced houses on small erven (erven < 500 m^2)
Category 4	Small houses, RDP type houses and shanties with water connection, but no or minimal sewage service
Category 5	Informal houses services only by communal taps and no water borne sewage
Category 6	No service from any water distribution system
Category 7	Other/Miscellaneous (includes industrial, commercial, hostels, military camps, etc.)

In terms of the water demand (input volume to the model), the intersections of the Umgeni Water bulk meter supply zones with each SDA were determined using GIS. By default, each SDA was therefore covered by one or more Umgeni Water bulk meter zone. Likewise, each Umgeni Water bulk sales meter zone covered one or more SDA. The billed volumes for customers in Categories 1, 2, 3 & 7 and an estimate of the demand from the informal service connection points, were then summed for each SDA (or part of an SDA) that constituted an Umgeni Water bulk sales meter zone. Provision was also made in the calculations for system losses, such that the following balance was maintained:

Input Volume = billed consumption + informal area demand + losses

The objective was therefore to ensure that the sum of all input volumes for the SDA's matched the measured input volume data from Umgeni Water. A further realistic distribution per SDA was achieved using the billings data for the respective User Categories, and the population per SDA was calculated in GIS from the 'hexagon' coverage. The only estimated variables were the informal sector water demand and the system real losses.

The return flows per SDA then had to be matched to the measured inflows at the respective WWTW. This was also only relevant to those areas of the SDA's that were on sewerage reticulation. A return flow factor per SDA was determined indicating what percentage of the SDA inflow was returning as effluent to each particular WWTW.

In the model itself, the per capita demand was calculated for each User Category, bearing in mind that the population had been calculated in GIS for each SDA and then disaggregated linearly to the number of dwellings in each SDA. The per capita demand for each User Category per SDA was estimated and adjusted along with the return flow and real loss factors, until the model achieved an acceptable match (or calibration) between system input volume and WWTW inflow.

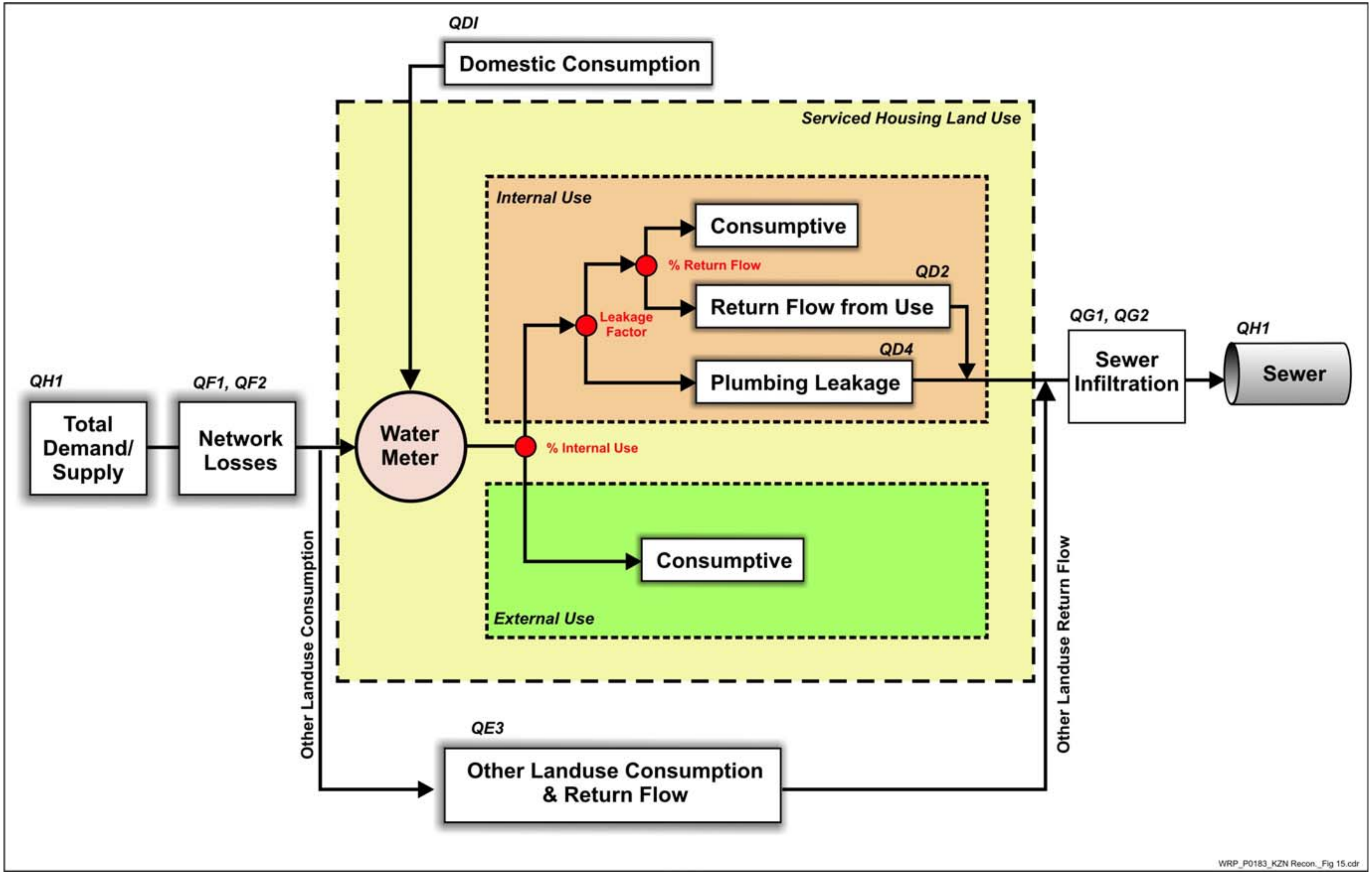

Figure 6.1: Conceptual Urban Return Flow Model for Serviced Housing Land Use

6.3 MODEL CALIBRATION

The model was calibrated for the 53 SDA's making up the Ethekwini and Msunduzi Municipal areas as illustrated graphically in **Figure 6.2**. The various SDA's in each of the municipal areas are listed in **Table 6.2**. Some of the SDA's identified are not linked to waste water treatment works (WWTW). The demands of these SDA's amount to 9% and 25% of the total demand for Ethekwini MM and Msunduzi LM respectively (12% of the combined demand).The demands were calibrated mainly by adjusting the unit consumption values for each SDA within the various serviced housing categories and the water loss factors (network losses). The return flows were calibrated mainly by adjusting the percentage internal use, leakage factor and % return flow (**Figure 6.1**). It must be noted that the values were adjusted within a realistic range. The calibration demand and return flow results compared to the actual measured demands and return flows for the SDAs are shown in **Table 6.3**. The only inaccurate calibration result obtained was for the Kwadengezi return flow volume. It was however provisionally accepted due to its minor contribution to the total return flow of the system. (Various refinements will be undertaken in Stage 2 of the study)

A map showing the SDA's in the Msunduzi and Ethekwini Municipalities is presented in **Figure 6.2**.

