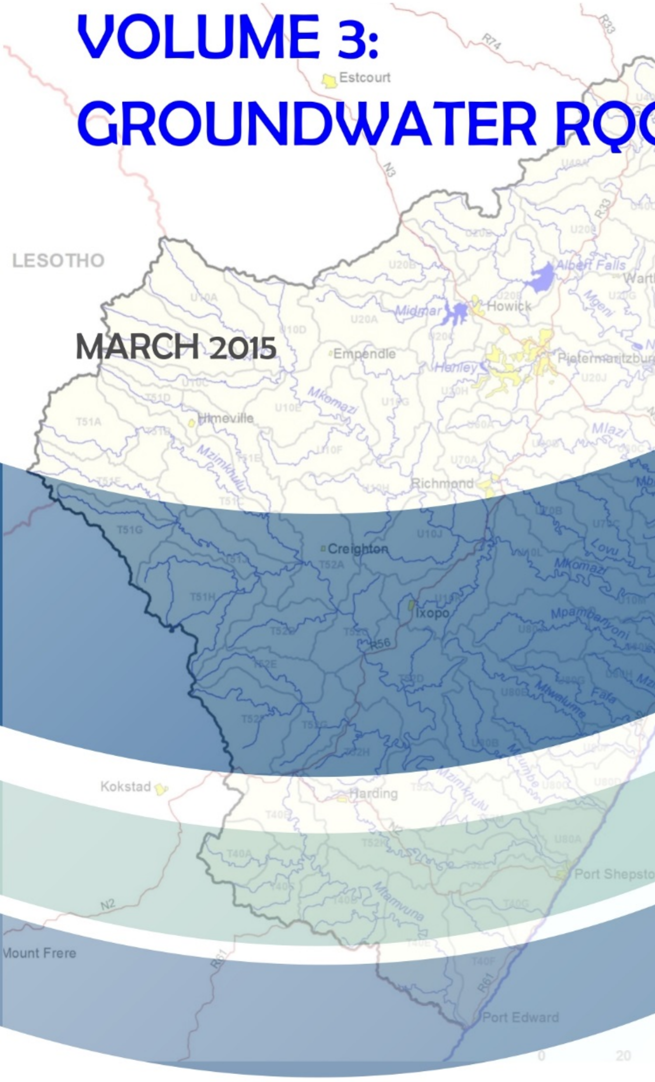
REPORT NO: RDM/WMA11/00/CON/CLA/0415

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

PROJECT NUMBER: WP 10679

VOLUME 3: GROUNDWATER RQOS



MARCH 2015

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

VOLUME 3: GROUNDWATER RESOURCE QUALITY OBJECTIVES

Report Number: RDM/WMA11/00/CON/CLA/0415

MARCH 2015

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2	*Report Number: RDM/WMA11/00/CON/CLA/0113*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Status Quo assessment, IUA delineation and Biophysical Node identification.**
3	*Report Number: RDM/WMA11/00/CON/CLA/0213*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **River Resource Units and EWR sites**
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12	*Report Number: RDM/WMA11/00/CON/CLA/0418*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Main Report**

DEPARTMENT OF WATER AND SANITATION

CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

VOLUME 3: GROUNDWATER RESOURCE QUALITY OBJECTIVES

Approved for RFA by:

……………………………………… ………………………………………

Delana Louw *Date*

Project Manager

DEPARTMENT OF WATER AND SANITATION (DWS)

Approved for DWS by:

……………………………………… ………………………………………

Date

Chief Director: Water Ecosystems

AUTHORS

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Editing:

- *Delana Louw: EWR coordinator and scenario process*
- *Shael Koekemoer: Report compilation*

REPORT SCHEDULE

Version	Date
First draft	*March 2015*
Final draft	

EXECUTIVE SUMMARY

BACKGROUND

The Mvoti to Umzimkulu WMA encompasses a total catchment area of approximately 27,000 km² and occurs largely within Kwazulu-Natal. A small portion of the Mtamvuna River and the upper and lower segments of the Umzimkulu River straddle the Eastern Cape, close to the Mzimvubu and Keiskamma Water Management Area (WMA) in the south (DWA, 2011). The Chief Directorate: Resource Directed Measures of the Department of Water Affairs initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area. The integrated steps for the study are provided below.

Step	Description
1	*Delineate the units of analysis and Resource Units, and describe the status quo of the water resource(s) (completed).*
2	*Initiation of stakeholder process and catchment visioning (on-going).*
3	*Quantify the Ecological Water Requirements and changes in non-water quality ecosystem goods, services and attributes*
4	*Identification and evaluation of scenarios within the integrated water resource management process.*
5	*Develop draft Water Resource Classes and test with stakeholders.*
6	**Develop draft RQOs and numerical limits.**
7	*Gazette and implement the class configuration and RQOs.*

This report provides the Groundwater RQOs as part of Task 6 (see red and bold above).

STUDY AREA

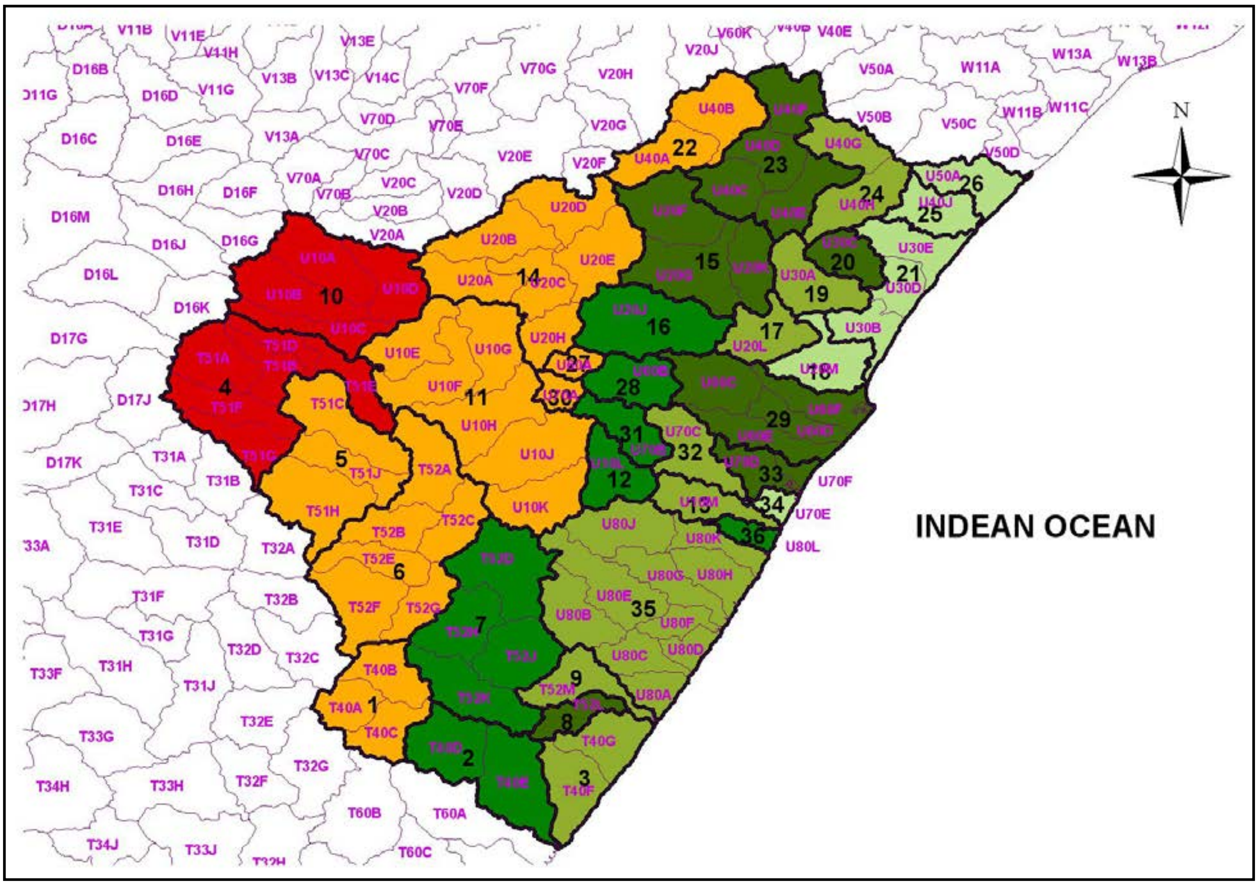
The Mvoti to Umzimkulu WMA encompasses a total catchment area of approximately 27,000 km² and occurs largely within Kwazulu-Natal. A small portion of the Mtamvuna River and the upper and lower segments of the Umzimkulu River straddle the Eastern Cape, close to the Mzimvubu and Keiskamma WMA in the south (DWA, 2011).

The WMA extends from the town of Zinkwazi, in the north to Port Edward and on the south along the KwaZulu-Natal coastline and envelopes the inland towns of Underberg and Greytown up until the Drakensberg escarpment. The WMA spans across the primary catchment "U" and incorporates the secondary drainage areas of T40 (Mtamvuna River in Port Shepstone) and T52 (Umzimkulu River). Ninety quaternary catchments constitute the water management area and the major rivers draining this WMA include the Mvoti, uMgeni, Mkomazi, Umzimkulu and Mtamvuna (DWA, 2011).

The study area was subdivided into Groundwater response Units (GRUs) by catchment areas, topography and geology:

- *Drakensberg Escarpment: (GRUs 4 and 10): This region consists of predominantly argillaceous rocks of the Tarkastad Subgroup, and the Molteno and Elliot Formations of the Karoo SuperGroup, capped by Clarens sandstones and Drakensberg Basalt. The basal sandstones of the Tarkastad Subgroup often form an escarpment of higher elevation than the underlying Adelaide Subgroup. On the high lying Drakensberg Escarpment, springs are common, especially along the Clarens/Drakensberg contact.*

- *Middelveld Karoo: (GRUs 1, 5, 6, 11, 14, 22, 27, and 30): This region consists of predominantly argillaceous rocks of the Ecca Group (Pietermaritzburg and Volksrust Formations) and Adelaide Subgroup, and arenaceous rocks of the Vryheid Formation, which lies in between the Volksrust and Pietermaritzburg Formations. It lies at a lower elevation than the Drakensberg Escarpment region. The Vryheid Formation forms an escarpment within this region. The median yield in the Vryheid Formation is slightly higher, 1.2 l/s compared to 0.9 l/s in the rest of the region. Fractures within the mudstones and shales tend to close once they are dewatered due to the ductility of the rock, making them prone to over exploitation. Fractures also tend to close up due to the oxidation of iron pyrite. Higher yields are associated with dolerite intrusions.*
- *Dwyka Tillites: (GRUs 2, 7, 12, 16, 28, 31, and 36): This region is underlain by fractured rocks of the Dwyka Group. The median yield is only 0.15 l/s and at least 40% of boreholes are dry, consequently, this is the poorest aquifer in the study area*
- *Natal Group: (GRUs 8, 15, 20, 23, 29, and 33): This region is underlain by fractured aquifers with well-developed jointing and faulting. Fault zones are of high importance for establishing high yielding boreholes. The median yield is 0.5 l/s and 80-90% of boreholes are successful. The Natal Group forms elevated plateaux and sheer cliffs and deep incised ravines. Many of the outcrops are fault bounded. Springs often occur at the contact between the Natal Group and the underlying Natal Metamorphic Province*
- *Natal Metamorphic Province: (GRUs 3, 9, 13, 17, 19, 24, 32, and 35): This aquifer forms a crystalline basement and consists of fractured overlain by a saturated clayey weathered zone. The region is also highly faulted. The median yield is 0.4 l/s and success rates are 70%.*
- *Coastal Karoo: (GRUs 18, 21, 25, 26, and 34): This region consists of varied Ecca and Dwyka lithologies from the Dwyka tillites to Pietermaritzburg shales and Vryheid Formation sandstones. These are faulted against Natal Group sandstones. Borehole yields are higher than inland due to the density of block faulting. On the coast, the rocks are overlain by unconsolidated Quaternary sediments of the Berea red sands.*



Groundwater RQOs each IUA and GRU

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
1	*T40A-C*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low yields, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 9.83 Mm^3/a evenly distributed in both time and space. Low flows at T4H001 should be maintained at a minimum of 35.78 Mm3/a*
2	*T40D-E*	*All users to comply with existing allocation schedules and individual licence conditions within the confirmed Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low yields, monitoring not required*	*No regional groundwater quality issues exist. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 7.9 Mm^3/a evenly distributed in both time and space.*
4	*T51A-B T51D-G*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 9.58 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l.*
5	*T51C T51H-J*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 10.28 Mm^3/a evenly distributed in both time and space.*
6	*T52A-C T52E-G*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 14.19 Mm^3/a evenly distributed in both time and space. Low flows at T5H002 should be maintained at a minimum of 72.75 Mm3/a Low flows at T5H007 should be maintained at a minimum of 131.7 Mm3/a Boreholes used for long term*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
						primary water supply should have a fluoride concentration of below 1.5 mg/l.
7	*T52D T52H*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation and AIPs, monitoring of baseflow is required in T52D. Due to the low groundwater use, monitoring not required in T52H.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 5.82 Mm^3/a evenly distributed in both time and space. Since no gauging weirs are located downstream of this GRU no numerical RQOs have been set. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
7	*T52J-K*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to baseflow reduction, monitoring of baseflow is required in T52K.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 5.53 Mm^3/a evenly distributed in both time and space. Low flows at T5H012 should be maintained at a minimum of 2.47 Mm3/a. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
8	*T52L*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the confirmed Harvest Potential*	*Due to the impacts of afforestation, sugar cane and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 1.36 Mm^3/a evenly distributed in both time and space. Since no gauging weirs are located downstream of this GRU no numerical RQOs have been set to monitor baseflow.*
9	*T52M*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride and salinity levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 3.11 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
10	*U10A-D*	*Significant ground water abstraction within 200m of a perennial channel*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, low yields and low*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 9.52*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
		should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential		*aquifer contribution to baseflow, monitoring not required*		*Mm^3/a evenly distributed in both time and space.*
11	*U10E-F*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, low yields and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 5.03 Mm^3/a evenly distributed in both time and space.*
11	*U10G-K*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 12.71 Mm^3/a evenly distributed in both time and space. Since no gauging weirs are located downstream of this GRU no numerical RQOs have been set to monitor baseflow.*
12	*U10L*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, low yields and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluorides levels and/or nitrates. Fluoride and nitrates need to be tested for domestic boreholes. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 2.54 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l and nitrates below 20 mg/l*
13	*U10M*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, low yields and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated salinity, natural fluorides levels and/or nitrates. Fluoride and nitrates need to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 2.90 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l and nitrates below 20 mg/l*
14	*U20A-C*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow,*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 13.06 Mm3/a evenly distributed in both*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
		All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential		*monitoring not required*		*time and space.*
14	*U20D-E*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 9.90* Mm^3/a *evenly distributed in both time and space.* *Low flows at U2R003 should be maintained at a minimum of 69.53 Mm3/a*
15	*U20F-G*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist.* *The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 13.80* Mm^3/a *evenly distributed in both time and space.* *Low flows at U2H012 should be monitored but an EWR has not been set.*
14	*U20H*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 2.99* Mm^3/a *evenly distributed in both time and space.*
16	*U20J*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Natural water quality problems exist in the catchment and boreholes for domestic use should be tested for compliance to drinking water standards.* *The potential exists for contamination. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 5.13* Mm^3/a *evenly distributed in both time and space.* *Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l and below 20 mg/l for nitrates.*
15	*U20K*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water*	*The sustainable volume of groundwater abstraction is 3.85* Mm^3/a *evenly distributed in both time and space.*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
		licence conditions within the Harvest Potential			*supply boreholes.*	
17	*U20L*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 3.21 Mm^3/a evenly distributed in both time and space.* *Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
18	*U20M*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes.* *The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 6.41Mm^3/a evenly distributed in both time and space.* *Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
19	*U30A*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 4.24 Mm^3/a evenly distributed in both time and space.*
21	*U30B*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 2.71 Mm^3/a evenly distributed in both time and space.*
20	*U30C*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.* *Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 2.85 Mm^3/a evenly distributed in both time and space.* *Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
21	*U30D*	*All users to comply with existing*	*Due to the low groundwater*	*Due to the low groundwater*	*No regional groundwater*	*The sustainable volume of*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
		allocation schedules and individual licence conditions within the Harvest Potential	*use, monitoring not required*	*use and low aquifer contribution to baseflow, monitoring not required*	*quality issues exist. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*groundwater abstraction is 2.17 Mm^3/a evenly distributed in both time and space.*
22	*U40A-B*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, sugar cane and AIPs, monitoring of baseflow is required.*	*Due to the moderate groundwater use and aquifer contribution to baseflow, monitoring is required to ensure water levels do not exhibit a declining trend*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 4.56 Mm^3/a evenly distributed in both time and space. Low flows at U4H002 should be maintained at a minimum of 6.41 Mm3/a*
23	*U40C*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, sugar cane and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use but significant aquifer contribution to baseflow, monitoring is required to ensure water levels do not exhibit a declining trend*	*No regional groundwater quality issues exist. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 3.42 Mm^3/a evenly distributed in both time and space. Due to the lack of a gauging station for this catchment, numerical RQOs have not been set for baseflow.*
24	*U40D*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, monitoring not required*	*No regional groundwater quality issues exist. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 2.70 Mm^3/a evenly distributed in both time and space.*
24	*U40E, G*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 5.04 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
23	*U40F*	*Significant ground water abstraction within 200m of a perennial channel*	*Due to the impacts of afforestation, and AIPs,*	*Due to the low groundwater use and low aquifer*	*No regional groundwater quality issues exist.*	*The sustainable volume of groundwater abstraction is 1.98*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
		should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential	*monitoring of baseflow is required.*	*contribution to baseflow, monitoring not required*	*The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*Mm^3/a evenly distributed in both time and space. Due to the lack of a gauging station for this catchment, numerical RQOs have not been set for baseflow*
24	*U40H*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 3.03 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
25	*U40-J*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 3.19 Mm^3/a evenly distributed in both time and space.*
21	*U30E*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 3.97 Mm^3/a evenly distributed in both time and space.*
26	*U50A*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Monitoring not required as the aquifer discharges to the sea*	*Due to the moderate groundwater use and aquifer contribution to baseflow, monitoring is required to ensure water levels do not exhibit a declining trend*	*Some boreholes have elevated natural salinity and fluoride levels and fluoride needs to be tested for domestic boreholes. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 4.65 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
27	*U60A*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.*	*Due to the impacts of afforestation, and AIPs, monitoring of baseflow is*	*Due to the low groundwater use and low aquifer contribution to baseflow,*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 1.43 Mm^3/a evenly distributed in both*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
		All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential	required.	monitoring not required		time and space. Since an EWR flow has not been set for U6H002t, numerical RQOs for baseflow have not been set
28	U60B	Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential	Due to the impacts of afforestation, and AIPs, monitoring of baseflow is required.	Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required	No regional groundwater quality issues exist	The sustainable volume of groundwater abstraction is 3.06 Mm^3/a evenly distributed in both time and space. Low flows at U6H003 should be maintained at a minimum of 5.92 Mm3/a
29	U60C	Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential	Due to the low groundwater use, monitoring not required	Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required	No regional groundwater quality issues exist. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.	The sustainable volume of groundwater abstraction is 2.98 Mm^3/a evenly distributed in both time and space.
29	U60D	All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential	Due to the low groundwater use, monitoring not required	Due to the low groundwater use, low borehole yield, and low aquifer contribution to baseflow, monitoring not required	Some boreholes have elevated salinity, nitrate and fluoride levels and water quality needs to be tested for domestic boreholes. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.	The sustainable volume of groundwater abstraction is 1.95 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l and nitrates below 20 mg/l
29	U60E	All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential	Due to the low groundwater use, monitoring not required	Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required	No regional groundwater quality issues exist. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.	The sustainable volume of groundwater abstraction is 3.06 Mm^3/a evenly distributed in both time and space.
30 and 31	U70A-B	Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual	Due to the impacts of afforestation, sugar cane and AIPs, monitoring of baseflow is required.	Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required	No regional groundwater quality issues exist	The sustainable volume of groundwater abstraction is 4.31 Mm^3/a evenly distributed in both time and space. Low flows at U7H001 should be

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
		licence conditions within the Harvest Potential				*maintained at a minimum of 2.75 Mm3/a*
32 and 33	*U70C-D*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 6.05 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l.*
29	*U60F*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Groundwater quality needs to be monitored for salinity levels. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 4.35 Mm^3/a evenly distributed in both time and space*
33 and 34	*U70E-F*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Insufficient data exists and monitoring boreholes need to established. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 1.52 Mm^3/a evenly distributed in both time and space. Approximately half of this volume can be abstracted from each catchment*
35	*U80B-C*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 5.5 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l.*
35	*U80E-F*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic*	*The sustainable volume of groundwater abstraction is 4.55 Mm^3/a evenly distributed in both time and space.*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
		allocation schedules and individual licence conditions within the Harvest Potential			*boreholes. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l.*
3, 35 and 36	*T40F-G U80A, D, G-L*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride, nitrate and salinity levels and quality needs to be tested for domestic boreholes. The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l and nitrate levels below 20 mg/l*

Priority Monitoring Areas for Water Level and Abstraction

Based on the level of groundwater stress (stress index of abstraction to aquifer recharge), the following catchments can be considered as priority areas for monitoring abstraction and groundwater level:

Catchment	*Stress Index*
U40B	*0.198*
U50A	*0.358*

Priority Monitoring Areas for Baseflow Reduction

Based the degree of baseflow reduction and the extent where the PEC does not meet the PEC due to the baseflow reduction, the following catchments have been identified where low flow monitoring via gauging stations is relevant:

Current PES < target EC

Catchment	*Baseflow reduction*
T52A	*28%*
U10G	*17%*
U20B	*15%*

Baseflow reduction >50%

Catchment	*Baseflow reduction*
T40B	*72 %*
U40A	*77%*
U40B	*57%*
U60B	*54%*
U70A	*75%*

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TERMINOLOGY AND ACRONYMS

AIPs	*Alien Invasive Plants*
Aquifer recharge	*The volume of recharge that enters the regional aquifer after interflow losses and is available to groundwater users*
Baseflow	*The volume of low flow generated from subsurface pathways, including interflow and groundwater baseflow*
CD: RDM	*Chief Directorate: Resource Directed Measures*
DWA	*Department Water Affairs (Name change from DWAF applicable after April 2009)*
DWAF	*Department Water Affairs and Forestry*
DWS	*Department Water and Sanitation (Name change from DWA applicable after May 2014)*
EC	*Ecological Category*
EWR	*Ecological Water Requirement*
GRA2	*Groundwater Resources Assessment phase II*
GRU	*Groundwater response unit*
Groundwater baseflow	*The volume of baseflow generated from the regional aquifer*
Interflow	*The volume of baseflow generated prior to entering the regional aquifer*
IUA	*Integrated unit of analysis*
MMTS	*Mooi-Mgeni Transfer Scheme*
PES	*Present Ecological state*
REC	*Recommended Ecological Class*
RQOs	*Resource Quality Objectives*
SFR	*Streamflow reduction*
Stress Index	*The ratio of groundwater use to recharge or aquifer recharge*
Target EC	*Target Ecological state*
WMA	*Water Management Area*
WR2005	*Water resources South Africa 2005*
WR2012	*Water Resources South Africa 2012*
WRSM2000	*Water Resources Simulation Model 2000. The Pitman Model with Sami Model Groundwater interactions*
WWTW	*Waste Water Treatment Works*

1 INTRODUCTION

1.1 BACKGROUND

There is an urgency to ensure that water resources in the Mvoti to Umzimkulu Water Management Area (WMA) are able to sustain their level of uses and be maintained at their desired states. The determination of the Water Resource Classes of the significant water resources in Mvoti to Umzimkulu WMA will ensure that the desired condition of the water resources, and conversely, the degree to which they can be utilised is maintained and adequately managed within the economic, social and ecological goals of the water users (DWA, 2011). The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water and Sanitation (DWS) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to Umzimkulu WMA.

1.2 STUDY AREA

The Mvoti to Umzimkulu WMA encompasses a total catchment area of approximately 27,000 km^2 and occurs largely within Kwazulu-Natal. A small portion of the Mtamvuna River and the upper and lower segments of the Umzimkulu River straddle the Eastern Cape, close to the Mzimvubu and Keiskamma WMA in the south (DWA, 2011).

The WMA extends from the town of Zinkwazi, in the north to Port Edward and on the south along the KwaZulu-Natal coastline and envelopes the inland towns of Underberg and Greytown up until the Drakensberg escarpment. The WMA spans across the primary catchment "U" and incorporates the secondary drainage areas of T40 (Mtamvuna River in Port Shepstone) and T52 (Umzimkulu River). Ninety quaternary catchments constitute the water management area and the major rivers draining this WMA include the Mvoti, uMgeni, Mkomazi, Umzimkulu and Mtamvuna (DWA, 2011).

Two large river systems, the Umzimkulu and Mkomazi rise in the Drakensberg. Two medium-sized river systems the uMngeni and Mvoti rise in the Natal Midlands and have been largely modified by human activities, mainly intensive agriculture, forestry and urban settlements. Several smaller river systems (e.g. Mzumbe, Mdloti, Tongaat, Fafa, and Lovu Rivers) also exist within the WMA (DWAF, 2004). Several parallel rivers arise in the escarpment and discharges into the Indian Ocean and the water courses in the study area display a prominent southeasterly flow direction (DWA, 2011). The WMA is very rugged and very steep slopes characterise the river valleys in the inland areas for all rivers and moderate slopes are found but comprise only 3% of the area of the WMA (DWAF, 2004).

1.3 GROUNDWATER RESPONSE UNITS

The study area was subdivided into Groundwater response Units (GRUs) by catchment areas, topography and geology (figure 1-1). These are described below and their location is shown in figure 1-2.

- *Drakensberg Escarpment: (GRUs 4 and 10): This region consists of predominantly argillaceous rocks of the Tarkastad Subgroup, and the Molteno and Elliot Formations of the Karoo SuperGroup, capped by Clarens sandstones and Drakensberg Basalt. The basal sandstones of the Tarkastad Subgroup often form an escarpment of higher elevation than the underlying Adelaide Subgroup. On the high lying Drakensberg Escarpment, springs are common, especially along the Clarens/Drakensberg contact.*

- *Middelveld Karoo: (GRUs 1, 5, 6, 11, 14, 22, 27, and 30): This region consists of predominantly argillaceous rocks of the Ecca Group (Pietermaritzburg and Volksrust Formations) and Adelaide Subgroup, and arenaceous rocks of the Vryheid Formation, which lies in between the Volksrust and Pietermaritzburg Formations. It lies at a lower elevation than the Drakensberg Escarpment region. The Vryheid Formation forms an escarpment within this region. The median yield in the Vryheid Formation is slightly higher, 1.2 l/s compared to 0.9 l/s in the rest of the region. Fractures within the mudstones and shales tend to close once they are dewatered due to the ductility of the rock, making them prone to over exploitation. Fractures also tend to close up due to the oxidation of iron pyrite. Higher yields are associated with dolerite intrusions.*
- *Dwyka Tillites: (GRUs 2, 7, 12, 16, 28, 31, and 36): This region is underlain by fractured rocks of the Dwyka Group. The median yield is only 0.15 l/s and at least 40% of boreholes are dry, consequently, this is the poorest aquifer in the study area*
- *Natal Group: (GRUs 8, 15, 20, 23, 29, and 33): This region is underlain by fractured aquifers with well-developed jointing and faulting. Fault zones are of high importance for establishing high yielding boreholes. The median yield is 0.5 l/s and 80-90% of boreholes are successful. The Natal Group forms elevated plateaux and sheer cliffs and deep incised ravines. Many of the outcrops are fault bounded. Springs often occur at the contact between the Natal Group and the underlying Natal Metamorphic Province*
- *Natal Metamorphic Province: (GRUs 3, 9, 13, 17, 19, 24, 32, and 35): This aquifer forms a crystalline basement and consists of fractured overlain by a saturated clayey weathered zone. The region is also highly faulted. The median yield is 0.4 l/s and success rates are 70%.*
- *Coastal Karoo: (GRUs 18, 21, 25, 26, and 34): This region consists of varied Ecca and Dwyka lithologies from the Dwyka tillites to Pietermaritzburg shales and Vryheid Formation sandstones. These are faulted against Natal Group sandstones. Borehole yields are higher than inland due to the density of block faulting. On the coast, the rocks are overlain by unconsolidated Quaternary sediments of the Berea red sands.*
- *Table 1-1 provides a summary of the geology of each GRU.*

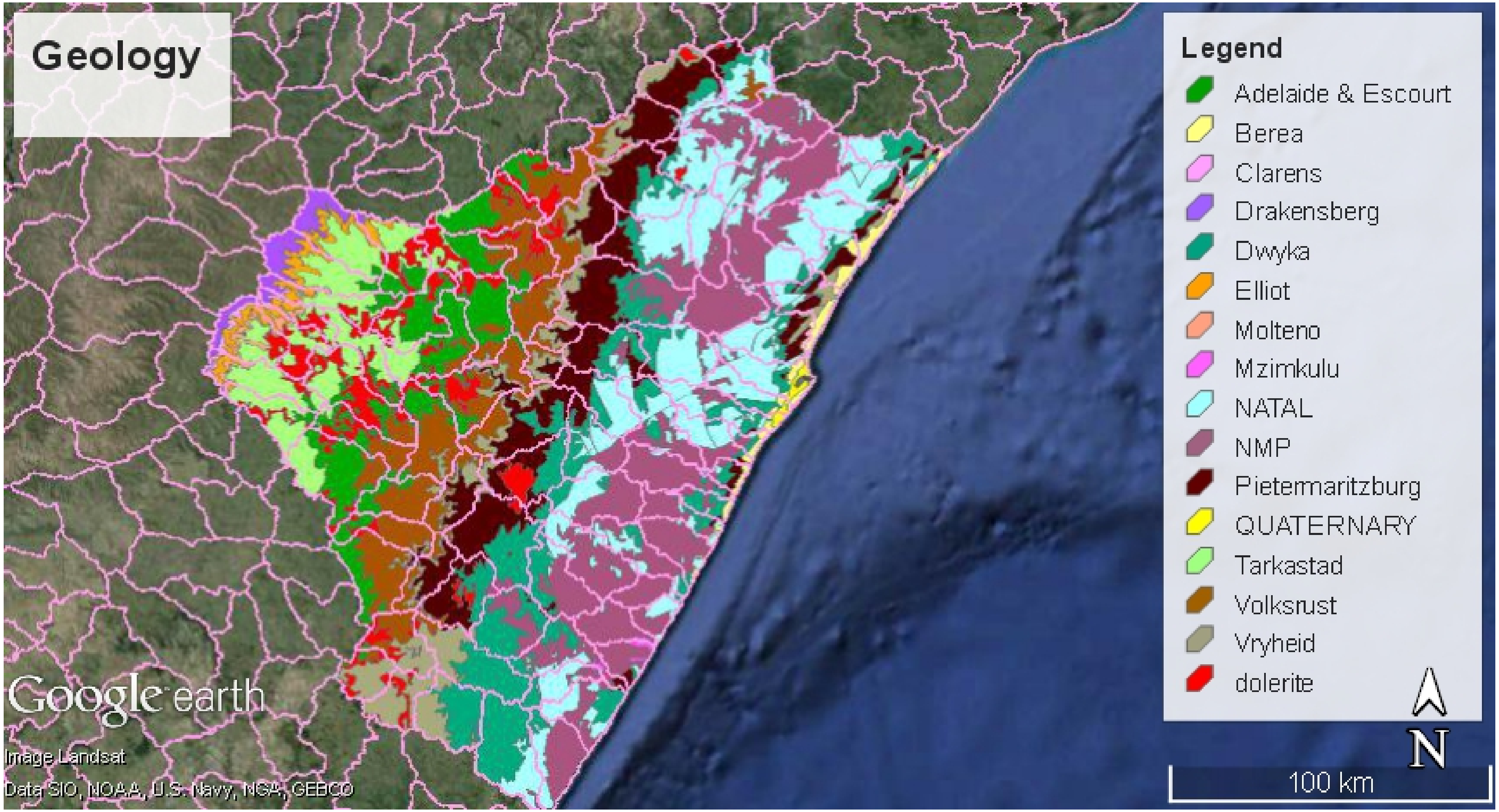

Figure 1-1 Geology of study area

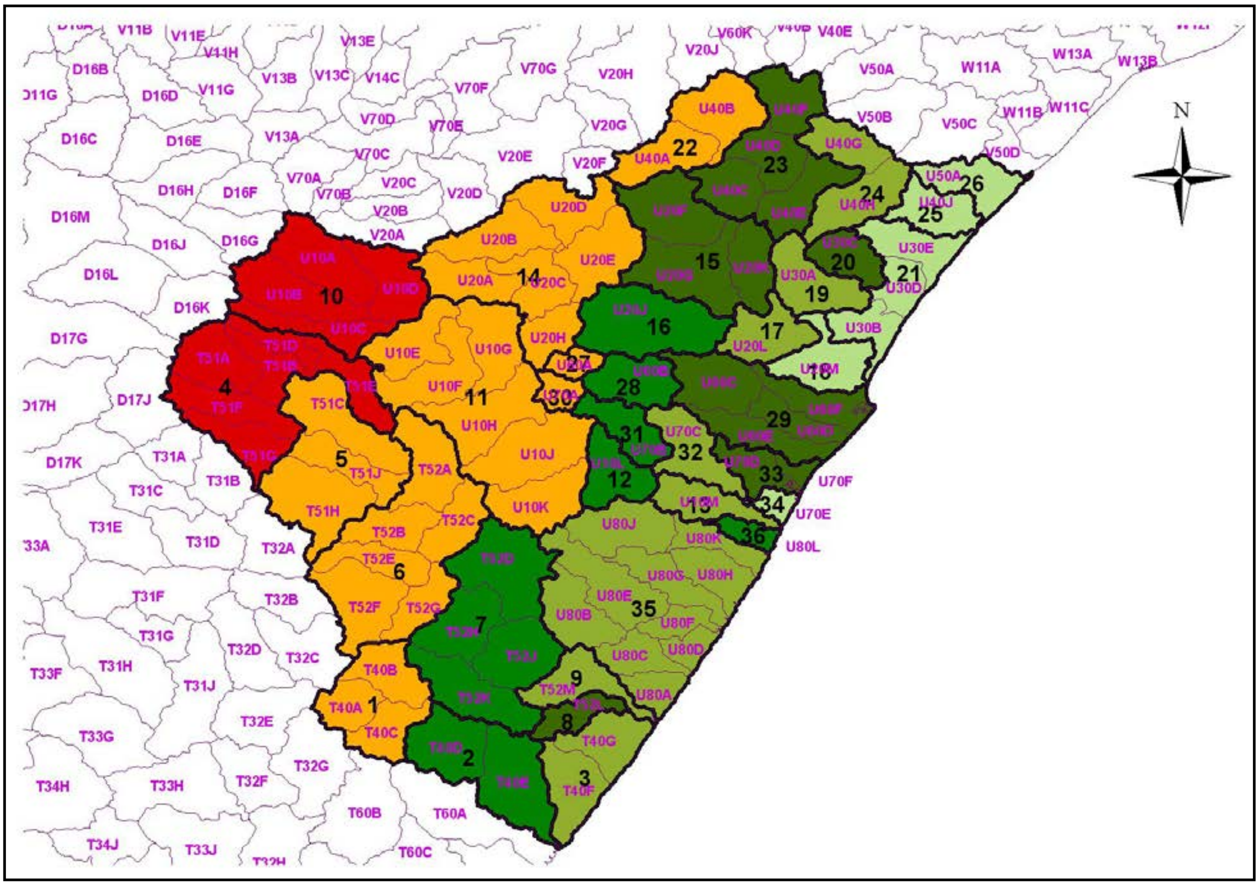

Figure 1-2 Groundwater Response Units in the WMA

Table 1-1 Summary of Groundwater Response Units

GRU	Primary Geology	Catchment	Quats	Description
1	*Volksrust, Vryheid*	*Mtamvuna*	*T40A, T40B, T40C*	*Upper Mtamvuna*
2	*Dwyka, Natal Group sandstone*		*T40D, T40E*	*Lower Mtamvuna*
3	*Natal Metamorphic Province,*	*South coast rivers*	*T40F, T40G*	*South coast*
4	*Drakensberg, Clarens, Elliot, Molteno, Tarkastad*	*Umzimkulu*	*T51A-B, T51D-E, T51F-G*	*Upper Umzimkulu escarpment zone*
5	*Adelaide, Volksrust*		*T51C, T51H, T51J*	*Upper Umzimkulu middelveld zone*
6	*Volksrust, Vryheid, Pietermaritzburg*		*T52A-C, T52E-G*	*Middle Umzimkulu*
7	*Dwyka*		*T52D, T52H-K*	*Middle Umzimkulu*
8	*Natal Group*		*T52L*	*Lower Umzimkulu*
9	*Natal Metamorphic Province*		*T52M*	
10	*Drakensberg, Ellliot, Molteno, Tarkastad*	*Mkomazi*	*U10A-D*	*Mkomazi Drakensberg Escarpment*
11	*Adelaide, Volksrust, Vryheid, Pietermaritzburg*		*U10E-K*	*Mkomazi middelveld*
12	*Dwyka*		*U10L*	*Lower Mkomazi*
13	*Natal Metamorphic Province*		*U10M*	
14	*Adelaide, Volksrust, Vryheid*	*Mgeni and Msunduze*	*U20A-E, U20H*	*Mgeni to Albert Falls, and upper Msunduze*
15	*Natal Group*		*U20F-G, U20K*	*Mgeni-Msunduze*
16	*Pietermaritzburg, Dwyka*	*Msunduze*	*U20J*	*Lower Msunduze*

GRU	Primary Geology	Catchment	Quats	Description
17	*Natal metamorphic Province*	*Mgeni*	*U20L*	*Mgeni to Inanda dam*
18	*Natal Group, faulted coastal Karoo*		*U20M*	*Lower Mgeni*
19	*Natal Metamorphic Province, Natal group*	*Mdloti*	*U30A*	*Upper Mdloti*
20	*Natal Metamorphic Province, Natal group*	*Tongati*	*U30C*	*Upper Tongati*
21	*Coastal faulted Karoo*	*Tongati and Mdloti, north coast rivers*	*U30B, U30D-E*	*Lower Mdloti and Tongati*
22	*Vryheid, Pietermaritzburg*	*Mvoti*	*U40A-B*	*Upper Mvoti*
23	*Natal Metamorphic Province, Natal Group*		*U40C-F*	*Middle Mvoti*
24	*Natal Metamorphic Province*		*U40G-H*	
25	*Natal Group, faulted coastal Karoo*		*U40J*	*Lower Mvoti*
26	*faulted coastal Karoo*	*North coast rivers*	*U50A*	*North coast*
27	*Volksrust, Vryheid, Pietermaritzburg*	*Mlazi*	*U60A*	*Upper Mlazi*
28	*Pietermaritzburg, Dwyka*		*U60B*	
29	*Natal Group, Dwyka*		*U60C-F*	*Lower Mlazi and central coast*
30	*Volksrust, Vryheid, Pietermaritzburg*	*Lovu*	*U70A*	*Upper Lovu*
31	*Pietermaritzburg, Natal Group*		*U70B*	*Middle Lovu*
32	*Natal Group, Natal Metamorphic Province*		*U70C*	
33	*Natal Group, Dwyka*		*U70D*	*Lower Lovu*
34	*Pietermaritzburg, Dwyka*	*Central coast rivers*	*U70E-F*	*Central coast*
35	*Natal Metamorphic Province*	*South and central coast rivers*	*U80A-K*	*South and Central coast rivers*
36	*Dwyka*		*U80L*	

1.4 INTEGRATED UNIT OF ANALYSIS

1.4.1 Integrated unit of analysis T4: Mtamvuna

Water resources: *The storage regulation in this Integrated unit of analysis (IUA) is low with no noticeable dams located in the area. There is no surface water developments planned in the IUA. The land use activities include extensive forestry in the upper reaches and some cultivation in the lower reaches. The IUA is predominantly rural with a large number of scattered rural and informal settlements supplied from regional water abstractions.*

Insignificant volumes of groundwater are utilised in the water resources IUA and there is a potential for some groundwater development in the upper reaches underlain by Karoo sediments. The lower reaches are underlain by low yielding Dwyka tillites.

