Cornerstone
ECONOMIC RESEARCH

Estimating the cost of sanitation infrastructure for selected sites in Khayelitsha in City of Cape Town

Final

April 2016

Research commissioned by the International Budget Partnership (IBP) working in partnership with the Social Justice Coalition (SJC)

Version control of drafts submitted

Date submitted	Draft number shown on cover	Name of file
2016.03.29		**2016.03.29 Sanitation Report**
2016.03.30	**First Draft**	**2016.03.30 Sanitation Report v1**
2016.04.01	**First Draft v.2**	**2016.04.01 Sanitation Report v2**
2016.04.04	**Final Draft**	**2016.04.04 Sanitation Report Final Draft**
2016.04.14	**Final Draft v2**	**2016.04.14 Sanitation Report Final Draft v2**
2016.04.17	**Final**	**Khayelitsha Sanitation Costing Report Final**

Project team –

Conrad Barberton
Matthew Townsend
Jonathan Carter

Senior Researchers with
Cornerstone Economic Research
www.cornerstonesa.net

Contents

EXECUTIVE SUMMARY VIII

1 INTRODUCTION 1

2 CONTEXT ISSUES FOR THE SANITATION COSTING MODEL 3

2.1 NATURE AND LOCATION OF THE SANITATION BACKLOG IN CAPE TOWN 3
2.2 TOILET TECHNOLOGY OPTIONS 4
2.3 CONSTRAINT FACTORS THAT IMPACT THE ROLLOUT OF FULL-FLUSH TOILETS 5
2.4 ANALYSIS OF CAPE TOWN'S BUDGETS FROM A SANITATION PERSPECTIVE 7

3 THE SANITATION COSTING MODEL 8

3.1 COSTING MODELS AS A POLICY TOOL 8
3.2 PURPOSE OF THE COSTING MODEL 8
3.3 PROCESSES TO DEVELOP THE COSTING MODEL 9
3.4 SOURCES OF DATA 9
3.5 DESIGN OF THE SANITATION COSTING MODEL 9
3.5.1 Geographic areas covered 10
3.5.2 Model setting options for running scenarios 11
3.5.3 Technology options 14
3.5.4 Modelling the constraint factors 15
3.5.5 General assumptions 15
3.5.6 Presentation of the costing results 16

4 OVERALL FINDINGS FROM THE SANITATION COSTING MODEL 19

4.1 UNIT COST OF EACH OF THE OPTIONS – CAPITAL, OPERATIONAL AND COMBINED 19
4.2 CUMULATIVE COST OF SERVICING 45 HOUSEHOLDS OVER A TEN-YEAR PERIOD 21
4.3 COST IMPACT OF CONSTRAINT FACTORS 22

5 SANITATION ROLLOUT SCENARIOS 23

5.1 CASE STUDY AREAS AND SCENARIO OVERVIEW 24
5.2 PARAMETERS USED TO DEVELOP THE SCENARIOS 24
5.3 ENKANINI SCENARIOS – WARD 109 26
5.4 CT SECTION SCENARIOS – WARD 18 30
5.5 RR SECTION SCENARIOS – WARD 89 34
5.6 TR SECTION SCENARIOS 38

ANNEXURE 1: TOILET TECHNOLOGY OPTIONS 46

1. Packet latrines 47
2. Pit latrines 48
3. Eco latrines 49
4. Twin pit pour-flush toilets 50
5. Biogas toilets 51
6. Incinerating toilets 52
7. Urine diversion dry toilets 53
8. Portable flush toilets 54
9. Chemical toilets 55
10. Full-flush toilets 57

ANNEXURE 2: ANALYSIS OF CAPE TOWN'S BUDGET FROM A SANITATION PERSPECTIVE 59

1. Budget information analysed 61
2. Information in the budget on sanitation service delivery 61
3. Capital Expenditure 65
4. Capital projects 69
5. Summary 70

ANNEXURE 3: ENKANINI SCENARIOS 74

ANNEXURE 4: RR SECTION SCENARIOS 77

ANNEXURE 5: CT SECTION SCENARIOS..... 86
ANNEXURE 6: TR SECTION SCENARIOS..... 92

LIST OF TABLES

TABLE 1: TOILET FACILITIES FOR HOUSEHOLDS IN CAPE TOWN 1
TABLE 2: CONSTRAINTS ON THE ROLLOUT OF SANITATION SERVICES TO INFORMAL SETTLEMENTS 6
TABLE 3: DATA SOURCES USED TO BUILD THE SANITATION COSTING MODEL 9
TABLE 4: KEY ASSUMPTIONS AND VARIABLES BY TECHNOLOGY OPTION 14
TABLE 5: PRESENTATION OF COSTING RESULTS IN THE SANITATION COSTING MODEL 17
TABLE 6: SUMMARY STATISTICS OF CASE STUDY AREAS 24
TABLE 7: SUMMARY OF SCENARIOS 25
TABLE 8: SUMMARY OF ENKANINI SCENARIOS 26
TABLE 9: TOTAL TOILET UNITS FOR TWO-YEAR ROLLOUT PERIOD 27
TABLE 10: TOTAL TOILET UNITS FOR FIVE-YEAR ROLLOUT PERIOD 28
TABLE 11: COST OF SCENARIOS 28
TABLE 12: SUMMARY OF CT SECTION SCENARIOS 30
TABLE 13: NEW TOILET UNITS FOR TWO-YEAR ROLLOUT PERIOD 31
TABLE 14: NEW TOILET UNITS FOR FIVE-YEAR ROLLOUT PERIOD 32
TABLE 15: COST OF SCENARIOS 32
TABLE 16: SUMMARY OF RR SECTION SCENARIOS 35
TABLE 17: NEW TOILET UNITS FOR TWO-YEAR ROLLOUT PERIOD 35
TABLE 18: NEW TOILET UNITS FOR FIVE-YEAR ROLLOUT PERIOD 36
TABLE 19: COST OF SCENARIOS 36
TABLE 20: SUMMARY OF TR SECTION SCENARIOS 39
TABLE 21: NEW TOILET UNITS FOR TWO-YEAR ROLLOUT PERIOD 39
TABLE 22: NEW TOILET UNITS FOR FIVE-YEAR ROLLOUT PERIOD 40
TABLE 23: COST OF SCENARIOS 40
TABLE 24: CITY OF CAPE TOWN: BASIC SERVICE DELIVERY MEASUREMENT – SANITATION/SEWERAGE 61
TABLE 25: HOUSEHOLDS BELOW MINIMUM SANITATION SERVICE LEVEL AS A PERCENT OF TOTAL HOUSEHOLDS 62
TABLE 26: TOTAL HOUSEHOLDS REPORTED BY CITIES IN SCHEDULE A10 63
TABLE 27: HOUSEHOLDS BELOW INCOME THRESHOLD USED IN LGES CALCULATIONS 63
TABLE 28: COST OF FREE BASIC SERVICES AS A PERCENT OF TOTAL OPERATIONAL EXPENDITURE 64
TABLE 29: PERFORMANCE INFORMATION REPORTED AS PER SECTION 71 64
TABLE 30: BUDGETED CAPITAL EXPENDITURE 65
TABLE 31: ANNUAL AVERAGE GROWTH ON CAPITAL BUDGETS 66
TABLE 32: WATER AND WASTE WATER MANAGEMENT EXPENDITURE, CAPE TOWN 66
TABLE 33: CAPITAL EXPENDITURE BY SERVICE AS A PERCENT OF TOTAL, CAPE TOWN 67
TABLE 34: WASTE WATER MANAGEMENT EXPENDITURE AS PERCENT OF CAPITAL EXPENDITURE, ALL METROS 67
TABLE 35: STRUCTURE OF SANITATION CAPITAL EXPENDITURE, CAPE TOWN 68
TABLE 36: REPAIRS AND MAINTENANCE AS A PERCENTAGE OF SANITATION ASSETS 68
TABLE 37: CHANGES BETWEEN BUDGET AND ADJUSTED BUDGET, SANITATION, CAPE TOWN 69
TABLE 38: SANITATION PROJECTS IN RELEVANT WARDS 70
TABLE 39: SANITATION PROJECTS DELAYED FROM PREVIOUS YEARS 2014 AND 2015, CAPE TOWN 70
TABLE 40: COCT: BASIC SERVICE DELIVERY MEASUREMENT – SANITATION/SEWERAGE 71
TABLE 41: 1:5 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 74
TABLE 42: 1:5 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 74
TABLE 43: 1:3 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 75
TABLE 44: 1:3 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 75
TABLE 45: 1:1 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 76
TABLE 46: 1:1 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 76
TABLE 47: 1:5 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 77
TABLE 48: 1:5 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 26 888 M^2 OF PURCHASED LAND 77
TABLE 49: 1:5 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 3 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 78
TABLE 50: 1:5 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 78
TABLE 51: 1:5 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 26 888 M^2 OF PURCHASED LAND 79
TABLE 52: 1:5 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 3 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 79

TABLE 53: 1:3 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 80
TABLE 54: 1:3 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 26 888 M^2 OF PURCHASED LAND 80
TABLE 55: 1:3 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 3 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 81
TABLE 56: 1:3 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 81
TABLE 57: 1:3 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 26 888 M^2 OF PURCHASED LAND 82
TABLE 58: 1:3 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 3 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 82
TABLE 59: 1:1 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 83
TABLE 60: 1:1 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 26 888 M^2 OF PURCHASED LAND 83
TABLE 61: 1:1 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 3 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 84
TABLE 62: 1:1 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 84
TABLE 63: 1:1 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 26 888 M^2 OF PURCHASED LAND 85
TABLE 64: 1:1 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 3 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 85
TABLE 65: 1:5 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 86
TABLE 66: 1:5 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 7.5 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS .. 86
TABLE 67: 1:5 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 87
TABLE 68: 1:5 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 7.5 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS .. 87
TABLE 69: 1:3 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 88
TABLE 70: 1:3 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 7.5 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS .. 88
TABLE 71: 1:3 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 89
TABLE 72: 1:3 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 7.5 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS .. 89
TABLE 73: 1:1 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 90
TABLE 74: 1:1 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 7.5 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS .. 90
TABLE 75: 1:1 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 91
TABLE 76: 1:1 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 7.5 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS .. 91
TABLE 77: 1:5 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 92
TABLE 78: 1:5 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 97 123 M^2 OF PURCHASED LAND 92
TABLE 79: 1:5 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 6 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 93
TABLE 80: 1:5 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 93
TABLE 81: 1:5 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 97 123 M^2 OF PURCHASED LAND 94
TABLE 82: 1:5 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 6 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 94
TABLE 83: 1:3 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 95
TABLE 84: 1:3 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 97 123 M^2 OF PURCHASED LAND 95
TABLE 85: 1:3 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 6 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 96
TABLE 86: 1:3 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 96
TABLE 87: 1:3 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 97 123 M^2 OF PURCHASED LAND 97
TABLE 88: 1:3 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 6 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 97
TABLE 89: 1:1 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD 98
TABLE 90: 1:1 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 97 123 M^2 OF PURCHASED LAND 98
TABLE 91: 1:1 TOILET TO HOUSEHOLD RATIO AND A 2-YEAR ROLLOUT PERIOD WITH 6 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS 99
TABLE 92: 1:1 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD 99
TABLE 93: 1:1 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 97 123 M^2 OF PURCHASED LAND 100
TABLE 94: 1:1 TOILET TO HOUSEHOLD RATIO AND A 5-YEAR ROLLOUT PERIOD WITH 6 PERCENT OF FLUSH TOILETS SITUATED IN FLOOD PLAINS ... 100

List of Figures

FIGURE 1: SUMMARY OF THE CONSTRAINT FACTORS RELATED TO SANITATION TECHNOLOGY OPTIONS 5
FIGURE 2: FLOW DIAGRAM OF THE SANITATION COSTING MODEL 10
FIGURE 3: DISTRICT SELECTION 10
FIGURE 4: POCKET SELECTION 11
FIGURE 5: MODEL SETTING OPTIONS FOR RUNNING SCENARIOS 11
FIGURE 6: THE CHOICE OF TIME PERIODS IN THE AUTOMATIC SETTING MODE 12
FIGURE 7: ASSUMPTIONS RELATED TO THE BREAKDOWN OF DIFFERENT TOILET TYPES 13
FIGURE 8: OPTION TO SUPPLEMENT ABLUTION BASED TOILETS WITH PORTABLE FLUSH TOILETS 13
FIGURE 9: INCLUDING CONSTRAINT FACTORS 15
FIGURE 10: MODEL ASSUMPTIONS 16
FIGURE 11: TOILET TECHNOLOGIES AS A PERCENTAGE OF TOTAL NEW UNITS 16
FIGURE 12: INCREASE/DECREASE IN BUDGET COMPARED TO 2015 BASELINE 18
FIGURE 13: TOTAL CAPITAL COSTS OF DIFFERENT TOILET OPTIONS (NO CONSTRAINTS) 19
FIGURE 14: TOTAL OPERATIONAL COSTS OF DIFFERENT TOILET OPTIONS OVER TEN YEARS 20
FIGURE 15: COST RATIOS BETWEEN INDIVIDUAL FULL-FLUSH TOILETS AND OTHER OPTIONS 20
FIGURE 16: TOTAL CAPITAL AND OPERATIONAL COST OF PROVIDING 45 HOUSEHOLDS WITH TOILETS (1:5 RATIO) OVER A TEN-YEAR PERIOD 21
FIGURE 17: TOTAL CAPITAL AND OPERATIONAL COST OF PROVIDING 45 HOUSEHOLDS WITH TOILETS (1:5 RATIO) WITH CONSTRAINTS OVER A TEN-YEAR PERIOD. 22
FIGURE 18: MAP OF KHAYELITSHA AS AT THE 2011 CENSUS 23
FIGURE 19: MAP OF ENKANINI, WARD 109 26
FIGURE 20: MAP OF CT SECTION 30
FIGURE 21: MAP OF RR SECTION 34
FIGURE 22: MAP OF TR SECTION 38

SUPPORTING DISCUSSIONS AROUND SANITATION OPTIONS

1. Cornerstone Economic Research is a specialist consulting company that focusses on public sector financial management. Among other things, we specialise in building costing models of public sector programmes so as to provide policy makers and managers with tools to cost the financial implications of rolling-out and scaling up public sector programmes. We are not affiliated or joined to either the International Budget Partnership or the Social Justice Coalition in any way.

2. The Sanitation Costing Model has been built around information on sanitation issues that the City of Cape Town (CoCT) has placed in the public domain, or that is available in public documents. In its current form the model is sufficiently robust to inform discussions around rollout scenarios, priorities and budget for sanitation in Cape Town. However, there is no doubt that the CoCT has further information that could usefully inform and strengthen the model. The model is designed to be flexible, so that where the CoCT has better information, the model can be updated or modified appropriately. The aim is that through engagement the parties using the Sanitation Costing Model can refine it.

3. The Sanitation Costing Model does not purport to produce costing results comparable to those that would be produced by a quantity surveyor based on detailed engineering plans. Rather it aims to produce ballpark costing figures that are sufficiently robust to inform discussions around rollout scenarios, priorities and budgets.

4. The price assumptions in the Sanitation Costing Model have been set based on our research at the start of 2016, and in consultation with an engineer active in the sanitation field. These prices will change over time, and so for the outputs of Sanitation Costing Model to remain relevant, they will need to be updated periodically.

Executive Summary

The International Budget Partnership (IBP) and the Social Justice Coalition (SJC) commissioned Cornerstone Economic Research to develop a model to cost sanitation upgrade scenarios for informal settlements across Cape Town. The resultant Sanitation Costing Model is built around information that the City of Cape Town (CoCT) has placed in the public domain, or that is available in public documents. There is no doubt that the CoCT has further information that could usefully inform and strengthen the model. However, even in its current form the model is sufficiently robust to inform discussions around rollout scenarios, priorities and budget for sanitation in Cape Town. The model is designed to be flexible, so that where the CoCT has better information, the model can be updated or modified appropriately.

It needs to be emphasised that the primary output of this project is the Sanitation Costing Model itself – this report is complementary to the model, describing it and illustrating how the information emerging from the model can inform discussions on the rollout of sanitation services.

The sanitation backlog

The sanitation backlog in Cape Town has different dimensions, but where it relates to access to full-flush toilets, it is almost entirely confined to the informal settlement areas. The CoCT is faced with the challenge of meeting the increasing demand for sanitation services arising from urbanisation, natural growth and changes in household size. The population growth was roughly 20 percent between 2001 and 2011 in Khayelitsha alone.

If the ultimate long term aim is to give each household in Cape Town access to a full-flush toilet linked to a network sewerage system, then the backlog in sanitation services has four dimensions:

1. Backlog in sewerage treatment works or treatment capacity.
2. Backlog in the bulk sewage network that links residential areas to the treatment works.
3. Backlog in the sewage networks in residential areas that links household stands to the bulk network.
4. Backlog in the number of flush toilets.

The CoCT is in the best position to provide information on the nature and extent of these aspects of the sanitation backlog. The nature of the backlogs affecting a particular area impacts on the strategy that needs to be implemented to overcome them. For instance, if sewerage networks are in place, then the backlog is relatively easily addressed by providing flush toilets. However, if there are no appropriately located treatment works, no bulk sewerage lines, and no sewerage networks in place, then addressing the backlog is much more complicated and is likely to take more time. The cost of resolving the backlogs is also directly related to the nature and extent of the backlogs in question.

Toilet technology options

Annexure 1 to this report provides a literature review of different toilet technology options that were considered for inclusion in the Sanitation Costing Model. The following figure provides a summary of the constraint factors relating to each of the different toilet technology options. Each of the blocks in figure was filled on the basis of local and international research that was reviewed.

The figure and the analysis in Annexure 1 highlights that, for a range of reasons, full-flush toilets are the most appropriate toilet technology for the informal settlement parts of Khayelitsha, provided there are suitable access routes into the areas. The cost of extending the sanitation system is a constraint in the short to medium term, but over the long term a full-flush or water-borne sewerage system is

likely to be more cost effective in high density environments such as Khayelitsha than the other toilet technologies, such as portable flush toilets and chemical toilets (see discussion in section 4).

In Figure E1 each of the constraints are classified as binding, non-binding or 'no constraint'. Binding means that the relevant technology cannot or should not be used. No constraint means that the relevant constraints do not apply. Non-binding means that the constraint is present, but can be overcome.

Figure E1: Summary of the constraint factors related to sanitation technology options

No constraint

Non-binding constraint

Binding constraint

Sanitation option	Social constraints	Geographic & logistical constraints	Environmental constraints	Cost constraints		Appropriateness of technology
				Initial	Operation & Maintenance	
Packet Latrine	Loss of dignity; perceived unclean	High water table; poor drainage; flooding; high population density; high delivery and supply costs; removal of incorrectly discarded packets;	Risk of personal safety; exposed waste			Not appropriate
Pit Latrine	Loss of dignity; outdated; smell and hygiene	High water table; high population density; lack of access; limited space; sandy soil	Seepage into water table			Not appropriate
Eco Latrine	Loss of dignity; outdated; smell and hygiene	Frequency of use; carbonaceous material not available; lack of transport infrastructure	Potential for wastewater overflow due to flooding			Not appropriate
Twin pit pour-flush toilet	On-site; unpleasant smells; loss of self-esteem and dignity; contact with faecal matter	High water table; high population density; lack of access; limited space; sandy soil	Seepage into water table			Not appropriate
Biogas toilet	Odiferous; perceived unclean	Stringent usage requirements; high frequency usage	Sensitivity of biological processes prone to cause system to fail			Not appropriate
Incinerating toilet	Complex to operate	Powered; high population and housing density; max 8 users	Use of electricty or fossil fuels; greenhouse gas emissions; risk of fire		Very expensive	Not appropriate
Urine diversion dry toilet	Complex to operate; removal of solid waste	Blockages; high population density;	Minimal risk of leakage		High maintenance	Not appropriate
Portable flush toilet	Apartheid-era "black bucket" system	High population density; small tanks (daily servicing)			Daily servicing	Short term option if there is no other option
Chemical toilet	Not for long-term use	Access to allow regular waste removal			Regular servicing (3X weekly)	Preferable short term option
Full flush toilet		Lack of piped water and sewage removal; sandy soil; flood plains				Best long term option

* Cost constraints are not long-term binding constraints, as they do not inherently inhibit the functionality or user acceptability (in a public provision situation) of the sanitation system.

Constraints to the rollout of waterborne sanitation solutions

While full-flush toilets may be the preferable option based on the available research, the CoCT has pointed to a range of constraints that impact on the provision of full-flush sanitation in many of the existing informal settlements, including those in Khayelitsha. These constraint factors can be divided up into four broad categories:

i. Practical and zoning constraints

Where structures are built over an existing body of water, it is not possible to extend the sewerage system to such households in a manner that is cost-effective. The situation is slightly more nuanced in areas that are prone to flooding. It may be possible to install storm water

systems that ensure effective drainage. However, the fact that such areas are prone to flooding means there is a risk of damage to sewerage pipes. This can only be overcome by increasing the technical specifications of the network, which drives up costs. The cost-benefit of taking steps to make flood-prone areas habitable needs to be determined on a case by case basis.

However, in many informal settlements, less than 25 percent of the area is affected by this particular constraint. This suggests that it is possible to provide the affected households with access to full-flush toilets located on the periphery of the flood prone area, such as in toilet banks or ablution blocks.

ii. Zoning constraints where there are health and safety risks to households

These zoning constraints do not impact on the practicality or cost of providing the affected households with access to full-flush toilets, but rather relate to the legality and desirability of doing so. Many of the zoning constraints relate to issues that pose a current risk to the health and safety of affected households. For instance, where a dwelling is built within a metro road buffer zone, the first priority should be to move the affected households out of such areas, and the CoCT should have a prioritised plan for doing so. While such a plan is being implemented, the CoCT will need to provide households with temporary toilet solutions.

iii. Zoning constraints where there are no risks to households

In many instances the zoning constraints do not relate to issues that pose a risk to households. For instance, where an informal settlement is located in an area designated to be used for the Integrated Rapid Transport system, the issue revolves around balancing the public interest versus the interests of the affected households. If it is in the public interest that a zoned area be protected, the CoCT needs to prioritise a plan to move the affected households to alternative formal sites. While such a plan is being implemented, the CoCT needs to provide households with temporary toilet solutions.

What these temporary solutions should be, depend on the particular circumstances. For instance, the CoCT should not violate its own zoning regulations by building permanent structures in road buffer zones. However, there may be a case for putting down a container ablution block in an area zoned for a proposed landfill site, if sewerage lines are available and until such time as the site is opened for use. In other instances, where the zone constraint only affects a small percentage of an informal settlement, the CoCT could consider providing full-flush solutions along the periphery of the affected area.

iv. Other constraints

The CoCT lists private land ownership as a constraint, because the CoCT would need to register a servitude on the land in order to place any form of public infrastructure on it. Alternatively, the CoCT would need to expropriate the land. Both these factors would drive up the cost of providing a full-flush sanitation solution to dwellings located on such land. As such, this is a cost constraint, not a practical constraint.

The CoCT does not list “dwelling density” or “lack of access routes” as a constraint affecting many informal settlements. However, the reality is that both these factors can make it very difficult to take a sewerage network into a given area.

The costing model allows the impact of those constraint factors to be costed, so as to assess whether they are indeed a binding constraint.

Overall findings from the Sanitation Costing Model

The Sanitation Costing Model was used to assess the capital and operating costs of various full-flush sanitation options and to compare them to the capital and operating costs of various temporary and portable sanitation options. The following two figures summarize the relative capital and operational costs of different sanitation provision options over a ten-year period.

Figure E2: The capital cost (no constraints) of different toilet options

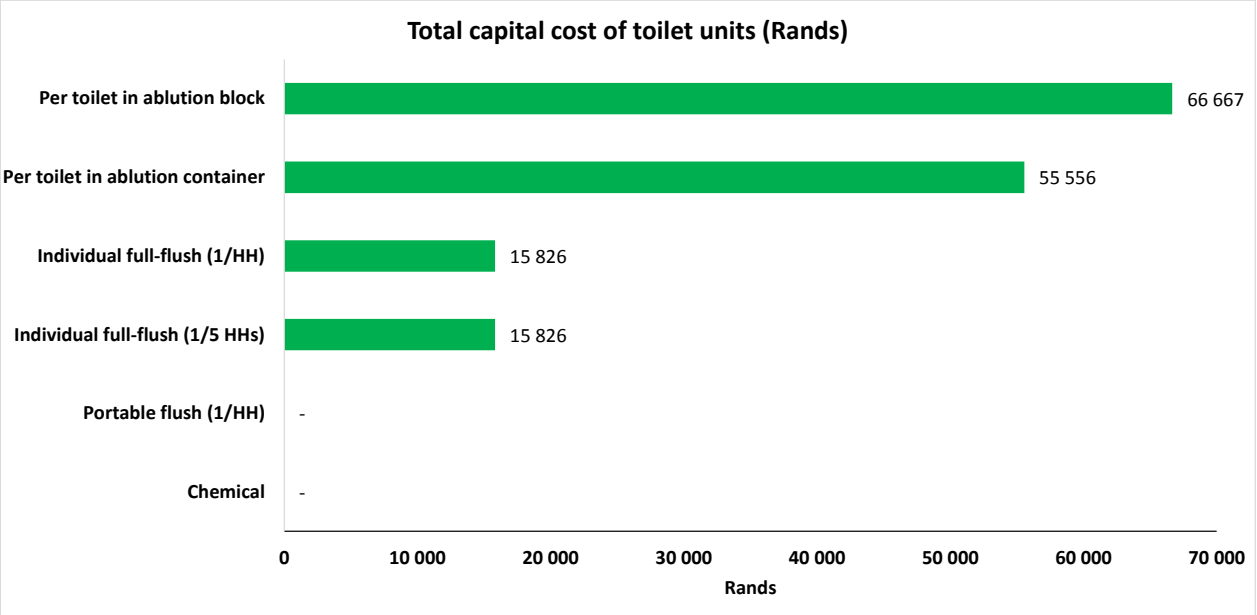
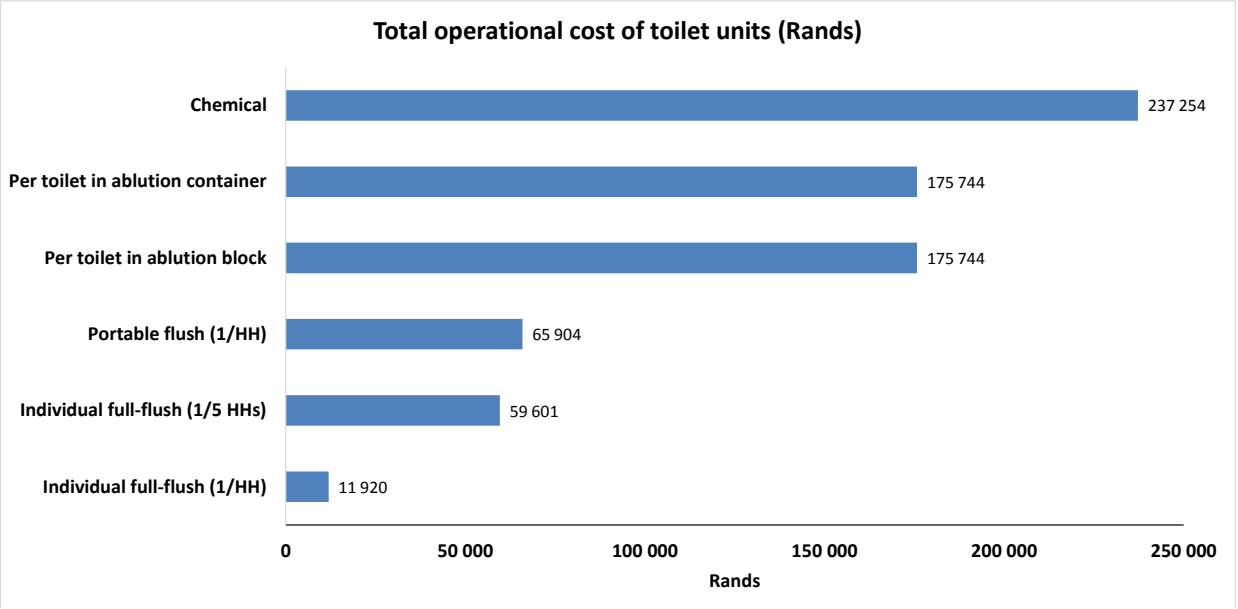


Figure E3: The operational cost of different toilet options (over ten years)



Note: Ablution blocks contain nine toilets. The "Per toilet in ablution block" and "Per toilet in ablution container" is the total capital, or current, cost of the ablution block shared across each individual toilet in the ablution block – so as to make these costs comparable to the other unit costs

Figure E2 shows the one-off capital outlay costs of different toilet options. There is no capital amount included for portable flush or chemical toilets because these technologies are outsourced and the capital cost of these temporary technologies are included in the monthly contract fee paid to service providers. As these technologies are temporary, they have a short lifespan and will need to be replaced at regular intervals. Figure E3 shows the operating or running costs of each of the technologies over a ten-year period.

The above figures show:

- The capital costs make ablution blocks the most expensive to install, even when the cost is shown as a unit cost for the individual toilets. The capital cost per toilet in an ablution container

(a mobile unit plugged into the sewerage mains) is second most expensive, and more than three times the cost of an individual full-flush toilet.

- The operating costs of an individual full-flush toilet for a single household are the lowest of all the toilet options. In contrast, the operating costs of chemical toilets are the highest, followed by toilets in ablution containers and ablution blocks. For every one chemical toilet in operation, 20 individual full-flush toilets could be operated.

In order to form an idea of the total costs (capital and operational) of each of these sanitation options over the long term, the following figure compares the cumulative cost of providing 45 households with toilets over a ten-year period at a ratio of one toilet to five households. The reason the graph shows provision to 45 households is that the ablution block units each contain nine toilets, which at a 1:5 ratio would service 45 households. In other words, it is for comparative purposes. The costs shown in this graph include initial capital outlay costs for full-flush options, as well as operating costs for all the technologies over a ten-year period. For full-flush toilets there is also an indication of costs changes when factoring in the cost of constraints. The table also takes into account the cost impact of providing full-flush sanitation in both crowded areas and in informal settlements located on flood plains.

Figure E4: Cumulative total cost of providing 45 households with toilets with and without constraints

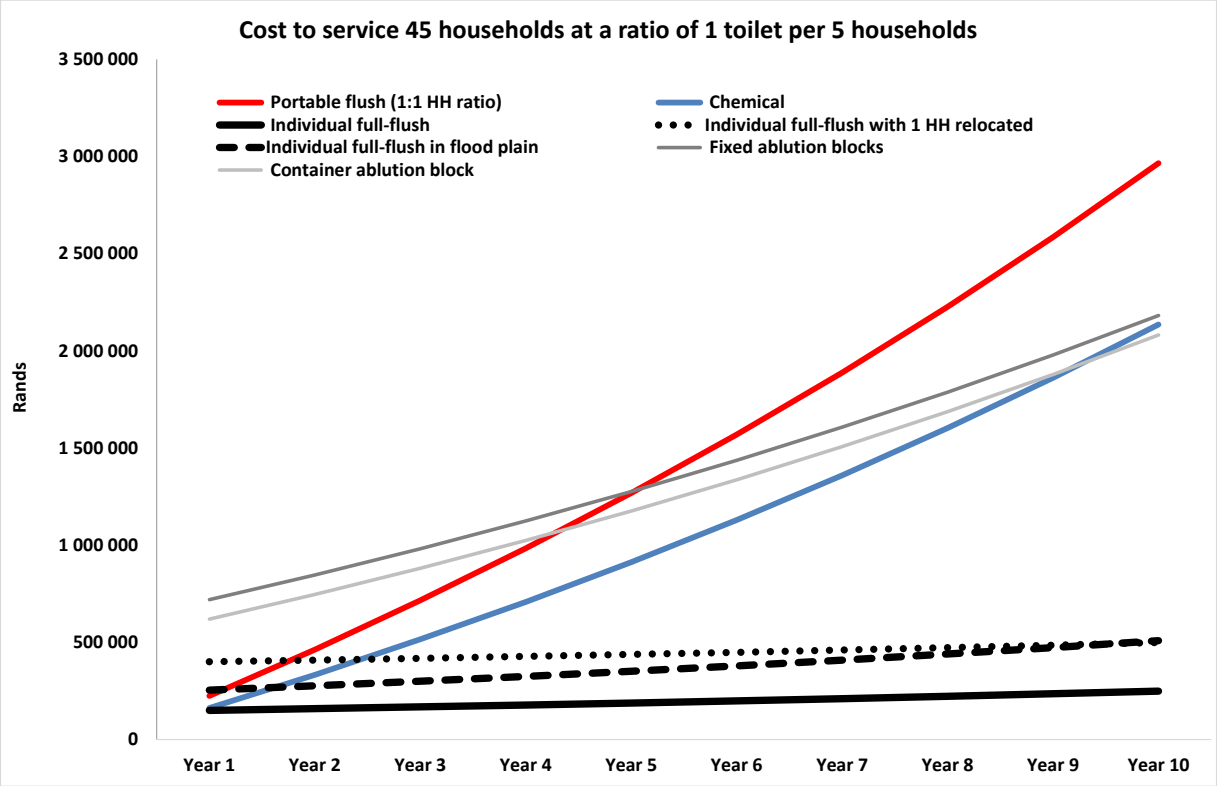


Figure E4 shows:

- Over a ten-year period, the full-flush toilet solution is substantially more affordable than any of the other toilet solutions.
- The portable flush toilets provided on a 1:1 household ratio are the most expensive option over the ten-year period.
- Despite the initial substantial capital costs associated with ablution blocks, they are still likely to be more cost effective than chemical toilets in the long run.

The following constraints restrict or impact on the cost of providing full-flush toilets:

- In many areas, the houses are so densely built that it is not possible to lay sewerage lines and install full-flush toilets, which means portable flush toilets are the only practical and acceptable option. To solve the sanitation problem requires these areas to be "blocked-out." This means that households would either need to be moved to new formalised areas or be reorganised in a way that de-densifies the area and creates access routes.
- In certain areas, households are built on private land or in areas that experience flooding. These factors would increase the unit costs of building the full-flush toilets and the ablution blocks. The extent of the cost increase could be substantial, depending on the conditions relating to a particular site. However, these areas are also relatively confined and there are in many instances options to work around these constraints, for example by carefully selecting sites for ablution blocks.
- Some of these constraints would drive up the cost of full-flush sanitation, but full-flush would remain cheaper than temporary toilets in the long run. As Figure E4 shows, despite the increased initial cost of providing full-flush toilets in settlements located on flood plains, *full-flush toilets still remain the most cost-effective toilet solution in long-run.*

Using the Sanitation Costing Model to develop scenarios for case study areas

This project included developing a range of sanitation rollout scenarios in four areas within Khayelitsha: Enkanini (ENK); CT Section (CT); RR Section (RR); and TR Section (TR).

The results of this scenario building exercise are presented in section 5 of this report. The CT section scenario illustrates the kinds of findings the model enables. These include:

- CT Section currently provides toilets to households at a 1:8 ratio. To reach the desired 1:5 ratio, a significant number of new units need to be installed.
- There is a large backlog of toilets in CT Section and 47.8 percent of CT Section is informal. This means that a relatively high number of chemical and portable flush toilets will continue to be required as short term solutions.
- The model suggests that the two-year rollout scenario of increased full-flush is cheaper than the five-year rollout scenario. In other words, the sooner full-flush toilets can be rolled out, the cheaper it will be for the CoCT.
- The flood plain constraint raises total costs by between 1.5 percent to 2.2 percent for the two-year rollout scenarios; and by between 1.3 percent to 2.1 percent for the five-year rollout scenarios, which is a relatively low impact on total costs.
- The costs spike in 2020 as the scenario envisages that the CoCT will need to replace a large number of portable flush and chemical toilets with full-flush solutions in this year.

1 Introduction

The South African Constitution identifies access to sufficient water as a right[1]. There is no similar right of access to sanitation. However, the South African Human Rights Commission holds that access to sanitation is integral to realising "other rights including rights to dignity, education, health, safety and the environment."[2] Based on the fact that "the state must take reasonable legislative and other measures, within its available resource to achieve the progressive realisation of the right" to have access to sufficient water[3], it is reasonable to expect that a similar obligation rests on the state with regards to providing access to an acceptable standard of sanitation in light of its close connection to the realisation of other rights.

In terms of the Constitution[4], municipalities are responsible for "domestic waste-water and sewage disposal systems." Consequently, the City of Cape Town (CoCT) is responsible for ensuring that sanitation services are extended to all residents within its jurisdiction. Table 1 shows the Census 2011[5] breakdown of toilet facilities for households in Cape Town.

Table 1: Toilet facilities for households in Cape Town

Toilet Facility	*Percentage*
None	2.7
Flush toilet (connected to sewerage system)	88.2
Flush toilet (with septic tank)	2.0
Chemical toilet	1.2
Pit toilet with ventilation	0.2
Pit toilet without ventilation	0.2
Bucket toilet	4.5
Other	1.0

In 2011, 90.2 percent of households in Cape Town had flush toilets connected to either the sewerage system or a septic tank. This means 9.8 percent of households in Cape Town did not have access to flush toilets in 2011; many had no access to toilet facilities, or only access to a bucket toilet. Section 153 of the Constitution places an obligation on municipalities, and therefore on the CoCT, to "structure and manage its administration and budgeting and planning to give priority to the basic needs to the community". Sanitation is undoubtedly a basic need. Communities in Cape Town that do not have access to acceptable sanitation services can therefore have a reasonable expectation that the CoCT should prioritise the eradication of the sanitation backlog, and ensure that all households have access to adequate toilet facilities.

It is against this background that the International Budget Partnership (IBP) and the Social Justice Coalition (SJC) commissioned Cornerstone Economic Research to develop a model to cost sanitation upgrade scenarios for informal settlements across Cape Town. This report presents a range of costed sanitation scenarios for four specific sections of Khayelitsha, namely CT Section, Enkanini, RR Section, and TR Section. These serve as case studies of the kind of information the Sanitation Costing Model can generate. The model is set up to cover all the informal settlements in Cape Town, and can be used to develop scenarios for the rollout of sanitation services in all these areas.

---

1 Section 27(1)(b) of the Constitution of the Republic of South Africa, 1996.
2 See page 14 of SAHRC, 2014. Report on the Right to Access Sufficient Water and Decent Sanitation in South Africa: 2014.
3 Section 27(2) of the Constitution of the Republic of South Africa, 1996.
4 Section 156(1)(b) of the Constitution of the Republic of South Africa, 1996.
5 Data from Statistics South Africa http://www.statssa.gov.za/?page_id=1021&id=city-of-cape-town-municipality accessed 09 April 2016 at 20h00.

The rest of this report is structured as follows:

- Section 2 reviews the range of context issues relating to the sanitation challenges in Cape Town taken into account in developing the Sanitation Costing Model;
- Section 3 describes the Sanitation Costing Model – its structure, the costing methodology, key assumptions, and how it reports costing scenario results;
- Section 4 discusses the overall findings emerging from the Sanitation Costing Model;
- Section 5 provides a set of context specific examples of the kinds of sanitation rollout scenarios the Sanitation Costing Model can be used to generate – focusing on the sanitation scenarios in four sections of Khayelitsha; and

It needs to be emphasised that the primary output of this project is the Sanitation Costing Model itself – this report is complementary to the model, describing it and illustrating how the information emerging from the model can inform discussions on the rollout of sanitation services.

The report is also supported by the following Annexures:

- Annexure 1 – A review of sanitation technology options.
- Annexure 2 – Analysis of Cape Town's Budget from a sanitation perspective.
- Annexures 3 to 6 – Detailed tables of the sanitation rollout scenarios for CT Section, Enkanini, RR Section, and TR Section, which are summarised in section 5 of the report.

2 Context issues for the Sanitation Costing Model

The sanitation challenges in Cape Town need to be understood in context, and any process of costing the provision of sanitation services needs to recognise that context. This section outlines the primary issues that the Sanitation Costing Model needs to address.

2.1 Nature and location of the sanitation backlog in Cape Town

The sanitation backlog in Cape Town has different dimensions, but where it relates to access to full-flush toilets, it is almost entirely confined to the informal settlement areas. The CoCT has been unable to match service provision in informal settlements with increased demand arising from the historical backlog, urbanisation, natural growth and changes in household size. The population growth was roughly 20 percent between 2001 and 2011 in Khayelitsha alone.

If the ultimate long term aim is to give each household in Cape Town access to a full-flush toilet linked to a network sewerage system, then the backlog in sanitation services has four dimensions:

1. ***Backlog in sewerage treatment works or treatment capacity***

   Of the treatment plants for which data was available, roughly 30 percent have reached their operational capacity. Sixty-five percent of the remaining facilities have less than five percent available capacity (as a percentage of total capacity). Depending on where any proposed new full-flush toilets are located, there may be insufficient capacity at the closest treatment works. This would need to be addressed in conjunction with any projects to expand the sanitation network and the number of households served.

2. ***Backlog in the bulk sewage network that links residential areas to the treatment works***

   As the number and distribution of informal settlements has grown, so too has the backlog in the bulk sewage network linking these areas to treatment works. As with the treatment works, depending on where any proposed new full-flush toilets are located there may be a need to up-grade or extend the existing bulk sewage network.

3. ***Backlog in the sewage networks in residential areas linking stands to the bulk network***

   There is a backlog in sewerage networks serving existing, formal residential areas. This backlog is relatively easily addressed given the presence of formal access routes. Far more difficult is dealing with the reticulation of sewerage lines in informal settlements. Where there are recognised access routes, putting in sewerage lines is possible. However, in most informal settlements the access routes are very haphazard or non-existent. This means that many households cannot be connected until such time as *in situ* blocking out of areas occurs or residents are relocated to formal residential areas.

4. ***Backlogs in the number of flush toilets.***

   This backlog is manifest in two ways. The first is through higher than accepted households to toilet ratios. Of the 437 informal settlement pockets in Cape Town, 132 have a toilet to household ratio greater than 1:5. Many of these toilets are chemical toilets or portable flush toilets – which means the household ratio to flush toilets is significantly higher.

   The other is reflected by the fact that in 2015, 189, or 43 percent, of the 437 informal settlement areas in Cape Town did not have access to flush toilets. They were served by either chemical toilets or portable flush toilets.

The nature of the backlogs affecting a particular area impacts on the strategy that needs to be implemented to overcome them. For instance, if sewerage networks are in place, then the backlog is

relatively easily addressed. However, if there are no appropriately located treatment works, no bulk lines and no sewerage networks in place, then addressing the backlog is much more complicated and is likely to take time. The cost of resolving the backlogs is also directly related to the nature and extent of the backlogs in question.

To complicate matters further, it is often not practically feasible to take sewerage lines into certain informal settlement due to the absence of access routes. In such instances, alternative sanitation solutions need to be provided until such time as the areas can be blocked out, or residents relocated to formal residential areas.

2.2 Toilet technology options

Annexure 1 to this report provides an analysis of different toilet technology options based on a review of all the available local and international research. The analysis considers the following constraints in relation to each of the available toilet technologies:

- social acceptability – this covers a range of issues such as dignity and privacy, equality and safety, as well as households' aspirations;
- the practicality – are there any geographic constraints, or constraints linked to location, that make the implementation of a particular technology impractical in a given context;
- health and environmental considerations;
- the cost and financial sustainability of the toilet technology; and
- the balance between immediate measures and longer term solutions.

Figure 1 provides a summary of the key findings of the discussion in Annexure 1 regarding the constraints impacting on the suitability of the different toilet technology options.

In the figure each of the constraints are classified as binding, non-binding or 'no constraint'. Binding means that the relevant technology cannot or should not be used. No constraint means that the relevant constraints do not apply. Non-binding means that the constraint is present, but can be overcome.

Figure 1: Summary of the constraint factors related to sanitation technology options

No constraint

Non-binding constraint

Binding constraint

Sanitation option	Social constraints	Geographic & logistical constraints	Environmental constraints	Cost constraints		Appropriateness of technology
				Initial	Operation & Maintenance	
Packet Latrine	Loss of dignity; perceived unclean	High water table; poor drainage; flooding; high population density; high delivery and supply costs; removal of incorrectly discarded packets;	Risk of personal safety; exposed waste			Not appropriate
Pit Latrine	Loss of dignity; outdated; smell and hygiene	High water table; high population density; lack of access; limited space; sandy soil	Seepage into water table			Not appropriate
Eco Latrine	Loss of dignity; outdated; smell and hygiene	Frequency of use; carbonaceous material not available; lack of transport infrastructure	Potential for wastewater overflow due to flooding			Not appropriate
Twin pit pour-flush toilet	On-site; unpleasant smells; loss of self-esteem and dignity; contact with faecal matter	High water table; high population density; lack of access; limited space; sandy soil	Seepage into water table			Not appropriate
Biogas toilet	Odiferous; perceived unclean	Stringent usage requirements; high frequency usage	Sensitivity of biological processes prone to cause system to fail			Not appropriate
Incinerating toilet	Complex to operate	Powered; high population and housing density; max 8 users	Use of electricty or fossil fuels; greenhouse gas emissions; risk of fire		Very expensive	Not appropriate
Urine diversion dry toilet	Complex to operate; removal of solid waste	Blockages; high population density;	Minimal risk of leakage		High maintenance	Not appropriate
Portable flush toilet	Apartheid-era "black bucket" system	High population density; small tanks (daily servicing)			Daily servicing	Short term option if there is no other option
Chemical toilet	Not for long-term use	Access to allow regular waste removal			Regular servicing (3X weekly)	Preferable short term option
Full flush toilet		Lack of piped water and sewage removal; sandy soil; flood plains				Best long term option

* Cost constraints are not long-term binding constraints, as they do not inherently inhibit the functionality or user acceptability (in a public provision situation) of the sanitation system.

