A 10-Year Waste Research Development and Innovation Roadmap for South Africa
2015-2025

2019/20 Annual Progress Report

REFLECTING ON THE FIFTH YEAR OF IMPLEMENTATION

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

CSIR
our future through science

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FOREWORD BY
THE DEPARTMENT OF SCIENCE AND INNOVATION

The 2019/20 financial year was the fifth year of implementation of the Waste Research, Development and Innovation (RDI) Roadmap. It was also the year that the White Paper on Science, Technology and Innovation (STI) was approved by Cabinet.

THE WHITE PAPER IDENTIFIED the Circular Economy as an area for new economic growth. The Waste RDI Roadmap would be an integral part of the transition to a Circular Economy. The Department of Science and Innovation (DSI) spent the year understanding how the European Union (EU) has been implementing the transition to a Circular Economy since 2015, through the SA-EU Dialogue Facility which enabled a Symposium in South Africa and a study tour to Europe.

In terms of transformation the programme is making progress in changing the cohort of expertise available to the country, with 77% of the 22 grant funded students being black and 50% female. The majority of the students (45%) were undertaking research in Municipal Solid Waste Management, reflecting the previous grant call into this waste sector that is aligned with the Presidential approved Outcomes of the Chemicals and Waste Phakisa.

> In response to the **global concern** around **plastic in the ocean**, the WRIU issued a **targeted call for marine plastic pollution**.

The Waste Research Implementation Unit (WRIU) at the Council for Scientific and Industrial Research (CSIR) has cemented itself into the sector as a knowledge hub, setting the research agenda based on the Roadmap. Prospective post-graduate students also approach the centre to seek advice on research topics, thus ensuring that progress towards the objectives of the Waste RDI Roadmap is being made. Representation on various Material Organisations Boards by the Manager of the WRIU, also offers guidance to the sector.

In response to the global concern around plastic in the ocean, the WRIU issued a targeted call for marine plastic pollution. This was to undertake five review papers to be published in a special edition of the South African Journal of Science in 2020, which would highlight research being done in South Africa and provide the country with its own research evidence to inform policy in combating this global scourge affecting our oceans. In addition, the WRIU is funding projects using Life Cycle Sustainability Assessment (LCSA) for carrier bags, and the use of waste plastic in road construction.

What became clear in the past year is that there is a definite demand for research in the waste sector, which is stymied by a lack of funding. The funding ask for the 2019/20 financial year was R119.3 million, of which the DSI only had slightly more than 10% to offer. Closer ties to industry and other government departments such as the Departments of Environment, Forestry and Fisheries (DEFF), Trade, Industry and Competition (DTIC) and Cooperative Governance and Traditional Affairs (COGTA), will be sought in the 2020/21 year to leverage additional funding that will get closer to the ask for the Roadmap and to increase the impact of the programme. It has to be emphasised that despite the current lower than ideal levels of investment, the programme managed to fund 73 researchers at 12 institutions of which 48% are female and 45% are black. As in other academic sectors, the DSI is working on developing a programme with the Department of Higher Education and Training (DHET) to maintain black post-graduate students in academia and start transforming the principal researcher cohort to reflect what is seen in the post-graduate cohort.

I would like to thank the Waste Roadmap Implementation Unit located within the CSIR for their continued partnership and leadership in implementing the Waste RDI Roadmap.

Imraan Patel
Deputy Director-General: Socio-Economic Partnerships

MESSAGE FROM
THE WRIU MANAGER, PROF LINDA GODFREY

The 2019/20 financial year marked the fifth year of implementation of the 10-Year Waste Research, Development and Innovation (RDI) Roadmap. As a midway point, this provides an opportunity to reflect not only on the achievements of this past financial year, but on the first five years of implementation of South Africa's national science, technology and innovation strategy for the waste and secondary resources sector.

THE WASTE RDI ROADMAP IMPLEMENTATION UNIT (WRIU) is committed to implementing the three main pillars of the Roadmap – human capital development, research and development and innovation. This is achieved through a number of funding instruments such as post-graduate scholarships, grant projects and the 'Waste & Society' and 'Waste & Climate Change' SARChI Chairs. The Roadmap directly supported 30 post-graduate students in 2019/20 with another 47 students supported through the two Chairs. The WRIU supported 21 grant projects in this financial year – 9 continuing projects and 12 new projects, providing funding support not only to post-graduate students, but also to 73 researchers across 12 different universities and science councils.

The 3rd NWMS was published for public comment in late 2019. Reflecting on the policy landscape it is clear that the principles of the White Paper on Integrated Pollution and Waste Management (2000), the National Environmental Management Act (1998) and the National Environmental Management: Waste Act (NEM:WA) (2008), as amended, remain valid.

The outcomes of the Chemicals and Waste Phakisa were approved by the South African President in early 2019, and aims to enhance South Africa's waste economy by increasing the commercialisation of the circular economy and creating value from resources currently discarded as waste.

South Africa's White Paper on Science, Technology and Innovation which was published in early 2019, recognises the waste sector for its role within the circular economy, an area of new economic growth for South Africa.

The recently developed Framework for Science, Technology and Innovation for a Circular Economy in South Africa, will provide valuable context for the new Decadal Plan.

The Medium-Term Strategic Framework, Government's strategic plan for the 2019-2024 electoral term, has set out targets for the reduction of waste to landfill and the development of transition plans for high carbon emitting sectors, including the waste sector.

At the heart of national policy, is the sound management of waste and the diversion of waste away from landfill towards value-adding opportunities, including prevention of waste and the optimised extraction of value through reuse, recycling and recovery, in order to create significant social, economic, and environmental benefit for South Africa. As such, the Waste RDI Roadmap remains relevant and well positioned to continue to support these policy objectives through the development of skills, and the practical application of science, technology and innovation.

As we enter the second 5-year funding cycle (2020-2025) of the Waste RDI Roadmap, the WRIU remains committed to working closely with its stakeholders in government, business and academia to support the improved management of waste and to shape its role within the larger circular economy discourse.

> At the heart of **national policy**, is the **sound management of waste** and the **diversion of waste** away from landfill **towards value-adding opportunities**, including prevention of waste and the **optimised extraction** of value through reuse, **recycling and recovery**, in order to create significant **social, economic, and environmental benefit** for South Africa.

Prof Linda Godfrey

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BACKGROUND AND OBJECTIVES

The Waste RDI Roadmap is an initiative of the Department of Science and Technology (DST) aimed at guiding South Africa's public and private sector investment in waste research, development and innovation (RDI) over the next 10 years (2015-2025).

Vision

Development and deployment of performance improvements in waste management has delivered a significant contribution to the strengthening of a sustainable regional secondary resources economy in South Africa.

Mission

This has been achieved by means of a National Waste RDI Programme that supports maximisation of diversion of waste from landfill towards value-adding opportunities, including prevention of waste and the optimised extraction of value from reuse, recycling and recovery, in order to create significant economic, social and environmental benefit.

Background

The DST recognised the role that RDI could play in achieving the objectives of the National Waste Management Strategy, in moving waste up the hierarchy away from landfilling, and in transforming the South African waste sector in a way that could provide environmental, social and economic benefit for the country.

In 2012, the DST, in partnership with the CSIR, embarked on a process to develop the Waste RDI Roadmap. This process, which was shaped by business, industry, government and academia, culminated in early 2015 with the publication of South Africa's first Waste RDI Roadmap.

The Waste RDI Roadmap is available to review online at **www.wasteroadmap.co.za.**

Objectives

With an investment ask of approximately R3.9 billion over 10 years, the successful implementation of the Roadmap is expected to assist government and industry to significantly increase the diversion of waste away from landfill towards value-adding alternatives, through more effective decision-making; faster insertion of context-appropriate technology; export of know-how and technology; and strengthened RDI capability and capacity.

The Roadmap, which is anchored in the mandate of the DSI, is structured around three key pillars –

- human capital development (HCD)
- research and development (R&D)
- innovation (technological and social)

The Roadmap aims to address issues relating to five priority waste streams –

- municipal solid waste
- waste electrical and electronic equipment (WEEE)
- waste plastic
- organic waste
- waste tyres

Within six broad areas, or clusters, of activity –

- strategic planning
- modelling and analytics
- technology solutions
- waste logistics performance
- waste and the environment
- waste and society

Implementation

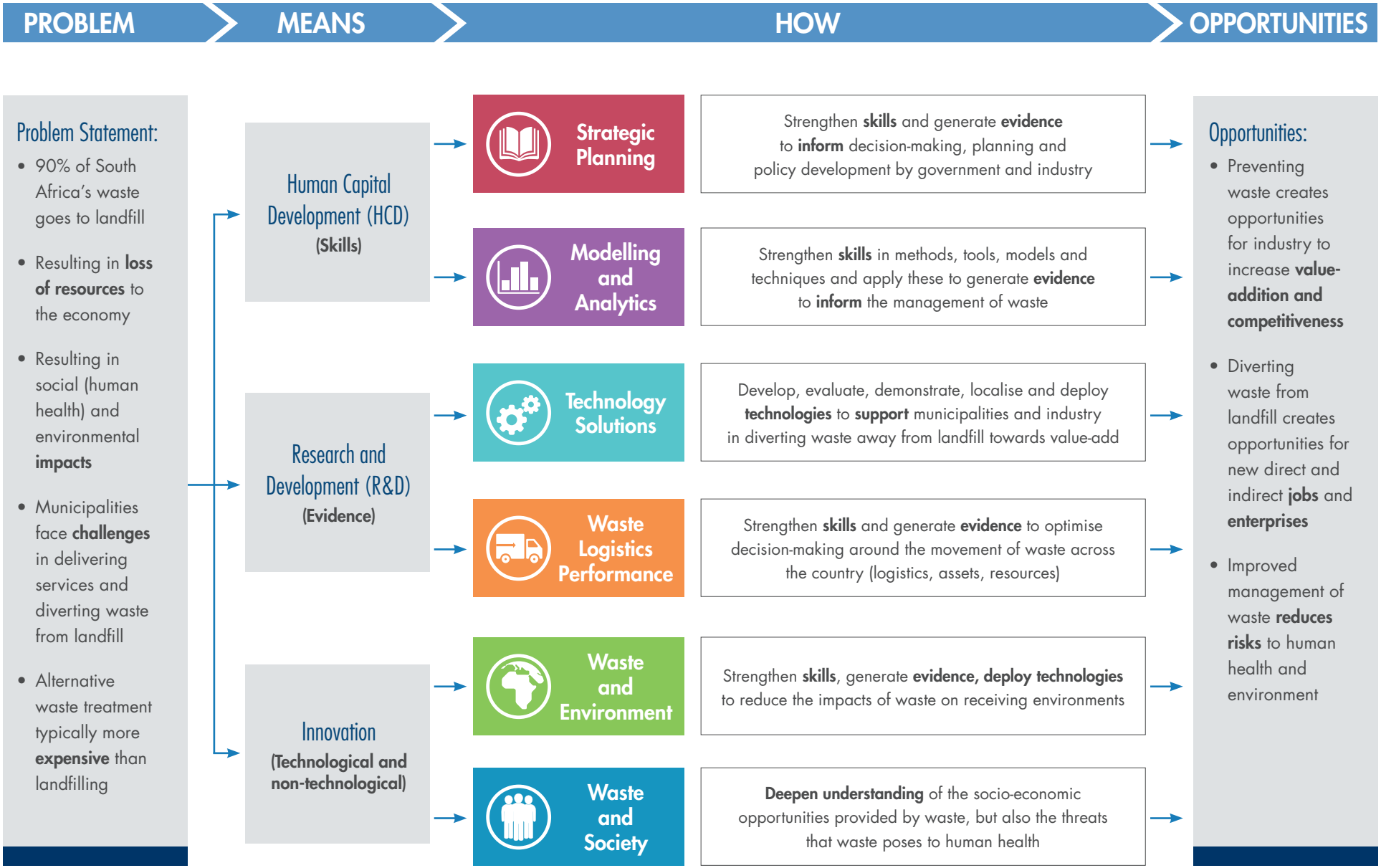
The CSIR was appointed by the DST to implement the Waste RDI Roadmap from 1 April 2015. The intention is for the CSIR, through the Waste RDI Roadmap Implementation Unit (WRIU), to drive human capital development (HCD), research and development (R&D) and innovation, in partnership with government, industry and academia; and to actively engage opportunities (local and international) for waste RDI collaboration and co-investment.

