Water Research Commission
Rainwater Harvesting Workshop

Birchwood Hotel Conference Centre, Johannesburg

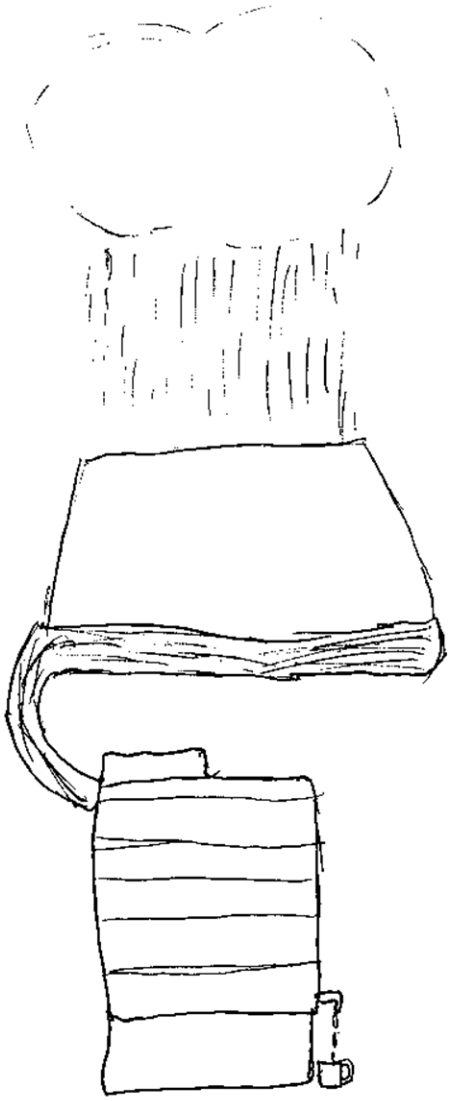
21 November 2013

Louiza Duncker

our future through science

STRUCTURE

- Introduction
- Kharkams case study
  - Assessments
  - Findings
  - Recommendations
  - Options and plans
- Performance evaluation



INTRODUCTION

INTRODUCTION

Rainwater harvesting from roofs:

INTRODUCTION

Rainwater harvesting from the landscape:

CASE STUDY:
Rainwater harvesting at Kharkams in the Northern Cape

CASE STUDY

Kharkams High School wanted to optimise their rainwater harvesting and storage:

- To augment water supply from the municipality
- To use as drinking water
- To irrigate the vegetable gardens
- To irrigate the sports grounds

CASE STUDY


Karas
Groot Karas Mountains
Northern Cape
Kharkams, Leliefontein, South Africa
South Africa
Western Cape
© 2012 Cnes/Spot Image
© 2012 AfriGIS (Pty) Ltd.
© 2012 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
30°23'31.16" S 19°02'47.63" E elev 918 m
Eye alt 1011.78 km


Sports grounds
School buildings
Hostel buildings
© 2012 AfriGIS (Pty) Ltd.
Image © 2012 GeoEye
Imagery Date: 1/24/2012
2003
Eye alt 1.32 km

CASE STUDY

CASE STUDY ASSESSMENT TOOL

To assess, and form baseline for:

- Needs
  - Water use and demand
  - Expectations
- Institutional context
  - Policies and strategies (IDP, WCP, etc)
  - Legal factors
  - Capacity and skills
  - Funder/donor activity

CASE STUDY ASSESSMENT TOOL

Assess:

- Environmental context
  - Water and rainfall
  - Climate
  - Geology and soils
  - Biological systems
- Social context
  - History and settlement pattern
  - Knowledge and attitudes re rainwater harvesting
  - Poverty level

CASE STUDY ASSESSMENT TOOL

Assess:

- Existing infrastructure
  - Elements/hardware
  - Condition
  - Orientation and layout
  - Operation and maintenance capabilities
  - Resources (HR and financial)

CASE STUDY: ASSESSMENTS

INSTITUTIONAL CONTEXT

National

- Policies and legislation – DWA interested in rainwater harvesting
- Strategies – included in Appropriate Technology Strategy, NWRS2, etc

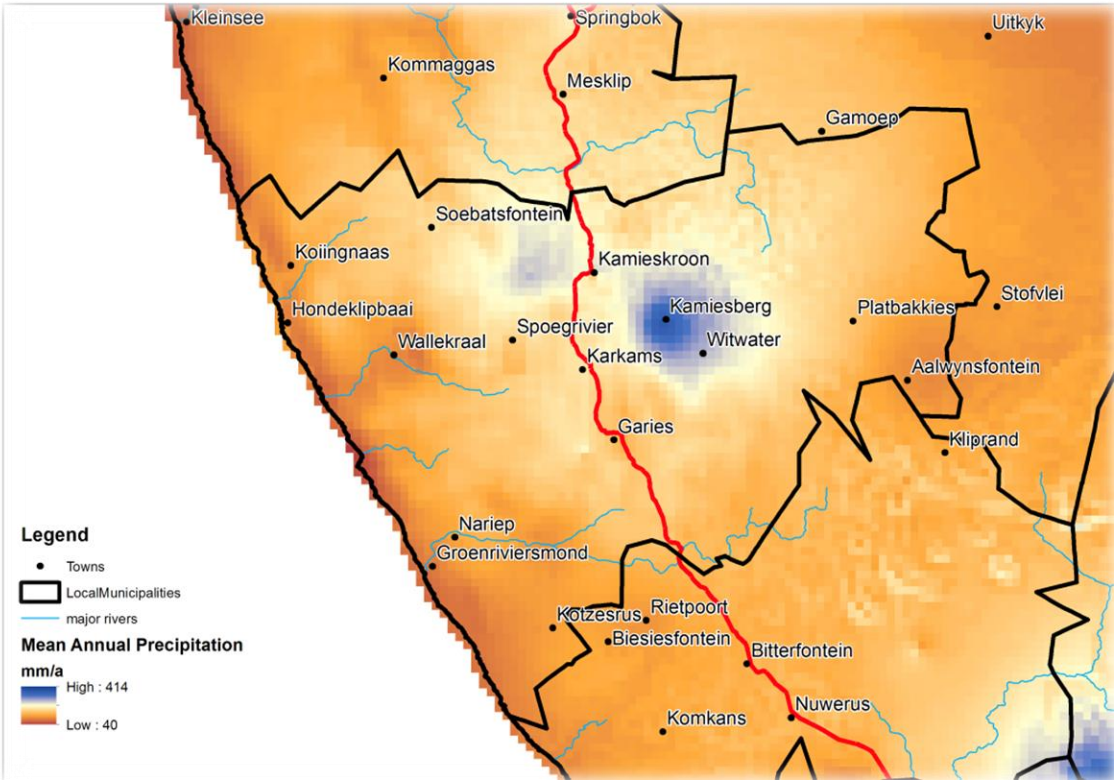
Regional/local

- Integrated Development Plans – not included
- Water Conservations Plans - mentioned
- Water Resources Management Plans - mentioned
- Donors involved – NORAD, Mining Trust, British High Commission, etc

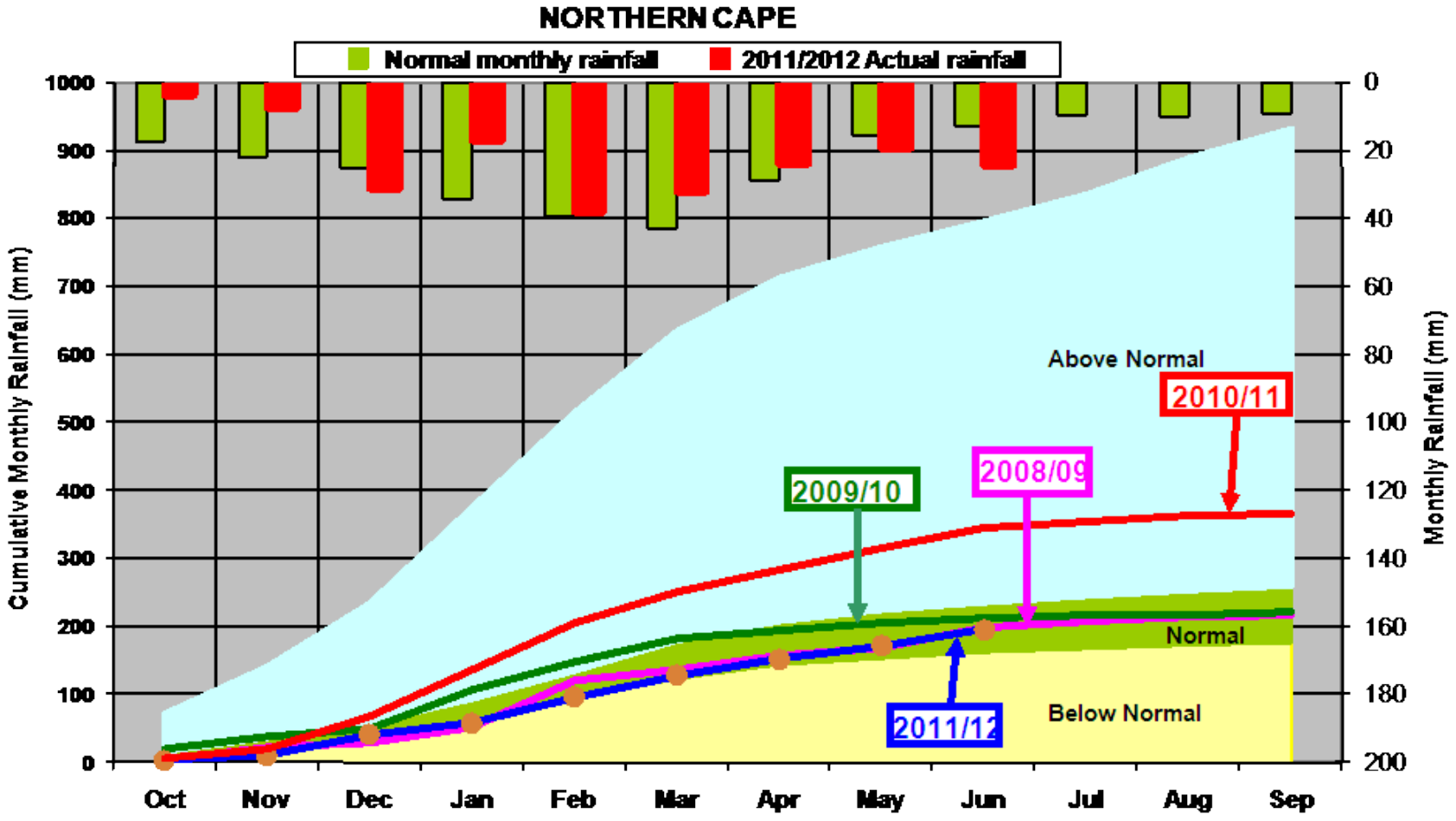
ENVIRONMENTAL CONTEXT

Rainfall, water and climate

- Rainfall between June and September
- Surface water scarce, rivers run underground
- Prone to flash floods
- Very hot summers
- Cool winters



