

Record Drilling Research Wells in the Karoo Basin*

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Abstract

With funding from South Africa's Centre of Excellence for Integrated Mineral and Energy Resource Analysis (CIMERA) and multiple international industry sponsors, the Karoo Research Initiative (KARIN) operated and successfully delivered two core research wells in the Tankwa Karoo (depth 670 meters) and Willowvale (depth 2380 meters) area.

Prior to a costly drilling program including potential hydraulic fracturing, explorers need to determine whether the organic rich shale's in the Karoo may have produced gas and if this gas is trapped and can it be produced. Ideally, this first exploration project could be executed by South African Geologists from local Universities and other institutions; that was the main reason why international sponsors supported the KARIN Research Project.

In order to analyse core samples, exploration drilling is required; the KARIN Research Project wanted this also be done by South African drilling companies.

The main purpose of drilling these wells was to demonstrate the latest state of core drilling process, with regards to Quality, Safety and Environmental Management, and to provide Geoscience researchers in South Africa with fresh rock samples for further analysis.

The second objective of the campaign was to prove the technical capabilities of South African drilling contractors for the execution of such a project to the level of international standards

These capabilities were known for decades in igneous and hard rock geology of the Witwatersrand. However, in the sedimentary formation of the Karoo Basin very important choices had to be made in terms of well design, drilling and hardware selection, mud system type, safety and environmental procedures.



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RECORD DRILLING RESEARCH WELLS IN THE KAROO BASIN

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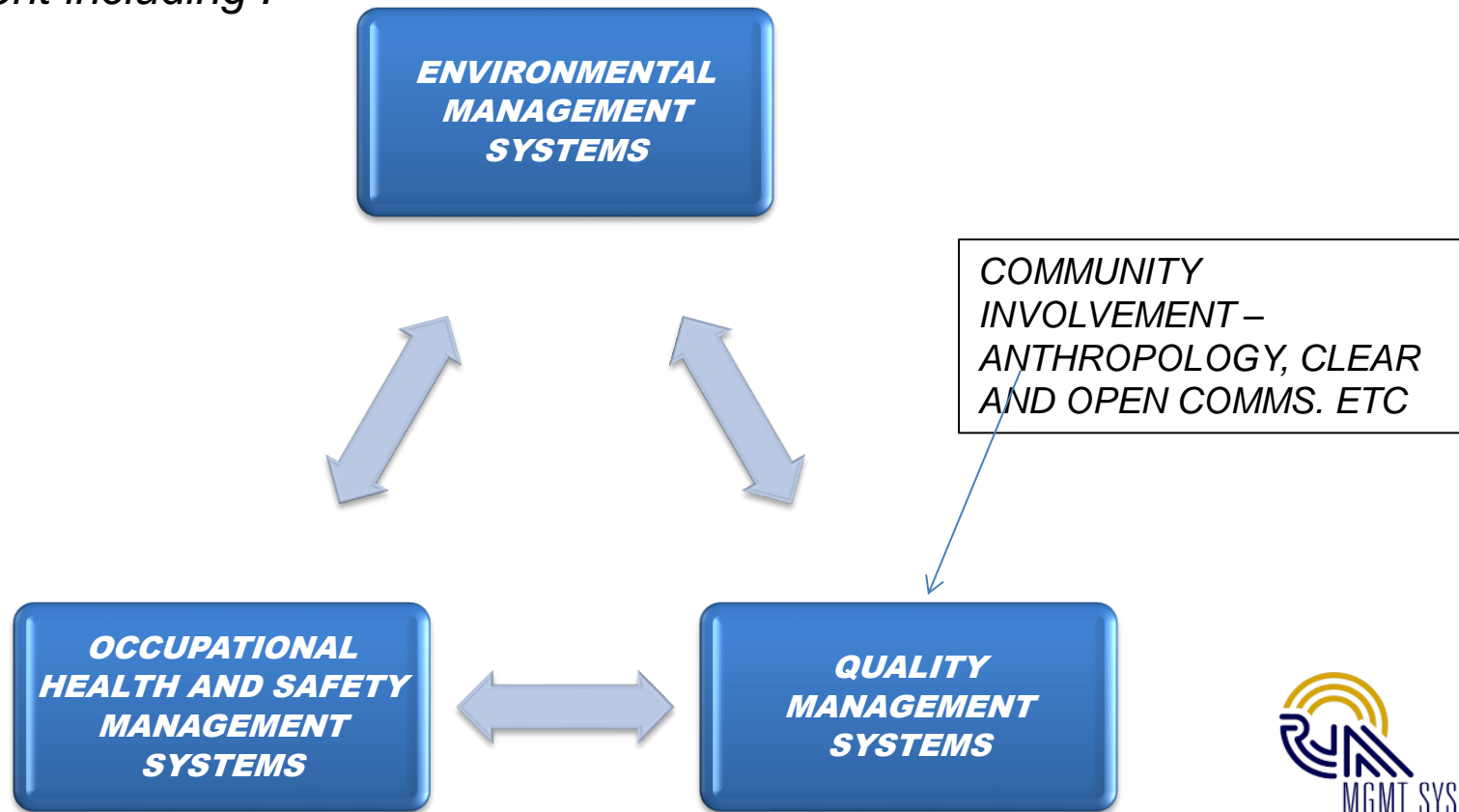




