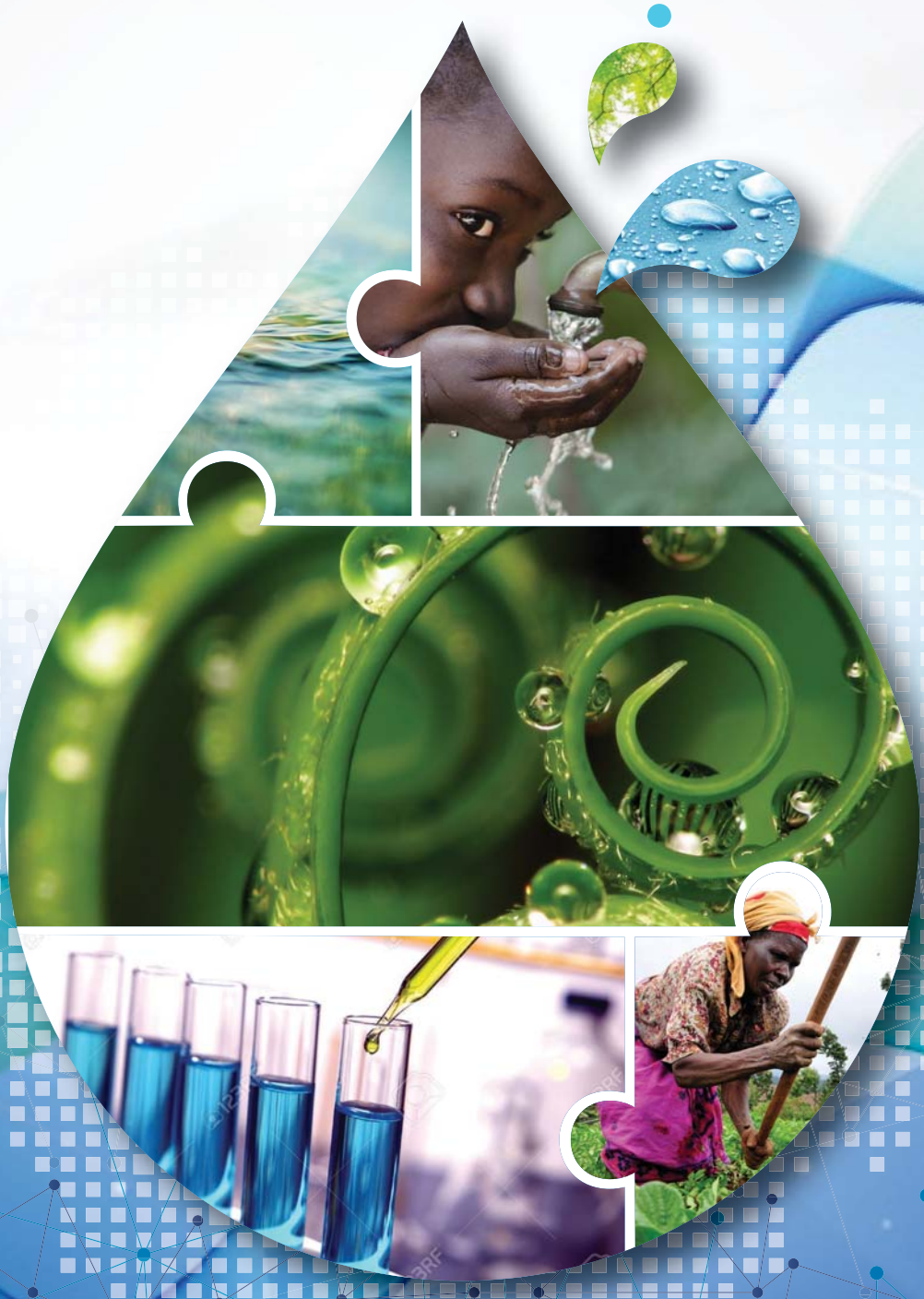
WATER RESEARCH COMMISSION

# CORPORATE PLAN

## 2019/20 - 2023/24



# Vision

To have highly informed water decision-making through science and technology at all levels, in all stakeholder groups, and innovative water solutions through research and development for South Africa, Africa and the world.

# Mission

To be a global water knowledge node and South Africa's premier water knowledge hub active across the innovation value chain that:

- informs policy and decision making;
- creates new products, innovation and services for socio-economic development;
- develops human capital in the water science sector;
- empowers communities and reduces poverty;
- supports the national transformation and redress project; and
- develops sustainable solutions and deepens water research and development in South Africa, Africa and the developing world.

# Values

- A culture of learning and sharing
- Innovation and creativity
- Integrity and fairness
- A spirit of professionalism and service orientation
- Facilitating empowerment and social change
- Good governance

## OFFICIAL SIGN-OFF

It is hereby certified that this Corporate Plan:

1. Was developed by the Water Research Commission under the guidance of the Water Research Commission Board

2. Takes into account all the relevant policies, legislation and other mandates for which the Water Research Commission is responsible

3. Accurately reflects the strategic outcome-oriented goals and objectives which the Water Research Commission will endeavour to achieve over the period 2019/20 – 2023/24

Chief Executive Officer

Chairperson of the WRC Board

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **BD&I** | Business Development & Innovation |
| **CEO** | Chief Executive Officer |
| **CoGTA** | Cooperative Governance & Traditional Affairs |
| **CMA** | Catchment Management Agency |
| **DAFF** | Department of Agriculture, Forestry and Fisheries |
| **DEA** | Department of Environmental Affairs |
| **DHS** | Department of Human Settlements |
| **DIRCo** | Department of International Relations and Cooperation |
| **DoH** | Department of Health |
| **DMR** | Department of Mineral Resources |
| **DRDLR** | Department of Rural Development and Land Reform |
| **DST** | Department of Science and Technology |
| **DTI** | Department of Trade and Industry |
| **DWS** | Department of Water and Sanitation |
| **GDP** | Gross Domestic Product |
| **GWRC** | Global Water Research Coalition |
| **HCD** | Human Capital Development |
| **HEI** | Higher Education Institution |
| **ICD** | Institute for Communicable Diseases |
| **ICT** | Information & Communications Technology |
| **I&I** | Innovation & Impact |
| **IP** | Intellectual Property |
| **IWRM** | Integrated Water Resource Management |
| **KSA** | Key Strategic Area |
| **MDG** | Millennium Development Goal |
| **NDP** | National Development Plan |
| **NSI** | National System of Innovation |
| **NWRS** | National Water Resource Strategy |
| **O&M** | Operations & maintenance |
| **OECD** | Organisation for Economic Cooperation and Development |
| **PDI** | Previously Disadvantaged Individual |
| **R&D** | Research and Development |
| **RDI** | Research, Development and Innovation |
| **RPS** | Research Policy and Strategy Committee |
| **SADC** | Southern African Development Community |
| **SALGA** | South African Local Government Association |
| **SANBI** | South African National Biodiversity Institute |
| **SDG** | Sustainable Development Goal |
| **S&T** | Science and Technology |
| **TIA** | Technology Innovation Agency |
| **WEF** | water–energy–food |
| **WIN-SA** | Water Information Network South Africa |
| **WRA** | Water Research Act |
| **WRC** | Water Research Commission |
| **WSD** | Water Sensitive Design |
| **WSA** | Water Services Authorities |
| **WSP** | Water Services Providers |
| **WWF** | Worldwide Fund for Nature |

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# EXECUTIVE SUMMARY

This year is on track to be the fourth hottest year on record. The abnormally high temperatures combined with extreme weather events have featured in the World Economic Forum's Global Risk Report as having a high likelihood and impact over the next decade. Of the top 5 identified risks all but one is linked to water. The sustainability of this unique resource is the foundation of the WRC's strategy and underpins the core themes that runs through the Corporate Plan for 2019/20 – 2023/24 (CP19).

Research and Development (R&D) at the WRC addresses the challenges and opportunities relating to water and sanitation (W&S) in South Africa and plays a crucial role in supporting the country with sustainable solutions. Water scarcity and security are major risks as it is associated with all drivers of growth, connecting all sectors into the broader economic system. Balancing sustainable economic growth, social needs and environmental interests in water-scarce regions such as ours(SADC) depends on the availability of sufficient water.

The WRC's project portfolio ties strongly to contributing to the the attainability of most of the UN Sustainable Development Goals and will continue to develop products and services in the areas of water resources, ecosystems, uses, waste management and agriculture. The CP 19 project portfolio further invests in the multiplier effect with the aim to overcome the 'cubed' challenge (poverty, inequality, and unemployment). The WRC's Knowledge Tree and Lighthouses provides critical guidance when selecting and allocating resources to projects and portfolios.

The knowledge, innovations and technologies from research and development feed into the branch Innovation and Impact (I&I), which ensures that all innovative ideas are given a chance to be developed, explored scientifically, and tested with the aim to enhance our resilience to water security risks

The strategy for I &I applies a holistic approach by engaging all stakeholders and deploying a wide array of actions such as improved knowledge dissemination, stakeholder management, business development, intellectual property management, marketing and communications. This branch aims to position the WRC as a premier knowledge hub; inspiring water conservations; creating a robust and vibrant innovative ecosystem; creating an environment whereby professionals and non-professionals can contribute to channel their knowledge and skills to solving water problems and drawing various stakeholders to engage in water conservations.

The I&I strategy for CP 19 further builds on the innovation value chain by aiming to accelerate research, innovation and human capital development by focusing on the following six pillars: operational effectiveness and excellence; connectivity; business intelligence and support; partnerships with other organisations; business development and implementation.

The WRC has embarked on a business development and partnership strategy to create impact from WRC managed research and to diversify its income streams as part of a risk reduction strategy to enhance financial sustainability which has been identified as a key risk in the organisation. CP 19 targets the filling of the gap in the water research, development and innovation value chain for South Africa. Investing in and leveraging support for water solutions, mechanisms and platforms that will contribute towards transforming the water sector and support capacity building and

knowledge sharing, is central to the WRC's Business Development and Partnership efforts.

The Water Research Commission (WRC) prides itself in being the leading funder of water research in South Africa. With this comes the ongoing development of the required financial planning, structuring and support tools to refine and better understand the WRC's funding requirements and funding sources for the achievement of the WRC vision and strategic objectives. In CP 19 the Finance strategy will focus on retaining the WRC's clean audit status and this means continued emphasis on financial reporting and compliance as core elements. This element is important as it provides our partners and key stakeholders with assurance of the organisation's financial soundness.

WRC's current funding model is premised on a high reliance on levy income as its primary source of funding is likely to continue in the foreseeable future. However, the reality is that there are no guarantees regarding availability of funds and like other research institutions the WRC's is faced with the uncertainty related to the various phases of the economic and business cycles. The CP 19 strategy increased focus on business development for income diversity is vital as a risk -reduction strategy where essentially the focus will be on increasing income sources; adding new products, services, customers and markets to the WRC portfolio.

CP19 builds on its strategic agenda of focusing on 'paradigm', 'people', 'partnerships' and 'positioning', creating a continuum of impact that embeds our vision to have highly informed water decision-making through science and technology at all levels in all stakeholder groups. One of the stakeholder groups that is also prioritised in the strategy is its employees. The WRC's workplace is defined by technology and the employees that are using it, corporate social responsibility, legal and compliance, culture and the physical work environment. The Corporate Services (CS) strategy integrates these areas into the WRC's World of Work, while striking a balance between current and future employee and business needs.

An important aspect of the world of work is corporate social responsibility. This incorporates social, wellness and environmental concerns into regular business activities. It encompasses many objectives ranging from the ethical treatment of employees, employee wellness, contribution to communities in which the WRC operates and having environmentally-friendly/sustainable business practises.

WRC's Corporate Services Strategy for CP 19 provides game-changing advances in how the area supports the key areas of academic research, knowledge dissemination and a distinctive, high-quality employee experience. The CS strategy highlights a number of areas, there are significant opportunities to improve how business units and functions operate across the WRC. This includes infrastructure step-change enhancements, carbon reduction initiatives, and employee skills development.

# STRATEGIC OVERVIEW

# 1. INTRODUCTION

*Access to sufficient water and adequate sanitation of an appropriate quality is necessary for life, human dignity, economic growth and social development. This underpins the wellbeing and prosperity of South Africa and all of its people. For the South African water science community, the challenges are clear – translating research, development and innovation (RDI) into real solutions to address poverty, inequality and unemployment, while applying knowledge solutions to advance opportunities to enable economic growth, improve competitiveness and ensure prosperity.*

**The four core principles of the WRC's strategy focus on:**

1 PARADIGM

2 PARTNERSHIP

3 POSITIONING

4 PEOPLE

## PARADIGM

- Impact orientation (Knowledge Tree)
- Development focus (R d <-> r D)
- Narrowing the implementation journey
- Multiplier effect

The WRC has conducted water research for more than 45 years and many research outputs have been produced throughout those years. The WRC model of dissemination was to produce research and transfer knowledge to academics and practitioners, who would then convert the knowledge into solutions. However, this linear approach does not achieve the level of impact that is required in a changing sector with severe water, skills and infrastructure challenges. National policies also call for knowledge and solutions to be accelerated to communities. A paradigm switch is thus required to take research outputs into outcomes and impact for the broader society. Hence, the WRC has re-orientated its strategy to focus on impact, using the Knowledge Tree objectives, shifted research and development (R&D) to a development focus in order to shorten the implementation pathway by accelerating solutions to the market and enhancing uptake. The WRC has invested in partnership building to achieve these objectives and the multiplier effect.

# PARTNERSHIP

- Across stakeholder groups
- Public and private
- Local and international
- Funding
- Implementation
- Development
- Research

The WRC is a small cog that turns many big wheels due to its mandate, flexibility and agility in the sector. This is a unique national role which no other organisation in the water science and technology sector plays in South Africa.

The WRC continues to develop expert partnerships in the science and development space and has strengthened its efforts to build sustainable and beneficial relationships with strategic traditional and non-traditional partners to complement the WRC mandate on either side of the value chain for strategic water sector and societal impacts. The WRC strategy is reinforced with a business development focus to ensure projects can be scaled up with implementation partners for greater uptake and diffusion. Finally, a new emphasis has been placed on enhancing international partnerships.

# POSITIONING

- Relationship with Executing Authority and DWS
- Recognition as key development player
- Leadership in Science and Innovation landscape
- Water sector leadership
- Increasingly important partner in the international sphere

The WRC is positioned as the premier water knowledge hub in South Africa, and a strategic water hub partner to Africa and the globe.

As a knowledge hub it positions itself to provide knowledge and technology exchange to as many stakeholders and water sector partners as possible. It is also aligned to national policies and therefore is a key development partner to the sector and in terms of human capital development within the science and technology space.

Our position as the WRC both nationally and internationally is more meaningful when there is a strong relationship with the Executive Authority and the Department of Water and Sanitation.

# PEOPLE

- Transforming and expanding the water R&D community
- Growing the new W&S cohort
- Building the youth cadres
- Community practitioners and entrepreneurs
- WRC leadership development
- Gender and youth foci

At the heart of the WRC strategy is people. Three of the six Knowledge Tree objectives are linked to growing and empowering both the science community, through the development of students, researchers, entrepreneurs and innovators, as well as the sector practitioners and society through the generation of new knowledge, products and services. The WRC will use its programmes and instruments to improve people's lives. This will be advanced by supporting transformation and expanding the water research and innovation community. The WRC is making strides in growing the new water and sanitation cohort working in water and sanitation research and innovation. This will involve having more women and youth leading and participating in WRC projects. To stimulate economic growth and development, the WRC continues to support SMMEs and entrepreneurship in water and sanitation innovation and development, the creation of new products and services, new business development and an enhanced competitive edge.

The four core principles of the strategy are implemented through the following instruments:

- **The WRC Knowledge Tree:** This is an investment in the multiplier effect which aims to inform policy and decision-making, contribute to sustainable development solutions, develop products and services for the economy, actively contribute to human capital development, directly empower communities, and enable the national transformation project. Secondly, it speaks to the continuous improvement of a programmatic approach to choose a significant proportion of new projects in each funding cycle that build on the knowledge base of existing and previous funding cycles.

- **The WRC Lighthouses:** This is the concentration of research for accelerated knowledge and solution development. These are trans-disciplinary, multi-branch and inter-institutional mega-projects (platforms) that will examine priority water issues across the innovation value chain.

- **Community involvement in research,** which further diversifies the research philosophy. This moves the WRC from the classical independent-observer scientific approach to an action-research paradigm. This entails the broadening of our research scope to one that actively involves communities in the research project, and engages key partners to upscale and also maintain interventions post-project.

- **Innovation and impact:** The WRC will pursue elevations in several key impact areas through, among others, technology scanning, reverse engineering, and the pursuit of ready-to-use solutions in a plug-and-play mode

# 2. STRATEGIC OUTCOME-ORIENTED GOALS
## OF THE INSTITUTION – THE WRC'S KNOWLEDGE TREE

### 2.1 The WRC Knowledge Tree

The WRC Knowledge Tree (Fig. 1) is an investment in the multiplier effect which aims to:

- Empower communities
- Inform policy and decision making
- Develop innovative products and services for economic growth
- Enhance human capital development and the water and science sectors
- Promote transformation and redress
- Drive sustainable development solutions

These outcome-oriented goals are described in more detail in Fig. 2 and Table 1.

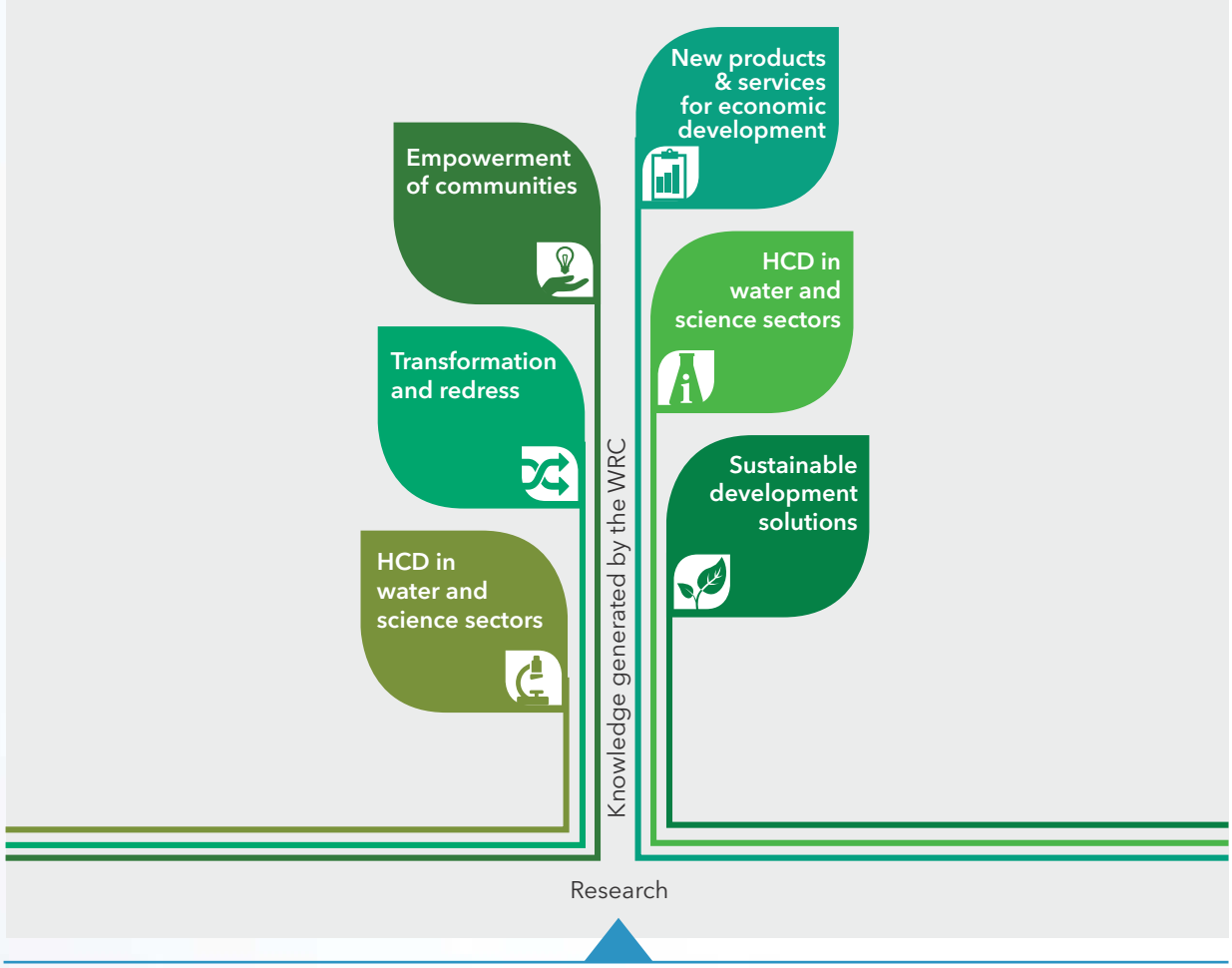



Figure 1. The WRC Knowledge Tree


Figure 2. The WRC's strategic outcome-oriented goals

Table 1. Strategic outcome-oriented goals depicted by the WRC Knowledge Tree

| STRATEGIC OUTCOME-ORIENTED GOAL 1 | INFORM POLICY AND DECISION-MAKING |
|---|---|
| **Goal statement** | The WRC will reinforce its efforts to commission appropriate research projects to actively inform both policy development by Government partners and decision-making by all parties in the water sector. Particular effort will be made to: (a) provide appropriate evidence-based information to guide decision-making, (b) effectively communicate scientific findings to decision-makers, (c) provide advisory services to Parliamentary portfolio committees, the shareholder department and other decision-making bodies, and (d) provide a platform for dialogue on various issues involving the policy landscape. |
| **Examples** | • **Use of RADAR to forecast rainfall and weather events:** The WRC through an informal partnership with funding through NRF to North-West University was able to test the real time radar, precipitation and weather data for free. Data generated will assist the Insurance industry, farmers and municipalities to plan and protect their assets from severe weather conditions. The Minister of Environmental Affairs launched the WRC Project Report. More importantly the project bridged the gap between research and operations by building real time infrastructure. Opportunities going forward could include evaluation of the knowledge transfer pathways and opportunities to partner to test translation to insurance industry.<br>• **Mapping of the strategic water source areas of South Africa:** In this WRC project scientists used hydrological and run-off data to map the areas that produced most of the country's water resources, for example water in streams, rivers, groundwater and wetlands. It was found that the regionally strategic water source areas make up only 10% of the land area of South Africa, Lesotho and Swaziland, yet they provide 50% of our water. Therefore, these areas are a key asset to the continued water security for the country and they need to be protected. Gauteng gets about 65% of its water from these areas, and Cape Town and eThekwini about 98%. The project also, for the first time, provided information on strategically important groundwater source areas. These findings have been incorporated into the Water and Sanitation Masterplan. Future opportunities could include strategic partnerships and dialogue to protect and value such assets appropriately.<br>• **Application of earth observation for agriculture:** The area irrigated and water use of irrigated crops in South Africa has been determined by means of a repeatable methodology for data capturing through satellite images and GIS techniques as well as modeling evapotranspiration (ET) water use of irrigated crops (WRC Report No TT 745/17).Irrigation water quality guidelines: A risk based approach has been followed as guideline for management of irrigation water quality which is a first for South Africa (WRC Report No TT 727/17). |

| STRATEGIC OUTCOME-ORIENTED GOAL 2 | DEVELOP NEW PRODUCTS AND SERVICES FOR ECONOMIC DEVELOPMENT |
|---|---|
| **Goal statement** | The WRC will capitalise on those projects that have potential to develop new intellectual property or to introduce innovations which create new or improved technologies, products and services to be used in the economy. |
| **Examples** | • **Wader:** In a joint partnership with DST, the WRC has established the Water Technologies Demonstration Programme (Wader) to optimise the water innovation value chain. Within the next threeyears, Wader will activate at least 27 additional technology demonstrators, expose at least 30 young engineers to boot camp, masterclasses and technology site visits and further provide technical guidance to SMME's and innovators to improve their products for the water sector through collaborative partnerships with industry, academia, government and civil society. This massive step forward is made possible through the General Budget Support Grant.<br>• **A technology to support water conservation (non-revenue water) programmes:** WADER has provided a critical intermediary service of support to entrepreneurs and SMME's that need their technologies to be tested in field by funding demonstrations and matchmaking innovators with local municipalities. The Aquatrip technology which functions like a trip switch preventing water losses, was demonstrated in 16 schools and shown to save both water by reducing leaks from old infrastructure and monthly water costs. This demonstration has allowed Aquatrip to develop further business partnerships strengthening their business model.<br>• **Modernising training & maintenance through technology:** WADER has also supported the LookSeeDo App which is a remote support PC and mobile communication tool which enables equipment experts from anywhere in the world to engage and help technicians in the most remote and poorly connected areas to operate, maintain, and fix equipment in any environment at low cost and with greatly reduced downtime. operates at extremely low bandwidth of under 1kbps so even equipment sites with very poor internet connectivity can be supported. This technology was supported in field testing at Johannesburg Water to show how South African can bridge the capacity building and expert base deficit by modernising and using technology.<br>• **Sanitation research leading to strategic partnerships and scale up:** WRC research on sanitation has been linked to technology development and O&M services in the past 10 years. This has also led to impactful partnerships such as with DST, African Development Bank and The Bill and Melinda Gates Foundation to test both global technologies in SA with the intention to localise them, thereby growing SMME's and preventing SA from becoming an import country. It has also tested the social franchising model further in Eastern Cape to include 5 new SMME's into the service industry for water and sanitation. This type of strategic partnerships contribute to developing the water industry and the IPAP (Industrial Policy Action Plan). |

| STRATEGIC OUTCOME-ORIENTED GOAL 3 | ENHANCE HUMAN CAPITAL DEVELOPMENT (HCD) |
|---|---|
| **Goal statement** | The WRC will strive for high student participation in its projects, as well as partnering with higher education institutions (HEIs) to grow capacity in new and emerging disciplines, e.g., biomimicry. |
| **Examples** | • **Student participation:** All WRC projects are encouraged to have a component of student participation where possible.<br>• **Supporting new PDI project leaders:** A special programme of short-term projects is planned to encourage and empower previously-disadvantaged individuals to be project leaders.<br>• **Student bursaries:** The WRC has partnered with DST to offer student bursaries in scarce-skills areas such as biomimicry and environmental ecosystem services. In 2018/2019 WRC attracted further funding from DST and DEA to support additional students in water research.<br>• **Chairs:** The WRC has attracted funding through the Water RDI Roadmap from DEA and NRF to co-fund a chair in resource economics thereby strengthening the building of research capability in water economics. |

| STRATEGIC OUTCOME-ORIENTED GOAL 4 | EMPOWER COMMUNITIES |
|---|---|
| **Goal statement** | The WRC and its partners will increase emphasis on projects that (a) have a direct impact on the lives and livelihoods of communities through water-related interventions, and (b) build sufficient capacity to assist with the post-project sustainability of those interventions. |
| **Examples** | • **AfDB (African Development Bank) partnership:** The WRC, in partnership with the AfDB African Water Facility, is improving water services delivery to the communities of Limpopo Province. Over 20 000 people are expected to get improved access to water for domestic and agricultural purposes, among others.<br>• **Working with communities (NGO/CBO Focus Group):** In 2018/2019 the WRC undertook to develop a database of NGO's as per social development department and sent an invite to all 9 provinces for NGO's to participate in an insight workshop. It is clear from the report that the WRC needs to develop and improve its relationships with a broader set of NGO's, who could be critical water and sanitation knowledge transfer ambassadors at community level. Gaps that WRC needs to fix are an appropriate intervention, translation of knowledge material relevant to such community organisations and a sustainable funding and partnership model.<br>• **Social Franchising:** The "Social Franchising for Operation and Maintenance of School Sanitation Facilities and Demonstration of On-Site Faecal Treatment" project in East London provided the context for the application of an innovative SMME Social Franchising Model in the Eastern Cape between May 2017 and October 2018. The project, funded by African Development Bank, used the Model which centred on a social franchising arrangement between a Franchisor and five SMME franchisees. A significant finding is that each of the 5 SMME social franchisees achieved professional growth during the implementation of the project, measured in terms of their respective CIDB grading. On account of their individual efforts and support from the Franchisor, all franchisees progressed in their CIDB grading. Two female-owned SMME franchisees had their CIDB grading improve sharply from CIDB 0 to CIDB 3 CE /GB. The only male-owned SMME franchisee progressed from CIDB 1 CE/ GB to 4 CE /GB. All the SMME franchisees are registered on the National Treasury's Supplier Database and are fully tax compliant, which is a statutory procurement requirement and a big hurdle for most SMMEs. This a further contribution to the sustainability of the franchisees. The SMME social franchisees earned regular incomes for their project implementation related work for a period of 18 months, ranging from R 482 570 to R 1 085 734. |

| STRATEGIC OUTCOME-ORIENTED GOAL 5 | PROMOTE TRANSFORMATION AND REDRESS |
|---|---|
| **Goal statement** | This 5-year Corporate Plan has transformation and redress as a central driver, both within the organisation as well as in the project portfolio. The goal is necessarily cross-cutting in that it drives the 'human capital development' and 'empowerment of communities' goals. |
| **Examples** | • **Project focus:** Continued diversification of the WRC portfolio is planned in terms of project leadership, student participation, institutional participation, project selection, and project site selection.<br>• **New Pathways:** The WRC continues to stay agile and flexible in testing new ways to be more inclusive to all tertiary institutions and persons. In 2018/2019 the call was opened to allow researchers to put forward concept notes towards short term research proposals. This could be a viable model for new and emerging researchers to build their research groups and capability while staying relevant to the strategic research needs of the water sector.<br>• **Development of an HDI strategy:** In 2018/2019 the WRC reviewed its portfolio over the past 5 years of funding to work towards an inclusive strategy for HDI's that are relevant to their needs. The 2019/2020 will results in the WRC evaluating which interventions could result in the highest transformative return on investment. |

| STRATEGIC OUTCOME-ORIENTED GOAL 6 | DRIVE SUSTAINABLE DEVELOPMENT SOLUTIONS |
|---|---|
| **Goal statement** | Sustainable development will remain a core principle driving all WRC projects and activities. Specific focus is placed on sustainable development solutions. |
| **Examples** | • **Water Sensitive Design:** The WRC invested in research looking at how different parts of the water cycle are managed within cities and built environments and highlighted the disconnect between spatial planners and water planners as well as the siloed planning within water services. WRC together with UCT developed a guideline and framework for integrated water sensitive design in 2013 and WRC took a strategic decision that elevating the concept to a Lighthouse would concentrate research from various institutions. Over the years WRC together with UCT has promoted the concept and practice at various forums (local, provincial and national level (including international R&D platforms). The WRC further created a Community of Practice at UCT to strengthen uptake and knowledge transfer. Some of the direct and indirect benefits have included : The Future Water Institute at UCT, the adoption of WSD into policy within City of Cape Town, development of green roof guidelines in eThekwini Municipality, consideration of WSD interventions and principles in a peri-urban social housing project in eThekwini, a partnership with CSE-India to train SA technical staff, a further partnership with DST to continue funding the CoP until 2022/2023 and finally a potential partnership opportunity with CSE-India for further training in additional municipalities.<br>• **Ecological Infrastructure:** From Research to Practice: Over the years the WRC has invested over R40 million towards ecological infrastructure research projects. This has spurred research, innovation, national initiatives and collaborations across science councils, NGO partners and government entities. In 2018/2019 this culminated in collaborative partnership with SANBI, WWF, DEA, WRC and DST which was successful in accessing R88 million from the Global Environment Facility. This 5 year project is significant towards mainstreaming the concept of ecological infrastructure into practice.<br>• **Protection of water resources:** A specific highlight is the WRC's current research to build a body of knowledge around unconventional gas mining. One new project is looking at the potential impact of this technology on South Africa's water resources with a view to develop best-practice guidelines.<br>• **Optimal water use:** The WRC's projects in the field of water utilisation in agriculture address this directly, for example, projects determining the water footprints of selected field and forage crops. Other projects are developing sustainability indicators that can be used to manage groundwater use. |

In terms of the achievement of the above-mentioned strategic outcome-oriented goals (Table 1; Fig. 2) depicted by the WRC Knowledge Tree (Fig. 1), the WRC manages a multi-year portfolio of projects numbering approximately 300 at any time (Table 2).

Table 2. Baseline summary for strategic outcome-oriented goals

| INDICATOR | 2016 | 2017 | 2018 |
|---|---|---|---|
| Number of projects approved | 75/ 262 | 60/261 | 64/ 158 |
| Budget over projects period | R106 122 621 | R50 712 178 | R60 588 123 |
| Total budget (1st year) | R29 320 276 | R13 565 698 | R18 873 147 |
| Projects with SMME as lead | 22 (31%) | 17 (28%) | 11 (17 %) |
| Community-based projects | 14 (18%) | 27 (45%) | 29 (45 %) |
| Number of projects led by Youth | - | 8 (13%) | 12 (19%) |
| Number of students (distinct) in proposals | 173 | 110 | 137 |
| HDI (Univ.) participation (contracting organisation lead) | 11 (15 %) | 6 (10%) | 10 (16 %) |
| Number of projects led by Female project leaders | 28% | 25 (41.7% | 27 (42%) |
| Number of projects led by Black project leaders | 19 (26%) | 18 (30%) | 24 (38%) |
| Number of projects led by African Black females | - | - | 11 (17%) |

*The WRC will reinforce its efforts to commission appropriate research projects to actively inform both policy development by Government partners and decision-making by all parties in the water sector. Particular effort will be made to: (a) provide appropriate evidence-based information to guide decision-making, (b) effectively communicate scientific findings to decision-makers, (c) provide advisory services to Parliamentary portfolio committees, the shareholder department and other decision-making bodies, and (d) provide a platform for dialogue on various issues involving the policy landscape.*

# 2. THE WRC LIGHTHOUSES

*The WRC Lighthouses are the concentration and crosscutting of research for accelerated knowledge and solution development. The Lighthouses are transdisciplinary, multi-branch and inter-institutional mega-projects (platforms) that will examine priority water issues across the innovation value chain.*

**The WRC has the following Lighthouses:**

1. Climate Change
2. The Green Village and Economy
3. Water–Energy–Food Nexus
4. Water Sensitive Design
5. Water Quality and Health
6. Water ICT
7. Sustainable Water Behaviours
8. Water and Big Data

## 3.1 CLIMATE CHANGE

### Scope

The WRC Climate Change Lighthouse is undertaken through collaborative research on priority water-related climate issues with partnerships forged along the innovation value-chain. Key issues of concern include extreme climate events (floods, droughts, landslides, heatwaves, wildfires, etc.), water quality and health, coastal zone management, water supply, groundwater recharge and the energy–water nexus. The role of this Lighthouse in climate-change response is embedded within adaptive capacity, resilience, improvement of early warning systems, reduced vulnerability and an improved ability to respond, coupled with proactive planning. Implementation of this Lighthouse is cross-cutting in research and development nationally and globally. The ultimate goal is to ensure empowerment of people for enhanced resilience, and development

of the knowledge base for climate adaptation and decision support tools, together with guidance and a framework for sectoral response. Water is critical for development, economic growth and 'a better life'. It is a key factor for inter-sectoral linkages. Climate change impacts on water resources, and development cannot be undermined. Increased occurrence of extreme climatic events comes with negative implications for infrastructure, health, production and economic growth, amongst others. All of these have a negative influence on development.

Climate change capital (Fig. 3) represents a cross-sectoral approach for implementation of the Climate Change Lighthouse. The approach will support a basic and applied research base for knowledge generation, innovation, capacity building and research for developmental impact. This will incorporate capacity development covering both research teams (and mentoring of upcoming scientists) and the recipients of the knowledge, interventions and innovations generated, including support for commercialisation of the generated technology.

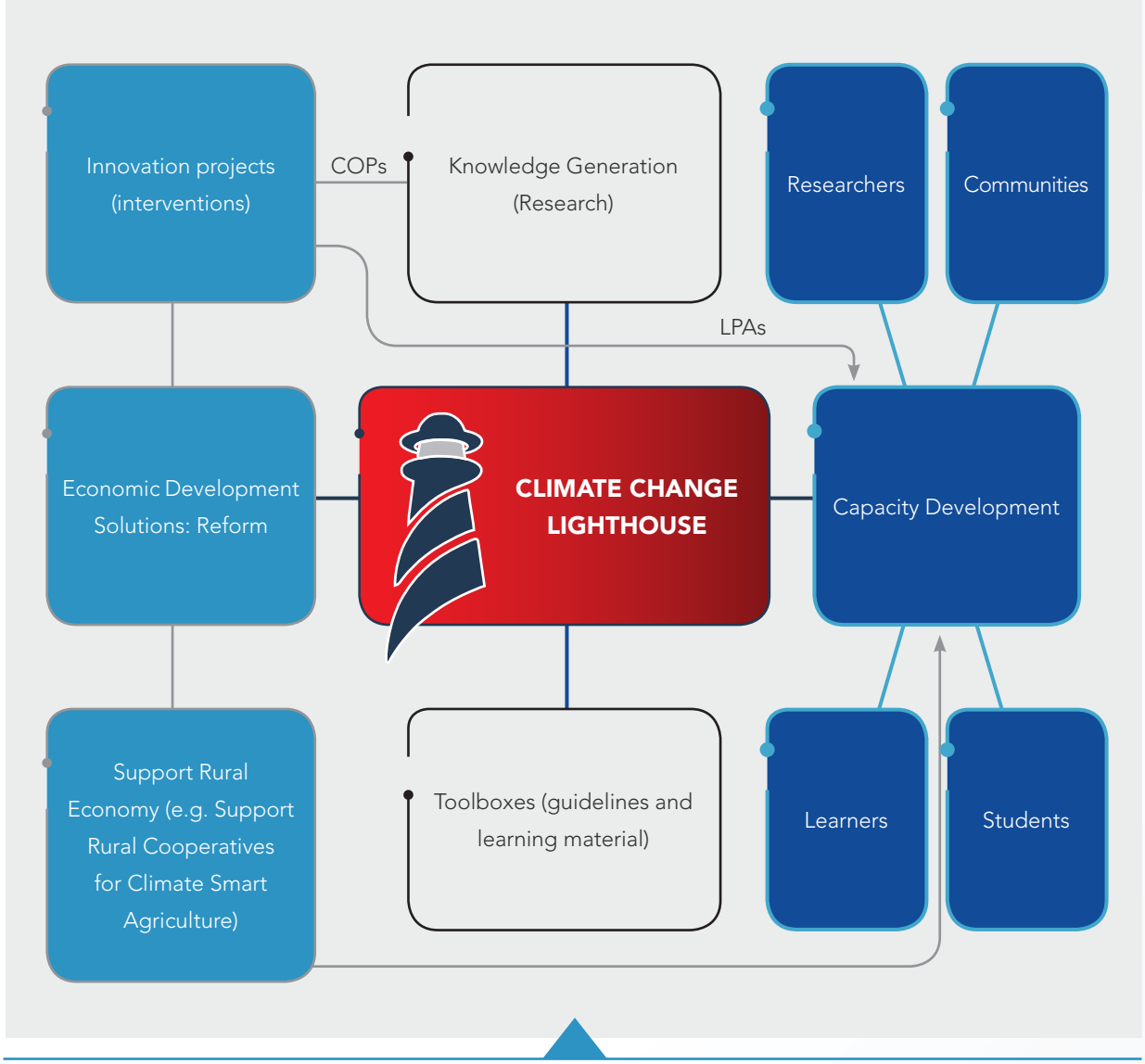



Figure 3. Climate change capital

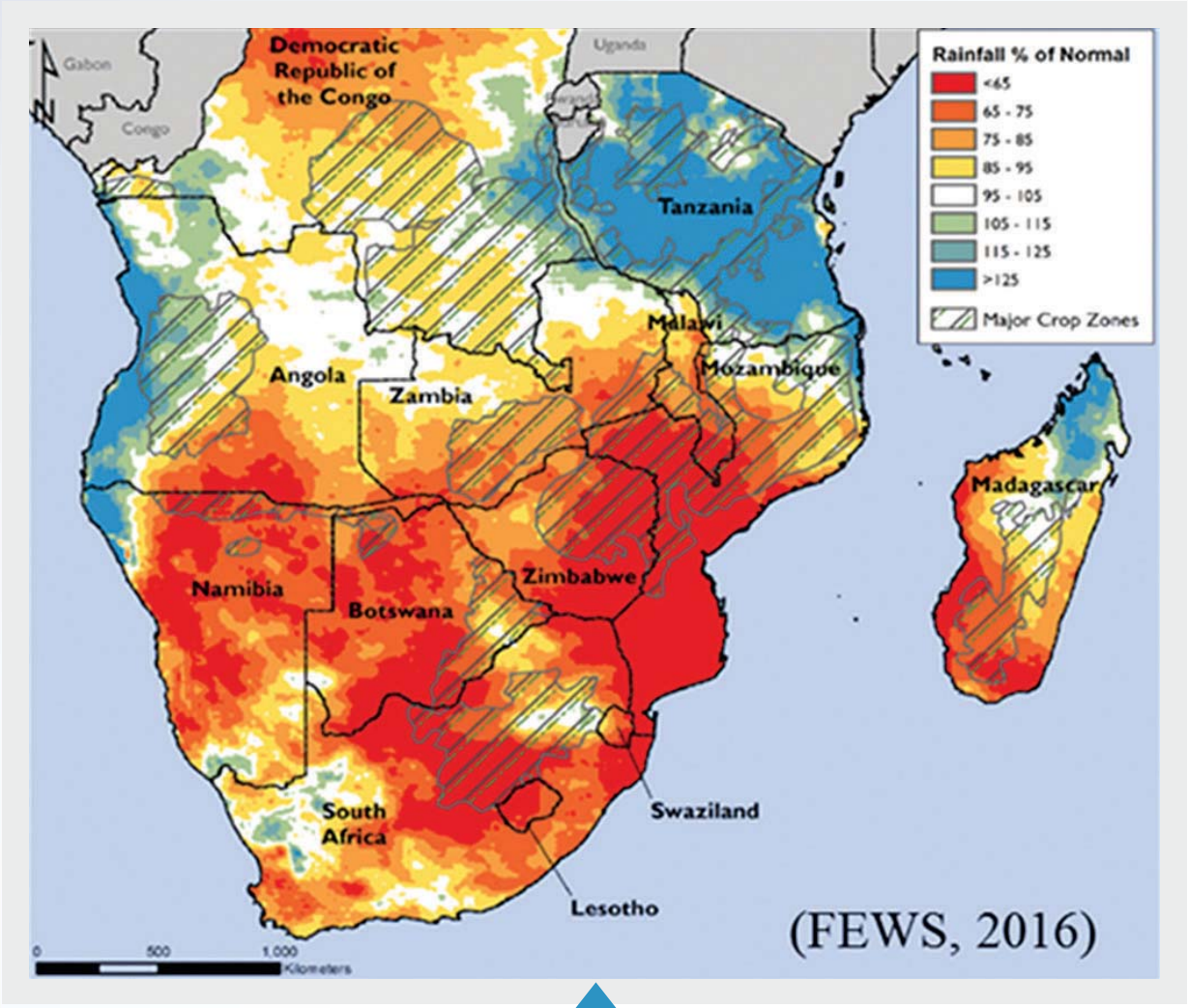



Figure 4. October 2015 – February 2016 rainfall anomaly (% of the 1982–2011 average) for Southern Africa

Both national and international stakeholders are expected to contribute significantly in terms of knowledge creation, funding and strategic direction. The knowledge generated will upscale to adaptation intervention projects/actions and mitigation guidelines (Fig. 4) in support of a climate-resilient economy. This will include sector- and site-specific responses determined and guided by need, together with national policy perspectives (NDP/NCCRP – National Climate Change Response Policy, Green Economy, and LTAS – Long Term Adaptation Scenarios) and integration of climate response into IDPs (integrated development plans) and catchment planning. The outcome is expected to be a climate-resilient society with improved adaptive capacity contributing to climate-smart development that does not compromise economic and social development.

Since its inception this Lighthouse has adopted a multi-sectoral and multi-level approach towards securing the water sector's contribution to enabling South Africa to characterize and prepare to deal effectively with a multiplicity of existing stresses brought about by climate change, through research embedded with capacity building. This involved bringing to the fore a portfolio of research covering the following themes:

- **Impacts of climate change:** A high priority was for the water sector, in partnership with other sectors, to research the development and support of appropriate institutions to refine and communicate climate-change scenarios, projections, information and data together with identification and quantification of impacts.
- **Adaptation to climate change:** A water-sector specific research priority was for Department of Water and Sanitation (DWS)-led collaborative research that would enable DWS and catchment management agencies (CMAs) to develop an integrated climate change adaptation response strategy, thereby mainstreaming adaptation within water resource management, nationally and regionally, with the overall aim of enhancing adaptive capacity.
- **Mitigation of climate change:** With relatively few exceptions, it was deemed that the water sector will not be responsible for taking the lead in mitigation-related research and development projects. However, the sector is clearly a stakeholder in other projects that have water use or water resource implications contributing to climate change mitigation. In such instances, the forging of inter-sectoral research partnerships with water sector participation is highly appropriate.

Over the past year, this Lighthouse has regained momentum by attracting the interest of stakeholders such as DWS, Department of Environmental Affairs (DEA), Department of Agriculture, Forestry and Fisheries (DAFF) and catchment management agencies, amongst others, who are now actively participating in prioritizing strategic areas of research, and participating in and evaluating the progress of such research and its impact.

The Lighthouse's research portfolio is composed of about 18 active research projects focusing on diverse fields: developing early warning systems for thunderstorms and floods for disaster management and aviation support, characterizing regionally extensive droughts and the influence of the ocean on inland climate with its impact on water resources, developing planning and decision support tools for climate hazards and predicting soil moisture–climate interactions under extreme events. The focus is also on determining the impact of climate change on aquatic ecology and defining the necessary response, which includes future impacts on fish distribution.

## Strategic objectives

In the light of a changing climate, the ultimate purpose of the Climate Change Lighthouse is premised entirely upon improving the adaptive capacity of the people and the sector to increase resilience and development of a knowledge base for climate change adaptation and decision support, while providing strategic guidance and framework for sectoral response.

This is embedded in the following objectives:

- Conducting research and knowledge generation on climate change adaptation and response
- Characterization of change and risks/ vulnerabilities and determining the type of response
- Contribute to human capital development
- Improve sectoral adaptive capacity and guide future response

This entails addressing practical adaptation options with a focus at catchment, municipal and national scale while translating the findings of research to aid operational response/local scale adaptation through mainstreaming adaptive actions to enhance resilience and response to the overall impacts of climate change.

## Future plans

The WRC Climate Change Lighthouse is a primary vehicle to drive research and knowledge generation on climate change adaptation, response, characterization of change and risks/

*In the years that follow, the Lighthouse is expected to downscale its focus to the catchment and municipal scale, to translate the findings of research to an operational level, and to mainstream adaptive actions to enhance resilience and response to the impacts of climate change.*

vulnerabilities and also to contribute to human capital development to improve sectoral adaptive capacity and future response. In the years that follow, the Lighthouse is expected to downscale its focus to the catchment and municipal scale, to translate the findings of research to an operational level, and to mainstream adaptive actions to enhance resilience and response to the impacts of climate change. The priority focal areas will include the following:

- Establishing new protocols for assessing vulnerability of existing infrastructure – models are needed that incorporate global climate science in order to improve their resilience
- Research on design of new water infrastructure for further development
- Develop climate change adaptation/mitigation guidelines focusing on the water sector to assist in mainstreaming climate change
- Develop cost/benefit models for adaptation approaches, evaluating these in a comprehensive way to justify adaptation choices, and valuing ecosystem services and the co-benefits of adaptation
- Research managing water quality and availability in the context of climate change impacts, focusing on things likely to occur as a result of climate change
- Examine climate impacts on socio-economic impacts of water demand (e.g., municipal/ industrial demand), focus not only on temperature and precipitation but also impacts on population shifts, migration, etc., that may drive water-intensive industry to relocate or change water use patterns (supply)
- Understand/identify indicators and thresholds of ecosystem services that affect water supply management (i.e., availability, infrastructure) (supply) at local scale
- Community-based innovation platforms and demonstrations for climate change response

It is, however, understood that climate change planning and response will over the long term be strategically adopted as part of business-as-usual in a quest to expand the interests of a climate-resilient economy and the realization of the Sustainable Development Goals (SDGs).

Implementation of this Lighthouse is cross-cutting in nature and requires a coordinated effort to address the consequences of a changing climate. The Lighthouse adopted a cross-sectoral approach (Fig. 5) for implementation which supported a basic and applied research base for knowledge generation, innovation, capacity building and research for developmental impact. This was undertaken through collaborative research on priority water-related climate issues with partnerships forged along the innovation value-chain to enhance water research and development, and positioning with respect to climate change. The aim was to incorporate capacity development covering both research teams (and mentoring of upcoming scientists) and the recipients of the knowledge, interventions and innovations generated. The knowledge generated was intended to upscale to adaptation intervention projects/ actions and to some extent contribute to mitigation through sector and site-specific responses. Each KSA would have a focal point to guide climate change projects. The overall outcome would be that of a climate-resilient society with improved adaptive capacity contributing to climate-smart development that do not compromise economic and social development.

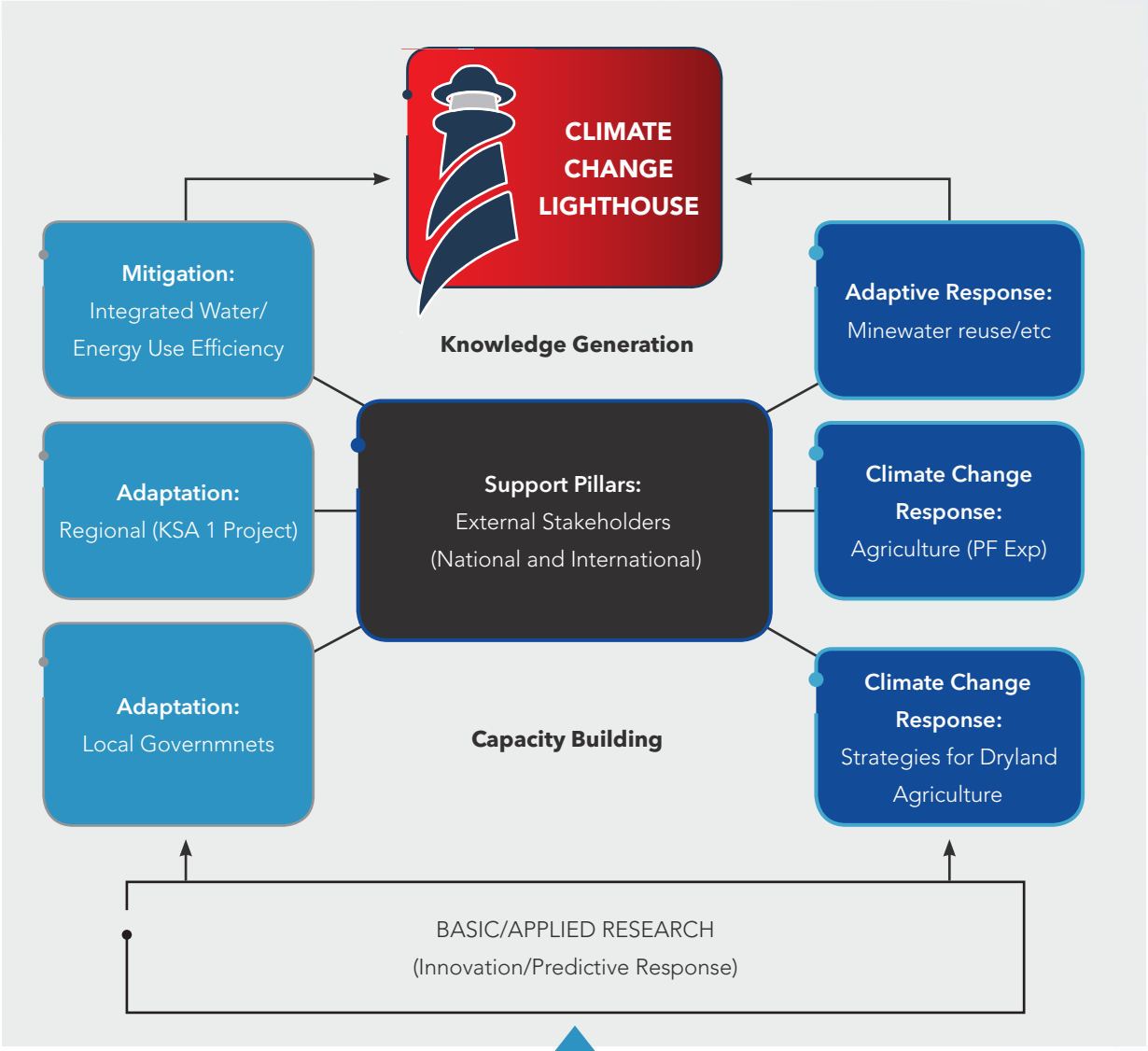



Figure 5. Initial broader Climate Change Lighthouse implementation model

## 3.2 THE GREEN VILLAGE AND ECONOMY LIGHTHOUSE (GV&E)

### Green economy

The 'green economy' is the economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low-carbon, resource efficient and socially inclusive (UNEP, 2011). The recently hatched concept of the 'blue economy' is a subsidiary of the green economy, with a global focus on coastal and marine resources (UNEP, 2013). Due to the overlapping principles of sustainability, the WRC decided to pool these concepts under one umbrella, the Green Village and Economy Lighthouse (GV&E). Its purpose is to concentrate research where possible in selected catchments, catalyse action through appropriate green innovations, position the organization through leading dialogues and presentations (including international conferences), and to market and communicate innovative products in order to see implementation, most likely through partnerships. GV&E was established in 2013, with a main aim of research and pilot testing of green innovations for meeting basic needs and providing fundamental services to marginalized rural and peri-urban communities in focal catchments (pilot areas), on a sustainable basis and at an affordable investment cost.

South Africa, similarly to other countries, is committed to eradicating poverty, ensuring water supply and sanitation, securing food and energy, and protecting ecological infrastructure, biodiversity and ecosystem resilience. Some of these commitments are expressed in the SDGs, the NDP, and various other strategies. The pressure from impacts of climate change and degradation of ecosystems must be considered alongside the needs of increasing numbers of people without jobs (latest estimated unemployment rate is 26% (Stats SA, 2013)). Even though the predictions are that 71.3% of people will be urbanized by 2030 (UN World Urbanization Prospectus, 2014), the challenges of escaping poverty, unemployment and inequality are not likely to disappear as long as the economic growth rate remains less than 5% per annum. About 12 million people live in abject poverty, while more than 50% of aquatic ecosystems (ecological infrastructure) are degraded, rendering them less capable of providing the services they are expected to offer. In an effort to move from poverty to prosperity, through knowledge acquisition and enterprise development, the WRC has prioritized the triple challenges of poverty, unemployment and inequality in CP17 and 18. Transitioning to a green economy is one of the key imperatives of Government (though this is clouded with numerous challenges, including disintegrated policies, and low uptake by society and business), as highlighted in the NDP. It is further recognised that there can be no transition to a green economy without green technologies and technological innovation (ASSAf, 2014). The GV&E will, through a serious paradigm shift, narrow the gap between innovation and application, build partnerships towards co-funding and implementation, influencing innovation through positioning via dialogues, conferences, and community interventions while centralizing the people, especially the 'game-changers' (youth), key in 'disruptive' innovation and enterprise development. Gender plays a core role, particularly in rural and disadvantaged communities, hence a

prominent effort will be directed towards woman emancipation/empowerment, along with that of the elderly and people living with disabilities.

## Strategic objectives

The objectives of the GV&E are aligned to the WRC Knowledge Tree, with projects addressing more than one aspect, depending on the case study. The following are the leading objectives:

- Restore degraded landscape ecosystems critical in nature-based solutions for water security and biodiversity services
- Promote resilience and mitigate environmental risks through investment in ecological infrastructure
- Develop adaptable and integrated green innovations that influence policy change
- Lead and align RDI with key national and international poverty, unemployment and inequity eradication aspirations, such as in NDP, SDG, Africa Agenda 2063
- Enterprise development to empower communities, especially women and youth, through green innovation
- Unlock economic wealth beyond the environmental processes by engaging the market value chain
- Encourage partnerships, particularly those that lead to co-funding and implementation
- Positioning RDI products in leadership, nationally and internationally, through dialogues, conferences, and community interventions
- Develop adaptable and integrated green innovation framework critical in entrepreneurship/business, community empowerment and influencing policy

## New focus

The re-conceptualized GV&E focus is on centralizing the protection of natural ecosystem services from the landscape perspective, noting the connectivity between land use and its impact on water resource quality. Various terms have been introduced to engage new approaches and traverse barriers to various disciplines, such as planning, engineering, social scientists, economists, business, residents and local indigenous knowledge, as well as various sectors and government departments. Maintaining ecological infrastructure (healthy ecosystems) that benefits society and business through their sustained services is the responsibility of every citizen. However, the levels of ecosystem degradation (more than 80% of all water resources are threatened) are alarming, hence this Lighthouse was planned to play a role in reversal of degradation and to proactively protect those in natural condition through development of green innovations to support legislation, business and society.

The Presidential office has created 18 Strategic Infrastructure Programmes (SIP), but none focuses on landscape maintenance. Therefore, SIP 19 was jointly initiated by DWS/DEA, pending Parliamentary approval. Through this process, the so-called water towers have been identified and refined. A number of these water sources are highly threatened by alien invasive plants and other forms of landscape degradation and pollution. One of the key inputs of the GV&E is to scientifically support the development of the evidence-based research, which is aimed at proving the 'ecological infrastructure' concept and its role in water security, particularly during times of extended low rainfall or drought. Figure 8 illustrates a comparison between ecological infrastructure and water supply and sanitation infrastructure. GV&E focuses on landscape nature-based solutions or EI with restoration at the centre of activities. The GV&E research projects are focused on catchment restoration, ecosystem resilience, enterprise development and governance.

