eThekweni Housing Typologies

Sustainable Design Progress Report no. 2

Prepared by WSP GREEN by DESIGN

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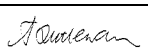
Signature			
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1. INTRODUCTION

This report compares the efficiencies of different water reuse systems together with sanitation alternatives in order to determine to (i) potential potable water savings achievable, and (ii) the reduction in waste water to sewer; for six housing typologies. Potable water demand can be reduced by means of rainwater systems, greywater systems or dry sanitation. Waste water volumes can be reduced by means of greywater systems or dry sanitation. The selection of the appropriate system is dependent on the order of priorities: maximum reduction of potable water demand or maximum reduction in waste water to sewer. Although these reductions do not directly correlate with one another, an overall optimal solution can be achieved.

2. DESCRIPTION OF TYPOLOGIES

The following is a description of the six typologies referred to in this report:

Typology no.	Ownership	Frontage type	No. storeys	Layout	Footprint [m2] per dwelling	No. of occupants per dwelling	No. dwellings
Typology 5	multiple	Narrow	Double Storey	Semi-detached	22	4	2
Typology 8	multiple	Narrow	Double Storey	Semi-detached	44	4	2
Typology 21	multiple	Medium	Double Storey	Semi-detached	42	4	2
Typology 22	multiple	Medium	Double Storey	Duplex row	42	4	2
Typology 30	single	Wide	Single Storey	Detached	43	4	1
Typology 34	multiple	Wide	Double Storey	Semi-detached	43	4	2

Table 1: Description of 6 housing typologies

3. WATER MODEL

Various water models have been developed for the 6 typologies to compare the efficiencies of different water recycling systems in terms of water usage and discharge to sewer. The aim of the exercise is to ascertain (a) whether the occupants can exist within the 9kL free municipal water supply per dwelling per month, and (b) which water system(s) is the most efficient for a particular typology.

The following water systems have been compared for each of the 6 typologies:

(i) Potable water supply only (water-borne sewer):

- Municipal water is used to meet all water demands,
- No waste water is diverted from sewer.

(ii) Rainwater supplemented with potable water supply (water-borne sewer):

- Rainwater is used for showering, laundry and space cleaning.
- Potable water is used for cooking, washing hands and toilet flushing, and shortfall required for showering, laundry and space cleaning.
- No waste water is diverted from sewer.
- Rainwater supplemented with potable water when necessary

(iii) Greywater supplemented with potable water supply (water-borne sewer):

- Greywater is used for toilet flushing, space cleaning and surplus to irrigation;
- Grey water is supplemented with potable water supply when necessary;
- Potable water is used for cooking, washing hands, showering and laundry;
- Water from toilets, sinks, space cleaning and laundry drains to sewer;
- Water from showers and basins is diverted from sewer and harvested for grey water use.

(iv) Potable water supply only (dry sanitation)

- Municipal water is used to meet all water demands,
- There is no waste water from toilets

(v) Rainwater supplemented with potable water supply (dry sanitation system):

- Rainwater is used for showering, laundry and space cleaning;
- Potable water is used for cooking, washing hands and toilet cleaning, and shortfall required for showering laundry and space cleaning;
- There is no waste water from toilets

(vi) Greywater supplemented with potable water (dry sanitation system):

- Greywater is used for space cleaning and surplus to irrigation;
- Potable water is used for cooking, washing hands, showering and laundry;
- Water from showers and basins is diverted from sewer and harvested for grey water use.
- There is no waste water from toilets

The water model makes the following assumptions regarding water usage per person per day:

- **Toilets:** Dual flush (6/3 litre WC)
  2 toilet flushes (solid) per person per day @ 6 litres per flush
  4 toilet flushes (liquid) per person per day @ 3 litres per flush
  1 litre per day for toilet cleaning (for dry sanitation)
- **Whb:** 6 hand washes per person per day @ 6 litres per minute for 10 seconds
- **Shower:** 1 shower per person per day @ 8 litres per minute for 4 minutes
- **Cooking:** 10 litres per person per day (2L for drinking, 4L for cooking, 4L for dishwashing)
- **Laundry:** 3 litres per person per day
- **Space cleaning:** once a week @ 10 litres per clean = 1.4 litres per day (regardless of no. of people)

The model assumes that no water is stored at the end of the month; any surplus is available for irrigation etc.

- **Water collection**

  Potable water is taken from the municipal mains.

  Rainwater is harvested from the dwelling's roof.

  Greywater is collected from showers and wash hand basins.