1.4.2 IUA T5-1: Upper Umzimkulu Mountain Zone

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and instream dams. There is no surface water developments planned in the IUA.*

The upper reach of the IUA is mainly a mountainous area below which the IUA is mainly characterised by agricultural activities including extensive forestry, extensive irrigation, cultivation, dairy, cattle and sheep farming. Some parts of the IUA are rural with some community water use from the scattered rural villages. Subsistence farming is practised in these areas. The towns Underberg and Himeville are also located in the IUA.

Some groundwater is utilised in the water resources IUA for rural supply and livestock watering purpose and there is some potential for further groundwater development as the Karoo sediments underlying the region are moderately yielding.

1.4.3 IUA T5-2: Middle Umzimkulu and Mzimkulwana Tributary

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. A surface water development planned for the area is the Ncwabeni off-channel dam with abstraction from a new weir on the Umzimkulu River for regional water supply, which will have some effect on the flows.*

The land use activities in the IUA include extensive forestry concentrated in the upper higher rainfall areas, irrigation in the upper reaches, cultivation, cattle farming and subsistence farming. There are a number of scattered rural villages supplied by regional water supply schemes. The towns Creighton and Umzimkulu are also located in the IUA.

Some groundwater is utilised by rural villages in the water resources IUA, with a potential for further groundwater development, however, the lower reaches are underlain by low yielding Dwyka tillites.

1.4.4 IUA T5-3: Umzimkulu

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The upstream development of the Cwabeni off-channel dam with abstraction from a new weir on Umzimkulu for regional water supply will have some effect on the flows.*

The land use activities include extensive forestry and sugar cane, Oribi Gorge Nature Reserve, natural areas with grazing, and run of river abstraction or regional water supply to rural villages. The town Harding is also located in the IUA. Industrial activities include limestone mining and the Illovo Umzimkulu sugar mill in the lower reach, which abstracts water directly from the Umzimkulu River just upstream of the estuary.

According to a desktop investigation conducted as part of this study, some groundwater is utilised by rural villages in the water resources IUA, with a potential for further groundwater development in areas underlain by Natal Metamorphic Province and Natal Group rocks.

1.4.5 IUA U8-1: Mzumbe

Water resources: *The storage regulation in this IUA is low with no significant dams present and there is no future surface water developments planned in the IUA.*

The IUA is predominantly rural with scattered rural villages located throughout. There is some forestry and cultivation located in the upper reach of the IUA.

Small volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for limited groundwater development in the area, since it is underlain by low yielding Natal Metamorphic Province rocks.

1.4.6 IUA U8-2: Mtwalume

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few instream dams. There is no future surface water developments planned in the IUA.*

Land use activities in the water resources IUAs generally include cultivation and some forestry in the middle and upper reaches. Rural villages are also scattered throughout the IUA with semi-urban and urban areas located along the coast.

According to a desktop investigation conducted as part of this study, small volumes of groundwater are utilised for rural supply in the water resources IUA and there is a limited potential for further groundwater development in the area since it is largely underlain by low yielding Natal Metamorphic Province rocks.

1.4.7 IUA SC: Southern Coastal

Water resources: *These include the coastal strips and immediate hinterland associated with Port Edward, Leisure Crest, Palm Beach, Southbroom, Ramsgate, Margate, Shelly Beach Oslo Beach, South Port, Pumula, Hibberdene, Bazeley Beach, Pennington, Park Rynie, and Palmcliffe. The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. There is no surface water developments planned in the IUA.*

Land use activities in the water resources IUAs generally include cultivation (mostly sugar cane with some orchards) and some forestry plantations slightly inland. Rural settlements are usually located more inland with semi-urban and urban areas towards the coast. Return flows from a number of Waste Water Treatment Works (WWTW) enter river systems affecting both the flow and quality of the river system.

Groundwater is utilised for rural supply in the water resources IUA and there is a limited potential for further groundwater development in the area since it is largely underlain by low permeability Dwyka tillites and Natal Metamorphic Province rocks. An exception may be the karstic rocks of the Mzimkulu Formation of the Natal Metamorphic Province in the vicinity of Umzimkulu.

1.4.8 IUA U1-1: Mkomazi Mountain Zone

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The proposed Smithfield Dam site is located at the lower end of the IUA and is likely to be developed in the future. The DWS is currently in the process of conducting a feasibility study for the Mkomazi River Development Project (Smithfield Dam) and the purpose of the project is to augment the Mgeni River supply area. The construction of Smithfield Dam will have a noticeable effect on the river flows downstream of the dam.*

The middle to upper reach of the IUA is mainly a mountainous area, where nature reserves (Lotheni, Vergelegen, Kamberg, Highmore Nature Reserves, and Mkomazi National Park) and the Sani Pass Tourism area are located. There is some agriculture and community water use. The *main activities in the middle to lower end of the IUA underlain by the Middelveld Karoo groundwater region include forestry, cultivation, irrigation, grazing, and community water use from low density rural settlements. Bulwer Town is located in the lower end of the IUA. In general there are few impacts on the river systems and the water quality can be regarded as good.*

Some groundwater is utilised in the water resources IUA and there is some potential for further groundwater development in the area.

1.4.9 IUA U1-2 Middle Mkomazi

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The development of the upstream Mkomazi River Development Project (Smithfield Dam) will have a significant impact on the Mkomazi River in the water resource IUA.*

The land use activities in the IUA include forestry, cultivation, irrigation, some sugar cane, cattle farming, and community water use from low density rural settlements. The small town Ixopo is also located in the IUA.

According to a desktop investigation conducted as part of this study, some groundwater is utilised for rural supply in the water resources IUA and there is some potential for further groundwater development in the area since it is underlain largely by moderately yielding sediments of the Ecca Group.

1.4.10 IUA U1-3: Mkomazi Gorge Zone

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The development of the upstream Mkomazi River Development Project (Smithfield Dam) will have a significant impact on the Mkomazi River in the water resource IUA.*

The land use activities are predominantly community water use from low density rural settlements.

Minimal volumes of groundwater are utilised in the water resources IUA and there is some potential for further groundwater development in the area.

1.4.11 IUA U1-4: Lower Mkomazi

Water resources: *The storage regulation in this IUA is low with no dams located in the IUA. The development of the upstream Mkomazi River Development Project (Smithfield Dam) will have a significant impact on the Mkomazi River in the water resource IUA.*

The land use activities are predominantly community water use from low density rural settlements and there is also an abstraction for Sappi Saiccor in the lower end of the IUA.

Some groundwater is utilised for rural supply in the water resources IUA and there is limited potential for further groundwater development in the area, since it is underlain by low permeability Dwyka tillites and Natal Metamorphic Province rocks.

1.4.12 IUA U7 Lovu

Water resources: *The storage regulation in this IUA is low and the only dams include a number of small farm and instream dams. There is no future surface water developments planned in the IUA.*

There are extensive forestry and sugar cane plantations located in the middle to upper reach of the IUA with Richmond town and adjacent township also located in the upper reach. The middle to lower reach of the IUA is occupied by scattered rural villages. Discharges from the Richmond and township area enter the river systems affecting both the flow and especially the water quality of the river.

Small volumes of groundwater are utilised for rural supply and livestock watering in the water resources IUA and there is a potential for further groundwater development in the area, especially in the lower reaches underlain by faulted Natal Metamorphic Province and Natal Group rocks.

1.4.13 IUA U6-1: Upper Mlazi

Water resources: *The IUA is regulated by the Shongweni Dam located at the lower end of the IUA and there are also a number of small farm and instream dams. There is no future surface water developments planned in the IUA.*

The main land use activities include cultivation (dryland sugar cane, maize), irrigation and forestry located in the upper half of the IUA. There are some low density settlements as well as semi-urban and urban areas with industries located in the lower half of the IUA. Discharges from the Hopewell and Hammersdale (industrial area) WWTWs into the rivers affect both the flow and especially the water quality of the river.

Small volumes of groundwater are utilised for rural supply and livestock watering in the water resources IUA and there is a potential for further groundwater development in the area, especially in the lower reaches underlain by faulted Natal Group sandstones.

1.4.14 IUA U6-2: Lower Mlazi

Water resources: *The IUA is regulated by the upstream Shongweni Dam and there is no future surface water developments planned in the IUA.*

The middle to upper reach of the IUA is occupied by scattered rural villages and the middle to lower reach by semi-urban and urban areas. Discharges from numerous WWTWs enter the river system affecting both flow and especially the water quality of the river. There is also a hazardous landfill site in the upper reaches of the tributaries which also affect the water quality of the Mlazi River, which is regarded as very poor. The lower end of the Mlazi River has been canalised and hence there is no estuary.

There are insignificant volumes of groundwater utilised in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Natal Group rocks.

1.4.15 IUA U6-3: Mbokodweni

Water resources: *The storage regulation in this IUA is low and there are no major dams present. There is no future surface water developments planned in the IUA.*

There is some sugar cane (dryland) located in the upper reaches of the IUA. The middle to upper reach of the IUA is occupied by scattered rural villages and the middle to lower reach by semi-urban areas, urban areas (Umlazi, Isipingo) as well as industrial areas close to the coast (Prospecton Industrial area). Discharges from numerous WWTWs enter the river system affecting both flow and especially the water quality of the river.

There are insignificant volumes of groundwater utilised in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Natal Group rocks.

1.4.16 IUA CC: Coastal Cluster

Water resources: *The storage regulation in this IUA is low and the only dams in the area include one or two small Instream dams. There is no surface water developments planned in the IUA.*

The area is predominantly urban with some semi-urban and rural settlements. Return flows from a number of WWTW enter river systems affecting both the flow and quality of the river system.

Small volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Natal Group rocks.

1.4.17 IUA U2-1: Mgeni: Upstream of Midmar Dam

Water resources: *The IUA is regulated by the Midmar Dam located at the lower end of the IUA and there are also a number of small farm and instream dams. The interbasin Mooi-Mgeni Transfer Scheme transfers water from the Mooi River System (Mearns Weir) to the Midmar Dam catchment (Mpofana River, a tributary of the Lions River that flows into Midmar Dam). This has resulted in increased flows in the effected rivers. The second phase of the Mooi-Mgeni Transfer Scheme (MMTS) is in the process of being constructed i.e. Spring Grove Dam in the Mooi River catchment, which will transfer additional volumes of water into the Midmar Dam catchment. Water is abstracted from Midmar Dam to supply Msunduze (Pietermaritzburg) and surrounding areas.*

The main land use activities in the IUA include forestry, cultivation and irrigation. The Mpophomeni semi-urban is located in the IUA, almost adjacent to the Midmar Dam.

Minimal volumes of groundwater are utilised in the water resources IUA and there is some potential for groundwater development in the area since it is underlain by moderately yielding argillaceous rocks of the Adelaide Sub group and Volksrust Formations.

1.4.18 IUA U2-2: Mgeni: Midmar Dam to Albert Falls Dam

Water resources: *The IUA is regulated by the upstream Midmar Dam, Albert Falls Dam located at the lower end of the IUA and also a number of small farm and instream dams. The IUA is regarded as highly regulated. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on the WWTW return flows entering the river system in the future. There is no surface water development options planned directly in the IUA but the implementation of MMTS Phase 2 will have an impact on the water resources.*

Howick town and industrial area are located in the IUA, just downstream of Midmar Dam. Return flows from the Howick WWTW enter the Mgeni River affecting both the flow and the water quality.

The main land use activities in the IUA include extensive forestry, cultivation (sugar cane and other cash crops) and irrigation.

Minimal volumes of groundwater are utilised in the water resources IUA and there is some potential for groundwater development in the area since it is underlain by moderately yielding sediments of the Ecca Group.

1.4.19 IUA U2-3: Mgeni Downstream of Albert Falls Dam to Msunduze Confluence

***Water resources:** The IUA is regulated by the upstream Midmar Dam and Albert Falls Dams as well as Nagle Dam located at the lower end of the IUA from where water is abstracted for the eThekwini supply area. Nagle Dam is supported from the upstream dam and the IUA is regarded as highly regulated. There are also a number of small farm and instream dams located in the IUA. There is no surface water development options planned directly in the IUA but the implementation of MMTS Phase 2 will have an impact of the water resources.*

Small towns such as New Hannover and Wartburg as well as other scattered rural and informal settlements are located in the IUA. The main land use activities in the IUA include extensive forestry and dry land sugar cane.

Some volumes of groundwater are utilised in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Natal Group sandstones.

1.4.20 IUA U2-4: Msunduze

***Water resources**:* *The storage regulation in this IUA is low. Henley Dam is located in the upper reaches of the IUA, which is a relatively small dam when compared to the dams located in the Mgeni System, and there are also a number of small farm and instream dams.*

A large portion of the IUA is occupied by the greater Pietermaritzburg urban area and there are also a large number of semi-urban and rural settlements. Discharges from the Darvill WWTW (Pietermaritzburg area) enter the Msunduze River and affect the flow and especially the water quality of the river. Umgeni Water is currently investigating the potential of re-using effluent from the Darvill WWTW, which could have a future impact on the Msunduze River. The possibility of implementing such a project at this stage is uncertain.

The main land use activities in the IUA include extensive forestry and dry land sugar cane.

Some volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for further groundwater development in the area in the upper reaches underlain by Ecca Group sediments.

1.4.21 IUA U2-5: Mgeni downstream of the Msunduze Confluence to Inanda Dam

***Water resources:** The IUA is regulated by the upstream Midmar Dam and Albert Falls Dams, Nagle Dam as well as Inanda Dam located at the lower end of the IUA and is regarded as highly regulated. Abstractions are made from Inanda Dam for supplying water to the eThekwini area and the dam is supported by the upstream dams. The water quality of the Mgeni River reduces after* *the confluence with the Msunduze River. There are no surface water development options planned directly in the IUA but the implementation of MMTS Phase 2 will have an impact on the water resources as well as the potential implementation of the Darvill re-use project.*

A large portion of the IUA is rural, with scattered rural villages and subsistence farming activities. There are a large number of rural settlements located around the Inanda Dam area.

Areas in the upper reaches of the IUA are covered by extensive cultivation (dryland sugar cane) and forestry.

Some volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for small scale further groundwater development in the area underlain by the Natal Metamorphic Province.

1.4.22 IUA U2-6: Downstream of Inanda Dam to Estuary

Water resources: *The IUA is regulated by the upstream Midmar, Albert Falls Dams, Nagle and Inanda Dam and is regarded as highly regulated. Inanda Dam is supported by the upstream dams in the Mgeni River and compensation releases are also made from Inanda Dam for environmental purposes. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on the WWTW return flows entering the river system in the future. The implementation of the upstream MMTS Phase 2 as well as the potential implementation of the Darvill re-use project will have an impact on the water resources in the IUA.*

A large portion of the IUA is semi urban area and urban in the lower reaches (eThekwini municipal area). There are a number of discharges form WWTW within the eThekwini municipal areas that enter the Mgeni River in the IUA that affect both the flow and the water quality of the river.

There is insignificant groundwater use in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Karoo and Natal Group sediments. .

1.4.23 IUA U3-1: Mdloti upstream of Hazelmere Dam

Water resources: *This zone includes all the rivers falling within quaternary catchments U30A (upper Mdloti), U30B (lower Mdloti), U30C (upper Tongati and Mona Rivers) and U30D (lower Tongati).*

The IUA is regulated by the Hazelmere Dam located at the lower end of the IUA. The raising of Hazelmere Dam has been approved, which will take place in the near future and will have a further impact on river flows downstream of the dam.

There is some dryland sugar cane located in the upper reaches of the IUA. There are a large amount of low density settlements and rural settlements spread throughout the IUA.

Minimal volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for further groundwater development in the area since is significantly faulted

1.4.24 IUA U3-2: Mdloti downstream of Hazelmere

Water resources: *The IUA is regulated by the upstream Hazelmere Dam. The raising of Hazelmere Dam has been approved, which will take place in the near future and will have a further impact on river flows in the IUA.*

A large portion of the IUA is occupied by urban areas (Verulam) and numerous WWTW discharges enter the Mvoti River from various WWTWs (Phoenix, Umhlanga, temporary WWTW from the King Shaka Airport) affecting both flow and water quality of the river. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on the WWTW return flows entering the river system in the future. A significant portion of the IUA is also covered by sugar cane (dryland and irrigated). There are also a large amount of low density rural settlements spread throughout the IUA.

There is minimal groundwater use in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Karoo and Natal Group sediments.

1.4.25 IUA U3-3: Tongati

Water resources**:** *The IUA is regulated by the Dudley Pringle Dam. There is no surface water resource developments planned in the IUA area.*

There are a large amount of low density settlements and rural settlements spread throughout the IUA. The Tongaat town and industries are located in the IUA area discharges from the Tongaat WWTW enter the Tongati River affecting both flow and water quality of the river. The area is predominantly a sugar cane farming area with most of the IUA covered with dry land sugar cane plantations.

Minimal volumes of groundwater are utilised and there is some potential for groundwater development since it is largely underlain by faulted Natal Group sediments.

1.4.26 IUA U4-1: Mvoti Upper Reaches

Water resources: *The main river is the Mvoti and the Heinespruit, Intinda, Mvozana and Khamanzi Rivers form its tributaries.*

The storage regulation in this IUA is low and the only dams in the area include a number of small farm and instream dams. The dams are of such nature that no releases are made for downstream users. The Greytown town is located in the upper reaches of the IUA and the discharges from the towns WWTW enter the river system, affecting both the flow and water quality of the river system. The Mvoti Poort Dam site is located at the lower end of the IUA. There is however a more favourable dam site lower down in the Mvoti River System (IsiThunda Dam Site), which is likely to be developed first.

The main land use activities in the IUA include extensive forestry and a significant amount sugar cane plantations and irrigation (sugar cane, maize etc.) also occur. There are also a few low density settlements and rural settlements located in the lower reaches.

There are insignificant volumes of groundwater utilised in the water resources IUA and there is a potential for further groundwater development in the area in areas underlain by faulted Natal Group sandstones, and limited potential in the Pietermaritzburg shales.

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1.4.27 IUA U4-2: Mvoti Middle Reaches

Water resources: *This zone includes the Mvoti River from U40D-03957 down to U40E-03985 and includes the Mtize, Faye, Sikoto and Hlimbitwa (including its headwater tributaries) Rivers. The confluence of the Mvoti and Hlimbitwa Rivers is the site of the proposed IsiThunda Dam.*

The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The dams are of such nature that no releases are made for downstream users. The IsiThunda Dam site is located at the lower end of the IUA, which is the most favourable dam site for development in the Mvoti River catchment, with a high likelihood of is being developed in the short to medium term. The main land use in the IUA is extensive forestry and sugar cane (dryland and irrigated).

Some groundwater is utilised by rural villages in the water resources IUA and there is a limited potential for further groundwater development in the area as it is underlain by faulted Natal Group Sandstones and Natal Metamorphic Province rocks. .

1.4.28 IUA U4-3: Mvoti Lower Reaches

Water resources: *This zone includes the Mvoti from U40H-04064 to the coast and includes the Nsuze and Pambela tributaries.*

The storage regulation in this IUA is low but could however be impacted by future surface water resource developments planned upstream in the catchment i.e. the development of IsiThunda Dam. The town Kwadukuza (Stanger) is located in the lower end of the IUA and water is abstracted directly from the Mvoti River (run of river abstraction) for supplying the town, which affects the downstream river flow.

There is some dryland sugar cane and subsistence farming occurring in the area and there are a vast amount of low density and rural settlements located throughout the IUA.

Some groundwater is utilised by rural villages in the water resources IUA and there is a potential for further groundwater development in the area, especially in the faulted sediments in the lower reaches.

1.4.29 IUA NCC: Northern Coastal Cluster

Water resources: *The storage regulation in this IUA is low and the only dams in the area include one or two small Instream dams.*

The area is predominantly a sugar cane farming area with most of the IUA covered with dry land sugar cane plantations. There are a few small coastal towns, some slightly inland and a few rural villages. Return flows from WWTW enter river systems in one or two cases.

Some groundwater is utilised by a municipality and rural villages in the water resources IUA and there is a potential for further groundwater development in the faulted Karoo sediments.

1.5 INTEGRATED STEPS APPLIED IN THIS STUDY

The integrated steps for the National Water Classification System, the Reserve and RQOs are supplied in table 1-2.

Table 1-2 Integrated study steps

Step	Description
1	*Delineate the units of analysis and Resource Units, and describe the status quo of the water resource(s) (completed).*
2	*Initiation of stakeholder process and catchment visioning (on-going).*
3	*Quantify the Ecological Water Requirements and changes in non-water quality ecosystem goods, services and attributes*
4	*Identification and evaluation of scenarios within the integrated water resource management process.*
5	*Develop draft Water Resource Classes and test with stakeholders.*
6	**Develop draft RQOs and numerical limits.**
7	*Gazette and implement the class configuration and RQOs.*

*This report forms **part** of the outcomes of Step 6 (red above) within the integrated approach (DWA, 2012.*

2 APPROACH

2.1 AVAILABLE DATA

Groundwater RQOs are developed to maintain the required groundwater contribution (groundwater baseflow) to the Ecological Reserve, which is assumed to equal the required maintenance low flow. The relevance off the groundwater RQOs to protect groundwater is twofold; 1) to maintain and support the ecological requirements of the receiving surface water bodies; 2) to protect groundwater resources for the direct and indirect users of the groundwater.

The reduction of groundwater baseflow can occur due to abstraction by the interception of groundwater water flow which would normally discharge into rivers, or by abstraction in the vicinity of rivers, which creates drawdown and reverses groundwater gradients so that flow in the river in induced into the aquifer. Therefore possible RQOs may stipulate the volume of abstraction that would cause an undesirable reduction in baseflow, or specific distances from a river, or specified distances from the surface water body where abstraction can take place.

Baseflow can also be impacted by afforestation and Alien Invasive Plants (AIPs), which can increase evaporation from groundwater if they occur in areas of shallow water table, or reduce interflow from high lying areas.

Selected indicators to monitor groundwater can be based on existing monitoring data, on simulated data if available, or extrapolation from other areas of similar hydrogeological conditions.

SRK (2014) was previously appointed to undertake the Classification and determine the Groundwater Component of the Reserve for the study area. This report builds on this study by setting the RQOs based on this report, and additional work undertaken by the project team.

2.2 METHODOLOGY

The approach used in developing the groundwater RQOs is shown in Figure 2.1.

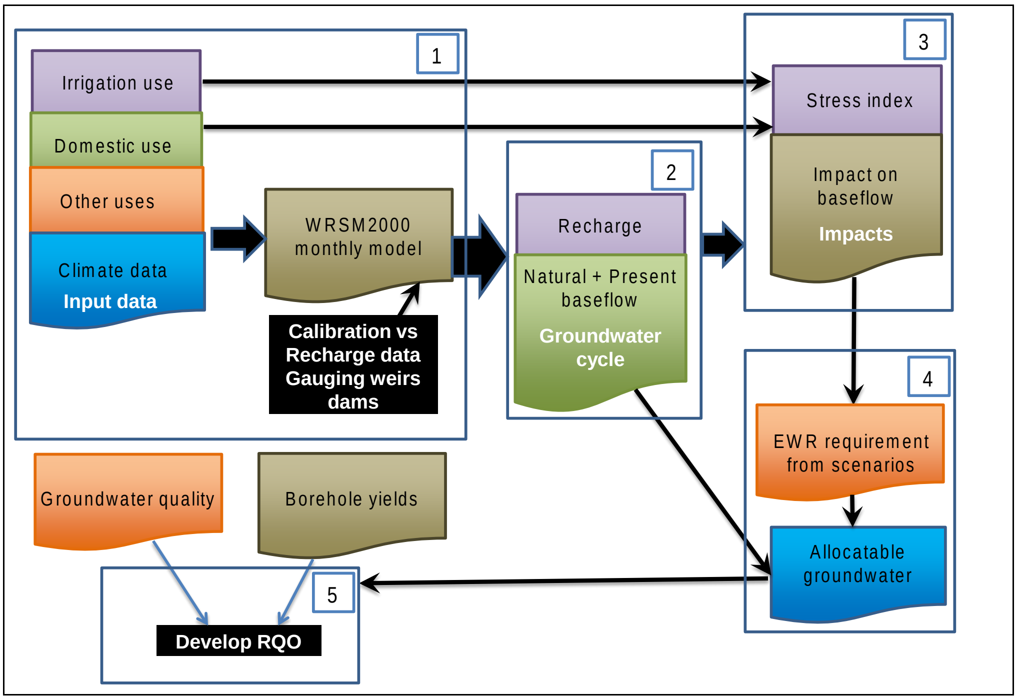

Figure 2-1 Approach to developing groundwater RQOs

The process followed to develop the data required for the RQOs was a 5 stage process:

1. *Data on surface and groundwater use and climatic data, together with hydrological parameters were entered into the WRSM2000 model to quantify surface and groundwater resources and interactions, such as recharge and baseflow and evapotranspiration from shallow groundwater. The data utilised was from WR2012 (Water Resources South Africa 2012) network set ups, and groundwater use was from SRK (2014). The model was run from 1920 - 2010 and calibrated against DWA flow gauging data, dam volumes, and recharge data such as in the Groundwater Resource Assessment Phase II (GRA2). For groundwater, calibration included calibrating recharge, aquifer recharge and interflow to fit observed low flows, and baseflow depletion due to abstraction and evaporation area. This provided a time series of recharge and baseflow.*
2. *Since the calibrated flows include non-stationary hydrology due to temporal variations in abstraction and afforestation, it cannot be used to determine mean annual values. The surface and groundwater abstraction and afforestation was removed and WRSM2000 was run under virgin conditions. Data was extracted from the model to determine the ground balance in terms of recharge, aquifer recharge, interflow, groundwater baseflow and evapotranspiration, both under virgin conditions and with groundwater abstraction, afforestation and AIPs at present day levels.*
3. *Present day ground water use was divided by aquifer recharge to determine the stress index of the units. Impacts on baseflow were determined from baseflow reduction under present day abstraction relative to virgin baseflow.*
4. *The allocatable groundwater was determined from the difference between present day abstraction and aquifer recharge.*
5. *Data from the above steps were utilised to develop qualitative and quantitative RQOs, and estimate reductions in baseflow from further groundwater abstraction.*

The following groundwater data were then synthesised for each quaternary catchment in each IUA in order to determine the RQOs:

- *Borehole yields and groundwater quality as limiting factors for groundwater use.*
- *Existing groundwater use and stress index (total use/aquifer recharge).*
- *The Harvest Potential of each catchment.*
- *Recharge and aquifer recharge (which excludes the component of recharge lost as interflow and not available to groundwater users).*
- *Natural or virgin groundwater contribution to baseflow, interflow and total baseflow from WRSM2000.*
- *The groundwater baseflow that would occur under present day present day groundwater abstraction and afforestation and AIPs from WRSM2000.*
- *The mean annual baseflow under present day afforestation, alien invasive plants (AIPs) and groundwater abstraction from WRSM2000*

2.3 CRITERIA USED FOR RQOS

- *Table 2-1 is a summary table of criteria that were concluded to be necessary for RQOs in each catchment.*

Table 2-1 Summary of criteria used to set the RQOs

Catchments	Water Resource Zone	GRU	Quaternary catchments	Baseflow	Quality	Groundwater level	Aquifer Recharge	Harvest Potential

Catchments	Water Resource Zone	GRU	Quaternary catchments	Baseflow	Quality	Groundwater level	Aquifer Recharge	Harvest Potential
North Coast Rivers	*NC*	*21*	*U30E*					*Y*
		26	*U50A*		*Y*	*Y*		*Y*
Mvoti	*U4-1*	*22*	*U40A - B*	*Y*		*Y*		*Y*
		23	*U40C*	*Y*				*Y*
		24	*U40D*					*Y*
	U4-2	*23*	*U40F*	*Y*				*Y*
		24	*U40E,G*		*Y*			*Y*
	U4-3	*24*	*U40H*		*Y*			*Y*
		25	*U40J*					*Y*
Mdloti	*U3-1*	*19*	*U30A*					*Y*
	U3-2	*21*	*U30B*					*Y*
Tongati	*U3-3*	*20*	*U30C*		*Y*			*Y*
	U3-4	*21*	*U30D*					*Y*
Mgeni	*U2-1*	*14*	*U20A - U20C*					*Y*
	U2-2	*14*	*U20D - U20E*	*Y*				*Y*
	U2-3	*15*	*U20F–G*	*Y*				*Y*
	U2-4	*14*	*U20H*					*Y*
		16	*U20J*					*Y*
	U2-5	*15*	*U20K*					*Y*
		17	*U20L*		*Y*			*Y*
	U2-6	*18*	*U20M*		*Y*			*Y*
Central Coast Rivers	*CC*	*29*	*U60F*		*Y*			*Y*
		33-34	*U70E-F*		*Y*			*Y*
Mlazi	*U6-1*	*27*	*U60A*	*Y*				*Y*
		28	*U60B*	*Y*				*Y*
		29	*U60C*		*Y*			*Y*
	U6-2	*29*	*U60D*		*Y*			*Y*
Mbokodweni	*U6-3*	*29*	*U60E*					*Y*
Lovu	*U7-1*	*30-31*	*U70A-B*	*Y*				*Y*
		32-33	*U70C-D*		*Y*			*Y*
Mkomazi	*U1-1*	*10*	*U10A – D*					*Y*
		11	*U10E-F*					*Y*
	U1-2	*11*	*U10G – K*	*Y*				*Y*
	U1-3	*12*	*U10L*		*Y*			*Y*
		13	*U10M*		*Y*			*Y*
South Coast Rivers	*SC*	*3, 35, 36*	*T40F-G U80A,D, G-L*		*Y*			*Y*
Mzumbe	*U8-1*	*35*	*U80B-C*		*Y*			*Y*
Mtwalume	*U8-2*	*35*	*U80E-F*		*Y*			*Y*
Umzimkulu	*T5-1*	*4*	*T51A–B, D-G*		*Y*			*Y*
		5	*T51C, H-J*					*Y*
	T5-2	*6*	*T52A–C, E-G*	*Y*	*Y*			*Y*
		7	*T52D, H*					*Y*
	T5-3	*7*	*T52J – K*		*Y*			*Y*
		8	*T52L*	*Y*				*Y*
		9	*T52M*		*Y*			*Y*
	T4-1	*1*	*T40A-C*	*Y*				*Y*
Mtamvuna		*2*	*T40-40E*					*Y*

2.4 CLASSIFICATION OF CRITERIA IN RQOS

2.4.1 Classification of groundwater status

To calculate the available groundwater resources, the standard DWA methodology (Parsons & Wentzel, 2007) was adopted to determine the stress index (groundwater use/ recharge), and a present status allocated according to the stress index. A fundamental flaw with this approach is that the use of recharge to calculate stress on groundwater resources ignores the fact that large part of recharge never enters the regional aquifers and is discharged as interflow from high lying regions, following rain events, or from saturated areas. Consequently, the stress index was calculated as the ratio of groundwater use to aquifer recharge, ignoring the interflow component not available to boreholes.

Once a stress index was calculated, each Quaternary was assigned a present status (PSC) based on the volume of groundwater abstracted compared to the volume recharged (stress index). The following categories were used to determine the present status:

Table 2-2 Terminology and classes used during the classification process.

Category	Present Status Category (PSC)	Stress Index (Use/recharge)	Water Resource Category
A	*Unmodified natural*	*<0.05*	*Natural*
B	*Largely natural*	*0.05-0.2*	*Good*
C	*Moderately modified*	*0.2-0.4*	*Fair*
D	*Largely modified*	*0.4-0.65*	*Poor*
E	*Seriously modified*	*0.65-0.95*	
F	*Critically modified*	*0.95*	

2.4.2 Abstraction

According to the level of abstraction, as determined by the stress index, groundwater use was classified according to the following categories:

Stress Index	Use	Class
<0.2	*Minimal or under utilised*	*I*
0.2-0.4	*Moderate*	*II*
0.4-0.65	*Significantly utilised*	*II*
0.65-0.95	*Heavily utilised*	*III*

Abstraction impacts on baseflow not only according the volume abstracted, but the proximity of abstraction to the river. Groundwater abstraction can deplete both groundwater storage and groundwater baseflow in a non-linear fashion depending on the transmissivity and storativity of the aquifer, the distance from the stream channel and the time since pumping started and the volume of recharge in that month. Using the methodology utilised in the WRSM2000 model (Pitman model) (Sami, 2014), distance and time curves for the impact of groundwater abstraction on baseflow were derived (figure 2-2) for an aquifer with a transmissivity of 10 m^2/day and a storativity of 0.01. Figure 2-2 shows that a distance of 200 m from a river over 90% of abstraction would originate from groundwater storage for 100 days without recharge. The remainder of the abstraction would originate as baseflow depletion. Hence at 200 m the impacts of abstraction on baseflow would be low. Consequently, 200 m was selected as a general distance from which to restrict groundwater abstraction in the absence of local data.

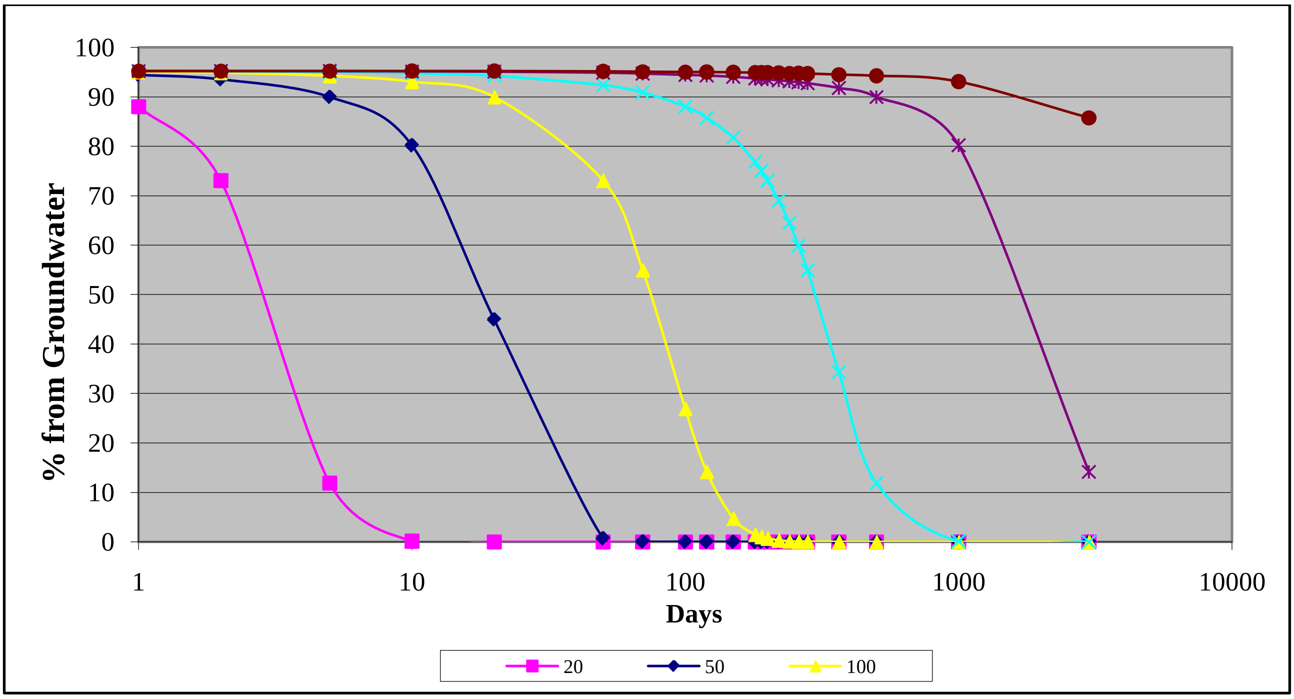

Figure 2-2 Relationship between time, distance and the source of groundwater to a borehole

2.4.3 Baseflow

In GRUs where baseflow reduction is greater than 20%, whether due to afforestation, sugar cane, AIPs or groundwater abstraction, it is considered necessary to monitor baseflow due to the potential impacts on the ecology. Monitoring baseflow can take the form on monitoring dry season flows at gauging stations and comparing flows to natural flows utilising flow duration curves, or via simulation of impacts on low flows by model simulation of changes in land or water use.

Where an EWR low flow has been set, this low flow at the nearest downstream gauging station was set as a numerical low flow.

2.4.4 Water Level

Setting water levels as an RQO is problematic since water levels vary by borehole location in terms of topography, pumping rates and aquifer hydraulic parameters. Hence water level below surface is a very site specific variable.

In addition, monitoring water level provides only localised information, and monitoring water level 'within 50 m of a river to ensure water levels do not drop more than 0.5 m' requires having a dense network of boreholes within 50 m of a river and being monitored; otherwise only point data is being gathered. It is not feasible monitoring action at catchment scale. Monitoring baseflow in catchments where groundwater is linked to rivers provides an integrated response of processes within the entire catchment, and where gauging weirs exist this data is already being collected. Hence monitoring flow in dry months, and undertaking hydrograph separations in high flow periods provides a time series of information on the maintenance of ecological flows. In catchments where groundwater levels are below stream levels, only groundwater levels can provide information on storage levels in an aquifer.

Monitoring water levels is not necessary where baseflow reduction occurs due to afforestation and AIPs, which reduce interflow from high lying areas. Where groundwater is underutilised relative to *recharge, dropping water levels are not expected, hence monitoring is not necessary, except as a record of background water level and its natural fluctuations, since the risk of a regional drop in water levels is unlikely. Monitoring of water levels should be prioritised in areas where the stress index is greater than 0.2, especially where the abstraction has had a significant impact on baseflow.*

Where monitoring is necessary, the specific water level is borehole dependent and the important issue is whether dry season water levels show a trend of decline over several years rather than an absolute level. This may occur in one borehole due to localised pumping but may not be applicable to an entire catchment.

2.4.5 Water Quality

The number of samples available for water quality in each Quaternary is very limited, hence it is not possible to derive meaningful statistics such as range, median etc. The number of samples in each DWS water quality class (table 2-3) is listed per catchment. Where boreholes of a quality worse than class II are present, monitoring is recommended.

Where water quality issues can be observed, the maximum recorded value is given. Due to the low number of samples, this does not imply that is the worst water quality that is present in the catchment.

Table 2-3 DWS Water Quality classes

Water quality class	Description	Drinking health effects
Class 0	Ideal water quality	No effects, suitable for many generations.
Class 1	Good water quality	Suitable for lifetime use. Rare instances of sub-clinical effects.
Class 2	Marginal water quality, water suitable for short-term use only	May be used without health effects by majority of users, but may cause effects in some sensitive groups. Some effects possible after lifetime use.
Class 3	Poor water quality	Poses a risk of chronic health effects, especially in babies, children and the elderly. May be used for short-term emergency supply with no alternative supplies available.
Class 4	Unacceptable water quality	Severe acute health effects, even with short-term use.

