WITHERS
ENVIRONMENTALCONSULTANTS

ENVIRONMENTAL PLANNING
IMPACT ASSESSMENTS
MANAGEMENT SYSTEMS

tel +27 21 887 4000
fax +27 21 883 2952
email info@withersenviro.co.za
web www.withersenviro.co.za
address P.O. Box 6118
Uniedal 7612

CIMERA – KARIN PROJECT

ECO CHECKLIST # 3

CLOSURE AND AUDIT

ECO SERVICES FOR THE DRILLING OF A RESEARCH BOREHOLE ON FARM ZANDFONTEIN NO. 89, CERES DISTRICT, WESTERN CAPE: PLANNING, OPERATION AND REHABILITATION PHASE.

PREPARED FOR: UNIVERSITY OF JOHANNESBURG
DRILLING CONTRACTOR: GEOSERVE

Distribution List: nbeukes@uj.ac.za; charl@geoservesa.co.za; bircha@absamail.co.za; ernst@geoservesa.co.za; enrico@geoservesa.co.za; michelle@witzenberg.gov.za; dcole@geoscience.org.za; hermansvn@uj.ac.za; krobey@geoscience.org.za; devlei@roggeveld.co.za; drblomerus@mweb.co.za; blomerus@ceresmed.co.za; jonathan.deal@globalcitizensalliance.org.za; sothembalodge@breede.co.za; Christi@graaff-fruit.com; aton@tiscali.co.za; hlange@breede.co.za; hermie@witzenberg.gov.za;

UNDERTAKEN BY: Aubrey Withers (Director / ECO) and Robert Laurie (ECO) of Withers Environmental Consultants (WEC)

DATE OF SITE VISIT(S): 17/09/2015 **DATE OF ISSUE: 28/09/2015**

TABLE ON CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

CIMERA	Centre of Excellence for Integrated Mineral and Energy Resource Analysis
DWS	Department of Water and Sanitation
ECO	Environmental Control Officer
EMP	Environmental Management Plan
KARIN	Karoo Research Initiative
OSH	Occupational Safety and Health
PPE	Personal Protective Equipment
SRU	Solid Removal Unit
UJ	University of Johannesburg
WEC	Withers Environmental Consultants

AIM	ACTION TO BE CHECKED BY ECO[1]	RESP[2]	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
PHASE 1: PLANNING					
1.1 Actions to be undertaken prior to the commencement of drilling					
Awareness of possible impacts, hazards and the mitigation measures required	Induction of personnel to be undertaken by ECO prior to the commencement of drilling.	ECO	ECO, GEOSERVE	N	Site personnel were inducted on 17 July 2015, prior to the commencement of drilling. An information board, containing the on-site conduct rules and the induction sheet (provided by Withers Environmental Consultants) was situated at the site entrance. The board included information on snake identification and on scene first aid procedures.
	A copy of the approved Environmental Management Plan (EMP) by AGES of 18 June 2015 must be present on-site during the planning, operation and rehabilitation phases.	GEOSERVE	GEOSERVE, UJ	N	A copy of all the relevant documentation, including the approved Environmental Management Plan (EMP) by AGES of 18 June 2015, was kept on site. Copies of the ECO Checklists were kept on site.
Establishment of appropriate services for the duration of the drilling	Appropriate, energy saving lights should be installed at the drill site (yellow lights, which do not attract insects). Lights should be faced in a downward position. Only necessary lighting should be used at night.	GEOSERVE	GEOSERVE; ECO	N	Appropriate energy saving lights were installed at the necessary locations. The designated smoking area was fitted with a solar powered light.
Adequate demarcation	The site should be appropriately demarcated to a 50m X 50m fenced area, as indicated in the EMP. The materials lay down area should be established in the already disturbed area near the old agricultural fields.	GEOSERVE	GEOSERVE; UJ	N	Appropriate signage was erected at the farm entrance. The site was appropriately demarcated with a security fence and safety netting. The methane burnout pit on the edge of the site was demarcated with the appropriate safety netting.

[1] Environmental Control Officer
[2] Responsibility

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
PHASE 2: OPERATION					
2.1 Air quality and noise					
Prevention of air pollution	The speed of vehicles to and from the drilling site should be kept as low as possible to reduce the generation of dust. If deemed necessary by the ECO, the access road to the site should be kept moist. The number of vehicles using the access road should be kept to the bare minimum.	GEOSERVE	GEOSERVE, UJ; ECO	N	This was explained to the contractors during the environmental site induction on 17 July 2015. Appropriate signage was erected at the farm entrance which indicated the speed limit to be adhered to on the property.
Prevention of excessive noise	No loud music may be played on site.	GEOSERVE	GEOSERVE, UJ; ECO	N	This was explained during the environmental site induction on 17 July 2015.
	Drilling machinery must be fitted with noise mufflers and be maintained in good working order. Noise levels must to conform to the OSH Act.	GEOSERVE	GEOSERVE; UJ; ECO	N	The noise levels of operating machinery were in compliance with the OSH act. Noise level measurements of drilling machinery being used on site were shown to the ECO indicating its compliance, and no complaints regarding noise were received for the duration of the drilling works.
2.2 Site access					
Maintenance of access roads	Existing access roads should be used. No new roads are to be made. Access roads should be maintained by GEOSERVE. Areas prone to water logging must be maintained using local road materials.	GEOSERVE	GEOSERVE, UJ; ECO	N	Sections of both of the access roads had started forming ruts due to the frequent use of construction vehicles (which was checked during the site visits of 24 July 2015 and 11 August 2015). As a temporary solution, Geoserve personnel experimented flattening the ruts by manual raking. (*cont.*)

