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TITLE: AN EXAMINATION OF RAND WATER'S SKILLS DEVELOPMENT FOR THE PRODUCTION OF QUALITY DRINKING WATER LOCALLY

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Contents

DECLARATION

I, Esthelyn Carol Govender declare that AN EXAMINATION OF RAND WATER'S SKILLS DEVELOPMENT FOR THE PRODUCTION OF QUALITY DRINKING WATER LOCALLY is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of the complete references contained.

Signature: ______________________________

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ABSTRACT

The study investigates the effectiveness of Rand Water's Scientific Services' skills development strategy for the assurance of quality drinking water as prescribed by the SANS 0241 National Drinking Water Quality Standard. The aim is to establish whether: 1) the present skills are adequate to provide the scientific data required for affirming drinking water quality and 2) the skills development taking place in the Scientific Services division is adequate for the level and quantity of scientific skills required for the future. There is also some discussion to understand the motivation for maintaining and increasing skills within the Scientific Services division for Rand Water.

Assuring drinking water quality within Rand Water is the sole responsibility of the Scientific Services division. The division provides regular routine and non-routine drinking water quality monitoring, testing, data collection, analyses and reporting on the organisation's performance against the SANS 0241 Drinking Water Quality Standards (SANS, 2006).The focus of the analysis is Scientific Services Division in Rand Water, although the discussion in view of the topic is not limited to the division. Production of drinking water encompasses two key aspects that must be investigated they are quality and quantity, however the close up analyses could only be successful completed for quality in the context of the quantity produced.

Skills development planning within Scientific Services has always been based on the division's feeder pipelines to be able to recruit from and retain scientific skills within the organisation. The division concentrates on Graduate, Bursar and Experiential Learner development ensuring a sustainable, trained and readily available pipeline of skills from which to recruit. Employees currently within the division both permanent and temporary form the type of scientific skills required for water quality monitoring and drinking water standard production and assurance. Employees have been placed within the functional scientific streams of the division and further by their levels of appointment and qualifications. The data analysis has also been done for the increasing of skills using the same framework. Age and gender was also included to show performance of the division in respect to transformation and equity.

Equity in relation to growth is currently a global matter that is under scrutiny. The World Economic Forum has put equity in the spotlight to ensure countries look at their performance. The significance is that it has an impact on how the water resources in a country are distributed and managed. The Water Reforms in most developing countries have sparked large scale discussions around provisioning of water for all. Human Development and Water Resource Management are agendas that countries need to handle collectively with the ultimate outcome being achieving equity for all (UNDP, 2013).

Rand Water's Scientific Service skills data indicates that it has adequate scientific capacity to meet its present mandate of providing drinking water quality assurance for the organisation. There is some concern that the aging workforce is concentrated at management and specialists levels, therefore developing these skills for the next 5 to 10 years requires immediate attention. Transfer of skills and retention of skills requires careful strategic planning in order to attract a younger transformed workforce. The study shows that in as much as routine quality assurance is core, it is also equally critical to have employees who can troubleshoot within the context of the new environmental pressures and diverse operational conditions. The demand for quality drinking water over the last 110 years has increased throughout the country.

The mandatory expansion of the organisation translates into sharing of human resources with other parts of the country to produce quality drinking water. Rand Water has been entrusted to take on the responsibility of other water utilities in the country and ensure that they reach the required standard for the production of quality drinking water. The full scope of the organisation's mandate requires that it provide skills to handle the treatment of drinking water and wastewater in the near future. Although wastewater treatment is currently managed by the local municipalities, Rand Water will be having an active role to improve services. This would mean distributing the existing capacity within the organisation over a greater area of work along with a significant increase in the demand for scientific analyses of drinking water quality.

The pace at which skills development takes place in Rand Water Scientific Services division shows that it will be able to meet the present needs. There are questions raised on the sustainability of the skills for the future. Maintaining and developing skills within the division is critical to be able to sustain the nature, structure and functioning of the division in its current form. The other factor that must also be maintained is the transformational equity demands of the country. The notion that there is a lack of experienced previously disadvantages scientists must be addressed directly to meet all the future demands of the sector, region and continent in a short space of time.

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For my husband Deenadayalan, daughter Jerile and my son Michael. May this study be an inspiration to you in all your pursuits in life and may it encourage you to strive towards reaching your amazing potential.

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ACRONYMS AND ABBREVIATIONS

ACI – African Coloured Indian

AR – Annual Report

AS – Analytical Services

BSc – Bachelor in Science

BSc Hons – Honours in Bachelor of Science

B Tech – Bachelor of Technology

CAD – Computer Aided Design

CAPS – Curriculum Assessment Policy Statements

CBM – Capacity Building Manager

CD – Correctional Department

CDP – Corporate Directive Planning

CGMA – Chartered Global Management Accountant

COO – Corporate Operations Officer

DCP – Dual Career Path

DoE – Department of Education

D Tech – Doctorate in Technology

DWA – Department of Water Affairs

EDP – Education Development Practitioner

ESETA – Energy Sector Education and Training Authority

ETDP – Education Training and Development Practitioner

EWSETA – Energy and Water Sector Education and Training Authority

EU – European Union

FET – Further Education and Training

GDP – Graduate Development Program

GDP – Gross Domestic Product

GIT – Graduate-in-Training

HDR – Human Development Report

HET – Higher Education and Training

HR – Human Resources

HR-ISO – Human Resources Information Systems Officer

IAR – Integrated Annual Report

ICT – Information and Communication Technology/Technologies

IDP – Integrated Development Plan

IM – Information Management

ISO – Information System Officer

IT – Information Technology

IWA – International Water Association

IWRM – Integrated Water Resources Management

IWRMS – Integrated Water Resources Management Strategy

KZN – KwaZulu Natal

LIMS – Laboratory Information Management System

LMS – Learner Management System

MDG – Millennium Development Goals

Ml – Mega litres

MSc – Masters in Science

M Tech – Master of Technology

MQA – Mining Qualifications Authority

NCS – National Curriculum Statement

NDP – National Development Plan

NQF – National Qualifications Framework

NSDS – National Skills Development Strategy

NTU – Nephelometric Turbidity Unit

OD – Organisational Development

(P) – Permanent

PDP – Personal Development Plan

PhD – Doctorate in Science

PMS – Performance Management System

QCTO - Quality Council for Trades and Occupations

RPL – Recognition of Prior Learning

RSA – Republic of South Africa

RW – Rand Water

RWA – Rand Water Academy

RWM – Rand Water Mpumalanga

SA – South African

SANS – South African National Standards

SAQA – South African Qualifications Authority

SDF – Skills Development Facilitator

SHC – Strategic Human Capital

SHREQ – Safety, Health, Risk, Environment and Quality

SS – Scientific Services

SSP – Sector Skills Plan

(T) – Temporary

TDC – Training and Development Co-ordinator

TM – Talent Management

UK – United Kingdom

UN – United Nations

UNICEF – United Nations Children's Fund

WDR – World Development Report

WHO – World Health Organisation

WISA – Water Institute of Southern Africa

WRC – Water Research Council

WSLG – Water Sector Leadership Group

WSP – Water Safety Plan

WSP – Workplace Skills Plan

WTT – Water Technology Training

WQSb – Water Quality Specialist Bulk Distribution

WQSc – Water Quality Specialist Customers

WQSp – Water Quality Specialist Production

WQSs – Water Quality Specialist Source Water

YWP – Young Water Professionals

Chapter 1: INTRODUCTION

1.1. Introduction

Water quality assurance is a vital component for any successful organisation involved in the provisioning of drinking water. The principles and structural functionality of any testing and monitoring unit of drinking water quality assurance will have essential aspects that are generic globally. A drinking water quality standard must be applied in any country for the assurance of drinking water acceptable for human consumption. The standard must be based on the World Health Organisation (WHO) standard being the minimum standard acceptable (WHO, 2011). The efficacy of the production and testing of quality drinking water requires having the right skills to be able to do the job successfully and sustainably.

"Human resources are the most valuable assets of any country hence every nation, no matter the economic situation or political leadership, has a formal education system of schools and other training institutions that organise and coordinate the transfer of values and attitudes, norms, knowledge and skills to new population groups and new generations" (WORK, 2005:1). The statements aptly sum up the essential focus of education and on education for any developing or developed nation. The importance of investing in skills development in the water sector in South Africa was again one of the key topics at the Southern African Young Water Professionals (YWP) Programme under the auspices of the International Water Association (IWA) and Water Institute of Southern Africa (WISA). Dr Jo Burgess, the chairman of the second South African Young Water Professionals Conference organising committee, highlighted the loss of skilled professionals in the water sector which is a major threat to effective water management in South Africa. She emphasised that sharing knowledge from the experienced to young water professionals is critical. Dr Burgess also added that the conference provided opportunity to strengthen the youth's leadership skills (www.25degrees.net, 2011).

Finance Minister Mr Pravin Gordhan in his 2011 South African Budget Speech to the National Assembly said, "We cannot view the fact that 42% of young people between the ages of 18 and 29 are unemployed as merely a statistic. Young men and women in cities, informal settlements, towns and villages may not have jobs, but have skills in life. They possess the awareness and the ability to learn, they drive fashion and inspire with their music... And they have hope, and look to us to give meaning to that hope" (National Treasury, 2011: 7).

The Honourable Minister's ideas are admirable yet the reality to enabling such systems in South Africa is an enormous challenge. South Africa is riddled with many complexities of past injustices in education and more specifically in higher education. The segregation of education systems and curriculums along racial lines had left a huge gap of not having enough non-white skilled professionals. Apartheid legislation still stifles economic transformation in South Africa. Government's effort to transform the workforce, with skilled non-white professionals has taken longer than envisaged. Black skilled professionals are having to catch-up to white professionals in terms of years of experience. Experience is a time-based phenomenon which cannot always be fast-tracked and is important for long term success in a changing diverse environment (WRC, 2015).

In a democratically organised society, education would be the tool to mould society and would equip the individuals for their future life in the family, local community and the economy of the country. Healthy society will have productive knowledge, skills and competencies to constitute the fundamentals for production and a sound balanced socio-economic climate. All the activities will be geared towards production in order to meet the basic needs and other requirements of all people to sustain and develop. Formal structured production will ensure financial stability of a country's necessary public activities such as education, health care and social security. Education would be to the entity key to a better life and a government failing to provide the relevant education to its population risks becoming developed or falling lower on the scale of economic growth (WORK, 2005).

In developing countries failure to provide relevant education will effectively cause the country to become poorer. The Human Development Report entitled *The Rise of the South: Human Progress in a Diverse World* has suggested five broad conclusions. One of the conclusions is Rising Economic

Strength in the South which must be matched by a full commitment to human development. The discussion to support this conclusion indicates that investments in human development are justified not only on moral grounds, but also because improved health, education and social welfare is key to success in a more competitive and dynamic world economy (UNDP, 2013).

South Africa finds itself challenged by a lack of education and a well-structured sustainable state driven education system for a developing nation. Education challenges have a direct negative impact on the socio-economic transformation of South Africa. The notion that when the legislative policies of countries have transformed it would result in implementation and application being a given. Reality is that, that is not the standard in any country. The Human Development Report 2013 indicates the importance of policy change in transformation. Transformed legislation is significant for contribution to the development thinking. It is by no means the final step in and for sustainable development (UNDP, 2013).

The Bantu Education Act of 1953, later known as the Black Education Act of 1953, was legislated segregation of education and training along a racially defined framework in South Africa with a deliberate intention to disadvantage the non-white population of the country. Non-white people, more specifically black people were steered into non-professional, non-academic rigour. This was to ensure that they would have virtually no chance of completing a tertiary qualification. The black South African will therefore, only be able to find work at a predetermined level in the country’s economy. This defining factor created generations of non-academic African people in South Africa, resulting in spheres of the major economy of the country being unattainable for them. The ill of limiting non-white academics was firmly embedded with prior complimentary legislation such as the 1951, Job Reservation Act. A legislation that ensured that any skilled persons needed were recruited from the United Kingdom, thus entrenching and eliminating opportunities in the fields of artisans and apprentices for all non-white South Africans (SA, 2015).

Rand Water from its inception to present has had overwhelming support and the confidence of the government. Local impression of the organisation is that it is adequately capacitated, although it faces similar challenges that most public utilities face of not having enough developed and experienced non-white skilled professionals. This challenge was more alarming in areas of science and engineering. Government is also urgently addressing the current situation of a lack of artisans by a major initiative to develop these skills for the country. Rand Water is a key stakeholder in this initiative, namely the War on Leaks Project. It is important to note that successful artisanship development programmes require time and effort by skilled experienced artisan trainers, who are predominantly white. Training artisans needs time and practical experience to yield good results. Artisans will be given an average development period of 2-3 years to acquire the skills. Well trained artisans usually go on to become recognised skilled labour that can function independently in more than one area of technical skills. An artisan once developed can take on an apprentice in his main area of competency (EWSETA, 2015).

Rand Water is recognised as a leader in the water sector nationally and by neighbouring countries for - the production of quality drinking water. This commitment to the production of quality drinking water for over a century is well known - the largest inland bulk water supplier in South Africa. Rand Water is also assumed to be the institution of best practice in the water sector for the production of quality drinking water. The operating principles practiced are thus regarded as sustainable and can with ease be replicated into the future. Skills development and skills transfer is assumed to be taking place in Rand Water and would be the most effective tool for sustainability and high performance. Rand Water therefore would be able to offer solutions needed in many regions of the country for addressing the drinking water quality challenges.

Rand Water’s future projects and strategic planning shows some integration with the water sector’s timeframe for improving the water and sanitation services challenges for the nation and the Sub-Saharan region. The Millennium Development Goals Report of 2010, projected that water and sanitation services would be improved from 1990 to the target year globally of 2015 (UN, 2015). Water services improvement for the Sub-Saharan region was projected for 2040 and sanitation for 2076, implying that the region would be in a lag of 25 years from other developing regions to be able to provide quality drinking water and a further 36 years lag for the provisioning of sanitation services (UN, 2000).

Solutions can be provided sooner through more concentrated strategic efforts to develop core skills and share best practice within the Sub-Saharan region. Rand Water can offer quick simple answers to many challenges. Best practice and intensive skills development efforts may be the genius required locally. A localised skills development framework and talent model as defined and implemented in Rand Water can be formulated to capacitate other water utilities (WSLG, 2009). Strategic planning for the water sector will be the responsibility of the water utilities to effectively share solutions and transfer skills that will drive growth optimally.

A careful examination of what Rand Water is doing for the improvement of skills development internally and in the sector is necessary. Alignment to the skills development framework must translate into a single entry point of all human resources irrespective of the type of skills development which will ultimately mean a pool of skills for the production of quality drinking water. The core skills for the production of quality drinking water must be identified and quantified for the next 30 years and beyond. It is further imperative to understand water as a natural resource and that its geographical location is significant a factor in determining how quality drinking water production is done.

Rand Water Scientific Services division adopts as its operational framework model water quality monitoring and assurance from catchment to consumer. Investigation into the skills base of the division will help to determine the skills necessary for assuring drinking water quality. Talent data for the division is the basis for understanding the skills necessary for the assurance of drinking water quality from the source (catchment) to the consumer. It is an indication of the skills required for the organisation and the sector. This must be considered in the context of the present challenges of the country and the pursuit by government to equitably transform its skilled workforce.

1.2. Study aim and objectives

1.2.1. The Study Aim:

The study aims to examine Rand Water's skills development for the production of quality drinking water locally

1.2.2. Objectives of the Study:

The study addresses the following objectives by using the data for the Scientific Services division

- To assess whether the skills needed for the next 5 years exists or is it currently being developed
- To identify current positions that are considered essential/core skills specific to drinking water quality assurance
- To determine the average ages and gender of the persons for jobs identified as essential/core skills
- To assess the current academic strength and is more being developed to sustain and deal with future drinking water quality challenges

1.3. Problem Statement

Rand Water defines its business capability as follows: It has the human resources and the experience needed to grow its business for the future along with the technology to support it (Rand Water, 2013). Present skills development data is the indicator of the quantity and types of skills being developed and can be assessed to determine whether the efforts are adequate to meet organisation's and government's current and future expectations. Government's expectations are not only limited to providing assistance to other water utilities within the country but to the Sub-Saharan region if not the continent.

Rand Water is a bulk water supplier to the local municipalities and a core function is the assurance of drinking water quality for customers. Scientific Services division is responsible specifically for the assurance of the quality of the drinking water. Rand Water's approach to skills development is not a focused well directed one. The resources for skills development and efforts throughout the organisation seem to have separate objectives. The challenge in this regard is that, Rand Water does not initiate all skills development initiatives from one co-ordinated point of authority. Currently Rand Water has taken on one water utility and assists other water utilities and municipalities with the maintenance of water quality within their distribution network. Rand Water also advises and assists with some municipal wastewater treatment plants to adequately provide sanitation services for area (Rand Water, 2014). In order to be able to successfully execute these mandates effectively there needs to be serious internal consideration to establish an organised approach.

An important aspect to note is that in as much as the study aims to answer the questions raised, it does not necessarily prove that any water utility that can prove they have these skills can be involved in the production of quality drinking water successfully. The production of quality drinking water entails various aspects that must be considered collectively and systematically in order to yield the success required for the exact geographical location. Another equally important aspect is sustainability of all aspects of the organisation to meet the customers' requirements. The factors that are core in the production of quality drinking water are the following:

- The quality and quantity of the source water and the skills required to ensure that the treatment processes are adequate to deliver the required quantity of quality drinking water.
- The relevant qualified skills to consistently monitor the entire production process and supply chain quality.
- The relevant qualified skills to consistently monitor the source water to identify any changing trends and advise on treatment process adjustments appropriately.
- The relevant skills to understand the dynamics of the geographical location of the source water and the socio-economic trends of the area.
- The quantity of quality drinking water needed and the supporting infrastructure required.
- The ability to support the growth of the country or region as required socially, economically and/or politically along with the required systems and processes of legislation for regulation.

