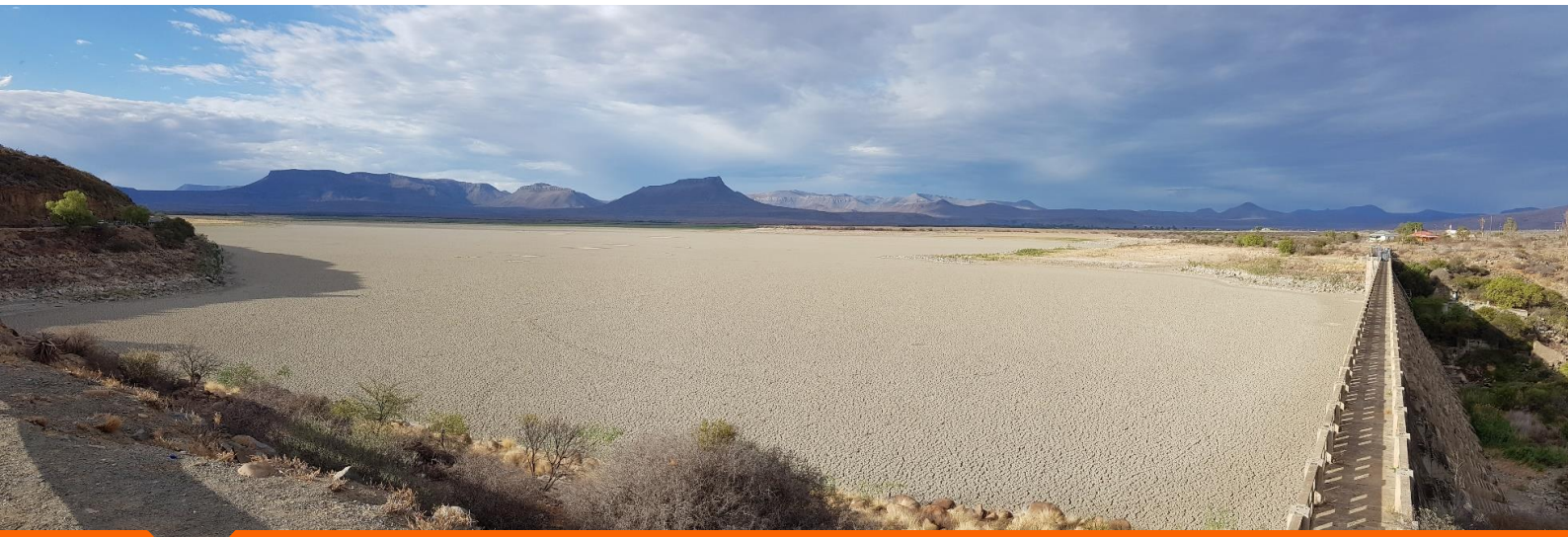
National Water Reuse Programme:

Programme Design and Preparation of a Full Funding Proposal to the Green Climate Fund (GCF)



Economic and Beneficiary Assessment

Annexure 22

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DEVELOPMENT BANK OF SOUTHERN AFRICA
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ACRONYMS & ABBREVIATIONS

CSIR	Council for Scientific and Industrial Research
EIRR	Economic Internal Rate of Return
GCF	Green Climate Fund
GNI	Gross National Income
GVA	Gross Value Added
WAREU	Water Reuse
WRP	Water Reuse Programme

1. ECONOMIC ASSESSMENT

The economic assessment supports various components of the full funding proposal to the GCF:

1. **Impact Potential:** Impact is estimated using the GCF's Adaptation Indicator
2. **Sustainable Development Potential:** The economic assessment contributes to articulating the WRP's social, economic, and environmental co-benefits.
3. **Effectiveness and Efficiency:** The assessment will produce an Economic Internal Rate of Return to support the project decision metrics produced by the financial analysis.