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
2.2 Site access (cont.)					
Maintenance of access roads (cont.)	Existing access tracks should be used. No new tracks are to be made. Access tracks should be maintained by GEOSERVE. Areas prone to water logging must be maintained using local road materials.	GEOSERVE	GEOSERVE, UJ; ECO	N	As per the recommendations made by the ECO in the second checklist, Geoserve personnel have rehabilitated the two access roads used to and from the drill site (**Photos 1a and 1b**) by filling three used tyre castings with concrete and dragging them in series across the ruts of each track with a 4X4 vehicle. The vegetation growing on the "middelmannetjie" of the "twee-spoor" tracks were not damaged by the tyres. No damage was noted at the areas of the access road prone to water logging (**Photo 2**) after rains. Thus, no corrective action was deemed necessary.
2.3 Conduct of personnel					
Proper conduct of personnel must be exercised	No personnel are allowed outside of the demarcated drilling and site areas. No personnel may trespass onto other properties.	GEOSERVE	GEOSERVE, UJ; ECO	N	This was explained during the environmental site induction on 17 July 2015. No complaints regarding trespassing of personnel onto adjacent properties were received during the duration of the drilling works.
	Drilling may take place 24 hours a day, with two teams working 12 hour shifts. No drilling may occur on a Sunday. Should drilling at night become a nuisance to nearby neighbours, alternative drilling hours should be agreed to.	GEOSERVE	GEOSERVE, UJ; ECO	N	Drilling took place 24 hours a day (except Sundays), with two teams working 12 hour shifts. Drilling was halted during the site visit on 24 July 2015 as the drill hole had been grouted with concrete ("cased off") (at a depth of approximately 45m). Drilling at night was halted during a cold spell (towards the end of July/ early August). Drilling reached a depth of approximately 365m during the site visit on 7 August 2015. Drilling was completed on 10 September 2015 at a depth of approximately 660m. No complaints regarding drilling works at night were received during the drilling contract.

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
2.3 Conduct of personnel (cont.)					
Health and safety of personnel	The contractor should ensure that adequate Personal Protective Equipment (PPE) is provided to personnel (including the necessary noise protection gear).	GEOSERVE	GEOSERVE, UJ	N	Personal Protective Equipment (PPE) was provided for each staff member and stored in the construction trailer which doubles as a first aid room. All personnel were observed to be using their PPE during each site visit during drilling operations.
2.4 Prevention of fires					
Prevention of fires and burning	Two (2) fire extinguishers should be present on site at all times. Fire extinguishers should be checked (and recorded) annually and be in good working order.	GEOSERVE	GEOSERVE; ECO	N	At least 5 fire extinguishers were present on site at all times (fire extinguishers were present at every fire hazard potential area). All fire extinguishers that were present on site had been serviced for 2015 (next service due in May 2016) and were properly pressurised.
	No burning of waste or cleared vegetation is allowed on site.	GEOSERVE	GEOSERVE; UJ: ECO	N	This was explained during the environmental site induction on 17 July 2015. All waste was stored in appropriate bins.
	No open flames are allowed on site, including the use of fires for cooking or heating at or near the drilling site.	GEOSERVE	GEOSERVE, UJ	N	This was explained during the environmental site induction on 17 July 2015 and was being adhered to at all times during drilling works.
	No smoking is allowed near the drill rig, but only in specific demarcated areas. Cigarette butts are to be disposed of in a lidded bin.	GEOSERVE	GEOSERVE, UJ; ECO	N	A designated smoking area was allocated, away from the drilling area.
2.5 Removal of vegetation					
Prevention of excessive removal of vegetation	Removal of vegetation should be limited to the drill site only. Search and rescue of succulents must be undertaken and planted away from the drill site. Any brushwood should be stored for later site rehabilitation. No dead brushwood should be collected.	GEOSERVE	ECO supervised personnel of GEOSERVE	N	This was explained during the environmental site induction on 17 July 2015. Several Jessop *Drimia marginata* and *Gladiolus* spp. were located on site and transplanted by the ECO during the site visit of 24 July 2015 within a nursery area for later use during the rehabilitation. Various bulbs were rescued from the site (e.g Karoo Slangkop. *Ornithoglossum undulatum*) during the site visit of 24 July 2015 by the ECO. Seeds from surrounding indigenous Tankwa Karoo Succulent Karoo vegetation were collected during each site visit and stored for use in the rehabilitation of the drill site (see **Section 3.2 below**).

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
2.6 Water contamination and use					
Prevention of water loss and waste of water through leaks and contamination of upper groundwater horizons with perhaps poorer quality groundwater from deeper horizons	Cement grout should be used to case off fracture zones to avoid water losses within the borehole and possible contamination of groundwater, should the contractor encounter fractured zones.	GEOSERVE	GEOSERVE; UJ	N	No drilling was in progress on 24 July 2015 as the drill hole had been grouted with concrete to "case-off" the borehole (and the fracture zone at about 35m). No water losses were noted, despite the large fracture zone intersected at 35m. This fracture zone appeared to yield groundwater. The concrete grout "cased-off" this fracture zone to prevent any contamination of this potential groundwater zone. A second fracture zone was encountered at a depth of approximately 250m, which did not yield any groundwater. This fracture zone was not cased off. As this fracture zone was causing a large water loss, a mixer unit was put into use which mixed Eeze-Pac R, soda ash and Ezee-Pac L with the groundwater extracted from the production borehole, forming a thick, viscous solution, which assisted with decreasing the amount of water lost during drilling. A third fracture zone was encountered at a depth of approximately 660m on 10 September 2015 near the base of the Ecca. This fracture zone yielded approximately 24200 litre of groundwater per day (artesian), which was re-directed off site via a trench to a small natural drainage channel (**Photo 3**). It is believed that the borehole did penetrate into the Dwyka Tilite, before drilling was halted. Once the various groundwater samples had been collected and the geophysical surveys had been completed, the borehole was sealed off using a number of rubber plugs at various depths. The upper ±30m of the borehole was filled with clean 19mm stone. The borehole was successfully sealed off and no artesian flow was noted (**Photo 4**).