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The intent of this presentation is to provide information and reference material which will illustrate exploration drilling methodologies with regards to project and risk management including :



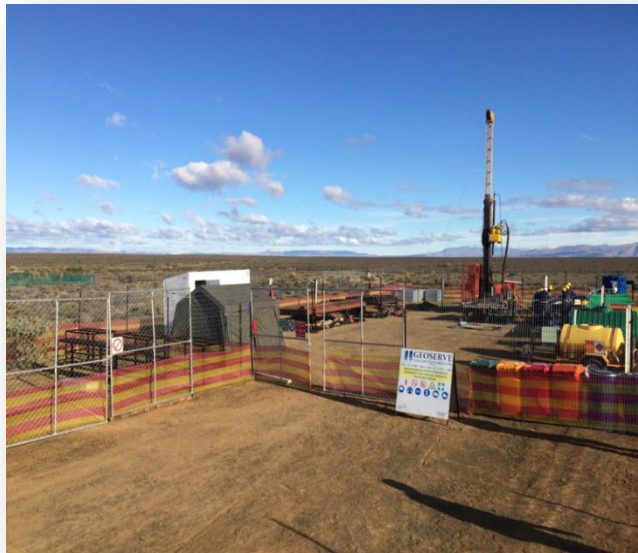


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2015 SCIENTIFIC DRILLING ACTIVITIES IN THE KAROO BASIN.

With funding from South Africa's Centre of Excellence for Integrated Mineral and Energy Resource Analysis (CIMERA) and multiple international industry sponsors, the Karoo Research Initiative (KARIN) operated and successfully delivered two core research wells in the Tankwa Karoo (depth 670 meters) and Willowvale (depth 2380 meters) area.





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As with any technically complex activity, appropriate planning helps to insure that set objectives can be achieved. This is particularly important in the sensitive Karoo Basin, where many eyes are focused on Environmental impact and carbon footprint.

The drilling operations at the Ceres site took place in July and August 2015, while the Willowvale well was drilled between September and December 2015. The total core lengths of almost 3000 meters make these wells record breakers in the Karoo Basin.

While successfully delivering the wells, Geoserve Drilling demonstrated that safe, low to almost zero impact on the environment, and cost effective drilling can be accomplished by South African Drilling contractors.

The core samples will assist South African geoscientists obtaining a better understanding of the Karoo geology and provide a sound foundation for future decision making and deferred exploration of shale gas.



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Only selected bidders were invited. Client required a commercial and a technical bid. As part of our service offer, Geoserve included the commercial plan in a suggested methodology drill hole plan. This created the opportunity for the client to compare actual cost to their budget program. (See schematic)

Part of bid requirements was that the successful contractor had to proof a technical procedure which includes Quality, Safety and Environmental Impact Management.

