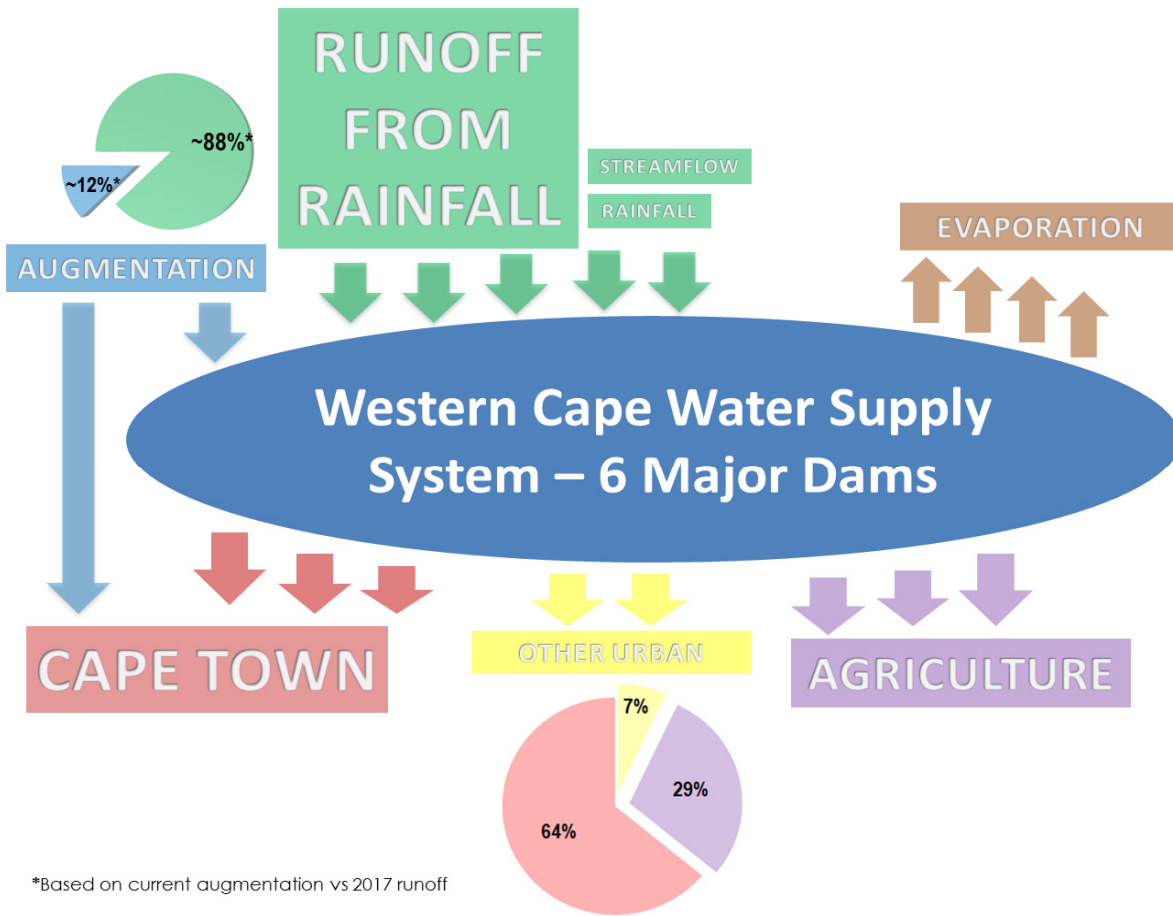


INTRODUCTION:

The City of Cape Town (CCT) is part of the Western Cape Water Supply System (WCWSS), which gets its water from a system of dams that supply agriculture and other urban areas. The current system is almost entirely dependent on rainfall. The National Department of Water and Sanitation (DWS) manages the 3 largest dams in the system and is responsible for planning and implementing water resource schemes to meet water demand for cities, industries, mining and agriculture. DWS plans at a 1 in 50 year level of assurance. This means that during droughts with a severity of 1:50 years or more, restrictions need to be imposed to reduce demand.



Dam levels rise principally from runoff from rainfall in catchment areas, and to a far lesser degree from streams flowing into the dams, and rainfall over the dams. Some augmentation will enter the system (such as groundwater from aquifers).

With climate change, worldwide weather patterns have changed and our catchment area has seen the worst drought on record. The current drought is much more severe than a 1 in 50 drought event. The best estimate of the return interval of the meteorological drought in the region of WCWSS dams is 311 years, with 90% confidence that it actually falls between 105 and 1280 years. The existing augmentation schemes will provide only about 12% of total available supply during 2018 while the poor rainfall of 2017 contributed 88%.

The next augmentation scheme for WCWSS was planned for 2022/3 and is being accelerated by the national Department. This scheme (surface water augmentation from Bergriver to Voelvlei Dam) is unlikely to be ready before 2021 and will provide about 60 million litres per day (MLD).

