EXECUTIVE SUMMARY

INTRODUCTION AND MOTIVATION

There are a limited number of laboratories that undertake water quality testing in South Africa. More significantly, many of these laboratories have capacity limitations. These laboratories are a critical link in the value chain that ensures safe drinking water for consumers and unpolluted water in our water resources. Until recently there has been little focus on the quality control of the laboratories utilized in the testing of water. This has resulted in municipalities and the Department of Water Affairs (DWA) using both centres of excellence and those with little evidence of being able to produce reliable results. However, the most startling issue is that although the problem was acknowledged within the sector, it could not be quantified. How many laboratories are there? Where are they? What quality control measures do they have in place? Do they have suitably qualified staff? This WRC project has begun the process of quantifying these gaps in the sector.

The process and cost of ISO 17025 accreditation with SANAS has been highlighted as a stumbling block for many laboratories. As a result, DWA is currently in the planning stages of implementing a laboratory strategy for ensuring the credibility of results from drinking water quality laboratories, based on a pared down version of ISO 17025, and focusing on technical competency.

AIMS AND OBJECTIVES

The aims and objectives of the project are:

- Conduct a survey of the status, capacity and geographic location of all available laboratories that would be able and considered to be capable of conducting chemical, microbiological, toxicity and bioassay testing on water and wastewater samples in South Africa;
- Identify problems and bottlenecks which hamper functioning and establishing of laboratories;
- Identify training requirements and basic skills required – sampling, analysis, interpretation, error recognition;
- Identify training materials needed for basic skills development;
- Use the information gathered from the survey to develop strategies to address the needs of water quality assessment in South Africa.

FINDINGS

Survey

This research project has developed a database of the existing laboratories that undertake water quality testing and, through a survey, obtained information on their capability and credibility. Nearly 200 laboratories were identified and 50% of these completed the survey. The geographic spread of the laboratories correlated to their testing capability has provided a useful tool in establishing if there are sufficient laboratories across the country, and where additional credible laboratories need to be established. The survey submitted to all water quality testing laboratories was based on staff capacity, laboratory capability, equipment, accreditation methodology, quality assurance methodology, area served and general remarks. By critically analysing these categories, a holistic gap analysis has been portrayed, providing a base for improvement in the water quality testing sector and thus improving water service delivery. DWA will be the custodians of the database, using it to build a list of recommended/approved laboratories for use by municipalities in their water quality monitoring programmes, and also maintaining the information so that it remains current.

Laboratories have been located (to nearest town) and categorised as follows: commercial, government, municipal, research, water board, university and site laboratories. This basic database of laboratory information is a key output of this research and an important tool for DWA and other sector stakeholders, as there has been no such database to date. Therefore, regardless of the survey responses received during the research, the basic establishment of a set of location and contact details is a marked success.

The basic laboratory information is useful to determine geographic spread, and thus analysing where there are sufficient laboratories, and which areas would benefit from additional laboratories being set up. It is also useful to look at the geographic spread of the laboratories that have SANAS.
accreditation in order to establish the number of accredited labs per province as well as any trends regarding accreditation or participation in proficiency testing schemes. This will also assist in the laboratory classification structure which requires certain knowledge of the location of laboratories and their accreditation status.

The discovery process identified approximately 200 laboratories, of which 103 completed and returned the survey. Fifty-eight laboratories with SANAS 17025 accreditation undertake water quality testing. This is approximately 30% of the total number of laboratories identified. The remainder of the laboratories listed various reasons for non-accreditation: financial; personnel; equipment; too difficult, in the process of obtaining accreditation; and “other”.