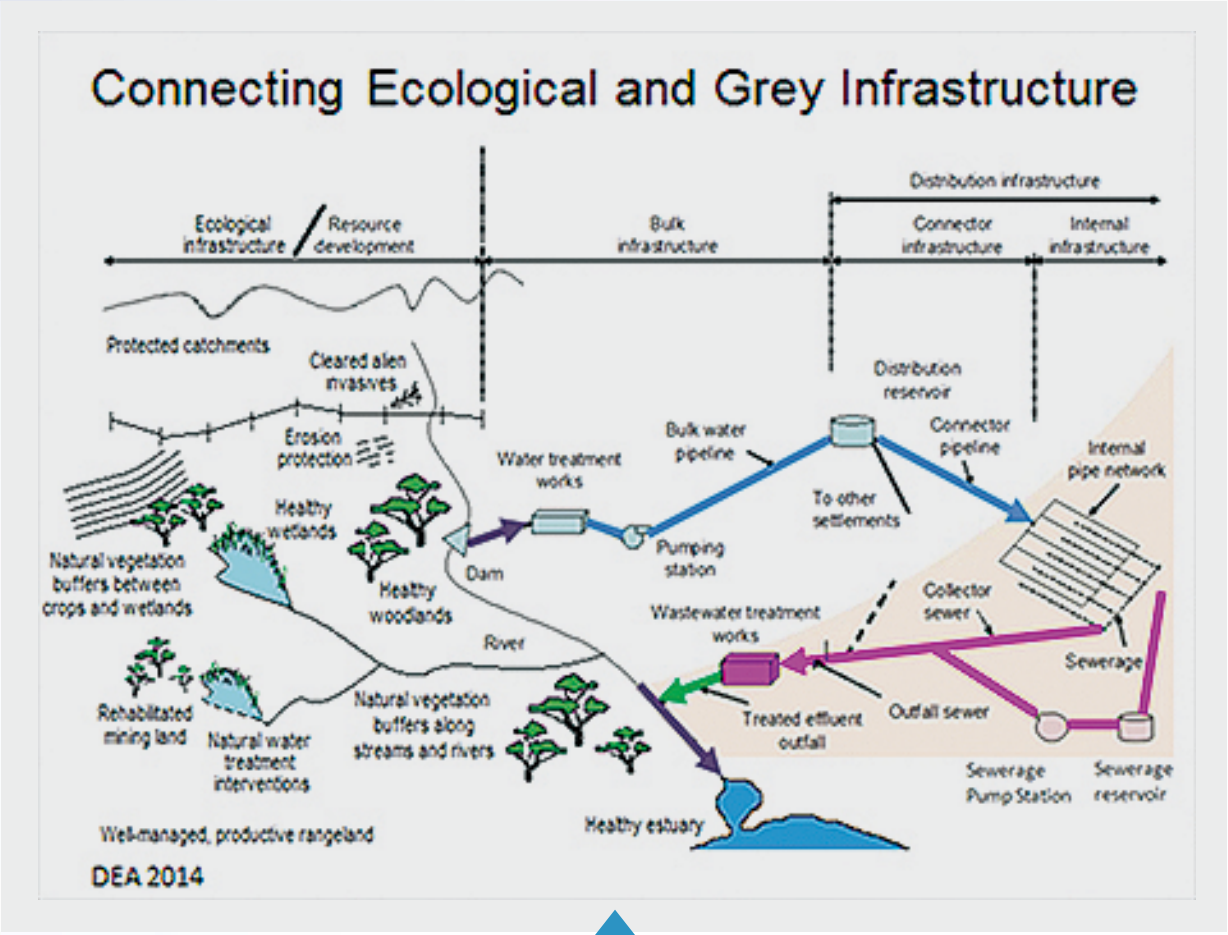



Figure 8. Comparison between ecological infrastructure (SIP:19) and Water Supply and Sanitation (SIP:18) (adopted from DEA/SANBI)

In order to be measurable, GV&E had well-defined objectives, and was piloted in two primary catchments. The first catchment was the uMzimvubu, a truly undeveloped rural area, characterized by severe poverty and unemployment. Dam infrastructure costing an estimated R20 billion was pronounced by DWS/Parliament (SONA). This costly engineering infrastructure is estimated to sink under silt way before the 50-year projected lifespan due to highly erosive soils in the catchment. This can be alleviated by improving the landscape/ecological infrastructure, extending the useful lifespan of the dam. Erosion of the ecological infrastructure threatens food security, property, schools, anthropological sites, churches, etc. To develop a nationally adaptable ecological investment and restoration framework, diverse and robust tools must be piloted in contrasting catchments. The developed and rapidly urbanizing uMngeni catchment, with very large municipalities, including the eThekwini Metro, was chosen as the second study site. The two chosen catchments have very different GDP contributions, business risks, governance and a range of other facets. However, both suffer from severe landscape degradation, leading to unhealthy ecological infrastructure. The leading aspect to reverse degradation is investment in rehabilitation or restoration, hence the GV&E focus. Partnership was the key criterion in the study site selection.

## Way forward (5-year plan) and link to WRC performance plan

In line with the corporate strategy, the GV&E continues to be reviewed and focused on the most recent strategic initiatives, such as ecological infrastructure, or nature-based solutions for water security (Fig. 16). This is critical in a country undergoing dramatic change, from urbanization to adaptation to climate change and resilience. All this is threatened by further degradation of the very ecosystem services on which society and business depend. The role of business investment in mitigating environmental risks is becoming more apparent than relying on mandated line function departments to protect our dwindling water resources; all stakeholders have a responsibility to care. A number of projects are therefore initiated within the Economics of Ecosystem Research Portfolio (ecosystem and water accounting, water pricing, review of RDM methods based on CBA, green jobs, etc). Even more critical is the plan to engage the uMngeni and Berg-Breede water security challenges in partnership with GEF:6 (SANBI/DEA/DBSA). Central to this initiative, is the investment in ecological infrastructure, so important in restoring degraded landscapes and mitigating broader environmental risks. Through international GV&E conference presentations, the WRC is co-hosting an international conference with the Society for Ecological Restoration (SER) in September 2019. The theme is 'Restoring land, water and community resilience'. This conference will be hosted in Africa for the first time, after more than 30 years of SER's existence. Reversing land degradation and eradicating poverty remain pillars of the SDG and Africa agenda 2063, so it makes sense to hold such a conference on a continent where poverty and soil erosion are but some of the challenges. The World Economic Forum has highlighted water security as a top-10 risk, for three consecutive years now! At home, NDP 2030 has similarly noted the growth dependence of SA on limited water resources. The DWS master plan clearly articulates that ecological infrastructure or restoration of ecosystem services is a priority.

It is very important to appreciate that unlocking wealth (creating green jobs) from natural capital is a slow process and demands increased investments across the value chain (especially funding of the risky 'valley of death' stage in the innovation continuum). On average, it takes 8 years to navigate from discovery, to regulations, demonstration, and finally marketing (Fig. 7).

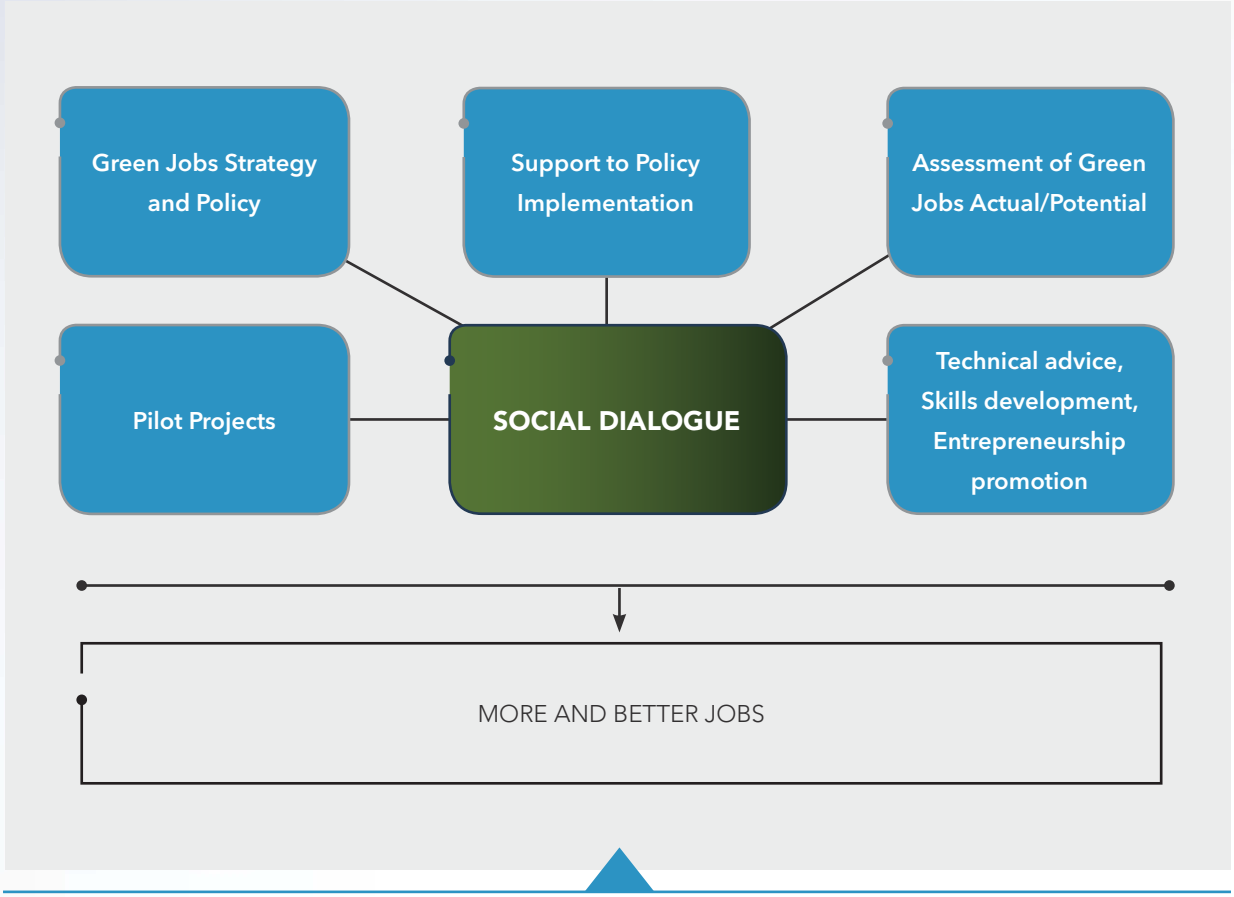



Figure 7. Time and cycle critical in green job creation. (adopted from ILO-2011)

Some green innovations are under way, such as protection of ecological infrastructure through benefits yielded from nature, such as wetlands. A typical example is extraction of medicinal characteristics from aquatic plants. About 70% of South Africans (both urban/rural) still use traditional medicines, openly or otherwise. Most of these medicines are sourced through unsustainable harvesting of natural resources, while traditional healers are not IP-protected and the market is seriously underrated. The opportunities presented by troublesome exotic plants, such as water hyacinth (more than 50% of South Africa's dams are hypertrophic) to renewable energy/or soil amelioration will be the subject of future research, as will green infrastructure as a 'proactive' input to preventing further urban ecosystem degradation.

*It is very important to appreciate that unlocking wealth (creating green jobs) from natural capital is a slow process and demands increased investments across the value chain (especially funding of the risky 'valley of death' stage in the innovation continuum).*

## 3.3 WATER-ENERGY-FOOD NEXUS

### Scope

During the late 2000s and early 2010s, the water–energy–food (WEF nexus emerged as an approach to sustainably manage these three resource sectors, by understanding the interlinkages between them, following the convergence of ideas from various political events, academic research and reports, as well as policy papers. The approach was consolidated by the 2030 Water Resources Group of The World Bank in 2008, which consisted of several role players, predominantly associated with food and beverage industries, such as the Coca-Cola Company, SABMiller, Nestlé and New Holland Agriculture. The group was originally formed when group members responded to the political and economic threat of water scarcity and eventually partnered with the Global Green Growth Institute (GGGI), the World Economic Forum, the World Wide Fund for Nature (WWF) and the Global Water Partnership (GWP). Following the conceptualisation of the WEF nexus, several conferences have been held to develop and promote the nexus approach. A prominent catalyst for the WEF nexus was the Bonn conference of 2011, which significantly increased the profile of the framework internationally. The Bonn conference focused on the need to integrate efforts to secure water, energy and food security, and highlighted current and future issues related to sustainable development. The conference further aimed to better understand the interlinkages between climate, water, food and energy through mitigating trade-offs, increasing efficiency, improving governance and building synergies across the sectors.

The WEF nexus is gaining recognition internationally as an intersectoral approach to resource management and sustainable development. The WRC has identified the WEF nexus as one of its focus 'Lighthouse' areas of research. The WEF Nexus Lighthouse was launched in 2013, and various role players or actors were identified across sectors. The WEF Lighthouse is not a stand-alone initiative as it is linked with the regional initiative. The Southern African Development Community (SADC) region has been actively involved in WEF nexus research development. In 2013, the SADC and GWP-SA explored the WEF nexus at the 6th Multi-stakeholder Water Dialogue in Lusaka, Zambia, where the interlinkages of the WEF nexus were addressed. Three years later, the SADC Energy and Water Joint Ministerial Workshop helped create WEF nexus awareness and context in the SADC region. The workshop proposed various steps to inform regional stakeholders on key overarching issues concerning the nexus, which included identifying relevant stakeholders and champions, conducting workshops at different levels (regional, national, sectoral and cross-sectoral) and identifying significant data gaps. In the same year, a technical workshop was held in Pietermaritzburg by the WRC, University of KwaZulu-Natal and Future Earth, investigating the WEF nexus and its linkages with the goal of achieving the SDGs. This was the fourth and final workshop held in connection with the Future Earth WEF nexus initiative. In 2017, SADC hosted a two-day meeting in Johannesburg, supported by the EU WEF Nexus Dialogue Program, promoting the efficient use of resources relating to water, energy and land planning. The meeting highlighted the role of stakeholders and governments in the

decision-making for WEF nexus resources and the management thereof.

## Strategic objectives

The WRC has been championing the WEF nexus approach since it first came to light in Davos in 2011. Thereafter, the WRC initiated its WEF Nexus Lighthouse with a goal to start championing water, energy and food planning and development for South Africa in an integrated and sustainable manner.

The objectives of the WEF Nexus Lighthouse:

- Development of a state-of-the-art literature review detailing currently available knowledge on the WEF nexus in South Africa, to provide a comprehensive assessment of this body of research, such that it can be accessed by all researchers in South Africa and applied to policy decisions
- To facilitate integrated assessment based on existing water, energy and food polices and strategies at a national level with a view to identifying gaps and opportunities for alignment based on the WEF nexus
- Translation of existing knowledge to inform policies for integrated sustainable resource management among the WEF sectors
- Participatory research aimed at demonstrating the applicability of the WEF nexus at the local level, especially among the poor, and generating cases that demonstrate how the WEF nexus could assist in achieving SDGs 2, 6 and 7
- To promote the WEF nexus within South Africa, and the Southern African region, African continent and also across the globe

## What was planned

During the first 5 years of the WEF Nexus Lighthouse several activities were initiated, such as awareness raising on the WEF Nexus across the water, energy and agriculture sectors. Key role players such as the University of KwaZulu-Natal, Future Earth, DWS, DAFF and Department of Science and Technology (DST) were identified and also brought on board. The purpose of bringing these roleplayers on board was to make sure that the WEF nexus shares information at both technical and policy levels. Some of the information on the WEF nexus was disseminated through the development of projects, hosting of dialogues and workshops, publication of popular and scientific articles, conference presentations, etc. The following project reports are linked to the WEF Nexus initiatives:

- Assessing the state of water–energy–food (WEF) nexus in South Africa. WRC Report No KV 365/18.
- Improving rural livelihoods through biogas generation using livestock manure and rainwater harvesting. WRC Report No. 1955/1/15.
- Water use of cropping systems adapted to bio-climatic regions in South Africa and suitable for biofuel production. WRC Report No. 1874/1/15.
- Nutrient and energy recovery from sewage: demo-researching an integrated approach. WRC Report No. TT661
- Guiding principles in the design and operation of a wastewater sludge digestion plant with biogas and power generation. WRC Report No. TT681
- Integrating agriculture in designing on-site, low cost sanitation technologies in social housing schemes. WRC Report No. TT700
- Energy recovery from wastewater sludge – a review of appropriate emerging and established technologies for the South African industry. WRC Report No. TT752
- Characterizing municipal wastewater sludge for sustainable beneficial agricultural use. WRC Report No. TT756

## Achievements to date

- Several dialogues were held with key stakeholders focusing on the WEF Nexus, among others:
- Improving rural livelihoods through biogas generation using livestock manure and rainwater harvesting, 19 August 2016
- Water use of cropping systems adapted to bio-climatic regions in South Africa and suitable for biofuel production, 24 September 2016
- A technical workshop on the WEF nexus was held from 23–24 November 2016 in Pietermaritzburg in partnership with Water Future, Future Earth, University of KwaZulu-Natal
- A Science–Policy Dialogue on the Water–Energy–Food Nexus and the role of the Sustainable Development Goals (SDGs) was held at Emperors Palace, 25 November 2016, in partnership with Water Future, Future Earth, and the University of KwaZulu-Natal.
- The WEF Nexus coordinator attended and participated as panellist on the Water–Energy–Food Nexus dialogue session organised by the European Union at the 8th World Water Forum, 19 March 2018.

The WEF Nexus Lighthouse activities and work completed with various strategic key partners are highlighted below:

- Water–Energy–Food security nexus: towards policy convergence in South Africa. Paper presented at the South African National Committee on Irrigation and Drainage Symposium, 18 November 2014.
- Biogas technology in the water–energy–food nexus: A case study of cooperatively run integrated farming system in rural areas of Limpopo Province of South Africa. Paper presented at 1st Univen–WSU International Research Conference, 2–4 September 2015, Eastern Cape Province.
- Understanding water–energy– food nexus on household's management through the use of biogas system. Paper presented at the 1st training course on farm water and management, Cairo, Egypt, 17–25 April 2016.
- Prospects for improving irrigated agriculture in Southern Africa – linking water, energy and food. 2nd World Irrigation Forum, Chiang Mai, Thailand, 6–8 November 2016.
- The water–energy–food nexus as a tool for transforming rural livelihoods and economies. Paper presented at the Water–Energy–Food Nexus Technical Workshop (partnership with UKZN & Future Earth), Pietermaritzburg, 21–23 November 2016.
- A water-energy-food nexus perspective for addressing the Sustainable Development Goals in South Africa. Paper presented at the World Sustainability Forum, Cape Town, 27–30 January 2017.
- Water–energy–food nexus: opportunities and challenges for southern Africa. Paper presented at the World Sustainability Forum, Cape Town, 27–30 January 2017.
- Managing the water–energy–food nexus in southern Africa: Linking water–energy–food nexus to Sustainable Development Goals. Paper presented at the United Nations Education Sports Cultural Organisation (UNESCO) IHP Symposium, 17 March 2017
- The water–energy–food nexus as an approach for sustainable advancement of food security in Southern Africa. Paper presented at the Global Food Security Conference, Cape Town, 8–11 October 2017
- Opportunities for water–energy–food Nexus in Southern Africa: linking WEF to Sustainable Development Goals (SDGs). Paper presented at the 6th World Sustainability Forum, Cape Town, South Africa, 27–30 January 2017
- Increasing land under irrigation in South Africa – water-energy-food nexus trade-offs. Paper presented at the 23rd ICID Congress, Mexico, 8–14 October 2017
- Integrating the water–energy–food nexus into national irrigation planning: South African perspectives. Paper presented at the 24th ICID Conference, Saskatoon, Canada, 12–17 August 2018

- 'Municipal waste to energy innovation in the water sector – partnerships & funding models for successful implementation' dialogue, Johannesburg, 27 June 2017
- 'Integrating agriculture with sanitation services in support of food security for small households' dialogue, Durban, 24 October 2017
- Mitigating climate change impacts through the water–energy–food nexus. Paper presented at the SANCID Symposium, White River, Mpumalanga, 13–15 November 2018
- The impact of climate change on the water, energy and agriculture sectors: Adaptation through the WEF Nexus in Southern Africa. Paper presented at the First International Conference on Environmental Sciences and Sustainability, University of Venda, November 2018
- Assessing the state of the water–energy–food nexus for South Africa – emerging lessons. Paper presented at the Waternet Symposium in Zambia, 31 October– 2 November 2018
- The water–energy–food nexus as a tool for transforming rural livelihoods in Southern Africa. Paper presented at the Waternet Symposium, Zambia, 31 October – 2 November 2018
- The water–energy–food nexus: Climate risks and opportunities in Southern Africa. Paper presented at the 24th ICID Conference, Saskatoon, Canada, 12–17 August 2018.
- 'Decision support tool for beneficial agriculture use of sludge by the wastewater and agricultural sector' workshop held in Pretoria, 10 May 2018
- 'Wastewater – tapping into this resource: Beneficial goods and services from wastewater' held in Cape Town, 25 June 2018

A number of papers have been submitted to scholarly journals:

- The impact of climate change on the water, energy and agriculture sectors: Adaptation through the WEF Nexus in Southern Africa. *International Journal of Sustainability and Public Health* (currently under review).
- Climate change adaptation through the water-energy-food nexus in southern Africa. Paper will be published as a conference proceedings.
- Linking the water–energy–food nexus to the Sustainable Development Goals: A South African perspective. Water (currently under review).
- Integration of the water-energy-food nexus through policy harmonisation in South Africa. *Water* (currently under review).
- Modelling energy efficiency and generation potential in the South African wastewater services sector, 2018. *Energy Efficiency* (submitted)
- Emerging innovative technology for energy recovery from wastewater sludge, 2018. (in preparation)

An opinion piece has been submitted:

- Transitioning to a circular economy in the South African Water Sector: Innovation key to catalyse the required paradigm shift in the South African water sector, 2018

A technical brief has been completed:

- Technical Brief: Optimisation of the Latrine Dehydration Pasteurisation Faecal Sludge Treatment Processor. (Brief for WRC Project No. K5/2137).

## Water, energy, food and land nexus proposed

Given the political dynamics in the country and the direction that the Government is taking on land issues, the application of the WEF nexus is particularly relevant when considering the recent proposed policy shift on land expropriation, which will significantly influence land utilisation, depending on the policies associated with it. Currently, the various governmental departments – DAFF, DWS, Department of Education (DoE), DEA, etc. – generally approach resource management in isolation, without considering the usage of water, energy and land

by other sectors. This is a major challenge in South African policymaking, especially when referring to the country's limited water availability, the scarcity of high-potential arable land, and its reliance on fossil-fuel based energy generation. Furthermore, it is predicted that climate change will have a negative impact on the availability of resources in South Africa, where rainfall frequency and distribution, and natural disasters will impact the reliability of ecosystem services. Ringler et al. (2013) present the concept of the water-energy-land and food (WELF) nexus. The study indicates that this concept is known to play out differently in various parts of the world.

*Given the political dynamics in the country and the direction that the Government is taking on land issues, the application of the WEF nexus is particularly relevant when considering the recent proposed policy shift on land expropriation, which will significantly influence land utilisation, depending on the policies associated with it.*

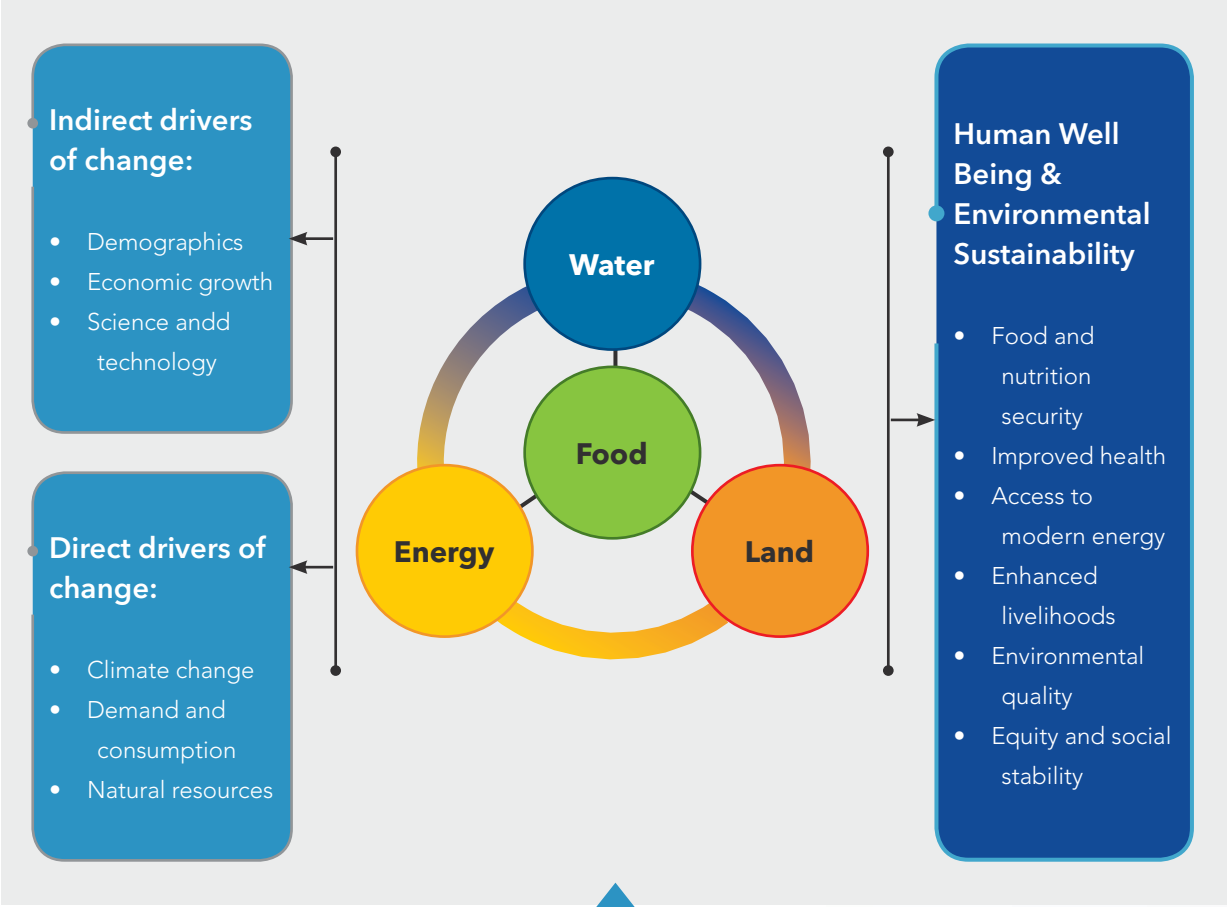



Figure 8. The extended water, energy, food and land nexus presented by Ringler et al., 2013

The WELF nexus framework evaluates the linkages that exist between the water, energy, land and food sectors (Fig. 8). The direct and indirect drivers of change, which affect these linkages, are clearly depicted. In most existing WEF nexus frameworks, the land dimension is not included, however this framework considers the dimension of land as it recognises its importance not only in the production of food but also for water (underground water storage, reservoirs) and energy supply (shale gas or biofuels). The study also sheds light on the importance of land scarcity. Many WEF nexus frameworks have been illustrated as being water-centric; however, this framework puts food at the centre of the nexus.

## Way forward

The WEF nexus (Fig. 9) offers opportunities to effectively attain sustainability through interdisciplinary cooperation across all levels (local, provincial and national) and also particularly in Southern Africa where resources are constrained. The nexus offers inclusive, transparent, intergovernmental approaches for all stakeholders, as well as supporting the UN SDGs using scientific and evidence-based policy, monitoring, assessment and cooperation models. Challenges in South Africa and also other Southern African countries are generally similar in nature, as they share the same resources and climate conditions. As the vast and unexploited resources within the region are shared, the WEF nexus could be a pathway for resilience building and reduction of vulnerabilities that permeate the region. Adoption of the nexus approach would be a step towards attaining the SDGs. Achieving this requires a paradigm shift from the present sovereignty mindset to one that is aimed at building integration and strengthening cooperation, to break the cycle of instability, extreme poverty and socio-economic insecurities.

5-year plan:

- The WEF Nexus team will keep on sharing information at different forums across the globe
- There are ongoing discussions to convert the WEF Nexus into a flagship programme/thrust
- Need to increase the number of projects in support of WEF Lighthouse
- Use current WEF Nexus successes to align with global initiatives and access leverage funding
- Improved engagement with policy makers and politicians regarding need to embrace WEF issues as part of the national discourse
- Improved dissemination and awareness of WEF activities

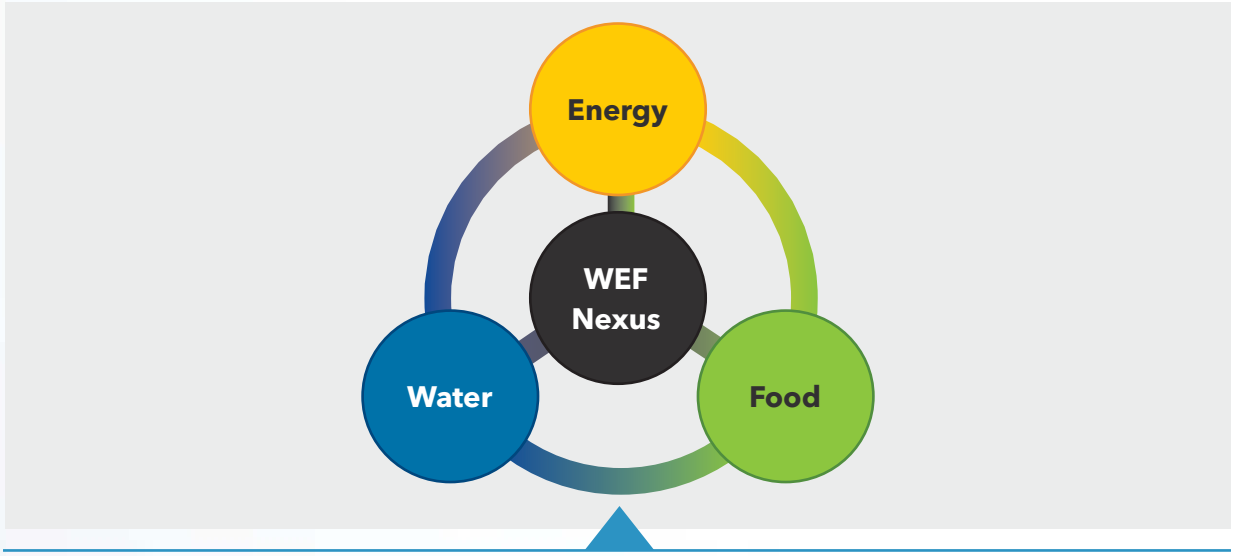



Figure 9. Water–energy–food nexus

## 3.4 WATER SENSITIVE DESIGN (WSD)

The current realities create a higher impetus to scale up the application of water-sensitive design (WSD) in both rural and urban environments. We will continue to put greater emphasis on training and capacity building, as well as demonstration projects with municipalities and business. The Water Sensitive Design Lighthouse has been progressing well since 2013. The purpose of this Lighthouse has been to develop a critical mass of knowledge around the integration of planning activities for the adoption of more integrated and sustainable solutions using the WSD (settlements) lens for urban, peri-urban and rural environments.

Thus, in 2014 the Community of Practice programme (CoP) was initiated aimed at building awareness (Fig. 10) and providing decision support by funding research and building capacity within the sector. In 2015, the WRC officially launched the concept to the broader planning community and water sector at the Khuluma Sizwe Series 'Two Histories, One Future' Dialogue, held in Johannesburg, at which the Framework and Guideline documents were shared. Under the CoP platform a total of 18 activities (dialogues, symposiums, seminars, conferences, etc.) are currently planned over the next 3 years (2018–2019) as part of the CoP awareness building and information sharing. However, this needs to be further strengthened and consolidated beyond 2019 through stronger partnerships and transformation of the shared knowledge into demonstrations and implementation as a way of stimulating innovation for economic growth, thereby catalysing development to address challenges associated with poverty, unemployment and inequality.

On the research front, there has been continued support of feasibility and scenario-planning projects to build capacity and understanding of the principles through context-specific examples. The Lighthouse also set out to involve practitioners (water and spatial planners) from municipalities early in the process, and can report that the City of Cape Town and eThekwini Metros have water-sensitive design principles written into their spatial development and related policies, while the City of Johannesburg and City of Tshwane Metros are in the process of considering them. Through research, demonstration and engagement it is envisaged that these principles will be adopted, adapted and ultimately incorporated into planning, guidelines and policy. To date, outside the guidelines for sustainable drainage systems and water-sensitive urban drainage, two projects in support of water-sensitive design have been completed, with six projects currently progressing. The WRC will continue to support projects about water-sensitive design.

### Strategic objectives

The objective of this Lighthouse is to develop a critical mass of knowledge around the integration of planning activities for the adoption of WSD in South Africa using the water lens. The WRC envisions WSD as the integration of water cycle management into planning and design for the growth and development of communities, and is inclusive of urban, peri-urban and rural environments. Thus, the definition of WSD is adopted from the principles of water-sensitive urban design which is the integration of planning and design with the management,

protection and conservation of the water cycle, which ensures water management is sensitive to natural hydrological and ecological processes. WSD incorporates water supply, wastewater (greywater), water resource management (groundwater and surface), design and environmental and human protection as part of its integrated design concept for environments. The research sets itself apart from international experiences since it will attempt to adapt the WSD principles in a developing country.

## Outcomes

The broad plan and outcome of the WSD Lighthouse is to transition the relevant South African cities, towns and villages closer towards water-sensitive environments which meet its socio-political drivers and its service delivery responsibilities. To this end, the WRC has already embarked on a project which aims to provide a framework for water-sensitive cities (urban environments) as a first step in achieving this outcome and will initiate a new project to provide a research framework for water-sensitive rural design. Water and water-sensitive design are seen as the enabler which could move South African institutions closer to meeting the developmental goals as set out in the National Development Plan (NDP) and the objectives of Water for Growth and Development, National Water Resource Strategy and the Climate Change Strategy. This pioneering integrated design paradigm shift for South Africa will require a societal openness to: embracing a WSD vision as part of its broader developmental vision, adapting planning processes, re-organizing planning departments, absorbing research and guiding new research, adopting new technologies and adapting old technologies, reviewing and applying new policy and legislation, building capacity (skills, competencies and judgment) and initiating demonstrators for technology transfer with partners and stakeholders.

## The WSD research roadmap and plans (2019 to 2024)

An investigation into the WRC portfolio shows that there is already a wealth of information around water supply, sanitation (sewerage), stormwater (drainage), management of diffuse and point source pollution in waterways, and fit-for-purpose water. These products are housed within all three KSAs and will be repackaged and updated using WSD criteria. The WSD Lighthouse has a 10-year timeline with a 5-year research review cycle. The research objectives will seek to: mine existing research products which contribute to the water transition states, critically review and repackage the products using the WSD lens, build a community of practice using research products as the enabler, build capacity through individual research projects, develop frameworks for urban and rural environments, develop guidelines and tools, inform policy and decision-making, and partner with stakeholders to demonstrate various sustainable options.

The first 5 years will consolidate past and current knowledge, build capacity and engage with stakeholders by sharing the vision of WSD through several platforms. The framework produced in K5/2071 for water-sensitive cities will be used to formulate the South African vision for relevant partners. The Lighthouse was presented to the broader sector at the WRC Symposium held in September 2013. Since the planning fraternity are considered critical to the adoption of the WSD concept, it is envisaged that the WRC will engage with partners like DST to conceptualize and drive the development of a WSD simulator, i.e., a virtual reality macro-planning design platform to bring the concept to life for decision-makers and planners. In addition, new projects will be initiated. The start of projects (a feasibility study and a WSD Community of Practice Programme) emanating from two directed calls commenced in the 2013/14 cycle, and was completed in 2015. The aim of the WSD CoP programme is to strengthen the researcher/ stakeholder and implementer interface in order

to leverage partnerships and facilitate, manage and document technology transfer opportunities from the design phase through to the piloting and adapting phases. The next 5 years will be guided by the research needs as defined through pilots, engagements and adaptation of design approaches and technology adoption for South African environments.

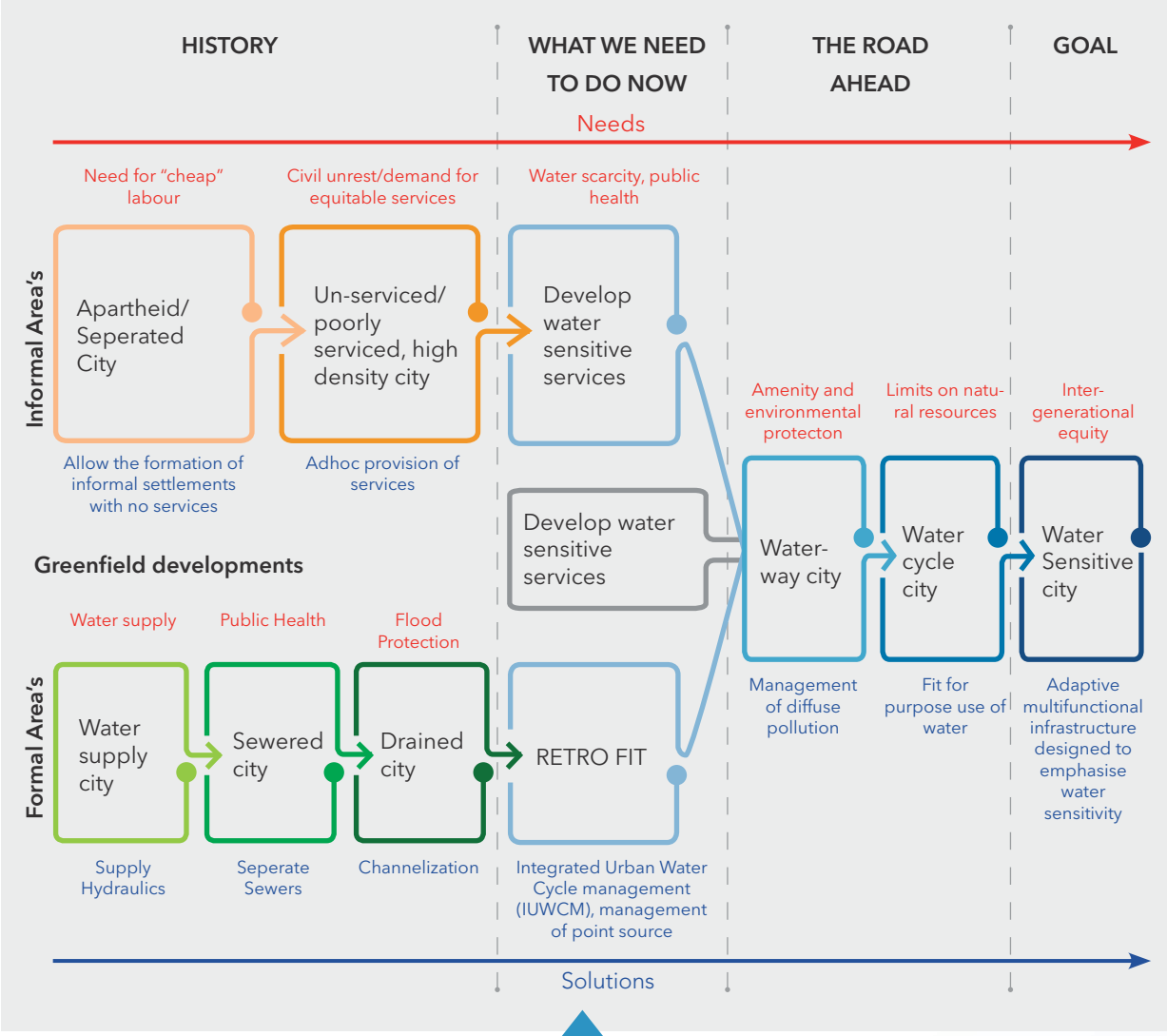



Figure 10. SA's transition to Water Sensitive Cities: 'Two history's, one future' (adapted from Brown et al., 2009; WRC Project K5/2071)

*The broad plan and outcome of the WSD Lighthouse is to transition the relevant South African cities, towns and villages closer towards water-sensitive environments which meet its socio-political drivers and its service delivery responsibilities.*

## Achievements to date

- The first South African Guidelines on SUDs (sustainable drainage systems) and WSUDs (water-sensitive urban design) have been published by the WRC.
- Several new and related studies have been initiated. A key one is developing spatial planning guidelines to incorporate WSD.
- • The community of practice continues to grow. A key development from this practice is the establishment of a full training and research centre by the Water Futures Group at the University of Cape Town (UCT) in Franschhoek, Western Cape.
- We have set up a strategic partnership with CSE India on running WSD training courses in South Africa and the region. In its second year of activity 5 training sessions have been held around the county, including one in Namibia. We are looking at rolling out this training further for another 3 years.
- Several new initiatives in the building sector are starting to incorporate these principles in their design. We are also seeing a greater shift and recognition in the larger Metros towards a WSD mix in their activities.

## New plans and way forward

Next year is set out in the timeline as the date for reviewing our strategy and achievements, as well as charting a way forward for the next 5 years. In the meantime, the following will be prioritised:

- It is evident that training is a good stimulus in building new capacity and stimulating a cohort of practice; it also helps to widen the discipline and participation
- An aspect to be considered in the new plans was to incorporate the elements of sanitation-sensitive design; this is required to accommodate new transformative off-the-grid non-sewered sanitation
- Scaling-up on pilots and demonstration project, as well as application
- Start capturing case studies and experiences and develop a log of all initiatives and new ones

## 3.5 WATER QUALITY AND HEALTH (WQH)

### Scope

The Water Quality and Health (WQH) Lighthouse is a cross-cutter within the WRC research KSAs as it is applicable to the entire water value chain and covers aspects of water resources, sanitation, drinking water, health and hygiene.

### Overview

Both natural/environmental and anthropogenic activities are a common cause for the deterioration of quality in water resources in South Africa. Being a water-scarce country, in many cases the pollutant load reaching the receiving water resources exceeds their assimilative capacity. Poor water quality is one of the dominant causes of water stress in South Africa, as it reduces the quantity of water available for use. Current projections indicate that climate change impacts related to climate variability, extreme weather events and changing rainfall seasonality could exacerbate the existing water quality/quantity situation in South Africa. Declining water quality (and availability of water resources) is not only a problem in South Africa, but is an issue of global concern with potential to cause detrimental effects on socio-economic development, ecosystems and human health. Water quality issues are complex and dynamic in nature and they call for fundamental changes in the way we use, manage, and even think about water. In the past, regulators have responded to the water quality crisis by imposing stricter water quality regulations/standards. Adapting to the new operating environment requires a shift from the traditional and fragmented sectoral approach to water quality management to a more integrated 'nexus' and coordinated approach as part of one urban water cycle, ensuring that all water users (including civil society) are aware of their responsibility for the protection of water resources and accountable for the impacts.

### Strategic objectives

The 'water quality' sessions at the WRC Symposium sought to share knowledge and deliberate on the divergent (both current and emerging) water quality issues, including: impacts on quantity, the economy and social development, ecosystem and environmental health; and the contribution of global and anthropogenic factors to water quality; as well as to stimulate discussions on innovative solutions to existing problems (either technological, infrastructural, regulatory or managerial) and their validation, including strategic foresight on future water quality changes and risks. The main aim of this Lighthouse is to guide integrated water quality management in South Africa, by providing an understanding of the water quality conditions over time, the contribution of global and anthropogenic factors to water quality, and impacts of water quality changes on the economy, ecosystem and human health. It also aims to develop solutions to address the identified challenges. The WRC WQ lighthouse is guided by both the WRC strategic objectives, as well as the following principles:

- Multi and trans-disciplinary approach – drawing on expertise in natural and social science, as well as engineering, humanities, sustainability

science, and other professions such as planning, law, and business

- Multi-sectoral approach – leveraging strategic partnerships (both local and international) in areas where research co-ordination is needed for successful problem analysis and solutions. Involvement of key stakeholders, e.g., government departments (DWS, DEA, Department of Public Works (DoPW), Department of Health (DoH), National Treasury (NT), Department of Trade and Industry (DTI), Cooperative Governance and Traditional Affairs (CoGTA), South African Local Government Association (SALGA), CMAs, industry and business, and civil society, is vital for the co-design of the research agenda and, similarly, collaborations with stakeholders for the generation and uptake of the knowledge/solutions are equally important. Co-designing research with the users of that research in mind plays a vital role in connecting research to decision making, promotes sustained engagement, and facilitates the evolution of the outputs into policy and implementation.
- Solution-oriented – finding solutions to existing problems and providing foresight into future water quality changes and risks, developing and testing the effectiveness of tools/solutions for water quality monitoring, testing and remediation, and providing a knowledge base for innovations are the main focus.
- Sustainable development – the current SDGs emphasizes the role of water quality (and quantity) on sustainable development. Thus, the programme activities should also focus on addressing the main challenges related to access to safe water, sanitation and hygiene, and implementation of water resources and quality management, as they are critical for socio-economic development, healthy ecosystems and human survival.
- Knowledge dissemination and capacity building – local and international engagement on water quality issues, capacity building, supporting the next generation of researchers and providing networking opportunities

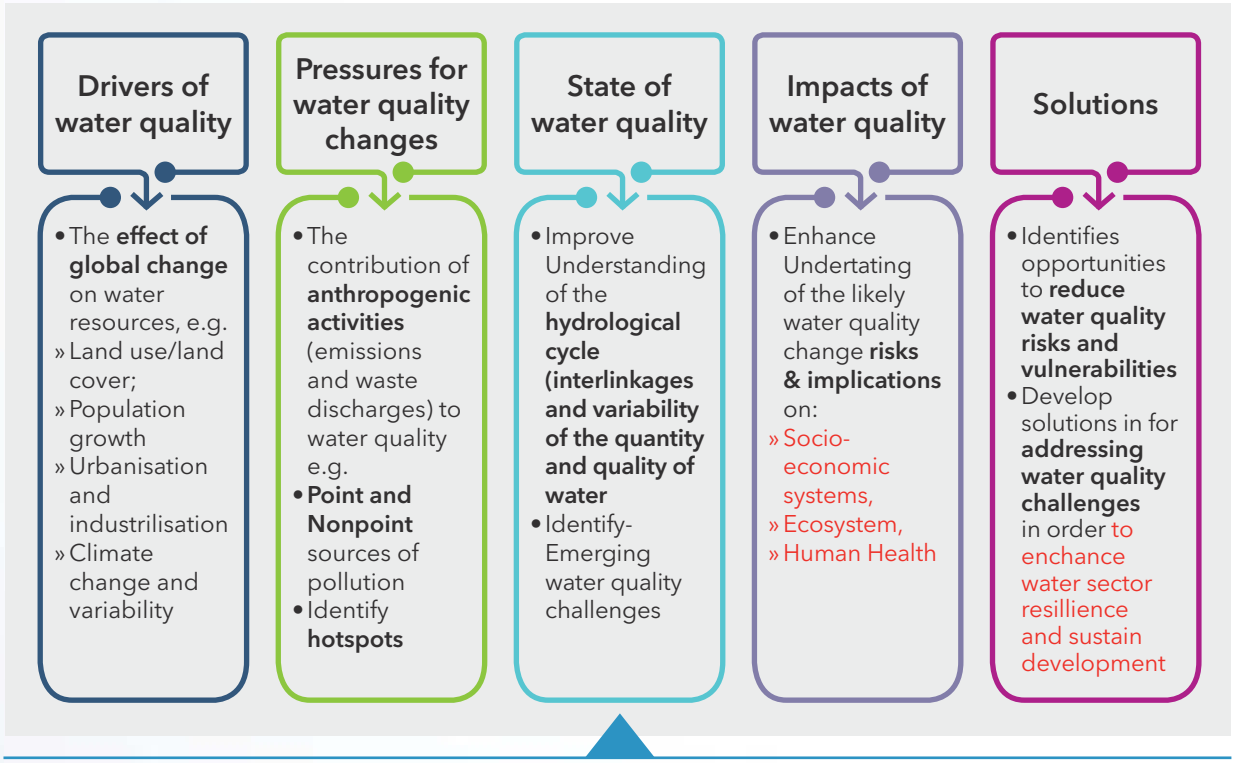



Figure 21. Focus areas of the Water Quality Lighthouse

The integrated water quality management (IWQM) concept promotes a more integrated and coordinated approach to water quality management, as part of one urban water cycle with both horizontal and vertical reporting functionalities (Fig. 21). This model replaces the traditional, fragmented sectoral approach to water quality management and ensures that all water users (including civil society) are aware of their responsibility and can respond to the uncertainty associated with managing complex water quality changes as they emerge. Similarly, adopting a circular economy approach promotes an integrated approach to water quality management and encourages better management and efficient use of water, combined with robust incentives for innovative solutions.

## Thematic areas and work plan

In line with the approach above, the focus areas, activities and outputs are aimed at establishing the evidence, science and solutions for responding to broad, fundamental issues related to:

- Drivers of water quality – investigate the effect of global change on resource and drinking water quality, e.g., land use/land cover, climate change
- Pressures directly causing water quality changes – investigate the contribution of anthropogenic activities (emissions and waste discharges) to water quality, e.g., point and non-point sources of pollution
- State of water quality – develop a scientific understanding of the hydrological cycle (and interlinkages) and variability of the quantity and quality of water available for use and development in terms of both current and long-term (emerging) water quality challenges for complex chemical and microbial pollutants
- Impacts of water quality – establish an understanding of the likely water quality change implications for socio-economic status, as well as ecosystem and human health
- Solutions – identify opportunities to reduce water quality risks and vulnerabilities and develop solutions for addressing water quality challenges in order to enhance water sector resilience and sustain development

## Achievements to date

Similar to other programmes, the WQH Lighthouse is cyclic and driven by identified challenges. The different activities of the programme will generate outputs, which in good time will mature to high-impact outcomes. These outcomes should provide responses or solutions to the identified water quality challenges. However, it must be noted that the transitioning of the outputs from the different activities to outcomes will occur over disparate time scales, and as such requires different models for execution. There will be quick solutions and those that will require a significant amount of time and funding to mature into solutions. Below are examples of some of the achievements, outcomes and outputs generated from WRC research on water quality.

## Influencing policy and decision-making

### Integrated water quality management

A conceptual model for IWQM was developed in a WRC-funded study (WRC Report No. TT 623/14). The model follows a risk-based approach and comprises defining principles; background conditions; management framework and approach (business process). The WRC study provided a basis for the review and revision of water quality management (WQM) policies in the DWS, which culminated in the development of an Integrated Water Quality Management Policy and Strategy. The WRC's contribution in guiding and strengthening the implementation of the integrated water quality management strategy has been acknowledged. Through dedicated research, the WRC has continued to support the implementation of the strategy.
A recent example is the completed WRC project K5/2431 on the identification and delineation of

strategic water source areas of South Africa with recommendations for amending the National Water Act to enable the declaration of protected water source areas as part of IWQM.
Other examples of recent strategic research outcomes and outputs supporting the implementation of IWQM include a number of guidelines and policy documents aimed at improving mine-water management. Mining has been an integral part of the South African economy for over 100 years. The mining sector is also a large user of water in certain areas, with the water pollution problems associated with mining being well publicised recently. The WRC has developed South Africa's first mine water atlas, a comprehensive reference of the true extent of mine-influenced water in the country, both on the surface and underground. The atlas informs the implementation of commitments made in the past, while decision-makers will also be able to reference the publication for background information to inform decisions in the future.

**Emerging contaminants research**

Through the WQH Lighthouse, the WRC has positioned itself as a leader in emerging pollutants research. The WRC and its partners have generated data, knowledge and understanding on emerging water quality issues. Such information has played a significant role in bridging the gap between science and policy. The following examples highlight some of the achievements, outcomes and outputs generated from WRC research on emerging contaminants:

- Initiated and completed projects on antimicrobial resistance in the environment. Findings from this research highlighted the role of the aquatic environment in harbouring and disseminating resistant organisms and genes. As a result, the WRC has been recognised as an ad-hoc member of the National Department of Health Ministerial Advisory Committee on Antimicrobial Resistance.
- Findings from a WRC project on emerging chemical contaminants (e.g. microplastics, pharmaceuticals, agrochemicals, engineered nanoparticles) have re-energised national conversations on water pollution prevention, control and waste management. In addition, these WRC studies have highlighted the need for policy alignment between economic growth activities and chemicals and waste management in the context of integrated water quality management.
- Understanding the linkages between water quality and infectious water-related diseases, e.g., diarrhoea. A number of WRC projects have looked into the prevalence and emergence of resistant microbial pathogens and the impact on the management of clinical infections. Outputs from such studies include: environmental monitoring guidelines, recommendations for rapid pathogen identification and diagnosis tools, to name a few, which have been shared with the health sector.

**Water quality and sustainable development**

As part of the organisation's strategic objectives, the WRC aims to support government activities related to the achievement of our own national development objectives, as well as the SDGs, through providing evidence-based research. Water is a key driver for sustainable development, thus availability of water of appropriate quality to support different developmental needs is essential. A suite of guidelines on alternative water sources and quality (e.g., rainwater harvesting, greywater harvesting and treatment, desalination, water reuse, etc.) have been developed to support this initiative.

**Development and demonstration of innovative water quality management technologies and solutions**

- Development of decision support tools for water quality management as part of the revision and update of the South African Water Quality Guideline Series; to date, reviews for the irrigation water quality guidelines have been

*Water is a key driver for sustainable development, thus availability of water of appropriate quality to support different developmental needs is essential. A suite of guidelines on alternative water sources and quality have been developed to support this initiative.*

completed, with the domestic and recreational water use guidelines under way
- Developed guidelines for monitoring and managing water quality for water reuse schemes, including a list of priority emerging compounds to be monitored for, as well as an identified need for a network of reference laboratories for specialised water quality analysis
- Evaluation of integrated algal pond systems (IAPS) for municipal wastewater treatment – WRC research has evaluated the IAPS technology for wastewater treatment, as well as its role in achieving the water–energy–food nexus goals for CO2 sequestration and to derive possible substitutes for fossil fuels. Further to generating acceptable wastewater effluent, the following products can also be recovered: water for recycle and re-use, methane-rich biogas and biomass.

## Work plan for the next 5 years

The following aspects need to be improved:

- Programme governance – the coordination of the water quality programme activities needs to be improved; Current oversight mechanisms are weak
- Partnerships – collaborations with other stakeholders needs to be strengthened
- Resources – funding (and period) and human resources and partners required to support the programme should be improved

Future priority research topics for the Water Quality Lighthouse are as follows:

Emerging contaminants research:

- Per- and poly-fluoroalkyl substances (PFAS): a workshop aimed at bringing GRWC members, partners and experts together was held on 8 July 2018 at the Marina Bay Sands Conference Centre, Singapore. The workshop discussed research activities and research collaboration opportunities and shared knowledge on common tasks in this field. Based on the workshop outcomes, a PFAS 'State of Knowledge' Report will be produced and finalised by end of 2018.
- Microplastics and engineered nanoparticles (ENPs): preliminary WRC studies have shown the presence of microplastics and ENPs in our waters. Future research will be aimed at standardising analytical protocols to support development of a surveillance programme to track material flow from source to sea. In addition, the use of quantitative risk assessment and life-cycle assessment approaches will be explored for supporting decision making in ecosystem management.
- Veterinary pharmaceuticals: there is a need for extended study in the monitoring of veterinary pharmaceuticals in different exposure routes of livestock farming communities across the country and to expand the study to more of South Africa's provinces. There is also a need to develop technologies for wastewater treatment systems that will remove these chemicals to control their levels in the environment. Please note that KSA 4 has done a study on 'Emerging contaminants from agriculture in water systems around Cape Town and Stellenbosch in the Western Cape'.
- Water pollutant fingerprinting: A workshop to identify and prioritise research on water

pollutant fingerprinting took place in October 2018. This is an emerging area of research for the WRC and future research will explore how this concept can be used as an early warning system for emerging issues in water quality and also for detecting specific chemical and biological fingerprints in wastewater to effectively inform the state of the environment and public health.

- Antiviral resistance: South Africa has a very large population on antiretroviral therapy. Antiretrovirals in water have been identified as an emerging water quality issue in South Africa. Preliminary WRC studies have already indicated that the presence of these drugs in water can result in a shift in microbial communities. Future work will investigate the effect of these drugs on resistance patterns of microorganisms, particularly viruses.
- Screening for emerging contaminants of concern (CECs) in feed water (raw seawater) for desalination: Marine plastic and nano-pollutant pollution is one concern that has been publicised. Future WRC research will investigate the presence/absence of CECs in raw seawater and evaluate the efficacy of reverse osmosis in removing nano-scale pollutants.
- Entry of contaminants of concern into the food chain through livestock/animal watering, irrigation and aquaculture
- Partitioning, persistence, and accumulation of contaminants of concern in faecal sludge, water treatment residues, sediments, etc.
    - Development of decision support tools for water quality management
    - Exploring the circular economy approach to water and wastewater management by studying resource recovery, explore the energy–water quality nexus; impact of water pollution on sustainable development, and other innovative concepts for water quality management, etc.

## 3.6 WATER ICT

### Scope

This Lighthouse will incorporate the scope of the Water and Big Data Lighthouse to facilitate the integration of related concepts. Being a water-scarce country, the smart management of water resources in South Africa is becoming important as the supply of clean, fresh water is steadily decreasing. In addition, the provision of related services remains an important national priority. It is apparent that many of the challenges faced by the water sector in South Africa require related foresight in order to design policies and strategies that exploit emerging and critical technologies for the benefit of sustainable development. Presently, there is already an established understanding on benefits of using information and communication technologies (ICTs) for development (ICT4D) across all sectors and all over the world. ICT has rapidly matured over the past half a century and the focus has shifted to application. Emergence of the mobile Internet (M-ICT) era has opened limitless opportunities for developing next-generation technologies as a result of the convergence of traditional ICT applications and the Internet. In the water sector, the integration of novel ICT-enabled products, tools and solutions has been identified as a key enabler for smart water management, consumption and governance.