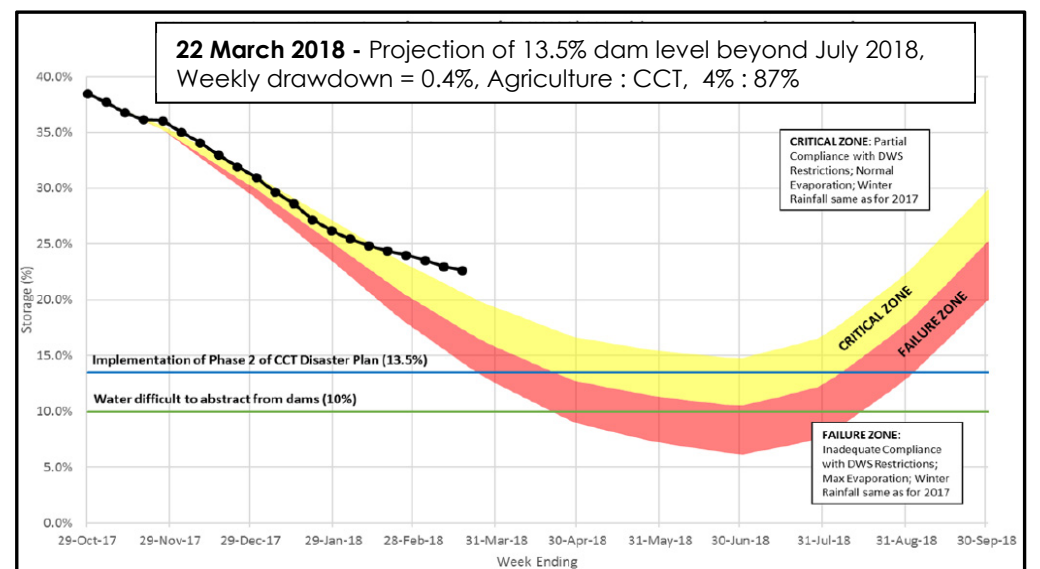
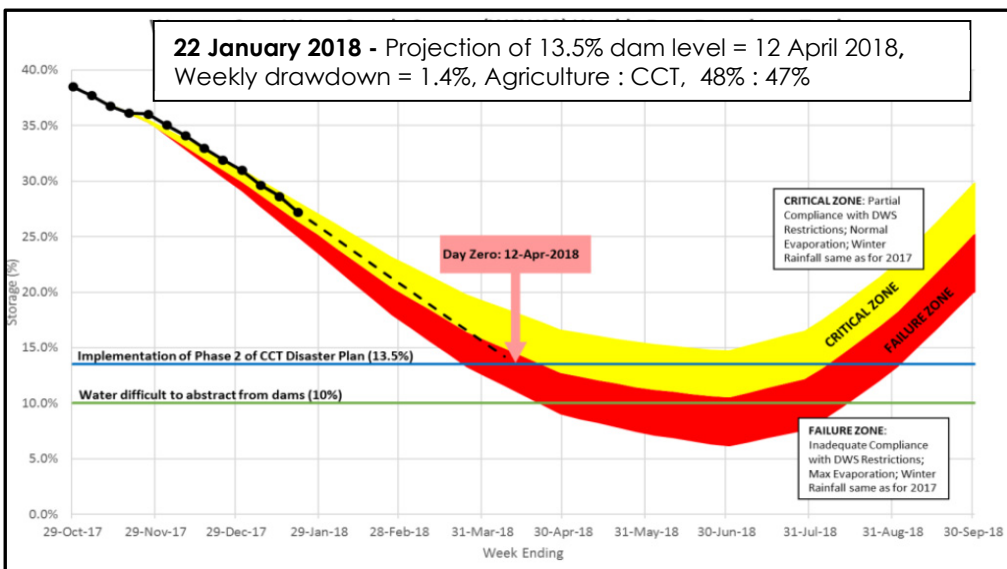
Global climate models are in agreement, that while simulations have very different outcomes, that it is not reasonable to plan for a scenario in which it does not rain in the future or in which it only rains at 2017 levels.

The capacity of the 6 dams is approximately 900 million m³ (Mm³). The unconstrained system allocation is ~570 Mm³ which provides an unconstrained daily demand of nearly 1,350 MLD to the supply system which includes CCT, agriculture and other urban areas. With current restrictions, this has been limited to an annual daily combined average of 680 MLD. To get through the drought, the DWS introduces restrictions to maintain dam levels above 15%, although water can be extracted to 10%, and with more difficulty, even lower.

WCWSS Yield	Unconstrained Allocation Mm ³	Unconstrained daily demand MLD	Restricted allocation Mm ³	Average restricted daily demand MLD
Cape Town	324	888	178	488
Agriculture	144	395	58	158
Other Urban	23	63	13	35
Total	570	1,346	248	681

To meet the DWS restriction target, CCT in turn has to implement restrictions on all consumers. The current restriction level is 6B, requiring savings of 45%. For non-residential customers monthly consumption needs to be reduced by 45% of unconstrained demand while individuals are restricted to 50 litres per capita per day (lpcd) and households to 6 kilolitres (kl) per month.

The severity of the drought prompted CCT to develop a disaster management plan if dam levels drop to the extent where it is no longer possible to provide water to the metropolitan area. The current drought restriction is part of Phase 1 of the disaster management plan. Phase 2 will be triggered in the event that dam levels become critically low, requiring major disruption. This provides a contingency plan premised on much of the city being disconnected from the reticulation system and households having to collect a volume of 25 liters per person from designated points of distribution. Based on consumption scenarios, the Day Zero dam level was set at 13.5%, which would provide 3 months' worth of water at a reduced volume supplied of 350MLD.