The figure and the analysis in Annexure 1 highlights that, for a range of reasons, full-flush toilets are the most appropriate toilet technology for the informal settlement parts of Khayelitsha, provided there are suitable access routes into the areas. The cost of extending the sanitation system is a constraint in the short to medium term, but over the long term a full-flush or water-borne sewerage system is likely to be more cost effective in high density environments such as Khayelitsha than the other toilet technologies, such as portable flush toilets and chemical toilets (see discussion in section 4).

However, implementing a full-flush toilet and sanitation option linked to individual households or stands is not possible for practical reasons in all informal settlements or all parts of all informal settlements, due to the lack of access routes, the lack of formal stands and the fact that dwellings are built very densely. In such situations, it is necessary to use one of the alternative technologies – either portable flush or chemical toilets – as interim solutions or in conjunction with more remote full-flush toilets located along access routes, in toilet banks or in ablution facilities.

2.3 Constraint factors that impact the rollout of full-flush toilets

While full-flush toilets may be the preferable option from a number of perspectives, the CoCT has pointed to a number of constraints that impact on the rollout of a water-borne sanitation solution in many of the existing informal settlements. Table 2 summarises the constraint factors that the CoCT

compiled for 204 informal settlements within the municipal area. It lists the number and percentage of informal settlements impacted by the particular constraint factor, then gives a percentage breakdown of the geographic area of the informal settlement affected by the particular constraint.

Table 2: Constraints on the rollout of sanitation services to informal settlements

assesment 204 informal settlement areas	Total no. of areas affected	No. of areas affected < 10%	No. of areas affected between 11%- 25%	No. of areas affected between 26%- 50%	No. of areas affect between 51%- 100%	% of total areas affected	% of total areas affected < 10%	% of total areas affected between 11%- 25%	% of total areas affected between 26%- 50%	% of total areas affected between 51%- 100%
Practical and zoning contraints										
Structures in water body	35	25	5	3	2	17.2%	12.3%	2.5%	1.5%	1.0%
Structures in flood prone areas	18	4	2	4	8	8.8%	2.0%	1.0%	2.0%	3.9%
Zoning constraints where there are health and safety risks to households										
Metro road: within buffer zones	76	46	16	9	5	37.3%	22.5%	7.8%	4.4%	2.5%
Noise zone: >65 decibels	7	1	0	2	4	3.4%	0.5%	0.0%	1.0%	2.0%
Koeberg: <5km radius	1	0	0	0	1	0.5%	0.0%	0.0%	0.0%	0.5%
Power lines: within buffer zone	26	10	8	2	6	12.7%	4.9%	3.9%	1.0%	2.9%
Railway: within buffer zones	27	8	7	3	8	13.2%	3.9%	3.4%	1.5%	3.9%
Landfill sites: within buffer zone	8	2	1	1	4	3.9%	1.0%	0.5%	0.5%	2.0%
Landfill sites: on proposed and closed sites	4	2	2	0	0	2.0%	1.0%	1.0%	0.0%	0.0%
Zoning constraints where there are no risks to households										
Structures on servitudes	54	35	10	2	7	26.5%	17.2%	4.9%	1.0%	3.4%
Structures in Integrated Rapid Transport areas	9	6	2	0	1	4.4%	2.9%	1.0%	0.0%	0.5%
Structures on heritage sites	2	0	1	0	1	1.0%	0.0%	0.5%	0.0%	0.5%
Biodiversity sensitive areas – core 1	21	11	4	1	5	10.3%	5.4%	2.0%	0.5%	2.5%
Biodiversity sensitive areas – core 2	1	1	0	0	0	0.5%	0.5%	0.0%	0.0%	0.0%
Other constraints										
Private land ownership	78	24	15	6	33	38.2%	11.8%	7.4%	2.9%	16.2%

Source: Compiled from a spreadsheet provided by the Water and Sanitation Department, City of Cape Town

The above table shows that the constraint factors can be divided up into four broad categories:

i. Practical and zoning constraints

Where structures are built over an existing body of water, it is not possible to cost-effectively extend the sewerage system to such households. In addition, such dwellings are built in an area that contravenes zoning regulations.

The situation is slightly more nuanced in areas that are prone to flooding. Ideally, and according to zoning regulations, households should not be built in such areas. It may be possible to install storm water systems that ensure effective drainage. However, the fact that they are prone to flooding means there is a risk of damage to sewerage pipes – which can only be overcome by increasing the technical specifications of the network, effectively driving up costs. The cost-benefit of taking steps to make flood-prone areas habitable needs to be determined on a case by case basis. Where it is not cost-effective, the CoCT needs to take steps to move households out of such areas in accordance with zoning regulations.

In many informal settlements less than 25 percent of the area is affected by the particular constraint. This suggests that it is possible to provide the affected households with access to full-flush toilets located on the periphery of the flood prone area, such as in toilet banks or ablution blocks. However, the long term solution remains moving the affected households out of such areas.

ii. Zoning constraints where there are health and safety risks to households

A large number of the constraints listed by the CoCT fall into the category of zoning constraints. These zoning constraints do not impact on the practicality or cost of providing the affected households with access to full-flush toilets, but rather relate to the legality and desirability of doing so.

Many of the zoning constraints listed by the CoCT relate to issues that pose a current risk to the health and safety of affected households. For instance, the dwelling is built within a metro road buffer zone, or in a zone where the noise levels are excessive. In such instances, the

CoCT has both a legal and moral obligation to enforce the zoning regulations so as to protect households from health and safety risks. The first priority should be to move the affected households out of such areas, and the CoCT should have a prioritised plan for doing so – working down from high risk to lower risk zones. In the interim, while such a plan is being implemented, the CoCT does need to provide households with temporary toilet solutions.

What these temporary solutions should be depend on the particular circumstances. For instance, the CoCT should not violate its own zoning regulations by building permanent structures in road buffer zones. However, there may be a case for putting down a container ablution block in an area zoned for a proposed landfill site – if sewerage lines are available and until such time as the site is opened for use. In other instances, where the zone constraint only affects a small percentage of an informal settlement, the CoCT could consider providing full-flush solutions along the periphery of the affected area.

iii. Zoning constraints where there are no risks to households

In many instances the zoning constraints do not relate to issues that pose a current risk to households. For instance, the informal settlement is located in an area designated to be used for the Integrated Rapid Transport system. In such instances, the issue revolves around balancing the public interest versus the interests of the affected households – and having evaluated the situation, the CoCT might decide to rezone an area for residential use.

However, where it is in the public interest that a zoned area be protected, then the CoCT needs to have a prioritised plan for moving the affected households to alternative formal sites. And as before, while such a plan is being implemented, the CoCT needs to provide households with temporary toilet solutions. The above proposal relating to providing toilet solutions along the periphery of zoned areas also applies in some instances.

iv. Other constraints

The CoCT lists private land ownership as a constraint, and it is assumed that the land does not belong to the households living on it (in which case it would not be a constraint at all). This is seen as a constraint because the CoCT would need to register a servitude on the land in order to place any form of public infrastructure on it. Alternatively, the CoCT would need to expropriate the land. Both these factors would drive up the cost of providing a full-flush sanitation solution to dwellings located on such land. They are a cost constraint, not a practical constraint.

Again it is evident from the above table that in many instances the private land constraint only affects a small proportion of the geographic area of the informal settlement. In such instances, providing full-flush toilets in toilet banks or ablution blocks on the periphery of the affected areas is an option.

The CoCT does not list “dwelling density” or “lack of access routes” as a constraint affecting many informal settlements. However, the reality is that both these factors can make it very difficult to take a sewerage network into a given area. In such instances, portable flush toilets are the only practical option. To solve the sanitation problem requires these areas to be “blocked-out”, which means to re-organise the households in a way that de-densifies the area and creates access routes, or the households need to be moved to new formalised areas.

2.4 Analysis of Cape Town’s budgets from a sanitation perspective

The annual MTREF budgets of the CoCT are an integral part of the context that gave rise to this project. As noted, the broader aim of developing the Sanitation Costing Model is to facilitate constructive discussions between the CoCT and communities that will hopefully inform budget priorities and decisions in future. To provide a better understanding of the budget context for such future allocation discussions, Cornerstone reviewed the CoCT and other metro’s budgets from a sanitation perspective. The details of this budget review are presented in Annexure 2.

3 The Sanitation Costing Model

This section describes how the Sanitation Costing Model was designed and how it should be used. Sections 4 and 5 describe the results when the model is applied.

3.1 Costing models as a policy tool

A costing model is a tool. A tool used wisely and with expertise will produce better results than if it is used haphazardly with no real attention to detail. The quality of cost estimates is directly dependent on the quality of the costing assumptions and the quality of data used. The validity of the results must be seen in the context of these two factors.

Despite the best efforts of those doing the costing work, there is a balance between the accuracy of the results produced by a costing model and whether that model can actually be used and understood by a range of role-players. Developing a very detailed, complicated costing model usually means it can only be understood and used by the person who developed it. This does not facilitate meaningful discussions of the costing results. When developing the Sanitation Costing Model, the aim was to strike a balance between accuracy and simplicity so that the results can be widely understood.

There will always be a margin of error in a costing model – an Excel spreadsheet cannot replicate reality 100 percent. Even very detailed and complicated models will have a margin of error. In fact, the more complicated the model is the more assumptions are made, and with every assumption there is a margin of error. This balance needs to be managed, and the results of the model need to be seen in this context. It is important that those responsible for presenting and/or using the results recognise that these margins of error exist.

3.2 Purpose of the costing model

The purpose of the Sanitation Costing Model is to provide a tool that can be used to cost different sanitation provision scenarios across Cape Town's informal settlements. The tool is able to calculate costs of the provision of a range of different sanitation technologies. The methodology used to calculate costs is consistent across the different options and caters for sanitation provision and improvement through a combination of technologies.

The provision scenarios can range from no action (or zero investment in the provision of sanitation to informal settlements) to a scenario of almost unlimited supply of chemical, portable flush, and full-flush toilet solutions. The scenarios include the initial capital investment as well as the different operating and maintenance expenses associated with each scenario. This means that users of the model can calculate the cost implications of a wide range of scenarios of their choice.

The model consists of two key components. The first is a set of underlying assumptions about things like population growth and the maintenance of the different sanitation technologies. The second component consists of a number of choices about time frames and ratios of toilets to households and various combinations of sanitation technologies.

There are also various options available to the user, based on the level of input they can or would like to provide, both in terms of underlying assumptions and other data. This means that the tool can be equally useful to someone with access to very detailed data about sanitation and someone who has limited access to this information. The quality and detail of the data inputted will inevitably inform costing estimates (or outputs of the model).

3.3 Processes to develop the costing model

The costing model was developed for and in conjunction with members of IBP and the SJC. Guidance was therefore given in terms of the functionality required and the different elements that needed to be included in the model.

The starting point was a set of site visits. These visits were conducted in areas of Khayelitsha, and provided the context for the model. This context includes the set of real world constraints faced by CoCT officials when trying to service informal settlements with sanitation facilities.

3.4 Sources of data

The table below details the data sources for the different variables used in the Sanitation Costing Model.

Table 3: Data sources used to build the Sanitation Costing Model

Variable	Source	Relevant documents
Population	City of Cape Town	Provision Matrix
Number of households	City of Cape Town	Provision Matrix
Population density	City of Cape Town	Provision Matrix
Area	City of Cape Town	Provision Matrix
Number of toilets in 2015	City of Cape Town	Provision Matrix
Constraint factors	City of Cape Town	Constraints Matrix
Technology cost information	Dept. of Water Affairs & Forestry Engineering consultant	"Sanitation technology options"

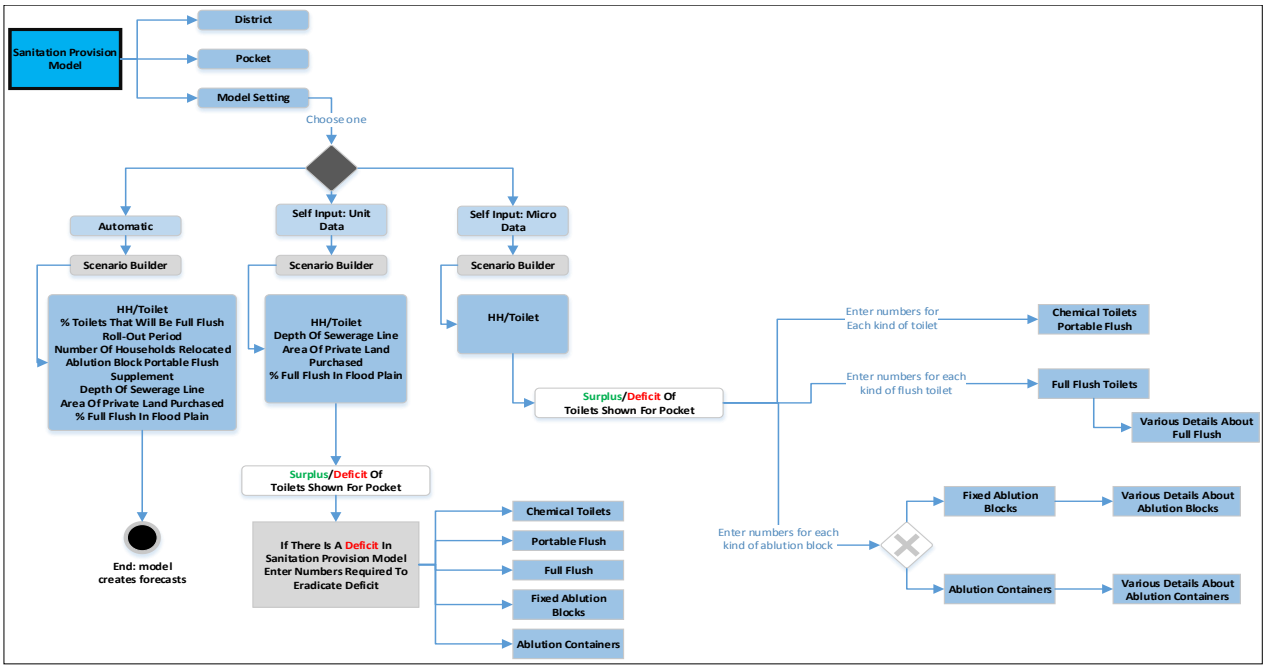
The Provision Matrix was released by the CoCT, on public request, and includes information on population, housing, geography, and sanitation solutions in 2015 for 437 informal settlement pockets across Cape Town. On public request the CoCT also released the Constraints Matrix which provides information on the specific constraint factors that may hinder the rollout of sanitation services in 204 informal settlement pockets.

The cost estimates for the provision of the different types of technology were calculated using data from two sources. The first source was a document published by the Department of Water Affairs and Forestry in 2002 entitled "Sanitation Technology Options". This document includes capital, operating, and maintenance cost information for a number of different sanitation technologies. The costs were adjusted for inflation to provide estimates for 2016. All costs were also verified by an engineering consultant to ensure their accuracy. Some of these costs may differ from the costs currently incurred by the CoCT, as certain types of technology are provided by independent contractors. The engineering consultant also provided any remaining cost estimates not included in the document published by the Department of Water Affairs and Forestry.

3.5 Design of the Sanitation Costing Model

Figure 2 shows the design of the Sanitation Costing Model and provides an overview of how the model works. The model allows the user to choose an informal settlement district and pocket, and then the preferred sanitation solutions. Based on these decisions, the model generates an estimated cost for the scenario. The sub-sections below describe how to use the model and the choices users will be asked to make in each phase of the model.

Figure 2: Flow diagram of the sanitation costing model



3.5.1 Geographic areas covered

The first step in the process is the selection of the geographic area. Figure 3 shows how the user can choose one of the following nine districts in the Cape Town metropolitan area by selecting the desired option from a drop-down menu:

- Ebenezer;
- Helderberg;
- Hillstar;
- Khayelitsha;
- Mitchells Plain;
- Panorama 6A;
- Panorama 6B;
- Southern Districts;
- Tygerberg.

The names of the districts are the same as those used in the CoCT's Provision Matrix.

Figure 3: District selection

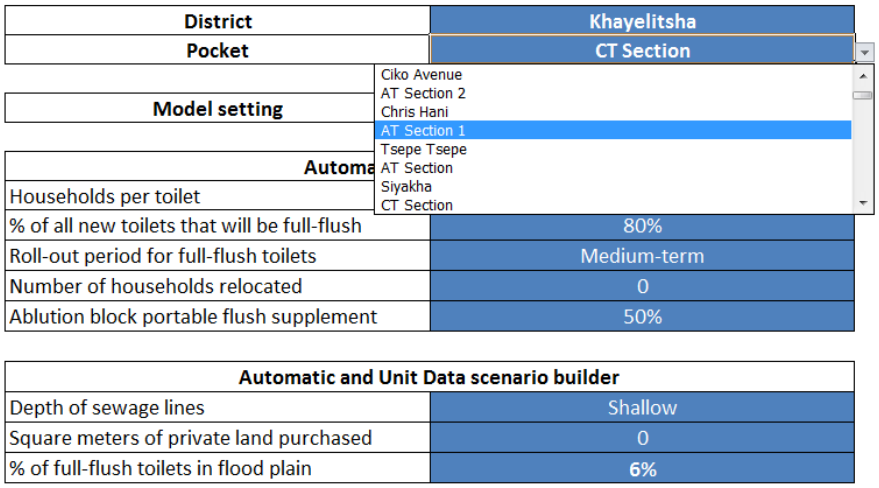
District	Khayelitsha
Pocket	
Model setting	
Automa	
Households per toilet	1
% of all new toilets that will be full-flush	80%
Roll-out period for full-flush toilets	Medium-term
Number of households relocated	0
Ablution block portable flush supplement	50%

Helderberg
Hillstar
Khayelitsha
Mitchells_Plain
Northern_Panarama_6A
Northern_Panarama_6B
Southern_District
Tygerberg

Automatic and Unit Data scenario builder	
Depth of sewage lines	Shallow
Square meters of private land purchased	0
% of full-flush toilets in flood plain	6%

Once the district has been selected, the user must select a specific pocket (area) for analysis. The model automatically adjusts to only show the pockets included in the selected district. Figure 4 shows how the user is able to select the desired pocket.

Figure 4: Pocket selection

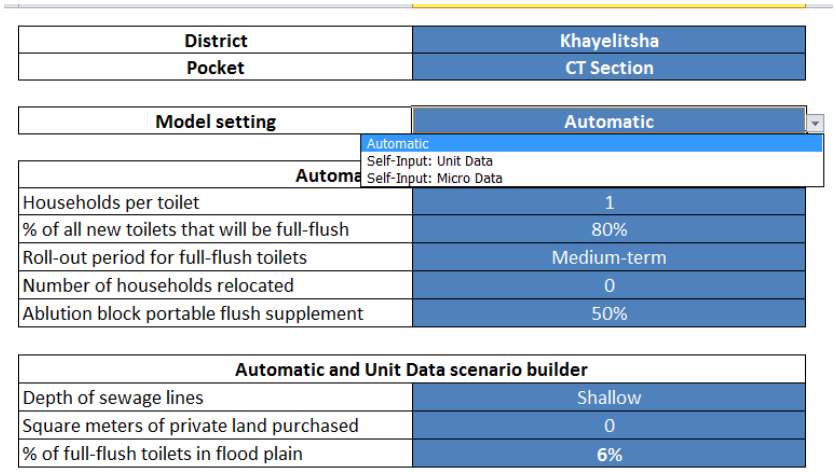


After the pocket has been selected, the model draws the relevant information on the population in that pocket to be used in the calculation of the costs to provide the different sanitation scenarios. The model has been designed to take account of population growth. An assumption has been included in the model that the population in each pocket grows annually by a set percentage. This percentage has been set based on the demographics of the specific pocket and can be updated in the assumptions sheet. It is not reasonable for the population in a pocket to grow ad infinitum, therefore the level is capped based on a maximum density of households per hectare

3.5.2 Model setting options for running scenarios

Next, the user must choose between three model settings in order to use the Sanitation Costing Model to calculate cost estimates for different sanitation provision scenarios. This is illustrated in Figure 5.

Figure 5: Model setting options for running scenarios



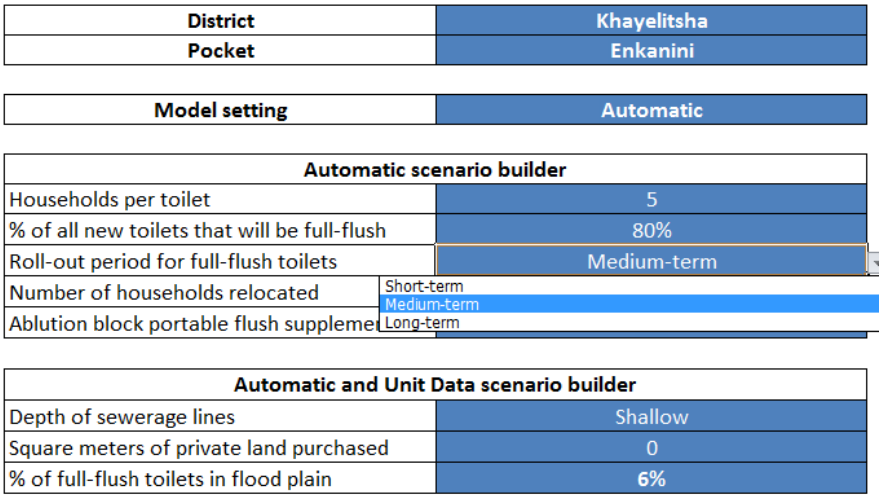
The three model settings are:

- **Automatic**: the model automatically determines the required number and provision schedule for each toilet type based on a set of assumptions.
- **Self-input unit data**: the user must enter the number of different types of units he/she requires and the model estimates related inputs.
- **Self-input micro data**: the user must enter the number of different types of units he/she requires and the information about related inputs

For each of the three model settings, the user must set the household to toilet ratio. This will then generate the surplus/deficit of toilets in each year. For example, if the user chooses one toilet per five households and in that section the CoCT is currently only providing one toilet per eight households, then the model will show a deficit. The deficit will be the number of toilets that the CoCT will need to provide to reach a one toilet per five households ratio in that area.

The **Automatic model setting** allows the user to select what percentage of all new toilets should be full-flush and the time period over which the provision (or rollout) of these toilets should take place, namely: short-term (two years), medium-term (five years), and long-term (eight years). The choice of time period is illustrated in Figure 6.

Figure 6: The choice of time periods in the automatic setting mode



In Figure 6, the following selections were made:

- a household per toilet ratio of five,
- 80 percent of all new toilets will be full-flush and
- a medium term rollout period for full-flush toilets.

That means that by the end of the five-year period, new toilet facilities should be provided in such a manner that every five households have access to a type of toilet and 80 percent of the new toilets should be full-flush. This means that over the five-year period, other types of toilet facilities will also have to be provided.

Based on the user's choice of a households per toilet ratio, the percentage of all new toilets that should be full-flush, and the rollout period, the model then generates the number of additional chemical, portable flush, individual full-flush, and ablution full-flush toilets required each year to keep pace with the population growth in that pocket.

The number of additional chemical and portable flush toilets to be provided is determined in part by an assumed split between chemical and portable flush toilets, which make up the remainder of all non-flush toilets. The required number of individual full-flush toilets and ablution blocks is determined in turn by a predetermined split between individual flush toilets and ablution blocks with full-flush toilets. Individual full-flush toilets are then broken down by standard and disabled-friendly units. The number of fixed ablution blocks and container ablution blocks is based on an assumed 50-50 split in the total number of required ablution blocks. These assumptions can be set in the assumption sheet in the model, and are shown in Figure 7 below.

Figure 7: Assumptions related to the breakdown of different toilet types

Automatic specific assumptions	
Split between chemical and portable flush toillets	
Chemical (% of total)	50%
Portable flush (% of total)	50%
Split between standard and disabled friendly full-flush toilets	
Standard (% of total)	90%
Disabled friendly (% of total)	10%
Split between individual full-flush and ablution blocks/containers	
Individual (% of total)	75%
Ablution block/container (% of total)	25%
Split between ablution blocks and containers	
Ablution blocks (% of total)	50%
Containers (% of total)	50%

The model also includes the option to supplement fixed ablution blocks and ablution containers with portable flush toilets. This means that residents who are reliant on ablution blocks will also have access to a portable flush toilet so that they do not need to walk to the ablution block at night, which is potentially unsafe. In the **Automatic** setting the user can select the percentage of ablution block toilets they would like to supplement, as seen in Figure 8, and the model then includes the additional portable flush toilets in the scenario.

Figure 8: Option to supplement ablution based toilets with portable flush toilets

Automatic scenario builder	
Households per toilet	1
% of all new toilets that will be full-flush	80%
Roll-out period for full-flush toilets	Medium-term
Number of households relocated	0
Ablution block portable flush supplement	50%

The **Automatic** setting also allows users to input the number of households that must be relocated to make space for ablution blocks or banks of full-flush toilets. Based on this assumption and an average household relocation cost, the cost of the required number of relocations is calculated. In the **Automatic** setting, the costs of relocations are distributed over the rollout period according to the percentage of full-flush toilets built in each year. For the other two modes, the user can specify the year that relocations take place.

The **Self-input unit data** setting allows the user slightly more freedom to customise the sanitation provision scenarios than in the **Automatic** setting. The user can manually input the number of new chemical, portable flush, individual full-flush, and ablution full-flush toilets to be provided in each year. Because the user manually selects the number of toilets, the type of toilets, and the year of investment, the option to select what percentage of all new toilets should be full-flush and the time period over which this transition should take place falls away. Like the **Automatic** setting, however, the length and type of sewerage lines, and the distribution between standard and disabled-friendly individual full-flush units, are set as assumptions. The **Self-input unit data** setting provides users the added option to include pump station costs.

The **Self-input micro data** setting provides the user with even more flexibility. In this mode the user is able to fully manipulate the sanitation provision scenario, ranging from the number of toilets, types of toilets, and investment year to the length and types of sewerage lines, the split between standard and disabled-friendly individual full-flush units, the number of households relocated, and pump house costs incurred. Because of the micro level data required to use this option, it is recommended as the preferred option only once a master plan for a specific pocket has been developed, or if the user is suitably qualified and has completed a site visit. This function setting is important because it provides the CoCT officials with the ability to use the costing model as a planning tool.

3.5.3 Technology options

Based on the findings in section 2.2, the model includes four sanitation technology options: portable flush toilets, chemical toilets, individual full-flush toilets, and ablution blocks. Ablution blocks are then further disaggregated to fixed ablution blocks and containers.

Table 4 shows all of the key assumptions and variables associated with each technology option. All of these assumptions and variables are located in the assumptions sheet in the model.

Table 4: Key assumptions and variables by technology option

Technology	Assumption/Variable	Description
Portable flush	Collection rate	How often PF toilets are collected
	Collection and cleaning cost	Unit cost to collect and clean
	Annual cost	All capital, operating, maintenance, & bulk costs
Chemical toilets	Cleaning frequency	How many days per week are toilets cleaned
	Annual cost	All capital, operating, maintenance, & bulk costs
Individual full-flush	Cleaning frequency	How many days per week are toilets cleaned
	Capital cost	All capital costs, disaggregated based on depth of sewage lines. Includes all on-site facilities and the sewer mains and sewerage treatment facilities.
	Operating cost	All operating costs, based on number of HH using a toilet
	Maintenance cost	All maintenance costs, disaggregated according to the depth on sewage lines and based on number of HH using a toilet. Includes all sewer, pump and treatment facility costs.
Fixed ablution block and Container ablution block	Number of cleaning staff	How many cleaners are there per facility
	Opening hours	Is the facility open 12 or 24 hours a day
	Security guard	Is there a security guard at the facility
	Capital cost	All capital costs, disaggregated based on depth on sewage lines. Includes all on-site facilities and the sewer mains and sewerage treatment facilities.
	Operating cost	All operating costs, based on number of HH using a toilet and including bulk costs
	Maintenance cost	All maintenance costs, disaggregated according to the depth of sewage lines and based on number of HH using a toilet. Includes all sewer, pump and treatment facility costs.

Sanitation upgrades cannot be considered in isolation from bulk waste water treatment facilities, which are used to treat sewerage from toilets. These bulk facilities all have a certain capacity which informs

the number of toilets they can service. This means that depending on the number of toilets added to the system there is also a possibility that existing bulk treatment facilities may need to be upgraded or new facilities built which would be a cost factor. This information was not available to the modelling team at the time the model was developed and so could not be costed in area specific detail. However overall treatment and maintenance costs do form part of the operating costs of each technology option.

Similarly, the distance from a pocket to a bulk treatment facility is a potential limitation to full-flush solutions. However this was also not included in the model as the relevant information has not been placed in the public domain. When the CoCT does make this information available, these cost variables can be modelled in greater detail in the model.

Even where the necessary information was made available by the CoCT, or gathered from other sources, disputes over cost inputs can be a hurdle. The model has been designed so that all of the cost inputs are entered as assumption variables, which means that these costs can be changed or updated at any time. If some of the input costs currently in the model do not align with those presented by the CoCT, or they change in future the users of the model can simply alter those specific assumptions and the model will automatically update.

3.5.4 Modelling the constraint factors

As noted in section 2.3, many of the constraint factors listed in the Constraints Matrix are zoning or urban design issues, and do not affect the cost of service provision. For example, the presence of power lines or road and railway buffer zones do not increase the cost of providing a full-flush toilet. The importance of these constraints is related to the decision the CoCT officials must make regarding whether or not construction of fixed facilities can take place in these areas.

On the other hand, privately owned land and wetland areas are two constraint factors that affect the cost of service provision. To address these two factors the model provides the option to purchase land and to use different sets of engineering specifications, respectively, as shown in Figure 9. If all of the full-flush toilets will be in a wetland area, the user can change the depth of sewerage lines from shallow (which is the default option) to deep. Alternatively, the user can input the percentage of full-flush toilets that will be located in a flood plain, and the cost of these units will be adjusted by an escalation factor that is housed in the assumptions sheet.

Figure 9: Including constraint factors

Automatic and Unit Data scenario builder	
Depth of sewerage lines	Shallow
Square meters of private land purchased	0
% of full-flush toilets in flood plain	6%

3.5.5 General assumptions

The remaining assumptions, shown in Figure 10, pertain to inflation rates and population growth.

Because of the differences between capital- and labour-related inflation rates, the two have been separated in the model. Annual population growth can also be set for each pocket in the assumptions sheet. As stated previously, it is unreasonable to assume that population growth in an area will continue ad infinitum. For this reason, the user can also select a maximum population density that serves to cap population at a certain concentration of households per hectare.

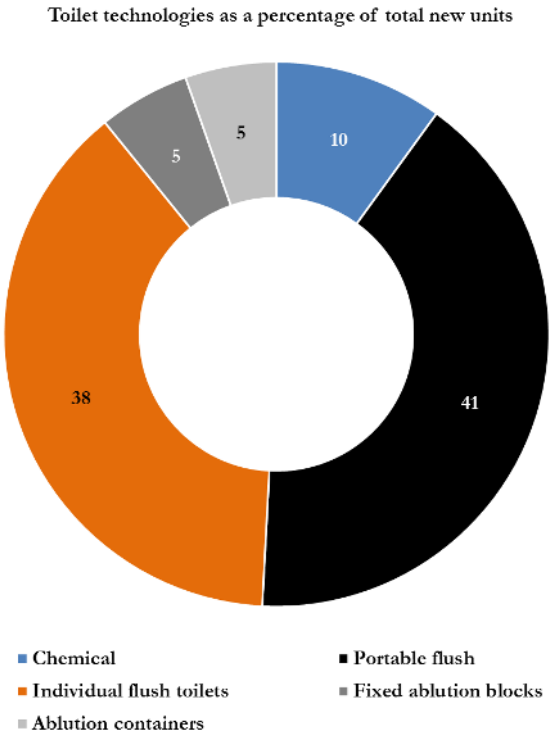
Figure 10: Model assumptions

General assumptions	
Economic	
Services Inflation rate	6.0%
Capital inflation rate	6.0%
Population	
Annual population growth	19.1%
Max population density (HH per Ha)	460

3.5.6 Presentation of the costing results

The results from the modelling are presented in a number of ways. Firstly, the type of toilet solutions provided are illustrated graphically. The example in Figure 11 has been taken from the main user interface page of the costing model, and shows the percentage of all new toilets by technology type for a selected provision scenario. The figure is not an exact reflection of the full-flush penetration percentage for two reasons: firstly, the model transitions to the desired penetration rate over the chosen time period – for example, five years. Up until that point full-flush penetration is transitioning to that level. Secondly, the figure reflects the number of new units which is again a slightly different measure to the full-flush penetration rate. This graph updates automatically if the user makes any changes to the model, and is a quick way for the user to see whether the outcome is in line with their preferences or not.

Figure 11: Toilet technologies as a percentage of total new units



Secondly, the total cost of a provision scenario is shown as a headline figure – the top row in Table 5 below – which is also presented on the main user interface page of the model.

Table 5: Presentation of costing results in the Sanitation Costing Model

Total cost of sanitation scenario	30 405 242	33 254 578	24 963 541	80 545 604	65 957 602	80 978 528	95 057 787	137 591 636	151 882 045	100 869 373
Portable flush toilets	15 545 000	17 129 600	5 567 438	16 870 742	19 031 840	17 309 948	9 716 856	14 622 804	17 922 822	14 225 413
Chemical toilets	10 404 000	11 238 120	1 982 030	6 988 882	8 544 444	9 081 199	6 996 136	10 528 419	12 910 169	10 248 379
Individual full-flush toilets	4 456 242	4 886 858	11 243 261	31 013 631	20 490 757	27 863 017	38 822 016	55 171 647	59 641 276	39 610 556
Fixed ablution blocks	0	0	3 316 867	13 756 235	9 400 403	14 051 369	20 784 142	30 105 685	32 017 220	18 479 521
Ablution containers	0	0	2 853 944	11 916 115	8 490 158	12 672 996	18 738 637	27 163 081	29 390 558	18 305 505
Purchase of private land	0	0	0	0	0	0	0	0	0	0
Household relocation	0	0	0	0	0	0	0	0	0	0
Capital costs	**0**	**528 441**	**10 470 629**	**39 404 060**	**17 252 675**	**26 262 084**	**39 194 514**	**57 312 189**	**51 253 462**	**3 823 688**
Individual full-flush toilets	0	528 441	5 526 789	19 752 296	7 531 602	11 541 603	17 349 320	25 886 317	23 201 736	1 965 261
Fixed ablution blocks	0	0	2 696 640	10 719 144	5 302 403	8 029 353	11 915 561	17 141 385	15 300 942	1 013 687
Ablution containers	0	0	2 247 200	8 932 620	4 418 669	6 691 128	9 929 634	14 284 487	12 750 785	844 739
2015 Baseline operating costs	**30 900 380**	**32 754 402**	**34 719 667**	**36 802 847**	**39 011 017**	**41 351 678**	**43 832 779**	**46 462 746**	**49 250 511**	**52 205 541**
Portable flush toilets	15 545 000	16 477 700	17 466 362	18 514 344	19 625 204	20 802 717	22 050 880	23 373 932	24 776 368	26 262 950
Chemical toilets	10 404 000	11 028 240	11 689 934	12 391 330	13 134 810	13 922 899	14 758 273	15 643 769	16 582 395	17 577 339
Individual full-flush toilets	4 951 380	5 248 462	5 563 370	5 897 172	6 251 003	6 626 063	7 023 627	7 445 044	7 891 747	8 365 252
Fixed ablution blocks										
Ablution containers										
Revised scenario operating costs	**-495 138**	**-44 119**	**-20 540 874**	**3 156 576**	**9 176 330**	**12 576 903**	**10 854 658**	**32 097 335**	**49 840 469**	**44 725 433**
Portable flush toilets	0	651 900	-11 898 924	-1 643 602	-593 364	-3 492 769	-12 334 024	-8 751 128	-6 853 547	-12 037 538
Chemical toilets	0	209 880	-9 707 904	-5 402 449	-4 590 366	-4 841 700	-7 762 137	-5 115 350	-3 672 226	-7 328 960
Individual full-flush toilets	-495 138	-905 899	-12 702	4 771 593	6 482 204	9 349 102	13 928 589	21 063 696	27 851 741	29 221 085
Fixed ablution blocks	0	0	539 328	2 715 516	3 938 928	5 781 134	8 511 115	12 450 059	16 257 250	17 435 423
Ablution containers	0	0	539 328	2 715 516	3 938 928	5 781 134	8 511 115	12 450 059	16 257 250	17 435 423

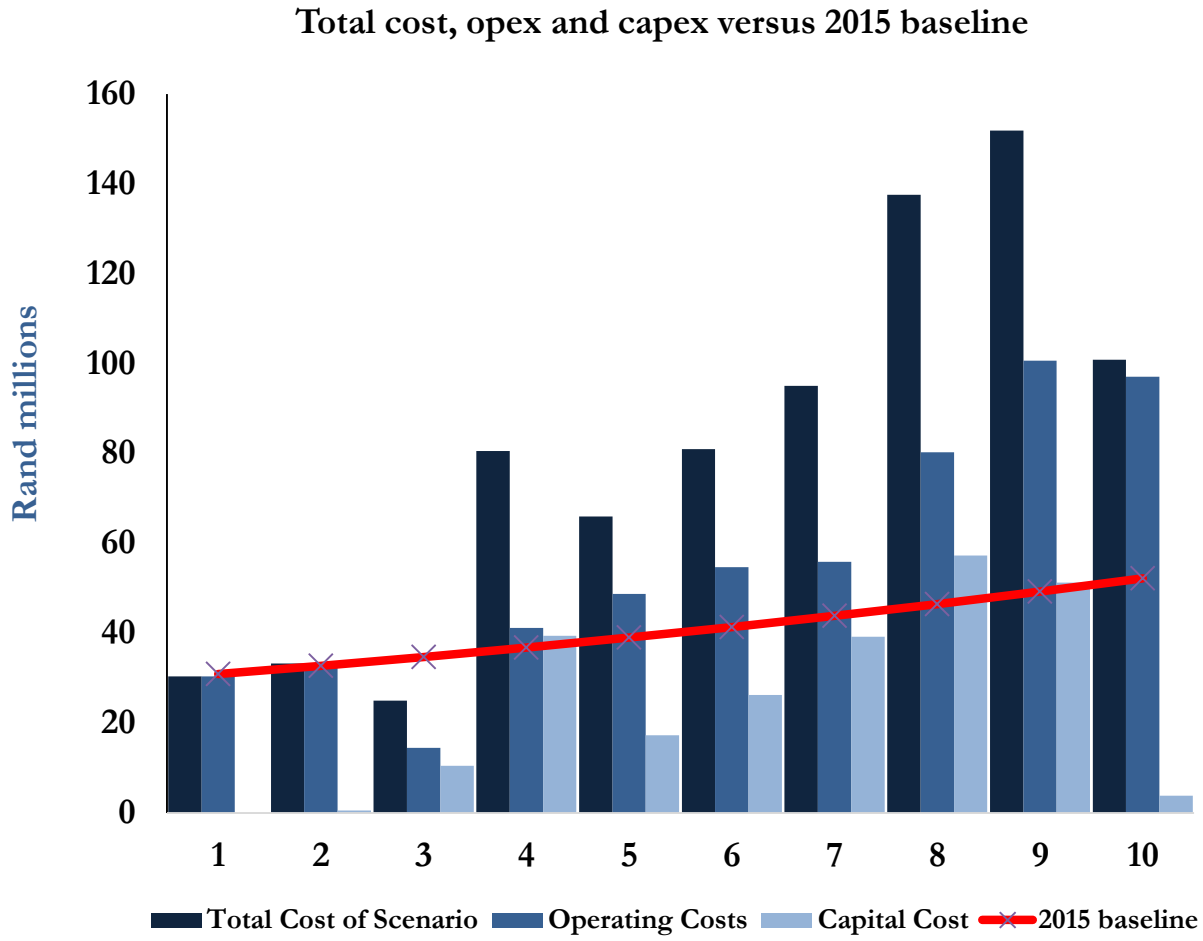
The total cost of the sanitation scenario presented here is the total additional funding required to improve the sanitation provision for that pocket to the standard selected in our example in Figure 6. This means that over the medium term (five years) 80 percent of all new toilets will be full-flush and the target is a ratio of five households per toilet. The costing results are given for years after the conclusion of the rollout period to take account of the fact that the population (and therefore demand for sanitation) will continue to grow and there will also be a cost involved in maintaining the existing level of service provisions.

The total cost is disaggregated by technology type and economic classification (capital vs operating costs). The operating costs are split into two sections, one for baseline costs and the other for the revised scenario. The baseline costs provide the operating costs that would be incurred in order to maintain the existing number of units for each technology type in 2015. This provides an indication of the cost to maintain the current (2015) level of service.

The revised scenario provides the operating costs associated with the new provision scenario developed by the user. The difference between the baseline and revised costs indicates the additional operating costs associated with the selected provision scenario. The capital costs are then added to provide the total additional funding required to provide sanitation in line with the scenario selected by the user.

Figure 12 compares the estimated 2015 baseline operating cost projected forward (red line) with the cost of implementing the new scenario, shown as total, capital and operating costs. If the bar indicating the new scenario's operating costs is below the red line, an operating costing saving is indicated. This figure is also on the results page of the Sanitation Costing Model.

Figure 12: Increase/Decrease in budget compared to 2015 baseline



Note that this figure is linked to the data in the model and updates in response to the scenario being modelled.

4 Overall findings from the Sanitation Costing Model

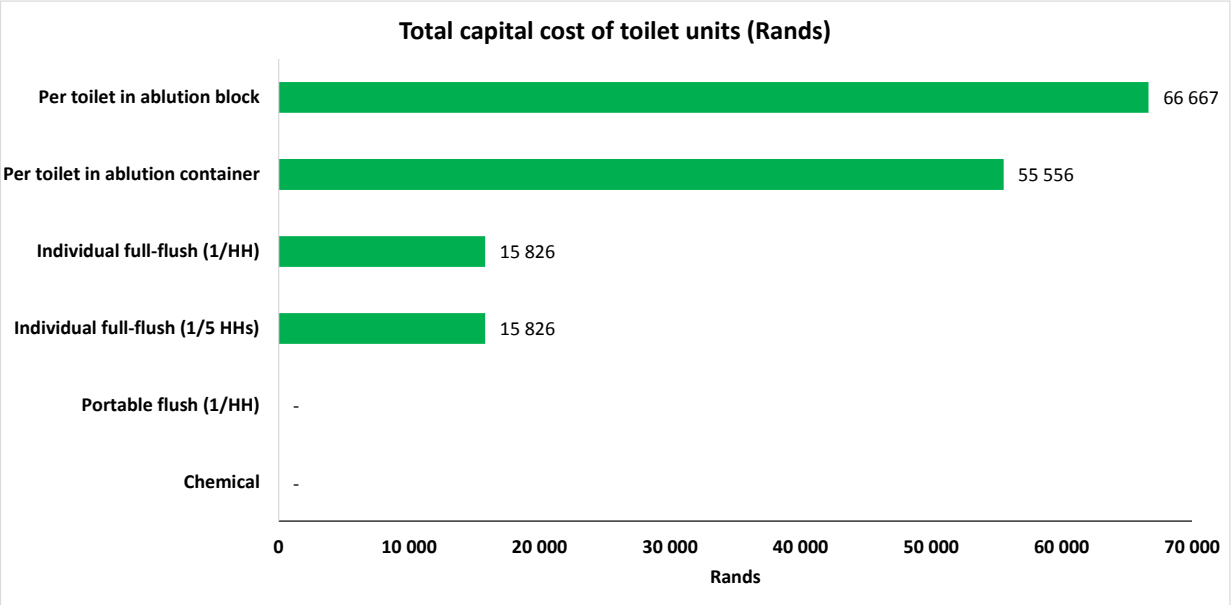
This section presents a set of general cost findings generated by the Sanitation Costing Model. As indicated above, all the assumptions in the model are variable, which means the costing outcomes will change in response to any change in the values of assumptions.

4.1 Unit cost of each of the options – capital, operational and combined

The following figures compare the relative capital and operational costs of different toilet options. The annual operational costs, taking into consideration inflation, are combined over a ten-year period to arrive at a cumulative total. In each graph, the most expensive option is shown at the top and the rest are shown in descending order of cost.

Ablution blocks contain nine toilets. The "Per toilet in ablution block" and "Per toilet in ablution container" is the average capital cost per individual toilet in an ablution block or an ablution container respectively to enable comparison with other cost per individual toilet options

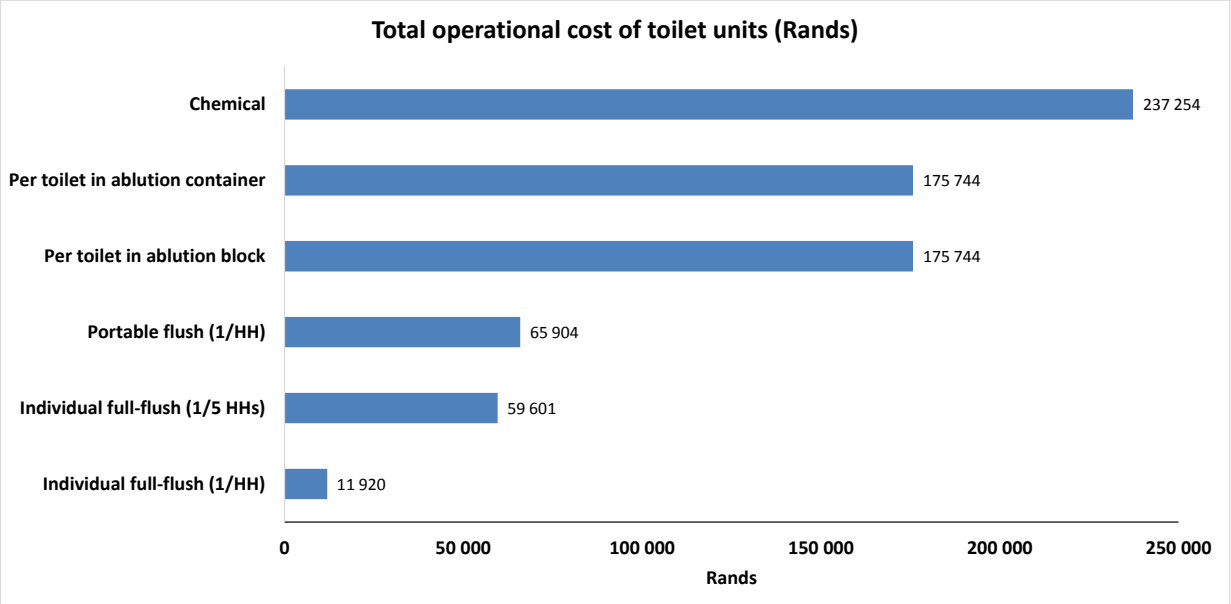
Figure 13: Total capital costs of different toilet options (no constraints)



Note the following:

- Ablution blocks are the most expensive to install, even when the cost is shown as a unit cost for the individual toilets.
- There are no capital costs associated with portable flush and chemical toilets, as these are borne by the contractors, who supply them on the basis of monthly operating contracts.
- The per toilet cost of a toilet in an ablution container is more than three times the cost of an individual full-flush toilet.