The production of quality drinking water is done in various ways around the globe and on varying scales. One aspect is comparable that is the standard of drinking water quality, which is not compromised in successful organisations. Drinking water quality assurance against the World Health Standard (WHO), which in South African translated to showing compliance to the South African National Standards (SANS) 0214, for Drinking Water Quality. The research questions have been limited to Rand Water's Scientific Services division which is responsible for the assurance of drinking water quality for the organisation. Deriving from the research questions, the principle main question is – how closely matched are both the existing skills and the skills being developed to meeting the organisational and governmental expectations?

The production of quality drinking water is however, not limited to one division in the organisation being able to deliver its outputs. Scientific Services being able to provide all the reports and data required to confirm that the water treated and supplied complies with the national drinking water standards is just one significant part of the process. The division and organisation's processes are based on both quality and quantity and must also show a clear indication that quality drinking water production is possible for now and the future. An aspect that is core to the production of quality drinking water sustainability is the organisational succession planning which needs to be measured against the transformation requirements of Rand Water, and South Africa.

In January 2013 at the Scientific Services Divisional Strategic Planning Workshop the core skills required for the assurance of quality drinking water was identified and presented to the divisional representatives (Rand Water, 2013). The core skills for the division were determined using the positions within the division that were directly involved in water quality assurance. There were at that point 55 positions identified to be core, and discussions revealed a total of 91 positions collectively being core/essential. The thinking formulated to identify core/essential roles in the division brought to light some important information that must be considered when talking skills development in the division. These important considerations are noted as follows:

i. Employees within the division are academically qualified do other jobs in the division and organisation. Employees have no opportunity to gain experience in those jobs since their current jobs are demanding with no additional resources to create availability.
ii. Graduates being developed in/for some positions are a temporary resource that can be lost, unless they are permanently employed into a similar position or in the same department or section.
iii. The divisions focus on specialisation and constant drive to use limited number of employees to produce required outputs does allow employees to develop even more scientific skills.

The daily operations on the treatment plants may not necessarily require scientists to execute it but require artisans and technicians. It is the daily water quality assurance analyses that require skilled scientists. The reports which confirm the water quality also require qualified experienced scientists to make the call of quality against quantity produced. Scientists in addition to daily reporting will also have to provide analyses that will give the assurance of the sustainability of quality drinking water. It is integral that water quality monitoring be done on a regular continuous basis and in a regular continuous pattern that cannot be compromised.

1.4. Significance

The production of quality drinking water is and will always be a requirement for life. Quality drinking water is in ever increasing demand due to the increase in the population and the socio-economic growth. A vital aspect to note within the context of the South African economic growth is the fact that South Africa is a water scarce country, being classified - semi-arid. In spite of these obvious facts around the provisioning of water in the country there is the additional challenge that Rand Water faces of having its main raw water source located 50 kilometres away from the major supply area. These aspects must be considered within the context of Rand Water's daily operations and providing assurance of quality drinking water. The important implication for Rand Water is having and developing an intricate combination of skills at various levels that is necessary for sustainability. Another key consideration is that Rand Water endeavours to maintain its huge operations through a conventional treatment process and distribution network with limited automation. A gradual increase in quantity has a direct impact on quality and on the skills required to ensure production standards are met and that the assurance of the water is provided.

The argument of whether such highly skilled scientists are required for daily operations and at the proportions being determined and developed presently. Rand Water's raw water quality does not necessarily have the challenges that other water utilities experience. Magalies Water is another inland water utility that has massive challenges with raw water quality which deteriorated as a result of extremely high levels of nitrification (Madibeng Local Municipality, 2015). Raw water quality deterioration in the direct abstraction area for Rand Water does not show significant or immediate or even long term concerns. There are others who may argue the contrary in view of the fact that trends shows raw water quality decline however slight it occurs. What would justify the perpetuation of highly skilled scientists in Rand Water Scientific Services presently and for the future?

Research done by the Process Technology department in Scientific Services on process capability assessment for the Vereeniging Treatment Plant as at November 2014, indicates that the last 10 years of raw water quality analysis, has only one major phenomenon that affects raw quality. Rand Water's direct abstraction area is affected by extreme weather patterns. This is in reference to the high rainfall years that results in the need for the dam wall gates (sluices) to be opened. The trend is the effect usually persisted for at least 3 to 4 years and thereafter the raw quality shows stabilisation. There are only four determinants that show any increase in the raw water, this was tested against the SANS 0241 drinking water standards. The effect was increases in Aluminium, Colour, Iron and Turbidity (Rand Water, 2014).

The answer for why the large numbers of highly skilled scientists are required is that assurance of drinking water quality is not as simple as having the skills to do regular and routine testing of drinking water quality parameters and be able to provide results to prove compliance to the national drinking water quality standards. In addition to regular routine testing, experienced and knowledgeable scientists are needed to argue articulately at all levels the accuracy and credibility of the quality of the drinking water test results produced.

Consumers of today are far from the consumers of 100 years ago or even of the past 30 years. Today's consumer is much more informed and aware of the drinking water quality and the different products of drinking water available to them. It is therefore, critical to provide precise scientific arguments to satisfy the discerning consumer more regularly of the drinking water quality. The affluent consumer can also afford to choose the product they believe to be of higher quality. These emerging consumer dynamics warrant having the skills to be able to defend the production of quality drinking water out of the tap against other types of drinking water products available on the market.

1.5. Limitations

The operational quantity component relating to infrastructure development and the treatment processes is necessary to understand the production of quality of drinking water in a complete precise way. Ancillary services e.g. maintenance of the organisation's infrastructure are directly associated with operations would also be given attention when investigating the production of quality drinking water fully but both components were not addressed. The areas of business not included were due to the limitations encountered in obtaining accurate current data both from the Learner Management System (LMS) and human resources' records. Scientific Services is the focus since the relevant data required for analysis was available on the system and on record.

More aspects of research would have been handled if the consolidated skills development data for the organisation from the Strategic Human Capital (SHC) Learner Management System (LMS) was available in its entirety. The data would have been analysed for the full talent perspective of the organisation and drilled down to the data for the production of quality drinking water. The technical skills data would be filtered on the appropriate level for the entire operations portfolio. The Strategic Human Capital skills development framework approach would have then been used; it would be easy to quantify skills development initiatives for all the operations areas. Frameworks like that formulated for the Blue Drop Process Controller development that shows the timeline for projected skills development to prove future compliance and sustainability would have been established. A strategy based on pipeline skills development taking place in all areas of the operations portfolio of the organisation would have then been shown. The results would have provided the information required by the Sector Growth Strategy and vision framework for Rand Water's skills development as far ahead as 30 years for its core business. All the required data is not available and the data captured for operations recently has not been verified and is not available on files for cross reference.

1.6. Assumptions

The data analysis is limited to the Scientific Services division thus the assumptions are confined to the division. One important assumption is that the current capacity of the division is sufficient and that the specialists are working optimally having no significant challenge of being overloaded in respect to their daily functions. The present complement of scientists within the division also work on other projects for water quality within the organisation and with other water utilities, the assumption is that it is not at the compromise of their current work. The numbers of scientists projected for the future have been calculated on the assumption that there are no drastic environmental changes or climatic change that directly impacts weather patterns which may warrant a significant increase of capacity. This will have significance since it has an impact on the catchment, which impacts the direct abstraction areas of Rand Water and thus the quality of the raw water entering the treatment plants.

Employees engaged in further study in scientific streams in the next 5 years will provide sustainability and be able to support growth. The assumption is that those committing to further study follow through and have no obstacles that may prevent them completing their studies by the projected time or some not completing at all. It is also assumed that the engineering skills development pipeline model and the process controller development framework in some aspects work concurrently with the Scientific Services' skills development pipeline model. The ,major assumption over hanging the study would be that the full scope of skills required for the production of quality drinking water in respect to quantity and quality outputs can be met within Rand Water. This will include the skills development of employees for the treatment plants' operations and infrastructure requirements current and future. The key focus remaining purely on the assurance of quality drinking water produced meeting the SANS 0241 standards.

1.7. Research Methodology

The study was initially aimed at doing a full analysis of the skills development within the organisation and drilling down in detail to the technical skills within the operations portfolio. Data for the organisation was drawn from Rand Water's LMS. It included all employees who have a qualification from NQF Level 5 and above. The result was assessed for any gaps and it was realised that the data was not complete. If the data was completed it would have been filtered for the science, engineering and technical streams which would be the collective technical skills required for the operations portfolio of the organisation aligned to the jobs and core functions.

The data gathered from the corporate LMS in August 2013, showed significant gaps. Data was then redrawn in January 2014, again in April 2014, and once more in June 2014 hoping to find an improvement of absent data. The data from August 2013, January 2014, April 2014 and June 2014, all 4 reports confirmed that there were significant gaps. This was not just the case for the Chief Operations Officer's (COO) portfolio but for the organisation as a whole. It was found that of the 3759 results, 1241 had no information recorded for employees. This meant that 33% of the organisational data was not available. The data contained could not be confirmed to be accurate since there was no verification done for as far back as the last 5 years, which was since 2009. The latest report drawn to monitor if there has been any progress since, showed an improvement of absent records by 4%, this was as at 12th October 2015.

The data available could not be confirmed to employees' files. The data available on the system was absent and was not the latest qualification for a large number of employees. The lack of accurate data is what confined the study to Scientific Services Division with the key focus being the assurance of quality drinking water. Data for Scientific Services showed core/essential skills required for the functioning of the divisions. The academic records for employees have been verified with their personnel files and what was reflected on LMS. The statistical discussions are specifically concentrated on the Scientific Services Division of Rand Water. Some high level linkage have been discussed looking at one local utility - Umgeni Water and one international water utility - Thames Water.

Rand Water's talent frameworks and skills development information for planning is in progress but not finalised for the entire organisation. The succession planning document is approved for discussion at all levels of the organisation and at stakeholder forums. The data for the full Engineering Division is in the process of being gathered and completed for some departments but cannot be verified on the LMS or to the employees' files. Operations sites have begun gathering data for the specific operations department to be able to plan skills development for the future. The data gathered for the Process Controls on the treatment plants is in the format required for Blue Drop audits. No conclusions were drawn from any data still in the collection stage and not verified. The information used for comparative discussion of the local and international utilities is the performance reporting information made available to the public for the utilities.

Chapter 2: LITERATURE REVIEW

2.1. Introduction

Monitoring of quality drinking water globally seems to have begun in around 1908 in cities in North America. The North American cities were the first to introduce continuous chlorination systems into their water treatment operations (Enviroharvest, 2015). The development in 1908 was the start of drinking water disinfection. Rand Water's focus on the quality of the water supplied to consumers began with discussions and some regulating in 1903.

Focus on the importance of source water protection was also brought to light in 1908. This drew specific attention to the monitoring of the water in the Great Lakes of Canada in 1909. The first International Commission report in 1918 addressed the issue of chaotic, perilous and disgraceful water pollution in parts of the Great Lakes. There were concerns raised in 1909 of negligence in respect to pollution of source water, however, these concerns were only properly addressed in 1972 with the 'Great Lakes Water Quality Agreement' (EPA & EC, 2013).

In the 1930s the United States in spite of its extensive water resources available faced the similar situation as the mining community of Johannesburg due to the pumping of underground water faster than it could be replenished. An important fact to note is that the 1930s had experienced a recent past which was drier than usual globally. This meant that the authorities at the time had to find viable solutions to provide safe water supplies using the surface water available. The demand for safe water had to be addressed for the rapid growing populations in the supply areas. The last century has transformed the way consumers understand the provisioning of water by water utilities. There is immense awareness of water quality, more so on drinking water quality which is a basic human right (Weise, 2016).

Water quality assurance testing and monitoring began in Rand Water in 1906 when Dr J McCrae a Government Analyst from 1906 until 1930 was appointed by the Rand Water Board. He remained an independent consultant for Rand Water in his retirement until 1961. An Analytical Chemist was appointed in 1948, followed Dr PR van der Riet Copeman, until 1967. In 1935, Mr WG Woxhalt and

Mr KR Brown were appointed as laboratory assistants at Vereeniging Pumping Station. Mr Woxhalt became the first Works Chemist of the Rand Water Board in 1939 and later the Board's first Chief Chemist in 1954. Mr Woxhalt remained at Vereeniging as Chief Chemist until 1968. His keen interest in pollution control initiated the Monday Weirs sampling programme in 1936, which has continued to present.

Ms Rochester was the first female appointed to the Rand Water Board in Vereeniging, and the first to be appointed to the laboratory staff, also the first Bacteriologist. Bacterial analyses prior to 1939 were done by the medical officer of health in Johannesburg. Mr Morgan joined the Rand Water Board as a Chemist in 1948, and was promoted to Station Chemist in 1954, when Mr Woxhalt became Chief Chemist. Mr Morgan was Station Chemist until 1964 and Mr Attwell took over from him. Mr Husselman became Station Chemist in 1970, thereafter Mr Hattingh in 1977. The first Pollution Control Officer, Mr RE Hayes, joined the organisation in 1965.

Rand Water Board's first Senior Scientist was Mr SW van der Merwe in 1967 he was an Assistant Scientist. He was responsible for the research laboratory, from 1970 to 1973. In 1975, Mr van der Merwe succeeded Dr RJ Wells to become Chief Chemist. In 1935, the first Analytical Laboratory was established in Filter House No 1. The laboratory included the foyer and the corridor, the latter being the Balance Room. Inadequate facilities led to a request by Mr Woxhalt for more formal laboratory space, which was made available in Filter House No 2 in Vereeniging in 1948. The laboratory in Zuikerbosch was completed in 1954; the first Station Chemist at Zuikerbosch was Mr W van Eeden, then Mr KR Brown and Mr BH Pieters. The laboratory in Zwartkopjes came into being in 1966 when the old chlorine room was renovated to serve as a laboratory. The first Scientific Assistant to work at Zwartkopjes was Mr JJJ Liebenberg (Rand Water, 2006).

The hydrobiology laboratory was founded in 1970; most recent additions to Rand Water's laboratories are the organic laboratory, the operations laboratory, and the research and development laboratory of the Pilot Plant. During the late 1980s, the functions of the Chief Chemist's department were structured into a separate division, Scientific Services. The first General Manager of Scientific Services was Mr Schalk van der Merwe, who undertook the restructuring of the division in 1994, into five departments. The departments were:

1. Treatment, headed by Mr Alwyn Husselman and was succeeded in 1996 by Mr Kista Naidoo
2. Water Environment, headed by Dr Chris Viljoen

3. Process Development, headed by Mr John Geldenhuys
4. Biological Sciences, headed by Dr Machiel Steynberg
5. Chemical Sciences, headed by Dr Elsie Meintjies, in 1997 by Mr van der Merwe.

The four laboratories in 1998 moved into the Analytical facilities in Vereeniging and in February 1999, Dr Hamanth Kasan was appointed General Manager of Scientific Services and currently still holds that position. Scientific Services was developed during that time to be the foundation of an independent division responsible not only for biological and chemical analyses, but also for water cycle management, water quality assurance, process development and research, technology training, and water quality marketing (Rand Water, 2006). The Station Chemist function returned to the Operations division (Rand Water, 2006).

The division was organised into service-oriented groups called departments. It is interesting to note that the first laboratory started in 1930 with one Analytical Chemist and grew steadily with 22 employees in 1950, 39 in 1980, and 47 in 1983, to 153 in January 2009. In January 2015 Scientific Services was made up of 136 employees inclusive of support employees. The nature of the functioning and structure of the Scientific Services division has evolved from the water analyses that were needed over the last 110 years. It has taken the form and mandatory responsible of water quality from catchment to consumer (Rand Water, 2006).

The Environmentalist, in 1992 addressed the water and sanitation crisis and looked at what should be considered when investing in water supply improvements in cities in most developing countries. It was noted that technologies needed to be simpler and should match the operation and maintenance skills available. The aim would be to maintain and sustain based on existing capabilities of the minimum needs (Harvey, *et al*., 1992).

In their article McCutcheon *et al* (2007) quoted the then South African Deputy President Phumzile Mlambo-Ngcuka to bring to light the importance of user-friendly systems, methodologies and technologies. The transformed legislation will have to accommodate the South African workforce and not that of developed countries (McCutcheon, *et al*, 2007). This unfortunately is the reality of there being limited experienced technical, scientific and engineering skills in South Africa. There has been some improvement since, as reflected in the Human Development Report 2013, which revealed 395.5 per million people to report for South African Graduates in Science and Engineering for the 10 year period of 2002-2011. In Innovation and Technology, research and development, and technical streams there are fewer graduates but a definite increase as indicated in Table 12 of the Human Development Report (UNDP, 2013:188).

2.2. Background

Education is the essence of progressive nations. Education not only improves the functioning of a human being but also enables him/her to positively contribute in a socio-economic context. The adaptability of people to change and innovation is heightened to the extent that the person is able to not just understand his contribution in a domestic context but in global context (WORK, 2005). When one acknowledges good education to be the essence for a country's growth it becomes apparent that a highly skilled workforce can be achieved by having a well formulated public education system. Priority should be given to skills development in science and engineering which are the critical human resources for the future success of progressive countries. A skilled workforce of the future will include a range of academically sound and experienced citizens being constantly developed. A superficial analysis of this requirement against South Africa's aim for a transformed workforce indicates that post-apartheid black South Africans have a mere 20 years of experience as opposed to a century of experience of white South Africans. The picture is not favourable but a developing nation like South Africa will still have to meet the requirements for it to be a global competitor.

The World Development Report of 2001 identifies Johannesburg's rate of theft and violent crimes to be amongst the highest in the world and the current statistics are not looking any better (UNDP, 2001). It is clear that health and education are paired and have a direct relationship to poverty resulting in high crime rates. Education is the pivotal control for moving the scale to a vantage point to finding the successful outcomes sort after. The National Planning Commission report, 11 November 2011 attempts to provide some consideration for both government and private sector to ensure a resolve around poverty and inequality. The effects of the previous government have left us with a missed generation of capital investment in roads, rail, ports, electricity, water and sanitation, public transport and housing. The Deputy Chairman of the Commission Cyril Ramaphosa indicates that a middle path needs to be found of both growth and redistribution (South Africa, 2011).