The assessment of economic impact is structured at the level of the municipality (i.e. project impact is assessed at municipality level using municipal population data and statistics). For the most part, impact is calculated using inputs and data from the CSIR Green Book, secondary literature (such as Green Cape case studies), and municipal statistics. The WRPs impact is delivered primarily through the additional water which the Programme avails to municipalities, as well as the employment created for the operationalisation of the Programme. The WRP could also contribute to ensuring jobs are not lost due to water shortages.[1]

Based on the per capita consumption of potable water in South Africa, and the additional water that will be supplied by the WRP across its projects, direct beneficiaries are counted as those additional people who benefit from the additional water supplied into the municipal systems (per capita water consumption * additional water supplied = additional people receiving water).

This calculation is then disaggregated by male and female beneficiaries using South Africa's national proportional split between males and females in the population. The WRP first phase (the pilot portfolio of reuse projects) will deliver an additional 445 Ml/day to select municipalities. Per capita water consumption ranges from 87 litres/person/day to 285 litres/person/day across municipalities). Water delivery and per capita consumption per municipality is shown in the table below.

PILOT MUNICIPALITIES (Showing Treated Water Output from WRP Ml/d)	Combined Treated Water Output from WRP Ml/d	Water Consumption per capita (litres on average)
Eastern Cape		
Nelson Mandela Metropolitan Municipality (40 Ml)	40	87[2]
Free State		
Mangaung Metropolitan Municipality (25 Ml)	25	178[3]
Gauteng		
City of Ekurhuleni (60 Ml)	60	90[4]
City of Johannesburg Metropolitan Municipality (50 Ml)	50	285[5]
City of Tshwane Metropolitan Municipality (30 Ml)	30	240[6]
KwaZulu-Natal		
eThekwini Metropolitan Municipality (100 Ml)	100	100[7]

[1] Job losses resulting from water shortages are aggregated across urban and agricultural sectors for the purposes of this assessment. Jobs saved per ML of supply deficit are estimated based on the GreenCape analysis from the Berg Water Management Area (Available at https://www.greencape.co.za/assets/Uploads/WATER-MIR-2019-WEB-01-04-2019.pdf)
[2] https://nelsonmandelabay.gov.za/DataRepository/Documents/water-restrictions-and-by-law-2020_4tVyc.pdf
[3] http://www.mangaung.co.za/wp-content/uploads/2021/03/ANNEXURE-E-Ten-Year-WCDM-Strategy.pdf
[4] https://www.ekurhuleni.gov.za/about-the-city/annual-reports/2017-18/3924-annual-report-2017-18-1/file.html
[5] https://www.johannesburgwater.co.za/annual-reports/
[6] https://www.tshwane.gov.za/sites/Departments/Water-and-Sanitation/High%20water%20consumption%20%20Job%20card%20and%20text/Water%20Consumption.pdf
[7] https://www.cogta.gov.za/ddm/wp-content/uploads/2020/07/Metro-Profile_Ethekwini.pdf

PILOT MUNICIPALITIES (Showing Treated Water Output from WRP Ml/d)	Combined Treated Water Output from WRP Ml/d	Water Consumption per capita (litres on average)
Indicative Municipality A (75 Ml)	75	182[8]
Northern Cape		
Indicative Municipality B (15 Ml)	15	115[9]
Western Cape		
City of Cape Town Metropolitan Municipality (40 Ml)	40	156[10]
Drakenstein Local Municipality (10 Ml)	10	171[11]

Based on the first phase selection of 10 water reuse projects, the WRPs indicative impact in terms of direct and indirect beneficiaries as well as jobs created and saved is outline in the table below.

The WRP first phase could reach a total of ***3 424 737 direct beneficiaries (Male=1654148 and Female=1770589)***. Indirect beneficiaries are counted as those reached with water supply through the full scale WRP (i.e. the full set of 27 water reuse projects delivering 1067 Ml of water across the country). At scale the WRP could reach a further ***3 877 805 indirect beneficiaries***.

While the WRP aims to target these direct beneficiaries during the course of the programme's implementation, it has been assumed that at the mid-term stage some 40% of this target will be attained, noting that the initial stages of the programme will require the establishment of the WPO. This means that the mid-term direct beneficiaries target would be 1369895 (comprised of Male=661659 and Female =708236)

The more comprehensive breakdown of these beneficiaries is provided in Appendix A, with the Excel Spreadsheet in Annex 26 to the Funding Proposal.