The results showed a high occurrence of financial reasons for non-accreditation (25%). The initial financial implications of attaining ISO 17025 accreditation are severe, as a management system needs to be put in place. The maintenance of equipment, procurement of stock, method validation, technician competency per method, and record keeping are vital in achieving ISO 17025 accreditation. These stipulations are specific to ISO 17025 standards which indicate the value of being accredited to this standard as opposed to ISO 9000 only. The perception that laboratories need a great deal of state of the art equipment to carry out testing is false. The only advantage to having excess equipment is that more samples can be processed. This ensures higher profit margins, thus making it easier to achieve accreditation. Another implication of accreditation is the stock of chemicals. In order to be accredited one extra sample from each chemical is needed from the stock for quality purposes. Every 10th sample is used for quality control purposes, which means that for every 10 samples one of them will not produce any profit. The financial implications of this may be a significant factor for laboratories when deciding to become accredited.

Staffing – The majority of the laboratories (73%) have less than ten staff members employed (permanent and contract included). However, the size of the laboratory does not appear to correlate with capability. Instead, within this sample of small laboratories there is a range of staffing qualifications, testing capabilities, and number of samples that can be processed. For example, these small laboratories (58 in total) are processing from as little as four samples to over 30 000 samples per month. However, the rate of samples processed depends heavily on the type and capability of instrumentation used by the laboratory. One correlation that does arise is that 52% of these small laboratories take part in a proficiency testing scheme and only 14 labs (24%) are ISO 17025 accredited.

Training – It appears that training is a priority for the majority of laboratories. A total of 79% of laboratories conduct training needs assessments, but the main concern lies with those laboratories with little or no training at all. A total of 77% of laboratories acknowledge the availability of assistance both internally and externally and 79% stated that their organisation is in a position to train personnel from their facilities to assist them in methodology training. Unfortunately the survey has limited use, as it can only identify the type of training offered, but not the quality of materials utilised. Persons with at least a diploma carry out all training provided at the labs, with the majority of trainers having tertiary degrees. This cannot guarantee quality, but is an indicator that training is carried out by a staff member with a higher qualification.

Geographic Spread – All identified laboratories have been located (to nearest town) and categorised as follows: commercial, government, municipal, research, water board, university and site laboratories. This basic database of laboratory information is a key output of this research and an important tool for DWA and other sector stakeholders, as there has been no such database to date. Therefore, regardless of the survey responses received during the research, the basic establishment of a set of location and contact details is a marked success. The basic laboratory information is useful to determine geographic spread, in order to analyse where there are sufficient laboratories and where additional laboratories should be established. It is also useful to look at the geographic spread of the laboratories that have SANAS accreditation in order to establish the number of accredited labs per province as well as any trends regarding accreditation or participation in proficiency testing schemes. This will also assist in the laboratory classification structure which requires certain knowledge of the location of laboratories and their accreditation status.
Training Needs and Availability

A key element of quality assurance and credibility of results is staff competence. Training programmes for staff are therefore very important in reaching and maintaining the required level of competence. Training helps maintain and improve quality and productivity. Providing training for employees not only helps them develop their skills and knowledge, but it is also motivational and a building block to organisational success. Training needs to be for the right people, it needs to be the right type of training and it needs to be at the right time. Unfortunately many companies do not have adequate budgets to allow them to have their employees trained adequately.

During the course of this project, the NLA held its annual Test and Measurement conference. Feedback from the attendees (125 out of 250 filled in the feedback forms) to this event provides an overview of both water laboratories and others. Whilst the responses from the T&M conference do not necessarily reflect the opinions of water testing laboratories, it is safe to make the assumption that the problems experienced in the different types of laboratories are generic.

The following were identified as “areas of concern”. They are not listed in any particular order.

- Accreditation requirements
- Method validation
- Estimation of uncertainty of measurement
- Proficiency testing schemes and inter laboratory comparisons
- Skills shortage, development of staff and how to retain skilled people,
- Quality control and quality assurance
- Water quality (chemical, organic and microbiology)
- Calibration of water lab equipment
- Laboratory safety and waste disposal
- Equipment, including calibration and maintenance.

These in essence cover all the different aspects of a testing laboratory and all have a direct effect on the quality of the results generated by the laboratory.