HUMAN CAPITAL DEVELOPMENT

RESEARCH & DEVELOPMENT

INNOVATION

PICTORIAL SUMMARY OF THE WASTE RDI ROADMAP



REFLECTING ON 2019/20

RESEARCH, DEVELOPMENT AND INNOVATION

29 final deliverables produced

73 researchers supported on Grant Projects

12 **new RDI grant projects awarded**

12 **successful recipient research institutions (new and existing)**

119 **MILLION RAND** of new R&D proposals received

21 research grant projects funded (new and existing)

12.8 **MILLION RAND** allocated to new targeted R&D projects

25.7 **MILLION RAND** **of committed funding for new and ongoing research projects**

HUMAN CAPITAL DEVELOPMENT

22 post-graduate students supported through grant projects

47 post-graduate students directly supported through SARChI Chairs

8 post-graduate students supported through scholarships

7 students successfully completed their degrees

1 PhD student supported through grant projects

6 Master's students supported through grant projects

COMMUNICATIONS IMPACT

POPULAR ARTICLES

25 print articles highlighting the Waste RDI Roadmap*

11 presentations made

4 radio interviews

2 television interview

TOP DOWNLOADED PUBLICATIONS

- Waste sector survey
- WEEE technology landscape assessment
- Trends in waste management
- Waste RDI Roadmap summary
- Current and required institutional mechanisms to support waste innovation

WEBSITE

4 693 UNIQUE VISITORS

7 314 NUMBER OF VISITS

65 149 PAGES VISITED

2 503 DOCUMENTS DOWNLOADED

TOP 5 COUNTRIES ACCESSING THE WASTE RDI ROADMAP WEBSITE

(*) while every effort is taken to identify print articles referencing the Waste RDI Roadmap, there may be articles which have not been picked up by the CSIR or DSI media services

HUMAN CAPITAL DEVELOPMENT (HCD)

Providing a pipeline of qualified post-graduate students into the waste and secondary resources sector with the skills to drive alternative waste treatment and to unlock opportunities

Increasing the supervisory capacity to mentor post-graduate students (honours, master's, doctoral) and post-doctoral researchers

> The Waste RDI Roadmap **provided funding for eight** (8) **scholarships** for the 2020 academic year. All eight students are **young, black South Africans** between the age of 22 and 33.

A CAPABLE PUBLIC AND PRIVATE WASTE SECTOR creates a strong foundation from which to achieve the objectives of the National Waste Management Strategy (NWMS), and transform the South African waste economy. Strengthening skills in waste management is therefore a cornerstone of the Waste RDI Roadmap.

The Roadmap has adopted the following instruments to support skills development in South Africa –

- Direct scholarships for post-graduate students
- Students supported partially or fully through Waste RDI grant projects
- Internships with organisations supported under the Waste RDI Roadmap
- SARChI Research Chairs

Post-graduate scholarships

In 2014, the Department of Science and Innovation (DSI) provided seed funding for the development of the first post-graduate degrees specialising in solid waste management in South Africa. North-West University (NWU) implemented an honours and a master's degree in Environmental Management: Specialization in Waste Management. The University of KwaZulu-Natal (UKZN) developed a new degree, a Master of Science in Engineering: Waste and Resources Management. The new UKZN MScEng saw its first intake of students in 2020. A total of 13 students were accepted into the programme, six (6) full-time and seven (7) part-time students. It is very encouraging to see the interest in this new degree.

To support full-time students registered for these new degrees, the Waste RDI Roadmap provided funding for eight (8) scholarships for the 2020 academic year. All eight students are young, black South Africans between the age of 22 and 33. It is inspiring to see the increasing number of young women entering the South African waste sector. Of the eight scholarships awarded, 50% were to young female students.

Ofentse Rabaji – NWU

Thabang Mokoena – NWU

Grant funded post-graduate students

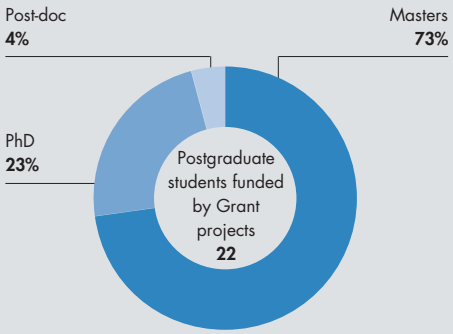
The 21 Waste RDI Roadmap grant projects funded during the 2019/20 financial year supported 22 Master's, PhD and Post-doc students (partially or fully). The grant projects remain an important mechanism for building capacity at the post-graduate level. While the Waste RDI Roadmap scholarship funding is only open to South African citizens and South African permanent residents, the grant projects are able to fund any student studying at an accredited, public Higher Education Institution in South Africa. In this way, the Waste RDI Roadmap is able to support the strengthening of waste skills not only of South Africans, but of students from across Africa and beyond.

In addition to the 17 South African post-graduate students supported on grant projects, an additional 5 students from other African countries were financially supported under the Waste RDI Roadmap. This is further discussed in the section on "Partnerships".

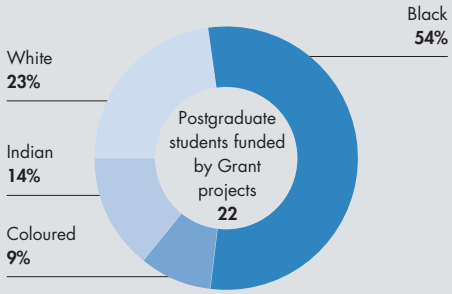
Previous years have seen a large percentage of post-graduate students working on organic waste related research projects. The focus has shifted in 2019/20, with the majority of grant funded students now working on municipal solid waste (45%), followed by waste electrical and electronic equipment (WEEE) (36%). This is the direct result of the targeted grant calls, which were published in 2016 (on WEEE) and 2018 (on MSW). This is important as the Roadmap diversifies its portfolio out to all five (5) priority waste streams and all six (6) Roadmap clusters (or focus areas).

A **capable public and private waste sector** creates a **strong foundation** from which to **achieve the objectives** of the National Waste Management Strategy, and **transform** the South African **waste economy**.

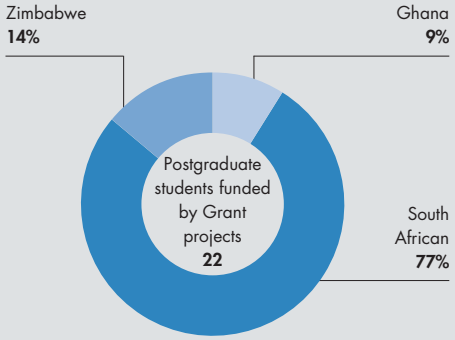
Grant funded students (by degree)



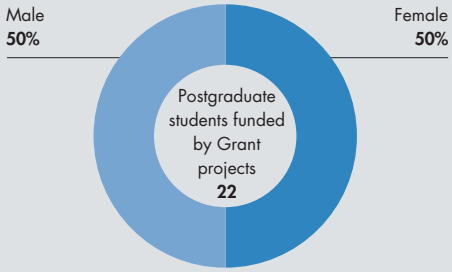
Grant funded students (by race)



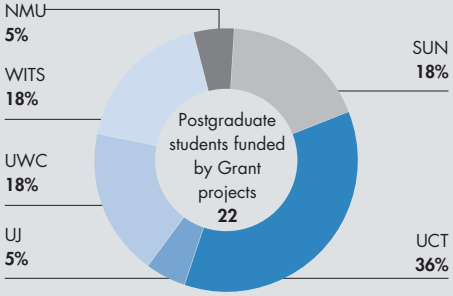
Grant funded students (by nationality)



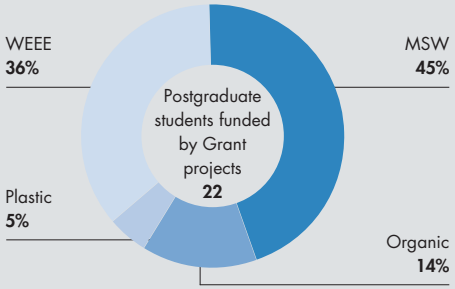
Grant funded students (by gender)



Grant funded students (by institution)



Grant funded students (by priority waste stream)



HUMAN CAPITAL DEVELOPMENT (CONTINUED)

Platforms for learning and knowledge exchange

South Africa has developed considerable expertise in waste and resource management in a developing country context, which is of growing interest to the local, regional and international waste community. The WRIU had the opportunity to share the South African perspective on waste management at a number of events in 2019/20. The rationale for participating in these events includes –

- Showcasing South Africa's waste R&D and Innovation locally and internationally
- Building local and international capacity based on South African learning
- Strengthening local and international partnerships

Creating and participating in platforms for knowledge exchange and learning, are important to achieving the objectives of the Roadmap, in particular, strengthening human capital.

International Labour Organisation (ILO)

The DSI and the CSIR were once again pleased to partner with the International Labour Organisation's training division (ILO-ITC) to present the green jobs in waste training programme in Turin, Italy, in November 2019. The training course was adapted to support the growing interest in entrepreneurship and business development in the waste sector.

The training course, entitled *"Promoting green jobs and business opportunities in the waste sector"* was attended by 15 participants from government, NGOs and business in Georgia, Ghana, Mexico, Malawi, Nigeria, Philippines, South Africa, Tunisia and Zimbabwe.

The WRIU was invited by the ILO Namibia/ Zimbabwe office to visit Zimbabwe in August 2019, to provide mentorship to the winners of the Simuka-Phakama Green enterPRIZE Innovation Challenge, an initiative of the ILO, in partnership with the Government of Zimbabwe, the Employers' Confederation of Zimbabwe, and the Zimbabwe Congress of Trade Unions. This Innovation Challenge is part of the Green enterPRIZE Innovation and Development Programme for Zimbabwe, supported by the Government of Sweden.

Participants of the ILO Green Jobs Training Programme, Turin, Italy, November 2019

> The WRIU continues to play a **mentorship role** to local and international **post-graduate students** in **shaping their research projects**.

International Solid Waste Association

The WRIU participated in the ISWA2019 Conference held in Bilbao, Spain from the 7-9 October 2019. This was the first time South Africa was represented as a national member of ISWA. The conference was attended by representatives from the Institute of Waste Management of Southern Africa (IWMSA), Department of Environment, Forestry and Fisheries (DEFF), and the DSI/NRF SARChI Chair in Waste & Society.

The WRIU made a presentation entitled *"Driving a transition from open dumping to a circular economy through research, development and innovation"*, Godfrey & Roman (2019)

Institute of Waste Management of Southern Africa

Prof Godfrey of the WRIU was invited to make the keynote presentation at the IWMSA Landfill Conference held in Cape Town in November 2019. The presentation was entitled *"Why the diversion of waste from landfill in South Africa requires improved landfill management"*.