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
2.6 Water contamination and use (cont.)					
Prevention of water loss and waste of water through leaks and contamination of upper groundwater horizons with perhaps poorer quality groundwater from deeper horizons (cont.)	Water is a precious resource and must be used sparingly; no water may be wasted on site. Water pipes and connections should be checked regularly, and any leaking water pipes / connections should be repaired as soon as possible.	GEOSERVE	GEOSERVE; ECO	N	No wastage of water was noted on-site during any of the site visits. Groundwater was sourced from a nearby borehole through a PVC pipe laid out on surface to the drill site. About 3000 litres of groundwater per day was pumped to a mixing unit, a Solid Removal Unit (SRU) and into three small “reservoirs”. Drilling mud (sludge) from the borehole was circulated by pumping to the SRU. No water loss was recorded before the intersection of the fracture at approximately 250m in depth. The 250m fracture intersection caused approximately 1500 litre of groundwater loss per day. A mixer unit was put into use which mixed Eeze-Pac R, soda ash and Ezee-Pac L with the extracted borehole water, forming a thick, viscous solution to decrease the amount of water lost during the drilling. Solids from the drilling process were sorted and removed (through centrifugal and shaking action) and sludge was dewatered and extracted in the SRU into a large plastic bag which was temporarily stored in a trailer lined with plastic. The drill sludge was transported to Johannesburg on Monday 17th of August 2015, where it was tested for its Gasoline Range Organics (GRO) (C6-C9), Diesel Range Organics (DRO) (C10-C36) and Methyl tert-butyl ether (MTBE) content by M&L labs. All three components tested proved to be below the National Norms and Standards for the Remediation of Contaminated Land Soil Quality (GN No. 331) in terms of the Soil Screening Values (SSV1) under the National Environmental Management: Waste Act, 2008 (NEM:WA) (Act No. 59 of 2008). The results have been added as **Appendix B**.

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
2.6 Water contamination and use (cont.)					
Prevention of water loss and waste of water through leaks and contamination of upper groundwater horizons with perhaps poorer quality groundwater from deeper horizons (cont.)	Water is a precious resource and must be used sparingly; no water may be wasted on site. Water pipes and connections should be checked regularly, and any leaking water pipes / connections should be repaired as soon as possible.	GEOSERVE	GEOSERVE; ECO	N	Five water samples were taken during the drilling process, i.e; ○ Water extracted from the nearby borehole; ○ Water from the flow line pipe used at a depth of 614m; ○ Water from the aquifer reached at approximately 660m; ○ Water extracted from the drilling sludge via centrifugal action in the SRU; and ○ The remaining cleaned water which was recycled back to the borehole. These samples were tested for their chemical constituents by Geoserve and showed acceptable total petroleum hydrocarbon (TPH) levels. The results are attached as (**Appendix C**).
Prevention of groundwater or surface water contamination	No contaminants (soaps, detergents, lime, drilling fluid additives, cement powder or fuels) may be discharged into the borehole which may contaminate groundwater aquifers that may exist within fracture zones or within various host sandstones at various horizons.	GEOSERVE	GEOSERVE; UJ; ECO	N	
2.7 Waste management					
Adequate disposal of solid waste	Drilling sludge must be stored in plastic bags in leak proof containers and may only be disposed of at a licenced Municipal landfill sites.	GEOSERVE	GEOSERVE; ECO	N	Drilling sludge collected from the SRU was temporarily stored in a large plastic bag which was transported to Johannesburg on Monday 17th of August 2015, where it was tested for its GRO, DRO and MTBE content by M&L labs. The results have been added as **Appendix B**. Drilling sludge was subsequently disposed of by Geoserve.

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
2.7 Waste management (cont.)					
Adequate disposal of solid waste (cont.)	The site should be kept neat and tidy. Any solid waste generated on site (including plastic, drilling sludge, waste cement grout etc.) must be kept in adequate waterproof containers. Solid waste must be disposed of weekly (at an approved Municipal landfill site) to prevent a build-up on site.	GEOSERVE	GEOSERVE; ECO	N	Solid waste generated on site was neatly separated, marked in adequate containers and adequately disposed of. Recyclables were sorted on site, put into separate bins and were appropriately disposed of.
	Sludge generated by the drilling process should be suitably stored in a leach proof container. Sludge is to be removed by Enviroserve, or transported to an Enviroserve depot for proper disposal or it must be appropriately disposed of by Geoserve at a licensed landfill site.	GEOSERVE	GEOSERVE; UJ; ECO	N	The sludge extracted from the borehole (via the SRU) was stored appropriately in large plastic bags on site. Drilling sludge collected from the SRU was transported to Johannesburg on Monday 17th of August 2015, where it was tested for its GRO, DRO and MTBE content by M&L labs. The results have been added as **Appendix B**. Drilling sludge was subsequently disposed of by Geoserve.
Adequate storage of litter	Lidded, scavenger proof waste bins should be provided for the staff at their living camp and on the drill site and should be removed with other solid waste on a weekly basis at a licenced Municipal landfill site.	GEOSERVE	GEOSERVE, UJ; ECO	N	Solid waste generated on site was neatly separated, marked in adequate containers and appropriately disposed of.
	Designated eating areas should be provided and appropriate bins provided for litter.	GEOSERVE	GEOSERVE, UJ; ECO	N	A tent was erected on-site which served as a designated eating/ recreational area for drilling staff. Adequate bins were available for temporary storage of litter.
2.8 Prevention of erosion					
Prevention of soil erosion	Appropriate stabilisation and soil protection measures should be implemented to prevent erosion occurring, especially where the access road to the drill site crosses small streams and clayey pans.	GEOSERVE	GEOSERVE; ECO	N	Despite a few millimetre of rain having fallen in the area, no destabilisation was noted at the areas of the access road prone to water logging (**Photo 2**). Thus, no corrective action was deemed necessary.