For the monitoring and evaluation framework provided in the Funding Proposal is has been assumed the 100% of these direct beneficiaries will realise improved water security based upon the per capita consumption levels of the additional water provided through reuse. Additionally, in Appendix A, the estimated number of unserved people in each municipality is provided indicating that in many instances the improved water security from the introduction of water reuse can support in providing water to address these needs.

For the monitoring of improved livelihood options (Supplementary Indicator 2.1) Statistics SA have estimated that 20% of the population endure on-going food insecurity[12]. Noting this it is assumed that 20% of the direct beneficiaries from improved water security will leverage that to undertake improved livelihood options, including food production and other businesses that use water productively. In terms of the mid-term target, and aligned to the approach for the direct beneficiaries, it is assumed that 40% of the final target would have been achieved.

[8] https://www.Indicative .gov.za/images/x33998-1.pdf
[9] http://www.solplaatje.org.za/CityManagement/Reporting/Annual%20Reports/Annual%20Report%202018-2019%20(Final).pdf
[10] https://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/damlevels.pdf
[11] http://www.drakenstein.gov.za/docs/Documents/4.%20Water%20Services%20Development%20Plan.pdf
[12] http://www.statssa.gov.za/?p=12135

Table 1 Beneficiaries and Employment Impact of the WRP

PILOT MUNICIPALITIES (Showing Treated Water Output from WRP Ml/d)	Number of direct beneficiaries disaggregated by gender		Jobs Created at new ATPs		Jobs Saved through avoided water shortages	
	% Male	% Female	% Male	% Female	% Male	% Female
Eastern Cape						
Nelson Mandela Metropolitan Municipality (40 Ml)	222 069	237 701	41	11	14	4
Free State						
Mangaung Metropolitan Municipality (25 Ml)	67 837	72 612	26	7	9	2
Gauteng						
City of Ekurhuleni (60 Ml)	322 000	344 667	62	17	22	6
City of Johannesburg Metropolitan Municipality (50 Ml)	84 737	90 702	52	14	18	5
City of Tshwane Metropolitan Municipality (30 Ml)	60 375	64 625	31	8	11	3
KwaZulu-Natal						
eThekwini Metropolitan Municipality (100 Ml)	483 000	517 000	103	28	36	10
Indicative Municipality A (75 Ml)	199 038	213 049	78	21	27	7
Northern Cape						
Indicative Municipality B (15 Ml)	63 000	67 435	16	4	5	1
Western Cape						
City of Cape Town Metropolitan Municipality (40 Ml)	123 846	132 564	41	11	14	4
Drakenstein Local Municipality (10 Ml)	28 246	30 234	10	3	4	1
TOTAL	**1 654 148**	**1 770 589**	**460**	**125**	**161**	**44**
GRAND TOTAL	**3 424 737 direct beneficiaries**				**790 jobs**	

2. BASIS FOR ECONOMIC IMPACT OF THE WRP

Water scarcity resulting from climate vulnerability has an economic cost. The economic case for the WRP is built around how the Programme contributes to alleviating that cost, as well as the Programme's broader socio-economic impacts. The articulation of impact for the Programme is rooted in its climate rationale and focuses on those municipalities with the strongest climate rationale **The rollout of the water reuse program delivers two key economic benefits to households and businesses connected to local reticulated water distribution networks:**

- **First, it delivers bulk water supply** which (if not readily available from other sources) is of value to households and businesses. This water is valued through a market transaction and is part of the financial case described in Section 4.4.2. Albeit noting that in there is no competitive market for water supply (one cannot choose to connect to an alternative provider at a different price point), we make the (broadly reasonable) assumption that the bulk water supply price is a fair reflection of the value of water delivered.

- **Second, it contributes to security of supply in water-stressed regions,** and reduces the risk of **water usage restrictions which may be required if there is a shortfall of supply in the event of a drought.**

As this second "value" is not traded, we develop a shadow price based on "willingness to pay" for households and economic output for businesses.[13] There is no market for water resilience – customers connected to a water network cannot choose to pay more (or less) to receive a more (or less) resilient water supply. They face a single tariff, and the local municipality then provides a supply of water accordingly, but one which does not "internalise" the risk of water shortages resulting in water restrictions.