With mobile technology penetration and adoption of mobile-to-web technologies in South Africa set to increase further by 2019, the water sector cannot miss out on this opportunity. This opportunity brings with it the potential to synergise with and contribute to the goals and objectives of the National ICT and Water Research, Development and Innovation (RDI) roadmaps. Thus, the main aim of the Water ICT Lighthouse is to serve as a platform for growing the knowledge and research base on the application of ICTs in the water sector, and to share current thinking and strategies of future technological development to advance development in the water sector. In this regard, the Water ICT Lighthouse, through the Wader platform, aims to:

- Coordinate related research, development and innovation activities, and increase access to and use of related knowledge and innovations
- Coordinate and facilitate engagements in ICT developments in the water sector
- Build relationships and establish collaborative partnerships with external organisations/ individuals, including drivers of innovations
- Strengthen the adoption of ICT-enabled

*With mobile technology penetration and adoption of mobile-to-web technologies in South Africa set to increase further by 2019, the water sector cannot miss out on this opportunity.*

solutions across all stakeholders (including public, government, private/non-governmental) and track progress towards supporting water sector objectives
- Strengthen capacity building in the sector and empower communities on the use of ICT

In recognition of the potential role of ICT in the water sector, the WRC has spearheaded a number of related projects on the development and use of ICT applications. So far, the work done at the WRC has demonstrated that ICT-enabled solutions have the potential to positively bring change in the way we manage our water resources and related services. Such projects have generated knowledge on the technological innovation concerned, demonstrated how it can be embedded in the sector for effective water management and services delivery; and provided recommendations on how it can be integrated into decision making and governance systems. Technologies such as satellite remote sensing, in combination with sensor and geographical information system (GIS) technologies, have been used as a smart tool for water resource management. For example, an integrated water quality management system (IWQMS) is being piloted in the Western Cape to obtain information in near-real-time about water quality, through web-enabled sensors and communication networks. The availability of the data on a timely basis is crucial for decision making in water resources management. There are future plans to develop this further into a water quality early warning system (EWS).

Smart metering technologies provide near-real-time information about water usage and such information can be used to shift consumer behaviour, detect leaks and have better control over water demand. The roll-out of smart water meters all over the country over the past 3 years is evidence that there is a sufficient knowledge base on the use of smart meters as an efficient solution to address the issues of water conservation and demand management, reduction of non-revenue water and improved customer service. The development of numerous mobile applications and platforms facilitates a two-way communication, and has changed the way water is governed and increased transparency in the sector. Examples in this category include: a municipal water supply reporting tool to improve water services delivery; miniSASS app – a simple tool which can be used by anyone to monitor the health of a river; and a number of decision support systems which enable the user to make informed decisions on water resources planning and management.

Given the knowledge base that has been generated from these projects, interest in using ICT interventions in the water sector has increased immensely. However, despite solid evidence on the benefits of ICTs, the water sector has not geared itself up to make the best use of the increasingly ubiquitous access to mobile technology. In addition, the lack of coordination in the water sector has hindered access to and use of big data to provide the needed intelligence for managing water resources and provision of related services. Thus, the short- to medium-term actions for the Lighthouse are as follows:

- Conduct a status quo and track the emergence of innovative ICT applications in the sector
- Document the relevant experiences of key ICT applications (both failures and good practices) in the water sector
- Identify opportunities, constraints and enablers for ICT
- Adoption and scale-up in the water sector
- Facilitate stakeholder engagement, dialogues and knowledge dissemination, and bring together partners in such a way that breakthrough/sector-shifting technologies can emerge
- Linking the water sector to big data opportunities in order to facilitate a new wave of trend tracking, opportunity trawling and responsive management options
- Understand how to match ICT options to different cultures and ways of working in water sector institutions to ensure appropriate ICT support tools are designed

## 3.7 SUSTAINABLE WATER BEHAVIOURS

### Scope

Human behaviour, culture, perceptions, paradigms and choices sit at the heart of how the supply of water is managed and demands for water are negotiated. Thus, in the context of the growing challenges of water scarcity, demand outstripping supply, high user expectations and required assurances, and climate variability, interventions are required beyond technical interventions. A focus on behaviour is thus crucial when managing supply and demand issues in the water sector. Behaviour is also important when considering water and its broader links to the green economy and wider sustainable development approaches.

Ensuring our long-term water supply requires the use of both supply-side approaches such as water augmentation through water recycling, reuse and recycling, and demand-side approaches such as water conservation. In an environment of high expectations and many promises, the conservation of water resources is a critical component of the effective and environmentally sustainable management of water supplies. It is anticipated that climate change will decrease the reliability of water supplies, due to reductions in rainfall and the increasing variability of rainfall events. The conservation of water resources will therefore become increasingly imperative. Given the imperative of water conservation for environmental sustainability, the efficient use and management of water, and climate change mitigation, it is critical to understand what factors contribute to water conservation behaviour. Being aware of these factors will inform water managers, government and public policy officers of how best to encourage water-conserving behaviours, and thus reduce the need to augment existing water supplies. Despite the importance of increasing water-conserving behaviours, relatively limited research has been conducted to date.

A focus on behaviour necessitates a dual approach, looking at the professionals who are the drivers of planning, management, governance and implementation in the water sector, as well as having an outward-looking approach that looks towards users of water at the level of individuals, communities, industry, and the public sector. This outward-looking focus on behaviour also needs to interact with the political agendas and priorities and how water is prioritized in the context of competing demands in the broader national economy. A behaviour focus looking inward at the professionals working and engaged with the water sector necessitates a focus on exploring issues around making use of alternative sources of water, rethinking our conceptualization around built and ecological supply infrastructure, and the behavioural shifts required to run water as a smart business from a management perspective. Here the focus is on the levers that can unlock behavioural and paradigm shifts in the traditional ways of managing water. A close focus on training, re-learning, procurement and similar mechanisms is crucial here. When looking outward towards the behaviour of the users of water the predominant focus has been on water conservation as a demand-side measure. This remains important. Equally important, however, are the behavioural shifts towards seeing water as a core driver of economy and business which stretches far beyond notions of conservation.

*The scope of this Lighthouse will drive the building of research capacity, knowledge and innovative products which will support the sector and Government to traverse the pathway towards building a strong and responsive society and consumers, who will contribute to the sustainable management of our water resources.*

A significant body of work on factors contributing to positive attitudes toward water conservation exists. However, it is known that attitudes do not necessarily translate into actual behaviour. Over the past decade, utilities, governments, businesses, and non-profit organisations have come to realize that more than just financial considerations and information drive behaviour. Social, cultural and psychological factors also play a significant role in shaping consumers' decisions and behaviours around resource use. Stakeholders have consequently turned their interest to behavioural science, a multidisciplinary field that draws from psychology, sociology, public health and behavioural economics to explain the complex mechanisms that shape human behaviour. In addition, a range of other social science disciplines, including political science, anthropology, linguistics, history and philosophy, help to interpret some of the broader contextual, cultural and historical factors that drive preferences, paradigms and attitudes. When used strategically, these disciplines support the potential to drive down resource use, drive up profits, and generate measurable gains in conservation and efficiency.

Sustainable behaviour typically focuses on understanding long-term behaviours and, where transformative tipping points can be leveraged, applies behavioural theory and requires rigorous measurement of outcomes and impact. Focusing on behaviour, actions and preferences thus provides one of the key opportunities and sustainable interventions which can contribute to the acknowledgement and management of the water resources, their exploitation and efficient use by households, agriculture, mining, industry and the environment.

The scope of this Lighthouse will drive the building of research capacity, knowledge and innovative products which will support the sector and Government to traverse the pathway towards building a strong and responsive society and consumers, who will contribute to the sustainable management of our water resources. New approaches will be supported by the use of evidence-based principles and apply proven behavioural strategies that align with the behaviours and cultures at multiple levels within the sector and that are best suited for achieving the objectives demonstrated. These new use behaviours can result in significant, persistent, and measurable reductions in resource consumption.

## 3.8 WATER AND BIG DATA

This Lighthouse will be incorporate the scope of the Water ICT Lighthouse to facilitate the integration of related concepts. Massive forces are re-fashioning the relationship between humans and water. Climate change, floods, droughts, population growth and rapid urbanisation all present communities around the globe with new challenges. We need to get smarter about how we monitor and manage this precious resource we call water. Where we were once only able to analyse data on an ad-hoc, hands-on basis through white boards, complex spreadsheets and business intelligence reports, the industry and global landscape have changed significantly, having moved to a clearer reactive analysis incorporating a much higher volume of historical data with more complexity, and analysing it much more quickly. Knowing what to look for can also yield insights from real-time information streams. With this historical and real-time data at hand, we can begin to look forward (a crystal ball almost) with predictive and prescriptive analytics, creating real value. Merely comparing historical data to identify trends in usage, water flows, below-ground water movement, quality and quantity, then overlaying weather maps and measurements and forecasts, we could more accurately predict water usage, above- and below-ground water storage and flow, impact and much more.

Gartner defines big data as high-volume, high-velocity, and/or high-variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimisation. The exponential increase of data being collected will only drive improvements in water research if that data is put to use. Big data becomes useful if it can be quickly converted into knowledge products. The analysis and meta-analysis by which such products are created requires that the appropriate hardware and software are available, for example, there is a new breed of software tools that can perform data mining and predictive analytics. In addition, distribution channels are needed to communicate the findings and predictions resulting from this analysis to the appropriate stakeholders. Whilst many of the components or software that support big-data analysis of that data – whether it's somebody telling the system what to do under certain circumstances or somebody that is directly acting because of the data they are receiving.

The water sector as a whole, by its very nature, generates significant volumes of data, which can and certainly should be harnessed and analysed to provide insight for improved management, reporting and decision-making ability. Utilising intelligent data analytics, based on past data combined with predictive flow modelling as well as real-time

*The water sector as a whole, by its very nature, generates significant volumes of data, which can and certainly should be harnessed and analysed to provide insight for improved management, reporting and decision-making ability.*

information on water levels, weather reports, water flows, and pressure and more, could assist us in significant event detection and/or prediction. This type of data analysis can create intelligent reporting and enhance our view on usage patterns, demand, quality issues and more. Big data is about taking previously disconnected data like water levels in a reservoir and pressure in the sewage mains – and linking them with other sources of information, such as meteorology, rainfall, and storm predictions. Data then becomes a predictive tool.

Within our customers' arenas (utility providers), operational processes and tools have increased and matured; so too has the amount of data being collected and the expectations of analytic capabilities evolved. Evolution and transformation are the words most often used to describe the journey being undertaken by today's utility providers across the globe. Big data and the analysis thereof provide each utility with an opportunity to better manage their enterprise based on data-driven decisions. A seismic shift could occur. Far beyond another technology evolution, a fundamental transformation could begin to occur, a cultural shift in which we as a research institution alter our thinking about big data and analytics and the ways in which both might be useful to our customers and fellow human beings. Throughout the water sector, technology-generated new data offer distinct opportunities for a holistically improved customer experience and relationship.

It is important to note that no matter how 'big', an incomplete or otherwise flawed set of data will not provide actionable information. The proper analytics (Figs 22, 23) can be developed only with a clear understanding of the quality and quantity of available data. Whilst the water sector might be generating and using more data today, we are not using this data as efficiently as possible and, as such, we are not realising the benefits of big data as quickly as possible. To adequately grasp the reins on the opportunities available to us will require a seismic shift in our culture. We need to pull down the historic data silos, and allow for a more open, holistic and collaborative environment to be formed in which data, in particular, is owned and used by the sector, rather than just specific departments, and our country, for input on a global scale.

To fully tap the well of new, actionable information available, it is imperative that we ask ourselves, what else can we do? How else can we achieve and provide value? How can we share our data, collate it and effectively leverage our analytics to drive bigger value of our input into the research sphere?

Questions that we will aim to answer:

- Will a Cloud-based software-as-a-service (SAAS) benefit our organisation?
- What will we measure/monitor?
- How will data capture and analysis transform the management of our most precious resource?
- What data are being collected (already exists) by sensors/monitors that we believe could add value to us?
- What sensor-type devices do we need?
- Are there technologies already in the market that could benefit us?
- Is there a solution that we could implement that would provide instant visibility into all areas of the water network?
- What improvements could be made from the correct analyses of this data?
- Could real-time and historic analysis of the correct information enhance our ability to respond to current/predicted events?
- What analysis tools and smart systems need to sit on top of the data (once we have it/access to it) in order for us to correctly interpret it and employ it in decision making, reporting and dissemination?
- 'Big data' raises the issue of privacy: Who has what information? How secure is it? How do we collate the various sources of information and share it, securely?
- How will the role of big data in the water sector benefit from developments of big data in other sectors?

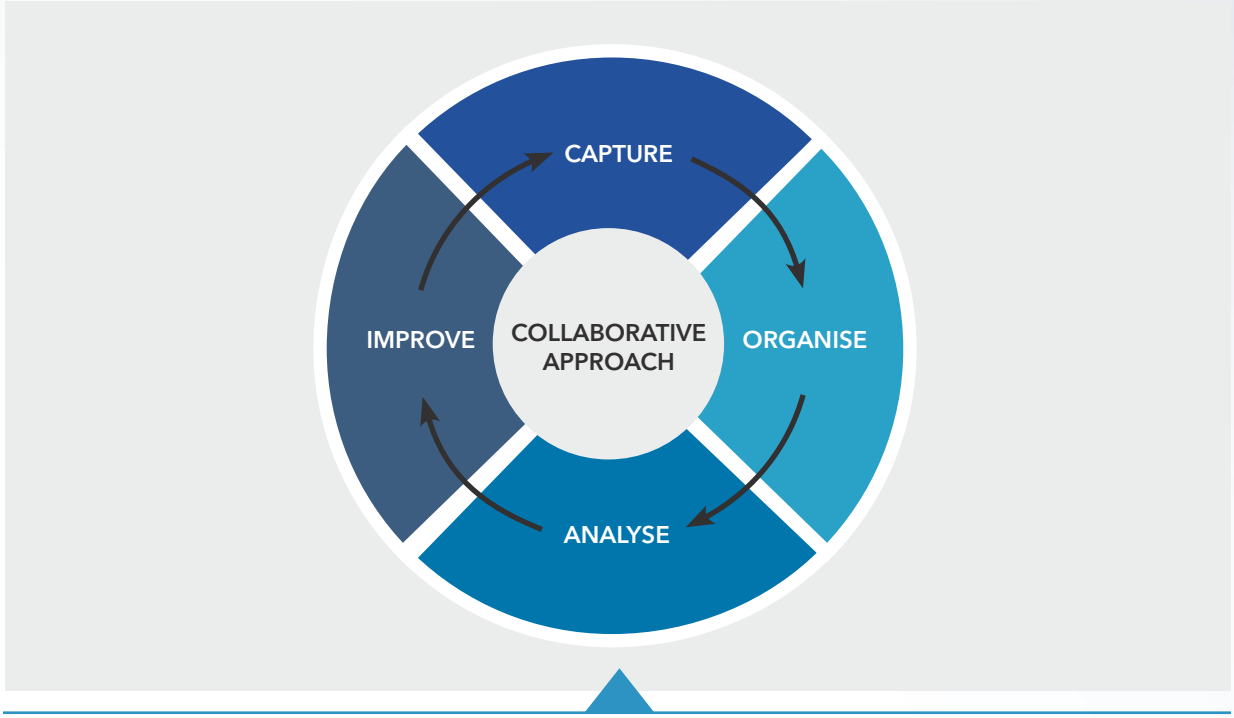



Figure 22. This closed-loop approach will help us create long-lasting analytical benefits


Figure 23. 'Big data' analytics

Integrating processes and technologies that collect more robust data will lead to a more strategic solution. The technology to improve our portfolio as an organization will only be as good as the managers and staff that support our efforts on a daily basis. It is envisaged that we would have to budget effectively for supporting the insights gained from implementing any big-data-analytics solution. A significant contributing factor for success when employing our big-data-analytics solution is to ensure that there is vast, core functionality that meets our business needs. The results of correctly sourced and analysed data promise enhanced decision making and a further improvement on enterprise-level water management, when the solution deployed is correctly aligned to our organisation's corporate plan.

## 3.9 WATER SCARCITY AND EXTREME WEATHER EVENTS

### Scope

South Africa is a semi-arid to arid country, with highly constrained freshwater resources which are unevenly distributed spatially and temporally. The country has been projected to experience water scarcity by 2025 due to exponentially increasing water requirements from a finite and limited resource. The improved socio-economic conditions (and the rapidly growing population) and the changing climatic conditions are cited as the main factors that put pressure on this limited resource. Specifically, the extreme weather events such as recurring droughts and floods as a result of climate change are projected to worsen societal impacts and to aggravate water scarcity in South Africa. Currently, water scarcity and climate change are acknowledged as the most important global risks for society. The risks largely stem from the unsustainable use of the water and land environment and the extreme human influence on natural systems. Water-related shocks, such as droughts, floods and pollution incidents, combined with ill-preparedness and low coping capacities, present high levels of risk for most of the world's poorest. Therefore, the main aims of this Lighthouse are to:

- Enhance the country's water security and resilience to current and future water scarcity
- Investigate, through prediction and early warning systems, the potential impacts of extreme weather events on water scarcity as well as to develop mitigation measures

With a semi-arid climate with limited water resources, South Africa has unique scientific requirements and challenges which are compounded by data limitations. The dynamics of South Africa's complex water systems and their response to extreme weather events and climate change are uncertain. The objective of this Lighthouse will be to harness the existing knowledge in order to develop novel approaches and tools that will advance our understanding and management of the water scarcity problem, both at the catchment and regional (national) level, and to mitigate the increasing vulnerability caused by extreme weather events. The main research questions will centre on 'managing the complex and dynamic water systems that require new understandings of hydrological process interactions and feedbacks across multiple scales, and the effects of human activities on the water environment'. The projects in this Lighthouse will be built on the principle that water scarcity (and hence water security) is an explicitly universal objective. Therefore, while research is conducted at a catchment scale to find solutions suited to local contexts (and vice versa), it should be recognised that water scarcity is a global problem that often requires addressing at multiple scales, i.e., local to regional and global. Therefore, local and national as well as international partnerships will be essential in this Lighthouse's endeavour.

### Current understanding

Over the past 40 years South Africa has conducted a number of large-scale water resources assessment studies (e.g. WR90, WR2005, WR2012, etc.) that aim to address large-scale water resources management and development. However, these studies focus on fundamental aspects of hydrology with little

to no in-depth research on the impacts of human and environmental change on water resources and their associated feedbacks. Additionally, there are a number of recently completed and ongoing climate change and land-use projects to assess the potential impact of the projected change on water resources. Most of these projects are conducted under the Climate Change Lighthouse and a few KSAs. However, it is postulated that these projects do not comprehensively address the understanding of water resources availability, water scarcity and water threats that are caused by extreme weather events.

There are also ongoing research projects on water resource accounting which could prove useful in determining the water use by different land types, and this study complements the water accounting research currently being conducted for Statistics South Africa.

## Future perspectives

There are a number of exciting national and international developments that can aid in the advancement of water scarcity and extreme weather events research. These include the growing global links and partnerships among the community of practice in global-scale models, which has led to a growing number of global datasets that reduce uncertainty in global modelling.

## Strategic objectives

The Lighthouse on Water Scarcity and Extreme Weather Events was conceived during the 2017/18 financial year to harness the existing knowledge on water scarcity in order to develop new approaches and tools that will advance our understanding and management of the water scarcity problem, both at the catchment and regional (national) level, and to mitigate the increasing vulnerability caused by extreme weather events. The main research questions will centre on 'managing the complex and dynamic water systems that require new understandings of hydrological process interactions and feedbacks across multiple scales, and the effects of human activities on the water environment'.

The Lighthouse was developed to achieve three key objectives such as:

- To enhance the country's water security and resilience to current and future water scarcity
- To investigate through prediction and early warning systems the potential impacts of extreme weather events on water scarcity
- To develop mitigation and adaptation measures against water scarcity

## What was planned to be done

A number of activities were planned to advance and implement this Lighthouse as follows:

- **Review of current research on water scarcity and extreme weather events (short to medium term):** A comprehensive review of the state-of-the-art in water scarcity (and extreme weather events) research to synthesise the existing knowledge and to identify gaps both nationally and internationally. The main objective of this review would be to provide a guide (or research strategy) on the long-term research on water scarcity and extreme weather events. The review should provide a quantitative analysis of the impacts of weather extremes (such as droughts and floods) on the hydrological variability, and how the hydrological variability transmits to economic variability, etc., as well as its implications for water resource management. The work should explore 'managing the complex and dynamic water systems that require new understandings of hydrological process interactions and feedbacks across multiple scales, and the effects of human activities on the water environment'.
- **Building partnerships national and internationally (medium to long term):** The projects of this Lighthouse will be built on the

principle that water scarcity (and hence water security) is an explicitly universal objective. Thus, while research is conducted at a catchment scale to find solutions suited to local contexts (and vice versa), it should be recognised that water scarcity is a global problem that often requires addressing at multiple scales, i.e., local to regional and global. Therefore, to accelerate the growth of the knowledge base, this Lighthouse will seek to strengthen partnerships with relevant national and international organisations which will support data, model and trend analysis comparisons. Such partners will also strengthen through advisory support the collaborative framework and institutional support required to improve South Africa's capability in this area. One such set of partners that the WRC is looking to strengthen includes NOAA, USGS, etc. We will seek national partnerships to strengthen exchanges as well as support seminars and events. Therefore, local and national as well as international partnerships will be essential in this Lighthouse's endeavour.

- **Institutionalised expertise (medium to long term):** The synthesis report will provide a strategy on the medium- to long-term research vision for this Lighthouse. Chief among the key issues to be prioritised is the establishment of the hydrology data facility (or centre) to collate and coordinate hydrologically important datasets in all their facets. Of particular interest will be rainfall (climate data), stream flows, groundwater recharge, land cover, etc which are key hydrological parameters in determining water scarcity.
- **Development of tools and novel approaches to mitigate the impacts of water scarcity and extreme weather events (long term):** The impacts of weather extremes on hydrological processes or variability will have a direct and indirect impact on the economic, agricultural, and other sectors. For instance, it is projected that the increase in population and economic growth will lead to an increase in the degree of water scarcity. The increase in the degree of water scarcity also leads to increasing vulnerabilities in agricultural, industrial and domestic activities. Therefore, work from this Lighthouse should stimulate development of novel approaches and appropriate tools that can improve resilience and strengthen adaptation and mitigation initiatives. The policy changes may also be required to mitigate the sensitivity and vulnerability of the economic sectors to water scarcity.

## What was achieved

The Lighthouse has had a very slow start due to the rather unfortunate delay in the key 'Review and synthesis study'. The review study has been approved to start and end during the 2018/19 financial year and its main product will be to provide a research strategy and a way forward for this Lighthouse.

However, over the past year a number of supporting initiatives (within the framework of the above plan) were brought into effect. These include, amongst others:

- Initiating a directed project (K5/2746) entitled 'The development of an integrated (early warning) system for adaptation and mitigation to hydrological drought in South Africa'. One of the key deliverables for this project is 'hydrological predictability' which forms a major scientific component of this Lighthouse. Dr Brian Thomas, formerly of NOAA and now with the University of Pittsburgh USA), was approached to assist the research team because of his expertise in streamflow forecasting and in the US Drought Monitor. He kindly agreed to assist the project team.
- Finalising a project (K5/2436) that developed a streamflow forecasting framework largely based on a desktop study and using an integrated hydrological model. This framework will form the basis for (K5/2746) hydrological predictability and prediction. Under this project (K5/2436) a Dam Balances & Forum on Seasonal

*Recent global water resource assessment and climate change studies have underscored a growing scarcity of freshwater relative to water demand. The depletion of water resources which is brought about by increasing population growth and changes in weather extremes. South Africa is already experiencing physical water scarcity.*

Hydrological Forecasting in South Africa was formed, bringing together water resources planners (dealing with reservoir forecasting), climatologists (from the South African Weather Service (SAWS), UCT, Agricultural Research Council (ARC), CSIR), hydrologists (for streamflow forecasting), etc., in an attempt to integrate forecasting processes and standardize the methodology. However, this forum disbanded at the end of the project.

- Finalising a project on Strategic Water Source Areas of South Africa or SWSAs (K5/2431) in which the findings confirm that only 10% of South Africa's land area generates more than 50% of the country's water supply. This study provides a quantitative estimate of the physical scarcity of the country's water resources.
- Finalising a project (K5/2458) on the use of satellites to monitor in near-real-time the eutrophication of 102 large dams throughout South Africa. The study highlights the extent to which point-source pollution (specifically nutrient-enrichment) is diminishing water quality and potentially poses health risks to the citizens.

## Way forward

Recent global water resource assessment and climate change studies have underscored a growing scarcity of freshwater relative to water demand. The depletion of water resources which is brought about by increasing population growth and changes in weather extremes. South Africa is already experiencing physical water scarcity. There are two key climatic characteristics that shape water resources in South Africa. These include:

- Generally low and highly variable levels of rainfall across most of the country control the amount of water available. The country's mean annual precipitation (MAP) is approximately 500 millimetres, which is way below the world average of 860 mm.
- High air temperatures and low humidity levels mean that most rainfall is lost via evaporation and less than 10% of the rainfall is converted into usable groundwater or river flows.
- Additionally, approximately 60% of the annual rainfall falls on only 20% of the country's land surface.

All of the above translates into natural physical water scarcity even before human-induced impacts are taken into account.

A recent WRC project (K5/2317) used standard approaches such as the Standardized Precipitation Evapotranspiration Index (SPEI) with Thornthwaite method for calculating the potential evapotranspiration, and SPEI with Penman–Monteith method for calculating the PET, to characterize drought in southern Africa. The findings were that drought frequency, intensity and severity have been increasing from the 1950s to the present, and the projections to year 2100 suggest that this situation will gradually worsen due to climate change.

The above examples serve to demonstrate that water scarcity in South Africa will be the main environmental risk (to economy, agriculture, food production, etc.) that should be understood and tackled with appropriate scientific precision. Therefore:

- Quantifying and mapping water scarcity is crucial to understanding vulnerability to water shortages and to scaling solutions across sectors.
- Accurate mapping of spatial and temporal spread of physical water scarcity is increasingly critical to decision-making in different contexts, to examine exposure to water-related risks.
- Floods and droughts alter the relationship between water availability and economic performance (as exemplified by the extreme drought in the Western Cape). Considered as a whole, South Africa is highly vulnerable to hydrological variability.

The plan over the next 5 years will largely be informed by the research strategy which will be developed from the short-term review and synthesis study. This study is planned to be completed by March 2019 in time to inform the focus of proposals in the 2019/20 cycle.

A dialogue on water scarcity is planned to provide inputs to the draft short-term review and synthesis study in March 2019. In the interim, partnerships and collaboration with national and international stakeholders will be established and strengthened. A community of practice on water scarcity is proposed for how extreme weather events such as droughts can be addressed across local and global scales.

Proposed modalities of action:

- **Short to medium term:** A comprehensive review of the state-of-the-art in water scarcity (and extreme weather events) research to synthesise the existing knowledge and to identify gaps both nationally and internationally, is planned. This work should provide a guide to the long-term research strategy for water scarcity and extreme weather events.
- **Medium to long term:** The synthesis report will provide a strategy on the medium- to long-term research vision for this Lighthouse. Chief among the key issues to be prioritised is the establishment of the hydrology data facility to collate and coordinate hydrology datasets in all its facets.

# 4. LEGISLATIVE AND OTHER MANDATES

*The WRC serves as the research and development partner of the sector leader, the Department of Water and Sanitation (DWS), and provides the sector with knowledge and capacity to ensure sustainable management of water resources and enhance water services.*

## 4.1 CONSTITUTIONAL MANDATE

The WRC is bound by the Bill of Rights contained within the Constitution that is applicable to all laws. In the execution of its mandate, the WRC upholds several key principles of the Bill of Rights, most notably section 27.1.b that gives everyone the right to have sufficient access to water. The WRC regards the ready availability of water knowledge and understanding as critically important to the adoption of effective and innovative strategies for equitable water service provision, management and use. It also has the pivotal role of being the knowledge partner to the respective implementing agents in the realisation of the Bill of Rights.

Additionally, section 16 of the Constitution, which addresses freedom of expression, including the right to academic freedom and freedom of scientific research, also applies to the work of the WRC.

## 4.2 LEGISLATIVE MANDATE

The WRC is governed by the Water Research Act (WRA), Act No. 34 of 1971, which outlines the purpose and mandated objectives of the organisation. The WRC also operates and accounts for its activities in accordance with the Public Finance Management Act (PFMA), Act No. 1 of 1999, and is listed as a national public entity in Schedule 3A of this Act.

The mandated objectives of the WRC are also in accordance with the requirements of the policies of the DWS for the Water Services Act (Act No. 108 of 1997) and the National Water Act (Act No. 36 of 1998). Key legislative frameworks and their applicability to the WRC are highlighted below.

### Water Research Act (Act No. 34 of 1971 as amended)

The principal aim of the Water Research Act (WRA) is to provide for the promotion of research in connection with water affairs. The Act requires the establishment of the WRC and the Water Research Fund, and sets the framework within which the WRC operates. It also provides for the establishment of the WRC as a Schedule 3A public entity, thereby requiring compliance with the PFMA Act (Act No. 1 of 1999) and Treasury Regulations.

The WRC's mandate, as set out in this Act, highlights the following functions to be carried out by the organisation:

- Promote co-ordination, co-operation and communication in the area of water research and development
- Establish water research needs and priorities
- Stimulate and fund water research according to priority
- Promote the effective transfer of information and technology

- Enhance knowledge and capacity building within the water sector

## National Water Act (Act No. 36 of 1998)

The objective of the National Water Act (NWA) is to ensure that South Africa's water resources are protected, used, developed, conserved, managed, and controlled in a sustainable and equitable manner, for the benefit of all persons. The NWA also provides for the pricing strategy for water use charges, the primary mechanism for the calculation of a charge, payable by some or all raw water users, that is set for research purposes by the WRC. The role of the WRC is to align its funding priorities with those key national water challenges articulated in the NWA, and to help solve water-related problems which are critical to South Africa's sustainable development and economic growth.

## Water Services Act (Act No. 108 of 1997)

The objective of the Water Services Act (WSA) is to provide for the right of access to basic water supply and basic sanitation by setting national standards and norms. Section 156, read in conjunction with Part B of Schedule 4 of the Constitution of the Republic of South Africa (Act No. 108 of 1996), vests in the Executive Authority the responsibility to support and strengthen the capacity of municipalities to manage their own affairs, to exercise their powers and to perform their functions. Again, the applicability of the WSA to the WRC rests in the WRC's duty to respond to water supply and sanitation needs with research and development that helps to address those needs.

## Review of the water-related legislation

The Department of Water and Sanitation is currently reviewing the National Water Act, 1998 (Act No. 36 of 1998), the Water Services Act, 1997 (Act No. 108 of 1997) and the Water Research Act, 1971 (Act No. 34 of 1971).

While the National Water Act provides a legal framework for the progressive realisation of the right to access to sufficient water, the Act is under review to ensure that there is equity in the allocation of water, to improve water resource management and to streamline regulatory processes. In turn, the Water Services Act is being reviewed to improve the provision of water services to ensure alignment with the provisions of the Municipal Systems Act, 2000 (Act No. 32 of 2000) and the Municipal Finance Management Act, 2003 (Act No. 56 of 2003).

The revised policy positions necessitate the consolidation of the NWA and WSA into one piece of legislation that will govern the entire water value chain covering water supply and sanitation services as well as water resource infrastructure. This consolidation will not only allow for managing water across the value chain but will also enhance cooperative governance and set clear institutional roles and responsibilities with commonly agreed targets for water delivery.

## Water Research Amendment Bill

Addressing current and future water knowledge gaps and the way in which these are currently prioritised in the South African context demands the evolution of the regulation and governance structures of any research institutions. The purpose of the Water Research Amendment Bill, 2013, is to:

- Amend the WRA so as to insert certain definitions and substitute others;
- Effect certain textual improvements and name changes;
- Provide for the appointment of members of the Board and the CEO in line with other public entities in the water sector and current practice of Corporate Governance;
- Regulate the governance of the Water Research Council (Water Research Commission in the current Act)
- Align the Act with applicable legislation,

such as the NWA, WSA and the Public Finance Management Act, 1999; and to

- Provide for matters incidental hereto.

While the new clauses in the Amendment Bill do not legislate for a change in the relationship between the DWS as the shareholder department and the WRC as a public entity, the process of developing the draft Bill has created the discussion space enabling these two public sector partners to draw closer together and iron out the modalities of governance, cooperation and the complementarity of roles.

## 4.3 POLICY MANDATES

The WRC will continue to support DWS in its call for mainstreaming of water and sanitation as the basis to enable and catalyse economic growth and sustainable development. The WRC is therefore actively involved in key DWS initiatives, including the legislative and policy review, and the institutional realignment programme, as well as the implementation of the National Water Resource Strategy 2 (NWRS-2). Specifically, the WRC's 5-year strategy is designed to support the further refinement and implementation of NWRS-2, together with the DWS and associated departmental plans for water services and sanitation. This is closely followed by the water-related components of the Presidential-led National Infrastructure Plan and its associated 18 Strategic Integrated Projects (SIPS), the Department of Environmental Affairs–led Climate Change Response Strategy and the Department of Science and Technology's 10-year Innovation Plan, as well as the broader South African sustainable development agenda. A third layer addresses the water-related components of the other core development strategies for these 5 years, for example, in the areas of local government, agriculture (including forestry), rural development, mineral resource development, the spatial development plans, and water-related enterprise development. The outcomes of our research projects provide scientific knowledge which informs initiatives such as the water pricing strategy and water infrastructure management.

*The objective of the National Water Act (NWA) is to ensure that South Africa's water resources are protected, used, developed, conserved, managed, and controlled in a sustainable and equitable manner, for the benefit of all persons.*

## 4.4 ALIGNMENT OF WRC STRATEGY AND ACTIVITIES

### National Water Resource Strategy 2 (NWRS-2)

The NWRS-2 calls for a much larger contribution from R&D to empower the implementation of the Strategy. In addition, the Strategy also engages the further development of water sciences in South Africa. One of the key deliverables that the NWRS-2 emphasises is the Sector Research and Innovation (R&I) Strategy.

In support of this, it is incumbent upon the WRC to coordinate and empower the implementation of the National Water and Sanitation R&D agenda. Some of the additional contributions that the NWRS-2 requires from the WRC include:

- Desalination of seawater
- Job creation
- Mining, energy and manufacturing industries
- Awareness and communication
- Research and development
- Scenarios, climate change modelling and water availability
- Hydraulic fracturing and coal-bed methane extraction

These areas call on the WRC to collaborate with the DWS and other Government departments such as the Department of Trade and Industry (DTI), Department of Economic Development (DED), Department of Environmental Affairs (DEA), Department of Human Settlements (DHS), and the Department of Mineral Resources (DMR), as well as other sector partners such as Eskom, Rand Water and Sasol, to develop appropriate technologies and support the development of relevant centres of excellence in several of the fields of research described above. In this regard, the WRC, together with the DST, has completed a consultative process and developed the Ten-Year Water Research, Development, and Innovation/Deployment Roadmap that provides a sector-defined, needs-driven research agenda that caters for the public sector (utilities, municipalities), private industry, agriculture, and environmental protection.

### Contributing towards achieving Government Outcomes and National Development Plan (NDP) objectives

As a national public agency, the WRC actively strives to support the Government of South Africa in achieving its strategic outcomes, with particular reference to the NDP objectives as well as the Corporate Plan (Annual Performance Plan) of the DWS and the performance agreement of the Minister of Water and Sanitation.

The WRC also applies the outcome-based approach developed by Government and aims to support all Government Outcomes and Outputs through its research portfolio, with special emphasis given to Government Outcomes 6, 7, 9 and 10 (Table 3). Firstly, Outcome 6 addresses the need for an efficient, competitive and responsible economic infrastructure network. WRC-funded projects support water availability through examining and finding solutions for issues related to bulk water supply, and through supporting the development of appropriate regulations regarding water quantity, quality and usage. A second emphasis is Outcome 7, which focuses on vibrant, equitable and sustainable rural communities and food security for all. This is carried out through a number of projects addressing water utilisation in agriculture as well as projects focusing on informal settlements and peri-urban communities. Thirdly, Outcome 9 aims at establishing a responsive, accountable, effective and efficient local government system. The WRC supports this outcome through research focused on improving services, with special emphasis on the delivery of water and sanitation services. Finally, Outcome 10 addresses the protection and enhancement of the country's environmental assets and natural resources. This outcome is supported

through research in aquatic ecosystem connectivity processes, sustainable utilisation, restoration, global change and biodiversity protection. The WRC workplan is geared to the improvement of the quality and quantity of South Africa's water resources through both its research projects as well as its innovation and technology development activities. Examples include technologies and strategies to reduce water loss in distribution systems, better sanitation solutions and improved wastewater treatment.

Table 3. Alignment with Government Outcomes and NDP objectives

| WRC KNOWLEDGE TREE GOALS | | ALIGNMENT WITH GOVERNMENT OUTCOMES | ALIGNMENT WITH NDP OBJECTIVES |
|---|---|---|---|
| **Inform policy and decision-making** | | | |
| Strategic Outcome-Oriented Goal 1 | The WRC aims to commission appropriate evidence-based knowledge generated to guide decision-making, influencing the development of policy, practice or service provision, shaping legislation, altering behaviour, contributing to the understanding of policy issues, and reframing debates. Through the R&D that it commissions it also aims to inform decision-making at all levels within government but also in non-governmental arenas. WRC projects also aim to improve basic services, with special emphasis on delivery of water and sanitation services. | 1. Government Outcome 9: A responsive, accountable, effective and efficient local government system.<br>2. Government Outcome 12: An efficient, effective and development oriented public service and an empowered, fair and inclusive citizenship. | Building a capable and developmental state objectives: Chapter |

| WRC KNOWLEDGE TREE GOALS | | ALIGNMENT WITH GOVERNMENT OUTCOMES | ALIGNMENT WITH NDP OBJECTIVES |
|---|---|---|---|
| **Develop new products and services for economic development** | | | |
| Strategic Outcome-Oriented Goal 2 | The WRC capitalises on those projects that have potential to develop new intellectual property or to introduce innovations which create new or improved technologies, products and services that can be used in the economy. Effectively, this is the WRC's contribution to job creation and economic development through water and sanitation science innovations. Additionally, WRC projects support water availability by finding solutions to problems related to bulk water supply and assisting the development of appropriate regulations regarding water quantity, quality, and usage. | 1. Government Outcome 4: Decent employment through inclusive economic growth.<br>2. Government Outcome 6: An efficient, competitive and responsive economic infrastructure network. | Economy and employment objectives: Chapter 3<br><br>Economic infrastructure objectives: Chapter 4 |
| **Enhance human capital development (HCD) in the water and science sectors** | | | |
| Strategic Outcome-Oriented Goal 3 | The WRC strives to have high student participation in its projects. Although the emphasis is on post-graduate degrees, inclusion of undergraduates has also been investigated. There is also a particular emphasis on previously disadvantaged individuals (PDIs) and women. The WRC also aims to support institutional development through mentorship provided to new research leaders. | 1. Government Outcome 1: Improved quality of basic education.<br>2. Government Outcome 5: A skilled and capable workforce to support an inclusive growth path. | Improving education, training and innovation objectives: Chapter 9 |
| **Empower communities** | | | |
| Strategic Outcome-Oriented Goal 4 | The WRC places an emphasis on projects that: (a) include communities not only as end-users of research but as active participants in the research process from the project design phase; (b) have a direct impact on the livelihoods of communities through | 1. Government Outcome 6: Vibrant, equitable and sustainable rural communities with food security for all. | Environmental sustainability and resilience objectives: Chapter 5 |

| WRC KNOWLEDGE TREE GOALS | | ALIGNMENT WITH GOVERNMENT OUTCOMES | ALIGNMENT WITH NDP OBJECTIVES |
|---|---|---|---|
| Strategic Outcome-Oriented Goal 4 *continued* | water-related interventions; and (c) build sufficient capacity to assist with the post-project sustainability of those interventions. Additionally, the WRC has projects addressing water utilisation in agriculture, as well as in informal settlements and peri-urban communities. The use of water by small-scale farmers (smallholders) and water allocation reform are being addressed. The WRC will continue to support the wise use of water for agriculture, and to reduce water demand from irrigation. | 2. Government Outcome 7: Sustainable human settlements and improved quality of household life. | Inclusive rural economy objectives: Chapter 6<br><br>Transforming human settlements objectives: Chapter 8 |
| **Promote transformation and redress** | | | |
| Strategic Outcome-Oriented Goal 5 | This goal focuses on growing PDI involvement/leadership in projects, as well as helping to promote socio-economic development through the reduction of poverty and inequality in South Africa, particularly of marginalised groups such as women and youth. | 1. Government Outcome 5: A skilled and capable workforce to support an inclusive growth path.<br>2. Government Outcome 11: Create a better South Africa and contribute to a better and safer Africa and World.<br>3. Government Outcome 12: An efficient, effective and development oriented public service and an empowered, fair and inclusive citizenship. | Improving education, training and innovation objectives: Chapter 9<br><br>Transforming human settlements objectives: Chapter 8<br><br>Building a capable and developmental state objectives: Chapter 13<br><br>Nation building and social cohesion objectives: Chapter 15 |

| WRC KNOWLEDGE TREE GOALS | | ALIGNMENT WITH GOVERNMENT OUTCOMES | ALIGNMENT WITH NDP OBJECTIVES |
|---|---|---|---|
| **Promote transformation and redress** | | | |
| Strategic Outcome-Oriented Goal 6 | The WRC prioritises those projects that provide sustainable development solutions that have had positive effects on the environment, economy and society, including: protection of water resources, optimal water use, and equity between generations, equitable access, environmental integration and good governance. Additionally, this goal focuses on developing knowledge products that are fit-for-use to ensure the uptake of research. Examples include technologies and strategies to reduce water loss in distribution systems, better sanitation solutions and improved wastewater treatment. The WRC will continue to invest in studies on climate change and related energy issues. Biodiversity related to aquatic life and ensuring ecosystem health | 1. Government Outcome 7: Vibrant, equitable and sustainable rural communities with food security for all.<br>2. Government Outcome 8: Sustainable human settlements and improved quality of household life.<br>3. Government Outcome 10: Environmental assets and natural resources that are well protected and continually enhanced. | Environmental sustainability and resilience objectives: Chapter 5<br><br>Inclusive rural economy objectives: Chapter 6<br><br>Transforming human settlements objectives: Chapter 8 |

## 4.5 ALIGNMENT WITH DWS STRATEGIC OBJECTIVES AND NATIONAL WATER & SANITATION MASTER PLAN

The National Water & Sanitation Master Plan (NWSMP) presents a solid affirmation and commitment from DWS to support water-related research, development and innovation. This is with a view to ensuring that there is highly informed water decision-making through science and technology at all levels, in all stakeholder groups, and innovative water solutions through research and development for South Africa, and the African continent. The DWS will thus continue to support efforts that position the country and its institutions as a global water knowledge node active across the whole water and sanitation innovation value chain.

The DWS with its relevant institutions has to construct, plant, and maintain a true Knowledge Tree which bears many desired fruits, resulting in new sustainable development solutions, new products and services, empowering of communities especially youth and women, informed policy and decision making, etc. In fact, this plan constructs a roadmap assuring the commitment of the DWS in addressing the challenges of unemployment, poverty and inequality as stated in the National Development Plan (NDP) of South Africa. The RDI Chapter of the NWSMP is aligned with and linked to key strategic goals of the DWS as well as other Government priorities. Above all, the NWSMP is meant to advance and comply with the Constitution and all other relevant policies and legislations of South Africa. The chapter thus provides:

- A brief comment on RDI gaps and opportunities
- An overview of the key activities and instruments that underpin the water RDI sector
- The key investment themes/clusters that should be prioritized
- Tracking progress
- An estimation of envisioned investment required
- An overview of the proposed implementation and partnership approach

The Water RDI Roadmap is a 10-year innovation plan (2016/17–2027/27) that provides strategic direction, a set of action plans and an implementation framework to guide, plan, coordinate and manage South Africa's water RDI investment. The Roadmap is a partnership initiative between the DST, DWS and the WRC. The Roadmap is thus positioned as the implementation plan for Chapter 14 of the NWRS-2 and its current revision processes. It also provides the basis for the research chapter of the National Water and Sanitation Master Plan. The Roadmap has strong alignment to the Water Chapter in the Industrial Policy Action Plan released in 2017/18. The plan focuses on tracking and driving a series of research, high-end skills development and innovation deployment activities focusing on a range of clusters/thematic areas, such as unlocking alternative sources of water, ecological and built infrastructure, or monitoring and metering. Ultimately the plan aims to:

- Address water knowledge gaps
- Grow the water sector high-end skills base
- Facilitate faster and more effective deployment of context-appropriate solutions to market
- Provide evidence that guides policy and implementation
- Develop content that guides education and awareness campaigns
- Unlock new opportunities for business and industry
- Deepen insight on how best to balance protection and use of the environment
- Facilitate a learning culture in water sector institutions about the challenges, risks, opportunities and solutions related to the water sector

Table 4 outlines the WRC's alignment with DWS strategic objectives.

Table 4. Alignment with DWS strategic objectives

| DWS STRATEGIC OBJECTIVES | WRC STRATEGIC OBJECTIVES |
|---|---|
| Sound cooperative governance and an actively engaged citizenry | 1. To enhance the governance of water in South Africa through knowledge and practice derived through research<br>2. To enhance human capital development through support of students in water research projects as well as the development of researchers<br>3. To contribute to economic transformation by supporting SMMEs in water research, development and innovation<br>4. Enhance the diversity of project leadership as part of the broader national transformation project to promote the ongoing transformation of the water R&D sector<br>5. Achieve efficient and effective institutional governance including a good audit report<br>6. Enhance the relevance and presence of the WRC locally and globally by coordinating strategic local and international partnerships by establishing MoUs, knowledge-sharing agreements/understandings or strategic partnership agreements with knowledge-sharing institutions and/or strategic partners<br>7. Strengthen the WRC's strategic position regarding water research and development |

| DWS STRATEGIC OBJECTIVES | WRC STRATEGIC OBJECTIVES |
|---|---|
| Equitable access to reliable, sustainable and acceptable water resources and sanitation services | 1. To increase knowledge on water and sanitation services by initiating new research projects<br>2. To provide the country with supportive knowledge via completed projects<br>3. To improve knowledge dissemination (number of final research reports and technical briefs published)<br>4. To promote the uptake and communication of WRC research in the form of manuals, guidelines, and other supporting materials produced<br>5. To engage the sector in knowledge-sharing events through public dialogues and workshops |
| Enhances and protects water resource across the value chain | 1. To increase water science focusing on protection of water across the value chain by initiating new research projects<br>2. To provide the country with supportive knowledge via completed projects<br>3. To improve knowledge dissemination (number of final research reports and technical briefs published)<br>4. To promote the uptake and communication of WRC research in the form of manuals, guidelines, and other supporting materials produced<br>5. To engage the sector in knowledge-sharing events through public dialogues and workshops |

## 4.6 ALIGNMENT WITH MILLENNIUM DEVELOPMENT GOALS AND SUSTAINABLE DEVELOPMENT GOALS

From food and energy security to human and environmental health, it is well recognised that water contributes to improvements in social well-being and inclusive growth. As the world grapples with increasing water scarcity, numerous international water bodies have identified water as a priority concern.

Originally, the Sustainable Development Goals (SDGs, a follow-on from the Millennium Development Goals, or MDGs) were established as a response to world poverty, inequality, and insecurity, but they have developed into drivers of the management of resources. The SDG agenda builds on the achievements of the MDGs and addresses areas that the MDGs did not achieve. The 2030 Agenda for Sustainable Development was adopted by the United Nations' Heads of State and Government for guiding the world towards a sustainable development path. The 17 SDGs target addressing social, economic and environmental problems facing countries by 2030. Specifically, the challenges that triggered the development of the SDG agenda include an increasing world population, climate change, increased urbanisation, environmental degradation and critical water shortages for domestic and agricultural purposes. The SDGs are more focused on human livelihoods, with a total of 169 targets which are global in nature and universally applicable. Additionally, the targets recognise different national realities, capacities and levels of development and varying national polices. Alignment of the WRC strategies with the SDGs is presented in Table 5.

### WEF nexus Links to the SDGs

The SDG agenda introduced an additional complex layer that recognises the linkages between the water, energy and food sectors. In the WEF nexus approach the three sectors are not only interdependent, but they impact upon each other. Literature has revealed

that the evaluation of the SDGs in relation to food, energy and water can be regarded as an important tool to establish a holistic approach towards achieving sustainability and meeting the SDG targets. Furthermore, the achievement of the SDGs requires decisions for nexus-based adaptations that take into consideration the need to build climate resilience in economic, social and environmental systems. Various studies proposed the calculation of a WEF nexus index using sustainability level indicators and population vulnerability in terms of each resource in the WEF nexus. Furthermore, human vulnerability indicators are key targets of the SDGs. It is also important to note that considering the SDGs through the WEF nexus lens makes it easier to understand the implications for other goals and accomplish targets across multiple goals. Since the implementation of SDGs is both directly and indirectly affected by socio-economic, environmental and political factors, the use of the WEF nexus as a framework to uncover these interconnections will increase the probability of the achievement of SDGs by 2030.

With the emergence of the SDGs, the WEF nexus has been recognised as a key tool for regional integration and development, as well as the actual achievement of the national SDGs targets. It is also anticipated that SDGs will drive future policies since the targets of SDGs 6, 7, 8 and 9 are related to the water-energy nexus planning approach. The WEF nexus has been identified as an approach for achieving SDGs 2, 6 and 7. SDG 2 accounts for zero hunger, SDG 6 refers to clean water and sanitation, SDG 7 focuses on affordable and clean energy, SDG 8 comprises affordable work and economic growth while SDG 9 is aimed at industry, innovation and infrastructure. Hence, it is crucial that the frameworks mention and account for the above SDGs as well as illustrate how the SDGs connect with the three primary sectors under consideration. For example, SDG 2 can be achieved by eradicating food insecurity and improving nutrition. SDG 6 can be achieved by ensuring basic access to water and sanitation and tackling the issue of water scarcity. SGD 7 requires the promotion of renewable energy sources, and access to these power sources. SDG 8 focuses on job creation, educating the unskilled workforce, as well as working towards sustainable economic development, while SDG 9 requires improvements in infrastructure, technology and industrialisation.

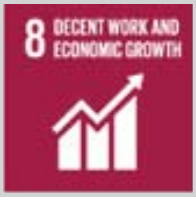
The following WRC projects, presented in no particular order, will aid in the future development and adoption of the WEF nexus in South Africa and link directly with the SDGs:

- Catchment-based assessments of selected water management areas (WMAs) utilising the WEF nexus as a framework to identify resilient upstream policy recommendations
- An assessment of the potential impact of climate change on water availability, energy generation capacity and food production in South Africa during the 21st Century
- The development of a roadmap to achieve SDGs 2, 6 and 7 by 2030 in South Africa utilising the WEF nexus approach
- Water usage per energy generation technology type
- A WEF nexus city-based metabolism study for Cape Town
- Potential sector-specific policy harmonisation to promote a WEF nexus approach to sustainable development in South Africa
- A study into practical household-level application of the WEF nexus approach in South Africa, with a focus on rural, peri-urban and urban areas
- Water and land requirements for bioenergy implementation in South Africa
- A review of the availability of WEF nexus data at different spatial and temporal scales within South Africa
- The development of a WEF nexus index, and its application to South Africa and SADC
- A study of water scarcity implications for food and energy security in South Africa
- A review of the applicability of available WEF nexus models to South Africa

Table 5. Alignment with Government Outcomes and NDP objectives


| | |
|---|---|
|   | End poverty in all its forms everywhere |
| | The WRC through the water–energy–food nexus aims to facilitate the integration of existing water, energy, food polices and strategies to increase food production, water availability and sustainable energy generation. This ensures that existing knowledge is used to inform policies for integrated sustainable resource management among the WEF sectors.<br><br>The WRC aligns to this goal by funding research projects that focus on the improvement of household food security, nutrition and health. Providing support to meet nutritional requirements of households in different rural villages with rain-fed and supplementary irrigated food production.<br>• 'Improvement of household food and nutrition security' (WRC Report No 2172/1/16). |
|   | End hunger, achieve food security and improve nutrition and promote sustainable agriculture |
| | The strategic focus for Water Utilisation in Agriculture KSA is on increasing knowledge for efficient use of water for production of food, forage, fibre, and fuel crops, improving food security, reducing poverty and increasing the wealth of people dependent on water-based agriculture and ensuring sustainable water resource use. Priority is therefore given to knowledge application and skills development of homestead food gardeners and smallholder farmers. The focus for this KSA is purposefully directed towards overcoming poverty, hunger and malnutrition and promoting resilience amongst members of the rural and urban population.<br>• 'Uptake of resource and training material for food production' (WRC Report No TT 694/16). |
|   | Ensure healthy lives and promote wellbeing for all at all ages |
| | Secure and sustainable access to water is essential for human health, economic growth and food security. However, in South Africa's semi-arid environments conventional water sources are not enough to meet the ever-growing demand. Therefore, the WRC through the Water Quality and Health Lighthouse endeavours to increase understanding and assessments of alternative sources of water such as fog water, desalination and water transfers. The WRC has positioned itself as a leader in emerging pollutants research, by funding projects on emerging chemical contaminants (for example microplastics, pharmaceuticals, agrochemicals, engineered nanoparticles). The results of these studies have re-energised national conversations on water pollution prevention, control and waste management. Research focused on protecting and monitoring sources of drinking water is prioritised:<br>• 'Cholera monitoring and response guideline' (Project: K5/2432) |

| | |
|---|---|
|  | Ensure inclusive and equitable education and promote lifelong learning opportunities |
| | The WRC is committed to providing South Africa with future researchers as well as a source of skilled human capital for other institutions within the water sector. This is done by investing in student training; project leaders are encouraged to include students on their projects, enabling them to participate in water research through the various projects supported by the WRC. Currently the WRC has 387 students training in its research projects. |
|  | Achieve gender equality and empower all women and girls |
| | Those who live in remote rural settings remain largely absent from water-related decision-making processes, as do women, who are affected but whose voices have not yet been adequately heard. The WRC endeavours to capture the narratives and voices of women, and in so doing to bring the wisdom, experience and concerns of women facing the effects and impacts of climate change and water scarcity in their everyday lives to the fore. Accordingly, through the Women in Water Empowerment Programme (an initiative of the DWS) the WRC continues to increase opportunities for women to work in the water and sanitation sector as consultants, contractors, suppliers and innovators.<br>• 'Towards gender-sensitive strategies for responding to challenges posed by climate related impacts' (Project K5/2314).<br><br>The WRC endeavours to increase the representivity of female researchers in its research teams. Accordingly, 121 (32%) WRC managed projects have female project leaders. |
|  | Ensure availability and sustainable management of water and sanitation for all |
| | The WRC through the Water Quality Lighthouse seeks to guide integrated water quality management in South Africa, by providing an understanding of the water quality conditions over time, the contribution of global and anthropogenic factors to water quality, and the impacts of water quality changes on the economy, ecosystem and human health, as well as to develop solutions to address the identified challenges.<br>A suite of guidelines on alternative water sources and quality (e.g. rainwater harvesting, greywater harvesting and treatment, desalination and water reuse) have been developed to support this initiative.<br>• 'Guiding principles in the design and operation of a wastewater sludge digestion plant with biogas and power generation (WRC Report No TT681) |
|  | Ensure access to affordable, reliable sustainable and modern energy for all |
| | The WRC aligns to this goal by channelling resources to renewable energy generation. Through the WEF nexus, specific attention is paid to efficient energy use for food production.<br>• 'Improving rural livelihoods through biogas generation using livestock manure and rainwater harvesting' (WRC Report No. 1955/1/15)<br>• 'Turning municipal sludge beds into bio-power plants using sediment microbial fuel' (Project no.: K5/2772)<br>• 'Water use of cropping systems adapted to bio-climatic regions in South Africa and suitable for biofuel production' (WRC Report No. 1874/1/15)<br>• 'Assessing the state of the Water–Energy–Food Nexus in South Africa' (WRC Report No. KV 365/18) |

| | |
|---|---|
|  | Promote sustained inclusive and sustainable economic growth, full and productive employment and decent work for all |
| | The WRC through its Green Village and Economy Lighthouse funds research that leads South Africa towards a resource-efficient, low-carbon and pro-employment growth path. The strategic objectives of the Lighthouse are:<br>• To lead and align research, development and innovation (RDI) with key national and international poverty, unemployment and inequity eradication aspirations<br>• Enterprise development to empower communities, especially women and youth through green innovation<br>• To unlock economic wealth beyond the environmental processes by engaging the market value chain<br>• To encourage partnership, particularly that leads to co-funding and implementation<br>• Positioning RDI products in leadership, nationally and internationally, through dialogues, conferences, and community interventions<br>• To develop an adaptable and integrated green innovation framework critical in entrepreneurship/business, community empowerment and influencing of policy |
|  | Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation |
| | The WRC capitalises on projects that have potential to develop new intellectual property or to introduce innovations which create new or improved technologies, products and services to be used in the economy. Requirements for entrepreneurial development and establishment of viable smallholder irrigation farming businesses has been determined for selected irrigation schemes in Limpopo, Eastern Cape and KwaZulu-Natal Provinces.<br>• 'Entrepreneurial development pathways' (WRC Report No. 2179/1/16; 2178/1/16 and 2278/1/18). |
|  | Reduce inequalities within and among communities |
| | The WRC aligns to this goal by funding projects that have a direct impact in uplifting rural economies through commercial food production and reducing income inequalities. Attention is given to building capacity to ensure post-project sustainability:<br>• 'Uptake of resource and training material for food production' (WRC Report No TT 694/16)<br><br>The WRC is committed to supporting national transformation and redress, ensuring that the new dispensation brings about the intended redress. Through the Water Utilisation in Agriculture KSA, the WRC addresses the needs of Black emerging farmers (BEF), contrasting with those of commercial White farmers, in accessing water for productive purposes:<br>• 'Water allocation for productive use – policy and implementation: A case study of the Black emerging farmers in the Breede-Gouritz Catchment Management Area, Western Cape, South Africa' (Project no.:K5/2530) |


**Make cities and human settlements inclusive, safe, resilient and sustainable**

The management of the combined effect of urbanisation, industrialisation and population growth on water resources is a challenging task and the increasing demands for water for different uses require a broad range of water management strategies and tools. The WRC has through the Water Sensitive Design Lighthouse adopted an integrated approach to manage hydrological and biochemical processes within catchments and ensure sustainable development in both urban and rural communities.