ENVIRONMENTAL CONTEXT

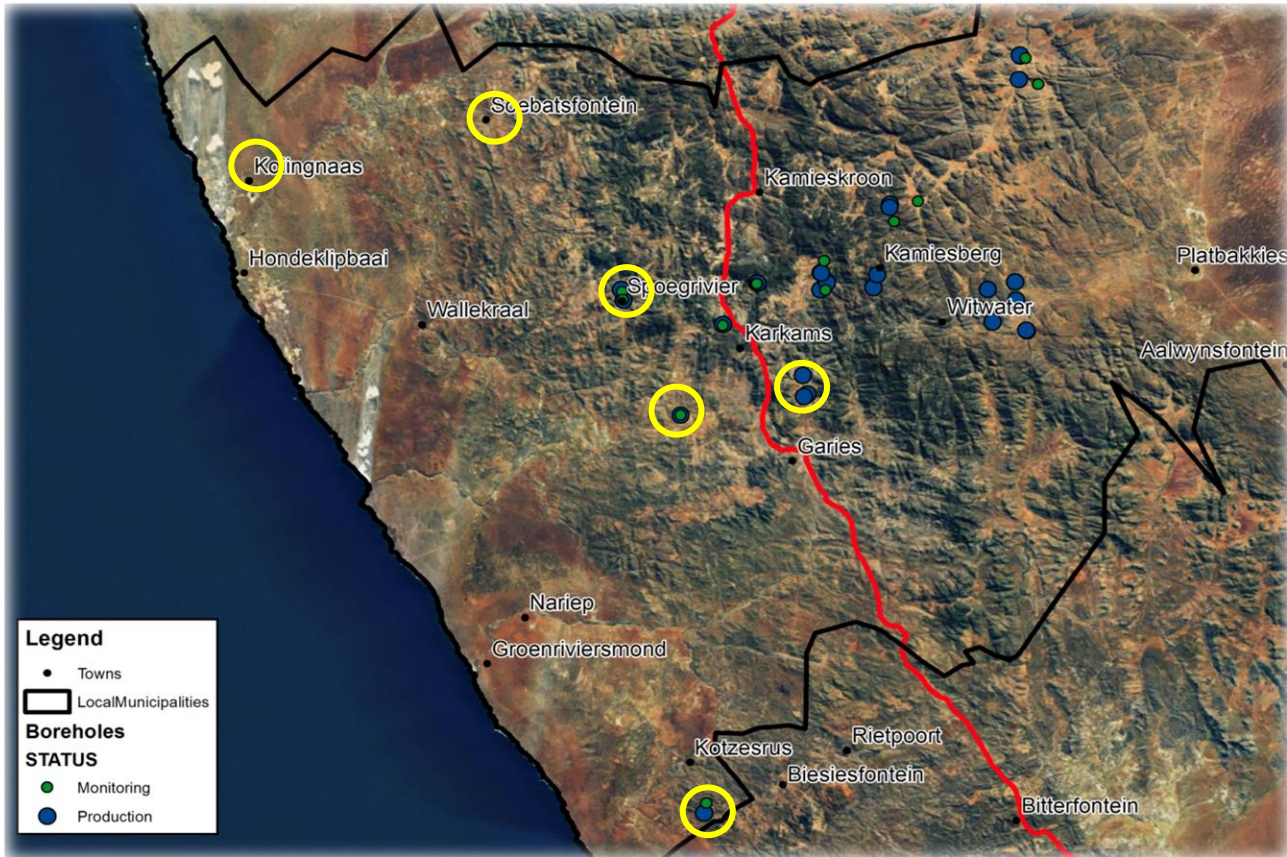


Average rainfall

ENVIRONMENTAL CONTEXT

Groundwater

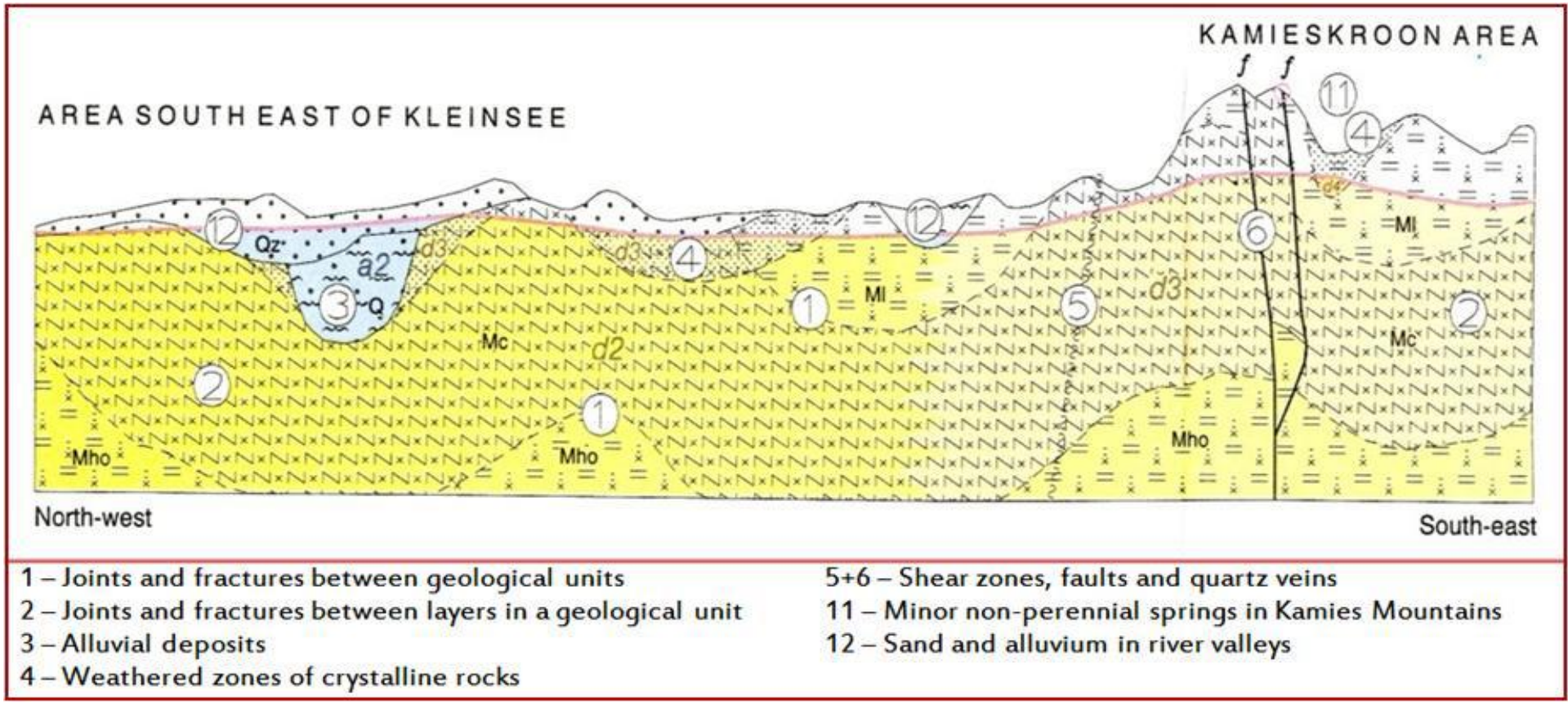
- Very saline due to geology
- Some reverse osmosis plants in place