The National Skills Development Strategy (NSDS) I, II, and III under the advice of the National Skills Authority is aimed at putting in place the key principles for skills development that will adequately equip the people of the country for economic growth, social development and sustainable employment growth. The three NSDS documents had underlining objectives which were summed up in their titles:

- National Skills Development Strategy I (2001-2005) – "Skills for Productive Citizenship for all"
- National Skills Development Strategy II (2005-2010) – "Skills for sustainability growth, development and equity"
- National Skills Development Strategy III (2011- to present) – emphasises institutional learning linked to occupationally directed programmes.

The educational framework strategy and the new strategy have attempted to address the national skills needs in a holistic manner for the present and future South African workforce. In addition to revised legislation, the Skills Development Act of 2008 in conjunction with the Quality Council for Trades and Occupations (QCTO) the initial vision of productive citizenship for all is still being pursued. Des Squire, in his critique of NSDS III, makes this significant comment - The success or failure of NSDS III depends on the participation and cooperation of all role players and on the creation of partnerships for the benefit of the recipients, the learners. Skills development for the country that can meet national and international standards needs collective initiative by both private and public sector. There will have to be sector wide collaboration for a transformed equipped workforce (Skillportal, 2011).

In their paper McCutcheon and Fitchett (2005) stressed the importance of people working and having the skills necessary to do so. The idea that in order to exist one requires natural things that are for the better part 'free', but there is a bigger component to living. There should be drive in the human being to be a greater contributor and understand that productivity is what measures progressiveness of a country and an individual. Productivity can only be fulfilling if there are physical and cognitive elements to human activities (McCutcheon & Fitchett, 2005).

Rand Water's success for well over a century has been possible due to extensive investment it makes in developing science and engineering skills as core and pivotal to its continued survival. The Water Sector Leadership Group Skills Development Task Team's report for 2009 on the water sector skills crisis of scientists and professionals indicated the following disciplines necessary for the key areas of health and sustainable water resources:

- Engineering categories of Civil, Chemical, Electrical, Mechanical (hydropower generation);
- Hydrology (to model water flow in the rivers and dams necessary to respond to national hazards such as climate change), Hydraulics (design, structures, flow materials),
- Hydrogeology and geology (to drill boreholes where there are no flowing rivers),
- Microbiology (analysis of bacteria in the water to identify organisms that could cause diseases, e.g. cholera),
- Biochemistry; Analytical chemistry,
- Limnology (in-land water research to determine water extraction to prevent over-extraction) (WSLG, 2009).

Skills development has to be more strategic in water utilities in order to meet the mandate of present and future generations' demand for the production of quality drinking water.

2.3. Skills Development Legislation

The Educational System in South Africa has over the last 20 years undergone immense changes and is currently in the process of greater transition. The principles of the National Educational Policy Act 27 of 1996, proves to be an on-going daunting challenge. The Act has its basis in Chapter 2 of the Constitution of the Republic of South Africa, Act 108 of 1996 which upholds the basic rights of all individuals. It stresses the utmost importance of an education system that contributes to the full personal development of every individual, and to the moral, social, cultural, political and economic development of the nation at large. The legislation encompasses the advancement of democracy and human rights (South Africa, 1996).

The National Educational Policy succinctly encourages equal educational opportunities and life-long learning for all. Education at large, promotes the cultivation of skills, disciplines and capacities, thus ensuring the holistic development of the individual (South Africa, 1996:27). A vital ingredient in developing the individual holistically, involves independent and critical thinking. The changes in the curriculum after 1994 intended to lay the foundations for a single national core curriculum – The National Curriculum Statement - in order to normalise and transform teaching and learning for the nation. This necessitated a paradigm shift from the traditional aims and objectives approach, to outcomes-based education set out in the National Education Policy Act (South Africa, 1996). The aim is to develop a prosperous, truly united, democratic and internationally competitive country. The education system as the vehicle to ensure a literate, creative and critical citizen leading a productive, self-fulfilled life in a country free of violence, discrimination and prejudice (RSA, 1996a).

Research on the management of critical thinking skills is limited and the implementation measures to instil skills in critical thinking are vague. This therefore poses the question of how will we increase development of the critical thinkers for any industry more especially the water sector. It is common knowledge that comparatively smaller numbers of students choose science and engineering at tertiary level and an even fewer students graduate in those faculties.

A nation like South Africa needs now more than ever a generation of critical thinkers that can take transformation and the challenge of an integrated society into a sustainable secure future. Skills development fundamentals must be addressed with greater vigour, since globalisation is no more an attractive option but a norm for building a progressive sustainable economy. The argument that non-white South Africans find themselves in an even greater battle against the ill of the past education system is strengthened and the on-going struggle for a transformed economy persists. The grind to develop more non-white science and engineering professionals and provide the appropriate experience remains a job for the progressive institutions whether governmental or private.

The water sector strategic planning relies heavily on the development science and engineering skills aimed at solving problems. The Water Sector has currently the perspectives, legislative documents and the alignment framework for the water utilities to be the key skills development drivers in a country. Skills development of scientists and engineers must be carefully tracked and reported on an on-going basis.

2.4. Best Practice on the Skills Development Model

Institutions strive to be recognised for their best practices in skills development which is achieved through a collection of successful results and valuable lessons. Marketing those achievements is what establishes institutions being acknowledged and preferred for the future. The World Development Report of 2013 records best practice on skills development in developing countries specifically in East Asia for vocational education which is emphasised to be a collaborative effort by government and private business. Job creation is the most viable solution to developing and skilling a developing country in order to fast-track the country's economic growth. The danger it may pose is that the people will still have low productivity and low skills. Job creation in developing countries provides instant income to people who previously earned no income and this instant gratification nullifies the drive to gain further skills or education. These economies will make little long term progress because of the lack of technical and innovation skills which are only acquired through organised education systems which remain inadequate (UNDP, 2013: 178).

All best practice must be applied in the context of the society it aims to serve and must have built-in flexibility and sustainability to sufficiently serve the people. The apparent lesson being that in any context the skills development system must be designed to be dynamic for the social and economic factors that prevail. In addition consideration must be given of the political principles, which should essentially have a fundamental understanding that people need to be safe first and then be given the opportunity to progress.

South Africa has a limited amount of technical skills in all sectors more especially in government. The water sector faces a constant battle to acquire the best technical skills and also comply with governmental equity targets. More jobs in the water sector will not mean more skills unless there are adequate strategic skills development programs in place to support the development of water professionals from the previously disadvantaged groups. The programs must have a strategic intent to put the right talent in the required streams through the rigour necessary to produce technically sound water professionals.

Thames Water in the United Kingdom is an international water utility that can be examined as a comparative mark in respect to water provision for the country with significant similarities to Rand

Water. The March 2013 Annual Report for Thames Water showed the production of quality drinking water compliance to the regulatory standard as 99.96%. It reports the public utility's measurable objectives for providing safe and reliable water service. Drinking water production is measured from the utility's 2.5 treatment works.

The measured objectives indicated below for Thames Water Utilities Limited, excludes financial, customer complaints, innovation, risk and investments and forward capital planning indicators of performance. The following performance indicators met were noted:

- Annual leakage-reduction target for the seventh consecutive year
- Quality of customers' tap water remains among the best in the country
- "Security of supply" of water to customers at top level
- Environmental compliance of 350 sewage works remains close to best level ever
- Greenhouse emissions cut 12.5% on 1990 levels, on track to hit 20% by 2015
- Desalination plant used for the first time to boost water supplies during drought
- Waste network under pressure - additional costs incurred tackling increased sewer flooding, pollutions and blockages
- 100% of sewage sludge put to beneficial use

The assumption would be that compliance to the regulatory standards for good quality drinking water is a naturally occurring as an operational activity and thus not noted as a performance indicators. The emphasis seems to be measuring consistency in performance and new measurable objectives along with strategic future initiatives. Compliance to the regulatory good quality drinking water as a given and the sustainability thereof is factored in as operational business as usual (Thames Water Utilities, 2014).

2.5. Global Trends in Water Skills Development

The educational challenges that children from schools to further education institutions face is not unique to South Africa. It is no mystery that South Africa's educational challenges are not any different from other developing countries with the majority of the population being disadvantaged. Countries that have a large amount of their population living in poverty will experience similar challenges. There is no simple solution to establish the balance through education. It takes generations to lay the foundations of a healthy socio-economic environment using sustainable best-fit educational principles and most importantly the eradication of any kinds of prejudices. Increased levels of education for all at various progression levels which will be from pre-primary right up to tertiary education can definitely be a long term solution.

Figure 1 shows the impact on Gross Domestic Product (GDP) growth compared over a 30 year period with an increase in schooling in various countries. The movement is extremely slow but a constant positive growth is noted. The indication is that if schooling continues to increase GDP growth is sustainable for any country (UNDP, 2010: 10).

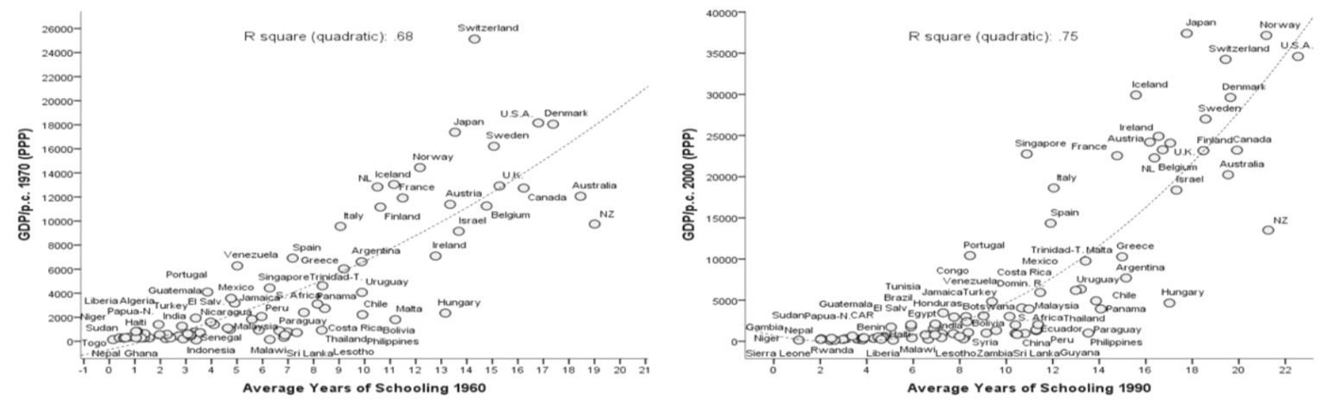

Figure 1: Years of Schooling increase Per Capita GDP World Bank Report 2010

2.6. The Importance of Engineering Skills Development

The production of quality drinking water is a complex and integrated process of science, engineering and technical experts working to ensure operational integrity. There is no one without the other, all three components for the production of quality drinking water are integral to achieve a sustainable system of drinking water that is safe. Engineering skills development is fundamental with an integrated systems dynamic inclusive of the environmental, economic and political aspects to reflect a holistic picture. The engineering in any country is interwoven with credible accurate scientific opinion. The efforts made in developing science and engineering skills can determine the future of certain institutions and even nations. Development in any country for socio-economic growth requires strategic infrastructure development and planning. All development no matter how complicated within a country must be done under the auspice of being able to provide safe water to sustain a growing economy.

2.7. The Current Situation

Skills development in the water sector has become a major concern over the past 10 years. Government has focused on increasing scarce and critical skills in the country. Statistics show a significant increase in the number of Science and Engineering graduates throughout academic institutions in the country. There is also a marked increase in the number of female graduates in Science and Engineering. Collective efforts by government institutions and government sectors to increase skills have proven to be more successful than expected. Civil Engineering graduates have over the past 5 years double and Science graduates are no more a shortage. There is also an increasing the amount of postgraduate study that is also an important contribution to sustainability for the country (Water Research Commision, 2015).

The Annual Report of 2013 for Umgeni Water a local water utility showed the skilled professionals and technical employees to be 572. Although the Scientific employees are not specifically noted the assumption is that they are a small number within the 572. Drinking water quality assurance would be done by the skilled professionals inclusive of management for the operations divisions. Complying with the transformation strategy of the country in respect to the demographic equity targets is not just a matter of showing the required equity percentages. It also requires that organisations adhere to alignment of equity at all levels of the organisation. There are even greater challenges in meeting the female and disability equity targets. Umgeni Water has of the 812 permanent employees 93% African Coloured and Indian (ACI), with 30% of females.

Table 1 shows from Umgeni Water's Annual Report 2012-2013 the utility's workforce demographics: employment type, category, race and gender for permanent employees in the parent company and wholly-owned subsidiary (Umgeni, 2013: 86).

Table 1: Umgeni Water Annual Report 2012-2013 Workforce

Employment Type/Category	Total	Male				Female			
		Indian	African	Coloured	White	Indian	African	Coloured	White
Top Management	5	0	2	0	1	0	1	0	1
Senior Management	27	8	7	2	3	3	3	0	1
Professionally qualified and experienced specialists and mid-management	202	34	57	5	28	19	49	4	6
Skilled Technical and academically qualified workers, junior management supervisors, foremen and superintendents	370	43	163	7	17	25	104	6	5
Semi-skilled and discretionary decision-making	177	2	164	1	0	4	6	0	0
Unskilled and defined decision-making	31	0	25	0	0	0	6	0	0
Total	**812**	**87**	**418**	**15**	**49**	**51**	**169**	**10**	**13**

Rand Water Scientific Services scientific positions in November 2013 were 90 employees in essential scientific operations water quality assurance positions with just an increase of 1 by May 2015. The extent of Rand Water's operations shows this phenomenon to be quite strange yet the norm in water utilities. Scientific water quality assurance is performed by a fairly small number of employees.

Table 2: Scientific Operations Positions in the Division in November 2013 and May 2015

Scientific Operations Position	Positions in November 2013	Positions in May 2015
Chemist/Quality*	20	20
Microbiologist	14	14
Biologist/Quality	10	10
Process Scientist*	9	9
IT/ LIMS/Statistician/Risk*	12	12
Water Quality Scientist**	25	26
Total * **Managers have been included in the respective area**	**90**	**91**

Training of water scientist through the Rand Water Graduate Programme takes forty two months - three and a half years. It does not mean that the person is trained to completely take over a specialist scientific role since an equal amount of experience will also be required. Development of water professionals whether they are recruited into permanent position or employed from the graduate programs need to be adequately trained. Training and development of water specific skills is an intensive process and time consuming for experienced water-specialist scientists. It requires careful planning and the allocation of much time for mentoring and coaching amidst daily operational tasks. Monitoring, evaluations records are required for all individuals trained and those records are kept for reference within the sections and in the training section.

2.8. The Sub-Saharan Africa Water and Sanitation Crisis

The water and sanitation crisis outlined in the Millennium Development Goals (MDG) is a major issue for Africa, and more especially the Sub-Saharan African region. The region looks to South Africa to provide the most support and the most viable solutions. South Africa has sustainably been able to produce world class quality drinking water and therefore the obvious assumption is that South Africa has the answers. Figure 2 shows the timelines for the water and sanitation solution of the geographical regions. The solutions were established in 2009 a way forward for the Millennium Development Goals. The Sub-Saharan African region shows the most alarming timeline for the delivery of water and sanitation services. Water services to the region will take 25 years more than the target that was set for 2015 and precedes only 1 other region by a mere 2 years. Sanitation service to the region will take a further 36 years after the delivery of water services. The world average lag is a year for water services and 7 years for sanitation services.

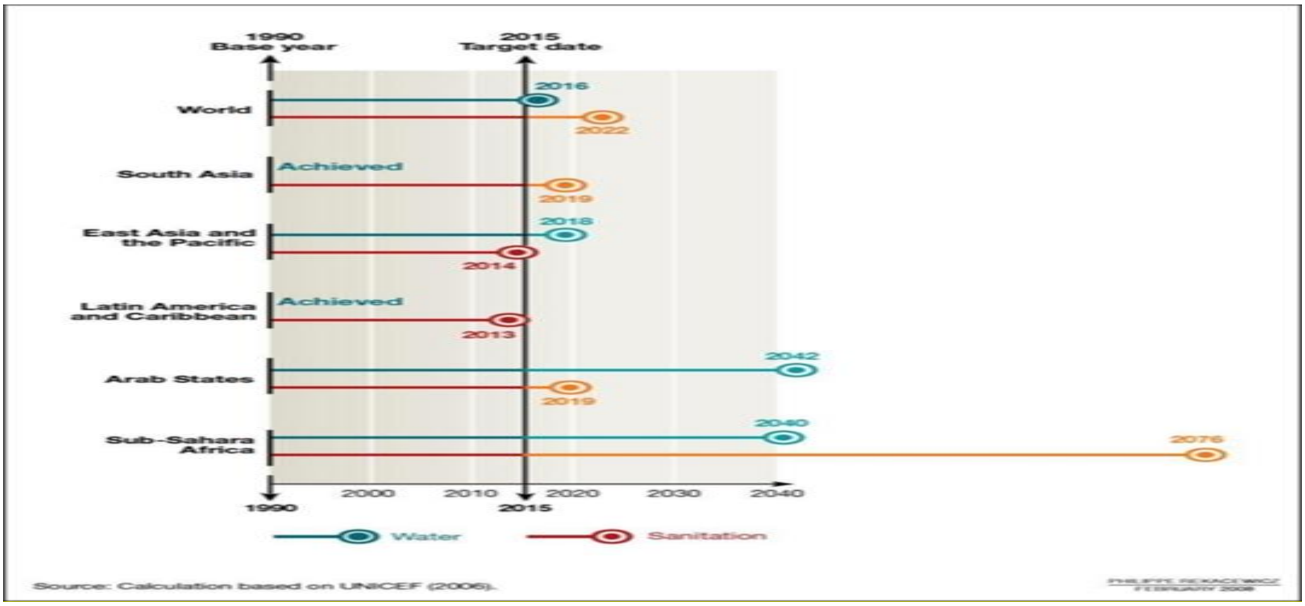

Figure 2: UNICEF 2006 Water and Sanitation delivery timeline

The Water Reforms for the region have hinged the solution largely on capacity building being the main vehicle for sustainable progress. Capacity building is however an investment which only yields long term sustainable returns with the right political will to drive continuous capacity building initiatives. These initiatives will require stringent rigorous monitoring and evaluation from a high level in governments. Local investment and skills transfer from the experts within the countries is what will make a huge different. Skills development is not a quick fix and cannot be the solution offered just to offer some solution. Investment in capacity building for developing nations cannot be solely dependent on external donors for funding and capacitating of skills. The success of capacity building lies in local commitment and sustainability at all levels of institutions and for all levels of skills development. Skills development is only a solution if given the required time and adequate provisioning of the required resources sustainably.