Through research projects such as:

- 'Combined effect of urbanisation, industrialisation and population growth on water quality of the Palmiet River and its tributaries in the Overberg West sub-catchment of the Breede Water Management Area: An integrated catchment risk assessment' (Project K5/2329).

Additionally, different approaches have been followed to determine the water footprints of fruit and vegetables for sustainable water use in selected groundwater and surface water catchments (WRC Report No TT 722/17). Currently, the WRC has 48 community-based projects.


**Ensure sustainable consumption patterns**

Through its Water Resources and Ecosystems KSA, the WRC aligns to this goal by funding research that provides knowledge on sustainable use of natural resources. This is to ensure that basic human needs are met and that resources necessary for long-term survival are not destroyed for short-term gain. This KSA also focuses on research that enhances knowledge on healthy ecosystems and preservation of biodiversity.


**Take urgent action to combat climate change and its impacts**

The WRC through its Water Resources and Ecosystems KSA has identified the potential adverse effects climate change has on ecosystems, resources and society. Secondary impacts (due to lack of access to adequate good quality water) negatively impact economic growth, food security, health and services. Consequently, to reduce vulnerability as a country/global community it is crucial that we adapt to the currently highly variable climate, as well as to projected climate change impacts on water availability.

The WRC climate change flagship programme encompasses collaborative research and development on priority water-related climate issues across the spectrum leading to impacts that will be felt at both national, regional and global scales. The ultimate purpose of this Lighthouse is premised entirely upon improving the adaptive capacity of the people and the sector to increase resilience and development of a knowledge base for climate change adaptation and decision support, while providing strategic guidance and framework for sectoral response.

Accordingly, below are some of the WRC's projects that focus on developing the understanding of global climate change and hydro-climatic variability impacts, crafting methodologies for vulnerability assessments and development of appropriate adaptation options and solutions at various scales:

| | |
|---|---|
| | • 'Future climate change impacts on flood and drought hazards in South Africa for planning and decision-making' (Project K5/ 2247)<br>• 'Soil moisture–climate interactions under climate change: implications for droughts, heat waves and desertification over Southern Africa' (Project K5/2247)<br>• 'Improving drought and flood early warning, forecasting and mitigation using real-time hydroclimatic indicators' (Project K5/2618) |
|  | Conserve and sustainably use the oceans, seas and marine resources for sustainable development |
| | The WRC Though its Green Economy Lighthouse aims to provide an improved conceptual understanding of ocean–atmosphere linkages to hydroclimatic variability in Southern Africa, to understand the role of the adjacent ocean in moisture transport, rainfall and extreme weather and climate of South Africa, and to understand the role of the ocean on decadal variability of the Southern African climate and explore potential decadal forecasting thereof.<br>• 'Ocean impact on southern African climate variability and water resources' (Project K5/2425)<br>The WRC is committed to ensuring sustainable water bodies through investing in research aimed at developing and implementing a technology-based decision support system for the use of aquatic toxicity testing guidelines as a screening and detailed water quality monitoring tool. These guidelines will be used in the municipal, mining, agricultural and industrial sectors.<br>• 'Development and benchmarking of decision support for aquatic toxicity testing: technology transfer and implementation of the toxicity testing guideline/technology' (Project K5/2445) |
|  | Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and reverse land degradation and halt biodiversity loss |
| | Global environmental change has negative effects on ecosystems and these are aggravated by stressors such as unsustainable use of water, deteriorating water quality, and land use and demographic changes in time and space. The focus is also on developing appropriate quantitative understanding, tools and strategies for managing the impacts of climate variability and change, as well as human interventions on the hydrological cycle and related water resources, with the aim of supporting the development of policy responses, at regional, national or catchment scale, to existing and emerging problems. This includes development of tools and systems for managing floods and droughts and the effects thereof on the resources and the people who rely on those resources. |
|  | Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels |
| | The WRC seeks a multi and trans-disciplinary approach – drawing on expertise in natural and social science, as well as engineering, humanities, sustainability science, and other professions such as planning, law, and business. |


**Strengthen the means of implementation and revitalise the goal partnerships for sustainable development**

Meeting the global water challenges is not a one-country or one-stakeholder effort. It requires an ongoing, collective, co-operative and coordinated effort to address common water and sanitation challenges. The WRC actively seeks local and international partnerships that address the WRC service pillars: research, technology innovation, knowledge sharing, capacity development and funding. These include research partnerships, implementation partnerships and innovation value chain partnerships.

The WRC endeavours to become an African partner of choice for water and sanitation research, development and innovation (RDI) and focuses on building partnerships with the purpose of:

- Contributing to setting and implementing a water and sanitation RDI agenda
- Building water and sanitation RDI capacity
- Supporting water and sanitation technology innovation through:
  a. Linking African technology innovations with South African partners
  b. Linking South Africa technology innovations with African partners
  c. Providing support for piloting of technology innovation in South Africa
- Facilitating knowledge sharing between South African, other African and global stakeholders
- Issuing Joint Calls for water and sanitation RDI (co-funding of RDI)

# 5. SITUATIONAL ANALYSIS

## 5.1 PERFORMANCE ENVIRONMENT

The WRC's performance environment is created on the premise that the crux of the water and sanitation challenge in South Africa is a capacity and capability challenge. The WRC addresses the three dimensions of this challenge, namely, new knowledge, human capital, and technological solutions. It will endeavour in its projects to create a high concentration of activities that support each of these dimensions. In so doing, the WRC funds and facilitates research in water-related innovation and disseminates such knowledge for the advancement of national water security. The recipients of this knowledge may be higher-education institutions (HEIs), science councils, or private agencies/contractors, as well as the various tiers of government.

While our increased efficiencies, innovation and partnerships will continue to maintain knowledge production levels, it is becoming increasingly difficult to meet two very basic challenges in the South African water and sanitation system. The first is the ability to address the increasingly complex nature of water problems such as non-revenue water and acid mine drainage. The second is the WRC's ability to both transform the South African R&D community through the development of researchers from the designated groups as well as to create further avenues for job creation and entrepreneurship development, which are all restricted by the limited availability of R&D funds.

At the same time, technological innovation, improvements in communication, increased collaboration and international partnerships have enhanced our ability as a South African water R&D community to conduct better research, to train students at higher levels, and to organise for better translation of research into products and services for the economy. These improvements, together with new resources, will guarantee our ability to make a significant difference to South Africa's water fortunes.

## 5.2 ORGANISATIONAL ENVIRONMENT

The primary functions of the WRC have always been to fund and steer the water research agenda in South Africa, and to effectively disseminate and communicate research findings. Administrative activities are carried out to ensure compliance with regulatory requirements and to provide an enabling environment for research management.

However, in recent years the WRC has been increasingly called upon to not only develop new knowledge in the water and sanitation science and technology domain, but also to support and further develop human capacity and skill as well as lead technology, product and industry development (Fig. 24). This not only necessitated an expanded mandate but also a suitable organisational structure capable of handling these added responsibilities. The WRC has re-engineered its operations and structure to address challenges faced by the water and science sectors and the country.

*The WRC's performance environment is created on the premise that the crux of the water and sanitation challenge in South Africa is a capacity and capability challenge. The WRC addresses the three dimensions of this challenge, namely, new knowledge, human capital, and technological solutions.*

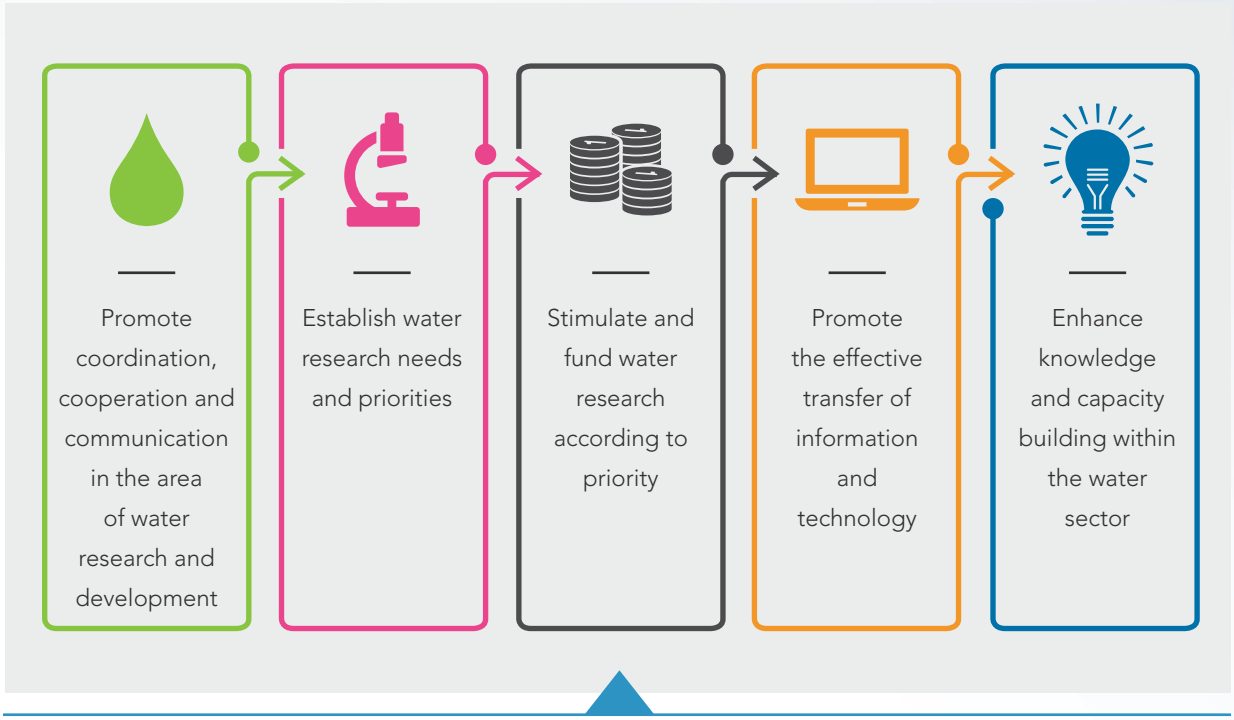



Figure 24. The WRC's primary function

As such, four core teams have been developed (Fig. 25):

1. Research and Development – which focuses on the generation of new knowledge as well as the mechanisms needed to support this, including human capital development and skills development.

2. Impact and Innovation – which entails a redefined focus on technology, product and industry development, business development and innovation realisation on the one hand, and enabling mechanisms such as knowledge dissemination, communication and marketing on the other.

3. Finance – which focuses on improved efficiencies and effectiveness with in the WRC;s supply chain and the enhancement of financial planning capabilities which will contribute towards creating and appropriately funded and financially stable operating environment.

4. Corporate Services -which focuses on the world of work for the WRC. This includes People and Culture, Information Technology, Corporate Social Responsibility, Legal and Compliance and Facilities.

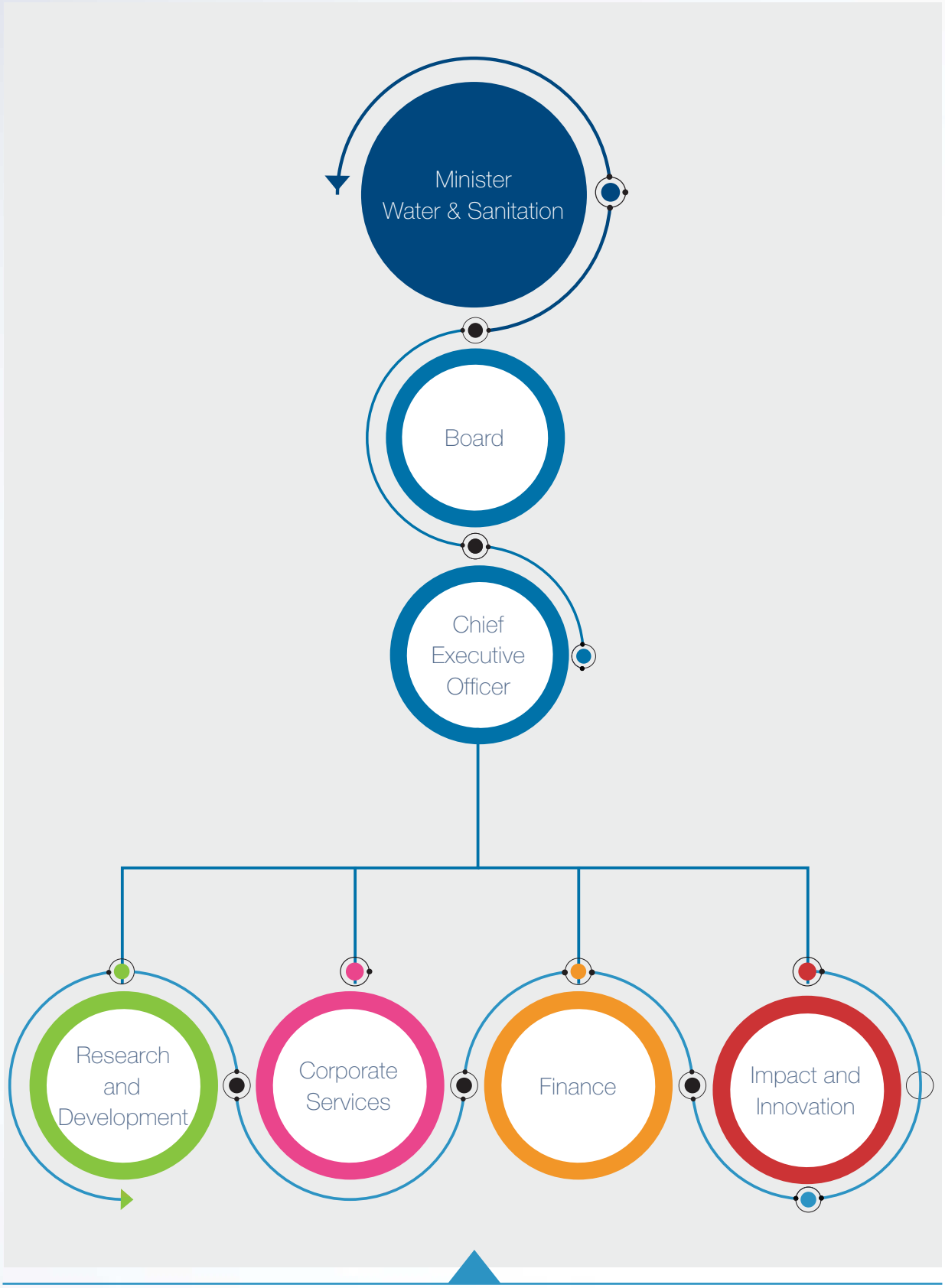



Figure 25. WRC organisational structure

The following structure defines the internal governance framework:

The Minister of Water and Sanitation is the Executive Authority of the WRC.

The Department of Water and Sanitation is the shareholder representative.

The WRC Board is the Accounting Authority of the WRC.

The Chief Executive Officer (CEO) is the Accounting Officer and a member of the WRC Board.

The Heads of Branches, which include the Group Executives, the Chief Financial Officer and the Executive Manager for Corporate Services, report directly to the CEO.

## 5.3 DESCRIPTION OF THE WRC'S CORPORATE PLANNING PROCESS

The process (Fig. 26) conducted to develop this Corporate Plan is characterised by three important elements. Firstly, it has been an ongoing and iterative process. Secondly, it has been consultative, incorporating discussions and considerations from the DWS and WRC stakeholders in various forums. Thirdly, it has employed both forecasting and back-casting approaches to the development of strategic objectives, involving an analysis of the WRC's current positioning in the sector as well as a reflection on developments and potential developments in the external and organisational environment that could have an impact on the 5-year planning cycle. All of these processes have been under the guidance of the WRC Board.

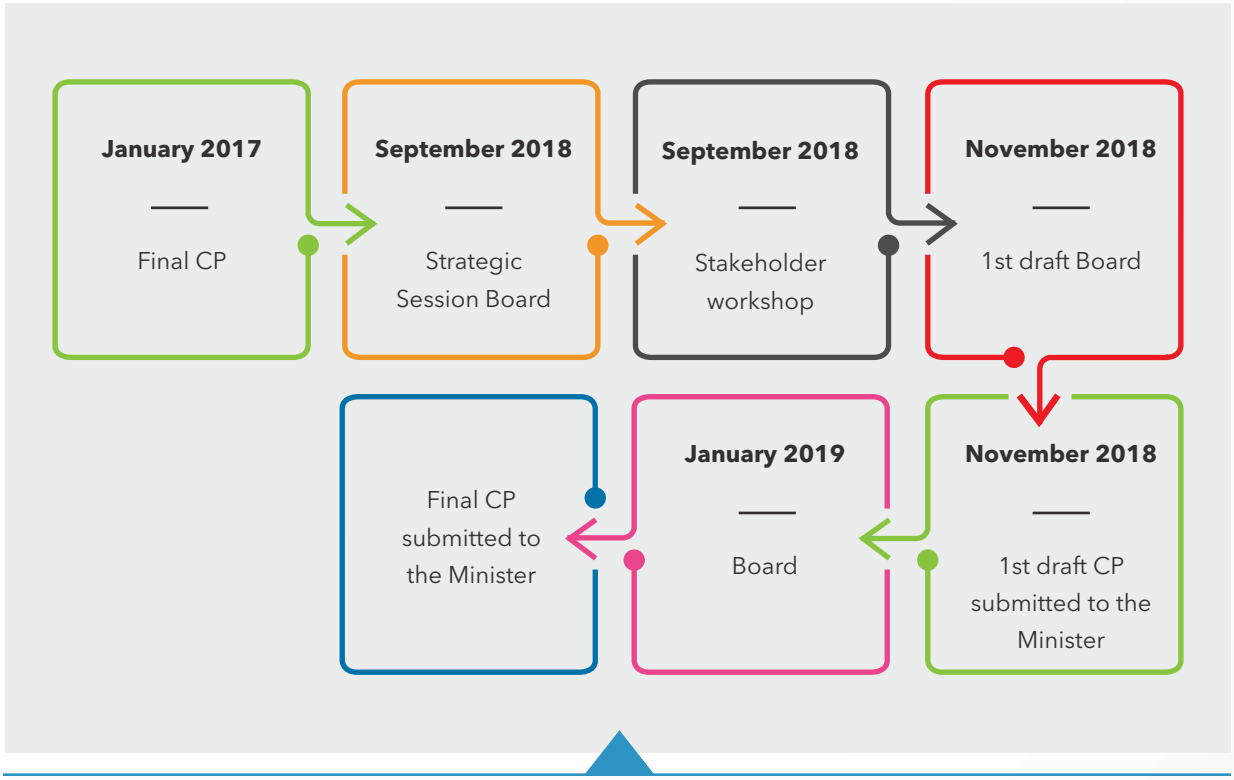



Figure 26. Corporate planning timeline

# STRATEGIC EMPHASES

*Within the Government Outcomes and the WRC Knowledge Tree goals, the next 5 years will place special emphasis on a series of elements that aim to further strengthen the WRC's impact.*

*These elements cut across the various units of the WRC and include the following key emphases (Fig. 27).*

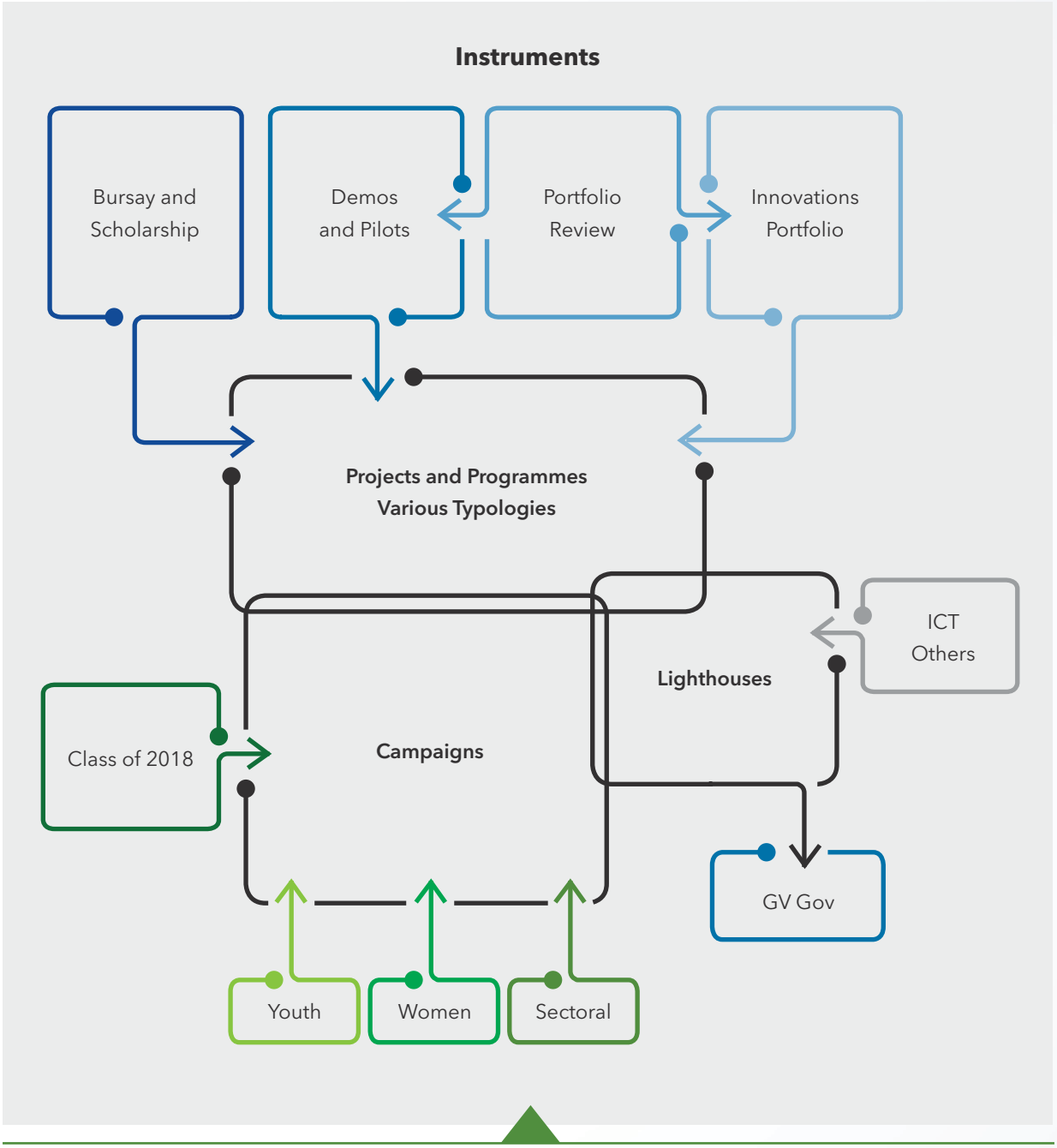



Figure 27. Key strategic instruments and elements

# 6. RESEARCH AND DEVELOPMENT

## 6.1 INTRODUCTION

The Research and Development (R&D) branch offers new knowledge in water and sanitation through research and development projects. The knowledge generated results in new or refined technologies and innovations which the WRC provides to the water sector to address specific needs and challenges. The branch is actively involved in human and institutional capacity development using research and development projects, research products and services. It supports other branches in the WRC with knowledge, innovations and technologies that enable them to fulfil their functions, for instance, I&I and Corporate Services (Corporate Social Responsibility) get R&D support when they embark on knowledge dissemination and transfer, screening and evaluation of new technologies, negotiation of new water business development initiatives, assisting schools and needy communities, etc. The R&D branch has three key strategic areas (or departments), which are Water Resources and Ecosystems, Water Use and Wastewater Management, and Water Utilisation in Agriculture (Fig. 28).

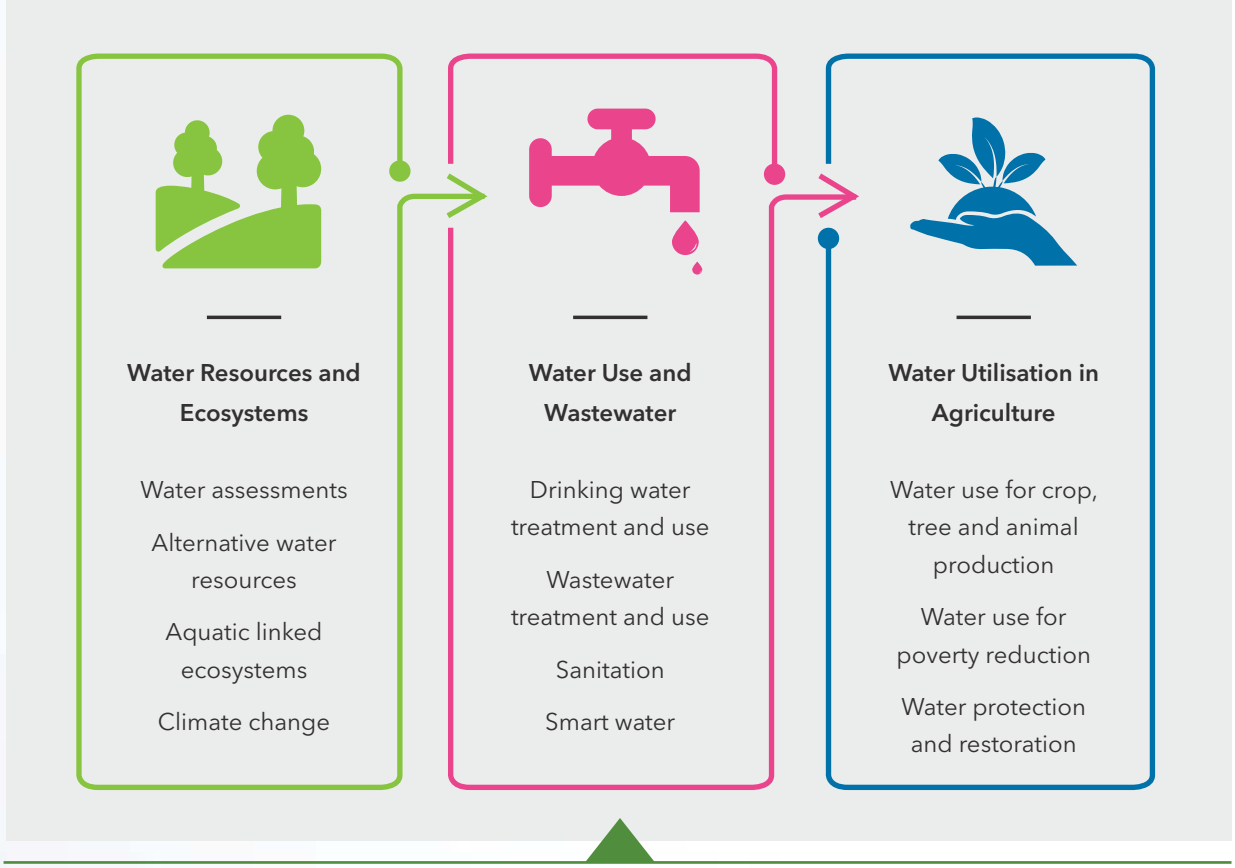



Figure 28. The three key strategic areas in the Research and Development branch of the WRC

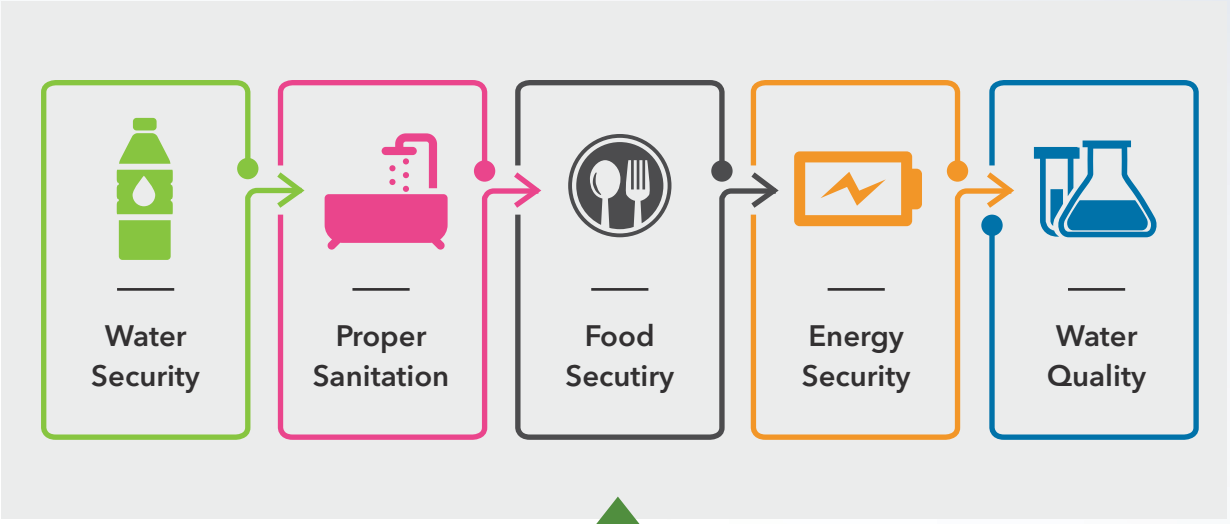



Figure 29. Identified critical water and sanitation challenges through stakeholder consultation process

*The Research and Development (R&D) branch offers new knowledge in water and sanitation through research and development projects. The knowledge generated results in new or refined technologies and innovations which the WRC provides to the water sector to address specific needs and challenges.*

## 6.2 SCOPE

The R&D branch in the WRC has considered both the macro- and micro-environment in developing the plan for 2019/20–2023/24. The R&D portfolio has to address both the challenges and opportunities relating to water and sanitation (W&S). Some of the challenges are global in nature, whereas the majority can be viewed in a local context. Water scarcity or security has been identified as a major risk in attaining sustainable economic growth and development. It is for this reason that the attainability of most of the UN Sustainable Development Goals (SDGs) depends on the availability of sufficient water. In a water-scarce region such as ours (SADC), where countries share water resources and cultures, water scarcity threatens socio-economic development and environmental sustainability. The WRC will continue to support and encourage new research initiatives which adequately address these challenges and associated risks. Socio-economic challenges have been given a special focus from the previous funding cycle and this emphasis will continue in this cycle. As we embark on consolidating our strategy, evaluation and refining of our existing structures and instruments will be important to enable the WRC and the water sector to thrive in these challenging times. The R&D portfolios will continue to develop products and services geared to overcome the 'cubed' challenge (poverty, inequality, and unemployment). The branch will put emphasis on ensuring that knowledge solutions support growth (economic and social), the competitiveness of water-related industries and thus enterprises, and the continuous development of current and future water knowledge workers (especially researchers and students).

In addition, more emphasis will be directed, through R&D projects and other activities, toward influencing water-related behaviour and approaches to water use and management. In addition, the R&D portfolio will address critical aspects about proper sanitation, food security, water quality, and energy challenges (Fig. 29). Addressing these aspects (challenges) will enable the WRC to develop disrupting innovations needed to support and grow the W&S sector. For instance, the WRC is already championing the sanitation evolution nationally and global, especially with regard to the development of novel but appropriate sanitation innovations for Africa and for schools. The exploration and implementation by the WRC and its partners of nature-based solutions for water and sanitation are at advanced stages. The WRC continues to support the development of technologies and knowledge that improve and protect water quality. The WRC will continue to generate knowledge that influences society and decision makers to be wise water resource users, while at the same time improving understanding of available innovation and the complexities of water management. The R&D Branch will pursue the generation and development of knowledge and tools to enable the water and sanitation sector to overcome inefficiencies in the use of water resources, and promote those practices and technologies that will result in high water security or high availability and access to clean water. To attain the above, the R&D Branch has begun to look at its research and development portfolios, with the intention to align them to what the WRC intends to achieve by 2035 and beyond. The competitiveness of the aspired products and services in relation to their value or relevance to the water and related sectors will be given special attention when selecting and allocating resources to projects/portfolios. The Knowledge Tree and the Lighthouses provide guidance on critical areas to focus on in addressing the cubed challenges. Figure 8 shows the possibilities we have to advance the organisation's strategic objectives, using budgetary allocations to promote a paradigm shift in research and development (from a big 'R' and small 'd' to small 'r' and big 'D').

The Branch will ensure that all innovative ideas are given a chance to be developed, explored scientifically, and tested. This will be made possible by ensuring that the R&D branch work closely with Innovation & Impact (I&I) and other branches in the WRC. All four P's in the WRC corporate strategy will be implemented in the operations and practices of our branch. The branch will continue to seek more relevant partnerships, addressing people's needs and ensuring that the WRC is properly positioned to fulfil its mandate.

## 6.3 PRIORITIES FOR R&D

The R&D branch will continue to focus on consolidation of the corporate strategy. This will include paying special attention to and promoting knowledge and innovation production in five identified main priority areas (see Fig. 30): supporting the Implementation of the Water Research, Development and Innovation (RDI) Roadmap; improving operation and maintenance in the sector, supporting efforts to develop and expand the water industries (family); ensuring the WRC is well positioned as a global water-and-science leader; and to support our country and Africa to achieve the water-related SDGs.

*The WRC continues to support the development of technologies and knowledge that improve and protect water quality. The WRC will continue to generate knowledge that influences society and decision makers to be wise water resource users, while at the same time improving understanding of available innovation and the complexities of water management.*

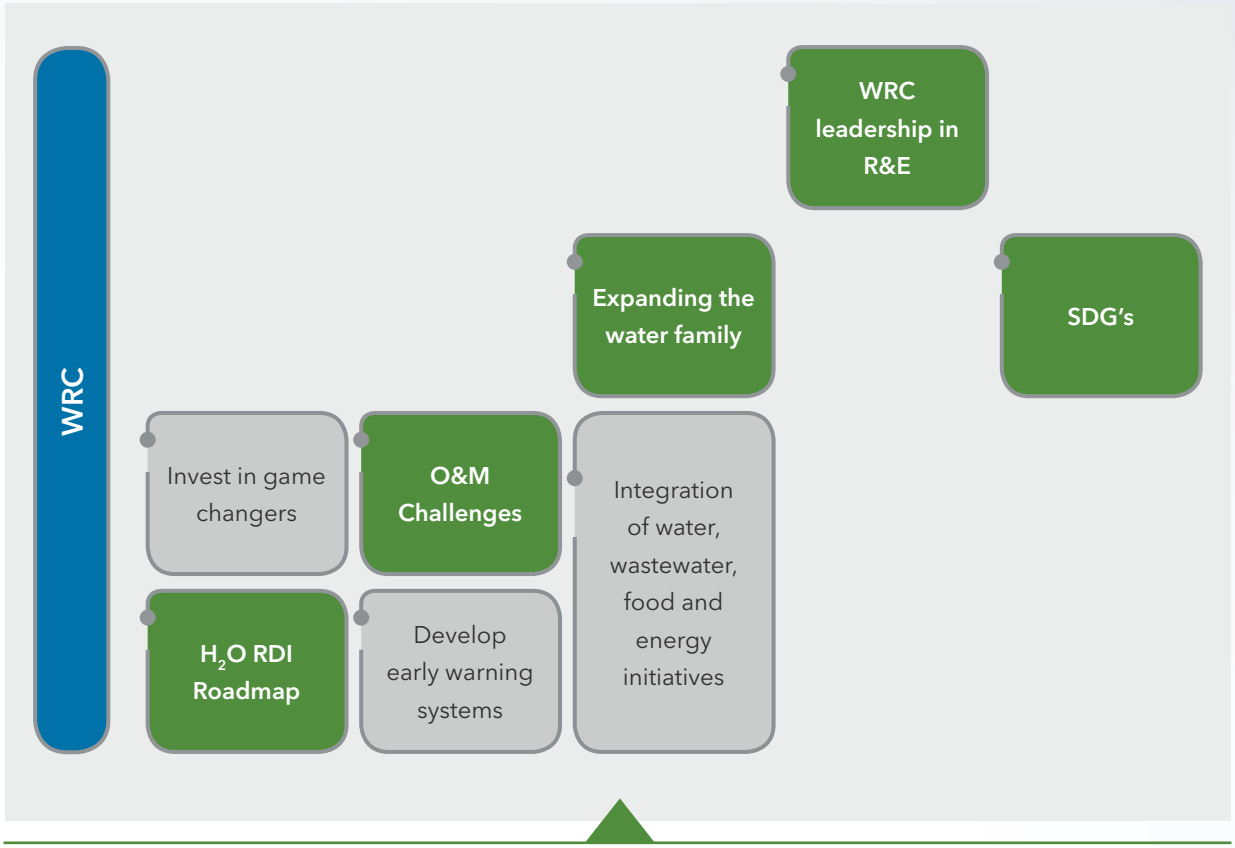



Figure 30. New priority areas to be focused on by the R&D branch

## Implementation of the Water Research, Development and Innovation (RDI) Roadmap

The Water RDI Roadmap is a programme initiated by DST. The WRC was appointed by DST to develop the programme on the Department's behalf. The RDI Roadmap has been endorsed by the Science and Technology Parliamentary Portfolio Committee and has been adopted by DWS and included in the R&D chapter of the NWRS-2. The WRC, like all other institutions in the water and science sectors, regards the Water RDI Roadmap as an important project to be supported through the initiatives of the WRC. The R&D portfolio will address all seven key areas identified in the Roadmap. These include all issues relating to water supply, such as: increase ability to make use of more sources of water, including alternatives; improve governance, planning and management of supply and delivery; improve adequacy and performance of supply infrastructure; and run water as a financially sustainable 'business' by improving operational performance. Regarding water demand, the RDI Roadmap identifies the following to be pertinent to South Africa: improve governance, planning, and management of demand and use; reduce losses and increase efficiency of productive use; and improve performance of pricing, monitoring, billing, metering and collection. The Water RDI Roadmap will be implemented or supported in the WRC in consideration of other identified critical areas such as prioritizing investment in the 'game-changers'; and developing and improving our early warning systems. There is a suite of Lighthouses that will effectively address the Water RDI Roadmap. In addition, the WRC has identified additional Lighthouses to ensure research concentration on issues that relate to people or society, i.e., Water Behaviour, Water and Big Data, Water ICT, and Water Scarcity and Extreme Weather Events. These Lighthouses and others are described in detail in the previous sections. The Water RDI Roadmap guides the water sector and others to address the entire water value chain, as shown in Fig. 31.

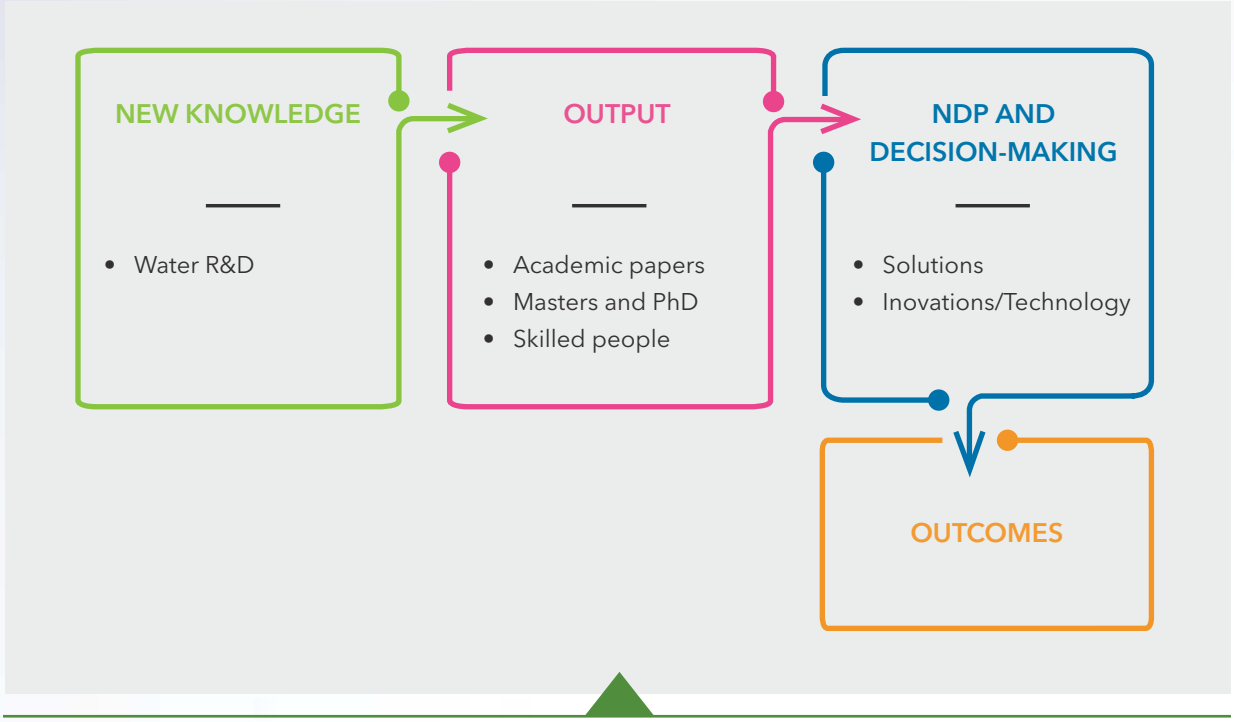



Figure 31. Water RDI and its contribution in the entire water value chain

### Improving operation and maintenance in the sector

WRC-funded projects will need to address identified operation and maintenance (O&M) challenges in the water sector. The R&D outputs of the WRC are aimed to inform policy, empower decision makers with credible world-class knowledge, and support training of water service providers/workers so that O&M challenges can be resolved resulting in all systems running efficiently and optimally. This will be advanced, among others, by producing tools and guidelines for use by practitioners and also materials that can be used for training. The WRC will continue to partner with other national and international agencies to start and implement R&D initiatives which address identified O&M challenges.

### Expand the water industries (family)

The WRC will continue to invest in and promote identified or developed 'game-changers' in the water and sanitation sector to promote sustainable socio-economic growth and development. The R&D Branch has a unique role of ensuring the production of new knowledge and innovation required to advance this cause. New knowledge, tools and innovation will enable the establishment of new enterprises in the water and associated sectors. New knowledge and more water enterprises will assist in addressing the cubed challenge (poverty, unemployment, and inequality).

### Global water-and-science leadership

It is the desire of the WRC to be a global water node and a national/regional water hub. This requires us to be positioned appropriately in the local water sector and in the global arena in water science and technology development. While the WRC is already a key global and regional player on water, CP17 emphasises the commitment of the R&D branch to implementation of the four P's (people, partnership,

paradigm shift, positioning) as strategic tactics to advance its leadership in water and sanitation. The R&D Branch will continue to identify and support research, development and innovation that can be uniquely identified with the WRC. The WRC is well positioned to lead in areas or matters that are unique to South Africa, Africa, and the developing world. We have shown this kind of leadership in the past by leading the world in research such as cloud seeding and fog harvesting, alternative sanitation, desalination, environmental flows or water requirements, irrigation water saving, and many others.

## Achieving the water and sanitation-related

Sustainable Development Goals (SDGs)

The WRC will support the Government and Africa's initiatives geared towards achieving SDGs, especially those that relate to water, sanitation, and ecosystems. The WRC will continue to initiate relevant projects to address identified knowledge or innovation gaps in water and sanitation. More effort will be made to integrate initiatives about water, wastewater, sludge, food and energy research, to attain sustainable gains or benefits addressing SDGs as shown in Fig. 32. The R&D Branch will work with I&I and DWS to ensure that available tools and materials are distributed and used by all relevant stakeholders to resolve water, sanitation, food, energy, and other environmental challenges in South Africa and Africa.

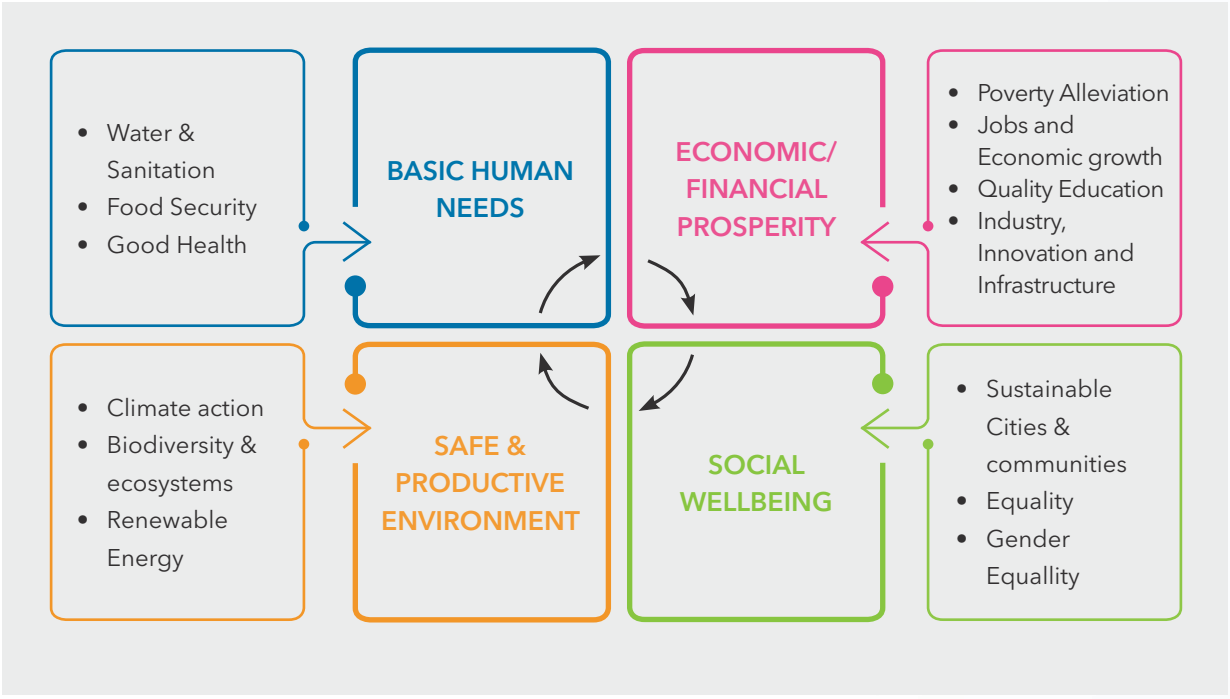



Figure 32. Conceptual model showing linkages between the SDGs and people's livelihoods

# 7. KEY STRATEGIC AREA (KSA) STRATEGIC OBJECTIVES

## 7.1 WATER RESOURCES AND ECOSYSTEMS

### Scope

The Water Resources and Ecosystems group continues to provide knowledge, experience and innovations to meet society's demands for natural resources, environmental and human health and resilience to extreme events. Attention is given to national, global and water sector related plans, roadmaps and goals. Inter- and intra-branch coordination and collaboration is encouraged to improve return on investment and to increase uptake of research and development outputs. The portfolio consists of projects and activities that will stretch the KSA further across the research, development and innovation value chain. Innovation is a key growth driver in the form of new and improved products, processes and services, underpinned by a strong science and technology foundation. Water resources include watercourses, surface water, estuaries and aquifers and, together with the related ecosystems, are best managed based on a hydro(geo)logical boundary, while considering administrative boundaries. Integrated water resource and ecosystem management calls for an improved understanding and quantitative description of the interactions between the different components of the hydrological cycle (atmosphere, surface and subsurface), linked ecosystems and society. Water Resources and Ecosystems will focus on hydrological and ecosystem processes, management, and protection, through social, institutional, economic and technological interventions at the appropriate scales. Benefit derivation from our water resources and ecosystems will enable meeting a variety of outcomes, such as the WRC's Knowledge Tree and Government Outcomes, for the benefit of society, the economy and the environment. The discipline-specific approach to solving water challenges is important but on its own cannot address current environmental problems and complexities. A coordinated approach that links various disciplines is important and achievable through the formation of strategic partnerships, positioning and coordination. Product and process innovation are encouraged within the new KSA. Innovative and empowered institutional arrangements and responses will ensure the implementation of resilient coping, adaptation and mitigation measures. The use and development of water resource technologies will be encouraged to ensure cost-effective and reliable data and information collection, processing, storing and modelling of these systems. Technologies that will enable in-situ water quality remediation and treatment will also form part of the research portfolio. Transdisciplinary communities of practices will be strengthened through Lighthouses and specific areas that requires attention to ensure awareness and policy uptake.

### Strategic objectives

The strategic objectives (Table 6) have embedded in them all of the elements of the WRC's Knowledge Tree and at the same time aim to enhance the development focus to ensure higher resource security and improve livelihoods in and around water and related systems. Fostering research and implementation partnerships at all levels will ensure that we create not only a robust science system but also a customer base for our research, development

*The Water Resources and Ecosystems group continues to provide knowledge, experience and innovations to meet society's demands for natural resources, environmental and human health and resilience to extreme events. Attention is given to national, global and water sector related plans, roadmaps and goals.*

and innovation outputs. High-impact, outcomes-based projects will form the basis of the portfolio while funding R&D projects that are complementary to existing products and solutions for maximum impact. Solutions exchange will be encouraged through a complementarity model as well as through process improvements with relevant stakeholders. The portfolio of projects will continue to build capacity at all levels and ensure that this capacity is maintained in the sector and beyond. In order to improve water security, a competent portfolio that will diversify South Africa's water supply mix and develop processes and technologies that will enhance and embed resilience in water resource and ecosystem use and protection will be built.

Table 6. Alignment with Government Outcomes and NDP objectives

| STRATEGIC OBJECTIVE | DESCRIPTION OF STRATEGIC OBJECTIVE |
|---|---|
| To establish better governance models aimed at facilitating equitable, productive and sustainable use of water resources and ecosystem goods and services | Typical areas related to water management reforms and the related governance aspects that will be covered include: governance at the national level, water sector legal frameworks and broader institutional arrangements, transparency and accountability, civil society participation and the equitable provision of access and services. The sustainability of installed schemes ultimately depends on how we operate and manage these schemes or interventions. Governance is a crosscutting issue within the water sector but also needs strengthening across the energy, agricultural and mining sectors to ensure sustainability as well as integrating the activities of departments responsible for water (DWS, CoGTA, DAFF). |
| To improve our understanding of hydrological and ecosystem processes that will enable efficient management and decision-making | This Thrust focuses on developing a scientific understanding of the hydrological cycle and inter-linkages in order to promote systematic water assessment and planning. Sound water resource assessment and planning can only be achieved with reasonably accurate and consistently recorded and processed data and information. |

| STRATEGIC OBJECTIVE | DESCRIPTION OF STRATEGIC OBJECTIVE |
|---|---|
| To improve environmental and climate change resilience and disaster and risk mitigation through improved understanding of the atmospheric, water, land and people interactions | The Thrust will address research to improve our understanding of the connectivity between land, water, atmosphere and people. Any change induced to the environment through natural and anthropogenic means may have an impact on the biophysical and socio-economic environment, ultimately affecting resource use, and should be assessed to be able to quantify the risks, determine response and adaptive strategies while implementing IWRM. The Thrust will also focus on movement of people (migration), changing land use and response of aquatic ecosystems to these population dynamics. |
| Converting natural assets into societal, economic and environmental benefits whilst maintaining healthy trade-offs | This Thrust is focused on research, innovation and development which specifically address tested sustainable management tools necessary in natural systems decision-making, and guide sustainable utilisation of these systems for the provision of the benefits that people depend on. Central to this is the need to manage the social and economic requirements of society from natural ecosystems and the implementation of policy and legislation. Outputs from research should contribute to improving the lives of people while also contributing to improving the condition of water resources and the environment at large. |
| To provide innovative solutions for water and ecosystem degradation and depletion and its impact on public health | This Thrust will focus on research on water resources (rivers, dams, groundwater) and their quality in terms of chemical, biological and ecological health as well as flow and how it links to or affects quality. The health/quality of these resources have an effect on water users (domestic, recreation, ecological, traditional, religious, industrial, mining and raw water abstraction) and similarly the users have an impact on the resources. There is a need to focus on research and development as well as innovative tools for monitoring, modelling, and the prediction and early warning of impacts. |
| To provide applicable and marketable technological solutions that will enable improved management of water and land resources | Use of electronics, earth observations, early warnings, numerical models, remediation technologies, sampling and analysis technologies, as well as innovations critical in water resource protection will form a key component of this Thrust. |

## Portfolio analysis

The portfolio will build on a rich research and development foundation that will draw from WRC and other research organisations' outputs. Key milestones have been the development of planning and governance tools for the sustainable management of water resources. There has been a steady decline in hydrological and related observed data, and issues with the acquisition of long-term weather and climatic data. This is a key risk for the country in general and the water sector in particular. Water resource management and decision-making relies on up-to-date and spatio-temporally significant datasets. The WRC is developing an innovation strategy to revive and enhance data and information collection (monitoring), management and usage. The development of robust remote-sensing techniques and numerical models to assist decision-making with sparse datasets over larger areas will continue to be a strategic focus. The broadening of tools to enhance citizen-based science – developing a multi-parameter database with online visualisation tools will assist communities and regulators to understand and manage their water resources better. Adaptation and coping mechanisms associated with extreme events also need robust and up-to-date data and information to ensure adequate management of water and land resources. Engendering key partnerships in this domain is a priority.

The diversification of the country's water supply mix from traditional surface water resources and rural groundwater supply schemes remains a key strategy for implementation through innovative solutions. Coupled with demand-side solutions from this KSA and other KSAs it is possible to significantly improve our water security vulnerabilities at all scales. Environmental change, especially climate change and variability and urbanisation, is a key challenge in managing water resources and the research portfolio is building towards developing coping and adaptation strategies through the understanding of weather and climate processes and patterns as well as the concomitant impact on water, land and socio-economics. A key focus will be to develop innovative real-time early warning systems and reporting tools that will enhance prediction and intervention capabilities at all levels. This work directly supports the following Lighthouses:

- Water Scarcity and Extreme Weather Events
- Water and Big Data
- Climate Change

Water quality and water resource protection remain key challenges to sustainable water supply due to the impacts of, among others, environmental changes, rapid urbanisation and poor land-use planning. Understanding pollutant fate and behaviour remains a key focus as it allows for strategic, technological and non-technological/social interventions, to protect the environment and public health. A key area that will be strengthened is around emerging contaminants within the environment as well as guidelines to assess and characterise water quality parameters. The portfolio will also significantly contribute to the Water Quality and Health Lighthouse as well as the Water–Energy–Food Nexus Lighthouse, through the unconventional gas research headed by the WRC, for example.

Unlocking water resources and ecosystems for societal and economic benefit through enhancing the developmental focus of the portfolio will continue to be a strategic deviation from the previous ecosystem portfolio. However, key research questions will still be pursued that will ensure that water- linked ecosystems are protected and that trade-offs are sustainably managed. The development of land and water can be made profitable, productive or useful if supported by proper strategies, tools and a good understanding of the environmental limits. Through the application of green and blue economy principles, a new economic growth paradigm is envisioned that is friendly to the Earth's ecosystems while contributing to poverty alleviation over multigenerational timescales. To this extent, a Lighthouse called Green Village and Economy will be strengthened in order to prioritize and concentrate green innovations

aimed at making an impact on society and the economy through partnerships.

## 7.2 WATER USE AND WASTE MANAGEMENT

### Scope

The Water Use and Waste Management KSA focuses mainly on water usage and wastewater management in the domestic, industrial and mining sectors. It aims to proactively and effectively lead and support the advancement of technology, science, management, and policies relevant to water supply, waste and effluent management, for these sectors. This KSA also supports studies on institutional and management issues, with special emphasis on the viability and efficient functioning of water service institutions. Research on infrastructure for both water supply and sanitation is included. A further focus is on water supply and treatment technology serving the domestic (urban, rural, large and small systems) as well as the industrial/commercial and mining sectors of our economy. This KSA encompasses waste and effluent as well as reuse, recycle and recovery technologies that can support the municipal, mining and industrial sectors and improve management in these sectors with the aim of improving productivity and supporting economic growth while minimising the negative effects of economic development on human and environmental health.

The provision and supply of water of adequate quality and quantity for economic and public health purposes remain continuous challenges. Water is a finite resource and, specifically in the context of South Africa, is becoming incrementally scarce. Managing water use and the waste released to the water environment is thus of paramount importance to ensure the sustainability of the resource and the activities relying on it. Water use and waste management in South Africa is consequently a key factor for social and economic growth, as well as for our environment. The entire way we think about and use water is thus an important factor in determining our future. In recent years, the focus of the KSA has been on supporting the implementation of various pieces of legislation that impact on the provision of sustainable water services. This support was in the form of unpacking and understanding key elements within legislation and the impact on the water services sector. The result has been a bias towards developing guidelines and tools to assist new and emerging municipalities and politicians to understand their responsibilities, which also included repackaging information of a technical nature. In the process, we have maintained a balance with dealing with cutting-edge technological advances and have been concentrating on their application and commercialisation. Developing innovative processes and technologies for water purification, reuse and treatment of wastewater from domestic to industrial and mining activities has been and is of even greater importance to our country, especially in the light of problems related to the deteriorating quality of our water resources and the rising costs and reliability of energy. Considering the emerging challenges, research in the KSA will continue to focus on greater innovation and development of cutting-edge technologies to respond to the issues of poor O&M, competency and capacity constraints, reuse, energy efficiency, climate change constraints, emerging contaminants and the aspect of drinking water quality. The next 5 years will be about building better resilience, responses and earlier reactions to water security.