Other contributing factors for executing the drilling program successfully:

- The surface sump and SRU system which contributed to a “close too zero” Environmental Carbon footprint. .*
- Drill mud composition and mud treatment program – See SRU System*
- Drill bit design have been adopted to the very heterogeneous geological strata.*
- Installation and removal of the temporary casing was done to these depths first time within the Karoo-Basin*

These factors and systems led to perfect core quality and 100% core recovery too the complete satisfaction of the client and according to the tender requirements



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The Solids Removal Unit (SRU) is an innovative alternative to fluid sumps, proving highly beneficial for the environment, on-site health and safety, operational efficiency as well as delivering significant cost savings. The SRU's closed-loop system is transforming drilling operations worldwide, reducing environmental impact and footprint of the drill site.



**SIGNIFICANT COSTS SAVINGS
DELIVERING BOTTOM LINE RESULTS**



WATER COSTS REDUCED BY UP TO 80%



**MUD CONSUMPTION
REDUCED UP TO 75%**



**ELIMINATES SITE REMEDIATION AND
ENVIRONMENTAL MANAGEMENT COSTS**



**IMPROVED ON-SITE HEALTH
AND SAFETY CONDITIONS**

BENEFITS FOR DRILLING COMPANIES

- ◆ Quick and easy installation
- ◆ Saves time managing and mixing mud
- ◆ Reduced water consumption and cartage costs
- ◆ Reduced mud usage and associated costs
- ◆ Reduced slurry volume, waste cartage and disposal
- ◆ Increased KPIs and metres drilled
- ◆ Reduced wear and tear on drill components
- ◆ Improved bit on bottom time
- ◆ Less rod trips, pulling and reaming
- ◆ Eliminates the costs of digging sumps
- ◆ Reduced manual handling and labour required
- ◆ Improved on-site health and safety, reducing slips and hazards due to mess, mud and water.



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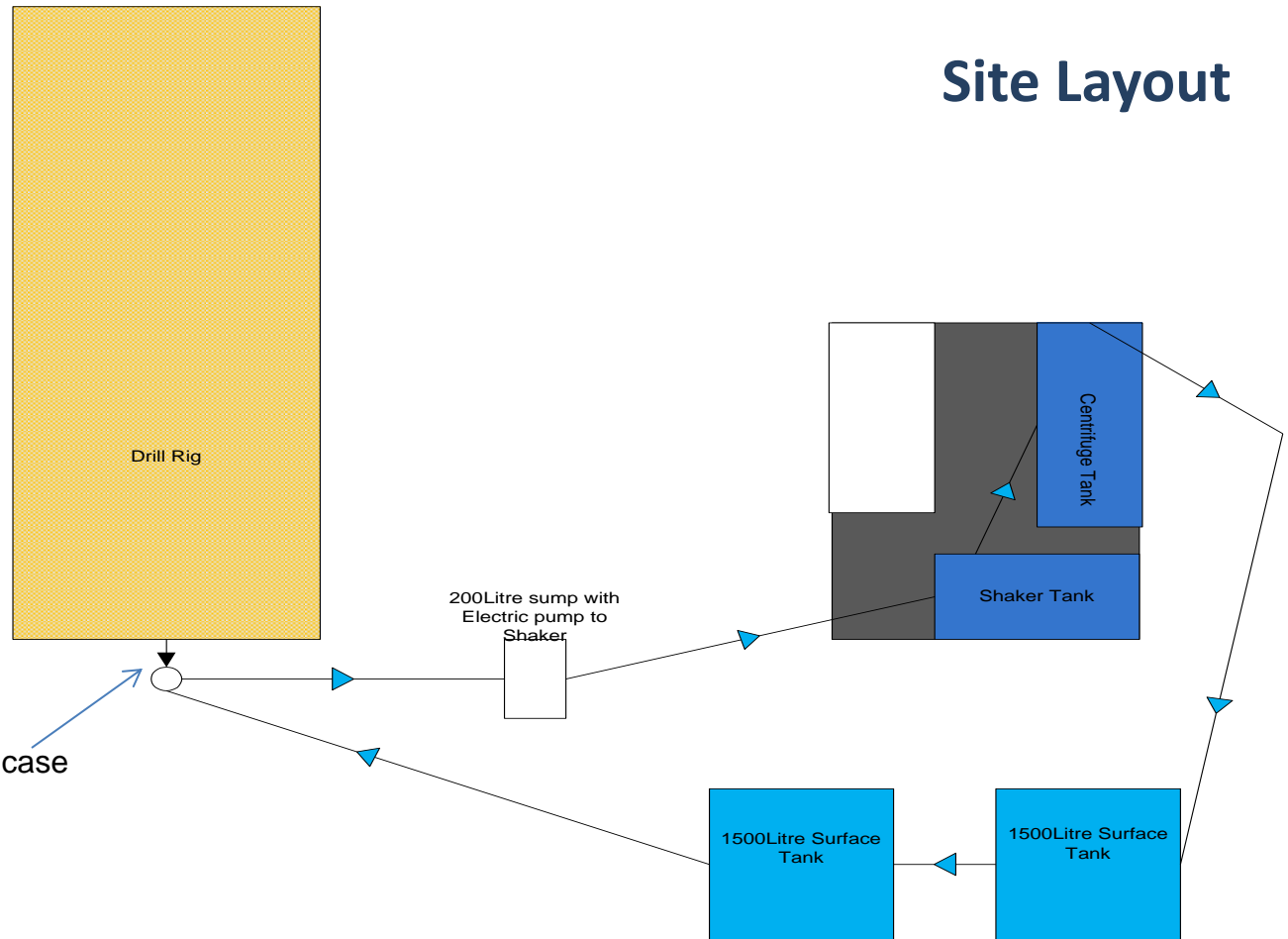