A groundwater quality class was allocated according to the following criteria:

Class I: 95% of samples of water quality class 0 and 1.
Class II 75% of samples of water quality class 0-2
Class III: <75% of samples class 0-2.

2.4.6 RQOs for catchments with no surface groundwater interactions

Due to the relatively high rainfall of the study area and the rugged topography, every catchment generates both interflow and groundwater baseflow, hence the potential to impact on baseflow via afforestation, AIPs, Streamflow reducing activities and groundwater abstraction exists in every Quaternary catchment.

3 RQOS OF IUAS

3.1 IUA T4 MTAMVUNA

3.1.1 Hydrogeology

This area is underlain By GRUs 1 (T40A-C) and 2 (T40D-E).

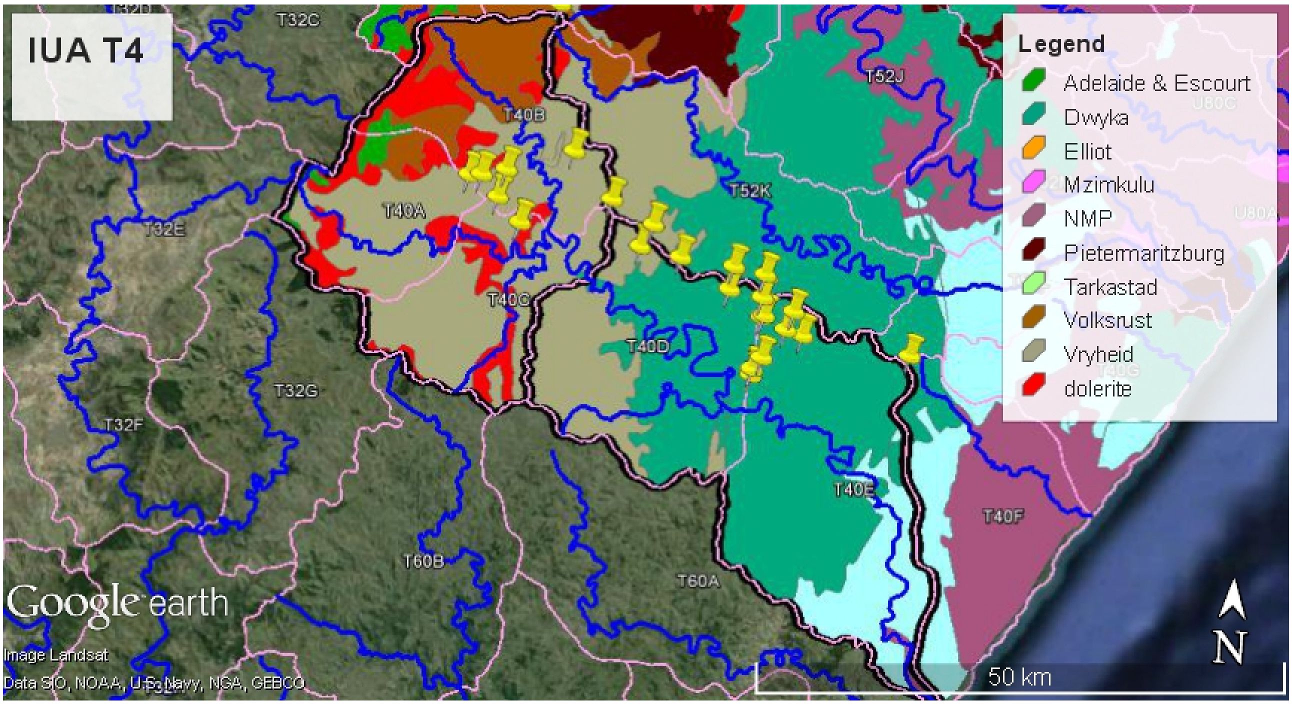

Figure 3-1 Geological map of IUA T4 showing location of chemistry data sampling points

GRU 1 is the Upper Mtamvuna catchment and is underlain by the Middleveld Karroo, which consists of predominantly argillaceous rocks of the Ecca Group and Volksrust Formations. Median yields are 0.9-1.2 l/s.

GRU 2 is the lower Mtamvuna and largely underlain by low yielding Dwyka Group tillites. The median yield is only 0.15 l/s and at least 40% of boreholes are dry, consequently, this is the poorest aquifer in the WMA. The lower 1/3 of T40E is underlain by Natal Group sandstones, which are associated with numerous springs and, ubiquitous groundwater, however, yields are generally below 1 l/s.

3.1.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is approximately 20-25%, with the remainder generating baseflow via interflow. (Table 3.1)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-1 Groundwater use and resources in IUA T4

	T40A	T40B	T40C	T40D	T40E
Recharge (Mm^3/a)	*25,43*	*31,76*	*23,28*	*22,23*	*31,60*
Aquifer recharge (Mm^3/a)	*6,35*	*6,68*	*5,82*	*4,45*	*7,71*
Harvest Potential (Mm^3/a)	*2.83*	*3.78*	*3.22*	*5.06*	*19.93*
Total Use (Mm^3/a)	*0,014*	*0,050*	*0,211*	*0,000*	*0,078*
Stress Index	*0,002*	*0,007*	*0,036*	*0,000*	*0,010*
Status	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*
Present Class	*I*	*I*	*I*	*I*	*I*

3.1.3 Borehole yields and quality

Borehole yields in the IUA are moderate, except in T40D, which is largely underlain by Dwyka tillites. This limits groundwater development to very small localised schemes.

Groundwater is generally of DWA Class 0-1, or Ideal to Good water quality. Elevated Fluorides can exist in GRU2 due to the presence of Natal Metamorphic Province rocks near the coast. Data is sparse in GRU1. (Table 3.2)

Table 3-2 Borehole yields and quality in IUA T4

		T40A	T40B	T40C	T40D	T40E
Average borehole yield (l/s)		*1,00*	*1,38*	*1,00*	*0,16*	*1,06*
Present Class		*I*	*I*	*I*	*I*	*II*
TDS quality class	*0*	*2*	*3*	*3*	*9*	*3*
	1				*2*	*3*
	2					
	3					
	4					
Nitrate quality class	*0*	*2*	*3*	*3*	*8*	*5*
	1				*3*	*1*
	2					
	3					
	4					
Fluoride class	*0*	*2*	*3*	*3*	*9*	*3*
	1				*1*	*2*
	2				*1*	
	3					*1*
	4					
	Maximum (mg/l)					*1.82*

3.1.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 20-25% of baseflow is from the regional aquifer in GRU1, and 10-15% in GRU2, the remainder originating as interflow. (Table 3.3)

Significant baseflow reduction occurs in T40B due afforestation and AIPs.

Table 3-3 Groundwater contribution to baseflow in IUA T4

	T40A	T40B	T40C	T40D	T40E
Baseflow (Mm^3/a)	25,12	31,63	22,46	20,53	26,75
Groundwater baseflow Component (Mm^3/a)	6,04	6,55	5	2,75	2,86
Interflow component (Mm^3/a)	19,08	25,08	17,46	17,78	23,89
Total Use (Mm^3/a)	0,014	0,050	0,211	0,000	0,078
Simulated groundwater baseflow Under current abstraction (Mm^3/a)	6.04	6.55	4.97	2.75	2.86
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	22.49	8.77	21.58	19.39	26.57
Baseflow reduction (%)	10.5	72.3	3.9	5.6	0.7
EWR Low flow (Mm^3/a)	12.61	9.78	35.78 (A-C)	8.59 (A-D)	72.03 (A-E)
Target EC	B	C	B	C	C
PES	B/C	C	B	C	C

3.1.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal and the low borehole yields imply that over abstraction on a regional scale is unlikely. The Groundwater component of baseflow is 10-25%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFRs, as is occurring in T40B.

GRU 1 is of moderate aquifer vulnerability and GRU 2 is of high vulnerability due to the shallow soils overlying the Dwyka Tillites and Natal Group sandstones. Due to the rural setting, no regional threats to groundwater quality exist.

The results for recharge and baseflow of GRU1 are calibrated against flows atT4H001 at the outlet of GRU1, hence can be considered of high confidence. The results for GRU2 are not calibrated against flows, and only mean annual recharge is calibrated against data in the GRA2 database, hence are of low confidence.

The abstractable volume of groundwater is based on the Harvest Potential for GRU1, which is below the aquifer recharge. For GRU2, the abstractable volume is assumed to be 65% of aquifer recharge.

3.1.6 Groundwater narrative and numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
1	*T40A-C*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low yields, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 9.83 Mm^3/a evenly distributed in both time and space.* *Low flows at T4H001 should be maintained at a minimum of*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
						35.78 Mm^3/a
2	*T40D-E*	*All users to comply with existing allocation schedules and individual licence conditions within the confirmed Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low yields, monitoring not required*	*No regional groundwater quality issues exist* *The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 7.9 Mm^3/a evenly distributed in both time and space.*

3.2 IUA T5-1 UPPER UMZIMKULU MOUNTAIN ZONE

3.2.1 Hydrogeology

This area is underlain By GRUs 4 and 5, catchments T51A-J.

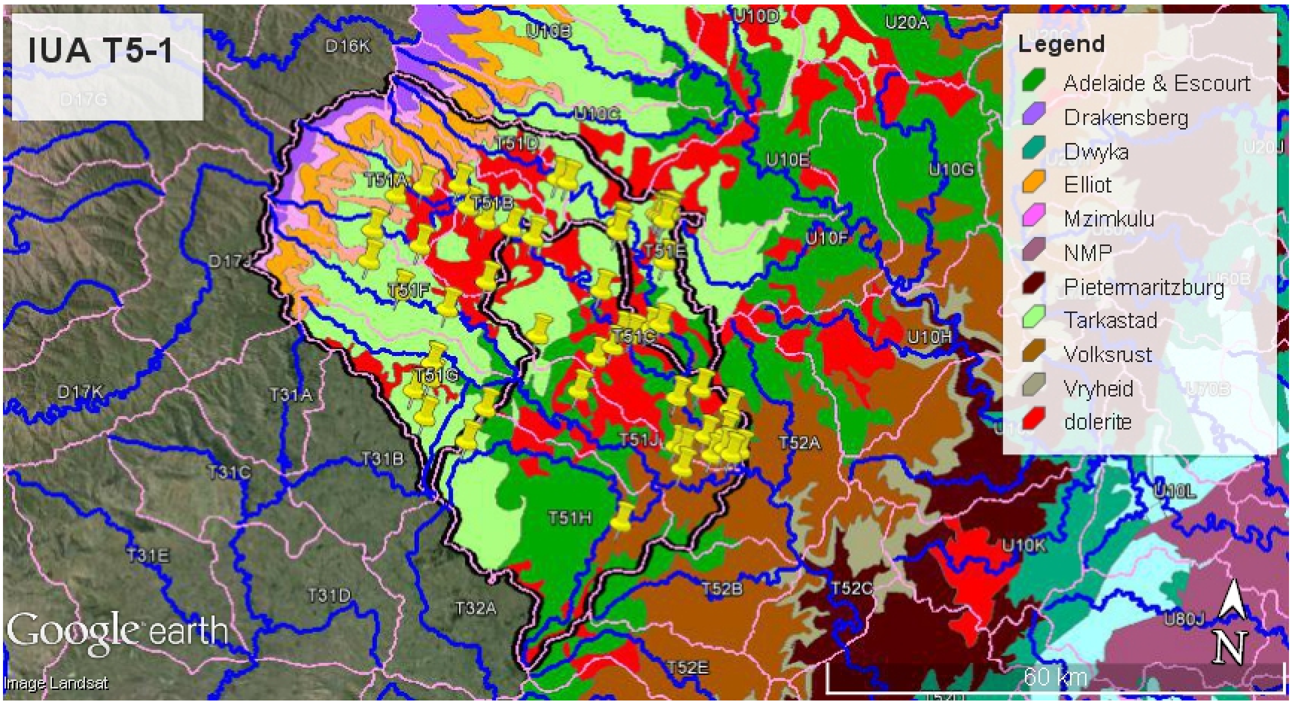

Figure 3-2 Geological map of IUA T5-1 showing location of chemistry data sampling points

GRU 4 is the upper Umzimkulu escarpment zone (T51A-B, T51D-G), and underlain by rocks of the Drakensberg Escarpment. This region consists of predominantly argillaceous rocks of the Tarkastad Subgroup, and the Molteno and Elliot Formations of the Karoo SuperGroup, capped by Clarens sandstones and Drakensberg Basalt. The basal sandstones of the Tarkastad Subgroup often form an escarpment of higher elevation than the underlying Adelaide Subgroup. On the high lying Drakensberg Escarpment, springs are common, especially along the Clarens/Drakensberg contact.

GRU5 is the upper Umzimkulu middelveld zone and underlain by Middelveld Karoo (T51C, T51H-J). This region consists of predominantly argillaceous rocks of the Adelaide Subgroup and Volksrust Formations. It lies at a lower elevation than the Drakensberg Escarpment region. Fractures within the mudstones and shales tend to close once they are dewatered due to the ductility of the rock, making them prone to over exploitation. Fractures also tend to close up due to the oxidation of iron pyrite. Higher yields are associated with dolerite intrusions.

3.2.2 Groundwater use and resources

Groundwater use in the IUA is minimal (Table 3.4). The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer in GRU4 (aquifer recharge) is only 7-9%, with the remainder generating baseflow via interflow. In GRU5 11-17% of recharge reaches the regional aquifer.

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-4 Groundwater use and resources in IUA T5-1

	T51A	T51B	T51C	T51D	T51E	T51F	T51G	T51H	T51J
Recharge (Mm^3/a)	44,02	24,24	40,14	17,75	23,56	35,92	27,17	42,36	44,02
Aquifer recharge (Mm^3/a)	3,23	2,00	5,52	1,38	2,11	2,90	3,12	7,06	3,23
Harvest Potential (Mm^3/a)	5,50	3,71	7,06	2,48	4,14	5,08	4,40	7,58	5,50
Total Use (Mm^3/a)	0,004	0,007	0,007	0.03	0,058	0,004	0,084	0,061	0,006
Stress Index	0,001	0,004	0,001	0,022	0,028	0,001	0,027	0,009	0,002
Status	A Unmodified	A Unmodified	A Unmodified	A Unmodified	A- Unmodified	A- Unmodified	A- Unmodified	A- Unmodified	A- Unmodified
Present Class	I	I	I	I	I	I	I	I	I

3.2.3 Borehole yields and quality

Borehole yields in the IUA are moderate. The high yield in T51D is based on only 1 borehole.

Groundwater is generally of DWA Class 0-1, or Ideal to Good water quality. Some cases of elevated Fluorides exist in T51D and E. These could be associated with boreholes drilled into the extensive dolerite sheets which cover these catchments. (Table 3.5)

Table 3-5 Borehole yields and quality in IUA T5-1

		T51A	T51B	T51C	T51D	T51E	T51F	T51G	T51H	T51J
Average borehole yield (l/s)		0,76	2,12	0,72	3,05	0,58	2,29	1,37	1,05	0.28
Present Class		I	I	I	II	II	I	I	I	I
TDS quality class	0	3	2	15	2	9	6	4	2	7
	1	1							1	1
	2									
	3									
	4									

		T51A	T51B	T51C	T51D	T51E	T51F	T51G	T51H	T51J
Average borehole yield (l/s)		0,76	2,12	0,72	3,05	0,58	2,29	1,37	1,05	0.28
Nitrate quality class	*0*	*4*	*2*	*14*	*2*	*9*	*6*	*4*	*3*	*7*
	1			*1*						*1*
	2									
	3									
	4									
Fluoride quality class	*0*	*3*	*2*	*15*	*1*	*7*	*6*	*4*	*3*	*8*
	1	*1*								
	2					*1*				
	3				*1*					
	4					*1*				
	Maximum (mg/l)				*2.1*	*3.68*				

3.2.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 13-15% of baseflow is from the regional aquifer in GRU5, and less than 10% in GRU4, the remainder originating as interflow.(Table 3.6)

Significant baseflow reduction occurs in T51C due afforestation and AIPs.

Table 3-6 Groundwater contribution to baseflow in IUA T5-1

	T51A	T51B	T51C	T51D	T51E	T51F	T51G	T51H	T51J
Baseflow (Mm^3/a)	*41,46*	*23,1*	*40*	*17,06*	*23,89*	*34,06*	*27,19*	*42*	*41,46*
Groundwater baseflow Component (Mm^3/a)	*0,67*	*0,86*	*5,38*	*0,69*	*2,44*	*1,04*	*3,14*	*6,7*	*0,67*
Interflow component (Mm^3/a)	*40,79*	*22,24*	*34,62*	*16,37*	*21,45*	*33,02*	*24,05*	*35,3*	*40,79*
Total Use (Mm^3/a)	*0,004*	*0,007*	*0,007*	*0.03*	*0,058*	*0,004*	*0,084*	*0,061*	*0,006*
Simulated groundwater baseflow Under current abstraction (Mm^3/a)	*0.67*	*0.86*	*5.38*	*0.69*	*2.44*	*1.04*	*3.13*	*6.7*	*0.67*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*40.18*	*20.87*	*32.56*	*15.63*	*19.61*	*31.66*	*25.09*	*38.48*	*18.68*
Baseflow reduction (%)	*3.1*	*9.7*	*18.6*	*8.4*	*17.9*	*7.0*	*7.7*	*8.4*	*10.6*
EWR Low flow (Mm^3/a)		*28.11 (T51A-B)*	*71.96 (T51A-C)*	*13.76*	*25.14 (T51D-E)*	*21.55*	*10.61*	*15.25*	*7.21 (T51F-J)*
Target EC	*B*	*B*	*C*	*B*	*B/C*	*C*	*C*	*B/C*	*B*
PES	*B/C*	*B*	*C*	*B*	*B/C*	*C*	*C*	*B*	*B*

3.2.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal and the low borehole yields imply that over abstraction on a regional scale is unlikely. The Groundwater component of baseflow is generally less than 10% in GRU4 and less than 15% in GRU5, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFRs, however SFR activities in the catchment are limited and baseflow reduction is less than 20%.

The IUA is of moderate aquifer vulnerability. The upper reach of the IUA is mainly a mountainous area below which the IUA is mainly characterised by agricultural activities including extensive forestry, extensive irrigation, cultivation, dairy, cattle and sheep farming. Due to the rural setting, no regional threats to groundwater quality exist.

The results for recharge and baseflow of parts GRU4 are calibrated against flows at T5H004 and T5H003 at the outlets of T51B and T51D, hence can be considered of high confidence. The remainder of GRU4 and GRU5 are only calibrated further downstream at T5H007 at the outlet of T52C, hence are of only moderate confidence.

The Harvest Potential for GRU4 and GRU5 is greater than the aquifer recharge, hence the abstractable volume is assumed to be 65% of aquifer recharge.

3.2.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
4	*T51A-B T51D-G*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 9.58 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l.*
5	*T51C T51H-J*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 10.28 Mm^3/a evenly distributed in both time and space.*

3.3 IUA T5-2 MIDDLE UMZIMKULU AND MZIMKULWANA TRIBUTARY

3.3.1 Hydrogeology

This area is underlain By GRUs 6 and 7, catchments T52A-H.

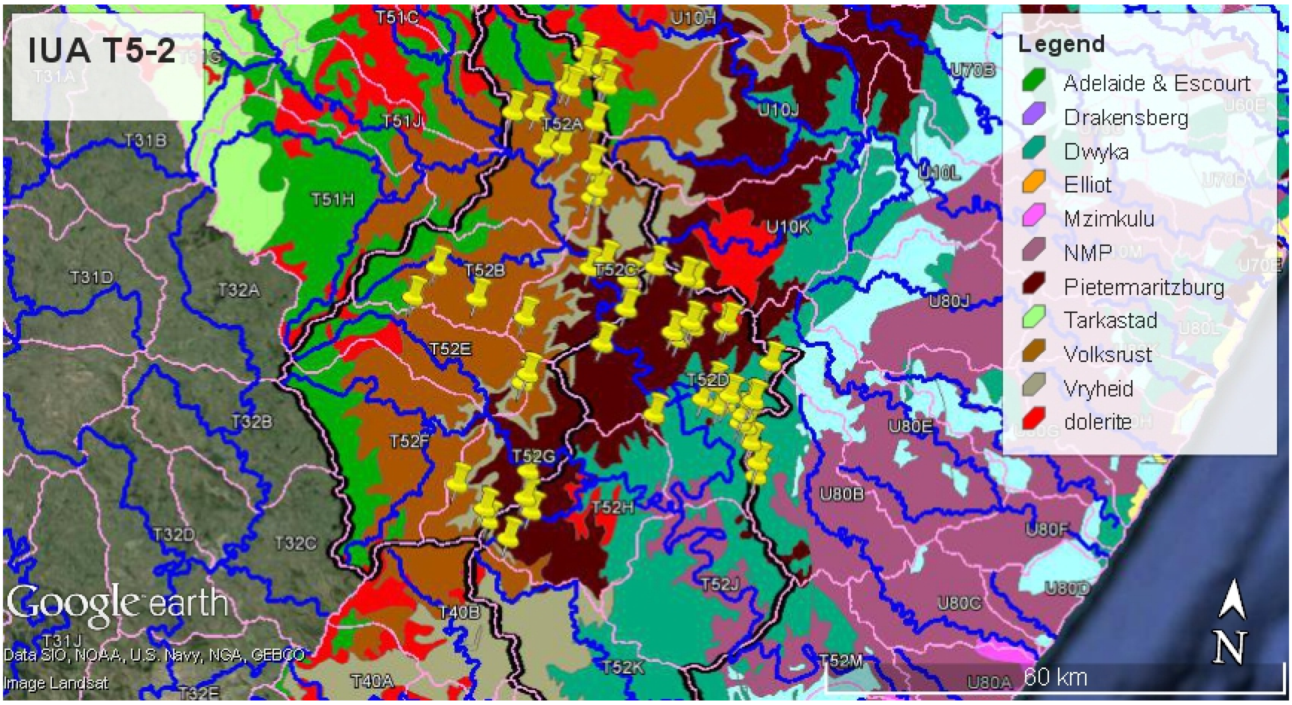

Figure 3-3 Geological map of IUA T5-2 showing location of chemistry data sampling points

GRU6 is middle Umzimkulu and underlain by Middelveld Karoo geology (T52A-C, T52E-G). This region consists of predominantly of arenaceous rocks of the Vryheid Formation, argillaceous rocks of the Volksrust and Pietermaritzburg Formations. The Vryheid Formation forms an escarpment within this region. The median yield in the Vryheid Formation is slightly higher, 1.2 l/s compared to 0.9 l/s in the rest of the region. Fractures within the mudstones and shales tend to close once they are dewatered due to the ductility of the rock, making them prone to over exploitation. Fractures also tend to close up due to the oxidation of iron pyrite.

GRU7 (T52D and H) is also the middle Umzimkulu but the lower half of the catchments are underlain by tillites of the Dwyka Group. The median yield is only 0.15 l/s and at least 40% of boreholes are dry, consequently, this is the poorest aquifer in the study area.

3.3.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer in GRU6 (aquifer recharge) is only 13-17%, with the remainder generating baseflow via interflow. In GRU7 20-25% of recharge reaches the regional aquifer.(Table 3.7)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-7 Groundwater use and resources in IUA T5-2

	T52A	T52B	T52C	T52D	T52E	T52F	T52G	T52H
Recharge (Mm^3/a)	*35.16*	*21.81*	*18.46*	*24.39*	*21.74*	*37.72*	*18.74*	*17.69*
Aquifer recharge (Mm^3/a)	*4.85*	*3.01*	*3.08*	*4.88*	*3*	*5.21*	*2.68*	*4.08*
Harvest Potential (Mm^3/a)	*5.2*	*3.48*	*3.55*	*7.71*	*3.17*	*5.68*	*3.01*	*5.05*

	T52A	T52B	T52C	T52D	T52E	T52F	T52G	T52H
Total Use (Mm³/a)	*0.004*	*0.005*	*0.069*	*0.159*	*0.012*	*0.04*	*0.015*	*0.03*
Stress Index	*0.001*	*0.002*	*0.022*	*0.033*	*0.004*	*0.008*	*0.006*	*0.007*
Status	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*
Present Class	*I*	*I*	*I*	*I*	*I*	*I*	*I*	*I*

3.3.3 Borehole yields and quality

Borehole yields in the IUA are moderate.

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality, however some cases of elevated fluorides exist in T52A, C and D. (Table 3.8)

Table 3-8 Borehole yields and quality in IUA T5-2

		T52A	T52B	T52C	T52D	T52E	T52F	T52G	T52H
Average borehole yield (l/s)		*0.95*	*1*	*3.01*	*0.72*	*1*	*1*	*1*	*0.88*
Present Class		II	I	II	I	I		I	I
TDS quality class	*0*	*13*	*2*	*4*	*23*	*4*		*3*	*4*
	1	*1*		*1*	*2*				*1*
	2			*1*	*1*				
	3								
	4								
Nitrate quality class	*0*	*13*	*2*	*6*	*25*	*4*		*3*	*5*
	1	*1*			*1*				
	2								
	3								
	4								
Fluoride quality class	*0*	*10*	*2*	*5*	*24*	*4*		*3*	*5*
	1	*2*							
	2				*1*				
	3	*2*							
	4			*1*	*1*				
	Maximum (mg/l)			*3.8*	*4.15*				

3.3.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 12-15% of baseflow is from the regional aquifer, the remainder originating as interflow.(Table 3.9)

Significant baseflow reduction occurs in all Quaternaries due to afforestation and AIPs. Consequently, the PES is lower than the target EC in T52A, T52D and E.

Table 3-9 Groundwater contribution to baseflow in IUA T5-2

	T52A	T52B	T52C	T52D	T52E	T52F	T52G	T52H
Baseflow (Mm³/a)	*34.79*	*21.69*	*18.16*	*24.05*	*21.61*	*37.59*	*18.72*	*16.13*
Groundwater baseflow Component (Mm³/a)	*4.48*	*2.89*	*2.78*	*4.54*	*2.87*	*5.08*	*2.66*	*2.52*

	T52A	T52B	T52C	T52D	T52E	T52F	T52G	T52H
Interflow component (Mm^3/a)	*30.31*	*18.8*	*15.38*	*19.51*	*18.74*	*32.51*	*16.06*	*13.61*
Total Use (Mm^3/a)	*0.004*	*0.005*	*0.069*	*0.159*	*0.012*	*0.040*	*0.015*	*0.030*
Simulated groundwater baseflow Under current abstraction (Mm^3/a)	*4.48*	*2.89*	*2.77*	*4.49*	*2.87*	*5.08*	*2.66*	*2.52*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*25.05*	*19.26*	*12.09*	*17.94*	*15.24*	*24.95*	*15.51*	*14.88*
Baseflow reduction (%)	*28.0*	*11.2*	*33.4*	*25.4*	*29.5*	*33.6*	*17.1*	*7.7*
EWR Low flow (Mm^3/a)	*10.65 (T51)*		*5.69*	*131.7 (T51) (T52A-D)*	*5.84*	*25.69*	*72.75 (T52E-G)*	*3.5 (T52E-H)*
Target EC	*B*	*B*	*C*	*B*	*B*	*C*	*B/C*	*B/C*
PES	*C*	*B*	*C*	*B/C*	*B/C*	*C*	*B/C*	*B/C*

3.3.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal, however, the moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is generally less than 13-15% in GRU6 and 16-19% in GRU7, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities have reduced baseflow by 25-35% in T52A, C, D-F.

The IUA is of moderate aquifer vulnerability. The land use activities in the IUA include extensive forestry concentrated in the upper higher rainfall areas, irrigation in the upper reaches, cultivation, cattle farming and subsistence farming. Due to the rural setting, no regional threats to groundwater quality exist.

The results for recharge and baseflow for GRU6 are calibrated against flows at T5H007 and T5H002 at the outlets of T52C and T52G, hence can be considered of high confidence. GRU7 has no gauging stations downstream, and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential for GRU6 and GRU7 is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.3.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
6	*T52A-C T52E-G*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 14.19 Mm^3/a evenly distributed in both time and space.* *Low flows at T5H002 should be*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
						maintained at a minimum of 72.75 Mm³/a *Low flows at T5H007 should be maintained at a minimum of 131.7 Mm³/a* *Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
7	*T52D T52H*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual licence conditions within the confirmed Harvest Potential*	*Due to the impacts of afforestation and AIPs, monitoring of baseflow is required in T52D.* *Due to the low groundwater use, monitoring not required in T52H.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 5.82 Mm³/a evenly distributed in both time and space.* *Since no gauging weirs are located downstream of this GRU no numerical RQOs have been set* *Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*

3.4 IUA T5-3 UMZIMKULU

3.4.1 Hydrogeology

This area is underlain By GRUs 7, 8 and 9, catchments T52J-M.

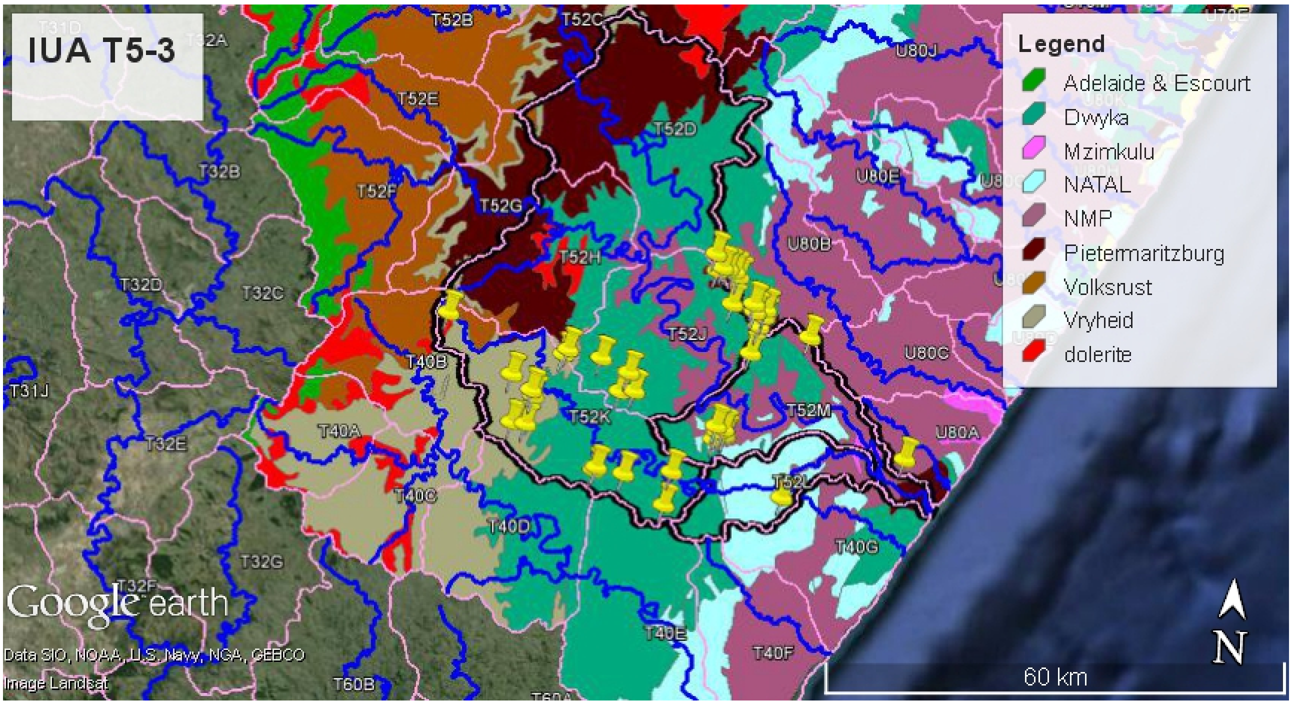

Figure 3-4 Geological map of IUA T5-3 showing location of chemistry data sampling points

GRU7 (T52J and K) is the middle Umzimkulu and underlain by Dwyka tillites. The median yield is only 0.15 l/s and at least 40% of boreholes are dry, consequently, this is the poorest aquifer in the study area

GRU8 (T52L) is the lower Umzimkulu and underlain by Natal Group sandstones. Fault zones are of high importance for establishing high yielding boreholes.

GRU9 (T52M) is also the lower Umzimkulu but underlain by the Natal Metamorphic Province. This aquifer is crystalline and consists of fractured overlain by a saturated clayey weathered zone.

3.4.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 17-23%, with the remainder generating baseflow via interflow. (Table 3.10)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-10 Groundwater use and resources in IUA T5-3

	T52J	T52K	T52L	T52M
Recharge (Mm^3/a)	*18.64*	*23.47*	*9.98*	*22.97*
Aquifer recharge (Mm^3/a)	*3.10*	*5.42*	*2.09*	*4.79*
Harvest Potential (Mm^3/a)	*7.80*	*5.79*	*13.41*	*12.29*
Total Use (Mm^3/a)	*0.029*	*0.302*	*0.010*	*0.483*
Stress Index	*0.009*	*0.056*	*0.005*	*0.101*
Status	*A-Unmodified*	*B- Largely Natural*	*A-Unmodified*	*B- Largely Natural*
Present Class	*I*	*I*	*I*	*I*

3.4.3 Borehole yields and quality

Borehole yields in the IUA are moderate.

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality. Higher salinity of Class 2 and 3 exists in the coastal region of T52M, as well as elevated fluorides in the Natal Metamorphic Province. (Table 3.11)

Table 3-11 Borehole yields and quality in IUA T5-3

		T52J	T52K	T52L	T52M
Average borehole yield (l/s)		*0.04*	*0.9*	*0.77*	*0.44*
Present Class		I	II	I	II
TDS quality class	*0*	*12*	*12*	*1*	*5*
	1	*1*	*2*		*2*
	2				*3*
	3				*1*
	4				
	Maximum (mg/l)				*5109*
Nitrate quality class	*0*	*12*	*12*	*1*	*10*
	1	*1*	*2*		*1*
	2				
	3				
	4				
Fluoride quality class	*0*	*13*	*10*	*1*	*6*
	1		*2*		*2*
	2				*2*
	3		*2*		*1*
	4				
	Maximum (mg/l)		*2.2*		*1.6*

3.4.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 11-20% of baseflow is from the regional aquifer, the remainder originating as interflow. (Table 3.12)

Significant baseflow reduction occurs in T52K and L, however, this catchment is not a significant source of baseflow in the Umzimkulu.

Table 3-12 Groundwater contribution to baseflow in IUA T5-3

	T52J	T52K	T52L	T52M
Baseflow (Mm^3/a)	*17.47*	*22.54*	*9.33*	*21.87*
Groundwater baseflow Component (Mm^3/a)	*1.93*	*4.49*	*1.44*	*3.69*
Interflow component (Mm^3/a)	*15.54*	*18.05*	*7.89*	*18.18*
Total Use (Mm^3/a)	*0.029*	*0.302*	*0.010*	*0.483*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*1.93*	*4.49*	*1.44*	*3.55*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*15.82*	*13.28*	*5.16*	*19.07*
Baseflow reduction (%)	*9.4*	*41.1*	*44.7*	*12.8*
EWR Low flow (Mm^3/a)	*8.47*	*2.47*	*6.65*	*308.93*

	T52J	T52K	T52L	T52M
	(T51 T52A-J)		*(T52K-L)*	*(T51 T52)*
Target EC		*B/C*	*B*	
PES		*B/C*	*B*	

3.4.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low borehole yields imply that over abstraction on a regional scale is unlikely.

The Groundwater component of baseflow is 11-20% in GRU7, 15% in GRU8, and 17% in GRU9, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities have reduced baseflow by more than 40% in T52K and T52L.

GRU 7 and 8 are of high aquifer vulnerability and GRU9 of moderate aquifer vulnerability. The land use activities include extensive forestry and sugar cane, Oribi Gorge Nature Reserve, natural areas with grazing, and run of river abstraction or regional water supply to rural villages. The town of Harding is also located in the IUA. Industrial activities include limestone mining and the Illovo Umzimkulu sugar mill in the lower reach. Due to the rural setting, no regional threats to groundwater quality exist, however, activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.

The results for recharge and baseflow for T52K and L are calibrated against flows at T5H012 and T5H006 at the outlets of T52K and the centre of T52L, hence can be considered of high confidence. T52J and T52M, on the main stem of the Mzimkhulu have no gauging stations downstream, and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential for the IUA is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.4.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
7	*T52J-K*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to baseflow reduction, monitoring of baseflow is required in T52K.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes* *The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply*	*The sustainable volume of groundwater abstraction is 5.53 Mm^3/a evenly distributed in both time and space.* *Low flows at T5H012 should be maintained at a minimum of 2.47 Mm^3/a.* *Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
					boreholes.	
8	*T52L*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the confirmed Harvest Potential*	*Due to the impacts of afforestation, sugar cane and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 1.36 Mm^3/a evenly distributed in both time and space. Since no gauging weirs are located downstream of this GRU no numerical RQOs have been set to monitor baseflow.*
9	*T52M*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride and salinity levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 3.11 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*

3.5 IUA U1-1 MKOMAZI MOUNTAIN ZONE

3.5.1 Hydrogeology

This area is underlain By GRUs 10 and 11, catchments U10A-F.

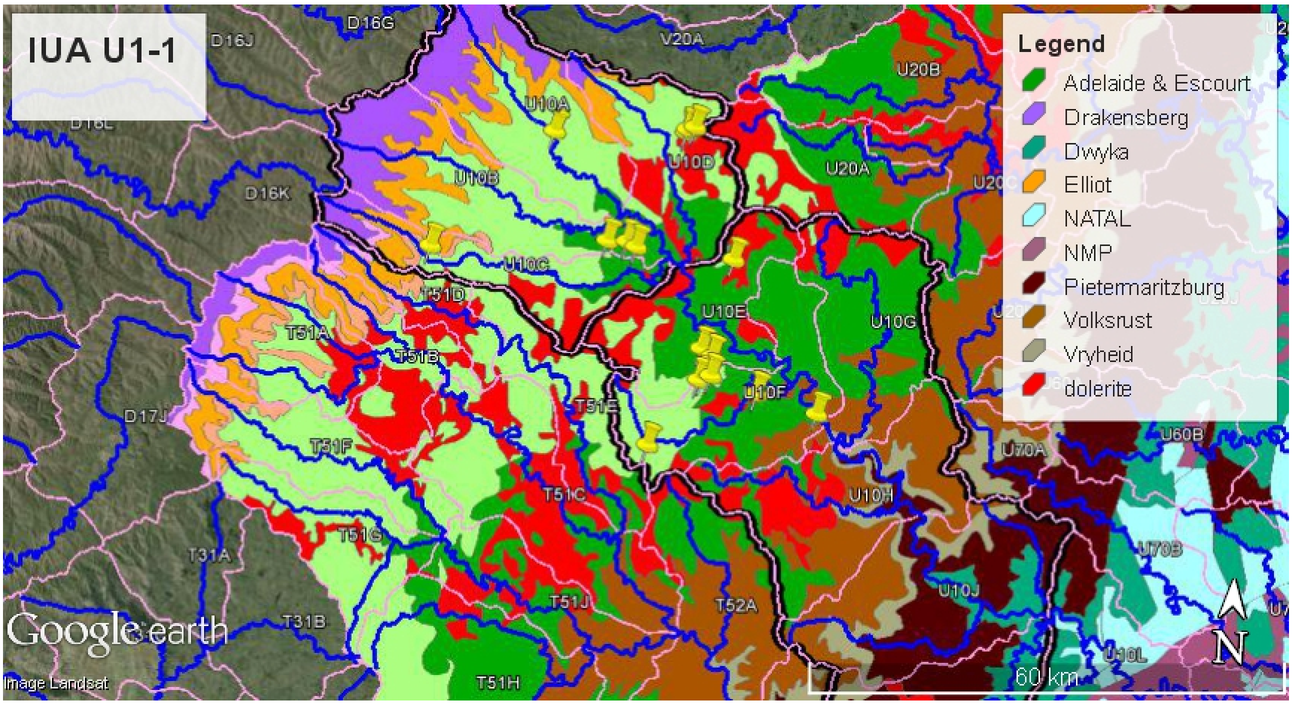

Figure 3-5 Geological map of IUA U1-1 showing location of chemistry data sampling points

GRU 10 is the Mkomazi escarpment zone and underlain by the Drakensberg Escarpment (U10A-D). This region consists of predominantly argillaceous rocks of the Tarkastad Subgroup, and the Molteno and Elliot Formations of the Karoo SuperGroup, capped by Clarens sandstones and Drakensberg Basalt. The basal sandstones of the Tarkastad Subgroup often form an escarpment of higher elevation than the underlying Adelaide Subgroup. On the high lying Drakensberg Escarpment, springs are common, especially along the Clarens/Drakensberg contact.