ENVIRONMENTAL CONTEXT

Geology and soils

- Rock formations and sandy soils
- Hydro-geology and chemistry



ENVIRONMENTAL CONTEXT

Biological systems

- Succulent Karoo biome
- Namaqua flowers – tourism
- National parks

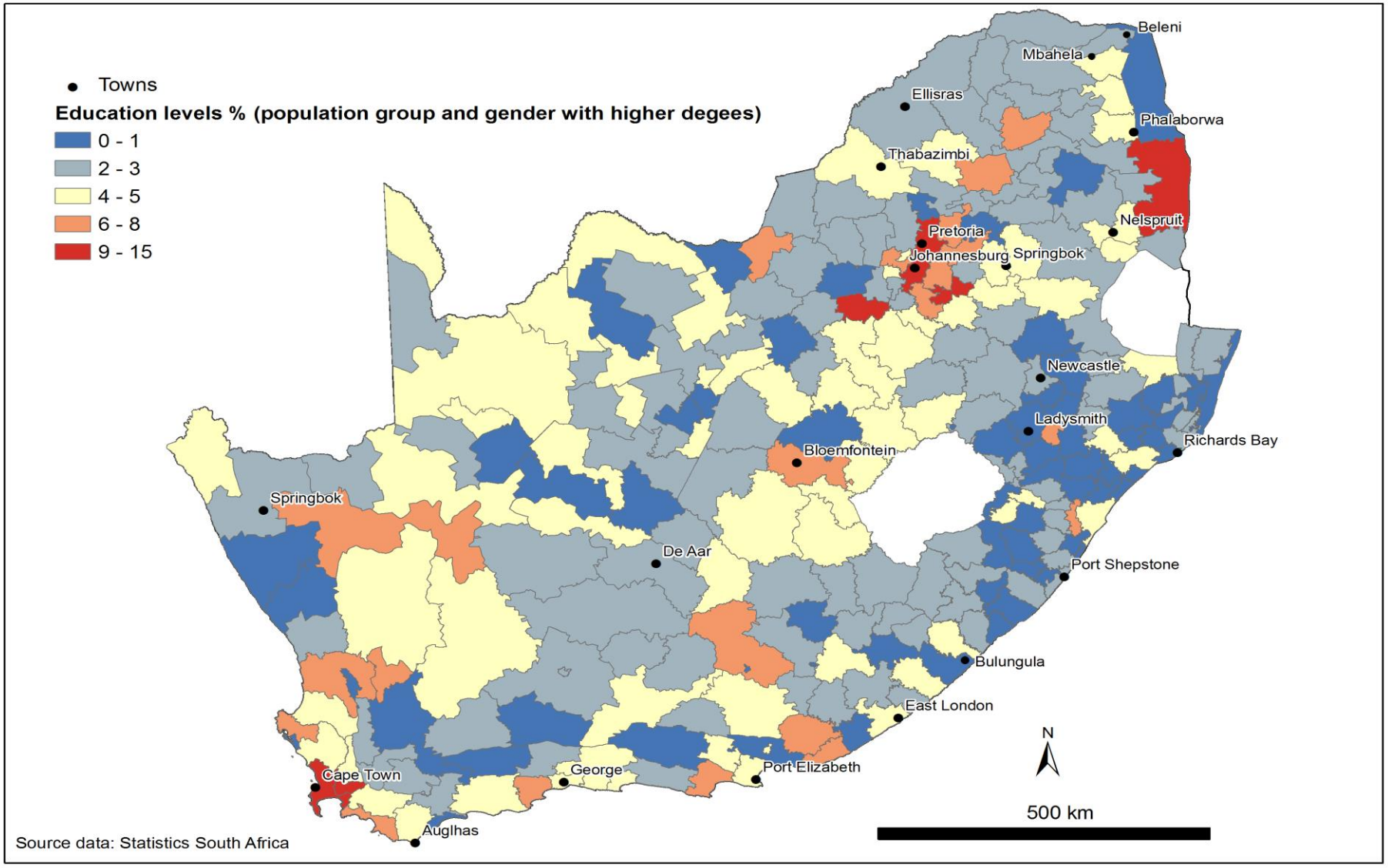
- Namaqua tent tortoise – endangered

SOCIAL CONTEXT

History, standard of living and knowledge

- Settlement patterns
  - Rural and remote rural, low population density (430p/km^2)
  - Descendants of San/Khoi people
- Knowledge, attitudes and perceptions of rainwater harvesting
  - Know about, but not educated
- Standard of living
  - Subsistence farmers, farmers and mine workers
  - High incidence of extreme poverty

SOCIAL CONTEXT



USER PERCEPTIONS

Preparation and development

- Consent forms and letters to parents
- Questionnaire:
  - Info re respondent – gender, age, household info
  - RWH at school and hostels – water source, preference, knowledge, practices
  - RWH at home – water source, preference, knowledge, practices
  - Willingness to be trained

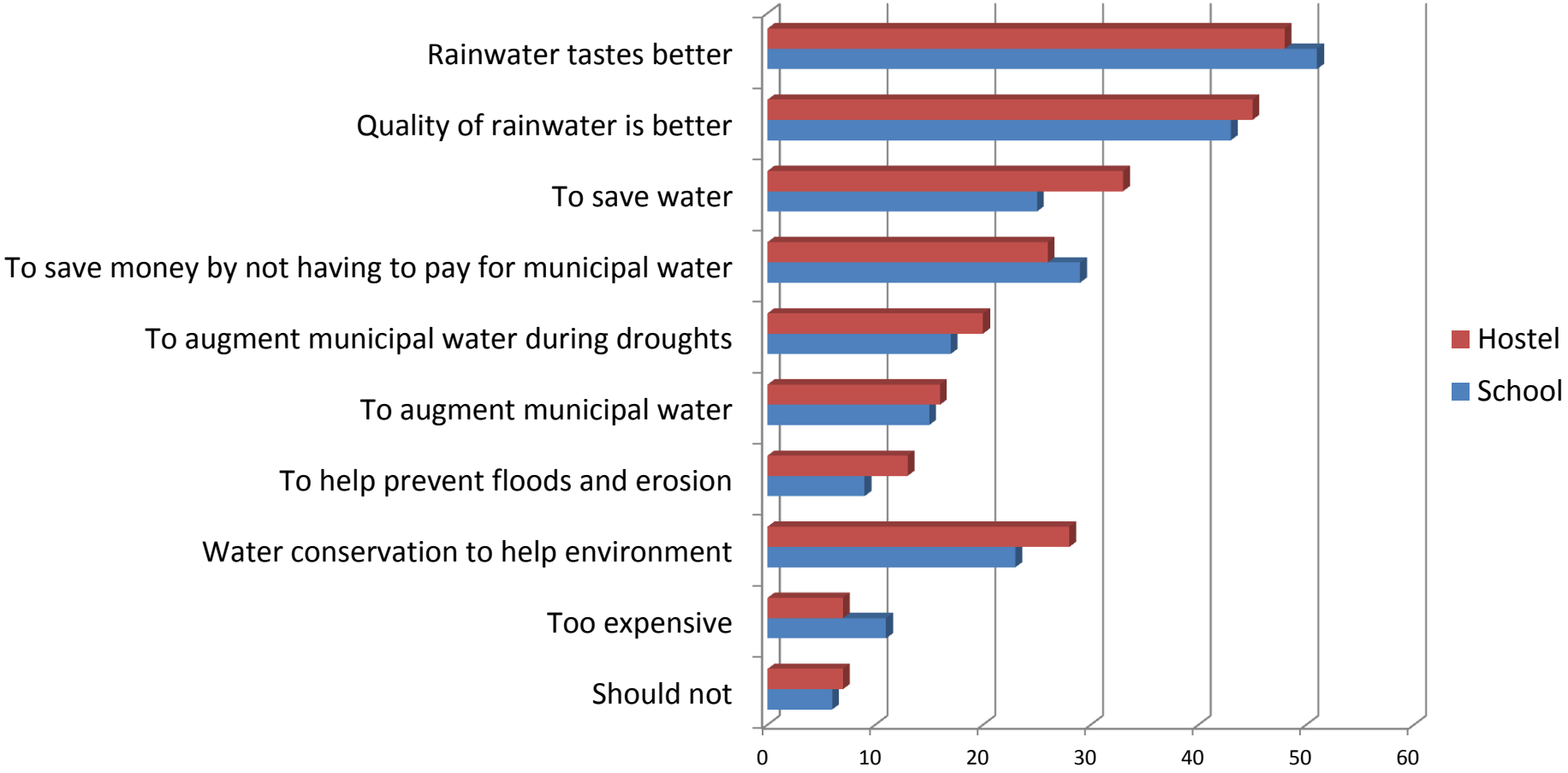
USER PERCEPTIONS

Sampling

- 3 sample frames (total = 633)
  - Learners - 403
  - Hostel dwellers - 200
  - Educators and staff - 30
- Sampled:
  - >10% sample from each
  - Total of 69 respondents
    - 46 learners
    - 24 hostel dwellers
    - 9 educators/staff

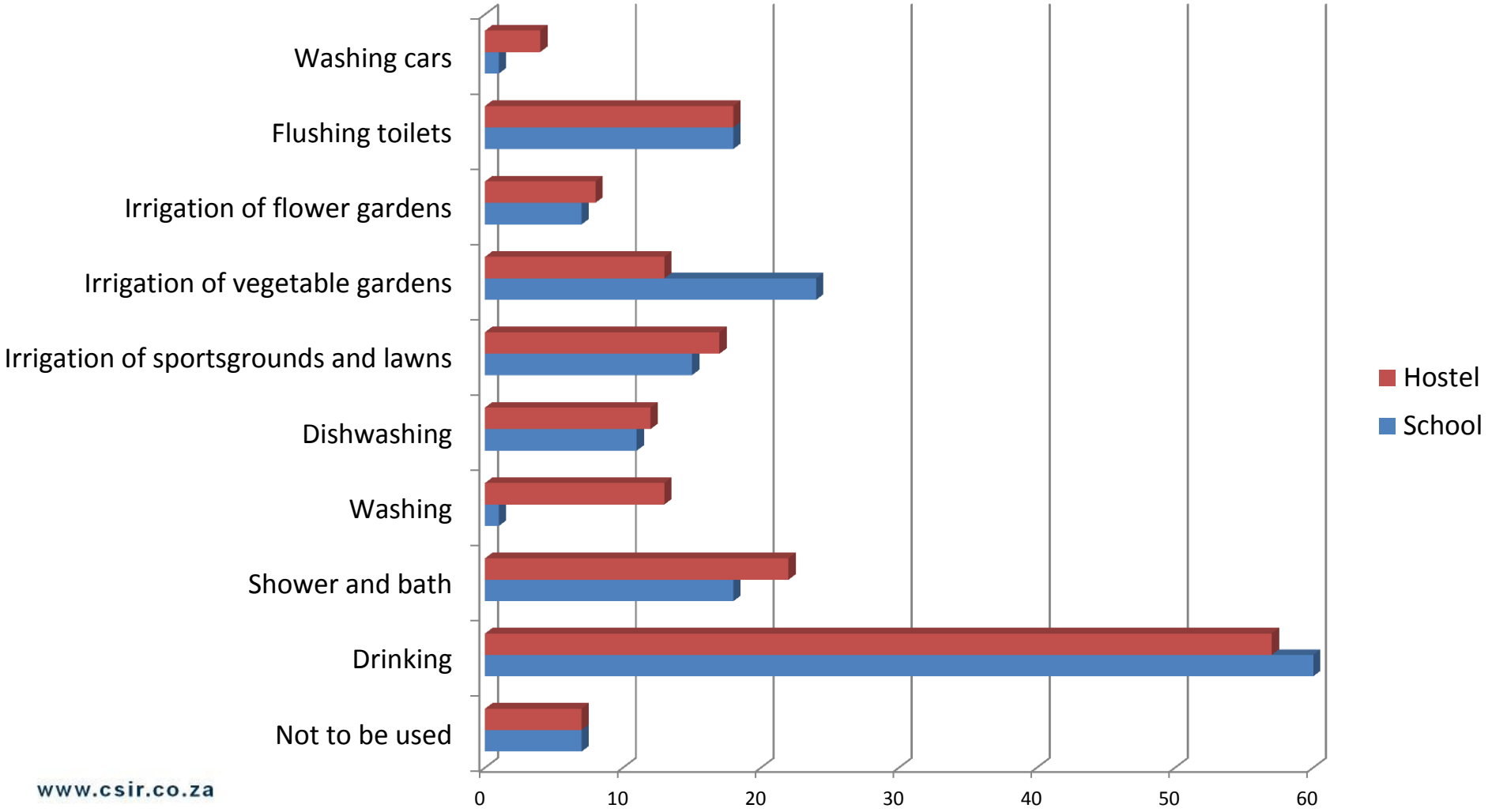
USER PERCEPTIONS

Perceptions of rainwater:



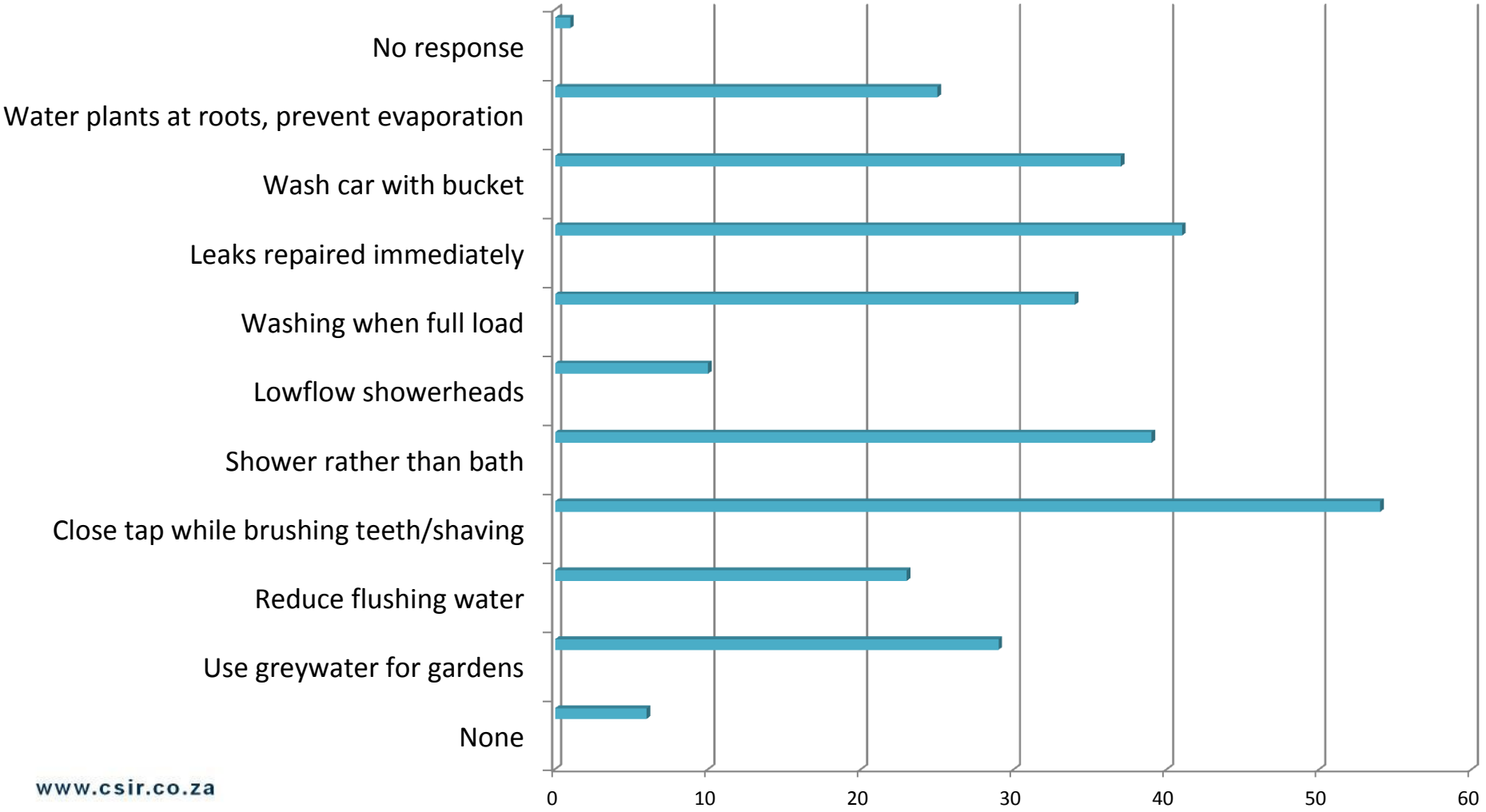
USER PERCEPTIONS

Uses for rainwater:



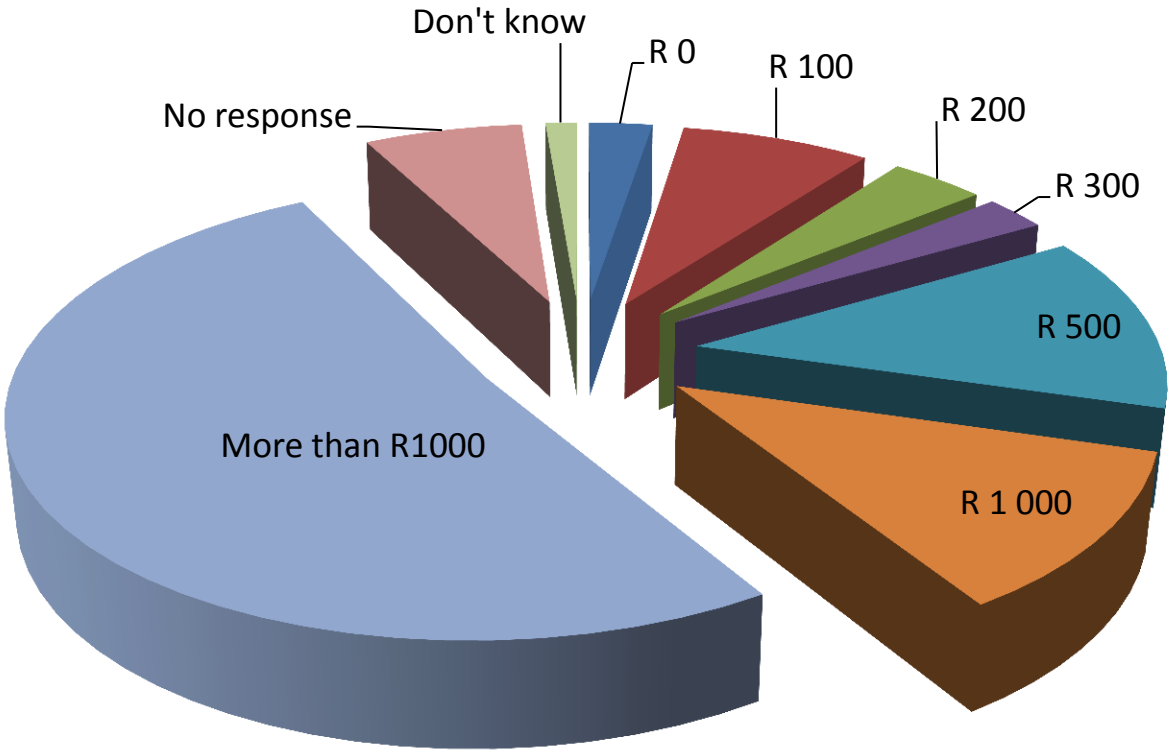
USER PERCEPTIONS

Water conservation practices at home:



USER PERCEPTIONS

Perceptions re costs (per year):



INFRASTRUCTURE ASSESSMENT

INFRASTRUCTURE ASSESSMENT

Roofs

- Asbestos
  - Good condition
  - Need to be replaced over time according to Asbestos Regulations (March 2008)
- Total harvesting area of **7 378m²**
  - School buildings = 3 786m² (1 893m² south-side only)
  - Hostel buildings = 3 592m² (1 796m² south-side only)
- No urgent repairs needed

INFRASTRUCTURE ASSESSMENT

Gutters and downspouts

- Asbestos
  - Some in bad condition
  - Need to be replaced over time
- Urgent repairs, replacement and maintenance needed

INFRASTRUCTURE ASSESSMENT

Storage tanks

- 8 storage tanks
  - 4 x 5 000 litres
  - 4 x 2 500 litres
- Average condition
- Tap connections leaking
- Some repairs needed

INFRASTRUCTURE ASSESSMENT

Storm water drainage

- Cement gulleys, gutters and pipes
  - Good condition
  - No urgent repairs needed on drainage system

- Spillways
  - Urgent attention needed to prevent further erosion

INFRASTRUCTURE ASSESSMENT

Header tank/reservoir and irrigation

- Cement reservoir/header tank
  - Bad condition
  - Serious repairs necessary

- Irrigation system
  - Seemed in good condition

No water to test

WATER QUALITY ASSESSMENT

Water quality in rainwater tanks

Sample No	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Cl mg/L	SO4 mg/L
Recommended level	<150	<70	<200	<50	<200	<400
Kharkams High School North	16.4	1.3	2.7	0.04	4.0	1.9
Kharkams High School South	7.3	0.7	2.4	0.03	4.3	1.4
Reference value	100	100	100	100	6	30
Analysed value	96.5	102	94.5	95.4	6.1	30.4

CASE STUDY: FINDINGS

CASE STUDY FINDINGS

Currently using harvested rainwater for:

- Drinking water
- Augmenting municipal water

Can use rainwater for:

- Drinking
- Irrigation
  - Vegetable gardens
  - Sports grounds

CASE STUDY FINDINGS

Calculations

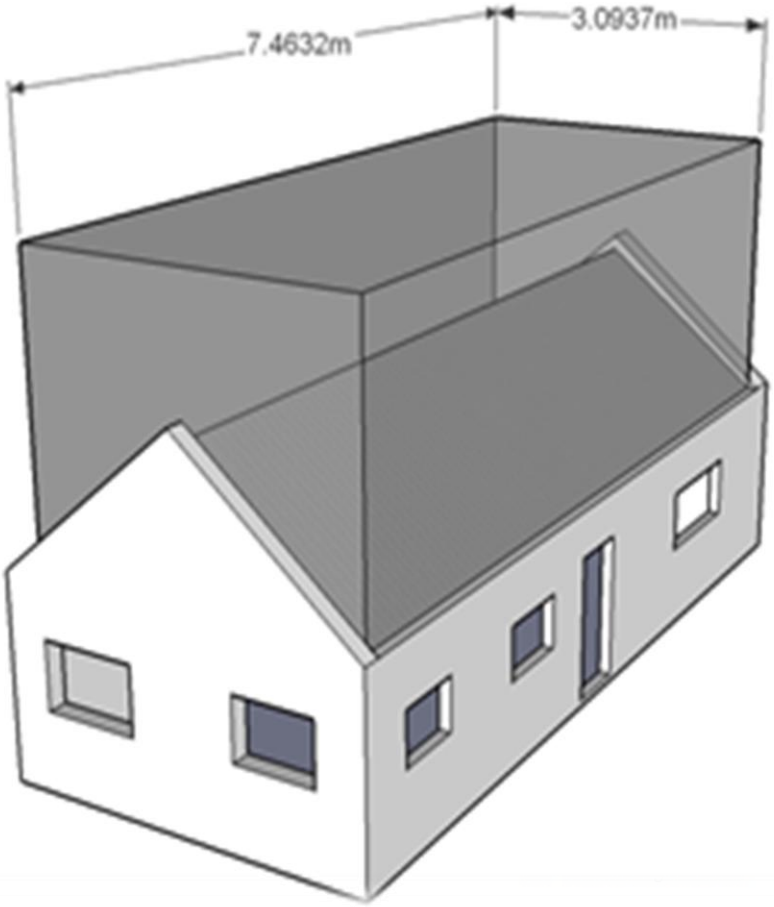
- Average rainfall = 285mm per year

x

- Roofed area = 7 378m^2

x

- Coefficient for asbestos surface = 0.8



CASE STUDY FINDINGS

Current water demand and use:

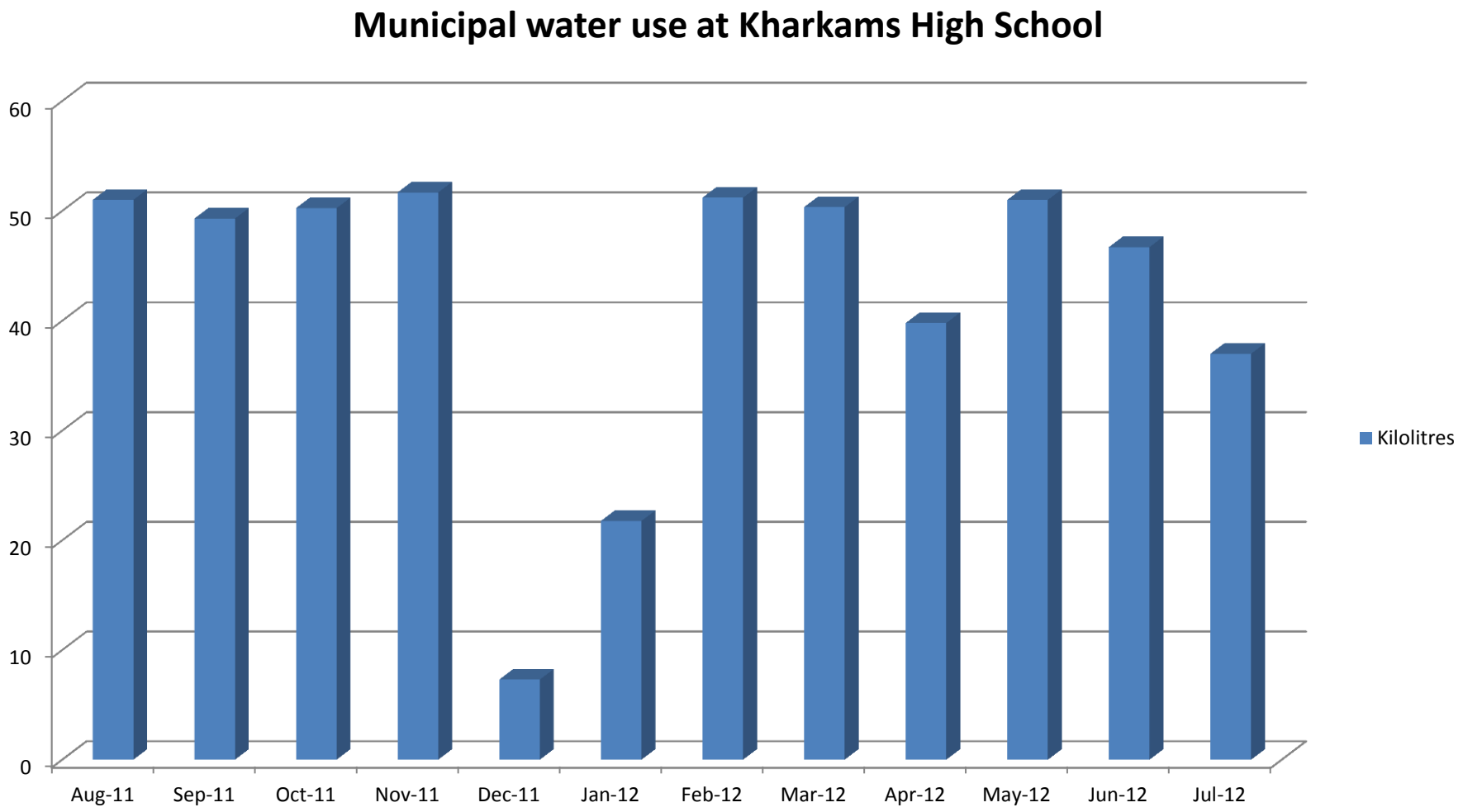
- School
  - 548 learners
  - 20 educators and staff members
  - Water demand (10ℓ/c/d for 200 half days) = 568 000 litres

Need: 1 333 600 litres per year
Municipal water metered Aug 2011 to July 2012 : 507 000 litres

- Hostels
  - 164 dwellers and 10 staff members
  - Water demand (25ℓ/c/d for 276 days) = 765 600 litres

CASE STUDY FINDINGS

Water use pattern:



CASE STUDY FINDINGS

Calculations

Rainfall (mm/year) x Area (m^2) x Runoff coefficient

285 x **7 378** x **0.8**

=

1 682 184 litres per year

(Need: 1 333 600 litres)

Can become independent from municipal water

Can store rainwater for later use

Will need **337** tanks of 5 000ℓ each….

CASE STUDY: RECOMMENDATIONS

CASE STUDY RECOMMENDATIONS

Modules of rainwater harvesting:

- Assessment module
- Physical infrastructure module
- Water quality module
- Support module

Sustainable and successful system

if all of above in place

CASE STUDY RECOMMENDATIONS

Assessment module:

- Needs
  - Water use and demand
  - Expectations
- Institutional context
  - Policies and strategies (IDP, WCP, etc)
  - Legislation, regulations, by-laws and legal factors
- Environmental context
  - Water, climate and rainfall
  - Geology and soil
  - Biological systems

CASE STUDY RECOMMENDATIONS

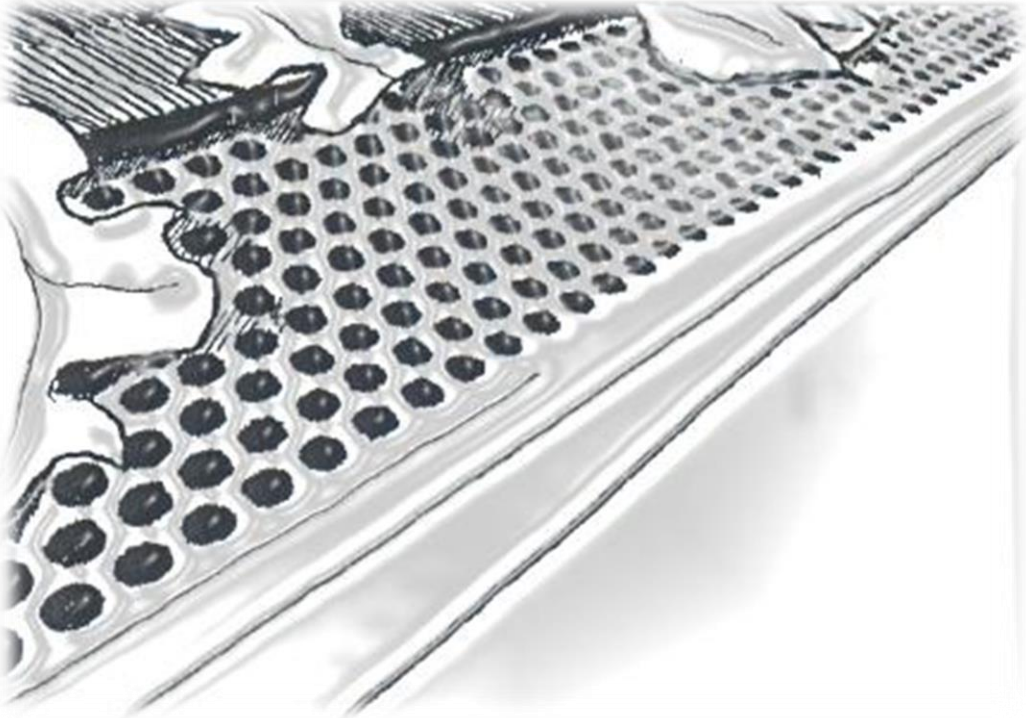
Assessment module:

- Social context
  - History and settlement pattern
  - Standard of living
  - Knowledge and attitudes towards rainwater harvesting
- Existing infrastructure
  - Elements/hardware
  - Condition
  - Operation and maintenance capabilities
  - Resources