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- Drill Rig
- 200 Lt Pit
- Badger – Shaker/Tank
- Badger – Centrifuge/Tank
- First 1,500 Lt surface tank
- Second 1,500 Lt surface tank
- Return to Rig
- Drill Pad Dimensions
- Gas diverter (As backup in the case of potential blow out)





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GEOSERVE EXPLORATION DRILLING PTY LTD.

INTERNAL AUDIT TEAM SUMMARY

SPECIAL REPORT

QUALITY AND SHE

SHEQIA01/2015

GEOSERVE DRILLING SERVICES

PROJECT REPORT UPDATE – CIMERA KARIN PROJECT – ZANDFONTEIN 89

INTEGRATED MANAGEMENT SYSTEM (IMS)

- **OHSAS 18001:2007**
- **ISO 9001:2008**
- **ISO 14001:2004**
- **ISSUE BASED RISK ASSESSMENT**
- **ENVIRONMENTAL IMPACT ASSESSMENT**

SEPTEMBER 2015

PROJECT TEAM

N. MOGRIDGE – OPERATIONS MANAGER

E. CROUS – SHE MANAGER

E. VD BERG – SITE MANAGER 2.6.1

A. BIRCH – CLIENT REPRESENTATIVE 2.6.1



Project No.: CIMERA KARIN PROJECT – ZANDFONTEIN 89

Date: 2015/09/21

Form Ref.: GEOSERVE SAFETY, ENVIRONMENTAL AND QUALITY PLAN

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GEOSERVE EXPLORATION DRILLING - CERES DRILLING METHODOLOGY

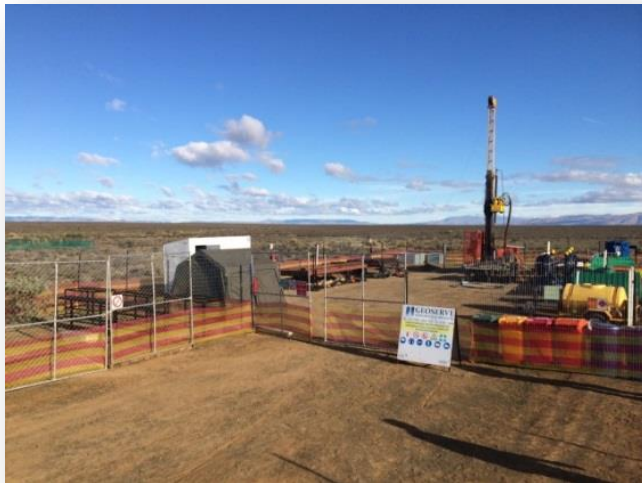
SIZE	DEPTH RANGE	COMMENT
PQ	0 -60M	DRILL PQ TO DEPTH OF 60M
HWS CASING	0 -60M	REAM HOLE TO 141MM WIDTH
	0-60M	INSTALL HWS CASING(114mm x 100mm) C/W STABILISERS/CENTRALISERS
		GROUT CASING IN ORDER TO SEAL FRESH WATER AQUAFER
GROUTING		GROUT HOLE AS PER GEOTECHNICAL REQUIREMENTS
DIVERTER		INSTALL DIVERTER
HQ	60M - 617,40M	DRILL HQ TO DEPTH OF 617,40M - STRONG WATER INTERCEPTED
NW Casing	0M - 617,40M	INSTALL 89,1mm x 76,4mm CASING
NQ	617,40M - 671M EOH	DRILL NQ/NQ2 TO END OF HOLE - 671M
EXTRACT ALL CASING EXCEPT 114mm CASING WHICH WAS GROUTED IN PLACE		
TALL PLUGS @ THE FOLLOWING DEPTHS & GROUT HOLE TO SURF/ 660M; 620M; 615M; 554M; 450M; 400M; 300M; 200M; 100M		