GRU11 is the Mkomazi middelveld and underlain by rocks of the Middelveld Karoo (U10E-F). This region consists of predominantly argillaceous rocks of the Adelaide Subgroup, and arenaceous rocks of the Tarkastad Formation. It lies at a lower elevation than the Drakensberg Escarpment region.

3.5.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer in GRU10 (aquifer recharge) is only 6-8%, with the remainder generating baseflow via interflow. In GRU11 8-13% of recharge reaches the regional aquifer. (Table 3.13)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries

Table 3-13 Groundwater use and resources in IUA U1-1

	U10A	U10B	U10C	U10D	U10E	U10F
Recharge (Mm^3/a)	*64.48*	*57.06*	*38.15*	*36.69*	*37.16*	*35.89*
Aquifer recharge (Mm^3/a)	*4.44*	*3.90*	*3.15*	*3.16*	*3.11*	*4.64*
Harvest Potential (Mm^3/a)	*7.12*	*6.78*	*4.44*	*5.50*	*4.83*	*5.51*
Total Use (Mm^3/a)	*0.003*	*0.182*	*0.003*	*0.191*	*0.008*	*0.730*
Stress Index	*0.001*	*0.047*	*0.001*	*0.061*	*0.003*	*0.158*
Status	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*	*B- Largely Natural*	*A-Unmodified*	*B- Largely Natural*
Present Class	*I*	*I*	*I*	*I*	*I*	*I*

3.5.3 Borehole yields and quality

Borehole yields in the IUA are very low in GRU10 to low in GRU 11.

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality. (Table 3.14)

Table 3-14 Borehole yields and quality in IUA U1-1

		U10A	U10B	U10C	U10D	U10E	U10F
Average borehole yield (l/s)		*0.03*	*0.05*	*0.06*	*0.08*	*0.22*	*0.23*
Present Class		I		I	I	I	
TDS quality class	*0*	*1*		*4*	*3*	*3*	*6*
	1						

	2						
	3						
	4						
Nitrate quality class	*0*	*1*		*4*	*3*	*3*	*4*
	1						*2*
	2						
	3						
	4						
Fluoride quality class	*0*	*1*		*4*	*3*	*3*	*6*
	1						
	2						
	3						
	4						

3.5.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Less than 5% of baseflow is from the regional aquifer, the remainder originating as interflow. Some baseflow reduction occurs due to afforestation and AIP, however, the PES is not below the target EC. (Table 3.15)

Table 3-15 Groundwater contribution to baseflow in IUA U1-1

	U10A	U10B	U10C	U10D	U10E	U10F
Baseflow (Mm^3/a)	*61.75*	*54.14*	*35.88*	*34.38*	*35.41*	*33.11*
Groundwater baseflow Component (Mm^3/a)	*1.71*	*0.98*	*0.88*	*0.85*	*1.36*	*1.86*
Interflow component (Mm^3/a)	*60.04*	*53.16*	*35*	*33.53*	*34.05*	*31.25*
Total Use (Mm^3/a)	*0.003*	*0.182*	*0.003*	*0.191*	*0.008*	*0.730*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*1.71*	*0.98*	*0.88*	*0.85*	*1.36*	*1.84*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*60.86*	*49*	*33.26*	*33.29*	*30.63*	*27.7*
Baseflow reduction (%)	*1.4*	*9.5*	*7.3*	*3.2*	*13.5*	*16.3*
EWR Low flow (Mm^3/a)			*21.67*	*15.96*	*142.5 (U10A-E)*	
Target EC	*B*	*B*	*B*	*B*	*C*	*C*
PES	*B*	*B*	*B*	*B/C*	*C*	*C*

3.5.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low borehole yields imply that over abstraction on a regional scale is unlikely.

The Groundwater component of baseflow is 18-25% in GRU10 and 39-56% in GRU11, hence the potential of groundwater abstraction to impact on baseflow is limited in GRU10, but large scale groundwater abstraction can impact significantly on baseflow in GRU11. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in the IUA are limited in GRU10 but have reduced baseflow by 15% in GRU11.

The IUA is of moderate aquifer vulnerability. The middle to upper reach of the IUA is mainly a mountainous area, where nature reserves (Lotheni, Vergelegen, Kamberg, Highmore Nature Reserves, and Mkomazi National Park) and the Sani Pass Tourism area are located. There is some agriculture and community water use. The main activities in GRU 11 include forestry, *cultivation, irrigation, grazing, and community water use from low density rural settlements. Bulwer Town is located in GRU11. In general there are few impacts or threats to the water resources and the water quality can be regarded as good.*

The results for recharge and baseflow for GRU10 are calibrated against flows at U1H005 at the outlet of U10E, hence can be considered of moderate confidence. GRU11 only has a gauging station much further downstream in U10M, hence mean annual recharge is calibrated against data in the GRA2 database, and hence results are of low confidence.

The Harvest Potential for GRU10 and GRU11 is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.5.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
10	*U10A-D*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, low yields and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 9.52 Mm^3/a evenly distributed in both time and space.*
11	*U10E-F*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the confirmed Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, low yields and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 5.03 Mm^3/a evenly distributed in both time and space.*

3.6 IUA U1-2 MIDDLE MKOMAZI

3.6.1 Hydrogeology

This area is underlain By GRU 11, catchments U10G-K.

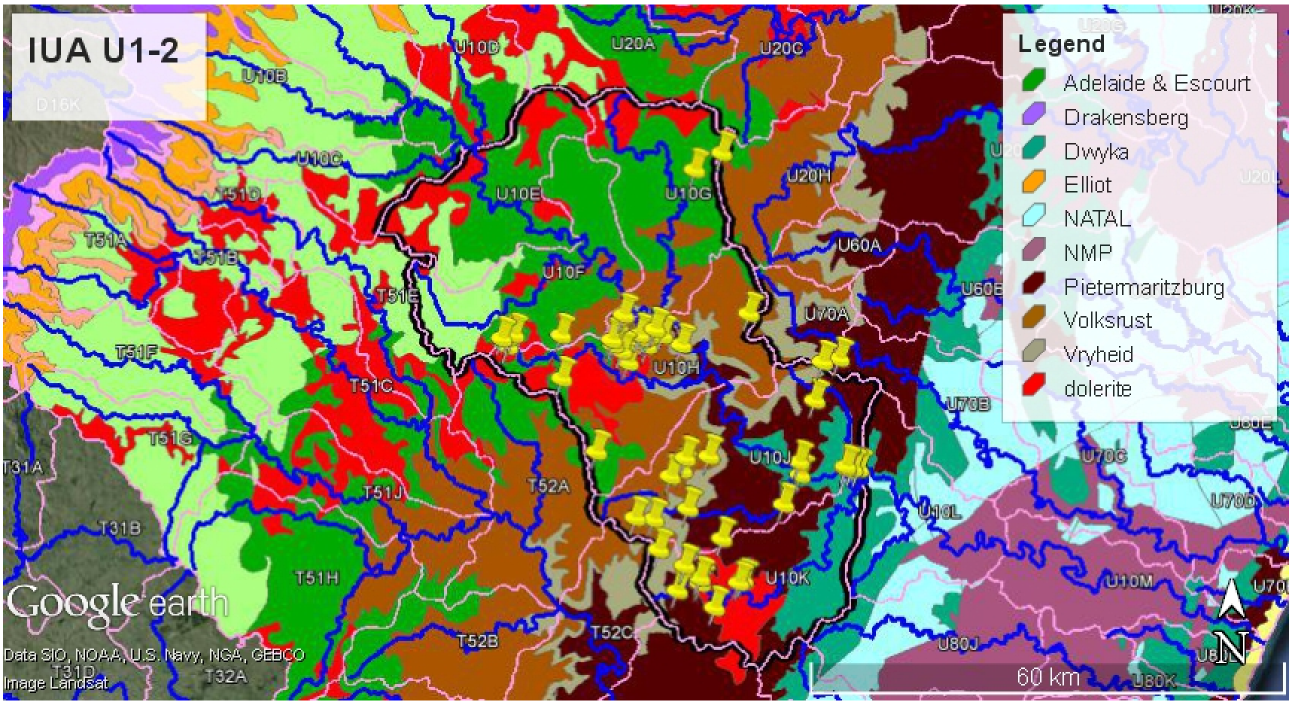

Figure 3-6 Geological map of IUA U1-2 showing location of chemistry data sampling points

GRU11 is the Mkomazi middelveld and underlain by the Middelveld Karoo. This region consists of predominantly argillaceous rocks of the Adelaide Subgroup (U10G), Pietermaritzburg and Volksrust Formations, and arenaceous rocks of the Vryheid Formation (U10H-K), which lies in between the Volksrust and Pietermaritzburg Formations. The Vryheid Formation forms an escarpment within this region. The median yield in the Vryheid Formation is slightly higher, 1.2 l/s compared to 0.9 l/s in the rest of the region. Fractures within the mudstones and shales tend to close once they are dewatered due to the ductility of the rock, making them prone to over exploitation. Fractures also tend to close up due to the oxidation of iron pyrite. Higher yields are associated with dolerite intrusions.

3.6.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 14-23%, with the remainder generating baseflow via interflow. (Table 3.16)

The present status is equal to or of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-16 Groundwater use and resources in IUA U1-2

	U10G	U10H	U10J	U10K
Recharge (Mm^3/a)	*33.37*	*32.96*	*30.33*	*16.34*
Aquifer recharge (Mm^3/a)	*4.60*	*5.24*	*5.95*	*3.77*
Harvest Potential (Mm^3/a)	*4.89*	*6.23*	*6.87*	*4.95*
Total Use (Mm^3/a)	*0.15*	*0.29*	*0.19*	*0.35*
Stress Index	*0.03*	*0.06*	*0.03*	*0.09*
Status	*A-Unmodified*	*B- Largely Natural*	*A-Unmodified*	*B- Largely Natural*
Present Class	*I*	*I*	*I*	*I*

3.6.3 Borehole yields and quality

Borehole yields in the IUA are low to moderate, with high yielding boreholes in U10K.

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality. (Table 3.17)

Table 3-17 Borehole yields and quality in IUA U1-2

		U10G	U10H	U10J	U10K
Average borehole yield (l/s)		*0.22*	*0.33*	*0.1*	*3.76*
Present Class		I	I	I	I
TDS quality class	*0*	*2*	*19*	*14*	*12*
	1		*1*	*1*	
	2				
	3				
	4				
Nitrate quality class	*0*	*2*	*20*	*15*	*12*
	1				
	2				
	3				
	4				
Fluoride quality class	*0*	*2*	*20*	*14*	*11*
	1				*1*
	2				
	3			*1*	
	4				
	Maximum (mg/l)			*2.0*	

3.6.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 7-15% of baseflow is from the regional aquifer, the remainder originating as interflow.

Significant baseflow reduction occurs in this IUA due to afforestation and AIPs and in U10G, H and K. The PES is below the target EC in U10G. (Table 3.18)

Table 3-18 Groundwater contribution to baseflow in IUA U1-2

	U10G	U10H	U10J	U10K
Baseflow (Mm^3/a)	*33.87*	*29.89*	*27.41*	*15.24*
Groundwater baseflow Component (Mm^3/a)	*5.1*	*2.17*	*3.03*	*2.67*
Interflow component (Mm^3/a)	*28.77*	*27.72*	*24.38*	*12.57*
Total Use (Mm^3/a)	*0.15*	*0.29*	*0.19*	*0.35*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*5.1*	*2.16*	*3.03*	*2.58*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*28.18*	*19.76*	*19.41*	*10.3*
Baseflow reduction (%)	*16.8*	*33.9*	*29.2*	*32.4*
EWR Low flow (Mm^3/a)	*14.94*	*187.83 (U10A-H)*	*216.12 (U10A-J)*	
Target EC	*B*	*B*	*C*	*C*
PES	*C*	*B*	*C*	*C*

3.6.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low borehole yields imply that over abstraction on a regional scale is unlikely. In U10K the moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is 7-17%, hence the potential of groundwater abstraction to impact on baseflow is limited in GRU11. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in the IUA have reduced baseflow by 30% or more.

The IUA is of moderate aquifer vulnerability. The land use activities in the IUA include forestry, cultivation, irrigation, some sugar cane, cattle farming, and community water use from low density rural settlements. Ixopo is also located in the IUA. The potential for contamination of groundwater is limited on a regional scale.

The results for recharge and baseflow are not calibrated against flows except at a gauging station much further downstream in U10M. Mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential for GRU11 is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.6.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
11	*U10G-K*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 12.71 Mm^3/a evenly distributed in both time and space. Since no gauging weirs are located downstream of this GRU no numerical RQOs have been set to monitor baseflow.*

3.7 IUA U1-3 MKOMAZI GORGE ZONE AND LOWER MKOMAZI

3.7.1 Hydrogeology

This area is underlain By GRU 12 and 13, catchments U10L-M, which form the lower Mkomazi.

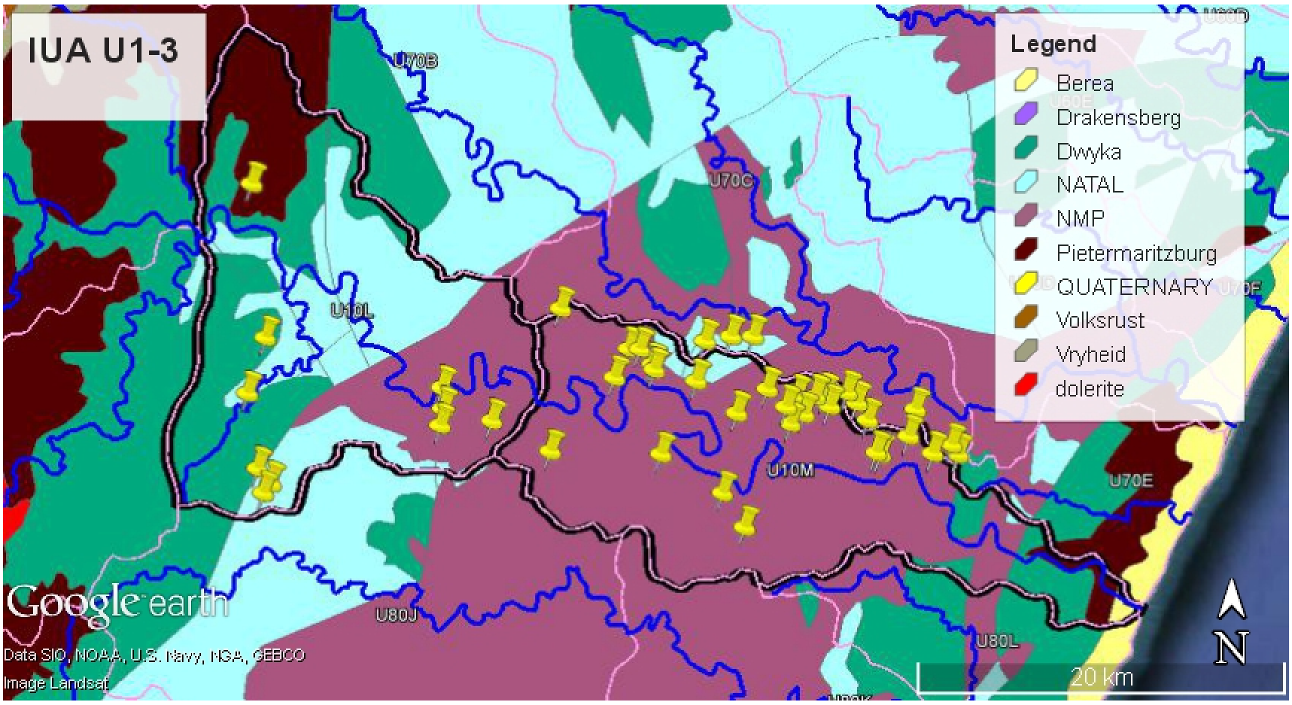

Figure 3-7 Geological map of IUA U1-3 showing location of chemistry data sampling points

GRU11 (U10L) is largely underlain by Dwyka tillites (upper sections), Natal Group Sandstones (middle section) and the Natal Metamorphic Province (lower section). The median yield of the Dwyka tillites is only 0.15 l/s and at least 40% of boreholes are dry. The Natal Group sandstones have well developed jointing and faulting. Fault zones are of high importance for establishing high yielding boreholes and yields are moderate. The Natal Metamorphic Province consists of crystalline basement rocks overlain by a saturated clayey weathered zone. Yields are moderate.

GRU12 consists largely of basement rocks of the Natal Metamorphic Province.

3.7.2 Groundwater use and resources

Groundwater use in this IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 29%, with the remainder generating baseflow via interflow. (Table 3.19)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-19 Groundwater use and resources in IUA U1-3

	U10L	U10M
Recharge (Mm^3/a)	*13.66*	*15.60*
Aquifer recharge (Mm^3/a)	*3.90*	*4.46*
Harvest Potential (Mm^3/a)	*12.41*	*9.70*
Total Use (Mm^3/a)	*0.06*	*0.05*
Stress Index	*0.01*	*0.01*
Status	*A-Unmodified*	*A-Unmodified*
Present Class	*I*	*I*

3.7.3 Borehole yields and quality

Borehole yields in the IUA are low to moderate.

Groundwater can be of DWS Class 2 (Marginal) in U10L due to elevated salts, nitrates and fluoride. U10M has over 40% of boreholes in Class 3-4 due to elevated fluorides. (Table 3.20)

Table 3-20 Borehole yields and quality in IUA U1-3

		U10L	U10M
Average borehole yield (l/s)		0.48	0.12
Present Class		II	III
TDS quality class	0	2	10
	1	6	14
	2	2	7
	3		2
	4		
	Maximum (mg/l)		2808
Nitrate quality class	0	6	28
	1	1	4
	2	3	1
	3		
	4		
Fluoride quality Class	0	8	9
	1		3
	2	2	7
	3		9
	4		5
	Maximum (mg/l)		13.19

3.7.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 22% of baseflow is from the regional aquifer, the remainder originating as interflow. (Table 3.21)

Table 3-21 Groundwater contribution to baseflow in IUA U1-3

	U10L	U10M
Baseflow (Mm^3/a)	12.45	14.34
Groundwater baseflow Component (Mm^3/a)	2.69	3.2
Interflow component (Mm^3/a)	9.76	11.14
Total Use (Mm^3/a)	0.06	0.05
Simulated groundwater baseflow under current abstraction (Mm^3/a)	2.69	3.2
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	11.71	14.2
Baseflow reduction (%)	5.9	1.0
EWR Low flow (Mm^3/a)		228.94 (U10A-M)
Target EC		C
PES		C

3.7.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low borehole yields imply that over abstraction on a regional scale is unlikely.

The Groundwater component of baseflow is 21-22%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in the IUA are limited and have reduced baseflow by less than 6% in U10L and 1% in U10M.

U10L is of high aquifer vulnerability and U10M of moderate vulnerability. The land use activities are predominantly community water use from low density rural settlements and there is also an abstraction for Sappi Saiccor in the lower end of the IUA. The potential exists for on-site sanitation contamination and elevated salinities in U10L and some elevated nitrates and salinities are observed. In U10M water qualities issues are mixed with natural water quality problems in the Natal Metamorphic Province.

The results for recharge and baseflow are calibrated against flows at U1H006 near the outlet of U10M. However, this station integrates the flows of the entire Mkomazi, hence the results for the IUS can only be considered of moderate confidence.

The Harvest Potential for GRU12 and GRU13 is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.7.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
12	*U10L*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, low yields and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluorides levels and/or nitrates. Fluoride and nitrates need to be tested for domestic boreholes The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 2.54 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l and nitrates below 20 mg/l*
13	*U10M*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, low yields and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated salinity, natural fluorides levels and/or nitrates. Fluoride and nitrates need to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 2.90 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l and*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
						nitrates below 20 mg/l

3.8 IUA U2-1 MGENI: UPSTREAM OF MIDMAR DAM

3.8.1 Hydrogeology

This area is underlain By GRU 14, catchments U20A-C, which is the Mgeni to Midmar dam.

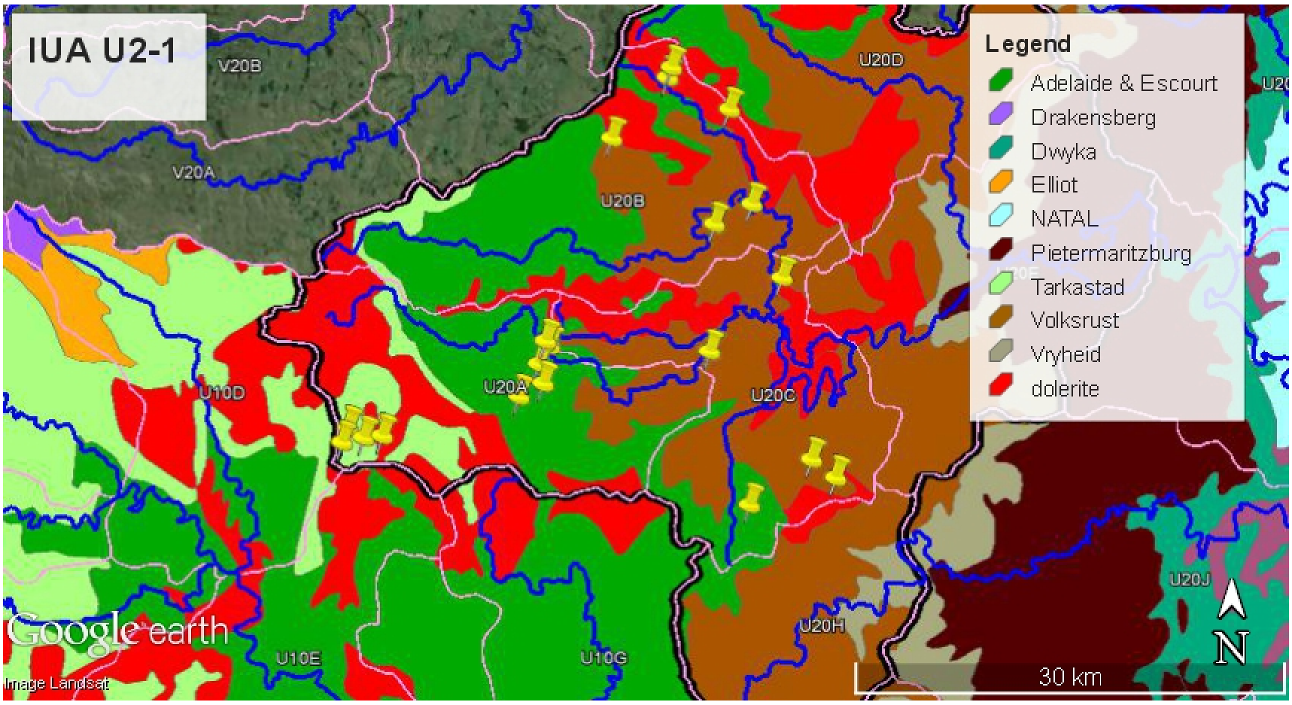

Figure 3-8 Geological map of IUA U2-1 showing location of chemistry data sampling points

GRU14 is the Middelveld Karoo. This region consists of predominantly argillaceous rocks of the Adelaide Subgroup and Volksrust Formations.

3.8.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 11-17%, with the remainder generating baseflow via interflow. (Table 3.22)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-22 Groundwater use and resources in IUA U2-1

	U20A	U20B	U20C
Recharge (Mm^3/a)	*41.16*	*53.50*	*48.30*
Aquifer recharge (Mm^3/a)	*4.45*	*8.28*	*7.99*
Harvest Potential (Mm^3/a)	*4.44*	*4.83*	*3.79*
Total Use (Mm^3/a)	*0.01*	*0.47*	*0.04*
Stress Index	*0.002*	*0.056*	*0.004*

	U20A	U20B	U20C
Status	*A-Unmodified*	*B- Largely Natural*	*A-Unmodified*
Present Class	*I*	*I*	*I*

3.8.3 Borehole yields and quality

Borehole yields in the IUA moderate to high.

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality. (Table 3.23)

Table 3-23 Borehole yields and quality in IUA U2-1

		U20A	U20B	U20C
Average borehole yield (l/s)		*0.9*	*3.44*	*3.08*
Present Class		I	I	I
TDS quality class	*0*	*9*	*7*	*6*
	1			
	2			
	3			
	4			
Nitrate quality class	*0*	*9*	*6*	*6*
	1			
	2			
	3		*1*	
	4			
Fluoride quality class	*0*	*8*	*7*	*6*
	1	*1*		
	2			
	3			
	4			

3.8.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 3-9% of baseflow is from the regional aquifer, the remainder originating as interflow. (Table 3.24)

Significant baseflow reduction occurs in this IUA due to afforestation and AIPs and PES is at or below the target EC.

Table 3-24 Groundwater contribution to baseflow in IUA U2-1

	U20A	U20B	U20C
Baseflow (Mm^3/a)	*37.75*	*49.59*	*43.38*
Groundwater baseflow Component (Mm^3/a)	*1.04*	*4.37*	*3.07*
Interflow component (Mm^3/a)	*36.71*	*45.22*	*40.31*
Total Use (Mm^3/a)	*0.01*	*0.47*	*0.04*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*1.04*	*4.35*	*3.07*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*31.05*	*42.2*	*36.83*
Baseflow reduction (%)	*17.7*	*14.9*	*15.1*
EWR Low flow (Mm^3/a)	*17.47*	*28.0*	*7.60*
Target EC	*C/D*	*B*	*B*
PES	*C/D*	*C*	*B/C*

3.8.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is only 3-9%, hence the potential of groundwater abstraction to impact on baseflow is limited to very low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in the IUA have reduced baseflow by 15-18%.

The IUA is of moderate aquifer vulnerability. The main land use activities in the IUA include forestry, cultivation and irrigation. The Mpophomeni semi-urban is located in the IUA, almost adjacent to the Midmar Dam. No groundwater quality issues exist in the IUA.

The results for recharge and baseflow are calibrated against flows at U2H013 for U20A, U2H007 for U20B, and at U2R001 for U20C, hence the results can be considered of very high confidence.

The Harvest Potential was assumed to be the sustainable groundwater abstraction volume.

3.8.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
14	*U20A-C*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 13.06 Mm3/a evenly distributed in both time and space.*

3.9 IUA U2-2 MGENI: MIDMAR DAM TO ALBERT FALLS DAM

3.9.1 Hydrogeology

This area is underlain By GRU 14, catchments U20D-E, which is the Mgeni from Midmar to Albert Falls.

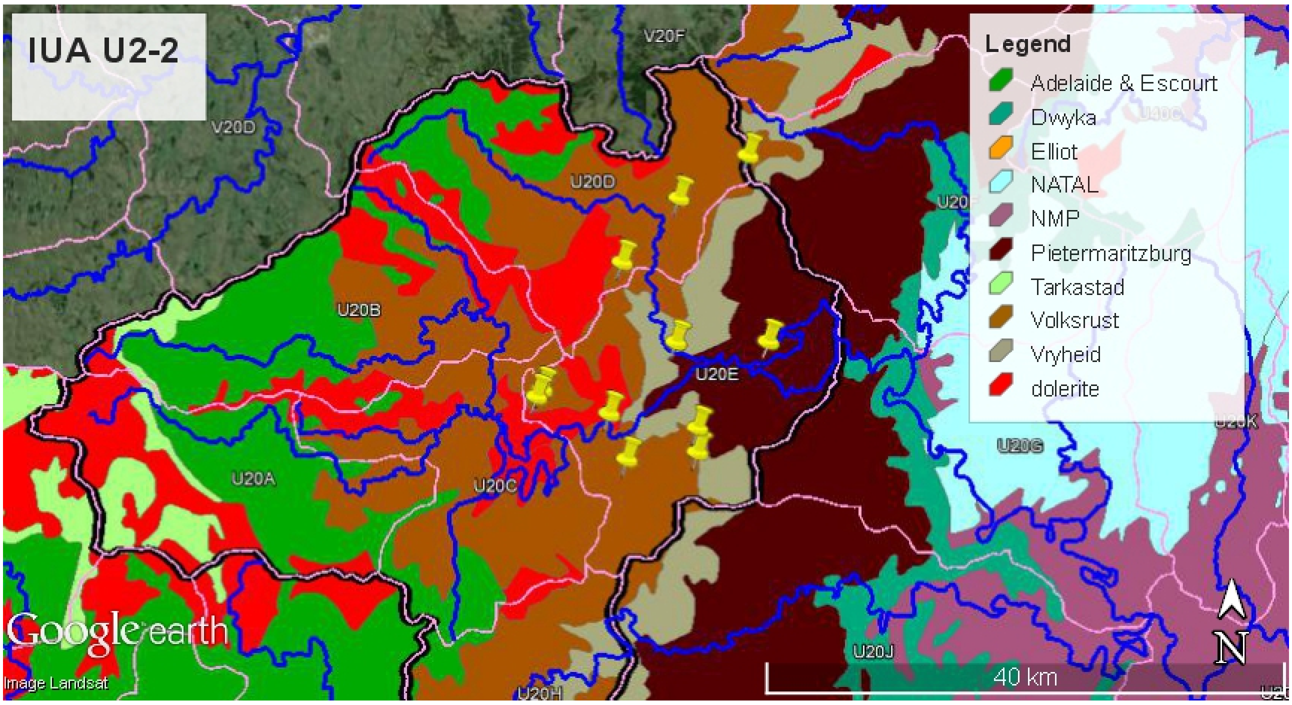

Figure 3-9 Geological map of IUA U2-2 showing location of chemistry data sampling points

GRU14 is the Middelveld Karoo. This region consists of predominantly argillaceous rocks of the Adelaide Subgroup (U20D), Pietermaritzburg (U20E) and Volksrust Formations, and arenaceous rocks of the Vryheid Formation (U20E), which lies in between the Volksrust and Pietermaritzburg Formations. U20D consists of the Adelaide and Volksrust Formations, while U20E is underlain by the Volksrust, Pietermaritzburg and Vryheid Formations. The Vryheid Formation forms an escarpment within this region. The median yield in the Vryheid Formation is slightly higher, 1.2 l/s compared to 0.9 l/s in the rest of the region. Fractures within the mudstones and shales tend to close once they are dewatered due to the ductility of the rock, making them prone to over exploitation. Fractures also tend to close up due to the oxidation of iron pyrite.

3.9.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 11-26%, with the remainder generating baseflow via interflow. (Table 3.25)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-25 Groundwater use and resources in IUA U2-2

	U20D	**U20E**
Recharge (Mm^3/a)	*54.99*	*30.55*
Aquifer recharge (Mm^3/a)	*5.99*	*7.89*
Harvest Potential (Mm^3/a)	*4.60*	*5.30*
Total Use (Mm^3/a)	*0.14*	*0.52*
Stress Index	*0.023*	*0.065*
Status	*A-Unmodified*	*B- Largely Natural*
Present Class	*I*	*I*

3.9.3 Borehole yields and quality

Borehole yields in the IUA moderate to high.

Groundwater is generally of DWS Class 0, or Ideal water quality. (Table 3.26)

Table 3-26 Borehole yields and quality in IUA U2-2

		U20D	U20E
Average borehole yield (l/s)		*2.76*	*0.79*
Present Class			
TDS quality class	*0*	*3*	*8*
	1		
	2		
	3		
	4		
Nitrate quality class	*0*	*3*	*8*
	1		
	2		
	3		
	4		
Fluoride quality class	*0*	*3*	*8*
	1		
	2		
	3		
	4		

3.9.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 4-15% of baseflow is from the regional aquifer, the remainder originating as interflow.

Significant baseflow reduction occurs in this IUA due to afforestation and AIPs. The PES as at or below the target EC so no further reduction in low flows should be accepted.(Table 3.27)

Table 3-27 Groundwater contribution to baseflow in IUA U2-2

	U20D	U20E
Baseflow (Mm^3/a)	*50.85*	*26.52*
Groundwater baseflow Component (Mm^3/a)	*1.85*	*3.86*
Interflow component (Mm^3/a)	*49*	*22.66*
Total Use (Mm^3/a)	*0.14*	*0.52*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*1.85*	*3.84*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*39.58*	*19.08*
Baseflow reduction (%)	*22.2*	*28.1*
EWR Low flow (Mm^3/a)		*69.53 (U20A-E)*
Target EC	*B*	*B/C*
PES	*B/C*	*B/C*

3.9.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is only 4-15%, hence the potential of groundwater abstraction to impact on baseflow is limited to very low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in the IUA have reduced baseflow by 22-28%.

The IUA is of moderate aquifer vulnerability. Howick town and industrial area are located in the IUA, just downstream of Midmar Dam. The main land use activities in the IUA include extensive forestry, cultivation (sugar cane and other cash crops) and irrigation. No groundwater quality issues exist in the IUA.

The results for recharge and baseflow are calibrated against flows at U2H006 for U20D, and at U2R003 for U20E, hence the results can be considered of very high confidence.

The Harvest Potential was assumed to be the sustainable groundwater abstraction volume.

3.9.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
14	*U20D-E*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, sugar cane and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 9.90 Mm^3/a evenly distributed in both time and space. Low flows at U2R003 should be maintained at a minimum of 69.53 Mm^3/a*

3.10 IUA U2-3 MGENI DOWNSTREAM OF ALBERT FALLS TO MSUNDUZE

3.10.1 Hydrogeology

This area is underlain By GRU 15, catchments U20F-G, which is the middle Mgeni from Albert Falls to the confluence with the Msunduze.

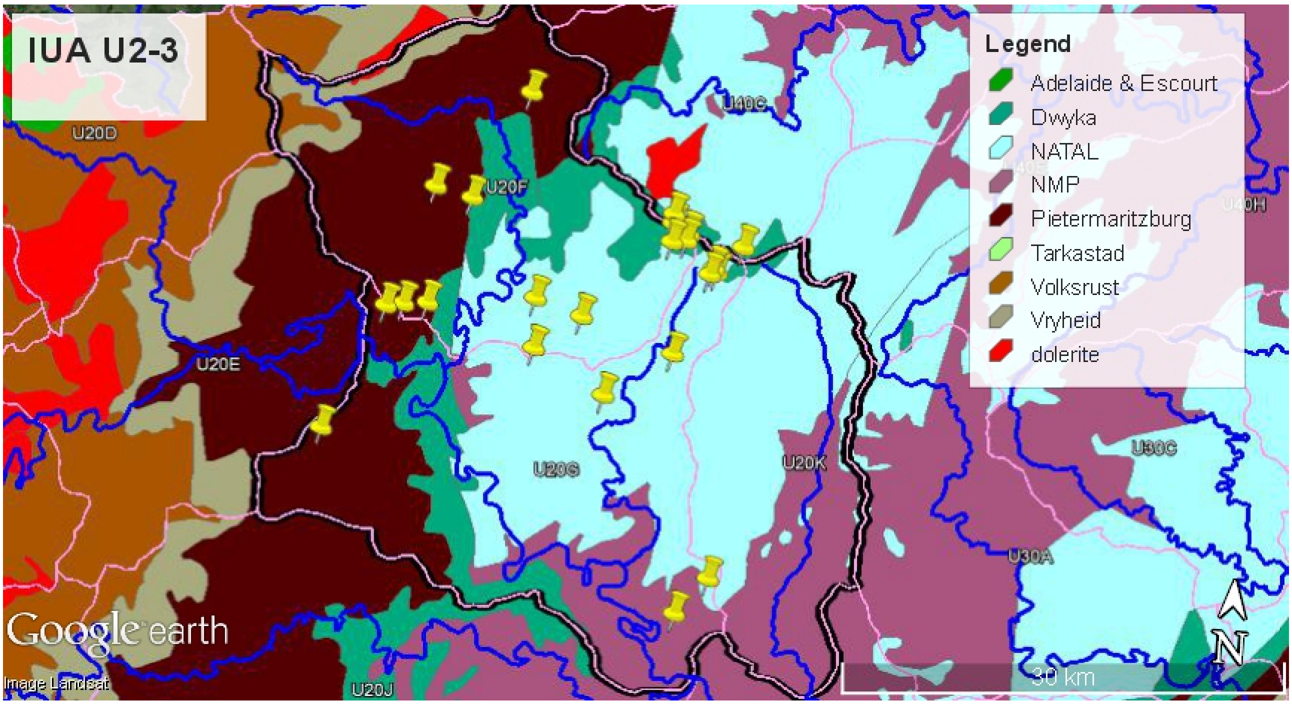

Figure 3-10 Geological map of IUA U2-3 showing location of chemistry data sampling points

The IUA is underlain by arenaceous rocks of the Vryheid Formation in the upper reaches of U20F, and by argillaceous rocks of the Pietermaritzburg shales in the upper reaches of U20F and G. The lower half of the IUA is underlain by fractured aquifers of the Natal Group sandstones. Fault zones are of high importance for establishing high yielding boreholes. The median yield is 0.5 l/s and 80-90% of boreholes are successful. The Natal Group forms elevated plateaux and sheer cliffs and deep incised ravines. Many of the outcrops are fault bounded. Springs often occur at the contact between the Natal Group and the underlying Natal Metamorphic Province, which outcrops in the lower reach of the Mgeni in U20G.

3.10.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 25%, with the remainder generating baseflow via interflow. (Table 3.28)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-28 Groundwater use ad resources in IUA U2-3

	U20F	U20G
Recharge (Mm^3/a)	*51.36*	*34.06*
Aquifer recharge (Mm^3/a)	*12.74*	*8.50*
Harvest Potential (Mm^3/a)	*16.43*	*27.35*
Total Use (Mm^3/a)	*0.25*	*0.28*
Stress Index	*0.019*	*0.033*
Status	*A-Unmodified*	*A-Unmodified*
Present Class	*I*	*I*

3.10.3 Borehole yields and quality

Borehole yields in the IUA are moderate to high.

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality. (Table 3.29)

Table 3-29 Borehole yields and quality in IUA U2-3

		U20F	U20G
Average borehole yield (l/s)		*2.49*	*3.88*
Present Class		*I*	*I*
TDS quality class	*0*	*10*	*12*
	1		*1*
	2		
	3		
	4		
Nitrate quality class	*0*	*7*	*13*
	1	*2*	
	2		
	3	*1*	
	4		
Fluoride quality class	*0*	*8*	*13*
	1	*1*	
	2		
	3	*1*	
	4		
	Maximum (mg/l)	*1.9*	

3.10.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 10-17% of baseflow is from the regional aquifer, the remainder originating as interflow.