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
2.9 Sanitation provision					
Implementation of proper sanitation	One (1) portable chemical toilet should be provided for every fifteen (15) workers. Toilet paper should be provided by the contractor.	GEOSERVE	GEOSERVE; ECO	N	A mobile toilet unit (from Fancy Flush) was situated adjacent to the site. The unit contained two toilets (adequate for the amount of on-site personnel during each drilling shift).
	Portable chemical toilets should be emptied once per week by the appropriate contractor.	GEOSERVE	GEOSERVE; ECO	N	Toilets were emptied as necessary.
	Portable chemical toilets should be placed in a suitable location, on even ground, be appropriately secured to prevent being blown over and may not be closer than 100m from a drainage line.	GEOSERVE	GEOSERVE; ECO	N	The mobile toilet was parked on level ground for the duration of the drilling works, and was also secured by plastic tyre chocks.
2.10 Vehicle and machinery management					
Prevention of fuel, oil and / or lubricant spills / leaks.	No vehicles may be extensively repaired on site. Vehicle and machinery maintenance should be undertaken in a maintenance yard of a farm homestead.	GEOSERVE	GEOSERVE, UJ	N	This was explained during the environmental site induction on 17 July 2015. No mechanical breakdowns were recorded and no repairs or maintenance was necessary.
	Vehicle and machinery should be checked, serviced and maintained daily to prevent fuel, oil and / or lubricant spills / leaks. Immediate action should be taken by the contractor should any machinery or vehicle be seen to be leaking fuel or oils, by placing a drip tray beneath the leak. Any spills / leaks should be reported to the ECO. Contaminated soil must be picked up in the appropriate manner and stored in a watertight bin for removal to the hazardous waste site at Vissershok, Cape Town.	GEOSERVE	GEOSERVE, UJ; ECO	N	No dumping of contaminated soils at Vissershok hazardous landfill was necessary. A spill kit was present on site during the drilling process. A small oil leak beneath the SRU necessitated that plastic lining and knitted absorbent socks from the spill kit were used. No further fuel, oil or lubricant spills were recorded. Drip trays and/ or plastic lining were present beneath all mechanical equipment and stored chemicals for the duration of the drilling process.

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
2.10 Vehicle and machinery management (cont.)					
Prevention of fuel, oil and / or lubricant spills / leaks.	Oil must be stored in a bunded area with an impermeable base, which is capable of containing 110% of the volume of oil to be stored. The mobile diesel bowser must be in good working order and its pipes and pump must be leak free.	GEOSERVE	GEOSERVE; ECO	N	A mobile diesel storage unit was parked on level ground (lined with plastic) for the duration of the drilling works, and secured with tyre chocks.
	Necessary servicing / major repairs of vehicles or machinery must be done at a nearby town. If this is not possible, on site repairs must be overseen by the contractor with the use of a fuel/oil spill kit and the use of drip trays. All fuel / oil contaminated parts must be stored for appropriate disposal in a leak proof container. Used oils must be stored in an appropriate container for disposal or recycling.	GEOSERVE	GEOSERVE, UJ; ECO	N	This was explained during the environmental site induction on 17 July 2015. No servicing or any repairs of vehicles or machinery were necessary during the drilling period.
Drilling lubricants	Biodegradable polymers should be used for lubricating and cooling of drill bits and strings. Petroleum free, water based fluids should be used during the drilling process. The use of bentonite clay may also be used as a drilling mud.	GEOSERVE	GEOSERVE; UJ	N	Bordet, a concentrated blend of anionic surfactants was added to the drilling mud to reduce torque during the drilling process and clean the bottom-hole assembly, i.e. for the removal of rock flower[3] (leading to higher rates of drilling penetration). Bentonite clay was not used for the drilling process.
Parking of vehicles and mechanical machinery	Parking areas for the storage of the diesel bowser and the drill machine must be prepared with a plastic liner on top of the soil. The liner should be covered with a thin layer of sand or shaley gravel. Such soil covering is to be removed from site and dumped at an appropriate landfill site when drilling has been completed.	GEOSERVE	GEOSERVE; ECO	N	A mobile diesel storage unit was parked on level ground (lined with plastic) for the duration of the drilling works, and secured with tyre chocks.

[3] Rock flower is the residue of diamond drilling through the rock – very finely ground which is removed to surface by the drilling fluids (drilling mud).