PLACE CAP/BEACON OVER HOLE		



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Model name	Age (Model)	Practical depth range (meters)*	Hole diameters (mm)*	Core sizes (mm)*
HR 6 SUITABLE FOR ANGLE HOLE DRILLING UP TO 60°	2012	1540M (BQ) 1200M (NQ) 800M (HQ) 475M (PQ)	60mm(BQ) 76mm(NQ) 96mm(HQ) 122mm(PQ)	36.4mm(BQ) 47.6mm(NQ) 63.5mm(HQ) 85.0mm(PQ)



UNIVERSITY OF JOHANNESBURG SCIENTIFIC DRILLING PROJECT TO EXPLORE FOR SHALE GAS IN THE KAROO BASIN



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INTERNAL AUDIT TEAM SUMMARY

SPECIAL REPORT

QUALITY AND SHE

SHEQIA01/2015

ACTIVITY

18/07/2015

Complete Site set up – demarcation, Emergency Procedure, Waste Control, Core Yard, Site office.



19/07/2015

DRILLING - START HOLE PQ3 – Drilled 3m



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QUALITY AND SHE
SHEQIA01/2015

ACTIVITY

23/07/2015

Grouted hole 60m. Waiting for cement to dry 24/07/2015. Installed Burn out pit in case of gas blow out.

24/07/2015

Site visit Aubrey Withers for Environmental Inspection. Prof N Beukes visit.



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ACTIVITY

27 AUGUST 2015 - HOLE COMPLETED END OF HOLE 671M. CREW ON BREAK TO RETURN ON 7 SEPTMEBER 2015

29 AUGUST 2015 - DOWNHOLE SUREVY COMPLETED

7 SEPTMEBER - START PLUGGING HOLE.

12 SEPTMEBER - HOLE PLUGGED AND REHAB COMMENCED



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INTERNAL REPORT SUMMARY

SPECIAL REPORT
QUALITY AND SHE
SHEQIA01/2015

GEOSERVE DRILLING SERVICES

PROJECT REPORT- CIMERA KARIN PROJECT - WILLOWVALE - KVV01

INTEGRATED MANAGEMENT SYSTEM (IMS)

- **OHSAS 18001:2007**
- **ISO 9001:2008**
- **ISO 14001:2004**
- **ISSUE BASED RISK ASSESSMENT**
- **ENVIRONMENTAL IMPACT ASSESSMENT**