Figure 14: Total operational costs of different toilet options over ten years

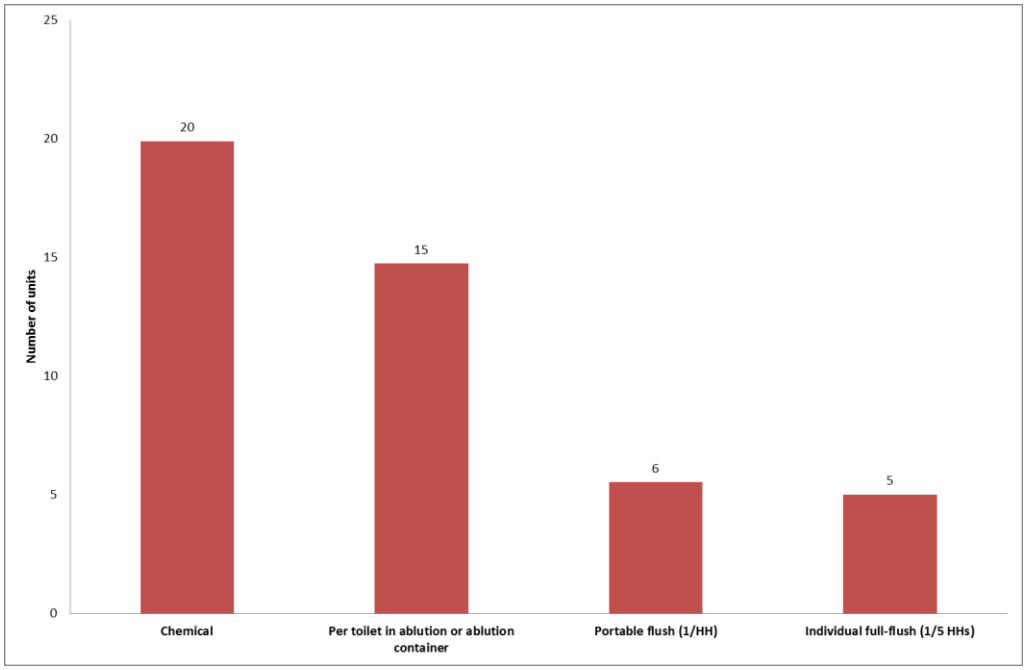


Note the following:

- The operating costs of an individual full-flush toilet for a single household are the lowest of all the toilet options. If individual full-flush toilets are shared between families, the operational and maintenance costs increase due to more individuals using a single toilet.
- At a per toilet cost, chemical toilets are the most expensive followed by toilets in ablution containers and ablution blocks. This is an important finding because it indicates that all the different full-flush options are cheaper to operate than the chemical toilets.

Figure 15 shows the number of individual full-flush toilets that could be operated with the funds required to operate each of the other toilet options. Note that comparisons are only made to individual units in ablution blocks and ablution containers.

Figure 15: Cost ratios between individual full-flush toilets and other options

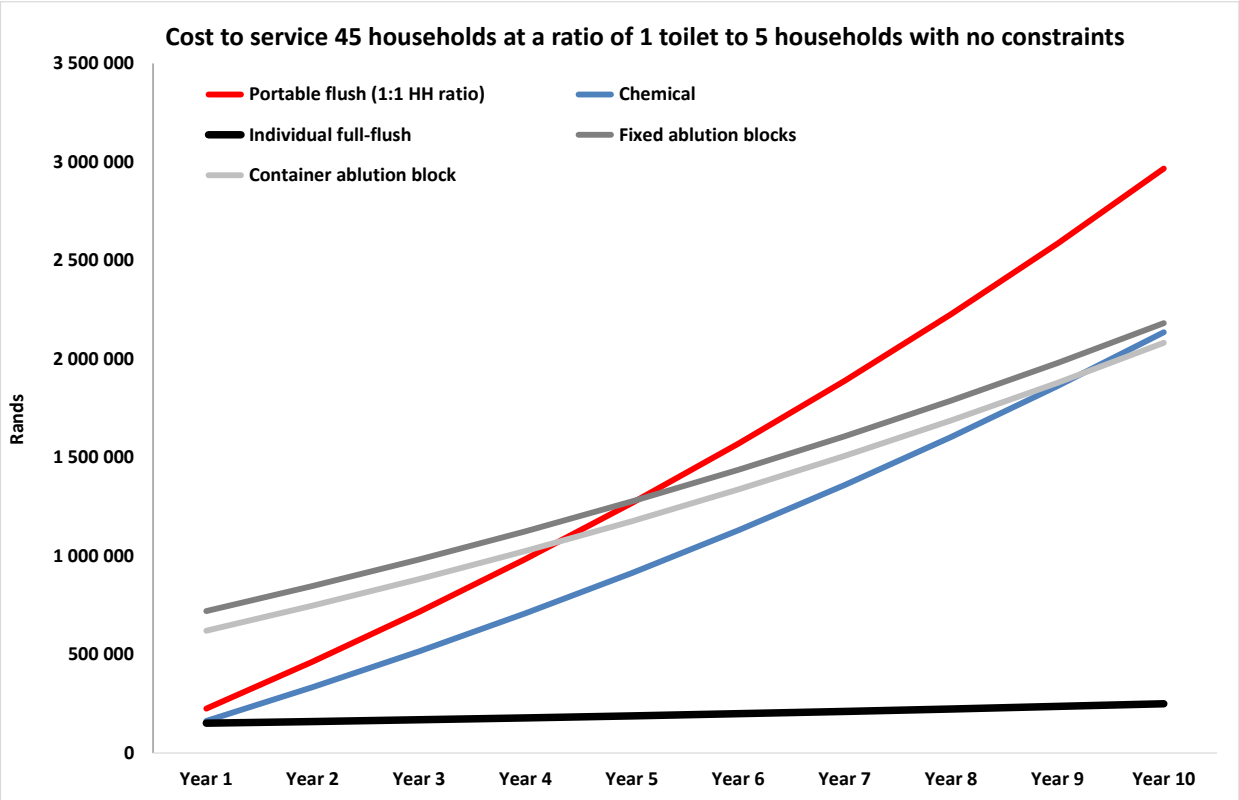


For every one chemical toilet in operation, 20 individual full-flush toilets could be operated, and for every toilet in an ablution block or ablution container, 15 individual full-flush toilets could be operated.

4.2 Cumulative cost of servicing 45 households over a ten-year period

The following figure shows the cumulative capital and operating cost over a ten-year period, of providing 45 households with toilets using the different technologies at a ratio of one toilet to five households, except in the case of portable flush toilets, which are provided at a ratio of one per household. This figure therefore compares the cost when only one type of toilet technology is provided to all households over the ten-year period.

Figure 16: Total capital and operational cost of providing 45 households with toilets (1:5 ratio) over a ten-year period



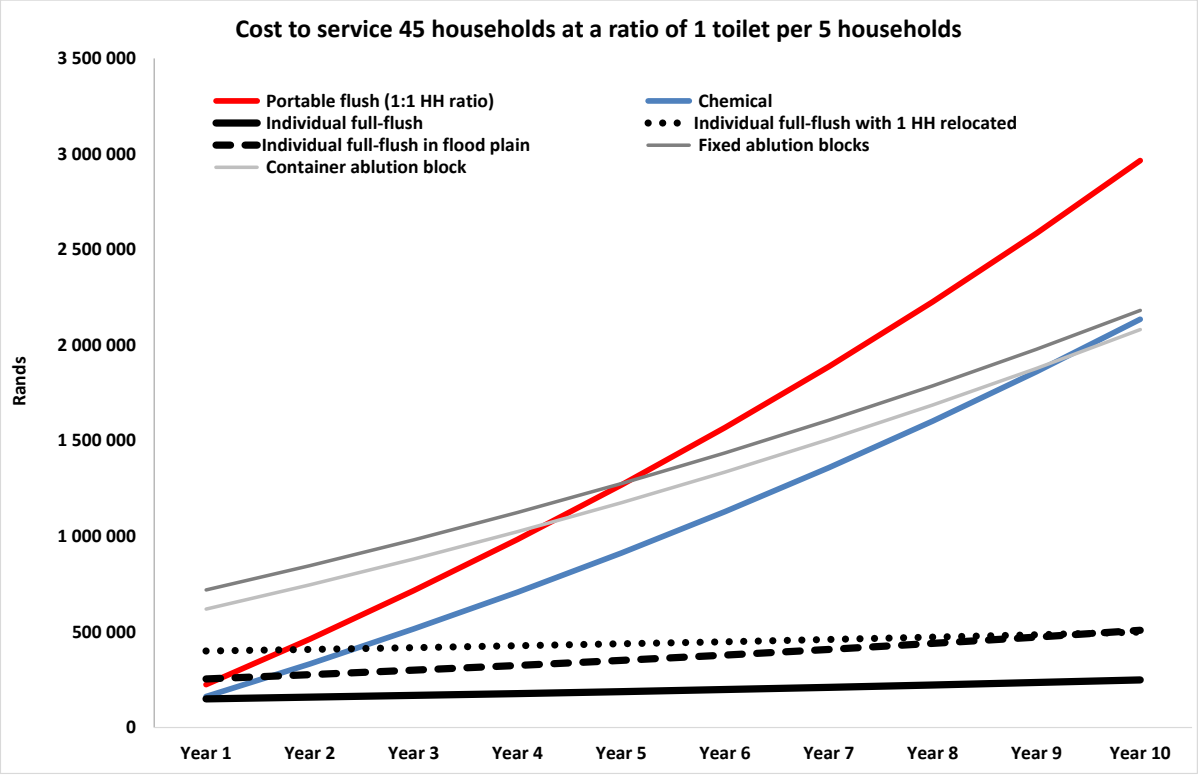
The above figure highlights that the following key points:

- The full-flush toilet solution is substantially more affordable than any of the other toilet solutions over a ten-year period.
- The extent of the cost difference between individual full-flush and the other options suggests *that there is substantial space to account for the cost impact of dealing with any potential constraints that would impact on the initial cost of installing the full-flush toilets*. Even if the impact of constraints were to double or triple the initial capital cost of full-flush toilets, they would still be a more affordable option than any of the other solutions over the ten-year period.
- The portable flush toilets provided on a 1:1 household ratio are the most expensive option over the ten-year period.
- Despite the initial substantial capital costs associated with ablution blocks, they are likely to be more cost effective than chemical toilets in the long run.

4.3 Cost impact of constraint factors

The estimates presented above in Figure 16 change only marginally when constraints are factored in. The results are shown in Figure 17 below.

Figure 17: Total capital and operational cost of providing 45 households with toilets (1:5 ratio) with constraints over a ten-year period.



The cost of relocating a household is a once-off additional cost, whereas the presence of a flood plain increases the operational costs of individual full-flush toilets due to higher maintenance costs. Despite the increased cost as a result of the constraints, *full-flush toilets still remain the most cost-effective toilet solution in long-run.*

The impact of constraint factors on unit costs depends on the number of households that are relocated compared to the number of flush toilets built and the percentage of total toilets that are in a flood plain or on private land.

The above findings need to be placed in context: the following constraints restrict the rollout of full-flush toilets:

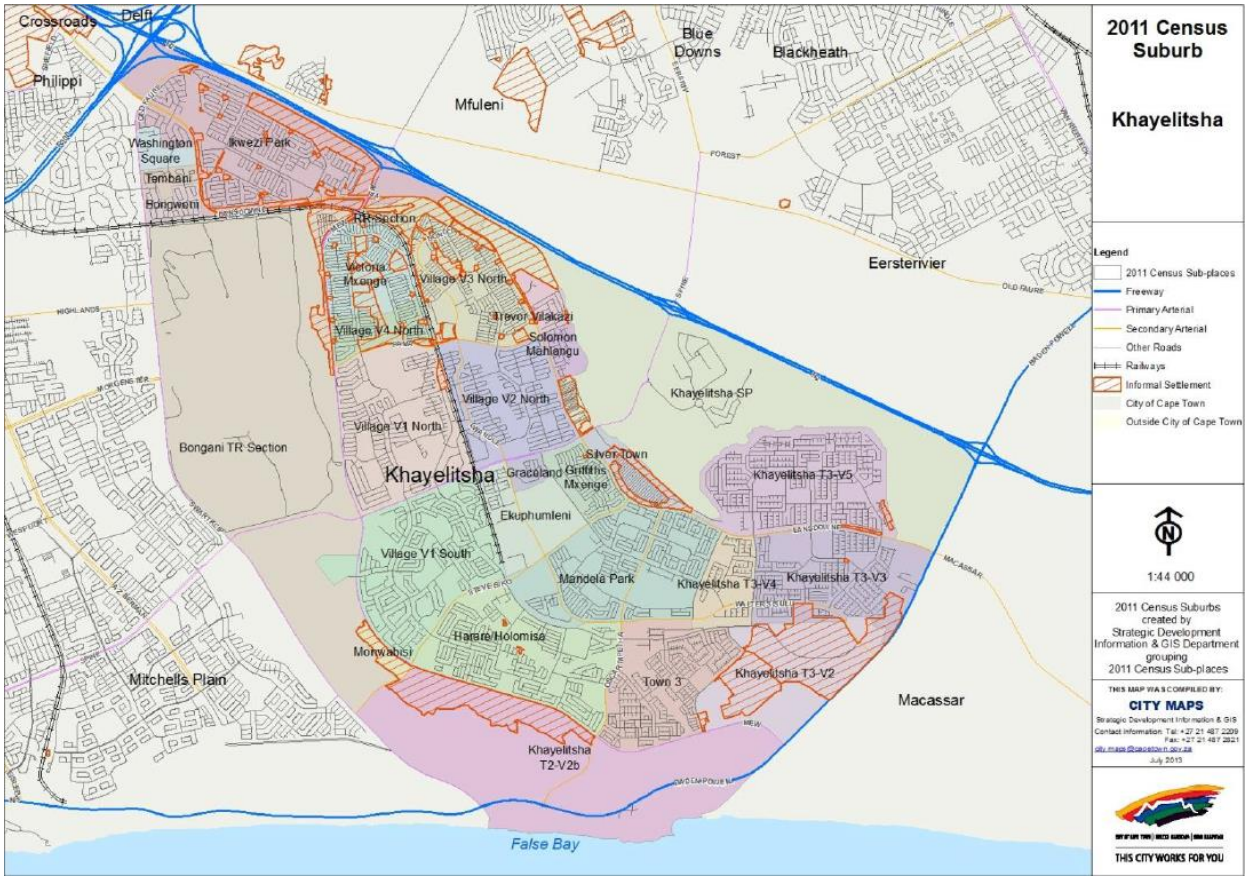
- In many areas the houses are so densely built that it is not possible to lay sewerage lines and install full-flush toilets – which means portable flush toilets are the only practical option. To solve the sanitation problem requires these areas to be "blocked-out" or the households moved to new formalised areas.
- In certain areas, households are built on private land or in areas that experience flooding. These factors would increase the unit costs of building the full-flush toilets and the ablution blocks. The extent of the cost increase could be substantial, depending on the conditions relating to a particular site. However, these areas are also relatively confined, and there may be options to work around these constraints in most instances – by selecting sites for, say, ablution blocks carefully.

5 Sanitation rollout scenarios

Khayelitsha is a township in the CoCT, situated around 30 to 35 kilometres from the Central Business District, made up of both formal and informal areas. The original Khayelitsha development plan intended the area to be made up of four towns that would each consist of four villages, with around 1 500 people in each village. In total, the area was supposed to span 1 070 hectares with approximately 24 000 residents (Affordable Land and Housing Data Centre, 2016).

According to the most recent census data, in 2011 Khayelitsha consisted of a minimum of 26 separate sub places spread over an approximate area of 352 hectares. Sub places are named locations determined by Statistics South Africa, and generally correspond to suburbs, villages, or localities. They are mostly aligned with the pockets included in the Sanitation Provision Model. Within these sub places were 118 809 households and 391 749 residents. Overall, the population of Khayelitsha grew 19.1 percent between the 2001 and 2011 Census.

Figure 18: Map of Khayelitsha as at the 2011 Census



Source: City of Cape Town, 2013a.

At the time of the 2011 Census, Khayelitsha included the following sub-places:

- Bongani TR Section
- Bongweni
- Ekuphumleni
- Graceland
- Griffiths Mxenge
- Harare/Holomisa
- Ikwezi Park
- Khayelitsha SP
- Khayelitsha T2- V2b
- Khayelitsha T3-V2
- Khayelitsha T3-V3
- Khayelitsha T3-V4
- Khayelitsha T3-V5
- Mandela Park
- Monwabisi
- RR Section
- Silver Town
- Solomon Mahlangu
- Tembani
- Town 3
- Trevor Vilakazi
- Victoria Mxenge
- Village V1 North
- Village V1 South
- Village V2 North
- Village V3 North
- Village V4 North
- Washington Square

Khayelitsha is the second largest township in South Africa after Soweto, and has the largest concentration of informal settlements in the CoCT. At the time of the 2011 Census 55.4 percent of households were classified as informal dwellings. While many of these informal settlements are located on land that the CoCT has zoned as unsuitable for housing due to flooding, the pressures of rural-urban migration and population growth have caused shack numbers to grow by around 10 000 every year according to the census. The majority of these shacks can be found in the newer sections of Khayelitsha. As many of these newer sections had not been formally planned, many are not provided with sufficient basic services.

This report uses four specific sub-areas in Khayelitsha as case study areas. Each of these areas represents a different combination of characteristics and constraints common to the areas in Khayelitsha. In each of these four areas the costing model is used to plan for and cost different scenarios for the roll out of improved sanitation services.

5.1 Case study areas and scenario overview

Table 6 provides a summary of the key characteristics in four scenario areas within Khayelitsha:

- Enkanini (ENK);
- CT Section (CT);
- RR Section (RR); and
- TR Section (TR).

The areas were selected because of their varied characteristics. The aim was to test the Sanitation Costing Model under a range of varying circumstances. The data on each area is drawn from the 2011 Census, the Provision Matrix, and the Constraints Matrix. As shown, the areas differ in terms of their age, population, level of formalisation, existing levels of service provision, and constraint factors.

Table 6: Summary statistics of case study areas

Pocket	Age (years)	Households (HH)	HH density (HH / Ha)	Formalised areas as a % of total	Access to flush toilets	Privately owned land (m^2)	Land in a flood plain as a % of total
Enkanini	5-10	9 468	98	81.2%	94.6%	N/A	N/A
CT Section	20	6 035	180	47.8%	70.9%	N/A	7.5%
RR Section	20 +	9 573	176	13.0%	46.8%	26 888	3%
TR Section	15-20	9 333	181	33.1%	59.3%	97 123	6.0%

While the CoCT often cites household density as one of the key constraints to service provision, the assumed maximum density of 460 households per hectare is not a constraint in any of these four areas. This maximum density was set based on the highest observed population densities in Khayelitsha after controlling for outliers. This means that household relocation is not required in any of the scenarios. According to population growth statistics for these areas however, the maximum of 460 households per hectare will become a constraint after 2020 if government does not implement necessary upgrading plans.

5.2 Parameters used to develop the scenarios

The Water Services Department of the CoCT has an obligation to ensure that all citizens in the city, irrespective of their ability to pay, have access to at least the minimum prescribed level of sanitation services. This minimum level currently prescribed is laid out in the White Paper on Basic Household

Sanitation (2001), which stipulates a waterborne-sanitation solution to household ratio of 1:5 and provision of a service point within a 100-meter radius of all dwellings.

- Based on this minimum prescribed sanitation service level, one of the scenarios modelled for each of the areas provides for this 1:5 ratio. 1:3 and 1:1 ratios are also included as more progressive scenarios.
- Two time periods are used for the modelled scenarios: a two-year and a five-year time period. The five-year scenario is in line with the timeframe of the Integrated Development Plan. The two-year scenario shows the costs if more immediate intervention measures can be adopted. While more formalised pockets are potentially able to transition to a fully waterborne solution in two years, other less formalised pockets will require the longer time horizon to realise this goal.
- The modelled scenarios all target a 50 percent improvement in access to flush toilets from the baseline scenario, over a two and five-year time period. This measured approach develops the scenarios based on an incremental improvement in access to full-flush toilets over the mentioned time periods.
- Based on household density and the prevalence of relevant constraints in the four selected areas, the scenarios assume that authorities are able to build around constraint factors and install toilets without having to move households.

All of the scenarios adhere to the breakdown of sanitation technologies outlined in Table 7 below.

Table 7: Summary of scenarios

Ratio of individual full-flush toilets to ablution facilities	*75:25*
Ratio of fixed ablution blocks to ablution containers	*50:50*
Split between chemical and portable toilets	*50:50*

In terms of full-flush options, three are used in the modelled scenarios: individual full-flush, fixed ablution facilitates and ablution containers. Between individual full-flush and ablution facilities the majority of flush toilets (75 percent) are individual units, as seen in row one of Table 7. This is based on the fact that individual full-flush toilets can be placed closer than ablution facilities to the majority of serviced households and the fact that they are the cheaper option. In other words individual full-flush is preferable both in terms of affordability and given the safety concerns of walking to toilets at night. This is reflected in the scenarios modelled. The individual units could either be arranged in banks or distributed more widely amongst the community, e.g., along access roads or on individual stands.

With regards to ablution block options, the second row of Table 7 shows that in the scenarios ablution facilities will be equally mixed between fixed structures and containers. Although fixed ablution blocks are slightly more expensive than containers, there is merit in the permanency and longevity of the fixed structures. Therefore an equal mix was chosen of fixed and container ablution blocks.

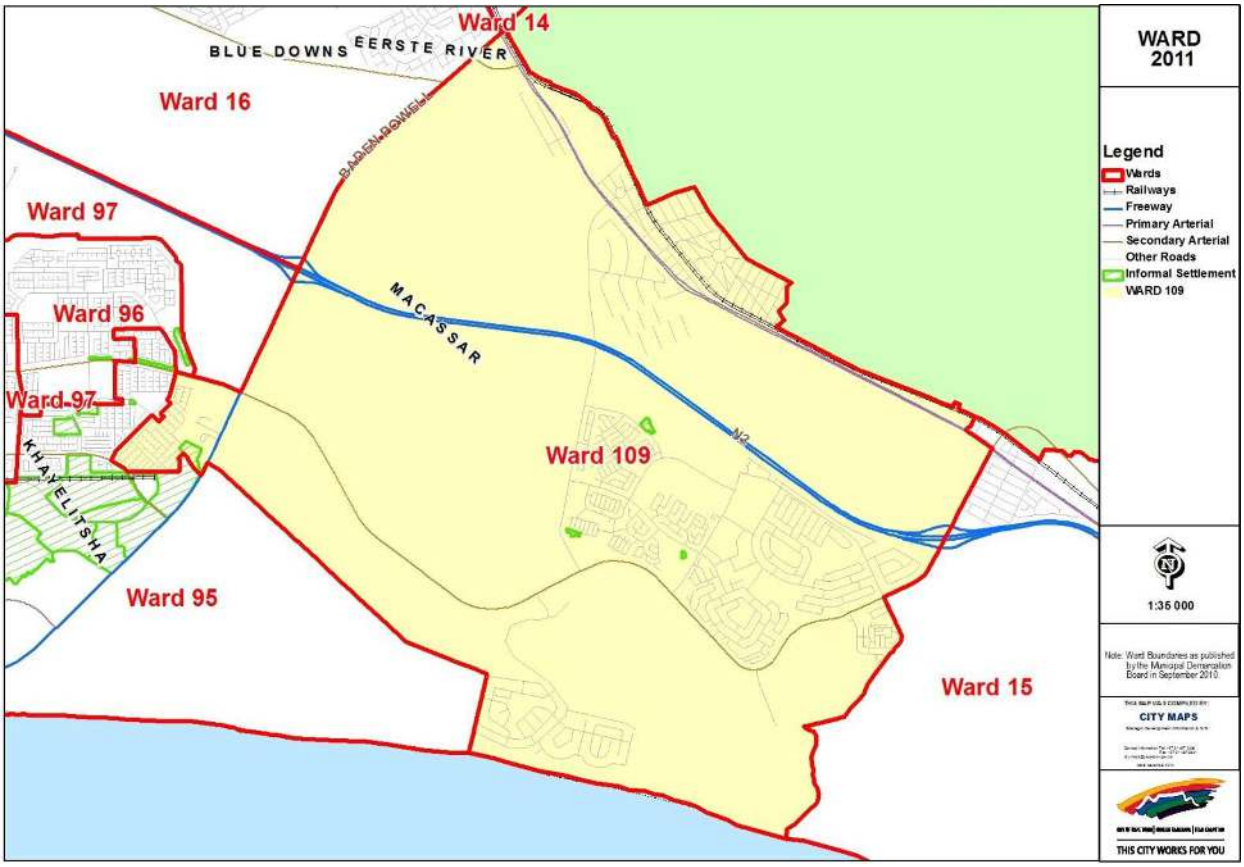
For all temporary non-flush toilets, row 3 of Table 7 shows that an equal split between chemical and portable flush toilets has been used.

These are the ratios that have been used for modelling scenarios in the four selected case study areas. However, when using the costing model to develop other scenarios, all of these variables can be changed in line with the users expressed preferences.

5.3 Enkanini scenarios – Ward 109

Ward 109 or Enkanini, which is depicted in Figure 19, includes the areas of Faure, Croyden, Kelderhof, Kramat, Macassar, Makhasa, Umrhabulo Triangle, and Sandvlei. As shown in Table 6, the Enkanini area is between five and ten years old. Household density is relatively low in this area at 98 households per hectare, which is largely due to the fact that 81.2 percent of the Enkanini area is formalised. Neither privately owned land nor flood plains are constraints in this area which means that there are no specific constraints included in the modelled scenarios for this area. Based on the 50 percent improvement in access to full-flush toilets, and the relatively high level of existing access to full-flush toilets in this area, the model is set so that 97.3 percent of all new toilets will be full-flush units after the implementation of rollout modelled in the scenario.

Figure 19: Map of Enkanini, Ward 109



Source: City of Cape Town, 2013b

Table 8 describes the different scenarios run for Enkanini. It shows that in terms of number of toilets to households, there is a 1:5, 1:3 and 1:1 scenario for both the two year and five-year time periods.

Table 8: Summary of Enkanini scenarios

Scenario	Toilet:HH Ratio	Rollout period	Full-flush penetration	M^2 of private land to be purchased	Percentage of toilets in flood plain
ENK 1	1:5	2 years	97.3%	N/A	N/A
ENK 2	1:3	2 years	97.3%	N/A	N/A
ENK 3	1:1	2 years	97.3%	N/A	N/A
ENK 4	1:5	5 years	97.3%	N/A	N/A
ENK 5	1:3	5 years	97.3%	N/A	N/A
ENK 6	1:1	5 years	97.3%	N/A	N/A

Annexure 3 presents detailed result tables for each of these scenarios. In Table 9, ENK 1, ENK 2 and ENK 3 show the technology combination for toilet to HH ratios of 1:5, 1:3 and 1:1 respectively for the two-year rollout scenario. In Table 10, ENK 4, ENK 5 and ENK 6 show the technology combination for toilet to HH ratios of 1:5, 1:3 and 1:1 respectively for the two-year rollout scenario. The column titled "2015 existing units" shows the number of existing units in this area in 2015. The subsequent year's show how the total number of units for each of the sanitation technologies will increase or decrease as the rollout of toilets progresses in line with the chosen scenario and in response to normal population growth.

It is important to be aware of three things when looking at these tables. These three things will help explain what at first glance might look like anomalies. The first is that each ablution unit includes nine individual toilets. In other words, in the outer years in the tables the total number of units might decrease, but the number of ablution facilities increases which means the number of individual toilets are more than the number of units.

Second, the total number of units tends to drop in line with the replacement of portable flush toilets. The reason for this is that full-flush toilets, which are replacing the portable flush toilets, service five households and three households respectively in the 1:5 and 1:3 scenarios whereas portable flush toilets, by their nature, can only be used for one household.

Third, it should also be noted that for the two-year rollout period, the provision of sanitation units will continue after the two years to ensure that the preferred household ratio (1:5, 1:3 and 1;1) and the targeted full-flush penetration rate remain constant as the population continues to grow. For that reason, units and cost estimates are provided for 2018, 2019 and 2020 for the two-year rollout periods.

Table 9: Total toilet units for two-year rollout period

		2015 existing units	2016	2017	2018	2019	2020
ENK 1 (1:5 HH Ratio)	**Total number of units:**	**4 782**	**4 673**	**4 612**	**1 271**	**2 702**	**3 190**
	Chemical toilets	578	578	579	8	33	42
	Portable flush toilets	3 109	3 109	3 113	41	165	209
	Individual full-flush toilets	1 095	986	918	1 206	2 438	2 853
	Fixed ablution blocks	0	0	1	8	33	43
	Ablution containers	0	0	1	8	33	43
ENK 2 (1:3 HH Ratio)	**Total number of units:**	**4 782**	**4 673**	**5 496**	**2 371**	**4 363**	**5 106**
	Chemical toilets	578	578	594	27	62	61
	Portable flush toilets	3 109	3 109	3 156	81	186	185
	Individual full-flush toilets	1 095	986	1 714	2 209	3 991	4 706
	Fixed ablution blocks	0	0	16	27	62	77
	Ablution containers	0	0	16	27	62	77
ENK 3 (1:1 HH Ratio)	**Total number of units:**	**4 782**	**8 841**	**10 241**	**8 230**	**11 247**	**15 033**
	Chemical toilets	578	891	917	370	143	185
	Portable flush toilets	3 109	4 661	4 687	1 609	143	185
	Individual full-flush toilets	1 095	3 225	4 521	6 073	10 611	14 177
	Fixed ablution blocks	0	32	58	89	175	243
	Ablution containers	0	32	58	89	175	243

Table 10: Total toilet units for five-year rollout period

		2015 existing units	2016	2017	2018	2019	2020
ENK 4 (1:5 HH Ratio)	**Total number of units:**	**4 782**	**4 673**	**4 718**	**2 054**	**4 519**	**4 783**
	Chemical toilets	578	578	587	67	174	173
	Portable flush toilets	3 109	3 109	3 222	839	2 077	2 004
	Individual full-flush toilets	1 095	986	909	1 140	2 222	2 544
	Fixed ablution blocks	0	0	0	4	23	31
	Ablution containers	0	0	0	4	23	31
ENK 5 (1:3 HH Ratio)	**Total number of units:**	**4 782**	**4 673**	**6 701**	**3 902**	**6 724**	**5 915**
	Chemical toilets	578	578	730	213	347	209
	Portable flush toilets	3 109	3 109	4 472	1 894	2 961	1 639
	Individual full-flush toilets	1 095	986	1 487	1 773	3 340	3 963
	Fixed ablution blocks	0	0	6	11	38	52
	Ablution containers	0	0	6	11	38	52
ENK 6 (1:1 HH Ratio)	**Total number of units:**	**4 782**	**9 142**	**10 792**	**8 983**	**11 230**	**14 970**
	Chemical toilets	578	1 041	1 191	741	500	432
	Portable flush toilets	3 109	5 554	6 317	3 821	2 273	1 592
	Individual full-flush toilets	1 095	2 521	3 238	4 337	8 235	12 560
	Fixed ablution blocks	0	13	23	42	111	193
	Ablution containers	0	13	23	42	111	193

With reference to the above two tables, the following is worth noting:

- Because the current full-flush toilet to household ratio is already less than 1:5, the number of toilets decreases in the 1:5 scenario. This means that for this area the CoCT can reasonably be looking at progressively increasing the full-flush to household ratio further in this area. The White Paper on Basic Household Sanitation (2001) specifies that the 1:5 ratio is the minimum service level therefore the CoCT should be striving to reach better services levels, as seen in Enkanini. However, this is the only one of the four areas that is currently experiencing sanitation service provision at a ratio of one toilet to five households.
- For the two-year rollout period, the existing portable flush toilets and chemical toilets will fall away in 2018 to be replaced almost exclusively by full-flush toilets. This illustrates that using a 1:5 ratio the CoCT can reasonably achieve close to full coverage of full-flush toilets in this area over a two-year period.
- For the five-year rollout period, it becomes even less onerous for the CoCT to provide an improved ratio of households to toilets or almost full coverage of full-flush, as full-flush units steadily replace portable flush and chemical toilets.

The following table sets out the costs of the scenarios in Table 9 and Table 10.

Table 11: Cost of scenarios

			Cost (Rands)					
	Rollout period	Toilet:HH	2016	2017	2018	2019	2020	Total
ENK 1	2 years	1:5	30 405 242	34 106 518	24 738 576	83 566 501	56 466 936	229 283 773
ENK 2	2 years	1:3	28 622 745	70 477 082	39 887 693	116 355 717	80 119 766	335 463 003
ENK 3	2 years	1:1	122 346 019	116 508 868	116 021 411	270 031 900	266 717 856	891 626 054
ENK 4	5 years	1:5	30 405 242	33 214 788	24 228 860	83 124 209	60 646 140	231 619 239
ENK 5	5 years	1:3	28 622 745	61 191 402	36 873 082	115 290 935	79 222 593	321 200 757
ENK 6	5 years	1:1	91 715 527	91 386 961	98 223 851	234 577 670	299 581 949	815 485 958

With reference to cost of the scenarios shown in Table 11, the following is worth noting:

- It would cost the CoCT less to transition to better full-flush penetration over two years, with 1:5 ratio, than it would over five years. This is in terms of total cost over the same

time period. This indicates that for Enkanini full-flush toilets should be prioritised over the short terms as this is linked with a cost saving in this scenario.

- Costs would grow significantly in 2017 and 2019 if the CoCT targeted a 1:3 toilet to household ratio. This is true for both the two and five year scenarios and suggests that, from a costing perspective, the 1:3 scenarios wouldn't be the best choice for improving sanitation provision in this area over a two or five-year time period.

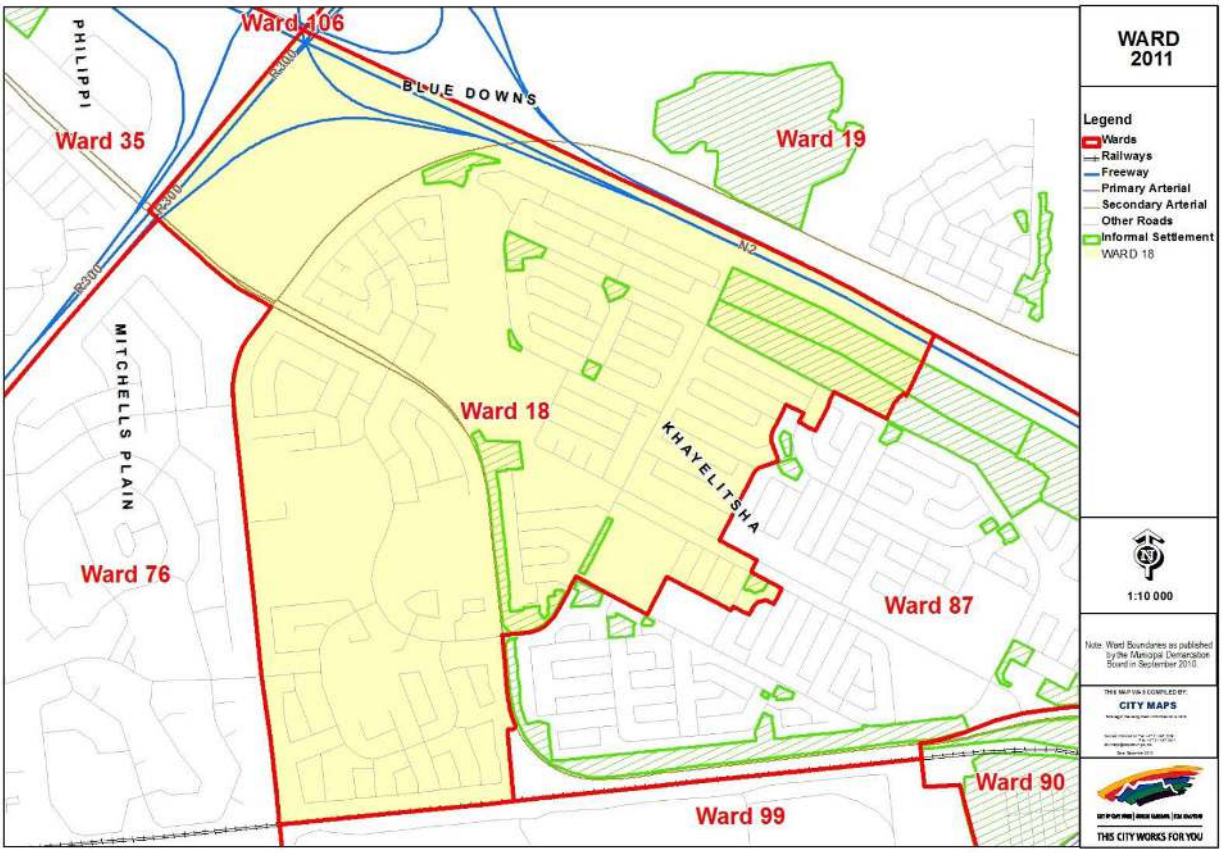
The costs spike in 2019 as the CoCT will be required to replace a large number of portable flush and chemical toilets with full-flush solutions in this year.

5.4 CT Section scenarios – Ward 18

CT Section is part of Ward 18, which includes the areas of Mxolisi Phetani and Thembokwezi. The area is mapped in Figure 20. As shown in Table 6, CT section is approximately 20 years old. Household density is 180 households per hectare, which is significantly below the stipulated maximum density of 460 households per hectare, and 47.8 percent of CT section is formalised. A small portion (7.5 percent of the total land area) of CT section is in a flood plain, which presents a constraint for building full-flush toilets in that area.

Based on the 50 percent improvement in the coverage of full-flush toilets, and the relatively high level of access to full-flush in this area, the model is set so that 85.5 percent of all toilets will be full-flush units.

Figure 20: Map of CT Section



Source: City of Cape Town, 2013d.

Table 12 describes the different scenarios run for CT Section. The costing scenario presented for CT section provides for two costed options. The first works on the assumption that toilets will simply be built around the flood plain (i.e. in the other 92.5 percent of CT section), the second costs in the provision of sanitation facilities that can operate effectively in these conditions.

Table 12: Summary of CT Section scenarios

Scenario	Toilet:HH Ratio	Rollout period	Full-flush penetration	M^2 of private land to be purchased	Percent of toilets in flood plain
CT 1	1:5	2 years	85.5%	N/A	N/A
CT 1 + flood plain constraint	1:5	2 years	85.5%	N/A	7.5%

CT 2	1:3	2 years	85.5%	N/A	N/A
CT 2 + flood plain constraint	1:3	2 years	85.5%	N/A	7.5%
CT 3	1:1	2 years	85.5%	N/A	N/A
CT 3 + flood plain constraint	1:1	2 years	85.5%	N/A	7.5%
CT 4	1:5	5 years	85.5%	N/A	N/A
CT 4 + flood plain constraint	1:5	5 years	85.5%	N/A	7.5%
CT 5	1:3	5 years	85.5%	N/A	N/A
CT 5 + flood plain constraint	1:3	5 years	85.5%	N/A	7.5%
CT 6	1:1	5 years	85.5%	N/A	N/A
CT 6 + flood plain constraint	1:1	5 years	85.5%	N/A	7.5%

Annexure 4 presents detailed results tables for each of these scenarios. In Table 13, CT 1, CT 2 and CT 3 show the technology combination for toilet to HH ratios of 1:5, 1:3 and 1:1 respectively for the two-year rollout scenario. In Table 14, CT 4, CT 5 and CT 6 show the technology combination for toilet to HH ratios of 1:5, 1:3 and 1:1 respectively for the five-year rollout scenario. The column titled "2015 existing units" shows the number of existing units in this area in 2015. The subsequent year's show how the total number of units for each of the sanitation technologies will increase or decrease in each of the following years. Table 15 provides the costs for each of the scenarios.

Table 13: New toilet units for two-year rollout period

		2015 existing units	2016	2017	2018	2019	2020
CT 1 (1:5 HH Ratio)	**Total number of units:**	**601**	**2 458**	**2 536**	**2 371**	**1 492**	**2 319**
	Chemical toilets	115	282	288	193	63	115
	Portable flush toilets	334	1 590	1 621	1 386	314	573
	Individual full-flush toilets	152	576	615	774	1 085	1 583
	Fixed ablution blocks	0	5	6	9	15	24
	Ablution containers	0	5	6	9	15	24
CT 2 (1:3 HH Ratio)	**Total number of units:**	**601**	**3 100**	**3 255**	**3 216**	**2 218**	**3 471**
	Chemical toilets	115	399	412	329	100	187
	Portable flush toilets	334	1 758	1 797	1 560	301	563
	Individual full-flush toilets	152	925	1 024	1 295	1 767	2 639
	Fixed ablution blocks	0	9	11	16	25	41
	Ablution containers	0	9	11	16	25	41
CT 3 (1:1 HH Ratio)	**Total number of units:**	**601**	**5 171**	**6 047**	**6 641**	**5 978**	**9 123**
	Chemical toilets	115	783	863	843	319	536
	Portable flush toilets	334	1 926	2 006	1 767	319	536
	Individual full-flush toilets	152	2 402	3 092	3 913	5 174	7 787
	Fixed ablution blocks	0	30	43	59	83	132
	Ablution containers	0	30	43	59	83	132

Table 14: New toilet units for five-year rollout period

		2015 existing units	2016	2017	2018	2019	2020
CT 4 (1:5 HH Ratio)	**Total number of units:**	**601**	**3 052**	**3 043**	**3 148**	**1 805**	**2 834**
	Chemical toilets	115	347	348	282	109	177
	Portable flush toilets	334	2 170	2 174	2 202	759	1 101
	Individual full-flush toilets	152	531	517	656	921	1 518
	Fixed ablution blocks	0	2	2	4	8	19
	Ablution containers	0	2	2	4	8	19
CT 5 (1:3 HH Ratio)	**Total number of units:**	**601**	**3 743**	**3 824**	**4 031**	**2 425**	**3 932**
	Chemical toilets	115	504	515	473	168	278
	Portable flush toilets	334	2 415	2 473	2 491	770	1 074
	Individual full-flush toilets	152	816	828	1 053	1 459	2 512
	Fixed ablution blocks	0	4	4	7	14	34
	Ablution containers	0	4	4	7	14	34
CT 6 (1:1 HH Ratio)	**Total number of units:**	**601**	**5 460**	**6 460**	**7 154**	**5 664**	**9 160**
	Chemical toilets	115	964	1 122	1 164	508	714
	Portable flush toilets	334	2 660	3 058	3 072	1 085	1 051
	Individual full-flush toilets	152	1 812	2 246	2 866	3 981	7 185
	Fixed ablution blocks	0	12	17	26	45	105
	Ablution containers	0	12	17	26	45	105

With reference to the above two tables, the following is worth noting:

- CT Section currently provides toilets to households at a 1:8 ratio. This is below the minimum service requirement prescribed in the Basic Household Sanitation White Paper. For this reason, there are a significant number of new units added in 2016 for all of the scenarios, including the 1:5 scenario.
- Because so many new toilets are required in 2016 just to achieve the prescribed minimum service level, the numbers reflect that a relatively high number of chemical and portable flush toilets will be required as short-term solutions to address this backlog. As seen in both tables, the significant shift to predominantly full-flush access only takes place in 2019.

Table 15: Cost of scenarios

			Cost (Rands)						
	Rollout period	Toilet:HH	2016	2017	2018	2019	2020	Total	Change in cost
CT 1	2 years	1:5	29 624 803	20 675 783	25 026 814	27 665 417	45 799 979	148 792 797	
CT 1 + flood plain constraint	2 years	1:5	30 104 621	20 755 178	25 288 392	28 202 150	46 672 265	151 022 605	1.5%
CT 2	2 years	1:3	43 635 764	27 467 276	35 220 134	38 222 510	70 093 580	214 639 265	
CT 2 + flood plain constraint	2 years	1:3	44 498 066	27 630 029	35 652 829	39 026 123	71 624 642	218 431 690	1.8%
CT 3	2 years	1:1	103 735 059	68 577 085	82 266 730	94 733 962	187 631 134	536 943 971	
CT 3 + flood plain constraint	2 years	1:1	106 384 021	69 611 199	83 594 360	96 860 110	192 250 435	548 700 124	2.2%
CT 4	5 yeats	1:5	28 723 527	21 164 579	27 853 875	24 886 791	53 510 215	156 138 988	
CT 4 + flood plain constraint	5 yeats	1:5	29 051 553	21 165 239	28 055 101	25 291 124	54 564 541	158 127 558	1.3%
CT 5	5 yeats	1:3	40 003 715	26 806 367	36 867 356	34 407 215	82 183 353	220 268 006	
CT 5 + flood plain constraint	5 yeats	1:3	40 591 842	26 824 202	37 175 146	35 063 585	84 065 121	223 719 896	1.6%
CT 6	5 yeats	1:1	76 205 076	57 831 646	73 722 861	81 760 130	213 733 605	503 253 319	
CT 6 + flood plain constraint	5 yeats	1:1	77 743 872	58 346 859	74 585 315	83 532 270	219 390 711	513 599 026	2.1%

The final column of the above table indicates the percentage increase in costs if the flood plain constraint is factored into the costing.