Significant baseflow reduction occurs in U20F. The PES is at the target EC so no further baseflow reductions should be accepted. (Table 3.30)

Table 3-30 Groundwater contribution to baseflow in IUA U2-3

	U20F	U20G
Baseflow (Mm^3/a)	*42.98*	*30.83*
Groundwater baseflow Component (Mm^3/a)	*4.36*	*5.27*
Interflow component (Mm^3/a)	*38.62*	*25.56*
Total Use (Mm^3/a)	*0.25*	*0.28*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*4.35*	*5.24*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*26.02*	*27.74*
Baseflow reduction (%)	*39.5*	*10.0*
EWR Low flow (Mm^3/a)		
Target EC	*B/C*	*B/C*
PES	*B/C*	*B/C*

3.10.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is only 5-9%, hence the potential of groundwater abstraction to impact on baseflow is limited to very low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in U20F have reduced baseflow by 39%.

U20F is of moderate aquifer vulnerability and U20G of high vulnerability. Small towns such as New Hannover and Wartburg as well as other scattered rural and informal settlements are located in the IUA. The main land use activities in the IUA include extensive forestry and dry land sugar cane. There is little threat for regional contamination and groundwater quality is ideal to good.

The results for recharge and baseflow are calibrated against flows at U2H012 for U20F, and at U2H005 for U20G, hence the results can be considered of very high confidence.

The Harvest Potential is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.10.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
15	*U20F-G*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 13.80 Mm^3/a evenly distributed in both time and space. Low flows at U2H012 should be monitored but an EWR has not been set.*

3.11 IUA U2-4 MSUNDUZE

3.11.1 Hydrogeology

This area is underlain by a part GRU 14 (U20H) and GRU16 U20J), which is the catchment of the Msunduze.

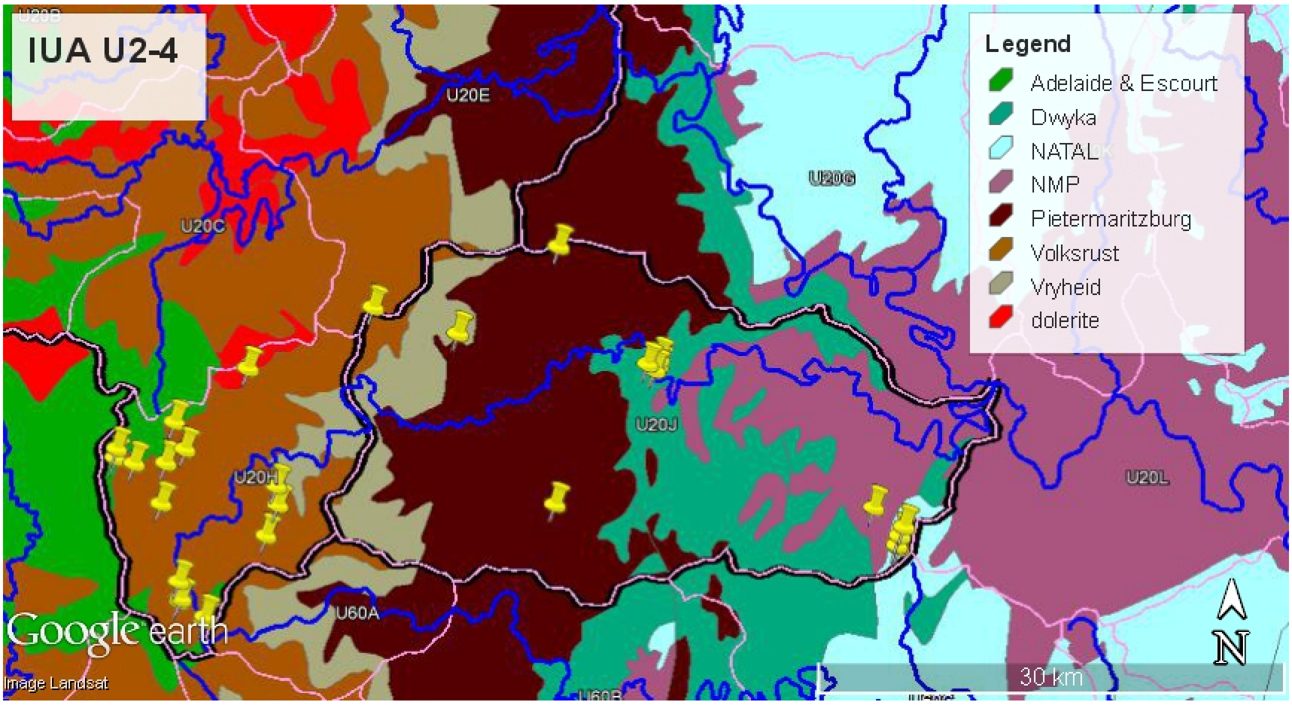

Figure 3-11 Geological map of IUA U2-4 showing location of chemistry data sampling points

U20H is underlain by arenaceous rocks of the Vryheid Formation and by argillaceous rocks of the Adelaide subgroup and Volksrust Formation. U20J is underlain by Vryheid sandstones and Pietermaritzburg shales in the upper reaches, while the lower half is underlain by Dwyka tillites and the Natal Metamorphic Province.

3.11.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 15-20%, with the remainder generating baseflow via interflow. (Table 3.31)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-31 Groundwater use and resources in IUA U2-4

	U20H	U20J
Recharge (Mm^3/a)	*27.85*	*39.51*
Aquifer recharge (Mm^3/a)	*4.26*	*7.89*
Harvest Potential (Mm^3/a)	*2.99*	*14.11*
Total Use (Mm^3/a)	*0.03*	*0.06*
Stress Index	*0.007*	*0.008*
Status	*A-Unmodified*	*A-Unmodified*
Present Class	*I*	*I*

3.11.3 Borehole yields and quality

Borehole yields in the IUA are moderate.

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality in U20H, but can be of class 3-4 in U20J due to elevated salts, nitrates and fluoride. (Table 3.32)

Table 3-32 Borehole yields and quality in IUA U2-4

		U20H	U20J
Average borehole yield (l/s)		*0.98*	*1.47*
Present Class		I	III
TDS quality class	*0*	*16*	*9*
	1		*1*
	2		*2*
	3		*1*
	4		*3*
	Maximum (mg/l)		*7776*
Nitrate quality class	*0*	*16*	*13*
	1		
	2		*1*
	3		*1*
	4		*1*
	Maximum (mg/l)		*166*
Fluoride quality class	*0*	*15*	*8*
	1	*1*	*1*
	2		*1*
	3		*2*
	4		*4*
	Maximum (mg/l)		*19.3*

3.11.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 8-9% of baseflow is from the regional aquifer, the remainder originating as interflow.

Little baseflow reduction occurs and the degraded PES is related to non baseflow reduction issues.(Table 3.33)

Table 3-33 Groundwater contribution to baseflow in IUA U2-4

	U20H	U20J
Baseflow (Mm^3/a)	*25.51*	*34.72*
Groundwater baseflow Component (Mm^3/a)	*1.92*	*3.1*
Interflow component (Mm^3/a)	*23.59*	*31.62*
Total Use (Mm^3/a)	*0.03*	*0.06*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*1.92*	*3.1*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*24.67*	*32.96*
Baseflow reduction (%)	*3.3*	*5.1*
EWR Low flow (Mm^3/a)		*15.42 (U20A-J)*
Target EC	*C*	*C*
PES	*C*	*C*

3.11.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is only 8-9%, hence the potential of groundwater abstraction to impact on baseflow is limited to very low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in the IUA are minimal and have reduced baseflow by 3-5%.

The IUA is of moderate aquifer vulnerability. The main land use activities in the IUA include extensive forestry and dry land sugar cane. A large portion of the IUA is occupied by the greater Pietermaritzburg urban area and there are also a large number of semi-urban and rural settlements, which has significantly surface water quality. Groundwater quality issues in exist in GRU16 related to fluorides in the Natal Metamorphic Province and nitrates and salinity.

The results for recharge and baseflow are calibrated against flows at U2H011 for U20H, hence the results can be considered of very high confidence. GRU15, U20J is only calibrated further downstream after the confluence with the Mgeni, hence the confidence can be considered moderate

The Harvest Potential was assumed to be the sustainable groundwater abstraction volume for GRU14. The Harvest Potential is greater than the aquifer recharge in GRU 16, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.11.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
14	*U20H*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 2.99 Mm^3/a evenly distributed in both time and space.*
16	*U20J*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Natural water quality problems exist in the catchment and boreholes for domestic use should be tested for compliance to drinking water standards The potential exists for contamination. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 5.13 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l and below 20 mg/l for nitrates.*

3.12 IUA U2-5 MGENI DOWNSTREAM OF MSUNDUZE TO INANDA DAM

3.12.1 Hydrogeology

This area is underlain by a part GRU15 and GRU17, catchments U20K-L, forming the middle Mgeni to Inanda dam.

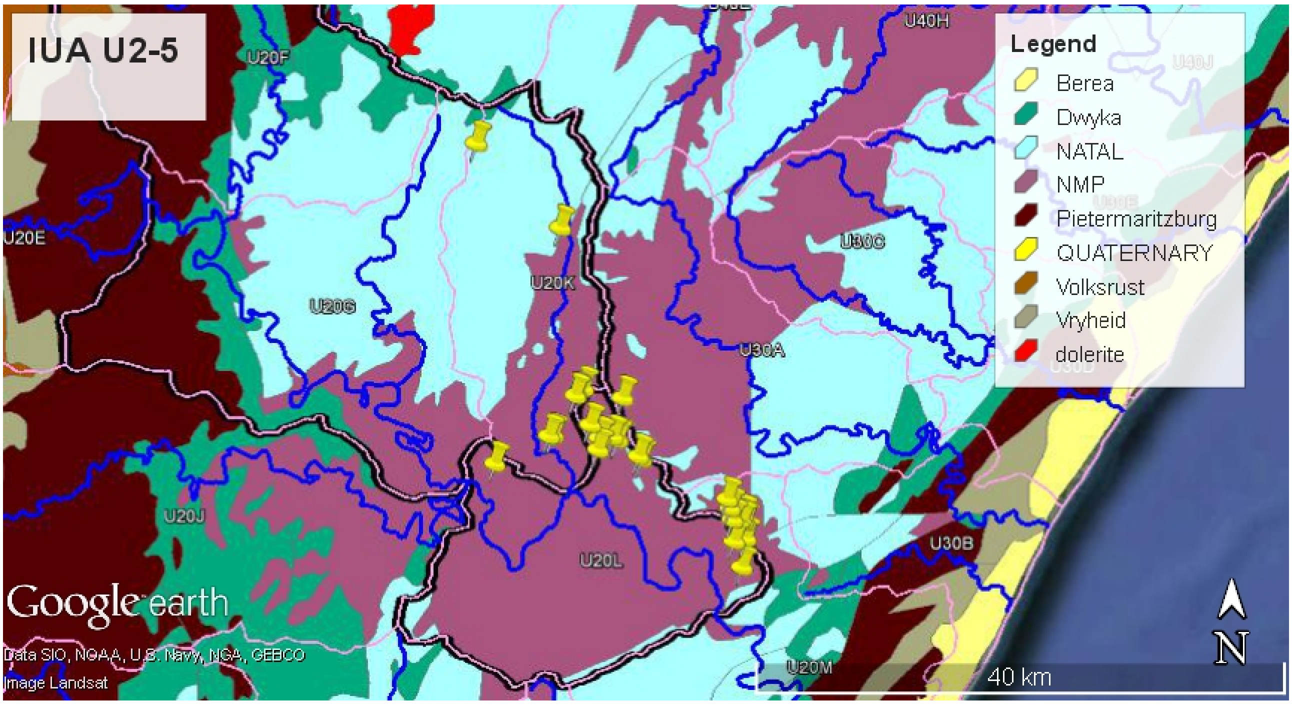

Figure 3-12 Geological map of IUA U2-5 showing location of chemistry data sampling points

U20K is underlain by Natal Group sandstones in its upper reach, and by the Natal Metamorphic Province in its lower half. U20L is underlain entirely by the Natal Metamorphic Province.

3.12.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 28%, with the remainder generating baseflow via interflow. (Table 3.34)

The present status is of a higher class than the Recommended Ecological Class (REC) in all Quaternaries.

Table 3-34 Groundwater use and resources in IUA U2-5

	U20K	U20L
Recharge (Mm^3/a)	*20.88*	*17.35*
Aquifer recharge (Mm^3/a)	*5.92*	*4.93*
Harvest Potential (Mm^3/a)	*14.18*	*12.90*
Total Use (Mm^3/a)	*0.03*	*0.01*
Stress Index	*0.004*	*0.003*
Status	*A-Unmodified*	*A-Unmodified*
Present Class	*I*	*I*

3.12.3 Borehole yields and quality

Borehole yields in the IUA are moderate to high.

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality in U20K, but can be of Class 3-4 in U20L due to elevated fluoride. (Table 3.35)

Table 3-35 Borehole yields and quality in IUA U2-5

		U20K	U20L
Average borehole yield (l/s)		2.4	3.05
Present Class		I	II
TDS quality class	0	6	16
	1	1	4
	2		
	3		
	4		
Nitrate quality class	0	6	18
	1	1	1
	2		1
	3		
	4		
Fluoride quality class	0	4	10
	1		2
	2	2	3
	3		3
	4	1	2
	Maximum (mg/l)	3.8	5.8

3.12.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 13-18% of baseflow is from the regional aquifer, the remainder originating as interflow. (Table 3.36)

Table 3-36 Groundwater contribution to baseflow in IUA U2-5

	U20K	U20L
Baseflow (Mm^3/a)	18.17	14.28
Groundwater baseflow Component (Mm^3/a)	3.21	1.86
Interflow component (Mm^3/a)	14.96	12.42
Total Use (Mm^3/a)	0.03	0.01
Simulated groundwater baseflow under current abstraction (Mm^3/a)	3.21	1.86
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	17.71	14.2
Baseflow reduction (%)	2.5	0.6
EWR Low flow (Mm^3/a)		3.25 (U20A-L)
Target EC	B	D
PES	B/C	D

3.12.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is only 13-18%, hence the potential of groundwater abstraction to impact on baseflow is limited to low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in the IUA are minimal and have reduced baseflow by less than 3%.

GRU 15 is of high aquifer vulnerability and GRU 17 is of moderate aquifer vulnerability. A large portion of the IUA is rural, with scattered rural villages and subsistence farming activities. There are a large number of rural settlements located around the Inanda Dam area. Areas in the upper reaches of the IUA are covered by extensive cultivation (dryland sugar cane) and forestry. GRU 17 is entirely underlain by the Natal Metamorphic Province and wide spread water quality problems exist relating to fluorides.

The results for recharge and baseflow are calibrated against flows at U2H002 for U20K, hence the results can be considered of high confidence. GRU17, U20L is calibrated at U2R004, hence the results can also be considered of high confidence.

The Harvest Potential is greater than the aquifer recharge hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.12.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
15	*U20K*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 3.85 Mm^3/a evenly distributed in both time and space.*
17	*U20L*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 3.21 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*

3.13 IUA U2-6 MGENI DOWNSTREAM OF INANDA DAM TO ESTUARY

3.13.1 Hydrogeology

This area is underlain by GRU 18, catchment U20M, the lower Mgeni.

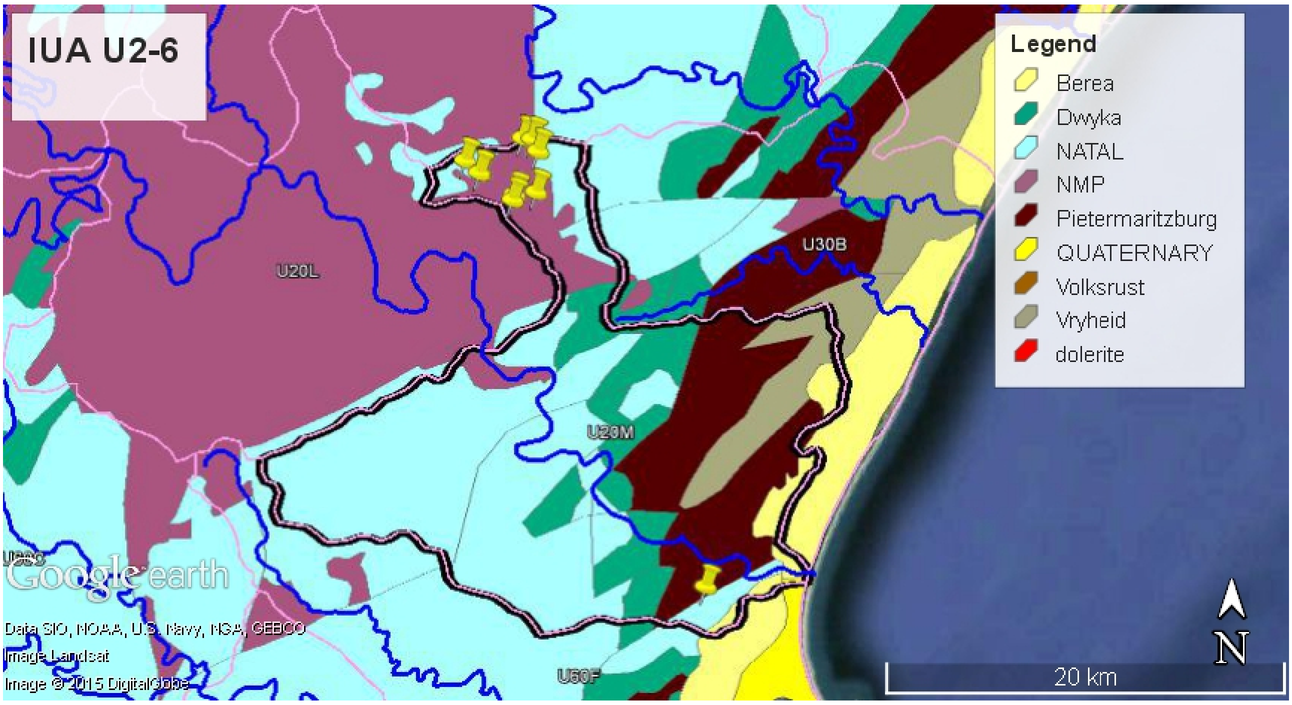

Figure 3-13 Geological map of IUA U2-6 showing location of chemistry data sampling points

U20M is underlain by the Coastal Karoo deposits. This region consists of varied lithologies from Dwyka Group to the Vryheid Formation, faulted against Natal Group sandstones. The upper reaches are underlain by the Natal Metamorphic Province. Borehole yields are higher than inland due to the density of block faulting. On the coast the rocks are overlain by unconsolidated Quaternary sediments of the Berea red sands.

3.13.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, only 36% reaches the regional aquifer, with the remainder generating baseflow via interflow. (Table 3.37)

The present status is of a higher class than the Recommended Ecological Class (REC) in this Quaternary.

Table 3-37 Groundwater use and resources in IUA U2-6

	U20M
Recharge (Mm^3/a)	*27.11*
Aquifer recharge (Mm^3/a)	*9.86*
Harvest Potential (Mm^3/a)	*27.00*
Total Use (Mm^3/a)	*1.12*
Stress Index	*0.114*
Status	*B-Largely natural*
Present Class	*I*

3.13.3 Borehole yields and quality

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality, in U20K, but can be of class 3-4 due to elevated fluoride where the Natal Metamorphic Province outcrops and where most of the samples were collected. (Table 3.38)

Table 3-38 Borehole yields and quality in IUA U2-6

		U20M
Average borehole yield (l/s)		
Present Class		*II*
TDS quality class	*0*	*10*
	1	
	2	
	3	
	4	
Nitrate quality class	*0*	*9*
	1	*1*
	2	
	3	
	4	
Fluoride quality class	*0*	*6*
	1	*2*
	2	
	3	*1*
	4	*1*
	Maximum (mg/l)	*5.7*

3.13.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 17% of baseflow is from the regional aquifer, the remainder originating as interflow. (Table 3.39)

Table 3-39 Groundwater contribution to baseflow in IUA U2-6

	U20M
Baseflow (Mm^3/a)	*20.72*
Groundwater baseflow Component (Mm^3/a)	*3.47*
Interflow component (Mm^3/a)	*17.25*
Total Use (Mm^3/a)	*1.12*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*3.37*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*18.48*
Baseflow reduction (%)	*10.8*
EWR Low flow (Mm^3/a)	*52.04 (U20A-M)*
Target EC	*C*
PES	*C*

3.13.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The borehole yield potential is not known but is expected to be moderate, implying that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is only 17%, hence the potential of groundwater abstraction to impact on baseflow is limited to low. Baseflow is largely derived by interflow, which *can be significantly impacted by SFR activities. SFR activities in the IUA are minimal and have reduced baseflow by 10%.*

GRU 18 is of high aquifer vulnerability. A large portion of the IUA is also semi urban area and urban in the lower reaches (eThekwini municipal area). Consequently there is a high risk for groundwater contamination. None of the monitoring boreholes exhibit poor quality, except for elevated fluorides on the Natal Metamorphic Province.

GRU18 has no gauging stations downstream, and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.13.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
18	*U20M*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 6.41Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*

3.14 IUA U3-1 MDLOTI UPSTREAM OF HAZELMERE DAM

3.14.1 Hydrogeology

This area is underlain by GRU 19, catchment U30A, the upper Mdloti.

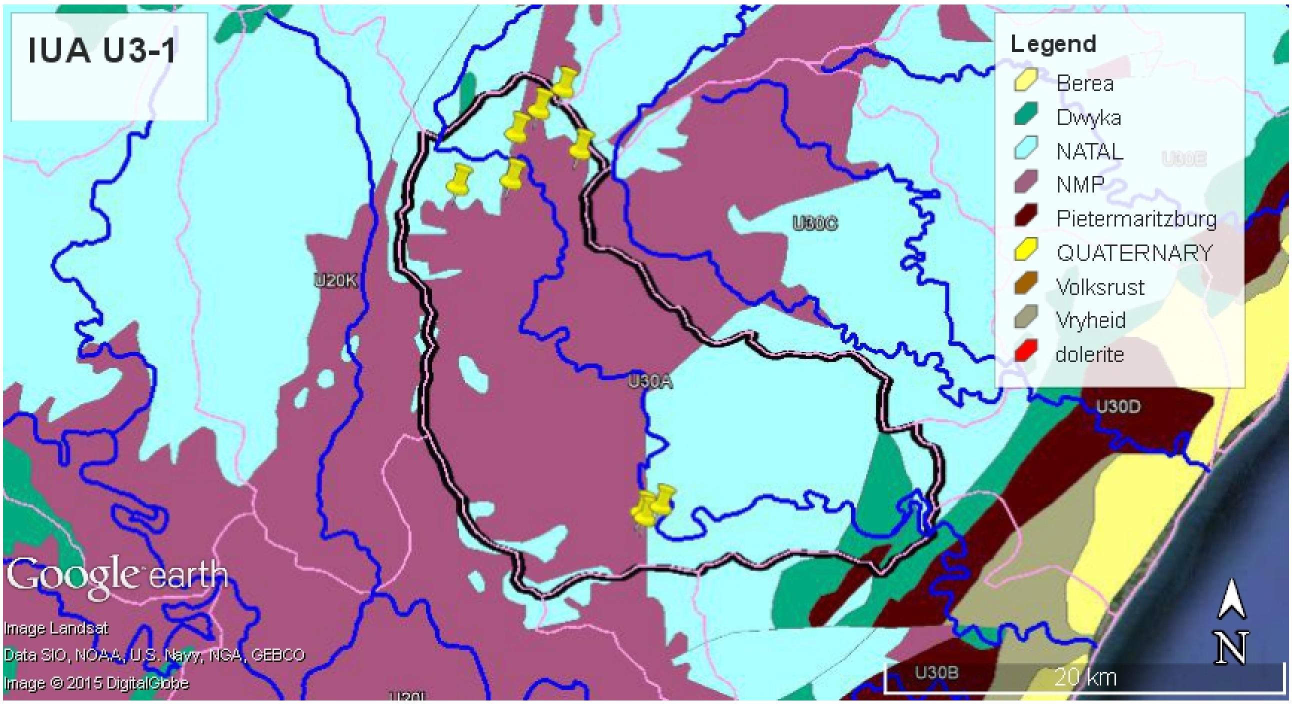

Figure 3-14 Geological map of IUA U3-1 showing location of chemistry data sampling points

U30A is underlain by the Natal Metamorphic Province in its upper half, and by the Natal Group sandstones in its lower half.

3.14.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, only 22% reaches the regional aquifer, with the remainder generating baseflow via interflow. (Table 3.40)

Table 3-40 Groundwater use and resources in IUA U3-1

	U30A
Recharge (Mm^3/a)	*29.42*
Aquifer recharge (Mm^3/a)	*6.52*
Harvest Potential (Mm^3/a)	*30.87*
Total Use (Mm^3/a)	*0.08*
Stress Index	*0.012*
Status	*A-Unmodified*
Present Class	*I*

3.14.3 Borehole yields and quality

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality. However, most of the samples were collected from the Natal Group sandstones.(Table 3.41)

Table 3-41 Borehole yields and quality in IUA U3-1

		U30A
Average borehole yield (l/s)		*0.5*
Present Class		I
TDS quality class	*0*	*9*

		U30A
Average borehole yield (l/s)		0.5
	1	
	2	
	3	
	4	
Nitrate quality class	0	9
	1	
	2	
	3	
	4	
Fluoride quality class	0	8
	1	1
	2	
	3	
	4	

3.14.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 21% of baseflow is from the regional aquifer, the remainder originating as interflow. (Table 3.42)

Table 3-42 Groundwater contribution to baseflow in IUA U3-1

	U30A
Baseflow (Mm^3/a)	28.93
Groundwater baseflow Component (Mm^3/a)	6.03
Interflow component (Mm^3/a)	22.9
Total Use (Mm^3/a)	0.08
Simulated groundwater baseflow under current abstraction (Mm^3/a)	6.02
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	28.47
Baseflow reduction (%)	1.6
EWR Low flow (Mm^3/a)	11.87
Target EC	B
PES	B/C

3.14.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low to moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is 21%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities are minimal and have only reduced baseflow by less than 2%.

U30A is of moderate aquifer vulnerability. There is some dryland sugar cane located in the upper reaches of the IUA. There are a large amount of low density settlements and rural settlements spread throughout the IUA. Consequently, the potential for regional contamination is low and no groundwater quality issues are encountered.

The results for recharge and baseflow are calibrated against flows at U3R001, hence the results can be considered of very high confidence.

The Harvest Potential is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.14.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
19	*U30A*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 4.24 Mm^3/a evenly distributed in both time and space.*

3.15 IUA U3-2 MDLOTI DOWNSTREAM OF HAZELMERE DAM

3.15.1 Hydrogeology

This area is underlain by GRU 21, catchment U30B, the lower Mdloti.

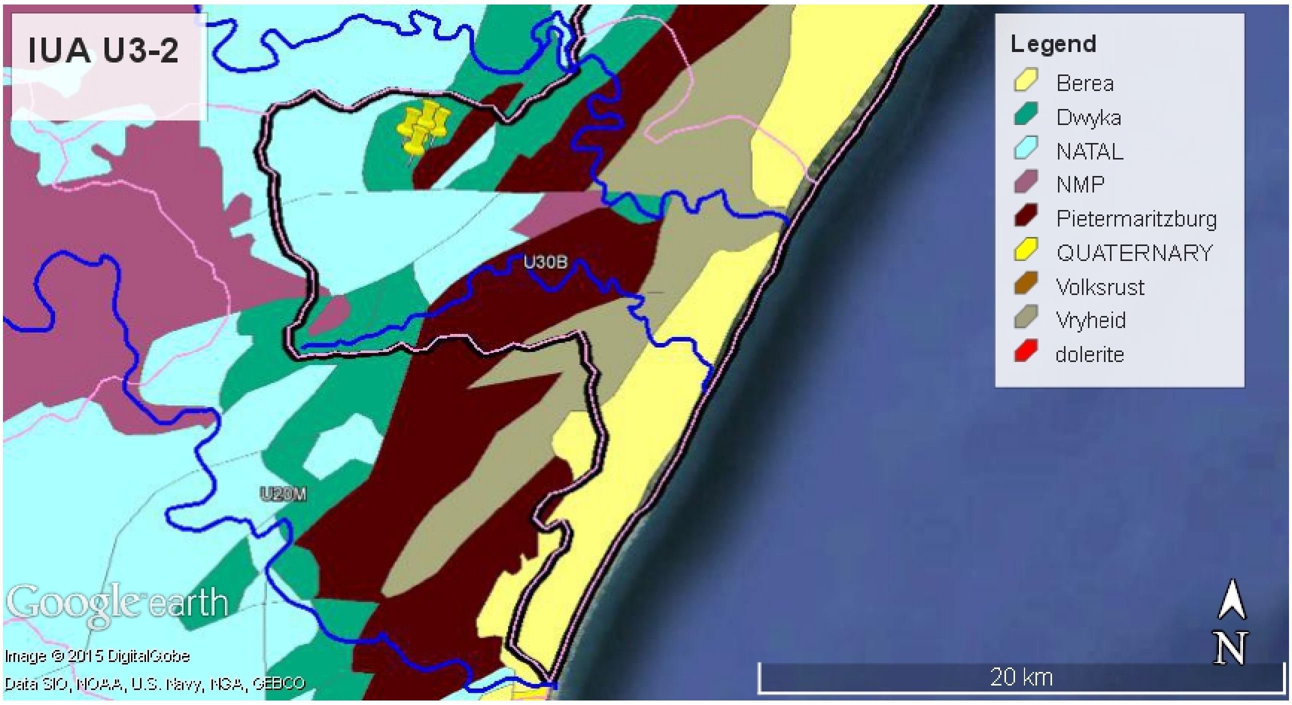

Figure 3-15 Geological map of IUA U3-2 showing location of chemistry data sampling points

U30B is underlain by the Coastal Karoo deposits. This region consists of varied lithologies from Dwyka Group to the Vryheid Formation, faulted against Natal Group sandstones. Borehole yields are higher than inland due to the density of block faulting. On the coast the rocks are overlain by unconsolidated Quaternary sediments of the Berea red sands.

3.15.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, only 21% reaches the regional aquifer, with the remainder generating baseflow via interflow. (Table 3.43)

The present status is of a higher class than the Recommended Ecological Class (REC) in this Quaternary.

Table 3-43 Groundwater use and resources in IUA U3-2

	U30B
Recharge (Mm^3/a)	19.84
Aquifer recharge (Mm^3/a)	4.17
Harvest Potential (Mm^3/a)	6.09
Total Use (Mm^3/a)	0.004
Stress Index	0.001
Status	A-Unmodified
Present Class	I

3.15.3 Borehole yields and quality

Groundwater is generally of DWS Class 1, Good water quality due to slightly elevated salts resulting from a coastal proximity. None of the samples were collected from the coastal zone, where quality is expected to be worse.(Table 3.44)

Table 3-44 Borehole yields and quality in IUA U3-2

		U30B
Average borehole yield (l/s)		0.71
Present Class		I
TDS quality class	0	
	1	5
	2	
	3	
	4	
Nitrate quality class	0	5
	1	
	2	
	3	
	4	
Fluoride quality class	0	5
	1	
	2	
	3	
	4	

3.15.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 14% of baseflow is from the regional aquifer, the remainder originating as interflow.

Significant baseflow reduction occurs due to afforestation and AIPs, and the main stem of the Mdloti is affected by Hazelmere dam, which is reduced to a PES of class D, largely due to water quality issues. (Table3.45)

Table 3-45 Groundwate contribution to baseflow in IUA U3-2

	U30B
Baseflow (Mm^3/a)	*18.16*
Groundwater baseflow Component (Mm^3/a)	*2.49*
Interflow component (Mm^3/a)	*15.67*
Total Use (Mm^3/a)	*0.004*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*2.49*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*15.03*
Baseflow reduction (%)	*17.2*
EWR Low flow (Mm^3/a)	*4.74 (U30A-B)*
Target EC	*D*
PES	*D*

3.15.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low to moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is 14%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities have reduced baseflow by less than 17%.

U30B is of high aquifer vulnerability. A large portion of the IUA is also occupied by urban areas (Verulam). A significant portion of the IUA is also covered by sugar cane (dryland and irrigated). There are also a large amount of low density rural settlements spread throughout the IUA. Consequently, the potential for regional contamination exists. However, no groundwater quality issues are encountered in the existing monitoring network.

GRU21 has no gauging stations downstream, and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.15.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
21	*U30B*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring*	*The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be*	*The sustainable volume of groundwater abstraction is 2.71 Mm^3/a evenly distributed in both time and space.*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
				not required	*restricted 50 m from water supply boreholes.*	

3.16 IUA U3-3 UPPER TONGATI

3.16.1 Hydrogeology

This area is underlain by GRU 20, catchment U30C, the upper Tongati.

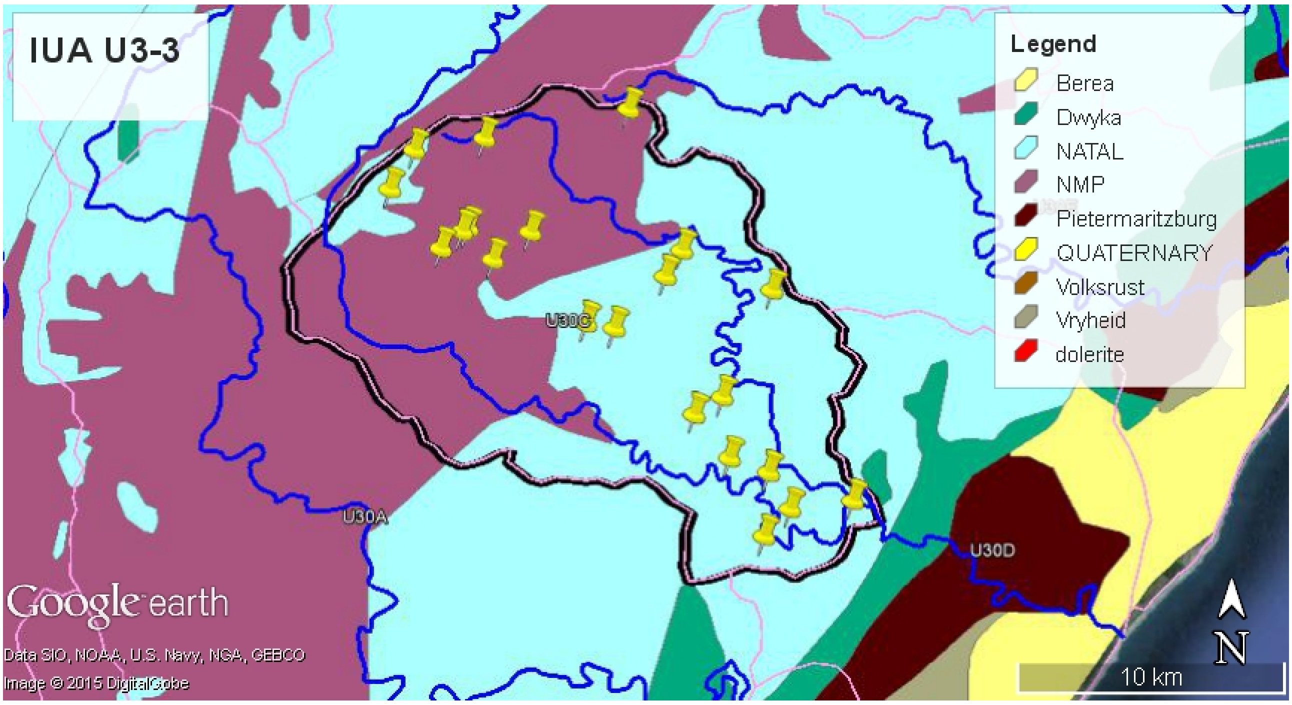

Figure 3-16 Geological map of IUA U3-3 showing location of chemistry data sampling points

U30C is underlain by the Natal Metamorphic Province in its upper half, and by the Natal Group sandstones in its lower half.

3.16.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, only 22% reaches the regional aquifer, with the remainder generating baseflow via interflow. (Table 3.46)

The present status is at the class of the Recommended Ecological Class (REC) in this Quaternary.

Table 3-46 Groundwater use and resources in IUA U3-3

	U30C
Recharge (Mm^3/a)	*20.22*
Aquifer recharge (Mm^3/a)	*4.38*
Harvest Potential (Mm^3/a)	*16.60*
Total Use (Mm^3/a)	*0.43*
Stress Index	*0.099*

	U30C
Status	*B-Largely Natural*
Present Class	*I*

3.16.3 Borehole yields and quality

Groundwater is generally of DWS Class 0-1, or Ideal to Good. Water quality can be of class 3 due to elevated fluoride where the Natal Metamorphic Province outcrops.(Table 3.47)

Table 3-47 Borehole yields and quality in IUA U3-3

		U30C
Average borehole yield (l/s)		*0.82*
Present Class		II
TDS quality class	*0*	*19*
	1	*2*
	2	
	3	
	4	
Nitrate quality class	*0*	*20*
	1	
	2	*1*
	3	
	4	
Fluoride quality class	*0*	*18*
	1	*1*
	2	
	3	*2*
	4	
	Maximum (mg/l)	*2.08*

3.16.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 12% of baseflow is from the regional aquifer, the remainder originating as interflow. (Table 3.48)

Table 3-48 Groundwater contribution to baseflow in IUA U3-3

	U30C
Baseflow (Mm^3/a)	*17.97*
Groundwater baseflow Component (Mm^3/a)	*2.13*
Interflow component (Mm^3/a)	*15.84*
Total Use (Mm^3/a)	*0.43*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*2.05*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*17.53*
Baseflow reduction (%)	*2.4*
EWR Low flow (Mm^3/a)	*4.85*
Target EC	*B/C*
PES	*B/C*

3.16.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low to moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is 12%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities are minimal and have only reduced baseflow by less than 3%.

U30C is of high aquifer vulnerability. The area is predominantly a sugar cane farming area with most of the IUA covered with dry land sugar cane plantations and some low density settlements. Groundwater quality issues related to nitrates and fluorides on the Natal Metamorphic Province are encountered.

The results for recharge and baseflow are calibrated against flows at U3H001, hence the results can be considered of moderate confidence.

The Harvest Potential is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.16.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
20	*U30C*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes. Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 2.85 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*

3.17 IUA U3-4 LOWER TONGATI

3.17.1 Hydrogeology

This area is underlain by GRU 21, catchment U30D, the lower Tongati.