On 22 January 2018, Day Zero was modelled to 12 April 2018, with weekly dam level drawdown at 1.4%, and agriculture exceeding CCT's daily demand. By 22 March 2018 the weekly drawdown had reduced to 0.4% with agriculture using only 4% of water from the system, resulting in 13.5% dam level being projected into August. The Day Zero calculation is based on conservative assumptions of consumption beyond the City's control, including releases to agriculture, urban demand, evaporation and rainfall. The projected Day Zero date was publicised weekly, based on the previous weeks' average volume extracted from the system, extrapolated into the future to the intersection point of 13.5% dam level without adjusting for potential rainfall, reduction in demand etc. Unlike previous years, DWS stopped releases to irrigation boards once allocations were reached late in January onwards thus dramatically reducing drawdown from the system. Furthermore, a sizeable transfer was made by an adjacent catchment area in February, also reducing the drop in dam level. These two aspects, as well as a reduction in urban demand led to the Day Zero date moving well beyond the anticipated start of the rainy season in 2018.

Keeping in mind that a significant rise in dam levels will only eventuate from rainfall, the WCWSS thus remains vulnerable to severe water scarcity should rainfall be very late or runoff be similar (or lower) to 2017 volumes. Demand management not only protects the dams in the current year but is critical to 2019 dam behaviour if rainfall is poor.

STRATEGY TO OVERCOMING THE DROUGHT: Getting through to the rainy season requires **A:** managing the remaining water in the dams, **B:** managing demand down as much as possible and **C:** bringing on-stream water from other sources (ground, re-used and desalinated).

Modelling dam behaviour indicates that:

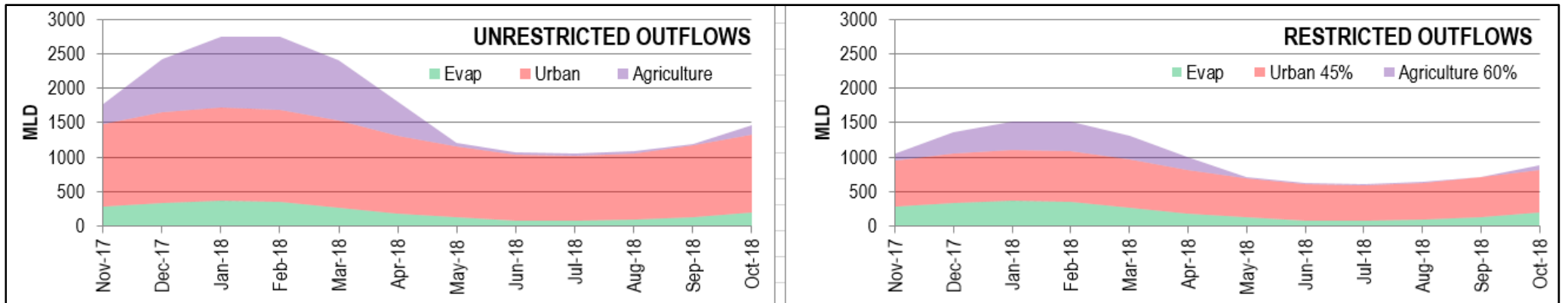
- Getting through the drought in 2018 requires that demand be reduced;
- Augmentation will not add sufficient water to carry the system through to the next rainy season but is critical to summer 2019 if 2018 winter rainfall is poor;
- CCT cannot reasonably go off-grid from the Western WCWSS.

A: MANAGING DAM LEVELS

Dam behaviour is modelled conservatively on 2017 runoff data. Dam levels drop from use by Agricultural, CCT, other municipalities, and through evaporation. Although we have progressed exceedingly well in curtailing our urban consumption and fast-tracking augmentation schemes, the poor rainfall of 2017 leaves us exposed to dams emptying too quickly.

CCT together with DWS monitors dam levels, and publishes change in dam levels and consumption every week. Tracking urban and agriculture demand against allocations has been included on CCT's water dashboard. Decisions around further restrictions will be made based on how dam levels are tracking against the anticipated behaviour. For every day that the 450 MLD target is exceeded it becomes more critical to use less as the over-use needs to be recovered by future reduced demand, while implementing augmentation projects to further reduce drawdown.

Out-flows from the system are shown below (based on maximum calculated evaporation, Urban and Agricultural allocations). Unrestricted, the system demand peaks in summer at over 2,500 MLD. Under the current restrictions the seasonal peak is at approximately 1,500MLD. Daily demand varies seasonally, specifically for agriculture. Urban demand fluctuates very little compared to historic patterns, with demand typically increasing slightly on hot days.