Figure 3 indicated improvement in the supply of drinking water to the population, and the Sub-Saharan Africa statistics are not promising. Sub-Saharan Africa has improved by 11% in 18 years and Developing Regions by 13% collectively. In South Africa there is much controversy around the exact interruption of what access to piped water means by government and the people. The percentage of people who actually have access to piped water is a number that cannot be accurately known for certain. Survey and census data provide numbers that differ from government officials as stated in their addresses (Rademeyer, 2013). The percentage of South Africans having access to piped water ranges from the statistical survey reports and government's reports from a low of 89.5% to a high of 98.3%. A true reflection of water and sanitation provisioning is essential. It cannot be a political perspective is exaggerated to be positive and not the reality that people of the countries experience (UN, 2000).

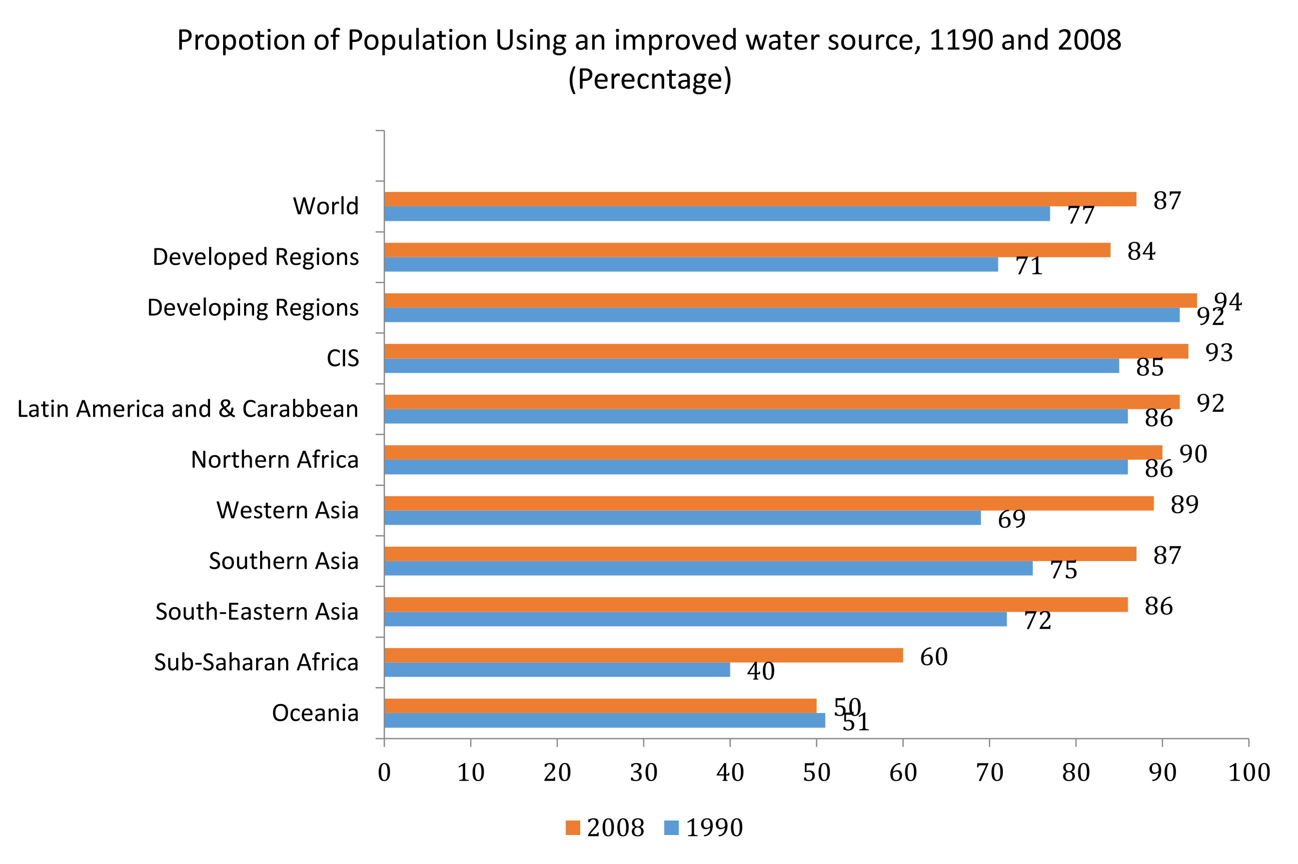

Figure 3: Percentage of the population using an improvement water source [Adapted from the United Nations Millennium Development Declaration – Source (UN, 2000)**]**

2.9. Major findings from the literature and the implications

Rand Water has projected that the implementation of further augmentation schemes can be postponed until 2020 if there are significant measures in place to prevent water losses and promoting the efficient use of water. The quality of water is determined on the success of the treatment of water to drinking water standard. Drinking water quality is often directly impacted yet all factors limiting the production of quality drinking water are not always technical. There can be various issues affecting the production of quality drinking water which are not necessarily water issues. The socio-economic and political factors of a region or country and even a continent can have a direct impact on water provisioning. Rand Water is aware of the need to improve the pool of skills for recruitment within the water sector on a larger scale and the need to prepare for greater water demand.

An appropriate system to secure drinking water quality is through the implementation of an integrated water quality management system that starts in the catchment and continues until the final point of delivery. Scientific Services division has developed a Water Safety Plan (WSP), to ensure operational integrity of the treatment plants. The division’s skills development framework and the distribution of the right skills in the right positions ensure success for assuring quality drinking water for Rand Water (Rand Water, 2006).

Skills development programmes throughout the organisation show significant steps in the right direction for the production of quality drinking water sustainably. The increasing lack of skills and the impact on service delivery is the challenge developing countries face and South Africa is no exception. The skills Rand Water requires for the core business is also required by other sectors. There is a great deal of competition to attract and retain technically skilled employees. Rand Water operating in the country’s economic hub means the organisation experiences competition for professional skills with other government sectors and organisations along with private companies for like skills.

Chapter 3: RESEARCH METHODOLOGY

3.1. Introduction

The research approach on the gathering of data would have involved establishing the current state of Rand Water's skills pool. Current skills development initiatives to sustain the production of good quality drinking water would also be reviewed to show the full scope of the study. The methodology was a statistical analysis of data available on personal qualification and skills sets in the organisation with specific focus on the operations portfolio. Data extraction was done for the full organisation's academic qualifications. This exercise revealed that the data was not an accurate representation of the organisational talent pool. Reports drawn on four occasions nine months apart indicated that there were significant gaps in the data available for many employees.

Statistical analysis of the data would therefore not have integrity and not reflect the true picture of skills in the organisation. The focus was then directed to the aspect of actual quality of drinking water monitoring and thus confined to Scientific Services division. Scientific Services is a division within the operations portfolio which is responsible for assuring the quality of drinking water produced by Rand Water against the National Drinking Water Standard. The division monitors all water quality from the source (raw water in the full catchment area and the direct areas of abstraction), water within the treatment process, water within the distribution network and water after it is supplied to the municipalities until it reaches the consumers' taps.

The approach was then modified to include a mixed methodology of quantitative and qualitative analysis, some informal interviews to established context using no formal instrument but a conversation approach. The context was substantiated by an extensive review of Rand Water documents to show reference in respect to the current status and the growth of the business. The results were presented in a descriptive design methodology so that all aspects discussed were given context within the organisation, the sector which is local and drinking water context internationally.

Rand Water Scientific Services skills development data was analysed to identifying the essential positions for water quality monitoring against the national drinking water standard. Scientific Services data was verified and then examined to establish the following:

- Scientific skills required to provide the assurance for the quality of drinking water produced within the Rand Water treatment and distribution system
- Division's current strategy to maintain a pipeline of scientific skills
- Efficiency and effectiveness of the strategy for the sector
- Integrated functions of scientists in the organisation for the production of quality drinking water
- Ages of the employees in core/essential functions of water quality assurance
- Monitoring the number of employees in the division engaged in further studies that can provide an indication of the sustainability and increase of the core/essential skills for the division

3.2. Methodology

The rationale of the methodology it is based on the framework of the Scientific Services division and its role within the operations portfolio. Scientific Services is responsible to assure the drinking water quality against the SANS 0241 standards (SANS, 2006). The national standard has been developed from the World Health Organisation (WHO) standards for quality drinking water (WHO, 2011). Rand Water goes further to establish and align and internal Production Standards to the SANS 0241 standards. Rand Water sets for itself higher compliance parameters for the determinants which are tested. An example of what is meant by higher compliance standard would be Turbidity compliance a physical determinant Rand Water's production standard is less than or equal to 0.5 NTU the SANS 0241 standard is less than or equal to 1 NTU. This essentially means that all determinants are measured in the laboratory against the organisation's Production Standard which enables Rand Water to assure quality drinking water quality to SANS 0241 even in extreme conditions.

Employees in the core/essential functions ages were noted and amount of relevant experience in the division. Information was also gathered for employees engaged in further study to be able to establish whether the required skills are increasing. An analysis of race was also done to be able to determine whether the increasing skills will meet the transformation targets of the organisation. Lastly to evaluate how effective the skills development and retention is in the division for the future - at least for the next 5 years.

3.3. Validity of Data

Scientific Services data can be verified using employees' training profile's on LMS. All the employees' positions and academic qualifications are also recorded in a Ladder of Learning compliance spread sheet, which is mapped to the level of the position with the core training required for all individuals. Employee's training records are stored within Scientific Services Human Resources training section. The records provide a full training history for employees and their highest qualifications. The Human Resources Information Systems Officer also captures the qualifications onto the qualifications sheet on LMS and keeps copies in the employees' personal files.

The data validation was at the 1st of July 2015 showed 100% compliance for all Scientific Services employees. The data validation for the rest of the organisation cannot be confirmed to 100% at present. Employees' profiles do not have their highest qualification and in some cases there is no qualification captured. The Information System Officers (ISO) is responsible at each Rand Water site to capture all new employees' highest qualification as provided by the employees. The employee's certified copies of their highest qualification/s must be sent for verification checks with the relevant institutions. This information should be placed on record in the employees' personal files and the employees' qualification information be regularly verified to ensure it is current, accurate and should be updated if necessary. The validation of the information can only be properly driven by each of the Rand Water operations sites. This process will ensure that the collective data of the organisation is accurate and has integrity to represent the true skills compliment of the organisation.

3.4. Limitations

The data used is specific to Scientific Services division and does not include of the entire Rand Water operations portfolio. It is in no way an indication that other employees in the organisation have no role in the production of quality drinking water. The efforts by the Talent Management department to establish what the exact compliment of core skills are within the operations portfolio and at what level they exit is still in progress. Talent Management department has gone further to do capability assessment for leadership for all employees from junior management (M Band) and above.

During the verification process in Scientific Services the Education Training and Development Practitioner (ETDP) discovered that employees who have done further studies since joining Rand Water funded themselves and their academic records were not updated. The update of an employee's qualifications in such an instance can only be triggered by the employee and if the employee neglects to do so there is no way of ensuring the most recent accurate academic records. This gap can be avoided by the ETDP sending out regular communication to alert employees to inform and send copies of their new qualification to HR-ISO to updating their talent records. The ETDP must also ensure that the bursary desk within Capacity Building captures completed qualification as soon as it is received from the employee or via the ETDP. This manual process of alerting the update of employees' qualifications is not ideal and thus a limitation for data integrity for which a more reliable process needs to be put in place.

The treatment plant technical employees' academic data is available as required for the Blue Drop audit. This data collection is done purely to provide adequate evidence, that the organisation is working towards having the required level of skills to meet the Blue Drop audit compliance standards. The data is compiled on a database within site operations department and verification with Human Resources' records for employees' in their personal files cannot be confirmed. The data also provides the projected skills development for the core/essential employees to ensure all employees will meet the required level of technical experience and academic qualification for compliance to the National Blue Drop standard for water services institutions.

Chapter 4: Skills Development Framework in Rand Water

4.1. Background

Rand Water's skills development framework is set within the landscape of national legislation and sector skills development guidelines in order for the business to reflect a picture of the present and future of the industry. The organisation has identified *Internal and External Drivers* which help to direct the business skills development planning to adequately fulfil its mandate within the country. The following are the drivers identified by Rand Water (Rand Water Academy, 2013):

- National Development Plan (NDP)
- Integrated Water Resources Management Strategy (IWRMS)
- Skills Development Act / SAQA Act / HET Act
- National Skills Development Strategy III (NSDS III)
- Sector Skills Plan (SSP)
- ESETA Strategic Planning
- Rand Water 2030 Vision
- Individual Development by way of an organisational Workplace Skills Plan (WSP)

Skills gap analyses and the impact on service delivery is one of the on-going activities for Rand Water, since the people and the service must be relevant. The gap analysis translates into an annual process of the skills audits and updates for the compilation of Person Development Plans which factors into an organisational WSP. Rand Water understands the constant competition to attract and retain skills in the water sector.

The Rand Water Academy was established for the purpose of developing skills for Rand Water as a business and for the sector. The Sector Skills Plan affirms water utilities as the drivers of skills development for the sector. It is believed that the utilities should provide as part of their service delivery continuous new capacity building opportunities for various skills sets and in progressively greater quantities. These growth aspects are accommodated within business with viable sustainable solutions also being offered to the sector.

Rand Water's Talent Framework as shown in Figure 4 underpins the organisational pool of skills being developed. There is a strong resemblance to the sector framework in order to provide the resource of skills currently required by the sector.

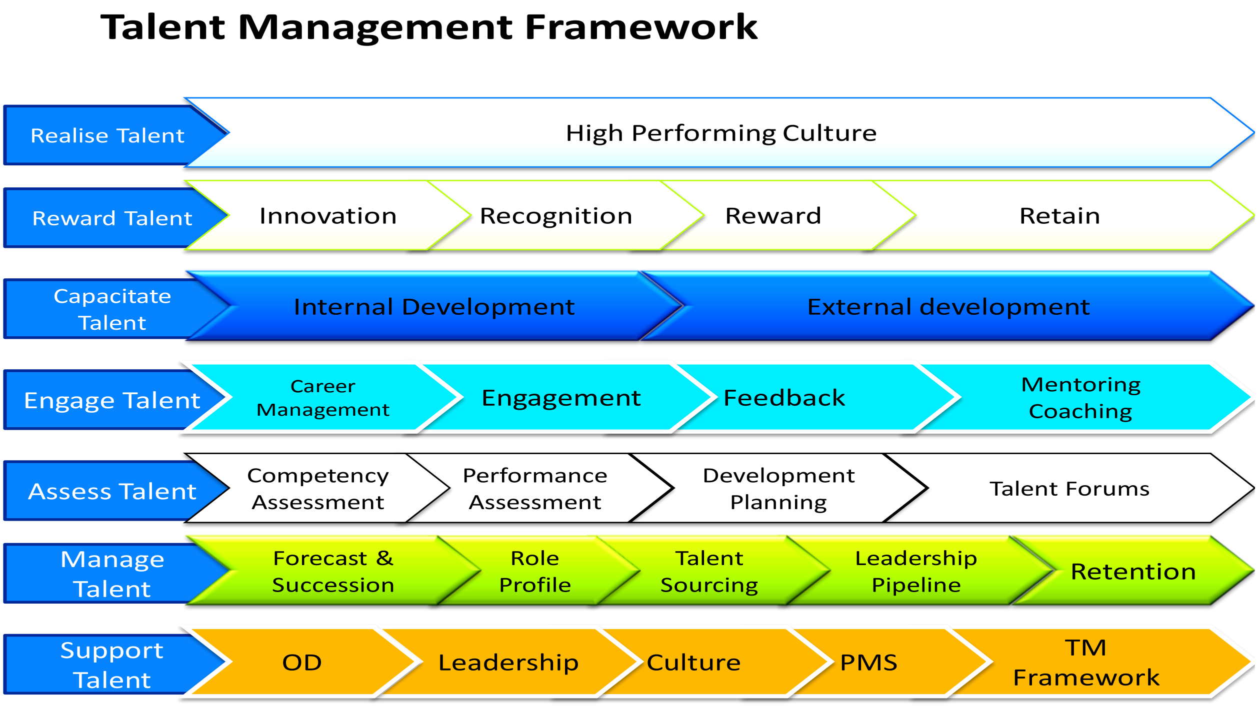

Figure 4: Rand Water Strategic Human Capital Talent Management Framework Model 2010

Rand Water's internal business processes have strategic objectives within which the context of business is operated. The objectives listed are the enablers increasing skills development in the organisation:

- ensure continuous supply of quality water to customers
- ensure the infrastructure meets current and future demands
- maintain the quality of water treated against SANS 0241 standards
- promote supply of water to new customers
- improve internal processes within the organisation
- ensure the organisation responds appropriately to its environment
- monitor risk in all spheres of the SHREQ legislation
- ensure sustainable health of business functioning through the Board
- ensure integrity of all business deliverables

- comply with statutory requirements
- promote ICT management

The Talent Model is a dynamic model that can from time to time undergo redefining and new development for future organisational needs and growth.

4.2. Current Situation

The Corporate Planning Directive indicates the current state of Rand Water and what will be necessary for organisational readiness into the next 15 years. The report highlights the following:

- Rand Water's water supply infrastructure meets past and present water demands sufficiently.
- The population statistic in 2010 was 50 million in South Africa; it is estimated to rise to 54 million by 2030.

South Africa's water resources are limited by virtue of the natural climate and there is therefore much debate on whether it can sustain the growth predicted. This concern is especially critical in the Gauteng province since it is growing faster than all the other provinces both in population and business. Gauteng is currently Rand Water's main operations area and supplies all of Gauteng and parts of four other provinces. The scope of Rand Water's business is taking on new locations and business services at a rapid pace (Rand Water, 2011).