The conference was attended by people from both accredited and non accredited laboratories. It does however seem as if there are uncertainties regarding accreditation issues even at accredited laboratories.

When analyzing the requirements for SANS 17025, the training categories identified as important for a laboratory doing water quality testing were:

- Accreditation
- Laboratory Techniques
- Statistical methods and method validation
- Laboratory Safety
- Sampling.

Courses dealing with these aspects are available at the following organizations:

South African National Accreditation System (SANAS)
- National Laboratory Association (NLA)
- LabHouse
- Alec Cameron & Associates
- CSIR Natural Resources and the Environment
- Tshwane University of Technology
- Chromatography Consultants (C4 Training)
- Unilever Centre for Environmental Water Quality
- Marcus Evans Conferences
- Action Training Academy
- Umgeni Water
- DNAbiotec
- Online courses
- Laboratories identified through the survey that are capable of training:
- Innovation Annalitical
- Consulting Microbiological Laboratory
Primary Industry Challenges
A workshop with key industry stakeholders identified the following issues as the Top 10 Challenges:
- Human resources
- Sector leadership
- Quality/credibility of results
- Sample integrity
- Financial constraints
- Supplier role and responsibility
- ISO 17025 accreditation
- Insufficient laboratories
- Water quality testing undervalued
- Communication.

DISCUSSION
Overall the survey produced interesting, but not unexpected results. Capacity and capability were known from the outset as priority gaps in the industry, but what was unexpected was that on surface the staff qualifications (high percentage of tertiary graduates) would suggest a well-trained, capable work force. From this, one can surmise that the capacity gap lies in the inability to apply the theory learnt on training/study courses. Training therefore needs to be focused on hands-on application, preferably in-house through mentoring and in-service training.

The results from the survey are fairly one-dimensional and need to be utilized as indicators of underlying problems. The results would most likely be of increased benefit if used in conjunction with other data sources as a means to cross-reference issues that have been raised. For example, where DWA receives inconclusive reporting from a municipality, the survey results database could be used to find out information on the laboratories utilized for the testing, to see if significant issues on training, capability, staffing, etc. can be identified.

Overall, the industry is highly challenged by the lack of skilled, experienced staff at all levels that are able to interpret and analyse data. This is directly linked to the poor standard of result credibility, and the low level of sample integrity evident across the industry. These capacity and credibility issues are partly a product of the lack of leadership in the sector. There is need for education at a high level so that budget, strategies, policies, knowledge dissemination and sector co-ordination can be prioritized. Hopefully if the sector leaders begin to value the water testing laboratories, issues around budget constraints, ISO 17025 accreditation, and the need for more laboratories across the country will be addressed.

RECOMMENDATIONS AND STRATEGIES
To begin to address the human resources challenge, it is recommended that in-service training for new graduates is promoted and practiced throughout the laboratories; regional training courses should be regularly held to make training more affordable and accessible; willing retirees could be contracted to train and mentor junior staff; and technicians and managers should be required to obtain registration/approval based on a set of competence criteria.

DWA is the sector leader and as such needs to set the tone regarding the importance of credibility in water quality testing results. Strategy and policy for regulation and support needs to be generated; a regulatory tool to influence municipal budgeting relating to water quality testing needs to be developed; DWA staff need to be capacitated to understand and interpret results submitted to them; and strategic partnerships with SANAS, the NLA, the NHLS and water boards need to be established. DWA can assist in improving the standard of result credibility by implementing their proposed Laboratory Strategy which will require laboratories undertaking water quality testing for municipalities to be “Approved” per method if the results are to be accepted by DWA.
Specifications for sample integrity, such as chain of custody forms and GPS readings of sample points should become mandatory. Laboratories and leadership need to develop a greater understanding of ISO 17025 – its benefits, costs and value it can add to any laboratory. Many misconceptions deter laboratories from attempting to obtain accreditation, and this needs to be rectified. Lastly, a communication strategy that includes the general public, laboratories, municipalities and relevant government departments is needed to raise the profile of water quality testing. Once there is a better understanding and a demand for credible water quality results, many of the current challenges will become priorities, and hopefully resolved/improved.