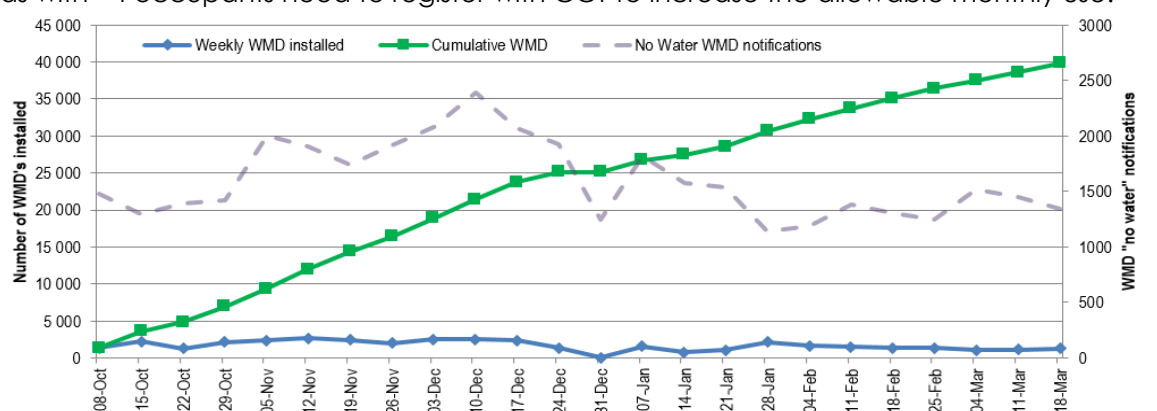
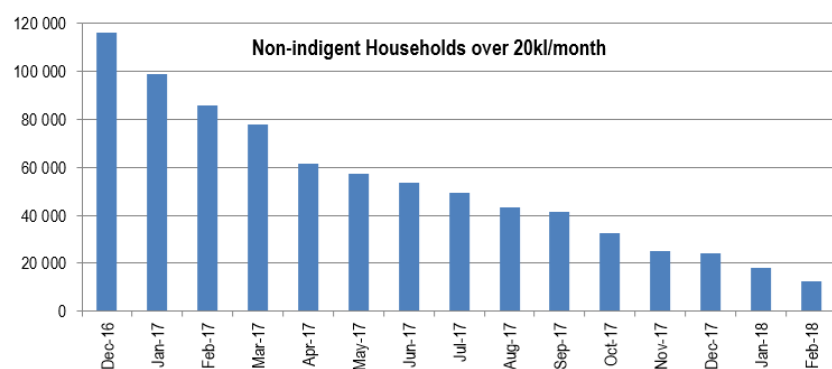
- o WCWSS covers West Coast district municipality and local municipalities of Drakenstein, Stellenbosch and Witzenberg, all urban restricted by 45%. CCT provides bulk water directly to parts of Stellenbosch and Drakenstein municipalities. The dams operate as a system, connected by pipelines, canals & tunnels;
- o CCT manages 3 of the 6 dams in the WCWSS: Steenbras Upper & Lower and Wemmershoek. Of these, Steenbras Upper is kept as full as possible as it provides for distribution over a wide area. From its elevated location, it can feed either Faure water treatment plant via the lower electricity pumped storage dam at Firlands, or Steenbras water treatment plant via the Lower Dam. Some water is held for the efficient operation of the Steenbras hydroelectric power station;
- o CCT also has a number of small dams in its control such as those on top of table mountain, with storage capacity of ~4.4Mm³
- o Domestic use ~ 70% of CCT use so demand management has been focussed on reducing domestic consumption.
- o Informal settlement in Cape Town use ~4% of water for approximately 15% of households.

B: MANAGING DEMAND

To manage daily demand requires that each person should use no more than the defined volume per day, whether they are home, at work or elsewhere. Reaching the overall demand target is only possible if individual use is curtailed.

What the City is doing:

- **Restriction Level 6B:** Level 6 was enforced from 1 January 2018, and 6B from 1 February 2018. The target has been reduced to 450MLD. Daily individual consumption must be limited to a maximum of 50 lcd to be aligned with Level 6 tariffs. 4 million people at 50 litres per day = 200MLD. Approximately 150MLD is consumed by industry, commerce, government etc. This results in 100MLD less than the daily target of 450MLD. The inability to adhere to restrictions thus far means that a stretch target of 50 litres is appropriate to ensure that the 450MLD target is reached
- **Communication campaigns:** Every person in the city needs to realise that this is a crisis. The city has launched numerous communication campaigns to assist people in reducing their consumption, such as household leak detection & repair and how to use 50 litres, and continues to use radio, print and social media to reach every citizen and mobilise to reduce consumption to 450MLD, aligned with 6B restrictions.
- **Pressure reduction:** Pressure reduction was initiated more than a decade ago and has been accelerated to automate zones across the city to optimise the system and reduce demand - especially the impact of leaks. Pressure zones are being used to force down consumption by throttling zones to the extent of partial supply if user behaviour in the zone is high in an effort to meet the daily water budget. Savings of nearly 50MLD have been affected so far.
- **Household flow regulators:** The city has been installing water management devices to manage debt for many years. The programme has been dramatically ramped up to households who have not reduced consumption to restrict daily household consumption and safeguard against the impact of leaks. In many cases this was due to undetected leaks, but under level 6 restrictions, the city will install these where consumption is higher than 10.5kl/month. A household of 4, each person using 50 lcd results in a monthly consumption of 6,000 litres per household. The allowance is per day, whether at home, work or school. Note also that the average household size in Cape Town is 3.2 people. While 6B restricts to 50 lcd, devices will only be fitted above 10.5kl, targeting highest users (4B targeted households using over 20kl). Households with >4 occupants need to register with CCT to increase the allowable monthly use.



CCT ideally would have preferred to manage household consumption through smart metering – similar to electricity, using pre-paid metering or remote monitoring and control – due to low cost of water this has not been viable. The city has installed more than 250,000 water management devices over the past decade. Household demand has declined significantly with just over 12,300 non-indigent households exceeding 20kl/month at end February 2018, an 85% reduction in a year. Since acceleration in installation from beginning October 2017, CCT installed 38,600 at high use households, and dealt with concomitant increase in no water service requests.