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
2.11 Mixing and use of cement					
Prevention of soil contamination by cement	Cement grout or concrete may only be mixed at a suitable mixing location (flat, away from drainage lines) and should be localised to such a location.	GEOSERVE	GEOSERVE; ECO	N	Cement mixing was limited and localised close to the drill hole. No drilling was in progress on 24 July 2015 as a portion of the drill hole had been concrete grouted. No further concrete grouting at deeper horizons was required.
	A protective lining (board and / or plastic sheet) should be placed on exposed soils to mix cement.	GEOSERVE	GEOSERVE; ECO	N	
2.12 Fauna and flora protection					
Prevention of harm to fauna	Vehicles should be prevented from speeding to ensure snakes, tortoises and / or other animals are not run over. Any animals encountered on site should not be trapped, snared or killed. Snakes should only be removed off site by a suitably qualified snake handler.	GEOSERVE	GEOSERVE, UJ; ECO	N	This was explained during the environmental site induction on 17 July 2015. Appropriate signage was erected at the farm entrance which indicated the speed limit to be adhered to on the property. No incidents were recorded during the drilling contract.
Prevention of damaging or removing flora	No plants may be damaged or removed without the permission of the ECO. Vehicles must remain on existing roads and may not drive off roads over plants.	GEOSERVE	GEOSERVE; UJ; ECO	N	This was explained during the environmental site induction on 17 July 2015. No incidents were recorded. The ECO did transplant certain bulbs from the drilling site to a non-disturbed locality.
2.13 Archaeological and Paleontological management					
Prevention of degradation to any heritage significant material	All works must be halted if any archaeological and / or paleontological remains are found, and must be reported to a Heritage specialist. No personnel may tamper with such finds.	GEOSERVE	GEOSERVE, UJ	N	The area around the drill site revealed no archaeological material. Archaeological hand tools found on surface from further afield around the drill site were shown to the staff and they were informed during the environmental site induction on 17 July 2015 not to pick up or remove such material if noted near the site.

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
PHASE 3: SITE REHABILITATION					
3.1 Borehole closure					
Ensuring adequate standards are maintained	The contractor should ensure that the borehole is closed (with a lockable steel cap) according to the standards of the Department of Water and Sanitation (DWS), should it need to be used again. If the borehole is not to be used again, it should be closed according to industry standards.	GEOSERVE	GEOSERVE, UJ; ECO	N	The borehole has been closed according to industry standards, i.e. steel casing has been used to close the borehole, which has been inserted into the upper horizons of the borehole and a steel casing has been welded over the casing. The number of the borehole (KZF01)[4] has been engraved onto the capping (**Photo 4**).
3.2 Rehabilitation of drill site and access roads					
Rehabilitation of disturbed areas and damaged access roads	Any disturbed areas must be rehabilitated by scarifying the surface, replanting recued plants; scattering any locally collected seeds (by the ECO). Once rehabilitation has been completed, the area should be lightly sprayed with freshwater if the soils are dry. Any available brushwood (or straw) should be spread over the rehabilitated areas.	GEOSERVE	GEOSERVE	N	Cuttings of damaged succulent species found around the site were taken and planted in an appropriate on-site location during the site visit of 24 July 2015 by the ECO. Seeds from surrounding indigenous Tankwa Karoo Succulent Karoo vegetation were collected during each site visit and stored. Various bulbs were rescued from the site (e.g Karoo Slangkop. *Ornithoglossum undulatum*) during the site visit of 24 July 2015 by the ECO. Some of the transplanted vegetation were relocated to the scarified surface and planted in rows packed with dried brushwood during the rehabilitation of the site (**Photo 5**). The area surrounding the drill site was scarified by Geoserve. During the site visit on 18 September 2015, the ECO packed dead pieces of brushwood in two rows (each, 10-13m in length and parallel to one another but at right angles to the prevailing winds) on the scarified denuded soil (**Photo 5**). The seed collected during site visits was broadcast among the rows of brushwood. The brushwood will provide a micro climate in which additional seeds blown into the area will be trapped, germinate, and grow as indicated in **Photo 6**.

[4] KZF01 – Karoo Zandfontein No. 1

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
3.2 Rehabilitation of drill site and access roads (cont.)					
Rehabilitation of disturbed areas and damaged access roads	Any disturbed areas must be rehabilitated by scarifying the surface, replanting recued plants; scattering any locally collected seeds (by the ECO). Once rehabilitation has been completed, the area should be lightly sprayed with freshwater if the soils are dry. Any available brushwood (or straw) should be spread over the rehabilitated areas.	GEOSERVE	GEOSERVE	N	The ECO recommended to the Geoserve SHE Officer (Ernst Crous) and two of his personnel that the remaining trampled site of the drill camp should also be scarified (indicated in **Photo 5**) and that additional brushwood rows should be made parallel to one another, approximately 3m apart. Geoserve completed the scarification and rehabilitation of the denuded areas on 19 September 2015 (**Photo 7**).
	Any deterioration of roads and tracks used during the drilling phase should be rehabilitated as soon as possible, to the satisfaction of the property owner and ECO.	GEOSERVE	GEOSERVE	N	Sections of both of the access roads used by drilling personnel and professional consultants had started forming ruts due to the frequent use of vehicles (noted during the site visits of 24 July 2015 and 11 August 2015). As a temporary solution, Geoserve personnel experimented flattening the ruts by manual raking. However, this was time consuming and not very effective (**Photo 8**). As per the recommendations made by the ECO in the second checklist, Geoserve personnel levelled the affected access road (**Photos 1a and 1b**) by filling three used tyre castings with concrete and dragging them in series across the ruts of each track of the "twee-spoor" tracks. It would probably have been more efficient had two tyres in series been dragged behind the 4X4 bakkie simultaneously. The concrete filled tyres could have been guided by Geoserve personnel (one person per track) in order to prevent flattening of vegetation occurring on the "middelmannetjie" of the "twee-spoor" track. The rutting of the farm tracks used during the drilling contract was sufficiently well rehabilitated using this method (**Photos 1a and 1b**). No destabilisation was noted at the areas of the access road prone to water logging (**Photo 2**). Thus, no corrective action was deemed necessary.