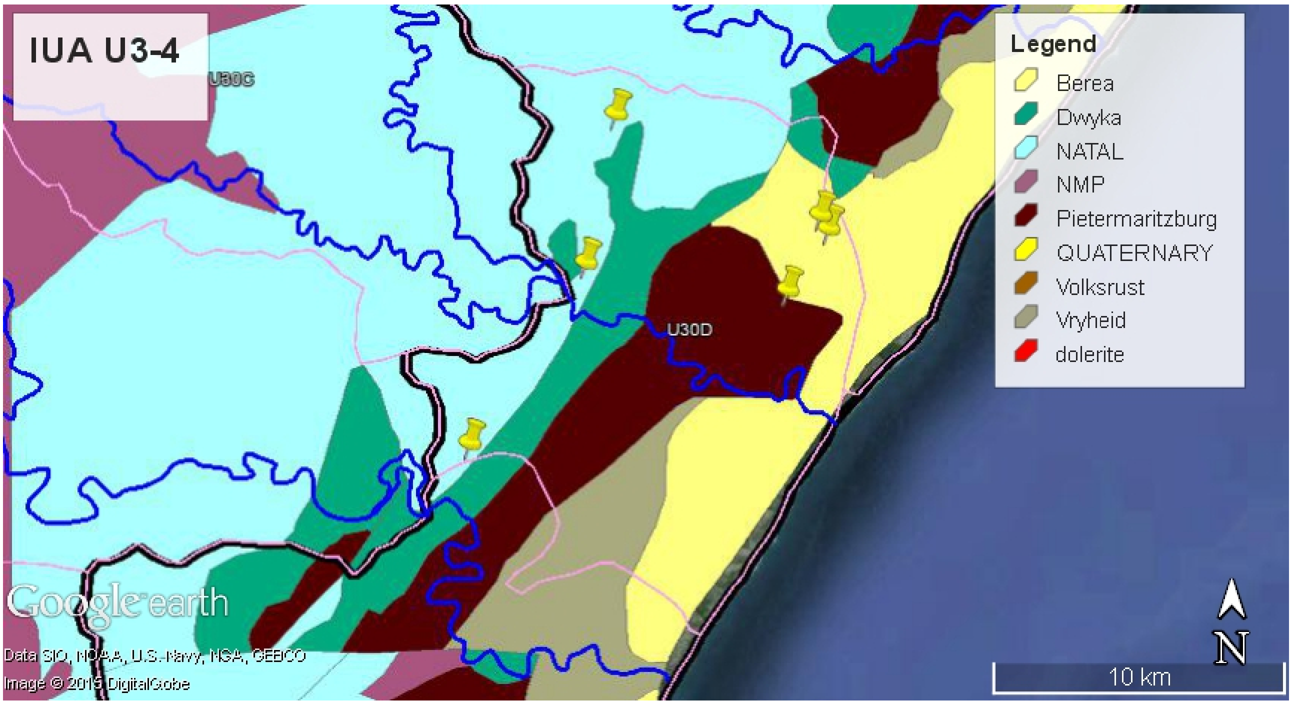

Figure 3-17 Geological map of IUA U3-4 showing location of chemistry data sampling points

U30D is underlain by the Coastal Karoo deposits. This region consists of varied lithologies from Dwyka Group to the Vryheid Formation, faulted against Natal Group sandstones. Borehole yields are higher than inland due to the density of block faulting. On the coast the rocks are overlain by unconsolidated Quaternary sediments of the Berea red sands.

3.17.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, only 23% reaches the regional aquifer, with the remainder generating baseflow via interflow. (Table 3.49)

Table 3-49 Groundwater use and resources in IUA U3-4

	U30D
Recharge (Mm^3/a)	*14.40*
Aquifer recharge (Mm^3/a)	*3.34*
Harvest Potential (Mm^3/a)	*6.36*
Total Use (Mm^3/a)	*0.19*
Stress Index	*0.058*
Status	*B-Largely Natural*
Present Class	*I*

3.17.3 Borehole yields and quality

Groundwater varies from DWS Class 0-2, or Ideal to Marginal. Water quality can be of class 2 due to elevated salts or fluoride. (Table 3.50)

Table 3-50 Borehole yields and quality in IUA U3-4

	U30D
Average borehole yield (l/s)	*1.51*

		U30D
Present Class		II
TDS quality class	*0*	3
	1	2
	2	1
	3	
	4	
Nitrate quality class	*0*	6
	1	
	2	
	3	
	4	
Fluoride quality class	*0*	5
	1	
	2	1
	3	
	4	

3.17.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 14% of baseflow is from the regional aquifer, the remainder originating as interflow. (Table 3.51)

Table 3-51 Groundwater contribution to baseflow in IUA U3-4

	U30D
Baseflow (Mm^3/a)	12.86
Groundwater baseflow Component (Mm^3/a)	1.8
Interflow component (Mm^3/a)	11.06
Total Use (Mm^3/a)	0.19
Simulated groundwater baseflow under current abstraction (Mm^3/a)	10.97
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	10.83
Baseflow reduction (%)	15.8
EWR Low flow (Mm^3/a)	3.5 (U30C-D)
Target EC	
PES	

3.17.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low to moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is 14%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities have reduced baseflow by less than 16%.

U30D is of high aquifer vulnerability. There are a large amount of low density settlements and rural settlements spread throughout the IUA. The Tongaat town and industries are located in the IUA. Consequently, there is a risk of widespread groundwater contamination.

GRU30D has no gauging stations downstream, and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.17.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
21	*U30D*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 2.17 Mm^3/a evenly distributed in both time and space.*

3.18 IUA U4-1 MVOTI UPPER REACHES

3.18.1 Hydrogeology

This area is underlain by GRUs 22 and 23 and 24, catchments U40A-D.

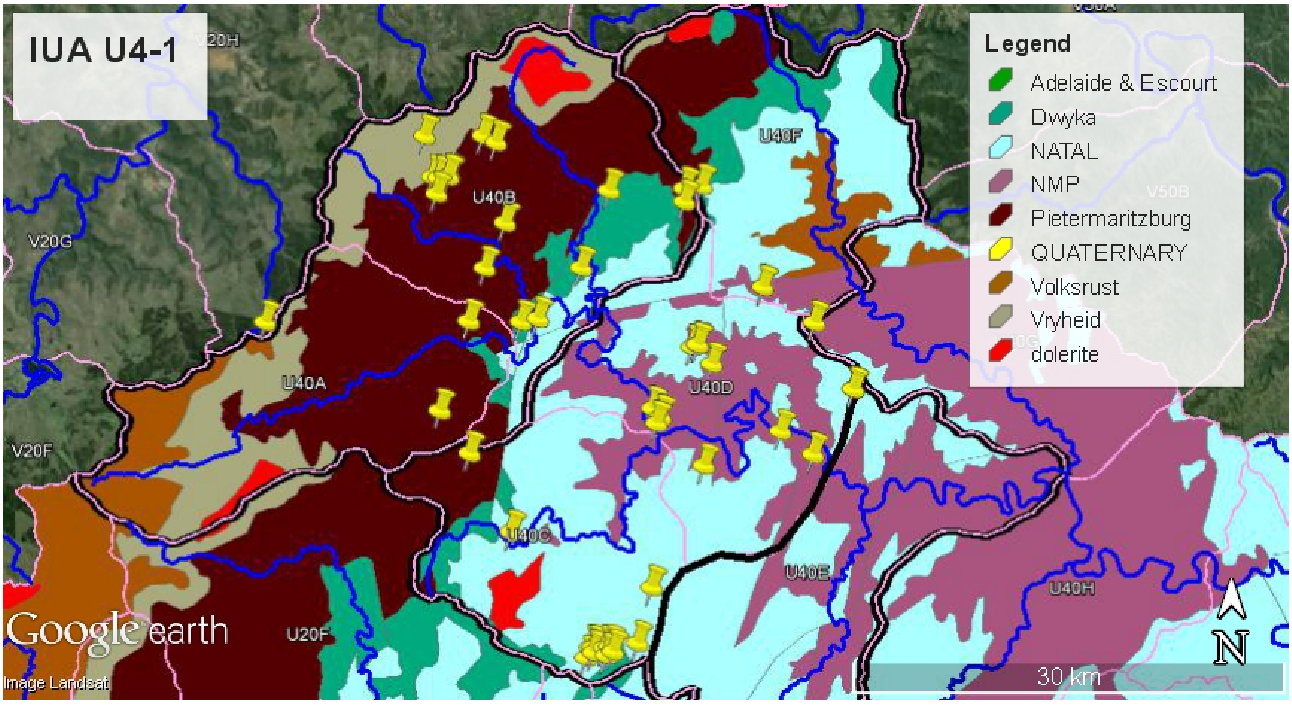

Figure 3-18 Geological map of IUA U4-1 showing location of chemistry data sampling points

GRU22 (U40A-B) is the upper Mvoti and underlain by Middelveld Karoo. This region consists of predominantly argillaceous rocks of the Pietermaritzburg Formation and arenaceous rocks of the

Vryheid Formation. The upper reaches of U41A are underlain by the Volksrust Formation, and the lower reaches of U41B by Dwyka tillites. The Vryheid Formation forms an escarpment within this region, which is the watershed with the V drainage region.

GRU23 (U40C) is the middle Mvoti and consists largely of Natal Group sandstones.

GRU24 (U40D) consists of Natal Metamorphic Province in the valley bottoms and Natal Group sandstones on the valley sides.

3.18.2 Groundwater use and resources

Groundwater use in the IUA is minimal, except for U40B, where usage approaches moderate. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 12-20% in GRU 22, with the remainder generating baseflow via interflow. In GRU23, 28-33% of recharge reaches the regional aquifer. (Table 3.52)

The present status is at or of a higher class than the Recommended Ecological Class (REC) in these Quaternaries.

Table 3-52 Groundwater use and resources in IUA U4-1

	U40A	U40B	U40C	U40D
Recharge (Mm^3/a)	*25.53*	*20.12*	*15.79*	*14.65*
Aquifer recharge (Mm^3/a)	*3.06*	*3.96*	*5.26*	*4.16*
Harvest Potential (Mm^3/a)	*4.80*	*8.71*	*19.42*	*15.59*
Total Use (Mm^3/a)	*0.047*	*0.783*	*0.490*	*0.084*
Stress Index	*0.015*	*0.198*	*0.093*	*0.020*
Status	*A-Unmodified*	*B/C- Largely Natural/ moderately modified*	*B- Largely Natural*	*A-Unmodified*
Present Class	*I*	*I*	*I*	*I*

3.18.3 Borehole yields and quality

Borehole yields in the IUA are moderate to high, with high yielding boreholes in GRU 22.

Groundwater is generally of DWS Class 0-1, or Ideal to Good water quality, except for elevated fluorides of Class 2 associated with the Natal Metamorphic Province in in GRU24. (Table 3.53)

Table 3-53 Borehole yields and quality in IUA U4-1

		U40A	U40B	U40C	U40D
Average borehole yield (l/s)		*2.1*	*1.79*	*0.69*	*0.79*
Present Class		I	I	I	I
TDS quality class	*0*	*3*	*17*	*12*	*13*
	1			*1*	*2*
	2				
	3				
	4				
Nitrate quality class	*0*	*3*	*17*	*12*	*12*
	1			*1*	*1*

		U40A	U40B	U40C	U40D
	2				*2*
	3				
	4				
Fluoride quality class	*0*	*3*	*15*	*12*	*14*
	1		*1*		
	2			*1*	*1*
	3		*1*		
	4				
	Maximum (mg/l)		*2.1*		

3.18.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 13-16% of baseflow is from the regional aquifer in GRU 22, the remainder originating as interflow. In GRU 23, 22-31% of baseflow is from the regional aquifer.

Significant baseflow reduction occurs in GRU 22 due to afforestation and AIPs. The PES is at or below the PES, hence further baseflow reduction should be restricted. (table 3.54)

Table 3-54 Groundwater contribution to baseflow in IUA U4-1

	U40A	U40B	U40C	U40D
Baseflow (Mm^3/a)	*26.69*	*18.51*	*15.27*	*13.47*
Groundwater baseflow Component (Mm^3/a)	*4.22*	*2.35*	*4.74*	*2.98*
Interflow component (Mm^3/a)	*22.47*	*16.16*	*10.53*	*10.49*
Total Use (Mm^3/a)	*0.047*	*0.783*	*0.490*	*0.084*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*4.22*	*2.34*	*4.65*	*2.98*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*6.24*	*7.97*	*10.46*	*11.79*
Baseflow reduction (%)	*76.6*	*56.9*	*31.5*	*12.5*
EWR Low flow (Mm^3/a)	*6.41*	*10.39*		
Target EC	*B*	*C/D*	*B*	*B*
PES	*B/C*	*C/D*	*B/C*	*B*

3.18.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal, except in U40B, where it is moderate. The moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is 13-16% in GRU22. However, in GRU23 and 24, groundwater contributes 22-31% of baseflow. The potential of groundwater abstraction to impact on baseflow is limited in GRU22 but moderate in the remainder of the IUA. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities have significantly affected baseflow in GRU 22 and 23, reducing baseflow by 31-77%.

GRU 22 is of moderate aquifer vulnerability while GRU23 and 24 are of high vulnerability. The main land use activities in the IUA include extensive forestry and a significant amount sugar cane *plantations and irrigation (sugar cane, maize etc.) also occur. There are also a few low density settlements and rural settlements located in the lower reaches. Consequently, the potential risk to groundwater are low, however, the high vulnerability in GR23 and GRU24 implies localised contamination from on-site sanitation is possible. Some elevated nitrates are observed in GRU24.*

The results for recharge and baseflow are calibrated against flows at U4H002 for U40A, hence the results can be considered of very high confidence. No other gauging stations exist downstream, and only mean annual recharge is calibrated against data in the GRA2 database, hence results for the rest of the catchment are of low confidence.

The Harvest Potential is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.18.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
22	*U40A-B*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, sugar cane and AIPs, monitoring of baseflow is required.*	*Due to the moderate groundwater use and aquifer contribution to baseflow, monitoring is required to ensure water levels do not exhibit a declining trend*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 4.56 Mm^3/a evenly distributed in both time and space. Low flows at U4H002 should be maintained at a minimum of 6.41 Mm^3/a*
23	*U40C*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, sugar cane and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use but significant aquifer contribution to baseflow, monitoring is required to ensure water levels do not exhibit a declining trend*	*No regional groundwater quality issues exist The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 3.42 Mm^3/a evenly distributed in both time and space. Due to the lack of a gauging station for this catchment, numerical RQOs have not been set for baseflow*
24	*U40D*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, monitoring not required*	*No regional groundwater quality issues exist The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 2.70 Mm^3/a evenly distributed in both time and space.*

3.19 IUA U4-2 MVOTI MIDDLE REACHES

3.19.1 Hydrogeology

This area is underlain By GRUs 23 and 24, catchments U40E-G, the middle Mvoti.

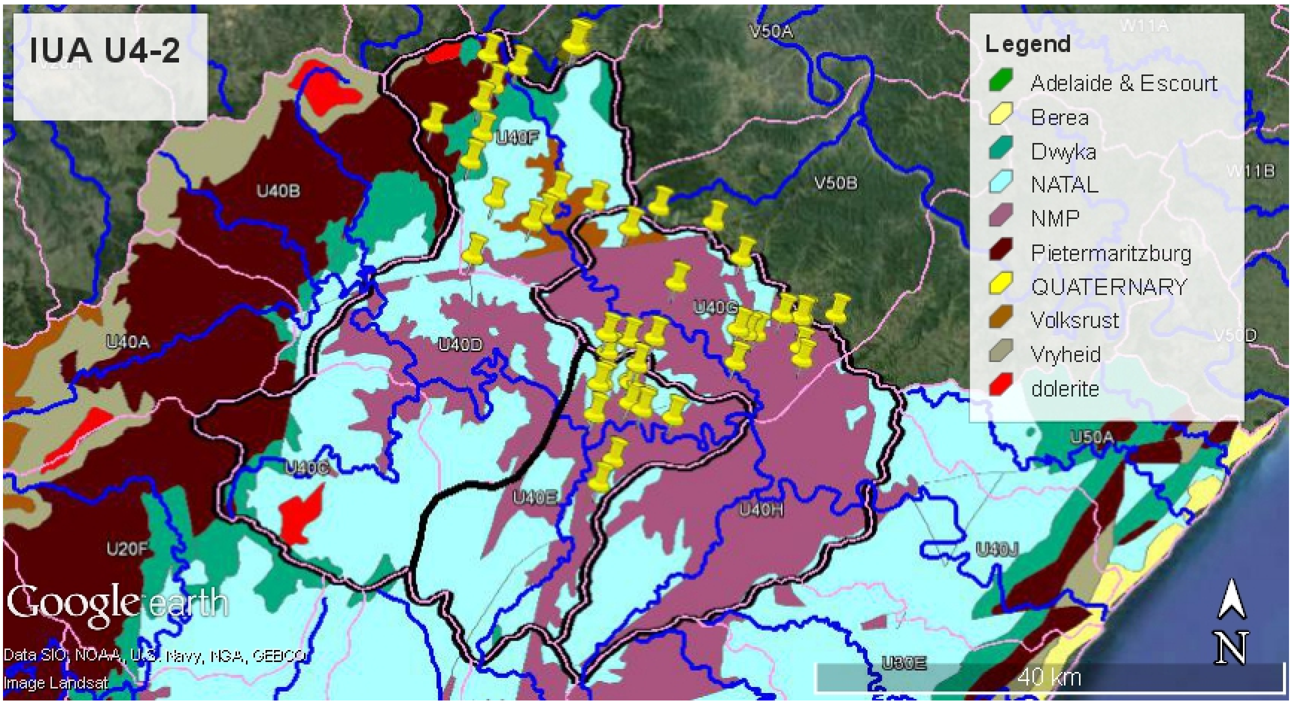

Figure 3-19 Geological map of IUA U4-2 showing location of chemistry data sampling points

GRU23 (U40F) consists of Natal Group sandstones. Pietermaritzburg shales and Dwyka tillites are found in the upper reaches of U40F, with a faulted outcrop of Volksrust Formation.

GRU24 (U40E and G, is largely underlain by the Natal Metamorphic Province.

3.19.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 23-28%, with the remainder generating baseflow via interflow. (Table 3.55)

The present status is of a higher class than the Recommended Ecological Class (REC) in these Quaternaries.

Table 3-55 Groundwater use and resources in IUA U4-2

	U40E	U40F	U40G
Recharge (Mm^3/a)	*16.85*	*13.16*	*12.82*
Aquifer recharge (Mm^3/a)	*4.80*	*3.04*	*2.96*
Harvest Potential (Mm^3/a)	*20.08*	*17.41*	*10.59*
Total Use (Mm^3/a)	*0.142*	*0.116*	*0.139*
Stress Index	*0.030*	*0.038*	*0.047*
Status	*A-Unmodified*	*A-Unmodified*	*A-Unmodified*
Present Class	*I*	*I*	*I*

3.19.3 Borehole yields and quality

Borehole yields in the IUA are low to moderate.

Groundwater of DWS Class 0-1, or Ideal to Good water quality in U40F. Where the IUA is underlain by the Natal Metamorphic Province in U40E and G, water quality can be of Class 2-4, Marginal to Unacceptable.(Table 3.56)

Table 3-56 Borehole yields and qualityin IUA U4-2

		U40E	U40F	U40G
Average borehole yield (l/s)		*0.12*	*1.39*	*0.2*
Present Class		II	I	II
TDS quality class	*0*	*13*	*16*	*19*
	1	*4*		
	2			
	3			
	4			
Nitrate quality class	*0*	*13*	*15*	*19*
	1	*2*	*1*	
	2	*2*		
	3			
	4			
Fluoride quality class	*0*	*15*	*16*	*14*
	1	*1*		*3*
	2			*1*
	3			*1*
	4	*1*		
	Maximum (mg/l)	*5.4*		*2.0*

3.19.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 3-9% of baseflow is from the regional aquifer, the remainder originating as interflow.

Baseflow reduction due to afforestation and AIPs is significant in U40F, however, the PES still meets the target EC in this IUA. (Table 3.57)

Table 3-57 Groundwater contribution to baseflow in IUA U4-2

	U40E	U40F	U40G
Baseflow (Mm^3/a)	*15.22*	*12.44*	*11.02*
Groundwater baseflow Component (Mm^3/a)	*3.17*	*2.32*	*1.16*
Interflow component (Mm^3/a)	*12.05*	*10.12*	*9.86*
Total Use (Mm^3/a)	*0.142*	*0.116*	*0.139*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*3.12*	*2.31*	*1.12*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*14.83*	*6.78*	*10.87*
Baseflow reduction (%)	*2.6*	*45.5*	*1.4*
EWR Low flow (Mm^3/a)	*37.29 (U40A-E)*	*2.9*	
Target EC	*B*	*B*	*B*

PES	B	B	B

3.19.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The moderate borehole yields in GRU23 imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes. In GRU24 the potential for overexploiting groundwater is limited due to low borehole yields.

The Groundwater component of baseflow is 11-21%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities have significantly affected baseflow in GRU 23, reducing baseflow by 45%.

The IUA is of high aquifer vulnerability. The main land use in the IUA is extensive forestry and sugar cane (dryland and irrigated), consequently, the potential for groundwater contamination is limited. Elevated fluoride is observed in GRU24 where boreholes are located on the Natal Metamorphic Province.

No gauging stations exist downstream, and only mean annual recharge is calibrated against data in the GRA2 database, hence results for the IUA are of low confidence.

The Harvest Potential is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.19.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
24	*U40E, G*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 5.04 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*
23	*U40F*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence*	*Due to the impacts of afforestation, and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring*	*No regional groundwater quality issues exist The aquifer is of high vulnerability. Activities that*	*The sustainable volume of groundwater abstraction is 1.98 Mm^3/a evenly distributed in both time and space. Due to the lack of*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
		conditions within the Harvest Potential		*not required*	*could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*a gauging station for this catchment, numerical RQOs have not been set for baseflow*

3.20 IUA U4-3 MVOTI LOWER REACHES

3.20.1 Hydrogeology

This area is underlain By GRUs 24 and 25, catchments U40H-J.

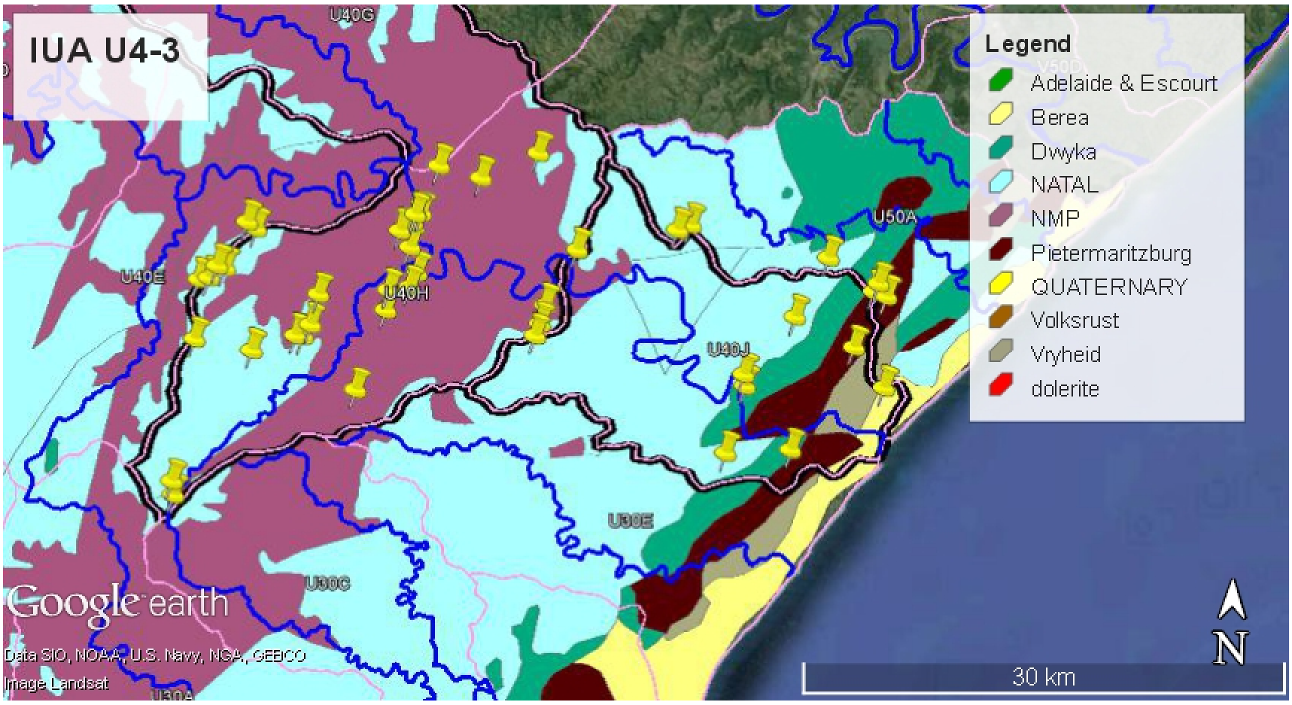

Figure 3-20 Geological map of IUA U4-3 showing location of chemistry data sampling points

GRU24 (U40H) is largely part of the middle Mvoti and is underlain by the Natal Metamorphic Province.

GRU 25 is the lower Mvoti, U40J, is underlain by the Coastal Karoo deposits. This region consists of varied lithologies from Dwyka Group to the Vryheid Formation, faulted against Natal Group sandstones. Borehole yields are higher than inland due to the density of block faulting. On the coast the rocks are overlain by unconsolidated Quaternary sediments of the Berea red sands.

3.20.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 22-23%, with the remainder generating baseflow via interflow. (Table 3.58)

The present status is of a higher class than the Recommended Ecological Class (REC) in these Quaternaries.

Table 3-58 Groundwater use and resources in IUA U4-3

	U40H	U40J
Recharge (Mm^3/a)	*20.30*	*22.22*
Aquifer recharge (Mm^3/a)	*4.66*	*4.91*
Harvest Potential (Mm^3/a)	*19.47*	*18.67*
Total Use (Mm^3/a)	*0.160*	*0.447*
Stress Index	*0.034*	*0.091*
Status	*A-Unmodified*	*B- Largely Natural*
Present Class	*I*	*I*

3.20.3 Borehole yields and quality

Borehole yields in the IUA are low in U40H and moderate in U40J.

Groundwater is highly variable in U40H due to fluoride concentrations in the Natal Metamorphic Province, but of DWS Class 0-1, or Ideal water quality in U40J. (Table 3.59)

Table 3-59 Borehole yields and quality in IUA U4-3

		U40H	U40J
Average borehole yield (l/s)		*0.1*	*1.38*
Present Class		III	I
4TDS quality class	*0*	*19*	*12*
	1	*7*	*4*
	2	*3*	
	3		
	4		
Nitrate quality class	*0*	*25*	*16*
	1	*2*	
	2	*1*	
	3		
	4	*1*	
Fluoride quality class	*0*	*14*	*14*
	1	*5*	*2*
	2	*1*	
	3	*6*	
	4	*3*	
	Maximum (mg/l)	*4.7*	

3.20.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 10-15% of baseflow is from the regional aquifer, the remainder originating as interflow.

Little impact on baseflow occurs within this IUA and impacts on the hydrological category are the result of activities upstream.(Table 3.60)

Table 3-60 Groundwater contribution to baseflow in IUA U4-3

	U40H	U40J
Baseflow (Mm^3/a)	*17.42*	*20.27*
Groundwater baseflow Component (Mm^3/a)	*1.78*	*2.96*
Interflow component (Mm^3/a)	*15.64*	*17.31*
Total Use (Mm^3/a)	*0.160*	*0.447*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*1.76*	*2.85*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*17.27*	*19.72*
Baseflow reduction (%)	*0.9*	*2.7*
EWR Low flow (Mm^3/a)	*59.31 (U40A-H)*	*39.89 (U40A-J)*
Target EC	*B*	*C*
PES	*B*	*C*

3.20.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The moderate borehole yields in GRU25 imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes. In GRU24 the potential for overexploiting groundwater is limited due to low borehole yields.

The Groundwater component of baseflow is 10-15%, hence the potential of groundwater abstraction to impact on baseflow is limited to low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities have insignificantly affected baseflow, reducing baseflow by less than 3%.

U40H is of moderate aquifer vulnerability and U40J is of high aquifer vulnerability. The town Kwadukuza (Stanger) is located in the lower end of the IUA. There is some dryland sugar cane and subsistence farming occurring in the area and there are a vast amount of low density and rural settlements located throughout the IUA. The risk for groundwater contamination is limited and elevated fluorides are observed in GRU24 (U40H) in the Natal Metamorphic Province.

No gauging stations exist downstream, and only mean annual recharge is calibrated against data in the GRA2 database, hence results for the IUA are of low confidence.

The Harvest Potential is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.20.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
24	*U40H*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 3.03 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
						concentration of below 1.5 mg/l.
25	*U40-J*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 3.19 Mm^3/a evenly distributed in both time and space.*

3.21 IUA NORTHERN COASTAL CLUSTER

3.21.1 Hydrogeology

This area is underlain By GRUs 21 and 26, catchments U30E and U50A, which are the catchments of the North Coast rivers.

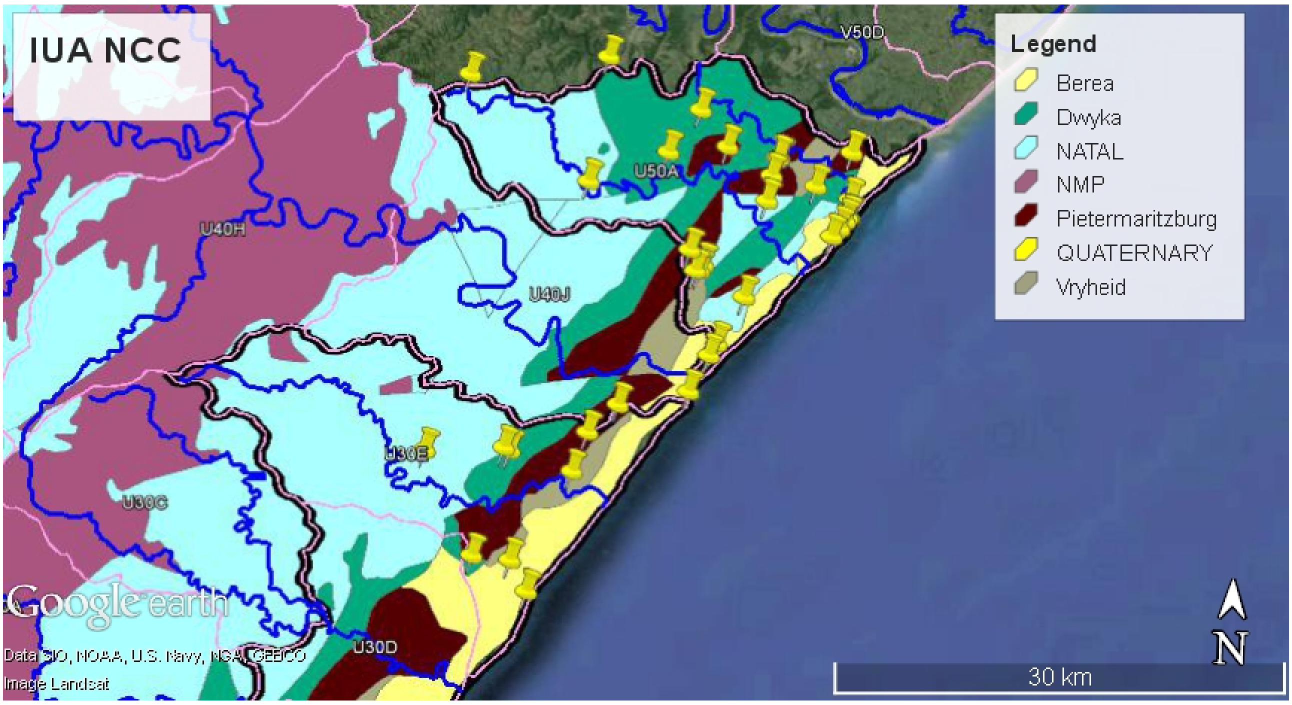

Figure 3-21 Geological map of IUA NCC showing location of chemistry data sampling points

GRUs 21 and 26 are underlain by the Coastal Karoo deposits. This region consists of varied Karoo lithologies from Dwyka Group to the Vryheid Formation, faulted against Natal Group sandstones. Borehole yields are higher than inland due to the density of block faulting. On the coast the rocks are overlain by unconsolidated Quaternary sediments of the Berea red sands.

3.21.2 Groundwater use and resources

Groundwater use in U30E is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Groundwater in U50A is moderately utilised. Although *recharge is high, the proportion reaching the regional aquifer is only 24-29%, with the remainder generating baseflow via interflow. (Table 3.61)*

The present status is of a higher class than the Recommended Ecological Class (REC) in U30E. In U50A groundwater abstraction has reduced the present status to a category C, while the REC is B/C. Groundwater abstraction has had a significant impact on groundwater baseflow (3.2.1.4).

Table 3-61 Groundwater use and resources in IUA NCC

	U30E	U50A
Recharge (Mm^3/a)	*25.17*	*24.42*
Aquifer recharge (Mm^3/a)	*6.10*	*7.15*
Harvest Potential (Mm^3/a)	*17.63*	*12.42*
Total Use (Mm^3/a)	*0.10*	*2.559*
Stress Index	*0.016*	*0.358*
Status	*A-Unmodified*	*C-Moderately Modified*
Present Class	*I*	*II*

3.21.3 Borehole yields and quality

Borehole yields in the IUA are moderate.

Groundwater is highly variable in salinity and fluorides depending on proximity to the coast and underlying lithology. (Table 3.62

Table 3-62 Borehole yields and quality in IUA NCC

		U30E	U50A
Average borehole yield (l/s)		*1.13*	*1.65*
Present Class		II	II
TDS quality class	*0*	*4*	*10*
	1	*6*	*6*
	2		*10*
	3		*1*
	4		
	Maximum (mg/l)		*3136*
Nitrate quality class	*0*	*8*	*24*
	1		*1*
	2	*2*	*2*
	3		
	4		
Fluoride quality class	*0*	*10*	*21*
	1		*3*
	2		*2*
	3		*1*
	4		
	Maximum (mg/l)		*1.8*

3.21.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 15-19% of baseflow is from the regional aquifer, the remainder originating as interflow.

Although groundwater baseflow has been decreased by 10% in U50A, the total baseflow reduction is less than 4% and the PES remains at the target EC. (Table 3.63)

Table 3-63 Groundwater contribution to baseflow in IUA NCC

	U30E	U50A
Baseflow (Mm^3/a)	*22.54*	*21.25*
Groundwater baseflow Component (Mm^3/a)	*3.47*	*3.98*
Interflow component (Mm^3/a)	*19.07*	*17.27*
Total Use (Mm^3/a)	*0.10*	*2.559*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*3.47*	*3.59*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*22.03*	*20.45*
Baseflow reduction (%)	*2.3*	*3.8*
EWR Low flow (Mm^3/a)	*8.24*	*6.7*
Target EC	*C*	*B/C*
PES	*C*	*B/C*

3.21.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal in GRU 21 and moderate in GRU26. The moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is 15-19%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities have insignificantly affected baseflow, reducing baseflow by less than 4%.

The aquifers are of high aquifer vulnerability. The area is predominantly a sugar cane farming area with most of the IUA covered with dry land sugar cane plantations. There are a few small coastal towns dependent on groundwater, some slightly inland and a few rural villages.

No gauging stations exist in this IUA, and only mean annual recharge is calibrated against data in the GRA2 database, hence results for the IUA are of low confidence.

The Harvest Potential is greater than the aquifer recharge, hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.21.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
21	*U30E*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 3.97 Mm^3/a evenly distributed in both time and space.*
26	*U50A*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Monitoring not required as the aquifer discharges to the sea*	*Due to the moderate groundwater use and aquifer contribution to baseflow, monitoring is required to ensure water levels do not exhibit a declining trend*	*Some boreholes have elevated natural salinity and fluoride levels and fluoride needs to be tested for domestic boreholes The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 4.65 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l.*

3.22 IUA U6-1 UPPER MLAZI

3.22.1 Hydrogeology

This area is underlain By GRUs 27, 28 and 29, catchments U60A-C of the upper and middle Mlazi.

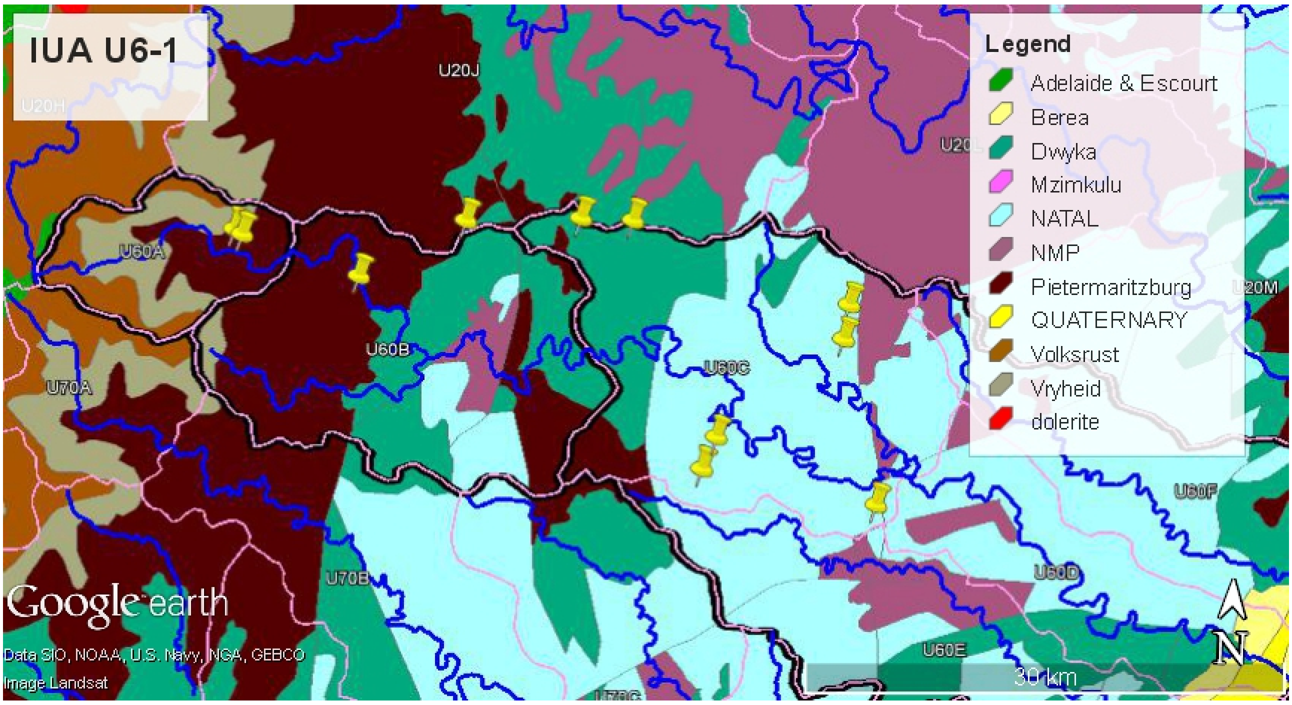

Figure 3-22 Geological map of IUA U6-1 showing location of chemistry data sampling points

GRU27, U60A, is underlain by argillaceous rocks of the Pietermaritzburg and Volksrust Formations, and arenaceous rocks of the Vryheid Formation.

GRU28, U60B, is underlain by Pietermaritzburg shales and Dwyka tillites.

GRU29, U60C, is underlain by Dwyka tillites and Natal Group sandstones.

3.22.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 12% in U60A-B, and 21% in U60C, with the remainder generating baseflow via interflow. (Table 3.64)

The present status is of a higher class than the Recommended Ecological Class (REC) in these Quaternaries.

Table 3-64 Groundwater use and resources in IUA U6-1

	U60A	U60B	U60C
Recharge (Mm^3/a)	18.72	39.68	21.74
Aquifer recharge (Mm^3/a)	2.27	4.71	4.58
Harvest Potential (Mm^3/a)	1.43	5.40	25.07
Total Use (Mm^3/a)	0.001	0.186	0.421
Stress Index	0.001	0.039	0.092
Status	A-Unmodified	A-Unmodified	B-Largely Natural
Present Class	I	I	I

3.22.3 Borehole yields and quality

Borehole yields in the IUA are moderate.

Groundwater of DWS Class 0-1, or Ideal to Good water quality. In U60C, some pockets of poorer quality water may exist in fault bounded outcrops of the Natal Metamorphic Province. (Table 3.65)

Table 3-65 Borehole yields and quality in IUA U6-1

		U60A	U60B	U60C
Average borehole yield (l/s)		0.82	1.86	1.44
Present Class		I	I	II
TDS quality class	0	2	2	6
	1			1
	2			
	3			
	4			
Nitrate quality class	0	2	2	5
	1			1
	2			1
	3			
	4			
Fluoride quality class	0	2	2	6
	1			
	2			
	3			1
	4			
	Maximum (mg/l)			1.7

3.22.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 9-10% of baseflow is from the regional aquifer in U60A-B, and 17% in U60C, the remainder originating as interflow.

