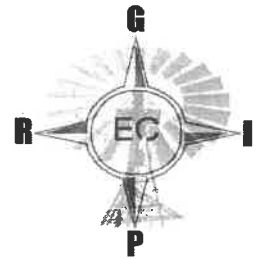


# GROUNDWATER RESOURCE INFORMATION PROJECT EASTERN CAPE PROVINCE

## GROUNDWATER INFORMATION SOURCE REFERENCE SHEET



|                       |               |             |   |                |   |
|-----------------------|---------------|-------------|---|----------------|---|
| <b>SOURCE REF NR:</b> | <b>SR 078</b> | Own Archive | ✓ | Copy attached  |   |
|                       |               | Sourced     |   | Copy at source | ✓ |

**A: SOURCE DESCRIPTION**

|  |  |         |            |   |           |            |        |  |            |
|--|--|---------|------------|---|-----------|------------|--------|--|------------|
| District Municipality:                 | <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">Amatole</td> <td style="width: 25%;">Chris Hani</td> <td style="width: 10%; text-align: center;">✓</td> <td style="width: 35%;">O.R Tambo</td> </tr> <tr> <td>Ukhahlamba</td> <td>Cacadu</td> <td></td> <td>Alfred Nzo</td> </tr> </table> | Amatole | Chris Hani | ✓ | O.R Tambo | Ukhahlamba | Cacadu |  | Alfred Nzo |
| Amatole                                | Chris Hani   | ✓       | O.R Tambo  |   |           |            |        |  |            |
| Ukhahlamba                             | Cacadu   |         | Alfred Nzo |   |           |            |        |  |            |
| Local Municipality:                    | <b>CHRIS HANI DM</b>   |         |            |   |           |            |        |  |            |
| Institution where information is held: | <b>SRK CONSULTING</b>  |         |            |   |           |            |        |  |            |
| Branch of Institution:                 | <b>EAST LONDON</b>   |         |            |   |           |            |        |  |            |
| Contact details:                       | Contact person: <b>Gert Nel</b>  |         |            |   |           |            |        |  |            |
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|  | Contact Email: <b>gnel@srk.co.za</b>   |         |            |   |           |            |        |  |            |

**B: TYPE OF INFORMATION**

|                         |   |                |   |                   |  |                   |  |          |  |            |  |       |  |
|-------------------------|---|----------------|---|-------------------|--|-------------------|--|----------|--|------------|--|-------|--|
| Information format:     | <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">Hard copy</td> <td style="width: 10%; text-align: center;">X</td> <td style="width: 25%;">Data Summary</td> <td style="width: 10%;"></td> <td style="width: 30%;">Electronic Report</td> <td style="width: 10%;"></td> </tr> </table>   | Hard copy      | X | Data Summary      |  | Electronic Report |  |          |  |            |  |       |  |
| Hard copy               | X   | Data Summary   |   | Electronic Report |  |                   |  |          |  |            |  |       |  |
|                         | Specify Other:  |                |   |                   |  |                   |  |          |  |            |  |       |  |
| Report / Info Title:    | <b>KLEINBULHOEK SANITATION</b>  |                |   |                   |  |                   |  |          |  |            |  |       |  |
| Report Nr:              | <b>327600</b> Date: <b>JAN '04</b>  |                |   |                   |  |                   |  |          |  |            |  |       |  |
| Author Details:         | <b>G NEL</b>  |                |   |                   |  |                   |  |          |  |            |  |       |  |
| Author's Qualification: | <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">Hydrogeologist</td> <td style="width: 10%; text-align: center;">✓</td> <td style="width: 25%;">Govt Dept</td> <td style="width: 10%;"></td> <td style="width: 30%;">Project Manager</td> <td style="width: 10%;"></td> </tr> <tr> <td>Engineer</td> <td></td> <td>Technician</td> <td></td> <td>Other</td> <td></td> </tr> </table> | Hydrogeologist | ✓ | Govt Dept         |  | Project Manager   |  | Engineer |  | Technician |  | Other |  |
| Hydrogeologist          | ✓   | Govt Dept      |   | Project Manager   |  |                   |  |          |  |            |  |       |  |
| Engineer                |   | Technician     |   | Other             |  |                   |  |          |  |            |  |       |  |
| Captured by: PS. Nel    | Date: <b>18/02/2004</b> Signed:   |                |   |                   |  |                   |  |          |  |            |  |       |  |

**C: GEOHYDROLOGICAL CATEGORIZATION**

|                                  |   |                    |           |                   |                   |                   |   |
|----------------------------------|---|--------------------|-----------|-------------------|-------------------|-------------------|---|
| Project Type                     | <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">Source development</td> <td style="width: 10%;"></td> <td style="width: 25%;">Feasibility Study</td> <td style="width: 10%;"></td> <td style="width: 30%;">Sanitation Study:</td> <td style="width: 10%; text-align: center;">X</td> </tr> </table> | Source development |           | Feasibility Study |                   | Sanitation Study: | X |
| Source development               |   | Feasibility Study  |           | Sanitation Study: | X                 |                   |   |
|                                  | Specify Other:  |                    |           |                   |                   |                   |   |
| Reference Co-ordinate:           | <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Latitude</td> <td style="width: 50%;">Longitude</td> </tr> <tr> <td style="text-align: center;"><b>32.0662222</b></td> <td style="text-align: center;"><b>26.4554722</b></td> </tr> </table>  | Latitude           | Longitude | <b>32.0662222</b> | <b>26.4554722</b> |                   |   |
| Latitude                         | Longitude   |                    |           |                   |                   |                   |   |
| <b>32.0662222</b>                | <b>26.4554722</b>   |                    |           |                   |                   |                   |   |
| Lithological & Construction Logs | X   |                    |           |                   |                   |                   |   |
| Hydrocensus Data                 | X   |                    |           |                   |                   |                   |   |
| Pump Testing Data                | X   |                    |           |                   |                   |                   |   |
| Chemical Water Analysis Data     | X   |                    |           |                   |                   |                   |   |
| Geohydrological Data             | X   |                    |           |                   |                   |                   |   |
| Spring Data                      | X   |                    |           |                   |                   |                   |   |
| Remote Sensing Data              | X   |                    |           |                   |                   |                   |   |
| Map Data                         | X   |                    |           |                   |                   |                   |   |