AIM	ACTION TO BE CHECKED BY ECO	RESP	ACTION BY	CORRECTIVE ACTION Y/N	COMMENTS
3.3 Cleaning of drill site					
Ensuring the site is left cleaned	The site should be cleaned in order for it to be reinstated to its original condition. All evidence of any oil/ diesel spills must be removed in the appropriate manner and such contaminated soils must be dumped at the Vissershok hazardous waste site near Cape Town.	GEOSERVE	GEOSERVE, UJ; ECO	N	No evidence of any oil/ diesel spills were recorded during the drilling contract. No evidence of any spills or soil contamination were observed on site during the final site visit/ audit.
	No waste materials of the drilling process, including any personal belongings of site personnel, tools; bits of machinery; or litter may not be left on site. All such extraneous waste material must be removed to the appropriate licenced landfill site.	GEOSERVE	GEOSERVE, UJ; ECO	N	No waste materials of the drilling process or any extraneous waste materials or litter was noted on the site during the final site visit/ audit. No personnel belongings of the site personnel, tools or bits of machinery were noted on the site during the final site visit/ audit.
Ensure that the homestead (where staff have stayed) is left neat and clean	All waste, including any personal belongings of site personnel, tools; bits of machinery; or litter may not be left on site. All such extraneous waste material must be removed to the appropriate licenced landfill site.	GEOSERVE	GEOSERVE, UJ; ECO	N	The site had been left in a neat and clean condition. The homestead of the Farm Rietfontein was in a neat condition when visited on 17 September 2015. A small Geoserve staff compliment was still staying on the Rietfontein Farm as they were assisting with the proper closure of the research borehole drilled by Dr De Ville Wickens on his Bizaansklip Farm further to the east.

Closure Audit: Findings

1. Drilling works

- Site personnel were inducted on 17 July 2015, prior to the commencement of drilling.
- Drilling took place 24 hours a day (except Sundays), with two teams working 12 hour shifts.
- Drilling was halted during the site visit on 24 July 2015 as a fracture zone had been intersected at approximately 45m and the fracture zone needed to be pressure grouted to "case-off" the fracture zone as it yielded a low flow of groundwater.
- The concrete grout "cased-off" this fracture zone to prevent any contamination of this potential groundwater zone or aquifer with any poorer quality groundwater which may be intersected deeper down in the borehole.
- Drilling at night was halted during an extremely cold spell (towards the end of July/ early August).
- A second fracture zone was encountered at a depth of approximately 250m, which did not yield any groundwater.
    - This fracture zone was not cased off.
    - However, this fracture zone did cause a loss of ±1500 litres of drilling mud. As a result, a mixer unit was put into use which mixed Eeze-Pac R, soda ash and Ezee-Pac L with the extracted borehole water, forming a thick, viscous muddy solution which decreased the amount of drilling water/ mud lost during the drilling.
- A third fracture zone was encountered at a depth of approximately 660m on 10 September 2015 near the base of the Ecca.
    - This fracture zone yielded approximately 24200 litre of clear groundwater (±40°C) per day (artesian), which was re-directed off site via a trench to a small natural drainage channel.
    - It is believed that the borehole did penetrate into the Dwyka Tilite, before drilling was halted.
    - Given that this fracture zone yielded artesian groundwater of 242000 litres per day, the borehole needed to be properly sealed off to prevent the loss of this groundwater on the surface.
        - Once the various groundwater samples had been collected and the geophysical surveys had been completed, the borehole was sealed off using a number of rubber plugs at various depths.
        - The upper ±30m of the borehole was filled with clean 19mm stone.
        - The borehole was successfully sealed off and no artesian flow was noted.
- The five water samples taken during the drilling process showed total petroleum hydrocarbon (TPH) levels below the recommended norms (GN No. 331).
- All three components of the drill sludge tested (GRO, DRO and MTBE) proved to be below the National Norms and Standards for the Remediation of Contaminated Land Soil Quality (GN No. 331) in terms of the Soil Screening Values (SSV1) under the National Environmental Management: Waste Act, 2008 (NEM:WA) (Act No. 59 of 2008).

2. Access to the site

- Sections of the access roads had started forming ruts due to the frequent use by construction vehicles, scientists and visitors. The deterioration of the access roads were checked during the ECO site visits of 24 July 2015 and 11 August 2015).
- As a temporary solution, Geoserve personnel experimented flattening the ruts by manual raking. However, this was time consuming and not very effective.
- As per the recommendations made by the ECO in the second checklist, Geoserve personnel have successfully rehabilitated the two access roads used to and from the drill site by filling three used tyre castings with concrete and dragging them in series across the ruts of each track with a 4X4 vehicle.
- The vegetation growing on the "middelmannetjie" of the "twee-spoor" tracks were not damaged by the tyres.
- No damage was noted at the areas of the access road prone to water logging after rains. Thus, no corrective action was deemed necessary.

3. Rehabilitation

- Seeds from surrounding indigenous Tankwa Karoo Succulent Karoo vegetation were collected during each site visit and stored for use in the rehabilitation of the drill site.
- During the site visit on 18 September 2015, the ECO packed dead pieces of brushwood in two rows (each, 10-13m in length and parallel to one another but at right angles to the prevailing winds) on the scarified denuded soil.
    - The seed collected during site visits was broadcast among the rows of brushwood.
    - The brushwood will provide a micro climate in which additional seeds blown into the area will be trapped, germinate, and grow.
- The ECO recommended to the Geoserve SHE Officer and two of his personnel that the remaining trampled site of the drill camp should also be scarified and that additional brushwood rows should be made parallel to one another, approximately 3m apart.
- The site was subsequently successfully rehabilitated (Geoserve completed the scarification and rehabilitation of the denuded areas on 19 September 2015).