With reference to cost of the scenarios shown in Table 15, the following is worth noting:

- As has been discussed, the cost of temporary portable solutions such as chemical and potable flush toilets are more expensive than full-flush toilets. Due to the need for so many new units in all the scenarios, from an affordability perspective it would be better to select a scenario where more full-flush toilets are rolled out sooner. The costing estimates in Table 15 shows that over a five-year period, the two-year rollout scenario is cheaper than

the five-year rollout scenario. In other words, the sooner full-flush toilets can be rolled out, the more affordable it will be for the CoCT.

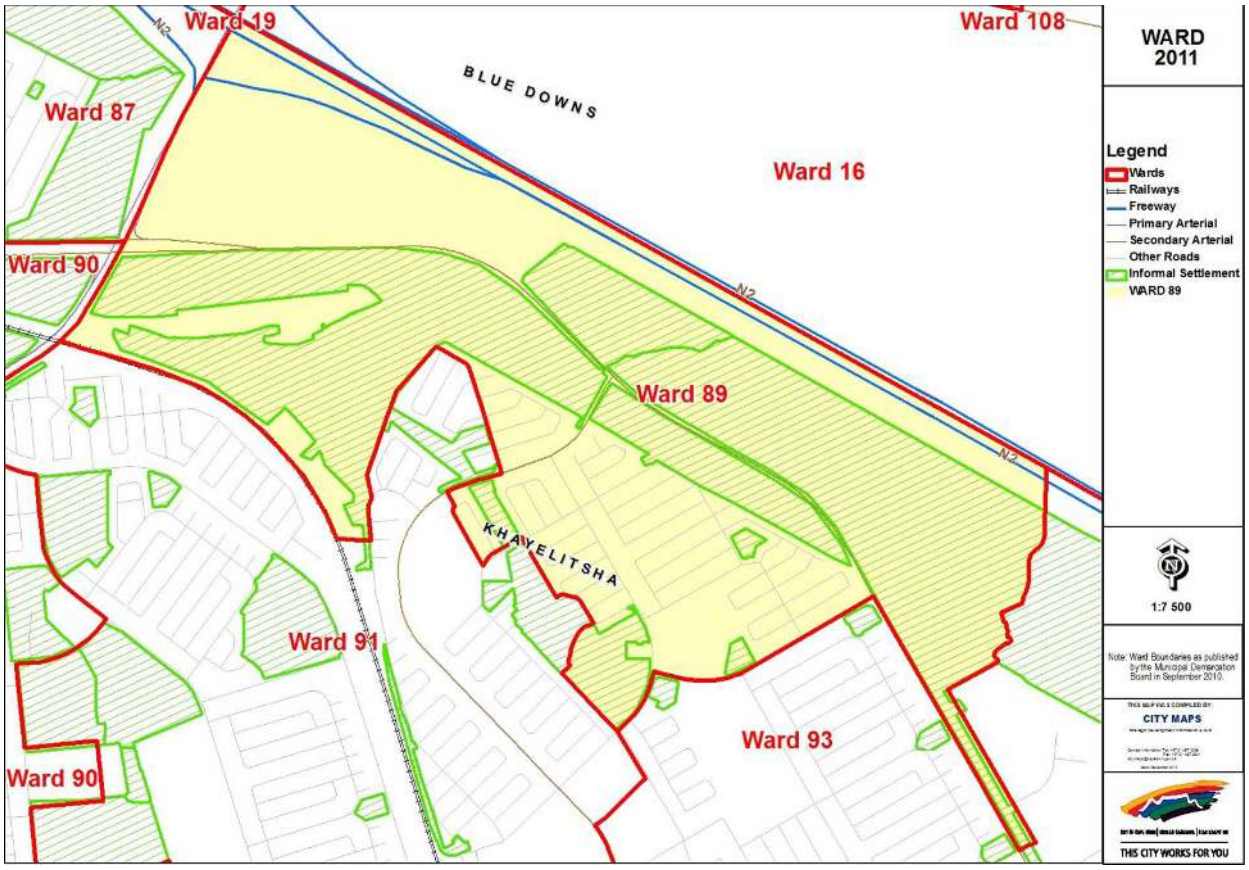
- Costs fall between 2016 and 2017. The reason for this is that a significant number of new units, and therefore comparatively high levels of spending, are required in 2016 to compensate for the current low levels of provision.
- The flood plain constraint serves to raise total costs by between 1.5 percent and 2.2 percent for the two-year rollout scenarios. And between 1.3 percent and 2.1 percent for the five-year rollout scenarios. This is a relatively small cost impact if the CoCT were to provide toilets that could operate in these conditions.
- The costs spike in 2020 as the CoCT will be required to replace a large number of portable flush and chemical toilets with full-flush solutions in this year.

5.5 RR Section scenarios – Ward 89

RR Section is part of Ward 89, which includes the areas of Barney Molokwana Corner and Nonqubela. The area is mapped in Figure 21. As shown in Table 6, RR section is more than 20 years old. Household density is 176 households per hectare, which is significantly below the stipulated maximum density of 460 households per hectare. A very small percentage of RR section is formalised (13 percent). This means that the majority of dwellings in this area are informal. RR has two constraints that impact on the provision of sanitation in the area. The first is that 26 886 m^2 (3 percent of the total land area) of the area is located on privately owned land. The second, and less significant constraint, is that a very small portion of RR is in a flood plain (3 percent). The costing scenario presented for RR section provides for costing options where addressing these constraints are costed, and it also provides for costed scenarios where these constraints are not costed. The latter operates on the assumption that the CoCT will provide toilets around these constrained areas rather than in them.

Based on the 50 percent improvement in the coverage of full-flush toilets, the model is set so that 73.4 percent of all new toilets will be full-flush units.

Figure 21: Map of RR Section



Source: CoCT of Cape Town, 2013c.

Table 16 describes the different scenarios run for RR Section. This table illustrates, as described above, that for each of the costed scenarios an option is provided where purchasing of private land and the provision of toilets in a flood plain is factored in.

Table 16: Summary of RR Section scenarios

Scenario	Toilet:HH Ratio	Rollout period	Full-flush penetration	M^2 of private land to be purchased	Percentage of toilets in flood plain
RR 1	1:5	2 years	73.4%	N/A	N/A
RR 1+ private land constraint	1:5	2 years	73.4%	26 888	N/A
RR 1 + flood plain constraint	1:5	2 years	73.4%	N/A	3 %
RR 2	1:3	2 years	73.4%	N/A	N/A
RR 2 + private land constraint	1:3	2 years	73.4%	26 888	N/A
RR 2 + flood plain constraint	1:3	2 years	73.4%	N/A	3%
RR 3	1:1	2 years	73.4%	N/A	N/A
RR 3 + private land constraint	1:1	2 years	73.4%	26 888	N/A
RR 3 + flood plain constraint	1:1	2 years	73.4%	N/A	3%
RR 4	1:5	5 years	73.4%	N/A	N/A
RR 4 + private land constraint	1:5	5 years	73.4%	26 888	N/A
RR 4 + flood plain constraint	1:5	5 years	73.4%	N/A	3%
RR 5	1:3	5 years	73.4%	N/A	N/A
RR 5 + private land constraint	1:3	5 years	73.4%	26 888	N/A
RR 5 + flood plain constraint	1:3	5 years	73.4%	N/A	3%
RR 6	1:1	5 years	73.4%	N/A	N/A
RR 6 + private land constraint	1:1	5 years	73.4%	26 888	N/A
RR 6 + flood plain constraint	1:1	5 years	73.4%	N/A	3%

Annexure 5 presents detailed result tables for each of these scenarios. In Table 17, RR 1, RR 2 and RR 3 show the technology combination for toilet to HH ratios of 1:5, 1:3 and 1:1 respectively for the two-year rollout scenario. In Table 18, RR 4, RR 5 and RR 6 show the technology combination for toilet to HH ratios of 1:5, 1:3 and 1:1 respectively for the five-year rollout scenario. The column titled "2015 existing units" shows the number of existing units in this area in 2015. The subsequent year's show how the total number of units for each of the sanitation technologies will increase or decrease in each of the following years.

Table 17: New toilet units for two-year rollout period

		2015 existing units	2016	2017	2018	2019	2020
RR 1 (1:5 HH Ratio)	**Total number of units:**	**998**	**1 493**	**1 651**	**1 215**	**1 422**	**1 801**
	Chemical toilets	120	157	175	83	109	141
	Portable flush toilets	571	941	1 033	601	544	704
	Individual full-flush toilets	307	393	439	523	751	930
	Fixed ablution blocks	0	1	2	4	9	13
	Ablution containers	0	1	2	4	9	13
RR 2 (1:3 HH Ratio)	**Total number of units:**	**998**	**2 080**	**2 260**	**1 884**	**1 832**	**2 541**
	Chemical toilets	120	224	249	171	158	234
	Portable flush toilets	571	1 242	1 318	872	474	702
	Individual full-flush toilets	307	608	683	825	1 170	1 559
	Fixed ablution blocks	0	3	5	8	15	23
	Ablution containers	0	3	5	8	15	23
RR 3 (1:1 HH Ratio)	**Total number of units:**	**998**	**3 498**	**4 096**	**4 109**	**4 211**	**6 121**
	Chemical toilets	120	469	569	566	448	688
	Portable flush toilets	571	1 543	1 643	1 189	448	688
	Individual full-flush toilets	307	1 458	1 840	2 292	3 217	4 595
	Fixed ablution blocks	0	14	22	31	49	75
	Ablution containers	0	14	22	31	49	75

Table 18: New toilet units for five-year rollout period

		2015 existing units	2016	2017	2018	2019	2020
RR 4 (1:5 HH Ratio)	**Total number of units:**	**998**	**1 636**	**1 937**	**1 633**	**1 863**	**2 088**
	Chemical toilets	120	163	186	97	121	148
	Portable flush toilets	571	1 079	1 319	1 031	1 014	1 026
	Individual full-flush toilets	307	394	432	503	718	896
	Fixed ablution blocks	0	0	0	1	5	9
	Ablution containers	0	0	0	1	5	9
RR 5 (1:3 HH Ratio)	**Total number of units:**	**998**	**2 327**	**2 565**	**2 308**	**2 121**	**2 809**
	Chemical toilets	120	235	259	184	163	249
	Portable flush toilets	571	1 492	1 661	1 355	862	1 023
	Individual full-flush toilets	307	598	641	761	1 078	1 503
	Fixed ablution blocks	0	1	2	4	9	17
	Ablution containers	0	1	2	4	9	17
RR 6 (1:1 HH Ratio)	**Total number of units:**	**998**	**3 634**	**4 297**	**4 372**	**4 186**	**6 212**
	Chemical toilets	120	458	551	544	434	729
	Portable flush toilets	571	1 906	2 200	1 902	953	1 047
	Individual full-flush toilets	307	1 258	1 528	1 898	2 743	4 320
	Fixed ablution blocks	0	6	9	14	28	58
	Ablution containers	0	6	9	14	28	58

With reference to the above two tables, the following is worth noting:

- Because only 13 percent of RR is formalised and the current penetration of full-flush toilets is relatively low, portable flush and chemical toilets remain a prominent feature of the rollout strategy throughout the forecast period.
- The low penetration of full-flush toilets means that the number of portable flush and chemical toilets in fact needs to grow year-on-year. This means that to achieve improved full-flush toilet provision in this area the CoCT would need to be a lot more aggressive with their roll out of full-flush units, than is reflected in these scenarios. When considering both costing and social factors for RR section a more aggressive approach to rolling out full-flush toilets would be preferable to the scenarios listed above.

Table 19: Cost of scenarios

			Cost (Rands)						
	Rollout period	Toilet:HH	2016	2017	2018	2019	2020	Total	Change in cost
RR 1	2 years	1:5	12 593 691	13 929 678	13 409 584	23 871 238	26 832 822	90 637 014	
RR 1 + private land constraint	2 years	1:5	12 957 601	14 568 263	14 495 372	26 001 925	29 929 128	97 952 289	8.1%
RR 1 + flood plain constraint	2 years	1:5	12 640 878	13 968 501	13 481 181	24 052 227	26 986 885	91 129 672	0.5%
RR 2	2 years	1:3	21 429 427	19 152 933	19 967 356	30 891 484	41 956 068	133 397 268	
RR 2 + private land constraint	2 years	1:3	22 051 967	20 025 630	21 262 853	33 120 235	45 330 037	141 790 722	6.3%
RR 2 + flood plain constraint	2 years	1:3	21 566 092	19 217 746	20 074 896	31 148 979	42 264 520	134 272 234	0.7%
RR 3	2 years	1:1	55 877 886	43 509 961	48 957 531	72 247 007	113 593 551	334 185 936	
RR 3 + private land constraint	2 years	1:1	56 635 779	44 597 494	50 462 909	74 582 742	117 223 944	343 502 868	2.8%
RR 3 + flood plain constraint	2 years	1:1	56 421 038	43 767 032	49 269 732	72 905 805	114 611 062	336 974 669	0.8%
RR 4	5 years	1:5	12 072 831	13 806 089	13 719 175	24 038 875	27 597 429	91 234 399	
RR 4 + private land constraint	5 years	1:5	12 437 875	14 416 022	14 727 205	26 043 256	30 565 682	98 190 040	7.6%
RR 4 + flood plain constraint	5 years	1:5	12 103 225	13 824 655	13 767 852	24 195 569	27 751 168	91 642 468	0.4%
RR 5	5 years	1:3	20 004 120	18 547 976	20 023 283	28 122 494	43 068 692	129 766 564	
RR 5 + private land constraint	5 years	1:3	20 614 034	19 344 140	21 195 061	30 167 225	46 355 463	137 675 924	6.1%
RR 5 + flood plain constraint	5 years	1:3	20 104 109	18 585 980	20 105 298	28 330 785	43 388 851	130 515 023	0.6%
RR 6	5 years	1:1	43 270 485	34 709 484	41 058 662	61 617 095	121 056 320	301 712 045	
RR 6 + private land constraint	5 years	1:1	43 926 410	35 618 805	42 327 277	63 672 311	124 623 609	310 168 413	2.8%
RR 6 + flood plain constraint	5 years	1:1	43 625 722	34 845 611	41 270 502	62 170 124	122 224 642	304 136 602	0.8%

With reference to cost of the scenarios shown in Table 19, the following is worth noting:

- The private land constraint has a significant effect on costs, and serves to raise total costs by between 2.8 percent and 8.1 percent for the two-year rollout scenarios, and between

0.8 percent and 7.6 percent for the five-year rollout scenarios. The change in cost is higher for the higher toilet to household ratios, as it is measured as a percentage change in total cost. If possible it would be advisable to plan sanitation provision for RR in a way that aims to build around the private land constraint in this area. Doing so could save the CoCT approximately R7 million, which may more than offset the cost to relocate households and build elsewhere in the area.

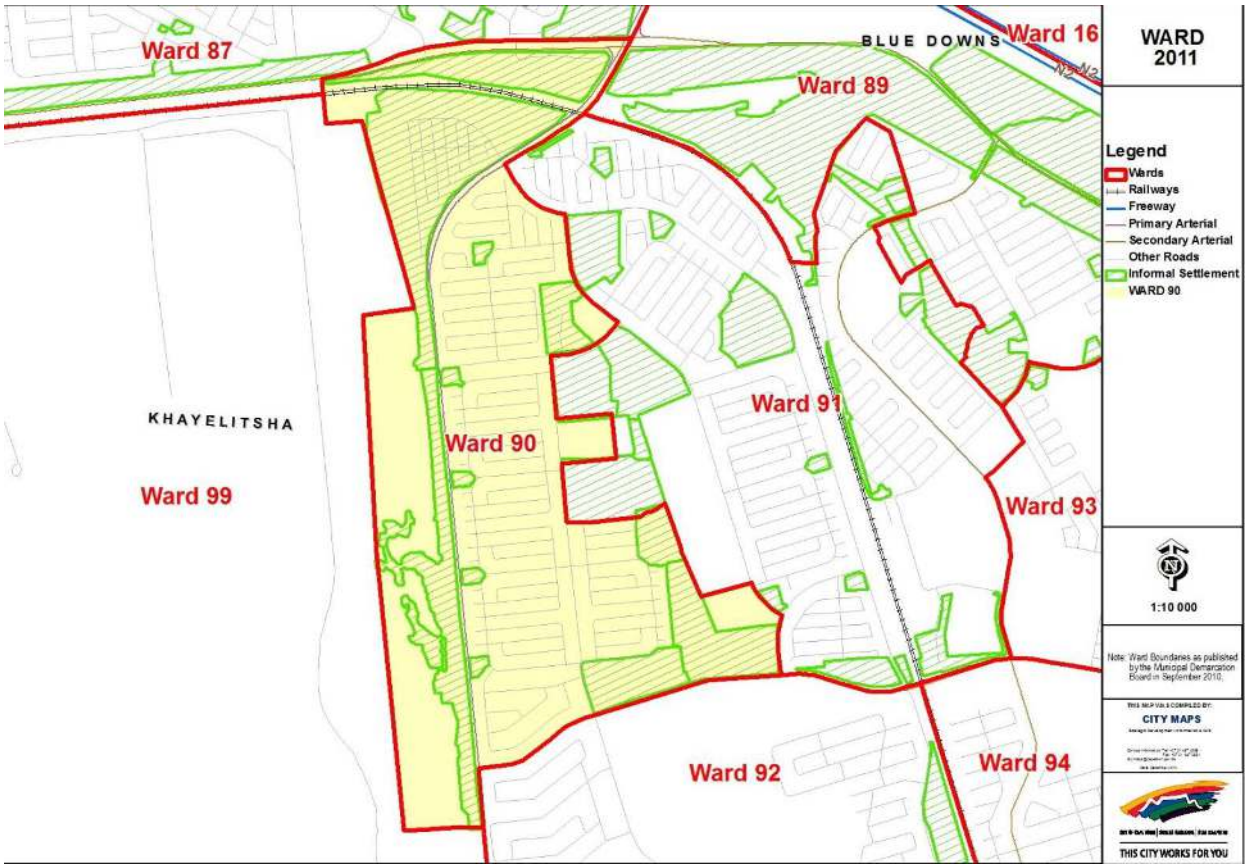
- The flood plain constraint has only a marginal effect on cost.
- The costs spike in 2019 as the CoCT will be required to replace a large number of portable flush and chemical toilets with full-flush solutions in this year.

5.6 TR Section scenarios

TR Section is part of Ward 90, which includes Bongani and Victoria Mxenge. The area is mapped in Figure 22. As shown in Table 6, TR section is between 15 and 20 years old. Household density is 182 households per hectare, which is very similar to CT section and is significantly below the stipulated maximum density of 460 households per hectare. 33.1 percent of TR section is formalised. Similarly to RR, TR has two constraints that impact on the provision of sanitation in the area. The first is that 97 123 m^2 of the area (6 percent of total land area) is located on privately owned land. The second is that a small portion of RR is in a flood plain (6 percent). The costing scenario presented for TR section provides for costing options where addressing these constraints are costed, and it also provides for costed scenarios where these constraints are not costed. The latter operates on the assumption that the CoCT will provide toilets around these constrained areas rather than in them.

Based on the 50 percent improvement in the coverage of full-flush toilets, the model is set so that 79.7 percent of all new toilets will be full-flush units.

Figure 22: Map of TR Section



Source: City of Cape Town, 2013e.

Table 20 describes the different scenarios run for TR Section. This table illustrates, as described above, that for each of the costed scenarios an option is provided where purchasing of private land and the provision of toilets in a flood plain is factored in.

Table 20: Summary of TR Section scenarios

Scenario	Toilet:HH Ratio	Rollout period	Full-flush penetration	M^2 of private land to be purchased	Percentage of toilets in flood plain
TR 1	1:5	2 years	79,7%	N/A	N/A
TR 1 + private land constraint	1:5	2 years	79,7%	97 123	N/A
TR 1 + flood plain constraint	1:5	2 years	79,7%	N/A	6.0%
TR 2	1:3	2 years	79,7%	N/A	N/A
TR 2 + private land constraint	1:3	2 years	79,7%	97 123	N/A
TR 2 + flood plain constraint	1:3	2 years	79,7%	N/A	6.0%
TR 3	1:1	2 years	79,7%	N/A	N/A
TR 3 + private land constraint	1:1	2 years	79,7%	97 123	N/A
TR 3 + flood plain constraint	1:1	2 years	79,7%	N/A	6.0%
TR 4	1:5	5 years	79,7%	N/A	N/A
TR 4 + private land constraint	1:5	5 years	79,7%	97 123	N/A
TR 4 + flood plain constraint	1:5	5 years	79,7%	N/A	6.0%
TR 5	1:3	5 years	79,7%	N/A	N/A
TR 5 + private land constraint	1:3	5 years	79,7%	97 123	N/A
TR 5 + flood plain constraint	1:3	5 years	79,7%	N/A	6.0%
TR 6	1:1	5 years	79,7%	N/A	N/A
TR 6 + private land constraint	1:1	5 years	79,7%	97 123	N/A
TR 6 + flood plain constraint	1:1	5 years	79,7%	N/A	6.0%

Annexure 6 presents detailed result tables for each of these scenarios. In Table 21, TR 1, TR 2 and TR 3 show the technology combination for toilet to HH ratios of 1:5, 1:3 and 1:1 respectively for the two-year rollout scenario. In Table 22, TR 4, TR 5 and TR 6 show the technology combination for toilet to HH ratios of 1:5, 1:3 and 1:1 respectively for the five-year rollout scenario. The column titled "2015 existing units" shows the number of existing units in this area in 2015. The subsequent year's show how the total number of units for each of the sanitation technologies will increase or decrease in each of the following years.

Table 21: New toilet units for two-year rollout period

		2015 existing units	2016	2017	2018	2019	2020
TR 1 (1:5 HH Ratio)	**Total number of units:**	**914**	**1 937**	**2 196**	**1 621**	**1 319**	**1 748**
	Chemical toilets	38	70	92	80	98	122
	Portable flush toilets	854	1 733	1 841	1 119	492	616
	Individual full-flush toilets	22	130	255	408	703	974
	Fixed ablution blocks	0	2	4	7	13	18
	Ablution containers	0	2	4	7	13	18
TR 2 (1:3 HH Ratio)	**Total number of units:**	**914**	**2 393**	**2 713**	**2 211**	**1 754**	**2 535**
	Chemical toilets	38	102	134	135	148	206
	Portable flush toilets	854	2 023	2 119	1 382	444	618
	Individual full-flush toilets	22	260	446	672	1 124	1 653
	Fixed ablution blocks	0	4	7	11	19	29
	Ablution containers	0	4	7	11	19	29
TR 3 (1:1 HH Ratio)	**Total number of units:**	**914**	**3 462**	**4 151**	**4 065**	**4 090**	**6 318**
	Chemical toilets	38	228	313	375	392	603
	Portable flush toilets	854	2 313	2 398	1 644	392	603
	Individual full-flush toilets	22	889	1 390	1 974	3 188	4 930
	Fixed ablution blocks	0	16	25	36	59	91
	Ablution containers	0	16	25	36	59	91

Table 22: New toilet units for five-year rollout period

		2015 existing units	2016	2017	2018	2019	2020
TR 4 (1:5 HH Ratio)	**Total number of units:**	**914**	**2 301**	**2 987**	**2 742**	**2 351**	**2 389**
	Chemical toilets	38	68	87	72	90	126
	Portable flush toilets	854	2 157	2 769	2 446	1 794	1 459
	Individual full-flush toilets	22	74	127	216	451	776
	Fixed ablution blocks	0	1	2	4	8	14
	Ablution containers	0	1	2	4	8	14
TR 5 (1:3 HH Ratio)	**Total number of units:**	**914**	**2 818**	**3 456**	**3 225**	**2 497**	**3 011**
	Chemical toilets	38	94	118	113	129	211
	Portable flush toilets	854	2 587	3 123	2 756	1 632	1 415
	Individual full-flush toilets	22	133	209	346	712	1 337
	Fixed ablution blocks	0	2	3	5	12	24
	Ablution containers	0	2	3	5	12	24
TR 6 (1:1 HH Ratio)	**Total number of units:**	**914**	**3 601**	**4 394**	**4 368**	**3 825**	**6 201**
	Chemical toilets	38	171	223	258	305	617
	Portable flush toilets	854	3 017	3 536	3 107	1 494	1 339
	Individual full-flush toilets	22	401	615	971	1 958	4 097
	Fixed ablution blocks	0	6	10	16	34	74
	Ablution containers	0	6	10	16	34	74

With reference to the above two tables, the following is worth noting:

- Similar to RR Section, because only 33.1 percent of TR is formalised, and the current penetration of full-flush toilets is relatively low, portable flush and chemical toilets remain a prominent feature of the rollout strategy throughout the forecast period.
- The number of portable flush toilets initially rises, but then falls as the provision of full-flush units take precedence.
- The spike in full-flush toilets in 2020 is due to the large number of portable flush toilets that are replaced in 2019 and 2020.

Table 23: Cost of scenarios

			Cost (Rands)						
	Rollout period	Toilet:HH	2016	2017	2018	2019	2020	Total	Change in cost
TR 1	2 years	1:5	15 019 872	18 319 655	18 487 780	26 272 831	30 345 979	108 446 117	
TR 1 + private land constraint	2 years	1:5	16 283 224	21 197 661	23 555 655	35 723 234	44 322 809	141 082 583	30.1%
TR 1 + flood plain constraint	2 years	1:5	15 140 710	18 456 727	18 686 400	26 684 998	30 726 109	109 694 943	1.2%
TR 2	2 years	1:3	22 004 094	23 659 272	24 730 120	34 347 068	48 058 329	152 798 883	
TR 2 + private land constraint	2 years	1:3	23 637 188	26 744 502	29 754 020	43 358 569	62 191 249	185 685 529	21.5%
TR 2 + flood plain constraint	2 years	1:3	22 255 741	23 863 559	25 006 709	34 931 061	48 809 148	154 866 218	1.4%
TR 3	2 years	1:1	52 353 529	45 727 738	53 090 244	85 236 657	131 737 797	368 145 966	
TR 3 + private land constraint	2 years	1:1	54 340 808	49 052 338	58 123 577	93 887 198	145 941 864	401 345 785	9.0%
TR 3 + flood plain constraint	2 years	1:1	53 314 751	46 308 364	53 826 918	86 862 646	134 168 614	374 481 293	1.7%
TR 4	5 years	1:5	14 580 062	19 586 077	21 565 640	27 260 714	35 937 533	118 930 027	
TR 4 + private land constraint	5 years	1:5	15 308 062	21 143 217	24 618 461	34 290 091	48 952 408	144 312 239	21.3%
TR 4 + flood plain constraint	5 years	1:5	14 639 983	19 650 121	21 691 331	27 558 649	36 393 312	119 933 395	0.8%
TR 5	5 years	1:3	19 545 091	22 706 393	25 258 846	34 669 942	55 397 056	157 577 329	
TR 5 + private land constraint	5 years	1:3	20 454 017	24 328 632	28 235 365	41 359 517	68 872 801	183 250 332	16.3%
TR 5 + flood plain constraint	5 years	1:3	19 667 425	22 782 592	25 411 424	35 163 569	56 291 619	159 316 629	1.1%
TR 6	5 years	1:1	32 896 791	34 597 586	42 093 686	70 419 739	150 038 500	330 046 302	
TR 6 + private land constraint	5 years	1:1	33 914 504	36 291 237	44 968 446	76 628 348	163 880 768	355 683 303	7.8%
TR 6 + flood plain constraint	5 years	1:1	33 284 730	34 851 649	42 517 252	71 714 428	153 052 476	335 420 535	1.6%

With reference to cost of the scenarios shown in Table 23, the following is worth noting:

- The two-year rollout scenario is cheaper than the five-year rollout scenario. This indicates that the sooner full-flush toilets can be rolled out, the more cost-effective it will be for the CoCT.

- The flood plain constraint has only a marginal effect on cost.
- The private land constraint has a significant effect on costs, and serves to raise total costs by between nine percent and 30.1 percent for the two-year rollout scenarios, and between 1.6 percent and 21.3 percent for the five-year rollout scenarios. The change in cost is higher for the higher toilet to household ratios as it is measured as a percentage change in total cost. This area is therefore associated with a sizeable risk (i.e. a potential significant increase in budget required) should the CoCT pursue fixed toilet solutions but not be able to circumvent the private land constraint.

References

Bartlett, S. (2003). "Water, sanitation and urban children: the need to go beyond "improved" provision." *Environment and Urbanization* 15(2): 57-70.

Beall, J., O. Crankshaw and S. Parnell. (2000). "Victims, Villains and Fixers: The Urban Environment and Johannesburg's Poor." *Journal of Southern African Studies* 26(4): 833-855.

Bolaane, B. and H. Ikgopoleng. (2011). "Towards improved sanitation: Constraints and opportunities in accessing waterborne sewerage in major villages of Botswana." *Habitat International* 35: 486-499.

Burra, S., S. Patel and T. Kerr. (2003). "Community-designed, built and managed toilet blocks in Indian cities." *Environment and Urbanization* 15(2): 11-32.

City of Cape Town. (2013). Integrated Development Plan 2012–2017: 2013/14 Review.

City of Cape Town. (2011). Water Services Development Plan 2011/12–2015/16.

Crous, P., J. Haarhof and C. Buckley. (2013). Can shared facilities be sustainable? Experience from communal ablution blocks in eThekwini, South Africa. *36th WEDC International Conference*. Nakuru, Kenya.

Department of Water Affairs and Forestry. (2008). Free Basic Sanitation Implementation Strategy.

Ferguson, B. (1996). "The environmental impacts and public costs of unguided informal settlement; the case of Montego Bay." *Environment and Urbanization* 8(2): 171-194.

Foppen, J.W. and F. Kansiime (2009). "SCUSA: integrated approaches and strategies to address the sanitation crisis in unsewered slum areas in African mega-cities." *Reviews in Environmental Science and Bio/Technology* 8(4): 305-311.

Govender, T., J.M. Barnes and C.H. Pieper. (2011). "Housing conditions, sanitation status and associated health risks in selected subsidized low-cost housing settlements in Cape Town, South Africa." *Habitat International* 35(2): 335-342.

Government of South Africa. (2000). Municipal Systems Act.

Government of South Africa. (1997). Water Services Act.

Government of South Africa. (1996). National Sanitation Policy White Paper.

Government of South Africa. (1996). Constitution of the Republic of South Africa.

Graham, J. and M. Polizzotto. (2012). "Pit latrines and their impacts on groundwater quality: a systematic review." *Environmental Health Perspectives*: 1-13.

Hardoy, A. and R. Schusterman (2000). "New models for the privatization of water and sanitation for the urban poor." *Environment and Urbanization* 12(2): 63-76.

Hasan, A. (2008). "Financing the sanitation programme of the Orangi Pilot Project–Research and Training Institute in Pakistan." *Environment and Urbanization* 20(1): 109-119.

Hobson, J. (2000). "Sustainable sanitation: experiences in Pune with a municipal-NGO-community partnership." *Environment and Urbanization* 12(2): 53-62.

Holden, R. (2010). "Urban sanitation technologies: is there a realistic alternative to waterborne sewage?"

Ingle, R., S. Berdau, F. Kleemann and P. Arndt. (2012). "What does it take to convince decision makers in Omaruru, Namibia to scale up urine diversion dehydration "Otji toilets"?." *4th International Dry Toilet Conference*.

Isunju, J.B., K. Schwartz, M.A. Schouten, W.P. Johnson and M.P. van Dijk. (2011). "Socio-economic aspects of improved sanitation in slums: a review." *Public Health* 125(6): 368-376.

Joshi, D., B. Fawcett and F. Mannan. (2011). “Health, hygiene and appropriate sanitation: experiences and perceptions of the urban poor.” *Environment and Urbanization* 23(1): 91-111.

Katukiza, A.Y., M. Ronteltap, A. Oleja, C.B. Niwagaba, F. Kansiime and P.N.L. Lens. (2010). “Selection of sustainable sanitation technologies for urban slums--a case of Bwaise III in Kampala, Uganda.” *Sci Total Environ* 409(1): 52-62.

Katukiza, A.Y., M. Ronteltap, C.B. Niwagaba, J.W.A. Foppen, F. Kansiime and P.N.L. Lens. (2012). “Sustainable sanitation technology options for urban slums.” *Biotechnol Adv* 30(5): 964-978.

Lagardien, A. and D. Cousins (2004). Sanitation demand and delivery in informal settlements – planning and implementation support, Water Research Commission.

Lagardien, A., C. Muanda and A. Benjamin (2012). User Acceptance and Functioning of Mobile Communal Sanitation Facilities in Informal Settlements of South Africa, Water Research Commission.

Langergraber, G. and E. Muellegger (2005). “Ecological Sanitation—a way to solve global sanitation problems?” *Environment International* 31(3): 433-444.

Letema, S., B. van Vliet and J. van Lier. (2014). “Sanitation policy and spatial planning in urban East Africa: Diverging sanitation spaces and actor arrangements in Kampala and Kisumu.” *Cities* 36: 1-9.

Lüthi, C., J. McConville and E. Kvarnström. (2010). “Community-based approaches for addressing the urban sanitation challenges.” *International Journal of Urban Sustainable Development* 1(1-2): 49-63.

Mara, D.D. (2003). “Water, sanitation and hygiene for the health of developing nations.” *Public Health* 117(6): 452-456.

McFarlane, C. (2008). “Sanitation in Mumbai's informal settlements: state, ‘slum’ and infrastructure.” *Environment and Planning* 40(1): 88-107.

Melo, J. (2005). “The Experience of Condominial Water and Sewerage Systems in Brazil: Case Studies from Brasilia, Salvador and Parauapebas.” The World Bank: Lima, Peru.

Mels, A., D. Castellano, O. Braadbaart, S. Veenstra, I. Dijkstra, B. Meulman, A. Singels and J.A. Wilsenach. (2009). “Sanitation services for the informal settlements of Cape Town, South Africa." *Desalination* 248(1-3): 330-337.

Muniz, E. (2013). “A proposed sustainable sanitation system for the Zwelitsha section of Langrug informal settlement in the Stellenbosch Municipality, South Africa.” Worcester Polytechnic Institute.

Murphy, H.M., E.A. McBean and K. Farahbakhsh. (2009). “Appropriate technology – A comprehensive approach for water and sanitation in the developing world.” *Technology in Society* 31(2): 158-167.

Nyenje, P., J. Foppen, S. Uhlenbrook, R. Kulabako and A. Muwanga. (2010). “Eutrophication and nutrient release in urban areas of sub-Saharan Africa – A review.” *Science of the Total Environment* 408: 447-455.

O’Keefe, M., U. Messmer, C. Lüthi and R. Tobias. (2015). “Slum inhabitants’ perceptions and decision-making processes related to an innovative sanitation service: evaluating the Blue Diversion Toilet in Kampala (Uganda)." *Int J Environ Health Res* 25(6): 670-684.

Pan, S.M., NN.P. Armitage and M.B. van Ryneveld. (2015). “Sustainable and equitable sanitation in informal settlements of Cape Town: a common vision?” *Water SA* 41(2): 222.

Parkinson, J., K. Tayler and O. Mark. (2007). “Planning and design of urban drainage systems in informal settlements in developing countries.” *Urban Water Journal* 4(3): 137-149.

Paterson, C., D. Mara and T. Curtis. (2007). "Pro-poor sanitation technologies." *Geoforum* 38(5): 901-907.

Pusch, D. (2005). "Quantitative detection of enteroviruses in activated sludge by cell culture and real-time RT-PCR using paramagnetic capturing." *Journal of Water and Health* 3(3): 313-324.

Richards, R., B. O'Leary and K. Mutsonziwa. (2006). "Measuring Quality of Life in Informal Settlements in South Africa." *Social Indicators Research* 81(2): 375-388.

Roma, E., K. Philp, C. Buckley, S. Xulu and D. Scott. (2015). "User perceptions of urine diversion dehydration toilets: Experiences from a cross-sectional study in eThekwini Municipality". *Water SA* 39(2): 305-312.

Satterthwaite, D., D. Mitlin and S. Bartlett. (2015). "Is it possible to reach low-income urban dwellers with good-quality sanitation?" *Environment and Urbanization* 27(1): 3-18.

Schouten, M.A.C. and R.W. Mathenge (2010). "Communal sanitation alternatives for slums: A case study of Kibera, Kenya." *Physics and Chemistry of the Earth, Parts A/B/C* 35(13-14): 815-822.

Scott, P., A. Cotton and M. Sohail Khan. (2012). "Tenure security and household investment decisions for urban sanitation: The case of Dakar, Senegal." *Habitat International* 40: 58-64.

Simiyu, S. (2015). "Determinants of usage of communal sanitation facilities in informal settlements of Kisumu, Kenya." *Environment and Urbanization*.

Stewart, C. (2014). "Toilets at last – Perceptions of the users of 'porta potty' toilets in Jim se Bos informal settlement in Phillipi, Cape Town."

Still, D. and B. Louton. (2012). "Piloting and testing the pour flush latrine technology for its applicability in South Africa". Water Research Commission Report No. 1887/1/12.

Sutherland, C. and S. Buthelezi. (2013). "Settlement Field Report: Durban, South Africa." Addressing Sub-Standard Settlements. Chance2Sustain.

Sutherland, C., G. Robbins, D. Scott and V. Sim. (2013). "Durban City Report". Chance2Sustain.

Taing, L. (2015). "Implementing sanitation for informal settlements: conflicting rationalities in South Africa". UCT: Cape Town, South Africa.

Takem, G.E., D. Chandrasekharam, S.N. Ayonghe and P. Thambidurai. (2009). "Pollution characteristics of alluvial groundwater from springs and bore wells in semi-urban informal settlements of Douala, Cameroon, Western Africa." *Environmental Earth Sciences* 61(2): 287-298.

Thye, Y., M. Templeton and M. Ali. (2011). "A critical review of technologies for pit latrine emptying in developing countries." *Critical Reviews in Environmental Science and Technology* 41(20): 1793-1819.

Tilmans, S., K. Russel, R. Sklar, L. Page, S. Kramer and J. Davis. (2015). "Container-based sanitation: assessing costs and effectiveness of excreta management in Cap Haitien, Haiti." *Environ Urban* 27(1): 89-104.

Tumwebaze, I.K., C.G. Orach, C. Niwagaba, C Lüthi and H.J. Mosler. (2013). "Sanitation facilities in Kampala slums, Uganda: users' satisfaction and determinant factors." *Int J Environ Health Res* 23(3): 191-204.

von Munch, E. and K. Mayumbelo. "Methodology to compare costs of sanitation options for low-income peri-urban areas in Lusaka, Zambia." *Water SA* 33(5): 593-602.

Wegelin-Schuringa, M. and K. Teresia (1997). "Tenancy and sanitation provision in informal settlements in Nairobi: revisiting the public latrine option." *Environment and Urbanization* 9(2): 181-190.

Westaway, M. S. (2006). “A longitudinal investigation of satisfaction with personal and environmental quality of life in an informal South African housing settlement, Doornkop, Soweto.” *Habitat International* 30(1): 175-189.

Annexure 1: Toilet technology options

Why is it necessary to discuss toilet technology options?

When a new, up-market housing development is approved by CoCT, it is almost always taken for granted that the households will have flush toilets linked to the sanitation system. In very rare instances, due to distance or location, the development may be approved on the basis that the developers will build flush toilets linked to septic tanks. In all instances, CoCT will require the developers to pay for the sanitation solution implemented. If the development is linked to the sewer system, then CoCT will charge the developer for the extension of the sewer system and the portion of spare capacity in the existing sanitation infrastructure "used up" by the new development. In some instances CoCT may require the developer to pay the cost of building new infrastructure. These payments are called "development charges", and ensure that the private sector pay the municipality for the full-cost of their development activities. They effectively pay for the sanitation solution they want.

When it comes to providing sanitation services to residential areas where households are poor, and particularly to informal settlements, the nature of the discussion changes. In such instance, the municipality carries both the capital and operating cost of the chosen sanitation solution. Consequently issues of cost and financial sustainability become important, as well as the balance between immediate measures and longer term solutions. Furthermore, there may be some very real practical limitations that impact on what type of toilet technology is feasible.

The most important limitations are the lack of access routes into certain settlements, and the lack of demarcated housing stands. Other challenges relate to the location of settlements: distance from existing sewerage infrastructure; location in low lying areas prone to flooding; beneath power lines; or on transport reserves. If these constraints prevent the municipality from implementing flush-toilets on individual stands, then the municipality must explore alternative toilet solutions. In such instances, the social acceptability of the different toilet options needs to be taken into consideration.

The soon-to-be-replaced National Sanitation Policy (1996)[6] states that adequate sanitation is the provision and ongoing operation and maintenance of a system of disposing of human waste and waste water, which should be acceptable, accessible and affordable to all users, structurally safe and hygienic, and should not have an unacceptable impact on the environment. This review of international and local literature seeks to identify those toilet technology options that both comply with this description and should be included in the costing model. Therefore it also considers the cost and financial sustainability of the toilet technology, as well as the balance between immediate measures and longer term solutions.

A range of toilet technologies are available and used in South Africa. For purposes of developing the Sanitation Costing Model, the following options were reviewed:

- packet latrines,
- pit latrines,
- eco latrines,
- twin pit pour-flush toilets,
- biogas toilets,
- incinerating toilets,
- urine diversion dry toilets,
- portable toilets,
- chemical toilets, and
- full-flush toilets.

[6] Government of South Africa. (1996). *National Sanitation Policy White Paper.*

1. Packet latrines

Packet latrines are an on-site, unimproved sanitation[7] option, a variant of the basic bucket toilet. They consist of biodegradable packets placed inside reusable buckets. The packet, along with the excreta, is removed and sealed with a knot after each use, then buried or otherwise disposed of.

Packet latrines require the immediate, and correct, disposal of the packets and their waste contents. For instance, packets need to be completely buried an adequate distance from any dwellings or walkways to completely remove the waste from human contact. The literature varies somewhat, but it is generally accepted that packets need to be buried at least 30 meters from any surrounding dwellings, walkways or water points[8]. The population density in Khayelitsha leaves little space for the proper disposal of the packets. There is a high likelihood that the waste would be left exposed, which would result in considerable environmental problems. Even if packets are correctly buried, the high water table, poor drainage and regular incidence of flooding means that contamination of ground water and spread of pathogens from the waste would be common. This is an enormous health risk in such a densely populated settlement. Environmental constraints must be considered binding on any prospective implementation of packet latrines.

The initial costs of the implementation of packet latrines in Khayelitsha would be very low. They require no additional infrastructure to be built, are small, easily transported and distributed, and direct operations and maintenance costs would be very low. However, the lack of infrastructure – coupled with the on-site, point-of-use nature of packet latrines – is likely to result in considerable indirect costs. To ensure all households have a continuous and adequate supply of packets, there would be substantial delivery and supply costs. There is also a high likelihood that the municipality would need to deal with the regular removal of incorrectly discarded packets. So even though direct costs may not represent a constraint, there would still be considerable associated costs to consider.

The need to bury the packet or dispose of it in some other way raises practical and safety issues. Open ground is often not accessible, and people would have to walk long distances to find suitable land to bury the packets. Several assessments of sanitation services in informal settlements in high-crime areas (such as Khayelitsha) have noted that proximity to the household is one of the key priorities in users' evaluations of sanitation services. Whilst the packet latrines may be stored in the household, their disposal requires walking long distances – at a significant risk to personal safety[9].

There are significant social issues attached to the implementation of packet latrines. Schouten and Mathenge[10] observe a distinct loss of personal dignity that stems from the perceived lack of cleanliness associated with such packet latrines. They further note that packet latrines rank as the least desirable sanitation technology from users' perspectives. Stewart[11] similarly notes that, in South Africa (and Khayelitsha in particular), all variants of the bucket system have extremely negative connotations. Ultimately, owing to the contentious history of bucket toilets in Khayelitsha, and the severe negative connotations associated with related toilet options, the lack social acceptance of packet latrines must be seen as binding – ruling it out as a possible toilet option.

---

7 In the sanitation context, "improved" sanitation refers to technologies that hygienically separate human excreta from human contact. Unimproved sanitation does not separate human excreta in the same way.

8 Letema, S., B. van Vliet and J. van Lier. (2014). "Sanitation policy and spatial planning in urban East Africa: Diverging sanitation spaces and actor arrangements in Kampala and Kisumu." *Cities* 36: 1-9.

9 Schouten, M.A.C. and R.W. Mathenge (2010). "Communal sanitation alternatives for slums: A case study of Kibera, Kenya." *Physics and Chemistry of the Earth, Parts A/B/C* 35(13-14): 815-822.

10 *Ibid.*

11 Stewart, C. (2014). "Toilets at last – Perceptions of the users of 'porta potty' toilets in Jim se Bos informal settlement in Phillipi, Cape Town."

In conclusion, the National Sanitation Policy (1996) explicitly states that packet latrines are not an adequate sanitation solution due to not only a number of social acceptability and environmental concerns, but also related cost considerations.

2. Pit latrines

Pit latrines are on-site, unplumbed sanitation facilities that generally consist of a pit in the ground of varying depth, a cover slab, or floor, with a small hole with a toilet seat, and a superstructure commonly referred to as an outhouse. Pit latrines can vary from a very basic, unimproved facility (consisting merely of a pit and a hole) through to ventilated improved pit (VIP) latrines – in which the superstructure is ventilated and has a fly-screen, to twin pit systems – which are discussed in a separate section below. In all pit latrines, the pit acts as a reservoir for waste, and once the pit fills to within 50 centimetres of the top, it is either emptied using a "honey sucker" and the sludge removed for treatment at a wastewater works, or the pit is filled and abandoned, and a new pit constructed in a different location.