A key emphasis for the KSA over the next 5 years, 2019/20–2023/24, will be in accordance with the core WRC strategy to shift the attention of WRC activities and research into the domains of application/demonstration and uptake. We believe that the KSA is ideally placed to be a key feeder of innovative technologies and processes. In this regard the following key focus activities are planned:

- Initiating and ramping up the concept of ‘innovation challenges’; two of these initiatives are already in planning and execution, namely the WaterSmart Fund and Sanitation Innovation Fund

- Further integrate and enhance objectives of the WRC Lighthouses
- Increasing innovation and technology demonstration, and at places at scale; key activities which are in place in this domain include sanitation technologies, AMD, and drinking water solutions
- Supporting technology advice and guidance
- Linking innovation solutions to industrial and commercial pathways
- Increasing our attention to provide greater support towards O&M activities, which may also mean extending our processes to support training and capacity building

Through these processes and interventions, we envisage developing a more vibrant and responsive area which will be able to address both long-term research needs and short-term solution requirements. We hope to achieve the balance of this strategy through our programmes and thrusts.

### Strategic objectives

The primary objective of this KSA is to provide knowledge and innovation that ensures reliable, affordable and efficient water use and waste management services to enhance the quality of life, and contribute to economic growth and improved public health.

The secondary objectives are to:

- Improve the management of water services in both rural and urban areas
- Develop appropriate technologies for improving the quality and quantity of our water supplies for both domestic use and industrial applications
- Develop new approaches to manage and enhance hygiene and sanitation practices
- Provide appropriate, innovative and integrated solutions to water and waste management in the industrial and mining sectors
- Develop innovative technologies and applications for improved treatment of wastewater and effluent and improve processes for enabling increased reuse thereof
- Improve health, economic and environmental conditions, while supporting the development of appropriate technologies and socially-focused management practices related to water and effluent management

## 7.3 WATER UTILISATION IN AGRICULTURE

### Strategic objectives

The primary objective of this KSA is to provide knowledge and innovation that ensures reliable, affordable and efficient water use and waste management services to enhance the quality of life, and contribute to economic growth and improved public health.

The secondary objectives are to:

- Improve the management of water services in both rural and urban areas
- Develop appropriate technologies for improving the quality and quantity of our water supplies for both domestic use and industrial applications
- Develop new approaches to manage and enhance hygiene and sanitation practices
- Provide appropriate, innovative and integrated solutions to water and waste management in the industrial and mining sectors
- Develop innovative technologies and applications for improved treatment of wastewater and effluent and improve processes for enabling increased reuse thereof
- Improve health, economic and environmental conditions, while supporting the development of appropriate technologies and socially-focused management practices related to water and effluent management

The strategic objectives directing the research and development activities in the portfolio of projects

in the KSA: Water Utilisation in Agriculture are still explicitly aligned to or in support of achieving the first four SDGs for the period 2015–2030. The report by the 2016 World Economic Forum highlights that two of the most interconnected risks are profound social instability and structural unemployment. According to the 2017 Global Risks Report, environmental risks influencing water use for food production are more prominent than before. Furthermore, in the strategic context of the R&D strategy of this KSA, it is shown that the top four interconnected SDGs guide the prioritisation of research to address sustainable production and reduce poverty, unemployment and inequality. Priority attention is therefore given to investment in research and development for knowledge creation and diffusion, as well as training for knowledge application and skills development of, in particular, homestead food gardeners and smallholder farmers. The focus for research, technology exchange and implementation, to exploit the benefits of research-based knowledge generated in this KSA, is purposefully directed towards overcoming poverty, hunger and malnutrition and promoting resilience amongst members of the rural and urban population.

Within the next 5-year planning period of CP19, and in continuation of CP18, the strategic direction in this KSA will be determined by the innovation cycle to achieve application and exploitation of the available research output. For this purpose, increasing attention will be given to knowledge dissemination targeting a range of end users in agriculture. The actual impact of existing and new research output will be increased through public and private partnerships and establishing Africa-wide as well as international linkages. The strategic focus for research and development is on increasing the system of knowledge for efficient use of water for production of food, forage, fibre, and fuel crops; improving food security, reducing poverty and increasing the wealth of people dependent on water-based agriculture; and ensuring sustainable water resource use. The requirements of present and future generations of subsistence, emergent and commercial farmers are addressed through creation and application of water-efficient production technologies, practices, models and information systems within the following five interrelated sub-sectors of agriculture:

- Irrigated agriculture
- Rain-fed agriculture
- Woodlands and forestry
- Grasslands and livestock watering
- Aquaculture and fisheries

The challenge for applied research and development is contributing to finding sustainable solutions for water use in agriculture, with priority given to innovative new products which support economic development and inform decision-making for private business and public policies. In the process of undertaking these research and development projects, the composition of research team's endeavours to increase representivity of Black and female researchers. Postgraduate students are trained to improve the expertise of human capital and encourage young scientists to choose a career in water research, while on-farm and participatory action research leads to empowerment of individuals and groups in rural communities.

In execution of the WRC's mandate and functions, the strategic objectives for research on and development of Water Utilisation in Agriculture are indicated in Table 7.

Table 7. Water Utilisation in Agriculture strategic objectives

| STRATEGIC OBJECTIVE | DESCRIPTION OF STRATEGIC OBJECTIVE |
|---|---|
| To increase the biological, technical and economic efficiency and productivity of water use | The primary objective is to increase national and household food security, improve livelihoods of people and increase efficient growth as well as equitable distribution of wealth on a farming, community and national level. The major challenge is to produce more food with the same or less water. This requires empowerment and capacity building for all farmers, especially women, with knowledge and practical skills for correct investment, marketing, production and financing decisions and actions. In this process, hunger must be eradicated, poverty reduced, new small farming businesses established and existing profitable farming enterprises maintained. Over the long term, sustainable agricultural activities and employment opportunities in rural and urban areas must be achieved, which implies obtaining benefits for people who are presently using water for food production, without compromising future benefits in food value chains. |
| To reduce poverty through water-based agricultural activities | |
| To increase profitability of water-based farming systems | |
| To ensure sustainable water resource use through protection, restoration and reclamation activities | |

## Portfolio analysis

Accordingly, a holistic systems approach is followed for knowledge creation and dissemination to enable people to utilise water in a sustainable way for food production and improved livelihoods. Research and development projects are managed within the innovation cycle to ensure that scientific research is applicable, and economically and socially beneficial. Key issues being addressed are the productivity of water use for crops and livestock, poverty reduction and wealth creation in rural areas and prevention of resource degradation. These efforts are aligned to the Vision for 2030 of the National Development Plan; the outputs for Outcomes 7 and 10 in the Programme of Action announced by the Presidency; core water strategies of the NWRS-2; measures in the framework for the New Growth Path; and the National Agricultural Research and Development Strategy. Recent reports by the FAO further emphasise that food production is essential to achieve better nutrition and health for improved human and economic performance.

Research and development work will continue to fill knowledge gaps that exist in the utilisation of water in agriculture, in relation to the following key priorities of the research portfolio:

- Increasing the productivity of rainwater and irrigation water for crop and livestock production
- Uplifting rural economies through commercial food production and reducing income inequalities
- Quantifying the water footprint and identifying employment opportunities in food value chains
- Eradicating hunger and reducing poverty
- Improving food security, nutrition and health
- Generating alternative sources of renewable energy
- Preventing soil and water degradation and pollution
- Adapting farming systems to climate change

## Focus for future knowledge investment

This KSA is actively working towards achieving a balance between projects in irrigated and rain-fed agriculture, agro-forestry and aquaculture, to promote farmer involvement in poor rural communities through participatory action research, and to take research projects further toward practical application of results with technology transfer activities. In order to promote development, increasing contributions are made to implement available research-based knowledge in co-operation with partners in the public and private sectors. Building on the baseline of completed and ongoing projects, the priority themes previously approved and selected for proposal calls during 2018 for research and development projects starting in 2019/20 are as follows: Consolidation and update of existing crop factors and identification of missing crop factors into a national-scale database using existing field measurement results; water use and water relations of different types of indigenous teas (rooibos, herbal, honey bush, etc.) in winter rainfall areas; ultra-violet treatment of irrigation water at farm level to reduce contamination for improved food safety; the use of national-scale remotely sensed evapo-transpiration estimates to quantify water use and differences between plantations in commercial forestry regions of South Africa; investigation into the factors influencing under-utilisation of existing smallholder irrigation schemes and opportunities for improved future operation as a base for sustainable livelihoods; review and develop guidelines for operating, maintaining and utilising water in small dams on farms in communal areas with macro rainwater harvesting for agricultural production with special attention to drought mitigation; water–energy–food nexus as a sustainable approach for advancing food and nutrition security and achieving SDGs 2, 6 and 7 with specific attention to efficient energy use for food production; use of drone technology for monitoring the state of crops to improve water use productivity with precision agriculture and improved irrigation scheduling; scoping study regarding technical and financial feasibility of alternative renewable energy sources (solar and wind) for irrigation; the state of irrigation water losses and measures for improving efficiency of operating and saving water on selected schemes; assessment of the impact and control of aquatic weeds and sustainable use of irrigation canals and storage dams; assessment and compilation of strategies, technologies and practices for coping with significant drought in specific production areas and agro-climatic zones; and assessment of the cumulative impact on quality and quantity of water resources of large-scale herbicide application for reducing bush encroachment in rangeland areas.

A stakeholder consultation workshop was held on 18 July 2018 and the following themes were identified as needs and prioritised for proposals of research and development projects starting from 2020/21. It should be noted that for the first three themes, no relevant proposals were received in the 2018 call, therefore these themes will again be included in the 2019 call: Assessment of impact of aquatic weeds and review of control measures and guidance for sustainable use of irrigation canals and dams; assessment of the cumulative impact on quality and quantity of water resources of large scale herbicide application for reducing bush encroachment in rangeland areas; review and develop guidelines for operating, maintaining, utilising water in small dams on farms and in communal areas with macro rainwater harvesting for agricultural production with special attention to drought mitigation. Further themes identified as needs and prioritised by stakeholders are the following: guidance for rainwater harvesting from rooftops and storage for domestic, household, livestock and/or garden use and impact of water quality on human and environmental health; technology exchange and training on hydroponics and vertical farming in closed environments with recycling of water; evaluating different techniques (e.g. canopy size reduction, deficit irrigation and partial root zone drying) for reducing citrus water use during drought periods and recovery time to optimal yields; investigating the conjunctive use and management of surface and ground water

for irrigation; water use of indigenous root and tuber food crops; determine water use of selected fruit tree crops at industry/national level within relevant food value chain; the use of machine learning to increase the benefits of remote-sensing products such as Fruitlook (e.g. evapotranspiration partitioning and biomass) datasets; studies to assess and reduce the water footprint of livestock in feedlots and planted pasture systems; assess and understand barriers for improving implementation of water-efficient irrigation technologies by small-scale farmers; determine the impact of over-abstraction of aquifers through pumping and/or afforestation on crop cultivation and livestock grazing and watering as well as domestic water use within groundwater-dependent ecosystems; promotion of rain-fed crops and associated best management practices through efficient water-use for food production to supplement irrigated crops; strategy to unlock investment in agro-ecological infrastructure and/or natural resource management in agriculture and mapping of areas where water can be released through change in land use; utilising the water–energy–food (WEF) nexus as a framework for catchment-based assessments and identifying policy recommendations to improve resilience within selected water management areas; review and develop guidelines for operating, maintaining and utilising surface and groundwater for dipping tanks to protect water quality for downstream users; scoping study on the use of bio-drainage as an alternative to conventional drainage; assessing and understanding the potential of social media in disseminating information for improved water use efficiency in agriculture; application of big data to improve agricultural water management: Phase 1 – collating multiple data sets and Phase 2 – interpreting data and application of information; evaluation of the use of pesticides (insecticides and herbicides) for sustainable production and improved water use efficiency of grain legumes in rain-fed agriculture; and finally the investigation into the entrepreneurial risk associated with quality and security of water supplied to urban-based farming and agro-processing enterprises.

The output of most of these projects will mainly contribute to the WRC Lighthouses on the Water–Energy–Food Nexus, Water Quality and Health, Water ICT, Water Scarcity and Extreme Weather Events, and Sustainable Water Behaviours.

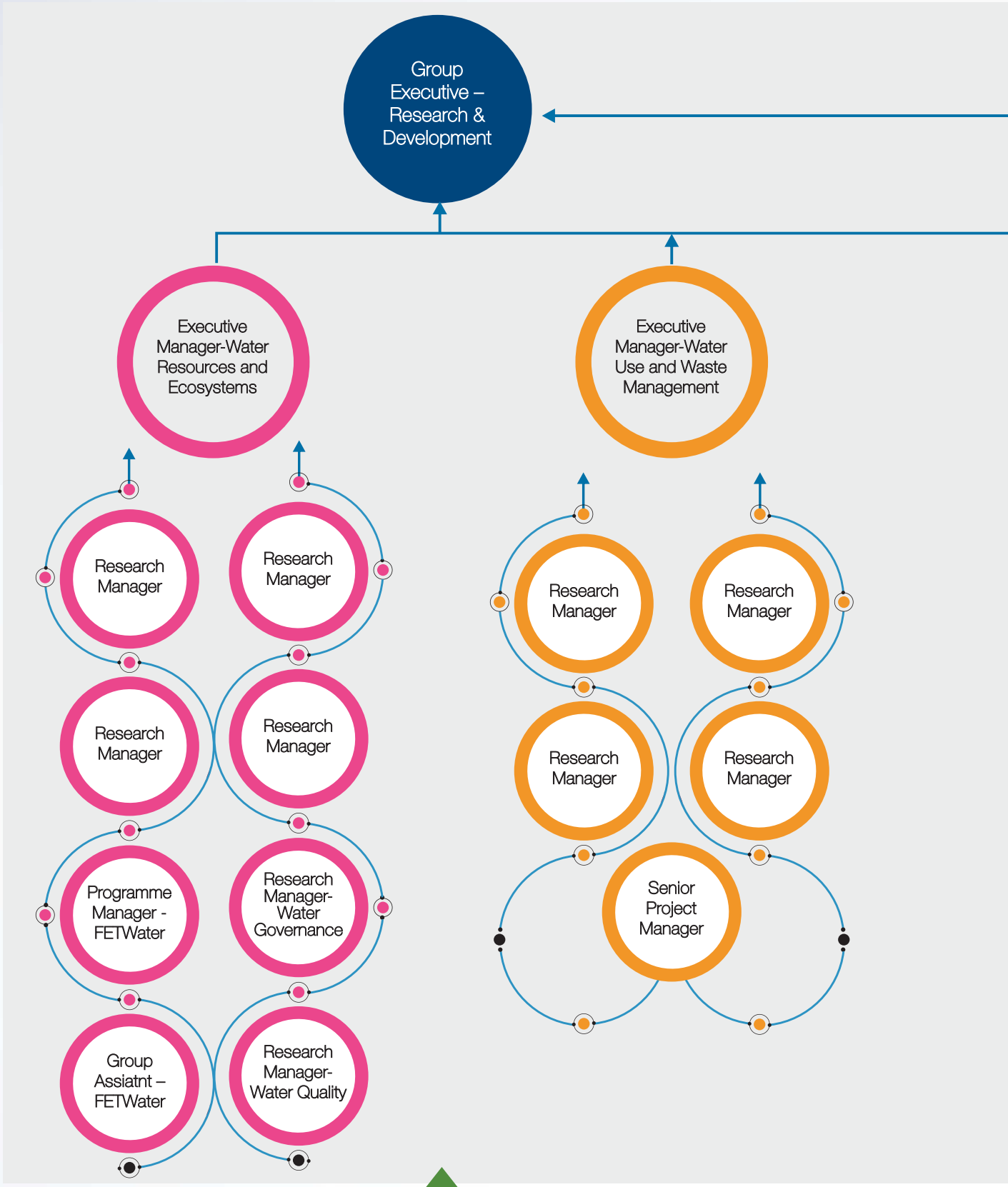
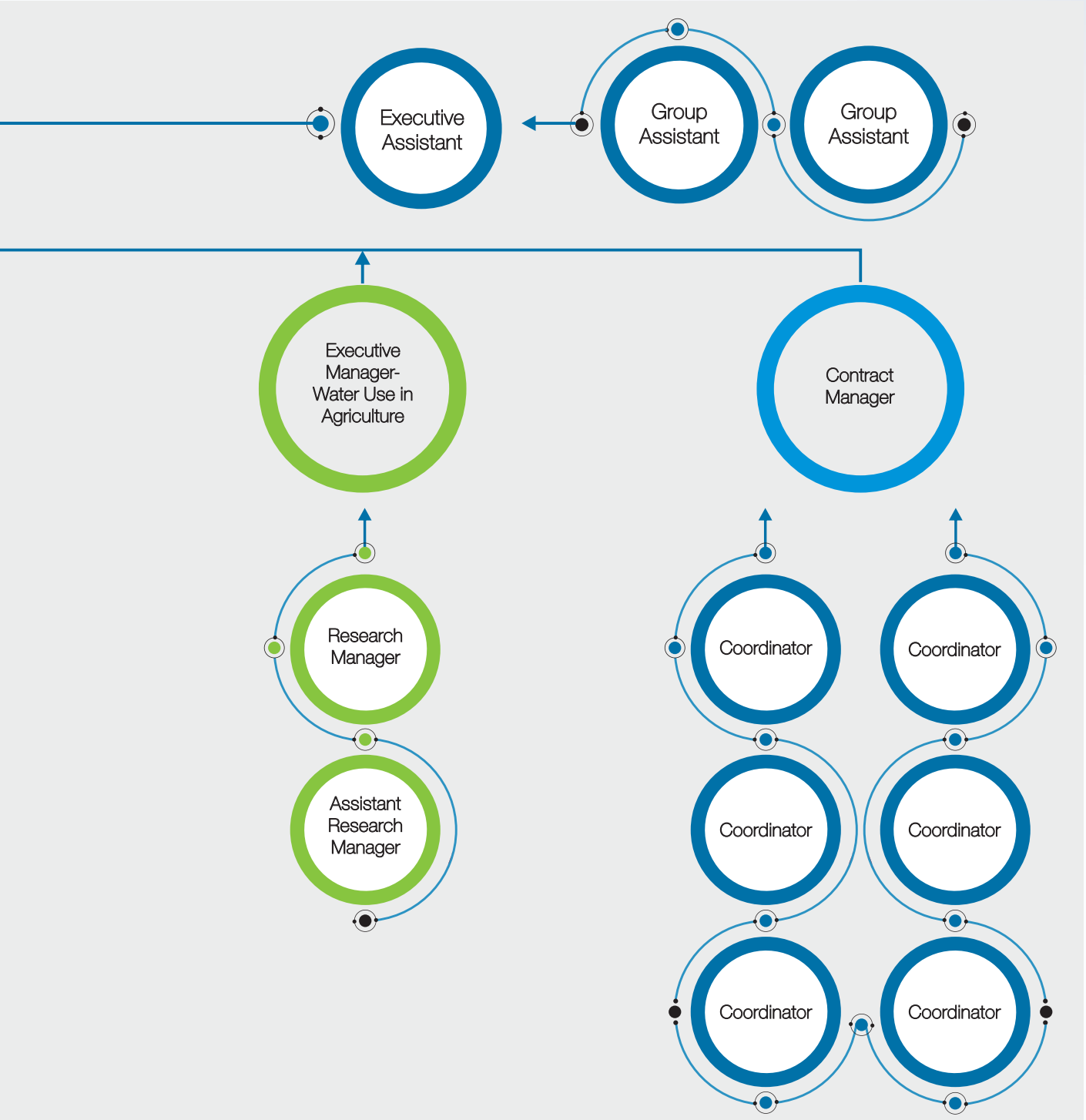



Figure 33. Research and Development Branch structure


Executive Assistant
Group Assistant
Group Assistant
Executive Manager- Water Use in Agriculture
Contract Manager
Research Manager
Assistant Research Manager
Coordinator
Coordinator
Coordinator
Coordinator
Coordinator
Coordinator

# 8. INNOVATION AND IMPACT

## 8.1 INTRODUCTION

The complexity of water challenges facing the nation mean that the water sector needs game changers and needs them urgently. Growth in population and the economy, along with urbanization and land-use changes, are threatening both water quality and the ability to meet water demand. Looking to the future, climate change is expected to further stress water systems in large parts of the country. Water infrastructure, by some measures the oldest and most fragile part of the country's built environment, has decayed. Current conversations around water challenges are painting a challenging picture for the future of water. Therefore, there is need to focus more on generating innovative solutions and to be able to urgently take those solutions to application.

Solutions to the country's growing water challenges lie, in part, with the development and adoption of new innovative technologies, and development of new products and services leading to the creation of new industries. But current investment in water innovation is extremely low, especially investment by the astute promoters of innovation – such as venture capital and corporate research and development. This low investment may explain the low levels of innovative output, as measured by patent filings and adoption and dissemination of new innovations.

The recent and current extreme weather conditions have further demonstrated to us that unless we take innovations to application, we shall continue to be challenged.

The Innovation and Impact Branch of the WRC, is geared to address the above issues, focusing on the following (Fig. 34):

- The positioning the WRC as a premier knowledge hub, leading the sector in terms of disseminating appropriately packaged knowledge products including multimedia and interactive solutions; taking things further we will embark on integrating knowledge generated by other bodies, making available and accessible credible water data and information, hence improving the general uptake and use of water management knowledge by the relevant sectors of the population.
- Inspiring water conversations, ensuring that water and water-related knowledge permeates though all sectors of our population leading to better understanding of water management issues and hence behavioural changes; positioning the WRC and its personnel as the credible water conversation leader in all media channels
- Creating a robust and vibrant innovation ecosystem that allows the WRC to play a lead and co-ordinating role with strategic sector partners in accelerating technologies to the market
- Creating an environment whereby professionals and non-professionals can contribute and channel their knowledge and innovative skills to solving water problems from a multidisciplinary point of view
- Drawing various stakeholders to engage in water conversations and tell their water stories

## Organising for maximum impact

Research impact has traditionally been defined at the WRC as 'the demonstrable contribution that excellent research makes to society and the economy'. Research impact encompasses all the ways that research-related products and skills benefit individuals, organisations and nations. These include: improved global economic performance (and specifically the economic competitiveness of South Africa), increasing the effectiveness of public service delivery and policy, and enhancing quality of life and public health. A defining characteristic of impact is that it must be demonstrable. It is not enough just to focus on activities and outputs that promote research impact, such as organising a conference or publishing a report. We must be able to provide evidence of research impact, for example, that it has been taken up and used by policy makers and practitioners and has led to improvements in service delivery or practice. Above all, research must be of the highest quality: we cannot have impact without excellence.

The primary reason for the renewed focus on achieving impact is that, as a public entity, we form part of a government that strives to improve the lives of its citizens. As such, we have a role to play in achieving national government objectives. Additionally, we are increasing our emphasis on the need for evidence of economic and social returns from our investment in research and development. Demonstrable impact helps to verify that research is important – that it is worth investing in and applying. Evaluating our impact also enables us to see what works and why. These lessons can then be implemented both by the WRC and our stakeholders.

High-quality research has the potential to enhance social and economic wellbeing across all sections of society. To maximise the impact of our research, we need to continue with engagement of our key user groups. This provides substantial benefits to the quality of our own research and development, including:

- **Feedback** to help shape our research agenda and improve methodologies
- **Relevance**, ensuring our research is meaningful, timely and useful
- **Human capacity development**, recruiting participants, for example, for Reference Groups or surveys
- **Recognition**, developing new skills and raising our profile

Our continued efforts aimed at achieving maximum research impact include socio-economic impact, academic impact, or both. Socio-economic impact is the demonstrable contribution that excellent research makes to society and the economy, of benefit to individuals, organisations and the nation. Academic impact is the contribution that excellent research makes to advances across and within disciplines, including significant advances and meaningful contribution to the water and water-related knowledge pool. The impact of research can be instrumental, (i.e. influencing the development of policy, practice or service provision, shaping legislation, altering behaviour, etc.) or conceptual (contributing to the understanding of policy issues, reframing debates, etc.).

To achieve our goals for maximum impact in the next 5 years, we will continue to:

- Identify and work with key partners and stakeholders, for example, other researchers, public sector and business/industry
- Identify how they will benefit from our research – types of impact might include: improving social welfare and/or public services, influencing policy, contributing to industrial competitiveness
- Position ourselves to ensure that we all can benefit, for example, through organising public events, conferences, interaction with the media, sharing of intellectual property
- Create platforms designed to receive stakeholder ideas, concerns and needs, that can reshape our research questions and continue to improve our offering


Figure 34. Rethinking Impact

## Knowledge dissemination

The dissemination of research findings is defined here simply as the process of sharing information and knowledge. Knowledge dissemination should address the challenge of improving accessibility of research findings to those we are trying to reach and ensure the physical availability of research output materials to a larger proportion of our target audience. Research dissemination should also seek to make research findings comprehensible to those who receive them. At the WRC, dissemination of research findings continues to be focused as follows:

- Highly prioritized and treated as essential

means of maximising the impact of research on development
- As an intrinsic element of all good research practice, especially in the water discipline
- As an enabler for content flow from where it has been generated to where it can be effectively applied
- As providing value to research projects, increasing their visibility and hence the potential for wider application
- As promoting the public profile of the WRC whilst strengthening its research profile

## Towards a premier knowledge hub

The conventional model that the WRC has been applying for quite some time is the linear knowledge transfer model. This model adopts the approach where information is seen to flow from the information provider, via a chosen media (publications and reports), to the information user. This model assumes that the dissemination is a one-way, top-down flow of information from research experts to a passive audience. Recent developments at the WRC have demonstrated that information flow is a far more complex process – it is an interactive, multidirectional exchange of knowledge and ideas and that should be reflected in the research dissemination approaches promoted in this strategy. The WRC continues to strive to develop and enhance its knowledge dissemination expertise and activities to deliver value effectively in these complex spaces.

## Maximising impact through inspiring water conversations

Advancing and inspiring water conversations within the water sector in South Africa defines the strategic approach of the WRC, building upon the insights, results and examples gleaned from research and development. This approach also builds upon the attributes of interpersonal conversation: intimacy, interactivity, inclusion, and intentionality and indicates a slight departure from traditional water sector engagements.

Critical elements of sector conversations include the following: exchange of comments and questions between a group of people which results in open and fluid exchange of knowledge (such as dialogues), as compared to seemingly closed and directive exchange. For decades now, organisations used to achieve scale and efficiency mainly through print and broadcast, in particular – operated in one direction only. But new channels have disrupted that one-way structure. Social technology gives sector leaders the means to foster a genuinely interactive culture – values, norms, and behaviours that create a welcoming space for dialogue.

The other attribute is inclusion. At best, sector conversation enables participants to share ownership of the substance of their discussion. Consequently, they can put their own ideas – and, indeed, their hearts and souls – into the conversational arena, and this is critical for the water sector.

Such an approach would also promote brand ambassadors and thought leaders within the sector. For the WRC to develop and promote thought leadership and storytelling is a smart and quick way to bolster the WRC's reputation and relevance.

## Fast-tracking water innovations to application

The goal of the South African water sector is to provide the public with reliable and safe water supplies and to dispose of wastewater safely and in compliance with national water quality regulations. However, several challenges have rendered the achievement of this goal rather difficult. On the other hand, this has opened opportunities for a variety of new technologies. The country is taking great strides in shifting focus from supply enhancement to demand management. Current practice has demonstrated that innovative

technologies, coupled with incentives and education, can greatly reduce water use. As a result, there is increasing interest in technologies that are more water efficient and in technologies that can help encourage greater conservation among consumers. These innovative technologies will generally fall under the following categories:

- **Supply enhancement:** A need to focus on technologies that are more drought resistant, such as water reclamation, water desalination, and technologies that allow localized resource enhancement such as rainwater harvesting, fog harvesting, etc.
- **Demand management:** Focus on technologies that encourage or enable water use efficiency (achieving the same with less water) and reducing water consumptive activities, decrease the costs and pollution associated with wastewater disposal, water-smart irrigation, technologies that encourage behavioural change, etc.
- **Governance improvement:** Technologies that will help tackle inefficiencies in the water governance system, such as smart metering, leak management, and better understanding of customer behaviour.

The innovative technologies may be classified as follows:

- **Technologies to explore alternative sources:** Technologies with the potential of producing water from non-traditional water sources such as desalination, acid mine drainage, rainwater or stormwater capture, and reuse of wastewater.
- **Smart water technologies:** Technologies that integrate information technology into water accounting and management, such as leak detection, smart water meters, and Internet-based water-use solutions and software. These innovative solutions enable water service providers to enhance supply and curb demand simultaneously.
- **Technologies promoting water use efficiency and conservation:** Technologies that enable short- and long-term demand management in various sectors, such as irrigation sensors, low-flow plumbing, and water-efficient appliances.
- **Water purification technologies:** All the technologies that are used to purify, filter, disinfect, and produce water of different quality for different beneficial uses.
- **Groundwater:** Technologies that enable water infiltration and groundwater banking and recovery.

While the water sector offers many opportunities to innovate and deploy new technologies, in practice the sector has barely tapped the potential those technologies offer. Various hurdles currently inhibit the development, testing, adoption, and diffusion of new water technologies. Other sectors of the economy have experienced various levels of success when it comes to addressing the need for new technology – yet very little of this cross-sectoral learning occurs in the water sector. Various barriers have inhibited fundamental change in recent decades in the basic technologies. Addressing the coming challenges will require new approaches. In this document, we put forth a new strategy to increase innovation and speed-up the deployment of new technologies in the water sector.

## Global impact and stature

The WRC recognises that water scarcity is one of the most important and complex challenges facing South Africa, the continent and the world today, and will continue to be the case for the future, especially for South Africa should the national water use and water resource management policies and operations continue as is. As the major funder of water research in the country, it is of crucial importance that the WRC establish international partnerships and facilitate collaborations between South Africa and leading teams in the continent and the world. This will help to position South Africa as a leading knowledge partner, resolve South Africa and Africa's water challenges, and make a substantial contribution to the generation of global knowledge and technological solutions.

Since its establishment, the WRC has built fruitful international partnerships across different stakeholder groups and undertaken a wide range of international activities that helped to raise awareness and build a good reputation for the WRC, the South African water sector, in the continent and internationally. The activities include: promotion of South African expertise; facilitating South Africa's access to international programmes, projects and funding; facilitating South Africa's participation in strategic conferences and workshops; and serving on international policy and technical steering committees and working groups that shape the global and regional water agendas.

**Organisational structure of Impact and Innovation Branch**

The Impact and Innovation Branch is organised into four units (Fig. 35) each focusing on specific activities to implement the WRC strategy whilst working together.


Figure 35. Research & Development research outputs

## 8.2 KNOWLEDGE SERVICES AND COMMUNICATION

Current conversations around water challenges are painting a dark picture for the future of water. The WRC needs to drive a different and a much more robust agenda if the above challenges are to be met head on. These 'game changers' need to set the WRC up to excel in the following:

- Inspiring water conversations
- Community empowerment though superior water content flows
- Improved reach of water information for improved water management, building resilient communities (who can better cope with water-stressed situations)
- Smart packaging of information to support superior content flows that will reach all sectors of our population

The following strategic initiatives need to be adopted:

- User-focused dissemination: getting the right content to the right user at the right time through strategic planning of content creation, delivery, and governance
- Approaching water information as a medium that needs to be strategically selected and placed to engage the audience, convey a message, and inspire action

### Maximising impact through smart content development and management

Dissemination of research findings will be re-positioned as follows:

**'From reaching 500 to reaching 5 million'**

- Multi-pronged approach to packaging information and knowledge: from one-page popular summaries, media releases, policy briefs, opinion pieces, targeted reports, special reports, video clips, audio clips, infographics, interactive reports, training materials, reference materials, and access to the full technical report
- Establishing and maintaining superior knowledge flows – continuously accessible knowledge which can readily be shared though any media platform or dissemination channel
- The word is 'anticipation': content development that can anticipate emerging issues and be ready with relevant content just in time

**Maximising impact through inspiring water conversations**

- We need to connect to people, to interact with them in a way that leaves them better than we found them, more able to get where they would need to go
- If our water content isn't driving water conversations nationally, then we are doing it wrong

- Messages should be clear, simple, action-oriented and tailored for each audience (i.e. knowledge user driven)
- Dissemination strategies should include a plan to evaluate the impact of the chosen approach, including ways to measure success
- Consider – What is the message? Who is the audience? Who is the messenger? What is the best dissemination method? What is the expected outcome?

Content Development, Marketing and Dissemination will therefore adopt the following approaches to improve our engagements with stakeholders for improved impact. The goal of this approach is to create meaningful, cohesive, engaging, and sustainable content. The strategy helps one to identify what already exists, what should be created and, more importantly, why it should be created.

- **Real-time marketing:** this is the process of leveraging events and using social media (live video / live tweets)

- **Video content:** a descriptive video or even slideshows can help one to deliver information in a more effective way, and one's audience will prefer looking at a video on their phones in addition to reading blogs/news through written content
- **Thought leadership:** this involves the senior management publishing blogs, articles, views, etc., on various portals; publishing such blogs on reputed portals like LinkedIn will help increase credibility of the manager as well as the WRC
- **New ways of content amplification:** to increase the readership and reach of content, one needs to amplify it through social media; using tools like Facebook Ads, Twitter Promoted Tweets and LinkedIn Sponsored Updates, one can choose exactly who one wants to target and gather the type of engagement one's content has generated.
- **Measuring engagement:** what will help us understand the real impact of the content shared is measuring the kind of engagement that it gathers; one can easily analyse the type of people one is engaging with one's content.
- **Content marketing:** content marketing is a strategy to create, curate and amplify content for building advocacy and thought leadership which can directly result in achieving business and marketing objectives by influencing a set target audience

**Towards a premier knowledge hub**

'We can either tell stakeholders that we are stars or show them that we are.' 'Good marketing will makes the WRC look smart. Great marketing makes the water user feel smart.'

Therefore, the WRC will focus on:

- Capture the attention of water users so they understand the needs, and challenges and options to solutions. 'People intuitively want to make the best decision possible.'
- Facilitate the prospect's decision-making process. Facilitate access to information that will assist water users to make the best water management decision. Give them enough information to facilitate their making the best decision possible when dealing with water and water-related issues. 'Everyone needs water now and in the future.'
- Give water users a low-risk, easy-to-follow way to become more informed and improve their capability to take further steps to improve their lives. This facilitates their ability to make a good decision. Lower the risk of taking the next step in the process so you can further educate them.

The national profile of the WRC as a credible knowledge broker and premier knowledge hub still needs to be widely communicated. New and fresh strategies are required to achieve this goal. Real impact of the WRC activities can only be experienced if people and communities are better able to access the wealth of information and solutions within the WRC. Therefore, the nation and the global community have to know about the WRC and what the WRC can offer them. Thus, there is still a critical need for the WRC to massively raise its public profile through well-planned interventions.

***'Maybe it's not so much about how credible we are as an organisation, how great is our knowledge base, but who is listening to us.'***

Marketing, in the next 5 years, will focus on the improvement of the public and political profile of the WRC by enhancing the credibility and relevance of the WRC and water knowledge through strategic positioning and strenghtening of stakeholder relations, public engagement, media engagement, parliamentary liaison, strategic communication, events management and marketing initiatives and programmes. This includes engagement with relevant stakeholders and national programmes and partners for impact.

The WRC marketing and communication strategy

should therefore seek to achieve, in general, the following:

- Achievement of the WRC's overall organizational objectives
- Enabling the WRC to engage effectively with stakeholders
- Demonstrating the success of the work and investments of the WRC
- Ensuring that people understand the role played or the work of the WRC
- Using the generated knowledge to influence or change behaviour and perceptions where necessary

## Knowledge services for impact

The strategic focus for knowledge services in the next few years, is to continue with the coordination of the WRC's knowledge dissemination and information and use these to position the WRC as the premier water knowledge hub, whilst integrating seamlessly with Communications and Marketing – with a superior content strategy for improved impact. The WRC will continue pursuing this goal via the following processes:

- Advance, or extract value from our research and development activities and those of our partners, generate content,develop knowledge products and explore business development opportunities
- Produce, manage, distribute and store information and knowledge resources, provide assistance, and share solutions
- Know, engage and develop our customers to receive the knowledge products and contribute to the generation of knowledge products
- Initiate and roll-out new initiatives leading to making water knowledge more accessible to the 'man-on-the-street'

Additionally, the WRC will introduce new initiatives to harvest new knowledge during the course of a research project through initiating conversations at project level and special publications that integrate and tell a story on water as indicated below.

## Management Area 1: Knowledge dissemination

This area will define itself through the management and service-delivery approach that converges **information management and publications and knowledge dissemination.**

The focus of this unit will be to disseminate information and knowledge to customers or users, nationally and internationally; continuously improve access to the knowledge resources by various categories of users; collect data, information and knowledge from its contributors, produce it, manage it, store it and manage access; manage data, information and knowledge as a critical resource for the WRC, whilst embracing 'lean and keen' principles:

- Moving focus from print-based research reports to electronic reports
- Publication and promotion of interactive research reports
- Special Reports for identified stakeholders
- 'Early bird' communication of potential research outputs

## Management Area 2: Content development and special publications

The focus of this unit is in content development and managing and enabling content flows, as in 'make it happen', an active process to communicate results to potential users by targeting, tailoring and packaging the message (usable intelligence) for a particular target audience. It also includes a process of extracting the main messages or key implications derived from research results and communicating them to targeted groups of decision makers and other stakeholders in a way that encourages them to factor the research implications into their work

– 'smart packaging for impact'. The driver for what needs to be done here is the increasing use of social media by stakeholders to access important information:

- Targeting, tailoring and packaging messages for particular target audiences
- Developing and implementing new content that can be easily accessed through social media and smart phones (turning knowledge into content and repurposing it for all channels/ platforms)
- Repurposing, translation and new non-technical content development
- Content management system across website, blog, app and social media platform, includes content creation and updates
- Editorial calendar
- Translation of selected content into video and summarised specified target audiences
- Measurement and evaluation of the impact of our content
- Training of staff to build an in-house writing team
- New products that will enhance the impact of WRC research – the Legacy Series
- New products that will enhance the global stature of the WRC such as the Global Impact Series
- Identifying and engaging with other knowledge generated by sources other than the WRC

## Management Area 3: Marketing and events

Event management (project management) entails the creation and development of large-scale events such as workshops, dialogues, think tanks, conferences, summits, or conventions. It involves studying the content, identifying the target audience, identifying partners and contributors, devising the event concept, planning the logistics and coordinating the technical aspects before actually launching the event.

Marketing Management will develop strategies, approaches and programmes to generate interest in our knowledge services, products and content, improve customer opinions of our content (products and services) and increase the WRC's peceived relevance. The strategies will include creative new plans and ways to deliver our message to the customer:

- Position the WRC as a premier knowledge resource for all water-related issues, locally and internationally
- Develop, coordinate and implement the WRC's Marketing Policy and Strategy
- Develop the WRC corporate identity (CI) to support targeted marketing campaigns
- Establish the WRC at the forefront of knowledge creation and knowledge dissemination
- Assist the business development unit to market new technologies and demonstrations for greater value and impact
- Manage and coordinate the WRC knowledge dissemination and knowledge sharing events
- Planning, implementation and follow-up for all special events (national, ministerial) and annual receptions

## Management Area 4: Communication and media relations

This will involve the systematic planning, implementing, monitoring, and revision of all of the channels of communication internally, and between the WRC and external partners, managing the flow of information, including online communication. Media relations involves working with the media for the purpose of informing the public of the WRC's mission, policies, achievement, and scientific water knowledge in a positive, consistent and credible manner. Typically, this means coordinating directly with the people responsible for producing the news and features in the mass media. The goal of media relations is to maximize positive coverage in the mass media without paying for it directly through advertising and, additionally, the preparation of internal staff members for media engagement. Key

to this is the continued development of a very strong social media presence.

Marketing and Communication will develop and implement various mini-strategies to pursue the following:

- Inspiring water conversations nationally – which may be considered as a 'push' strategy, engaging the nation in water discussions and imparting critical water management knowledge
- Partnership with other national and private initiatives to promote water solutions and the WRC brand
- Promoting WRC professionals so that their knowledge and skills can benefit communities
- Effective and efficient use of various media channels, including social
- Redefining the events space to support the above initiatives
- Support the political profile of the WRC by enhancing the credibility and relevance of the WRC through strategic positioning and strengthening stakeholder relations
- Develop, coordinate and implement the WRC's Media and Communication Strategy (ensuring that all activities related to the media, parliamentary liaison, conference exhibitions, sponsorships, awards, advertisements, press releases, corporate videos, social media, and multi-media presentations are part of the communication portfolio's plans)
- Meet regularly with KSAs to assess KSA-specific communication
- Broaden social networking to benefit the organisation
- Continuous engagement with research managers to ensure proper engagement with the media

## 8.3 INNOVATION AND BUSINESS DEVELOPMENT

The WRC vision and strategic shifts over the past 5 years have resulted in the emergence of many attractive value propositions for both local and international partners. By effectively and smartly collaborating with the right public and private sector organisations, the WRC can:

- Influence policy and decision-making across all water sector institutions and via cross-sectoral partnerships particularly around innovations, technology transfer and science, technology and innovation (STI) policy
- Scale up sustainable solutions with strategic and business development partners
- Develop and facilitate the innovations to the stage where products and services are closer to the market and ready for uptake and diffusion
- Strengthen human capital development opportunities for the sector across the entire water value chain
- Empower communities with knowledge, innovations and skills
- Develop initiatives that support transformation and redress in the R&D, water and socio-economic domains using various partnership models

This also recognizes the power of building the right networks of ecosystem partners on either side of the WRC water value chain, and empowering them with the relevant knowledge, skills, and opportunities. This model offers a unique opportunity to create a multiplier effect (Fig. 36) which will accelerate diffusion of water knowledge, products, and services to policy-makers, practitioners, professionals, NGO's, entrepreneurs, and communities.

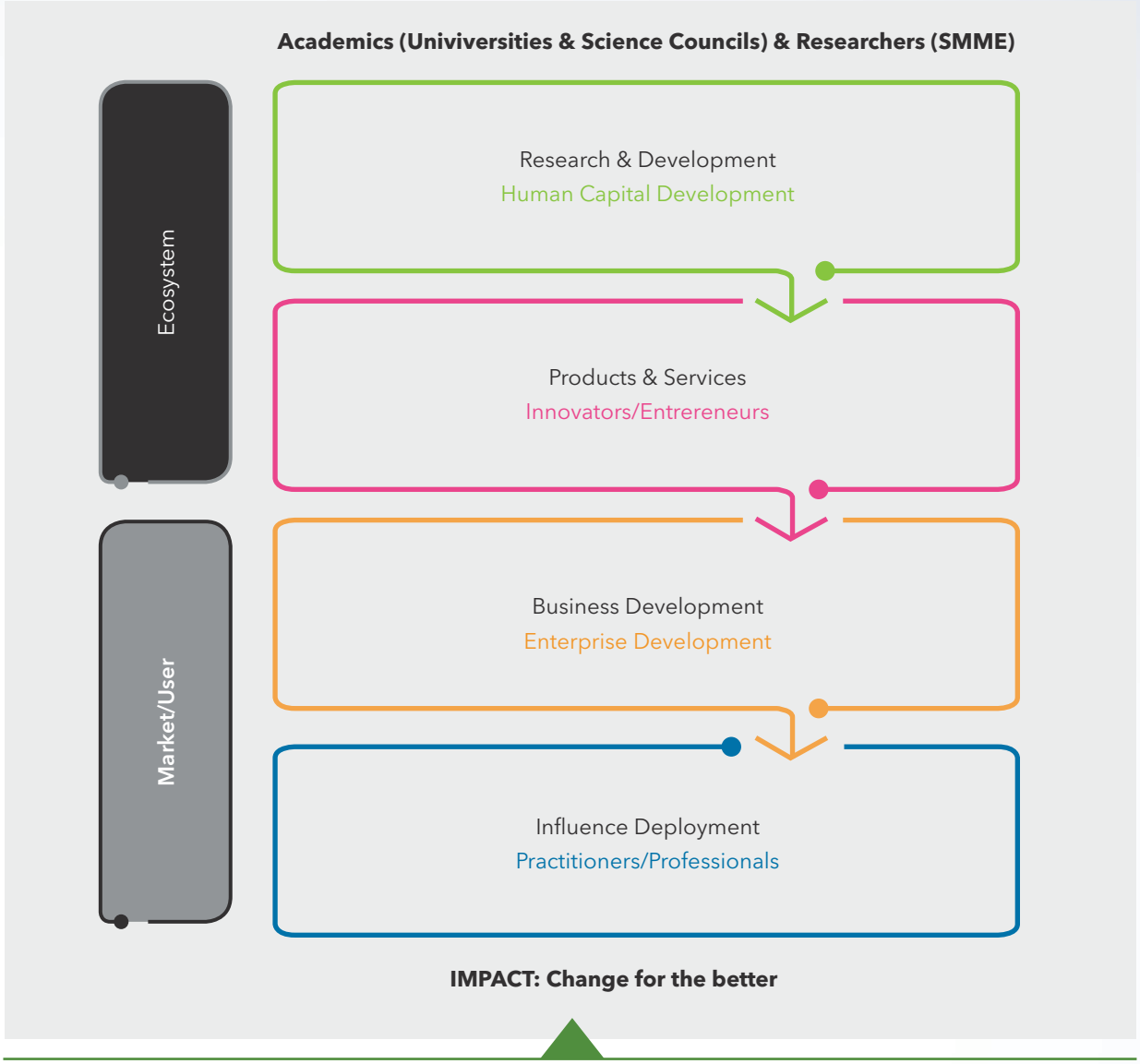



Figure 36 . Using multiplier effect to create impact for the WRC, the water sector and its cohort of researchers, entrepreneurs and professionals

At the heart of the Business Development and Innovation (BD&I) strategy is the recognition that South Africa is faced with the triple challenge of poverty, unemployment, and inequality. Therefore, one of the primary directives is to use knowledge-based capital and the innovations that are developed to create opportunities for new businesses to enter the water sector, thereby transforming the sector (Fig. 37) through inclusivity of women, youth and previously disadvantaged individuals in opportunities of entrepreneurship, research, consultancy, and practice. Knowledge transferred to researchers, consultants and practitioners is fairly well entrenched in various WRC activities such as material development, workshops and conferences. However, support of entrepreneurs and enterprise development support calls for the development of an enterprise development strategy focused on pipeline development in support of the broader ecosystem of partners and sustainable water practices and solutions.

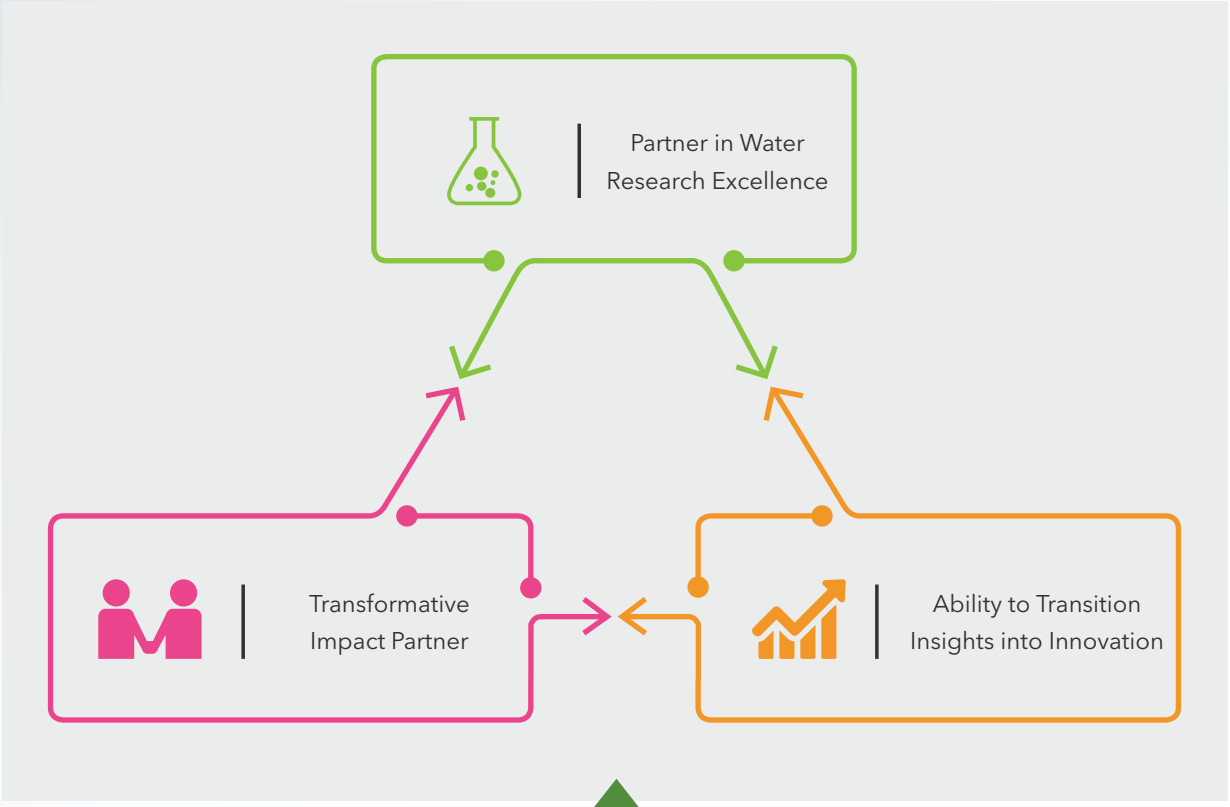



Figure 37. Business Development strengthening the role of the WRC as a transformative partner

To ensure that the WRC achieves its vision of creating knowledge that positively impacts on the lives of millions of South Africans either directly or indirectly through the water sector and R&D cohort, the Business Development and Innovation KSA has organised to accelerate research, innovation, and human capital development by focusing on the following six pillars (Fig. 38):

- **Operational effectiveness and excellence:** Create both internal and external enablers to effectively implement the corporate plan by adopting a model of operational flexibility that allows the organisation to pilot, test, and incubate ideas and opportunities that support the water and sanitation national system of innovation (NSI), the water sector and the internal operations of the WRC. The team will seek to strengthen internal processes further in 2019/20 by having quarterly R&D and I&I Branch meetings to improve communication, prioritize opportunities and focus efforts on 'big hits'. The KSA will seek collaborative platforms with traditional and non-traditional partners to stimulate and encourage innovations thinking and 'intrapreneurship' in the WRC and with strategic institutional partners.
- **Connectivity:** Grow the capabilities of the WRC as a collaborative connector organisation with local, national, and global partners and stimulate and influence support for the broader water and sanitation national system of innovation ecosystem development, support and alignment.
- **Business intelligence and support:** Develop demand-driven and relevant innovation services mechanisms to support the acceleration of innovations through the value chain and work with partners to develop a vibrant ecosystem of innovators, entrepreneurs, enterprises, investors, and funders. In 2019/20 we will continue to assess methodologies and approaches with

strategic private sector and public sector partners to ensure a more robust analysis of the water innovations portfolio in order to improve investment, re-investment and support of critical market-driven innovations, entrepreneurship and enterprise development. We will also continue to support catalytic projects that provide insights and recommend opportunities for ecosystem alignment and business development opportunities. In 2018/19 this was further strengthened to support intellectual property (IP) management, IP advisory services and partnership and business development processes.

- **Partnership:** Develop long-term beneficial relationships with strategic traditional and non-traditional partners to complement the WRC mandate on either end of the value chain for strategic WRC and water sector outcomes. BD&I will focus on building partnering capabilities across the WRC that are able to cross institutional and sectoral boundaries to achieve systemic impact. It will seek to raise the strategic nature of current partnerships to achieve greater impact in prioritised areas and to enable the achievement of the strategic Knowledge Tree) goals.
- **Business development:** Create long-term value for the WRC and the water sector through the creation of new services, products, programmes, and platforms, which strengthen the financial sustainability of the WRC and support the development of improved infrastructure for the Water and Sanitation National System of Innovation with the possibility of the WRC playing a central co-ordination role across water sector institutions and the NSI.
- **Implementation:** Play an implementation role for large and strategic projects, programmes and platforms that support research, development, innovation and water RDI infrastructure with the aim of evaluating the formation of a fully skilled PMU to ensure excellent delivery for partners and focused management to minimize risk and amplify opportunity.

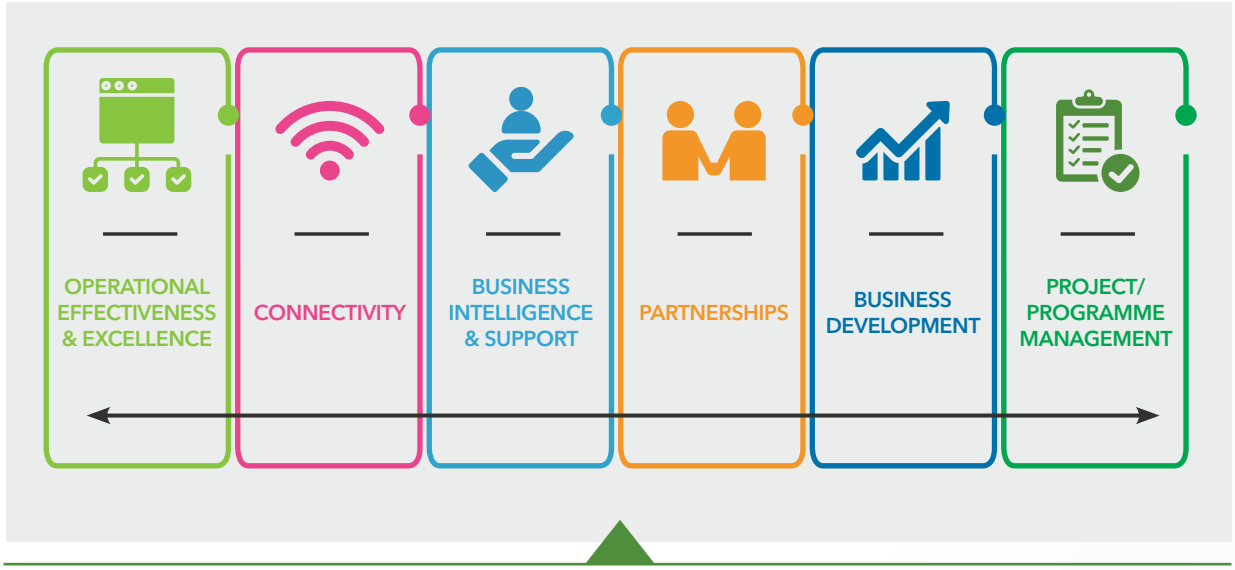



Figure 38. Key enablers for business development and innovations

## Business development and partnerships

The WRC has embarked on a business development and partnership strategy to create impact from WRC managed research and to diversify its income streams as part of a risk reduction strategy to enhance financial sustainability which has been identified as a key risk in the organisation. The latter is due to a number of factors such as the increased budget demands, difficult economic conditions, uncertain political environment and a predominant view that RDI is a cost rather than an investment. The WRC plays a critical role in filling the gap in the water research, development and innovation (RDI) value chain for South Africa. Investing in and leveraging support for water solutions, mechanisms and platforms, that will contribute towards transforming the water sector and support capacity building and knowledge sharing, is central to the WRC's Business Development and Partnership efforts. Creating sustainable value also requires a focus on social innovation to create enabling environments for policy shifts, concepts such as water-sensitive design and the uptake of innovative solutions.

The WRC values the partnerships that have been created and maintained thus far, as they have catalysed opportunities that are bearing fruit for new knowledge, smart implementation and SMME advisory and developmental support. However, the need for cross-sector engagement and establishing co-creation business development opportunities remains high on the WRC's agenda. The WRC's BD strategy (Fig. 39) will involve seeking new leverage and business development opportunities from existing partners, new (non-traditional) partners, co-creating or developing new platform launches, and evaluating and monetizing products and services relevant to the WRC business model. The latter two opportunities will require an investment in new resources and skills, relevant revenue models and alternative innovative implementation models.

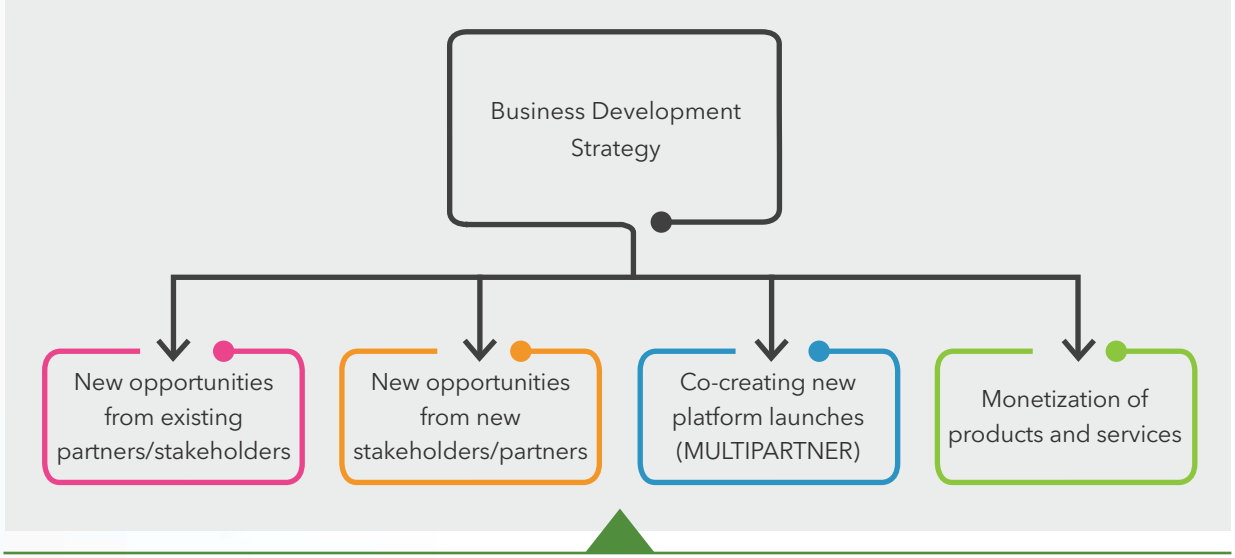



Figure 39. Four strategic areas of exploration for business development

The key success factors for business development in the WRC are depicted in Fig. 40, in which strategic focus is primary to achieving the goals. The strategy can be further enhanced by ensuring that a common growth and change vision is shared by employees, and through innovative partnership and revenue models, technology utilization for expanded connectivity, experience and implementation, clear financial and impact success factors, a global and national footprint, a consistent business proposition, and brand reputation.