Universities

The WRIU made a number of presentations to students and staff at South African universities in 2019/20. The intention being to share information on the Waste RDI Roadmap and on waste management in South Africa and Africa.

Post-graduate students

The WRIU continues to play a mentorship role to local and international post-graduate students in shaping their research projects. This includes identifying potential research topics of local, regional or international importance, to ensure impact through research. During 2019/20, 16 Master's and PhD students engaged with the WRIU, seeking input and guidance on their research projects.

South African delegates at the ISWA 2019 Conference, Bilbao, October 2019

Engagement with young entrepreneurs in Zimbabwe

RESEARCH AND DEVELOPMENT

Supporting the generation of new scientific evidence, relevant to South Africa, that will inform policy, planning, decision-making

Supporting the development of new technology and of adapting technology to South African conditions through R&D

Research, Development and Innovation Grants

Over the past three financial years, the WRIU has issued targeted grant calls on waste electrical and electronic equipment (WEEE) (2016/17) and municipal solid waste (2018/19). No grant call was issued in 2017/18. The 2019 grant call was the first open grant call to be issued under the Waste RDI Roadmap since 2015 and solicited a large response from universities and science councils.

The WRIU also published a smaller, targeted grant call for academics to undertake a science review of marine plastic pollution in South Africa. The intention of this targeted grant call was to consolidate and evaluate existing South African research, and to identify current gaps in knowledge. The outcomes of the science review will be used to drive a more targeted research agenda for marine plastic pollution research in South Africa.

Applications received

A total of 66 proposals were received under the 2019 open grant call, a funding ask of R119.3m for projects commencing in 2020. Applications were received from 14 universities and science councils. This is the largest funding ask since the Roadmap implementation in 2015. It is particularly encouraging to see the increase in proposals from the emerging universities and universities of technology. This can be attributed, to some extent, to the roadshow undertaken in 2018 and early 2019, aimed at raising awareness regarding the Roadmap and the associated funding opportunities.

The grant proposals included a large number of academic, business and government partners. In addition to the 14 applying institutions, another 71 research partners were included in the proposals – 45 from academia, 24 from business or non-governmental organisations (NGO) and two (2) from government. This is very encouraging as it creates opportunities for impact through research collaboration with potential implementation partners.

The proposals were evaluated by an independent panel of experts from government, business and academia.

Awarded R&D grants

Of the 66 proposals received under the open grant call, 7 projects were awarded to South African public research institutions. The number of grants awarded was limited by the available funding, and not by the quality of proposals received. The overall success rate of eligible proposals received under the call was 11%. This is down from the 50%, 45% and 14% of previous years. This not only reflects the ongoing limitations of available grant funding, but also, the growing number of researchers working in waste-related R&D, which means greater competition for research funding.

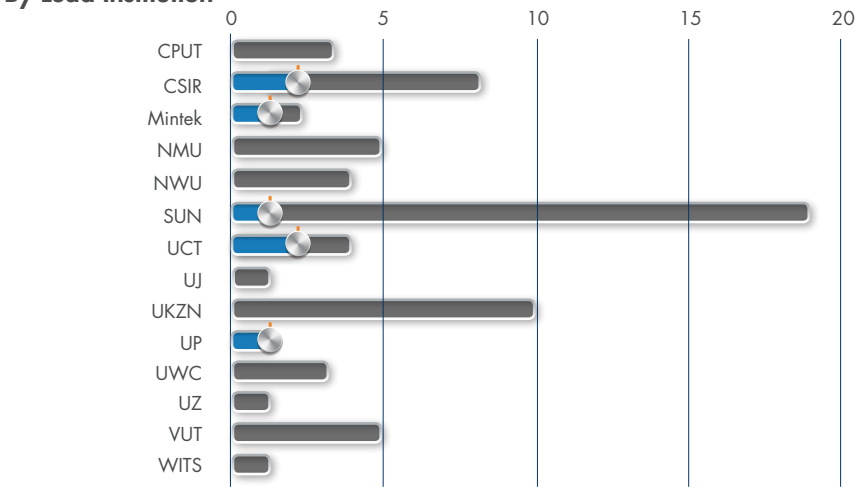
In addition to the open grant call, the WRIU also issued a targeted call on marine plastic pollution during 2019. Of the 20 proposals received under the targeted call, five (5) grants were awarded, in line with the five thematic areas of the science review –

i. Sources and pathways of marine plastic litter
ii. Transport and fate of marine plastic litter
iii. Ecological impacts of marine plastic litter
iv. Ecosystem service and economic impacts of marine plastic litter
v. Marine plastic litter monitoring and methods

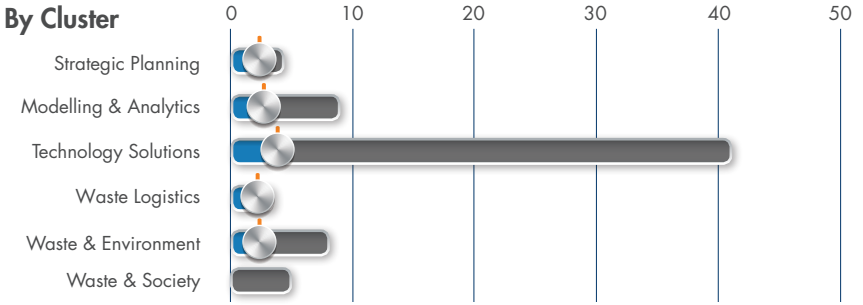
> The WRIU also published a **smaller, targeted grant call** for academics to undertake a science review of **marine plastic pollution in South Africa**. The intention of this targeted grant call was to **consolidate and evaluate existing South African research**, and to **identify current gaps in knowledge**.

Thematic spread of RDI proposals and awards under the Open Grant Call

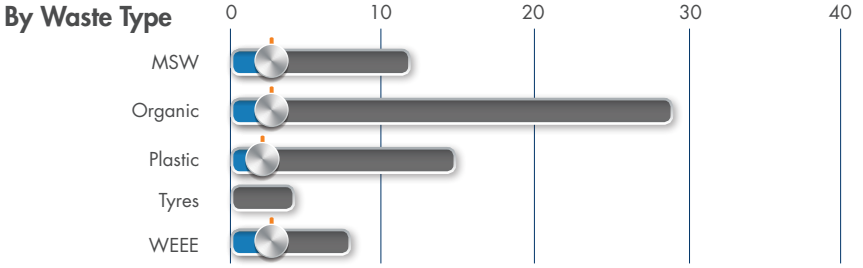
By Lead Institution



By Cluster



By Waste Type



Awarded Application

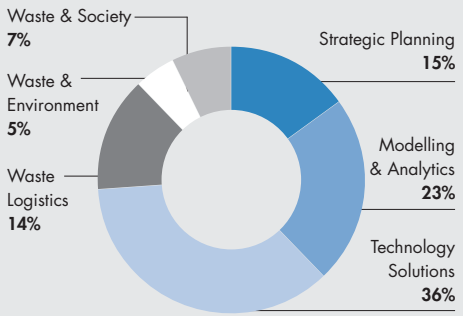
Monitoring of current grant projects

The 21 Waste RDI grant projects (9 existing and 12 new) awarded to South African universities and science councils, were monitored over the financial year by means of quarterly reporting and regular engagement with the grant holders.

The profile of the current 21 grant projects against the Waste RDI Roadmap clusters and priority waste streams are shown below.

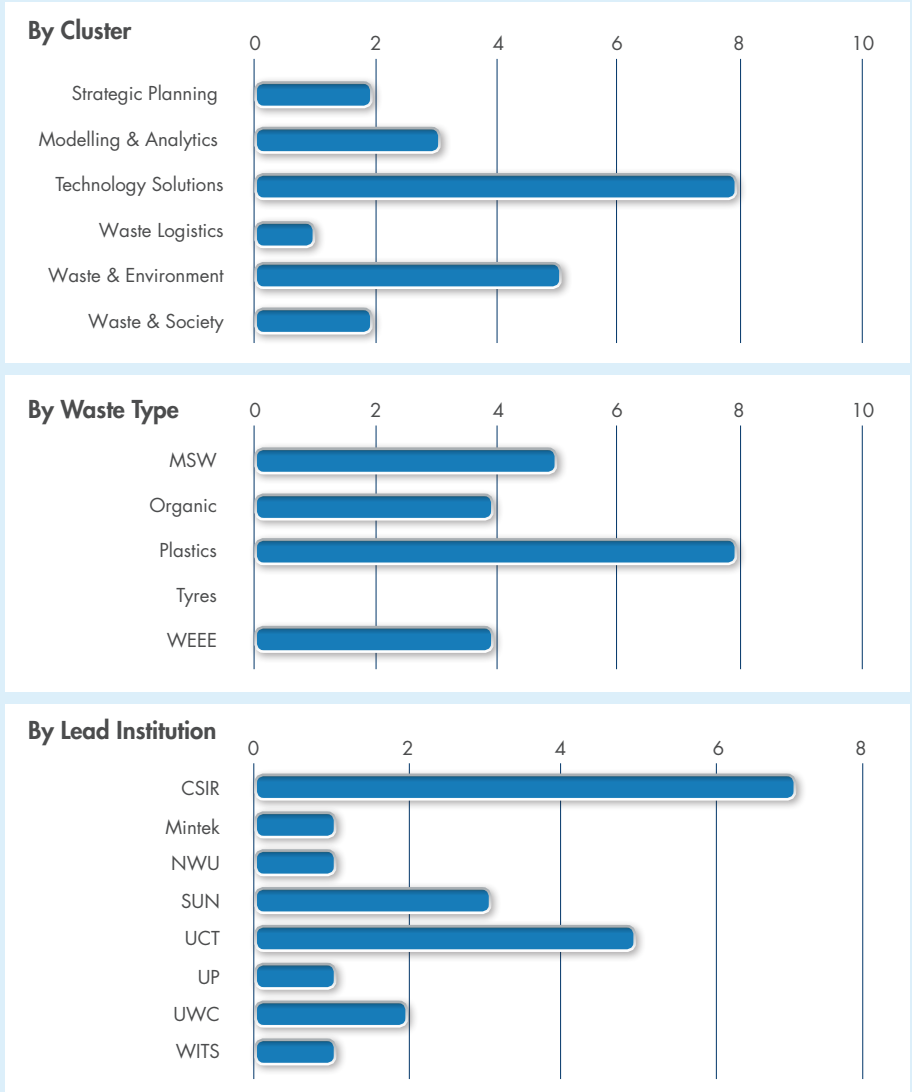
As with previous years, and in line with the strategic intent of the Roadmap, the largest grant funding allocation was to projects within the Technology Solutions cluster. It is very exciting to see though, the increased funding allocation to 'Modelling and Analytics' and 'Waste Logistics', which were under represented in previous years due to limited capability. This was the first year that grant funding has been allocated across all six clusters of the Waste RDI Roadmap.

Allocation of grant funding to the 6 clusters for current RDI grant projects (existing and new)



RESEARCH AND DEVELOPMENT (CONTINUED)

Thematic spread of current RDI grant projects (existing and new)



The new grant projects held their inception meetings in early 2020, to discuss research plans and the appointment of post-graduate students onto the projects.

Targeted projects

The Waste Roadmap managed four (4) targeted grant projects (existing and new) in 2019/20 –

- Informing decisions on single-use plastic carrier bags in South Africa: Evidence from a Life Cycle Sustainability Assessment
- The use of plastic waste in road construction in South Africa (demonstration project)
- Science review of marine plastic pollution in South Africa
- Waste Technology and Innovation Centre (WTiC) Feasibility Study

Informing decisions on single-use plastic carrier bags

Given the increase in bans on single-use plastics regionally and internationally, the Waste RDI Roadmap funded this targeted project to determine the most appropriate carrier bag option for South Africa. As a life cycle sustainability assessment, this project considers not only the environmental impacts of various carrier bags, but also importantly the social and economic impacts. The intention is for this research to inform possible single-use plastic policy in South Africa. While most of the research has been completed in 2019/20, the final report is expected in mid-2020.