Pit latrines represent the most common form of sanitation in the developing world, particularly in sub-Saharan Africa. In their study of the usage of pit latrines globally, Graham and Polizzotto note that 36 percent of South Africans use pit latrines as their chief form of sanitation[12]. The widespread use of pit latrines is not indicative of their social acceptability, however: it is because they are easy to construct and cheap to maintain. As Bolaane and Ikgopoleng note, in their study of constraints to sanitation access in Botswana, "the predominance in the use of the pit latrine as a sanitation option does not mean that users are entirely happy with its use". Rather, more than half of all households "strongly agree that pit latrines are an out-dated sanitation technology"[13]. This sentiment is mirrored in the South African context, where various studies and surveys have noted a considerable loss in personal dignity associated with the use of pit latrines. A report by Sutherland *et al.* highlights the criticism of pit latrines (even in their improved form) as an "inadequate form of sanitation delivery due to poor management and maintenance, particularly in terms of the emptying pit toilets; the smell produced by the toilets; hygiene problems associated with such systems when they are shared and have to be emptied; and the lack of space within these toilets"[14].

There are significant geographic constraints on the prospective use of pit latrines as a sanitation solution for Khayelitsha. Firstly, the high water table in Khayelitsha, which sits on average two to five metres below the surface, does not lend itself to the construction of deep pits. Several authors note that a water table this close to the surface is not suitable for the construction or operation of pit latrines as the bottom of the pit will likely fill with water, creating an environment for the growth of pathogens within the toilet[15]. Even if the pit does not intersect the water table, the inevitable seepage into the water table will generate grave environmental and health risks.[16]. This danger is exacerbated by the fact that, being a low-lying area, Khayelitsha is prone to flooding. The open-top of pit latrine holes and the unsealed storage pits also mean that they are easily flooded.

It is generally accepted, by most authors and studies, that pit latrines are only viable for use in rural areas and peri-urban areas, owing to the low frequency of use in such areas[17]. The high population

---

12 Graham, J. and M. Polizzotto. (2012). "Pit latrines and their impacts on groundwater quality: a systematic review." *Environmental Health Perspectives*: 1-13.

13 Bolaane, B. and H. Ikgopoleng. (2011). "Towards improved sanitation: Constraints and opportunities in accessing waterborne sewerage in major villages of Botswana." *Habitat International* 35: 486-499.

14 Sutherland, C., G. Robbins, D. Scott and V. Sim. (2013). "Durban City Report". Chance2Sustain.

15 Mels, A., D. Castellano, O. Braadbaart, S. Veenstra, I. Dijkstra, B. Meulman, A. Singels and J.A. Wilsenach. (2009). "Sanitation services for the informal settlements of Cape Town, South Africa." Desalination 248(1-3): 330-337.

16 Nyenje, P., J. Foppen, S. Uhlenbrook, R. Kulabako and A. Muwanga. (2010). "Eutrophication and nutrient release in urban areas of sub-Saharan Africa – A review." *Science of the Total Environment* 408: 447-455.

17 Letema, S., B. van Vliet and J. van Lier. (2014). "Sanitation policy and spatial planning in urban East Africa: Diverging sanitation spaces and actor arrangements in Kampala and Kisumu." *Cities* 36: 1-9.

density of Khayelitsha means that pits would fill very rapidly, there is limited space for the digging of new pits, and the lack of access routes in many areas makes emptying the pits impractical.[18] The sandy soil type in Khayelitsha is also unsuited to the construction of secure pit latrines and the safe storage of waste matter in the pit.

As indicated above, the predominance of pit latrines is mainly driven by the low cost of construction and maintenance: in their most basic form, they require little more initial capital expense than the digging of a pit, and the construction of a hole and a rudimentary outhouse. There would be no initial cost constraints. This said, extensive use combined with the high population density in Khayelitsha would require that pits be serviced, emptied or relocated on a very regular basis. This could drive maintenance and operating costs up considerably, although not to the point that they would become prohibitive.

The National Sanitation Policy (1996)[19] explicitly states that pit latrines are not an adequate sanitation solution due to the concerns related to their social acceptability and the environment mentioned above.

3. Eco latrines

Eco latrines, or composting toilets, are on-site improved sanitation facilities that use an aerobic composting system to decompose human waste. These dry toilets consist of elevated cubicles constructed over a container or tank that contains carbonaceous organic matter, such as sawdust and ash/lime, which dries out the waste and facilitates decomposition. This organic matter and ash must be deposited into the latrine after each use to ensure that waste is made innocuous. Once the tank is full, and following an adequate period of decomposition – typically six to 12 months – the resulting decomposed waste is removed by service providers and put through a curing process. It can then be used as compost for agricultural soil enrichment.

The environmental constraints associated with the implementation of eco latrines are less severe than the majority of alternative dry, on-site sanitation options, such as pit latrines in their various forms. Waste matter being housed in a secure tank means that leakages are uncommon, and the height of the water table in Khayelitsha is of little concern. Moreover, the acceleration of the decomposition process, through the addition of carbonaceous organic matter, and the dehydration of the solid waste material, through the addition of drying agents, means that the contents of the tank itself are far less harmful than the contents of a regular, untreated pit-type latrine. Though Mels et. al. cite the potential for overflow of wastewater as a concern for eco latrines in Khayelitsha, owing to a proneness to flooding, this constraint is considered largely non-limiting.[20]

Eco latrines are appropriate in rural settings where grass cuttings are readily available and compost is in demand, population density is low and usage less regular. The frequency of use in an urban informal settlement environment like Khayelitsha will not allow for waste to sit in the tank for the required six to 12-month period in order for sufficient decomposition to occur. Also grass cuttings or other carbonaceous material are not readily available. Furthermore, the lack of transport infrastructure presents considerable practical problems as to how to deal with the tanks once they fill up. Access paths are generally not accessible. In spite of the benefits of eco latrines over basic pit latrines in terms of their storage of waste matter, and their lack of vulnerability to the high water table in Khayelitsha, the usage levels will prohibit them from performing their basic function of producing compost from waste matter.

---

[18] Thye, Y., M. Templeton and M. Ali. (2011). "A critical review of technologies for pit latrine emptying in developing countries." *Critical Reviews in Environmental Science and Technology* 41(20): 1793-1819.

[19] Government of South Africa. (1996). *National Sanitation Policy White Paper*.

[20] Mels, A., D. Castellano, O. Braadbaart, S. Veenstra, I. Dijkstra, B. Meulman, A. Singels and J.A. Wilsenach. (2009). "Sanitation services for the informal settlements of Cape Town, South Africa." Desalination 248(1-3): 330-337.

With the construction of an elevated cubicle and the provision of a waste storage tank, the initial capital costs of installing eco latrines is greater than more rudimentary sanitation systems. However the additional costs are not large enough to discourage their construction. Additionally, the production of a usable, or sellable, by-product – namely fertilizer – softens the operational costs somewhat. Final maintenance and operating costs would be similar to those for basic pit latrines. These are emptying, transport and routine maintenance costs. Much like pit latrines, these costs, and the initial capital costs of installation would represent no constraint to the implementation of eco-latrines as a possible sanitation solution.

Although the key selling point of eco latrines is their production of a useful output from human waste inputs, in Khayelitsha, this actually presents a key social constraint to eco latrines. They are seldom regarded as suitable or beneficial by users in urban or peri-urban locales, where there is no demand for compost[21]. Writing about user perceptions of sanitation systems in eThekwini, Roma et. al. note that users do not perceive any difference between a pit latrine and an eco latrine, and do not recognise the added value of the latter, as the benefits do not accrue to them[22]. Because pit latrines and eco latrines are considered identical forms of sanitation in their usage and benefit, by users in informal urban environments, the social constraints to eco latrines would, naturally, mirror those for pit latrines mentioned above. That is: outdatedness, a loss of personal dignity, and smell and hygiene concerns.

4. Twin pit pour-flush toilets

The twin pit pour-flush toilet is an improvement on the basic pit latrine. Much like the VIP latrine, it is an on-site improved, unplumbed sanitation facility consisting of a toilet pan, a pit and a cubicle superstructure. Unlike regular pit latrines, however, the toilet pan has a water-seal and requires the manual addition of (non-piped) water for flushing after each use. Similarly distinct from traditional pit latrines, the sub-structure of twin pit pour-flush toilets consists of two pits, both linked to the toilet pan using a Y-junction. The pits are used in isolation for the storage of waste, so that one pit is blocked off while the other is in use. This alternation in pit use allows for the drainage of blackwater[23] and the decomposition of waste in the unused pit, which means that the waste, when ultimately removed by service providers, is largely innocuous and can often be treated and used as compost.

In spite of this apparent environmental advantage over traditional pit latrine systems, Still and Louton note that a critical observed drawback of twin pit pour-flush toilets is that the use of a junction box greatly increases the chance of blockages over the single pit design[24]. This increases the likelihood of leakage of undecomposed waste, exacerbating all of the health and environmental risks associated with inefficient sanitation systems.

The geographic constraints to the prospective use of pit latrines as a sanitation solution for Khayelitsha would be common to twin pit pour-flush latrines. These include the high water table in Khayelitsha, which does not lend itself to the construction of deep pits. Deep pits would be a necessity as the toilets would be used extensively and would fill up quickly. Lack of access routes in many areas also creates considerable practical problems for emptying pits. In addition, the soil type in Khayelitsha does not lend itself to the secure construction of twin pit pour-flush toilets nor the safe storage of waste matter in the pit. Much like with pit latrines, these geographical and logistical constraints must be considered

---

21 Thye, Y., M. Templeton and M. Ali. (2011). "A critical review of technologies for pit latrine emptying in developing countries." *Critical Reviews in Environmental Science and Technology* 41(20): 1793-1819.

22 Roma, E., K. Philp, C. Buckley, S. Xulu and D. Scott. (2015). "User perceptions of urine diversion dehydration toilets: Experiences from a cross-sectional study in eThekwini Municipality". *Water SA* 39(2): 305-312.

23 In the sanitation context, blackwater is a term used to refer to wastewater containing faeces, urine and flush water from flush toilets along with anal cleansing water (if water is used for cleansing) or toilet paper.

24 Still, D. and B. Louton. (2012). "Piloting and testing the pour flush latrine technology for its applicability in South Africa". Water Research Commission Report No. 1887/1/12.

binding on any proposed implementation of twin pit pour-flush toilets as a sanitation solution for Khayelitsha.

Although the twin pit pour-flush latrine is effectively a variant on the traditional pit latrine (which has very low initial capital costs), the construction of two pits, rather than one, and the incorporation of a Y-junction means that these initial costs are higher for twin pit toilets, generally costing 50 per cent more than their single pit counterparts to install. Furthermore, blockages caused by the incorporation of the Y-junction to the system would result in higher operations and maintenance costs over other single-pit-based latrine systems[25]. In spite of this increase in initial and running costs over single-pit latrines, the costs are not excessive to the point of being prohibitive.

Still and Louton note, in their survey of user perceptions of twin pit pour-flush systems across several municipalities in South Africa that more than three quarters of households reported a high level of dissatisfaction with these toilets. This was largely due to the on-site nature of the toilet, unpleasant smells and loss of self-esteem and dignity[26]. The toilets require manual flushing, which means that user contact with faecal matter is commonplace. This reduces the likelihood of user acceptance, and greatly increases user dissatisfaction[27].

5. Biogas toilets

A biogas toilet is an on-site improved sanitation facility that uses a bio-digester to anaerobically digest waste. Effectively an adaptation of the VIP latrine, a biogas toilet consists of a shallow pit, bio-digester and a vent pipe – equipped with a fly screen for the control of odour and flies. Waste that is deposited into the pit is digested in the bio-digester (often with other organic waste) to produce methane gas, which is stored under a fixed dome by hydraulic displacement. This biogas can be used locally for lighting, heating and cooking purposes. After the production of methane, the resulting sludge is deposited in a further pit or a septic tank. This pit or tank needs to be emptied regularly to avoid the disruption of methane production by inert materials.

The benefits of biogas toilets are supposed to accrue directly to the community they service through the provision of a free fuel source. However, it is generally felt by most users of biogas toilets in peri-urban and urban slum settings, that the disadvantages of the production of biogas from these toilets far outweigh the benefits. For example, in a project in Uganda in which community biogas latrines were built to produce biogas for domestic energy, the service went largely unused by the community owing to malodours emanating from the toilet and a widespread reluctance to use a byproduct of human waste for cooking[28]. Similarly, in a survey of users' perceptions of various improved communal sanitation facilities in Nairobi, biogas toilet facilities received the lowest acceptability rating of all of the reviewed sanitation options. This low score was largely due to the unpleasant odours associated with the use and operation of the toilet, and a perceived uncleanliness of the system.[29]. Assuming similar social attitudes exist in Khayelitsha, the social constraints on the implementation of biogas toilets should be considered binding.

As a variant of a VIP latrines, biogas toilets do not encounter some of the logistical and geographic constraints that prohibit the possible implementation of pit latrines as a sanitation solution in Khayelitsha. The shallower nature of the waste storage pit means that concerns associated with water table interference, and the associated pit flooding and waste overflow, are greatly reduced. Moreover,

---

25 *Ibid.*
26 *Ibid.*
27 *Ibid.*
28 O'Keefe, M., U. Messmer, C. Lüthi and R. Tobias. (2015). "Slum inhabitants' perceptions and decision-making processes related to an innovative sanitation service: evaluating the Blue Diversion Toilet in Kampala (Uganda)." *Int J Environ Health Res* 25(6): 670-684.
29 Schouten, M.A.C. and R.W. Mathenge (2010). "Communal sanitation alternatives for slums: A case study of Kibera, Kenya." *Physics and Chemistry of the Earth, Parts A/B/C* 35(13-14): 815-822.

the anaerobic digestion of the solid waste with a bio-digester means that pits fill up and have to be emptied far less frequently than most other dry latrine systems.[30] However, these benefits are largely outweighed by the stringent requirements for proper usage, and the sensitivity of the biological processes involved in the biogas production process. These biological processes can be completely disrupted by the addition of small volumes of plastic bags, detergent or water to the toilet system. Schouten and Mathenge cite a large-scale communal biogas sanitation facility in Kenya that ceased to function shortly after construction, and ultimately had to be converted to a conventional pit latrine system, owing to the incorrect usage[31]. The sensitivity of these operating processes, coupled with the high frequency usage that the toilets will inevitably face in Khayelitsha, means that the implementation of biogas toilets cannot be considered a viable option.

Biogas toilets are generally considered to be amongst the most environmentally friendly dry sanitation options for urban informal settlement scenarios. In an extensive study to determine selection criteria for the implementation of sustainable sanitation technologies for informal urban areas, sanitation experts from academic institutions, government and the private sector ranked biogas latrines as the second-most environmentally friendly dry sanitation solution – based on their relatively low levels of environmental pollution, and a low potential for exposure to pathogens[32]. However, the sensitivity of the biological processes is a significant risk factor, nevertheless is a seen as a non-binding environmental constraint on the implementation of biogas toilets. The failure of this process will result in all the environmental constraints common to regular pit latrines applying.

The initial capital costs involved in the installation of biogas toilets is greater than that for standard single or twin-pit latrine systems because of the requirement for a domed gas receptacle and a vent pipe. The operating and maintenance costs of biogas toilets are generally lower than alternative pit-based latrines as a result of the bio-digestion process. The higher initial costs, but reduced subsequent operations costs, are noted in several case studies[33]. The external cost savings generated by the production of usable methane gas in the sanitation process further reduces the operating costs of the toilet[34]. In sum, there are no severe cost constraints to the implementation of biogas toilets.

6. Incinerating toilets

An incinerating toilet is an on-site improved self-contained dry sanitation unit that produces no liquid or continuous effluent stream. An incinerating toilet uses a heating system to incinerate waste products housed in a holding tank. This heating system can rely on electric power, natural gas, propane or oil to incinerate the human waste. The incineration process produces a fine, sterile ash that is nontoxic and can be reused in agriculture, or simply disposed of with everyday refuse.

There are significant factors that would promote user acceptability of incinerating toilets over many of the alternative dry sanitation options available. There is little chance of user contact with waste, and the complete incineration of the waste matter means that the toilets do not create unpleasant smells. This said, knowledge gaps that inhibit user uptake of sanitation options with complex waste disposal systems – such as urine diversion dry toilets and biogas toilets – would likely be a factor in the operation of incinerating toilets.

The significant logistical constraint associated with incinerating toilets is that they require the ready and constant supply of electrical power, oil, gas or propane. Even if this access weren't a binding

30 *Ibid.*
31 *Ibid.*
32 Katukiza, A.Y., M. Ronteltap, A. Oleja, C.B. Niwagaba, F. Kansiime and P.N.L. Lens. (2010). "Selection of sustainable sanitation technologies for urban slums--a case of Bwaise III in Kampala, Uganda." *Sci Total Environ* 409(1): 52-62.
33 Schouten, M.A.C. and R.W. Mathenge (2010). "Communal sanitation alternatives for slums: A case study of Kibera, Kenya." *Physics and Chemistry of the Earth, Parts A/B/C* 35(13-14): 815-822.
34 Katukiza, A.Y., M. Ronteltap, A. Oleja, C.B. Niwagaba, F. Kansiime and P.N.L. Lens. (2010). "Selection of sustainable sanitation technologies for urban slums--a case of Bwaise III in Kampala, Uganda." *Sci Total Environ* 409(1): 52-62.

constraint, the operation of electricity- or propane-based systems in a crowded informal settlement environment, characterised by housing congestion and inadequate building materials, would pose significant threats to safety. In a review of proposed sustainable sanitation solutions for an informal settlement in Stellenbosch, Muniz discards incinerating toilets as an option due to a dearth of requisite energy sources and the associated safety concerns.[35] A further binding constraint on incinerating toilets is that they can only serve a maximum of eight people, which at the cost of installation and operation (mentioned below) makes it a very expensive sanitation choice.

Although the final waste output of an incinerating toilet – fine, sterile ash – is the least environmentally risky output of all of the dry toilet systems available, there are significant environmental constraints associated with the operation of the toilet itself. The toilet requires the use of electricity or various fossil fuels to incinerate the waste. With incinerating cycles typically lasting longer than two hours, just the once-off operation of an incinerating toilet would result in significant greenhouse gas emissions, which would be contrary to the CoCT's environmental objectives set out in its IDP.[36] The widespread use of such a fuel-based system in a crowded informal settlement would also heighten the risk of fires, which are notoriously damaging and difficult to control in urban informal settlements such as Khayelitsha.

The most significant constraint on any proposed implementation of incinerating toilets in Khayelitsha would be the cost implications of both their installation and operation. Muniz highlights the fact that the average per unit cost of the cheaper electric-powered incinerating toilets is more than double that for any of the alternative self-contained dry sanitation systems. Gas-fired incinerating toilets cost nearly four times the next cheapest option to install[37]. Furthermore, the extensive use of electricity, or gas, in the incineration process means that operating costs will be exorbitant.

7. Urine diversion dry toilets

A urine diversion dry toilet (UDDT) is an on-site improved form of dry sanitation that does not require additional wastewater disposal systems. It consists of a waterless toilet that separates urine and faeces at source by diverting both forms of waste into separate receptacles within an enclosed cubicle. The urine is drained off into a storage tank located below the system, where it is either treated and used as fertilizer, or absorbed into the ground. The faeces are collected in a separate container, which has a ventilation pipe to remove odour from the system and aid in the dehydration of the solid waste. In some instances users are required to sprinkle ash, sawdust or another type of drying agent onto the faeces, which aids the dehydration process further. This dehydrated solid waste is then either composted or dehydrated further and used as soil fertilizer.

The chief social constraint to the implementation of UDDTs stems from the inherent complexities in their operation and use. In a study of the rollout of UDDTs in informal settlements in the eThekwini municipality, Sutherland and Buthelezi note that several users have declined to use the provided systems. Instead they resort to open defecation or the construction of makeshift pit latrines, claiming that it is too hard to follow all the rules to using the urine diversion toilets properly. In addition, they do not like disposing of the solid faecal matter from the back of the toilet[38]. Similarly, O'Keefe *et al.* cite a project in China in which the implementation of a large-scale urban sanitation project failed due to the

[35] Muniz, E. (2013). "A proposed sustainable sanitation system for the Zwelitsha section of Langrug informal settlement in the Stellenbosch Municipality, South Africa." Worcester Polytechnic Institute.
[36] City of Cape Town. (2013). Integrated Development Plan 2012–2017: 2013/14 Review.
[37] Muniz, E. (2013). "A proposed sustainable sanitation system for the Zwelitsha section of Langrug informal settlement in the Stellenbosch Municipality, South Africa." Worcester Polytechnic Institute.
[38] Sutherland, C. and S. Buthelezi. (2013). "Settlement Field Report: Durban, South Africa." Addressing Sub-Standard Settlements. Chance2Sustain.

lack of training on how to correctly use and adequately maintain the UDDTs provided.[39] This lack of understanding is a constraint in and of itself.

The complexities of the inner workings of UDDTs generate considerable logistical constraints. Blockages of the urine diversion pipe with foreign materials are commonplace, whilst the precipitation of struvite and calcium phosphates found in urine can cause blockages that require regular chemical cleaning or the replacement of pipes[40]. This tendency to block is exacerbated by frequent use, which will undoubtedly occur should they be implemented in the high population density of Khayelitsha. Mels *et al.* cite population density and the associated excessive use of UDDTs as the key limiting constraint on their implementation in Khayelitsha[41].

Perhaps the most beneficial aspect of UDDTs is the reduction in health and environmental risks. This stems largely from the separation of urine and solid waste into separate tanks, and the subsequent treatment of both for further beneficial use – as fertiliser and compost respectively. The effective management of waste means that both liquid and solid waste is rendered largely innocuous early in the storage process, such that urine can be absorbed into the ground and leakages of solid waste (albeit rare) are less harmful to the environment than in most other mixed storage sanitation systems. A review of urine diversion dry toilets in urban and peri-urban areas of East Africa found that the public and health risks associated with spillage of mixed waste streams into the environment are minimised by the storing of waste in separate, secure chambers[42]. Furthermore, UDDTs were found to be particularly advantageous in areas prone to flooding or with high water tables (such as Khayelitsha), as faecal matter is stored in a water proof chamber and thus leakages seldom occur.

Owing to the complexities in design that separate UDDTs from more conventional dry toilet systems, the initial capital costs associated with the installation of these toilets is higher than most alternative on-site improved systems. However the separation, and ultimate drainage, of the urine waste, combined with the aided dehydration and decomposition of the faecal waste in UDDT systems, means that emptying is far less frequent. The treatment of the waste material is less onerous, resulting in lower operation costs relative to alternative dry toilet systems. In an assessment of cost estimates of sanitation options for low-income peri-urban areas in Lusaka, Zambia, von Munch and Mayumbelo found that, whilst initial capital costs for the installation of a UDDT system was 25 percent higher than for a VIP latrine, the total operating costs, per annum, were ten percent lower[43]. As mentioned, the complexities of the inner workings of UDDTs do cause numerous blockages, which generate considerable maintenance costs. These costs, particularly in a situation of frequent, improper use, could restrict the successful and sustainable implementation of UDDTs in Khayelitsha.

8. Portable flush toilets

A portable flush toilet is an on-site improved portable plastic container that utilises a water-flushing mechanism to deliver waste matter into a holding tank not visible to users. It consists of a standard toilet seat and two tanks, one containing clean water for flushing and the other for housing waste and blackwater. The second of these tanks is a sealed container containing chemicals to deodorize the waste. This sealed tank can be removed from the unit for disposal. The small size of these tanks

---

39 O'Keefe, M., U. Messmer, C. Lüthi and R. Tobias. (2015). "Slum inhabitants' perceptions and decision-making processes related to an innovative sanitation service: evaluating the Blue Diversion Toilet in Kampala (Uganda)." *Int J Environ Health Res* 25(6): 670-684.

40 Katukiza, A.Y., M. Ronteltap, C.B. Niwagaba, J.W.A. Foppen, F. Kansiime and P.N.L. Lens. (2012). "Selection of sustainable sanitation technologies for urban slums--a case of Bwaise III in Kampala, Uganda." *Sci Total Environ* 409(1): 52-62.

41 Mels, A., D. Castellano, O. Braadbaart, S. Veenstra, I. Dijkstra, B. Meulman, A. Singels and J.A. Wilsenach. (2009). "Sanitation services for the informal settlements of Cape Town, South Africa." Desalination 248(1-3): 330-337.

42 Katukiza, A.Y., M. Ronteltap, C.B. Niwagaba, J.W.A. Foppen, F. Kansiime and P.N.L. Lens. (2012). "Sustainable sanitation technology options for urban slums." *Biotechnol Adv* 30(5): 964-986.

43 von Munch, E. and K. Mayumbelo. "Methodology to compare costs of sanitation options for low-income peri-urban areas in Lusaka, Zambia." *Water SA* 33(5): 593-602.

means they must be collected on a regular basis by a sanitation service provider, the waste disposed of appropriately, and a clean tank inserted in its place.

With the widespread rollout of portable flush toilets in informal settlements throughout South Africa, some informal settlement residents have readily accepted the portable flush toilet system. A survey of residents of Jim se Bos informal settlement in Phillipi, Cape Town saw all respondents affirm that they accepted the portable flush toilets, and considered these to be the preferred method of sanitation.[44] It is worth pointing out, however, that all of these respondents also reported having never used a full-flush toilet, which likely influences their preferences. In a case study of residents of one district of Khayelitsha, residents who had remote access to full-flush toilets overwhelmingly preferred those to the portable flush units the City provided in their section of the informal settlement, going as far as to walk long distances to use public full-flush services, or private flush toilets in shops or the homes of family members[45]. As community acceptance of existing portable flush toilets in various informal settlements across South Africa varies, so there may be varying degrees of social constraint to the potential implementation of a portable flush toilet-based sanitation solution for Khayelitsha. Some would likely welcome the improvement that portable flush toilets provide over existing unimproved systems, while many more would likely reject them based on the associated legacies of the Apartheid-era "black bucket" toilet system – an in-house, on-site, unplumbed form of sanitation that does not flush the waste away. Social constraints on the implementation of flush toilets must therefore be considered non-binding, conditional on the subsequent move to an improved sanitation system.

There are significant logistical benefits to the implementation of portable flush toilets as a sanitation solution in Khayelitsha. They are relatively small, self-contained units, and therefore easy to distribute and install. They don't require any water supply or plumbing, and they can be used inside the home, therefore eliminating the safety risks of walking to communal toilets – although this does imply a loss of dignity. Owing to their small size and manoeuvrability, the sealed waste tanks are easily removed and transported, making for simple maintenance of the entire system – although proper management is critical. This small size, however, is also the portable flush toilet's greatest downfall, as the tiny volume of the tank requires nearly daily replacement of tanks. This is likely to be a barrier to the long-term sustainability of the sanitation system.[46]

Owing to the storage of waste matter in a separate, sealed container, there is no risk of flooding or intrusion into the water table, portable flush toilets are considered to be free of environmental constraints[47].

The initial capital costs of portable flush toilets are not considered to be a constraint to implementation as, owing to the small size of the unit, transport and installation costs are minimal, even though the cost per unit is high relative to many other waterless sanitation systems. The requirement for near daily emptying, however, does represent a considerable maintenance cost – such that portable flush toilets cannot be considered fiscally, as well as logistically, sustainable over the long term.

9. Chemical toilets

A chemical toilet is an on-site, portable waterless latrine that stores waste in a sealed container. A foot pedal or hand lever is used to flush waste into the container, where chemicals are used to treat and deodorise the waste to make it innocuous. The containers need to be emptied by a service provider once full, and their contents transported to a wastewater treatment works. Because the latrine housing

---

44 Stewart, C. (2014). "Toilets at last – Perceptions of the users of 'porta potty' toilets in Jim se Bos informal settlement in Phillipi, Cape Town."
45 Taing, L. (2015). "Implementing sanitation for informal settlements: conflicting rationalities in South Africa". UCT: Cape Town, South Africa.
46 Pan, S.M., NN.P. Armitage and M.B. van Ryneveld. (2015). "Sustainable and equitable sanitation in informal settlements of Cape Town: a common vision?" *Water SA* 41(2): 222.
47 Mels, A., D. Castellano, O. Braadbaart, S. Veenstra, I. Dijkstra, B. Meulman, A. Singels and J.A. Wilsenach. (2009). "Sanitation services for the informal settlements of Cape Town, South Africa." Desalination 248(1-3): 330-337.

and waste receptacle are in one self-contained unit, chemical toilets are considered to be wholly portable.

The social constraints on the implementation of chemical toilets are largely temporal in manner, with an expected short-term acceptance of chemical toilets if they are a stop-gap sanitation solution on route to the implementation of a full-flush toilet-based plan. Such was the case when mobile chemical toilets were installed in the Kayamandi informal settlement in Stellenbosch in 2007, as an apparent intermediate sanitation solution until full-flush toilets could be built[48]. Initially, residents were satisfied with these toilets being an improvement on the existing unimproved toilets systems, and a step towards plumbed, full-flush toilets. However, over time – once it became apparent that the chemical toilets were to be a permanent fixture rather than a transitionary plan – residents began to grow disgruntled with the chemical toilets and user satisfaction and acceptability diminished greatly.[49] Chemical toilets can be considered to carry a time delimited social constraint, such that they are a socially acceptable short term sanitation solution (more so than portable flush toilets[50]), but not a viable long term option.

A key logistical benefit to chemical toilets is that these systems, being wholly portable self-contained units, require minimal installation costs. There is no need for piping, water connections, or any construction whatsoever. Rather, chemical toilets simply need to be transported to and placed at the designated site. Chemical toilets are specifically designed for mass use, so the population density in Khayelitsha, which was a constraint to the implementation of several other sanitation solution options, does not hinder the operability of the toilet[51]. Being an entirely above-ground, self-contained unit, chemical toilets aren't susceptible to flooding or water table contamination concerns. The type and quality of soil, or the slope of the land, doesn't affect their installation either[52]. The requirement for regular (three times a week) removal of the waste for treatment represents the only logistical constraint on chemical toilets.

The most noteworthy advantage of a chemical toilet from a hygiene perspective is that the user does not come into contact with the waste matter. The waste is flushed out of the toilet bowl with the chemical liquid when the manual flush mechanism is used. The container is then sealed off until the next flush. Both of these functions dramatically reduce the risk of diseases commonly associated with faecal contact. The chemicals inside the containers typically consist of ammonia compounds, which also provide a basic level of hygiene for users[53]. These compounds begin the process of breaking down the waste, although they do not totally sterilize it. Owing to this storage and chemical treatment of waste matter in a sealed container, chemical toilets are considered to be largely free of environmental constraints[54].

Due to the ease with which chemical toilets are transported and erected, initial capital costs refer exclusively to the unit cost of purchasing the toilet unit and the requisite chemicals, which, whilst high relative to other sanitation options, are not prohibitive. The self-contained nature of the toilet, and the relative ease of use, also means that operational costs are low. The cost of ongoing and regular maintenance does represent a considerable constraint. A janitorial service is required for basic cleaning of the cubicles at least three times a week. The waste from the toilet container needs to be

---

48 Lagardien, A. and D. Cousins (2004). Sanitation demand and delivery in informal settlements - planning and implementation support, Water Research Commission.

49 *Ibid.*

50 Stewart, C. (2014). "Toilets at last – Perceptions of the users of 'porta potty' toilets in Jim se Bos informal settlement in Phillipi, Cape Town."

51 Mels, A., D. Castellano, O. Braadbaart, S. Veenstra, I. Dijkstra, B. Meulman, A. Singels and J.A. Wilsenach. (2009). "Sanitation services for the informal settlements of Cape Town, South Africa." Desalination 248(1-3): 330-337.

52 *Ibid.*

53 Taing, L. (2015). "Implementing sanitation for informal settlements: conflicting rationalities in South Africa". UCT: Cape Town, South Africa.

54 Mels, A., D. Castellano, O. Braadbaart, S. Veenstra, I. Dijkstra, B. Meulman, A. Singels and J.A. Wilsenach. (2009). "Sanitation services for the informal settlements of Cape Town, South Africa." Desalination 248(1-3): 330-337.

removed and transported to a septic tank or sewage system. These regular maintenance costs mean that chemical toilets are not sustainable in the long run.[55]

10. Full-flush toilets

A full-flush toilet is a sanitation system that consists of a toilet that disposes of human excreta using water to flush it away through a drainpipe and into a sewage system that links to a sewage treatment plant or a septic tank. The water used to flush the toilet can come directly from a plumbed water supply or be poured into the bowl manually – this is referred to as a pour flush toilet. A flush toilet can either have a pedestal with a toilet seat, or a squat pan where the toilet bowl is installed in the floor – either way, the flushing mechanism remains the same.

Full-flush toilets can be provided in several ways. One option is individual units, which can be placed either in households or on household stands. The benefit of this option is that households are in close proximity to the unit. In areas where access is an issue, individual toilets can also be arranged in banks or rows of toilets. This allows for multiple toilets to be grouped in one location without the need to construct a fixed ablution facility. The bank arrangement could also extend the provision area if the toilets are arranged in a long row rather than a denser setup.

Another provision option is ablution blocks, which are larger structures that include several flush toilets. Ablution blocks can be implemented either as fixed structures or mobile units. Mobile units include tailor-made containers that can be connected to the sewerage mains. Because ablution blocks are larger than individual units, they have the added advantage of including shower and storeroom facilities. The drawback of larger units like ablution blocks, however, is that it is often difficult to locate them close to the households they service. As such, some users are expected to travel long distances to reach toilets. Traveling to access a toilet is not ideal, especially at night in Khayelitsha. To install ablution blocks in high density areas, or to place them closer to residents, also often requires households to be relocated, which is an added cost.

There should be no social constraints to the implementation of full-flush toilets.

A significant hindrance to the implementation of full-flush toilets in Khayelitsha is the lack of an extant sewage and piped water system to all parts of the informal settlement[56]. This constraint should not be considered binding, however, as it can be overcome through the construction of a network of sewage and water pipes. This constitutes an additional initial capital cost, rather than a binding logistical cost. The construction of such a pipe network raises a further geographic constraint, namely unsuitable subsoils and flood plains, which do not lend themselves readily to the construction of a stable pipe network[57]. A clear logistical benefit of the flush toilet is that it is easy to maintain. Non-flush toilets require the removal of waste, whereas for full-flush toilets the waste is removed through the sewage system. This means that the only regular maintenance required is cleaning and general repairs. Cleaning can be done with basic cleaning equipment and household detergents and bleaches, and with the correct toilet usage, breakages and blockages should be uncommon – keeping maintenance costs at a bare minimum.

Full-flush toilets remove excreta from the toilet – the waste is flushed down the drainpipe and into the sewage system or septic tank immediately. In addition, the toilet bowl is designed to hold a small amount of water that acts as a seal, preventing malodours from entering the immediate environment, and reducing the attraction of insects and pests. This feature make it a hygienic form of waste removal, allowing users to live in an environment that is not harmful to their health or wellbeing – also a basic

---

55 Taing, L. (2015). "Implementing sanitation for informal settlements: conflicting rationalities in South Africa". UCT: Cape Town, South Africa.
56 Mels, A., D. Castellano, O. Braadbaart, S. Veenstra, I. Dijkstra, B. Meulman, A. Singels and J.A. Wilsenach. (2009). "Sanitation services for the informal settlements of Cape Town, South Africa." Desalination 248(1-3): 330-337.
57 *Ibid.*

human right as outlined by the South African Constitution. Therefore full-flush toilets can be considered to have no environmental constraints.

Foremost among the constraints prohibiting the provision of full-flush toilets in Khayelitsha would be the upfront cost constraints associated with their implementation. Over and above the expense of the toilet unit itself, the construction of the network of water and sewage pipes serves to raise the initial capital costs for the implementation of a full-flush toilet-based sanitation solution. Unlike social, geographic and environmental constraints, initial capital cost constraints are not to be considered binding in the long run. They do not absolutely inhibit the functionality or user acceptability of the sanitation system. They are merely an additional cost to be carried by the service provider for the improvement of overall sanitation conditions. However, such costs are prohibitive in the short run, as adequate funding needs to be sourced for the initial capital outlay.

Annexure 2: Analysis of Cape Town's Budget from a sanitation perspective[58]

A key issue in the sanitation debate has been whether the CoCT's budget adequately prioritises the provision of sanitation services to poor households.

The project therefore included an analysis of the CoCT's past and current budgets[59] from a sanitation perspective. The aim of the analysis is to review how budget allocations for sanitation have evolved, and more specifically to assess:

- the level of priority being given to sanitation issues in the budget,
- where funding for sanitation has been directed, and
- what the medium term budget for sanitation looks like.

The project analysed publicly-available information relating to the CoCT's budget, as well as the budgets of seven other cities. The comparisons to other cities provide context, and a comparative benchmark for measuring the extent to which the CoCT is prioritising access to sanitation issues affecting poor households.

It needs to be recognised that the budgets cities are required to publish in terms of the Municipal Finance Management Act (2003) are summary documents. They provide high level information on overall allocations to the different functions the municipality is responsible for delivering. As a result, publicly-available budget information very often does not contain the level of detail necessary to track allocations for specific services or projects in specific areas. This can be frustrating to both activists and residents who would like to see from the budget whether their concerns around a particular service in a particular area are being prioritised.

Our review of the narrative sections of the CoCT's budget documents for 2013/14, 2014/15 and 2015/16 revealed no information specific to the sanitation situation in Khayelitsha. On the one hand, it could be argued that the CoCT's Water and Sanitation Department has a large number of projects and priorities to deliver on and therefore cannot be expected to provide detailed discussions on activities in all areas. The 2014/15 and 2015/16 budget documents do acknowledge the sanitation pressures created by urbanisation. The section in the 2014/15 budget for the Water and Sanitation Department states:

> The principal challenge for the department is to maintain an existing water and sanitation service for the City while also providing services for an ever-increasing number of households in a sustainable way. This has to be achieved in the context of providing basic needs, ensuring economic growth, maintaining an ageing infrastructure, limiting negative environmental impact, managing water resource scarcity and consolidating a transformed metro administrative infrastructure.
>
> The overall trend is that Cape Town's population will continue to grow each year although at a slower rate than previous years.
>
> The number of households living in informal settlements and backyards has been growing due to urbanisation, natural growth and changes in household size. If the trends continue to increase, it will eventually force more and more households into the indigent bracket or even within informal sector. Considering the latter, it means more and more people will fall within the City's subsidised housing programme

[58] Note that this analysis was done before the release of CoCT's draft budget for 2015/16.

[59] The CoCT budgets comply with the standards set in the Municipal Budget and Reporting Regulations of 2009, and its budget information is submitted in the required format to the National Treasury. The National Treasury publishes this information for all municipalities on its website in Excel format, which greatly facilitates analysis.

which creates implications for the growth of the City and its infrastructure. Increased city sprawl will increase the cost of infrastructure to new households.

Infrastructure investment also creates an environment for economic growth and is important for sustainable growth. Failure to improve the current state of infrastructure poses a serious threat to the local economy. In order to ensure medium to long-term sustainability of the existing infrastructure, proactive rehabilitation and maintenance of the infrastructure needs to be implemented.

On the other hand, the sanitation problems in Khayelitsha are clearly a significant issue, having been in the news, and the subject of demonstrations and various investigations – and it would therefore be appropriate for the CoCT to communicate in the budget document how it plans to address the issues – even a half page textbox would have been in order. The lack of any specific information on the issue in the last three budget documents suggests a deliberate decision by the CoCT to not provide information relating to its sanitation plans and budgets for Khayelitsha. It is submitted that this lack of transparency has exacerbated the situation, and is not consistent with the CoCT's obligation to engage communities on important matters that affect them.

Nevertheless, a detailed analysis of the CoCT and other metro's budgets does reveal a range of interesting trends that provide context to the discussion of sanitation issues affecting Khayelitsha and the development of the Sanitation Costing Model.

Where to find the City of Cape Town's budget information?

Information on the City of Cape Town's budget is available from:

- The CoCT's website: www.capetown.gov.za/
- The National Treasury website: www.treasury.gov.za/

The CoCT's actual budget documents are available on the CoCT's website. These are in PDF format, which complicates analysis. The National Treasury website hosts information on the National Treasury Local Government Database[60]. This database covers all municipalities and the information is in Excel format, which greatly facilitates analysis, and includes comparisons across municipalities. The information in the National Treasury Local Government Database is identical to that published by each municipality in its budget documents.

The location of the Local Government Budget Database on www.treasury.gov.za is not intuitive. Indeed the information is "well hidden" and the design of the website does not allow one to copy the relevant URLs. Therefore the following instructions provide a guide to finding this information:

1. Go to www.treasury.gov.za
2. Click on "Legislation" on the left hand menu bar, and select "MFMA"
3. This takes you to the MFMA page. Click on "Publications and Media Releases"
4. In the middle of the screen a list of options will appear. Under "Publications" select Municipal Budget Information
5. Select the relevant MTREF and then "XXXX Municipal MTREF Information", This opens the Local Government Budget Database for the relevant year. Key sections of the database are:
   i. Medium-term budget (three-year budget perspective of the summarised operational and capital appropriations)
   ii. Municipal Budget and Reporting Regulations format (Detail of schedules A2 to A10)

[60] http://mfma.treasury.gov.za/Media_Releases/mbi/Pages/Municipal%20Budgets%20-%20Main%20Page.aspx

iii. Municipal Budget and Reporting Regulations format (Summary of financial dimensions)

1. Budget information analysed

The following information relating to the CoCT and other cities' budgets for 2013/14, 2014/15 and 2015/16 was analysed:

- Table A1: Budget Summary
- Table A2: Budgeted Financial Performance (revenue and expenditure by standard classification)
- Table A5: Budgeted Capital Expenditure by Standard Classification and Funding
- Table A9: Asset Management for 4th Quarter ended 30 June 2015
- Table A10: Basic Service Delivery Measurement
- Capital Budget for various years: Medium-term budget (three-year budget perspective of the summarised operational and capital appropriations)
- Table SA36: Detailed Capital Budget (projects)
- Table SA37: Projects delayed from previous years 2015

In addition the following other information was analysed:

- Local Government Equitable Share formula data for 2013/14 to 2016/17
- MFMA Section 71 Quarterly Reports

2. Information in the budget on sanitation service delivery

Municipalities are required to report on a number of service delivery measures in their budgets – in Table A10 in the budgets. This section reviews the information relating to the sanitation and sewerage indicators reported by cities in their budget documents. Note that the measures used are aligned to those prescribed by National Treasury the Municipal Budget and Reporting Regulations (2009).

Table 24 shows the basic service delivery measures related to Sanitation/sewerage as reported in the CoCT's budgets.

Table 24: City of Cape Town: Basic Service Delivery Measurement – Sanitation/sewerage

	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16 MTREF		
	Audited Outcome	Audited Outcome	Audited Outcome	Audited Outcome	Full Year Forecast	Budget Year 2015/16	Budget Year 2016/17	Budget Year 2017/18
Flush toilet (connected to sewerage)	812 000	828 000	999 000	1 045 000	1 043 129	1 044 323	1 050 398	1 056 229
Flush toilet (with septic tank)								
Chemical toilet	16 000	17 000	23 000	24 000	29 080	29 955	29 955	29 955
Pit toilet (ventilated)	2 000	2 000	1 560	1 560				
Other toilet provisions (> min.service level)	50 000	51 000	58 000	70 840	70 506	60 647	66 723	72 553
Minimum Service Level and Above sub-total	880 000	898 000	1 081 560	1 141 400	1 142 715	1 134 925	1 147 076	1 158 737
Bucket toilet	4 000	4 000	800	600	377			
Other toilet provisions (< min.service level)								
No toilet provisions	20 000	20 000	60 000	40 000				
Below Minimum Service Level sub-total	24 000	24 000	60 800	40 600	377	-	-	-
Total number of households	**904 000**	**922 000**	**1 142 360**	**1 182 000**	**1 143 092**	**1 134 925**	**1 147 076**	**1 158 737**

Source: Table A10 Basic Service Delivery Measurement, CoCT 2015/16 Budget.

The above table indicates that the CoCT has made significant progress in expanding access to flush toilets. The number of households below the minimum service level fluctuated between 2010/11 and 2013/14. The table shows that the CoCT expects there to be very few households below the minimum service level for the 2014/15 year, and none during the 2015 MTREF.

These numbers show that the CoCT is working to provide households whose access to sanitation services is "below minimum service level" with access to sanitation services that in its view comply with minimum services levels. This is reflected by the growth in the number of households that have access to chemical toilets and "other toilet provisions" – which probably includes portable flush toilets. There are groups that contest whether portable flush toilets fall within the minimum service level for sanitation services, and would argue that they are simply a more sophisticated version of a bucket toilet.

However, far more revealing are the trends in the number of households being reported: there are 1 182 000 households in 2013/14 of which 40 600 have access to below minimum service level sanitation services. In 2015/16 there are only 1 134 925 households (i.e. 47 075 households fewer) – and all the households that were previously recorded as having access to below minimum service level sanitation services have disappeared. By the CoCT's own admission, the number of households in Cape Town is increasing. Therefore these sanitation numbers are not reflecting the full picture – there is a substantial block of households the CoCT is not reporting on here. To put it bluntly, the numbers appear to be wrong, and therefore convey an inaccurate picture of the real situation with regards to the provision of sanitation services in the CoCT.

Table 25 compares the number of households below the minimum sanitation level to the total number of households in all eight metros.