3. ESTIMATING THE VALUE OF RESILIENT WATER SUPPLY TO HOUSEHOLDS

The "willingness to pay" for a more resilient water supply can be estimated based on how much extra households are prepared to pay to reduce the risk of water restrictions. This is a common "stated preference" approach, where values can be elicited by household surveys using either contingent valuation techniques (i.e. asking customers how much extra they would be prepared to be for a defined service), or choice experiments (offering households a hypothetical range of packages of services, each with a different hypothetical price).

A major review of household willingness to pay in the UK estimated a value of up to £80 per day to avoid the most severe usage restrictions. As shown in Table 2 households would pay between £0.25 and £1.00 per day to avoid temporary use orders or non-essential use bans,[14] which would include for example hosepipe bans. A much higher value of between £40 and £80 is placed on avoiding emergency drought orders, which at the most extreme would involve no water supply from the reticulated water network and households would have to buy bottled water or receive water from tankers.

Table 2 Household willingness to pay to avoid usage restrictions (per day) – UK 2016

	Temporary use ban / Non-essential use	Emergency drought order
Low	£0.27	£44
Medium	£1.09	£87
High	£2.72	£174

Source: Water UK (2016) "Water resources long term planning framework (2015-2065)", Appendix F3

Using a cautious "benefits transfer" approach, these values can be translated to provide a reasonable benchmark for the value to South African households of avoiding similar usage restrictions. The main adjustment we make is to (1) bring the values from the 2016 UK study into

[13] In a "perfectly competitive" market, the value of a good or service is its price. For example, the hourly wage would typically be used as the economic value of an hour's work, assuming there is both a competitive supply of labour and demand for that labour.
[14] Note we do not take the "high" end of these estimates to ensure we err on the side of caution and avoid the risk of "overstating" the value of resilience.

present value by inflating up to 2021 price base, (2) converting this into South African Rand value using the average purchasing power parity exchange rate over the past 12 months, and (3) adjusting downwards using the ratio of GNI per capita of South Africa relative to the GNI per capita of the UK (USD 12,640 in SA, and USD 47,620 in the UK in 2019 according to World Bank data).

There are many other reasons that the willingness to pay of a South African household may be different from that of a UK household. not least (1) different household size and composition, (2) a greater or lesser ability to adapt to water shortages, (3) different expectations on the baseline level of service. These caveats notwithstanding, we translate the UK evidence into a reasonable valuation for avoiding water outages in the event of severe drought events as described below.

Table 3 Household willingness to pay to avoid usage restrictions (per day) – South Africa 2021 (est.)

	Non-essential use (NEU)	Emergency drought order (EDO)
Low	R0.72	R115.68
Medium	R2.89	R231.36
High	R7.23	R462.71

Source: Water UK (2016) "Water resources long term planning framework (2015-2065)", Appendix F3

The potential value at risk for households by municipality per day of restrictions is then estimated as shown in Table 4. The first step is to multiply the number of households connected to the reticulated water system in each municipality by the estimated willingness to pay to avoid water usage restrictions as described above. This gives the value at risk per day of water usage restrictions at a lower (NEU) and upper (EDO) estimate.

Table 4 Value at risk for households in each municipality

Municipality	Households (#)	ZAR Value at risk per day (NEU)	ZAR Value at risk per day (EDO)
Nelson Mandela Metropolitan Municipality (40 Ml)	89 721	R259 470	R20 757 626
City of Ekurhuleni (60 Ml)	1 034 797	R2 992 601	R239 408 043
City of Johannesburg Metropolitan Municipality (50 Ml)	1 414 768	R4 091 465	R327 317 182
City of Tshwane Metropolitan Municipality (30 Ml)	957 917	R2 770 266	R221 621 278
eThekwini Metropolitan Municipality (100 Ml)	360 000	R1 041 109	R83 288 699
Indicative Municipality A (75 Ml)	110 937	R320 826	R25 666 107
City of Cape Town Metropolitan Municipality (40 Ml)	1 312 500	R3 795 709	R303 656 713
Drakenstein Local Municipality (10 Ml)	66 575	R192 533	R154 026 25
Indicative Local Municipality B (15 Ml)	72 012	R208 256	R16 660 516
Mangaung Metropolitan Municipality (25 Ml)	297916	R861 564	R68 925 100
Total	**5 717 143**	**R16 533 799**	**R1 322 703 888**