Table 6.2: List of Sewage Drainage Areas according to Municipal Areas

Municipality	Sewage Drainage Areas	Number of SDAs
eThekwini	Southern Works, Umhlathuzana, Central, Kingsburgh, Amanzimtoti, Isipingo, Northern, New Germany, KwaMashu, Umbilo, Mpumalanga, Kwadengezi, Dassenhoek, Hillcrest, Hammersdale, Phoenix, Umhlanga, Umdloti, Verulam, Tongaat Southern, Tongaat Central, Tongaat Central Below, Gennazano, Fredville, Cato Ridge and 19 SDA's without waste water treatment works	44
Msunduzi	Darvill and 8 SDA's without waste water treatment works	9
TOTAL NUMBER OF SEWAGE DRAINAGE AREAS		**53**

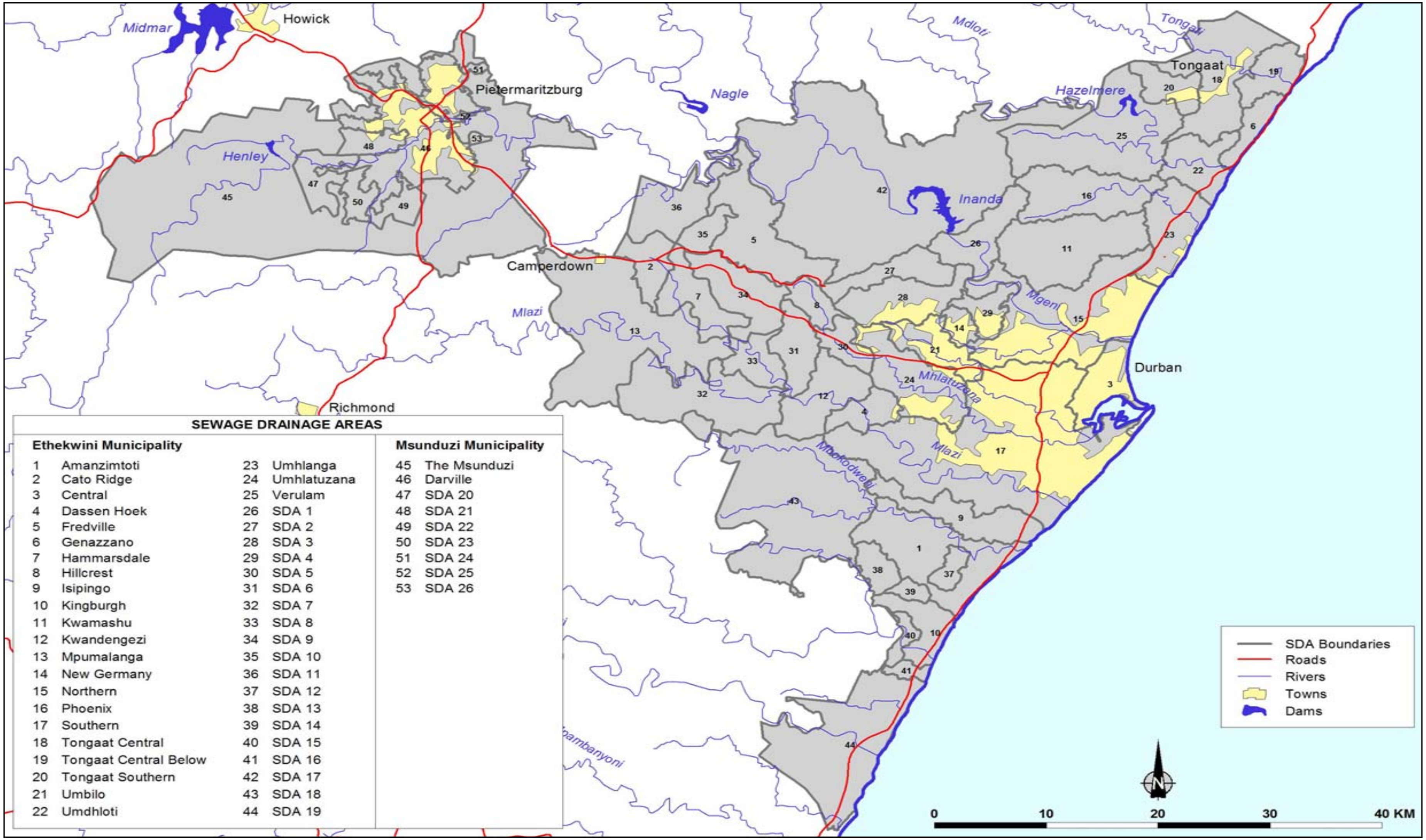

Figure 6.2: Map showing Sewage Drainage Catchments in the Ethekwini & Msunduzi Municipal areas.

Table 6.3: Ethekwini and Msunduzi demand and return flow calibration results

DA Name	Demand (million m^3/a)			Return Flow (million m^3/a)		
	Simulated	Measured	% Diff	Simulated	Measured	% Diff
SOUTHERN WORKS	76.81	76.14	0.9	64.75	65.85	-1.7
UMHLATUZANA	4.73	4.68	1.2	4.28	4.20	1.8
CENTRAL	30.65	30.44	0.7	26.61	26.98	-1.4
KINGSBURGH	1.89	1.88	0.5	1.68	1.69	-0.3
AMANZIMTOTI	12.09	11.94	1.3	8.79	8.77	0.2
ISIPINGO	6.76	6.74	0.3	4.80	4.73	1.4
NORTHERN	32.25	32.29	-0.1	19.79	19.74	0.3
NEW GERMANY	2.77	2.79	-0.7	1.26	1.25	0.6
KWA MASHU	40.82	41.10	-0.7	23.17	22.88	1.2
UMBILO	6.18	6.27	-1.4	5.51	5.51	0.0
MPUMALANGA	3.00	3.02	-0.7	1.10	1.11	-1.2
KWANDENGEZI	0.51	0.51	0.9	0.39	0.46	-15.5
DASSENHOEK	0.64	0.62	1.7	0.29	0.29	-0.7
HILLCREST	0.92	0.93	-0.1	0.19	0.19	0.0
HAMMARSDALE	4.11	4.05	1.5	2.80	2.76	1.4
PHOENIX	21.28	21.45	-0.8	5.14	5.13	0.3
UMHLANGA	6.79	6.82	-0.6	3.23	3.23	0.0
UMDHLOTI	0.59	0.59	0.4	0.40	0.40	-0.3
VERULAM	4.83	4.75	1.5	2.34	2.35	-0.3
TONGAAT TOTAL	3.30	3.26	1.2	2.87	2.90	-1.1
GENNAZANO	0.79	0.78	1.6	0.49	0.48	1.0
FREDVILLE	1.03	1.01	1.9	0.00	0.00	0.0
CATO RIDGE	0.18	0.18	-0.5	0.00	0.00	0.0
SDA 1	6.03	5.97	0.9	0.00	0.00	0.0

SDA 2	1.67	1.69	-1.0	0.00	0.00	0.0
SDA 3	4.20	4.15	1.1	0.00	0.00	0.0
SDA 4	2.18	2.15	1.0	0.00	0.00	0.0
SDA 5	0.77	0.78	-1.2	0.00	0.00	0.0
SDA 6	0.24	0.24	1.3	0.00	0.00	0.0
SDA 7	0.12	0.12	0.8	0.00	0.00	0.0
SDA 8	0.12	0.12	-0.8	0.00	0.00	0.0
SDA 9	0.66	0.66	0.2	0.00	0.00	0.0
SDA 10	0.33	0.33	-0.2	0.00	0.00	0.0
SDA 11	0.96	0.94	1.4	0.00	0.00	0.0
SDA 13	0.27	0.27	-0.4	0.00	0.00	0.0
SDA 14	0.03	0.03	1.4	0.00	0.00	0.0
SDA 15	0.16	0.16	-1.0	0.00	0.00	0.0
SDA 16	0.32	0.33	-1.6	0.00	0.00	0.0
SDA 17	6.58	6.47	1.6	0.00	0.00	0.0
SDA 18	0.91	0.92	-1.3	0.00	0.00	0.0
SDA 19	1.40	1.41	-0.5	0.00	0.00	0.0
*DARVILL	37.89	37.83	0.2	28.40	28.62	-0.8
*SDA 20	2.95	2.91	1.4	0.00	0.00	0.0
*SDA 21	1.22	1.20	1.2	0.00	0.00	0.0
*SDA 22	2.30	2.29	0.5	0.00	0.00	0.0
*SDA 23	3.81	3.75	1.5	0.00	0.00	0.0
*SDA 24	0.70	0.71	-0.8	0.00	0.00	0.0
*SDA 25	1.00	1.00	-0.6	0.00	0.00	0.0
*SDA 26	0.45	0.44	1.4	0.00	0.00	0.0
*MSUNDUZI	0.33	0.34	-0.4	0.00	0.00	0.0

*SDA's in the Msunduzi Municipal area

For practical reasons, additional results are illustrated only for the main SDAs contributing to majority of the demands and return flows in the two municipal areas, namely Southern Works, Central, Northern, KwaMashu, Phoenix and Darvill (Msunduzi). The domestic and non-domestic component of the demands, the units consumption values and the percentage population split into the different serviced housing categories are shown in **Table 6.3**, **Table 6.4** and **Table 6.5** respectively.