AUG 2015 - JAN 2016

PROJECT TEAM

N. MOGRIDGE - OPERATIONS MANAGER

E. CROUS - SHEQ MANAGER

J BOTES - SITE MANAGER 2.6.1

A. BIRCH - CLIENT REPRESENTATIVE 2.6.1



KVV01 PRE - PROJECT

**KVV01 - (LO 25 CAPE) - SOUTHING 32°14"08'
(LO 25 CAPE) - EASTING 28°35"08'
ELEVATION (amsl) - 263m**



KVV01 POST PROJECT

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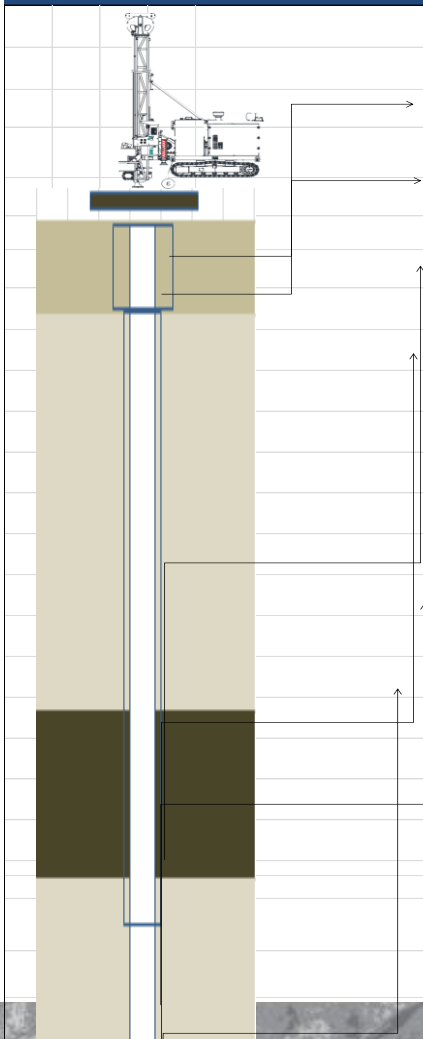




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GEOSERVE EXPLORATION DRILLING - WILLOWVALE DRILLING METHODOLOGY

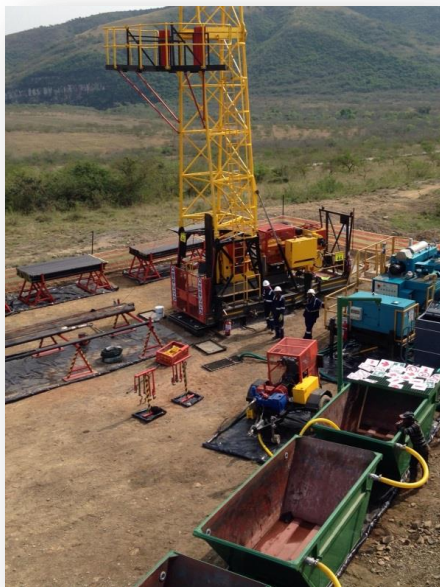
	SIZE	DEPTH RANGE	COMMENT
	PQ	0 -18M	SPUD - DRILL THROUGH OVERBURDEN PQ
	PWS Casing	0 -18M	REAM HOLE TO 141MM WIDTH
		0-18M	INSTALL 139,7mm x 125,5mm CASING
			GROUT CASING
	PQ	18M - 300M	DRILL PQ TO 300M
	HWS Casing	0 -300M	INSTALL 114mm x 100mm CASING
	TOE GROUT CASING	300M	CASING SHOE INSTALLED AT BOTTOM OF CASING
	DIVERTER		INSTALL DIVERTER
	HQ	300M - 1000M	DRILL HQ TO DEPTH OF 1000M
	NW Casing	0M - 1000M	INSTALL 89,1mm x 76,4mm CASING
	TOE GROUT CASING	1000M	CASING SHOE INSTALLED AT BOTTOM OF CASING
	NQ	1000M - 2353,39M	DRILL NQ/NQ2 TO END OF HOLE
	EXTRACT ALL CASING EXCEPT 141mm CASING WHICH WAS GROUTED IN PLACE		
	PLACE CAP/BEACON OVER HOLE		