Table 25: Households below minimum sanitation service level as a percent of total households

	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16 MTREF		
	Audited Outcome	Audited Outcome	Audited Outcome	Audited Outcome	Original Budget	2015/16	2016/17	2017/18
Ekurhuleni Metro	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
City Of Tshwane	0.97%	0.86%	1.25%	0.00%	0.00%	0.00%	0.00%	0.00%
Mangaung	3.95%	1.19%	1.53%	0.80%	0.74%	0.80%	0.79%	0.77%
Cape Town	**2.65%**	**2.60%**	**5.32%**	**3.43%**	**0.05%**	**0.00%**	**0.00%**	**0.00%**
City Of Johannesburg	3.98%	3.81%	3.74%	1.76%	1.62%	1.60%	1.51%	1.43%
Nelson Mandela Bay	10.87%	11.62%	9.80%	9.84%	7.23%	6.48%	6.48%	6.48%
Buffalo City	25.67%	25.67%	2.87%	23.27%	8.49%	8.49%	8.49%	8.49%
eThekwini	21.81%	24.84%	24.84%	19.80%	18.25%	17.53%	16.84%	16.35%

Source: National Treasury Database, Medium-term budget (three year budget perspective of the summarised operational and capital appropriations)

In the above table, the cities are ranked from lowest to highest average percent between 2010/11 and 2014/15. Cape Town is ranked fourth behind Ekurhuleni, Tshwane and Manguang. All cities report a decline in the proportion of households with access to sanitation below the minimum service level. Only Ekurhuleni, Cape Town and Mangaung anticipate that there will be no households below the minimum service level for sanitation over the 2015 MTREF, but as noted above, the accuracy of the CoCT's numbers is questionable. Ekurhuleni reports no households below the minimum service level for the entire period, which suggests they do not collect and/or report this data.

Table 26 shows the total number of households reported by cities in Schedule A10 of their annual budgets.

Table 26: Total households reported by cities in Schedule A10

	2011/12	2012/13	2013/14	2014/15	Average Annual Growth
	Audited Outcome	Audited Outcome	Audited Outcome	Full Year Forecast	2011/12 - 2014/15
Ekurhuleni Metro	650 295	658 214	666 269	847 863	9.2%
Cape Town	**922 000**	**1 142 000**	**1 182 000**	**1 143 092**	**7.4%**
City Of Johannesburg	1 169 048	1 169 048	1 434 856	1 434 856	7.1%
eThekwini	946 000	946 000	1 020 367	1 041 000	3.2%
City Of Tshwane	831 040	929 770	938 800	911 536	3.1%
Mangaung	160 674	159 368	167 143	175 083	2.9%
Buffalo City	230 493	233 093	232 093	235 093	0.7%
Nelson Mandela Bay	327 000	297 841	307 052	324 292	-0.3%
	5 236 550	**5 535 334**	**5 948 580**	**6 112 815**	**5.3%**

Source: Schedule A10, National Treasury Database

The above table ranks the cities by average annual growth in the number of households between 2011/12 and 2014/15. According to these numbers, Cape Town has experienced the second fastest growth in the number of households after Ekurhuleni. It follows that cities experiencing more rapid urbanisation will experience more pressure on their resources to meet service delivery requirements. However, closer analysis of the numbers for all the cities reveals anomalies in the growth trend across years that strongly suggest that these numbers are not reliable. Given that household numbers are supposed to underpin cities' service delivery budgets, this is a serious indictment of the reliability of the information the CoCT and other cities are using to compile their budgets.

The above analysis should be considered in the context of Table 27, which shows the number of households below specific income thresholds. This data is compiled by the National Treasury, and is used as a measure of the number of poor households per municipality for the purpose of calculating the local government equitable share (LGES) allocations. It could be said that the number of households shown below determines how much each municipality receives through the LGES to provide free basic services, although it is more complicated than that.

Table 27: Households below income threshold used in LGES Calculations

Indicator	Households with monthly income < R2299			Households with monthly income < 2 old age pensions		Average Annual Growth
Source	*Based on Census 2011 Data*	*Census 2011 data, updated using 2013 General Household Survey*		*Based on Census 2011 data*	*Census 2011 data updated by assumed household growth rate*	
Year	2013	2014	2015	2016	2017	2013 -2017
Cape Town	470 237	484 997	500 351	512 579	532 683	3%
Buffalo City	134 930	137 191	139 622	146 950	150 642	3%
Nelson Mandela	178 457	182 638	187 095	190 638	196 785	2%
Ekurhuleni	532 516	553 393	575 154	593 275	621 058	4%
Ethewkini	529 748	540 992	557 023	579 396	601 048	3%
Manguang	126 187	130 045	134 258	144 641	150 356	4%
Johannesburg	708 634	739 757	772 332	800 399	841 719	4%
Tshwane	413 085	433 564	455 108	474 035	501 146	5%

Source: Local Government Equitable Share Formula data, National Treasury

The above table only covers households below the stated income thresholds. This data indicates that Cape Town is experiencing lower levels of growth in poor households compared to other metros. The significance of this becomes apparent after contemplating the data shown in Table 28.

Table 28 compares the cost of free basic services as a percent of total operational expenditure across the cities. The darker the shading, the closer that value is to the highest value in the table.

Table 28: Cost of free basic services as a percent of total operational expenditure

	2011/12	2012/13	2013/14	2014/15		2015/16 MTREF		
	Audited Outcome	Audited Outcome	Audited Outcome	Original Budget	Adjusted Budget	2015/16	2016/17	2017/18
Cape Town	6%	6%	6%	6%	6%	6%	6%	6%
Buffalo City	6%	6%	5%	5%	5%	5%	5%	5%
Nelson Mandela	3%	3%	3%	4%	4%	4%	4%	4%
Ekurhuleni	3%	3%	3%	3%	3%	4%	4%	3%
Ethewkini	1%	1%	2%	1%	3%	5%	5%	5%
Manguang	0%	0%	2%	2%	2%	6%	6%	6%
Johannesburg	0%	0%	1%	2%	3%	4%	4%	4%
Tshwane	2%	2%	2%	2%	2%	2%	2%	2%

Source: Own calculations applied to data from the National Treasury Local Government Database

The above table shows that the CoCT spends the highest percentage of its operating budget on free basic services relative to other cities. Secondly, according to the population data reported in Table 27, the growth in total households in Cape Town is much faster than the growth in the allocation it is receiving through the LGES to service poor households, yet it spends much more on free basic services than the other cities.

In terms of section 71 of the MFMA, municipalities are required to report on a range of service delivery targets on a quarterly basis, including information on performance targets related to "Sewerage":

- number of additional sanitation service points (toilets) to be installed for informal settlement dwellers; and
- number of additional households to be provided with sewer connections.

Table 29 presents data from 2013/14, 2014/15 and 2015/16 reports that the CoCT submitted to the National Treasury as required in terms of section 71. These section 71 reports report on the implementation of the municipalities' Service Delivery and Budget Implementation Plans (SDBIP).

Table 29: Performance Information Reported as per Section 71

			1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Summary	
	Backlog / Baseline	Year Target	Planned output	Actual output	Planned output	Actual output	Planned output	Actual output	Planned output	Actual output	Planned output	Actual Output
2015/16	*Number of additional sanitation service points (toilets) to be installed for informal settlement dwellers*											
	Backlog											
First Quarter		2 800	250	53	800		1 600		2 800		5 450	53
Second Quarter		2 800	250	53	800		1 600		2 800		5 450	53
2014/15	*Number of sanitation service points (toilets) installed for informal settlement dwellers*											
	Basline											
Fourth Quarter	5 043	3 100	500	270	1 000	634	1 500	790			3 000	1 154
2013/14	*Number of sanitation service points (toilets) installed for informal settlement dwellers*											
	Baseline											
First Quarter	5 043	3 100	700	1 988	1 500		2 300		3 100		7 600	1 988
Second Quarter	5 043	3 100	700	1 988	1 500		2 300		3 100		7 600	1 988
Third Quarter	5 043	3 100	700	1 988	1 500		2 300		3 100		7 600	1 988
Fourth Quarter	5 043	3 100	700	1 988	1 500	4 834	2 300	5 921	3 100	8 973	7 600	21 716

Source: Section 71 Reports, National Treasury Local Government Database

Up till 2014/15 municipalities reported "baseline information" at the start of the year, and since 2015/16 they are required to show backlogs at the beginning of the year. Also, before 2014/15 municipalities were required to report on "Backlog in the provision of basic sanitation services (above RDP standards)" on a quarterly basis. In the three years for which data was accessible, the CoCT does not show any data for this indicator. Either the CoCT does not have data on its backlogs, or it believes there are no backlogs. This is inconsistent with the data reflected in Table 24 above, which shows 40 600 households below the minimum service level for sanitation in 2013/14.

In 2013/14 the CoCT reported providing 21 716 additional sanitation service points for informal settlement dwellers. This is substantially larger than their target of 5 043 for the same period. However, given the information in Table 1 above, it is surprising that their baseline in 2014/15 is only 5 043.

The data for 2014/15 is incomplete, and therefore total delivery in that year is not known.

Note that the target for 2015/16 is 2 800 service points compared to the total of the quarterly targets, which is 5 450. Similarly, there is a difference in the target at the start of 2014/15 and the totals for each of the quarters.

In their monthly Report to Utility Services Portfolio Committee for December 2015, the Water and Sanitation Services Department note that by the end of December 441 services points had been delivered against the service target of 800. The target is consistent with the above table, but the performance has not been reflected in the data, even though it should be. These reporting gaps and anomalies suggest weaknesses in the CoCT's planning, delivery and monitoring of the rollout of sanitation services to informal settlements. It also suggests poor reporting oversight by the CoCT Council, given that section 71 reports should be tabled in Council, and ordinarily councillors should pick up on these gaps and anomalies and hold the administration accountable.

3. Capital Expenditure

Cities incur both operational and capital expenditure on sanitation systems and sewerage works. An analysis of the CoCT's capital expenditure shows the relative priority being given to expanding its infrastructure to deliver services. This section analyses all capital expenditure relevant to sanitation and sewerage. Municipalities are required to report on large capital projects – which sometimes includes information on the areas served by the project. However, more often the detail provided is limited, and this lack of transparency or lack of detail limits the usefulness of the information.

Municipalities are required to provide a range of details about capital expenditure in their budgets and in reporting schedules required by National Treasury. Table 30 shows what cities have budgeted for "Sewerage Purification and Reticulation" between 2013/14 and 2017/18.

Table 30: Budgeted Capital Expenditure

R'000s	Actual 2013/14	Actual 2014/15	MTREF 2015/16	2016/17	2017/18	Total 2013/14 to 2017/18
Sewerage Purification and Reticulation						
Cape Town	505 750	547 578	734 327	900 339	933 829	**3 621 824**
Buffalo City	158 854	173 258	-	-	-	**332 112**
Ekurhuleni Metro	179 000	144 217	268 100	178 500	155 000	**924 817**
eThekwini	770 400	700 750	556 069	640 252	691 301	**3 358 772**
City Of Johannesburg	-	-	316 824	399 974	482 958	**1 199 755**
Mangaung	227 147	118 238	452 337	620 694	621 800	**2 040 216**
Nelson Mandela Bay	249 000	303 450	264 450	356 350	341 600	**1 514 850**
City Of Tshwane	420 783	487 245	115 071	100 000	104 788	**1 227 887**
Sewerage Purification and Reticulation as Percent of Total Capital Expenditure						
Cape Town	9.3%	23.7%	12.7%	16.2%	17.4%	**14.8%**
Buffalo City	21.1%	3.1%				**3.2%**
Ekurhuleni Metro	6.0%	0.7%	6.0%	3.6%	3.0%	**2.4%**
eThekwini	14.1%	6.2%	9.2%	9.9%	10.0%	**9.3%**
City Of Johannesburg			3.2%	4.1%	5.2%	**2.9%**
Mangaung	26.2%	3.8%	25.2%	25.9%	28.4%	**19.7%**
Nelson Mandela Bay	21.2%	10.1%	16.4%	22.3%	20.8%	**16.8%**
City Of Tshwane	9.7%	48.4%	3.0%	2.5%	2.5%	**7.1%**

Source: Table A5 National Treasury Local Government Budget Database

Due to the lumpy nature of capital projects, the numbers do not present a smooth trend, and some cities report zero capital spending in certain years. Over this five-year period, the CoCT is planning to spend R3.6 billion on sewerage and reticulation capital projects. This is more than any other metro. It represents 14.8 percent of the CoCT's capital budget of R24.5 billion planned over the five years. This is a significant commitment to improving sanitation-related infrastructure. However, what these numbers do not show is which communities will be benefitting from this expenditure.

Table 31 compares average growth of budgeted expenditure on Sewerage Purification and Reticulation to growth in total budgeted capital expenditure.

Table 31: Annual Average Growth on Capital Budgets

	Annual Average Growth			
	Sewerage Purification and Reticulation		Total Capex	
	2013/14 - 2017/18	2015/16- 2017/18	2013/14 - 2017/18	2015/16- 2017/18
Cape Town	16.6%	12.8%	-0.3%	-3.6%
Buffalo City			19.3%	9.2%
Ekurhuleni Metro	-3.5%	-24.0%	14.8%	7.7%
eThekwini	-2.7%	11.5%	6.1%	7.1%
City Of Johannesburg		23.5%	5.2%	-3.0%
Mangaung	28.6%	17.2%	26.1%	10.4%
Nelson Mandela Bay	8.2%	13.7%	8.7%	1.0%
City Of Tshwane	-29.4%	-4.6%	-1.1%	3.9%

Source: Table A5 Budgeted Capital Expenditure by Standard Classification

The analysis shows that the CoCT is prioritising spending on capital infrastructure for Sewerage Purification and Reticulation relative to other capital spending – since spending on this item is growing while total capital spending is declining.

Table 32 presents information on the CoCT's capital budget for sanitation services from a different perspective. It shows capital expenditure on waste water management, which includes sanitation, storm water management and public toilets.

Table 32: Water and Waste Water Management Expenditure, Cape Town

	2011/12	2012/13	2013/14	Current year 2014/15			2015/16 Medium Term Revenue & Expenditure Framework			Annual Average Growth	
	Audited Outcome	Audited Outcome	Audited Outcome	Original Budget	Adjusted Budget	Original vs Adjusted	Budget Year 2015/16	Budget Year 2016/17	Budget Year 2017/18	2011/12- 2013/14	2015/16- 2017/18
Cape Town											
Total Capex	4 233 245	5 868 810	4 502 293	6 211 315	6 128 220	-1%	5 780 819	5 554 113	5 377 120	3.1%	-3.6%
Trading Services	1 723 002	2 010 573	2 118 932	2 741 528	2 278 597	-17%	2 916 115	2 950 434	2 938 115	10.9%	0.4%
Water + Waste Water Management	612 920	607 887	831 027	1 069 932	1 048 234	-2%	1 275 665	1 566 698	1 634 389		
Water	260 052	303 326	458 746	513 312	555 304	8%	576 954	688 988	734 259	32.8%	12.8%
Waste Water Management	352 868	304 561	372 281	556 619	492 930	-11%	698 711	877 710	900 130	2.7%	13.5%

Source: Table A5 Budgeted Capital Expenditure by Standard Classification

This table shows quite a mixed picture. The original vs adjusted columns for 2014/15 show the change between what the CoCT budgeted to spend and then what it forecast to spend at the end of the year. These are in-year changes in expenditure. Water and Waste Water Management fall under Trading Services[61]. The CoCT shows that it forecast to spend 17 percent less on capital for trading services

[61] The Trading Services not shown are ElectriCoCT and Waste Management.

than was budgeted. Expenditure on water was 8 percent higher than planned, but expenditure on waste water management was 11 percent lower than planned.

Over the period 2011/12–2013/14, capital expenditure for trading services grew at 10.9 percent but expenditure on waste water management grew at only 2.7 percent. In comparison, expenditure on water grew at 32.8 percent. This indicates that the CoCT prioritised spending on water infrastructure between 2011/12 and 2013/14. However, since 2014/15 the CoCT gives greater priority to capital spending for waste water management infrastructure. Over the 2015/16 MTREF, planned capital expenditure on waste water management grows at 13.5 percent compared to a declining capital budget on trading services was a whole. Again it is noted that these high level numbers indicate a deliberate strategy on the part of the CoCT to address sanitation infrastructure backlogs. However, it is also noted that these high level numbers do not show which communities will benefit from this expenditure.

The analysis continues in Table 33, which shows how capital expenditure is allocated across the different services.

Table 33: Capital expenditure by service as a percent of total, Cape Town

	2011/12	2012/13	2013/14	2014/15	2015/16 MTREF		
	Audited Outcome	Audited Outcome	Audited Outcome	Adjusted Budget	2015/16	2016/17	2017/18
As per cent of Total Standard Capital Expenditure							
Governance and Administration	8%	5%	7%	9%	9%	8%	7%
Community and Public Safety	20%	18%	19%	24%	14%	10%	9%
Economic and Environmental Services	31%	43%	26%	30%	26%	29%	30%
Trading Services	41%	34%	47%	37%	50%	53%	55%
As per cent of Trading Services							
Water	15%	15%	22%	24%	20%	23%	25%
Waste Water Management	20%	15%	18%	22%	24%	30%	31%

Source: Table A5 Budgeted Capital Expenditure by Standard Classification

The share of the capital budget allocated to trading services fluctuates slightly during the period under review, but grows from 41 percent to 55 percent. Similarly, the share of capital expenditure on trading services allocated to water as well as waste water management grew. This supports the comments made above – that the CoCT is prioritising funds towards these services.

Table 34 compares waste water management expenditure as a percent of total expenditure across all the metros.

Table 34: Waste water management expenditure as percent of capital expenditure, all metros

	2011/12	2012/13	2013/14	Current year 2014/15		2015/16 MTREF		
	Audited Outcome	Audited Outcome	Audited Outcome	Original Budget	Adjusted Budget	Budget Year 2015/16	Budget Year 2016/17	Budget Year 2017/18
Ethewkini	28%	22%	24%	12%	14%	10%	12%	11%
Manguang	20%	15%	22%	16%	21%			
Buffalo City	11%	21%	19%	23%	17%	20%	13%	19%
Tshwane	18%	15%	17%	8%	10%	9%	10%	10%
Nelson Mandela	9%	14%	14%	22%	19%	17%	23%	21%
Cape Town	**8%**	**5%**	**8%**	**9%**	8%	12%	16%	17%
Ekurhuleni	11%	5%	4%	3%	3%	6%	4%	3%
Johannesburg	0%	0%	0%	4%	4%	2%	3%	5%

Source: Table A5 Budgeted Capital Expenditure by Standard Classification

The cities are ranked from highest to lowest average between 2011/12 and 2013/14. Capital expenditure on waste water management in Cape Town has grown steadily, and over the 2015 MTREF its share of capital expenditure is also growing. However, in terms of waste water management as a percent of total capital expenditure, the CoCT is spending a lower percentage of its total budget on this function.

Table 35 shows the structure of capital expenditure on sanitation in the CoCT's budget. This is taken from budget Table A9. The purpose of this table is to show the balance between what a municipality is spending on new assets versus the renewal of existing assets, and what it is spending on repairs and maintenance relative to the asset value reflected on its asset register.

Table 35: Structure of sanitation capital expenditure, Cape Town

	2013/14	2014/15	2015/16 MTREF			Total Capital Expenditure 2013/14 to 2017/18	Expenditure as a % of Total Capital Expenditure
	Audited Outcome	Full Year Forecast	2015/16	2016/17	2017/18		
New Assets							
Total	2 503 677	3 585 792	3 036 236	3 071 321	2 933 986	15 131 013	55%
Sanitation	162 468	161 645	221 774	278 479	304 049	1 128 415	33%
Renewal of Existing Assets							
Total	1 998 616	2 542 428	2 744 583	2 482 792	2 443 134	12 211 553	45%
Sanitation	227 890	351 299	512 553	621 860	629 780	2 343 382	67%
Capital Expenditure							
Total	**4 502 293**	**6 128 220**	**5 780 819**	**5 554 113**	**5 377 120**	**27 342 566**	
Sanitation	**390 358**	**512 944**	**734 327**	**900 339**	**933 829**	**3 471 797**	

Source: Table A9 Asset Management, National Treasury Local Government Database

The above table shows that of the R3.5 billion the CoCT plans to spend on sanitation infrastructure, R2.3 billion (67 percent) will be for the renewal of existing assets and R1.1 billion (33 percent) will be for new sanitation assets. This stands in contrast with other areas of infrastructure investment, where the ratio of new to renewal is 55:45. While this seems to suggest that the CoCT is prioritising the renewal of existing sanitation infrastructure over the building of new sanitation infrastructure, the situation is actually more nuanced. If one considers that 90 percent of Cape Town's residents are serviced by the existing sanitation infrastructure, then the above numbers indicate that the CoCT is actually prioritising the extension of new sanitation infrastructure by spending 33 percent of the sanitation infrastructure budget on reaching the remaining 10 percent of residents with new infrastructure.

Table 36 shows repairs and maintenance expenditure on sanitation infrastructure as a percentage of the asset value of sanitation infrastructure.

Table 36: Repairs and maintenance as a percentage of sanitation assets

	2013/14	2014/15	2015/16 MTREF		
	Audited Outcome	Full Year Forecast	Budget Year 2015/16	Budget Year 2016/17	Budget Year 2017/18
Ekurhuleni Metro	3%	5%	6%	7%	7%
City Of Tshwane	12%	15%	43%	51%	50%
Mangaung	3%	5%			
Cape Town	18%	3%	3%	3%	3%
City Of Johannesburg	0%				
Nelson Mandela Bay	11%	12%	9%	8%	8%
Buffalo City	2%	1%	2%	2%	2%
eThekwini	4%	5%	5%	5%	5%

Source: Own calculations applied to data from Table A9 Asset Management, National Treasury Local Government Database

The above table shows that the CoCT's expenditure on the repair and maintenance of sanitation assets comes in at 3 percent of the value of such assets. This is lower than most of the other metros for which similar numbers are available.

The Municipal Finance Management Act allows municipalities to adjust budget allocations through an in-year adjustments budget. Table 37 shows the changes between the budget and adjusted budget made in the budget years of 2012/13 to 2014/15 for capital expenditure on sanitation.

Table 37: Changes between budget and adjusted budget, sanitation, Cape Town

	Budget Year		
	2012/13	2013/14	2014/15
New Assets			
Total	3%	4%	**-2%**
Sanitation	**-13%**	**-15%**	**-42%**
Renewal of Existing Assets			
Total	8%	2%	**-1%**
Sanitation	**-8%**	10%	0%
Capital Expenditure			
Total	**-6%**	**-2%**	**-10%**
Sanitation	**-11%**	**-3%**	**-18%**

The above table shows that the CoCT has struggled to adhere to its planned budgets for new sanitation infrastructure. In each of the three years shown, the budgets for new sanitation infrastructure have been adjusted down – in 2014/15 the downward adjustment was 42 percent of the original budget. While delays in capital projects happen, the downward adjustment of spending on new sanitation infrastructure over a three-year period raises questions about the quality of new infrastructure planning, as well as the ability of the CoCT to implement its plans for new sanitation infrastructure. This poor performance in relation to sanitation infrastructure stands in sharp contrast to the CoCT's ability to execute the rest of its infrastructure budget.

4. Capital projects

Municipalities are encouraged to provide (supporting documentation) a detailed project list of capital projects with their budgets, found in Table SA36: Detailed Capital Budget. National Treasury publishes this table for all municipalities on its website. The table requires a range of important variables about projects to be listed, such as the GPS co-ordinates of the project, expenditure per year, the ward location and whether the project is renewing capital or building a new capital asset.

The CoCT's project list in Table SA36 does not always provide the requested information. Many projects cut across a number of wards, and therefore "multi-ward" is often, but not always, given as the ward location. No GPS coordinates are provided for any project in Cape Town's project lists, which is a lost opportunity. Instead of using the "multi-ward" label, the CoCT might consider listing the relevant wards in certain instances so as to give residents a better sense of which areas will benefit from specific projects.

Table 38 gives a sample of the sanitation projects listed in the CoCT's Table SA36 for the 2014/15 and 2015/16 MTREFs periods. This sample covers projects in the areas of Khayelitsha covered in the scenarios for this project.

Table 38: Sanitation Projects in relevant Wards

Project Decription	Asset Sub-Class	Total Project Estimate	Audited Outcome	Full Year Forecast	Budget Year	Budget Year	Budget Year	New /Renewal
2014 MTREF			**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	
Bus. Park Main sewer	Reticulation	61 714 867	78 350		40 000 000	20 000 000	0	N
Water & Sanitation: Zandvliet WWTW-Extension	Sewerage purification	166 471 710	0	0	44 050 000	67 000 000	50 000 000	R
Water & Sanitation: Macassar WWTW-extension	Sewerage purification	60 000 000	0	0	0	5 000 000	5 000 000	R
2015 MTREF			**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	
Bus. Park Main sewer	Reticulation	69 207 672	592 807	18 500 000	36 500 000	12 500 000	0	N
Water & Sanitation: Zandvliet WWTW-Extension (Multi-Ward)	Sewerage purification	892 386 227	0	10 291 694	135 942 823	206 500 000	263 230 000	R
Water & Sanitation: Macassar WWTW Extension	Sewerage purification	138 800 000	0	0	0	5 000 000	63 150 000	R

Source: Table SA36, National Treasury Local Government Database

All of the projects are listed as falling in Ward 109, and the asset class is infrastructure-sanitation. The Zandvliet WWTW-Extension is listed as being in Ward 109 in the 2014 MTREF, but as multi-ward in 2015 MTREF. The scope of the project clearly changed between the MTREFs, as the total project cost grew substantially. The Macassar WWTW-Extension appears to increase in scope and its start delayed by a year between MTREFs. The Business Park Main Sewer Project appears to be progressing according to plan, with an increase in expenditure.

The information in Table SA36 has the potential to be a useful source of information to communities about the capital projects the CoCT is planning for their areas – which is ultimately the intention.

Municipalities are also encouraged to provide with their budgets (as supporting documentation) a detailed list of those capital projects that were delayed from the previous year in Table SA37: Projects delayed from the previous year. National Treasury publishes this table for all municipalities on its website. Table 39 shows the information that the CoCT listed in this table relating to sanitation projects that were delayed in 2014 and 2015.

Table 39: Sanitation projects delayed from previous years 2014 and 2015, Cape Town

Project Decription	Asset Sub-Class	Prev Target Year	Original Budget 2013/14	Forecast 2013/14	Budget year 2014/15	Budget year 2015/16	Budget year 2016/17	
Water & Sanitation: Trappies Sewerage System	Reticulation	2012/13	3 000 000	0	500 000	10 000 000	30 000 000	
				Original Budget 2014/15	**Forecast 2014/15**	**Budget year 2015/16**	**Budget year 2016/17**	**Budget year 2017/18**
Water & Sanitation: Construction of new Head Office	Buildings	2011/12		10 500 000	2 850 000	16 805 111	121 902 000	73 487 000
Water & Sanitation: Borchards Quarry WWTW	Sewerage purification	2011/12		15 000 000	13 238 492	52 000 000	66 000 000	66 500 000
Water & Sanitation: Scottsdene WWTW	Sewerage purification	2011/12		1 500 000	750 000	10 000 000	10 500 000	0
Water & Sanitation: Fisantekraal Housing Garden City - Sewer	Reticulation	2013/14		4 382 505	2 568 964	6 031 160	0	0
				31 382 505	**19 407 456**	**84 836 271**	**198 402 000**	**139 987 000**

Source: Table SA37, National Treasury Local Government Database

5. Summary

The annual MTREF budgets of the CoCT are an integral part of the context that gave rise to this project. As noted, the broader aim of developing the Sanitation Costing Model is to facilitate constructive discussions between the CoCT and communities that will hopefully inform budget priorities and decisions in future. To provide a better understanding of the budget context for such future allocation discussions, Cornerstone reviewed the CoCT and other metro's budgets from a sanitation perspective. This section summarises the main findings:

1. The CoCT's annual budget tables comply with the budget formats prescribed in terms of the Municipal Budget and Reporting Regulations (2009). This facilitates budget comparisons over

time and across municipalities. In this regard, the National Treasury Local Government Database is a very valuable source of municipal budget information, as it makes the information available in Excel format – thus facilitating analysis.

2. The narratives in the CoCT's 2014/15 and 2015/16 budget documents do acknowledge the sanitation pressures created by urbanisation. However, there is no specific information on the sanitation problems in Khayelitsha or any other informal area – not even a half page text box. It is submitted that the CoCT could use the opportunity presented by the annual budget to communicate its plans relating to sanitation rollout better.

3. The following table presents information from the CoCT's 2015/16 budget Table A10. It shows the progress the CoCT is making in addressing basic service delivery backlogs related to access to sanitation/sewerage services.

Table 40: CoCT: Basic Service Delivery Measurement – Sanitation/sewerage

	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16 MTREF		
	Audited Outcome	Audited Outcome	Audited Outcome	Audited Outcome	Full Year Forecast	Budget Year 2015/16	Budget Year 2016/17	Budget Year 2017/18
Flush toilet (connected to sewerage)	812 000	828 000	999 000	1 045 000	1 043 129	1 044 323	1 050 398	1 056 229
Flush toilet (with septic tank)								
Chemical toilet	16 000	17 000	23 000	24 000	29 080	29 955	29 955	29 955
Pit toilet (ventilated)	2 000	2 000	1 560	1 560				
Other toilet provisions (> min.service level)	50 000	51 000	58 000	70 840	70 506	60 647	66 723	72 553
Minimum Service Level and Above sub-total	880 000	898 000	1 081 560	1 141 400	1 142 715	1 134 925	1 147 076	1 158 737
Bucket toilet	4 000	4 000	800	600	377			
Other toilet provisions (< min.service level)								
No toilet provisions	20 000	20 000	60 000	40 000				
Below Minimum Service Level sub-total	24 000	24 000	60 800	40 600	377	-	-	-
Total number of households	**904 000**	**922 000**	**1 142 360**	**1 182 000**	**1 143 092**	**1 134 925**	**1 147 076**	**1 158 737**

Source: Table A10 Basic Service Delivery Measurement, CoCT 2015/16 Budget.

4. The above table indicates that the CoCT is making progress in expanding access to flush toilets. It also shows that the CoCT expects there to be very few households accessing below minimum standard sanitation services (as defined in the table) in 2014/15, and none during the 2015 MTREF.

5. However, the trends in the number of households being reported are inconsistent – there were 1 182 000 households in 2013/14, of which 40 600 had access to below minimum service level sanitation services. In 2015/16 there are only 1 134 925 households (i.e. 47 075 households fewer) – and all the households that were previously recorded as having access to below minimum service level sanitation services have disappeared. To put it bluntly, the numbers appear to be wrong, and therefore convey an inaccurate picture of the real situation with regards to the provision of sanitation services to, particularly, poorer households in the CoCT.

6. CoCT reports that it spends six percent of its operational budget on the provision of free basic services (which includes sanitation). This is the highest level among the metros, and indicates that the CoCT is prioritising the provision of free basic services within its budget.

7. The CoCT's section 71 reports on the implementation of its Service Delivery and Budget Implementation Plan (SDBIP) reveal that there are numerous gaps in reporting, and anomalies in the numbers themselves. These problems suggest weaknesses in the CoCT's planning, delivery and monitoring of the rollout of sanitation services to informal settlements. It also suggests poor reporting oversight by the CoCT Council, given that section 71 reports should be tabled in Council, and ordinarily councillors should pick up on these gaps and anomalies and hold the administration accountable.

8. Over the five-year period 2013/14 to 2017/18, the CoCT is planning to spend R3.6 billion on sewerage and reticulation capital projects. This is more than any other metro. It represents 14.8 percent of the CoCT's capital budget of R24.5 billion planned over the five years. This is a significant commitment to improving sanitation-related infrastructure. However, what these numbers do not show is which communities will benefit from this expenditure.

9. Over the period 2011/12–2013/14, capital expenditure for the trading services (electricity, water, waste water management (which includes sanitation) and solid waste management) grew at 10.9 percent. However, expenditure on waste water management grew at only 2.7 percent. In comparison, expenditure on water grew at 32.8 percent. This indicates that the CoCT prioritised spending on Water infrastructure between 2011/12 and 2013/14. However, since 2014/15 the CoCT is giving greater priority to capital spending for waste water management infrastructure. Over the 2015/16 MTREF, planned capital expenditure on waste water management grows at 13.5 percent compared to a declining capital budget on trading services was a whole. Again it is noted that these high level numbers indicate a deliberate strategy on the part of the CoCT to address sanitation infrastructure backlogs. However, it is also noted that these high level numbers do not show which communities will benefit from this expenditure.

10. Of the R3.5 billion the CoCT plans to spend on sanitation infrastructure between 2013/14 and 2017/18, R2.3 billion (67 percent) will be for the renewal of existing assets and R1.1 billion (33 percent) will be for new sanitation assets. This suggests that the CoCT is prioritising the renewal of existing sanitation infrastructure over the building of new sanitation infrastructure. However, the situation is actually more nuanced. If one considers that 90 percent of Cape Town's residents are serviced by the existing sanitation infrastructure, then the above numbers indicate that the CoCT is actually prioritising the extension of new sanitation infrastructure by spending 33 percent of the sanitation infrastructure budget on reaching the remaining 10 percent of residents with new infrastructure.

11. In the 2012/13, 2013/14 and 2014/15 financial years the CoCT adjusted sanitation infrastructure budgets downwards in each of the respective year's adjustments budgets. In 2014/15 the downward adjustment was 42 percent of the original budget. While delays in capital projects happen, the downward adjustment of spending on new sanitation infrastructure over a three-year period raises questions about the quality of new infrastructure planning, as well as the ability of the CoCT to implement its plans for new sanitation infrastructure. This poor performance in relation to sanitation infrastructure stands in sharp contrast to the CoCT's ability to execute the rest of its infrastructure budget.

12. Municipalities are encouraged to provide with their budgets (as supporting documentation) a detailed project list of capital projects in Table SA36: Detailed Capital Budget. This format requests project level information such as GPS co-ordinates of the project, expenditure per year, the Ward Location, and whether the project is renewing capital or building a new capital asset. The CoCT's project list in Table SA36 lists most projects as "multi-ward", and does not give GPS co-ordinates. This is a missed opportunity to provide detailed information on where capital spending is taking place. On the other hand, the names of the projects themselves often convey information of the areas where the projects are located.

13. The project lists in Table SA36 for 2015/16 show three capital projects being implemented in Ward 109 in Khayelitsha. Two appear to be going according to plan, and one has been

rescheduled by a year. The total project cost of two these projects has increased substantially between the 2014 and 2015 MTREFs.

Overall the analysis of CoCT's budgets from 2012/13 through to 2017/18 show that the CoCT is prioritising the provision of free basic services (including sanitation) in its operational budget, and spending on new sanitation infrastructure in its capital budget. The information in budget table SA36 should indicate which communities will benefit from this expenditure – but in many instances the geographical markers in the data are not very specific. Of particular concern is the CoCT's inaccurate reporting on the level of sanitation services that households receive, and the fact that the CoCT has consistently adjusted its original sanitation infrastructure budget downward in each of the financial years 2012/13 to 2014/15.

Annexure 3: Enkanini scenarios

Table 41: 1:5 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**4 782**	**0**	**49**	**455**	**1 541**	**602**
Chemical toilets	578	0	1	7	25	10
Portable flush toilets	3 109	0	4	37	124	48
Individual full-flush toilets	1 095	0	42	397	1 342	524
Fixed ablution blocks	0	0	1	7	25	10
Ablution containers	0	0	1	7	25	10
Total capital costs:		**0**	**1 905 818**	**16 064 339**	**59 313 643**	**24 880 448**
Individual full-flush toilets		0	739 818	7 412 619	26 560 703	10 993 202
Fixed ablution blocks		0	636 000	4 719 120	17 865 240	7 574 862
Ablution containers		0	530 000	3 932 600	14 887 700	6 312 385
Total number of units:	**4 782**	**4 673**	**4 612**	**1 271**	**2 702**	**3 190**
Chemical toilets	578	578	579	8	33	42
Portable flush toilets	3 109	3 109	3 113	41	165	209
Individual full-flush toilets	1 095	986	918	1 206	2 438	2 853
Fixed ablution blocks	0	0	1	8	33	43
Ablution containers	0	0	1	8	33	43
Total operating costs:		**30 405 242**	**32 200 701**	**8 674 236**	**24 252 859**	**31 586 488**
2015 baseline operating costs		30 900 380	32 754 402	34 719 667	36 802 847	39 011 017
Revised scenario operating costs						
Chemical toilets		0	21 200	-17 236 024	-17 531 756	-18 305 916
Portable flush toilets		0	19 080	-11 528 136	-11 683 867	-12 180 378
Individual full-flush toilets		-495 138	-848 382	561 418	7 232 788	10 033 002
Fixed ablution blocks		0	127 200	1 078 656	4 716 423	6 514 381
Ablution containers		0	127 200	1 078 656	4 716 423	6 514 381
Total cost of scenario		30 405 242	34 106 518	24 738 576	83 566 501	56 466 936

Table 42: 1:5 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**4 782**	**0**	**155**	**1 132**	**2 575**	**495**
Chemical toilets	578	0	9	58	107	8
Portable flush toilets	3 109	0	113	726	1 238	40
Individual full-flush toilets	1 095	0	33	340	1 192	431
Fixed ablution blocks	0	0	0	4	19	8
Ablution containers	0	0	0	4	19	8
Total capital costs:		**0**	**581 285**	**11 292 179**	**48 484 155**	**20 151 916**
Individual full-flush toilets		0	581 285	6 348 339	23 591 921	9 042 118
Fixed ablution blocks		0	0	2 696 640	13 577 582	6 059 889
Ablution containers		0	0	2 247 200	11 314 652	5 049 908
Total number of units:	**4 782**	**4 673**	**4 718**	**2 054**	**4 519**	**4 783**
Chemical toilets	578	578	587	67	174	173
Portable flush toilets	3 109	3 109	3 222	839	2 077	2 004
Individual full-flush toilets	1 095	986	909	1 140	2 222	2 544
Fixed ablution blocks	0	0	0	4	23	31
Ablution containers	0	0	0	4	23	31
Total operating costs:		**30 405 242**	**32 633 503**	**12 936 681**	**34 640 054**	**40 494 224**
2015 baseline operating costs		30 900 380	32 754 402	34 719 667	36 802 847	39 011 017
Revised scenario operating costs						
Chemical toilets		0	598 900	-12 752 860	-6 145 643	-6 975 185
Portable flush toilets		0	171 720	-10 334 873	-8 661 068	-9 203 457
Individual full-flush toilets		-495 138	-891 520	226 091	6 069 510	8 269 021
Fixed ablution blocks		0	0	539 328	3 287 204	4 696 414
Ablution containers		0	0	539 328	3 287 204	4 696 414
Total cost of scenario		30 405 242	33 214 788	24 228 860	83 124 209	60 646 140

Table 43: 1:3 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**4 782**	0	933	671	2 102	915
Chemical toilets	578	0	16	11	35	15
Portable flush toilets	3 109	0	47	34	105	46
Individual full-flush toilets	1 095	0	838	604	1 892	824
Fixed ablution blocks	0	0	16	11	35	15
Ablution containers	0	0	16	11	35	15
Total capital costs:		0	33 417 121	24 873 197	83 300 353	38 117 889
Individual full-flush toilets		0	14 761 121	11 277 637	37 446 237	17 287 020
Fixed ablution blocks		0	10 176 000	7 415 760	25 011 336	11 362 293
Ablution containers		0	8 480 000	6 179 800	20 842 780	9 468 577
Total number of units:	4 782	4 673	5 496	2 371	4 363	5 106
Chemical toilets	578	578	594	27	62	61
Portable flush toilets	3 109	3 109	3 156	81	186	185
Individual full-flush toilets	1 095	986	1 714	2 209	3 991	4 706
Fixed ablution blocks	0	0	16	27	62	77
Ablution containers	0	0	16	27	62	77
Total operating costs:		28 622 745	37 059 961	15 014 496	33 055 364	42 001 877
2015 baseline operating costs		28 919 828	30 655 017	32 494 319	34 443 978	36 510 616
Revised scenario operating costs						
Chemical toilets		0	249 100	-17 011 304	-17 406 699	-18 457 413
Portable flush toilets		0	305 280	-11 143 865	-11 062 157	-11 748 611
Individual full-flush toilets		-297 083	1 780 163	3 394 418	9 357 924	12 366 710
Fixed ablution blocks		0	2 035 200	3 640 464	8 861 159	11 665 287
Ablution containers		0	2 035 200	3 640 464	8 861 159	11 665 287
Total cost of scenario		28 622 745	70 477 082	39 887 693	116 355 717	80 119 766

Table 44: 1:3 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**4 782**	0	2 138	997	2 932	815
Chemical toilets	578	0	152	61	134	14
Portable flush toilets	3 109	0	1 363	531	1 067	41
Individual full-flush toilets	1 095	0	611	395	1 677	732
Fixed ablution blocks	0	0	6	5	27	14
Ablution containers	0	0	6	5	27	14
Total capital costs:		0	17 758 583	13 555 076	68 564 158	34 799 061
Individual full-flush toilets		0	10 762 583	7 375 276	33 190 983	15 356 916
Fixed ablution blocks		0	3 816 000	3 370 800	19 294 459	10 604 806
Ablution containers		0	3 180 000	2 809 000	16 078 716	8 837 339
Total number of units:	4 782	4 673	6 701	3 902	6 724	5 915
Chemical toilets	578	578	730	213	347	209
Portable flush toilets	3 109	3 109	4 472	1 894	2 961	1 639
Individual full-flush toilets	1 095	986	1 487	1 773	3 340	3 963
Fixed ablution blocks	0	0	6	11	38	52
Ablution containers	0	0	6	11	38	52
Total operating costs:		28 622 745	43 432 818	23 318 006	46 726 777	44 423 532
2015 baseline operating costs		28 919 828	30 655 017	32 494 319	34 443 978	36 510 616
Revised scenario operating costs						
Chemical toilets		0	7 223 900	-6 825 870	-881 352	-9 279 206
Portable flush toilets		0	2 900 160	-7 382 052	-4 952 245	-8 385 372
Individual full-flush toilets		-297 083	1 127 341	2 065 306	7 254 330	9 821 781
Fixed ablution blocks		0	763 200	1 483 152	5 431 033	7 877 856
Ablution containers		0	763 200	1 483 152	5 431 033	7 877 856
Total cost of scenario		28 622 745	61 191 402	36 873 082	115 290 935	79 222 593

Table 45: 1:1 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**4 782**	4 168	1 510	1 785	4 992	3 947
Chemical toilets	578	313	26	31	86	68
Portable flush toilets	3 109	1 552	26	31	86	68
Individual full-flush toilets	1 095	2 239	1 406	1 661	4 648	3 675
Fixed ablution blocks	0	32	26	31	86	68
Ablution containers	0	32	26	31	86	68
Total capital costs:		72 406 905	55 082 272	69 328 262	204 662 772	171 532 545
Individual full-flush toilets		37 206 905	24 766 272	31 013 502	91 992 658	77 099 268
Fixed ablution blocks		19 200 000	16 536 000	20 898 960	61 456 426	51 509 060
Ablution containers		16 000 000	13 780 000	17 415 800	51 213 688	42 924 217
Total number of units:	4 782	8 841	10 241	8 230	11 247	15 033
Chemical toilets	578	891	917	370	143	185
Portable flush toilets	3 109	4 661	4 687	1 609	143	185
Individual full-flush toilets	1 095	3 225	4 521	6 073	10 611	14 177
Fixed ablution blocks	0	32	58	89	175	243
Ablution containers	0	32	58	89	175	243
Total operating costs:		49 939 114	61 426 596	46 693 148	65 369 128	95 185 311
2015 baseline operating costs		26 939 276	28 555 632	30 268 970	32 085 109	34 010 215
Revised scenario operating costs						
Chemical toilets		7 760 000	8 363 400	-8 427 000	-17 662 767	-18 457 413
Portable flush toilets		5 634 000	6 468 120	-4 206 758	-9 325 655	-8 930 762
Individual full-flush toilets		1 925 838	3 284 243	5 057 840	10 249 770	14 935 615
Fixed ablution blocks		3 840 000	7 377 600	12 000 048	25 011 336	36 813 828
Ablution containers		3 840 000	7 377 600	12 000 048	25 011 336	36 813 828
Total cost of scenario		122 346 019	116 508 868	116 021 411	270 031 900	266 717 856

Table 46: 1:1 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**4 782**	4 469	1 760	1 987	5 265	4 762
Chemical toilets	578	463	150	128	222	82
Portable flush toilets	3 109	2 445	763	613	897	82
Individual full-flush toilets	1 095	1 535	827	1 208	4 008	4 434
Fixed ablution blocks	0	13	10	19	69	82
Ablution containers	0	13	10	19	69	82
Total capital costs:		39 808 084	26 227 359	46 038 515	169 723 969	206 898 049
Individual full-flush toilets		25 508 084	14 567 359	22 555 275	79 325 855	93 022 628
Fixed ablution blocks		7 800 000	6 360 000	12 809 040	49 308 062	62 113 866
Ablution containers		6 500 000	5 300 000	10 674 200	41 090 052	51 761 555
Total number of units:	4 782	9 142	10 792	8 983	11 230	14 970
Chemical toilets	578	1 041	1 191	741	500	432
Portable flush toilets	3 109	5 554	6 317	3 821	2 273	1 592
Individual full-flush toilets	1 095	2 521	3 238	4 337	8 235	12 560
Fixed ablution blocks	0	13	23	42	111	193
Ablution containers	0	13	23	42	111	193
Total operating costs:		51 907 443	65 159 602	52 185 337	64 853 701	92 683 899
2015 baseline operating costs		26 939 276	28 555 632	30 268 970	32 085 109	34 010 215
Revised scenario operating costs						
Chemical toilets		12 225 000	17 002 400	4 000 016	-4 978 447	-9 575 888
Portable flush toilets		8 334 000	11 696 040	3 296 642	-1 672 186	-3 317 789
Individual full-flush toilets		1 289 167	2 054 330	3 293 820	7 690 559	13 089 428
Fixed ablution blocks		1 560 000	2 925 600	5 662 944	15 864 333	29 238 966
Ablution containers		1 560 000	2 925 600	5 662 944	15 864 333	29 238 966
Total cost of scenario		91 715 527	91 386 961	98 223 851	234 577 670	299 581 949