Comments:

Reviewed by: **NELG**      Date:      Signed:

#2  
12

**ILISO CONSULTING ENGINEERS**

**KLEINBULHOEK VILLAGES**

**DRAFT**

**GEOHYDROLOGICAL INVESTIGATION TO  
DETERMINE THE RISK OF GROUNDWATER**

**CONTAMINATION FROM ON-SITE**

**SANITATION**

Report No. 327600/1

JANUARY 2004



# **ILISO CONSULTING**

## **GEOHYDROLOGICAL INVESTIGATION TO DETERMINE THE RISK OF GROUNDWATER CONTAMINATION FROM ON-SITE SANITATION**

### **KLEINBULHOEK VILLAGES**

By:

**GP Nel [Pr Sci Nat]**

**Report No. 327600**

**January 2004**

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## 1. INTRODUCTION AND TERMS OF REFERENCE

SRK Consulting (SRK) was appointed by Iliso Consulting on 4 December 2003 to conduct a hydrogeological investigation to determine the contamination risk to groundwater from on-site sanitation. The investigation was based on the guidelines as given by the Department of Water Affairs and Forestry<sup>1</sup>.

### The methodology was as follows:

- A desk study to determine the position of Geological structures (e.g. dykes and faults in the area);
- A hydrocensus to determine the positions of existing boreholes, groundwater usage and to measure any physical parameters such as water levels (where possible);
- Description of the generic soil type in the area, derived from discussions with the community;
- Determination of the groundwater potential;

## 2. LOCALITY OF PROJECT AREA

The study area is situated between Queenstown and Tarkastad in the Chris Hani district area. The locality of the area can be seen from the geohydrological map in Appendix 1 (Map 1).

## 3. GROUNDWATER PROTOCOL

As background to the study, the key aspects from DWAF's Protocol document are included in Appendix 3.

<sup>1</sup> A protocol to manage the potential of groundwater contamination from on site sanitation. Edition 1, 1997



TECHNOLOGY  
T.O.P. - 100

**Partners** MJ Braune, JM Brown, AC Burger-Pintér, IS Cameron-Clarke, JAC Cowan, Dr M. Harley\*, T Hart, PR Labrum, RRW McNeill\*, HAC Meintjes, BJ Middleton, MJ Morris, SG Müller, GP Murray, PN Rosewarne\*, PE Schmidt, PJ Shepherd, AA Smither, Dr OKH Steffen, RJ Stuart\*, AH Swart, PJ Terbrugge, PJ Theron, KM Uderstadt, D van Bladeren, DJ Venter, HG Waldeck, DW Warwick, Dr A Wood\*  
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**Directors** AJ Barrett, AC Burger-Pintér, PR Labrum, H Lachporia, BJ Middleton, E Molobi, PE Schmidt, PJ Terbrugge

**Associates** N Boersema, JGJ Boshoff, FM Cesford, CD Dalglish, NM Holdcroft, SA McDonald, LGA Maclear, GP Nel, BH Read, VS Reddy, MJ Stanway, AC White

**Consultants** JH de Beer, *PrSci Nat, MSc*; GA Jones, *PrEng, PhD*; WD Ortlepp, *PrEng, MEng*; RP Plasket, *PrEng, MSc*; TR Stacey, *PrEng, DSc*

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|------------------|---------------------|
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| Durban           | +27 (0) 31 312 1355 |
| East London      | +27 (0) 43 748 6292 |
| Harare           | +263 (4) 496 182    |
| Johannesburg     | +27 (0) 11 441 1111 |
| Pietermaritzburg | +27 (0) 33 345 6311 |
| Port Elizabeth   | +27 (0) 41 581 1911 |
| Pretoria         | +27 (0) 12 361 9821 |
| Rustenburg       | +27 (0) 14 594 1280 |

## 4. GEOHYDROLOGICAL ASSESSMENT - KLEINBULHOEK VILLAGES

### 4.1 GROUNDWATER POTENTIAL ASSESSMENT

**Regional scale:** The Kleinbulhoek area can be classified as a Minor Aquifer System<sup>2</sup>, i.e. "groundwater occurs mainly along structures, fractures or along geological contacts" (Aquifer Classification Map of South Africa).

**Local scale:** The development potential of groundwater in the study area revolves mainly around the occurrences of dolerite dykes and sheets (sills) which cuts across all the project villages, with the exception of Spring Grove (see Map 1: Geohydrological Map, Appendix 1). This does however not imply that groundwater is only found near or in the above structures, but implies that the development potential of groundwater is normally the highest around these features. Groundwater can also be encountered in fractured and/or weathered media away from the above structures.

The areas around the villages are generally flat with well-developed drainage patterns, in which most of the existing boreholes were drilled.

Given the abundance of dolerite in the area and the flat gradient, the **groundwater potential** for all the villages are therefore seen as **high**.

The geology of the study area comprises mudstone and sandstone from the Katberg and Burgersdorp Formations, Beaufort Group with intrusions of dolerite.