Table 6.4:Major SDA Demands

DA Name	Demand (million m^3/a)		
	Domestic	Non Domestic	Total
SOUTHERN WORKS	47.68	29.13	76.81
CENTRAL	13.61	17.04	30.65
NORTHERN	26.76	5.49	32.25
KWA MASHU	36.14	4.68	40.82
PHOENIX	21.02	0.26	21.28
*DARVILL	33.54	4.35	37.89

*SDA in Msunduzi Municipal Area

Table 6.5: Major SDA unit consumptions

DA Name	Unit Consumption (l/capita/day)						
	CAT 1	CAT 2	CAT 3	CAT 4	CAT 5	CAT 6	CAT 7
SOUTHERN WORKS	225	225	70	50	7	5	50
CENTRAL	320	320	170	80	15	10	80
NORTHERN	300	300	160	70	10	7	70
KWA MASHU	320	320	150	80	15	10	80
PHOENIX	360	360	250	180	150	30	130
*DARVILL	390	390	240	140	55	25	140

Table 6.6: Major SDA percentage population split

DA Name	Percentage Population per Category (%)						
	CAT 1	CAT 2	CAT 3	CAT 4	CAT 5	CAT 6	CAT 7
SOUTHERN WORKS	25.3	25.8	20.8	9.7	18.0	0.4	0.0
CENTRAL	32.5	60.3	6.5	0.7	0.0	0.0	0.0
NORTHERN	42.3	15.6	14.1	12.2	15.6	0.1	0.0
KWA MASHU	9.7	15.4	41.3	17.3	16.2	0.1	0.0
PHOENIX	5.4	6.1	32.2	19.7	35.9	0.7	0.0
*DARVILL	29.8	13.8	40.8	2.3	5.3	8.0	0.0

7 LONG-TERM WATER REQUIREMENT SCENARIOS

7.1 SCENARIO WORKSHOP WITH KEY STAKEHOLDERS

In order to include the insight and knowledge of experts from various stakeholder groups in the scenario planning process, a workshop was convened in September 2007 to debate the issues and reach consensus on future prospects (see delegate list in **Appendix A**).

The Approach included the following considerations:

- To consider specialist input on:
  - Population statistics and demographics (Dr McCarthy)
  - Historic water demands and return flows
  - Land-use and urbanisation
  - Socio-economic indicators
- To consider the views of key sector representatives (eg. commerce & industry, Eskom, forestry, sugar, environment) and realistic possibilities for the study area
- To consider the use and appropriateness of the urban water demands and return flow model

The Objectives were as follows:

- To understand the complexities of the multi-sectoral and multi-variable nature of the forecasting of water requirements;
- To quantify key variables for inclusion in the compilation of the water requirement scenarios;
- To understand the alignment and differences between sectors an dtheir long-term views; and
- To reach consensus on the parameters for developing the high, middle and low road scenarios.

Key note presentations were made by Dr Jeff McCarthy (population, demographics and regional development), Ken Breetzke (Ethekwini Strategic Development Planning), Brendan Magill (sector water demands in Ethekwini); Alison Walton (Eskom), Clive Coetzee (UKZN, economic indicators), while summary presentations were made from the representatives of Umgeni Water and the irrigation, sugar and forestry sectors.

Consensus was reached on the approach and methodology adopted by the study team, including the use of the urban demands and return flow model. However, the study tema was alerted to the following macro influences on the water requirement scenarios:

- State and Provincial Government investment strategies, eg. in ports, airports, roads and rail infrastructure;
- The Provincial Spatial Development Plan;
- Local Authority development initiatives, eg. accelerated housing delivery program of the Ethekwini Municipality, as well as the effect of policy and capacity constraints which can limit growth;
- Private sector investment strategies, eg. housing estates, commercial and retail centres;
- The national battle for a very limited pool of skills and resources and the ability of commerce and industry in KwaZulu-Natal to retain its skills base;
- The time-lag between new developments and measurable increases in water demands;
- The impact on ARV's on HIV mortality rates, as well as reductions in HIV infection rates;
- The ability of the construction sector to sustain the economy during an inevitable retail downturn;
- The impact of climate change;
- The sustainability of the Chinese and Indian commodities boom; and
- The impact of a national pricing strategy for raw water.

It was agreed that the measurable impact of these issues was difficult to determine for use in a deterministic model, but that cognisance should be taken of them when subsequent reviews of the water requirements are undertaken.

7.2 DEVELOPMENT OF WATER REQUIREMENT SCENARIOS

Various demand projections scenarios were investigated with the calibrated model. Descriptions of the demand projection scenarios are presented in **Table 7.1** below.

Table 7.1: Summary of the demand projection scenario's

Scenario		Description
1	Low	• Low population Projection (McCarthy)
2	Medium	• Medium population Projection (McCarthy)
3	High	• High population Projection (McCarthy)
4	High Sc	• High population growth (as 3 above) • Improved water supply services (increased proportion of people in Category 2 and 4) • Increase in unit consumption (Cat1,2,3) up to 2011 • Increased non-domestic consumption in identified SDA's (Hammarsdale, Cato Ridge, Hillcrest, Southern, Umhlanga, Phoenix, Verulam, Tongaat) • Non-domestic consumption in remaining SDA's grew according to the population growth
5	Alternative High Sc	• Same as 4 but with constant unit consumption
6	Alternative Low Sc	• Same as 4 but with constant unit consumption and Low population growth
7	Alternative Medium Sc	• Same as 4 but with constant unit consumption and Medium population growth
8	Umgeni Water 2007	• Umgeni Water demand curve (2008)

As described in **Section 6.2**, the demands and return flow model examined four variables, *viz.* population, per capita demand and water loss and effluent return flow factors. The calibration was done on the 2006 data sets for Ethekwini and Msunduzi, but for subsequent years, the population growth data from Dr Jeff McCarthy was the primary input. Changes were made on the per capita consumption rates as well as the number of dwellings per User Category (as a result of economic prosperity and/or housing roll-out plans). The flexibility of the model is thus immediately obvious, allowing the future demand curves to be derived from more than just reference to previous trends.

The specific focus areas for the water requirement determinations are presented in **Figure 7.1**.