The daily operations of the treatment plants are not monitored by the Scientific Services division except for the sample testing and reporting on any variations in compliance. The same applies to the Engineering division in respect to daily plant maintenance. The scientists and engineers are consulted on upgrades, major breakdowns, enhancement of plant operations relating to efficiency and optimisation. The treatment plant operations and maintenance has a direct impact on scientific analyses. Scientific Services also has no direct control over the advice provided on changes to be implemented, optimisation and operational activities.

Scientific Services as a division has a large dependency on the other operations divisions to be able to assure the drinking water quality. The employees involved in daily routine treatment plant operations are pivotal for success in respect to the samples being tested. Scientific Services does its analysis with the assumption that routine operational activities have taken place as required. The operational site laboratories are limited to testing for daily operations monitoring e.g. P^H, turbidity and chlorine. It is the role of the Scientific Services division to test for all other variables included in the SANS 0241 standards to determine the business performance in respect to drinking water quality. Scientific Services laboratories also do non-routine testing and monitoring in respect to organisational research projects and special projects.

Planning and projections for the division have been based on the existing undergraduate and post graduate scientists remaining in the organisation. The division is most importantly dependent on scientists remaining in their current positions or in their current area of work. Promotion within the Dual Career Path on the management line is specifically in their current area of work (Rand Water, 2010: 6). Figure 5 show the career path of a specialist and a manager and the limited flexibility of the model to specialist moving out of their scientific streams. The nature of the work in Scientific Services requires that managers of the specific sections are specialist or have extensive experience in the specific scientific stream.

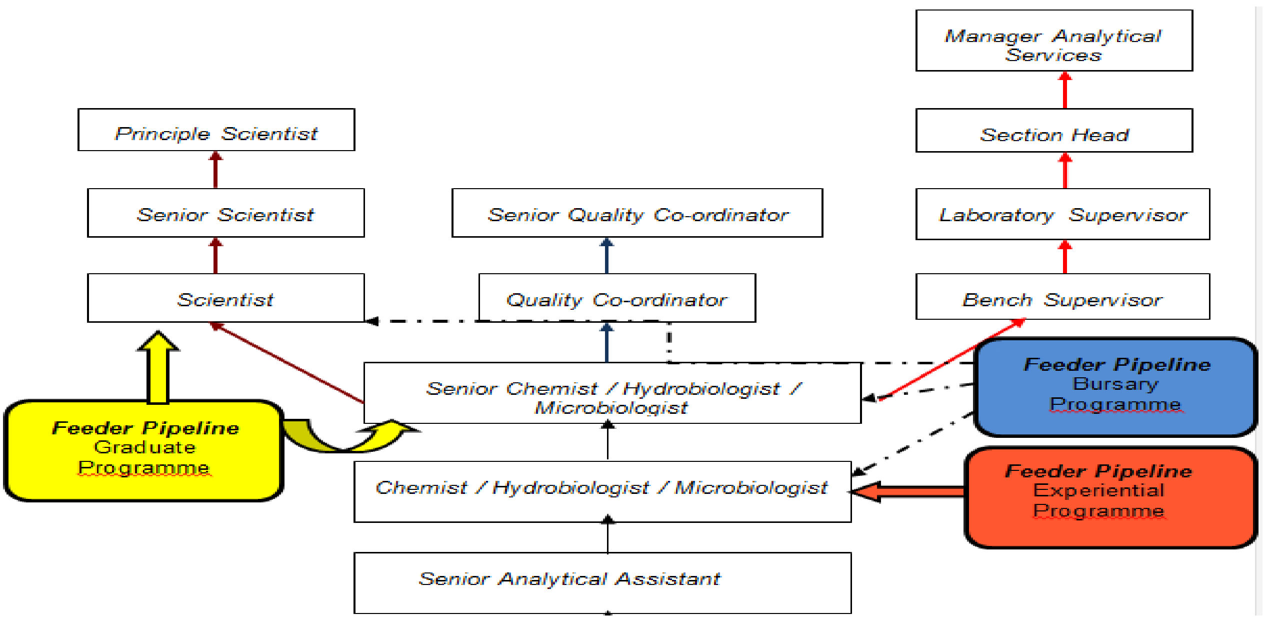

Figure 5: Career Path and Designations for the Analytical Services Department

The retention of scientific professionals and the projected number of scientists in the organisation will depend on the organisation's retention strategy and rewards plan. Retention of scientific professionals in the water sector is an on-going challenge more so in government sectors. It is difficult to determine exactly what causes people to leave an organisation or stay. Information of this nature is not easy to obtain since some issues are vast and complex when considering people's behaviour. The socio-economic, environmental and political aspects of the country are can also be contributing factors.

The 2013-2014 Personal Development Plans cycle showed the number of employees in the Scientific Services division who had intentions to study further. The information was a projection of employees' academic qualification in the next 5 years. These projections were determined on the assumption that all employees follow through as recorded on their PDP. The projected figures are for the future specialist scientists envisaged to meet the challenges for the next 5 years for the division.

4.3. Forward Planning

Organisational forward planning is done in conjunction with daily operational sustainability challenges. An integrated approach is essential keeping in mind the on-going demands of the sector and region. There is an urgency to provide skilled resources to effectively improve the current water and sanitation situation in many parts of the country. The skills developed will also have to provide solutions to the challenges of the region since the organisation is called on to share best practice.

A progressive growth model has been developed which shows predictions over the next three to five years. This is largely based on the internal focus of the Rand Water Academy in meeting the needs of Rand Water first then the needs of the sector and other growth needs over the next three to five years. The RWA will initially have high investment costs constituting capital works in the form of buildings and pedagogical facilities. The scale at which the Academy presently operates is not necessarily an indication of the needs assessed but rather the budget allocation and present human resources. Historically African training academies are not success stories, since there has been no sustainability. The Rand Water Academy needs a systematic, demand driven and principled foundation to be able to show a sustainable and workable institution. There is no clear picture that can be captured for the RWA at this point. The Rand Water Academy Concept Presentation 2013 shows the alignment to the sector planning (Rand Water Academy, 2013).

The programmes shown on Figure 6 have been rolled-out in part. These programmes will be required continuously and at a high standard with monitoring and evaluation to ensure it is meeting the present and future demands of the organisation, sector and region adequately.

Professionals	**Programme**
Engineers ✓ Scientists Technicians Artisans ✓ Operators Graduates Experiential Learners Internships Bursary Holders ✓ Managers & Supervisors	Graduate In-training Programme for Engineers ✓ Graduate In-training Programme for Scientists Technicians In-training Programme for Diplomats Artisan Training Programme ✓ Process Controller/Operator Training Programme – Blue Drop/RPL Graduate Programmes – General Experiential Learners Programmes Laboratory interventions and learning over a time frame Rand Water Bursary Schemes ✓ Rand Water Leadership programmes Finance and Accounting programmes

Figure 6: Rand Water Academy Skills Development Concept 2013

Rand Water has on its radar all the critical issues required to be able to protect the source water. It is a fact that all contamination ends up in our source water, and these devastating effects of pollution can be reduced if it is detected early. The effects of source water contamination on the treatment process are also being monitored constantly. There are tangible measures in place to ensure that the infrastructure that has been effective for the last 80 years will still continue to be sufficient and effective. The core skill for the production of quality drinking water lies in the reciprocal maintenance and support skills being available and being trained along with a high level of technical skills.

Chapter 5: SKILLS DEVELOPMENT IN THE AREA OF QUALITY DRINKING WATER IN RAND WATER

5.1. Background

Quality drinking water production is an old concept requiring consistent innovation for sustainability and the monitoring of equity in supply for the future. The focus must not be lost in thinking that it is a privilege rather than a right of all people in South Africa to have direct access to safe drinking water. The challenge is maintaining production costs of quality drinking water at the lowest. Government has committed to increase access to quality drinking water in all areas of the country. Skills development is critical to grow and empower societies to be able to use the finite water source wisely in spite of the challenges the country faces with regards to low rainfall patterns. Although much in South Africa and in Gauteng has changed in the last century of Rand Water's existence, Rand Water's core business has remained the same. It has continued to be the supplier of bulk potable water to the local authorities. Some secondary activities Rand Water is involved in include community projects, promoting Water-Wise gardening and education, and supporting the *Working for Water* programmes. Rand Water has adopted an institutional approach in respect to its custodianship for supplying of water to the 5 provinces and the collective preservation of the environment in all its activities. Scientific Services has extensive involvement in the sustainability of these value adding initiatives for the country.

The most appropriate manner in which to secure drinking water quality is through the implementation of an integrated water quality management system that starts in the catchment and ends at the final point of delivery. Scientific Services' four-part divisional structure reflects this holistic approach to water quality management. Three units, Process Technology, Analytical Services, and Divisional Support Services, underpin and support the fourth, which is Water Quality Specialist Services. The Rand Water's quality chain which is from the catchment to the consumer is monitored. Figure 7 shows the strategic model against which the Scientific Services division defines its role and function within the operations portfolio. The model was 2000, and there has been no significant deviation to date except shifting one of the support services' reporting lines within the organisation.

Skills recruited and developed in the division are concentrated in Chemistry – Organic and Inorganic; Biology – Microbiology and Hydrobiology; Process Scientist – Environmental Sciences, Water Care and all the other scientific streams on a lesser scale within the division. Limnologists and hydrologists are also needed in the division. The Information Technology (IT) within Divisional Support Services have IT specialists who develop and maintain the Laboratory Information Systems Management to ensure all results generated can be captured and reported as required by the SANS 0241 standards. The division uses its Ladder of Learning skills development framework to develop the core skills of all employees. This is also the framework for the development of all temporary employees within the division, and the adherence and compliance to these requirements are continuously assessed.

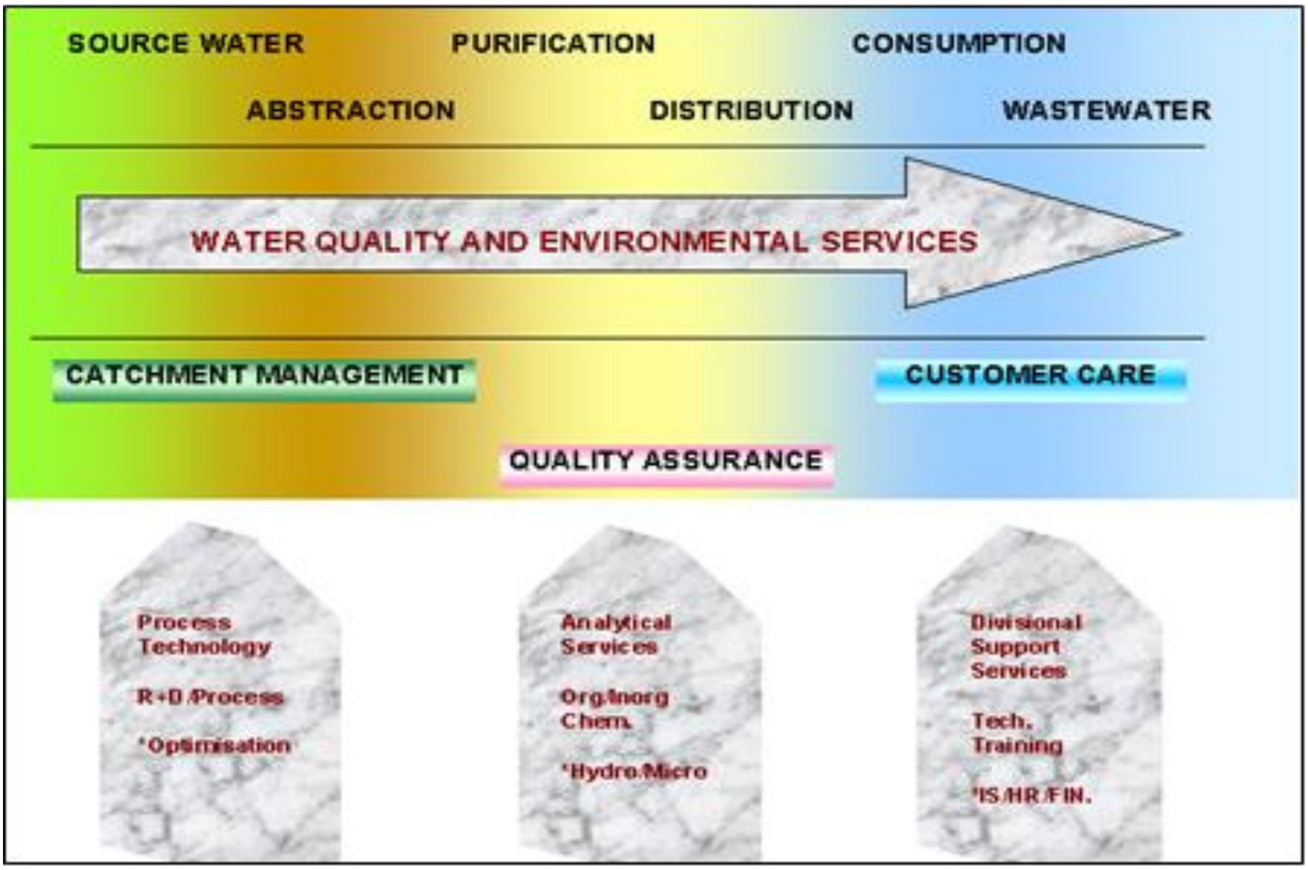

Figure 7: The Four-part Structure of the Scientific Services Division

5.2. Current Situation

In the 2016 to 2020 Scientific Services Business Plan, the role of the division remains to provide advice and services related to all aspects of water quality management for public health protection across the entire drinking water supply chain (Rand Water, 2006:1). The objectives listed below are still the core areas of focus. In order to achieve this commitment, the division performs the following activities:

a) Evaluation of water supply systems and establishment of water quality management programmes across the drinking water supply chain;
b) Sustaining accredited Analytical Services laboratories, capable of analysing all water quality determinants included in the national standards;
c) Optimisation of the water treatment processes through applied process technology investigations and research; and
d) Provision of water quality training and education services to both internal and external customers.

Employees in Scientific Services are not all recruited having water testing knowledge but the key scientific qualifications and competencies. They then undergo intensive training to become a water scientist specifically and are further streamlined to a particular laboratory or area of specialisation within a department. All scientists recruited have to attend all the in-house training prescribed for them. They are assessed against the standards and then deemed competent to perform the relevant tests in the laboratories. They are trained and assessed in this way no matter the level of their qualifications. A scientist employed in the testing laboratory can only work independently and produce results to be recorded as compliance once the employee has completed the relevant requirements. The method/s he/she would be testing and or analysing for must be regularly practiced. Additional preliminary laboratory procedures and testing skills will also have to be confirmed before the individual becomes fully functional. Scientists are trained to understand the production standards to be the measure and all systems and equipment are configured to measure against the organisation's production standards.

Table 3 shows the type of scientists' positions and the number of scientist qualified in the various scientific streams in 2013 and in 2015.

Table 3: Routine operations positions in Scientific Services 2013 and in 2015

Scientific Operations Position	Positions in November 2013	Positions in May 2015	Qualification Specific as at 2015
Chemist/Quality*	20	20	24
Microbiologist	14	14	5
Biologist/Quality	10	10	22
Process Scientist*	9	9	10
IT/ LIMS/Statistician/Risk*	12	12	10
Water Quality Scientist**	25	26	20
Total * Managers have been included in the respective area	**90**	**91**	**91**

In October 2012 analysis of employees' academic qualifications revealed a lack of desire by the younger employees to pursue further academic studies. The percentage of employees with the intention to study further was determined at 8.2% at the end of November 2012. This alarming statistic had the divisional General Manager on a drive to have more employees pursuing further study which brought the number to 20.1 % by the end of January 2013. It is clear that a division with its core focus being confirming drinking water quality needs to have sustainable scientific capacity to go on for longer than the next 5 years. The General Manager has placed strong emphasis on further studies. He motivates on employees perusing further studies at every divisional meeting, since November 2012.

The more stringent SANS 0241:2015 Drinking Water Standards has brought new challenges for the limited scientists within the division. The average age of the experienced employees in Scientific Services is 50 years. There are 22 employees with 10 years and more experience in the division 50% are White and 22.7% Female. The experienced scientists are required to provide scientific advice on the changes and developments in the division, organisation and sector.

Table 4: Highest Qualification Summary of Scientific Services in Operations Position as at May 2015

Core Scientific Positions *Rand Water Hay-Bands*	Number of Positions (91)	Diploma (21)	BSc (9)	B–Tech (15)	BSc Hons (20)	Masters (19)	PhD (7)	Average Age
Q	1	0	0	0	0	0	1 (M)	55
P	3	0	0	0	0	2 (1 M ; 1 F)	1 (F)	51
O	11	2 (M)	1 (M)	0	4 (M)	3 (2 M; 1 F)	1 (M)	48.5
N	34	5 (2 M; 3 F)	3 (2 M; 1 F)	5 (1 M; 4 F)	9 (7 M; 2 F)	8 (1 M; 7 F)	4 (2 M; 2 F)	41.4
M	30	8 (7 M; 1 F)	4 (F)	8 (1 M; 7 F)	6 (3 M; 3 F)	4 (1 M; 3 F)	0	36.1
L	12	6 (2 M; 4 F)	1 (M)	2 (F)	1 (F)	2 (F)	0	31.7
Gender	42 (M) 49 (F)	13 (M) 8 (F)	4 (M) 5 (F)	2 (M) 13 (F)	14 (M) 6 (F)	5 (M) 14 (F)	4 (M) 3 (F)	39.3

Scientific Services is a fairly small division in operations with an average of about 140 the analysis of the scientists' in core/essential scientific positions' talent profiles by academic strength are as follows:

- 7 PhDs - 2 of whom are professors and 1 is below 35 years, there are 3, 50 years and above and 3 between 40 and 50 years of age
- Minimum qualification of employees in core/essential scientific positions for the assurance of quality drinking water is a National Diploma (NQF 6).
- There were 90 employees in November 2013, 20 of the 90 employees had National Diplomas and only 3 had the intention to study further.
- Employees with a first degree a Bachelor of Science or Technology were 24 and 8 of these employees intended to do post graduate degrees in science fields.
- Maximum academic qualification of employees is Doctorates (NQF 10) and there were 5 employees in the division in November 2013. In May 2015 there were 7 PhDs - 2 of whom are professors and 1 is below 35 years, there are 3, 50 years and above and 3 between 40 and 50 years of age
- The total number of employees in the division in November 2013 was 141 and 64% of the employees were qualified at a minimum level of a National Diploma.
- In May 2015 there were 138 employees and there are 69% of the employees qualified at a minimum of NQF Level 6.