### 4.2 HYDROCENSUS

The results of the hydrocensus are portrayed in Appendix 2. In summary, the following:

- All of the villages that were investigated currently uses groundwater as source of drinking water;
- Some of the boreholes are not in working order;
- Two water level measurements indicated 5.2 and 4.8 metres below ground level;
- Pit latrines are currently used in most of the villages;
- Some of the pit latrines are situated close to existing boreholes;
- The community reported that some of the existing pit latrines collapsed due to unstable soil;
- The reported depth to bedrock varies between 0.5 and 1.5m;
- The bedrock mostly comprises fractured sandstone or mudstone with decomposed dolerite in areas where the dolerite sheets are situated;
- According to the ward councillors, some of the boreholes had yields in excess of 3 l/s with the highest yield being 17.5 l/s. No information to verify these yield figures could however be obtained.

### 4.3 GROUNDWATER QUALITY

Three water samples from three existing boreholes were taken and analysed for Nitrate, Conductivity and Faecal Coliform. The water from all three boreholes tested within acceptable drinking limits. The results are presented in Appendix 2.

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<sup>2</sup> According to the Aquifer Classification Map of South Africa

#### 4.4 ASSESSMENT OF FLAG CONDITIONS & RISK EVALUATION

The risk of contaminating groundwater from on-site sanitation basically hinges around the following aspects:

- Pollution load;
- Flag conditions, especially the depth to groundwater and nature of the unsaturated zone (i.e. the zone between the base of the pit and the groundwater level) - ;
- Presence of existing boreholes and/or springs close to the latrines (they can act as conduits);
- Presence of geological structures or features where economical quantities of groundwater can be expected (including dolerite dykes, sill contacts and faults).

##### **Pollution load:**

The estimated number of households per hectare is less than 10. The pollution load is therefore **low**.

##### **Flag conditions:**

As part of the risk evaluation, an assessment is made of whether flag conditions exist at any of the villages. The general flag conditions are listed in Table 4.4a and are referenced as such in Table 4.4b.

**Table 4.4a: General Flag Conditions**

|  |
|--|
| 1. Is the groundwater less than 3 m from the base of the pit?                    |
| 2. Is the base of the pit in or on fractured bedrock?                            |
| 3. Is the source of water down-gradient of latrine sites?                        |
| 4. Is the water source within 50 m of latrine sites?                             |
| 5. Is the water source within 75 m of high volume latrines?                      |
| 6. Is the groundwater already contaminated by activities in the village or town? |

Table 4.4b: Evaluation of risk

| Village      | Nature of bedrock     | Dykes, sills or faults within 400m | Pollution load (t/ha) | Depth to bedrock (m) | Depth to WL (m) | Water use | Existing boreholes / springs | Flag conditions (refer to Table 4.4) | Risk of contamination to groundwater |
|--------------|-----------------------|------------------------------------|-----------------------|----------------------|-----------------|-----------|------------------------------|--------------------------------------|--------------------------------------|
| Tentergate   | Fractured & weathered | Sills                              | < 10                  | 1.0                  | 4.8             | Boreholes | Boreholes                    | 2,3                                  | Possible                             |
| Khayaletu    | Fractured & weathered | Sill                               | < 10                  | 1.5                  | 5.2             | Boreholes | Boreholes                    | 2,3                                  | Likely                               |
| Kwezi        | Fractured & weathered | Sill                               | < 10                  | 1.0                  | No info         | Boreholes | Boreholes                    | 2,3,4                                | Likely                               |
| Tembalethu   | Fractured & weathered | Sill                               | < 10                  | 0.7                  | No info         | Boreholes | Boreholes                    | 2,3                                  | Likely                               |
| Spring Grove | Fractured & weathered | None                               | < 10                  | 0.5                  | No info         | Boreholes | Boreholes                    | 2,3                                  | Possible                             |

**Notes:**

- The classification of the pollution load was done in accordance with Table 1, Appendix 4.

#### 4.5 CONCLUSIONS

Based on the available information, the following are concluded:

- The pollution load is low;
- The bedrock comprises fractured rock and weathered dolerite;
- The depth to bedrock ranges from 0.5 m to 1.5 m;
- Groundwater is currently used for drinking purposes;
- The depth to groundwater will vary due to the varying topography, but was measured as ~ 5.2 m and 4.8 m in two of the villages.
- Flag conditions exist, mainly due to the fractured nature of the bedrock and the positions of existing boreholes relative to the pit latrines.

#### 4.6 RECOMMENDATIONS

The communities are currently using groundwater for drinking and are therefore dependant on the groundwater. Should this groundwater become contaminated with nitrate, expensive treatment methods will have to be applied (e.g. reverse osmosis) which the community cannot afford.

The overall risk to groundwater is classified as “**possible**”, with a “**likely**” classification in villages where the boreholes are situated closer than 50 m from existing or new pit latrines. This classification is mainly due to the good groundwater potential, existing boreholes inside the villages and a shallow groundwater level in places.

In accordance with the Groundwater Protocol (see Table 2 and 3, Appendix 4), the following are therefore recommended:

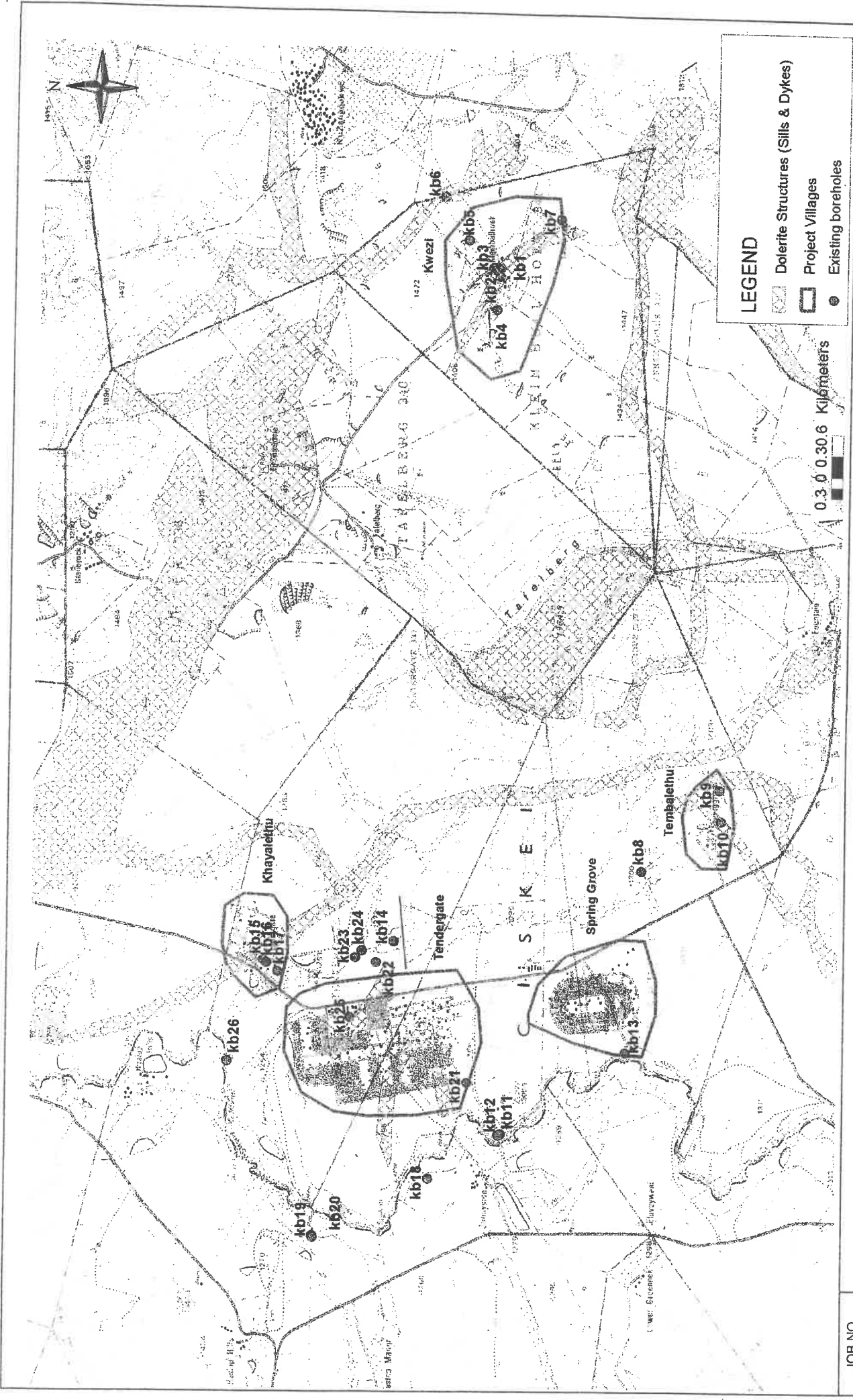
- The sanitation engineer must investigate alternative methods to prevent contamination to groundwater;
- All production boreholes (e.g. equipped with motorised equipment) and other boreholes that are being used for drinking purposes (e.g. hand pumps and windmills) must be frequently monitored for changes in water quality.
- Where existing boreholes are within 200m of existing or new latrines, the existing unused equipment must be recovered from the boreholes to allow for water level and water quality monitoring.
- Existing boreholes should not be closed or sealed before their yield potential have been determined.
- The borehole numbers on the existing boreholes (e.g. EC-numbers and T-numbers) must be forwarded to the Department of Water Affairs and Forestry to obtain more information on their yield potential. This information could then be incorporated into a **borehole refurbishment programme**.

GP NEL Pr Sci Nat

Principal Hydrogeologist - SRK CONSULTING

## **APPENDIX 1**

**Fig 1: Geohydrology Map**



**LEGEND**

- Dolerite Structures (Sills & Dykes)
- Project Villages
- Existing boreholes

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**APPENDIX 2:**  
**Hydrocensus Information**