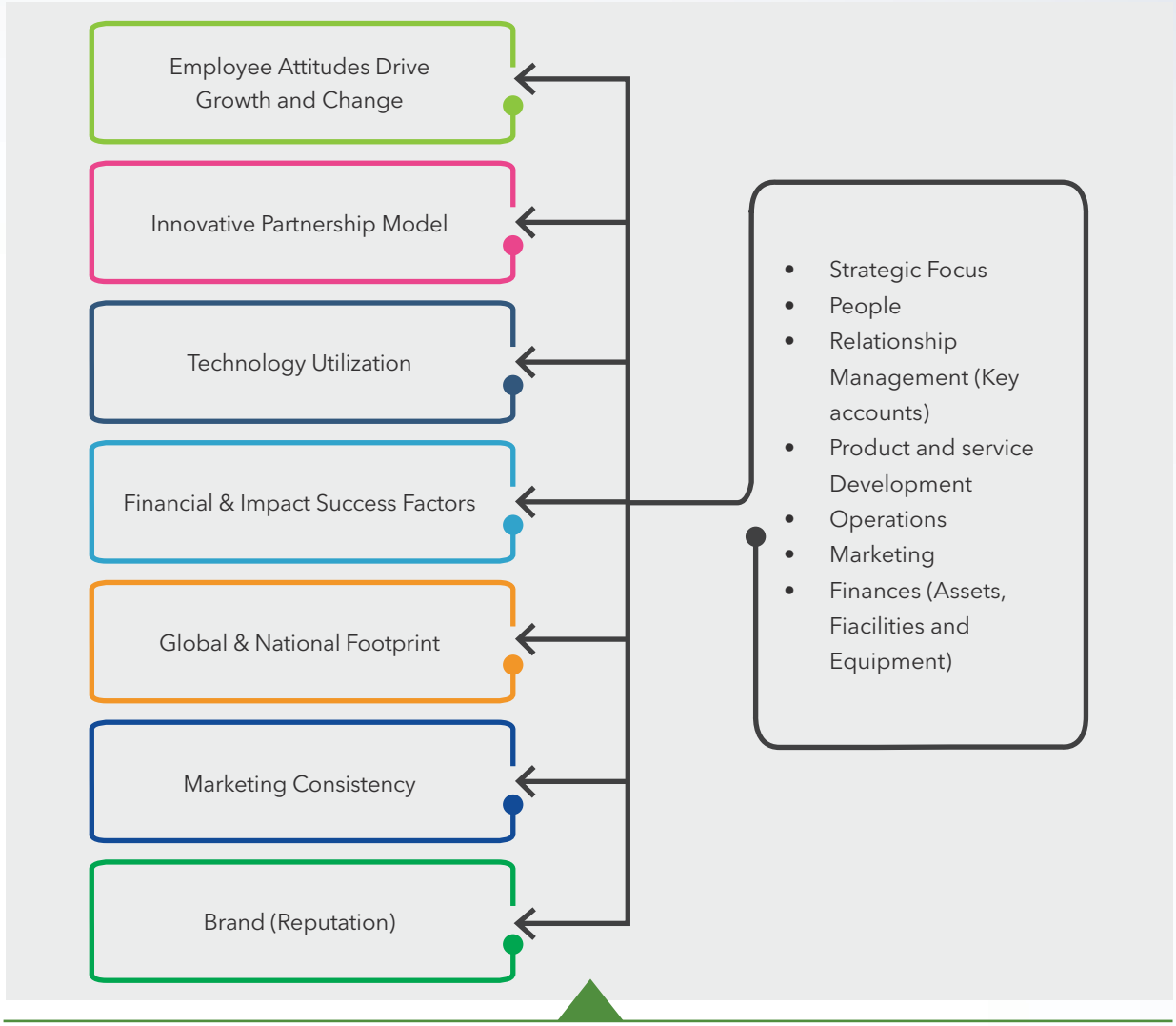



Figure 40. Key success factors for business development sustainability

Looking ahead, areas that have been prioritised to seek further leverage and business development opportunities include:

- **Engaging on water industrialisation:** Working with partners such as DTI on catalysing opportunities for industry partnerships and establishing triple-helix mechanisms to fast-track solutions to impact. The WRC contribution to the development of the water and sanitation chapter in the Industrial Policy Action Plan of 2017/2018 with DTI was also aimed at creating further incubation and industry support for innovators and technology developers in the water and sanitation sector, thereby understanding market demands and creating a market pull.
- **Expanding the impact of the WRC's knowledge products:** Enhancing the translation of knowledge into training and capacity development opportunities, assessing application models and developing programmes with SETAs, professional associations (WISA, SAICE, SACNASP) and non-profit partners. The WRC produces many guidelines which can be translated into training material for extension officers and practitioners, and when linked to certifications, accreditation and continuing professional development (CPD), points can translate into tangible benefits for all water sector professionals.
- **Aligning and co-ordinating the water ecosystem partners for impact:** The Water RDI

Roadmap is a partnership initiative between the DST, DWS and WRC. It is the key implementation instrument behind the Research and Development chapters of the NWRS-2 and the National Water and Sanitation Master Plan. The Roadmap is also closely linked to the priorities of the Industrial Policy Action Plan 2017–2021.

The National Water Research, Development, and Innovation (RDI) Roadmap is a sector-wide plan to focus interventions in water research, high-end skills and innovation. This includes development, testing, demonstration, positioning and deployment of new solutions, know-how and technologies. The Roadmap helps to position South Africa for a water-secure future by ensuring that we are equipped with knowledge, solutions and skills to respond to a future water sector demand gap of 17% by 2030.

In the 2019/20–2023/24 Corporate Plan the WRC will maintain strategic alignment to the RDI and also support a range of the priority initiatives that emerged from the Roadmap prioritization process, and will align and partner with additional water sector and National System of Innovation organisations. The PMU will also seek additional funds to support more research in the following areas: economics of water and pro-poor societal issues. It will support business and partnership development for strategic initiatives such as the Industrial Policy Action Plan (IPAP) and the creation or piloting of a South African Hydrological Centre. It will seek funds and alignment from sectoral partners to support new communities of practice, chairs, centres of excellence, centres of competence, and professional service centres, or develop hybrid models with partners to accelerate skills and knowledge transfer in the water sector. In 2019 we expect the launch of the Water Chair in Natural Resource Economics, in partnership with DEA and the National Research Foundation (NRF) with the support of the WRC and DST in framing the ToR, and alignment to the National Water RDI Roadmap clusters. In 2019/20, the WRC will engage with the NRF and partners to develop a framework for a Water Centre of Excellence and/or a National Water Institute.

***Supporting cross-sector collaboration for water security and community resilience***

Considering the importance of water-sensitive design in response to climate and weather variability requires engagement with development finance institutions (DFIs), property, construction and planning stakeholders across rural, peri-urban and urban environments. Equally, financial and investment partners are critical in shifting private sector models towards sustainable practices.

***Developing a new industry around next-generation sanitation***

Sanitation remains a key challenge in South Africa especially in rural, peri-urban and informal areas. With renewed focus from the Presidency on school sanitation through the launch of the SAFE Programme in 2018, developing and supporting next-generation sanitation products to the market remains a key imperative. The Business Development and Innovation KSA will support the business and industry development component with partners while KSA 3 will continue to support the research and technology components.

In 2018/19, the WRC completed a study on unlocking additional financial resources for research, development and innovation. In 2019/20, the WRC will continue to evaluate options for additional leverage funds, test and incubate ideas, and seek business development opportunities for the WRC and its sector partners.

**Improving leverage (SWOT analysis)**

The WRC Business Development KSA has been in operation for about 3 years with the initial years dealing with programmes like Wader and the Water RDI Roadmap. Since then several large projects have been secured and rolled out. Thus, a SWOT analysis (Fig. 41) was done on the larger complex projects (multi-partner, international and/or > R5 million) that have been implemented in the WRC. A key concern has been that the resources in BD are largely contractually based and, while several successes have been recorded, their focus remains on the partner needs and the agreed business plans

for the programme. Secondly, business development contracts require additional relationship management and significant financial and project reporting to partners. Thirdly, sub-optimal support from internal teams can lead to delays and business development opportunities failing. Hence, smarter internal modalities need to be looked at. Finally, seeking new business development opportunities requires time and skills to develop concepts, proposals, tenders and business cases, engage with partners in collaborative spaces and develop implementation plans. These will need to be strengthened through resourcing, skills and smart models to give effect to the financial sustainability strategy for the WRC.

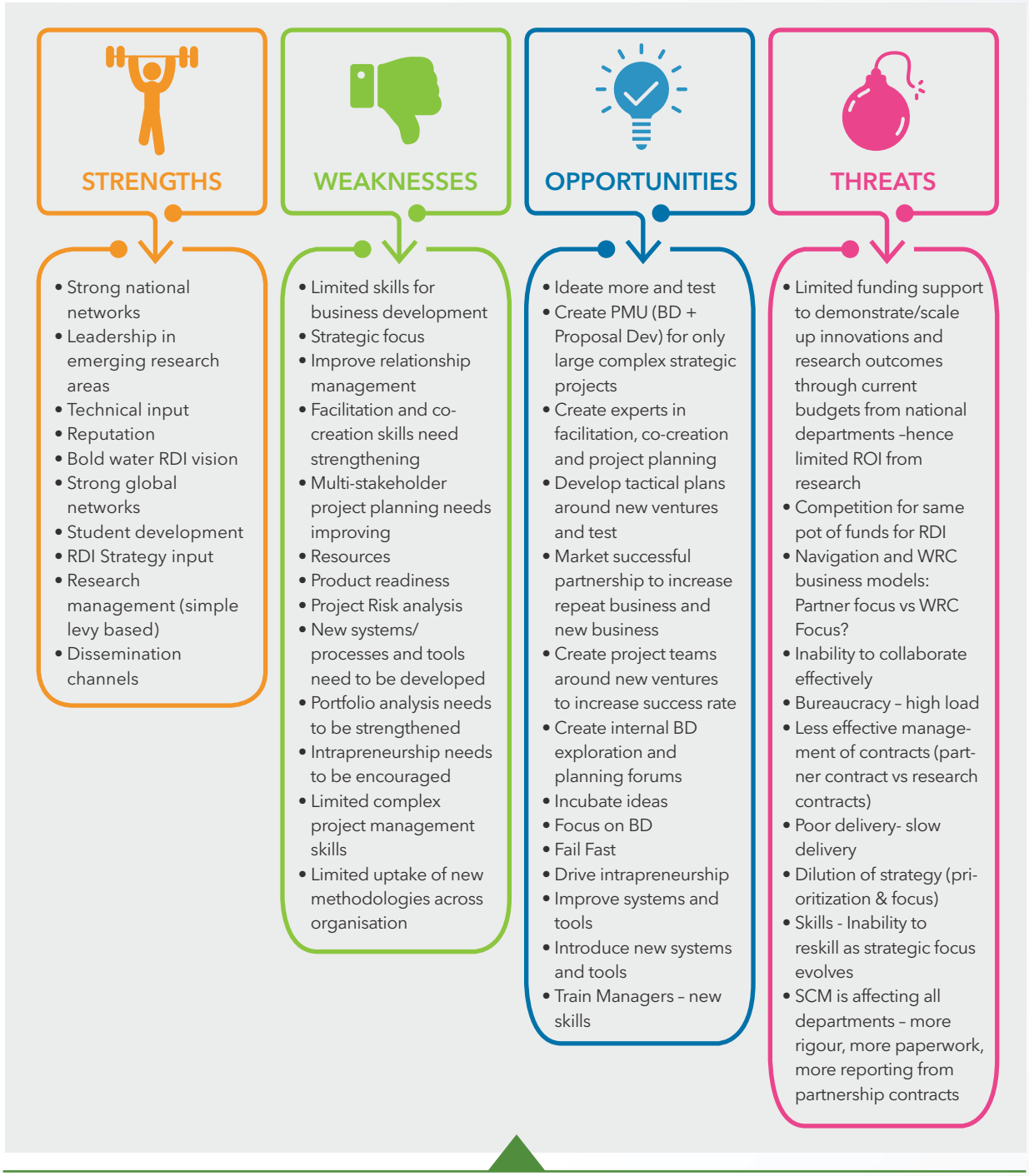



Figure 41. SWOT analysis of Business Development within the WRC

## Innovations

The WRC innovations team, comprising of the Water Technologies Demonstration programme (Wader) and the Technology Transfer Office (TTO), supports and facilitates successful innovations, demonstration, and technology transfer for socio-economic impact. The WRC strategy on funding for research and development is moving toward the obligation to show tangible impact by turning knowledge into solutions for communities, service delivery, wealth-creation and a better future for all. As such, the innovations team supports the WRC's mandate and vision through the provision of support and advice to innovators, entrepreneurs, SMME's, the R&D Branch, as well as the water sector as a whole.

The focus of the innovations team becomes instrumental to the WRC achieving its goals as set out by the organization's Knowledge Tree. The work of the team will add value to each branch of the Knowledge Tree through the detailed activities outlined below.

- **Inform policy and decision making through:**
  - Driving catalytic projects required to better understand the ecosystem and influence internal and external decision making
  - Ensure rigorous portfolio analysis of WRC innovations to fast-track opportunities and inform investment and innovation prioritization decisions
  - Inform the Water and Sanitation National System of Innovation (NSI) through policy, publications and strategic engagements
  - Develop and assess commercial and diffusion pathways for tools developed
  - Seek business development opportunities for Wader and the TTO through agreements with ecosystem partners

- **Develop new products and services for economic development through:**
  - Focus on matchmaking initiatives to increase development and competitiveness of local SMME with well-defined partnership agreements
  - Technology transfer activities to accelerate technology readiness levels (TRL), business readiness levels (BRL) and market readiness levels (MRL)
  - Localization opportunities through sector partners such as the Technology Localization Implementation Unit (TLIU)
  - Industrialization activities of water and sanitation as highlighted in the Industrial Policy Action Plan (IPAP)

- **Enhance human capital development (HCD) in the water and science sectors through:**
  - Audits conducted by the TTO to understand support needs and drive strategy and alignment with academic institutions where required
  - Facilitate internal development/training for staff on IP portfolio analysis, new processes and systems
  - Using effective partnership models, develop training and awareness programmes for young practitioners, entrepreneurs, SMME's, women and regulators

- **Empower communities by:**
  - Support of small businesses through technical advisory services and technical evaluation of technologies, IP and market reports support
  - Information sharing through platforms such as websites, newsletter, dialogues and summits
  - Matchmaking with investor partners through exhibitions and summits with the intention of identifying and securing opportunities for enterprise development
  - Train new entrepreneurs and SMME's with new knowledge and tools
  - Create strategic fora with industry, associations, and water sector institutions

- **Promoting transformation and redress by:**
  - Developing initiatives to support Black businesses, youth entrepreneurs and women where opportunities arise and partnership support can be attained.

- **Drive sustainable development solutions by:**
  - Focusing on demonstrations of relevant technologies that are linked/prioritized in the Water Research Development and Innovation (RDI) Roadmap through the Wader platform that could also lead to achieving the SDGs
  - Engagement by Wader and the TTO with sector partners to identify potential business development activities to fast-track solutions

A major focus for the innovations team is to streamline the process of transferring knowledge and innovations in order to address certain needs and ensure impact. The proposed organization-wide process flow for the transfer of technology is illustrated in Fig. 42.

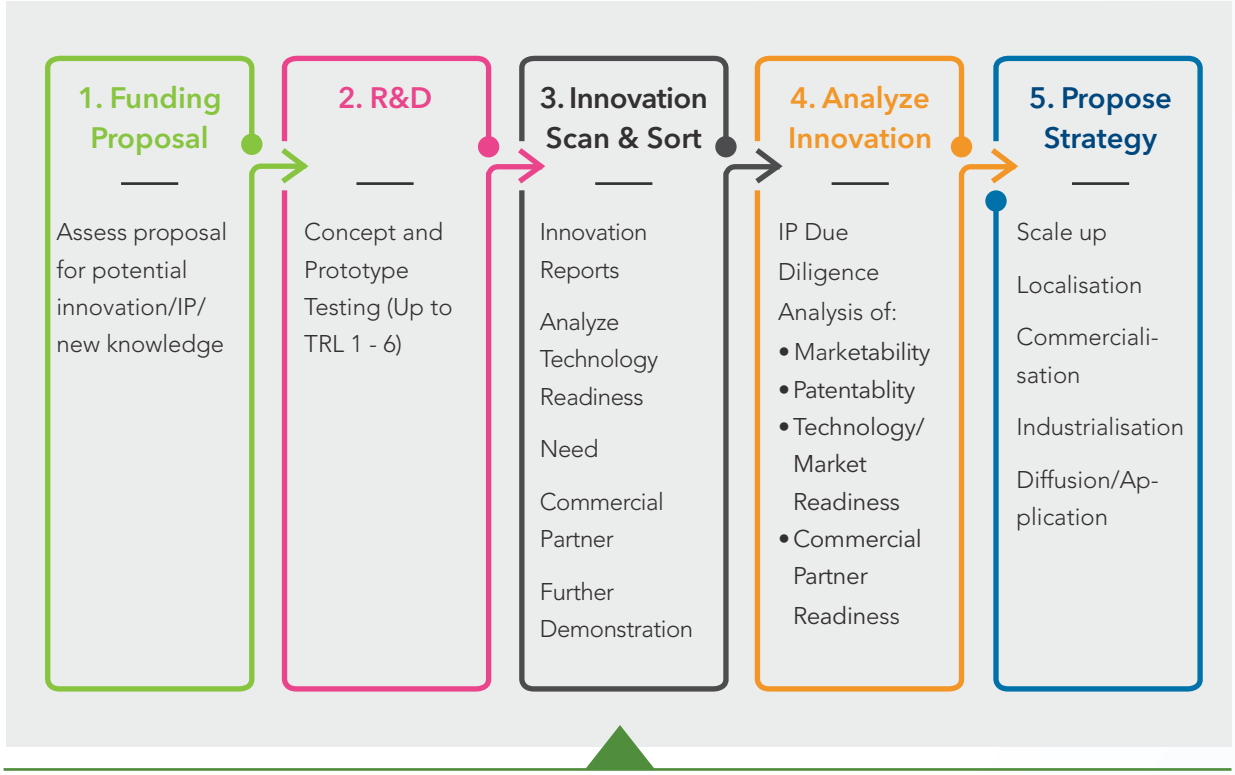



Figure 42. Proposed technology transfer process flow

*The WRC innovations team, comprising of the Water Technologies Demonstration programme (Wader) and the Technology Transfer Office (TTO), supports and facilitates successful innovations, demonstration, and technology transfer for socio-economic impact..*

The proposed process flow aims to ensure a streamlined pipeline for not only the transfer of technologies, but their implementation as well. Innovation is an end-to-end process requiring the participation and collaboration of all research managers and KSAs within the WRC. Therefore, different parties will play a role at different stages of the process flow; with the R&D Branch championing the funding proposal and R&D stages, and the innovations team supporting the scanning, sorting, and analysis of identified innovations, as well as the proposition of strategies to take these innovations forward. This process will be strengthened by including a series of portfolio analysis methodologies such as technology readiness levels, and fail fast opportunity analysis framework. Wader and the Technology Transfer team have developed several services for the sector and have been evaluating its adoption by technical sector partners. Table 8 maps the different services offered and the activities associated with the offering.

Table 8. Wader service offerings

| STRATEGIC OBJECTIVE | DESCRIPTION OF STRATEGIC OBJECTIVE |
|---|---|
| 1. Demonstration | Offers a scan-and-sort function<br>Offers some funds for demonstrations but requires more robust partnerships to increase the funding pool |
| 2 Access to information | Development of Wader website with regular updates<br>Development of databases of technologies and innovators/entrepreneurs |
| 3. Credible technical information | Offers expert independent panel to evaluate new and emerging technologies/tools |
| 4. Networking and brokering role | Allow peer-to-peer networking opportunities with entrepreneurs/innovators via events |
| 5. Matchmaking | Brokers opportunities between innovators, funders, organisations and municipalities |
| 6. Growth of SMMEs & ED | Based on feedback from tech pitching sessions Wader connects innovators with economic development partners and innovation hubs/ incubators |
| 7. Technical advice | Offers an advisory on a scientific basis for private sector–driven technologies |
| 8. Drives innovation in priority areas | Link to Water RDI, W&S Masterplan, IPAP |

In CP18 Wader introduced two new information offerings for the sector. These include:

- Validation framework for evaluations to standardize approaches for different types of technologies
- Testbed map of opportunities

**Strategic Project: Water and Sanitation National System of Innovation**

The WRC is strategically placed in the water sector to play a co-ordinating and influencing partner role in the Water and Sanitation National System of Innovation. The National System of Innovation (NSI) can be defined as the flow of technology

and information among people, enterprises and institutions which is key to the innovative process on the national level for the water sector. An effective Water and Sanitation NSI will lead to more tangible results for South Africa such as positioning the water sector for growth, job creation and competitiveness.

If one follows the OECD diagram for an NSI, it is clear that while the South African water sector has many players in the NSI, it is not fully developed, aligned and co-ordinated to generate impact (Fig.43). The relationship between the public sector and private sector needs to be improved such that the public sector becomes business-, innovation- and entrepreneurship-friendly, rather than a purely regulatory and oversight partner. Some of the core principles that could lead to an effective Water and Sanitation NSI is collaboration, crowd-funding, lean inovation modalities for high-priority water sector initiatives and agility of partners. This is challenging in a highly regulated public sector.

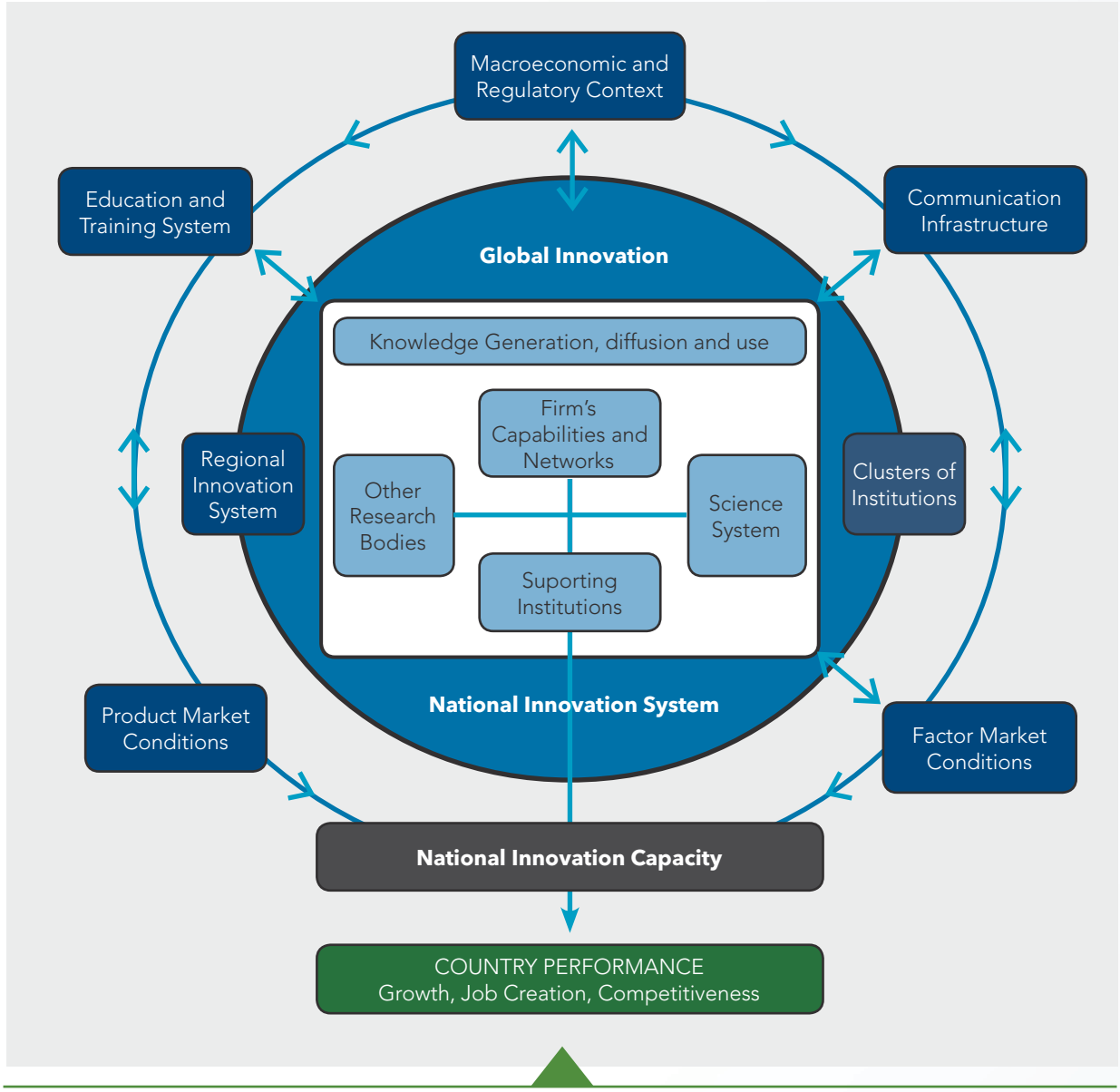



Figure 43. Example of National System of Innovation and its alignment to achieve high impact country-wide objectives (OECD, 1999)

Hence, one of the critical steps will be to complete a comprehensive gap analysis of the Water and Sanitation NSI, followed by a critical needs analysis of what will be required to ensure its effectiveness. Figures 44 and 45 illustrate the high-level breakdown of primary, secondary and tertiary partners which was done through the lens of the WRC and how it intended to ensure innovations get to the market. In Fig. 45, while there appears to be funding across the value chain, there is no critical mass of aligned water sector funding from NSI instruments of the DST or the DTI. It would be smarter for some of the funds to be aligned to the WRC startegy (public sector institution innovation) and the National Water RDI Roadmap to ensure critical water security needs of the future are being prepared for. In the past 2 years, the WRC has sought alignment with these various entities for co-ordinated funding to university-developed products and services but this has been challenging. The WRC has also engaged with private sector investors such as ASISA but no venture capital is available for innovation development. Investment funds from the public and private sector are available for certain public-private partnership opportunities and large infrastructure-related projects but it requires guaranteed 'business' from water sector institutions (the water sector market). In 2018/19 the WRC and TIA have attempted to better align and work towards collaborative processes. Co-ordinated funding using a sectoral stage gate innovation funnel mechanism could lead to more impactful innovation development and commercialisation. Future analysis will look at the partners through a Water and Sanitation NSI lens.

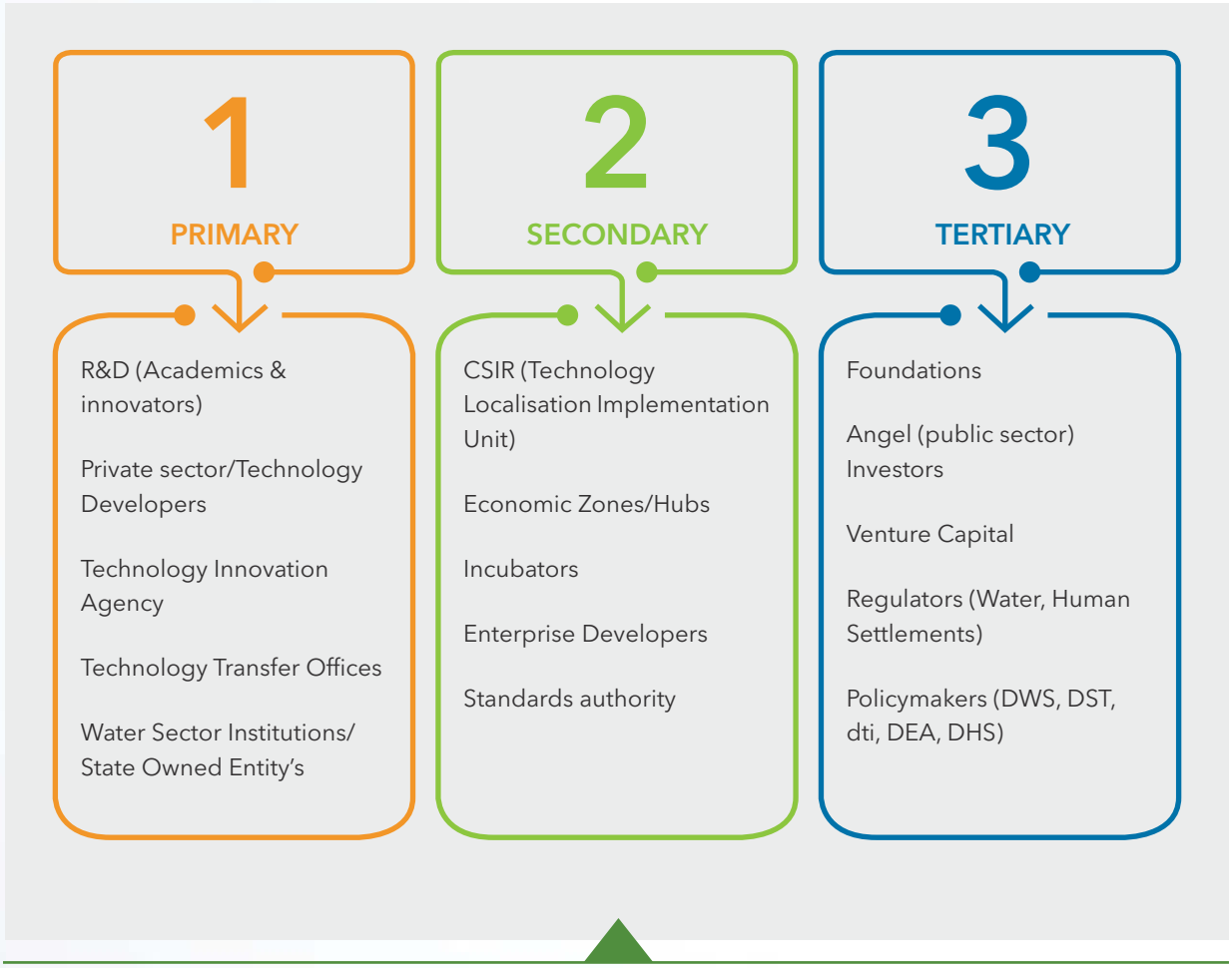



Figure 44. WRC innovation value chain partnership mapping

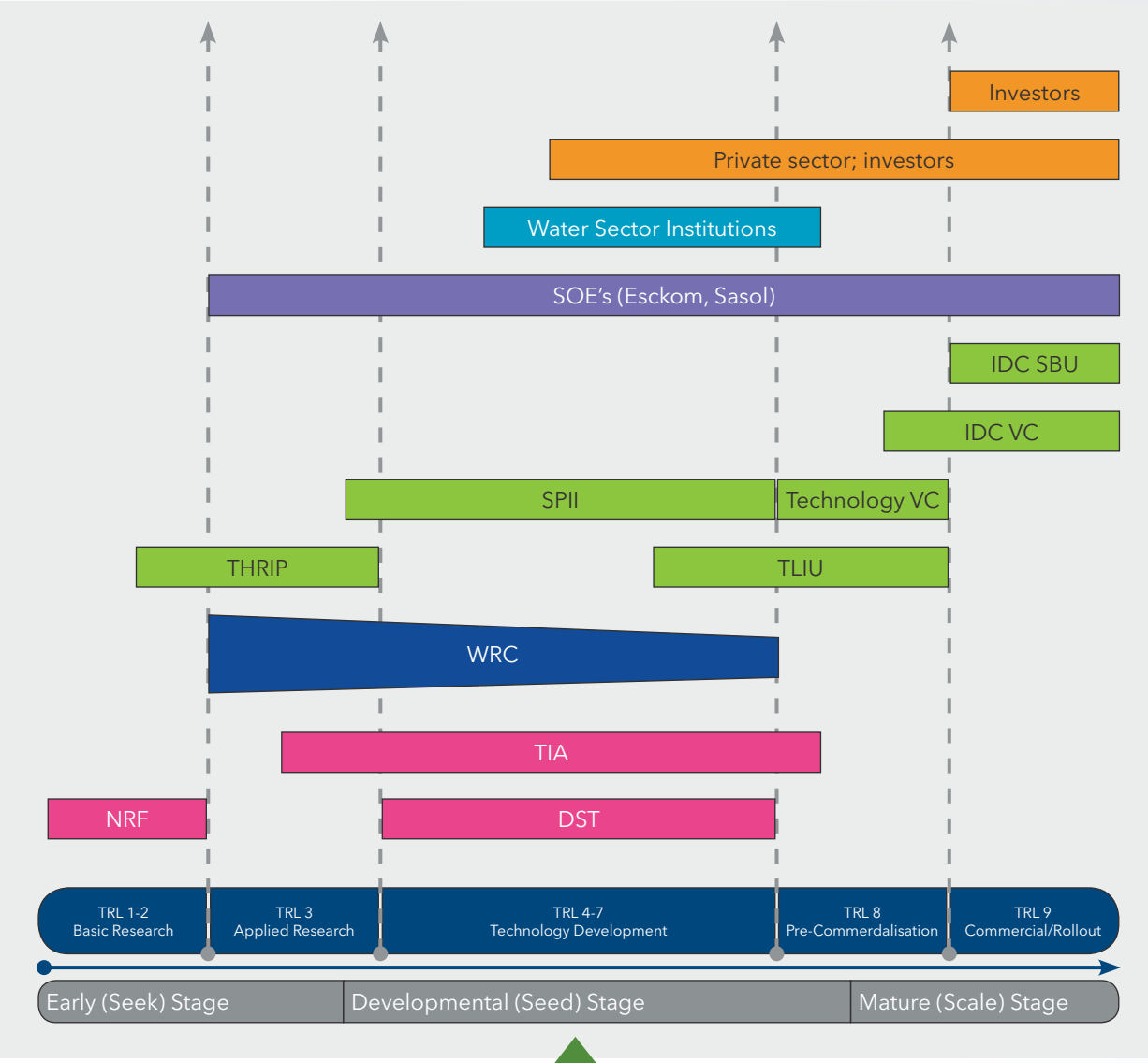



Figure 45. The innovation funding landscape

**SWOT analysis for innovations**

A SWOT analysis (Fig. 46) was done to evaluate the strengths, weaknesses, opportunities and threats relating to the innovation strategy. While there is significant sectoral work to be done, initial projects evaluating opportunity and testing ideas have shown support from innovators and SMMEs.


Figure 46. SWOT analysis of innovation strategy

### Organisational structure (Business Development and Innovation)

The organisational structure which supports the WRC strategic goals is represented in Fig. 47. Currently, the Innovations team, its support staff and the RDI Manager is supported through external partnership funding from DST and the National Intellectual Property management Office (NIPMO). It is a flexible structure where the Group Assistant and Programme Administrator support the Wader and RDI managers, and the Technology Transfer Officer and Technology Analyst supports the Technology Transfer Manager. In future, it is envisaged that new resources need to be made available to support the BD strategy to strengthen the funding diversification strategy. In 2018/19 the Business Development and Innovation KSA will add a new team focused on a national strategic objective of supporting next-generation sanitation in South Africa until 2021. The sanitation team will be funded by the DST and the Bill & Melinda Gates Foundation.

## 8.4 INTERNATIONAL COOPERATION AND PARTNERSHIPS

The WRC International Cooperation and Partnerships strategy aims to establish new, and strengthen existing, partnerships that will extend the WRC footprint, especially in the African continent, and derive maximum value for the WRC, the South African water sector and the continent. The international partnerships will be guided by five objectives of:

- Global positioning of the WRC as a competitive and key development player and a leader on water and sanitation knowledge-based solutions
- Influencing and contributing to the global and continental water agenda
- Securing international resources for the WRC, South Africa and the continental water sector
- Contributing to strengthening capacity on the continent
- Facilitating impact-driven research, innovation and value-adding engagements

The strategy will provide guidance and a framework for common principles and a clear WRC value proposition for international partnerships.
The implementation of the strategy will be an integrated process and effort by the Research and Development (R&D) and Innovation and Impact (I&I) Branches. The strategy will guide the proactive identification of internal, systemic, and international risks that could inhibit successful implementation of the WRC international partnerships, prevent the risks from occurring or establish mitigation actions. Below are some of the high potential risks that will be addressed over the short and long term:

- Internal: Lack of WRC prioritisation, and a framework to drive African cooperation and partnerships, internal alignment and integration of international strategy implementation within the branches, and co-funding to leverage international investment.
- Systemic: Lack of national strategy, joint planning and a unified approach for South Africa's engagement with the continent and multilateral fora/platforms which may lead to losing leverage and benefit associated with the platforms. The national strategy should be led by the Department of International Relations and Cooperation (DIRCo) supported by the relevant line departments, state-owned entities and other water stakeholders.
- Continent: Lack of African agenda established and driven solely by African member states, dependency on donor funding, and low intra-African collaboration and partnerships.
- International: Building and maintaining South Africa and the continent's global competitiveness (technical expertise, policy, technological and innovation), diminishing development and international research funding, lack of prioritisation of water and sanitation in global agendas.

**The 5-year framework**

The WRC will embark on a new approach to strengthen and improve its international partnerships for the next 5 years, starting in the 2018/19 financial year. The approach will focus on strategic, impact-driven and value-adding international engagements guided by a carefully considered framework. The WRC will put more effort and resources towards establishing African water flagship programmes, to leverage maximum benefit from the existing partnerships, and to create dependencies on the WRC to provide leadership in water RDI knowledge-based solutions.

The international partnerships will be driven by four pillars and will incorporate a range of activities specifically designed to derive maximum benefit and value from each partnership, as highlighted in Fig. 47.

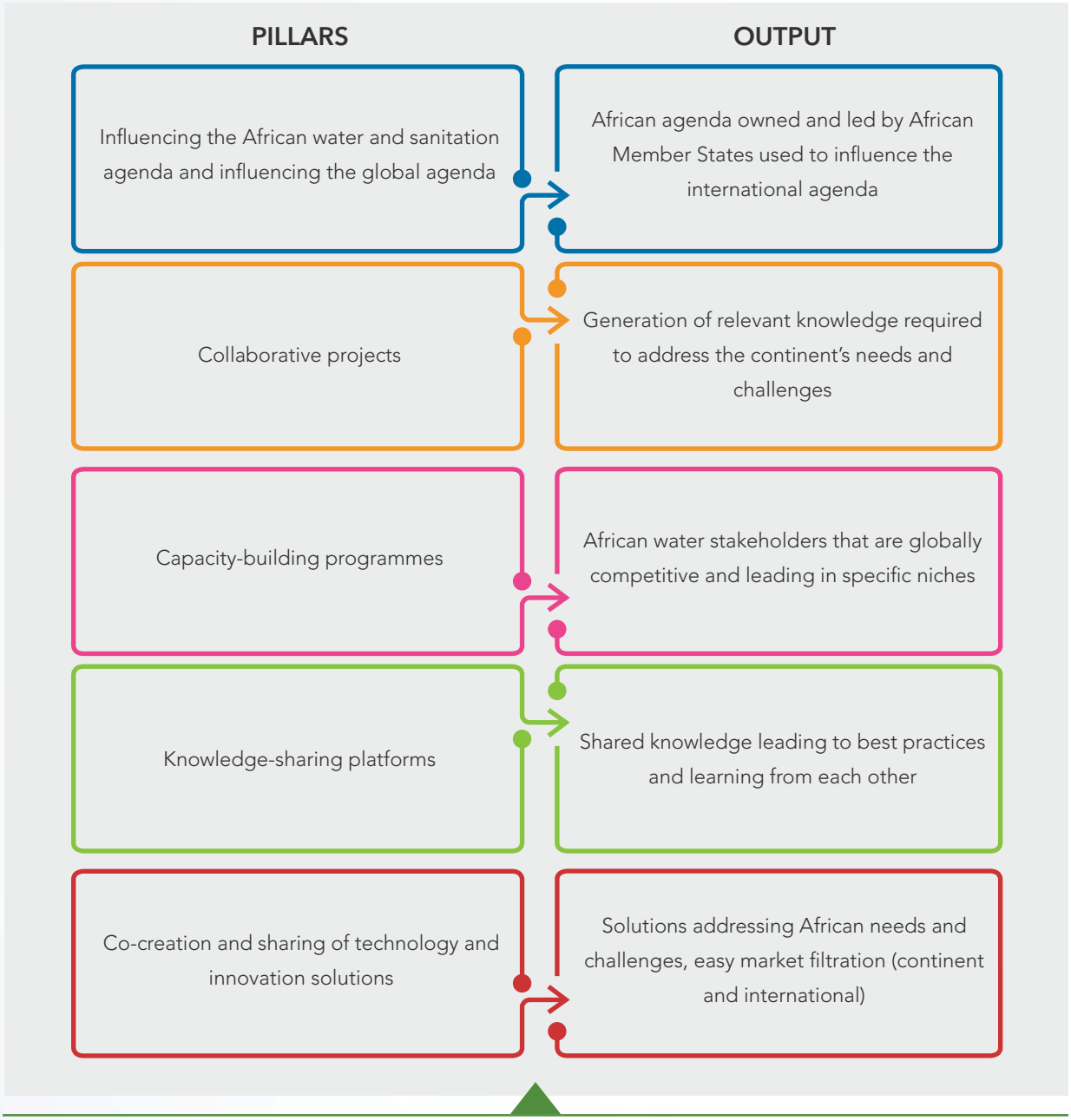



Figure 47. WRC International cooperation and partnerships pillars

The short-term goals for the implementation of the international strategy in 2018/19 are as follows:

- Establish the international value proposition and marketing material together with Communications and Marketing and Knowledge Services teams
- Commission a study to conduct a comprehensive mapping of water RDI landscapes, priorities and funding opportunities in the different regions of the world
- Revise the current international strategy, also adding the Africa 'game plan'
- Examine the feasibility and value of being a global connector, like Stockholm as the World Water Week lead convener, but for the African continent
- Identify opportunities for the WRC to join existing or new continental programmes/ projects
- Influence prioritization of water and sanitation as key programmes for the Indian Ocean Rim Association (IORA) and Southern African Development Community (SADC), capitalizing on South Africa's chairmanship

The long-term goals for the implementation of the international strategy in 2017–2020 are as follows:

- Positioning the WRC as a preferred African partner
    - Key competitive player (technical know-how)
    - Water and sanitation knowledge and key development player
    - Co-convener of international strategic events (explore hosting the SIWI-like African-led conference)

- Leverage international resources
    - Management and implementation of long-term water and sanitation programmes in the continent
    - African regional water flagship programmes (regional) with joint funding from local, regional and international partners and investors
    - Implementation of capacity-building programmes for the continent (knowledge sharing, technology transfer and solution co-development)

- WRC used as an effective and efficient water and sanitation knowledge hub for the continent
    - Partnerships with leading institutions to provide training on the continent
    - Increased water and sanitation programmes influenced by the WRC's strategic continental and global agenda
    - Prioritisation and allocation of resources for water and sanitation (IBSA, IORA, SADC, etc.)
    - Alignment of the global agenda to the African agenda

## 8.5 GROUP STRUCTURE

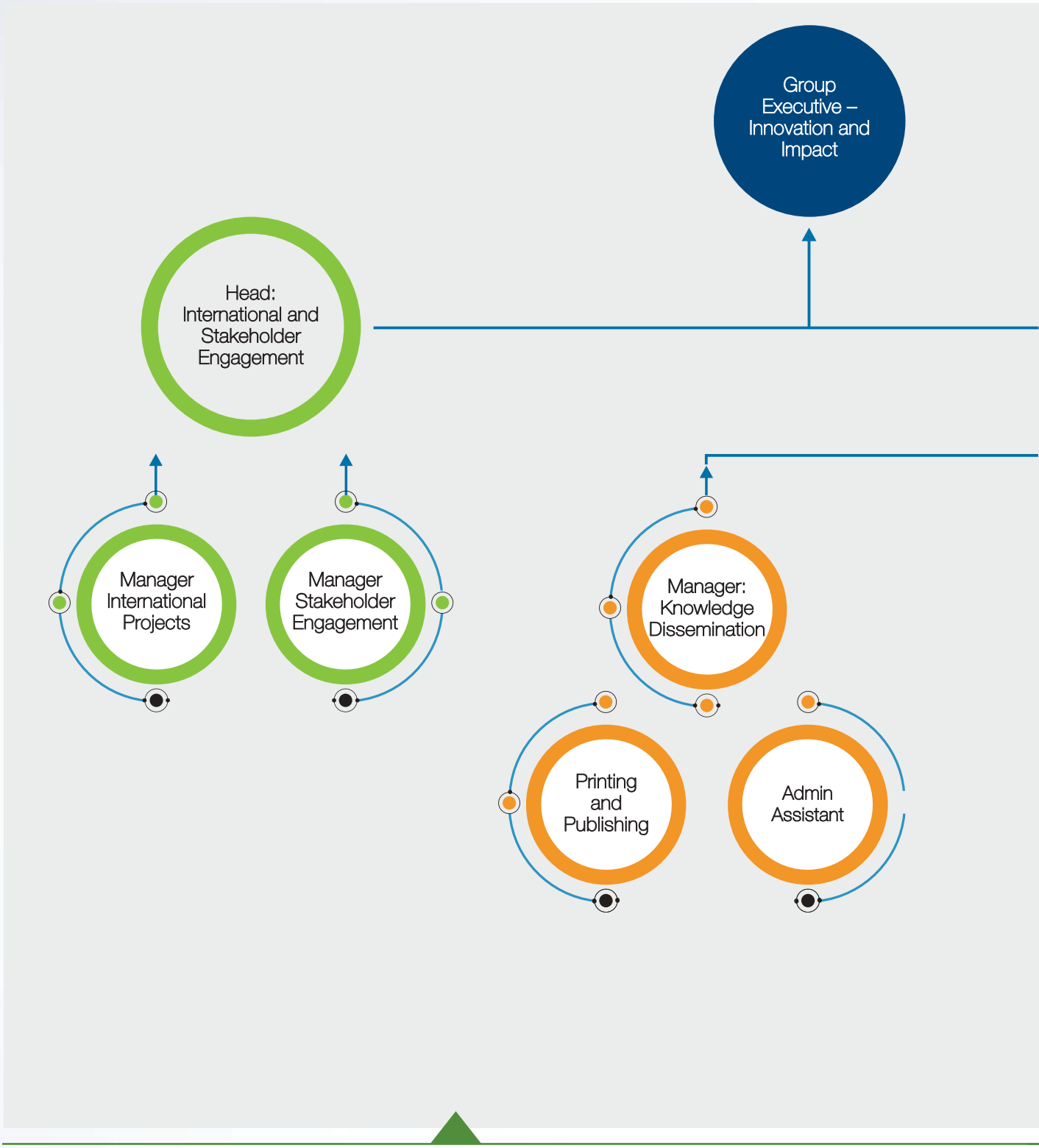
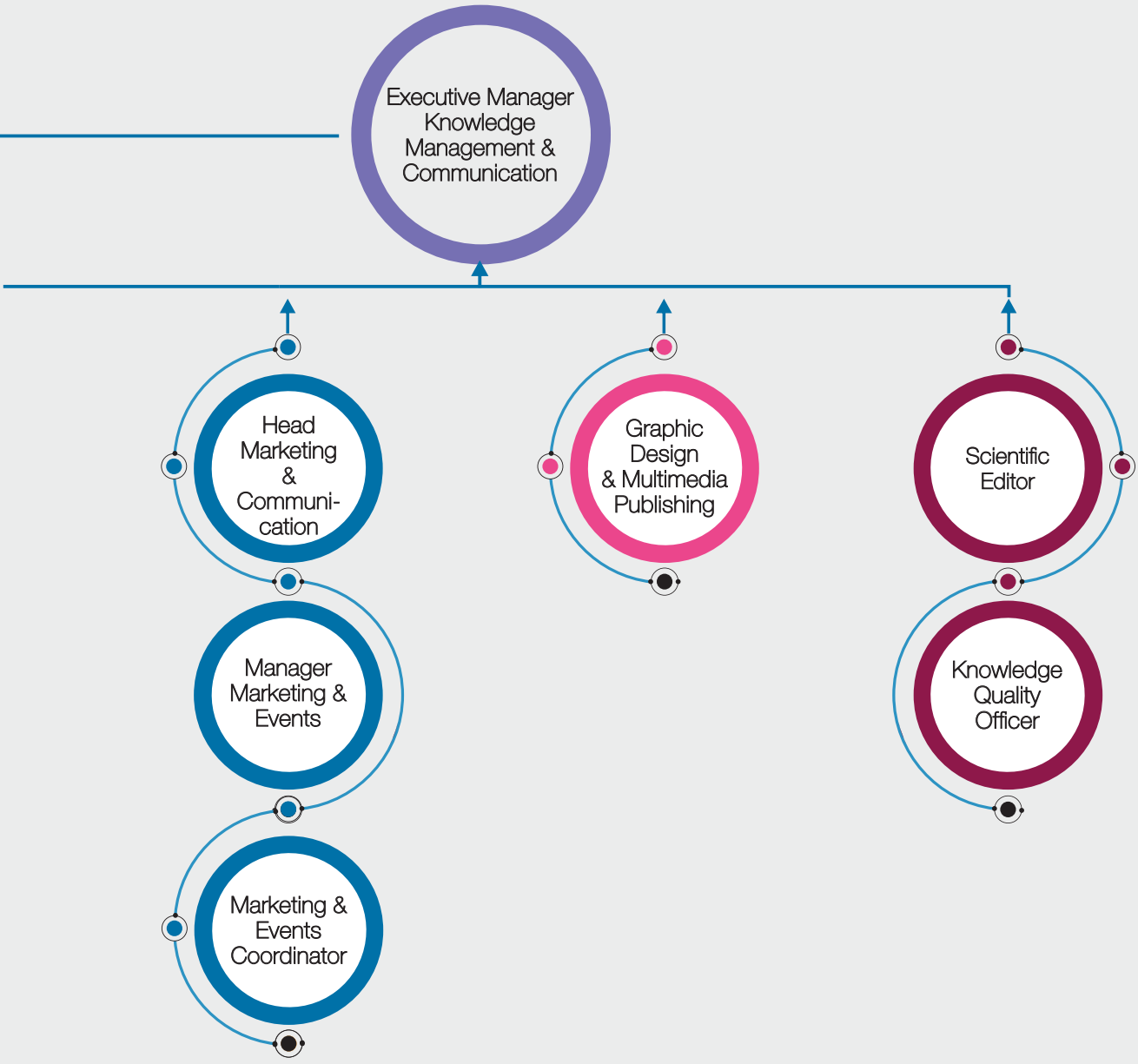



Figure 48. Group structure: Knowledge Dissemination and Stakeholder Engagement


Executive Manager Knowledge Management & Communication
Head Marketing & Communi-cation
Manager Marketing & Events
Marketing & Events Coordinator
Graphic Design & Multimedia Publishing
Scientific Editor
Knowledge Quality Officer

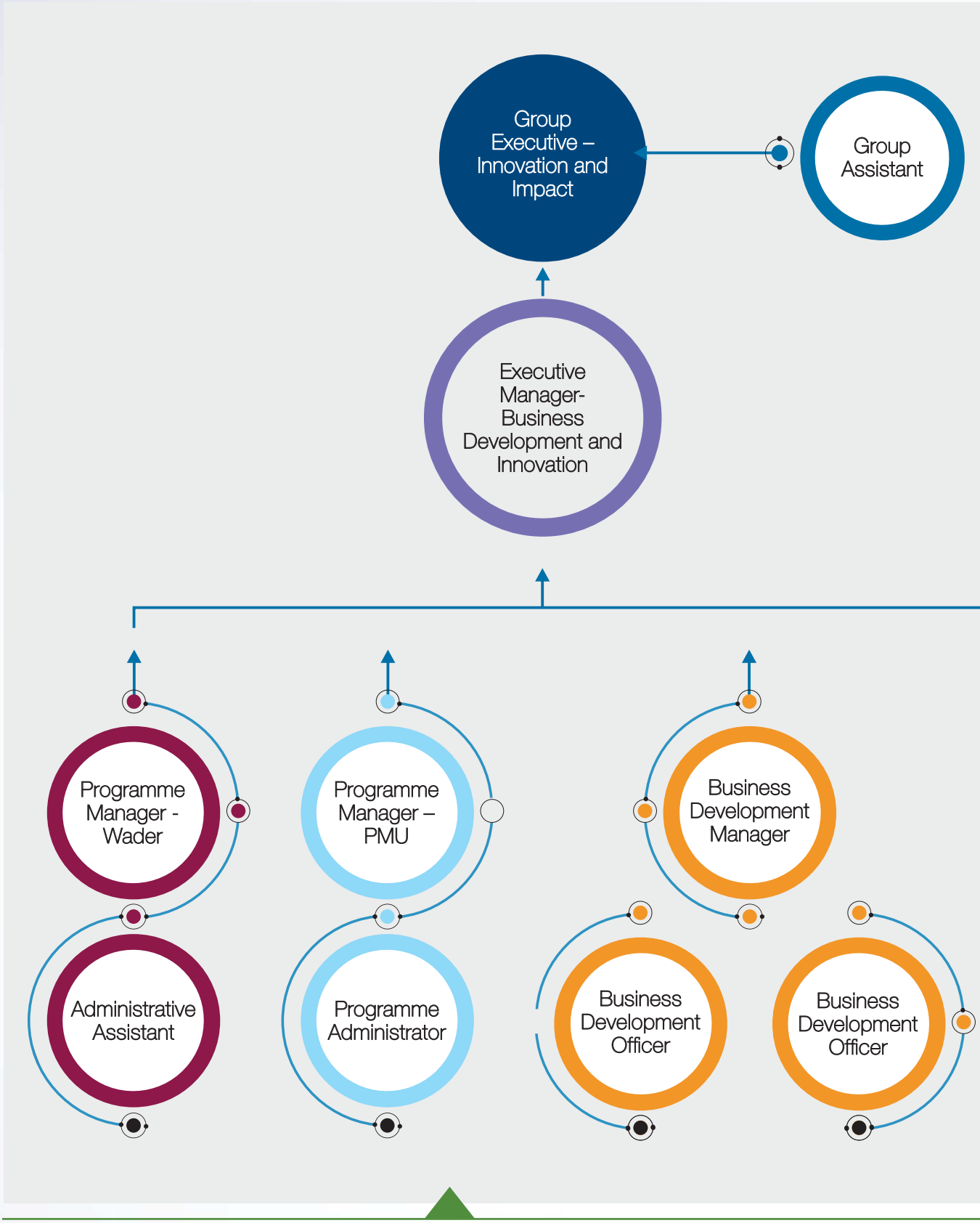
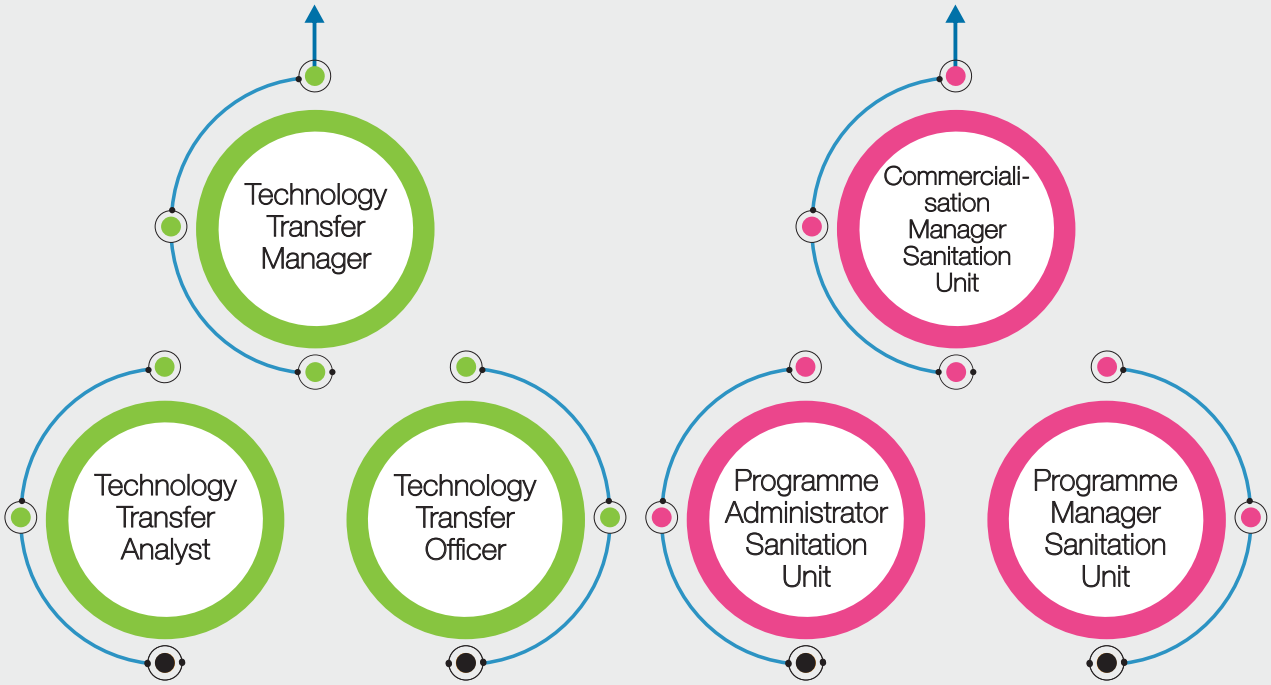



Figure 49. Group structure: Business Development and Innovation


Technology Transfer Manager
Commerciali-sation Manager Sanitation Unit
Technology Transfer Analyst
Technology Transfer Officer
Programme Administrator Sanitation Unit
Programme Manager Sanitation Unit

# 9. FINANCE

## 9.1 EXECUTIVE OVERVIEW

Over the CP19 period the Finance Branch will continue to focus on retaining the WRC's clean audit status and this means ongoing emphasis on financial reporting and compliance as core elements, which is an imperative in providing our partners and key stakeholders with the assurance of the organisation's financial soundness.