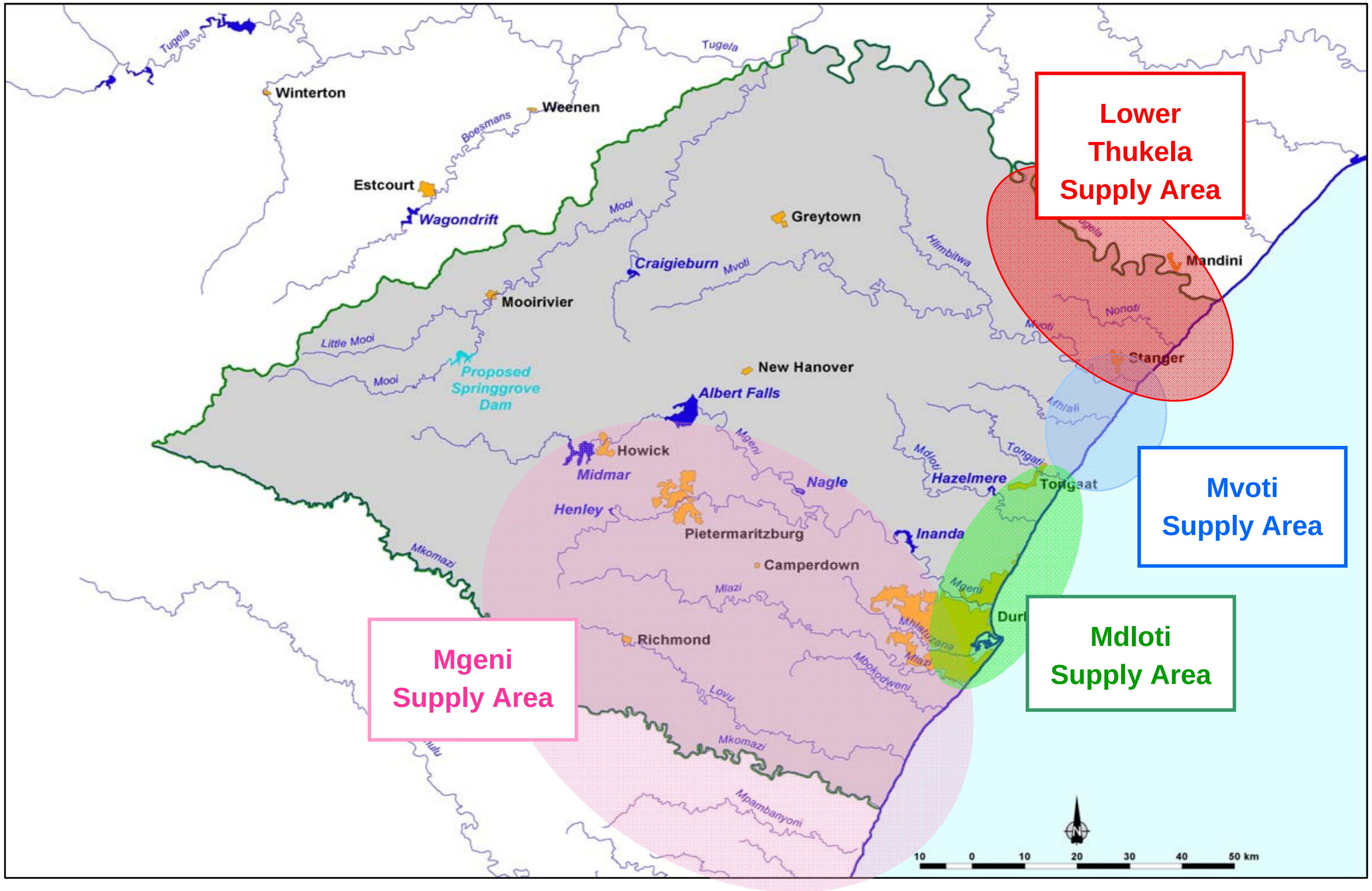

Figure 7.1: Water supply areas

7.3 LONG-TERM WATER REQUIREMENTS: MGENI SYSTEM, BASELINE SCENARIO

The baseline scenarios considered the following:

- Projections according to the high, middle and low population growth scenarios proposed by Dr Jeff McCarthy;
- The proportion of population in each of the 7 housing categories to remain the same; and
- The indirect use to remain in the same proportion as direct use.

In all cases, the Umgeni Water water requirements scenario has been plotted on the graphs for reference purposes. The baseline water requirement projections are presented in **Figure 7.2**.

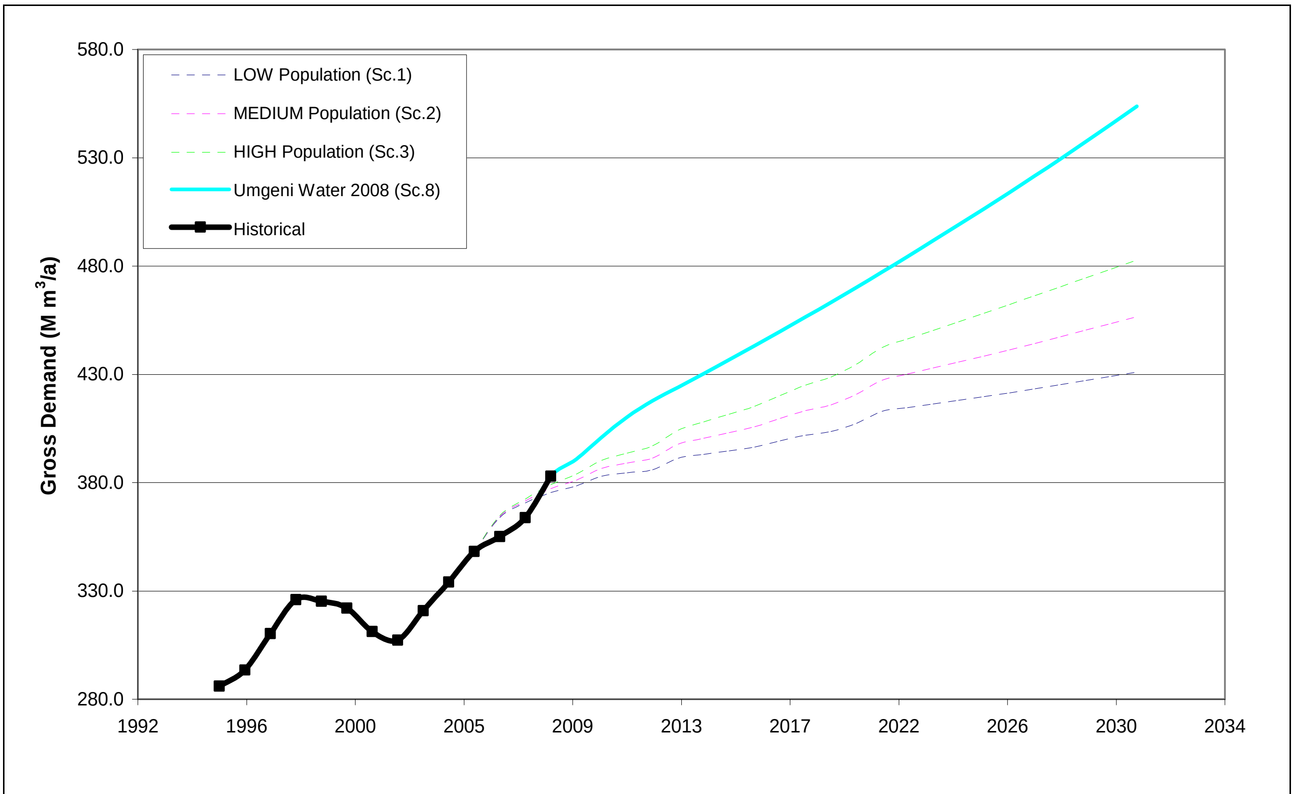

Figure 7.2: Baseline Water Requirement Scenarios for the Mgeni System

7.4 LONG-TERM WATER REQUIREMENTS: MGENI SYSTEM, BASELINE WITH SOCIO-ECONOMIC MIGRATION

The baseline scenarios, including increased service levels as a result of the Reconstruction and Development Programme (RDP) housing implementation programmes that have been scheduled in Ethekwini and Msunduzi Municipal areas, considered the following:

- An increase in the proportion of the population in housing categories, eg. migration from Category 5/6 to Category 4, and from Category 4 to Category 2 (in line with the Ethekwini and Municipality's accelerated housing development program), using the High, Low and Medium population growth forecasts from Dr Jeff McCarthy. The migation to Categories 4 and 2 were based on the Ethekwini and Msunduzi Municipalities accelerated housing development programmes:

  - <u>Ethekwini Municipality</u>: 12 000 RDP houses per year (**Moodliar, 2008**) i.e 50 000 people per year will move from Category 5/6 to Category 4 (assuming an average of approximately 4 persons per houshold) and it was assumed that 10 000 people (20% of 50 000) will move from Category 4 to Category 2.
  - <u>Msunduzi Municipality</u>: 1 000 RDP houses per year (**Subramanian, 2007** and **Enoch, 2007**) i.e 4 000 people per year will move from Category 5/6 to Category 4 (assuming an average of approximately 4 persons per houshold) and it was assumed that 800 people (20% of 4 000) will move from Category 4 to Category 2.