Annexure 4: RR Section scenarios

Table 47: 1:5 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**526**	**188**	**286**	**645**	**519**
Chemical toilets	120	37	18	28	63	50
Portable flush toilets	571	370	92	139	313	252
Individual full-flush toilets	307	117	76	115	259	209
Fixed ablution blocks	0	1	1	2	5	4
Ablution containers	0	1	1	2	5	4
Total capital costs:		**3 044 264**	**2 504 717**	**4 619 152**	**11 676 685**	**9 939 592**
Individual full-flush toilets		1 944 264	1 338 717	2 147 232	5 126 097	4 384 693
Fixed ablution blocks		600 000	636 000	1 348 320	3 573 048	3 029 945
Ablution containers		500 000	530 000	1 123 600	2 977 540	2 524 954
Total number of units:	**998**	**1 493**	**1 651**	**1 215**	**1 422**	**1 801**
Chemical toilets	120	157	175	83	109	141
Portable flush toilets	571	941	1 033	601	544	704
Individual full-flush toilets	307	393	439	523	751	930
Fixed ablution blocks	0	1	2	4	9	13
Ablution containers	0	1	2	4	9	13
Total operating costs:		**9 549 427**	**11 424 961**	**8 790 432**	**12 194 553**	**16 893 230**
2015 baseline operating costs		6 403 195	6 787 387	7 194 630	7 626 308	8 083 886
Revised scenario operating costs						
Chemical toilets		1 850 000	2 448 600	168 540	-160 787	839 547
Portable flush toilets		666 000	1 049 400	-748 318	-235 821	477 216
Individual full-flush toilets		390 232	630 774	1 096 924	2 392 259	3 553 652
Fixed ablution blocks		120 000	254 400	539 328	1 286 297	1 969 464
Ablution containers		120 000	254 400	539 328	1 286 297	1 969 464
Total cost of scenario		12 593 691	13 929 678	13 409 584	23 871 238	26 832 822

Table 48: 1:5 toilet to household ratio and a 2-year rollout period with 26 888 m^2 of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**526**	**188**	**286**	**645**	**519**
Chemical toilets	120	37	18	28	63	50
Portable flush toilets	571	370	92	139	313	252
Individual full-flush toilets	307	117	76	115	259	209
Fixed ablution blocks	0	1	1	2	5	4
Ablution containers	0	1	1	2	5	4
Total capital costs:		**3 044 264**	**2 504 717**	**4 619 152**	**11 676 685**	**9 939 592**
Individual full-flush toilets		1 944 264	1 338 717	2 147 232	5 126 097	4 384 693
Fixed ablution blocks		600 000	636 000	1 348 320	3 573 048	3 029 945
Ablution containers		500 000	530 000	1 123 600	2 977 540	2 524 954
Total number of units:	**998**	**1 493**	**1 651**	**1 215**	**1 422**	**1 801**
Chemical toilets	120	157	175	83	109	141
Portable flush toilets	571	941	1 033	601	544	704
Individual full-flush toilets	307	393	439	523	751	930
Fixed ablution blocks	0	1	2	4	9	13
Ablution containers	0	1	2	4	9	13
Total operating costs:		**9 549 427**	**11 424 961**	**8 790 432**	**12 194 553**	**16 893 230**
2015 baseline operating costs		6 403 195	6 787 387	7 194 630	7 626 308	8 083 886
Revised scenario operating costs						
Chemical toilets		1 850 000	2 448 600	168 540	-160 787	839 547
Portable flush toilets		666 000	1 049 400	-748 318	-235 821	477 216
Individual full-flush toilets		390 232	630 774	1 096 924	2 392 259	3 553 652
Fixed ablution blocks		120 000	254 400	539 328	1 286 297	1 969 464
Ablution containers		120 000	254 400	539 328	1 286 297	1 969 464
Total cost of scenario		12 957 601	14 568 263	14 495 372	26 001 925	29 929 128

Table 49: 1:5 toilet to household ratio and a 2-year rollout period with 3 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**526**	**188**	**286**	**645**	**519**
Chemical toilets	120	37	18	28	63	50
Portable flush toilets	571	370	92	139	313	252
Individual full-flush toilets	307	117	76	115	259	209
Fixed ablution blocks	0	1	1	2	5	4
Ablution containers	0	1	1	2	5	4
Total capital costs:		**3 044 264**	**2 504 717**	**4 619 152**	**11 676 685**	**9 939 592**
Individual full-flush toilets		1 944 264	1 338 717	2 147 232	5 126 097	4 384 693
Fixed ablution blocks		600 000	636 000	1 348 320	3 573 048	3 029 945
Ablution containers		500 000	530 000	1 123 600	2 977 540	2 524 954
Total number of units:	**998**	**1 493**	**1 651**	**1 215**	**1 422**	**1 801**
Chemical toilets	120	157	175	83	109	141
Portable flush toilets	571	941	1 033	601	544	704
Individual full-flush toilets	307	393	439	523	751	930
Fixed ablution blocks	0	1	2	4	9	13
Ablution containers	0	1	2	4	9	13
Total operating costs:		**9 549 427**	**11 424 961**	**8 790 432**	**12 194 553**	**16 893 230**
2015 baseline operating costs		6 403 195	6 787 387	7 194 630	7 626 308	8 083 886
Revised scenario operating costs						
Chemical toilets		1 850 000	2 448 600	168 540	-160 787	839 547
Portable flush toilets		666 000	1 049 400	-748 318	-235 821	477 216
Individual full-flush toilets		390 232	630 774	1 096 924	2 392 259	3 553 652
Fixed ablution blocks		120 000	254 400	539 328	1 286 297	1 969 464
Ablution containers		120 000	254 400	539 328	1 286 297	1 969 464
Total cost of scenario		12 640 878	13 968 501	13 481 181	24 052 227	26 986 885

Table 50: 1:5 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**669**	**331**	**418**	**812**	**518**
Chemical toilets	120	43	23	31	67	50
Portable flush toilets	571	508	240	283	491	252
Individual full-flush toilets	307	118	68	102	246	208
Fixed ablution blocks	0	0	0	1	4	4
Ablution containers	0	0	0	1	4	4
Total capital costs:		**1 960 882**	**1 197 800**	**3 140 462**	**10 109 273**	**9 918 612**
Individual full-flush toilets		1 960 882	1 197 800	1 904 502	4 868 802	4 363 714
Fixed ablution blocks		0	0	674 160	2 858 438	3 029 945
Ablution containers		0	0	561 800	2 382 032	2 524 954
Total number of units:	**998**	**1 636**	**1 937**	**1 633**	**1 863**	**2 088**
Chemical toilets	120	163	186	97	121	148
Portable flush toilets	571	1 079	1 319	1 031	1 014	1 026
Individual full-flush toilets	307	394	432	503	718	896
Fixed ablution blocks	0	0	0	1	5	9
Ablution containers	0	0	0	1	5	9
Total operating costs:		**10 111 949**	**12 608 289**	**10 578 713**	**13 929 602**	**17 678 817**
2015 baseline operating costs		6 403 195	6 787 387	7 194 630	7 626 308	8 083 886
Revised scenario operating costs						
Chemical toilets		2 540 000	3 964 400	2 584 280	2 638 100	2 872 135
Portable flush toilets		774 000	1 259 280	-465 170	21 438	636 288
Individual full-flush toilets		394 754	597 222	995 310	2 214 536	3 359 557
Fixed ablution blocks		0	0	134 832	714 610	1 363 475
Ablution containers		0	0	134 832	714 610	1 363 475
Total cost of scenario		12 072 831	13 806 089	13 719 175	24 038 875	27 597 429

Table 51: 1:5 toilet to household ratio and a 5-year rollout period with 26 888 m² of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**669**	**331**	**418**	**812**	**518**
Chemical toilets	120	43	23	31	67	50
Portable flush toilets	571	508	240	283	491	252
Individual full-flush toilets	307	118	68	102	246	208
Fixed ablution blocks	0	0	0	1	4	4
Ablution containers	0	0	0	1	4	4
Total capital costs:		**1 960 882**	**1 197 800**	**3 140 462**	**10 109 273**	**9 918 612**
Individual full-flush toilets		1 960 882	1 197 800	1 904 502	4 868 802	4 363 714
Fixed ablution blocks		0	0	674 160	2 858 438	3 029 945
Ablution containers		0	0	561 800	2 382 032	2 524 954
Total number of units:	**998**	**1 636**	**1 937**	**1 633**	**1 863**	**2 088**
Chemical toilets	120	163	186	97	121	148
Portable flush toilets	571	1 079	1 319	1 031	1 014	1 026
Individual full-flush toilets	307	394	432	503	718	896
Fixed ablution blocks	0	0	0	1	5	9
Ablution containers	0	0	0	1	5	9
Total operating costs:		**10 111 949**	**12 608 289**	**10 578 713**	**13 929 602**	**17 678 817**
2015 baseline operating costs		6 403 195	6 787 387	7 194 630	7 626 308	8 083 886
Revised scenario operating costs						
Chemical toilets		2 540 000	3 964 400	2 584 280	2 638 100	2 872 135
Portable flush toilets		774 000	1 259 280	-465 170	21 438	636 288
Individual full-flush toilets		394 754	597 222	995 310	2 214 536	3 359 557
Fixed ablution blocks		0	0	134 832	714 610	1 363 475
Ablution containers		0	0	134 832	714 610	1 363 475
Total cost of scenario		12 437 875	14 416 022	14 727 205	26 043 256	30 565 682

Table 52: 1:5 toilet to household ratio and a 5-year rollout period with 3 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**669**	**331**	**418**	**812**	**518**
Chemical toilets	120	43	23	31	67	50
Portable flush toilets	571	508	240	283	491	252
Individual full-flush toilets	307	118	68	102	246	208
Fixed ablution blocks	0	0	0	1	4	4
Ablution containers	0	0	0	1	4	4
Total capital costs:		**1 960 882**	**1 197 800**	**3 140 462**	**10 109 273**	**9 918 612**
Individual full-flush toilets		1 960 882	1 197 800	1 904 502	4 868 802	4 363 714
Fixed ablution blocks		0	0	674 160	2 858 438	3 029 945
Ablution containers		0	0	561 800	2 382 032	2 524 954
Total number of units:	**998**	**1 636**	**1 937**	**1 633**	**1 863**	**2 088**
Chemical toilets	120	163	186	97	121	148
Portable flush toilets	571	1 079	1 319	1 031	1 014	1 026
Individual full-flush toilets	307	394	432	503	718	896
Fixed ablution blocks	0	0	0	1	5	9
Ablution containers	0	0	0	1	5	9
Total operating costs:		**10 111 949**	**12 608 289**	**10 578 713**	**13 929 602**	**17 678 817**
2015 baseline operating costs		6 403 195	6 787 387	7 194 630	7 626 308	8 083 886
Revised scenario operating costs						
Chemical toilets		2 540 000	3 964 400	2 584 280	2 638 100	2 872 135
Portable flush toilets		774 000	1 259 280	-465 170	21 438	636 288
Individual full-flush toilets		394 754	597 222	995 310	2 214 536	3 359 557
Fixed ablution blocks		0	0	134 832	714 610	1 363 475
Ablution containers		0	0	134 832	714 610	1 363 475
Total cost of scenario		12 103 225	13 824 655	13 767 852	24 195 569	27 751 168

Table 53: 1:3 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	1 113	210	346	754	840
Chemical toilets	120	104	25	42	91	101
Portable flush toilets	571	671	76	125	273	304
Individual full-flush toilets	307	332	105	173	376	419
Fixed ablution blocks	0	3	2	3	7	8
Ablution containers	0	3	2	3	7	8
Total capital costs:		8 817 058	4 181 544	6 938 064	16 612 570	19 900 163
Individual full-flush toilets		5 517 058	1 849 544	3 230 184	7 441 747	8 790 366
Fixed ablution blocks		1 800 000	1 272 000	2 022 480	5 002 267	6 059 889
Ablution containers		1 500 000	1 060 000	1 685 400	4 168 556	5 049 908
Total number of units:	998	2 080	2 260	1 884	1 832	2 541
Chemical toilets	120	224	249	171	158	234
Portable flush toilets	571	1 242	1 318	872	474	702
Individual full-flush toilets	307	608	683	825	1 170	1 559
Fixed ablution blocks	0	3	5	8	15	23
Ablution containers	0	3	5	8	15	23
Total operating costs:		12 612 369	14 971 389	13 029 292	14 278 914	22 055 905
2015 baseline operating costs		5 847 917	6 198 792	6 570 720	6 964 963	7 382 860
Revised scenario operating costs						
Chemical toilets		3 355 000	3 959 100	1 691 018	-577 643	826 922
Portable flush toilets		1 872 000	2 461 320	1 031 465	814 655	2 590 603
Individual full-flush toilets		817 452	1 080 177	1 578 778	2 789 282	4 286 647
Fixed ablution blocks		360 000	636 000	1 078 656	2 143 829	3 484 436
Ablution containers		360 000	636 000	1 078 656	2 143 829	3 484 436
Total cost of scenario		21 429 427	19 152 933	19 967 356	30 891 484	41 956 068

Table 54: 1:3 toilet to household ratio and a 2-year rollout period with 26 888 m^2 of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**1 113**	**210**	**346**	**754**	**840**
Chemical toilets	120	104	25	42	91	101
Portable flush toilets	571	671	76	125	273	304
Individual full-flush toilets	307	332	105	173	376	419
Fixed ablution blocks	0	3	2	3	7	8
Ablution containers	0	3	2	3	7	8
Total capital costs:		**8 817 058**	**4 181 544**	**6 938 064**	**16 612 570**	**19 900 163**
Individual full-flush toilets		5 517 058	1 849 544	3 230 184	7 441 747	8 790 366
Fixed ablution blocks		1 800 000	1 272 000	2 022 480	5 002 267	6 059 889
Ablution containers		1 500 000	1 060 000	1 685 400	4 168 556	5 049 908
Total number of units:	**998**	**2 080**	**2 260**	**1 884**	**1 832**	**2 541**
Chemical toilets	120	224	249	171	158	234
Portable flush toilets	571	1 242	1 318	872	474	702
Individual full-flush toilets	307	608	683	825	1 170	1 559
Fixed ablution blocks	0	3	5	8	15	23
Ablution containers	0	3	5	8	15	23
Total operating costs:		**12 612 369**	**14 971 389**	**13 029 292**	**14 278 914**	**22 055 905**
2015 baseline operating costs		5 847 917	6 198 792	6 570 720	6 964 963	7 382 860
Revised scenario operating costs						
Chemical toilets		3 355 000	3 959 100	1 691 018	-577 643	826 922
Portable flush toilets		1 872 000	2 461 320	1 031 465	814 655	2 590 603
Individual full-flush toilets		817 452	1 080 177	1 578 778	2 789 282	4 286 647
Fixed ablution blocks		360 000	636 000	1 078 656	2 143 829	3 484 436
Ablution containers		360 000	636 000	1 078 656	2 143 829	3 484 436
Total cost of scenario		22 051 967	20 025 630	21 262 853	33 120 235	45 330 037

Table 55: 1:3 toilet to household ratio and a 2-year rollout period with 3 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**1 113**	**210**	**346**	**754**	**840**
Chemical toilets	120	104	25	42	91	101
Portable flush toilets	571	671	76	125	273	304
Individual full-flush toilets	307	332	105	173	376	419
Fixed ablution blocks	0	3	2	3	7	8
Ablution containers	0	3	2	3	7	8
Total capital costs:		**8 817 058**	**4 181 544**	**6 938 064**	**16 612 570**	**19 900 163**
Individual full-flush toilets		5 517 058	1 849 544	3 230 184	7 441 747	8 790 366
Fixed ablution blocks		1 800 000	1 272 000	2 022 480	5 002 267	6 059 889
Ablution containers		1 500 000	1 060 000	1 685 400	4 168 556	5 049 908
Total number of units:	**998**	**2 080**	**2 260**	**1 884**	**1 832**	**2 541**
Chemical toilets	120	224	249	171	158	234
Portable flush toilets	571	1 242	1 318	872	474	702
Individual full-flush toilets	307	608	683	825	1 170	1 559
Fixed ablution blocks	0	3	5	8	15	23
Ablution containers	0	3	5	8	15	23
Total operating costs:		**12 612 369**	**14 971 389**	**13 029 292**	**14 278 914**	**22 055 905**
2015 baseline operating costs		5 847 917	6 198 792	6 570 720	6 964 963	7 382 860
Revised scenario operating costs						
Chemical toilets		3 355 000	3 959 100	1 691 018	-577 643	826 922
Portable flush toilets		1 872 000	2 461 320	1 031 465	814 655	2 590 603
Individual full-flush toilets		817 452	1 080 177	1 578 778	2 789 282	4 286 647
Fixed ablution blocks		360 000	636 000	1 078 656	2 143 829	3 484 436
Ablution containers		360 000	636 000	1 078 656	2 143 829	3 484 436
Total cost of scenario		21 566 092	19 217 746	20 074 896	31 148 979	42 264 520

Table 56: 1:3 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	1 360	268	465	880	911
Chemical toilets	120	115	24	45	94	110
Portable flush toilets	571	921	169	265	428	330
Individual full-flush toilets	307	322	73	151	348	455
Fixed ablution blocks	0	1	1	2	5	8
Ablution containers	0	1	1	2	5	8
Total capital costs:		6 450 881	2 451 873	5 291 329	13 438 162	20 655 421
Individual full-flush toilets		5 350 881	1 285 873	2 819 409	6 887 574	9 545 624
Fixed ablution blocks		600 000	636 000	1 348 320	3 573 048	6 059 889
Ablution containers		500 000	530 000	1 123 600	2 977 540	5 049 908
Total number of units:	998	2 327	2 565	2 308	2 121	2 809
Chemical toilets	120	235	259	184	163	249
Portable flush toilets	571	1 492	1 661	1 355	862	1 023
Individual full-flush toilets	307	598	641	761	1 078	1 503
Fixed ablution blocks	0	1	2	4	9	17
Ablution containers	0	1	2	4	9	17
Total operating costs:		13 553 239	16 096 102	14 731 954	14 684 332	22 413 271
2015 baseline operating costs		5 847 917	6 198 792	6 570 720	6 964 963	7 382 860
Revised scenario operating costs						
Chemical toilets		4 605 000	5 777 000	4 404 512	1 732 928	2 853 198
Portable flush toilets		2 070 000	2 652 120	1 294 387	921 846	2 931 472
Individual full-flush toilets		790 322	959 390	1 383 679	2 492 000	4 094 835
Fixed ablution blocks		120 000	254 400	539 328	1 286 297	2 575 453
Ablution containers		120 000	254 400	539 328	1 286 297	2 575 453
Total cost of scenario		20 004 120	18 547 976	20 023 283	28 122 494	43 068 692

Table 57: 1:3 toilet to household ratio and a 5-year rollout period with 26 888 m² of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**1 360**	**268**	**465**	**880**	**911**
Chemical toilets	120	115	24	45	94	110
Portable flush toilets	571	921	169	265	428	330
Individual full-flush toilets	307	322	73	151	348	455
Fixed ablution blocks	0	1	1	2	5	8
Ablution containers	0	1	1	2	5	8
Total capital costs:		**6 450 881**	**2 451 873**	**5 291 329**	**13 438 162**	**20 655 421**
Individual full-flush toilets		5 350 881	1 285 873	2 819 409	6 887 574	9 545 624
Fixed ablution blocks		600 000	636 000	1 348 320	3 573 048	6 059 889
Ablution containers		500 000	530 000	1 123 600	2 977 540	5 049 908
Total number of units:	**998**	**2 327**	**2 565**	**2 308**	**2 121**	**2 809**
Chemical toilets	120	235	259	184	163	249
Portable flush toilets	571	1 492	1 661	1 355	862	1 023
Individual full-flush toilets	307	598	641	761	1 078	1 503
Fixed ablution blocks	0	1	2	4	9	17
Ablution containers	0	1	2	4	9	17
Total operating costs:		**13 553 239**	**16 096 102**	**14 731 954**	**14 684 332**	**22 413 271**
2015 baseline operating costs		5 847 917	6 198 792	6 570 720	6 964 963	7 382 860
Revised scenario operating costs						
Chemical toilets		4 605 000	5 777 000	4 404 512	1 732 928	2 853 198
Portable flush toilets		2 070 000	2 652 120	1 294 387	921 846	2 931 472
Individual full-flush toilets		790 322	959 390	1 383 679	2 492 000	4 094 835
Fixed ablution blocks		120 000	254 400	539 328	1 286 297	2 575 453
Ablution containers		120 000	254 400	539 328	1 286 297	2 575 453
Total cost of scenario		20 614 034	19 344 140	21 195 061	30 167 225	46 355 463

Table 58: 1:3 toilet to household ratio and a 5-year rollout period with 3 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**1 360**	**268**	**465**	**880**	**911**
Chemical toilets	120	115	24	45	94	110
Portable flush toilets	571	921	169	265	428	330
Individual full-flush toilets	307	322	73	151	348	455
Fixed ablution blocks	0	1	1	2	5	8
Ablution containers	0	1	1	2	5	8
Total capital costs:		**6 450 881**	**2 451 873**	**5 291 329**	**13 438 162**	**20 655 421**
Individual full-flush toilets		5 350 881	1 285 873	2 819 409	6 887 574	9 545 624
Fixed ablution blocks		600 000	636 000	1 348 320	3 573 048	6 059 889
Ablution containers		500 000	530 000	1 123 600	2 977 540	5 049 908
Total number of units:	**998**	**2 327**	**2 565**	**2 308**	**2 121**	**2 809**
Chemical toilets	120	235	259	184	163	249
Portable flush toilets	571	1 492	1 661	1 355	862	1 023
Individual full-flush toilets	307	598	641	761	1 078	1 503
Fixed ablution blocks	0	1	2	4	9	17
Ablution containers	0	1	2	4	9	17
Total operating costs:		**13 553 239**	**16 096 102**	**14 731 954**	**14 684 332**	**22 413 271**
2015 baseline operating costs		5 847 917	6 198 792	6 570 720	6 964 963	7 382 860
Revised scenario operating costs						
Chemical toilets		4 605 000	5 777 000	4 404 512	1 732 928	2 853 198
Portable flush toilets		2 070 000	2 652 120	1 294 387	921 846	2 931 472
Individual full-flush toilets		790 322	959 390	1 383 679	2 492 000	4 094 835
Fixed ablution blocks		120 000	254 400	539 328	1 286 297	2 575 453
Ablution containers		120 000	254 400	539 328	1 286 297	2 575 453
Total cost of scenario		20 104 109	18 585 980	20 105 298	28 330 785	43 388 851

Table 59: 1:1 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	2 531	628	735	1 454	2 140
Chemical toilets	120	349	100	117	231	340
Portable flush toilets	571	972	100	117	231	340
Individual full-flush toilets	307	1 182	412	483	956	1 408
Fixed ablution blocks	0	14	8	9	18	26
Ablution containers	0	14	8	9	18	26
Total capital costs:		35 042 055	16 585 258	20 142 015	42 503 154	65 645 826
Individual full-flush toilets		19 642 055	7 257 258	9 018 375	18 921 037	29 538 985
Fixed ablution blocks		8 400 000	5 088 000	6 067 440	12 862 973	19 694 641
Ablution containers		7 000 000	4 240 000	5 056 200	10 719 144	16 412 200
Total number of units:	998	3 498	4 096	4 109	4 211	6 121
Chemical toilets	120	469	569	566	448	688
Portable flush toilets	571	1 543	1 643	1 189	448	688
Individual full-flush toilets	307	1 458	1 840	2 292	3 217	4 595
Fixed ablution blocks	0	14	22	31	49	75
Ablution containers	0	14	22	31	49	75
Total operating costs:		20 835 830	26 924 703	28 815 516	29 743 852	47 947 725
2015 baseline operating costs		5 292 639	5 610 197	5 946 809	6 303 618	6 681 835
Revised scenario operating costs						
Chemical toilets		4 860 000	5 681 600	3 471 924	-732 475	738 549
Portable flush toilets		6 282 000	8 566 920	9 020 261	7 031 758	12 907 564
Individual full-flush toilets		1 041 191	1 469 186	2 016 938	3 134 603	4 895 192
Fixed ablution blocks		1 680 000	2 798 400	4 179 792	7 003 174	11 362 293
Ablution containers		1 680 000	2 798 400	4 179 792	7 003 174	11 362 293
Total cost of scenario		55 877 886	43 509 961	48 957 531	72 247 007	113 593 551

Table 60: 1:1 toilet to household ratio and a 2-year rollout period with 26 888 m² of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**2 531**	**628**	**735**	**1 454**	**2 140**
Chemical toilets	120	349	100	117	231	340
Portable flush toilets	571	972	100	117	231	340
Individual full-flush toilets	307	1 182	412	483	956	1 408
Fixed ablution blocks	0	14	8	9	18	26
Ablution containers	0	14	8	9	18	26
Total capital costs:		**35 042 055**	**16 585 258**	**20 142 015**	**42 503 154**	**65 645 826**
Individual full-flush toilets		19 642 055	7 257 258	9 018 375	18 921 037	29 538 985
Fixed ablution blocks		8 400 000	5 088 000	6 067 440	12 862 973	19 694 641
Ablution containers		7 000 000	4 240 000	5 056 200	10 719 144	16 412 200
Total number of units:	**998**	**3 498**	**4 096**	**4 109**	**4 211**	**6 121**
Chemical toilets	120	469	569	566	448	688
Portable flush toilets	571	1 543	1 643	1 189	448	688
Individual full-flush toilets	307	1 458	1 840	2 292	3 217	4 595
Fixed ablution blocks	0	14	22	31	49	75
Ablution containers	0	14	22	31	49	75
Total operating costs:		**20 835 830**	**26 924 703**	**28 815 516**	**29 743 852**	**47 947 725**
2015 baseline operating costs		5 292 639	5 610 197	5 946 809	6 303 618	6 681 835
Revised scenario operating costs						
Chemical toilets		4 860 000	5 681 600	3 471 924	-732 475	738 549
Portable flush toilets		6 282 000	8 566 920	9 020 261	7 031 758	12 907 564
Individual full-flush toilets		1 041 191	1 469 186	2 016 938	3 134 603	4 895 192
Fixed ablution blocks		1 680 000	2 798 400	4 179 792	7 003 174	11 362 293
Ablution containers		1 680 000	2 798 400	4 179 792	7 003 174	11 362 293
Total cost of scenario		56 635 779	44 597 494	50 462 909	74 582 742	117 223 944

Table 61: 1:1 toilet to household ratio and a 2-year rollout period with 3 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**2 531**	**628**	**735**	**1 454**	**2 140**
Chemical toilets	120	349	100	117	231	340
Portable flush toilets	571	972	100	117	231	340
Individual full-flush toilets	307	1 182	412	483	956	1 408
Fixed ablution blocks	0	14	8	9	18	26
Ablution containers	0	14	8	9	18	26
Total capital costs:		**35 042 055**	**16 585 258**	**20 142 015**	**42 503 154**	**65 645 826**
Individual full-flush toilets		19 642 055	7 257 258	9 018 375	18 921 037	29 538 985
Fixed ablution blocks		8 400 000	5 088 000	6 067 440	12 862 973	19 694 641
Ablution containers		7 000 000	4 240 000	5 056 200	10 719 144	16 412 200
Total number of units:	**998**	**3 498**	**4 096**	**4 109**	**4 211**	**6 121**
Chemical toilets	120	469	569	566	448	688
Portable flush toilets	571	1 543	1 643	1 189	448	688
Individual full-flush toilets	307	1 458	1 840	2 292	3 217	4 595
Fixed ablution blocks	0	14	22	31	49	75
Ablution containers	0	14	22	31	49	75
Total operating costs:		**20 835 830**	**26 924 703**	**28 815 516**	**29 743 852**	**47 947 725**
2015 baseline operating costs		5 292 639	5 610 197	5 946 809	6 303 618	6 681 835
Revised scenario operating costs						
Chemical toilets		4 860 000	5 681 600	3 471 924	-732 475	738 549
Portable flush toilets		6 282 000	8 566 920	9 020 261	7 031 758	12 907 564
Individual full-flush toilets		1 041 191	1 469 186	2 016 938	3 134 603	4 895 192
Fixed ablution blocks		1 680 000	2 798 400	4 179 792	7 003 174	11 362 293
Ablution containers		1 680 000	2 798 400	4 179 792	7 003 174	11 362 293
Total cost of scenario		56 421 038	43 767 032	49 269 732	72 905 805	114 611 062

Table 62: 1:1 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	2 667	693	797	1 518	2 443
Chemical toilets	120	338	93	113	228	388
Portable flush toilets	571	1 335	294	273	386	388
Individual full-flush toilets	307	982	300	401	876	1 607
Fixed ablution blocks	0	6	3	5	14	30
Ablution containers	0	6	3	5	14	30
Total capital costs:		22 918 526	8 782 411	13 667 106	35 679 333	75 375 624
Individual full-flush toilets		16 318 526	5 284 411	7 487 306	17 337 687	33 713 884
Fixed ablution blocks		3 600 000	1 908 000	3 370 800	10 004 534	22 724 585
Ablution containers		3 000 000	1 590 000	2 809 000	8 337 112	18 937 154
Total number of units:	998	3 634	4 297	4 372	4 186	6 212
Chemical toilets	120	458	551	544	434	729
Portable flush toilets	571	1 906	2 200	1 902	953	1 047
Individual full-flush toilets	307	1 258	1 528	1 898	2 743	4 320
Fixed ablution blocks	0	6	9	14	28	58
Ablution containers	0	6	9	14	28	58
Total operating costs:		20 351 958	25 927 073	27 391 557	25 937 761	45 680 696
2015 baseline operating costs		5 292 639	5 610 197	5 946 809	6 303 618	6 681 835
Revised scenario operating costs						
Chemical toilets		6 675 000	8 633 700	7 477 558	2 274 841	3 004 695
Portable flush toilets		6 084 000	8 223 480	8 575 315	6 731 622	13 839 272
Individual full-flush toilets		860 319	1 170 096	1 616 578	2 624 053	4 581 214
Fixed ablution blocks		720 000	1 144 800	1 887 648	4 001 814	8 786 840
Ablution containers		720 000	1 144 800	1 887 648	4 001 814	8 786 840
Total cost of scenario		43 270 485	34 709 484	41 058 662	61 617 095	121 056 320

Table 63: 1:1 toilet to household ratio and a 5-year rollout period with 26 888 m² of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**2 667**	**693**	**797**	**1 518**	**2 443**
Chemical toilets	120	338	93	113	228	388
Portable flush toilets	571	1 335	294	273	386	388
Individual full-flush toilets	307	982	300	401	876	1 607
Fixed ablution blocks	0	6	3	5	14	30
Ablution containers	0	6	3	5	14	30
Total capital costs:		**22 918 526**	**8 782 411**	**13 667 106**	**35 679 333**	**75 375 624**
Individual full-flush toilets		16 318 526	5 284 411	7 487 306	17 337 687	33 713 884
Fixed ablution blocks		3 600 000	1 908 000	3 370 800	10 004 534	22 724 585
Ablution containers		3 000 000	1 590 000	2 809 000	8 337 112	18 937 154
Total number of units:	**998**	**3 634**	**4 297**	**4 372**	**4 186**	**6 212**
Chemical toilets	120	458	551	544	434	729
Portable flush toilets	571	1 906	2 200	1 902	953	1 047
Individual full-flush toilets	307	1 258	1 528	1 898	2 743	4 320
Fixed ablution blocks	0	6	9	14	28	58
Ablution containers	0	6	9	14	28	58
Total operating costs:		**20 351 958**	**25 927 073**	**27 391 557**	**25 937 761**	**45 680 696**
2015 baseline operating costs		5 292 639	5 610 197	5 946 809	6 303 618	6 681 835
Revised scenario operating costs						
Chemical toilets		6 675 000	8 633 700	7 477 558	2 274 841	3 004 695
Portable flush toilets		6 084 000	8 223 480	8 575 315	6 731 622	13 839 272
Individual full-flush toilets		860 319	1 170 096	1 616 578	2 624 053	4 581 214
Fixed ablution blocks		720 000	1 144 800	1 887 648	4 001 814	8 786 840
Ablution containers		720 000	1 144 800	1 887 648	4 001 814	8 786 840
Total cost of scenario		43 926 410	35 618 805	42 327 277	63 672 311	124 623 609

Table 64: 1:1 toilet to household ratio and a 5-year rollout period with 3 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**998**	**2 667**	**693**	**797**	**1 518**	**2 443**
Chemical toilets	120	338	93	113	228	388
Portable flush toilets	571	1 335	294	273	386	388
Individual full-flush toilets	307	982	300	401	876	1 607
Fixed ablution blocks	0	6	3	5	14	30
Ablution containers	0	6	3	5	14	30
Total capital costs:		**22 918 526**	**8 782 411**	**13 667 106**	**35 679 333**	**75 375 624**
Individual full-flush toilets		16 318 526	5 284 411	7 487 306	17 337 687	33 713 884
Fixed ablution blocks		3 600 000	1 908 000	3 370 800	10 004 534	22 724 585
Ablution containers		3 000 000	1 590 000	2 809 000	8 337 112	18 937 154
Total number of units:	**998**	**3 634**	**4 297**	**4 372**	**4 186**	**6 212**
Chemical toilets	120	458	551	544	434	729
Portable flush toilets	571	1 906	2 200	1 902	953	1 047
Individual full-flush toilets	307	1 258	1 528	1 898	2 743	4 320
Fixed ablution blocks	0	6	9	14	28	58
Ablution containers	0	6	9	14	28	58
Total operating costs:		**20 351 958**	**25 927 073**	**27 391 557**	**25 937 761**	**45 680 696**
2015 baseline operating costs		5 292 639	5 610 197	5 946 809	6 303 618	6 681 835
Revised scenario operating costs						
Chemical toilets		6 675 000	8 633 700	7 477 558	2 274 841	3 004 695
Portable flush toilets		6 084 000	8 223 480	8 575 315	6 731 622	13 839 272
Individual full-flush toilets		860 319	1 170 096	1 616 578	2 624 053	4 581 214
Fixed ablution blocks		720 000	1 144 800	1 887 648	4 001 814	8 786 840
Ablution containers		720 000	1 144 800	1 887 648	4 001 814	8 786 840
Total cost of scenario		43 625 722	34 845 611	41 270 502	62 170 124	122 224 642

Annexure 5: CT Section scenarios

Table 65: 1:5 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	**1 872**	**93**	**300**	**559**	**879**
Chemical toilets	115	167	6	20	37	58
Portable flush toilets	334	1 256	31	99	184	290
Individual full-flush toilets	152	439	54	175	326	513
Fixed ablution blocks	0	5	1	3	6	9
Ablution containers	0	5	1	3	6	9
Total capital costs:		**12 795 146**	**2 117 194**	**6 975 407**	**14 312 858**	**23 260 950**
Individual full-flush toilets		7 295 146	951 194	3 267 527	6 452 153	10 762 428
Fixed ablution blocks		3 000 000	636 000	2 022 480	4 287 658	6 817 376
Ablution containers		2 500 000	530 000	1 685 400	3 573 048	5 681 146
Total number of units:	**601**	**2 458**	**2 536**	**2 371**	**1 492**	**2 319**
Chemical toilets	115	282	288	193	63	115
Portable flush toilets	334	1 590	1 621	1 386	314	573
Individual full-flush toilets	152	576	615	774	1 085	1 583
Fixed ablution blocks	0	5	6	9	15	24
Ablution containers	0	5	6	9	15	24
Total operating costs:		**16 829 657**	**18 558 589**	**18 051 407**	**13 352 559**	**22 539 029**
2015 baseline operating costs		4 427 315	4 692 954	4 974 531	5 273 003	5 589 383
Revised scenario operating costs						
Chemical toilets		6 280 000	6 821 100	5 910 136	-119 102	1 508 660
Portable flush toilets		3 006 000	3 300 840	1 577 534	-1 114 791	0
Individual full-flush toilets		1 916 342	2 217 296	3 162 230	5 025 791	8 169 119
Fixed ablution blocks		600 000	763 200	1 213 488	2 143 829	3 635 934
Ablution containers		600 000	763 200	1 213 488	2 143 829	3 635 934
Total cost of scenario		29 624 803	20 675 783	25 026 814	27 665 417	45 799 979

Table 66: 1:5 toilet to household ratio and a 2-year rollout period with 7.5 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	**1 872**	**93**	**300**	**559**	**879**
Chemical toilets	115	167	6	20	37	58
Portable flush toilets	334	1 256	31	99	184	290
Individual full-flush toilets	152	439	54	175	326	513
Fixed ablution blocks	0	5	1	3	6	9
Ablution containers	0	5	1	3	6	9
Total capital costs:		**12 795 146**	**2 117 194**	**6 975 407**	**14 312 858**	**23 260 950**
Individual full-flush toilets		7 295 146	951 194	3 267 527	6 452 153	10 762 428
Fixed ablution blocks		3 000 000	636 000	2 022 480	4 287 658	6 817 376
Ablution containers		2 500 000	530 000	1 685 400	3 573 048	5 681 146
Total number of units:	**601**	**2 458**	**2 536**	**2 371**	**1 492**	**2 319**
Chemical toilets	115	282	288	193	63	115
Portable flush toilets	334	1 590	1 621	1 386	314	573
Individual full-flush toilets	152	576	615	774	1 085	1 583
Fixed ablution blocks	0	5	6	9	15	24
Ablution containers	0	5	6	9	15	24
Total operating costs:		**16 829 657**	**18 558 589**	**18 051 407**	**13 352 559**	**22 539 029**
2015 baseline operating costs		4 427 315	4 692 954	4 974 531	5 273 003	5 589 383
Revised scenario operating costs						
Chemical toilets		6 280 000	6 821 100	5 910 136	-119 102	1 508 660
Portable flush toilets		3 006 000	3 300 840	1 577 534	-1 114 791	0
Individual full-flush toilets		1 916 342	2 217 296	3 162 230	5 025 791	8 169 119
Fixed ablution blocks		600 000	763 200	1 213 488	2 143 829	3 635 934
Ablution containers		600 000	763 200	1 213 488	2 143 829	3 635 934
Total cost of scenario		30 104 621	20 755 178	25 288 392	28 202 150	46 672 265

Table 67: 1:5 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	**2 466**	**6**	**570**	**740**	**1 049**
Chemical toilets	115	232	1	49	59	69
Portable flush toilets	334	1 836	4	362	393	346
Individual full-flush toilets	152	394	1	155	280	612
Fixed ablution blocks	0	2	0	2	4	11
Ablution containers	0	2	0	2	4	11
Total capital costs:		**8 747 352**	**17 615**	**5 366 016**	**10 782 197**	**28 115 360**
Individual full-flush toilets		6 547 352	17 615	2 894 096	5 541 726	12 839 388
Fixed ablution blocks		1 200 000	0	1 348 320	2 858 438	8 332 348
Ablution containers		1 000 000	0	1 123 600	2 382 032	6 943 623
Total number of units:	**601**	**3 052**	**3 043**	**3 148**	**1 805**	**2 834**
Chemical toilets	115	347	348	282	109	177
Portable flush toilets	334	2 170	2 174	2 202	759	1 101
Individual full-flush toilets	152	531	517	656	921	1 518
Fixed ablution blocks	0	2	2	4	8	19
Ablution containers	0	2	2	4	8	19
Total operating costs:		**19 976 176**	**21 146 964**	**22 487 859**	**14 104 594**	**25 394 856**
2015 baseline operating costs		4 427 315	4 692 954	4 974 531	5 273 003	5 589 383
Revised scenario operating costs						
Chemical toilets		9 180 000	9 752 000	10 494 424	2 530 909	4 841 599
Portable flush toilets		4 176 000	4 445 640	3 377 542	-128 630	1 408 924
Individual full-flush toilets		1 712 861	1 747 570	2 562 707	4 142 562	7 798 055
Fixed ablution blocks		240 000	254 400	539 328	1 143 375	2 878 447
Ablution containers		240 000	254 400	539 328	1 143 375	2 878 447
Total cost of scenario		28 723 527	21 164 579	27 853 875	24 886 791	53 510 215

Table 68: 1:5 toilet to household ratio and a 5-year rollout period with 7.5 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	**2 466**	**6**	**570**	**740**	**1 049**
Chemical toilets	115	232	1	49	59	69
Portable flush toilets	334	1 836	4	362	393	346
Individual full-flush toilets	152	394	1	155	280	612
Fixed ablution blocks	0	2	0	2	4	11
Ablution containers	0	2	0	2	4	11
Total capital costs:		**8 747 352**	**17 615**	**5 366 016**	**10 782 197**	**28 115 360**
Individual full-flush toilets		6 547 352	17 615	2 894 096	5 541 726	12 839 388
Fixed ablution blocks		1 200 000	0	1 348 320	2 858 438	8 332 348
Ablution containers		1 000 000	0	1 123 600	2 382 032	6 943 623
Total number of units:	**601**	**3 052**	**3 043**	**3 148**	**1 805**	**2 834**
Chemical toilets	115	347	348	282	109	177
Portable flush toilets	334	2 170	2 174	2 202	759	1 101
Individual full-flush toilets	152	531	517	656	921	1 518
Fixed ablution blocks	0	2	2	4	8	19
Ablution containers	0	2	2	4	8	19
Total operating costs:		**19 976 176**	**21 146 964**	**22 487 859**	**14 104 594**	**25 394 856**
2015 baseline operating costs		4 427 315	4 692 954	4 974 531	5 273 003	5 589 383
Revised scenario operating costs						
Chemical toilets		9 180 000	9 752 000	10 494 424	2 530 909	4 841 599
Portable flush toilets		4 176 000	4 445 640	3 377 542	-128 630	1 408 924
Individual full-flush toilets		1 712 861	1 747 570	2 562 707	4 142 562	7 798 055
Fixed ablution blocks		240 000	254 400	539 328	1 143 375	2 878 447
Ablution containers		240 000	254 400	539 328	1 143 375	2 878 447
Total cost of scenario		29 051 553	21 165 239	28 055 101	25 291 124	54 564 541

Table 69: 1:3 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	2 514	170	426	725	1 320
Chemical toilets	115	284	13	32	55	100
Portable flush toilets	334	1 424	39	97	165	301
Individual full-flush toilets	152	788	114	287	487	887
Fixed ablution blocks	0	9	2	5	9	16
Ablution containers	0	9	2	5	9	16
Total capital costs:		22 994 704	4 340 076	11 538 545	21 429 704	40 828 316
Individual full-flush toilets		13 094 704	2 008 076	5 358 745	9 638 646	18 608 721
Fixed ablution blocks		5 400 000	1 272 000	3 370 800	6 431 486	12 119 779
Ablution containers		4 500 000	1 060 000	2 809 000	5 359 572	10 099 816
Total number of units:	601	3 100	3 255	3 216	2 218	3 471
Chemical toilets	115	399	412	329	100	187
Portable flush toilets	334	1 758	1 797	1 560	301	563
Individual full-flush toilets	152	925	1 024	1 295	1 767	2 639
Fixed ablution blocks	0	9	11	16	25	41
Ablution containers	0	9	11	16	25	41
Total operating costs:		20 641 061	23 127 200	23 681 589	16 792 806	29 265 265
2015 baseline operating costs		4 152 389	4 401 532	4 665 624	4 945 562	5 242 295
Revised scenario operating costs						
Chemical toilets		7 120 000	7 753 900	6 887 668	-196 518	1 445 536
Portable flush toilets		5 112 000	5 666 760	4 328 107	-321 574	1 636 170
Individual full-flush toilets		2 096 672	2 506 608	3 485 566	5 219 240	8 518 490
Fixed ablution blocks		1 080 000	1 399 200	2 157 312	3 573 048	6 211 387
Ablution containers		1 080 000	1 399 200	2 157 312	3 573 048	6 211 387
Total cost of scenario		43 635 764	27 467 276	35 220 134	38 222 510	70 093 580

Table 70: 1:3 toilet to household ratio and a 2-year rollout period with 7.5 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	2 514	170	426	725	1 320
Chemical toilets	115	284	13	32	55	100
Portable flush toilets	334	1 424	39	97	165	301
Individual full-flush toilets	152	788	114	287	487	887
Fixed ablution blocks	0	9	2	5	9	16
Ablution containers	0	9	2	5	9	16
Total capital costs:		22 994 704	4 340 076	11 538 545	21 429 704	40 828 316
Individual full-flush toilets		13 094 704	2 008 076	5 358 745	9 638 646	18 608 721
Fixed ablution blocks		5 400 000	1 272 000	3 370 800	6 431 486	12 119 779
Ablution containers		4 500 000	1 060 000	2 809 000	5 359 572	10 099 816
Total number of units:	601	3 100	3 255	3 216	2 218	3 471
Chemical toilets	115	399	412	329	100	187
Portable flush toilets	334	1 758	1 797	1 560	301	563
Individual full-flush toilets	152	925	1 024	1 295	1 767	2 639
Fixed ablution blocks	0	9	11	16	25	41
Ablution containers	0	9	11	16	25	41
Total operating costs:		20 641 061	23 127 200	23 681 589	16 792 806	29 265 265
2015 baseline operating costs		4 152 389	4 401 532	4 665 624	4 945 562	5 242 295
Revised scenario operating costs						
Chemical toilets		7 120 000	7 753 900	6 887 668	-196 518	1 445 536
Portable flush toilets		5 112 000	5 666 760	4 328 107	-321 574	1 636 170
Individual full-flush toilets		2 096 672	2 506 608	3 485 566	5 219 240	8 518 490
Fixed ablution blocks		1 080 000	1 399 200	2 157 312	3 573 048	6 211 387
Ablution containers		1 080 000	1 399 200	2 157 312	3 573 048	6 211 387
Total cost of scenario		44 498 066	27 630 029	35 652 829	39 026 123	71 624 642