4. ESTIMATING THE VALUE OF RESILIENT WATER SUPPLY TO BUSINESSES

The value of water resilience to businesses can instead by proxied by the vulnerability of economic output to a curtailment in water supply. That is, the value to a business from reducing the risk of interruptions to water supply is a function of its reliance on water supply to produce economic

output, defined here by gross value added. The economic value of each sector varies from one municipality to another, while the exposure of economic value to water restrictions varies from one sector to another, in function of the climate stress in each municipality. The estimated value in GVA reduction is provided in Table 5.

The next step in estimating the potential value at risk from water outages in the event of a drought or water restrictions is to multiply these values through by the share of economic activity by sector in South Africa. GVA per sector per municipality was assessed using output from the CSIR Greenbook (Ngepah, et al., 2019). Economic sectors were summarised to include the following categories:

- Agriculture, Forestry and Fishing
- Mining and quarrying
- Manufacturing
- Electricity, gas and water
- Wholesale and retail trade, catering and accommodation
- Transport storage and communication
- Finance, insurance, real estate and business services
- Government and community, social and personal services

Table 5 Value at risk for businesses in each municipality

Municipality	Contribution to National GDP (%)	Value at risk per day (NEU)	Value at risk per day (EDO)
Nelson Mandela Metropolitan Municipality (40 Ml)	3.35%	R7 508 475	R77 631 110
City of Ekurhuleni (60 Ml)	6.21%	R12 521 860	R140 879 848
City of Johannesburg Metropolitan Municipality (50 Ml)	16.71%	R27 970 588	R359 231 426
City of Tshwane Metropolitan Municipality (30 Ml)	10.03%	R14 680 229	R212 351 709
eThekwini Metropolitan Municipality (100 Ml)	10.71%	R22 481 098	R250 707 047
Indicative Municipality A (75 Ml)	0.57%	R1 431 665	R13 792 625
City of Cape Town Metropolitan Municipality (40 Ml)	11.18%	R21 055 711	R246 045 531
Drakenstein Local Municipality (10 Ml)	0.45%	R1 114 327	R9 597 779
Indicative Local Municipality B (15 Ml)	0.68%	R1 348 854	R13 700 637
Mangaung Metropolitan Municipality (25 Ml)	1.72%	R3 279 009	R33 392 419
Total	61.61%	**R113 391 816**	**R1 357 330 133**

5. ESTIMATING THE ECONOMIC INTERNAL RATE OF RETURN (EIRR)

The economic IRR is then a function of the contribution of the WAREU program to reducing the risk of water shortages in the event of a drought. Ideally, this would be based on a hydro-economic analysis of climate stress and drought risk in each municipality with and without the additional capacity provided by the WRP (and which would/could not be provided by other water supply options). However, the sophisticated technical hydrological models to underpin this analysis do not exist (certainly not

consistently and on a comparable basis) in all municipalities. Instead, we use a "stylised" drought event consisting of four months of temporary use bans, two months of non-essential use restrictions, and two-weeks of emergency restrictions (at the most extreme resulting in rota cuts with no water available from the reticulated distribution network). The economic IRR of the WAREU is then estimated by adding in this "resilience" value to improving the resilience to water shortages resulting from climate stress (and worsened by climate change), by comparing the security of supply with and without the WAREU[15].

The WRP contributes to minimising the water supply deficit and the chance of water restrictions in response to water shortages at the local level. This forecasted contribution of the WRP is applied to the value at risk to households and businesses across all municipalities to generate an indication of the value of the WRP in terms of the avoided cost of water shortages. This is summarised in the figure below.