- Commercial/Industrial water use in the different SDA's generally increased in same proportion as domestic use. The economic analysis however identified certain areas where substancial industrial/commercial growth will take place in certain years which was accounted for. These included Hammarsdale, Cato Ridge, Hillcrest, Southern, Umhlanga, Phoenix, Verulam and Tongaat SDA's (see **Table 7.2**); and

- The per capita consumption rate to remained unchanged in each housing category.

The water requirement projections are presented in **Figure 7.3**. The biggest driver of the water demand increase is from upgraded service levels to the low income housing sector according to the RDP housing implementation programmes that have been scheduled in the Ethekwini and Msunduzi municipal areas.

Table 7.2: Summary of the growth in the commercial/Industrial water use

PERIOD	COMMERCIAL/INDISTRIAL GROWTH DESCRIPTION
SOUTH	
2006-2011	Growth as per Domestic Consumption
2011-2016	Growth as per Domestic Consumption
2016-2021	10% Increase in growth (implementation of industry at existing airport i.e. existing airport will be decommissioned and move to the new airport)
2021-2026	Growth as per Domestic Consumption
2026-2031	Growth as per Domestic Consumption
WEST	
2006-2011	Growth as per Domestic Consumption with Hammarsdale, Cato Ridge and Hillcrest growth at double the Domestic Consumption
2011-2016	Growth as per Domestic Consumption with Hammarsdale, Cato Ridge and Hillcrest growth at double the Domestic Consumption
2016-2021	Growth as per Domestic Consumption with Hammarsdale, Cato Ridge and Hillcrest growth at double the Domestic Consumption
2021-2026	Growth as per Domestic Consumption (Total West)
2026-2031	Growth as per Domestic Consumption (Total West)
NORTH	
2006-2011	Growth as per Domestic Consumption with Umhlanga, Phoenix, Verulam and Tongaat growth at double the Domestic Consumption
2011-2016	Growth as per Domestic Consumption with Umhlanga, Phoenix, Verulam and Tongaat growth at double the Domestic Consumption
2016-2021	Growth as per Domestic Consumption with Umhlanga, Phoenix, Verulam and Tongaat growth at double the Domestic Consumption
2021-2026	Growth as per Domestic Consumption (Total West)
2026-2031	Growth as per Domestic Consumption (Total West)

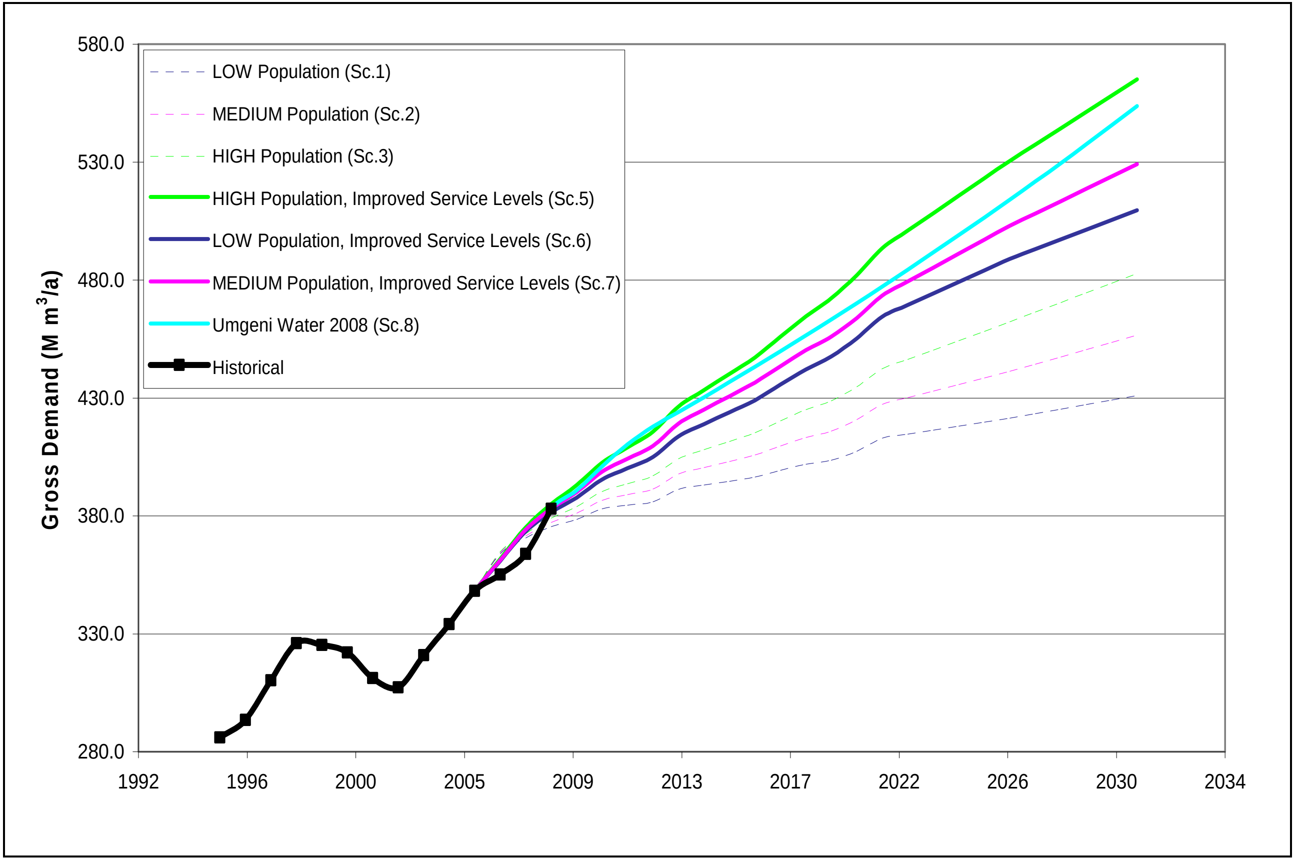

Figure 7.3: Long-term Baseline Water Requirement Scenarios for the Mgeni System with Socio-Economic Migration

7.5 LONG-TERM WATER REQUIREMENTS: MDLOTI SYSTEM

The flow in the Mdloti River is regulated by the Hazelmere Dam, which is the source of water supply to the surrounding urban areas and also irrigation (see **Figure B-1** in **Appendix B**). Umgeni Water is the WSA responsible for the operation of the dam as well as the treatment and bulk distribution of the water for urban supply. The areas supplied are northern eThekwini, Siza Water (WSA), surrounding rural areas (Ndwedwe and Groutville) and limited supply to Kwadukuza. In 2006 the total use of the system was 12.0 million m^3/annum, of which 52.2% was supplied to northern eThekwini, 27.0% to Siza Water, 18.5% to Ndwedwe and Groutville and 2.3% to Kwadukuza. Umgeni Water and ILembe DM had compiled recent up to date water requirement scenarios which were adapted for the study.