4. Conclusions

4.1. Geoserve is commended on the execution of drilling works (e.g. conduct of staff, condition of machinery etc.) and general neatness of the site (e.g. site demarcation, waste storage etc.) during its establishment, operation and closure phases of the drilling project.

4.2. All recommendations made by the ECO in the previous checklists were adhered to, i.e.:

4.2.1. Geoserve personnel have successfully rehabilitated the two access roads used to and from the drill site; and

4.2.2. The site was successfully rehabilitated (Geoserve completed the scarification and rehabilitation of the denuded areas on 19 September 2015).

4.3. No corrective action was found to be necessary during the final site visit and close-out audit.

4.4. No further rehabilitation work is required.

4.5. We are satisfied that the drilling operations were carried out in accordance with the Environmental Management Programme (EMPr) and that no non-compliance remarks needed to be made during the ECO-Checklist audits undertaken for the duration of the drilling project.

4.6. We are also satisfied that no pollution of groundwater or surface water occurred during drilling operations.

4.7. The rehabilitation of the drill site has been undertaken to the satisfaction of the ECO for the project. No further mitigation actions are required.

AW WITHERS
WITHERS ENVIRONMENTAL CONSULTANTS

Appendix A: Photo Sheet

Photos 1a and 1b: The rust in the internal access tracks on farm Zandfontein have been successfully levelled by running three tyre casings filled with concrete over each track of the “twee-spoor” farm track. No damage (as a result of the flattening of the ruts) to the vegetation occurring on the “middelmannetjie” of the “twee-spoor” track was observed.

Photo 2: No damage was noted at sections of the access road prone to water logging (outlined above).

Photo 3: The artesian groundwater flowing from the borehole was directed along a natural secondary drainage line. The borehole was subsequently sealed, cased and capped. The groundwater has subsequently dried.

Photo 4: The borehole was cased-off and sealed by welding a steel cap onto the casing. A number of the borehole was engraved onto the cap (KZF01 – Karoo Zandfontein Farm Borehole No. 1).

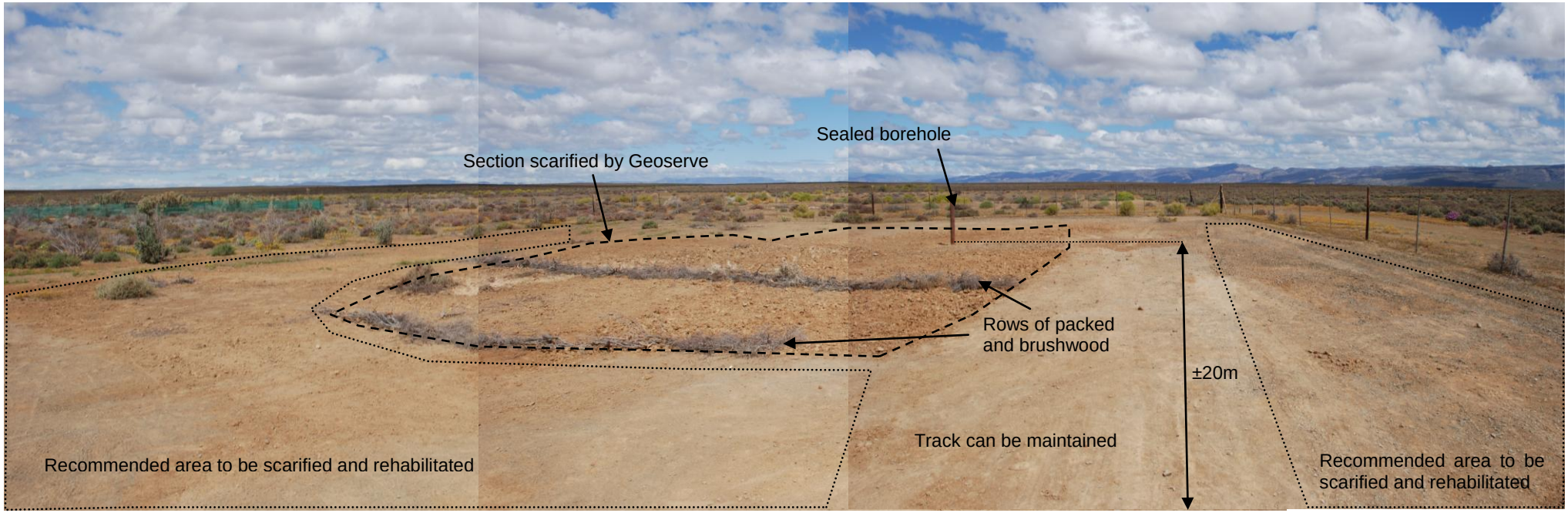

Photo 5: A section surrounding the closed borehole had been scarified by Geoserve. Two rows of brushwood were packed over the scarified area at right angles to the prevailing winds to assist natural succession of plants. The seed collected during the ECO site visits were broadcast between the brushwood to hopefully germinate.

Photo 6: An example of the natural succession of the germination of seed trapped by brushwood. The brushwood also forms a stable microclimate for the germination and protection of seedlings of pioneer and climax vegetation.

Photo 7: Subsequent to our recommendations, Geoserve completed the scarification and rehabilitation of the drill site by means of packing rows of dead brushwood on 19 September 2015. The brushwood and scarified areas forms “roughage” to trap seeds for later germination and natural succession of indigenous plants.