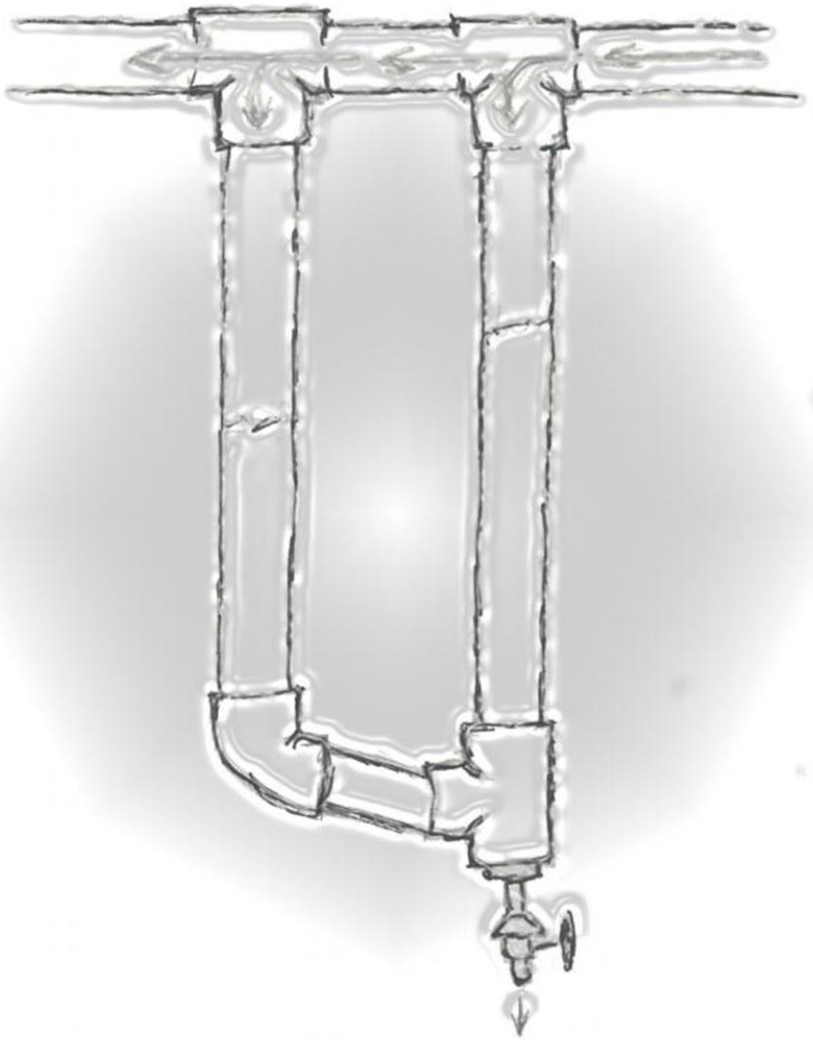
CASE STUDY RECOMMENDATIONS

Physical infrastructure module

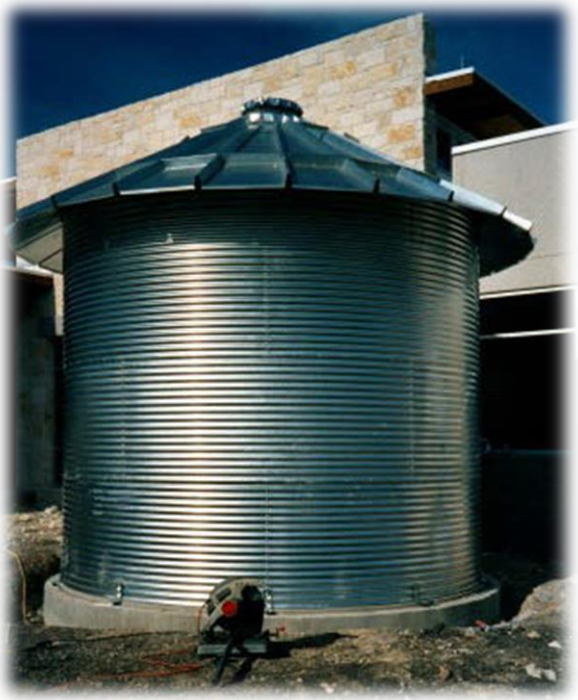
- Catchment - roofs, gutters, parking areas, etc
- Strainers, filters
- First-flush diverters and overflows
- Storage
  - Tank, reservoir, dam, wetland
- Purification equipment
  - Chlorination, carbon filter, reverse osmosis, etc
- Outlets/distribution
  - Pumps, reticulation, taps, irrigation



Gutter mesh and sieves

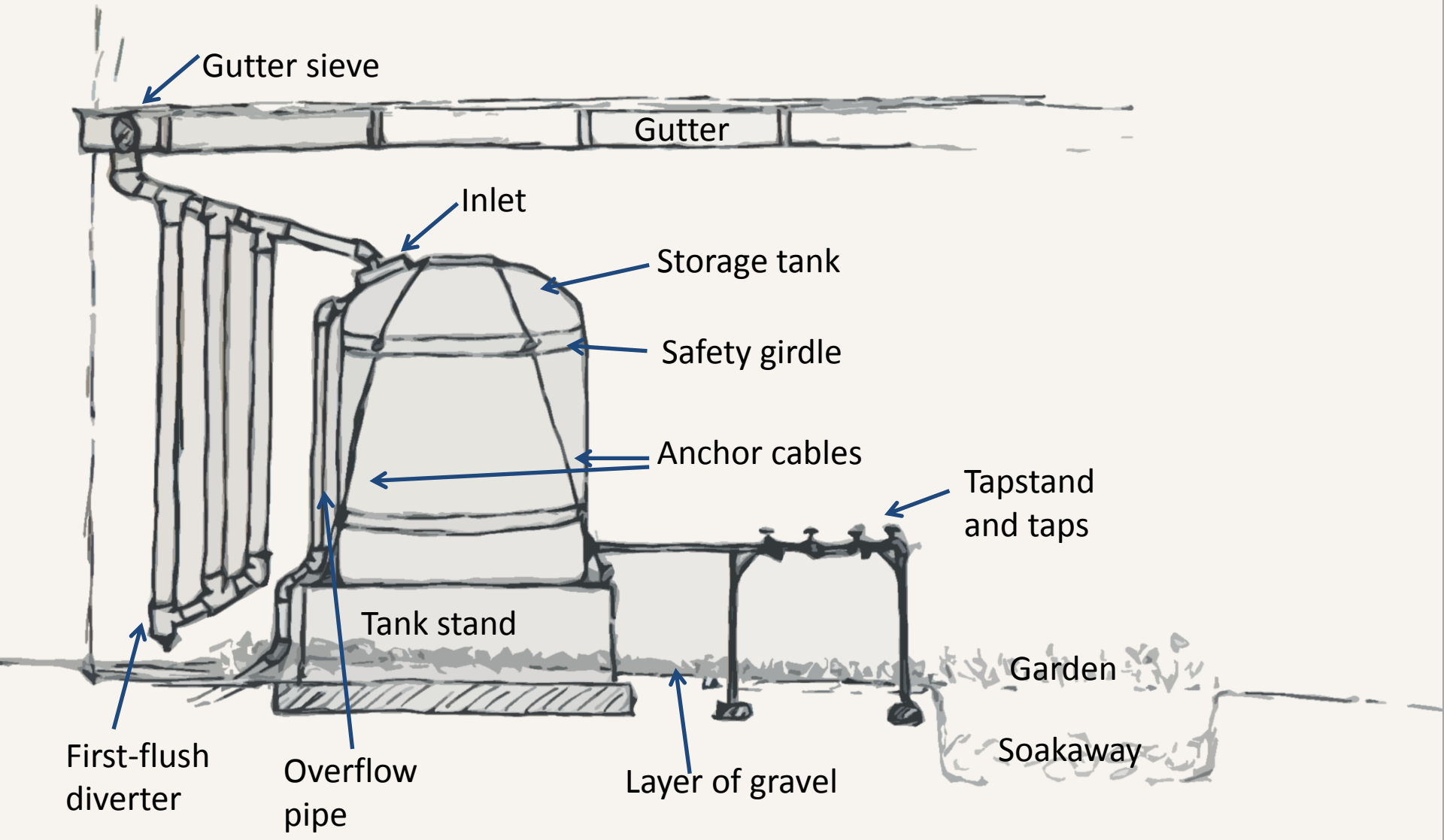


First-flush diverters



Tanks

CASE STUDY RECOMMENDATIONS

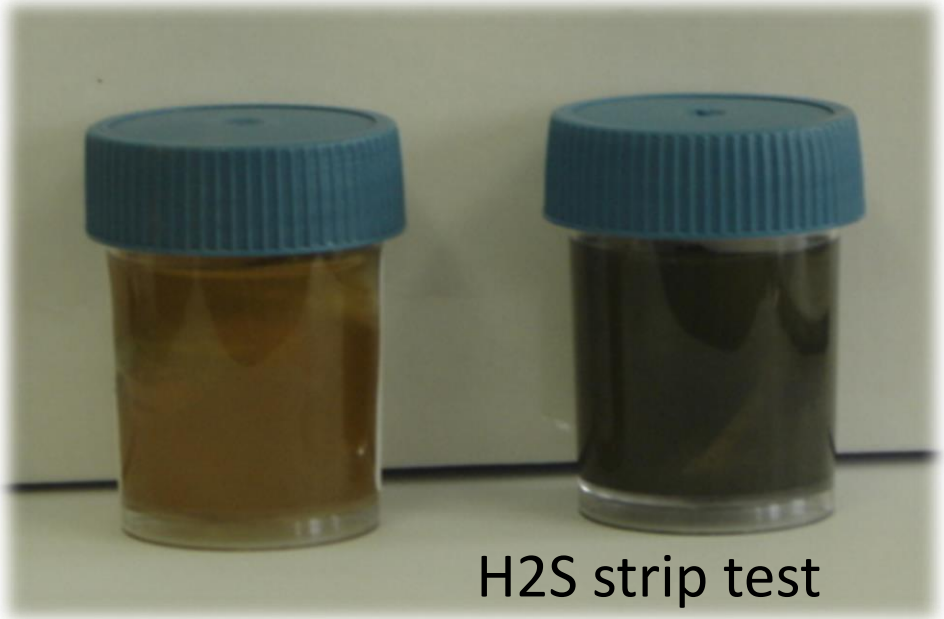


CASE STUDY RECOMMENDATIONS

Water quality module

- Water quality monitoring activities
- Sampling and testing water
- Treating and/or purifying water
- Trouble shooting
- Recording and reporting

Dip-stick test



Water quality monitoring

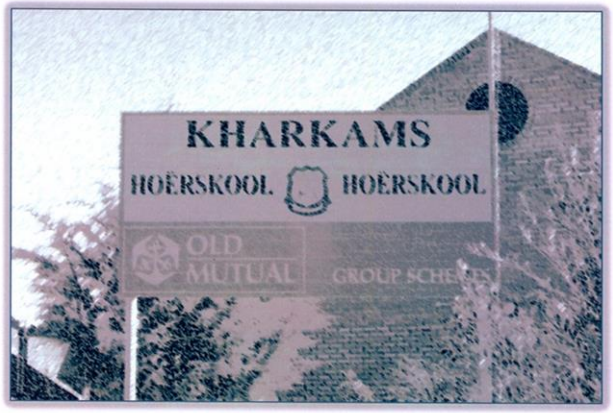
Water treatment methods

Point-of-use water treatment methods

CASE STUDY RECOMMENDATIONS

Support module

- Training of operators
- Operation and monitoring of infrastructure
- Maintenance and repairs
- Budgeting
- Planning
- Management and control