The use of plastic waste in road construction

The development of new high-value end use markets for waste streams, including waste plastic, is a priority of the Waste RDI Roadmap. Given the interest by business in using waste plastic in road construction, the Roadmap funded this demonstration project to assess the feasibility of this technology given South Africa's strict standards with regards to the use of additives in bitumen and the impacts on road performance. This targeted demonstration project aims to determine the most appropriate plastic fractions (currently non-recyclable) and their performance with respect to local standards, through a phased approach –

- Phase 1: Proposal of concept
- Phase 2: Proof of concept for South African conditions
- Phase 3: Long-term performance simulation using a Heavy Vehicle Simulator (HVS)

Phases 1 and 2 which were laboratory based, were completed in 2019/20 and the team has moved to Phase 3 which will involve laying a stretch of test road for *insitu* testing. Unfortunately the Covid-19 lockdown which came into force in South Africa towards the end of March 2020, is likely to delay Phase 3 of the project.

Science review of marine plastic pollution

Marine plastic pollution is considered an issue of global concern, in the league of climate change, ocean acidification and biodiversity loss. While a fair amount of research has been conducted on the state and impact of micro-, meso- and macro-plastic in fresh and marine waters in South Africa, this research had not been consolidated and as such, had not been used to assess the current threat of waste plastic to ecosystems, human health and the South African economy. This targeted project is discussed further in the 'Partnerships' section.

Waste Technology and Innovation Centre (WTiC) Feasibility Study

The WRIU entered into a contract with Lindon Consulting in 2019, to undertake an independent study on the feasibility of establishing a Waste Technology and Innovation Centre (WTiC) in South Africa. The aim of the Centre being to provide technical support to municipalities and businesses, and facilitate faster insertion of context-appropriate, alternative waste treatment (AWT) technology in South Africa. The immediate focus of the WTiC is expected to be on AWT technologies for municipal solid waste (MSW) management. The WTiC should reduce the risk of implementation of waste technologies, and improve decision-making through access to independent technical evidence.

The consultants were contracted to critically evaluate the feasibility of such a WTiC within the South African context. If found to be feasible, to then prepare a 5-year business plan outlining the final, agreed upon design and functional operation of a national Centre, including associated costs of operation and funding instruments to sustain its operation.

In order to determine the need for, and operational design of such a Centre, key stakeholders were

Inception meeting for the UCT WEEE project, with a site visit to project partner TraX Interconnect

Members of the CSIR project team examining possible sites for the HVS testing

RESEARCH AND DEVELOPMENT (CONTINUED)

engaged through regional workshops (5) and one-on-one meetings. The concept of the WTiC was well received by delegates from local, provincial and national government, and business. The following resolution was reached at the regional workshop held at the Waste Khoro workshop –

> "Stakeholders recognise the need for support in the implementation of appropriate alternative waste treatment technologies in South Africa. Support which is acknowledged can be provided by an independent, accessible and affordable Waste Technology and Innovation Centre. Acknowledging that 'implementation' includes all support from needs analysis to post commissioning."

The Feasibility Report, finalised in February 2020, found that municipalities acknowledge the absence of, and the need for, technical support in the selection and implementation of context-appropriate AWT technologies in South Africa. Support that can be provided by an independent and affordable Waste Technology and Innovation Centre. The conceptual business plan is expected in mid-2020.

The project is being overseen by a Project Steering Committee, including representatives from the DSI, DEFF, SALGA, CSIR and UKZN.

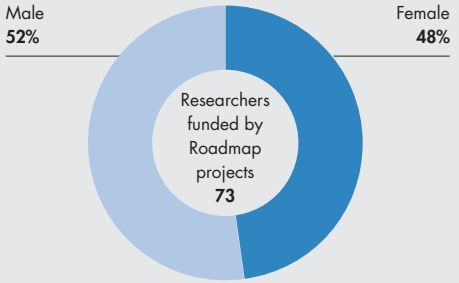
Profile of research teams on projects

The 21 Waste RDI grant projects supported in 2019/20 provided funding support to 73 researchers (non-unique) at 12 research institutions.

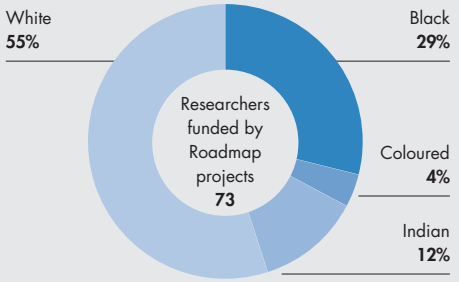
As with the post-graduate students, researchers supported on the grant projects stem predominantly from South Africa (77%), but also from other African countries, Europe and Asia. This is positive for the South African waste sector, as not only is the Roadmap helping to build international capability and networks, but it is also ensuring that new ideas are introduced into the South African research community.

> Stakeholders recognise the **need for support** in the implementation of appropriate **alternative waste treatment technologies** in South Africa. Support which is acknowledged can be provided by an **independent, accessible and affordable** Waste Technology and Innovation Centre. Acknowledging that **'implementation' includes all support from needs analysis to post commissioning**.

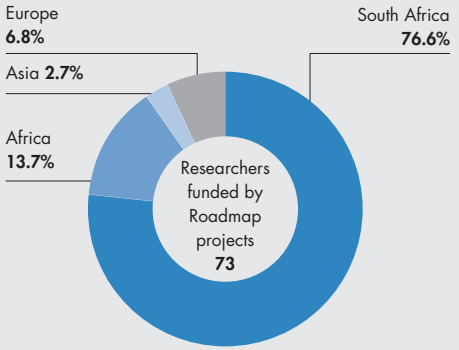
Grant funded researchers (by gender)



Grant funded researchers (by race)



Grant funded researchers (by nationality)



Completed grant projects

Three grant projects were completed during the 2019/20 financial year. A summary of the key findings of these grant projects is provided in Annexure 1. The final research deliverables have been made available on the Roadmap website.

Completed projects include –

- Lessons from waste picker integration initiatives (Dr M Samson, University of the Witwatersrand)
- Biogas and volatile fatty acids biorefinery by co-digestion of fruit juice industry solid and liquid wastes with lignocellulosic biomass (Prof J Görgens, Stellenbosch University)
- The development of an integrated process flowsheet for the sequential extraction and recovery of valuable metals from WEEE (Prof S Harrison, University of Cape Town)

> A core finding of the waste picker integration project is that pickers are already **deeply integrated into municipal solid waste management systems** and the recycling economy through their **'separation outside source'** (SoS) system. SoS predates government interest in recycling and is the **primary way** that post-consumer recyclables are collected.

Grant project deliverables

The portfolio of grant projects produced 29 final deliverables during 2019/20. This includes post-graduate dissertations, journal papers, technical reports, conference papers and presentations, and briefing notes.

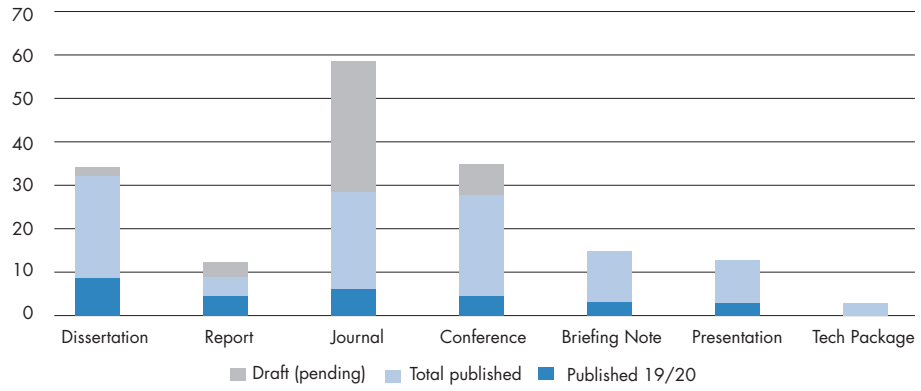
- 9 Dissertations
- 6 Journal papers
- 4 Technical reports
- 4 Conference papers and presentations
- 3 Briefing notes
- 3 Summary presentations

This number is lower than previous years and may be due to a smaller number of projects ending in 2019/20. The early closure of universities and science councils in March 2020 may also have impacted the reporting on deliverables in the last quarter of 2019/20. A number of grant projects have also 'ended' in terms of contract completion dates, but have not yet submitted all of the final project deliverables (mostly related to student delays). These projects will be monitored by the WRIU to ensure that all contracted deliverables are submitted.

An overview of some of the research reports and peer reviewed journal papers is provided in Annexure 2 and also referenced in the section "Waste RDI Outputs".

The current status of published RDI Roadmap project deliverables and draft deliverables is shown in the figure below.

Current status of published RDI Roadmap grant project deliverables and draft deliverables



SARCHI RESEARCH CHAIRS

Prof C Trois
Waste and Climate Change
Tier I Research Chair
University of KwaZulu-Natal

The objective of the Waste and Climate Change Research Chair is to develop and implement a research programme that delivers evidence to support the improved understanding of the –

- Climate impacts associated with the generation and disposal of waste in South Africa
- Measures (including technologies) to mitigate these impacts
- Impact of climate change on the waste sector.

Prof C Schenck
Waste and Society
Tier II Research Chair
University of the Western Cape

The objective of the Waste and Society Research Chair is to develop and implement a research programme that delivers evidence to support the improved understanding of the –

- Opportunities to create jobs and improve livelihoods through the transition away from landfilling
- Business models to support a secondary resources economy, with a focus on SMMEs
- Required behaviour change to drive the transition away from landfilling, including appropriate behaviour change interventions such as awareness and communication strategies for South Africa as a developing country.

> The Research Chairs provide a means of embedding key aspects of the Roadmap within the National System of Innovation.

Waste and Climate Change

The Waste & Climate Change Chair has leveraged funding to support 29 post-graduate students in 2019/20. This includes 23 students under the SARChI Chair funding and an additional 6 students through alternate funding.

A recent project of the Chair involves the provision of biogas and energy to rural communities in the Ndwedwe Municipality, through anaerobic digestion of organic waste. In 2019, the team optimised 26 digesters and are proceeding with the installation of a further five digesters in selected early childhood development centres.

Recent publications by the Chair include:

- Sawyerr, N.,Trois, C. and Workneh, T. (2019). Optimization of biogas yield through co-digestion of cassava biomass and vegetable and fruits waste at mesophilic temperatures. I*nt. J. Renew. Energy Res.*, 9(2), 771-782.
- Sawyerr, N., Trois, C. and Workneh, T. (2019). Identification and characterization of potential feedstock for biogas production in South Africa. *J. Ecol. Eng.*, 20 (6).
- Mahdjoub, N., Reddy, P. and Trois, C. (2019). The use of municipal waste in the construction of smart pavements as a waste diversion strategy. In: Proceedings of Sardinia Symposium, Italy, 2019

Waste and Society

The Waste & Society Chair has leveraged funding to support 22 post-graduate students in 2019/20. This includes 4 post-graduate students funded under the Waste RDI Roadmap Clean Cities grant project. The Chair, together with four other Chair holders from the University of Cape Town (UCT) and the University of KwaZulu-Natal (UKZN) were awarded a National Research Foundation (NRF) Community of Practice (COP) Grant in 2019/20.