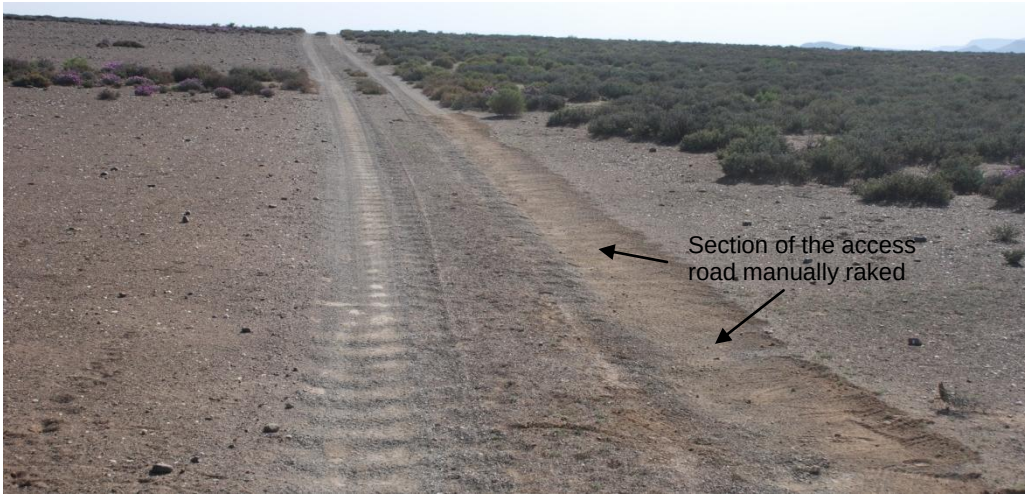

Photo 8: Geoserve personnel experimented flattening the ruts by manual raking, which was time consuming and not very effective.

Appendix B – Drill sludge results

P.O. Box 82124,

Southdale, 2135,
South Africa.
TEL. (011) 661-7900
FAX (011) 496-2239

Ref.No. :8804863

Issued at : Johannesburg

Date : 07/09/2015

COMPANY NAME	:	GEOSERVE EXPLORATION DRILLING
ADDRESS	:	44A GOODWOOD STREET NEWMARKET PARK ALBERTON
SUBJECT	:	ANALYSIS OF 1 SOLID SAMPLE
MARKED	:	AS BELOW
INSTRUCTED BY	:	ANSA NEL
ORDER NO	:	N/A
RECEIVED ON	:	20/08/2015
LAB NO(S)	:	H01039

DATE ANALYSED (GRO C_6-C_9, MTBE) :28/08/2015

DATE ANALYSED (DRO C_{10}-C_{36}) :31/08/2015

Analysis on as received basis:

Test: TPH

Test Ref.: GRO: E042-14-W Based on E.P.A. 8015B
DRO: E042-12-W Based on E.P.A. 8015B

LAB NUMBERS	SAMPLE MARKS:	$C_6 – C_9$	$C_{10} – C_{36}$	MTBE
H01039	DRILLING SLUDGE WASTE	6.0	4.2	<0.2

QUALITY CONTROL	225	1500	270
QUALITY CONTROL RESULTS	232	1797	310
LIMIT OF DETECTION(LOD)	0.6	3.5	0.2
LIMIT OF QUANTIFICATION(LOQ)	2.2	11.6	0.6

Methods:

GRO/MTBE – GC / FID Following Purge & Trap Technique
DRO – GC / FID Following Solvent Extraction

All results reported as mg/kg
BDL= Below Detection Limit

Appendix C – Water sample results

DD SCIENCE cc
ENVIRONMENTAL MONITORING

TEST REPORT

COOKE 1 RESIDENCES
(OFF R559)
COOKE 1
RANDFONTEIN

CC CK97/47253/23
34 LARK CRESCENT
GREENHILLS
RANDFONTEIN
1759

TEL (082) 654-0478
FAX (086) 520-1390

EXOL OIL REFINERY (PTY) LTD.
PO Box 1126
Krugersdorp
1740

Tel. No.: (011) 769-2257
Fax. No.: (011) 769-2257
e-mail: ecodynamics@exol.co.za
awc@exol.co.za
Report Date: 7-Sep-2015
Ref: 18696/20150828
PO No: 01065

Attention: Gert Steyn

Sample identification

Type of sample:	Water Samples			
Number of samples:	5			
Condition of sample(s):	Acceptable			

Sampled By: Exol

Sampling procedure: N/A

Date received: 28-Aug-2015

Test results:

Sample ID	Sample Date	Lab ID	Oil (TPH)
Units			mg/l
Methods			M092
Geoserve Tankwa Borehole Water	2015-08-27	18696/1	1.0
Geoserve Tankwa Flowline Sample Depth:614-	2015-08-27	18696/2	0.8
Geoserve Tankwa Aquafer Water after hole	2015-08-27	18696/3	1.2
Geoserve Tankwa Centrifuge Return 614-95m	2015-08-27	18696/4	0.6
Geoserve Tankwa Mixing Tank Pac L, Pac R	2015-08-27	18696/5	1.0

Opinions and interpretations (if any):

Compiled and approved by: Alfred Molubi (Technical Signatory)

Reviewed by: D. Dorling (Executive Manager)

Date of issue: 07-Sep-15

Please note:

1. Results are strictly confidential and will not be disclosed to Report Date:
2. Results relate only to the samples tested;
3. This report shall not be reproduced, except in full, without the written approval of DD Science cc
4. While every effort is made to provide a service of the highest quality, the liability of DD Science cc shall not extend beyond the cost of services rendered;
5. The resposibility of any work subcontracted rest with DD Science.
6. Samples will be disposed of two weeks after the date of issue of this report, unless otherwise instructed by the client.