- **Water usage**

  Municipal water is used for all cooking and wash hand basin water requirements.

  Rainwater is used for showers and laundry water requirements.

  Greywater is used for toilet flushing and space cleaning requirements.

  Any surplus rainwater or greywater is available for irrigation.

- **Free water supply**

  The model assumes that every dwelling receives 9kL free potable water per month.

- **Occupancy**

  Occupancy as per the six typologies (Table 1).

- **Roof area**

  Roof area as per the six typologies (Table 1)

4. WATER DEMAND & SUPPLY

The eThekweni Municipality currently provides households with 9kl free potable water per month. It would be ideal if occupants of government subsidised housing could exist within the 9kl free water allocation.

Progress Report no. 1 detailed the municipal water requirements for single, double and triple storey dwellings housing with varying numbers of occupants. In each case the municipal water requirement was reduced by the inclusion of:

- rainwater systems, or
- grey water systems, or
- dry sanitation systems.

In this case all 6 typologies house 4 occupants each; hence the minimum potable water requirement for each typology will be the same.

Potable water demand per dwelling per month [kl]						
Sewerage option:	**Option 1: water-bourne sewerage**	**Option 1: water-bourne sewerage**	**Option 1: water-bourne sewerage**	**Option 2: dry sanitation**	**Option 2: dry sanitation**	**Option 2: dry sanitation**
Water source:	**potable**	**rain + potable**	**grey + potable**	**potable**	**rain + potable**	**grey + potable**
Typology 5	9.2	7.4	6.2	6.2	4.5	6.2
Typology 8	9.2	7.4	6.2	6.3	4.5	6.2
Typology 21	9.2	7.5	6.2	6.3	4.6	6.2
Typology 22	9.2	7.5	6.2	6.3	4.6	6.2
Typology 30	9.2	5.7	6.2	6.3	2.8	6.2
Typology 34	9.2	7.5	6.2	6.3	4.5	6.2

Table 2: Potable water demand per dwelling per month

4.1 Rainwater

- The amount of rainwater collected correlates with the area of the roof. Therefore the affect of rain water harvesting for a typology with two owners in a double storey house is smaller that the affects of rain water harvesting for a typology with one owner with the same size roof.
- Rainwater reduces the potable water demand by 20% for the double storey typologies with two owners.
- Rainwater reduces the potable water demand by 38% for the single storey typology with one owner.

4.2 Grey water systems

- The amount of grey water collected correlates with the numbers of occupants in the house. Since the numbers of occupants is the same for all typologies, the savings in potable water due to greywater harvesting is the same for all typologies.
- Grey water reduces the potable water demand by 33% for all typologies with four occupants in each.

4.3 Dry sanitation

- Dry sanitation reduces the potable water demand by 32% for all typologies with four occupants in each.
- Dry sanitation in combination with a rainwater system reduces the potable water demand by 51% for all typologies with four occupants in each.
- Dry sanitation in combination with a grey water system reduces the potable water demand by 33% for all typologies with four occupants in each.
- There is no reduction in potable water demand when a grey water system is used in conjunction with a dry sanitation system, since there is no need for toilet flushing.
- Any greywater collected can be used for irrigation since it is not required for toilet flushing.

4.4 Summary of potential potable water savings

The following table summaries the percentage potable water savings achievable with the above systems, in order of percentage savings:

Water source	Sewerage system	% potable water savings achieved	qualification
Potable water	Municipal sewer	-	-
Rainwater + potable	Municipal sewer	20%	2 owners (duplex) 4 occupants per house
		38%	1 owner 4 occupants
Greywater + potable	Municipal sewer	33%	4 occupants
Potable water	Dry sanitation	33%	4 occupants
Greywater + potable	Dry sanitation	33%	4 occupants
Rainwater + potable	Dry sanitation	51%	2 owners (duplex)
		70%	1 owner

Table 3: Percentage potable water savings

5. SANITATION

Progress Report no. 1 compared the resultant waste water volumes in conjunction with (i) a water-borne sewer system, and (ii) a dry sanitation system; together with the following permutations:

- Potable water supply, or
- Rainwater supply, or
- grey water supply

Water to sewer per dwelling per month [kl]						
Sewerage option:	Option 1: water-borne sewerage			Option 2: dry sanitation		
Water source:	potable	rain + potable	grey + potable	potable	rain + potable	grey + potable
Typology 5	9.2	9.2	4.5	6.3	6.3	1.7
Typology 8	9.2	9.2	4.5	6.3	6.3	1.7
Typology 21	9.2	9.2	4.5	6.3	6.2	1.7
Typology 22	9.2	9.2	4.5	6.3	6.2	1.7
Typology 30	9.2	9.2	4.5	6.3	6.3	1.7
Typology 34	9.2	9.2	4.5	6.3	6.3	1.7

Table 4: Waste water discharge to sewer per dwelling per month

5.1 Option 1: water-borne sanitation

(i) With potable water supply only

- This is the base case for water-borne sewerage ie the maximum amount of water to sewer, assuming 4 people per house.