Recent publications by the Chair include:

- Schenck CJ, Blaauw PF, Viljoen JMM, Swart EC. (2019). Exploring the potential health risks faced by the waste pickers on landfills in South Africa: A socio ecological perspective. *International Journal of Environmental Research and Public Health,* 16(11):1-21
- Viljoen JMM, Blaauw PF, Schenck CJ. (2019). The opportunity and value adding activities of buy back centres in South Africa's recycling industry: A value chain analysis. *Local Economy,* 34(3):294-315
- Blaauw PF, Pretorius A, Schenck, C. (2019). The economics of urban waste picking. *African Review of Economics and Finance,* 11(2);129-164.

SARChI Chair Waste & Society workshop with post-graduate students and research collaborators, August 2019

PARTNERSHIPS

"Waste research, development and innovation cannot, on its own, transform the waste sector. The Roadmap is one mechanism being implemented by government, through the Department of Science and Innovation, to move waste away from landfilling. To ensure success, the Roadmap must be adopted as part of a suite of public and private sector responses aimed at addressing the challenges currently facing the waste sector"

BUILDING LOCAL, regional and international partnerships with government, academia and business, is important to achieving the long-term objectives of the Waste RDI Roadmap. The following section highlights just some of the engagements with key stakeholders during the 2019/20 financial year.

South Africa

Government

In addition to the Department of Science and Innovation (DSI), as the custodian of the Waste RDI Roadmap, partnerships with other government departments are important to ensuring that the outputs of the Roadmap support decision-making, policy development and implementation in South Africa. Investment in the Waste RDI Roadmap helps to build capacity and provides robust, independent evidence necessary to achieve the seven national priorities of the South African Government, as outlined in the Medium-Term Strategic Framework (2019-2024) – (1) capable, ethical and developmental state, (2) economic transformation and job creation, (3) education, skills and health, (4) consolidating the social wage through reliable and quality basic services, (5) spatial integration, human settlements and local government, (6) social cohesion and safer communities, and (7) a better Africa and World.

Department of Environment Forestry and Fisheries

As line department responsible for waste, the Department of Environment, Forestry and Fisheries (DEFF) is an important partner for the Roadmap. Collaboration with DEFF during 2019/20 included –

- Partnering on the University of the Witwatersrand grant project (Dr M Samson) on the "integration of the informal waste sector". In addition to co-funding the research, the DEFF supported the extension of the research into a guideline for practical integration of informal waste pickers in South Africa, which was finalised in early 2020.
- Invitation to the WRIU to serve in a review/advisory role on current national government waste projects
- Partnering with DEFF to host one of the regional Waste Technology and Innovation Centre (WTiC) workshops at the Waste Khoro, held on the 18 September 2019, in Kimberley.

In addition to the Chemicals and Waste Branch of DEFF, the WRIU also partnered with the Oceans and Coasts Branch on the marine plastic pollution science review.

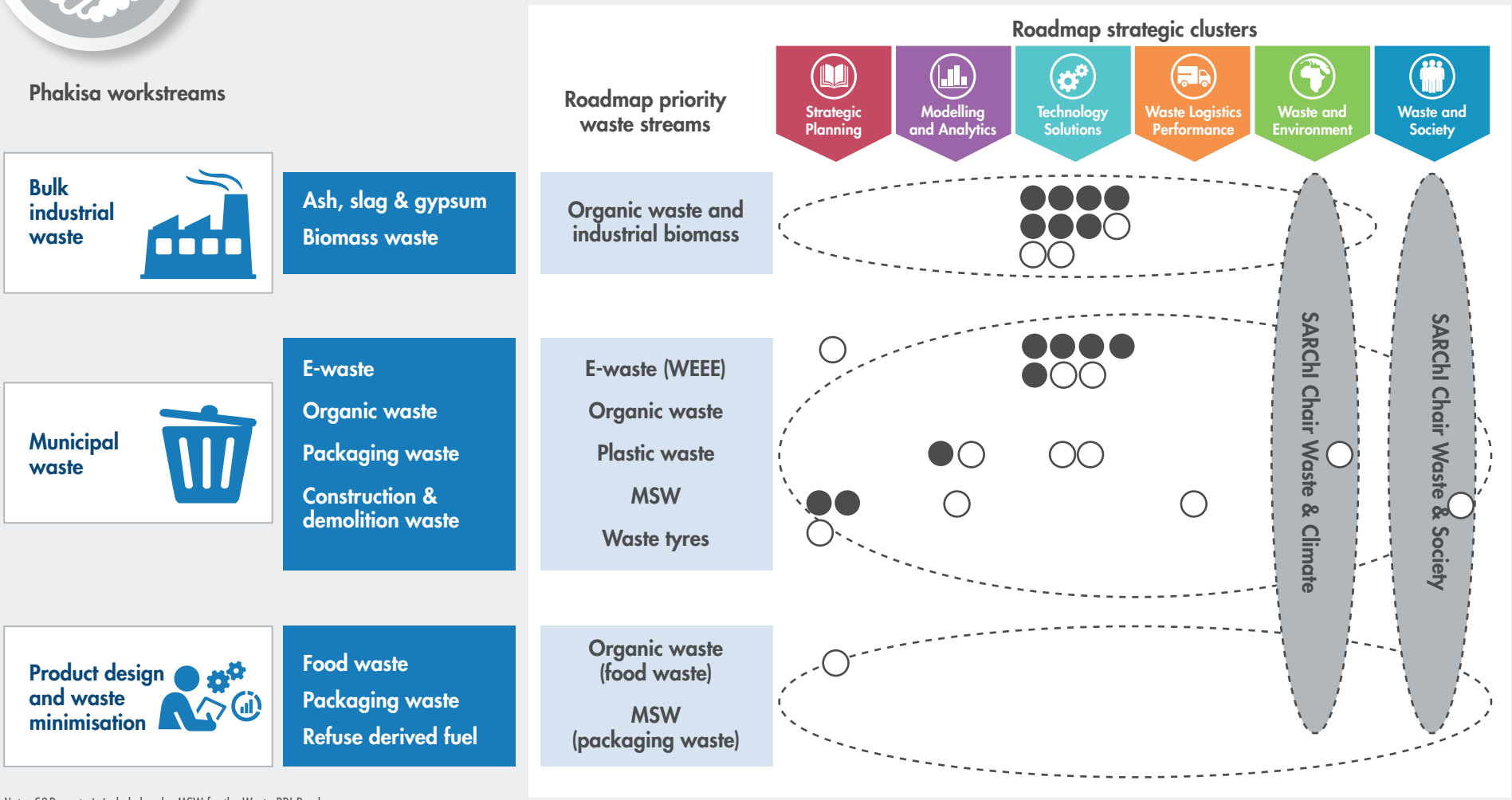
Chemical and Waste Phakisa

The outcomes of the Chemicals and Waste Phakisa were approved by the President in early 2019. The Phakisa addresses the opportunity to enhance South Africa's waste economy, by increasing the commercialisation of the circular economy and creating value from resources currently discarded as waste; and fostering inclusive growth through positioning South Africa as a globally competitive producer of sustainable products.

The priorities identified under the Phakisa in 2017, largely map to the priorities identified by stakeholders during the development of the Waste RDI Roadmap in 2014. As such, there is a good overlap between the Phakisa workstreams and the Waste RDI Roadmap. The Waste RDI Roadmap continues to support the objectives of national policy, as framed in the Phakisa, i.e. to unlock value from waste, through strategic investment in science, technology and innovation (STI).

"Building local, regional and international partnerships with government, academia and business, is important to achieving the long-term objectives of the Waste RDI Roadmap."

PARTNERSHIPS (CONTINUED)



Note: C&D waste is included under MSW for the Waste RDI Roadmap

● Grant projects (completed) funded under the Roadmap (2015-2020)

○ Grant projects (current) funded under the Roadmap (2015-2020)
A number of additional grant projects are directly supported under the Chairs

1 Stakeholders did not prioritise bulky waste streams (ash, slag, mining waste) for the first phase of implementation of the Roadmap

2 The thermal treatment of waste is a lower priority for the Roadmap (focus on beneficiation) and does not address the processing of refuse derived fuel (RDF)

Mapping of Waste RDI Roadmap activities (2015-2020) onto the Chemicals and Waste Phakisa workstreams

During 2019/20, staff from the WRIU have driven and participated in –

- Activities that have directly increased waste RDI collaboration with the private sector;
- Provided technical advisory support to government and industry; and
- Collaborated in the international waste RDI arena,
  - in support of showcasing South Africa's waste RDI, and
  - in ensuring that intelligence is brought back in support of the Waste RDI Roadmap implementation.

This has included active engagement with, and specialist advisory support to –

South Africa –

- Academy of Science of South Africa (ASSAf)
- Department of Environment, Forestry and Fisheries (DEFF)
- National Research Foundation (NRF)
- Water Research Commission (WRC)
- Various waste sector organisations (packaging, WEEE, organic waste)
- Various businesses, SMMEs and non-governmental organisations
- Various municipal and provincial green economy, innovation and green skills forums
- Informal waste reclaimer organisations

International –

- International Solid Waste Association (ISWA)
- United Nations Agencies
  - International Labour Organization (ILO)
  - UN Environment (UNEP)
  - United Nations Industrial Development Organisation (UNIDO)
  - International Environmental Technology Centre (IETC)
- Royal Academy of Engineering (UK)

National Waste Management Strategy

Government's 3rd National Waste Management Strategy (NWMS) was published for public comment in December 2019. The updated Strategy focuses on three main implementation themes –

- Waste minimisation
- Effective and sustainable waste services
- Awareness and compliance

At the heart of South Africa's waste policy, is the safe management of waste and the diversion of waste away from landfill through prevention, reuse, recycling and recovery. The WRIU remains committed to supporting the implementation of the NWMS through the provision of sound evidence, and the development of local capability.

The DEFF and the Department of Trade, Industry and Competition (**the dtic**), both serve on the Waste RDI Roadmap Steering Committee.

Academia

Universities and science councils are core to the Waste RDI Roadmap, undertaking much of the RDI necessary to evidence national decision-making and inform policy development and implementation. The response of academia to the Waste RDI Roadmap Calls remains very positive.

The WRIU currently has a network of more than 120 researchers working in solid waste management and associated fields across South African public research institutions.

Africa

As noted in the sections on grant-funded post-graduate students and grant-funded researchers, a number of students (5) and researchers (10) from other African countries have been provided with the opportunity to build their skills through Waste RDI Roadmap funded research projects. These students and researchers, who are currently studying and working at South African universities and science councils, create a potential for research partnerships with their respective countries. In this way, the Roadmap is able to contribute to skills development on the continent, in order to create a better Africa as envisaged in South Africa's Medium-Term Strategic Framework (2019-2024). However, it is important that regional and international funding support is made available to nurture and grow these intra-African research partnerships (e.g. African Union, SADC, NRF, etc.).

International

In addition to direct research collaboration between South African researchers and their international counterparts, the WRIU continues to develop and strengthen international relationships in support of the Roadmap. Some of the engagements during 2019/20 include –

United Kingdom

The WRIU has worked closely with a number of UK-based organisations during 2019/20 on various issues around waste management. The intention of the partnerships has been to

PARTNERSHIPS (CONTINUED)

understand how other countries are addressing issues through RDI, and to explore opportunities for greater research collaboration, including possible leveraged RDI funding.

Centre for Environment, Fisheries and Aquaculture Science

The WRIU partnered with the Centre for Environment, Fisheries and Aquaculture Science (Cefas) on the South African marine plastic pollution science review. In addition to the Roadmap funding, subsidiary funding was provided under the Commonwealth Litter Programme (CLiP) implemented by Cefas and funded by the UK Department for Environment, Food and Rural Affairs (Defra). Cefas hosted a marine plastic litter workshop on the 1-2 October in Cape Town. The first day of the workshop was dedicated to the South African marine plastic pollution science review.