Table 5 shows the comparison of employees' qualifications between November 2013 and May 2015. There were 4 employees who completed further studies within the 19 month gap in scientific streams. The figures do not show employees who are also engaged in non-scientific studies and leadership studies.

Table 5: Highest Qualification Summary of Scientific Services Operations in November 2013 and as May 2015

Scientist in Operations Positions 2015	**2013**	**2015**
PhD	5	7 (2 completed further studies)*
Masters	19	19 (1 completed further studies*, 1 recruited, 1 exit)
BSc Hons	22	20 (1 recruited, 3 exists)
B Tech/BSc	24	24 (1 completed further studies*, 1 exist)
N. Dip	20	21 (2 recruited, 1 exit)*
***Graduate/Experiential/Intern has been recruited or completed further studies**		

The number of positions in the division remains fairly static even though the qualification of employees increases. There has been since 2013 only 2 new positions in the division, 1 requiring qualifications at a minimum of a National Diploma. The other requiring relevant years of experience in laboratory support and was not a core/essential position.

5.3. Forward Planning

Scientific Services graduates have become a pipeline of scientific skills not only for the division but for other portfolios in the organisation. This resource of skill has become sort after not only in the organisation but by the sector. The graduates' training for scientific services graduate program entails a thorough understanding of the business as a whole and more especially the full supply chain in terms of the water treatment processes and water quality assurance from the catchment to the consumer. Table 6 shows Scientific Services' development pipeline model for graduates, interns, bursars and experiential learners over the next 10 years (Rand Water, 2011). Scientific Services Division Pipeline Model was documented in 2011 by the then Human Resources Manager Hudson Maila; the model was aimed at and still is ensuring a continuous pool of scientific skills into the division from the minimum level to the maximum level of qualifications.

Table 6: Scientific Services' 10 year Development Pipeline Planning as at 2011

Scientific Services Development Pipeline

Graduates, Interns and Bursars

2011/07/01

Type of Programme	Name	Surname	Section	Specialisation	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Divisional Support Services															
Graduate Retention	Nomsa	Chikobi	IM	LIMS		Sept									
	John	Moatshe	IM	Statistics		Sept									
	Salome	Chiloane	WTT	Training		Sept									
GDP Graduate	Sandiso	Mthombeni	IM	LIMS		Dec		Jun							
	Lungelo	Mkhize	IM	Statistics		Dec		Jun							
	Mogoshadi	Sebake	RISK	Risk		Dec		Jun							
GDP New Intake (2013-2018)	Graduate1-2		IM	LIMS	N/A			Dec		Jun					
	Graduate3		IM	Statistics				Dec		Jun					
	Graduate4		WTT	Training				Dec		Jun					
	Graduate5-6		IM	LIMS	N/A					Dec		Jun			
	Graduate7		IM	Statistics						Dec		Jun			
	Graduate8		WTT	Training						Dec		Jun			
Experiential Learnership intake (2013-2021)	Experiential Learner 1		IM	Database and systems Admin	N/A		Jan	April							
	Experiential Learner 2		IM	Database and systems Admin	N/A			Jan	April						
	Experiential Learner 3		RISK	Risk				Jan	April						
	Experiential Learner 4		IM	Database and systems Admin	N/A				Jan	April					
	Experiential Learner 5		RISK	Risk					Jan	April					
	Experiential Learner 6		IM	Database and systems Admin	N/A					Jan	April				
	Experiential Learner 7		RISK	Risk						Jan	April				
	Experiential Learner 8		IM	Database and systems Admin	N/A						Jan	April			
	Experiential Learner 9		RISK	Risk							Jan	April			
	Experiential Learner 10		IM	Database and systems Admin	N/A							Jan	April		
	Experiential Learner 11		RISK	Risk								Jan	April		
	Experiential Learner 12		IM	Database and systems Admin	N/A								Jan	April	
	Experiential Learner 13		RISK	Risk									Jan	April	
	Experiential Learner 14		IM	Database and systems Admin	N/A									Jan	April
	Experiential Learner 15		RISK	Risk										Jan	April
Water Quality Services															
GDP Graduate	Simphiwe	Chabalala	WQSp	Production		Dec		Jun							
GDP New Intake (2012-2020)	Graduate1		WQSc	Consumer	N/A		Dec								
	Graduate 2		WQSb	Distribution			Dec		Jun						
	Graduate 3		WQSc	Hydrology	N/A				Dec						
	Graduate 4		WQSp	Production	N/A						Dec				
	Graduate 5		WQSs	Consumer							Dec				
	Graduate6		WQSp	Management System & Process	N/A							Dec		Jun	
Bursar New Intake (2014 - 2018)	Bursar 1		WQSb	Public Health	N/A										
	Bursar 2		WQSb	Env Health	N/A										
	Bursar 3		WQSb	Organic Chemistry	N/A										
Analytical Services															
Experiential Learnership intake (2012-2017)	Experiential Learner 1		CHEMISTRY	Organic	N/A	Jan	April								
	Experiential Learner 2		CHEMISTRY	Inorganic		Jan	April								
	Experiential Learner 3		CHEMISTRY	Organic	N/A			Jan	April						
	Experiential Learner 4		CHEMISTRY	Inorganic				Jan	April						
	Experiential Learner 5		CHEMISTRY	Organic	N/A					Jan	April				
	Experiential Learner 6		CHEMISTRY	Inorganic						Jan	April				
GDP New Intake (2012-2019)	Graduate 1		CHEMISTRY	Organic	N/A		Dec		Jun						
	Graduate 2		CHEMISTRY	Inorganic			Dec		Jun						
	Graduate 3		CHEMISTRY	Organic	N/A						Dec		Jun		
	Graduate 4		CHEMISTRY	Inorganic							Dec		Jun		
Experiential Learner/Intern	Slindile	Mkhize	BIOLOGY	Micro	Apr	Mar									
	Peatel	Maschaka	BIOLOGY	Micro	Apr	Mar									
Experiential Learnership intake (2012-2021)	Experiential Learner 1-3		BIOLOGY	Micro	N/A	Jan	April								
	Experiential Learner 4-6		BIOLOGY	Micro	N/A		Jan	April							
	Experiential Learner 9-12		BIOLOGY	Micro	N/A			Jan	April						
	Experiential Learner 13-15		BIOLOGY	Micro	N/A				Jan	April					
	Experiential Learner 16-18		BIOLOGY	Micro	N/A					Jan	April				
	Experiential Learner 19-21		BIOLOGY	Micro	N/A						Jan	April			
	Experiential Learner 22-24		BIOLOGY	Micro	N/A							Jan	April		
	Experiential Learner 25-27		BIOLOGY	Micro	N/A								Jan	April	
	Experiential Learner 28-30		BIOLOGY	Micro	N/A									Jan	April
Graduate Retention	Linette	Ferreira	BIOLOGY	Hydro		Sept									
GDP Graduate	Hendrik	Ewerts	BIOLOGY	Hydro		Dec		Jun							
	Nokukhanya	Nondumiso	BIOLOGY	Micro		Dec		Jun							
Process Technology															
Bursar	Terrence	Lamola	PROCESS	Chemistry		Dec		Dec		Jun					
GDP Graduate	Nonhlanhla	Ngwenya	PROCESS	Water Treatment		Dec		Jun							
	Sayjith	Ramphal	PROCESS	Chemistry		Dec		Jun							
GDP New Intake (2013-2020)	Graduate 1		PROCESS	Water Treatment	N/A			Dec		Jun					
	Graduate 2		PROCESS	Chemistry	N/A					Dec		Jun			
	Graduate 3		PROCESS	Water Treatment	N/A							Dec		Jun	
	Graduate 4		PROCESS	Chemistry								Dec		Jun	
Experiential Learnership intake (2012-2015)	Experiential Learner 1		PROCESS	Chemical Eng	N/A		Apr	Mar							
	Experiential Learner 2		PROCESS	Chemical Eng	N/A			Apr	Mar						

Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Graduate Retention	4	4	8	11	8	5	4	6	5	3	0
GDP Graduate	8	12	8	6	5	8	7	3	0	0	0
Exp Learner/Intern	2	5	6	9	9	8	8	6	6	6	3
Bursars	1	1	0	1	2	2	1	1	0	0	0
TOTAL	15	22	22	27	24	23	20	16	11	9	3

- Graduate Retention
- GDP Graduate
- Experiential Learner/Intern
- Bursar

All employees recruited within the division whether in temporary or permanent positions will all require a minimum of 12 months of training. This enables employees to function independently in a routine laboratory doing testing and analysis or in any scientific position with a context and understanding of water quality assurance. Graduates who recruited into engage positions are required to have successfully completed the initial Induction and project phase of the program and some have also completed the 18 months retention period during that time the graduate is fully integrated into operational work of the department and involved in further research and special projects within the division.

Table 7: Analysis of the present situation against the plan projected on Table 6 since November 2015 as follows:

Employees in the Scientific Services Pipeline	Planned in 2011	Actual	Variance	Permanently Employed within Rand Water as at November 2015	Permanently Employed within Scientific Services as per date indicated
Graduates Recruited 2011	8	8	0	4	1
Graduates Retained 2011	4	6	+2	5	5
Graduates Recruited 2012	12	0	-12	N/A	N/A
Graduates Retained 2012	4	4	0	6	5
Graduates Recruited 2013	8	12	+4	7	6
Graduates Retained 2013	8	2	-6	2	1
Graduates Recruited 2014	6	0	-6	N/A	N/A
Graduates Retained 2014	11	1	-10	4	1
Graduates Recruited 2015	5	6	+1	N/A	N/A
Graduates Retained 2015	8	6	-2	4	3
Experiential Learners as at November 2011	1	0	-1	N/A	N/A
Experiential Learners as at November 2012	5	2	-3	0	0
Experiential Learners as at November 2013	6	5	-1	0	0
Experiential Learners as at November 2014	9	6	-3	1	1
Experiential Learners as at July 2015	0	3	+3	3	3
Experiential Learners as at November 2015	9	6	-3	N/A	N/A
Bursar Students as at November 2011	1	1	0	1	1
Bursar Students as at November 2012	1	1	0	N/A	N/A
Bursar Students as at November 2013	0	N/A	N/A	N/A	N/A
Bursar Students as at March 2014	1	1	0	N/A	N/A
Bursar Students as at November 2015	2	4	+2	1	0

The bursar student who qualified in January 2015 is employed permanently within the organisation in Environmental Management Services and 2 graduates from the first cycle.
The time and effort spent training scientists to become competent is extensive. Retaining skills is therefore most vital from a return on investment perspective. Vacancies are scarce since employees exiting the organisation are fairly low. This is an unusual phenomenon for the number of professionally qualified scientists in the division. The staff turnover rate was calculated based on an average for the last 5 years and was 3%. The irony being that Rand Water has only recently formulated a retention plan. It has since 2009 introduced the incentive bonus which that is not guaranteed and based on performance measuring over each financial period.

Scientific Services has since 2010, used the Dual Career Path to promote employees in specialist positions. The DCP was formulated initially in 2002 for the division and revised in 2010 to outline the full process and to align to current processes within the organisation. Analytical Services and Process Technology have the full criteria and skills development for the scientists outlined so that employees can work towards promotion as they become most experienced and specialised. The third specialist department which is Water Quality Specialist services has no draft for integration into the division’s existing document. The fourth department is support and therefore must align to the corporate model for those sections within Scientific Services.

Chapter 6: CHALLENGES OVER THE NEXT 5 YEARS IN THE AREA OF QUALITY DRINKING WATER THAT IMPACT SKILLS DEVELOPMENT IN RAND WATER

6.1. Background

Rand Water in all its strategic planning whether current or futuristic has to always consider careful monitoring of the source water quality. The Vaal Dam water is currently the source and environmental impacts in and around the abstraction area influence how Rand Water's treatment process is adjusted to achieve compliance to drinking water standards. Rand Water's Integrated Annual Report lists the deterioration of raw water quality as its number one risk. This risk is listed number one for many years and therefore there is a huge focus and emphasis on raw water quality monitoring. Analysis indicates the deterioration of raw water quality is not significant at present. A distinct factor affecting source water quality is extreme weather patterns and this prompts the alert of climate change monitoring (Rand Water, 2011: 36). Figure 8 gives a detailed description of the organisation's number one risk and the control measures are not extremely innovative activities yet require diligence and sound scientific context.

Risk Description		Root Cause	Existing Controls
RISK No.	RISK NAME	STRATEGIC OBJECTIVE	SOME OF THE EXISITING CONTROLS
1.	Deterioration in raw water quality	Achieve operational integrity and use of best fit technology	1. Identified sampling points are sampled, analysed and reported on monthly (raw water monitoring target set at 95%). 2. Functional Quarterly Catchment Forum meetings to discuss pollution. Raw water quality information disseminated weekly/quarterly and posted to the Reservoir website. 3. Quality Information Management Decision Support System (QIMDSS) in place and complemented by on-line raw water quality monitoring (OBSERVATOR System). 4. Maintenance programme to remove invasive alien plant species in Vaal Barrage Reservoir. 5. Environmental Awareness educational programs developed to educate communities on water practices.

Figure 8: Annual Report for 2012-2013 Number 1 Organisational Risk

The Emfuleni Local Municipality Vaal River City, initiatives report recommendations were formulated for the preservation of Rand Water's raw water source. National government recognised the Vaal River in addition to being the largest water source for the largest water utility in South Africa; it is also a unique resource in the Gauteng area. It provides an attraction for an extensive number of tourists and upmarket residential development opportunities for the area and province. It is vital to ensure that the water supply capacity and conservation value of the Vaal River both existing and future potential is in no way threatened by over development and a lack of preservation. Strategies must be developed to reverse the current pollution levels along with essential preventative as well as remedial measures should be put in place. The development along the Vaal River must be of benefit to all residents along the Vaal River and the activities that are promoted should become a part of the value-chain as opposed to ad-hoc development (Emfuleni Local Municipality, 2013: 83).

The recommendations by local government provide some comfort for Rand Water in respect to its source water quality. Water utilities rely heavily on regulation and monitoring by local and national government to preserve water resources. The production of quality drinking water is an interdependent process between national government, local governments and water utilities in the country. The Integrated Water Resource Management recommendations urge governments to have localised plans for the preservation of their source water. It is believed that localised water resource preservation plans are what build into regional, and then continental and finally into a well-balanced global plan for all source water (UN Water, 2008).

6.2. Current Situation

Forward planning for skills development needs to take place within the context of the broader economic growth environment. In so doing there needs to be cumulative planning, like outlined in government's recent policy documents - The New Growth Path: The Framework is focused on growing a range of economic sectors and the National Skills Accord 1. This type of planning and commitment along with the exact vocational training could provide a feasible medium to long term plan for the country's sector specific skills development challenges. The Sector Skills Plan for the Mining and Mineral Sector submitted by the Mining Qualifications Authority (MQA) to the Department of Higher Education and Training in February 2011 shows a significant correlation of skills required by the Energy Sector inclusive of water. The report describes the supply of the skills to the sector in terms of new skills for the sector. The fields of study relevant to the mining sector have been identified to be engineering, metallurgy, chemical engineering, geology, electrical engineering, mechanical engineering, analytical chemistry, environmental management, mine surveying, and jewellery design and manufacturing and CAD (Computer Aided Design) a component of many of qualification in these study areas (SA, 2015).

Graduate programmes and short term vocational training is and will be a temporary solution for as long as there are no accompanying sector retention strategies that are being implemented simultaneously. Young professionals are driven in a transforming country by high salaries rather than passion for a particular industry. There also need to strong collective initiative by private sector to provide more growth and opportunities for young people being developed.

The impact of upcoming industries on the Upper Vaal compared with the current water quality status in relation to pollution occurrences must be considered in the context of Rand Water's operations. The risk of raw water deteriorating is an ever present threat as long as there continues to be development along the Vaal River. South Africa is a semi-arid country which is characterized by high seasonal variability in terms of rainfall and runoff, with high evaporation rates. This causes stream flow to be relatively low for most of the year with seasonal sporadic high flows. Further stress is applied to the water resources through population growth, increased urbanization and industrial activities (Ochese, 2007).

The Vaal Dam is located on the Vaal River approximately 56km south of Johannesburg close to Vereeniging. The catchment area of the dam is approximately 38 500 km^2 most of which is located in the Free State Province with the remainder in the North West, Gauteng and Mpumalanga provinces. The catchment area has an average annual precipitation of approximately 700 mm with a corresponding annual potential evaporation of 1500 mm. Rand Water and the municipality engage in important research to ensure constant monitoring of all activities around the main abstraction area. Changes in the source water quality will have a direct impact on the operations treatment process of Rand Water, more especially to Scientific Services division that monitors the water quality.

Innovative solutions are needed to optimise the treatment process and plant to meet and improve for future changes in the supply and quality of the raw water. The skills for changes in the treatment process will have to come from Scientific Services division to advise infrastructure changes and process adjustments. The current status of Rand Water's operations may not need immediate change but there must be on-going planning for change. Rand Water's current operations can be expanded to a further 20% at maximum capacity if infrastructure is properly maintained. Projected increase in supply will have no allowance for down time of treatment plants for maintenance or any other interruptions.

6.3. Forward Planning

The organisation shows progressive growth developed for the organisation shows predictions over the next three to five years and beyond. This would be largely based on the internal focus of the operations portfolio thus an increase in skills required by Scientific Services division. This is already evident with 9 new positions being recruited for the expansion of Rand Water Mpumalanga. There have been a number of more positions within the operations portfolio also advertised.

The Rand Water Academy and the rest of the organisation's skills development initiatives are aimed primarily at meeting the needs of Rand Water first and then of the sector. Government has recognised the need to invest in the water sector development and the necessary funding has been allocated to ensure progress. Estimates of Public Expenditure from 2005-2010, National Treasury reflects that Expenditure on Training Water Affairs has received the highest funding with only the exception of Police, Correctional Services and Justice & CD receiving more (National Treasury, 2010). Rand Water has also been tasked with the massive War on Leaks program that government has embarked on to ensure the country develops artisans for the present and future developments in the water sector.