Baseflow reduction due to afforestation and AIPs is significant in U60A-B and the PES is at the target EC. Further baseflow reduction should be restricted. (Table 3.66)

Table 3-66 Groundwater contribution to baseflow in IUA U6-1

	U60A	U60B	U60C
Baseflow (Mm^3/a)	18.16	39.03	20.65
Groundwater baseflow Component (Mm^3/a)	1.71	4.06	3.49
Interflow component (Mm^3/a)	16.45	34.97	17.16
Total Use (Mm^3/a)	0.001	0.186	0.421
Simulated groundwater baseflow under current abstraction (Mm^3/a)	1.71	4.06	3.38
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	10.13	17.83	20.12
Baseflow reduction (%)	44.2	54.3	2.6
EWR Low flow (Mm^3/a)		5.92 (U60A-B)	9.2 (U60A-C)
Target EC	C	C/D	C/D
PES	C	C/D	C/D

3.22.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is only 9-17%, hence the potential of groundwater abstraction to impact on baseflow is limited to low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in GRUs 27 and 28 have reduced baseflow by 44-54%.

GRUs 27 and 28 are of moderate aquifer vulnerability and GRU 29 of high vulnerability. The main land use activities include cultivation (dryland sugar cane, maize), irrigation and forestry located in the upper half of the IUA. There are some low density settlements as well as semi-urban and urban areas with industries located in the lower half of the IUA. Groundwater quality is generally good, except in the lower portion of the IUA in U60C where elevated fluorides occur in isolated outcrops of the Natal Metamorphic Province.

The results for recharge and baseflow are calibrated against flows at U6H002 for U60A, and U6H003 for U20B, hence the results can be considered of very high confidence. The remainder of the catchment is ungauged and only mean annual recharge is calibrated against data in the GRA2 database, hence results for U60C are of low confidence.

The Harvest Potential is greater than the aquifer recharge for U60B and C hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge. The Harvest Potential was assumed to be the sustainable groundwater abstraction volume for U60A.

3.22.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
27	*U60A*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 1.43 Mm^3/a evenly distributed in both time and space. Since an EWR flow has not been set for U6H002t, numerical RQOs for baseflow have not been set*
28	*U60B*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 3.06 Mm^3/a evenly distributed in both time and space. Low flows at U6H003 should be maintained at a minimum of 5.92 Mm^3/a*
29	*U60C*	*Significant ground water*	*Due to the low*	*Due to the*	*No regional*	*The sustainable*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
		abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential	*groundwater use, monitoring not required*	*low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*groundwater quality issues exist The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*volume of groundwater abstraction is 2.98 Mm^3/a evenly distributed in both time and space.*

3.23 IUA U6-2 LOWER MLAZI

3.23.1 Hydrogeology

This area is underlain by GRU 29, catchment U60D, the lower Mlazi.

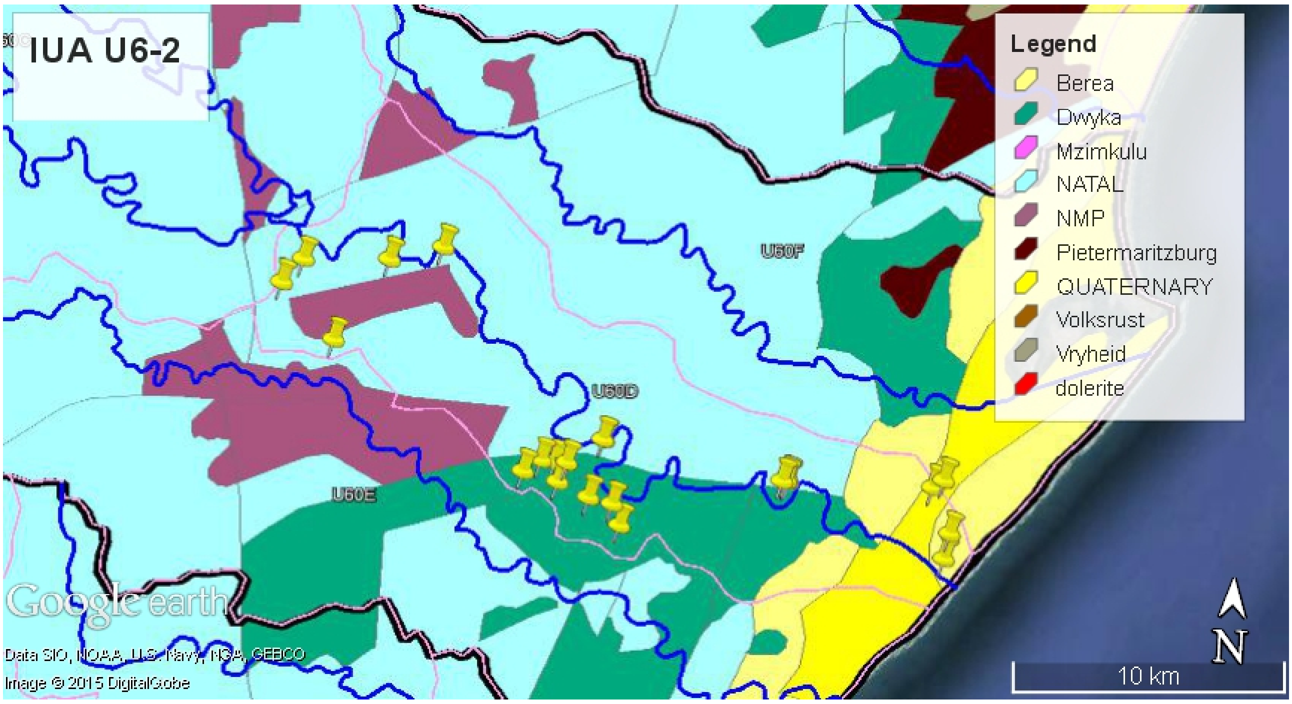

Figure 3-23 Geological map of IUA U6-2 showing location of chemistry data sampling points

U60D is underlain largely by Natal Group sandstones faulted against Dwyka tillites. These are overlain by unconsolidated Quaternary sediments of the Berea red sands near the coast. Faulted windows of the Natal Metamorphic Province also outcrop.

3.23.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, only 21% reaches the regional aquifer, with the remainder generating baseflow via interflow. (Table 3.67)

The present status is of a higher class than the Recommended Ecological Class (REC) in this Quaternary.

Table 3-67 Groundwater use and resources in IUA U6-2

	U60D
Recharge (Mm³/a)	14.25
Aquifer recharge (Mm³/a)	3.00
Harvest Potential (Mm³/a)	11.54
Total Use (Mm³/a)	0.008
Stress Index	0.003
Status	A-Unmodified
Present Class	I

3.23.3 Borehole yields and quality

Borehole yields are low. Groundwater quality is highly variable due to the presence of coastal salts and high fluorides where the Natal Metamorphic Province outcrops. (Table 3.68)

Table 3-68 Borehole yields and quality in IUA U6-2

		U60D
Average borehole yield (l/s)		0.3
Present Class		II
TDS quality class	0	5
	1	16
	2	3
	3	
	4	3
Nitrate quality class	0	21
	1	2
	2	2
	3	2
	4	
	Maximum (mg/l)	30.4
Fluoride quality class	0	24
	1	
	2	
	3	2
	4	1
	Maximum (mg/l)	5.4

3.23.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 16% of baseflow is from the regional aquifer, the remainder originating as interflow.

Baseflow reduction is minimal, however, the catchment has a low PES due to impacts from upstream and water quality issues. (Table 3.69)

Table 3-69 Groundwater contribution to baseflow in IUA U6-2

	U60D
Baseflow (Mm^3/a)	*13.41*
Groundwater baseflow Component (Mm^3/a)	*2.16*
Interflow component (Mm^3/a)	*11.25*
Total Use (Mm^3/a)	*0.008*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*2.16*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*12.73*
Baseflow reduction (%)	*5.1*
EWR Low flow (Mm^3/a)	*1.17*
Target EC	*C/D*
PES	*C/D*

3.23.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low borehole yields imply that over abstraction on a regional scale is unlikely.

The Groundwater component of baseflow is only 16%, hence the potential of groundwater abstraction to impact on baseflow is limited to low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities are limited and have reduced baseflow by 5%.

U60D is of high aquifer vulnerability. The IUA is occupied by semi-urban and urban areas. Discharges from numerous WWTWs enter the river system affecting both flow and especially the water quality of the river. There is also a hazardous landfill site in the upper reaches of the tributaries which also affect the water quality of the Mlazi River, which is regarded as very poor. Groundwater quality varies from good to poor, with elevated salinities, nitrates and fluorides encountered.

The catchment is ungauged and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.23.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
29	*U60D*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use, low borehole yield, and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated salinity, nitrate and fluoride levels and water quality needs to be tested for domestic boreholes The aquifer is of high vulnerability. Activities that could cause groundwater*	*The sustainable volume of groundwater abstraction is 1.95 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l and nitrates below 20*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
					contamination should be restricted 50 m from water supply boreholes.	*mg/l.*

3.24 IUA U6-3 MBOKODWENI

3.24.1 Hydrogeology

This area is underlain by GRU 29, catchment U60E, the Mbokodweni catchment.

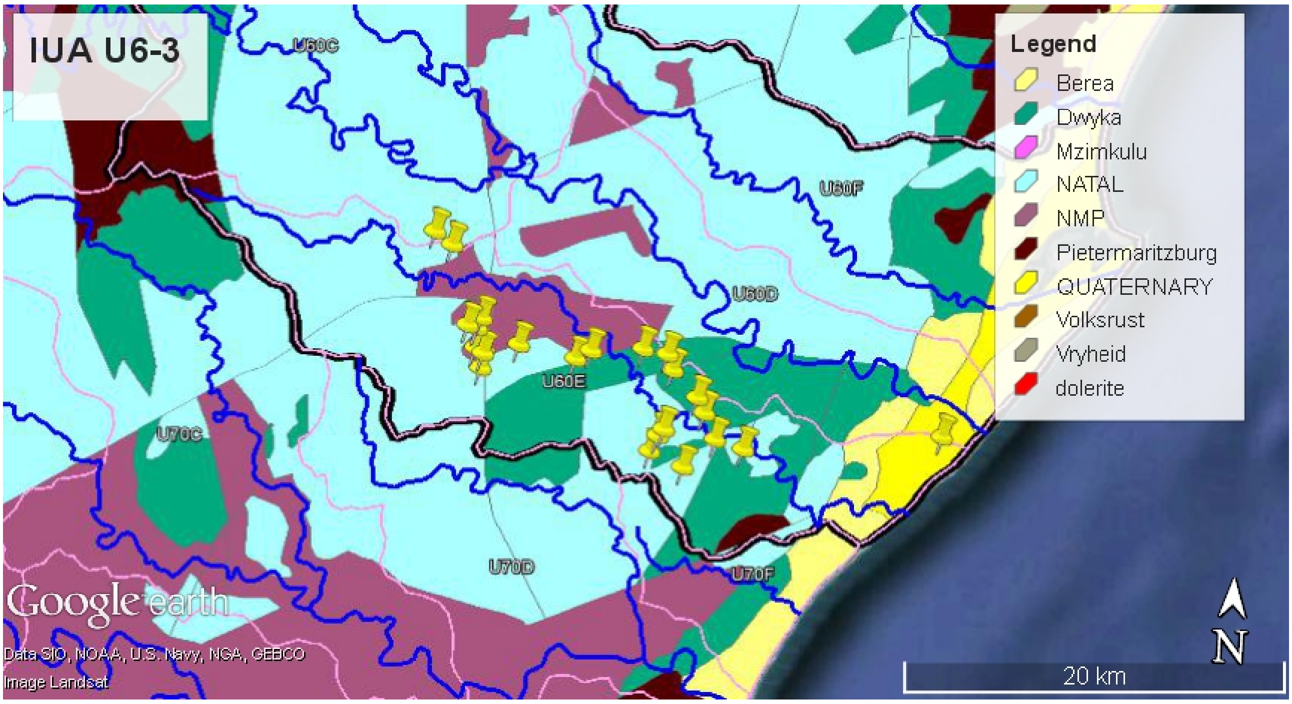

Figure 3-24 Geological map of IUA U6-3 showing location of chemistry data sampling points

U60E is underlain largely by Natal Group sandstones faulted against Dwyka tillites. These are overlain by unconsolidated Quaternary sediments of the Berea red sands near the coast. Faulted windows of the Natal Metamorphic Province also outcrop.

3.24.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, only 21% reaches the regional aquifer, with the remainder generating baseflow via interflow. (Table 3.70)

The present status is of a higher class than the Recommended Ecological Class (REC) in this Quaternary.

Table 3-70 Groundwater use and resources in IUA U6-3

	U60E
Recharge (Mm^3/a)	*22.33*
Aquifer recharge (Mm^3/a)	*4.70*

	U60E
Harvest Potential (Mm^3/a)	*16.62*
Total Use (Mm^3/a)	*0.005*
Stress Index	*0.001*
Status	*A-Unmodified*
Present Class	*I*

3.24.3 Borehole yields and quality

Borehole yields are low. Groundwater quality is DWS Class 0-1, Ideal to Good quality for domestic purposes. (Table 3.71)

Table 3-71 Borehole yields and quality in IUA U6-3

		U60E
Average borehole yield (l/s)		*0.41*
Present Class		I
TDS quality class	*0*	*16*
	1	*7*
	2	
	3	
	4	
Nitrate quality class	*0*	*22*
	1	*1*
	2	
	3	
	4	
Fluoride quality class	*0*	*22*
	1	
	2	*1*
	3	
	4	

3.24.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 15% of baseflow is from the regional aquifer, the remainder originating as interflow.

Although baseflow reduction is only 3%, the IUA has a PES of class C due to water quality issues (Table 3.72).

Table 3-72 Groundwater contribution to baseflow in IUA U6-3

	U60E
Baseflow (Mm^3/a)	*20.86*
Groundwater baseflow Component (Mm^3/a)	*3.23*
Interflow component (Mm^3/a)	*17.63*
Total Use (Mm^3/a)	*0.005*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*3.23*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*20.18*
Baseflow reduction (%)	*3.3*
EWR Low flow (Mm^3/a)	*7.02*
Target EC	*C*

PES	C

3.24.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low borehole yields imply that over abstraction on a regional scale is unlikely.

The Groundwater component of baseflow is only 15%, hence the potential of groundwater abstraction to impact on baseflow is limited to low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities are limited and have reduced baseflow by 3%.

U60E is of high aquifer vulnerability. There is some sugar cane (dryland) located in the upper reaches of the IUA. The middle to upper reach of the IUA is occupied by scattered rural villages and the middle to lower reach by semi-urban areas, urban areas (Umlazi, Isipingo) as well as industrial areas close to the coast (Prospecton Industrial area), consequently, there is a risk of groundwater contamination. However, groundwater quality in existing monitoring boreholes is good.

The catchment is ungauged and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.24.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
29	*U60E*	*All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 3.06 Mm^3/a evenly distributed in both time and space.*

3.25 IUA U7-1 LOVU

3.25.1 Hydrogeology

This area is underlain by GRUs 30-33, catchments U70A-D, which is the catchment of the Lovu.

GRU30 (U70A) is underlain by argillaceous rocks of the Pietermaritzburg and Volksrust Formations, and arenaceous rocks of the Vryheid Formation.

GRU31, U70B, is underlain by Pietermaritzburg shales, Natal Group sandstones and Dwyka tillites.

GRU32, U70C, is underlain by Dwyka tillites, the Natal Metamorphic Province and Natal Group sandstones.

GRU33, U70D, is underlain the Natal Metamorphic Province and Natal Group sandstones.

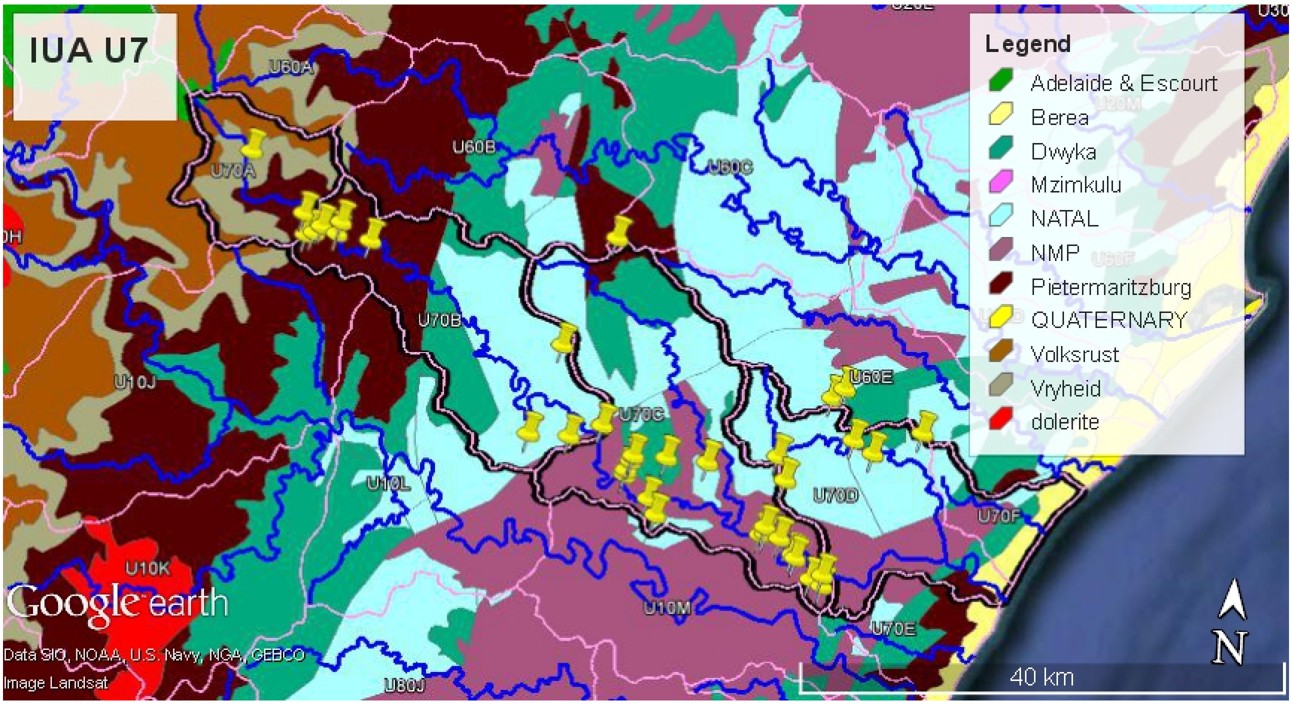

Figure 3-25 Geological map of IUA U7 showing location of chemistry data sampling points

3.25.2 Groundwater use and resources

Groundwater use in the IUA is minimal although approaching moderate in U70A and U70B. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 20-25%, with the remainder generating baseflow via interflow.(Table 3.73)

The present status is of a higher class than the Recommended Ecological Class (REC) in these Quaternaries.

Table 3-73 Grondwater use and resources in IUA U7-1

	U70A	U70B	U70C	U70D
Recharge (Mm^3/a)	*12.14*	*17.01*	*22.09*	*15.13*
Aquifer recharge (Mm^3/a)	*2.42*	*4.25*	*5.52*	*3.78*
Harvest Potential (Mm^3/a)	*1.55*	*12.36*	*22.94*	*13.70*
Total Use (Mm^3/a)	*0.367*	*0.800*	*0.163*	*0.006*
Stress Index	*0.152*	*0.188*	*0.030*	*0.002*
Status	*B- Largely Natural*	*B- Largely Natural*	*A-Unmodified*	*A-Unmodified*
Present Class	*I*	*I*	*I*	*I*

3.25.3 Borehole yields and quality

Borehole yields in the IUA are low to moderate.

Groundwater is generally of DWS Class 0, or Ideal in U70A-B. In U70C-D, poor quality water of Class 3 can exist due to elevated fluorides associated with the Natal Metamorphic Province. (Talbe 3.74)

Table 3-74 Borehole yields and quality in IUA U7-1

		U70A	U70B	U70C	U70D
Average borehole yield (l/s)		*0.5*	*0.62*	*0.76*	*0.21*
Present Class					
TDS quality class	*0*	*2*	*8*	*16*	*6*
	1			*5*	
	2			*2*	
	3				
	4				
Nitrate quality class	*0*	*2*	*8*	*21*	*5*
	1				*1*
	2			*2*	
	3				
	4				
Fluoride quality class	*0*	*2*	*8*	*18*	*5*
	1			*1*	
	2				
	3			*4*	*1*
	4				
	Maximum (mg/l)			*3.5*	*2.36*

3.25.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 11-19% of baseflow, the remainder originating as interflow.

Significant baseflow reduction occurs in U70A-B due to afforestation and AIPs and the PES is at the target EC, consequently, no further baseflow reduction should be permitted. (Table 3.75)

Table 3-75 Groundwater contribution to baseflow in IUA U7-1

	U70A	U70B	U70C	U70D
Baseflow (Mm^3/a)	*10.90*	*15.82*	*20.36*	*14.04*
Groundwater baseflow Component (Mm^3/a)	*1.18*	*3.06*	*3.79*	*2.69*
Interflow component (Mm^3/a)	*9.72*	*12.76*	*16.57*	*11.35*
Total Use (Mm^3/a)	*0.367*	*0.800*	*0.163*	*0.006*
Simulated groundwater baseflow under current abstraction (Mm^3/a)	*1.16*	*2.96*	*3.78*	*2.69*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*2.76*	*8.89*	*18.85*	*13.87*
Baseflow reduction (%)	*74.7*	*43.8*	*7.4*	*1.2*
EWR Low flow (Mm^3/a)		*6.09 (U70A-B)*	*9.48 (U70A-C)*	*5.87 (U70A-D)*
Target EC	*B/C*	*C/D*	*C*	*B/C*
PES	*B/C*	*C/D*	*C*	*B/C*

3.25.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal but approaching moderate in U70A and U70B. The moderate borehole yields in U70A-C imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is only 11-19%, hence the potential of groundwater abstraction to impact on baseflow is limited to low. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities in U70A and U70B have reduced baseflow by 75 and 44%.

U70A is of moderate aquifer vulnerability and the remainder of the IUA is of high vulnerability. There are extensive forestry and sugar cane plantations located in the middle to upper reach of the IUA with Richmond town and adjacent township also located in the upper reach. The middle to lower reach of the IUA is occupied by scattered rural villages. Consequently there is no regional risk to groundwater quality. Groundwater quality is good except for elevated fluorides in boreholes in the Natal Metamorphic Province in U70C and U70D, and a few elevated nitrate levels may be indicative of localised sanitation contamination.

The results for recharge and baseflow are calibrated against flows at U7H007 for U70A, hence the results can be considered of very high confidence. The remainder of the catchment is ungauged and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge for U70B-D hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge. The Harvest Potential was assumed to be the sustainable groundwater abstraction volume for U70A.

3.25.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
30 and 31	*U70A-B*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the impacts of afforestation, sugar cane and AIPs, monitoring of baseflow is required.*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*No regional groundwater quality issues exist*	*The sustainable volume of groundwater abstraction is 4.31 Mm^3/a evenly distributed in both time and space. Low flows at U7H001 should be maintained at a minimum of 2.75 Mm^3/a*
32 and 33	*U70C-D*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes The aquifer is of high vulnerability. Activities that could cause*	*The sustainable volume of groundwater abstraction is 6.05 Mm^3/a evenly distributed in both time and space. Boreholes used for long term primary water supply should have a Fluoride*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
					groundwater contamination should be restricted 50 m from water supply boreholes.	*concentration of below 1.5 mg/l.*

3.26 IUA CC CENTRAL COASTAL CLUSTER

3.26.1 Hydrogeology

This area is underlain By GRUs 29, 33 and 34, catchments U60F, and U70E-F, which are the catchments of the central coast rivers.

GRU29, U60F, is underlain largely by Natal Group sandstones faulted against Dwyka tillites. These are overlain by unconsolidated Quaternary sediments of the Berea red sands near the coast. Faulted windows of the Natal Metamorphic Province also outcrop.

GRUs 33 and 34, U70E-F, are underlain by the Natal Metamorphic Province and Dwyka tillites. The tillites are overlain by unconsolidated Quaternary sediments of the Berea red sands near the coast.

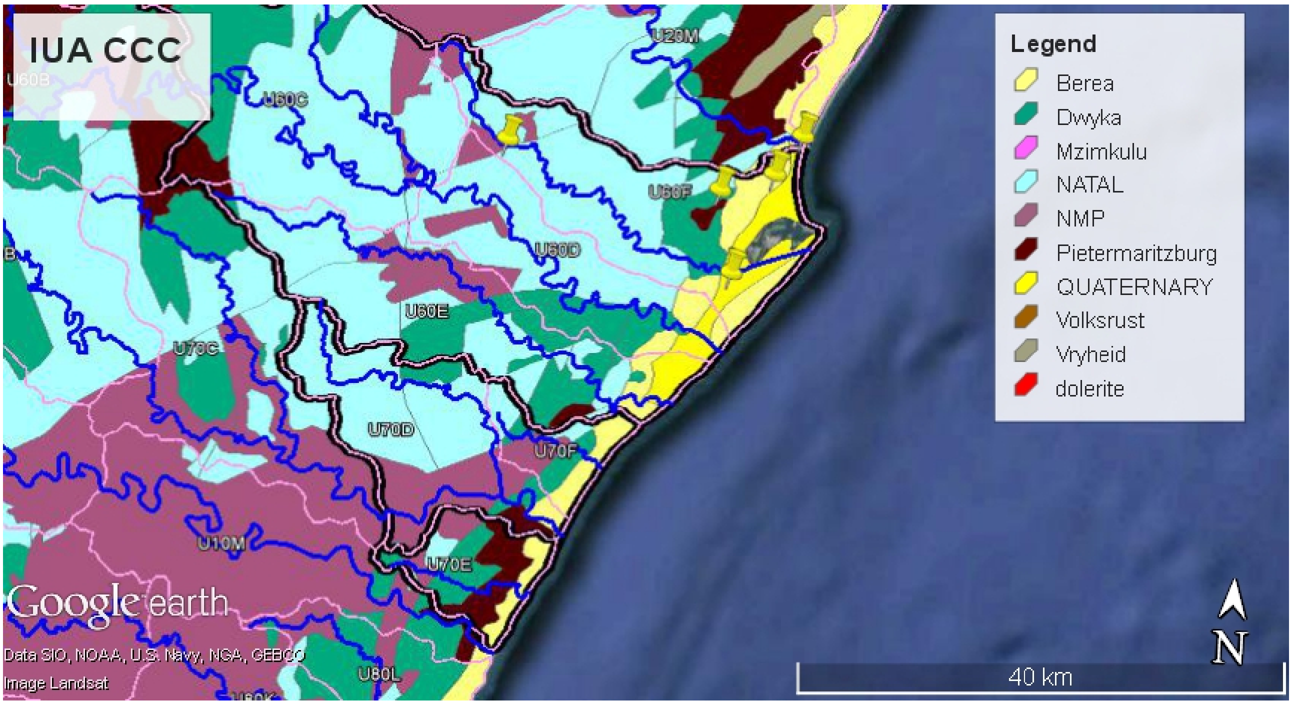

Figure 3-26 Geological map of IUA CCC showing location of chemistry data sampling points

3.26.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 25-29%, with the remainder generating baseflow via interflow. (Table 3.76)

The present status is of a higher class than the Recommended Ecological Class (REC) in these Quaternaries.

Table 3-76 Groundwater use and resources in IUA CC

	U60F	U70E	U70F
Recharge (Mm^3/a)	*22.74*	*8.82*	*4.75*
Aquifer recharge (Mm^3/a)	*6.69*	*1.15*	*1.19*
Harvest Potential (Mm^3/a)	*15.83*	*2.09*	*2.26*
Total Use (Mm^3/a)	*0.112*	*0.072*	*0.140*
Stress Index	*0.017*	*0.063*	*0.118*
Status	*A-Unmodified*	*B-Largely Natural*	*B-Largely Natural*
Present Class	*I*	*I*	*I*

3.26.3 Borehole yields and quality

Borehole yields in the IUA are moderate.

Groundwater quality is highly variable due to varying lithology, the presence of coastal salinity and urbanisation. Little data exists to categorise groundwater quality. (Table 3.77)

Table 3-77 Borehole yields and quality in IUA CC

		U60F	U70E	U70F
Average borehole yield (l/s)			*1.98*	*1.03*
Present Class				
TDS quality class	*0*	*1*		
	1	*2*		
	2	*1*		
	3	*1*		
	4			
	Maximum (mg/l)	*2534*		
Nitrate quality class	*0*	*4*		
	1			
	2	*1*		
	3			
	4			
Fluoride quality class	*0*	*4*		
	1			
	2	*1*		
	3			
	4			

3.26.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 10-20% of baseflow is from the regional aquifer, the remainder originating as interflow. (Table 3.78)

Table 3-78 Groundwater contribution to baseflow in IUA CC

	U60F	U70E	U70F
Baseflow (Mm^3/a)	*21.72*	8.57	4.39
Groundwater baseflow Component (Mm^3/a)	*5.45*	*0.9*	*0.83*
Interflow component (Mm^3/a)	*16.05*	7.67	3.56
Total Use (Mm^3/a)	*0.112*	*0.072*	*0.140*

Simulated groundwater baseflow under current abstraction (Mm^3/a)	*5.19*	*0.88*	*0.82*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*19.21*	*8.34*	*4.38*
Baseflow reduction (%)	*11.6*	*2.7*	*0.2*
EWR Low flow (Mm^3/a)		*2.88*	*1.94*
Target EC	*D*	*C*	*C*
PES	*D*	*C*	*C*

3.26.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The moderate borehole yields imply that over abstraction on a localised scale is possible and borehole abstraction rates should consider sustainable yields derived from pumping tests and aquifer recharge volumes.

The Groundwater component of baseflow is only 11-25%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities have reduced baseflow by 12% in U60F and less than 3% in U70E and F%.

The IUA is of high aquifer vulnerability and the area is predominantly urban with some semi-urban and rural settlements. U60F underlies Durban. Consequently, the potential for groundwater contamination is high. Little data is available on groundwater quality; and none for U70E and F where groundwater is being utilised. The network will need to be expanded to include these localities.

The results for recharge and baseflow are calibrated against flows at U7R001 for U70E, hence the results can be considered of very high confidence. The remainder of the IUA is ungauged and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.26.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
29	*U60F*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Groundwater quality needs to be monitored for salinity levels The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 4.35 Mm^3/a evenly distributed in both time and space*
33 and 34	*U70E-F*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution*	*Insufficient data exists and monitoring boreholes need to established The aquifer is of*	*The sustainable volume of groundwater abstraction is 1.52 Mm^3/a evenly distributed in both*

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
		allocation schedules and individual licence conditions within the Harvest Potential		*to baseflow, monitoring not required*	*high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*time and space. Approximately half of this volume can be abstracted from each catchment*

3.27 IUA U8-1 MZUMBE

3.27.1 Hydrogeology

This area is underlain By GRU 35, catchments U80B-C, which is the catchment of the Mzumbe.

GRU 35 is underlain largely by the Natal Metamorphic Province.

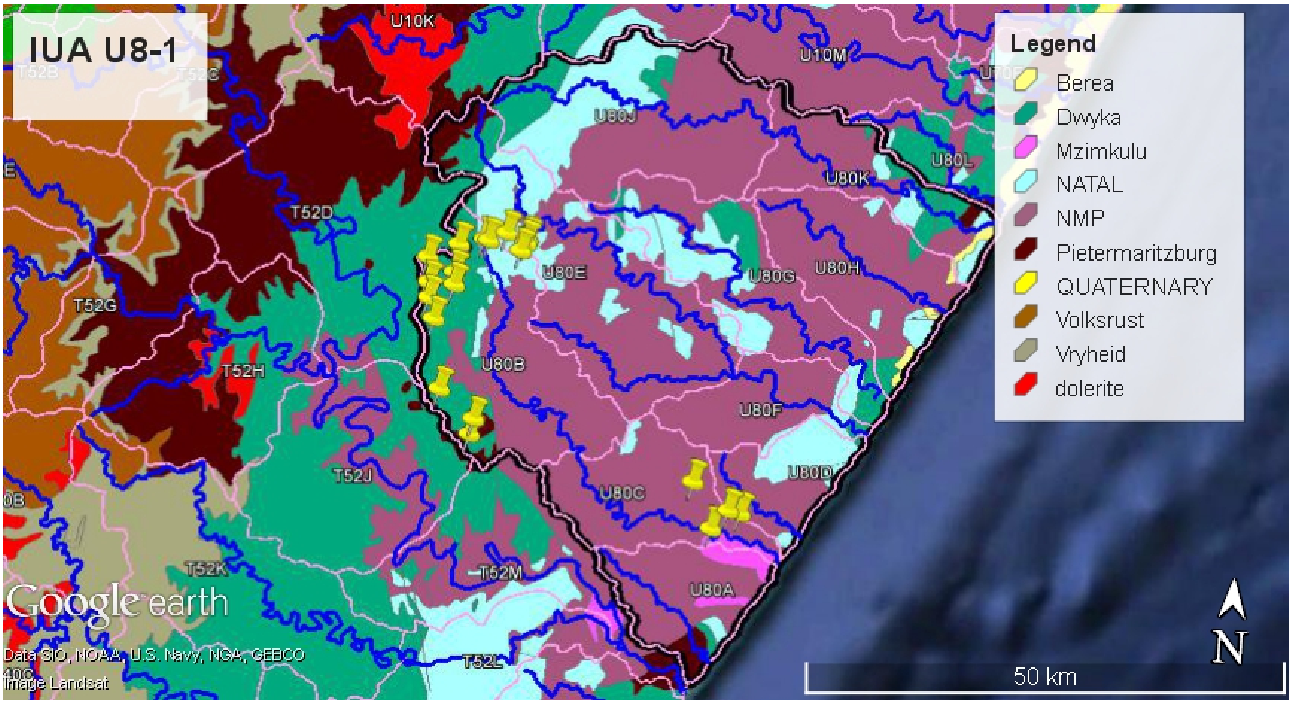

Figure 3-27 Geological map of IUA U8-1 showing location of chemistry data sampling points

3.27.2 Groundwater use and resources

Groundwater use is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 24-29%, with the remainder generating baseflow via interflow. (Table 3.79)

The present status is at the Recommended Ecological Class (REC) in these Quaternaries.

Table 3-79 Groundwater use and resources in IUA U8-1

	U80B	U80C
Recharge (Mm^3/a)	*16.45*	*15.99*
Aquifer recharge (Mm^3/a)	*4.70*	*3.76*
Harvest Potential (Mm^3/a)	*10.68*	*7.27*

Total Use (Mm³/a)	*0.393*	*0.203*
Stress Index	*0.084*	*0.054*
Status	*B-Largely Natural*	*B-Largely Natural*
Present Class	*I*	*I*

3.27.3 Borehole yields and quality

Borehole yields in the IUA are low.

Groundwater quality is DWS Class 0-1, Ideal to Good in U80B, however most of the data is from the minority of the catchment underlain by tillites, and not by the predominant Natal Metamorphic Province. In U80C water quality varies from Ideal to Marginal, with Nitrates fluoride and salinity occurring near the coast. (Table 3.80)

Table 3-80 Borehole yields and quality in IUA U8-1

		U80B	U80C
Average borehole yield (l/s)		*0.06*	*0.3*
Present Class		II	II
TDS quality class	*0*	*17*	*1*
	1		*2*
	2		*1*
	3		
	4		
Nitrate quality class	*0*	*16*	*3*
	1	*1*	
	2		*1*
	3		
	4		
Fluoride quality class	*0*	*17*	*3*
	1		
	2		*1*
	3		
	4		

3.27.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 18-21% of baseflow is from the regional aquifer, the remainder originating as interflow.(Table 3.81)

Table 3-81 Groundwater contribution to baseflow in IUA U8-1

	U80B	U80C
Baseflow (Mm³/a)	*14.88*	*14.84*
Groundwater baseflow Component (Mm³/a)	*3.13*	*2.61*
Interflow component (Mm³/a)	*11.75*	*12.23*
Total Use (Mm³/a)	*0.393*	*0.203*
Simulated groundwater baseflow under current abstraction (Mm³/a)	*2.99*	*2.56*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm³/a)	*13.51*	*14.35*
Baseflow reduction (%)	*9.2*	*3.3*
EWR Low flow (Mm³/a)	*5.92*	*18.23 (U80B-C)*
Target EC	*B*	*B*

PES	*B*	*B*

3.27.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low borehole yields imply that over abstraction on a regional scale is unlikely.

The Groundwater component of baseflow is only 18-21%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities is not significant and has reduced baseflow by 3-9%.

The IUA is of moderate aquifer vulnerability. The IUA is predominantly rural with scattered rural villages located throughout. There is some forestry and cultivation located in the upper reach of the IUA. The potential risk for regional groundwater contamination is low. There is the potential for elevated fluorides due to the lower to middle reaches of the IUA being underlain by the Natal Metamorphic Province but this cannot be observed in the monitoring data. All of the monitoring boreholes located in U80B are located on Dwyka tillites, hence the data does not reflect conditions across the catchment. The boreholes in U80C reflect higher fluoride concentrations.

The IUA is ungauged and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.27.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
35	*U80B-C*	*Significant ground water abstraction within 200m of a perennial channel should be restricted.* *All users to comply with existing* *allocation schedules and individual licence conditions* *within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes*	*The sustainable volume of groundwater abstraction is 5.5 Mm^3/a evenly distributed in both time and space Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l.*

3.28 IUA U8-2 MTWALUME

3.28.1 Hydrogeology

This area is underlain By GRU 35, catchments U80E-F, which is the catchment of the Mtwalume.

GRU 35 is underlain largely by the Natal Metamorphic Province, with Natal Group sandstones outcropping in the upper reaches of U80E.

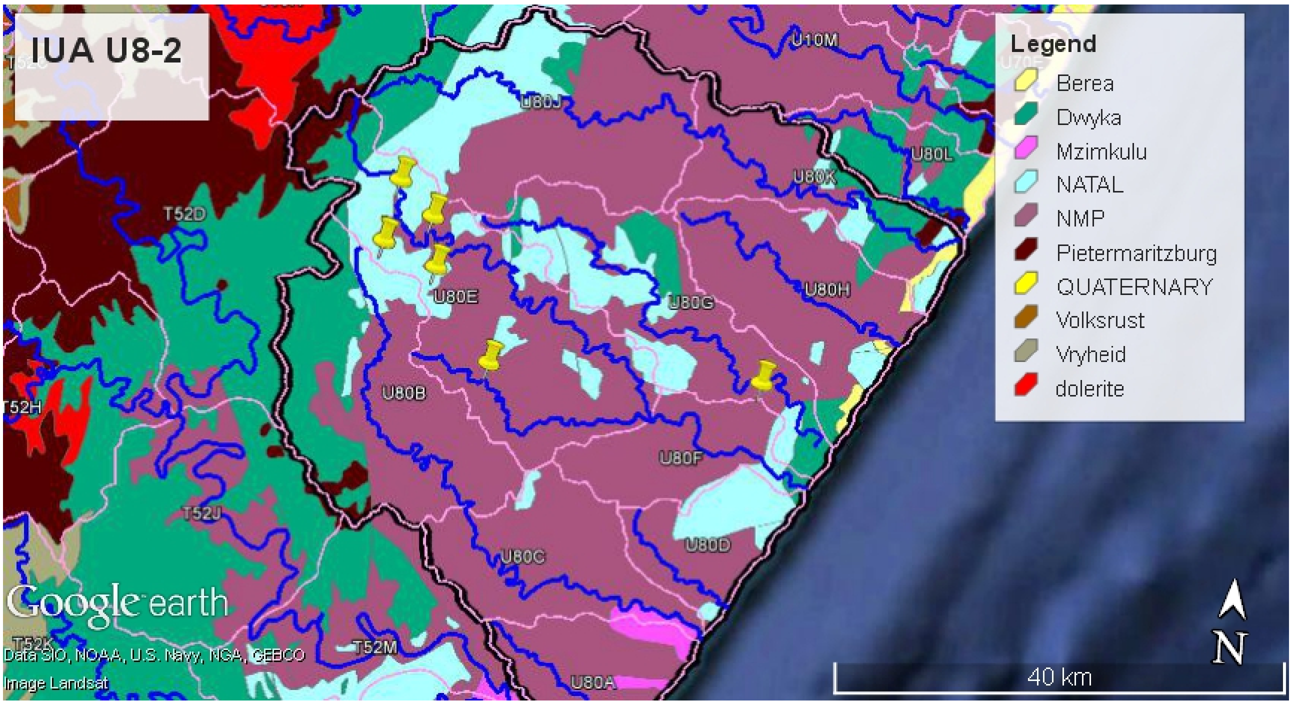

Figure 3-28 Geological map of IUA U8-2 showing location of chemistry data sampling points

3.28.2 Groundwater use and resources

Groundwater use is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is only 20-25%, with the remainder generating baseflow via interflow. (Table 3.82)

The present status is above the Recommended Ecological Class (REC) in these Quaternaries.