**Table 1: Hydrocensus - Kleinbulhoek**

| Village Name:                | Borehole Spring School/Sample | Borehole Reference No | Bhole No   | Latitude  | Longitude  | Water level (mbs.g) | Yield (l/s) | Equipment     | Comments   | Sanitation Type | Geology | Contact Person              |
|------------------------------|-------------------------------|-----------------------|------------|-----------|------------|---------------------|-------------|---------------|--|-----------------|---------|-----------------------------|
| KLEINBULLHOEK                | VILLAGE COORDINATE            |                       |            | 32 5 48.3 | 26 33 35.6 |                     |             |               |  |                 |         | SIPHO NOZITHO<br>0827734438 |
|                              | BOREHOLE 1                    | kb1                   | T26351     | 32 5 57.2 | 26 33 20.1 |                     |             | DIESEL ENGINE | GET WATER FROM TAPS WHICH COMES FROM BOREHOLE - 01. BOREHOLE IS BETWEEN THE VILLAGE. DISTANCE FROM BOREHOLE TO THE NEAREST HOUSE IS 60M. |                 |         |                             |
|                              | BOREHOLE 2                    | kb2                   |            | 32 5 57.0 | 26 33 16.1 |                     |             | WINDMILL      | BROKEN. IT IS WITHIN THE HOUSEHOLDS.   |                 |         |                             |
|                              | BOREHOLE 3                    | kb3                   | T26350     | 32 5 54.3 | 26 33 19.9 |                     |             | HANDPUMP      | BROKEN. IT IS WITHIN THE HOUSEHOLDS.   |                 |         |                             |
|                              | BOREHOLE 4                    | kb4                   |            | 32 5 55.7 | 26 33 1.0  |                     |             | CASING        | USED TO BE WINDMILL  |                 |         |                             |
|                              | BOREHOLE 5                    | kb5                   | CHB636     | 32 5 42.8 | 26 33 32.3 |                     |             | WINDMILL      | BROKEN. BOREHOLE ADJACENT TO THE VILLAGE.  |                 |         |                             |
|                              | BOREHOLE 6                    | kb6                   | CHB753B    | 32 5 31.8 | 26 33 51.6 |                     |             | DIESEL ENGINE | STILL WORKING. BOREHOLE - 06 IS ADJACENT TO THE VILLAGE ABOUT 60M TO NEAREST HOUSE.  |                 |         |                             |
| THEMBALETHU (TENTERGATE - 3) | BOREHOLE 7                    | kb7                   |            | 32 6 24.0 | 26 33 42.4 |                     |             | CASING        | USED TO BE A WINDMILL. BOREHOLE IS ON TOP OF THE VILLAGE. DISTANCE FROM BOREHOLE TO THE VILLAGE IS 50M.                                  |                 |         |                             |
|                              | VILLAGE COORDINATE            |                       |            | 32 7 39.0 | 26 28 45.5 |                     |             |               | THE VILLAGE IS BELOW THE MOUNTAIN ON A FLAT LAYING AREA.   |                 |         | SIPHO NOZITHO<br>0827734438 |
|                              | BOREHOLE 1                    | kb8                   |            | 32 7 3.9  | 26 28 47.2 |                     |             | WINDMILL      | GET WATER FROM BOREHOLE AND SUPPLIED BY MUNICIPAL TRUCK.   |                 |         |                             |
|                              | BOREHOLE 2                    | kb9                   | EC-632-030 | 32 7 35.6 | 26 28 24.6 |                     |             | PUMP ONLY     | NO ENGINE. BOREHOLE IS BELOW THE MOUNTAIN ON TOP OF THE VILLAGE. DISTANCE FROM BOREHOLE TO THE VILLAGE IS 330M.                          |                 |         |                             |
| TENTERGATE - 02              | BOREHOLE 3                    | kb10                  |            | 32 7 39.4 | 26 28 10.3 |                     |             | OLD CASING    | WINDMILL IS BROKEN. BOREHOLE IS BELOW THE VILLAGE. DISTANCE FROM BOREHOLE - 3 TO THE VILLAGE IS 100M.                                    |                 |         |                             |
|                              | VILLAGE COORDINATE            |                       |            | 32 6 46.2 | 26 27 53.2 |                     |             |               | THE VILLAGE IS ON A FLAT LAYING AREA.  |                 |         | SIPHO NOZITHO<br>0827734438 |
|                              | BOREHOLE 1                    | kb11                  | T26365     | 32 6 1.1  | 26 28 47.3 |                     | 6 l/s       | DIESEL ENGINE | BOREHOLE IS WORKING BUT THE RETICULATION IS DAMAGED AND RESERVOIR IS LEAKING. PRESENTLY SUPPLIED BY MUNICIPAL TRUCK.                     |                 |         |                             |
|                              | BOREHOLE 2                    | kb12                  | T26365/2   | 32 6 0.3  | 26 28 46.9 |                     |             | CASING        | BOTH BOREHOLE IS DOWN GRADIENT FROM THE VILLAGE NEXT TO RIVER.   |                 |         |                             |
| BOREHOLE 3                   | kb13                          | CHB 757               |            | 32 6 57.1 | 26 27 24.3 |                     |             | DIESEL ENGINE | BOREHOLE IS DOWN GRADIENT FROM THE VILLAGE. DISTANCE FROM BOREHOLE TO THE VILLAGE IS 200M.   |                 |         |                             |