- **Punitive tariffs:** Restrictions go hand-in-hand with stepped tariffs, charging more for water use at higher volumes. Progressively more punitive tariffs have been introduced on inclining blocks so that higher use of volumes come at an increased cost. Level 6 tariff was introduced on 1 February 2018 where punitive tariff applies to all use over 50lcd. Water is still cheap compared to other goods and services, and is supplied to every formal household. As households are now required to dramatically reduce consumption, the volumes in higher usage steps have shrunk considerably. Step 1 & 2 (up to 10.5kl per month) will still be provided as free service to indigent households at Level 6.
- **Adaptation:** The city has engaged with large and small business with possible solutions and is working to incentivise reduced consumption. Avenues still to be evolved include usage of private boreholes in the system.
- **Information to drive behaviour change:** Examples include the Star rating tool for buildings, and making visually available household consumption data to incentivise all households to stay within usage limits (dark green & green dots).

What is happening with Agriculture? Agricultural restriction is currently set at 60%. DWS is responsible for regulating and controlling use, including releasing water for agriculture. CCT has been working with DWS and the Western Cape Provincial Government to ensure that releases are controlled – as at the end of February, DWS stopped releases to those irrigation boards who had reached their allocation increasing confidence that the agricultural restriction target will be met;

And other urban areas? Similarly to managing agriculture, DWS is responsible for managing other urban use. The outflow to other urban is relatively small. Cumulatively other urban centres are meeting restrictions and being monitored to prevent exceeding targeted consumption.

To reiterate, to make it through the drought and into the rainy season, we need to ensure management of releases out of the dams, reduction in demand that drives these releases, while maximising water flow into the system. The third component is augmentation of supply.

C: AUGMENTATION

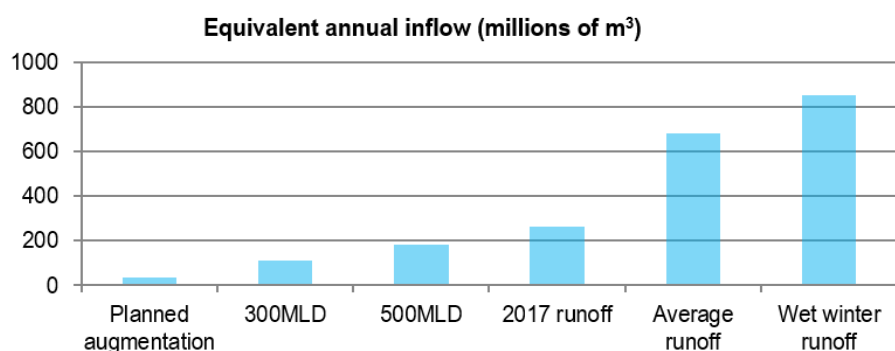
Non-surface water augmentation schemes are a much more expensive source of water compared to rain-fed dams. Even under very poor rainfall conditions such as that experienced in 2017, the volume of water added to the dams was the equivalent of ~720MLD. For practical reasons Cape Town will continue to rely significantly on surface water dams supplied by rainfall. Reliability of the system will be increased by adding ground water, re-use and desalination. The costs of these schemes must be compared to the cost of water from dams which is **R5.20/kl** to ensure financial sustainability.

The augmentation programme has evolved significantly since introduction of the Water Resilience programme in May 2017 (for more comprehensive background information please see *Cape Town New Water Programme*). In summary, to ensure resilience against drought, the WCWSS needs diversified supply sources. Details of implementation and cost apportionment are still to be resolved but it is agreed that resilience requires diversification:

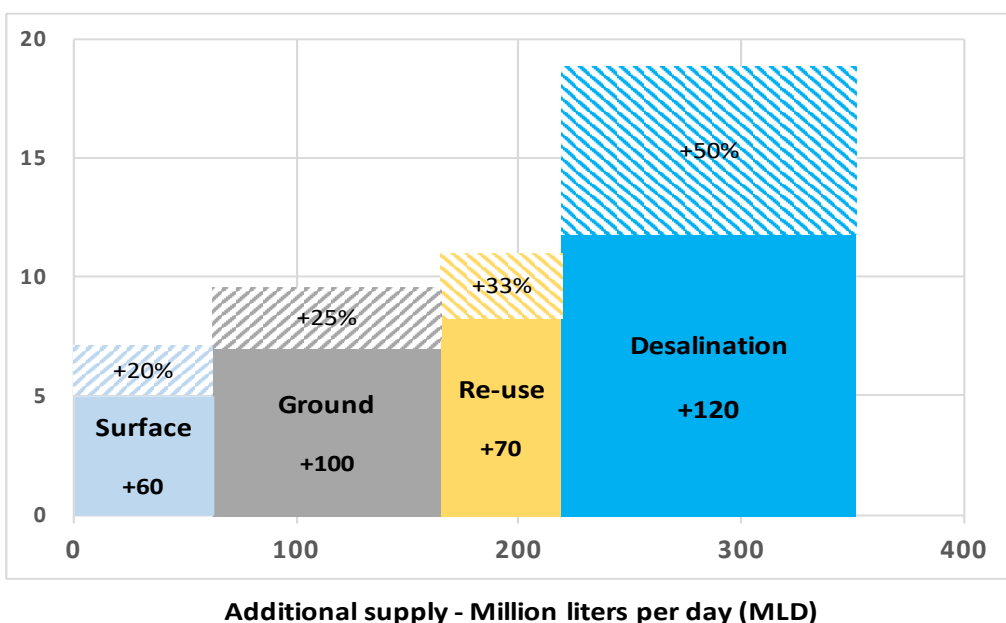
- **Prioritise groundwater extraction:** Fast-track extraction of water from Cape Flats Aquifer (CFA) and Table Mountain Group (TMG) Aquifer. Both these aquifers have significant storage volumes. The water use licences provide for yields of only a fraction of the available storage, and yields will be maximised in the short-term within the annual allowable volumes. Groundwater is also subject to the impact of drought but with significant time delay. The CFA license requires recharge from treated wastewater to replenish the aquifer and improve water quality in some instances.
- **Pursue permanent desalination at optimal scale.** Plan and execute permanent desalination at an optimum scale, at a plant size or in modules of 120-150 Ml/day. Do not build desalination plants of capacity larger than 200 MLD. Explore alternative procurement such as competitively bid turnkey approach, using the private sector and with a water purchase agreement, will yield the lowest cost per unit of water compared to the alternatives and be quicker to implement provided regulatory processes are fast-tracked as part of the emergency. Decisions around desalination must not be delayed. Desalination provides the only "new" source of water, and other than technical and financial constraints, has unlimited augmentation capacity.
- **Implement water re-use:** As the cost of desalinated (and to a lesser extent ground) water is significantly higher than surface water, it is logical to re-use the water to maximise the benefit. The optimal location for a large plant has been identified at the Faure Water Treatment Plant.
- **Further surface water augmentation:** DWS is implementing the Bergriver Voelvlei Augmentation Scheme (BRVAS) which is expected to add 23 Mm³ (60MLD) into the WCWSS in 2021.