The Water and Sanitation Master Plan for the iLembe District Municipality (**DWAF, 2007b**) had been completed at the time of the study and contained water requirement projections for the demand centres supplied from the Mdloti System. The projection however excluded the component supplied to the northern parts of eThekwini. The projection for this area was developed using the water requirements and return flow model and the two projections were combined to develop a total water requirement projection (**Scenario M-A**).

The Umgeni Water 2007 (**Scenario M-B**) projection consists of a combination of projections for the northern parts of eThekwini, Siza Water and additional areas in the ILembe DM supplied from the Mdloti System. The Siza Water and iLembe DM components could further be disaggregated into projections for “approved”, “approval pending” and “conceptual” projects. It was indicted by both Umgeni and Siza Water that several of the approved projects take longer to be developed than expected and that the Umgeni Water Projection is optimistic. The actual consumption in 2007 was also lower than the volume projected by Umgeni Water. Based on these facts, the “approval pending” and “conceptual” categories were removed in order to derive a more realistic water requirement projection (**Scenario M-C**).

A summarised description of the water requirement projection scenarios are shown **Table 7.3** and are illustrated graphically in **Figure 7.4**.

Table 7.3: Mdloti River System water requirement scenarios

Scenario	Description
Scenario M-A	• iLembe Master Plan projection with the eThekwini component supplied from the Mdloti System included (**Scenario 5 – Table 7.1**)
Scenario M-B	• Umgeni Water 2007 projection
Scenario M-C	• Umgeni Water 2007 projection excluding pending and conceptual developments

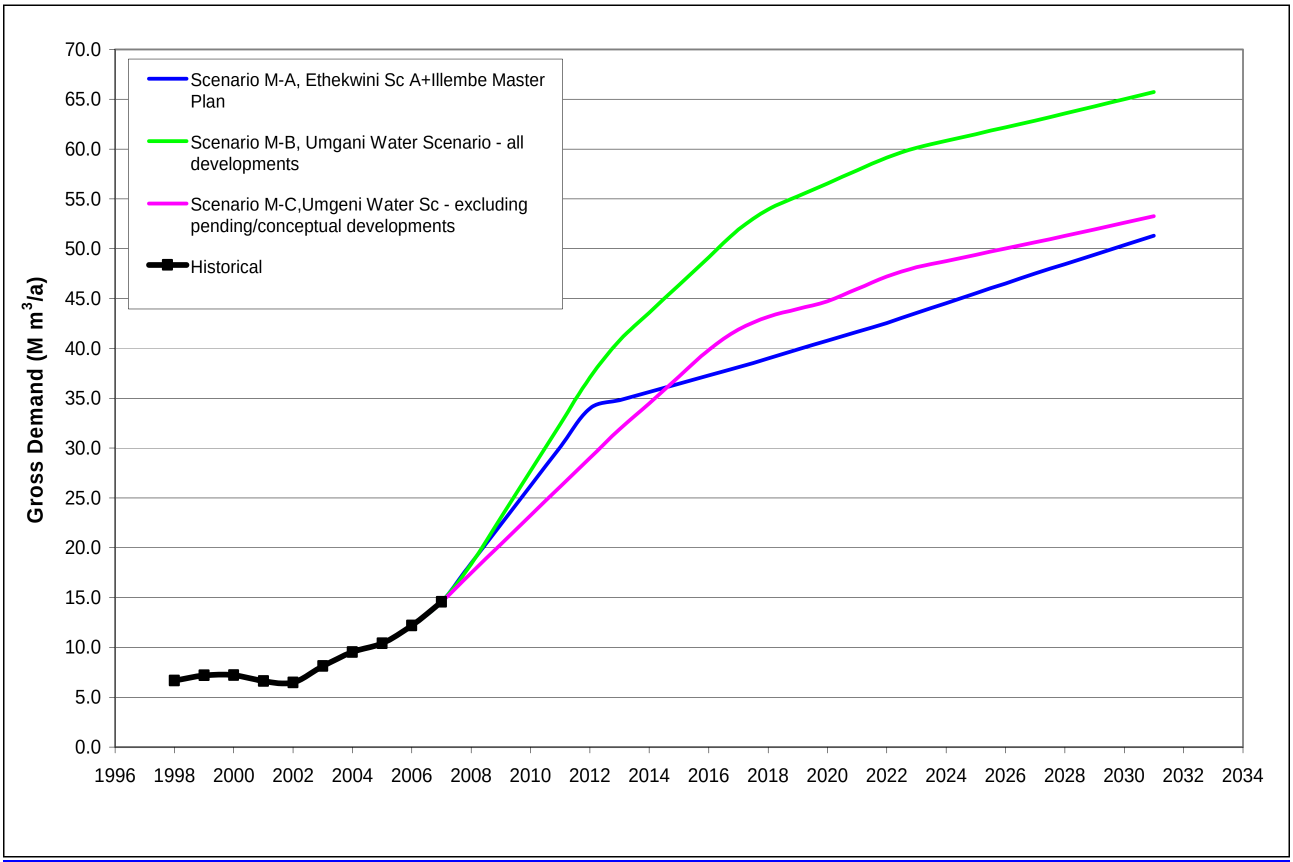

Figure 7.4: Long-Term Water Requirement Scenarios for the Mdloti System

7.6 LONG-TERM WATER REQUIREMENTS: MVOTI

Water is currently supplied from the river abstraction on the Mvoti River System to KwaDukuza via the Mvoti Works. The treatment works have a capacity of 12 Ml/day (4.38 million m^3/annum) which is fully utilised. Additionally, there are two industrial water users also abstracting water directly from the river. These include (**DWAF, 1996b**):

- Sappi fine paper mill (3.6 million m^3/annum)
- Gledhow sugar mill (2.5 million m^3/annum)

According to the Mvoti Dam Feasibility Study: Water Demands report (**DWAF, 1996b**) Glendale sugar mill, distillery and village located upstream of KwaDukuza consumed a total volume of 0.3 million m^3/annum from the Mvoti system. The sugar mill was closed in the late 1990's, while the distillery is still functioning. The water requirement of the distillery is minimal and was regarded as negligible.

Water requirement projections for KwaDukuza and the surrounding towns (Blythdale, Zinkwazi and Darnall) were sourced from the Water and Sanitation Master Plan for the iLembe District Municipality (**DWAF, 2007b**). These were combined with the industrial demand requirements to produce total water requirement projection for the Mvoti System (**Scenario K-A**) as illustrated in **Figure 7.5**.

The purpose of the ILembe Master Plan was to plan bulk supply schemes to all areas in the ILembe DM area. Water requirement projections were therefore compiled based on the total water requirements that would ultimately be required in the area. It was assumed that the bulk supply scheme will take time to implement. The assumption made was that the total current water use of 10.5 million m^3/annum will increase to what was projected in the ILembe Master Plan by 2012, after which the growth from the ILembe Master Plan was assumed.