| Village Name:           | Borehole Spring School/Sample | Borehole Reference No | Bhole No   | Latitude  | Longitude  | Water level (mbsgl) | Yield (l/s) | Equipment         | Comments   | Sanitation Type  | Geology  | Contact Person           |
|-------------------------|-------------------------------|-----------------------|------------|-----------|------------|---------------------|-------------|-------------------|--|--|--|--------------------------|
| KHAYALETHU (TENTERGATE) | VILLAGE COORDINATE            |                       |            | 32 4 18.4 | 26 28 22.8 |                     |             |                   | ALL THREE BOREHOLES ARE BELOW THE VILLAGE. DISTANCE FROM BOREHOLES TO THE VILLAGE IS 150M. ONLY BOREHOLE -1 IS ADJACENT TO ANOTHER VILLAGE. THE VILLAGE IS BELOW THE MOUNTAIN ON A FLAT LAYING AREA. |  |  |                          |
|                         | BOREHOLE 1                    | k014                  | EC-026-5B  | 32 5 12.4 | 26 28 14.3 |                     |             |                   | GET WATER FROM TAPS WHICH COME FROM TWO BOREHOLES.   |  |  |                          |
|                         | BOREHOLE 2                    | k015                  | EC-038-5B  | 32 4 13.8 | 26 28 5.6  |                     |             | ELECTRICAL ENGINE | ONE BOREHOLE IS SITUATED IN ANOTHER VILLAGE (TENTERGATE -1)  | 30% OF THE VILLAGE ARE USING PIT LATRINES THE REST BUSHES AND DONGAS. DEPTH TO ROCK IS 1.5M. | REDDISH BROWN CLAYEY TOPSOIL WITH SANDSTONE AND DOLERITE ON THE SURFACE. |                          |
|                         | BOREHOLE 3                    | k016                  | EC-039-5B  | 32 4 13.2 | 26 28 4.3  | 5.2M                |             | WINDMILL          | BROKEN   |  |  |                          |
|                         | BOREHOLE 4                    | k017                  | T26349     | 32 4 20.2 | 26 28 0.3  |                     | 3.5l/s      | ELECTRICAL ENGINE | STILL WORKING.   |  |  |                          |
| TENTERGATE - 1          | VILLAGE COORDINATE            |                       |            | 32 5 8.7  | 26 27 9.0  |                     |             |                   | THE VILLAGE IS ON A FLAT LAYING AREA. BOREHOLE 01 & 09 ARE THE ONES SUPPLY THE VILLAGE.  |  |  | SIPHO NOZITHO 0827734438 |
|                         | BOREHOLE 1                    | k018                  | EC-024-5B  | 32 5 28.7 | 26 28 27.0 |                     | 17.5l/s     | ELECTRICAL ENGINE | GET WATER FROM TAPS WHICH COME FROM TWO BOREHOLES.   |  |  |                          |
|                         | BOREHOLE 2                    | k019                  | EC-042-5B  | 32 4 37.2 | 26 28 1.2  |                     | 7.2l/s      | ELECTRICAL ENGINE | BOREHOLE IS DOWN GRADIENT FROM THE VILLAGE. DISTANCE FROM BOREHOLE TO THE VILLAGE IS ± 900M.   |  |  |                          |
|                         | BOREHOLE 3                    | k020                  |            | 32 4 37.4 | 26 28 0.4  |                     |             | OLD CASING        |  |  |  |                          |
|                         | BOREHOLE 4                    | k021                  | EC-040-5B  | 32 5 45.7 | 26 27 10.5 | 4.8M                |             | WINDMILL          | BROKEN, CLOSE TO THE VILLAGE.  |  |  |                          |
|                         | BOREHOLE 5                    | k022                  | EC-022-5B  | 32 5 4.8  | 26 28 4.9  |                     | 3.5l/s      | ELECTRICAL ENGINE | BOREHOLE IS ADJACENT TO VILLAGE. DISTANCE FROM BOREHOLE TO THE VILLAGE IS 200M.  |  |  |                          |
|                         | BOREHOLE 6                    | k023                  | CHB 767    | 32 4 55.4 | 26 28 7.0  |                     |             | DIESEL ENGINE     | THEY ARE NOT USING THIS BOREHOLE.  |  |  |                          |
|                         | BOREHOLE 7                    | k024                  | CHB 788 C  | 32 4 56.3 | 26 28 10.2 |                     |             | DIESEL ENGINE     |  |  |  |                          |
|                         | BOREHOLE 8                    | k025                  | EC-S32-008 | 32 4 53.2 | 26 27 39.7 |                     |             | ROUNDABOUT        |  |  |  |                          |
|                         | BOREHOLE 9                    | k026                  | T 26381    | 32 3 56.4 | 26 27 19.7 |                     |             | CASING            |  |  |  |                          |

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## APPENDIX 4:

### DWAF GROUNDWATER PROTOCOL

Due to the risk of on-site sanitation systems to groundwater, the National Sanitation Co-ordinating Office (NaSCo) and the Directorate of Geohydrology of the Department of Water Affairs and Forestry initiated the development of a protocol. The aim of the protocol is to ensure that reasonable measures are taken to guard against contamination of valuable groundwater resources by inappropriately located or designed sanitation systems. The risks of groundwater contamination are related to a number of factors, but ultimately risk depends on aquifer vulnerability and the magnitude of the pollutant threat.

*To assess the risk, three aspects need to be investigated:*

- *Pollution load;*
- *Geological conditions (saturated and unsaturated flow);*
- *Hydrogeological conditions*
- *Surface Runoff*

#### **Pollution load**

The loading in a specific area depends on the density of latrines per hectare and the number of people utilising each pit. Muller (1989) defined population densities as follows:

|                        |   |           |
|------------------------|---|-----------|
| - 50 houses/ha         | : | Low       |
| - 50 - 150 houses/ha : | : | Medium    |
| - 150 - 300 houses/ha  | : | High      |
| - > 300 houses/ha      | : | Very high |

#### **Geological conditions**

Geological conditions play a major role in attenuating pollutants entering the subsurface system. As a basic principle, the longer it takes the contaminants to reach the groundwater, the lower the impact on water quality. Adequate thickness for the unsaturated zone does, however, depend on the prevailing permeability's.

Problems associated with unsaturated zone travel time in South Africa are thin soil cover and the fractured nature of the bedrock. Under fractured conditions flow can be exceptionally rapid. Lewis et al. (1980) measured rates of flow as high as 3 m in 25 minutes.

*If the unsaturated zone consists of permeable sands or fractured bedrock, attenuation of the pollution would be limited and the risk of groundwater pollution would be high.*

#### **Hydrogeological conditions**

To assess the threat and impacts of contamination the prevailing water usage and hydrogeological conditions have to be assessed. A hydrocensus should therefore be undertaken and data collected regarding the groundwater environment. If the aquifer has an important role in supplying water, contamination has to be limited, either by altering the sanitation system or by moving the source of water. The contamination of the groundwater sources will have a major economic impact and could prevent the goals of the RDP being met.

### **Surface water runoff**

Surface water run-off entering the pits **increases** the risk of groundwater contamination. Further, surface run-off can transport contaminants from overflowing or poorly managed pits to adjacent surface streams. *Every effort must therefore be made to manage both the surface runoff and the pit latrines correctly.* For example, a small drainage ditch can be installed around the latrine or the latrine can be raised slightly.

To **summarise**, the protocol consists of a number of steps, simplified in the Contamination Risk Assessment Flow Sheet. Each step consists of a separate task:

- (a) Assessment of groundwater potential.
- (b) Evaluation of groundwater use.
- (c) Assessment of sensitive "flag" situations.
- (d) Evaluation of pollution risk to the groundwater resource.
- (e) Evaluation of measures to reduce the risk.
- (f) Implementation of risk reduction measures.