The Finance Branch will continue to enhance the financial administration, supply chain management (SCM) and reporting business processes and systems to ensure the realisation of improved efficiencies and effectiveness within those core support services.

The Branch will focus on providing the WRC with the required financial planning, structuring and support tools to refine and better understand its funding requirements and funding sources, thereby supporting the WRC vision and strategic objective of remaining financially sound and sustainable. During this period skills development and empowerment of the team, refining of business processes and IT systems deployed within the finance domain will be fundamental to ensure the successful attainment of the finance goals and objectives contained in CP19.

The key strategic focus areas, more fully described below, include:

- Improved efficiencies and effectiveness within the WRC SCM function to ensure improved turnaround times
- Enhancing the financial planning capabilities which will contribute towards creating an appropriately funded and financially stable operating environment

## 9.2 SCM AND FINANCE PLANNING FOCUS TO SUPPORT THE WRC STRATEGY DURING CP19

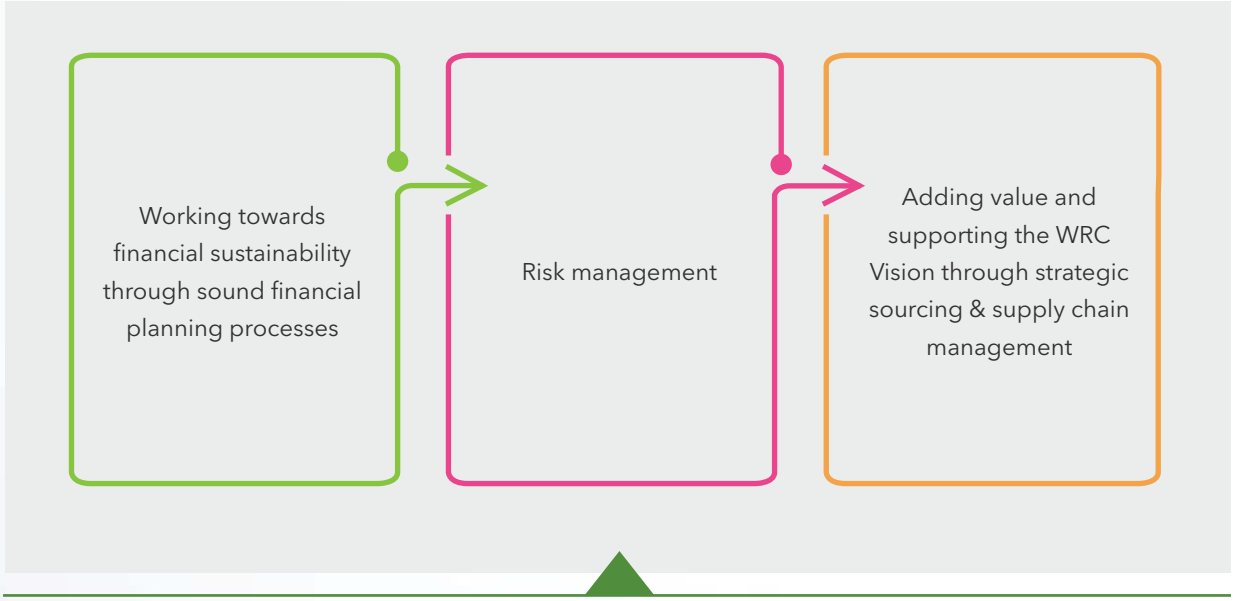



Figure 50. Enhancing the effectiveness and efficiency of the SCM function

SCM is responsible for the sourcing and procurement of all goods and services that are non-research related. This function has the potential of significantly impacting on the effectiveness of the overall WRC business operations. We recognise that over the next 5 years there is an expectation that the WRC must concentrate on greater impact and this means greater emphasis on non-research procurement including demonstrations and piloting of the research. The WRC will be working with a more diverse partnership base and this will require it to have an SCM capability that can adapt to the dynamic requirements associated with working in a partnership model, where cognizance of various stakeholder processes may have to be accommodated.

What this means is that there will be an increased demand for more sophistication with respect to SCM. Specifically, the sourcing of materials and possibly other associated professional services that may require dealing with international suppliers and service providers. This will require the following:

- Ongoing skills development and empowerment of the SCM team
- Refining the SCM business processes and making these less cumbersome without compromising the legislative requirements and compliance with the various SCM prescripts
- Where appropriate, ongoing refinement and customisation of the IT systems and technologies that are deployed within the SCM environment

The WRC sourcing and procurement strategy will continue to include:

- Awarding multi-year contracts for specific goods and services to appropriate service providers after following the required procurement and tender frameworks; this approach allows the WRC to obtain competitive pricing and enhances the efficiency of the procurement process
- Where appropriate and advantageous the WRC will consider sourcing goods and services utilising existing transversal contracts if this is favourable

In addition to being a key role player with regard to ensuring compliance with legal and other relevant prescripts SCM must always have a client service orientation. The ongoing engagement with various stakeholders and recipients of the SCM services therefore remain paramount during the design, development and implementation of the various elements required to build a more responsive and effective SCM function.

## Enhancing the financial planning business processes and capability

Figure 51 provides an overview of the key financial planning and budgeting elements that are coordinated by the Finance Branch.

*Over the CP19 period the Finance Branch will continue to focus on retaining the WRC's clean audit status and this means ongoing emphasis on financial reporting and compliance as core elements, which is an imperative in providing our partners and key stakeholders with the assurance of the organisation's financial soundness.*

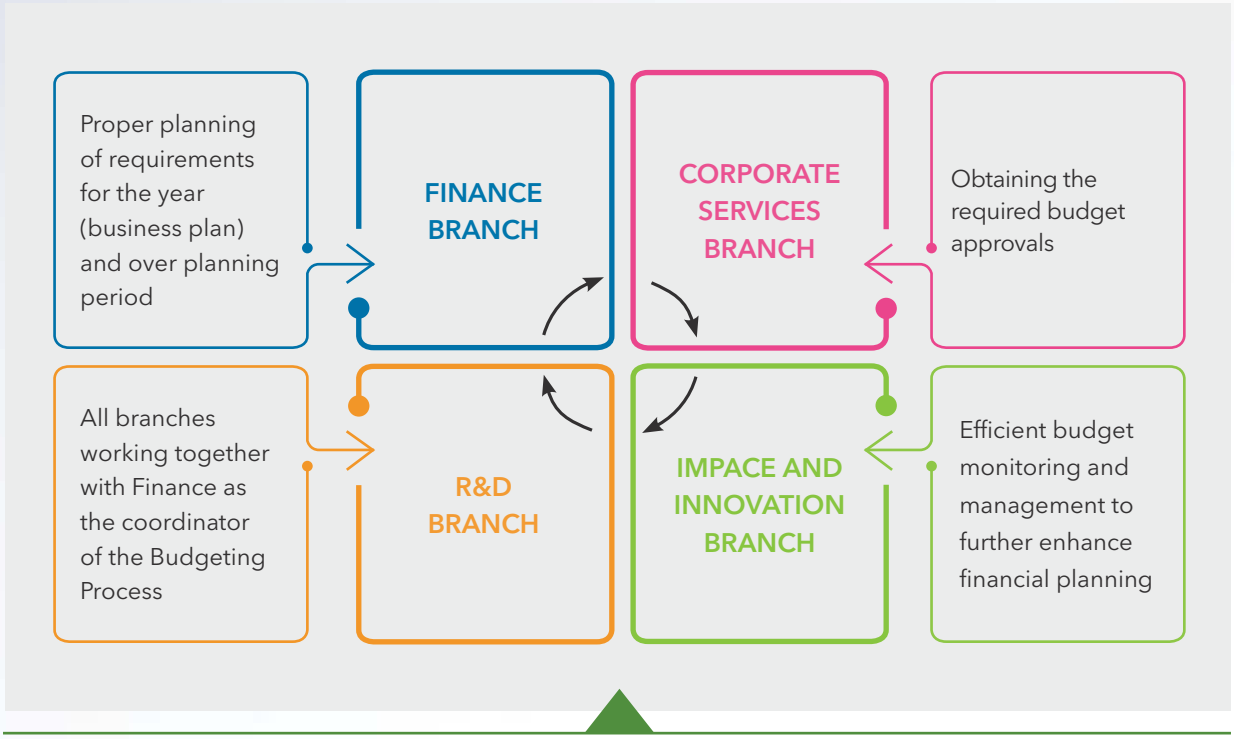



Figure 51. Key financial planning and budgeting elements coordinated by the Finance Branch

Over the planning period the areas of focus that will support the WRC goals with respect to financial sustainability include:

- Ongoing focus on the coordination of the Budget planning and formulation processes to ensure:
  - Emphasis on key financial performance indicators.
  - That revenue generation activities, in particular diversification of income streams, are planned and prioritised
  - Cost containment and cost-saving measures are fully explored and implemented
- Formalised engagement and discussions between the various WRC branches to allow the budgets and financial projections to be realistic and informed
- Ongoing cost control and expenditure monitoring processes that include:
  - Dedicated monthly and quarterly WRC financial performance meetings where revenue and expenditure analysis are reviewed
  - Ensuring corrective measures are devised where financial performance is not on target for specific areas
  - Following up on the progress in relation to corrective measures taken

**Diversification of income streams**

The current WRC funding model that is premised on a high reliance on levy income as its primary source of funding is likely to continue in the foreseeable future. However, the reality is that there are no guarantees regarding availability of funds and like other research institutions we are faced with the ongoing uncertainty related to the various phases of the economic and business cycles. There is also still a predominant view that spending on RDI is not an investment. Financial sustainability has been identified as a critical risk on the WRC risk register.

We believe that an increase in income sources is a risk-reduction strategy; adding new products, services, customers and markets to the WRC portfolio will essentially be in line with a fundamental financial planning principle which basically says 'don't put all your eggs in one basket'.

It must also be highlighted that the WRC research and development projects are generally underpinned by multi-year contracts; we also have a fixed overhead cost structure related to staff, office and other infrastructure. Therefore, the development and implementation of an income diversification strategy is vital.

The income diversification strategy development will include:

- Fully analysing the current business model and this involves looking at how do we create value, for whom we create value, are the things we do to create value consistent with our mission and vision. Once the business model is described more fully, ask some basic strategy questions:
  - Is this the business we thought we were in?
  - Is this the business we want to be in?
  - Is this the business that will sustain the organization?
- Assessing the existing revenue sources, consider: what is the cost to generate this revenue and what is the resulting net revenue, what trends are related to this revenue source, and does it have growth potential?
- Identifying new revenue sources and this will entail partnering
- Vetting the selected potential opportunities which will include developing a formal 'business case' that includes:
  - Financial modelling (with all critical assumptions clearly spelled out), including revenue and expense estimates, capital requirements, and cash flow forecasts
  - Market analysis based on both internal and external data, and more formal market research (if available), specific to the potential opportunity
  - Risk analysis that includes both the upside and downside potential
  - Staffing needs (numbers and expertise)
- A marketing plan that identifies key target markets and communications strategies
- A 'likelihood of success' analysis and an exit strategy with metrics and trigger points
- Consistency with the WRC's mission and vision

*We believe that an increase in income sources is a risk-reduction strategy; adding new products, services, customers and markets to the WRC portfolio will essentially be in line with a fundamental financial planning principle which basically says 'don't put all your eggs in one basket'.*

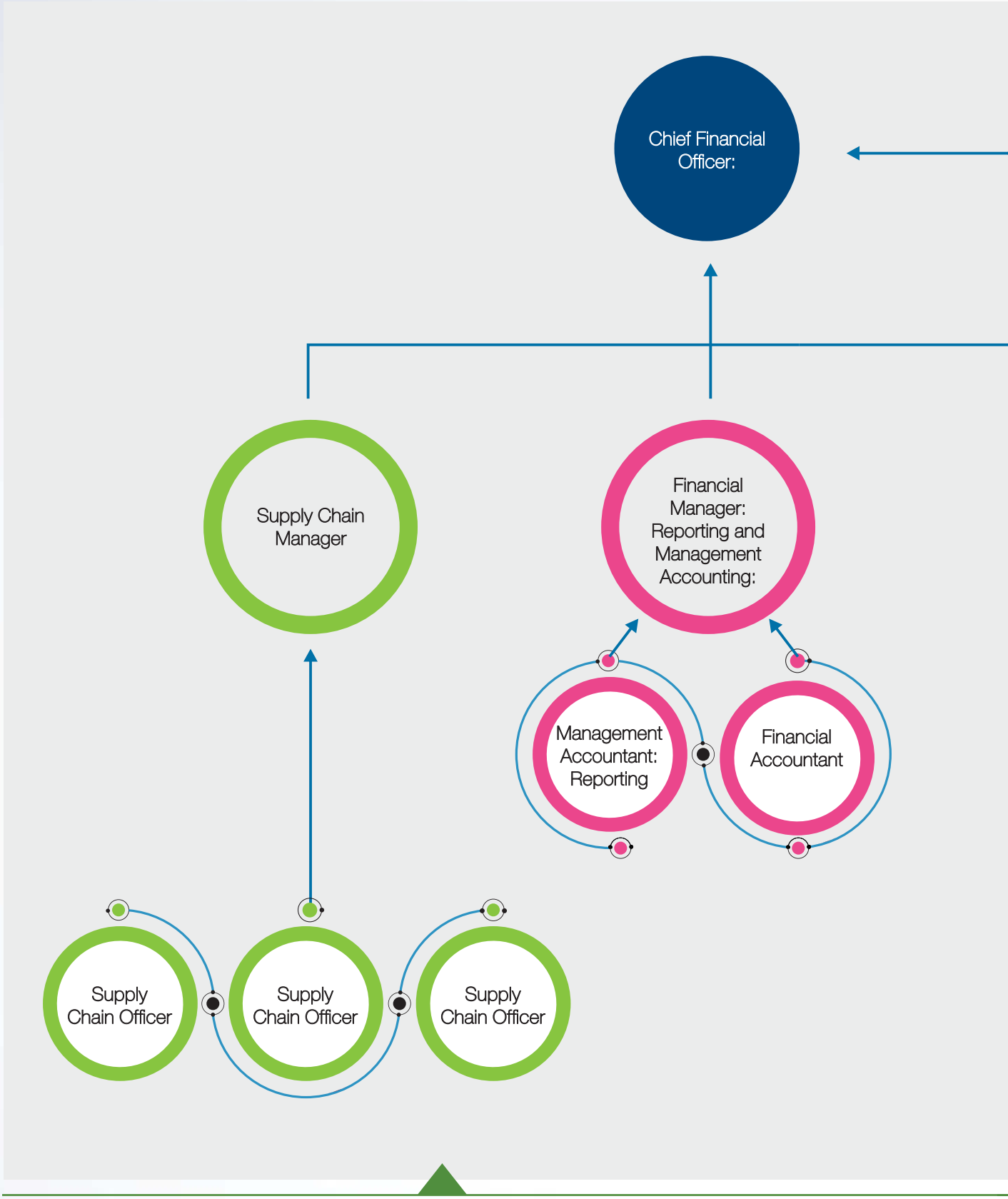
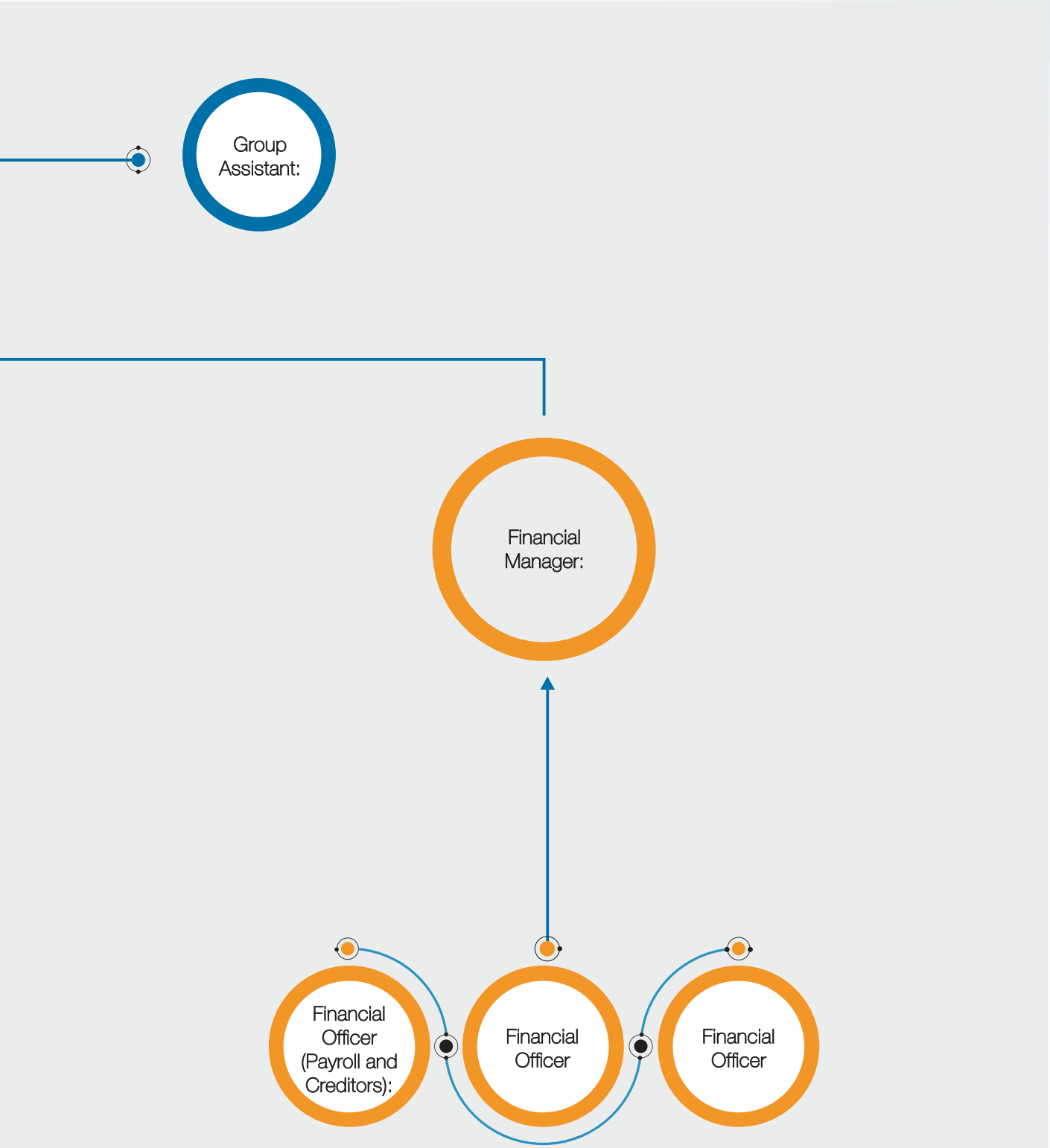



Figure 52. Finance Branch


Group Assistant:
Financial Manager:
Financial Officer (Payroll and Creditors):
Financial Officer
Financial Officer

# 10. CORPORATE SERVICES

## 10.1 INTRODUCTION

The WRC's workplace is being defined by technology and the employees that are using it, corporate social responsibility, good governance and the physical work environment.

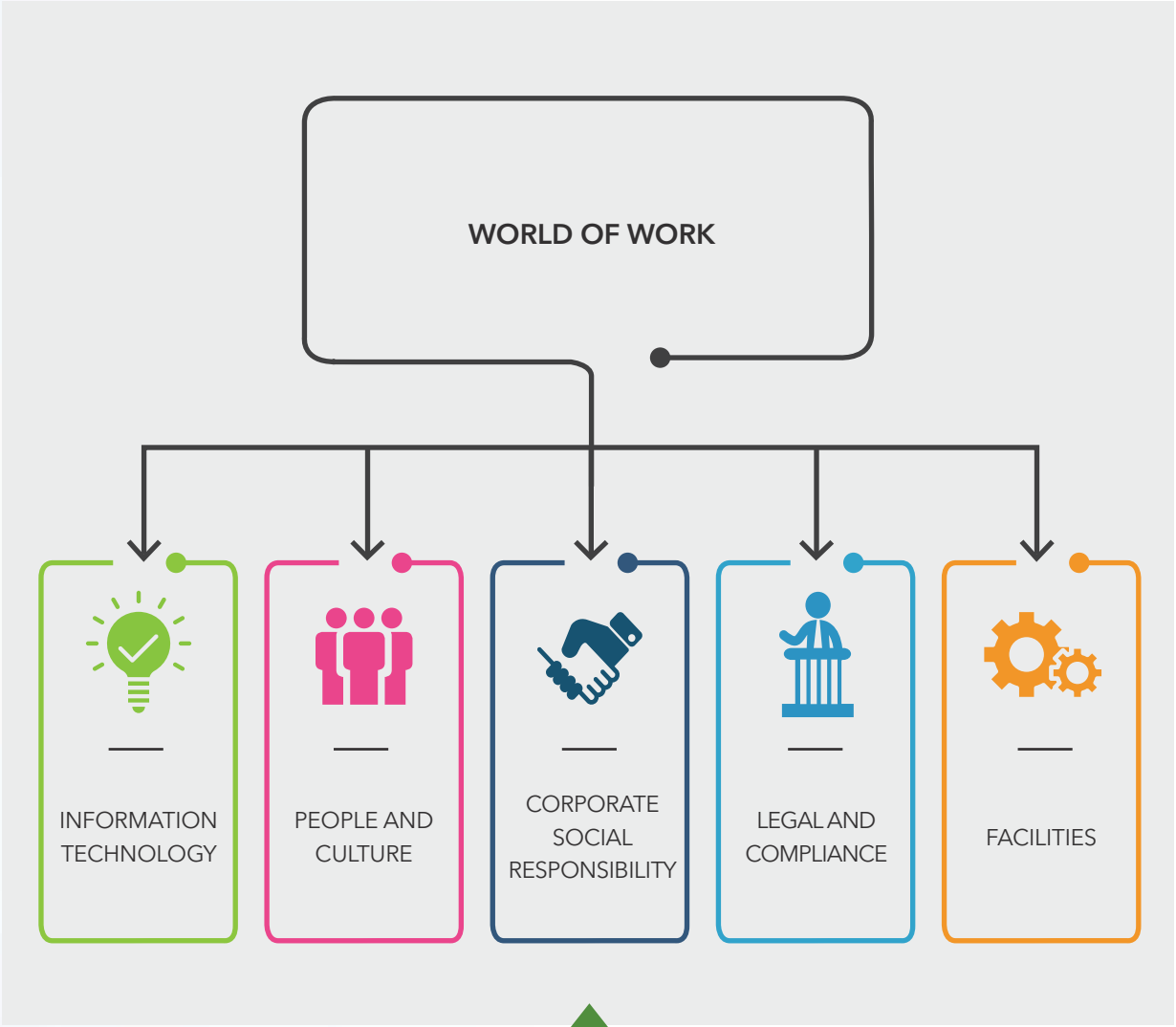



Figure 53. Corporate Services

The Internet of Everything (IoE) is enabling new forms of connectivity, changing communications and fostering new ways of working. With the plethora of devices, apps and solutions now available and growing at a phenomenal rate, to remain relevant and competitive, the WRC must move with the times, while striking a balance between current and future employee and business needs.

The Internet of Everything, enabling people globally to be connected wherever they are and whatever they are doing, has led to the rise of 'Supertaskers' – members of Generation X and Y who have honed their skills of completing several tasks efficiently and simultaneously. The dynamic is changing and the lines between work and home life are blurring as technology enables employees to make the most of what used to be wasted hours sitting in a traffic jam or a doctor's waiting room. This flexibility minimizes downtime during load shedding, which can often be a challenge in South Africa, as staff can work anywhere they find power and a Wi-Fi connection.

For the workplace, this means the emergence of a generation of workers with the potential to be highly productive. It also suggests the need to ensure that employees are given the variety of tasks they need to tap into this skill and lead to their fulfilment. It will therefore be essential to create a working environment that engages and encourages this way of thinking.

Together with ICT, another important aspect of the world of work is corporate social responsibility. This is a business management practice that incorporates social and environmental concerns into regular business activities. It encompasses many objectives ranging from the ethical treatment of employees and members of the supply chain, to safe and healthy ingredients, to environmentally-friendly/sustainable product manufacturing.

As consumers, employees expect a high level of corporate social responsibility, and not meeting those expectations can be a major turnoff.

Essentially, the WRC's Corporate Services Strategy straddles the fine line between what has traditionally worked and what will work in the future, based on the needs, strengths and mindset of the future workforce. Each new generation is progressively more Internet- and technology-focused, and also more social-responsibility focused. With this in mind the world of work must focus on human resources, information technology, governance and Facilities in an integrated approach (Fig. 53). This approach will ensure that the WRC will move to the next level in terms of business success and employee satisfaction.

## 10.2 INFORMATION TECHNOLOGY

The IT Strategy is based on the following three principles:

- **IT as an enabler of business functions (business intelligence):** IT systems that are developed and implemented to improve traditional business functions in order to improve the financial accuracy and reporting aspects of fund and project management.
- **IT as a facilitator to new impact areas:** The use of different types of media can reach different demographics. IT will play the role of facilitator because it acts as a go-between between the business itself and the new impact area.
- **IT to provide agility:** The economy, events, trends and circumstance play a part in the WRC's impact and growth. Agility is a measure of the WRC's ability to adapt and even embrace change. Technology plays a decisive role in modern business. Examples of technology that enable agile responses are: Cloud services, remote access, as-a-service products and mobility products.

The IT Strategy has five themes, which are:

- Advancing the WRC – targeted investment in key strategic areas
- Effective information stewardship – recognizing the growing importance of capturing, storing

and providing secure, effective access to a growing inventory of information
- WRC operational excellence – providing common structural solutions in support of sustainable excellence and the various departmental initiatives
- IT complexity reduction – reducing the burden of maintaining and evolving existing services to release resources that deliver new advances
- IT functional excellence – continuing to build effective processes, approaches and structures in how IT delivers projects and services

The general approach for IT finances, governance and organization is proposed to be strengthened through

- **Finances**
  - Driving IT complexity reduction to release resources to be available for new initiatives and innovation
  - Increasing central oversight of IT spend, including management of all major IT capital investments – with critical review of ongoing spend

- **IT governance**
  - Include service governance in our KPIs
  - Assess and address gaps in overall IT governance
  - Encourage and steer risk-taking IT service innovation initiatives

- **Organisation**
  - Periodic reskilling of IT resources to deliver the IT Strategy
  - Supporting a review of IT services and engagement structures across Corporate Services

## Our view of the future

The strategic vision can be viewed in overview using these three lenses:

**LENS 1: Research vision for IT**

IT provision should enhance and facilitate the WRC's world-class research. This goal is described with respect to three main areas:

- **Communication:** IT should facilitate communication within the WRC, with other institutions in the national and international context, with business and with the general public. This requires tools for collaborative working, fostering a sense of the WRC academic and research community through technology, and using data requests intelligently to understand the needs of students, researchers and the users of research outputs.
- **Infrastructure:** Researchers should be able to exploit near-state-of-the-art IT infrastructure for high-performance computing and have access to in-house expertise to make projects viable. IT provision and support should ensure excellent value for money to the benefit of both external users and our institution. IT infrastructure should reflect the changing ways in which researchers work, supporting virtualization and untethered working.
- **Data:** The WRC needs to be proactive in the 'big data' era, providing the means to access and share datasets, as well as ensuring security and resilience in data storage. IT should provide the means to both protect and exploit the institution's electronic assets.

The WRC is committed to delivering a distinctive and high-quality user experience. IT can support this significantly through:

- Higher quality interactions – where services are seamless, highly accessible (mobile), and deliver comprehensive solutions, including interactions with our in-house staff, our external researchers and general consumers
- Facilitating more responsive, inclusive and tuned collaboration environments, supporting communities both within and outside the WRC

- Fostering ongoing innovation and focused development of new services
- Supporting researchers and consumers through a full relationship lifecycle

**LENS 2: Professional services vision for IT**

Business systems within the WRC are necessarily complex because they have to both underpin the core business of research and also support the WRC's legislative and compliance agenda.

In the past, business systems were largely developed in isolation from the researcher, user or consumer community and this led to a proliferation of local applications resulting in duplication and inefficiency. More recently it has resulted in the need for major reconfigurations to existing systems to allow greater access and functionality.

The vision for the institution is therefore to move forward to a more integrated and simplified provision which promotes and facilitates collaborative working and provides data across the WRC that is fit for purpose, accessible, portable, agile, robust, accurate, timely, scalable and secure and provides comprehensive reporting solutions.

This will be achieved by turning off legacy systems, investing in integrated systems and ensuring appropriate interconnection between applications through the use of middleware solutions, to be underpinned by a comprehensive business-wide training programme. Broadly the direction is to follow an approach of 'best in class overall' rather than **'best in class for each specific requirement'.**

**LENS 3: End-user/researcher vision for IT**

The WRC is committed to delivering a distinctive and high-quality user/researcher/consumer experience. IT can support this through:

- Higher quality interactions – where services are seamless, highly accessible and deliver comprehensive solutions (including interaction with people/users who are not based in our offices)

## IT strategy themes

The IT Strategy to deliver against these future visions is encapsulated in five themes:

- **Advancing the WRC:** It is key to the strategic framework goals that energy and focus is directed towards the key areas for development and delivery. This IT theme is to deliver game-changing advances in how IT supports the key areas of academic research, knowledge dissemination and a distinctive, high-quality user experience. It will do this through a market-focused approach coupled with collaborative innovation for each of these three areas.
- **Effective information stewardship:** It is critical that greater focus with systems and procedural support is established in capturing, storing and providing effective secure access to a wide range of assimilated information sets. This will ensure (i) legal compliance, balanced with (ii) cost effective and responsive service provision, and (iii) practical procedures and guidelines to assist WRC staff and administrators to manage information most effectively.
- **Operational excellence:** In a number of areas, there are significant opportunities to improve how departments and functions operate across the WRC. This theme focuses on underlying infrastructure step-change enhancements, carbon reduction initiatives, and staff skills development which can directly contribute to such improvements.
- **IT complexity reduction:** Recognizing the current economic realities together with an existing IT provision capability which is already fully committed, it is necessary to adopt new approaches for IT delivery. A key driver of the current IT provision is technical complexity. Therefore, delivering a step-change reduction in IT complexity can facilitate a repurposing of resources to help deliver the overall IT Strategy,

particularly in the areas of data centre hardware platforms and application architecture.
- **IT functional excellence:** As a core function for an information-driven institution with high aspirations, IT needs to be striving for 'best in sector' provision of IT services and projects.

## 10.3 CORPORATE SOCIAL RESPONSIBILITY

Corporate social responsibility is the commitment by the WRC to behave ethically and contribute to economic development while improving the quality of life of its employees as well as the community and the environment in which it operates.

The principal goal of the strategy is to establish the directives necessary to achieve respect for the employees and environment, and to contribute to society.

The specific objectives of the strategy are as follows:

- Minimise impact to the environment through waste and pollution reduction
- Enhance the wellbeing of employees
- Ensure empowerment and improvement of the communities in which the WRC operates

These objectives are detailed in the following strategic focus areas/thrusts:

- Community
- Employee wellness
- Environment

Community
The WRC will contribute to communities through sustainable interventions that will result in a direct improvement in the lives and livelihoods of communities (Table 9):

- Programme 1:
  Community involvement in research projects; build capacity through knowledge transfer and training
- Programme 2:
  Use of innovations/technology from research projects in the community

Table 9. Corporate Social Responsibility implementation plan

| | OUTPUT INDICATORS | OUTCOME INDICATORS |
|---|---|---|
| PROGRAMME 1:<br>COMMUNITY INVOLVEMENT IN RESEARCH PROJECTS<br><br>PROGRAMME 2:<br>USE OF INNOVATIONS/ TECHNOLOGY FROM RESEARCH PROJECTS IN THE COMMUNITY | 1.1 To select projects that have community involvement<br><br>1.2 Use of innovations/ technology for research projects | • Build capacity through knowledge transfer and training<br>• Enhance infrastructure in the community that will result in an improved quality of life |
| | Activities for Programme 1 & 2: | |
| | 1. Proposal submitted detailing community involvement in the research project<br><br>2. The implementation of the innovation/technology from the research project in the community | |

## Employee wellness

The WRC's performance is directly influenced by the health and wellbeing of its employees. In today's dynamic environment it is critical for the WRC to step forward and invest in its human capital as a competitive advantage, and with this comes a need to nurture the wellness of its employees.

**Scope:** To improve the health and wellbeing of the WRC's employees through education and activities that will support positive lifestyle change thereby resulting in improved employee productivity and morale, and health-care cost savings for the employee and the organisation.

The fundamental **objectives** of this strategy are to:

- Improve the health and wellbeing of WRC employees
- Improve the quality of work-life
- Reduce the use of health care
- Enhance productivity

The Employee Wellness Strategy will focus on three areas of wellness (Table 10):

- Programme 1: Health management
- Programme 2: Wellness management
- Programme 3: Socio-economic wellness

**Programme 1: Health management**

**Scope:** Health management is the integrated management of health risks for chronic illness, occupational injuries and diseases, mental diseases and disability. Health management activities are efforts to promote and maintain the general health of employees through prevention, intervention, awareness, education, risk assessment and support in order to reduce the impact and effect of communicable and non-communicable diseases and injuries on the productivity and quality of life of employees.

Target areas for intervention:

- Body mass index
- Waist circumference
- Blood pressure
- Cholesterol
- Glucose
- Chronic diseases of lifestyle

**Programme 2: Wellness management**

Wellness management is the promotion of the physical, social and emotional wellness of individuals. This is achieved by creating an organisational climate and culture that is conducive to wellness and work–life balance. Wellness management strives to meet the health and wellness needs of WRC employees through preventative and curative measures, by customizing those aspects that are most relevant and fit the dynamic environment of the WRC.

Target areas for intervention:

- Smoking status
- Alcohol consumption
- Nutritional intake
- Physical activity
- Mental health

**Programme 3: Socio-economic wellness**

The current economic pressures, such as the rise in interest rates, high cost of living and economic uncertainty are major contributing factors in influencing the psycho-social wellness of employees. Many of the presenting problems, such as stress, depression, interpersonal and work-related problems, are actually caused by financial difficulties employees are experiencing. In this respect the WRC will seek financial-related interventions that assist employees.

Target areas for intervention:

- Financial planning
- Debt counselling

Table 10. Employee wellness programmes and indicators

| | OUTPUT INDICATORS | OUTCOME INDICATORS |
|---|---|---|
| **PROGRAMME 1:** HEALTH MANAGEMENT | 1.1. To provide wellness screening to employees<br>1.2. To provide health-related information | • WRC employees know their health status<br>• Employees become aware of health risks enabling early detection and treatment |
| | **Activities for Programme 1:** | |
| | 1. Fitness screening of all employees<br>2. Nutrition screening of all employees<br>3. Know-the-disease campaign | |

| | OUTPUT INDICATORS | OUTCOME INDICATORS |
|---|---|---|
| **PROGRAMME 2:** WELLNESS MANAGEMENT | 1.1. To promote individual physical wellness of employees in order to promote fitness and healthy lifestyle | • Majority of employees with a Body Mass Index of 18.5–24.9<br>• Majority of employees with waist circumference less than 88 cm for women and 102 cm for men<br>• Majority of employees with blood pressure within acceptable range<br>• Majority of employees with cholesterol within acceptable range<br>• Majority of employees with glucose level within acceptable range<br>• Majority of employees on non-smoking status<br>• Majority of employees with an alcohol consumption level within range<br>• Majority of employees with acceptable nutritional intake<br>• Majority of employees with acceptable physical activity |
| | **Activities for Programme 2:** | |
| | 1. Increase physical activity initiatives<br>2. Nutrition education programmes<br>3. Healthy eating plans (healthy meal options)<br>4. Work–life balance initiatives | |

| | OUTPUT INDICATORS | OUTCOME INDICATORS |
|---|---|---|
| **PROGRAMME 3:** SOCIO-ECONOMIC WELLNESS | 1.1. To promote individual socio-economic wellness of employees in order to decrease the related effects to employee health | • Employees who are informed of financial matters that impact on their socio- economic wellness<br>• Employees who are equipped to deal with debt issues |
| | **Activities for Programme 3:** | |
| | 1. Financial planning workshops<br>2. Debt counselling workshops | |

## Environment

The WRC acknowledges that the environment is a fundamental aspect of social responsibility. The business activity of the WRC has an impact to a greater or lesser degree on the environment.
Scope: To reduce the impact of the WRC activities on the environment and ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.

The environment strategic focus area is targeted via two programmes (Table 11):

- Programme 1: Waste and pollution reduction
- Programme 2: Green ICT

**Programme 1: Waste and pollution reduction**
Scope: To raise awareness of the impact of excessive consumption on the environment, waste and pollution reduction will be achieved through intensive recycling programmes. One of the main objectives of recycling is to reduce the amount of garbage that gets sent to landfills.

**Programme 2: Green ICT**
Scope: The alignment of WRC IT initiatives with measures that address environmental and sustainability issues. These include designing, manufacturing, using and disposing of computer systems efficiently and effectively with minimal or no impact on the environment.

Table 11. Environment programmes and indicators

| | OUTPUT INDICATORS | OUTCOME INDICATORS |
|---|---|---|
| **PROGRAMME 1:** WASTE AND POLLUTION REDUCTION | 1.1. To recycle waste from the WRC activities<br>1.2. To purchase products manufactured from recycled goods<br>1.3. To reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of products | • Reduction in landfill<br>• Reduction of pollution from landfill leachate<br>• Reduction in the depletion of natural resources by the re-use of materials<br>• Reduction of energy consumption by the reuse of materials<br>• Support to the economy as recycling creates jobs<br>• Reduce energy consumption<br>• Ensure that hazardous waste is disposed of in a way that does not harm the environment |
| | **Activities** | |
| | 1. Provision of recycling bins<br>2. Recycling campaign to increase collection of waste<br>3. Remove active screensavers:<br>o Monitors left running with active screensavers can consume the same amount of energy as when the screen is in full use<br>4. Switch monitors to standby after 10 minutes of inactivity (no active screensavers)<br>5. Shut down computers after office hours:<br>o Ensure that all users shut down their computers once they are done working so that their computers do not utilise unnecessary energy when not being used.<br>6. Ensure re-use of equipment that is no longer required. If re-use is not possible recycle or ensure green disposal:<br>o A lot of energy is consumed in the manufacture, delivery and disposal of equipment. By extending the life of a product it will save energy and materials (at the manufacturing stage) as well as purchase and disposal costs. The WRC is also committed to ensuring that recycling or disposal of all waste or retired products, is done in an environmentally friendly way.<br>7. Recycle toners and paper<br>8. Set default green printing including duplex and grey-scale by default<br>9. Optimise power-saving mode on printers | |

## 10.4 PEOPLE AND CULTURE

Changing employee expectations, new technologies, increasing globalization and a need for agility in the face of a turbulent business environment mean that tomorrow's workplace will be barely recognizable from today. With the WRC operating in a complex environment, we are already experiencing:

- An increasingly competitive market for talent compounded by significant demographic changes
- Shortage of technical and leadership skills
- Constant change brought upon by a broader stakeholder economic, political and social environment – this requires ongoing examination of the alignment of WRC priorities with national interests

For the WRC to keep pace with the changing environment its Human Resources Strategy focuses on the following three principles:

- **Agility.** A workforce that is agile and responsive, with the soft and hard skills and competencies that reflect the changing needs of the WRC – this implies identification of workforce requirements and solutions, and empowering talent with the skills, tools, systems and support needed to work more effectively, and be more adaptable.
- **High performance.** A high-calibre, motivated workforce that works in partnerships internally and externally, with an emphasis on results, innovation, solution-driven collaboration, and team performance.
- **Shared responsibility** – The WRC is 'everyone's business'. Employees at all levels of the organisation must work together and be accountable to each other to improve our ability to deliver on the WRC's mission.

### Strategic objectives

**Workplace flexibility and complexity**

The WRC is increasingly composed of an ever-shifting, complex environment of a global network of partners, business partners and outsourcing providers. As talent stretches beyond the confines of the company, Human resources (HR) teams may have to pay as much attention to people outside of the organisation as to those inside.

**Employees and technology**

The use of technology to integrate talent management into the fabric of everyday business. HR IT will become a vital component of the WRC characterised by social media, Cloud computing, mobility, and 'big data'.

**Talent management**

With a mismatch between areas of supply and demand of jobs, the WRC will be composed of a highly diverse workforce. HR will need to adopt new recruitment strategies to effectively match talent with tasks across the business. The skills gap is also widening and HR will increasingly need to ensure that the WRC has the right people. HR needs to

*Changing employee expectations, new technologies, increasing globalization and a need for agility in the face of a turbulent business environment mean that tomorrow's workplace will be barely recognizable from today.*

develop initiatives to be able to quickly tap skills when and where they are needed.

**Driving the agile WRC**

The world is becoming increasingly unpredictable and organisations that can adapt to changing business conditions will outperform. HR will fundamentally reshape itself to enable a new organisation designed around nimble and responsive talent.

**WRC's talent management that meets the science of human behaviour**

As new discoveries into human behaviour are emerging, the WRC will be investing in organizational development strategies that will begin to arm it with the tools and insights to achieve better performance from the workforce.

**The use of social media to enhance communication and employee engagement**

Social media is pervading the workplace and making it easier for employees to exchange information and ideas online. HR will play a vital role in helping build effective organisational cultures that support this, as well as incentives and processes for knowledge sharing, innovation and engagement.

**Navigating risk and privacy in a more complex world**

As the Internet continues to break down information barriers, HR will now be adopting risk management strategies covering everything from protecting confidential information and data, to risks associated with weak hiring or turnover of talent.

**Delivering seamless employee experiences**

HR will evolve from being a clearly-defined, stand-alone function to one that collaborates closely with other parts of the business, such as IT, strategy and marketing, to deliver well-rounded HR and talent management processes.

**Tapping skills anywhere, anytime**

These trends are happening now and will only get more real and impactful. A very different set of HR and talent management practices will be required, which are better suited to a highly volatile, global and knowledge-oriented age.

The implementation of the principles of agility, high performance and shared responsibility would require the following:

- That the WRC embeds a revised HR service delivery model and standardised processes across the business
- Ensure the right talent in the right place at the right time to enable the WRC's growth and innovation strategy
- Design and deliver the WRC's employee value proposition to drive employee engagement as well as cultural and organisational transformation

## Legal and compliance

In order to continually improve our role in supporting and enhancing the mandate of the WRC, Corporate Services also has the objectives to:

- To establish unified business processes in order to create a unified administration
- To enable the integration of the WRD's processes into the governance and management of the organisation
- To keep the WRC's governance structure under review to ensure that it is fit for purpose, i.e., it provides a flexible and responsive legislative and decision-making framework for the organisation
- Review of legislation
- Shorten lines of decision-making
- Distinguish between decision-making, consultation and communication; bring greater transparency to the decision-making process

## 10.5 FACILITIES

Facilities at the WRC is responsible for creating an optimal environment for the organisation's primary functions, taking an integrated view of the business infrastructure, and using this to deliver satisfaction and best value through support for and enhancement of the core business. Thus, facilities management can be described as something that will:

- Deliver effective and responsive services
- Enable changes in the use of space in the future
- 'Sweat the assets', i.e., make them highly cost effective
- Create competitive advantage for the organisation's core business
- Enhance the organisation's culture and image
- Ensure that the work environment enhances stakeholder satisfaction

Managing facilities efficiently and effectively is achieved by a robust strategy that is developed within the context of the WRC's Corporate Plan and space/accommodation strategy. These involve development of strategic objectives and a plan for facilities management, with proper reference to the overall Corporate Plan and space/accommodation strategy within which it is contained, and which considers the needs of the organisation, differentiating between core and non-core business activities.

### Facilities strategic objectives

- Identify and establish effective and manageable processes for meeting those needs
- Establish the appropriate resource needs for providing services, whether obtained internally or externally
- Identify the source of the means to finance the strategy and its practical implications

*Facilities at the WRC is responsible for creating an optimal environment for the organisation's primary functions, taking an integrated view of the business infrastructure, and using this to deliver satisfaction and best value through support for and enhancement of the core business.*

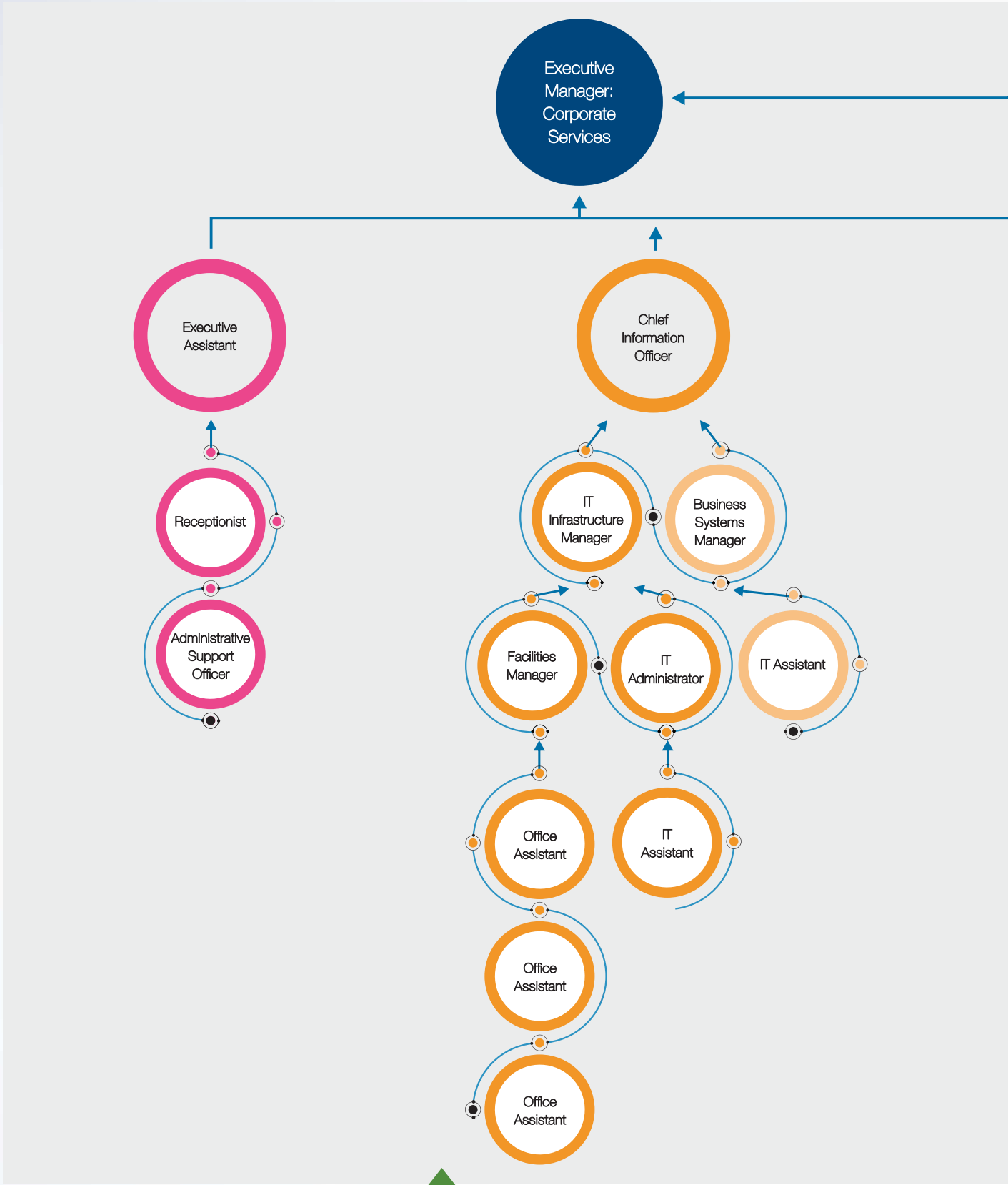
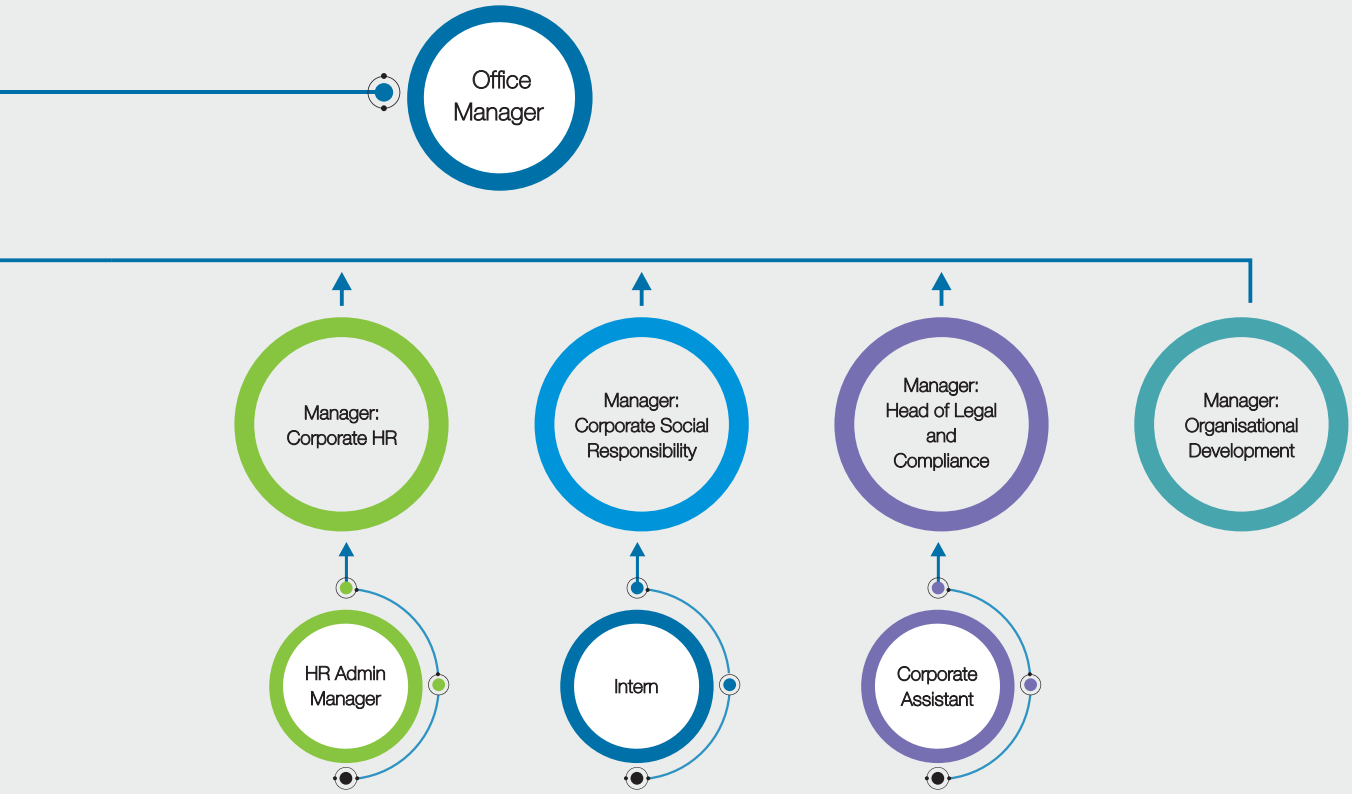



Figure 54. WRC Corporate Services


Office Manager
Manager: Corporate HR
Manager: Corporate Social Responsibility
Manager: Head of Legal and Compliance
Manager: Organisational Development
HR Admin Manager
Intern
Corporate Assistant

# 11. RISK MANAGEMENT

*The WRC's risk management framework is made up of a risk assessment which identifies internal and external risks to the WRC and details an implementation plan for their mitigation. Executive Management and the Board undertake the risk assessment annually in November. After completion of the assessment and approval by the Board, quarterly reviews of the document evaluate the progress against the plan and identify any new risks.*

The WRC Board and management team identified 12 risks as outlined in Table 12.

Table 12. Summary of WRC Risk Register

| RISK NAME | LINK TO STRATEGIC OBJECTIVE |
|---|---|
| 1. Limited availability, continuity and growth of adequate research and innovation expertise to deal with the increasing complexity in the water and sanitation sector, both institutionally and externally | • To support human capacity building in the water sector<br>• To enhance knowledge across the water knowledge and innovation cycle<br>• To support community empowerment |
| 2. Financial sustainability | • Financial sustainability & corporate wellbeing<br>• To develop new products and services (new innovations)<br>• To develop sustainable solutions |
| 3. Limited application and packing of research, solutions and technologies to maintain the water sector primarily but also across sectors (energy, industry, agriculture, mining etc) | • To enhance knowledge across the water knowledge and innovation cycle<br>• To develop sustainable solutions<br>• To inform policy and decision making<br>• To develop new products and services (new innovations)<br>• To support community empowerment |
| 4. Inadequate participation of South Africa in Research, Development and Innovation within SADC and Africa | • Financial sustainability & corporate well being |

| RISK NAME | LINK TO STRATEGIC OBJECTIVE |
|---|---|
| 5. Inability to recover quickly in the event of a disaster | • Financial sustainability & corporate wellbeing |
| 6. Fraud and corruption | • Financial sustainability & corporate wellbeing |
| 7. Losing competitive edge (Increase competition for available leverage funding) | • Financial sustainability & corporate wellbeing |
| 8. Uncertainty within the tertiary education environment | • To support human capacity building in the water sector<br>• To enhance knowledge across the water knowledge and innovation cycle<br>• To support community empowerment |
| 9. Non-compliance to Acts, Regulations, Legislations, Policies and Procedures | • Financial sustainability & corporate wellbeing<br>• To inform policy and decision making |

# 12. BUDGET

In the WRC's budget estimates over the 5-year review period we have taken a conservative approach when estimating WRC income growth. This is based on the emerging trend of a general reduction in water consumption volumes due to a number of factors, including drought. The WRC aims to have a substantial impact on the sector through improved technologies and efficiency measures. Research undertaken in water conservation and demand management are critical in the sector where water losses are exceptionally high. Furthermore, the WRC undertakes pilot studies and demonstrations in order to ensure that theoretical solutions are tested. Due to the scientific nature of the research, the cost of equipment required is impacted by scientific inflation, which is much higher than the general inflation rates.

The WRC's aim over the review period is to emphasize and strengthen the WRC's research funding and research support activities while striving to improve internal processes. The budget reflects the WRC's commitment to improve its internal processes that support its core process of knowledge creation, sharing, dissemination and transfer. Therefore, the budget reflects a change in the ratio between the WRC's investment in research & development funding, innovation and impact, and other support costs (human resource and infrastructure costs).

## 12.1 BUDGETS FOR 2019/20 TO 2023/24

The budgets and financial plans for CP19 remain effective as the budget revisions have been approved by the Executive Authority (Minister of Water and Sanitation).

## 12.2 BUDGET ESTIMATES FOR THE PERIOD 2019/20 TO 2023/24

In developing and refining the WRC budget estimates over the planning period some key revenue and cost drivers and other related assumptions based on the latest available data were considered. In the WRC's budget estimates over the five-year review period we have linked its income growth to the current trend of a general reduction in water consumption volumes as declared by Water Boards. The lower water consumption trends follow the drought and consequential water use restrictions coupled with the fact that demand historically takes time to recover.

The inflation projections utilised for the period 2019/20 to 2023/24, are in accordance with the 2019 MTEF Technical guidelines issued by National Treasury in June 2018, which are as follows:

- 2019/20 financial year: 5.3%
- 2020/21 financial year: 5.5%
- 2021/22 financial year: 5.5%

The National Treasury inflation estimate of 5.5% for 2021/22 has been carried through in the WRC budget estimates for the 2022/23 and 2023/24 financial years.