CONCLUSIONS

Results show that the geographic spread of laboratories is skewed significantly towards the main centres of Gauteng, Cape Town and Durban/Pietermaritzburg, leaving vast areas in the Northern Cape, Limpopo, Mpumalanga and the Eastern Cape that are potentially poorly serviced. Further, the primary shortage is in laboratories able to undertake microbiological testing – vital for detecting immediate health risk. In determining the strategies for the way forward, a wide range of training courses and materials was investigated, establishing that there appears to be sufficient breadth and depth of training available, but that the gap lies in the application of such training in the work place. Mentoring, hands-on management and insitu training are all identified as key in raising the standard of results produced, paving the way to more confidence in water quality testing results across the country.

The primary conclusions related to training can be summarised as:
- Laboratories need to be made more aware of the training courses currently available in the market.
- Laboratories could be encouraged to become members of associations such as the NLA so that they are regularly notified of training courses;
- Organisations that can offer training need to be established in centres other than Gauteng (perhaps those laboratories identified in Chapter 5 need to be encouraged to formalise their offer to provide training); and
- Training needs to be more affordable for the smaller laboratories.
- Skills shortage is a serious problem in small and big labs. One of the biggest shortcomings is the lack of experienced personnel that can mentor new people that have just started working in a lab. Support is required from experienced technicians in the laboratory to allow for more insight and understanding of processes and tests.

It is not necessarily feasible for all laboratories to head towards accreditation based on the reasons stated in this report, but for those laboratories that may benefit financially from accreditation may find that becoming DWA Approved is a more reachable target in the interim. The starting point in the process of achieving accreditation is also unknown to various laboratories. In order to overcome this obstacle, there is a great need for management to support accreditation in all aspects. This will increase solidarity in the goal of accreditation thus making it more reachable. Laboratories that are aiming for accreditation should have one person (a senior technologist or scientist) employed solely to administer the process. The recently developed DWA Approval System will assist in filling the gap regarding the present problem of expense for accreditation. Once laboratories grasp what is required for DWA Approval, accreditation will not seem so unobtainable. When DWA Approval status is obtained these laboratories are likely to increase their level of commercial work due to the recognition received from approval status, which will boost their income and in turn some of that profit can be utilised to obtain accreditation.

PROJECT ASSESSMENT

The project was able to achieve all the objectives, and more with the development of the laboratory database and a DVD format information toolkit. The survey was fairly successful, with the 50% return rate, however the information gathered was limited and lacked context in some areas, resulting in the analysis being limited. The database of basic laboratory information and testing capabilities is of significant use to the industry, DWA, municipalities and the public if it made available on the DWA website and regularly updated so that information is current. The identification of training needs and availability was eye-opening, as it became apparent that there is a demand for training in all the important aspects of laboratory work. The concern that was highlighted was that although training in all fields was offered, it was generally only available in Gauteng, which escalated costs and became out of reach for many laboratories. The sector/industry challenges identified were not unexpected,
however the pivotal role of DWA in improving the status quo was highlighted on numerous occasions and stresses the urgent need for DWA to finalise and implement their proposed Laboratory Strategy as soon as possible. As a contribution to the information dissemination challenge highlighted through the project, the project team has developed an information DVD toolkit which not only contains the information from the research project, but attempts to include as much relevant information as possible relating to water quality testing. The purpose of the toolkit is to empower laboratory technicians and municipal management (amongst others) in the important elements of attaining credibility of results and ensuring compliance to the forthcoming DWA regulatory requirements. The main benefits to users arise from the database and the information toolkit, which hopefully will assist in making water quality testing laboratories more visible and valuable within South Africa.