Indicative target volumes from diverse sources

Cost considerations have to factor in the calculation of the yield from diverse water sources together with the level of assurance. The City is currently in the process of optimising the extent of the build programme as increasing the yield from the diverse sources will also increase the cost of water. An appropriate balance between assurance of supply and the cost of water will have to be found.



Target Unit Costs and uncertainty (Rand per thousand liters)



Cape Town's current augmentation projects:

GROUNDWATER (±150MLD variable, permanent augmentation)

- **Cape Flats aquifer** ±80 MLD) underway. Exploratory drilling has proceeded well. Yield and quality testing is still underway, which will determine the infrastructure installations at the various sites. Water use licenses were received in March. The licence condition provides for an annual yield as well as annual recharge requirement. The augmentation programme currently shows a constant yield across the year of 55MLD, but this will be varied as required, to a maximum yield of approximately 80MLD for the first phase. The aquifer has substantial capacity and while recharge will be introduced as soon as possible, it is apparent that it is not immediately required at the license condition yield.
- **Atlantis aquifer**, ±20MLD additional capacity underway, 12MLD already into system. Atlantis is already operating off-grid at 12MLD, and the additional yield of 20MLD will be fed into the bigger water supply system. Investigation of required infrastructure requirements to absorb the 20MLD are underway.
- **TMG aquifer** ±50 MLD underway (incremental). The City has renewed efforts to ensure environmental sustainability in providing water from the TMG. Currently borehole placement is under review following environmental inputs which threatened to reduce the yield in the medium term considerably. The license covers a variety of different sites, and the City is prioritising sites to minimise environmental impact while optimising yield. Current planning includes Steenbras, Cape Peninsula, Bergriver, Theewaterskloof and possible Wemmershoek while Helderberg is being re-assessed.

WATER TRANSFERS (±60 MLD over two months)

- ~8 Mm³ from Groenland Water User Association, based on a release of ~10Mm³ (assuming approximately 20% losses. This was planned to happen over 4 months (Feb-May 2018), but the release from Groenland will be completed between February and April.

TEMPORARY DESALINATION (16MLD fixed yield over ~ 2 years)

The temporary desalination projects are generally progressing well and will be introducing new water into the system as per the program.

- Strandfontein, 7MLD, full production early in 2018;
- Monwabisi, 7MLD, full production early in 2018;
- V&A, 2MLD, full production early in 2018 (to be converted to a permanent yield of 5MLD by the V&A. Off-take agreement not yet finalised).

TEMPORARY WATER RE-USE (10 MLD fixed yield over ~ 2 years)

- Zandvliet, temporary re-use scheme - full production in late-2018.