### ***Groundwater Potential:***

Two levels of geohydrological assessment are necessary - an assessment of the regional strategic value of the aquifer and an assessment of the local value of the aquifer. For the regional scale assessment, the Aquifer Classification Map of South Africa is used.

### ***Groundwater use:***

Reliance on groundwater and other water supplies, position of boreholes/springs used and borehole details

### ***Flag conditions:***

Circumstances exist where conditions are less suitable for on-site sanitation systems (flag conditions)

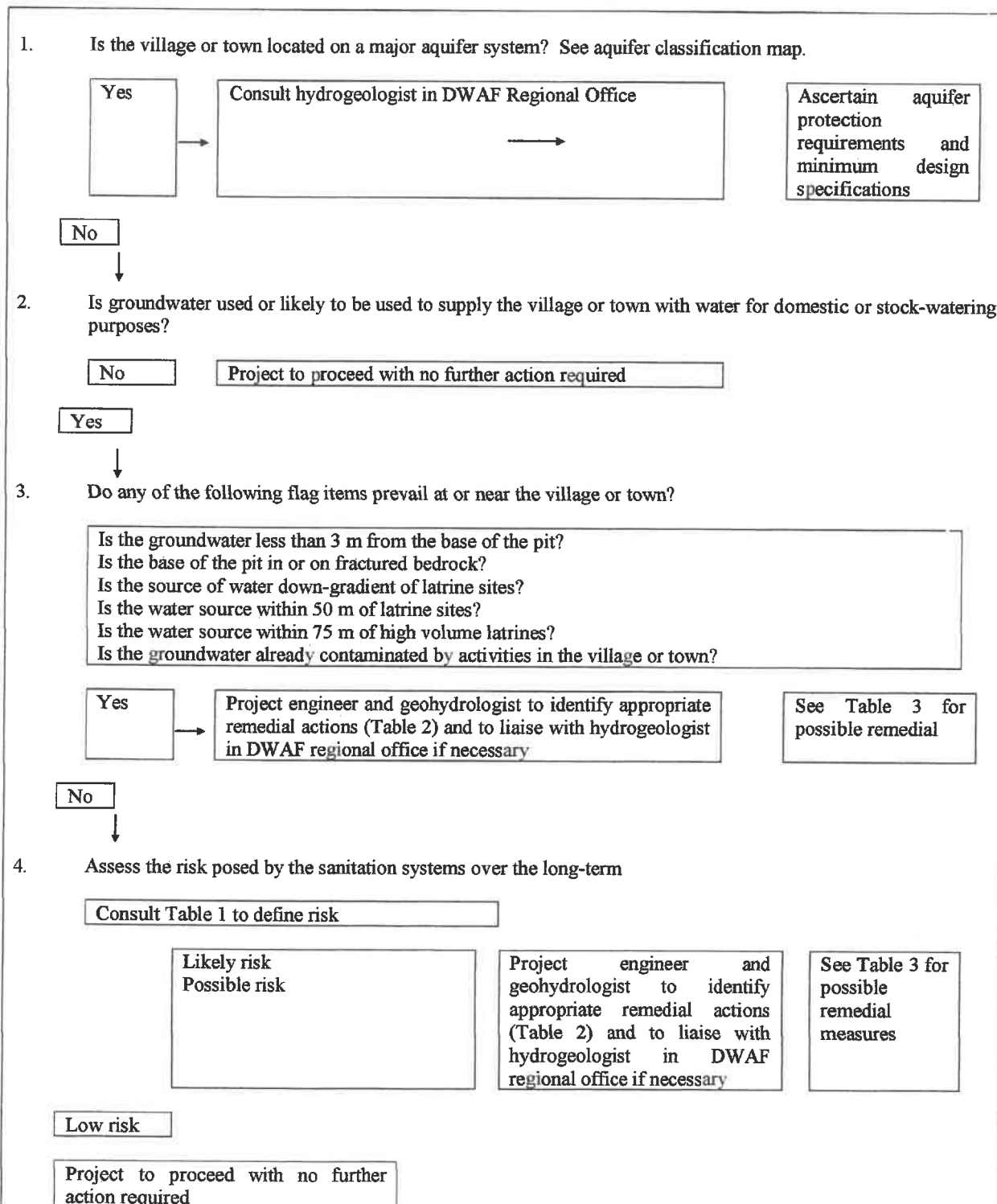
### ***Risk to groundwater:***

The threat posed by the sanitation system and the potential of the unsaturated zone to attenuate contaminants before reaching the groundwater.

### ***Measures to reduce risk:***

If **possible risk** exists; the sanitation engineer should investigate risk reduction options. If **likely risk** exists, the sanitation engineer and a hydrogeologist will have to investigate risk reduction options and their recommendations should be discussed with DWAF officials."

**CONTAMINANT RISK ASSESSMENT FLOW SHEET (From Protocol Document)**



| TABLE 2: RECOMMENDED STEPS TO DECIDE ON WHAT RISK REDUCTION MEASURES SHOULD BE IMPLEMENTED |   |
|--|---|
| LEVEL OF RISK  | ACTION  |
| Flag situations  | Meeting between sanitation engineer, qualified hydrogeologist and community representative to decide on most suitable option available and on protection requirements.  |
| Low risk   | No action required, other than monitoring to check that pollution is not taking place.  |
| Possible risk  | Sanitation engineer to investigate alternatives to reduce the threat posed by the sanitation system (see Table 3). If it is impossible to alter the sanitation system and the aquifer is still possibly at risk, a qualified hydrogeologist will have to be called in to assess changes to the supply system (see Table 3).   |
| Likely risk  | Investigation of alternative water supply options by a qualified hydrogeologist and the investigation of alternative sanitation systems by a qualified sanitation engineer. A meeting between the sanitation engineer and a qualified hydrogeologist must be organised to decide on most suitable options available (see Table 3). The hydrogeologist must make certain that the staff in the Directorate of Geohydrology in the regional office of DWAF are satisfied with the options proposed. |