Table 3-82 Groundwater use and resources in IUA U8-2

	U80E	U80F
Recharge (Mm^3/a)	*22.63*	*9.88*
Aquifer recharge (Mm^3/a)	*4.53*	*2.47*
Harvest Potential (Mm^3/a)	*18.05*	*4.52*
Total Use (Mm^3/a)	*0.306*	*0.020*
Stress Index	*0.068*	*0.008*
Status	*B-Largely Natural*	*A-Unmodified*
Present Class	*I*	*I*

3.28.3 Borehole yields and quality

Borehole yields in the IUA are low.

Groundwater quality is DWS Class 0-1, Ideal to Good however there can potentially be high fluorides due to the extensive areas underlain by the Natal Metamorphic Province. (Table 3.83)

Table 3-83 Borehole yields and quality in IUA U8-2

	U80E	U80F
Average borehole yield (l/s)	*0.1*	*0.09*
Present Class	II	II

		U80E	U80F
TDS quality class	0	5	1
	1		
	2		
	3		
	4	1	
Nitrate quality class	0	5	1
	1	1	
	2		
	3		
	4		
Fluoride quality class	0	4	1
	1		
	2	1	
	3	1	
	4		
	Maximum (mg/l)	3.09	

3.28.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 16-18% of baseflow is from the regional aquifer, the remainder originating as interflow.(Table 3.84)

Baseflow reduction occurs in U80E, however, the PES is at the recommended target EC.

Table 3-84 Groundwater contribution to baseflow in IUA U8-2

	U80E	U80F
Baseflow (Mm^3/a)	21.43	9.08
Groundwater baseflow Component (Mm^3/a)	3.33	1.67
Interflow component (Mm^3/a)	18.1	7.41
Total Use (Mm^3/a)	0.306	0.020
Simulated groundwater baseflow under current abstraction (Mm^3/a)	3.23	1.67
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	17.01	8.89
Baseflow reduction (%)	20.6	2.1
EWR Low flow (Mm^3/a)	7.9	3.71 (U80E-F)
Target EC	C	B
PES	C	B/C

3.28.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The low borehole yields imply that over abstraction on a regional scale is unlikely.

The Groundwater component of baseflow is only 16-18%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities are significant in the upper part of the IUA and have reduced baseflow by 21% in U80E.

U80E is of moderate aquifer vulnerability and U80F is of high vulnerability. Land use activities generally include cultivation and some forestry in the middle and upper reaches. Rural villages are *also scattered throughout the IUA with semi-urban and urban areas located along the coast. Consequently, the risk for groundwater is low in the upper reaches and moderate to high in the lower reaches. The IUA is largely underlain by the Natal Metamorphic Province, hence the risk of elevated fluorides exists. Only one monitoring borehole exists in U80F. The boreholes in U80E are largely in the Natal Group samples. Consequently, the available data is not representative of catchment conditions.*

The IUA is ungauged and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.28.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	Baseflow	Water Level	Water Quality	
35	*U80E-F*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride levels and fluoride needs to be tested for domestic boreholes The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*The sustainable volume of groundwater abstraction is 4.55 Mm^3/a evenly distributed in both time and space Boreholes used for long term primary water supply should have a Fluoride concentration of below 1.5 mg/l.*

3.29 IUA SC SOUTHERN COASTAL CLUSTER

3.29.1 Hydrogeology

This area is underlain By GRUs 3 (T40F-G), 35 (U80A, D, G-K, and GRU 36 (U80L).

GRU 3 and 35 are underlain by the Natal Metamorphic Province, Natal Group sandstones, and Dwyka tillites.

GRU 36 is underlain largely by Dwyka tillites with some outcrop of the Natal Metamorphic Province.

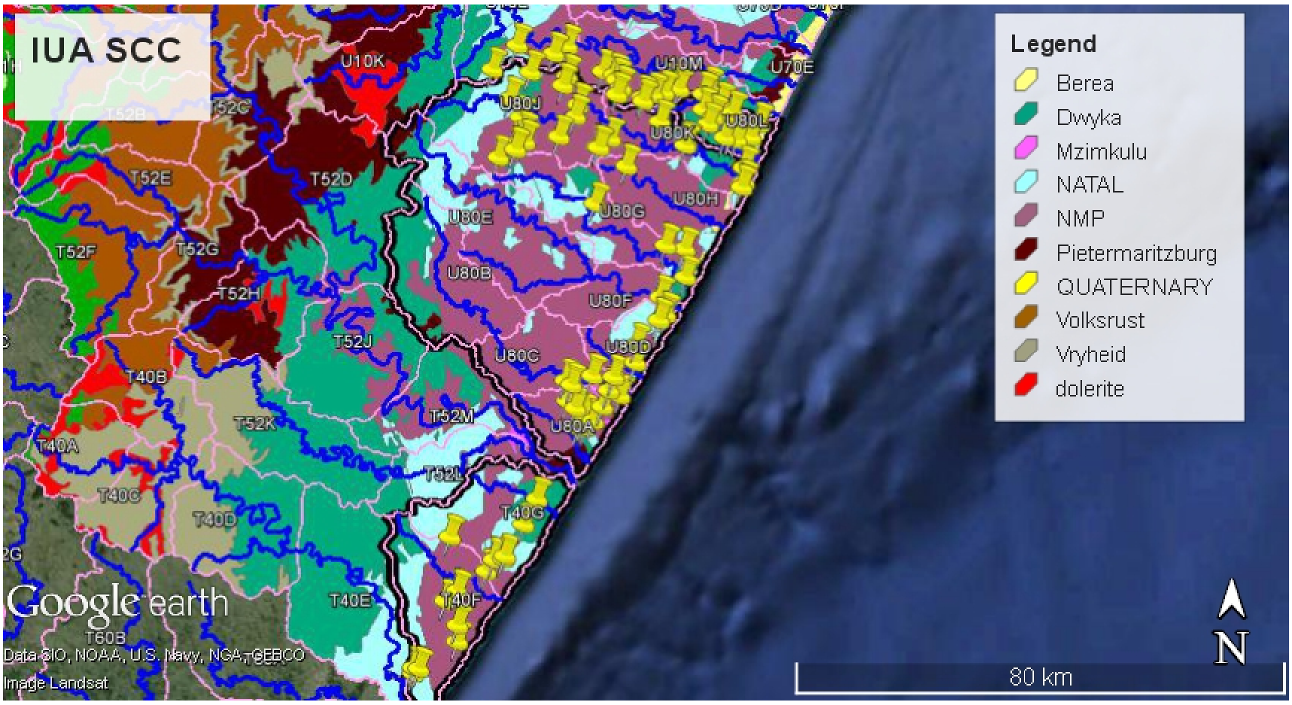

Figure 3-29 Geological map of IUA SCC showing location of chemistry data sampling points

3.29.2 Groundwater use and resources

Groundwater use in the IUA is minimal. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer in GRU4 (aquifer recharge) is only 14-21%, with the remainder generating baseflow via interflow.(Table 3.85)

The present status is at or above the Recommended Ecological Class (REC) in these Quaternaries.

Table 3-85 Groundwater use and resources in IUA SC

	T40F	T40G	U80A	U80D	U80G	U80H	U80J	U80K	U80L
Recharge (Mm^3/a)	42.17	37.56	15.53	11.95	18.95	23.18	21.31	13.59	8.48
Aquifer recharge (Mm^3/a)	14.18	12.52	3.27	2.52	4.74	4.88	5.50	3.40	2.12
Harvest Potential (Mm^3/a)	15.96	10.52	5.42	3.57	14.60	8.45	17.75	5.89	2.58
Total Use (Mm^3/a)	0.718	0.334	0.056	0.082	0.031	0.055	0.187	0.140	0.007
Stress Index	0.051	0.027	0.017	0.033	0.007	0.011	0.034	0.041	0.003
Status	B-Largely Natural	A-Unmodified	A-Unmodified	A-Unmodified	A-Unmodified	A-Unmodified	A-Unmodified	A-Unmodified	A-Unmodified
Present Class	I	I	I	I	I	I	I	I	I

3.29.3 Borehole yields and quality

Borehole yields in the IUA are low.

Groundwater quality is highly variable with regards to nitrates and Fluorides and varies from DWS Class 0-4. (Table 3.86)

Table 3-86 Borehole yields and quality in IUA SC

		T40F	T40G	U80A	U80D	U80G	U80H	U80J	U80K	U80L
Average borehole yield (l/s)		*0.3*	*0.53*	*1.06*	*0.32*	*0.35*	*0.06*	*0.04*	*0.07*	*0.05*
Present Class		III	II	III	II	II	II	II	II	III
TDS quality class	*0*	*8*	*2*	*5*	*4*	*9*	*2*	*10*	*7*	*4*
	1	*3*	*3*	*9*	*1*	*1*	*1*	*2*	*8*	*6*
	2					*1*		*2*	*2*	*1*
	3									
	4									
Nitrate quality class	*0*	*10*	*4*	*14*	*4*	*7*	*3*	*13*	*9*	*10*
	1	*1*			*1*	*3*			*3*	
	2		*1*						*2*	
	3					*1*			*3*	*1*
	4							*1*		
	Maximum (mg/l)					*25.78*		*42.08*	*28.53*	*27.15*
Fluoride quality class	*0*	*3*	*2*	*4*	*4*	*9*	*2*	*9*	*6*	*3*
	1	*1*	*1*	*3*		*1*		*2*	*3*	*2*
	2	*3*	*1*	*3*			*1*	*2*	*4*	*1*
	3	*4*	*1*	*3*	*1*	*1*		*1*	*3*	*4*
	4			*1*					*1*	*1*
	Maximum (mg/l)			*3.54*	*1.57*	*1.52*		*1.79*	*4.52*	*16.89*

3.29.4 Groundwater contribution to baseflow

Groundwater abstraction has a minimal impact on groundwater baseflow in this IUA. Only 16-19% of baseflow is from the regional aquifer in GRU5, the remainder originating as interflow. (Table 3.87)

Table 3-87 Groundwater contribution to baseflow in IUA SC

	T40F	T40G	U80A	U80D	U80G	U80H	U80J	U80K	U80L
Baseflow (Mm^3/a)	*33.79*	*30.51*	*14.5*	*11.2*	*17.53*	*21.71*	*19.52*	*12.61*	*7.86*
Groundwater baseflow Component (Mm^3/a)	*5.8*	*5.47*	*2.24*	*1.77*	*3.32*	*3.41*	*3.88*	*2.42*	*1.5*
Interflow component (Mm^3/a)	*27.99*	*25.04*	*12.26*	*9.43*	*14.21*	*18.3*	*15.81*	*10.19*	*6.36*
Total Use (Mm^3/a)	*0.718*	*0.334*	*0.056*	*0.082*	*0.031*	*0.055*	*0.187*	*0.140*	*0.007*
Simulated groundwater baseflow Under current abstraction (Mm^3/a)	*5.7*	*5.42*	*2.21*	*1.75*	*3.31*	*3.38*	*3.81*	*2.38*	*1.5*
Simulated baseflow under current afforestation AIPs and groundwater abstraction (Mm^3/a)	*32.37*	*29.03*	*13.15*	*10.77*	*14.35*	*18.73*	*18.1*	*12.38*	*7.75*
Baseflow reduction (%)	*4.2*	*4.9*	*9.3*	*3.8*	*18.1*	*13.7*	*7.3*	*1.8*	*1.4*
EWR Low flow (Mm^3/a)	*9.33*	*8.05*				*8.13*		*2.55*	
Target EC	*B*	*B*			*B*	*C*	*B*	*C*	
PES	*B*	*B/C*			*B/C*	*C/D*	*B*	*C*	

3.29.5 Critical Characteristics for Setting RQOs

Groundwater use in the IUA is minimal. The yields in U80A appear to be moderate but the results are based on only 5 boreholes, one of which yields 4 l/s and rest all being under 0.4 l/s. The low borehole yields imply that over abstraction on a regional scale is unlikely.

The Groundwater component of baseflow is only 15-19%, hence the potential of groundwater abstraction to impact on baseflow is limited. Baseflow is largely derived by interflow, which can be significantly impacted by SFR activities. SFR activities are insignificant, except in U80G and H, where they have reduced baseflow by 14-18%.

Aquifer vulnerability is variable. U80J is of low vulnerability. U80G and K are of moderate vulnerability and the remainder of the catchments are of high vulnerability. Landuse activities in the IUA generally include cultivation (mostly sugar cane with some orchards) and some forestry plantations slightly inland. Rural settlements are usually located more inland with semi-urban and urban areas towards the coast. Consequently, the coastal strip is most at risk of groundwater contamination. Groundwater is generally of poor quality due to elevated fluorides since a large proportion of the IUA is underlain by the Natal Metamorphic Province, and due to elevated nitrates and salinity.

Except for U80G, which is gauged at UH8001, the IUA is ungauged and only mean annual recharge is calibrated against data in the GRA2 database, hence results are of low confidence.

The Harvest Potential is greater than the aquifer recharge hence the sustainable abstractable volume is assumed to be 65% of aquifer recharge.

3.29.6 Narrative and Numerical RQOs

GRU	Quat	Groundwater narrative RQO				Groundwater numerical RQO
		Abstraction	**Baseflow**	**Water Level**	**Water Quality**	
3, 35 and 36	*T40F-G U80A, D, G-L*	*Significant ground water abstraction within 200m of a perennial channel should be restricted. All users to comply with existing allocation schedules and individual licence conditions within the Harvest Potential*	*Due to the low groundwater use, monitoring not required*	*Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required*	*Some boreholes have elevated natural fluoride, nitrate and salinity levels and quality needs to be tested for domestic boreholes The aquifer is of high vulnerability. Activities that could cause groundwater contamination should be restricted 50 m from water supply boreholes.*	*Boreholes used for long term primary water supply should have a fluoride concentration of below 1.5 mg/l and nitrate levels below 20 mg/l*

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 PRIORITY MONITORING AREAS FOR WATER LEVEL AND ABSTRACTION

Based on the level of groundwater stress (stress index of abstraction to aquifer recharge), the following catchments can be considered as priority areas for monitoring abstraction and groundwater level:

Catchment	*Stress Index*
U40B	*0.198*
U50A	*0.358*

4.2 PRIORITY MONITORING AREAS FOR BASEFLOW REDUCTION

Based the degree of baseflow reduction and the extent where the PEC does not meet the PEC due to the baseflow reduction, the following catchments have been identified where low flow monitoring via gauging stations is relevant:

Current PES < target EC

Catchment	*Baseflow reduction*
T52A	*28%*
U10G	*17%*
U20B	*15%*

Baseflow reduction >50%

Catchment	*Baseflow reduction*
T40B	*72 %*
U40A	*77%*
U40B	*57%*
U60B	*54%*
U70A	*75%*

5 REFERENCES

Department of Water Affairs and Forestry (DWAF), South Africa. 2004. Internal Strategic Perspective: Umvoti to Mzimkulu Water Management Area: Prepared by Tlou & Matji (Pty) Ltd, WRP (Pty) Ltd, and DMM cc on behalf of the Directorate: National Water Resource Planning (East). DWAF Report No. P WMA 11/000/00/0304.

Department of Water Affairs (DWA), South Africa. 2011. Classification of Significant Water Resources in the Mvoti to Umzimkulu Water Management Area (WMA 11): Scoping Report. Report No: RDM/WMA11/00/INT/CLA/0112. September 2011.

Department of Water Affairs (DWA), South Africa. 2012. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Mzimkhulu Water Management Area. Inception Report. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. September 2012.

Department of Water Affairs (DWA), South Africa. 2013. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Resource Units and EWR sites. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. Report Number: RDM/WMA11/00/CON/CLA/0213. July 2013.

Department of Water Affairs (DWA), South Africa. 2014. Groundwater Resource Directed Measures: Mvoti to Umzimkulu Water Management Area. Prepared by: SRK Consulting (Pty) Ltd. Report Number: 4111183/2. June 2014

Parsons, R. and Wentzel, J. (2007). Setting Resource Directed Measures (RDM) for Groundwater: a Pilot Study. WRC Report No TT 299/07.

6 APPENDIX A: CATCHMENT INFORMATION

AFFORESTATION AND ALIEN VEGETATION									
Quaternary Catchment	**WRSM2000 Network**	**Area of Afforestation (km²)**	**Percentage split (%)**			**Area of Alien Vegetation (km²)**	**Percentage split *%)**		
			Pine	**Eucalyyptus**	**Wattle**		**Tall Trees**	**Medium Trees**	**Tall Shrubs**
U10A	U101	2.30	100.00			1.40	92.93	4.47	2.6
U10B	U101	8.70	100.00			6.50	93.26	5.29	1.45
U10C	U101	39.00	100.00			4.10	89.61	9.87	0.52
U10D	U101	15.30	100.00			4.50	56.87	13.04	30.09
U10E	U101	41.60	100.00			3.70	83.36	12.98	3.66
U10F	U102	24.20	100.00			3.00	77.50	9.70	12.80
U10G	U102	26.20	99.85	0.15		2.90	52.89	14.70	32.41
U10H	U102	112.50	71.79	27.51	0.70	3.70	50.10	13.81	36.10
U10J	U102	99.60	24.90	65.25	9.85	4.20	51.81	12.25	35.94
U10K	U102	62.80	2.42	87.92	9.66	4.40	58.90	7.70	33.40
U10L	U102	12.50	0.00	92.48	7.52	2.70	48.31	12.34	39.35
U10M	U102	0.00				2.70	21.58	23.43	54.99
Total U10		444.70				43.80			
U20A	U201	45.80	52.67	45.25	2.07	6.80	63.79	4.03	32.18
U20B	U202	42.70	88.02	11.98	0.00	7.70	60.83	5.64	33.53
U20C	U203	36.20	25.23	74.77	0.00	6.30	62.35	5.04	32.62
U20D	U204	72.30	94.23	4.98	0.79	2.90	39.78	10.74	49.47
U20E	U205	101.40	63.97	25.71	10.32	2.20	47.43	13.68	38.89
U20F	U206	160.80	31.91	34.21	33.88	9.40	20.32	4.87	74.81
U20G	U207	38.10	8.54	32.05	59.41	10.50	20.24	4.79	74.97
U20H	U208	5.60	90.81	9.19	0.00	1.60	43.34	10.92	45.74
U20J	U209	20.60	8.56	0.00	91.44	5.90	54.17	12.42	33.41
U20K	U210	5.60	4.80	0.00	95.20	2.20	45.57	10.85	43.58

AFFORESTATION AND ALIEN VEGETATION									
Quaternary Catchment	WRSM2000 Network	Area of Afforestation (km²)	Percentage split (%)			Area of Alien Vegetation (km²)	Percentage split *%)		
			Pine	Eucalyyptus	Wattle		Tall Trees	Medium Trees	Tall Shrubs
U20L	U210	0.00				1.90	49.74	11.74	38.52
U20M	U210	0.00				24.10	12.17	34.90	52.92
Total U20		529.10				81.50			
U30A	U301	2.50	48.99	0.00	51.01	0.00	41.16	14.97	43.88
U30B	U301	0.00				37.60	7.81	37.97	54.22
U30C	U302	1.50	0.00	38.06	61.94	0.00	39.76	15.86	44.38
U30D	U302	0.00				26.50	7.60	38.16	54.25
U30E	U302	0.00				6.60	7.28	35.44	57.28
Total U30		4.00				70.70			
U40A	U401	178.60	16.45	29.42	54.12	66.00	54.44	0.75	44.81
U40B	U401	170.70	22.93	20.40	56.68	47.20	39.65	1.19	59.17
U40C	U401	75.90	9.79	24.37	65.85	5.50	19.87	4.78	75.35
U40D	U401	24.20	1.86	11.08	87.06	9.50	14.16	3.20	82.64
U40E	U401	4.80	77.55	0.00	22.45	2.30	46.57	11.01	42.42
U40F	U401	116.10	34.02	5.29	60.69	15.10	7.22	1.72	91.07
U40G	U401	0.00				2.50	41.82	9.90	48.28
U40H	U401	0.00				3.00	49.75	11.78	38.47
U40J	U401	2.60	0.00	100.00	0.00	2.20	12.06	27.43	60.52
Total U40		572.90				153.30			
U50A	U501	3.50	0.00	100.00	0.00	3.10	10.64	27.97	61.40
Total U50		3.50				3.10			
U60A	U601	47.50	95.64	1.10	3.27	0.60	48.59	13.05	38.35
U60B	U602	48.30	4.39	48.28	47.33	3.10	56.69	12.15	31.16
U60C	U602	0.50	0.00	100.00	0.00	10.70	68.69	12.64	18.68
U60D	U602	0.00				4.50	30.05	22.75	47.20

AFFORESTATION AND ALIEN VEGETATION									
Quaternary Catchment	**WRSM2000 Network**	**Area of Afforestation (km²)**	**Percentage split (%)**			**Area of Alien Vegetation (km²)**	**Percentage split *%)**		
			Pine	**Eucalyyptus**	**Wattle**		**Tall Trees**	**Medium Trees**	**Tall Shrubs**
U60E	*U603*	*4.50*	*0.00*	*100.00*	*0.00*	*3.20*	*23.50*	*22.59*	*53.91*
U60F	*U604*	*0.60*	*0.00*	*0.00*	*100.00*	*18.50*	*33.53*	*22.92*	*43.55*
Total U60		*101.40*				*40.60*			
U70A	*U701*	*73.00*	*28.71*	*71.29*	*0.00*	*9.40*	*69.08*	*1.44*	*29.48*
U70B	*U701*	*110.50*	*0.00*	*76.47*	*23.53*	*6.30*	*61.72*	*5.00*	*33.28*
U70C	*U701*	*22.80*	*0.00*	*62.28*	*37.72*	*2.70*	*43.87*	*14.18*	*41.95*
U70D	*U701*	*0.00*				*2.60*	*14.78*	*26.24*	*58.98*
U70E	*U702*	*0.00*				*1.20*	*2.49*	*31.54*	*65.97*
U70F	*U703*	*0.00*							
Total U70		*206.30*				*22.20*			
U80A	*U803*	*0.00*				*14.19*	*0.20*	*37.29*	*62.52*
U80B	*U804*	*25.00*	*0.00*	*100.00*	*0.00*	*2.90*	*24.94*	*21.97*	*53.09*
U80C	*U804*	*0.00*				*4.83*	*2.20*	*33.60*	*64.20*
U80D	*U805*	*0.00*				*4.41*	*0.86*	*32.61*	*66.53*
U80E	*U801*	*79.60*	*0.00*	*99.15*	*0.85*	*3.70*	*16.89*	*24.53*	*58.58*
U80F	*U801*	*1.60*	*0.00*	*100.00*	*0.00*	*1.60*	*2.45*	*31.41*	*66.14*
U80G	*U802*	*43.80*	*0.00*	*100.00*	*0.00*	*2.80*	*9.18*	*28.58*	*62.24*
U80H	*U806*	*30.16*	*0.00*	*100.00*	*0.00*	*2.19*	*4.55*	*30.59*	*64.86*
U80J	*U807*	*36.32*	*0.00*	*87.64*	*12.36*	*3.70*	*44.07*	*12.85*	*43.08*
U80K	*U807*	*0.78*	*0.00*	*100.00*	*0.00*	*1.74*	*8.80*	*28.79*	*62.41*
U80L	*U808*	*0.00*				*1.48*	*2.47*	*31.42*	*66.12*
Total U80		*217.26*				*43.54*			
Total U		*2079.16*				*458.74*			
T40A	*T40*	*9.00*	*99.34*	*0.66*		*12.80*	*34.65*		*65.28*
T40B	*T40*	*123.60*	*86.00*	*14.00*		*79.70*	*7.75*	*0.22*	*79.7*

AFFORESTATION AND ALIEN VEGETATION									
Quaternary Catchment	**WRSM2000 Network**	**Area of Afforestation (km^2)**	**Percentage split (%)**			**Area of Alien Vegetation (km^2)**	**Percentage split *%)**		
			Pine	**Eucalyyptus**	**Wattle**		**Tall Trees**	**Medium Trees**	**Tall Shrubs**
T40C	*T40*	*5.10*		*100.00*		*4.00*	*23.74*		*75.59*
T40D	*T40*	*9.60*	*0.00*	*88.49*	*11.51*	*11.10*	*74.69*	*6.51*	*18.8*
T40E	*T40*	*1.50*	*0.00*	*100.00*	*0.00*	*6.00*	*16.22*	*3.81*	*79.97*
T40F	*T401*	*2.80*				*7.60*	*12.02*	*9.48*	*78.50*
T40G	*T402*	*0.00*	*0.00*	*100.00*	*0.00*	*12.40*	*11.27*	*3.53*	*85.2*
Total T40		*151.60*				*133.60*			
T51A	*T51*	*6.40*	*92.00*	*1.00*	*7.00*	*3.70*	*79*	*21*	
T51B	*T51*	*17.40*	*78.00*	*22.00*		*2.50*	*70*	*30*	
T51C	*T51*	*69.80*	*32.00*	*63.00*	*5.00*	*15.60*	*26.00*	*74*	
T51D	*T51*	*10.00*	*78.00*	*22.00*		*1.10*	*71*	*29*	
T51E	*T51*	*37.60*	*61.00*	*33.00*	*6.00*	*9.00*	*35*	*65*	
T51F	*T51*	*16.80*	*52.00*	*47.00*	*1.00*	*4.60*	*51*	*49*	
T51G	*T51*	*15.50*	*96.00*	*4.00*		*4.70*	*37*	*63*	
T51H	*T51*	*29.10*	*29.00*	*71.00*		*14.60*	*0*	*100*	
T51J	*T51*	*17.50*	*43.00*	*57.00*		*10.10*	*2*	*98*	
Total T51		*220.10*				*65.90*			
T52A	*T52*	*89.40*	*79.00*	*13.00*	*8.00*	*15.60*	*5*	*95*	
T52B	*T52*	*16.80*	*0.00*	*100.00*		*11.80*		*100*	
T52C	*T52*	*69.00*	*3.00*	*67.00*	*30.00*	*14.30*		*100*	
T52D	*T52*	*78.70*	*12.00*	*59.00*	*29.00*	*44.10*	*2.00*	*98.00*	
T52E	*T52*	*63.40*	*97.00*	*3.00*		*5.90*		*100*	
T52F	*T52*	*125.80*	*91.00*	*9.00*		*14.30*		*100*	
T52G	*T52*	*23.50*	*72.00*	*21.00*	*7.00*	*13.70*		*100*	
T52H	*T52*	*9.30*	*0.00*	*100.00*		*17.70*	*4.00*	*96.00*	
T52J **	*T52*	*20.70*	*0.00*	*100.00*	*0.00*	*14.40*	*1.00*	*99.00*	

AFFORESTATION AND ALIEN VEGETATION									
Quaternary Catchment	WRSM2000 Network	Area of Afforestation (km²)	Percentage split (%)			Area of Alien Vegetation (km²)	Percentage split *%)		
			Pine	Eucalyyptus	Wattle		Tall Trees	Medium Trees	Tall Shrubs
*T52K ***	*T52*	*167.20*	*6.00*	*78.00*	*16.00*	*20.60*	*3.00*	*97.00*	
*T52L ***	*T52*	*24.00*	*0.00*	*80.00*	*20.00*	*4.10*	*22.00*	*10.00*	*68.00*
*T52M ***	*T52*	*24.10*	*100.00*	*0.00*	*0.00*	*11.50*	*27.00*	*9.00*	*64.00*
Total T52		*711.90*				*188.00*			
Total T in WMA 11		*1455.30*				*587.00*			
TOTALS WMA 11 (2004)		*3534.46*				*1045.74*			

*Note : ** Includes sugar cane (100% Pine)*

7 APPENDIX B: REPORT COMMENTS

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Comments from DWS (PMC) May 2015				
		First and foremost, the RQOs need to indicate the condition that the resource needs to be in at any given time	*Y*	*The PES and target EC was added for each catchment*
		Refer to the table below and apply the comments throughout the report, the statement "monitoring not required" appears frequently in the report - does it mean that there is no need to conduct groundwater monitoring in the area to monitor water levels on monthly and quarterly basis? KZN regional office is currently in the process of extending KZN monitoring network; and if this report can give the target areas where monitoring is required, then it will also be helpful. Please indicate where priority GRU's are and why they are regarded as priorities; also indicate the areas with risks. A section to identify the priority units for monitoring can be added.	*Y*	*A section in Chapter 2 (2.4) was added defining the criteria for which monitoring is required to monitor specific indicators.* *In Chapter 4 groundwater hotspots in terms of abstraction and baseflow reduction were identified as priority monitoring areas*
		The words 'groundwater use' in the IUA are used frequently with Minimal. Is it possible for the report to define what values indicate/represent **minimal or moderate.** *How do these categories (minimal/moderate etc.) link to Class I, Class II?*	*Y*	*Section 2.4 was added defining classification*
	Significant ground water abstraction within 200 m of a perennial channel should be restricted.	*At what abstraction rate? What is the technical rationale behind the 200 m?*	*Y*	*The rationale was described in 2.4. It is a calculation based on regionalized aquifer parameters and the distance at which abstraction has minimal impact on rivers over a dry season*
	Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not	*What should the objective be for managing the resource? i.e the water level should not exceed by ….(provide value).*	*Y*	*The reason was water level was not considered a good indicator is given in 2.4. Water levels vary by borehole topographic position relative to rivers, and provide only site specific information. In addition monitoring baseflow via boreholes requires a dense network of boreholes adjacent to rivers across a catchment, not a realistic monitoring option at a catchment scale. Baseflow can be monitored at existing gauging weirs.*

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	Some boreholes have elevated natural Fluoride levels which needs to be tested for domestic boreholes.	*Give the amounts of natural levels; and provide a narrative RQO*	*Y*	*Fluoride varies greatly, even within a lithology. Given the limited sampling, the actual range cannot be defined. The maximum recorded was provided for each catchment whether a class lower than II is observed.*
2.1	*the statement "Groundwater RQOs are developed to maintain the required groundwater contribution (groundwater baseflow) to the Ecological Reserve, which is assumed to equal the required maintenance low flow",*	*This is not the only reason why groundwater RQOs are determined. This statement should be linked with the 5th paragraph. Page 2-1.*	*Y*	*This was linked*
		er to the table above, are RQOs not set where there is no interaction between surface and groundwater? Please indicate the RQOs that are required where there is baseflows (groundwater-surface water interaction) and where there isn't but Groundwater is being utilised.	*N*	*There are no catchments with no baseflow consequently the same RQOs are potentially applicable in all catchments. In some the degree of impact is negligible, hence they are not a priority for monitoring. This is given in the RQO*
		ase structure your recommendations in the report to be aquifer specific; align the broad GRU units and come up with these aquifer specific RQOs utilising the existing reports [NSM] (Setting of Groundwater Resource Directed Measures (GRDM), March 2007. WRC Report No: TT 299/07 - Chapter 11; GRDM, 2011 Edition. WRC Project No: K8/891 - Section 5 and 6 and Procedures for development and implementation of RQO's, March 2-11); which are clear when recommending the determination of the RQO's.	*N*	*GRUs cannot be defined on a single lithology because in many cases due to topography the high lying areas are capped by one lithology, while slopes and valley bottoms underlain by another. Consequently, lithologies are grouped and the main lithology in the low lying areas where boreholes exist are the main criteria for a GRU. Consequently, a different RQO can't be set for a Natal Group cap compared to the NMP rocks in a valley bottom. Many of the Karoo Formations have similar lithologies and are distinguished only by sandstone/shale/ mudstone ratios. These are not sufficiently hydrogeologically different in terms of yield or quality.*
		Critical characteristics or attributes of the groundwater system to maintain the aquifer functionality must be set; these should include groundwater levels and gradients, groundwater quality, discharge volumes into rivers and groundwater abstraction at a localised scale;	*Y*	*A section was added to each IUA describing the critical characteristics in that IUA*

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		Key outcomes should be based on the type of risk posed to the resource and uses. Groundwater quality at a specific site must consider the water uses and set RQO's such that groundwater is protected, using specific parameters as reference conditions (e.g where there is an industry, indicate the risk that is associated with it and the variable put in place to protect against this);	*N*	*It is uncertain to which portion of the report this refers to. The report cannot address risks at specific industry localities as it is at regional scale. Consequently, only land uses which pose a risk are described. At a point scale it requires site specific criteria and since quality is variable even with a lithology, a general blanket condition cannot be applied at catchment scale.*
		RQOs developed during the GRDM process must ensure that the GRU is managed in an integrated manner; consider the GRDM and utilize it fully, work already done to date should be considered and utilised.	*N*	*The existing report of SRK was the basis for this report, except the hydrology was revised since many of the numbers in the SRK report did not fit the hydrology in WR2005 or 2012 and a water balance of recharge to baseflow and abstraction was not possible. Nor was water use by SFR activities given, which is a major impact in much of the study area*
		Under Section 2.8 of the report (incl Figure 2.1.7) which show aquifer vulnerability, aquifers which were reported as having a vulnerability of greater than 50% have not been delineated at aquifer, but rather at quart level (which is relevant to SW). It is important to identify these specific aquifer boundaries so that appropriate protection measures can be applied to these.	*N/Y*	*There is no section 2.8 nor a fig 2.1.7 in the report so it is unclear what this comment refers to.* *The aquifer vulnerability for each Quaternary as given by SRK was included for each IUA*
		Ideally groundwater level within a particular distance (200m is too broad) of river/groundwater fed surface water body should not be lowered by a certain depth. Frequency of monitoring must be defined such that groundwater is not negatively impacted on. Surface water team would have set the flows required in a river, therefore groundwater should also be given the appropriate level of protection;	*Y*	*The reason for 200 m buffer was given in 2.4 Why monitoring borehole levels is not feasible without a dense monitoring level was also given. It catchments where baseflow is largely interflow driven, groundwater levels will not predict impacts on baseflow and are only site specific information, whereas the EWR requires information on regional volumes of baseflow*
		The main purpose of this study was to provide practical and implementable RQO's that will be monitored to ensure that the classification of the groundwater unit is not compromised;	*Y*	*Why parameters that can be monitored, such as baseflow at existing gauging stations were selected over parameters that cannot, such as borehole levels within 50 m of rivers in a network of boreholes along all major rivers, were selected is given in 2.4.*

Page / Section	Report statement	Comments	Changes made?	Author comment
		It is said that the GRU's were obtained through the geological and topographical subdivision conducted per quaternary catchment resulting in 36 GRU's in the WMA. The executive summary provides general group description of geology in each of these GRU's. However, in the subsequent sections it is indicated that these GRU's can have a mixture of geology (i.e. GRU11 is underlain by Dwyka tillites, Natal Group Sandstones and the Natal Metamorphic Province). Reading the executive summary GRU 11 is only underlain by Middelveld Karoo but not reflected on subsequent sections.	*N*	*See explanation above for GRUs having a mixture of lithologies*
		The approach is aimed at developing RQO's to maintain the required baseflow to the Ecological Reserve and also protect groundwater resources, and the WRSM 2000 model was used to quantify surface water and groundwater and the interactions thereof. The assumptions and calibration approaches were provided but the **limitations** *of this modelling is not provided as is the case with all models. Further, that the* **level of confidence** *in the results should also be clearly indicated.*	*Y*	*With an objective to maintain he required baseflow for the Ecological Reserve, borehole water levels do not provide a suitable RQO as the level in a borehole cannot be translated to baseflow in a catchment. A borehole water level can remain constant, yet afforestation up or downstream can greatly reduce baseflow. A model calibrated against observed baseflow over a historic time series including changes in land use provides a more feasible option and future changes in land use can be simulated and verified against observed data* *Where the WRSM model is of high confidence due to calibration data being available, or where it is of low confidence due to lack of data, has been given.* *As the WRSM model is the standard in the RSA for providing the hydrology on which water resource planning is undertaken, it is an obvious tool on which to base scenarios of land or water use change impact on ecological flows.*
		Include a section indicating reports used and what they were used for;	*N*	*This was already provided in 2.1 and 2.2 and in 5.*
		The last question would be, as some data was obtained from the SRK groundwater reserve study, was the Groundwater Resource		*Yes SRK used the GRIP data. The project team felt that the SRK report had unrealistic use data due to duplication of data between*

Page / Section	Report statement	Comments	Changes made?	Author comment
		Information Project (GRIP) data in the WMA utilised?		*GRIP, the NGA and the hydrocensus. SRK revised the data and provided a new groundwater use data set with duplications removed. This new data set was used, which differs greatly form the original data in the SRK report. The yield, quality and water use data all include GRIP, according to SRK. This must be correct as SRK provided the team with the GRIP spreadsheets, as they utilised them*
Comments from Adaora July 1 2015				
		The CD and WMA has changed so that needs to be reflected on the report.	*Y*	*Reference to WMA11 removed and renamed Mvoti to Umzimkulu*
		What are the criteria used in prioritising RQOs?	*N*	*This was discussed in Chapter 4. The level of stress based on the stress index, the degree of baseflow reduction, and the current PES less than the target EC*
		Does the page xiv represent the prioritised RQOs?	*N*	*Yes*
		RQOs are not only important where there is groundwater and surface water interaction. A groundwater resource unit might not be linked to surface water but needs RQOs to be set due to its importance to its users. The use might be minimal but it might also be important to its users.	*N*	*Narrative and numerical RQOs were set for all GRUs regardless of use. All GRUs have interactions in this WMA*
		RQOs are set at resource unit level and not catchment level so when water level data are available, they help in the management of the resource unit.	*N*	*RQOs were set at GRU level, which are often several catchments*
		If we cannot set a water level for a resource unit where there is long term monitoring data, then why do we monitor boreholes in the first place.	*N*	*Monitoring water level is to monitor local overexploitation, which in most cases does not impact an entire catchment or GRU. Dropping water levels are only evident over the cone of depression of abstraction, which is localised. To monitor an entire catchment requires a dense network of monitoring boreholes.*
		The importance of the groundwater to its users and the threat posed to users were not considered and these help with the	*N*	*The importance of groundwater usein each IUA is described in 1.4, and is implicit in the Present Class allocated in each GRU (2.4.2).*

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		prioritisation of resource unit		*This class was assigned to each GRU and catchment in 3.x.2*