Table 71: 1:3 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	3 157	96	672	879	1 591
Chemical toilets	115	389	11	73	84	121
Portable flush toilets	334	2 081	58	352	360	362
Individual full-flush toilets	152	679	27	241	421	1 068
Fixed ablution blocks	0	4	0	3	7	20
Ablution containers	0	4	0	3	7	20
Total capital costs:		15 683 380	475 597	8 207 732	17 503 205	50 180 485
Individual full-flush toilets		11 283 380	475 597	4 499 852	8 332 381	22 405 991
Fixed ablution blocks		2 400 000	0	2 022 480	5 002 267	15 149 724
Ablution containers		2 000 000	0	1 685 400	4 168 556	12 624 770
Total number of units:	601	3 743	3 824	4 031	2 425	3 932
Chemical toilets	115	504	515	473	168	278
Portable flush toilets	334	2 415	2 473	2 491	770	1 074
Individual full-flush toilets	152	816	828	1 053	1 459	2 512
Fixed ablution blocks	0	4	4	7	14	34
Ablution containers	0	4	4	7	14	34
Total operating costs:		24 320 335	26 330 770	28 659 624	16 904 011	32 002 868
2015 baseline operating costs		4 152 389	4 401 532	4 665 624	4 945 562	5 242 295
Revised scenario operating costs						
Chemical toilets		10 405 000	11 336 700	12 118 026	2 596 415	4 671 165
Portable flush toilets		7 002 000	7 632 000	7 240 478	1 136 229	3 704 107
Individual full-flush toilets		1 800 946	1 942 938	2 747 848	4 223 991	8 083 488
Fixed ablution blocks		480 000	508 800	943 824	2 000 907	5 150 906
Ablution containers		480 000	508 800	943 824	2 000 907	5 150 906
Total cost of scenario		40 003 715	26 806 367	36 867 356	34 407 215	82 183 353

Table 72: 1:3 toilet to household ratio and a 5-year rollout period with 7.5 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	3 157	96	672	879	1 591
Chemical toilets	115	389	11	73	84	121
Portable flush toilets	334	2 081	58	352	360	362
Individual full-flush toilets	152	679	27	241	421	1 068
Fixed ablution blocks	0	4	0	3	7	20
Ablution containers	0	4	0	3	7	20
Total capital costs:		15 683 380	475 597	8 207 732	17 503 205	50 180 485
Individual full-flush toilets		11 283 380	475 597	4 499 852	8 332 381	22 405 991
Fixed ablution blocks		2 400 000	0	2 022 480	5 002 267	15 149 724
Ablution containers		2 000 000	0	1 685 400	4 168 556	12 624 770
Total number of units:	601	3 743	3 824	4 031	2 425	3 932
Chemical toilets	115	504	515	473	168	278
Portable flush toilets	334	2 415	2 473	2 491	770	1 074
Individual full-flush toilets	152	816	828	1 053	1 459	2 512
Fixed ablution blocks	0	4	4	7	14	34
Ablution containers	0	4	4	7	14	34
Total operating costs:		24 320 335	26 330 770	28 659 624	16 904 011	32 002 868
2015 baseline operating costs		4 152 389	4 401 532	4 665 624	4 945 562	5 242 295
Revised scenario operating costs						
Chemical toilets		10 405 000	11 336 700	12 118 026	2 596 415	4 671 165
Portable flush toilets		7 002 000	7 632 000	7 240 478	1 136 229	3 704 107
Individual full-flush toilets		1 800 946	1 942 938	2 747 848	4 223 991	8 083 488
Fixed ablution blocks		480 000	508 800	943 824	2 000 907	5 150 906
Ablution containers		480 000	508 800	943 824	2 000 907	5 150 906
Total cost of scenario		40 591 842	26 824 202	37 175 146	35 063 585	84 065 121

Table 73: 1:1 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	4 585	891	1 059	1 612	3 320
Chemical toilets	115	668	80	95	144	297
Portable flush toilets	334	1 592	80	95	144	297
Individual full-flush toilets	152	2 265	705	837	1 276	2 628
Fixed ablution blocks	0	30	13	16	24	49
Ablution containers	0	30	13	16	24	49
Total capital costs:		70 638 964	27 576 365	35 403 477	56 697 261	123 181 352
Individual full-flush toilets		37 638 964	12 418 365	15 628 117	25 254 439	55 133 844
Fixed ablution blocks		18 000 000	8 268 000	10 786 560	17 150 630	37 116 823
Ablution containers		15 000 000	6 890 000	8 988 800	14 292 192	30 930 686
Total number of units:	601	5 171	6 047	6 641	5 978	9 123
Chemical toilets	115	783	863	843	319	536
Portable flush toilets	334	1 926	2 006	1 767	319	536
Individual full-flush toilets	152	2 402	3 092	3 913	5 174	7 787
Fixed ablution blocks	0	30	43	59	83	132
Ablution containers	0	30	43	59	83	132
Total operating costs:		33 096 096	41 000 720	46 863 253	38 036 701	64 449 782
2015 baseline operating costs		3 877 463	4 110 111	4 356 717	4 618 120	4 895 208
Revised scenario operating costs						
Chemical toilets		7 960 000	8 861 600	8 050 594	-89 326	1 275 102
Portable flush toilets		12 024 000	14 271 840	14 723 654	4 373 411	9 567 050
Individual full-flush toilets		2 034 633	2 817 969	3 822 112	5 409 457	8 717 152
Fixed ablution blocks		3 600 000	5 469 600	7 955 088	11 862 519	19 997 635
Ablution containers		3 600 000	5 469 600	7 955 088	11 862 519	19 997 635
Total cost of scenario		103 735 059	68 577 085	82 266 730	94 733 962	187 631 134

Table 74: 1:1 toilet to household ratio and a 2-year rollout period with 7.5 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	4 585	891	1 059	1 612	3 320
Chemical toilets	115	668	80	95	144	297
Portable flush toilets	334	1 592	80	95	144	297
Individual full-flush toilets	152	2 265	705	837	1 276	2 628
Fixed ablution blocks	0	30	13	16	24	49
Ablution containers	0	30	13	16	24	49
Total capital costs:		70 638 964	27 576 365	35 403 477	56 697 261	123 181 352
Individual full-flush toilets		37 638 964	12 418 365	15 628 117	25 254 439	55 133 844
Fixed ablution blocks		18 000 000	8 268 000	10 786 560	17 150 630	37 116 823
Ablution containers		15 000 000	6 890 000	8 988 800	14 292 192	30 930 686
Total number of units:	601	5 171	6 047	6 641	5 978	9 123
Chemical toilets	115	783	863	843	319	536
Portable flush toilets	334	1 926	2 006	1 767	319	536
Individual full-flush toilets	152	2 402	3 092	3 913	5 174	7 787
Fixed ablution blocks	0	30	43	59	83	132
Ablution containers	0	30	43	59	83	132
Total operating costs:		33 096 096	41 000 720	46 863 253	38 036 701	64 449 782
2015 baseline operating costs		3 877 463	4 110 111	4 356 717	4 618 120	4 895 208
Revised scenario operating costs						
Chemical toilets		7 960 000	8 861 600	8 050 594	-89 326	1 275 102
Portable flush toilets		12 024 000	14 271 840	14 723 654	4 373 411	9 567 050
Individual full-flush toilets		2 034 633	2 817 969	3 822 112	5 409 457	8 717 152
Fixed ablution blocks		3 600 000	5 469 600	7 955 088	11 862 519	19 997 635
Ablution containers		3 600 000	5 469 600	7 955 088	11 862 519	19 997 635
Total cost of scenario		106 384 021	69 611 199	83 594 360	96 860 110	192 250 435

Table 75: 1:1 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	4 874	1 015	1 159	1 700	4 067
Chemical toilets	115	849	158	157	193	364
Portable flush toilets	334	2 326	398	348	339	364
Individual full-flush toilets	152	1 675	449	636	1 130	3 219
Fixed ablution blocks	0	12	5	9	19	60
Ablution containers	0	12	5	9	19	60
Total capital costs:		41 034 554	13 739 002	22 998 768	47 257 059	150 856 145
Individual full-flush toilets		27 834 554	7 909 002	11 875 128	22 364 824	67 532 665
Fixed ablution blocks		7 200 000	3 180 000	6 067 440	13 577 582	45 449 171
Ablution containers		6 000 000	2 650 000	5 056 200	11 314 652	37 874 309
Total number of units:	601	5 460	6 460	7 154	5 664	9 160
Chemical toilets	115	964	1 122	1 164	508	714
Portable flush toilets	334	2 660	3 058	3 072	1 085	1 051
Individual full-flush toilets	152	1 812	2 246	2 866	3 981	7 185
Fixed ablution blocks	0	12	17	26	45	105
Ablution containers	0	12	17	26	45	105
Total operating costs:		35 170 522	44 092 644	50 724 093	34 503 072	62 877 460
2015 baseline operating costs		3 877 463	4 110 111	4 356 717	4 618 120	4 895 208
Revised scenario operating costs						
Chemical toilets		11 630 000	14 437 200	15 382 084	4 472 265	4 525 980
Portable flush toilets		15 282 000	19 213 560	21 215 815	8 425 247	13 612 027
Individual full-flush toilets		1 501 059	2 006 974	2 758 212	4 124 466	8 029 827
Fixed ablution blocks		1 440 000	2 162 400	3 505 632	6 431 486	15 907 210
Ablution containers		1 440 000	2 162 400	3 505 632	6 431 486	15 907 210
Total cost of scenario		76 205 076	57 831 646	73 722 861	81 760 130	213 733 605

Table 76: 1:1 toilet to household ratio and a 5-year rollout period with 7.5 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**601**	4 874	1 015	1 159	1 700	4 067
Chemical toilets	115	849	158	157	193	364
Portable flush toilets	334	2 326	398	348	339	364
Individual full-flush toilets	152	1 675	449	636	1 130	3 219
Fixed ablution blocks	0	12	5	9	19	60
Ablution containers	0	12	5	9	19	60
Total capital costs:		41 034 554	13 739 002	22 998 768	47 257 059	150 856 145
Individual full-flush toilets		27 834 554	7 909 002	11 875 128	22 364 824	67 532 665
Fixed ablution blocks		7 200 000	3 180 000	6 067 440	13 577 582	45 449 171
Ablution containers		6 000 000	2 650 000	5 056 200	11 314 652	37 874 309
Total number of units:	601	5 460	6 460	7 154	5 664	9 160
Chemical toilets	115	964	1 122	1 164	508	714
Portable flush toilets	334	2 660	3 058	3 072	1 085	1 051
Individual full-flush toilets	152	1 812	2 246	2 866	3 981	7 185
Fixed ablution blocks	0	12	17	26	45	105
Ablution containers	0	12	17	26	45	105
Total operating costs:		35 170 522	44 092 644	50 724 093	34 503 072	62 877 460
2015 baseline operating costs		3 877 463	4 110 111	4 356 717	4 618 120	4 895 208
Revised scenario operating costs						
Chemical toilets		11 630 000	14 437 200	15 382 084	4 472 265	4 525 980
Portable flush toilets		15 282 000	19 213 560	21 215 815	8 425 247	13 612 027
Individual full-flush toilets		1 501 059	2 006 974	2 758 212	4 124 466	8 029 827
Fixed ablution blocks		1 440 000	2 162 400	3 505 632	6 431 486	15 907 210
Ablution containers		1 440 000	2 162 400	3 505 632	6 431 486	15 907 210
Total cost of scenario		77 743 872	58 346 859	74 585 315	83 532 270	219 390 711

Annexure 6: TR Section scenarios

Table 77: 1:5 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 025**	**261**	**320**	**611**	**561**
Chemical toilets	38	32	22	26	50	46
Portable flush toilets	854	879	108	132	252	232
Individual full-flush toilets	22	110	127	156	297	273
Fixed ablution blocks	0	2	2	3	6	5
Ablution containers	0	2	2	3	6	5
Total capital costs:		**4 027 941**	**4 569 067**	**6 620 647**	**13 738 894**	**12 670 998**
Individual full-flush toilets		1 827 941	2 237 067	2 912 767	5 878 188	5 727 374
Fixed ablution blocks		1 200 000	1 272 000	2 022 480	4 287 658	3 787 431
Ablution containers		1 000 000	1 060 000	1 685 400	3 573 048	3 156 192
Total number of units:	**914**	**1 937**	**2 196**	**1 621**	**1 319**	**1 748**
Chemical toilets	38	70	92	80	98	122
Portable flush toilets	854	1 733	1 841	1 119	492	616
Individual full-flush toilets	22	130	255	408	703	974
Fixed ablution blocks	0	2	4	7	13	18
Ablution containers	0	2	4	7	13	18
Total operating costs:		**10 991 931**	**13 750 587**	**11 867 133**	**12 533 937**	**17 674 982**
2015 baseline operating costs		5 053 480	5 356 689	5 678 090	6 018 775	6 379 902
Revised scenario operating costs						
Chemical toilets		4 395 000	5 231 100	1 488 770	-2 155 739	-1 502 348
Portable flush toilets		576 000	1 030 320	849 442	1 286 297	1 908 865
Individual full-flush toilets		487 451	1 114 879	1 963 184	3 668 634	5 434 662
Fixed ablution blocks		240 000	508 800	943 824	1 857 985	2 726 950
Ablution containers		240 000	508 800	943 824	1 857 985	2 726 950
Total cost of scenario		15 019 872	18 319 655	18 487 780	26 272 831	30 345 979

Table 78: 1:5 toilet to household ratio and a 2-year rollout period with 97 123 m^2 of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 025**	**261**	**320**	**611**	**561**
Chemical toilets	38	32	22	26	50	46
Portable flush toilets	854	879	108	132	252	232
Individual full-flush toilets	22	110	127	156	297	273
Fixed ablution blocks	0	2	2	3	6	5
Ablution containers	0	2	2	3	6	5
Total capital costs:		**4 027 941**	**4 569 067**	**6 620 647**	**13 738 894**	**12 670 998**
Individual full-flush toilets		1 827 941	2 237 067	2 912 767	5 878 188	5 727 374
Fixed ablution blocks		1 200 000	1 272 000	2 022 480	4 287 658	3 787 431
Ablution containers		1 000 000	1 060 000	1 685 400	3 573 048	3 156 192
Total number of units:	**914**	**1 937**	**2 196**	**1 621**	**1 319**	**1 748**
Chemical toilets	38	70	92	80	98	122
Portable flush toilets	854	1 733	1 841	1 119	492	616
Individual full-flush toilets	22	130	255	408	703	974
Fixed ablution blocks	0	2	4	7	13	18
Ablution containers	0	2	4	7	13	18
Total operating costs:		**10 991 931**	**13 750 587**	**11 867 133**	**12 533 937**	**17 674 982**
2015 baseline operating costs		5 053 480	5 356 689	5 678 090	6 018 775	6 379 902
Revised scenario operating costs						
Chemical toilets		4 395 000	5 231 100	1 488 770	-2 155 739	-1 502 348
Portable flush toilets		576 000	1 030 320	849 442	1 286 297	1 908 865
Individual full-flush toilets		487 451	1 114 879	1 963 184	3 668 634	5 434 662
Fixed ablution blocks		240 000	508 800	943 824	1 857 985	2 726 950
Ablution containers		240 000	508 800	943 824	1 857 985	2 726 950
Total cost of scenario		16 283 224	21 197 661	23 555 655	35 723 234	44 322 809

Table 79: 1:5 toilet to household ratio and a 2-year rollout period with 6 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 025**	**261**	**320**	**611**	**561**
Chemical toilets	38	32	22	26	50	46
Portable flush toilets	854	879	108	132	252	232
Individual full-flush toilets	22	110	127	156	297	273
Fixed ablution blocks	0	2	2	3	6	5
Ablution containers	0	2	2	3	6	5
Total capital costs:		**4 027 941**	**4 569 067**	**6 620 647**	**13 738 894**	**12 670 998**
Individual full-flush toilets		1 827 941	2 237 067	2 912 767	5 878 188	5 727 374
Fixed ablution blocks		1 200 000	1 272 000	2 022 480	4 287 658	3 787 431
Ablution containers		1 000 000	1 060 000	1 685 400	3 573 048	3 156 192
Total number of units:	**914**	**1 937**	**2 196**	**1 621**	**1 319**	**1 748**
Chemical toilets	38	70	92	80	98	122
Portable flush toilets	854	1 733	1 841	1 119	492	616
Individual full-flush toilets	22	130	255	408	703	974
Fixed ablution blocks	0	2	4	7	13	18
Ablution containers	0	2	4	7	13	18
Total operating costs:		**10 991 931**	**13 750 587**	**11 867 133**	**12 533 937**	**17 674 982**
2015 baseline operating costs		5 053 480	5 356 689	5 678 090	6 018 775	6 379 902
Revised scenario operating costs						
Chemical toilets		4 395 000	5 231 100	1 488 770	-2 155 739	-1 502 348
Portable flush toilets		576 000	1 030 320	849 442	1 286 297	1 908 865
Individual full-flush toilets		487 451	1 114 879	1 963 184	3 668 634	5 434 662
Fixed ablution blocks		240 000	508 800	943 824	1 857 985	2 726 950
Ablution containers		240 000	508 800	943 824	1 857 985	2 726 950
Total cost of scenario		15 140 710	18 456 727	18 686 400	26 684 998	30 726 109

Table 80: 1:5 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 389**	**688**	**650**	**944**	**671**
Chemical toilets	38	30	19	23	48	55
Portable flush toilets	854	1 303	612	531	651	277
Individual full-flush toilets	22	54	55	92	237	327
Fixed ablution blocks	0	1	1	2	4	6
Ablution containers	0	1	1	2	4	6
Total capital costs:		**1 997 353**	**2 134 809**	**4 189 706**	**9 931 146**	**15 192 609**
Individual full-flush toilets		897 353	968 809	1 717 786	4 690 676	6 860 261
Fixed ablution blocks		600 000	636 000	1 348 320	2 858 438	4 544 917
Ablution containers		500 000	530 000	1 123 600	2 382 032	3 787 431
Total number of units:	**914**	**2 301**	**2 987**	**2 742**	**2 351**	**2 389**
Chemical toilets	38	68	87	72	90	126
Portable flush toilets	854	2 157	2 769	2 446	1 794	1 459
Individual full-flush toilets	22	74	127	216	451	776
Fixed ablution blocks	0	1	2	4	8	14
Ablution containers	0	1	2	4	8	14
Total operating costs:		**12 582 709**	**17 451 269**	**17 375 934**	**17 329 568**	**20 744 924**
2015 baseline operating costs		5 053 480	5 356 689	5 678 090	6 018 775	6 379 902
Revised scenario operating costs						
Chemical toilets		6 515 000	10 149 500	8 943 856	5 597 775	3 818 993
Portable flush toilets		540 000	934 920	687 643	1 114 791	1 999 764
Individual full-flush toilets		234 230	501 360	987 689	2 311 476	4 304 343
Fixed ablution blocks		120 000	254 400	539 328	1 143 375	2 120 961
Ablution containers		120 000	254 400	539 328	1 143 375	2 120 961
Total cost of scenario		14 580 062	19 586 077	21 565 640	27 260 714	35 937 533

Table 81: 1:5 toilet to household ratio and a 5-year rollout period with 97 123 m² of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 389**	**688**	**650**	**944**	**671**
Chemical toilets	38	30	19	23	48	55
Portable flush toilets	854	1 303	612	531	651	277
Individual full-flush toilets	22	54	55	92	237	327
Fixed ablution blocks	0	1	1	2	4	6
Ablution containers	0	1	1	2	4	6
Total capital costs:		**1 997 353**	**2 134 809**	**4 189 706**	**9 931 146**	**15 192 609**
Individual full-flush toilets		897 353	968 809	1 717 786	4 690 676	6 860 261
Fixed ablution blocks		600 000	636 000	1 348 320	2 858 438	4 544 917
Ablution containers		500 000	530 000	1 123 600	2 382 032	3 787 431
Total number of units:	**914**	**2 301**	**2 987**	**2 742**	**2 351**	**2 389**
Chemical toilets	38	68	87	72	90	126
Portable flush toilets	854	2 157	2 769	2 446	1 794	1 459
Individual full-flush toilets	22	74	127	216	451	776
Fixed ablution blocks	0	1	2	4	8	14
Ablution containers	0	1	2	4	8	14
Total operating costs:		**12 582 709**	**17 451 269**	**17 375 934**	**17 329 568**	**20 744 924**
2015 baseline operating costs		5 053 480	5 356 689	5 678 090	6 018 775	6 379 902
Revised scenario operating costs						
Chemical toilets		6 515 000	10 149 500	8 943 856	5 597 775	3 818 993
Portable flush toilets		540 000	934 920	687 643	1 114 791	1 999 764
Individual full-flush toilets		234 230	501 360	987 689	2 311 476	4 304 343
Fixed ablution blocks		120 000	254 400	539 328	1 143 375	2 120 961
Ablution containers		120 000	254 400	539 328	1 143 375	2 120 961
Total cost of scenario		15 308 062	21 143 217	24 618 461	34 290 091	48 952 408

Table 82: 1:5 toilet to household ratio and a 5-year rollout period with 6 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 389**	**688**	**650**	**944**	**671**
Chemical toilets	38	30	19	23	48	55
Portable flush toilets	854	1 303	612	531	651	277
Individual full-flush toilets	22	54	55	92	237	327
Fixed ablution blocks	0	1	1	2	4	6
Ablution containers	0	1	1	2	4	6
Total capital costs:		**1 997 353**	**2 134 809**	**4 189 706**	**9 931 146**	**15 192 609**
Individual full-flush toilets		897 353	968 809	1 717 786	4 690 676	6 860 261
Fixed ablution blocks		600 000	636 000	1 348 320	2 858 438	4 544 917
Ablution containers		500 000	530 000	1 123 600	2 382 032	3 787 431
Total number of units:	**914**	**2 301**	**2 987**	**2 742**	**2 351**	**2 389**
Chemical toilets	38	68	87	72	90	126
Portable flush toilets	854	2 157	2 769	2 446	1 794	1 459
Individual full-flush toilets	22	74	127	216	451	776
Fixed ablution blocks	0	1	2	4	8	14
Ablution containers	0	1	2	4	8	14
Total operating costs:		**12 582 709**	**17 451 269**	**17 375 934**	**17 329 568**	**20 744 924**
2015 baseline operating costs		5 053 480	5 356 689	5 678 090	6 018 775	6 379 902
Revised scenario operating costs						
Chemical toilets		6 515 000	10 149 500	8 943 856	5 597 775	3 818 993
Portable flush toilets		540 000	934 920	687 643	1 114 791	1 999 764
Individual full-flush toilets		234 230	501 360	987 689	2 311 476	4 304 343
Fixed ablution blocks		120 000	254 400	539 328	1 143 375	2 120 961
Ablution containers		120 000	254 400	539 328	1 143 375	2 120 961
Total cost of scenario		14 639 983	19 650 121	21 691 331	27 558 649	36 393 312

Table 83: 1:3 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	1 481	322	393	778	911
Chemical toilets	38	64	32	39	77	90
Portable flush toilets	854	1 169	96	117	231	270
Individual full-flush toilets	22	240	188	229	454	531
Fixed ablution blocks	0	4	3	4	8	10
Ablution containers	0	4	3	4	8	10
Total capital costs:		8 388 235	6 809 564	9 219 633	19 466 454	25 027 304
Individual full-flush toilets		3 988 235	3 311 564	4 275 793	8 985 514	11 140 058
Fixed ablution blocks		2 400 000	1 908 000	2 696 640	5 716 877	7 574 862
Ablution containers		2 000 000	1 590 000	2 247 200	4 764 064	6 312 385
Total number of units:	914	2 393	2 713	2 211	1 754	2 535
Chemical toilets	38	102	134	135	148	206
Portable flush toilets	854	2 023	2 119	1 382	444	618
Individual full-flush toilets	22	260	446	672	1 124	1 653
Fixed ablution blocks	0	4	7	11	19	29
Ablution containers	0	4	7	11	19	29
Total operating costs:		13 615 859	16 849 708	15 510 487	14 880 613	23 031 025
2015 baseline operating costs		5 013 688	5 314 509	5 633 380	5 971 382	6 329 665
Revised scenario operating costs						
Chemical toilets		5 845 000	6 704 500	2 966 304	-2 441 583	-1 489 723
Portable flush toilets		1 152 000	1 831 680	1 961 806	2 358 212	3 817 730
Individual full-flush toilets		645 172	1 218 218	1 982 694	3 561 569	5 586 513
Fixed ablution blocks		480 000	890 400	1 483 152	2 715 516	4 393 420
Ablution containers		480 000	890 400	1 483 152	2 715 516	4 393 420
Total cost of scenario		22 004 094	23 659 272	24 730 120	34 347 068	48 058 329

Table 84: 1:3 toilet to household ratio and a 2-year rollout period with 97 123 m^2 of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 481**	**322**	**393**	**778**	**911**
Chemical toilets	38	64	32	39	77	90
Portable flush toilets	854	1 169	96	117	231	270
Individual full-flush toilets	22	240	188	229	454	531
Fixed ablution blocks	0	4	3	4	8	10
Ablution containers	0	4	3	4	8	10
Total capital costs:		**8 388 235**	**6 809 564**	**9 219 633**	**19 466 454**	**25 027 304**
Individual full-flush toilets		3 988 235	3 311 564	4 275 793	8 985 514	11 140 058
Fixed ablution blocks		2 400 000	1 908 000	2 696 640	5 716 877	7 574 862
Ablution containers		2 000 000	1 590 000	2 247 200	4 764 064	6 312 385
Total number of units:	**914**	**2 393**	**2 713**	**2 211**	**1 754**	**2 535**
Chemical toilets	38	102	134	135	148	206
Portable flush toilets	854	2 023	2 119	1 382	444	618
Individual full-flush toilets	22	260	446	672	1 124	1 653
Fixed ablution blocks	0	4	7	11	19	29
Ablution containers	0	4	7	11	19	29
Total operating costs:		**13 615 859**	**16 849 708**	**15 510 487**	**14 880 613**	**23 031 025**
2015 baseline operating costs		5 013 688	5 314 509	5 633 380	5 971 382	6 329 665
Revised scenario operating costs						
Chemical toilets		5 845 000	6 704 500	2 966 304	-2 441 583	-1 489 723
Portable flush toilets		1 152 000	1 831 680	1 961 806	2 358 212	3 817 730
Individual full-flush toilets		645 172	1 218 218	1 982 694	3 561 569	5 586 513
Fixed ablution blocks		480 000	890 400	1 483 152	2 715 516	4 393 420
Ablution containers		480 000	890 400	1 483 152	2 715 516	4 393 420
Total cost of scenario		23 637 188	26 744 502	29 754 020	43 358 569	62 191 249

Table 85: 1:3 toilet to household ratio and a 2-year rollout period with 6 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 481**	**322**	**393**	**778**	**911**
Chemical toilets	38	64	32	39	77	90
Portable flush toilets	854	1 169	96	117	231	270
Individual full-flush toilets	22	240	188	229	454	531
Fixed ablution blocks	0	4	3	4	8	10
Ablution containers	0	4	3	4	8	10
Total capital costs:		**8 388 235**	**6 809 564**	**9 219 633**	**19 466 454**	**25 027 304**
Individual full-flush toilets		3 988 235	3 311 564	4 275 793	8 985 514	11 140 058
Fixed ablution blocks		2 400 000	1 908 000	2 696 640	5 716 877	7 574 862
Ablution containers		2 000 000	1 590 000	2 247 200	4 764 064	6 312 385
Total number of units:	**914**	**2 393**	**2 713**	**2 211**	**1 754**	**2 535**
Chemical toilets	38	102	134	135	148	206
Portable flush toilets	854	2 023	2 119	1 382	444	618
Individual full-flush toilets	22	260	446	672	1 124	1 653
Fixed ablution blocks	0	4	7	11	19	29
Ablution containers	0	4	7	11	19	29
Total operating costs:		**13 615 859**	**16 849 708**	**15 510 487**	**14 880 613**	**23 031 025**
2015 baseline operating costs		5 013 688	5 314 509	5 633 380	5 971 382	6 329 665
Revised scenario operating costs						
Chemical toilets		5 845 000	6 704 500	2 966 304	-2 441 583	-1 489 723
Portable flush toilets		1 152 000	1 831 680	1 961 806	2 358 212	3 817 730
Individual full-flush toilets		645 172	1 218 218	1 982 694	3 561 569	5 586 513
Fixed ablution blocks		480 000	890 400	1 483 152	2 715 516	4 393 420
Ablution containers		480 000	890 400	1 483 152	2 715 516	4 393 420
Total cost of scenario		22 255 741	23 863 559	25 006 709	34 931 061	48 809 148

Table 86: 1:3 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	1 906	640	664	1 063	1 076
Chemical toilets	38	56	24	33	72	106
Portable flush toilets	854	1 733	536	487	609	319
Individual full-flush toilets	22	113	78	140	368	627
Fixed ablution blocks	0	2	1	2	7	12
Ablution containers	0	2	1	2	7	12
Total capital costs:		4 077 794	2 539 947	5 085 942	16 454 235	29 818 775
Individual full-flush toilets		1 877 794	1 373 947	2 614 022	7 283 412	13 154 079
Fixed ablution blocks		1 200 000	636 000	1 348 320	5 002 267	9 089 834
Ablution containers		1 000 000	530 000	1 123 600	4 168 556	7 574 862
Total number of units:	914	2 818	3 456	3 225	2 497	3 011
Chemical toilets	38	94	118	113	129	211
Portable flush toilets	854	2 587	3 123	2 756	1 632	1 415
Individual full-flush toilets	22	133	209	346	712	1 337
Fixed ablution blocks	0	2	3	5	12	24
Ablution containers	0	2	3	5	12	24
Total operating costs:		15 467 298	20 166 446	20 172 904	18 215 707	25 578 281
2015 baseline operating costs		5 013 688	5 314 509	5 633 380	5 971 382	6 329 665
Revised scenario operating costs						
Chemical toilets		8 665 000	12 025 700	10 685 436	4 633 052	3 541 248
Portable flush toilets		1 008 000	1 526 400	1 516 860	1 950 884	3 931 353
Individual full-flush toilets		300 610	536 637	988 908	2 230 262	4 504 147
Fixed ablution blocks		240 000	381 600	674 160	1 715 063	3 635 934
Ablution containers		240 000	381 600	674 160	1 715 063	3 635 934
Total cost of scenario		19 545 091	22 706 393	25 258 846	34 669 942	55 397 056

Table 87: 1:3 toilet to household ratio and a 5-year rollout period with 97 123 m² of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 906**	**640**	**664**	**1 063**	**1 076**
Chemical toilets	38	56	24	33	72	106
Portable flush toilets	854	1 733	536	487	609	319
Individual full-flush toilets	22	113	78	140	368	627
Fixed ablution blocks	0	2	1	2	7	12
Ablution containers	0	2	1	2	7	12
Total capital costs:		**4 077 794**	**2 539 947**	**5 085 942**	**16 454 235**	**29 818 775**
Individual full-flush toilets		1 877 794	1 373 947	2 614 022	7 283 412	13 154 079
Fixed ablution blocks		1 200 000	636 000	1 348 320	5 002 267	9 089 834
Ablution containers		1 000 000	530 000	1 123 600	4 168 556	7 574 862
Total number of units:	**914**	**2 818**	**3 456**	**3 225**	**2 497**	**3 011**
Chemical toilets	38	94	118	113	129	211
Portable flush toilets	854	2 587	3 123	2 756	1 632	1 415
Individual full-flush toilets	22	133	209	346	712	1 337
Fixed ablution blocks	0	2	3	5	12	24
Ablution containers	0	2	3	5	12	24
Total operating costs:		**15 467 298**	**20 166 446**	**20 172 904**	**18 215 707**	**25 578 281**
2015 baseline operating costs		5 013 688	5 314 509	5 633 380	5 971 382	6 329 665
Revised scenario operating costs						
Chemical toilets		8 665 000	12 025 700	10 685 436	4 633 052	3 541 248
Portable flush toilets		1 008 000	1 526 400	1 516 860	1 950 884	3 931 353
Individual full-flush toilets		300 610	536 637	988 908	2 230 262	4 504 147
Fixed ablution blocks		240 000	381 600	674 160	1 715 063	3 635 934
Ablution containers		240 000	381 600	674 160	1 715 063	3 635 934
Total cost of scenario		20 454 017	24 328 632	28 235 365	41 359 517	68 872 801

Table 88: 1:3 toilet to household ratio and a 5-year rollout period with 6 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**1 906**	**640**	**664**	**1 063**	**1 076**
Chemical toilets	38	56	24	33	72	106
Portable flush toilets	854	1 733	536	487	609	319
Individual full-flush toilets	22	113	78	140	368	627
Fixed ablution blocks	0	2	1	2	7	12
Ablution containers	0	2	1	2	7	12
Total capital costs:		**4 077 794**	**2 539 947**	**5 085 942**	**16 454 235**	**29 818 775**
Individual full-flush toilets		1 877 794	1 373 947	2 614 022	7 283 412	13 154 079
Fixed ablution blocks		1 200 000	636 000	1 348 320	5 002 267	9 089 834
Ablution containers		1 000 000	530 000	1 123 600	4 168 556	7 574 862
Total number of units:	**914**	**2 818**	**3 456**	**3 225**	**2 497**	**3 011**
Chemical toilets	38	94	118	113	129	211
Portable flush toilets	854	2 587	3 123	2 756	1 632	1 415
Individual full-flush toilets	22	133	209	346	712	1 337
Fixed ablution blocks	0	2	3	5	12	24
Ablution containers	0	2	3	5	12	24
Total operating costs:		**15 467 298**	**20 166 446**	**20 172 904**	**18 215 707**	**25 578 281**
2015 baseline operating costs		5 013 688	5 314 509	5 633 380	5 971 382	6 329 665
Revised scenario operating costs						
Chemical toilets		8 665 000	12 025 700	10 685 436	4 633 052	3 541 248
Portable flush toilets		1 008 000	1 526 400	1 516 860	1 950 884	3 931 353
Individual full-flush toilets		300 610	536 637	988 908	2 230 262	4 504 147
Fixed ablution blocks		240 000	381 600	674 160	1 715 063	3 635 934
Ablution containers		240 000	381 600	674 160	1 715 063	3 635 934
Total cost of scenario		19 667 425	22 782 592	25 411 424	35 163 569	56 291 619

Table 89: 1:1 toilet to household ratio and a 2-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	2 550	691	809	1 676	2 400
Chemical toilets	38	190	85	100	207	296
Portable flush toilets	854	1 459	85	100	207	296
Individual full-flush toilets	22	869	503	587	1 216	1 744
Fixed ablution blocks	0	16	9	11	23	32
Ablution containers	0	16	9	11	23	32
Total capital costs:		32 040 733	19 354 195	24 555 780	54 199 631	81 027 250
Individual full-flush toilets		14 440 733	8 860 195	10 960 220	24 066 926	36 588 061
Fixed ablution blocks		9 600 000	5 724 000	7 415 760	16 436 021	24 239 558
Ablution containers		8 000 000	4 770 000	6 179 800	13 696 684	20 199 631
Total number of units:	914	3 462	4 151	4 065	4 090	6 318
Chemical toilets	38	228	313	375	392	603
Portable flush toilets	854	2 313	2 398	1 644	392	603
Individual full-flush toilets	22	889	1 390	1 974	3 188	4 930
Fixed ablution blocks	0	16	25	36	59	91
Ablution containers	0	16	25	36	59	91
Total operating costs:		20 312 797	26 373 543	28 534 464	31 037 026	50 710 547
2015 baseline operating costs		4 973 896	5 272 330	5 588 669	5 923 990	6 279 429
Revised scenario operating costs						
Chemical toilets		7 295 000	8 183 200	4 438 220	-2 751 247	-1 584 409
Portable flush toilets		3 420 000	5 247 000	6 815 758	7 589 154	12 839 391
Individual full-flush toilets		783 901	1 311 013	1 983 913	3 410 343	5 603 639
Fixed ablution blocks		1 920 000	3 180 000	4 853 952	8 432 393	13 786 248
Ablution containers		1 920 000	3 180 000	4 853 952	8 432 393	13 786 248
Total cost of scenario		52 353 529	45 727 738	53 090 244	85 236 657	131 737 797

Table 90: 1:1 toilet to household ratio and a 2-year rollout period with 97 123 m^2 of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**2 550**	**691**	**809**	**1 676**	**2 400**
Chemical toilets	38	190	85	100	207	296
Portable flush toilets	854	1 459	85	100	207	296
Individual full-flush toilets	22	869	503	587	1 216	1 744
Fixed ablution blocks	0	16	9	11	23	32
Ablution containers	0	16	9	11	23	32
Total capital costs:		**32 040 733**	**19 354 195**	**24 555 780**	**54 199 631**	**81 027 250**
Individual full-flush toilets		14 440 733	8 860 195	10 960 220	24 066 926	36 588 061
Fixed ablution blocks		9 600 000	5 724 000	7 415 760	16 436 021	24 239 558
Ablution containers		8 000 000	4 770 000	6 179 800	13 696 684	20 199 631
Total number of units:	**914**	**3 462**	**4 151**	**4 065**	**4 090**	**6 318**
Chemical toilets	38	228	313	375	392	603
Portable flush toilets	854	2 313	2 398	1 644	392	603
Individual full-flush toilets	22	889	1 390	1 974	3 188	4 930
Fixed ablution blocks	0	16	25	36	59	91
Ablution containers	0	16	25	36	59	91
Total operating costs:		**20 312 797**	**26 373 543**	**28 534 464**	**31 037 026**	**50 710 547**
2015 baseline operating costs		4 973 896	5 272 330	5 588 669	5 923 990	6 279 429
Revised scenario operating costs						
Chemical toilets		7 295 000	8 183 200	4 438 220	-2 751 247	-1 584 409
Portable flush toilets		3 420 000	5 247 000	6 815 758	7 589 154	12 839 391
Individual full-flush toilets		783 901	1 311 013	1 983 913	3 410 343	5 603 639
Fixed ablution blocks		1 920 000	3 180 000	4 853 952	8 432 393	13 786 248
Ablution containers		1 920 000	3 180 000	4 853 952	8 432 393	13 786 248
Total cost of scenario		54 340 808	49 052 338	58 123 577	93 887 198	145 941 864

Table 91: 1:1 toilet to household ratio and a 2-year rollout period with 6 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**2 550**	**691**	**809**	**1 676**	**2 400**
Chemical toilets	38	190	85	100	207	296
Portable flush toilets	854	1 459	85	100	207	296
Individual full-flush toilets	22	869	503	587	1 216	1 744
Fixed ablution blocks	0	16	9	11	23	32
Ablution containers	0	16	9	11	23	32
Total capital costs:		**32 040 733**	**19 354 195**	**24 555 780**	**54 199 631**	**81 027 250**
Individual full-flush toilets		14 440 733	8 860 195	10 960 220	24 066 926	36 588 061
Fixed ablution blocks		9 600 000	5 724 000	7 415 760	16 436 021	24 239 558
Ablution containers		8 000 000	4 770 000	6 179 800	13 696 684	20 199 631
Total number of units:	**914**	**3 462**	**4 151**	**4 065**	**4 090**	**6 318**
Chemical toilets	38	228	313	375	392	603
Portable flush toilets	854	2 313	2 398	1 644	392	603
Individual full-flush toilets	22	889	1 390	1 974	3 188	4 930
Fixed ablution blocks	0	16	25	36	59	91
Ablution containers	0	16	25	36	59	91
Total operating costs:		**20 312 797**	**26 373 543**	**28 534 464**	**31 037 026**	**50 710 547**
2015 baseline operating costs		4 973 896	5 272 330	5 588 669	5 923 990	6 279 429
Revised scenario operating costs						
Chemical toilets		7 295 000	8 183 200	4 438 220	-2 751 247	-1 584 409
Portable flush toilets		3 420 000	5 247 000	6 815 758	7 589 154	12 839 391
Individual full-flush toilets		783 901	1 311 013	1 983 913	3 410 343	5 603 639
Fixed ablution blocks		1 920 000	3 180 000	4 853 952	8 432 393	13 786 248
Ablution containers		1 920 000	3 180 000	4 853 952	8 432 393	13 786 248
Total cost of scenario		53 314 751	46 308 364	53 826 918	86 862 646	134 168 614

Table 92: 1:1 toilet to household ratio and a 5-year rollout period

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	2 689	795	869	1 755	2 949
Chemical toilets	38	133	52	73	180	364
Portable flush toilets	854	2 163	519	425	550	364
Individual full-flush toilets	22	381	216	359	989	2 141
Fixed ablution blocks	0	6	4	6	18	40
Ablution containers	0	6	4	6	18	40
Total capital costs:		12 931 322	8 468 776	14 118 859	43 156 286	100 465 866
Individual full-flush toilets		6 331 322	3 804 776	6 703 099	19 574 169	44 916 880
Fixed ablution blocks		3 600 000	2 544 000	4 044 960	12 862 973	30 299 447
Ablution containers		3 000 000	2 120 000	3 370 800	10 719 144	25 249 539
Total number of units:	914	3 601	4 394	4 368	3 825	6 201
Chemical toilets	38	171	223	258	305	617
Portable flush toilets	854	3 017	3 536	3 107	1 494	1 339
Individual full-flush toilets	22	401	615	971	1 958	4 097
Fixed ablution blocks	0	6	10	16	34	74
Ablution containers	0	6	10	16	34	74
Total operating costs:		19 965 468	26 128 810	27 974 827	27 263 453	49 572 634
2015 baseline operating costs		4 973 896	5 272 330	5 588 669	5 923 990	6 279 429
Revised scenario operating costs						
Chemical toilets		10 815 000	14 214 600	12 657 354	3 811 251	3 061 507
Portable flush toilets		2 394 000	3 529 800	4 449 456	5 724 023	13 157 535
Individual full-flush toilets		342 572	568 080	964 724	2 085 499	4 652 573
Fixed ablution blocks		720 000	1 272 000	2 157 312	4 859 345	11 210 795
Ablution containers		720 000	1 272 000	2 157 312	4 859 345	11 210 795
Total cost of scenario		32 896 791	34 597 586	42 093 686	70 419 739	150 038 500

Table 93: 1:1 toilet to household ratio and a 5-year rollout period with 97 123 m² of purchased land

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**2 689**	**795**	**869**	**1 755**	**2 949**
Chemical toilets	38	133	52	73	180	364
Portable flush toilets	854	2 163	519	425	550	364
Individual full-flush toilets	22	381	216	359	989	2 141
Fixed ablution blocks	0	6	4	6	18	40
Ablution containers	0	6	4	6	18	40
Total capital costs:		**12 931 322**	**8 468 776**	**14 118 859**	**43 156 286**	**100 465 866**
Individual full-flush toilets		6 331 322	3 804 776	6 703 099	19 574 169	44 916 880
Fixed ablution blocks		3 600 000	2 544 000	4 044 960	12 862 973	30 299 447
Ablution containers		3 000 000	2 120 000	3 370 800	10 719 144	25 249 539
Total number of units:	**914**	**3 601**	**4 394**	**4 368**	**3 825**	**6 201**
Chemical toilets	38	171	223	258	305	617
Portable flush toilets	854	3 017	3 536	3 107	1 494	1 339
Individual full-flush toilets	22	401	615	971	1 958	4 097
Fixed ablution blocks	0	6	10	16	34	74
Ablution containers	0	6	10	16	34	74
Total operating costs:		**19 965 468**	**26 128 810**	**27 974 827**	**27 263 453**	**49 572 634**
2015 baseline operating costs		4 973 896	5 272 330	5 588 669	5 923 990	6 279 429
Revised scenario operating costs						
Chemical toilets		10 815 000	14 214 600	12 657 354	3 811 251	3 061 507
Portable flush toilets		2 394 000	3 529 800	4 449 456	5 724 023	13 157 535
Individual full-flush toilets		342 572	568 080	964 724	2 085 499	4 652 573
Fixed ablution blocks		720 000	1 272 000	2 157 312	4 859 345	11 210 795
Ablution containers		720 000	1 272 000	2 157 312	4 859 345	11 210 795
Total cost of scenario		33 914 504	36 291 237	44 968 446	76 628 348	163 880 768

Table 94: 1:1 toilet to household ratio and a 5-year rollout period with 6 percent of flush toilets situated in flood plains

	2015 existing units	2016	2017	2018	2019	2020
New units:	**914**	**2 689**	**795**	**869**	**1 755**	**2 949**
Chemical toilets	38	133	52	73	180	364
Portable flush toilets	854	2 163	519	425	550	364
Individual full-flush toilets	22	381	216	359	989	2 141
Fixed ablution blocks	0	6	4	6	18	40
Ablution containers	0	6	4	6	18	40
Total capital costs:		**12 931 322**	**8 468 776**	**14 118 859**	**43 156 286**	**100 465 866**
Individual full-flush toilets		6 331 322	3 804 776	6 703 099	19 574 169	44 916 880
Fixed ablution blocks		3 600 000	2 544 000	4 044 960	12 862 973	30 299 447
Ablution containers		3 000 000	2 120 000	3 370 800	10 719 144	25 249 539
Total number of units:	**914**	**3 601**	**4 394**	**4 368**	**3 825**	**6 201**
Chemical toilets	38	171	223	258	305	617
Portable flush toilets	854	3 017	3 536	3 107	1 494	1 339
Individual full-flush toilets	22	401	615	971	1 958	4 097
Fixed ablution blocks	0	6	10	16	34	74
Ablution containers	0	6	10	16	34	74
Total operating costs:		**19 965 468**	**26 128 810**	**27 974 827**	**27 263 453**	**49 572 634**
2015 baseline operating costs		4 973 896	5 272 330	5 588 669	5 923 990	6 279 429
Revised scenario operating costs						
Chemical toilets		10 815 000	14 214 600	12 657 354	3 811 251	3 061 507
Portable flush toilets		2 394 000	3 529 800	4 449 456	5 724 023	13 157 535
Individual full-flush toilets		342 572	568 080	964 724	2 085 499	4 652 573
Fixed ablution blocks		720 000	1 272 000	2 157 312	4 859 345	11 210 795
Ablution containers		720 000	1 272 000	2 157 312	4 859 345	11 210 795
Total cost of scenario		33 284 730	34 851 649	42 517 252	71 714 428	153 052 476