Chapter 7: SKILLS DEVELOPMENT FOR THE FUTURE IN THE AREA OF QUALITY DRINKING WATER IN RAND WATER

7.1. Background

Rand Water has for many years been involved in training graduates within the organisation. It is a high priority for the organisation and more so for the Scientific Services division. Scientific Services' experience in rolling out graduate programs has revealed that the development of professionals requires a structured and concentrated effort by Human Resources and the division. The programme is time specific and needs committed experienced scientists since there is no quick fix solution to fast-track the development of science professionals for the water sector. Sustainable skills development requires a secure teaching and learning environment that can without compromise roll-out program after program or even programs simultaneously throughout the organisation with diligence, equity and consistently.

Rand Water has through the years sustained its operations on the transfer of skills. The reality simply is that infrastructure investment hinges on future scientific and engineering skills to ensure knowledgeable monitoring of the operational systems daily. Ensuring quality drinking water is produced every day and the monitoring thereof requires more specialists in the scientific fields. There seems to be an increase in understanding by developing country officials of the need to deliver safe drinking water to the household tap and how heavily the production of quality drinking water assurance relies on having scientific skills. The operational shortfalls can only be corrected and avoided if there is regular routine monitoring of treated water into, within and out of a treatment plant.

Discussion on water quality assurance from 1903 provides context of how Rand Water came to be the company it is today. It helps to in part explain the intricate puzzle that gives context to the role of the Scientific Services division in Rand Water. The realisation that good quality drinking water is not an option but mandatory has been the daily challenge that Rand Water has had to occupy itself with and will have to for as long as it exists. The question remains whether skills development within Rand Water is able to take the organisation further?

7.2. Current Situation

Water supply systems can deliver an acceptable quantity of water; the water must meet safe drinking water quality standards. Scientific skills are needed to do the continuous monitoring and testing required to assure quality to the consumers. A sizeable portion of the total investment in most developing countries is provided for facilities to treat the water to produce quality drinking water. Monitoring of quality throughout the utility's distribution network is of equal to greater importance and requires skilled scientists to do the job. Scientific Services division uses the slogan*:* *Water Quality for Life*. All activities in the division are aimed towards making the slogan a reality: ensuring Rand Water produces and delivers quality drinking water that is fit for lifelong consumption by all consumers. Employees work towards this in everything they do, whether in operating the database, undertaking microbiological analysis, supervising others, or counting *Daphnia* in a water sample all of which contribute to assuring drinking water quality to Rand Water's supply area.

Rand Water's decision to embark on a vigorous drive to improve and increase its technical skills has been no easy task. The Strategic Human Capital division realises that the pool of skills within the organisation must be retained with immediate solutions. It has been for the last four years incentivising through monetary remuneration in the form of a 14^{th} cheque. The quality assurance attached to the incentivising is the implementation of a Performance Management System (PMS) for all employees. The establishment of the Rand Water Academy aims to increase skills within the organisation but also for the sector and the focus not being just on technical skills.

Rand Water understands as a major water utility the responsibility it has to the people of South Africa not only for the provisioning of water but to community enhancement. Skills development within the Strategic Human Capital portfolio places a lot of emphasis on *giving back to the community* projects in terms of skills development for unemployed youth. Rand Water's Business Corporate Plan identifies Critical Skills attraction and retention which Figure 9 shows as the 4th highest Risk of the 10 Risks prioritised (Rand Water, 2011:62).

Critical Skills attraction and retention	1. Attraction and Retention of scarce and critical skills. 2. Ability of RW to manage talent. 3. Transformation and Change Management. 4. HR Policies, procedures and processes. 5. Having the requisite/optimal capacity to execute projects outside areas of supply and into Africa. 6. Having the cadre of employees that are willing and able to learn to work in the African continent.	1. No integrated HR Policies, Processes and Procedures. 2. No Talent Management Strategy. 3. No retention plan of critical skills. 4. Misaligned reward philosophy. 5. No critical workforce segments to define critical skills. 6. No forecast plan on demand and supply of skills. 7. No succession management. 8. No integrated performance management system (PMS) to ensure cascading of business objectives to individuals. 9. Lack of understanding the African water sector 10. No career planning. 11. Failure to deliver on set timeframe	1. Capacity Building. Development of talent and capacity. 2. An integrated Talent management framework. 3. Performance management system – salary surveys. 4. Market related salary rates in competition with private sector, however, historical restrictions in conditions and terms of employment.	1. Final interaction with Labour on performance management system is outstanding. 2. Performance management system rolled out to M-Q band employees. Training under way for JKL band employees. In principle agreement with Labour to roll out to the bargaining unit employees. 3. Implement Knowledge management policy/system. 4. Implement and execute retention strategy. 5. Draft critical skills framework developed, being tabled through participative and governance

Figure 9: Critical Skills Analysis Matrix 2012 Rand Water Risk No 4

The current scope of training within the organisation and in the RWA as shown on Figure 6 comprises the following imperatives:

- Identifying the exact training opportunities for:
  - Engineers: electrical, mechanical, civil, etc.
  - Technologists, artisans, apprentices
  - Scientists
- Assisting municipalities to determine their needs and capacity to participate in the training and accommodation of the trained persons
- Determination and procurement of necessary resources to implement new programmes
- Identification and selection of young people who have completed Grade 12 or having qualifications for training and internships
- Identification and selection of mentors and supervisors within the organisation and within the universities for skills development within the sector

- Selection of programme coordinators and administrative assistants to effectively roll-out initiatives
- Development of an Individual Development Plan for all trainees
- Implementation of relevant programmes through other institutions
- Integration and alignment of all programmes existing and future programmes

The collective co-ordination, monitoring and evaluation of these programs are continuous cycles requiring at all levels of the organisation careful management. There is at present no exact documented monitoring and evaluation for the current programs and those rolled-out.

7.3. Forward Planning

The production of quality drinking water on a very basic high level is as specific as the location of the utility and the customers it supplies. There is definitely no one size fits all since the dynamics the utility works within will determine how its operations are fashioned to meet the needs of the customers. There is however one common aspect in the production of quality drinking water and that is the assurance of the water quality against the drinking water standard. The drinking water standard of any country, organisation or utility will be guided by the WHO-Drinking Water Quality Standards. The comparison factor thus of water utilities can be based on their compliance to the WHO drinking water standards of assurance within the utility, irrespective of the operations.

The Water Dialogue held in Kenya aimed at discussing *the impact of capacity development to management of water resources in the transition period of water sector reforms, specifically responding to the question 'Capacity for What?' and its link to development goal*. There was specific focus on water resources, sanitation, water services and disaster risk management. These were the questions raised for debate:

- Has capacity building been useful in managing competing demands and improving equity and efficiency in water use and management?
- How systematic exchange of project experiences, lessons learned, and best practices improved integrated water resources management?

- How can dissemination mechanisms of the capacity development knowledge be improved to positively impact management of water resources?

The session was titled the *Lessons from IWRM Capacity Building Process within the Kenyan Water Sector Reforms Transition*. It was at Strathmore University; School of Business Studies, in March 2015. The proposed way forward was a Multi-Stakeholders Platform for Knowledge Exchange and Collaboration for Integrated Water Resources Management in Kenya.

The questions raised by Kenyan officials on the matter of water management have significance to us locally in respect to the South African developmental framework. There must be a common understanding that water is a constitutional right of all to be provided with quality drinking water and it must be accessible (Kisma, 2008).

All future planning for the production of quality drinking water should establish its context from these two fundamental ideas that the production of quality drinking water hinges on:

- The production of the quality drinking water needs to take place based on the geographical location of the source water to meet the drinking water quality standard.
- Quality drinking water is a basic human right and all governments need to be able to ensure the equity and sustainability thereof.

Chapter 8: ANALYSIS OF DATA

8.1. Introduction

Talent profile data for Scientific Services has been gathered through a manual process of requesting it from all employees existing and new employee's. They provided evidence of their highest qualifications. This information has been verified and captured on the LMS and on a divisional technical training matrix called the Ladder of Learning. This is fundamentally a divisional specific model to integrate employees' academic talent profile and their divisional skills development requirements summarised in one model. All sections within the division have a sectional training matrix specific to their area of work based on Technical Operational, Safety, Quality, and Functional Behavioural training required for individuals. A skills audit process of all individuals is done by their line managers in consultation with the risk, quality and training officer/s.

The Ladder of Learning is an organisational concept but is not implemented throughout the organisation. It is a sure way of being able to properly profile skills in any area of work and can be extended to an entire portfolio of the business. The skills profiles drills down to specific jobs and to the individual in a position. Skills development is certainly a slow and strategic process which must be well guided by training professionals. Recruiting graduates from institutions with first degrees or even postgraduate degrees does not guarantee sustainable skills development for an organisation. The careful recruitment will have to be reciprocated with a well thought out sector context and more specifically an organisational training program. Organisations need to plan ahead for skills development of employees who will be recruited in the future.

The training programs of the organisation must be prioritised along the long term strategic objectives of the divisions feeding into the portfolio and organisational as a collective whole. It is difficult to measure actual success of skills development for an organisation because the framework for skills development is a dynamic process. The measure used in the investigation for the purpose of determining return on investment focused on the graduates within Scientific

Services division. Graduates retained within Scientific Services and in the organisation as at November 2015.

8.2. Summary of Analysis

The succession planning of the division is in the form of a Scientific Graduate Development Program (GDP), Experiential Learners and Internship Students. Scientific skills are harnessed and nurtured by the 3 feeder pipelines, while the graduate programme looks to develop specialist scientific skills for the division and sector. The development of graduates is a time based model, with the thinking that the longer an individual with a science qualification is exposed to the water business the greater the chance of the individual realising an affinity to the industry. Two contractual agreements with the graduates are designed to retain graduates for a maximum period of three and a half years – 42 months continuously. They are for the 42 months temporary employees, yet having the benefit of engaging within the organisation, sector both locally and internationally. This experience is guided by water scientists within the division and the graduate is trained and developed to his/her full potential of their project and the division's operations and the business as a whole. Many graduates use the fortunate position of having access to resources and information to further study. The ultimate aim of the graduate being to be appointed into a permanent position within the organisation with the experience gained. The graduate is given theoretical knowledge and practical experience of the scientific streams within the framework of the division's functioning of monitoring water quality from the catchment to the consumer.

Employment of the graduate into a permanent position in the division is not guaranteed and the skills transferred from specialists scientists are not all retained within the organisation. There is an understanding within the organisation that graduates should be retained. Retention of graduates into permanent positions is shown in Table 8.

Table 8: Scientific Services' Retention of Graduates through Pipeline Planning as at 2015

Graduate Programme Identify	Number Recruited	Number Permanently Employed in Rand Water	Number Employed within Scientific Services
GDP 01-2009	10	8	6
GDP 02-2011	8*(1 deceased) -7	4	1 (was 2 until 2014)
GDP 03-2013	12	4	3 (RWM)
GDP 04-2015	6	N/A	N/A

The percentage of graduates retained within the organisation as at November 2015 was 45.7% and the percentage retained in the Scientific Services division is 62.5%. The number of graduates offered extended contracts of retention for a further 18 months is determined by the budget available to accommodate a minimum of 50% of the intake. The next intake is scheduled for 2017 and the recruitment process will be concluded in 2016. The model used to train scientists is entrenched in the skills development architecture of Scientific Services. The model has over the years been reviewed and augmented to include the growth and changes in the organisation.

Rand Water Scientific Services has since March 2009 to January 2015 recruited 36 graduates with the following degrees: BSc, BSc Hons, B.Tech, M.Tech, MSc and PhD. There has also been in the program a graduate with a Risk Management Diploma and an Honours Commerce graduate who was also trained using the scientific training model. These 2 graduates are included in the permanently employed figures within the organisation in Risk and Finance.

Skills development of the graduates over the last 7 years has yielded a success rate for the division of over 50% which is definitely encouraging. The division also retains the same percentage from the Experiential Learners and Internship Students trained. Graduates that are still in temporary positions in the division are 44.4%. Graduates who have existed the organisation are 13, 37.1% of the number recruited, 2 of the graduates who have exited Rand Water are employed within government in water and energy sector. An aspect that cannot be quantified is attitude and passion of the graduates for the water business which has a strong bearing on who hangs in there after the initial 24 month period hoping to be retained for a further 18 months or be permanently employed within the that period. There is definitely greater intention of graduates to study further Table 9, shows 16 of the 24 graduates within the organisation that have completed studies or are engaged in further studies. The percentage of graduates engaged in further studies in scientific fields are 62.5%. A comparison of permanent employees who are engaged in further studies in science fields indicated that only one third of permanent employees study further compared to temporary employees.

The Experiential Learners are recruited in the Analytical Services Laboratories to do routine basic to intermediate level analyses. These are students who have completed the third year for a National Diploma. These students can be employed for a minimum period of 6 months and a maximum period of 24 months.

Table 9: Graduates in Rand Water involved with Further Studies as at November 2015

Recruited Qualification Status	Employment Status	Area of Employment in Rand Water	Status of Further Studies
Graduate 1	BSc Hons	Scientific Services (P)	Completed MSc
Graduate 2	MSc	Scientific Services (P)	Second MSc still in progress
Graduate 3	MSc	Scientific Services (P)	Nothing further
Graduate 4	MSc	Scientific Services (P)	Completed PhD
Graduate 5	MSc	Environmental Services (P)	Nothing further
Graduate 6	MSc	Environmental Services(P)	Nothing further
Graduate 7	BSc Hons	Scientific Services (P)	MSc still in progress
Graduate 8	BSc	Scientific Services (P)	BSc Hons still in progress
Graduate 9	MSc	RWA (P)	Completed PhD
Graduate 10	BSc Hons	RWA (P)	Nothing further
Graduate 11	National Diploma	Vg Pumping Station (P)	Nothing further
Graduate 12	BSc Hons	Scientific Services (P)	Second BSc still in progress
Graduate 13	BSc Hons	Corporate Finance (P)	Completed CGMA
Graduate 14	BSc Hons	Scientific Services (P)	MSc still in progress
Graduate 15	BSc Hons	Scientific Services (P)	MSc still in progress
Graduate 16	BSc Hons	Scientific Services (P)	MSc still in progress
Graduate 17	BSc Hons	Scientific Services (T)	Nothing further
Graduate 18	MSc	Scientific Services (T)	PhD still in progress
Graduate 19	BSc Hons	Scientific Services (T)	MSc still in progress
Graduate 20	MSc	Scientific Services (T)	PhD still in progress
Graduate 21	MSc	Scientific Services (T)	PhD still in progress
Graduate 22	MSc	Scientific Services (T)	Nothing further
Graduate 23	BSc Hons	Scientific Services (T)	Completed MSc
Graduate 24	PhD	Scientific Services (T)	Nothing further

*(P) Permanent (T) Temporary

The students are able to acquire the skills for their qualification with the experience received in the laboratories and are able to graduate for a National Diploma. There is no guarantee of employment for the Experiential Learners even after obtaining their National Diploma. National Diploma students can apply for positions of Microbiologist; Hydrobiologist or Chemist and any other position within the organisation requiring a National Diploma. Further qualifications are required to progress in Analytical Services Dual Career Path requirements. The division has since 2005 to July 2015 employed 15 of their previous Experiential Learners permanently. The Experiential Learners who do not find employment are also kept on a database as a pool of developed skill for the laboratories. They are offered from time to time temporary employment on the level they have been trained or lower when permanent employees take long leave or otherwise as and when required. There are Experiential Learners who have developed from Chemist/Microbiologist to Senior Chemist/Senior Microbiologist shown on Figure 10. There are Experiential Learners who have gone as high as Bench Supervisor on the management leg of the DCP, shown on Figure 7 (Rand Water, 2010: 8).

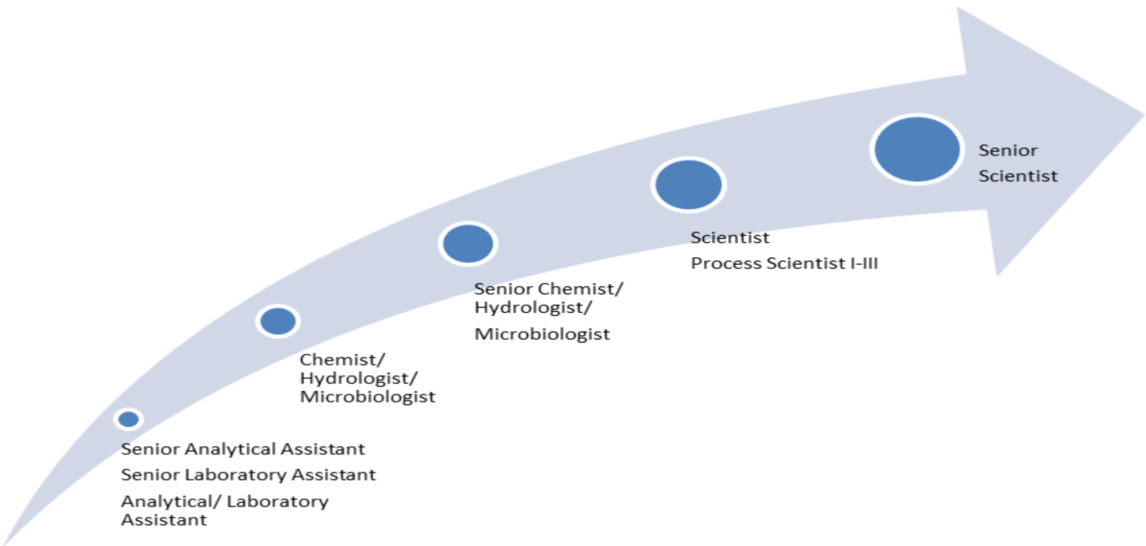

Figure 10: Progression Positions as per the Analytical Services Dual Career Path for specialist roles

The Internship Students are recruited as per their choice of relevant scientific degrees after matric or any other year of study from first to fourth year. These students are a part of Rand Water's External Bursary Program. These students are awarded bursaries based on their continuous good academic results and based on transformation opportunities for the previously disadvantaged population groups. They are also offered temporary positions to engage in vacation work within the organisation. Those with scientific qualifications are accommodated within Scientific Services for operational experience for short periods of time during their vacations. The longest period that they are in the company is 2 months during their end of year vacation which will be for December and January. Students who make good progress during their 4 year degree would have collectively a year of experience within the organisation. There was no guarantee of permanent employment of Internship Students.