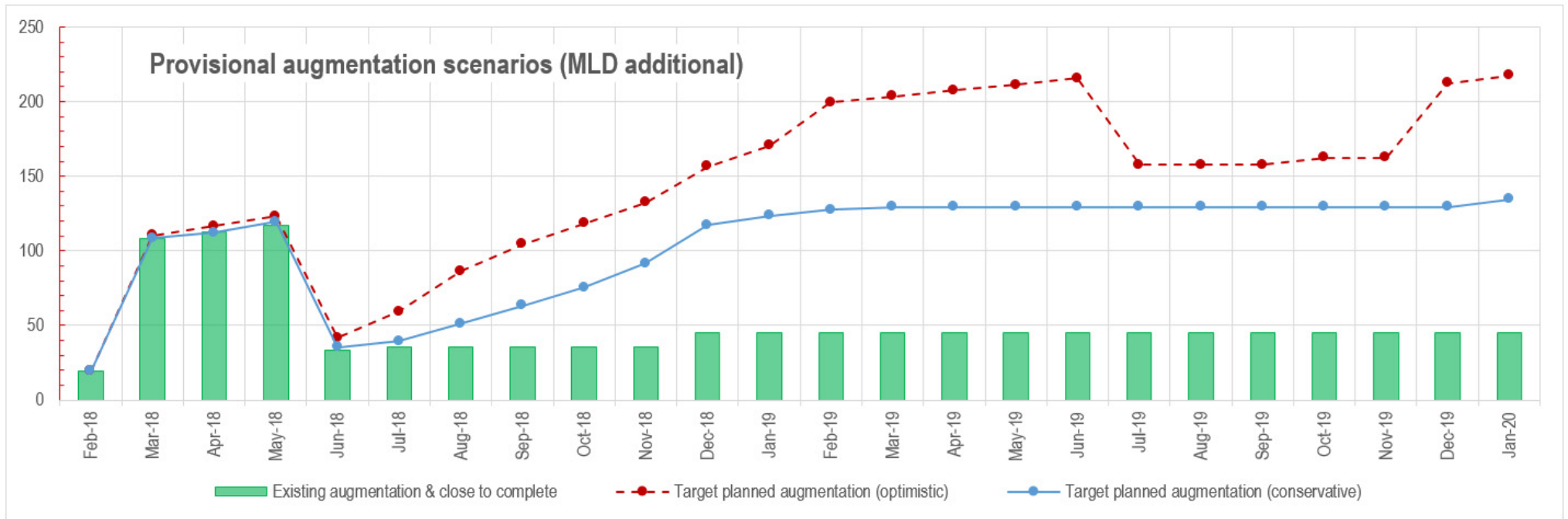
SPRINGS & RIVERS (7.5 MLD)

- Newlands – Albion spring in operation at ~3MLD. We aim to add all feasible springs into the reticulation system which will increase the volume;
- Oranjezicht – routed 1MLD into the system, looking at other springs to enter into system where possible to increase volume;
- Lourensriver – injection of 3.5MLD into system.

PERMANENT RE-USE AND DESALINATION:

- **Desalination:** The City is currently contending with the decision of the right volume, location, timing and procurement method of permanent desalination. At the current stage of evaluation, this appears to be optimal between 120 – 150MLD at a single plant, with delivery of first water possible in 2021. In parallel work is continuing at the pilot site at Koeberg which is planned to produce ~20MLD in 2 years' time (March 2020);
- **Re-use:** The introduction of more expensive water such as ground and desalinated water necessitates maximising value by re-use. Having assessed all the available capacity at the City's waste water treatment plants alongside the Cape Flats aquifer injection requirements, a plant of between 70 – 90MLD is being assessed for injection at Faure water treatment plant at an attractive cost with first water in the second half of 2020.

The above assessment with Cape Town providing in the region of 350MLD thus needs to be considered as provisional and is likely to change given changing rainfall patterns and risk appetite.