Manual
for the
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in Kharkams
Northern Cape

Contact: Louiza Duncker
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CSIR

CASE STUDY: OPTIONS

CASE STUDY OPTIONS

Option 1: Optimise current infrastructure (8 storage tanks and roof catchment) – short term

- Repair current infrastructure
- Install strainers, filters and first-flush diverters
- Purify harvested water
- Construct tap stands
- Train responsible person/s

- Regular water quality monitoring
- Ongoing monitoring, repairs and maintenance
- Ongoing support and management

CASE STUDY OPTIONS

Option 1 Funding sources:

CSIR/SRP project – capex

Current O&M budget of the school - labour

Annual O&M budget of school – monitoring and management

CASE STUDY OPTIONS

Option 2: **Expand** current infrastructure (20 storage tanks and roof catchment) – short to medium term

- Repair all gutters
- Procure 12 x 5 000liter storage tanks and components – CSIR
- Install strainers, filters and first-flush devices for new tanks
- Install purification equipment for all tanks
- Construct tap stands and connections at new tanks

CASE STUDY OPTIONS

Option 2:

- Regular water quality monitoring
- Ongoing monitoring, repairs and maintenance
- Ongoing support

Funding sources:

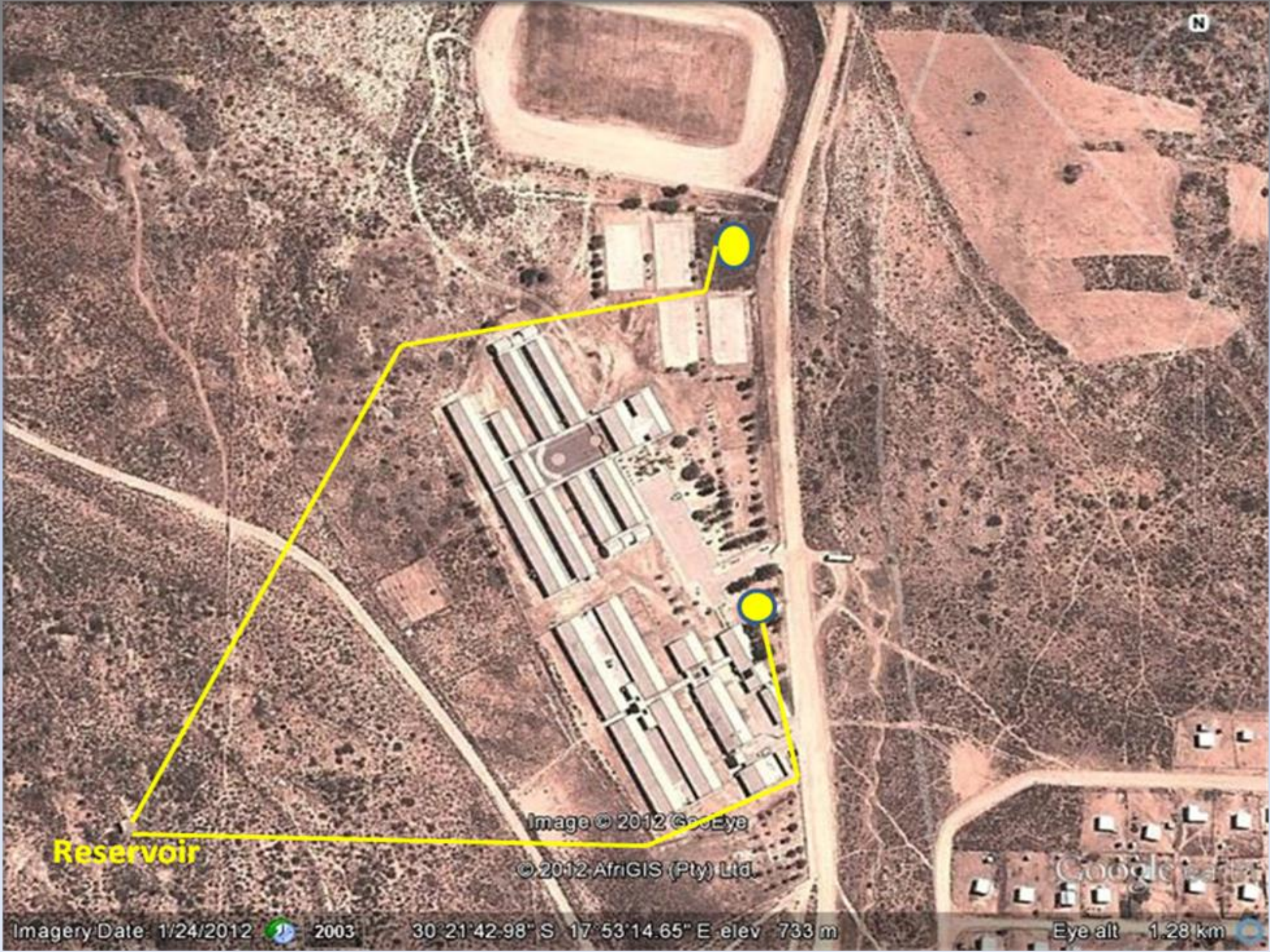
CSIR/SRP project – capex

Annual O&M budget of the school – labour and management

CASE STUDY OPTIONS

Option 3: Include storm water harvesting with roof water harvesting – <u>medium to long term</u>

- Measure storm water volume and design system
- Construct concrete reservoir/s
- Install purification equipment
- Construct reticulation and install pumps for pumping water to the header tank:
  - Irrigation
  - Drinking water
  - Augmenting municipal water


Reservoir
Image © 2012 GeoEye
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Imagery Date 1/24/2012
2003
30°21'42.98" S 17°53'14.65" E elev 733 m
Eye alt 1.28 km

CASE STUDY OPTIONS

Option 3:

- Regular water quality monitoring
- Ongoing monitoring, repairs and maintenance
- Ongoing support

Funding sources:

Capex from DBE, DWA, donors, etc

Annual O&M budget of the school – labour and management

CASE STUDY OPTIONS

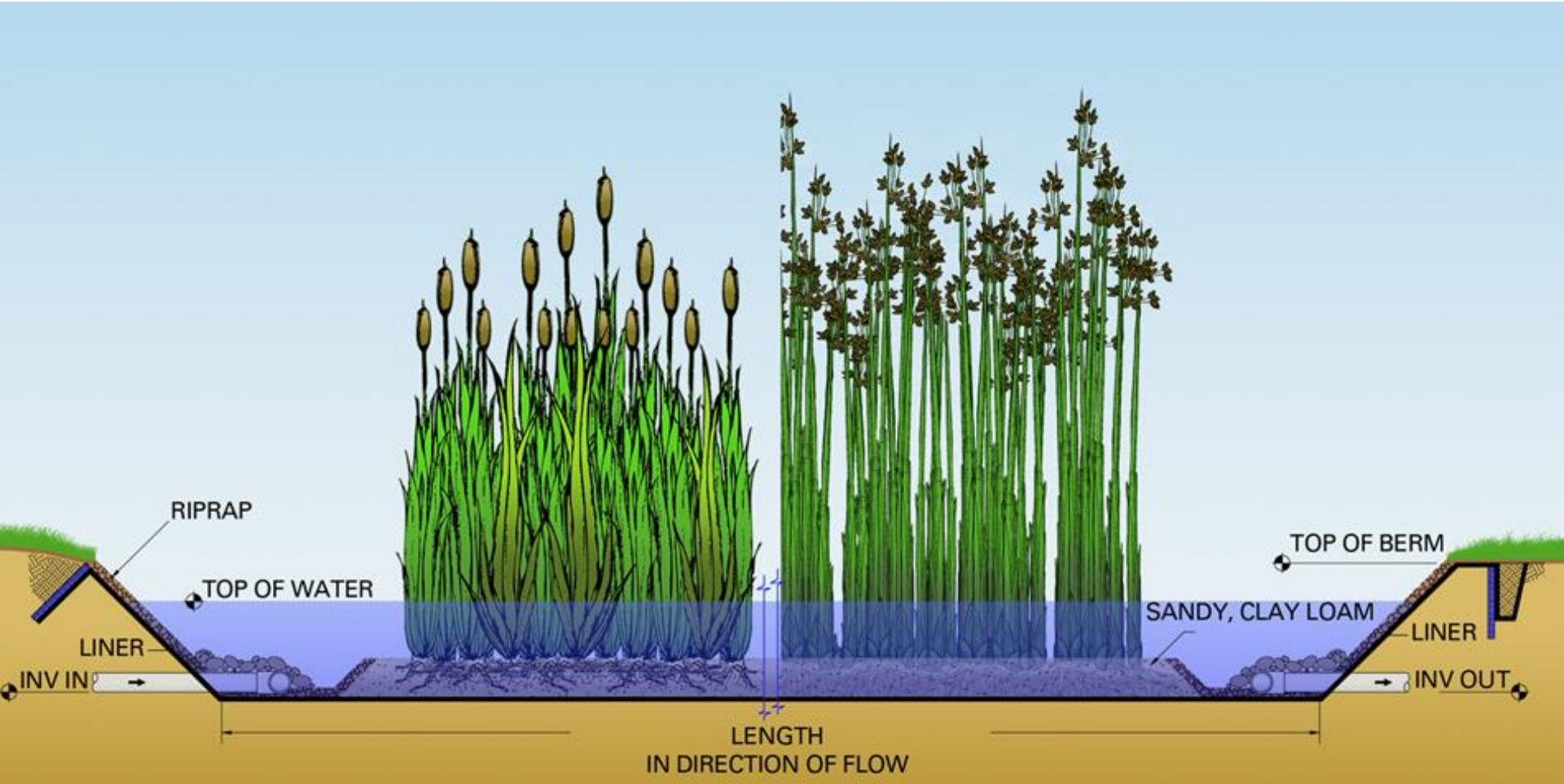
Option 4: Infrastructure for **comprehensive** rainwater harvesting system – long term

- Measure **rainwater**, **storm water** and **grey water** volumes
- Investigate impact on sewer treatment works
- Environmental impact assessment
- Construct wetlands
- Construct reticulation and install pumps for:
    - Irrigation
    - Potable water
    - Use municipal water for flushing toilets