Royal Academy of Engineering

The WRIU was invited to serve on the Technical Advisory Group for the Royal Academy of Engineering project entitled *"Global Review on Safer End of Engineered Life"*. The programme seeks to reduce the number of incidents, accidents and casualties that happen as a result of safety issues, and associated environmental impacts of poor management of waste.

PEW/SYSTEMIQ

The Pew Charitable Trusts and SYSTEMIQ project entitled *"Global Roadmap to Zero Ocean Plastic Leakage"* was first reported on in the 2018/19 Annual Report. Given the strategic importance of this project, the WRIU was pleased to continue their involvement in the international Expert Technical Panel during 2019/20.

Members of the Systemiq/Pew project team and Expert Technical Panel, London, July 2019

The intention of this project is to develop a model, which will guide decision-makers in addressing the leakage of waste plastic to the environment, including the marine environment. Participation in the expert panel provides opportunity to give input on waste challenges facing Africa. It also ensures that the model provides value to African countries on how to manage waste plastic in the future, e.g. evidence-based policy development. The final technical report is expected in mid-2020.

United Nations Agencies

The WRIU has over the past five years established strong partnerships with a number of United Nations agencies and UN sub-programmes, including UN Environment (UNEP), the UN Industrial Development Organization (UNIDO) and the International Labour Organisation (ILO).

International Environmental Technology Centre

Prof Godfrey, manager of the WRIU, serves as a member of the International Advisory Board of the UN International Environmental Technology Centre (IETC). The Advisory Board was established to provide the Director of the IETC with policy and technical advice on the strategic direction and content of the programme of work of the Centre. The Board consists of international policy and technical experts covering major geographical regions.

IETC International Advisory Board meeting, Japan, May 2019

Signing ceremony for the launch of the Japan-UNIDO-SA project, South African, July 2019

Inaugural National Steering Committee Meeting for the EEWiGI project, South Africa, January 2020

The first Advisory Board Meeting was held in Osaka, Japan on the 20 May 2019. This was followed by the IETC Global Dialogue on *"Waste and the private sector"* from the 21-23 May 2019.

UNIDO

The WRIU was part of the UNIDO-South Africa project team which scoped and prepared the proposal to the Government of Japan entitled *"Support for transitioning to more environmentally sustainable alternatives from conventional plastics"*. The project was approved by the Japanese Government in June 2019. The signing ceremony, held in July 2019, was attended by the Japanese Ambassador to South Africa, Mr Maruyama; Deputy Minister of Trade and Industry, Ms Gina; Advisor to the South African President, Ms Makhaya; DSI DDG for International Cooperation, Mr du Toit; UNIDO representative Mr El Mekwad; CSIR Executive for Business Excellence and Integration, Ms Njobe; and Executive Director Plastics SA, Mr Hanekom. The project received very good media coverage, both locally and regionally.

The WRIU was invited to serve on the National Steering Committee for the new UNIDO project entitled *"Economic Empowerment of Women in Green Industry (EEWiGI)"*. The purpose of this global project is to advise policymakers and practitioners, in selected countries, on the establishment and implementation of a framework to integrate gender and green industrial policies. The aim is to effect change and empower more women to take leadership roles in green industries as entrepreneurs or industrial professionals.

Western Indian Ocean Marine Science Association

The WRIU was invited to serve on the Western Indian Ocean Marine Science Association (WIOMSA) Group of Experts for Marine Litter and Microplastics. The broad goal of the Group of Experts is to provide a forum for the sharing and exchange of information on marine plastics; to provide policy guidance and advice to the Nairobi Convention and other regional frameworks; and to synthesize information on the topic from different sources and produce peer-reviewed publications and other products.

The first meeting of the WIOMSA Group of Experts was held in Cape Town from the 12-14 June 2019. The Group includes representatives from South Africa, Kenya, Mozambique, Reunion, Seychelles and Tanzania. The meeting also included observers from the African Marine Waste Network (AMWN), IUCN, Indian Ocean Commission and UNEP.

European Union

South Africa has a long history of working with the European Union and the European Commission on waste-related R&D and innovation, having first partnered with the Commission in 2013 to build a joint European and African research and innovation agenda on waste management, *"Waste as a resource: Recycling and recovery of raw materials (2014-2020)"*.

The waste sector was identified by local stakeholders in 2019, as one of three opportunity sectors to support a transition to a more circular economy in South Africa. The others include the renewable energy and water sectors. The WRIU was therefore proud to partner with the DSI in hosting a SA-EU Dialogue Facility on Science, Technology and Innovation for a Circular Economy in 2019/2020.

The objectives of the SA-EU Dialogue Facility are to strengthen relations between the European Union (EU) and South Africa. To facilitate the implementation of priority aspects of the SA-EU Trade, Development and Cooperation Agreement and the Strategic Partnership Joint Action Plan, and to facilitate and support current and future implementation of policy dialogues between South African Government Departments and Agencies and the EU and its Member States.

PARTNERSHIPS (CONTINUED)

SA-EU Dialogue Facility on Circular Economy, symposium delegates, November 2019

> Regional and international **partnerships** are important to ensuring that the waste issues facing South Africa and Africa are **appropriately represented** and to bring international experience to the African context.

The Dialogue Facility included a preparatory workshop, held in June 2019, with the aim of highlighting key themes which would inform a later Circular Economy Symposium. This multi-stakeholder symposium, held in Pretoria in November 2019, covered key lessons from circular policy development, with a focus on the opportunities and STI needs for a transition to a more circular economy in South Africa.

A local study tour followed on from the Symposium, where South African and European delegates had the opportunity to engage with South African organisations already active in aspects of the circular economy, including CSIR (biopolymers) and Distell (GreenUp project). A reciprocal study to the EU was undertaken in November 2019. The South African delegation to the EU included representatives from DSI, DEFF, **the dtic**, the Presidency, CSIR, GreenCape and NBI.

Although the circular economy, as a concept, is not new to South Africa, the delegation learnt from a rich history of policy, programmes and institutions established to promote circularity within the EU. The EU study included visits to organisations in Spain, Belgium and the Netherlands advanced in driving circular economy activities. These included Ihobe (Environmental Agency) and ACLIMA (Business Association) in Bilbao, Spain; the European Commission (Directorate Generals Environment, Research and Technology), Joint Research Commission and EXPRA in Brussels, Belgium; Blue City and ISWA in Rotterdam and the Economic Advisory Board of Amsterdam, hosted by Circular Hotspot, in Rotterdam, Netherlands.

The outcomes and lessons from the workshop, symposium and study tours have been written up in a draft Framework for Science, Technology and Innovation for a Circular Economy in South Africa, which will inform the new Decadal Plan of the DSI.

Further information of the DSI's work to support South Africa's transition to a circular economy can be found at www.circulareconomy.co.za

International Solid Waste Association

South Africa officially joined the International Solid Waste Association (ISWA) as a new national member in 2019. Ongoing engagement with ISWA is important in ensuring that South Africa and Africa are appropriately represented in international solid waste platforms.

The WRIU was invited to provide technical input, as well as review, to the draft Global Waste Management Outlook 2 currently under development by ISWA and UN Environment. The WRIU was to participate in the first project review meeting, to be held in Paris from the 24-27 March, however, due to the Covid-19 pandemic, this meeting was cancelled, and the review meetings were moved online.

WASTE RDI OUTPUTS

THE IMPACT THAT THE WASTE RDI ROADMAP AIMS TO ACHIEVE is to support the improved management of waste and the increased diversion of waste away from landfill towards alternative waste treatment technologies, thereby maximising the potential environmental, social and economic benefits. In support of this goal, the Waste RDI Roadmap committed to the following research, development and innovation outputs over the next 10 years, if fully supported financially –

		Target	*Supported*[1]	*Completed*[2]
Human Capital Development	Post Docs	65	5	0
	PhDs	165	19	7
	Master's	245	46	26
	Honours	–	1	9
Knowledge Generation	Registered patents	25	–	–
	Patent applications	70	–	–
	Publications	590	59	29
Technology Development	Products and services to market	4	–	–
	Technology packages	20	–	3
	Prototypes	60	–	–

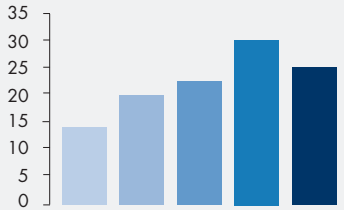
[1] These students are at various stages of completion but have not graduated with their degrees
[2] Students who successfully completed their degrees may also be counted under "supported"

A total of 77 Honours, Masters, PhD and Post-doc students were supported in 2019/20 under the Waste RDI Roadmap – 8 students through scholarships, 22 students through grant projects, and 47 students through SARChI Chairs (and associated funding) (excluding the 4 grant funded students). In terms of students directly funded under the Roadmap, a total of 36 students have to date completed their degrees – 4 through scholarships and 32 through grant projects. This includes 9 Honours, 23 Masters students and 4 PhD students. These figures exclude students funded through other funding mechanisms, such as the NRF (unavailable) or industry (unavailable).

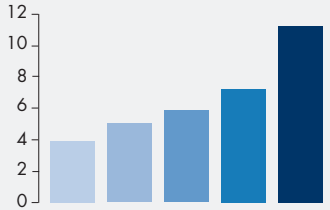
Other key indicators of impact include: investment in waste RDI (See Section on Investment), and waste RDI collaboration between the South African research community and the private waste and secondary resources sector.

Trends

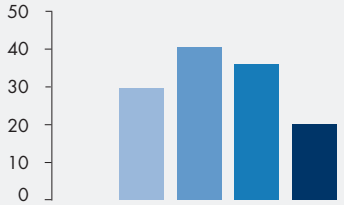
Total value of grant projects (new and ongoing RDI grants) (Rm) (2015-2019)



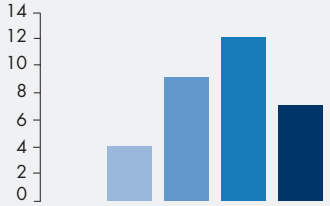
Annual transfer to RDI grants (Rm) (2015-2019)



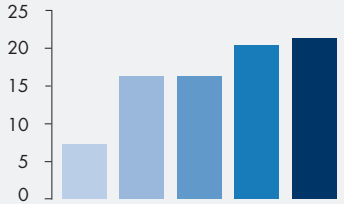
Grant-funded students supported (2015-2019)



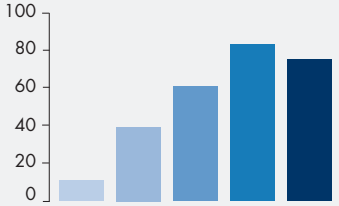
Grant-funded students completed (2015-2019)



Number of RDI grants funded (2015-2019)



Grant-funded researchers supported (2015-2019)



FINANCIAL STATEMENT

The 2019/20 financial investment in the Waste RDI Roadmap was down from the 2018/19 financial year. However, the WRIU was able to increase the investment in grant projects due to ring-fencing of funding for continuing operations. This allowed for the WRIU to issue a new open grant call in 2019/20 and a targeted grant call on marine plastic pollution. The funding still remains significantly below that outlined in the Waste RDI Roadmap. This has a direct bearing on the extent and magnitude of activities of the Roadmap.

All financial figures are exclusive of VAT.