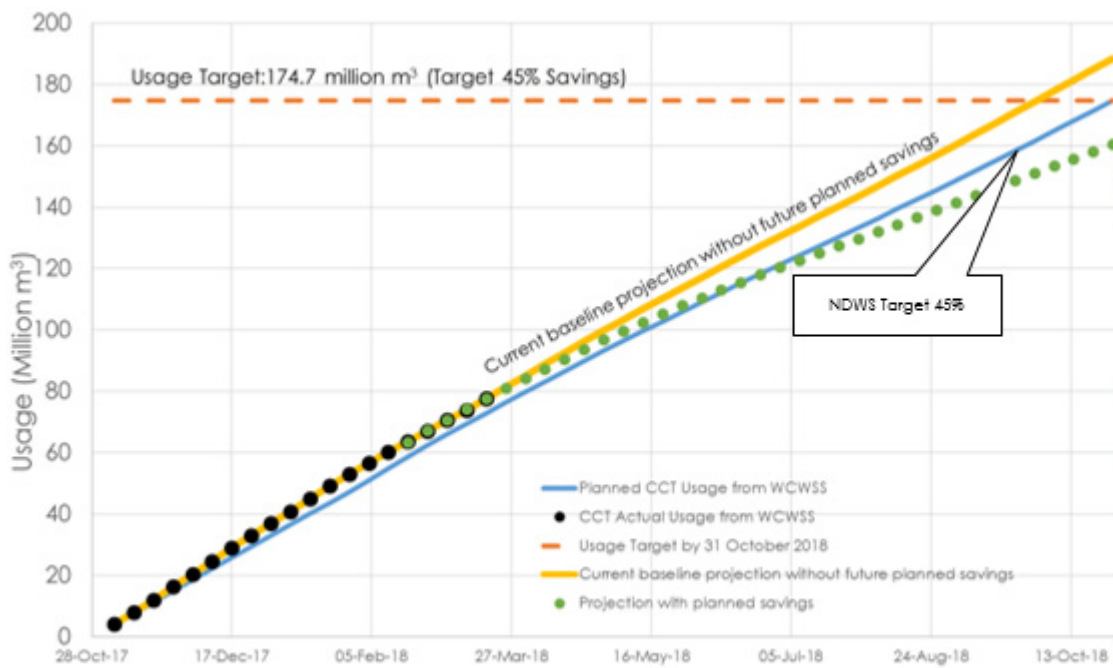
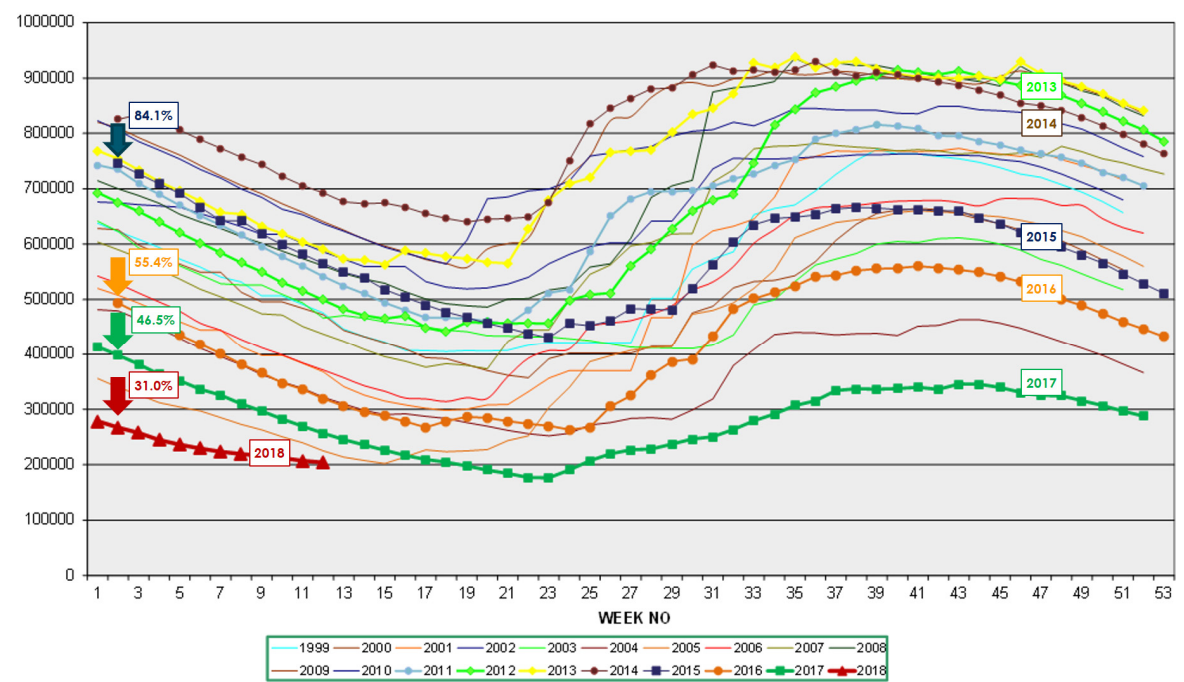
Existing augmentation volumes include springs & rivers, Atlantis aquifer, and the three small scale temporary desalination plants. The difference between the optimistic and conservative projections are related to the timing of getting groundwater into the system at both Cape Flats and TMG as the projects are still in exploratory phase and will become more certain as we move to production phase.

CONCLUSION:

Dam levels have been tracked for many years – for the first months of the year (summer), levels drop, and increase again once the rainy season starts. The 2018 dam behaviour can be seen plotted against that of the past 20 years. As we are not expecting any significant rain between now and May 2018, we can confidently predict dam levels at various stages of the coming months if we adhere to the restrictions. If we don't adhere, then dam levels will drop too quickly and we will not reach the rainy season with dams at safe operating levels. Currently, levels are dropping at round 0.4% per week (as compared to 1.5% in March 2017). Tracking 2018 dam levels indicates far better control as evidenced by the flattened slope.

Meeting urban restriction:

- ASSUMPTIONS:**
- Incremental Savings assigned as follows:
 - Tariff Increases: estimated at 50MI/day by end of June 2018
 - WMD installations: estimated at 10MI/day by end of June 2018
 - Pressure Management; Target High Consumers; Leak Repair: 32MI/day (mid February to Oct 2018)
 - Build Programme
 - 80% success on build programme delivering an additional 75 MI/day by end Oct 2018



In terms of the unrestricted five-year allocation, a 45% restriction translates to an annual allocation of 174.7 million m³ to CCT. CCT has to adhere to the imposed restriction and has been warned in a pre-directive from DWS that the 45% saving is not currently being achieved.

Based on projections of further reduction in demand due to tariffs, installation of water management devices and pressure management as well as some success in the augmentation projects, CCT is programmed to achieve the 45% saving towards the end of the hydrological year as shown on the green dotted line. As the major drawdown is now related to urban consumption with agriculture releases having virtually ceased, achieving the CCT restriction target, will work in favour of managing the WCWSS system at safe operating level. Communication efforts in ensuring demand is minimised remain urgent.

We are also considering the longer term surface water storage situation which is wholly reliant on rainfall. Assumptions in dam behaviour need to be conservative and thus we assume extreme evaporation, with rainfall of 85% of that of 2017 where rainfall was exceptionally low and late. By varying the anticipated demands of agriculture and urban use, the percentage reached before the impact of the rainy season is evident and a two-year view is shown below. While the focus on Day Zero has softened in the current year, it is fully dependent on winter rainfall to safely get through next summer.

As we progress into autumn and winter, more certainty will be achieved in terms of where dam levels are likely to be at the end of winter. This will inform restrictions imposed by DWS, while the City will continue in its efforts to manage demand and fast-track sustainable augmentation.