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Model name	Age (Model)	Practical depth range (meters)*	Hole diameters (mm)*	Core sizes (mm)*
<i>LY50 Spindle Type Rigs</i>	2010,2011	3000M (BQ)	60mm(BQ)	36.4mm(BQ)
		2400M (NQ)	76mm(NQ)	47.6mm(NQ)
		1500M (HQ)	96mm(HQ)	63.5mm(HQ)
		800 M (PQ)	122mm(PQ)	85.0mm(PQ)



UNIVERSITY OF JOHANNESBURG SCIENTIFIC DRILLING PROJECT TO EXPLORE FOR TRACES OF SHALE GAS IN THE KAROO BASIN – WILLOWVALE (**FINAL HOLE DEPTH – 2371M**)



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ACTIVITY

24 – 27 August 2015

Site Mobilization. Waterpoint allocated at river crossing. All working areas bunded – spillage control. Waterpump situated at river bunded and general local worker employed to monitor water pipeline for any water leaks etc. Machine cemented on 500cm block and bolted on for stability and prevention of rig falling over



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QUALITY AND SHE
SHEQIA01/2015

ACTIVITY

19/10/2015 – 24/10/2015

DEPTH – 1231,27m – 1402,27m

- DRILLING
- 6m SOLID CORE RECOVERY



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QUALITY AND SHE

SHEQIA01/2015

ACTIVITY

18/11/2015 – 27/11/2015

DEPTH 1897m – 2097m

- *BROKEN/SOLID FORMATION*
- *TRACES OF HIGHLY WEATHERED FORMATION*
- *IMPRINT OF PYRITIZED LEAF*
- *IMPRINT OF BLACK CARBON-RICH PLANT STEM*



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SHEQIA01/2015

28 - 29 JANUARY 2016 –

THE REHABILITATION OF THE DRILL SITE HAS BEEN CONDUCTED TO THE SATISFACTION OF THE FIELD MANAGER ALECK BIRCH. NO FURTHER MITIGATION ACTIONS WERE REQUIRED AS PER CLIENT GEOLOGIST. JACO BOTES (GEOSERVE SITE MANAGER) AND ALECK BIRCH (SITE GEOLOGIST) CONDUCTED OVER INSPECTION – NO NON CONFORMITIES LISTED. HOLE CAPPED. STANDPIPE INSERTED AND LOCKED.





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SHEQIA01/2015

10 JANUARY 2015

LIASED WITH LOCAL COMMUNITY CHIEF WITH REGARDS TO LOCAL EMPLOYMENT AND PROGRESS ON COMMUNITY HALL BUILDING PROJECT. (PROFESSOR BEUKES)



11 DECEMBER 2015 - 2353M – END OF HOLE – DWYKA FORMATION INTERSECTED

13 –27 JANUARY 2016 – DOWN HOLE ELECTRICAL LOGGING – WEATHERFORD. ALL DOWHOLE EQUIPMENT RETRIEVED.