| TABLE 3: RECOMMENDED STEPS TO DECIDE ON WHAT RISK REDUCTION MEASURES SHOULD BE IMPLEMENTED |   |
|--|---|
| Alterations to on-site systems (short term measures)                                       | <ul style="list-style-type: none"> <li>- move sanitation system as far away as possible from existing boreholes (at least 50 m in unfractured rocks and 200 m in fractured rocks)</li> <li>- excavate larger, shallower pits</li> <li>- use composting type systems</li> <li>- raise pits above ground level to increase unsaturated zone</li> <li>- seal fractures in pits excavated to a fractured bedrock with a clay/slurry mixture</li> <li>- introduce clay into natural permeable soils</li> <li>- line the pits with cemented blocks and seal all the joints</li> <li>- bio-augmentation of pits to increase breakdown</li> </ul> |

|  |  |
|--|--|
|  | <ul style="list-style-type: none"> <li>- addition of glucose or other carbon sources to the pit</li> <li>- improve maintenance in poorly run systems</li> <li>- if economically possible, consider water-borne systems with off-site treatment and disposal</li> </ul>   |
| Alterations to existing borehole supplies                | <ul style="list-style-type: none"> <li>- re-equip boreholes, ensuring that surface sanitary seal exists</li> <li>- make certain that the holes are screened at the greatest depth possible</li> <li>- treat contaminated water</li> <li>- pump at lower rates to reduce the cone of depression and thus the capture zone</li> <li>- modify the size of the wellhead protection zone around the borehole</li> </ul> |
| Alteration to aquifer supply system (long term measures) | <p>If feasible, and after exhausting all other alternatives, new sources of groundwater can be investigated. The existing water supply system can be abandoned (if polluted) and new boreholes can be sited upgradient from any sources of pollution. These new supplies would have to be confirmed before any existing supplies were abandoned. Abandoned boreholes are to be effectively sealed.</p>             |

TABLE 1: ASSESSMENT OF RISK

| UNSATURATED ZONE* CONDITIONS    | POLLUTION LOAD                    |                   |                |               |  |                |               |                   |   |               |                   |                |                                    |                   |                |  |
|---------------------------------|-----------------------------------|-------------------|----------------|---------------|--|----------------|---------------|-------------------|---|---------------|-------------------|----------------|------------------------------------|-------------------|----------------|--|
|                                 | SETTLEMENT SIZE < 500 inhabitants |                   |                |               | SETTLEMENT SIZE 500 - 1000 inhabitants |                |               |                   | SETTLEMENT SIZE 1000 - 5000 inhabitants |               |                   |                | SETTLEMENT SIZE > 5000 inhabitants |                   |                |  |
|                                 | <10 houses/ha**                   | 10 - 50 houses/ha | > 50 houses/ha | <10 houses/ha | 10 - 50 houses/ha                      | > 50 houses/ha | <10 houses/ha | 10 - 50 houses/ha | > 50 houses/ha                          | <10 houses/ha | 10 - 50 houses/ha | > 50 houses/ha | <10 houses/ha                      | 10 - 50 houses/ha | > 50 houses/ha |  |
| Clay                            | Low                               | Low               | Low            | Low           | Low                                    | Low            | Low           | Low               | Low                                     | Low           | Low               | Low            | Low                                | Low               | Possible       |  |
| Massive Shale's                 | Low                               | Low               | Low            | Low           | Low                                    | Low            | Low           | Low               | Low                                     | Low           | Low               | Low            | Low                                | Low               | Possible       |  |
| Solid granites                  | Low                               | Low               | Low            | Low           | Low                                    | Low            | Low           | Low               | Low                                     | Low           | Low               | Low            | Low                                | Low               | Possible       |  |
| Silt                            | Low                               | Low               | Low            | Low           | Low                                    | Possible       | Low           | Possible          | Low                                     | Possible      | Possible          | Possible       | Possible                           | Possible          | Likely         |  |
| Sandy loam                      | Low                               | Low               | Possible       | Low           | Possible                               | Possible       | Low           | Possible          | Possible                                | Possible      | Likely            | Likely         | Likely                             | Likely            | Likely         |  |
| Bedded shale's                  | Low                               | Low               | Possible       | Low           | Possible                               | Possible       | Low           | Possible          | Possible                                | Possible      | Likely            | Likely         | Likely                             | Likely            | Likely         |  |
| Weathered or fractured granites | Low                               | Low               | Possible       | Low           | Possible                               | Possible       | Low           | Possible          | Possible                                | Likely        | Likely            | Likely         | Likely                             | Likely            | Likely         |  |
| Fractured/weathered sandstone's | Low                               | Possible          | Likely         | Possible      | Likely                                 | Likely         | Likely        | Likely            | Likely                                  | Likely        | Likely            | Likely         | Likely                             | Likely            | Likely         |  |
| Cavernous limestone's/calcretes | Low                               | Possible          | Likely         | Possible      | Likely                                 | Likely         | Likely        | Likely            | Likely                                  | Likely        | Likely            | Likely         | Likely                             | Likely            | Likely         |  |
| Sand and Gravel                 | Possible                          | Likely            | Likely         | Likely        | Likely                                 | Likely         | Likely        | Likely            | Likely                                  | Likely        | Likely            | Likely         | Likely                             | Likely            | Likely         |  |

\* The unsaturated zone is the distance between the base of the latrine to the groundwater level.

\*\* Houses/ha, calculated by dividing the number of houses in the village by the total area, without subtracting the roads, parks, etc

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