REVENUE	2019/20	2018/19
DST seed funding	21 289 086.96	26 027 048.30
Other revenue	225 000.00	395 000.00
Total Revenue	**21 514 086.96**	**26 422 048.30**
EXPENSES		
Communications	69 298.75	69 317.82
CSIR Project Management Unit	2 073 778.55	2 383 690.07
Non-recoverable innovation grants	0.00	0.00
Non-recoverable R&D grants	11 086 609.57	7 003 067.67
Targeted RDI projects	1 195 509.57	0.00
Post-graduate scholarships[1]	0.00	34 731.32
SARChI Research Chairs	1 705 200.00	3 360 000.00
Travelling	124 623.52	108 241.42
Workshops and general running	0.00	0.00
Total Expenses	**16 255 019.96**	**12 959 048.30**
Income for continuing operations [2]	**5 259 067.00**	**13 463 000.00**
Net Income	**0.00**	**0.00**

Notes to financial statement:

(1) Funding was made available for scholarship support in 2019/20 but due to the early closure of Universities in March 2019, the funding will only be transferred to the Universities in the new financial year

(2) Income for continuing operations is committed funding for grant projects awarded in 2015-2019, for which disbursements will be made in the 2020/21 financial year.

THE OUTLOOK FOR 2020/21

While the public and private sector investment in the Waste RDI Roadmap remains significantly below that necessary to achieve its outlined objectives, good progress continues to be made in human capital development, R&D and innovation in the South African waste sector. The waste policy space continues to shift and as such, there remains a very relevant role for the Waste RDI Roadmap in evidencing decision-making, policy development and implementation in South Africa.

There is also a growing interest in the opportunities that transitioning to a circular economy provides for South Africa. The coming years will need to address the role of the waste sector within a circular economy, and the social, economic and environmental opportunities the sector provides.

The focus for the coming financial year, 2020/21 will be on –

- Closely monitoring currently funded post-graduate studies and research projects to ensure maximum impact through this first phase of investment.
- Increasing national activity in waste RDI through industry and government partnerships
- Ensuring that investments in waste RDI are strategic, and research outputs are relevant, thereby increasing impact and supporting uptake by local and regional partners
- Continuing the science advocacy role in supporting capacity development, profiling South African waste RDI, and increasing RDI collaboration
- Strengthening the investment in local waste RDI through, among others, country-to-country bilateral agreements and industry partnerships
- Ongoing support for the two SARChI Research Chairs

In addition, the following new activities are planned –

- A new micro-grant call to be launched mid-2020 to strengthen waste RDI in South Africa's emerging universities
- A new targeted marine plastic pollution grant call to be launched mid-2020, building on the outcomes of the 2019/20 marine plastic pollution science review.

As the Waste RDI Roadmap enters its 6th year of implementation, our sights remain firmly on achieving the vision and mission of the 10-year Waste RDI Roadmap and the anticipated RDI outputs.

GOVERNANCE

The Waste RDI Roadmap is implemented by the CSIR's Waste RDI Roadmap Implementation Unit (WRIU) in partnership with the DST, DST entities, other government departments, universities and science councils, business and industry. Effective governance and oversight of activities within the WRIU is fundamental to the Roadmap's implementation. The Waste RDI Roadmap governance structure is as follows:

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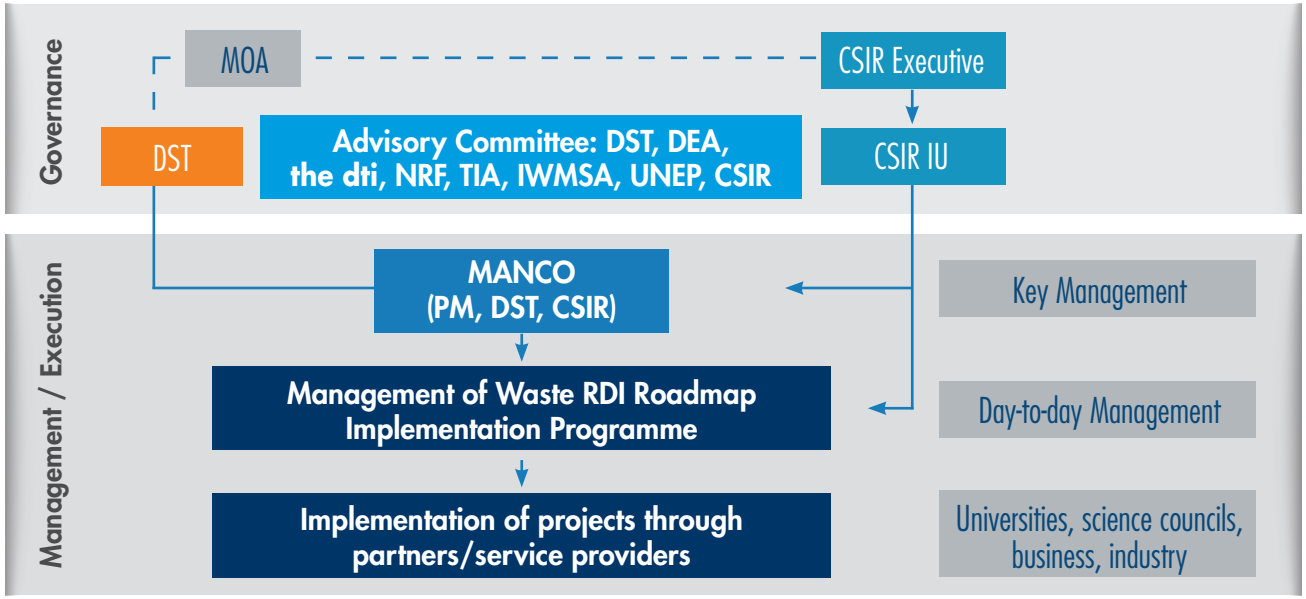

The DST would like to thank the members of the Steering Committee for their valuable guidance and input during 2018. The Steering Committee, convened for the period 2018-2020, includes representatives from:

Sector	Organisation
National Government	Department of Science and Innovation, Department of Environment, Forestry and Fisheries, The Department of Trade Industry and Competition
R&D and Innovation Agencies	National Research Foundation (NRF), Technology Innovation Agency (TIA), Council for Scientific and Industrial Research (CSIR) (Host)
Waste Sector	Institute of Waste Management South Africa (IWMSA)
Multilateral non-governmental organisation	United Nations Environment Programme (UNEP)
Associations	South African Local Government Association (SALGA)

1 an **Operations Committee**, made up of the DST Director: Environmental Services and Technologies and the WRIU Manager, who meet monthly, or more frequently if required, to discuss operational matters

2 a **Management Committee** (MANCO), made up of senior representatives of the DST and CSIR Implementation Unit, who meet annually, or more frequently if required, to discuss management and oversight issues; and

3 an advisory **Steering Committee**, made up of representatives of government, government entities and the waste sector, who are tasked with reviewing the progress of the WRIU and giving input on the planned activities for the following year.

ANNEXURE 1: **SUMMARY OF COMPLETED WASTE RDI ROADMAP RESEARCH PROJECTS**

Lessons from waste picker integration initiatives – Development of evidence based guidelines to integrate waste pickers into South African municipal waste management system

Grant number: CSIR/IU/WRIU/2016/001 • **Lead Institution:** University of the Witwatersrand • **Project Leader:** Dr M Samson

As South Africa moves forward with implementation of 'waste picker integration' it is important to draw lessons from existing experiences. This briefing note presents findings from research on initiatives to integrate reclaimers (waste pickers) in Johannesburg and Metsimaholo. A core finding is that reclaimers are already deeply integrated into municipal solid waste management systems and the recycling economy through their 'separation outside source' (SoS) system. SoS predates government interest in recycling and is the primary way that post-consumer recyclables are collected. However, the municipalities and industry did not acknowledge SoS. In addition, the dominant 'charity model' of integration did not recognise reclaimers' expertise and assumed that reclaimers should simply participate in programmes designed by professionals and officials. As a result, projects did not meet reclaimers' core needs and some made reclaimers worse off. Officials tasked with implementing integration did so without the benefit of national policy or guidance, and identified the need for training, resources, time, and guidelines to support their work on integration. Highly informal approaches to integration undermined its success, and projects perpetuated existing power relations. Separation at source (S@S) contracts dispossessed reclaimers and worsened their incomes, working conditions, and relationships with residents. They were structural 'reclaimer dis-integration' interventions that overrode gains from small integration projects. Integration and S@S cannot be treated as distinct policy spheres and 'integrated S@S' is crucial for the success of both. Integration and S@S also cannot be imposed from above – residents adopted five different approaches to S@S and reclaimers created their own integration and S@S programmes, from which they derived the greatest benefit. Rather than integrating individual reclaimers into new S@S and recycling systems, new policies and programmes must integrate with the existing SoS system. Key starting points include valuing and paying reclaimers for their services, inverting the charity model, dedicating sufficient resources to integration, supporting reclaimers to organise, and ensuring reclaimers play a leading role in the development and implementation of integration and integrated S@S.

The development of an integrated process flowsheet for the sequential extraction and recovery of valuable metals from waste electrical and electronic equipment (WEEE)

Grant number: CSIR/IU/WRIU/2017/013 • **Lead Institution:** University of Cape Town • **Project Leader:** Prof S Harrison

The project explored the potential of staged hybrid chemical and biological technologies in the extraction and recovery of metals from waste electrical and electronic equipment (WEEE). Studies were concentrated on developing key kinetics of complementary chemical leaching reactions and microbial ferric iron regeneration mechanisms in bioleaching systems to maximise the extraction of valuable metals from printed circuit boards (PCBs). Abiotic leaching of pure metals in acidic environments was very fast when ferric iron was used as the primary oxidant. Given these rapid kinetics and the stoichiometric requirements, a significant economic investment was needed to continually supply the necessary reagents to sustain such a process. Biologically facilitated systems alleviated this economic burden as acidophilic microorganisms regenerate the ferric iron oxidant needed to promote the dissolution of metals from PCBs. Reactor design and the mode of operation was essential in realising the benefits of bioleaching since acidophilic microorganisms were susceptible to inhibition as metals accumulated in the reaction environment. Enhanced extraction rates were achieved when microbial and chemical reaction mechanisms were separated into two-staged reactor configurations with reactors in series providing the greatest improvement in performance as inhibitory effects were alleviated. Integrated flowsheet analysis showed that this approach minimized the large volume of effluent generated during chemical leaching. This lessened the process dependence on replenishing resources and resulted in lower overall operating costs compared to traditional hydrometallurgical approaches.

Biogas and volatile fatty acids biorefinery by co-digestion of fruit juice industry solid and liquid wastes with lignocellulosic biomass

Grant number: CSIR/IU/WRIU/2016/008 • **Lead Institution:** Stellenbosch University
Project Leader: Prof J Görgens

Gas stripping was found to be inefficient and ineffective for the continuous removal and recovery of VFAs. An alternative in situ method, based on liquid-liquid extraction (LLE), was investigated. LLE was found to be more effective than gas stripping and the investigation showed that LLE was strongly dependent on pH, and the degree of extraction was higher in actual anaerobic digestion (AD) effluent than synthetic. Biocompatibility experiments were conducted with biochemical methane potential tests (BMPs) to test the toxicity of the solvents used in the LLE. Trioctylamine (TOA) in canola oil and Tributyl phosphate (TBP) in kerosene had the highest biogas production, 168.0 mL ± 26.15 mL and 145.7 ± 5.03 ml, respectively. These two solvents (extractant and diluent) had slightly higher methane percentages compared to the control (9.73 ± 1.33), with 12.62% ± 2.82% for TOA in canola oil and 14.68% ± 6.73% for TBP in kerosene. Based on the BMPs, LLE studies have shown that there is opportunity to co-produce VFAs and biogas. An experimental 17 L scale-up run demonstrated the potential for producing both biogas and VFAs continuously.