21 JANUARY 2016 – OFFICIAL HANDOVER OF CHAMEMNYANGO COMMUNITY HALL. GEOSERVE HAS OVERSEEN THE CONSTRUCTION PROJECT.



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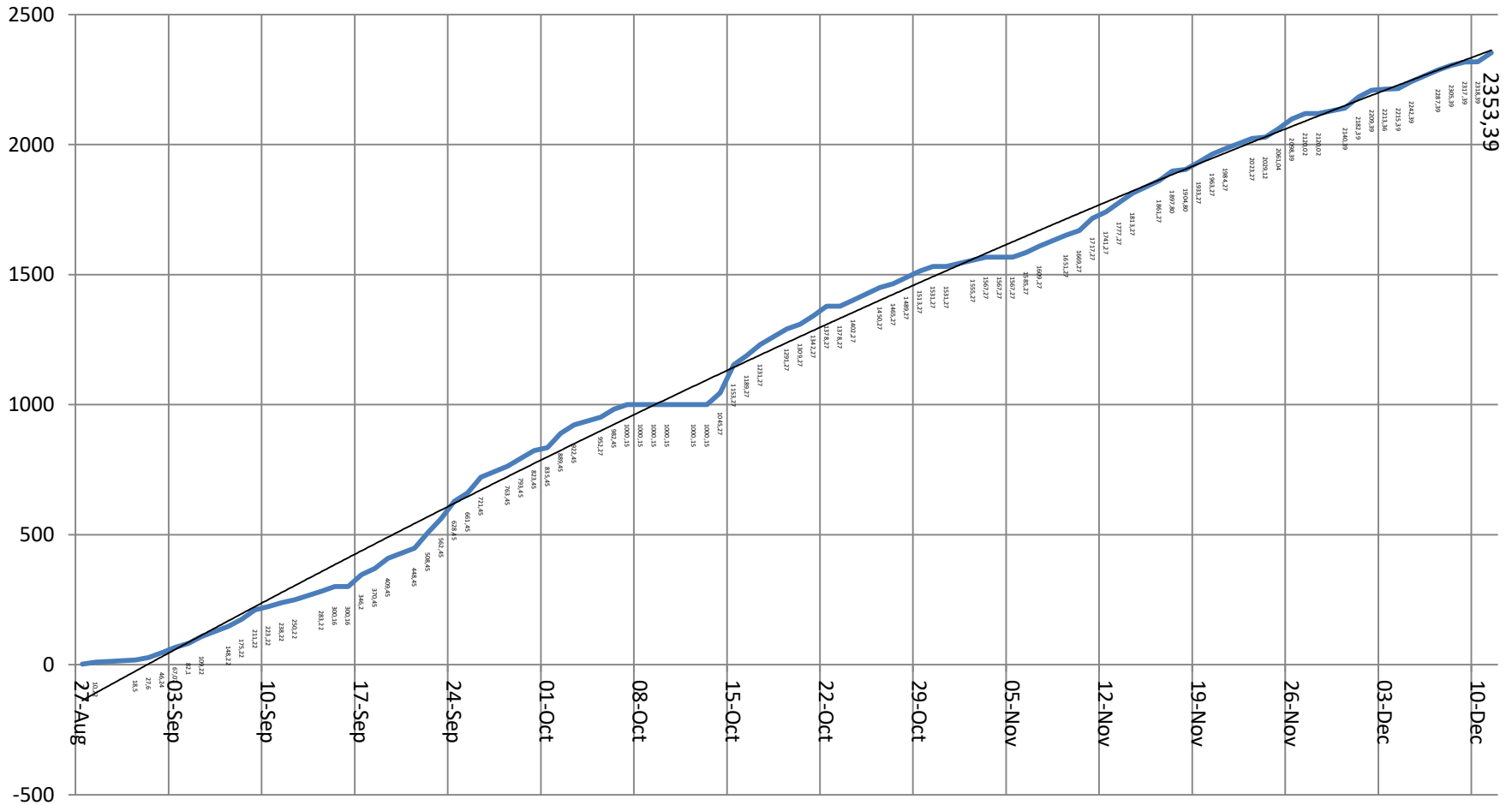
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WILLOWVALE ACCUM. PRODUCTION PROGRESS - TARGET VS ACTUAL



Series1 Poly. (Series1)



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CONCLUSION

The drilling program proved that sophisticated Exploration drilling projects can be executed by local exploration contractors to international standard requirements

Researchers are now able to interpret the data and make recommendations, based on the results, for future shale gas exploration and production in the Karoo Basin.

The project proved that drilling costs can be much lower compared to Oil and Gas companies. It also proves that local contractors can execute drilling projects to international technical requirements.





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GEOSERVE RECOGNIZES ITS RESPONSIBILITY AS A PROVIDER OF QUALITY PRODUCTS/SERVICES.

GEOSERVE ACCEPTS RESPONSIBILITY FOR THE COMPLETE SATISFACTION OF ITS CUSTOMERS.

WE EXERCISE THIS RESPONSIBILITY THROUGH ADEQUATE TRAINING OF OUR EMPLOYEES, ADHERENCE TO PROVEN PROCEDURES, AND TOTAL COMMITMENT IN MEETING AND EXCEEDING CUSTOMER REQUIREMENTS, AND TO MAINTAIN AN ORGANIZATIONAL CULTURE THAT FOSTERS CONTINUOUS IMPROVEMENT.





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