Two possible locations for a constructed wetland, depending on EIA

CASE STUDY OPTIONS

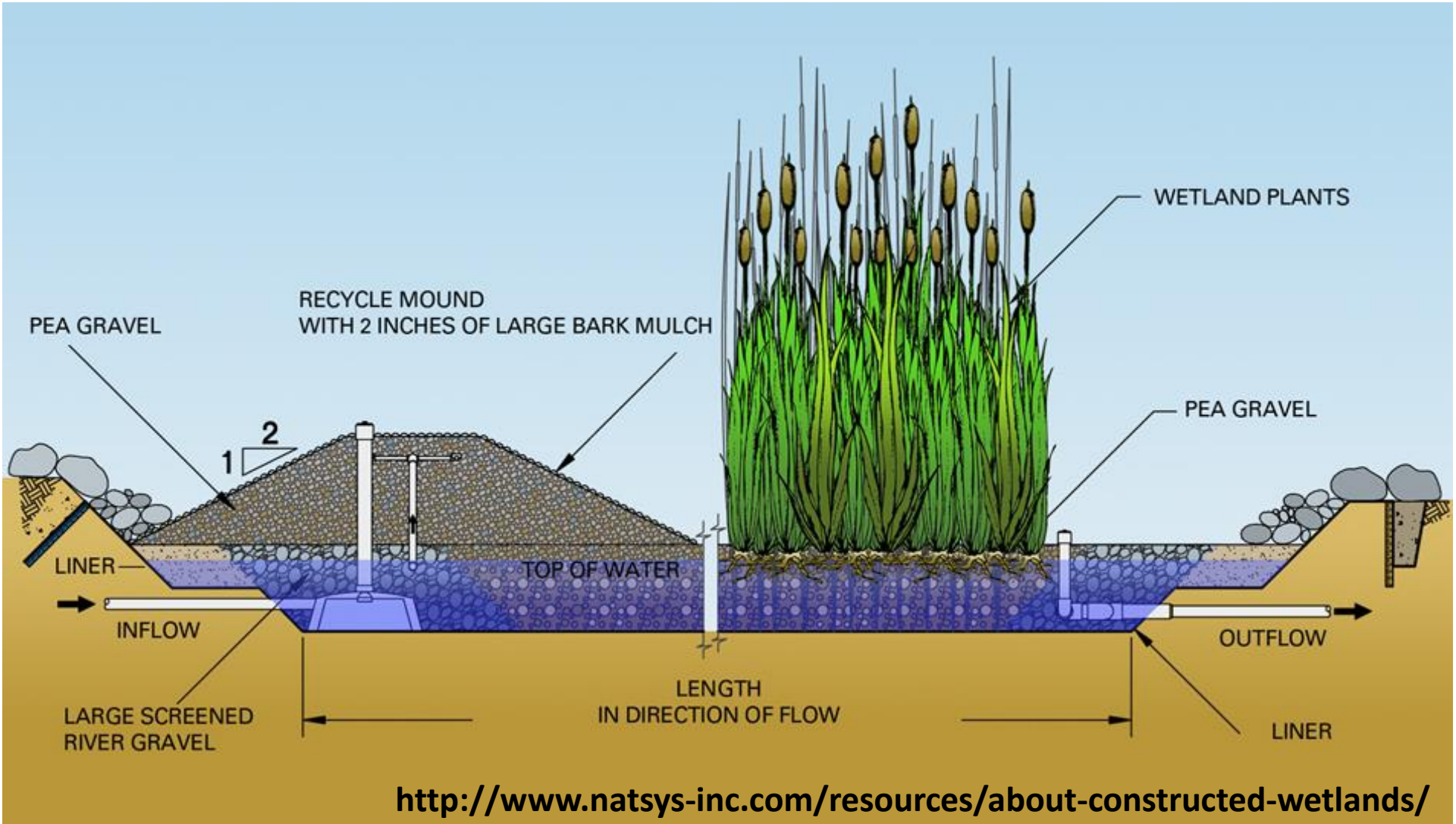
Surface wetland



http://www.natsys-inc.com/resources/about-constructed-wetlands/

CASE STUDY OPTIONS

Subsurface wetland



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CASE STUDY OPTIONS

Option 4:

- Regular water quality monitoring
- Ongoing monitoring, repairs and maintenance
- Ongoing support

Funding sources:

Capex from donors, funders

Annual O&M budget of the school – labour and management

CASE STUDY OPTIONS

Dam

CASE STUDY OPTIONS

No option - Dam

- Evaporation rates very high
- Mineral concentrations
- Flash flood damages
- Extreme silting
- High capital costs
- Operation and maintenance costly

CASE STUDY OPTIONS AND COSTS

Summary of estimated costs (2012)

Option	CAPEX	Training	O&M and management	Total
1 Repair	R52 000	R30 000	R39 000	R121 000
2 Expand	R108 000	R10 000	R49 000	R167 000
3 Include storm water	R5.05million	R10 000	R250 000	R5.21million
4 Wetland	R4.2million	R10 000	R40 000	R4.2million
0 Dam	R8million	R15 000	R500 000	R8.5million

CASE STUDY OPTIONS AND COSTS

Summary of estimated costs (2012)

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CASE STUDY: OPTIONS SELECTED

CASE STUDY OPTIONS SELECTED

Short term

- Option 1 and 2 = Plan 1 and 2: Repair and expand

Completed end May 2013

Long term

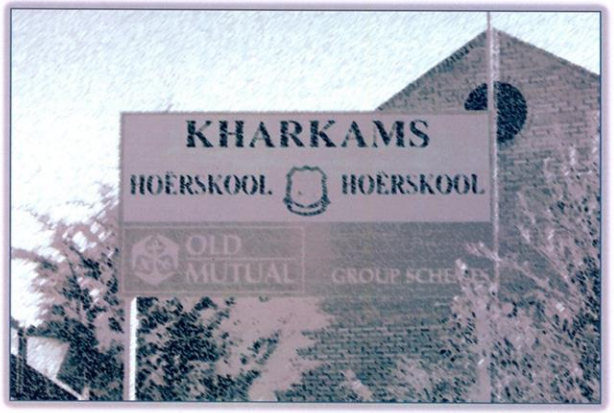
- Option 4 = Plan 3: Design and construct wetlands

Seeking funding

CASE STUDY PLANS

Plans 1&2:

- Repair and construction
- Training in O&M



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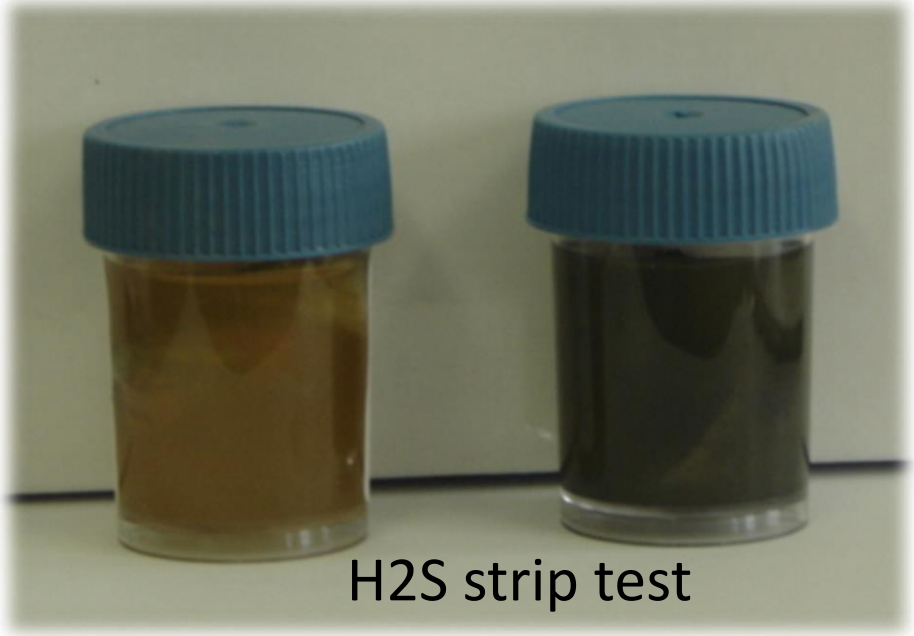
CASE STUDY PLANS

Construction

CASE STUDY PLANS



H2S strip test

Bleach

Dip-stick test

Water monitoring and treatment

CASE STUDY PLANS

Seeking funding for:

- Option 4 = Plan 3: Design and construct wetlands
  - Water use measurements
  - Water quantity measurements
  - Environmental Impact Assessment
  - Impact assessment on treatment works
  - Design of wetland system
  - Construction
  - Training in operation and maintenance
  - Training in water quality monitoring

PERFORMANCE EVALUATION

PERFORMANCE EVALUATION

What is performance evaluation?

- Assessing on a periodic basis whether performance is:
  - Up to minimum standards
  - Effective (doing the right thing)
  - Efficient (doing the thing right)
- Learn lessons to make decisions re:
  - Re-alignments
  - Extensions
  - Terminations

PERFORMANCE EVALUATION

Current situation in South Africa:

- Rainwater harvesting exists
  - Mostly informally at household level
  - Few businesses ‘going green’
- RWH included in water sector policies, strategies and programmes
  - NWRS2, etc
  - Appropriate Technology strategy
- No performance evaluation methods or tools
- No formal/minimum standards

PERFORMANCE EVALUATION

Develop indicators and standards/benchmarks for each module of rainwater harvesting:

- Assessment module
  - Needs, institutional, environmental, social
- Physical infrastructure module
  - Catchment, collection, storage, distribution
- Water quality module
  - Testing, treatment, purification
- Support module
  - O&M, budgeting/financing, management/control

PERFORMANCE EVALUATION

Develop monitoring and reporting procedures:

- National level:
  - Blue Drop/Green Drop
  - M&E system for RWH (Rain Drop)
- Local level:
  - M&E procedures and tools
  - Indicators and measurements
  - Minimum standards

PERFORMANCE EVALUATION

Commission research on:

- Water quality and treatment of rainwater
- Quantification and use levels
- Understanding and uptake by beneficiaries
- M&E system for sustainability
- Performance evaluation methods and tools
- Impact assessments
  - Water conservation & climate change
  - Quality of life
  - Poverty reduction and job creation

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