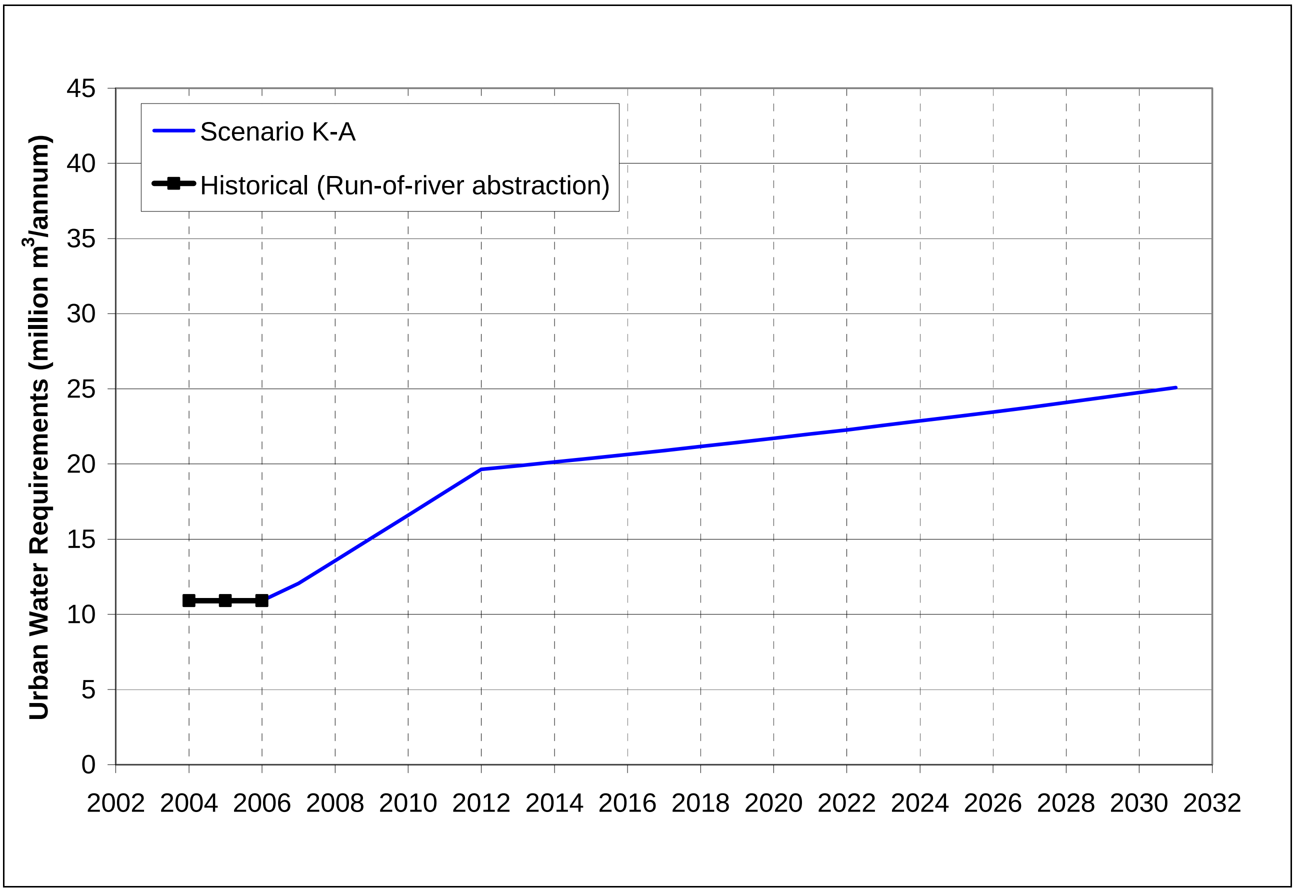

Figure 7.5: Mvoti River System water requirement projection

7.7 LONG-TERM WATER REQUIREMENTS: LOWER THUKELA

The lower Thukela River System is defined as the river section between Kranskop and the Thukela Mouth in this report. The three largest abstractions in this part of the river are (see **Figure B-1** in **Appendix B**):

- The Middeldrift abstraction, from where water can be conveyed to the Ngcebo settlement south of the Thukela and also north over the watershed into the Mhlathuze River catchment and thereby serve the needs of greater Richards Bay.

- The Sundumbili abstraction upstream of Mandeni and serves as source for a water treatment works that serves Sundumbili and surrounds.

- The SAPPI abstraction that provides water for the Thukela paper mill of SAPPI, as well as potable water to the town of Mandeni.

A water requirement projection for the Lower Thukela supply area (**Scenario T-A**) was adopted from the ILembe Master Plan (**DWAF, 2007b**) and included the Ngcebo Scheme supplied from the proposed Middeldrift abstraction and the towns north of the Thukela River supplied from the Sundumbili abstraction (see **Figure A-3** in **Appendix A**). The water requirement projection excludes the existing demands and only includes the projected growth in demands in order to compare the projection to the existing available yield in the Lower Thukela System. The water requirement projection is illustrated in **Figure 7.6**.

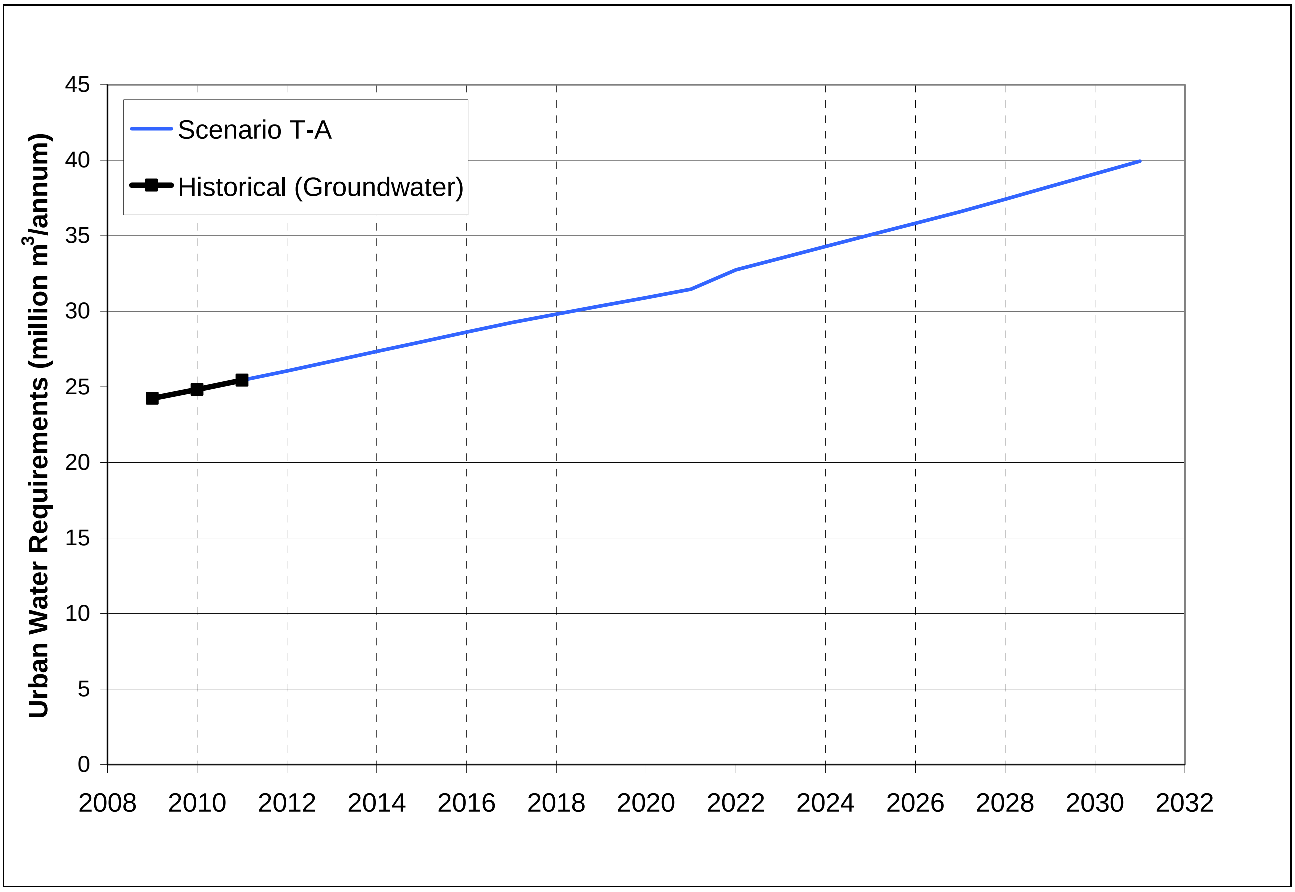

Figure 7.6: Lower Thukela River System water requirement projection

8 CONCLUSIONS

A robust population model was developed by Dr Jeff McCarthy. The key findings were as follows:

- Overall population growth projections for the study area :
  - 0.7% pa : best estimate
  - 1% pa : high road
  - 0.4% pa : low road
- Key growth corridors
  - N2, Durban – Stanger (best estimate growth rate, North) : 1.2% pa
  - N3, Durban – Pietermaritzburg (best estimate growth rate, West) : 0.9%pa
- Total population estimates for 2030 for the study area:
  - Low Road : 5.6 million
  - Best Estimate : 6.0 million
  - High Road : 6.5 million
- The inward migration to the Ethekwini Municipal area is now being countered by declining rural populations.
- The research undertaken by the Ethekwini Transport Authority recommended a 1% pa growth rate for Ethekwini.
- There was no significant correlation (other than obvious relationships) between water demand growth and economic indicators. Cognisance of the obvious relationships between water demands and the boom or bust phase of an economy, are addressed by allowing rates of consumption to vary in the demand and return flow model.

In terms of water demands, the following are significant considerations:

- Domestic consumption comprises between 60% and 65% of the supply to Ethekwini and Msunduzi Municipalities;
- Overall water demand growth has been ±2.6% pa in Ethekwini since 2005, significantly exceeding the population growth rate;
- The biggest driver of water demand increases has been from the upgrading of service levels to the low income housing sector, rather than from the up-market housing projects.

- The high scenario projections for the Mgeni System show an increase from the current levels of ±380 million m^3/annum to ±560 million m^3/annum by 2030.

- The demands on the Mdloti system will increase significantly in the period to 2014, during which time demands are forecast to more than double over current levels to ±35 million m^3/annum.

- The demand and return flow model was generally robust, although certain SDA correlation factors appeared unrealistic. However, their influence on the overall outcome of the demand projections was minimal.

- The 'per capita' consumption rates for the 7 housing categories necessary to achieve an acceptable calibration with the measure system input volume were similar to those determined on other water reconciliation strategy studies undertaken in South Africa. It must be noted that these rates are an equivalent 'system' demand per capita, and they thus appear relatively high.

Overall it is believed that the water requirements forecasts are fundamentally sound and can be used with confidence in the resource and infrastructural planning modules of the study.

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APPENDIX A

WATER RESOURCES SYSTEMS AND DEMAND CENTRES SCHEMATIC

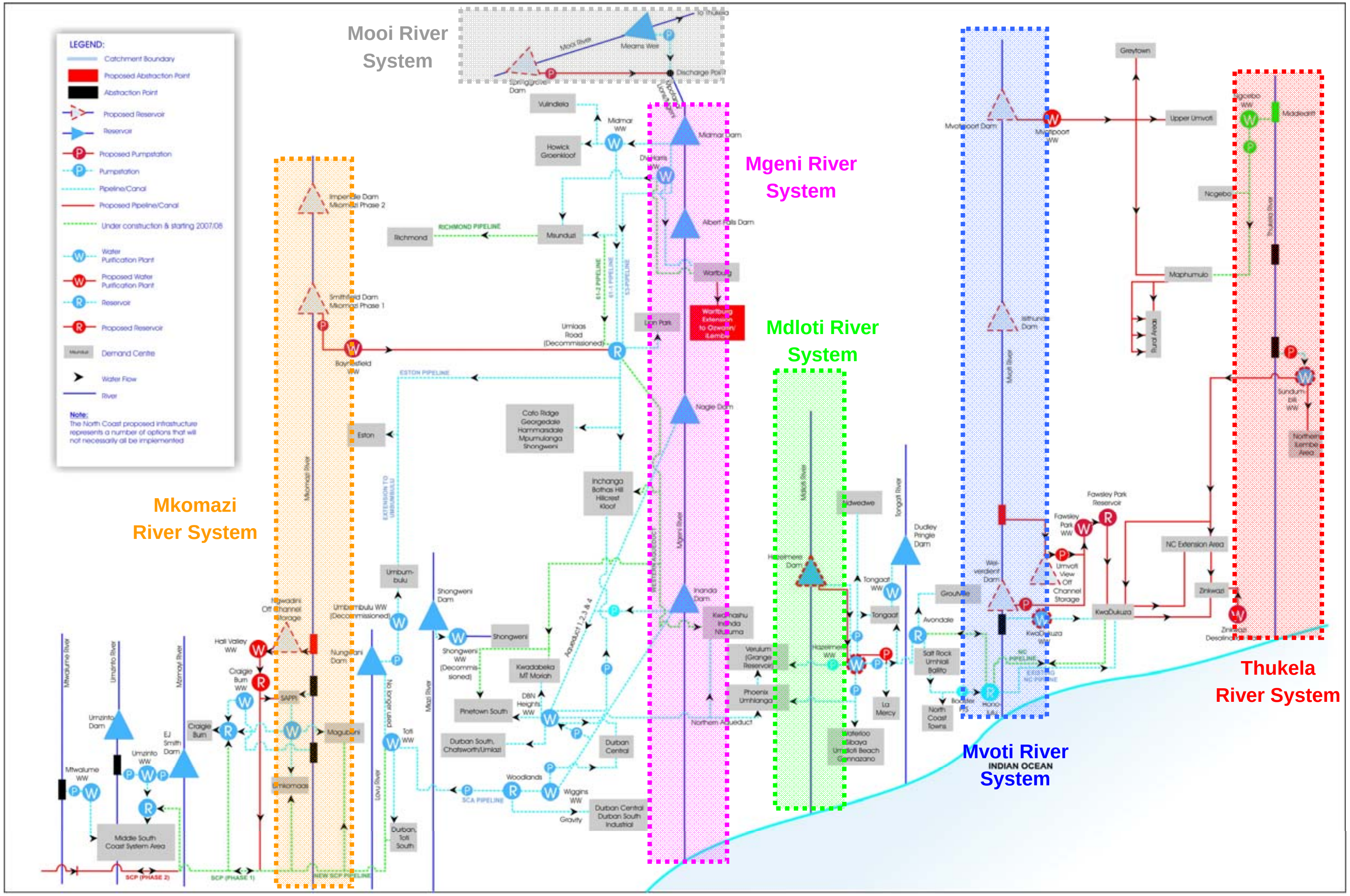

Figure A-1: Water resources systems and demand centers

APPENDIX B

DELEGATE LIST FOR THE SCENARIO PLANNING WORKSHOP

DEPARTMENT: WATER AFFAIRS AND FORESTRY

Directorate: National Water Resource Planning

WATER RECONCILIATION STRATEGY STUDY FOR THE KWAZULU-NATAL COASTAL METROPOLITAN AREAS

WORKSHOP TO DISCUSS THE COMPILATION OF WATER REQUIREMENT SCENARIOS IN THE STUDY AREA TO 2030

13 September 2007 @ DWAF Offices, Durban

DELEGATE LIST

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Johan van Rooyen	DWAF
Niel van Wyk	DWAF
Tendani Nditwani	DWAF
Johann Geringer	DWAF
Angela Masefield	DWAF
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Peter Roberts	Forestry Sector
Laurie Forsyth	Organised Agriculture & Irrigators Association
David Still	Duzi Conservation Trust (DUCT)
Dr Jeff McCarthy	Specialist Consultant
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