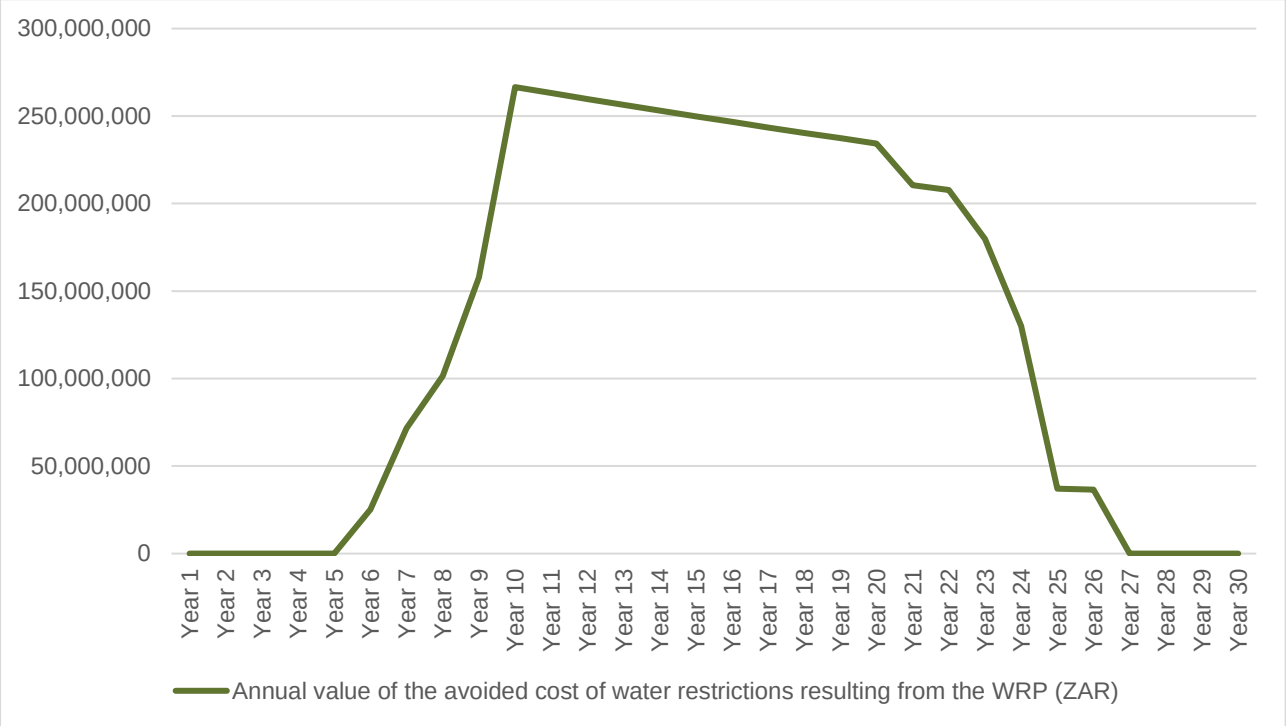

Figure 1 Annual value of the avoided cost of water restrictions resulting from the WRP (ZAR)

The average annual avoided cost to households and businesses that would have resulted from water restrictions in the absence of the WRP is over ZAR 130 million (approx. USD 8.1 million). The annual value of avoided water restrictions to households and businesses is summed with the net financial cashflows for the programme and discounted over the period to 2050.[16]

[15] Note we do not project changes to the underlying household or business values of water resilience over time. This is to err on the side of caution, and given the significant macroeconomic uncertainty in the current climate (including the as yet unknown impact of Omicron and other future COVID-19 variants). Specifically, we use the same number of households connected to the municipal reticulated water systems in future, the same willingness to pay (which for example would increase if incomes rise), the same economic output (GVA) and the same sector composition of the economy as in present day.

[16] This study tests the impact of two social discount rates. The first is a slightly lower social discount rate (3.66%) which is in the range generally applied in the context of interventions responding to the impacts of climate change. The second is slightly higher (8.35%) and is more aligned with observable market interest rates. Please see Appendix A for more information.

- **The Economic IRR for the WRP as a whole is 28%, where the Financial IRR for the programme as a whole is around 26%.**
- **The Net Present Value for the programme as a whole factoring in economic co-benefits ranges from ZAR 13 billion to ZAR 34 billion (USD 817 million to USD 2.1 billion), justifying the investment from an economic perspective.**

6. ECONOMIC IMPACTS OF THE WESTERN CAPE DROUGHT (CASE STUDY)

Understanding the way in which drought induced water shortages flowed through and affected different parts of the Western Cape economy during the 2017/2018 drought provides a practical example that further defends the statements made in the economic assessment above. A snapshot of the economic impacts in selected sectors is outlined below.