All project deliverables are available for download from the Waste RDI Roadmap website: **http://wasteroadmap.co.za**

ANNEXURE 2: **SELECTED WASTE RDI ROADMAP DELIVERABLES PUBLISHED IN 2019/20**

Grant /001: M Samson (Wits)

Ntuli, Z. (2019). Local realities and political histories: The waste pickers in Sasolburg and their struggle for transformation in the waste management system of South Africa. Masters dissertation. Johannesburg: University of the Witwatersrand.

Sekhwela, MM. and Samson, M. (2020). Contested understandings of reclaimer integration - Insights from a failed Johannesburg pilot project. *Urban Forum* 31, 21–39. *doi.org/10.1007/s12132-019-09377-1*

Shogole, M.P. (2019). Embodiment and separation at source studied through the lens of everyday informal street reclaiming in Johannesburg. Masters dissertation. Johannesburg: University of the Witwatersrand.

Samson, M. (2019). Whose frontier is it anyway? Reclaimer "integration" and the battle over Johannesburg's waste-based commodity frontier, Capitalism Nature Socialism. *doi.org/10.1080/10455752.2019.1700538*

Samson, M., Gewer, H., Guya, J., Harrison, K., Kesselman, B.,Ntuli, Z., Pholoto, L., Sekhwela, M. and Timm, S. (2020). Lessons from Waste Picker Integration Initiatives. Technical report: Metsimaholo Case Study. Johannesburg: University of the Witwatersrand.

Samson, M., Timm, S., Chidzungu, T., Dladla, N., Kadyamadare, G., Maema, K., Mahlase, M., Mokobane, A., Molefe, K., Ndlovu, L., Ntuli, Z., Phakoe, K., Pholoto, L., Sekhwela, M. and Shogole, M. (2020). Lessons from Waste Picker Integration Initiatives. Technical report: Johannesburg Case Study. Johannesburg: University of the Witwatersrand

Samson, M. (2020). Lessons from Waste Picker Integration Initiatives. Technical Report: Integrating reclaimers into our understanding of the recycling economy. Johannesburg: University of the Witwatersrand.

Grant /003: B Sithole (CSIR)

Andrew, JE. (2018). Beneficiation of sawdust waste material within the context of an integrated forest biorefinery. Doctoral dissertation. Durban: University of KwaZulu-Natal.

Badat, Z. (2019). Beneficiation of sawdust: Chemical fractionation of lipophilic extractives. Masters dissertation: Durban: University of KwaZulu-Natal.

Kekana, PT., Sithole, BB. and Ramjugernath, D. (2019). Ultrafiltration of lignin from black liquor: Modelling decline in flux. Journal of Scientific and Industrial Research 78(02): 91-95. *nopr.niscair.res.in/handle/123456789/45765*

Grant /004: B Sithole (CSIR)

Khumalo, M., Sithole, B. and Tesfaye, T. (2020). Valorisation of waste chicken feathers: Optimisation of keratin extraction from waste chicken feathers by sodium bisulphite, sodium dodecyl sulphate and urea. Journal of Environmental Management 262, 110329. *doi.org/10.1016/j.jenvman.2020.110329*

Grant /005: M John (CSIR)

Naidu, D. (2020). Development of bio-based xylan composites for food packaging applications. Doctoral dissertation: Port Elizabeth: Nelson Mandela University.

Grant /006: S Harrison (UCT)

Harrison, STL., Johnstone-Robertson, M., Rademeyer, S., Murhonyi, L., Ngwenya, C., Horn, C., Rumjeet, S. and Smart, M. (2019). Value recovery from Solid Confectionery Waste: Technical Report. Cape Town: University of Cape Town.

Rademeyer, S. (2018). Poly(γ-glutamic) acid (PGA) production from confectionery waste using Bacillus species. Masters dissertation. Cape Town: Cape Peninsula University of Technology.

Grant /008: J Görgens (SUN)

James, G. (2020). *In situ* extraction of volatile fatty acids from anaerobic digestion systems. Masters dissertation. Stellenbosch: Stellenbosch University.

Kell, CJK. (2019). Anaerobic co-digestion of fruit juice industry wastes with lignocellulosic biomass. Masters dissertation. Stellenbosch: Stellenbosch University.

Grant /009: A Chimphango (SUN)

Ceaser, R. (2019). Comparative analysis of methods for producing nanocellulose from wheat straw and bran, with co-extraction of valuable products. Masters dissertation. Stellenbosch: Stellenbosch University.

Grant /017: S Oelofse (CSIR)

Oelofse, S., Nahman, A., Baig, MB., Salemdeeb, R., Nizami, AS. And Reynolds, C. (2020) Food waste within South Africa and Saudi Arabia. In: Reynolds, C., Soma, T., Spring, C. and Lazell, J., (eds.) Routledge Handbook of Food Waste. Routledge. *doi.org/10.4324/9780429462795*

ANNEXURE 3: **WASTE RDI ROADMAP GRANT PROJECTS (CURRENT)**

No	Applicant	Title	Aligned with priority waste	Aligned with cluster	Principal Investigator	Funding instrument	Funding term
2016_9	**Stellenbosch University**	Organic waste: a bioresource for production of novel cellulose nanocomposites	Organic	Technology solutions	Dr A Chimphango	Non-recoverable open R&D grant	4/2016 - 3/2020
2017_15	**Stellenbosch University**	Thermal treatment of printed circuit board waste and its effect on downstream metal recovery processes	WEEE	Technology solutions	Prof C Dorfling	Non-recoverable open R&D grant	1/2017 - 3/2020
2018_17	**CSIR**	Increasing reliable, scientific data and information of food losses and waste in South Africa	Organic	Strategic Planning	Dr S Oelofse	Non-recoverable targeted grant	4/2018 - 3/2021
2018_19	**UWC**	Understanding societal behaviour in order to reduce and divert waste going to landfills	MSW	Waste & Society	Prof C Schenck	Non-recoverable open R&D grant	1/2019 - 12/2021
2018_20	**CSIR**	Incentives for municipalities to divert waste from landfill in South Africa	MSW	Strategic Planning	Mr A Nahman	Non-recoverable open R&D grant	1/2019 - 3/2021
2018_21	**CSIR**	The use of plastic waste in road construction in South Africa	Plastic	Technology solutions	Mr G Mturi	Non-recoverable targeted grant	3/2019 - 5/2020
2018_22	**CSIR**	Informing decisions on single-use plastic carrier bags in South Africa: Evidence from a life cycle sustainability assessment	Plastic	Modelling & Analytics	Mr A Nahman	Non-recoverable targeted grant	3/2019 - 3/2020
2019_24	**UCT**	Assessing economy-wide prospects for a more sustainable circular economy in South Africa (Material Flow Analysis)	(All)	Modelling & Analytics	Prof H von Blottnitz	Non-recoverable open R&D grant	1/2020 - 3/2022
2019_25	**CSIR**	Production of high-value dissolving wood pulps from sawdust waste material	Organic	Technology solutions	Dr J Andrew	Non-recoverable open R&D grant	4/2020 - 3/2023
2019_26	**UCT**	Co-processing of PCB leach solutions with effluent streams from PCB manufacturing	WEEE	Technology solutions	Prof J Petersen	Non-recoverable open R&D grant	1/2020 - 3/2023
2019_27	**Stellenbosch University**	Curbing post-harvest losses using methane from anaerobic digestion of organic waste to drive the cold chain	Organic	Technology solutions	Dr E van Rensburg	Non-recoverable open R&D grant	1/2020 - 3/2023
2019_28	**University of Pretoria**	Municipal waste at household level: Demand estimation and service design	MSW	Waste Logistics Performance	Prof J Joubert	Non-recoverable open R&D grant	1/2020 - 3/2022
2019_29	**CSIR**	End-of-life options of biobased plastic materials and its biocomposites in landfill, compost and marine water conditions	Plastic	Technology solutions	Dr S Muniyasamy	Non-recoverable open R&D grant	1/2020 - 3/2022
2019_30	**Mintek**	Technology landscape report and business case for the recycling of Li-ion batteries in South Africa	WEEE	Strategic Planning	M Gericke	Non-recoverable open R&D grant	1/2020 - 3/2021

ANNEXURE 3: **COMPLETED GRANT PROJECTS**

No	Applicant	Title	Aligned with priority waste	Aligned with cluster	Principal Investigator	Funding instrument	Funding term
2016_1	**University of the Witwatersrand**	Lessons from waste picker integration initiatives – Development of evidence based guidelines to integrate waste pickers into South African Municipal Waste Management Systems	MSW	Waste & Society	Dr M Samson	Non-recoverable open R&D grant	4/2016 - 9/2019
2016_2	**CSIR (NRE)**	A Decision Support Tool for Implementing Municipal Waste Separation at Source: Incorporating Socio-economic and Environmental Impacts	MSW	Modelling & Analytics	Mr A Nahman	Non-recoverable open R&D grant	4/2016 - 3/2018
2016_3	**CSIR (NRE)**	Beneficiation of forestry biomass waste streams	Organic	Technology solutions	Dr B Sithole	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_4	**CSIR (NRE)**	Valorisation of chicken feathers	Organic	Technology solutions	Dr B Sithole	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_5	**CSIR (MSM)**	Sustainable utilization and conversion of post-harvest agricultural waste residues into value added materials	Organic	Technology solutions	Dr M John	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_6	**University of Cape Town**	Value recovery from solid confectionary waste	Organic	Technology solutions	Prof S Harrison	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_7	**Stellenbosch University**	Reactor design for industrial furfural production from sugar cane agricultural residues	Organic	Technology solutions	Prof J Görgens	Non-recoverable open R&D grant	4/2016 - 3/2018
2017_8	**Stellenbosch University**	Biogas and volatile fatty acids biorefinery by co-digestion of fruit juice industry solid and liquid wastes with lignocellulosic biomass	Organic	Technology solutions	Prof J Görgens	Non-recoverable open R&D grant	4/2016 - 6/2018
2016_10	**Stellenbosch University**	Amino acid leaching of metals from printed circuit board waste	WEEE	Technology solutions	Prof C Dorfling	Non-recoverable open R&D grant	4/2016 - 3/2018
2016_11	**Stellenbosch University**	Extraction of value from solid waste by pyrolysis conversion: Pilot scale optimisation	Plastics	Technology solutions	Prof J Görgens	Non-recoverable open innovation grant	4/2016 - 3/2018
2017_12	**Stellenbosch University**	Recycling rare earth elements from fluorescent lamps	WEEE	Technology solutions	Prof C Dorfling	Non-recoverable open R&D grant	1/2017 - 3/2019
2017_13	**University of Cape Town**	Integrated process flowsheet for the sequential extraction and recovery of valuable metals from WEEE	WEEE	Technology solutions	Prof S Harrison	Non-recoverable open R&D grant	1/2017 - 3/2020
2017_14	**Stellenbosch University**	Environmentally friendly lithium ion battery (LIB) recycling process	WEEE	Technology solutions	Dr G Akdogan	Non-recoverable open R&D grant	1/2017 - 3/2019
2017_16	**Stellenbosch University**	Use of PCB leach residue as reductant in pyrometallurgical operations	WEEE	Technology solutions	Dr G Akdogan	Non-recoverable open R&D grant	1/2017 - 3/2019
2018_18	**CSIR**	Techno-economic feasibility assessment on the viability of using waste PET to produce MOFs	Plastic	Technology solutions	Dr J Ren	Non-recoverable targeted grant	5/2018 - 3/2019
2019_23	**Various**	Marine plastic pollution science review (5)	Plastic	Environment	Various	Non-recoverable targeted grant	

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