*The WRC aims to have a substantial impact on the sector through improved technologies and efficiency measures. Research undertaken in water conservation and demand management are critical in the sector where water losses are exceptionally high.*

Table 13. Budget for the five-year period 2019/20 to 2023/24

| DESCRIPTION | BUDGET ESTIMATES 2019/20 | BUDGET ESTIMATES 2020/21 | BUDGET ESTIMATES 2021/22 | BUDGET ESTIMATES 2022/23 | BUDGET ESTIMATES 2023/24 |
|---|---|---|---|---|---|
| Levy income | 261 884 068 | 288 072 475 | 316 879 723 | 348 567 695 | 383 424 464 |
| Interest received | 5 166 912 | 4 860 467 | 4 537 167 | 4 196 087 | 3 836 246 |
| Leverage income | 50 861 578 | 53 658 964 | 56 610 207 | 59 723 769 | 63 008 576 |
| Sales/ commercial income | 6 002 | 6 332 | 6 680 | 7 047 | 7 435 |
| Miscellaneous income | 124 813 | 131 677 | 138 920 | 146 560 | 154 621 |
| **Total income** | **318 043 372** | **346 729 915** | **378 172 697** | **412 641 158** | **450 431 343** |
| Fixed costs | 13 069 944 | 14 065 132 | 15 138 483 | 16 296 318 | 17 545 483 |
| Running costs | 12 381 349 | 12 981 924 | 13 612 122 | 14 273 428 | 14 967 401 |
| Human resource costs | 107 288 306 | 121 792 376 | 137 230 259 | 151 649 994 | 167 002 376 |
| Research, development and innovation costs | 178 052 843 | 191 662 564 | 205 442 933 | 222 653 579 | 241 944 324 |
| Corporate expenses | 2 963 905 | 3 126 919 | 3 298 900 | 3 480 340 | 3 671 758 |
| Capital expenditure | 4 287 026 | 3 100 000 | 3 450 000 | 4 287 500 | 5 300 000 |
| **Total expenditure** | **318 043 372** | **346 729 915** | **378 172 697** | **412 641 158** | **450 431 343** |

**Levy income**

During both the 2017 and 2018 National Stakeholder Consultation sessions for Water Research Levies the WRC requested a levy increase of 10% in order to ensure that it achieves optimum impact and delivers on its business plans. There was consensus from the water sector that the work of the WRC is highly valued and as a result there was overwhelming support for the 10% increase for the three years 2018/19 to 2020/21 for the Water Research Levy. We therefore have included a 10% year-on-year levy increase.

**Leverage income**

The leverage income budget outlook has been revised downwards over the planning period due to several factors including the current economic climate that affects all entities making it more difficult to receive funding. Several projects and programmes that were budgeted for to have a

significant impact over the planning period are now not likely to be realised due to funding challenges. This includes:

- Women Empowerment Programme: DWS is the funder of this programme and no longer has a budget to fund this programme.
- AMD Demonstration: DWS and TCTA were the funders for this project, but DWS no longer has sufficient funds.

In order to ensure that the WRC remains financially sustainable the WRC will pursue over the planning period an income diversification strategy and its successful implementation will place the entity in a robust financial position. The financial impact of this diversification strategy has not yet been embedded in the budget results and estimates. An appropriately risk-averse and conservative approach has been adopted where the known costs associated with the diversification strategy have been included in the budget forecasts. Once the potential income streams and its values are more determinable then these will also be incorporated in the budget income line.

**Human resources**

An integral part of the WRC financial sustainability is ensuring that its income diversification strategy is adequately supported and this entails an investment in business development staff capacity that will have a fulltime focus on pursuing and closing leverage income opportunities. During the 2019/20 financial year the WRC plans to recruit two business development professionals.

In pursuit of its impact strategy and in order to respond to the large demand for decision-making information from the public the WRC is bolstering its in-house research capacity and this includes recruiting three post-doctorate candidates on a contract basis during the 2019/20 financial year.

The above investment initiatives in capacity and capability are envisaged to have a positive impact on our income and its sustainability and also enhance the WRC ability to efficiently delivery on projects, thereby improving its attractiveness to potential partners.

**Research and development expenditure**

As reflected in Table 14, the expenditure on research development and innovation (RDI) is estimated to increase on a year-on-year basis by an average of 8% over the planning period. The RDI expenditure as a percentage of overall expenditure amounts to an average of 55% over the planning period.

Table 14. Research and Development expenditure as a percentage (%) of total expenditure

| | | | | | |
|---|---|---|---|---|---|
| Research, development and innovation expenditure | 178 052 843 | 191 663 564 | 205 442 933 | 222 653 579 | 241 944 324 |
| Research, development and innovation expenditure year-on-year increase (%) | - | 7.6% | 7.2% | 8.4% | 8.7% |
| Total expenditure | 318 043 372 | 346 729 915 | 378 172 697 | 412 641 158 | 450 431 343 |
| RDI expenditure as a % of total expenditure | 56% | 55% | 54% | 54% | 54% |

As reflected in Table 15, levy income is utilised to fund between 71% and 74% of the RDI expenditure over the planning period. Based on the current economic and other historical data trends levy income will remain our primary funding source for core research and impact activities in the foreseeable future. The WRC will continue to build on its partnership model and refine it with the objective of increasing leverage funding and the diversification thereof.

Table 15. Research and Development expenditure analysis of funding sources

| | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 |
|---|---|---|---|---|---|
| Leverage RDI | 50 861 578 | 53 658 964 | 56 610 207 | 59 723 769 | 63 008 576 |
| Levy RDI | 127 191 265 | 138 004 600 | 148 832 726 | 162 929 810 | 178 935 748 |
| Total Research and Development Cost | 178 052 843 | 191 663 564 | 205 442 933 | 222 653 579 | 241 944 324 |

| | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 |
|---|---|---|---|---|---|
| Leverage RDI | 29% | 28% | 28% | 27% | 26% |
| Levy RDI | 71% | 72% | 72% | 73% | 74% |
| Total Research and Development Cost | 100% | 100% | 100% | 100% | 100% |

# APPENDIX 1

## KEY PERFORMANCE INDICATORS MULTI-YEAR PERFORMANCE PLAN

The WRC's Annual Performance Plan indicator set is a life-cycle approach to measuring performance that integrates strategy, people, resources, processes and measurements to improve decision-making, transparency and accountability. The management of performance allows the WRC to learn from experiences, reflect on what has worked and what has not and adapt to the changing environment.

In using the streamlined indicator set, the WRC is able to monitor and report on results through the development and provision of integrated financial and non-financial information. This information will be used for both internal management purposes and for external accountability to the Minister of Water and Sanitation, Parliament, and the public.

# 1. IMPACT PORTFOLIO

| Objective | Indicator | Target for 2018/19 | Target for 2019/20 | Target for 2020/21 | Target for 2021/22 | Target for 2022/23 |
|---|---|---|---|---|---|---|
| **1.1 Strategic Objective: To develop innovative products and services for economic growth** | | | | | | |
| To capitalise on projects that develop intellectual property or to introduce innovations which create new or improved technologies, products and services used in the economy | The number of innovations, products and services that have been supported and/ or implemented/ demonstrated /piloted | 12 | 16 | 16 | 17 | 18 |
| **1.2 Strategic Objective: To drive sustainable development solutions** | | | | | | |
| To ensure that the WRC increasingly drives to sustainable solutions for the Water Sector by hosting events that disseminate knowledge produced from WRC research | The number of WRC Dialogues | 18 | 18 | 20 | 22 | 24 |
| | The number of conferences/summits with the WRC as a host | 2 | 2 | 3 | 2 | 3 |
| **1.3 Strategic Objective: To inform policy and decision making** | | | | | | |
| To support policy and decision makers with research based knowledge | The number of policy briefs produced and distributed to relevant government departments and other entities | 12 | 14 | 13 | 13 | 13 |
| | The number of ministerial briefs produced by the WRC and received by the Minister's Office | 14 | 14 | 15 | 15 | 15 |
| | The number of Parliamentary briefs produced and disseminated | 8 | 8 | 8 | 9 | 10 |
| | The number of working papers produced that support decision makers with research based knowledge | 6 | 8 | 8 | 10 | 10 |

# 2. PARTNERSHIPS

| Objective | Indicator | Target for 2018/19 | Target for 2019/20 | Target for 2020/21 | Target for 2021/22 | Target for 2022/23 |
|---|---|---|---|---|---|---|
| **Strategic Objective: To promote transformation and redress** | | | | | | |
| To enhance the profile of project partnership as part of the national transformation project to promote the ongoing transformation of the water research and development | To develop a strategy for historically disadvantaged institutions that assists the institutions add value to its activities in research in the water domain | Approved strategy by Executive in Q4 | 1 | n/a | n/a | n/a |
| WRC 101 to better enable researchers to participate in WRC funding instruments and specialized contracts | The number of WRC 101 workshops held in the financial year | 6 | 6 | 6 | 6 | 6 |
| **Strategic Objective: To invest in the multiplier effect by building partnerships for greater uptake and diffusion of research outputs** | | | | | | |
| To ensure that the WRC invests in the multiplier effect by partnering with strategic traditional and non-traditional partners to complement the WRC's mandate on either side of the value chain for water sector and societal impact | The number of workshops held in partnerships with other institutions | 20 | 22 | 22 | 22 | 22 |
| | The number of partnership agreements signed with partnering institutions | 4 | 4 | 5 | 6 | 6 |

# 3. RESEARCH, DEVELOPMENT AND INNOVATION PORTFOLIO

| Objective | Indicator | Target for 2018/19 | Target for 2019/20 | Target for 2020/21 | Target for 2021/22 | Target for 2022/23 |
|---|---|---|---|---|---|---|
| **Strategic Objective: To enhance knowledge across the water knowledge and innovation cycle.** | | | | | | |
| To enhance knowledge through new research projects initiated | The number of new research projects initiated in the 2018/19 financial year | 80 | 70 | 90 | 90 | 90 |
| To maintain a portfolio of projects that enhances water knowledge and the innovation cycle | The total number of RDI projects managed by the WRC in the 2018/19 financial year | 250 | 250 | 350 | 350 | 350 |
| To complete and finalize research projects scheduled in the financial year | The total number of research projects that have been completed in the 2018/19 financial year | 80 | 80 | 84 | 85 | 85 |
| **Strategic objective: To support transformation and redress and capacity building in the science and technology sector** | | | | | | |
| Growing a more inclusive water and sanitation science community of practice. | The total number of WRC managed projects led by female project leaders | 80 (32%) | 80 | 85 | 85 | 85 |
| | The total number of new projects led by female project leaders | 26 (33%) | 25 | 26 | 27 | 28 |
| | The total number of WRC managed projects led by black male project leaders | 85 (34%) | 75 | 85 | 87 | 90 |
| | The total number of new projects led by black male project leaders | 20 (25%) | 20 | 25 | 30 | 30 |

| Objective | Indicator | Target for 2018/19 | Target for 2019/20 | Target for 2020/21 | Target for 2021/22 | Target for 2022/23 |
|---|---|---|---|---|---|---|
| **Strategic objective: To support transformation and redress and capacity building in the science and technology sector *continued*** | | | | | | |
| | The total number of new projects led by black female project leaders | 20 (48%) | 10 | 15 | 20 | 10 |
| | The total number of WRC managed projects led by black female project leaders | 50 (63%) | 20 | 30 | 25 | 35 |
| Growing a more inclusive water and sanitation science community of practice. | The number of students supported on The number of students supported on all WRC managed research projects. | 300 | 250 | 300 | 200 | 310 |
| | • Postdocs, PhDs and Masters | 210 (70%) | 200 | 210 | 110 | 215 |
| | • Honours and others all WRC managed research projects. | 90 (30%) | 50 | 90 | 90 | 95 |
| **Objective** | **Indicator** | **Target for 2018/19** | **Target for 2019/20** | **Target for 2020/21** | **Target for 2021/22** | **Target for 2022/23** |
| **Strategic Objective: To develop innovative products and services for economic growth** | | | | | | |
| To increase the number of new innovations/ products and services produced from WRC Research. | The number of innovations/products and services produced from WRC research | 24 | 24 | 24 | 24 | 24 |

# 4. FINANCIAL PORTFOLIO

| Objective | Indicator | Target for 2018/19 | Target for 2019/20 | Target for 2020/21 | Target for 2021/22 | Target for 2022/23 |
|---|---|---|---|---|---|---|
| **Strategic Objective: To maintain financial and income sustainability** | | | | | | |
| To maintain income financial sustainability | The total amount of leverage income | R71 697 923 | R50 861 678 | R 82 711 981 | R 87 426 564 | R98 210 906 |
| | Initiate contracts with other organisation's that increase leverage funding | 4 | 4 | 5 | 6 | 6 |
| To diversify the income streams of the WRC | Development of Diversification Income Strategy to maintain financial sustainability | Approved Strategy | n/a | n/a | n/a | n/a |
| To improve the response to internal audit results | The percentage of the internal audit findings fully addressed | 100% of findings resolved | 100% of findings resolved | 100% of findings resolved | 100% of findings resolved | 100% of findings resolved |
| To improve the response to the external audit results | The achievement of an unqualified audit report vs a qualified audit report | Unqualified audit report to be achieved | Unqualified audit report to be achieved | Unqualified audit report to be achieved | Unqualified audit report to be achieved | Unqualified audit report to be achieved |
| | The percentage of external audit findings fully addressed | 100% of audit findings resolved | 100% of audit findings resolved | 100% of audit findings resolved | 100% of audit findings resolved | 100% of audit findings resolved |

# 5. HUMAN RESOURCES AND CORPORATE SOCIAL RESPONSIBILITY

| Objective | Indicator | Target for 2018/19 | Target for 2019/20 | Target for 2020/21 | Target for 2021/22 | Target for 2022/23 |
|---|---|---|---|---|---|---|
| **Strategic Objective: To enhance social responsibility and corporate responsibility** | | | | | | |
| | The total number of active research and non-research community based projects | 106 | 70 | 108 | 108 | 108 |
| | The total number of initiated community based research projects | 27 | 20 | 28 | 28 | 28 |
| | The total number of SMME's on WRC research projects | 120 | 70 | 68 | 68 | 68 |
| | The total number of SMME's on new WRC research projects | 20 | 10 | 22 | 22 | 22 |
| To ensure social and corporate responsibility | To maintain or increase the percentage of black, female and employees with a disability at the WRC. Measured by | | | | | |
| | • The total number of black employees | 86% | 88% | 88% | 88% | 88% |
| | • The total number of female employees | 56% | 52% | 52% | 52% | 52% |
| | • The total number of employees with a disability | 1.3% | 3% | 4% | 4% | 4% |

| Objective | Indicator | Target for 2018/19 | Target for 2019/20 | Target for 2020/21 | Target for 2021/22 | Target for 2022/23 |
|---|---|---|---|---|---|---|
| **Strategic Objective: To enhance social responsibility and corporate responsibility *continued*** | | | | | | |
| | Maintain the number of employees with Masters | 20 | 22% | 24% | 24% | 24% |
| | Maintain the number of employees with PHD's | 14 | 15% | 17% | 17% | 17% |

# APPENDIX 2

## LIST OF RESEARCH PROJECTS TO BE INITIATED IN THE 2019/ 2020 FINANCIAL YEAR

| ITEM # | PROPOSAL # | KSA | OPEN OR DIRECTED PROPOSAL | RM | TITLE | LEAD ORGANISATION | APPROVED BUDGET | APPROVED BUDGET (TOTAL) (R) | PROJECT DURATION (YEARS) (R) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1005668 | 1&2 | Open | Dr E Ubomba-Jaswa | Application of indigenous plants for remediation of contaminated water and land | University of the Witwatersrand | 89 132,00 | 250 726,00 | 3 |
| 2 | 1005769 | 1&2 | Open | Dr E Ubomba-Jaswa | Mapping informal settlement-induced water pollution and its potential impacts on human health in Tshwane Metropolitan Area | SANSA | 475 944,00 | 889 723,00 | 2 |
| 3 | 1005735 | 1&2 | Open | Dr E Ubomba-Jaswa | Development of chlorophyll-a and total suspended solids algorithms for water quality monitoring in the Inanda Dam, KwaZulu=Natal, using remotely sensed Landsat-8 imagery | University of KwaZulu-Natal | 100 000,00 | 200 000,00 | 1 |
| 4 | 1005797 | 1&2 | Open | Dr E Ubomba-Jaswa | Microplastics as emerging contaminants: methods development, ecotoxicity testing and risk assessment towards freshwater resource protection in South Africa | IWR | 400 000,00 | 1 500 000,00 | 3 |
| 5 | 1005799 | 1&2 | Open | Ms V Molose | Utilisation of indigenous knowledge in sustaining water security for human and livestock in rural communities of KwaZulu-Natal | University of KwaZulu-Natal | 300 000,00 | 1 400 000,00 | 3 |
| 6 | 1005680 | 1&2 | Open | Ms V Molose | Co-creating sustainable dam stewardship: A sociological assessment of host readiness and strategies for community-based impact monitoring of the proposed Ntabelanga Dam, Eastern Cape | University of Fort Hare | 500 000,00 | 1 500 000,00 | 3 |
| 7 | 1005718 | 1&2 | Open | Ms V Molose | Legal and Institutional barriers to community owned water supply schemes | CSIR | 300 000,00 | 300 000,00 | 1 |

| ITEM # | PROPOSAL # | KSA | OPEN OR DIRECTED PROPOSAL | RM | TITLE | LEAD ORGANISATION | APPROVED BUDGET | APPROVED BUDGET (TOTAL) (R) | PROJECT DURATION (YEARS) (R) |
|---|---|---|---|---|---|---|---|---|---|
| 8 | 1005715 | 1&2 | Open | Mr W Nomquphu | The applicability of the use of radar data to develop Areal Reduction Factors in South Africa | University of Stellenbosch | 250 000,00 | 500 000,00 | 2 |
| 9 | 1005770 | 1&2 | Open | Mr W Nomquphu | Development of a regionalised approach to estimate areal reduction factors and catchment response time parameters for improved design flood estimation in South Africa | Central University of Technology | 220 000,00 | 450 000,00 | 2 |
| 10 | 1005766 | 1&2 | Open | Mr W Nomquphu | Impacts of floods and data availability, data quality and data screening on the estimation of design floods in South Africa | University of KwaZulu-Natal | 250 000,00 | 500 000,00 | 2 |
| 11 | 1005767 | 1&2 | Open | Mr W Nomquphu | Further development, updating and assessment of the SCS-SA model for design flood estimation in South Africa using a continuous simulation approach | University of KwaZulu-Natal | 250 000,00 | 550 000,00 | 2 |
| 12 | 1005771 | 1&2 | Open | Mr W Nomquphu | Critical catchment hydrological model inter-comparison and model use guidance development | SAEON | 400 000,00 | 900 000,00 | 2 |
| 13 | 1005717 | 1&2 | Open | Mr B Madikizela | The role, benefits and prioritisation of Ecological Infrastructure (EI) in mitigating the impacts of droughts in South Africa | Rhodes University | 200 000,00 | 500 000,00 | 2 |
| 14 | 1005731 | 1&2 | Open | Dr B Petja | The application of the ESA Tiger-NET Water Observation Information System (WOIS) for the improvement of integrated water resource management (IWRM): A case study in the uMngeni catchment, KwaZulu-Natal | INR | 299 906,00 | 299 906,00 | 1 |
| 15 | 1005788 | 1&2 | Open | Dr B Petja | Adaptive sustainable stormwater drainage system: a scenario-based study of the proposed Vaal River City | Vaal University of Technology | 120 000,00 | 300 000,00 | 3 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 16 | 1005831 | 1&2 | Open | Dr B Petja | Development of Climate Change Mitigation and Adaptation Strategies for South Africa's Estuarine Lakes | CSIR | 614 606,00 | 1 844 081,00 | 3 |
| 17 | 1005777 | 1&2 | Open | Mr J Dini | Aligning land and water allocation reform processes for more equitable development in South Africa in the Inkomati-Usutu Water Management Area (IUWMA) | The Pegasys Institute NPC | 300 000,00 | 300 000,00 | 1 |
| 18 | 1005782 | 1&2 | Open | Mr J Dini | SDG indicators for SDG6 and crossover SDGs | Rhodes University | 300 000,00 | 300 000,00 | 1 |
| 19 | 1005835 | 1&2 | Open | Mr J Dini | Contributions of an ethically-grounded and value-based approach to water governance: the case of two contrasting catchments | IWR | 300 000,00 | 1 200 000,00 | 3 |
| 20 | 1005841 | 1&2 | Open | Mr J Dini | An evaluation of the OECD Water Governance Indicator and MuSSA frameworks as tools to promote dialogue, self-assessment and learning in the South African local government context | Bunker Hills Investment | 200 000,00 | 200 000,00 | 1 |
| 21 | 1005803 | 1&2 | Open | Dr S Adams | Monitoring hydrological dynamics and connectivity in non-perennial rivers using remote sensing | CSIR | 300 000,00 | 2 000 000,00 | 4 |
| 22 | 1005822 | 1&2 | Open | Dr S Adams | Smart monitoring and early warning system of sinkhole development using fibre optic sensors and InSAR | University of Johannesburg | 150 000,00 | 430 000,00 | 2 |
| 23 | 1005829 | 1&2 | Open | Dr S Adams | Enhancement of stormwater harvesting systems with real time control | University of Cape Town | 150 000,00 | 500 000,00 | 3 |
| 24 | 1005714 | 3 | Open | Mr JN Bhagwan | Hydropower Atlas for South Africa | University of Pretoria | 350 000,00 | 1 050 000,00 | 2 |
| 25 | 1005751 | 3 | Open | Mr JN Bhagwan | Assessment of water affordability in municipalities: a spatial tool | Palmer Development Group (Pty) Ltd | 300 000,00 | 600 000,00 | 2 |

| ITEM # | PROPOSAL # | KSA | OPEN OR DIRECTED PROPOSAL | RM | TITLE | LEAD ORGANISATION | APPROVED BUDGET | APPROVED BUDGET (TOTAL) (R) | PROJECT DURATION (YEARS) (R) |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 1005716 | 3 | Open | Dr N Kalebaila | Approaches to monitor and characterize the biological stability of drinking water in distribution networks | University of Pretoria | 300 000,00 | 1 000 000,00 | 3 |
| 27 | 1005793 | 3 | Open | Dr N Kalebaila | Evaluation of health risks associated with occupational exposures to biological and chemical contaminants at wastewater treatment plants and recycled water use sites | NIOH | 370 000,00 | 2 300 000,00 | 5 |
| 28 | 1005804 | 3 | Open | Dr N Kalebaila | Shotgun metagenomics investigation of the incident and risk of infection of pathogenic and antibiotic resistant campylobacter species in selected drinking water sources bodies in The Eastern Cape | Rhodes University | 300 000,00 | 1 450 000,00 | 3 |
| 29 | 1005806 | 3 | Open | Dr N Kalebaila | Detection and quantification of emerging micro-pollutants using capillary electrophoresis: A new and rapid method to monitor drinking water quality | University of the Western Cape | 320 000,00 | 800 000,00 | 3 |
| 30 | 1005809 | 3 | Open | Dr N Kalebaila | Thermoresponsive sponges for application in roof top air-water harvesting | Stellenbosch University | 200 000,00 | 400 000,00 | 1 |
| 31 | 1005860 | 3 | Open | Dr N Kalebaila | Rapid and efficient silver -gold nanoparticles interdigitated nanobiosensors arrays for water quality | Cape Peninsula University of Technology | 200 000,00 | 300 000,00 | 3 |
| 32 | 1005878 | 3 | Open | Dr N Kalebaila | Water recovery and valorisation of reject brine concentrates from desalination processes. | University of Cape Town | 200 000,00 | 350 000,00 | 3 |
| 33 | 1005728 | 3 | Open | Dr JN Zvimba | Beneficiation of waste streams for resource recovery using algal systems | Durban University of Technology | 300 000,00 | 700 000,00 | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 34 | 1005747 | 3 | Open | Dr JN Zvimba | Source separated wastewater treatment: design for the circular economy | University of KwaZulu-Natal (Howard College campus) | 350 000,00 | 1 000 000,00 | 3 |
| 35 | 1005758 | 3 | Open | Dr JN Zvimba | Resolving the complex sulphate reducing and sulphide oxidising microbial communities catalysing biogenic concrete corrosion of South African sewer systems | University of Cape Town | 250 000,00 | 500 000,00 | 2 |
| 36 | 1005816 | 3 | Open | Dr JN Zvimba | Development of an integrated wetland microbial fuel cell and sand filtration system for the on-site treatment and recycling of handwashing water | University of Cape Town | 200 000,00 | 450 000,00 | 2 |
| 37 | 1005847 | 3 | Open | Dr JN Zvimba | Re-purposing wastewater streams for urban and peri-urban agriculture: a wastewater biorefinery approach | University of Cape Town | 318 000,00 | 2 000 000,00 | 4 |
| 38 | 1005887 | 3 | Open | Dr JN Zvimba | Electrochemically driven analytical systems for screening and quantification of emerging pollutants | University of the Western Cape | 250 000,00 | 500 000,00 | 2 |
| 39 | 1005750 | 3 | Open | Dr S Pillay | Using solid substrate fermentation to produce mycelium from faecal waste | University of Cape Town | 220 000,00 | 440 000,00 | 2 |
| 40 | 1005754 | 3 | Open | Dr S Pillay | Refinement of the world's first fertilizer-producing urinal | University of Cape Town | 159 724,00 | 464 763,00 | 2 |
| 41 | 1005768 | 3 | Open | Dr S Pillay | Towards the development and standardisation of a modified helminth extraction and quantification method for sanitation samples. | University of KwaZulu-Natal | 250 250,00 | 450 250,00 | 3 |
| 42 | 1005792 | 3 | Open | Dr S Pillay | Investigating the feasibility of treating urine using eutectic freeze crystallization | University of Cape Town | 398 835,00 | 398 835,00 | 1 |
| 43 | 1005795 | 3 | Open | Dr S Pillay | Evaluation and Field Testing of an Emerging Hydrothermal Polymerisation Process for Treatment of Faecal Sludge | TruSense Consulting Services | 408 500,00 | 678 500,00 | 2 |

| ITEM # | PROPOSAL # | KSA | OPEN OR DIRECTED PROPOSAL | RM | TITLE | LEAD ORGANISATION | APPROVED BUDGET | APPROVED BUDGET (TOTAL) (R) | PROJECT DURATION (YEARS) (R) |
|---|---|---|---|---|---|---|---|---|---|
| 44 | 1005885 | 3 | Open | Dr S Pillay | An assessment of shared sanitation-related diarrhoeal risk in the eThekwini Municipality, South Africa: Faecal-pathogen contamination in community ablution blocks (CABs) | University of KwaZulu-Natal | 300 000,00 | 600 000,00 | 1 |
| 45 | 1005892 | 3 | Open | Dr S Pillay | Development of an in-situ faecal sludge solar dryer at pilot-scale | University of KwaZulu-Natal | 273 200,00 | 689 750,00 | 3 |
| 46 | 1005817 | 3 | Open | Dr S Pillay | Willingness to accept new toilet systems that save water by South Africans. A contingent valuation approach | Imperium Dynasty Group | 250 000,00 | 450 000,00 | 3 |
| 47 | 1005854 | 3 | Open | Dr S Pillay | Long-term impacts of entrenchment of pit latrine and waste water sludge | Partners in Development (Pty) Ltd | 101 900,00 | 508 592,00 | 2 |
| 48 | 1005711 | 3 | Open | Dr JE Burgess | Prediction of PAHs release from coal tars and development of photocatalytic degradation techniques from their removal from water | North-West University | 330 100,00 | 939 555,00 | 3 |
| 49 | 1005858 | 3 | Open | Dr JE Burgess | Evaluation of the long-term operation of membrane capacitive deionization: industrial scale MCDI system development | University of the Western Cape (SAIAMC) | 450 000,00 | 2 250 000,00 | 4 |
| 50 | 1005899 | 3 | Directed | Dr JE Burgess | Natsurv 18: Water and wastewater management in the South African pelagic fishing and fish processing industry | Water Group Holdings (Pty) Ltd | 425 000,00 | 1 185 000,00 | 2 |
| 51 | 1005911 | 3 | Directed | Dr JE Burgess | Guidance for attaining regulatory approval of irrigation as a large scale, sustainable use of mine water | CSV Water Consulting Engineers | 400 000,00 | 1 000 000,00 | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 52 | 1005702 | 4 | Open | Dr S Mpandeli | Water-energy-food nexus as a sustainable approach for advancing food and nutrition security and achieving SDGs 2, 6 and 7 with specific attention to efficient energy use food production | University of KwaZulu-Natal | 300 000,00 | 1 200 000,00 | 4 |
| 53 | 1005708 | 4 | Open | Dr S Mpandeli | Bioaccumulation and toxicokinetics of cyanotoxins on terrestrial food plants and the development of a novel sorbent for monitoring cyanotoxins in irrigation water | University of Venda | 300 000,00 | 1 578 500,00 | 3 |
| 54 | 1005740 | 4 | Open | Dr S Mpandeli | Water use and physical as well as economic productivity of indigenous herbal teas in the winter rainfall region | CSIR | 299 850,00 | 1 198 570,00 | 3 |
| 55 | 1005755 | 4 | Open | Dr GR Backeberg | Scoping study regarding technical and financial feasibility of alternative renewable energy sources and technologies in irrigated agriculture | Isowat Consulting cc | 300 000,00 | 1 200 000,00 | 3 |
| 56 | 1005763 | 4 | Open | Dr GR Backeberg | The state of irrigation water losses and measures to improve water use efficiency on selected irrigation schemes | ARC | 300 000,00 | 1 800 000,00 | 4 |
| 57 | 1005775 | 4 | Open | Dr S Mpandeli | Assaying water requirements and hydric stress tolerance of the South African indigenous sheep genetic resources for water food security | University of Stellenbosch | 250 000,00 | 1 100 000,00 | 3 |
| 58 | 1005784 | 4 | Open | Dr GR Backeberg | Ultra-violet (UV) treatment of irrigation water at farm level to reduce microbial contamination for improved food safety | University of Stellenbosch | 400 000,00 | 2 200 000,00 | 4 |
| 59 | 1005789 | 4 | Open | Dr S Mpandeli | Development of agricultural drought preparedness frameworks for South African croplands and grasslands | ARC - ISCW | 300 000,00 | 1 800 000,00 | 4 |

| ITEM # | PROPOSAL # | KSA | OPEN OR DIRECTED PROPOSAL | RM | TITLE | LEAD ORGANISATION | APPROVED BUDGET | APPROVED BUDGET (TOTAL) (R) | PROJECT DURATION (YEARS) (R) |
|---|---|---|---|---|---|---|---|---|---|
| 60 | 1005813 | 4 | Open | Dr GR Backeberg | The use of national scale remotely sensed evapotranspiration (ET) estimates to quantify water application and differences between plantations in commercial forestry regions of South Africa | University of Stellenbosch | 348 200,00 | 1 799 600,00 | 3 |
| 61 | 1005876 | 4 | Open | Dr S Mpandeli | Opportunities to improve operation of smallholder canal schemes in Vhembe, Limpopo Province | University of the Witwatersrand | 300 000,00 | 1 121 772,00 | 3 |
| 62 | 1005877 | 4 | Open | Dr GR Backeberg | Use of drone technology for monitoring the state of crops to improve water use productivity with precision agriculture and improved irrigation scheduling | University of KwaZulu-Natal | 300 000,00 | 1 800 000,00 | 4 |
| 63 | 1005879 | 4 | Open | Dr S Mpandeli | Consolidation and update of existing crop factors and identification of missing crop factors into a national data base using existing field measurements | CSIR | 300 000,00 | 1 200 000,00 | 3 |
| 64 | 1005914 | 4 | Open | Dr S Mpandeli | Sustainable application of livestock water footprints in different production systems and regions of South Africa. | Tshwane University of Technology | 300 000,00 | 1 200 000,00 | 3 |

# APPENDIX 3

## MATERIALITY FRAMEWORK IN TERMS OF TREASURY REGULATION 28.3

# 1. DEFINITIONS

| | | |
|---|---|---|
| Accounting Authority | - | Board of Directors |
| Executive Authority | - | Minister of Water and Sanitation |
| Entity | - | Water Research Commission |
| PFMA | - | Public Finance Management Act (Act 1 of 1999 as amended by Act 29 of 1999) |
| Treasury Regulations | - | Public Finance Management Act, 1999: amendment of Treasury Regulations in Terms of section 76 s published in Government Gazette No. 7372. |

# 2. INTRODUCTION

In terms of Treasury Regulation 28.3, the Accounting Authority must develop and agree a framework of acceptable levels of materiality and significance with the relevant executive authority.

# 3. FRAMEWORK

| **1.3 Fiduciary duties of the accounting authority (PFMA section 50)** | **Quantitative (Amount)** | **Qualitative (Nature)** |
|---|---|---|
| (1) The accounting authority must -<br>c. On request, disclose to the executive authority responsible for that public entity or the legislature to which the public entity is accountable, all material facts, including those reasonably discoverable, which in any way influence the decisions or actions of the executive authority or that legislature. | Any fact discovered of which the amount exceeds the determined materiality figure as calculated in Annexure A. | 1. Any item or event of which specific disclosure is required by law.<br>2. Any fact discovered of which its omission or misstatement, in the Board's opinion, could influence the decisions or actions of the executive authority or legislature. |
| **1.4 Annual Report and Financial Statement (PFMA section 55)** | **Quantitative (Amount)** | **Qualitative (Nature)** |
| (2) The annual report and financial statements referred to in subsection (1) (d) must – | 1. Losses through criminal conduct – any loss identified. | Any identified loss through criminal conduct. |

| **1.4 Annual Report and Financial Statement (PFMA section 55)** ***continued*** | **Quantitative (Amount)** | **Qualitative (Nature)** |
|---|---|---|
| **a. Fairly** present the state of affairs of the public entity, its business, its financial results, its performance against predetermined objectives and its financial position as at the end of the financial year concerned:<br>b. Include particulars of –<br>i. Any material losses through criminal conduct and any irregular expenditure and fruitless and wasteful expenditure that occurred during the financial year;<br>ii. Any criminal or disciplinary steps taken as a consequence of such losses or irregular expenditure or fruitless and wasteful expenditure;<br>iii. Any losses recovered or written off;<br>iv. Any financial assistance received from the state and commitments made by the state on its behalf; and<br>v. Any other matters that may be prescribed. | 2. Losses through irregular / fruitless / wasteful expenditure – if the combined total exceeds the planning materiality figure used by the external auditors for the year under review. | |
| **1.5 Annual Report and Financial Statement (PFMA section 54)** | **Quantitative (Amount)** | **Qualitative (Nature)** |
| (3) Before a public entity concludes any of the following transactions, the accounting authority for the public entity must promptly and in writing inform the relevant treasury of the transaction and submit relevant particulars of the transaction to its executive authority for approval of the transaction:<br>a. Participation in a significant partnership, trust, unincorporated joint venture or similar arrangement;<br>b. Acquisition or disposal of a significant shareholding in a company;<br>c. Acquisition or disposal of a significant asset;<br>d. Commencement or cessation of a significant business activity. | Not applicable<br>Not applicable<br>Not applicable<br>Not applicable | Any participation, outside of the approved strategic plan and budget.<br>Any acquisition or disposal, outside of the approved strategic plan and budget.<br>1. Any asset that would increase or decrease the overall operational functions of the WRC, outside of the approved strategic plan and budget.<br>2. Disposal of the major part of the assets of the WRC. Any business activity that would increase or decrease the overall operational functions of the WRC, outside of the approved strategic plan and budget. |

This framework was approved by the Board on 28 September 2018.

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Chairperson of the Board

# 4. DETERMINATION OF MATERIALITY

**1. Materiality Basis**

| MATERIALITY BASES | % USED | 2017/18 ACTUAL (R) | MATERIALITY (R) |
|---|---|---|---|
| Gross Income | 0.625% | 294 793 665 | 1 842 460 |
| Gross Expenditure | 0.625% | 298 736 471 | 1 867 103 |
| Total Assets | 1.250% | 196 035 540 | 2 450 444 |
| Net Surplus (deficit) for the Year | 6.250% | (3 942 806) | (246 425) |

**2. Materiality basis selected and the reasons therefore**

Gross income consists of levies, leverage income and investment and other revenue. Both gross income and expenditure have shown consistent growth and have been a stable proxy for the activities of the WRC over the past 3 years. Net surplus/(deficit) is derived from the difference between gross income and gross expenditure.

The WRC is not a capital-intensive entity and therefore total assets would not be considered the most appropriate basis for calculating materiality.

Whilst gross income and gross expenditure have shown consistency, gross income has historically been regarded as the most appropriate basis for the calculation of materiality and also as a good proxy for the scale of WRC business operations. All indications are that gross revenue continues to be the most reliable and representative basis for the WRC materiality calculation.

**3. Justification of figures used.**

The audited figures as at the 31st of March 2018 have been used as this constitutes the most reliable, verifiable and objective information available to use.

**4. Materiality figure**

The most appropriate indicator for the purposes of setting materiality is Gross Income. For this reason, materiality has been selected at 0.625% of Gross Income which amounts to R 1,842,460. In the previous financial year, materiality was set at R 1,914,504. The decrease in the materiality figure amounting to R72 044 (3.8%) is considered insignificant. It is furthermore noteworthy that the WRC's internal control environment has improved consistently over the past 3 years, as evidenced by the clean audit report received for the 2017/18 financial year.

# APPENDIX 4

## WRC RISK REGISTER 2018/19 FINANCIAL YEAR

| | LINK TO STRATEGIC OBJECTIVE | RISK NAME | ROOT CAUSES OF THE RISK | POTENTIAL CONSEQUENCES OF THE RISK | POTENTIAL IMPACT (WORST CASE SCENARIO) | LIKELIHOOD OF RISK OCCURRING IF NO MANAGEMENT CONTROLS ARE IN PLACE | INHERENT RISK EXPOSURE WITH NO MANAGEMENT CONTROLS IN PLACE | CURRENT BUSINESS PROCESSES / CONTROLS IN PLACE TO MANAGE IDENTIFIED RISKS | RISK OWNER | PERCEIVED CONTROL EFFECTIVENESS | PRIORITY DUE TO RESIDUAL RISK EXPOSURE | LIKELIHOOD OF RISK OCCURRING IF CONTROLS ARE IN PLACE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | To support human capacity building in the water sector<br><br>To enhance knowledge across the water knowledge and innovation cycle<br><br>To support community empower-ment | Limited availability, continuity and growth of adequate research and innovation expertise to deal with the increasing complexity in the water and sanitation sector, both institutionally and externally | Insufficient skills and competencies in the country and lack of clarity on the exact nature of the skills/competencies gap<br><br>Inadequate capability and capacity of partners, systems and processes available to ensure the development of skills, and knowledge uptake in the water sector (supervision, mentorship gap).<br><br>Inability of the sector to retain graduates<br><br>Limited career and research training opportunities<br><br>Current funding model for HEI (Higher Education Institution) is inadequate<br><br>Lack of a multi-sectoral research coordination and holistically trained and exposed graduates (transdisciplinary exposure)<br><br>Lack of collaboration between vested parties (spanning across technical, vocational, business skills). | Insufficient capacity to either identify or take advantage of opportunities<br><br>Under-performance in the areas of emerging water management challenges<br><br>Inadequate research outputs to service the water sector<br><br>Research outputs not dealing with the complexity and trans-disciplinary nature of water problems<br><br>Not meeting stakeholders needs and expectations | Critical | Likely | High | A robust and diversified WRC project portfolio to structure the sector and make it more attractive to work in at multiple levels.<br><br>Leverage additional bursary and student support funding from partners<br><br>Partnerships and collaboration with other organisations that have the capability<br><br>Capacity building as part of research contracts and research prioritisation in particular post graduate student support to develop skills in the water sector<br><br>Engagement and strengthening of relationships with research partners to facilitate implementation<br><br>Support publication and exposure of students and training material and marketing research careers (through schools, universities etc.)<br><br>Lobby for increased research funds through DWS and DST and other players partners<br><br>Strengthening of the Lighthouse programmes that accommodates transdisciplinary collaboration. social sciences interdisciplinary programme and other transdisciplinary research programmes to address to complexity in the water sector<br><br>Technical, policy, ministerial briefs and parliamentary engagement to ensure faster exposure to research outcomes.<br><br>Periodic strategic review of research portfolio<br><br>Annual reporting Strengthening and monitoring of the Knowledge Tree objectives. Developing a higher presence in career fairs with good support materials. | CEO | Satisfactory | Priority 3 | Likely |

| | LINK TO STRATEGIC OBJECTIVE | RISK NAME | ROOT CAUSES OF THE RISK | POTENTIAL CONSE-QUENCES OF THE RISK | POTENTIAL IMPACT (WORST CASE SCENARIO) | LIKELIHOOD OF RISK OCCURRING IF NO MAN-AGEMENT CONTROLS ARE IN PLACE | INHERENT RISK EXPOSURE WITH NO MANAGE-MENT CONTROLS IN PLACE | CURRENT BUSINESS PROCESSES / CONTROLS IN PLACE TO MANAGE IDENTIFIED RISKS | RISK OWNER | PERCEIVED CONTROL EFFECTIVE-NESS | PRIORITY DUE TO RESIDUAL RISK EXPOSURE | LIKELIHOOD OF RISK OCCURRING IF CONTROLS ARE IN PLACE | MITIGATING ACTION PLANS TO FURTHER ADDRESS THE RESIDUAL RISK EXPOSURE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Financial sustainability & corporate well-being<br><br>To develop new products and services (new innovations)<br><br>To develop sustainable solutions | Financial sustainability | Due to the inefficient and ineffective revenue collection processes and low collection results achieved by the DWS (Legislated Collection Agency for the WRC levies) payments of levies to the WRC are therefore substantially funded from the DWS own budget<br><br>Given that the DWS is not effectively collecting its own outstanding debts for raw water charges coupled with the significant reductions in the DWS National Treasury budget allocations, the DWS ability to continue paying WRC levies becomes significantly hampered<br><br>Challenges in attracting new leverage income partners due to changing funder priorities often impacted by changes in the economic climate.<br><br>Impact of water saving solutions (reduced volumes thereby reducing water levy, and drought (climate change) on levy | Limited ability to grow research development and innovation portfolio due to funding uncertainty<br><br>Potential negative impact on stakeholder trust relationships if cash flow and funding challenges should ever materialise<br><br>Insufficient budget to implement the strategic plan and sustain the WRC ongoing operations | Critical | Almost certain | Extreme | Renewed MOA (memorandum of agreement) of monthly payments with DWS up to 2022<br><br>Infinite period agreements for direct collection of WRC levies with two largest agencies (RW and UW)<br><br>Annual levy escalation provisions governed by legislation whereby annual increase is published in Government Gazette<br><br>Strategy to diversify funding to be approved by Executive<br><br>Regular interaction with shareholder (Department of Water and Sanitation) and stakeholders on funding issues<br><br>Prioritisation of available funds | CEO | Satisfactory | Priority 2 | Likely | Implementation of the approved Finance Diversification strategy |
| 3 | To enhance knowledge across the wa-ter knowledge and innovation cycle<br><br>To develop sustainable solutions | Limited application and packing of research, solutions and technologies to maintain the water sector primar-ily but also across sectors (energy, industry, agriculture, mining etc) | The sector not having the capability and willingness to translate what is technical and scientific to policy and decision making (what research tells us there is no capability - is it capability? Is it packaging ? Is it the lack of collaborative platforms (push vs pull) ; are we pushing too many policy shifts and not targeting the big ones? ) | Inability to rapidly make changes to sectoral practice to improve service delivery<br><br>Inappropriate research outputs | Critical | Likely | High | Development of policy and ministerial briefs to influence decision making.<br><br>Development of manuals, guidelines and support tools, e.g. dialogues, symposiums and conferences for implementation and development<br><br>Strengthen collaborative platforms with key (primary) stakeholders (incorporated below) | CEO | Satisfactory | Priority 3 | Possible | |

| | LINK TO STRATEGIC OBJECTIVE | RISK NAME | ROOT CAUSES OF THE RISK | POTENTIAL CONSEQUENCES OF THE RISK | POTENTIAL IMPACT (WORST CASE SCENARIO) | LIKELIHOOD OF RISK OCCURRING IF NO MANAGEMENT CONTROLS ARE IN PLACE | INHERENT RISK EXPOSURE WITH NO MANAGEMENT CONTROLS IN PLACE | CURRENT BUSINESS PROCESSES / CONTROLS IN PLACE TO MANAGE IDENTIFIED RISKS | RISK OWNER | PERCEIVED CONTROL EFFECTIVENESS | PRIORITY DUE TO RESIDUAL RISK EXPOSURE | LIKELIHOOD OF RISK OCCURRING IF CONTROLS ARE IN PLACE | MITIGATING ACTION PLANS TO FURTHER ADDRESS THE RESIDUAL RISK EXPOSURE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | To inform policy and decision making<br><br>To develop new products and services (new innovations)<br><br>To support community empowerment | | Institutions and strategic partners not clearly identified at beginning of research, development and innovation process and not involved in development of research questions and results and the selection of technologies<br><br>Insufficient marketing & communication between researchers across disciplines as well as researchers and the end users to facilitate the uptake of research (or are the strategies robust enough to enable uptake, application and commercialisation)<br><br>Limited engagement with the sector nationally and internationally (is it limited or do we have to reinvent ourselves?)<br><br>Mismatched information Architecture between WRC and its NSI partners<br><br>Lack of responsiveness from the sector<br><br>Lack of appetite for knowledge based research, solutions and technology<br><br>Lack of incentives (not sure what this was intended for) - for researchers, for private sector, for community based organisations, for expert bodies<br><br>Insufficient technical knowledge and support to maintain new innovations and systems in the sector.<br><br>Resistance to review and/or implement water saving technologies<br><br>Lack of knowledge from decision makers<br><br>Relevance of research not adequately assessed | Inability to take advantage of developments and contribute to improved water management and development outcomes in the country<br><br>No or little new knowledge created (translated into practice) and goods and services for economic development and best practice<br><br>Poor uptake on implementation of results (solutions)<br><br>Limited impact on research, development and innovation | Critical | Likely | High | Incorporation of research uptake and interventions into WRC research proposal template and Corporate Plan and periodic strategic review of research portfolio<br><br>Innovation and Impact branch created in the WRC to bring business development and innovation into the Research and Development space.<br><br>De-risking and direct support through demonstrations, pilots, IP and market analysis and standards development through Business Development, WADER and technology transfer unit to accelerate solutions to the "market"<br><br>Packaging of research to various technical stakeholders vs packaging of solutions for practitioners | CEO | Satisfactory | Possible | Possible | Branding and communication of products (use DWS, DST and WRC as test sites for technology solutions). WRC Board, EXCO, MANCO and employees also to be used as product samplers - adopt a community. Create Water activist. Strength website to better showcase and promote technology and the water solutions |

| | LINK TO STRATEGIC OBJECTIVE | RISK NAME | ROOT CAUSES OF THE RISK | POTENTIAL CONSEQUENCES OF THE RISK | POTENTIAL IMPACT (WORST CASE SCENARIO) | LIKELIHOOD OF RISK OCCURRING IF NO MANAGEMENT CONTROLS ARE IN PLACE | INHERENT RISK EXPOSURE WITH NO MANAGEMENT CONTROLS IN PLACE | CURRENT BUSINESS PROCESSES / CONTROLS IN PLACE TO MANAGE IDENTIFIED RISKS | RISK OWNER | PERCEIVED CONTROL EFFECTIVENESS | PRIORITY DUE TO RESIDUAL RISK EXPOSURE | LIKELIHOOD OF RISK OCCURRING IF CONTROLS ARE IN PLACE | MITIGATING ACTION PLANS TO FURTHER ADDRESS THE RESIDUAL RISK EXPOSURE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | To develop sustainable solutions<br><br>Financial sustainability & corporate well being | Inadequate participation of South Africa in Research, Development and Innovation within SADC and Africa | Limited funding for increased international partnership engagement especially with regards to joint projects.<br><br>Inhibitory travel policy limits interaction and exposure<br><br>Insufficient interaction with the international community, especially other African countries<br><br>Inadequate dissemination of research findings and marketing of WRC internationally<br><br>Limited financial instruments to support African research partnership<br><br>Budgetary constraints to promote the profile of the WRC<br><br>Limited global partnership profile of the South African technology, Science and Technology sector.<br><br>Governance systems changes (change in protocol for approval of international travel) | Limited credibility in the international water research field<br><br>Reduction in ability to attract donor and other funding<br><br>Negative impact on possible partnerships with international or non South-African research institutions<br><br>Limited potential to lead on African solutions<br><br>Insufficient research output (output might not consider other relevant practices)<br><br>Difficult for WRC to create African footprint<br><br>WRC can be regarded as a poor contributor to the national system of innovation, i.e. limited market ready products (derived from research and subsequent development and innovation) | Critical | Likely | High | Establishment of the international unit within the WRC<br><br>Improve the implementation of the WRC international strategy<br><br>Participation in international conferences and events etc.<br><br>Involvement in global, African and SADC level projects<br><br>Interaction with stakeholders on SADC, Africa and global involvement<br><br>Conducting Southern Africa wide projects with donor partners and new donor funded relationships in Southern Africa<br><br>Contracts in place with researchers to acknowledge the WRC<br><br>Innovation and Impact unit established in the WRC to focus on business development and innovation<br><br>Development of Region wide projects<br><br>Increased utilisation of technology (teleconferencing) for improved participation in International meetings | CEO | Satisfactory | Priority 3 | Likely | Continuous monitoring of the risk<br><br>Engagement with the Director General to change approval protocol |
| 5 | Financial sustainability & corporate well being | Inability to recover quickly in the event of a disaster | Theft of computer hardware<br><br>Power and water supply failure<br><br>Fire, flood, hacking, negligence<br><br>IT Viruses<br><br>Hacking into the WRC information system | Delays and disruptions in operations<br><br>Possible loss of life / injury on duty<br><br>Financial loss | Critical | Possible | Moderate | WRC continuity plan in place for all are areas (virtual operation multiple locations and sites)<br><br>Offsite backups of core systems and data, Disaster Recovery site and plans<br><br>Uninterrupted Water and Power Supply | Executive Manager Corporate Services | Good | Priority 5 | Likely | |

| | LINK TO STRATEGIC OBJECTIVE | RISK NAME | ROOT CAUSES OF THE RISK | POTENTIAL CONSE-QUENCES OF THE RISK | POTENTIAL IMPACT (WORST CASE SCENARIO) | LIKELIHOOD OF RISK OCCURRING IF NO MAN-AGEMENT CONTROLS ARE IN PLACE | INHERENT RISK EXPOSURE WITH NO MANAGE-MENT CONTROLS IN PLACE | CURRENT BUSINESS PROCESSES / CONTROLS IN PLACE TO MANAGE IDENTIFIED RISKS | RISK OWNER | PERCEIVED CONTROL EFFECTIVE-NESS | PRIORITY DUE TO RESIDUAL RISK EXPOSURE | LIKELIHOOD OF RISK OCCURRING IF CONTROLS ARE IN PLACE | MITIGATING ACTION PLANS TO FURTHER ADDRESS THE RESIDUAL RISK EXPOSURE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | | | Loss of hard copy information<br><br>Poor security control (logical access and physical control)<br><br>Failure of support services (Eskom, Post Office) | Loss of research re-sults / data (reports/ loss of knowledge base - intellectual property)<br><br>Harm to reputation<br><br>Possible rework resulting in increased cost<br><br>Legal implications | | | | Anti-virus software (renewed annually and daily updates) and Firewalls<br><br>Insurance<br><br>Emergency response teams<br><br>Evacuation plans and procedures<br><br>Fully functional private network (van)<br><br>Logical and physical access controls<br><br>Fire proof strong room for research contracts (Offsite)<br><br>Digitisation of documentation<br><br>3G and cell phone enablement<br><br>24 hour security with armed response<br><br>Outsource courier service provider<br><br>Annual simulation testing | | | | | |
| 6 | Financial sustainability & corporate well being | Fraud and corruption | Limited effectiveness of fraud and corruption prevention systems<br><br>Possible unethical behaviour<br><br>Non-adherence to policy and procedures<br><br>Effectiveness of management oversight<br><br>Opportunists (bribes, corruption, collusion)<br><br>Increase in cyber crime and inadequate cyber security | Financial loss<br><br>Operational inefficiencies<br><br>Harm to reputation<br><br>Inability to meet set performance delivery targets<br><br>Increased pressure from stakeholders<br><br>Loss of research results (reports/ loss of knowledge base – intellectual property) | Critical | Likely | High | Financial and management (reconciliatory, supervisory, etc.) controls<br><br>Monitoring daily cash balance<br><br>Segregation of duties<br><br>Audit trails<br><br>Delegation of authority<br><br>Change controls<br><br>Fraud prevention plan implemented and work shopped annually<br><br>24 hour Fraud hotline<br><br>Whistle blowing policy implemented<br><br>Code of Ethics<br><br>Establishment of a SCM unit<br><br>Management of Intellectual property - establishment of IP Office<br><br>Fraud Prevention Plan | CFO | Satisfactory | Priority 3 | Likely | Ethics Compliance for Research Projects |

| | LINK TO STRATEGIC OBJECTIVE | RISK NAME | ROOT CAUSES OF THE RISK | POTENTIAL CONSEQUENCES OF THE RISK | POTENTIAL IMPACT (WORST CASE SCENARIO) | LIKELIHOOD OF RISK OCCURRING IF NO MANAGEMENT CONTROLS ARE IN PLACE | INHERENT RISK EXPOSURE WITH NO MANAGEMENT CONTROLS IN PLACE | CURRENT BUSINESS PROCESSES / CONTROLS IN PLACE TO MANAGE IDENTIFIED RISKS | RISK OWNER | PERCEIVED CONTROL EFFECTIVENESS | PRIORITY DUE TO RESIDUAL RISK EXPOSURE | LIKELIHOOD OF RISK OCCURRING IF CONTROLS ARE IN PLACE | MITIGATING ACTION PLANS TO FURTHER ADDRESS THE RESIDUAL RISK EXPOSURE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | To enhance knowledge across the water knowledge and innovation cycle | Losing competitive edge (increased competition for available leverage funding) | External changes<br><br>High degree and rapid pace of Water RDI globally<br><br>Inadequate capacity and skills in critical domains<br><br>Loss of expertise<br><br>Other institutions entering the environment<br><br>Lack of strategic marketing and branding<br><br>Limited intelligence to dominate leverage funding market | Reputational damage<br><br>Loss of leverage funding<br><br>Loss of research partnerships and collaborations | Serious | Likely | Moderate | Environmental scanning<br><br>Development of a dynamic tactical strategy to enable the ambitions of the Corporate Plan<br><br>Development of strategic partnerships to boost talent availability and stretch resources<br><br>External reviews<br><br>International engagement processes<br><br>Local partnership strategy<br><br>WRC staff development and retention<br><br>WRC positioning strategy | CEO | Satisfactory | Priority 4 | Rare | Branding strategy and funding of Branding strategy<br><br>Tool to improve market intelligence for leverage funding |
| 8 | To support human capacity building in the water sector<br><br>To enhance knowledge across the water knowledge and innovation cycle<br><br>To support community empowerment | Uncertainty within the tertiary education environment | Tertiary education environment is uncertain<br><br>Financial pressure in the tertiary education environment may lead to research subsidy may be diverted to pay for student fees<br><br>Lack of adequate supervision and mentoring<br><br>Higher Education Model may be inappropriate | Research portfolio at risk<br><br>The future of the researcher base is at risk Increase in admin costs (overheads for non-research related costs)<br><br>Researcher and relevant expertise pipeline not sufficient<br><br>Loss of expertise to other jurisdictions<br><br>Failure to address national priorities<br><br>Failure of Universities to operate independently | Serious | Likely | Moderate | Fair number of projects are not on Tertiary campuses<br><br>Flexibility in projects (project timetables etc. has a set)<br><br>Research capacity teams are diverse<br><br>WRC student support e.g. FETwater initiative<br><br>Flexibility in project planning to accommodate PHD student support | Group Executive: Impact and Innovation<br><br>Group Executive: Research and Development | Satisfactory | Priority 4 | Likely | Flexibility of project execution (if required)<br><br>Work with partners to move current resources to areas most needed<br><br>Mentoring and Coaching for skills transfer and developing new project leaders<br><br>Develop a tertiary education support plan |

| | LINK TO STRATEGIC OBJECTIVE | RISK NAME | ROOT CAUSES OF THE RISK | POTENTIAL CONSE-QUENCES OF THE RISK | POTENTIAL IMPACT (WORST CASE SCENARIO) | LIKELIHOOD OF RISK OCCURRING IF NO MAN-AGEMENT CONTROLS ARE IN PLACE | INHERENT RISK EXPOSURE WITH NO MANAGE-MENT CONTROLS IN PLACE | CURRENT BUSINESS PROCESSES / CONTROLS IN PLACE TO MANAGE IDENTIFIED RISKS | RISK OWNER | PERCEIVED CONTROL EFFECTIVE-NESS | PRIORITY DUE TO RESIDUAL RISK EXPOSURE | LIKELIHOOD OF RISK OCCURRING IF CONTROLS ARE IN PLACE | MITIGATING ACTION PLANS TO FURTHER ADDRESS THE RESIDUAL RISK EXPOSURE |
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| 9 | Financial sustainability & corporate well being<br><br>To inform policy and decision making | Non-compliance to Acts, Regulations, Legislations, Policies and Procedures | Changes in legislation (not being monitored by the WRC as well as inability to adapt to the rapid changes in legislation)<br><br>Internal capacity to meet compliance demands<br><br>Increasing compliance requirements and reporting burden<br><br>Insufficient knowledge of new applicable legislations | Possible charges against Accounting Authority and/ or staff<br><br>Possible fines and litigation<br><br>Harm to reputation<br><br>Increased pressure from stakeholders<br><br>Qualified audit report<br><br>Potential loss of donor and partner funding<br><br>Focus too much on compliance rather than strategic issues<br><br>Health and Safety liabilities resulting in possible injuries to staff/ suspension of activities | Critical | Possible | Moderate | Good internal knowledge of the PFMA and other legislation and regulations applicable to the WRC<br><br>Good relationship with Treasury and Auditor General secures continuous updates<br><br>Ongoing training<br><br>Assessment by means of internal and external audits<br><br>Appointment of a Head of Legal and Compliance and Health and Safety representatives<br><br>Health and Safety awareness campaigns and reviews<br><br>Policies and procedures and associated internal controls exist, these are communicated to staff and compliance is monitored on a ongoing basis<br><br>Policies and procedures are reviewed and approved on an annual basis<br><br>A compliance checklists covering all relevant legislation has been developed and is planned for roll-out during the year under review. | Head of Legal and Compliance | Good | Priority 5 | Likely | Implementing of the compliance checklists |

# NOTES

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