Agriculture

The most comprehensive study by Pienaar & Boonzaaier (2018) found that the Western Cape agricultural sector was set to lose an estimated R6.44 billion (adjusted to 2021) in the 2017/18 season due to the drought. The 2019 Provincial Economic Review and Outlook (WCG Provincial Treasury, 2019) analysing net farm income found that the sectors Gross Value Added declined by R12 billion between 2017 and 2018 (adjusted to 2021).

Construction

The SAM analysis undertaken forecast the Buildings and Other Construction industry would contribute R1.4 billion (2021 adjusted) less between 2017 – 2020 due to the drought, representing approximately 2% of sector output (WCG DEDAT, 2019).

Tourism

In 2017 domestic arrivals to the province declined by 25% and further declined by 18.8% in 2018. Total foreign direct spend from foreign tourists in 2018 reduced by R6.8 billion in 2018 (R7.4 billion adjusted to 2021). Total direct domestic spend declined by approximately R1 billion and 2017 and recovered slightly increasing by R300 million in 2018. This direct spend reduction would in turn have multiplier effects on the economy, and was lost on account of the drought. The economic impact projected in the SAM modelling process ranged, under a middle case scenario, from R400 million to R1.2 billion, however only accounted for supply side constraints.

Employment

The SAM analysis projections (WCG DEDAT, 2019) forecast job losses ranging from 36 000 in the best-case low compliance scenario to 126 000 in the middle case high compliance scenario. The impact of the drought on job creation has not been systematically assessed and inferred across sectors, however estimates have been produced with the most recent being that the drought cost the province 37 000 employment opportunities. 30 000 of these were estimated to have come from the agricultural sector.

Impacts on Municipal Revenue and Expenditure (case: City of Cape Town)

The City of Cape Town experienced a reduction in water sales by almost 50% between 2015/16 and 2018/19, from 1.1 billion litres per day to about 600 million litres per day. The City of Cape Town

increased expenditure in numerous ways to manage social and economic risks, primarily through increasing supply augmentation:

- Operational expenditure for water and sanitation increased by 2.6% over the two-year period of 2015/16 – 2017/18 and therefore an operational surplus was achieved.
- Capital expenditure on water infrastructure declined by 5 percent (Y-o-Y) in 2016/17 before dramatically increasing year on year by 47% or R285 million in 2017/18, and thereafter stabilised.

Appendix A: Detailed Beneficiary Calculation Spreadsheet

MUNICIPALITIES with Climate Rationale	Combined Treated Water Output from WRP Ml/d	Water Consumption per capita (litres on average)	Number of direct beneficiaries disaggregated by gender		Total number of direct beneficiaries per municipality	Municipal Population	Proportion of unserved population per municipality	Number of unserved population per municipality
			% Male	% Female				
EC								
Nelson Mandela Metropolitan Municipality	40	87	222 069	237 701	459 770	1254000	3,20%	40 128
FS								
Mangaung Metropolitan Municipality	25	178	67 837	72 612	140 449	893749	5,70%	50 944
GP								
City of Ekurhuleni	60	90	322 000	344 667	666 667	3894000	4,25%	165 495
City of Johannesburg Metropolitan Municipality	50	285	84 737	90 702	175 439	5600000	4,40%	246 400
City of Tshwane Metropolitan Municipality	30	240	60 375	64 625	125 000	2300000	9,40%	216 200
KZN								
eThekwini Metropolitan Municipality	100	100	483 000	517 000	1 000 000	3158000	9,50%	300 010
uMhlatuze Municipality	75	182	199 038	213 049	412 088	410465	10,70%	43 920
NC								
Sol Plaatjie Local Municipality	15	115	63 000	67 435	130 435	285000	4%	11 400
WC								
City of Cape Town Metropolitan Municipality	40	156	123 846	132 564	256 410	4618000	2,70%	124 686
Drakenstein Local Municipality	10	171	28 246	30 234	58 480	284475	12%	34 137
TOTALS			**1 654 148**	**1 770 589**	**3 424 737**	**22 697 689**		**1 233 319**