A new development in the Capacity Building space since January 2015, now allows for Internship Students to be retained in a temporary capacity as Graduates-in-Training for a period of 18 months through the Pipeline Model developed to enhance retention of skills developed from an organisational Talent perspective (Rand Water, 2015).

TYPE OF PIPELINE	PP1 A	PP2	PP3 A	PP4	ENTRY LEVEL POSITION
	Bursary Program	Experiential Training	GIT Program	GIT Retention Program	GIT will need to apply for the vacant position and follow the normal recruitment processes
Duration	**36 months**	**6–12 months**	**24 months**	**18 months**	
References	External Bursary Policy & External Bursary procedure	External Bursary Policy & External Bursary procedure	GIT & Internship Policy GIT & Internship Procedure		
Owner	**ED Practitioner**	**SDF & ETDP**	**SDF & ETDP**	**SDF & ETDP**	

Figure 11: Capacity Building Pipeline Model for Graduates

Internship Students will be able to accumulate 30 months – two and a half years operational experience within the organisation and science graduates within the Scientific Services division.

The division has since 2005 to 2015 employed 5 Internship Students permanently. The division has currently as at November 2015, 3 previous students permanently employed in the division. One in a management position - Head Treatment Technology and 2 Bench Supervisors, refer Figure 12 which shows the Head Treatment Technology position as part of the management leg of the DCP which is filled through recruitment the other 2 position in Figure 5. One previous student has since been promoted within the organisation in the auditing section, auditing scientific processes. There has been just 1 Internship Students who was permanently employed and left the organisation (Rand Water, 2010: 7).

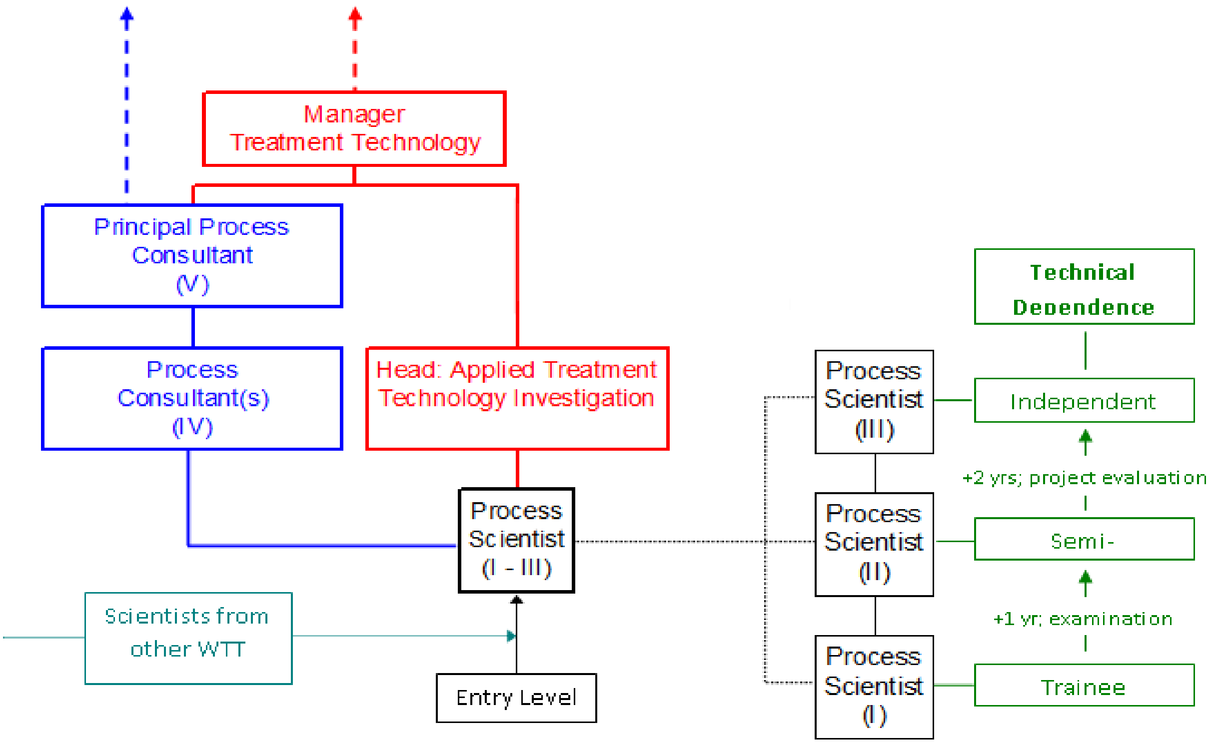

Figure 12: Dual Career Path and Designations for the Process Technology Department

Scientific Services division has a well-structured in-house training programme and a very concise on-the-job training plan for all individuals in the testing laboratories and within the other 3 departments. Compliance to the divisional training requirements equips employees with a strong technical know-how providing a high degree of comfort for scientists. The division has over the last 10 year period recruited 20% of the required skills from its pipeline programs.

Comparatively the divisional shows a definite success for developing more skills than is required and the minimal staff turnover. This is a clear indication that Rand Water's skills development strategy in the area of quality drinking water assurance is yielding success in the area of quality drinking water assurance. Organised well formulated skills developed models yields good results along with programmes that are sustainable. Skills development and retention of skills is definitely associated with Rand Water as a brand which adds value to the sector.

Scientific Services is and has been a fairly small division, the idea of having more than one specialist for a position has not been explored. The flexibility to move from one specialist position to another is also very limited and not the most viable option for employees in terms of career progression. Specialist positions are at the same level and limited within departments of the division. The division is challenged to show greater productivity for routine work and therefore requesting more specialists' roles are not feasible. The Dual Career Path framework also limits more specialist roles being added to the current levels.

The efforts in operations to gather information to establish the level of skill of operations employees responsible for the treatment process is steadily improving through effort by Capacity Building's Water Technology Training section which is primarily responsible for the training and upgrading of plant Process Controllers. It must be noted that all initiatives to improve the skills of the present aging operations employees is a struggle, since the need to be schooled. Attending structured programmes is daunting when employees are 5 years or less from retirement. The question employees ask is: 'What is in it for me?' The reality is it actually that it is only to confirm a level of education and that does not motivate these employees who are close to retirement.

Further study for aged operations employees will have to have some monetary compensation to become attractive for employees to pursue. These operators of the plant have gathered their knowledge over the years and do not need to know any more to do their jobs at the levels they are employed. The notion that new employees can be recruited at the right level of academic qualification in operations is not an immediate solution. New employees will have to be trained by experienced operations employees, since Rand Water's successful operations is largely dependent on experience of the treatment system. The highly unionised environment of the operations plants makes fast-tracking progress sometimes complicated.

The production of quality drinking water in 2012, was an average of 3 978 mega litres with a peak day demand in supply of 4 677 Ml. Rand Water's current capital expenditure commitments are projected to increase the supply capacity by 600 mega litres by 2016. The supply and projection of supply was indicated in the 2011-2012, IAR reported by the Chief Executive (Rand Water, 2012: 7). The average growth predicted in 2012 is calculated at 12% by 2016, the actual increase being 11.37% and which has been rounded off to 12%.

Table 10 shows a possible prediction for the organisation's future scientific skills projected as per the expansion of the operations. The following are the assumptions in respect to the projection numbers:

- There is no significant deterioration in the raw water quality in the direct abstraction areas of the organisation
- The expanded supply remains from the current raw water source
- The population growth predicted for the next 20 years in 2010 of 8% of 54 million by 2030
- The operations of Scientific Services grows by the steady pace of 12% over the 5 years
- The current scientific skills is required in the same proportions for the next 10 years
- The projected increase in operations translates directly to Scientific Services employees as present
- Systems and processes in Scientific Services remain as present

Table 10: Scientists as per May 2015 projected figures for 5 years and 10 years forward

Operations Scientific Skills	**Positions in May 2015**	**Scientific Skills Required in 2020**	**Scientific Skills Required in 2025**
Chemist	20	22	25
Microbiologist	14	16	18
Biologist	10	11	12
Process Scientist	9	10	11
IT/ LIMS/Statistician	12	13	15
Water Quality Scientist	27	30	34
Total	**92**	**102**	**114**

The increases predicted in Table 10 are just an indication of the required skills into the future 10 years and must be understood in the context of water services dynamics in South Africa. The collective determinants and drivers have many variables that must be considered in an integrated way. The predicted increase in scientific employees is anchored in the scenario of the last 100 years of Rand Water's existence the prevailing factor being consistent increasing demand in the supply area. All other concerns in the production of quality drinking water are not drastic and immediate. Graduates developed within Scientific Services can meet the future demand of skills required shown on Table 8, the division produces in excess of 50% more graduates than the organisation can retain. This does not include the Experiential Learners and Bursars.

In respect to transformation Table 4 shows that the percentage of females in the division in core functions is 52.8%. The percentage of female employment in the organisation is targeted at 50% which shows consistency with the organisational drive for more female appointments in technical positions. The average age being at 39.3 years this indicates an averaged workforce of younger and older employees. The race equity on the more experience employees is at 50% white which indicates that transformation can only be achieved at in that area when employees retire. The possible option is creating more specialist positions to enable non-white employees the opportunities of higher specialist positions. The age analysis between management and entry level employees would be obvious yet not totally transformational in that younger employees almost understand that attaining management level in the division will take a long time and that management employees remain until retirement. This can become a concern in the future that younger excellent employees see as limiting for their careers in the organisation, especially those who have a strong leadership and management potential but may never receive the opportunity until a vacancy is created as a result a manager retiring.

Chapter 9: CONCLUSIONS AND RECOMMENDATIONS

9.1. Introduction

Rand Water receives a limited amount of financial support from the state therefore the organisation is always under pressure to maintain good financial health and sustainability. It serves an area of 18 001 km^2, which is home to more than 12 million people, and 60% of South Africa's total economic output is produced in the area of supply. Rand Water is the biggest bulk supplier of potable water in South Africa, able to supply more than 4 300 million litres of drinking water per day. The quantity is equivalent to 1 litre of water per person for two thirds of the entire world population every day – this should count as being truly remarkable. Water supply and demand in the coming decades will sharpen due to demography, economic development, and government policy. Urbanisation, industrialisation, and ecosystem maintenance also expand the demand for water. Current projections of future water quantities of the Vaal River supply area are dramatically lower than that of the 1980s. The huge mandate Rand Water carries and the levels of delivery it has provided places immense pressure on the organisation to continue to perform as shown. Innovative solutions to accessing different sources water are already in place but require premium costs and high levels of skills.

9.2. Conclusions

The investigation shows that Rand Water has a vigorous drive to develop skills across the sector and also for governments in particular the War on Leaks Program. These efforts however seem to be random and have taken on the characteristic of ad-hoc initiatives throughout the organisation. The focus seems a little diluted in that the resources are being spread over multiple projects internally and externally. The monitoring, evaluation and analysis of the return on investment seems not to be taking place except in some areas of Rand Water. This will definitely yield long-term challenges in terms of resource sustainability.

The emphasis and focus on the scientific core skills for development shown in Table 3 for the organisation must also be aligned to sector. There needs to be greater emphasis on skills identified in the Sector Skills Planning and skills for the core operations of the sector. This is a matter to be addressed with immense accuracy right from the new recruitment advertising to stricter budget allocations. This helps to clearly define selection criteria and the return on investment on the individuals selected for pipeline development. The strides made in Scientific Services are evident in the completed project by graduates for the division, organisation's operations and thus the sector that increases operational integrity.

It is important to understand that analysis done for skills development for the assurance of quality drinking water is actually successful in the Scientific Services division within the context of Rand Water as an organisation. Application within the organisation on the specific aspect of skills developed for the assurance of drinking water quality will ultimately be the true value adds. The skills requirements and the training and development established for scientists in Rand Water can be modelled in other areas of business. The competency model of a water scientist is known for the organisation and has been measured and can be applied to the sector with discretion.

The skills development framework for future drinking water quality assurance operations employees can be sustainable with the relevant human resource capacity to drive it consistently. The prediction of the quantity of water scientists required in the next 5 years has been calculated and can be used as indicators for recruitment. The organisations' risks are determined and strategic planning can be streamlined to priority around these activities.

9.3. Recommendations

The Water Sector Leadership Group Skills Development Report, Task Team: A Coordinated Approach to the Water Sector Skills Crisis February indicates that globally, the problem of skills shortages requires strategic planning that links to the education system with sector specific technical and management skills development (WSLG, 2009: 30). The current high mobility of scarce skilled professionals such as registered engineers and professional scientists requires that workplace skills planning and employee development, employee retention strategies be of paramount importance to ward off competition for these scarce skills. Salaries, working and living conditions must become major future determinants of recruitment. Strategies to recruit scarce water sector skills such as engineering, technical, scientific and water business management professionals should be looked at within the context that South Africa will compete with other more developed countries on the international market for these skills. A successful skills development program is linked to the formal education system to meet the needs of all sectors of the economy for sustainable. An Integrated alignment to the advancement of human health and most importantly a fairly risk-free socio-economic development environment are the pre-requisites for political stability of any country.

Global pressure on water the sector and the extreme emphasis on scarce skills and further drawing on the conclusion of the investigation. Rand Water will have to look more closely at some immediate aspects to establish a more aggressive organisational approach for the local skills development arenas as well as on the continent:

- Rand Water's framework and tools to effectively engage in skills development and skills transfer more extensively within the sector is not sufficiently organised.
- Rand Water's skills development/talent data and data systems need serious attention in order to accurately establish the organisational/divisional skills pools and competency.
- Rand Water may presently have the expertise for assuring quality drinking water but the study does not include the treatment processes and infrastructure development.
- Rand Water can be doing more for skills development in the sector with sustainable and synchronised efforts, beginning within the organisation to apply more cost effective means thus having a greater impact and avoiding any duplication.
- Strict adherence to national legislation on cost containment measures to ensure all funding yields more skills development returns
- Rand Water's alignment to skills development drivers in the water sector needs a more focused approach of using the sector skills development drivers strategically. e.g. the artisan development program

The organisational business processes must apply throughout Rand Water for skills development irrespective of where the budget allocation resides - Rand Water Academy, Capacity Building Corporate or at site level. The priority purpose is to capacitate young people of the country for the water business whether within the organisation or if they are being recruited into the sector. There should be a meticulous account for alignment of programs to ensure that there are no duplications and thus exhausting funding of the organisation or sector unnecessarily and not yield any great return. The ultimate aim being to develop skills for the water sector to answer the water services needs in a quick efficient way, while also looking at sanitation collectively for both the country, region and continent.

9.4. Limitation

The key limitation would be the availability and accessing of accurate academic data and skills analysis information for perusal. The functionality of Rand Water in the water and energy sector creates the impression of long term sustainability which is a 'false floor effect'. It is this vulnerability that present management of Rand Water will have to establish strategic mechanisms to overcome. The water industry is a unique industry in that the demand will always exist and the raw product will forever remain a constant. The factors which change are those that determine the limitations and or risks. The quantity and quality of the raw water has a converse relationship to the demand. The added challenge is the aspect of water being the basic human right of all which in most developing countries is far from achievable but necessary for development to continue. A major risk for undeveloped and developing countries whether national, regional, and continental or globally is the approach to the allocation and provisioning of water equitably.

9.5. Further Study

Rand Water's readiness for the future being based on academic qualification, skills, experience and age as determinants for establishing the organisation's strength for sustainability are not absolutes. The skills analysis data must be matched with the changing local trends in water scarcity and meeting the demand of quality drinking water into the next 5 years and beyond. It must be noted that the Rand Water Academy has not as yet defined its precise structure. There is mention of two approaches in Rand Water's Corporate Directive Planning (Rand Water, 2011: 36).

- Structured Approach – this approach however has not been followed and should have been clearly defined if it was the approach to follow from the very on set. This approach if decided on at a later stage will then require some degree of undoing and redoing. The structured approach would have been the slower progressive step by step approach which would require strong academic rigour to establish. The Academy's inception was in 2011 and it has not moved in this direction in any significant way.
- An incremental approach – this approach would have been the easier approach to follow in the organisation since it already has various intervention within the organisation and on the outside aimed at upgrading skills. This is driven predominantly by Human Resources but housed in the various portfolios of the organisation. These current pockets have their funding however since 2010 all concentrated in Strategic Human Capital Portfolio, but distributed under the different divisions of SHC. The glaring advantage would be that all funding will be collectively allocated to one 'portfolio budget' looking at all intervention specific for purpose whether on the outside or inside. It will also allow for resources to be relocated and or allocated more concisely. This would be particularly advantageous in financial terms.

The incremental approach will be a more focused approach to funding from within the organisation and for that which is redeemed from donors locally and internationally. The collaborations with other institutions will also be given greater emphasis and larger accountability can be initiated. The RWA used the incremental approach from its inception although the financial advantages for the approach were not practiced. The RWA approach and financial discretion needs a new mandate within the context of the business as a whole.

A more innovative and integrated model is required for all research within the organisation and co-ordinated collaborations with other academic institutions. There is a definite need for Rand Water and the sector as a whole to move towards common goals to produce more ready to use skills in Science and Engineering. The University of Witwatersrand the Dean of The Faculty of Engineering and the Built Environment, Professor Beatrys Lacquet, highlights the following in the area of scarce skills projects. As well as four South African research chairs, the Faculty of Engineering and the Built Environment has 12 industry-supported chairs, which are important because it links with industry. The Faculty is able to keep research projects focused. The Wits Research Report 2012 highlights the collaboration between the School of Chemical and Metallurgical Engineering and colleagues from the University of South Africa led to patentable inventions which focused on water purification using nanoparticles (WITS, 2012). Rand Water has collaborations with universities both in Science and Engineering this needs to be intensified for maximum purpose and return and more importantly to foster greater funding for continuous research. This will also include skills development and heightened credibility to both institutions locally and internationally. These collaborations are win-win relationship that must be nurtured and solidified for continuity based on common purpose of improving life for all.

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