(ii) With rainwater supply and potable water top-up

- There is no net reduction in water to sewer with the addition of a rainwater system because no waste water is diverted.

(iii) With greywater supply and potable water top-up

- Grey water reduces the waste water to sewer by 51% for all typologies with four occupants in each.
- The amount of waste water diverted correlates with the amount of grey water collected
- The amount of grey water collected correlates with the numbers of occupants in the house. Since the numbers of occupants is the same for all typologies, the reduction in waste water to sewer due to greywater harvesting is the same for all typologies.

5.2 Option 2: dry sanitation

(i) **With potable water supply only**

- Dry sanitation achieves a net reduction of 32% water to sewer per dwelling.
- This is the base case for dry sanitation ie the maximum amount of water to sewer, assuming 4 people per house.

(ii) With rainwater supply and potable water top-up

- There is no net reduction of water to sewer with the addition of a rainwater system.

(iii) With greywater supply and potable water top-up

- Dry sanitation together with greywater collection achieves a net reduction of 73% water to sewer per dwelling

5.3 Summary of potential reduction in waste water to sewer

The following table summaries the percentage reduction in waste water to sewer achievable with the above systems, in order of percentage reduction:

Sewerage system	Water source	% reduction of water to sewer	qualification
Water-borne sewerage	Potable water	-	-
Water-borne sewerage	Rainwater + potable	-	-
Dry sanitation	Rainwater + potable	-	-
Dry sanitation	Potable water	32%	4 occupants
Water-borne sewerage	Greywater + potable	51%	4 occupants
Dry sanitation	Greywater + potable	73%	4 occupants

Table 5: Percentage reduction of waste water to sewer

6. OBSERVATIONS & COMMENTS

6.1 Water supply

The occupants of all 6 housing typologies can exist within this 9kL free water allocation, assuming a water-borne sewerage system is in place. However the following **crucial implications** need to be considered:

- The ability to exist within the 9kL free water allocation is constrained by the number of occupants in the house. In the event that more than 4 people occupy any of the 6 typologies (which we anticipate to be the more likely scenario), the **monthly potable water demand will exceed the 9kL free water allocation.**

- The cost of Municipal water is currently relatively cheap in comparison with the cost of electricity. However the imminent shortage of municipal water due to increased demand may well result in increased water tariffs.

6.2 Sanitation

Water-borne sanitation has the following disadvantages:

- High cost to provide bulk sewer services
- Sewer lines dictate the urban form
- Increased water demand for flushing

Dry sanitation has the following advantages:

- No bulk services required
- Allows for flexibility of design of the urban form
- Reduces water demand (water only required for cleaning toilets)

7. RECOMMENDATIONS

The selection of systems is dependent on whether the emphasis is placed on reducing the demand for potable water or reducing the demand for waste water to sewer. The following table summarises these reductions per system:

Water source	Sewerage system	% potable water savings achieved	% reduction of water to sewer	qualification
Potable water	Municipal sewer	-	-	-
Rainwater + potable	Municipal sewer	20%	-	2 owners (duplex) 4 occupants per house
		38%	-	1 owner 4 occupants
Greywater + potable	Municipal sewer	33%	51%	4 occupants
Potable water	Dry sanitation	33%	32%	4 occupants
Greywater + potable	Greywater + potable	33%	73%	4 occupants
Rainwater + potable	Potable water	51%	32%	2 owners (duplex)
		70%	32%	1 owner

Table 6: Summary of % reduction of potable water requirement and waste water to sewer

- If the priority is reducing the demand for potable water, a **rainwater system** in conjunction with **dry sanitation** is recommended for all 6 typologies.
- If the priority is reducing waste water volume to sewer, then a **greywater system** in conjunction with **dry sanitation** is recommended for all 6 typologies.

These systems would need to be sized and costed. It is likely that the current water tariff will not make a business case for these systems. However, in the likely event of the increase in water tariffs and the increased occupancies of these houses, the installation of these systems would become a viable solution.