Desk Study and Siting Report for One Borehole at Omauni Primary Health Care Clinic in the Ohangwena Region

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GARNET ENGINEERING
P.O. Box 81033, Olympia, Windhoek
Email: Garnet@iway.na
Tell: +26461 254 021/ +264 811 284 629,
Fax: +264 88 613 052
Reg No: cc/2009/1387

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Project Manager	S Nalusha
Project Manager e-mail	
Author	Immanuel Ambata
Reviewer	
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DESK STUDY AND SITING OF ONE BOREHOLE AT OMAUNI IN THE OHANGWENA REGION

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Below a list of acronyms and abbreviations used in this report.

Acronyms / Abbreviations	**Definition**
GTC	Green Team Consultants
mm/a	Millimetre per annum
Mm	Millimetre
m_3/h	Cubic metres per hour
RWL	Rest Water Level
h	Hour
Bgl	Below ground level
DPA	Discontinuous Perched Aquifer
MSAAN	Main Shallow Aquifer
MDAAN	Main Deep Aquifer
TDS	Total Dissolved Solids
M	Metre
Km	Kilometre
t(minute)	Time
AMSL	Above Mean Sea Level
ASL	Above Sea Level

1. INTRODUCTION

1.1 BACKGROUND

Green Team Consultants CC (GTC) was contracted by Ministry of Works and Transport through Twali Construction CC to site, drill, develop and test a water borehole at Omauni in the Ohangwena region situated in the northern part of Namibia. The borehole is wanted for a primary health care clinic construction site.

The project area is located between Okongo and Mungu village towns within the Cuvelai basin. Garnet Engineering carried out need assessment site visit and provided GTC with coordinates and site information. The pre-selected site is illustrated in figure 1. Prior to siting activity desk study and hydrocensus of the proposed borehole site was carried out including the gathering of readily available data from various sources and the interpretation of satellite images and/or aerial photography and geological maps.

1.2 OBJECTIVES OF THE REPORT

The siting report summarises the borehole siting activities and gives drilling and testing recommendations as well as borehole installation specifications. Detailed hydrogeological information, general settings and site characteristics are also included in this report.

1.3 GENERAL SETTINGS

The project location is in Ohangwena region. Ohangwena region is situated in the Cuvelai basin in the northern part of Namibia. The Cuvelai Basin is bordered in the south and west by the surface water divide running from Otavi to Outjo, Kamanjab, Otjovasandu, Otjondeka, Opuwo and Ruacana. In the east, the boundary is formed by a faint ground water divide running north from Tsintsabis almost at 18°E longitude, while in the north it is the international border between Angola and Namibia. The hydrogeological Cuvelai Basin thus comprises the Omusati, Oshana, Ohangwena, and Oshikoto regions and parts of the Kunene Region. Most of the land surface of the basin is very flat dipping from some 1150m above sea level (asl) in the north-east to 1 080m asl in the Etosha Pan, which is the largest pan in Namibia. The Cuvelai Basin is the most densely populated area of

Namibia and most of the inhabitants live in rural communities dependent on agriculture. Rainfall decreases from 600 mm/a in the north-east to 300 mm/a in the west. In the same direction, potential evaporation increases from 2 700 to 3000 mm/a.

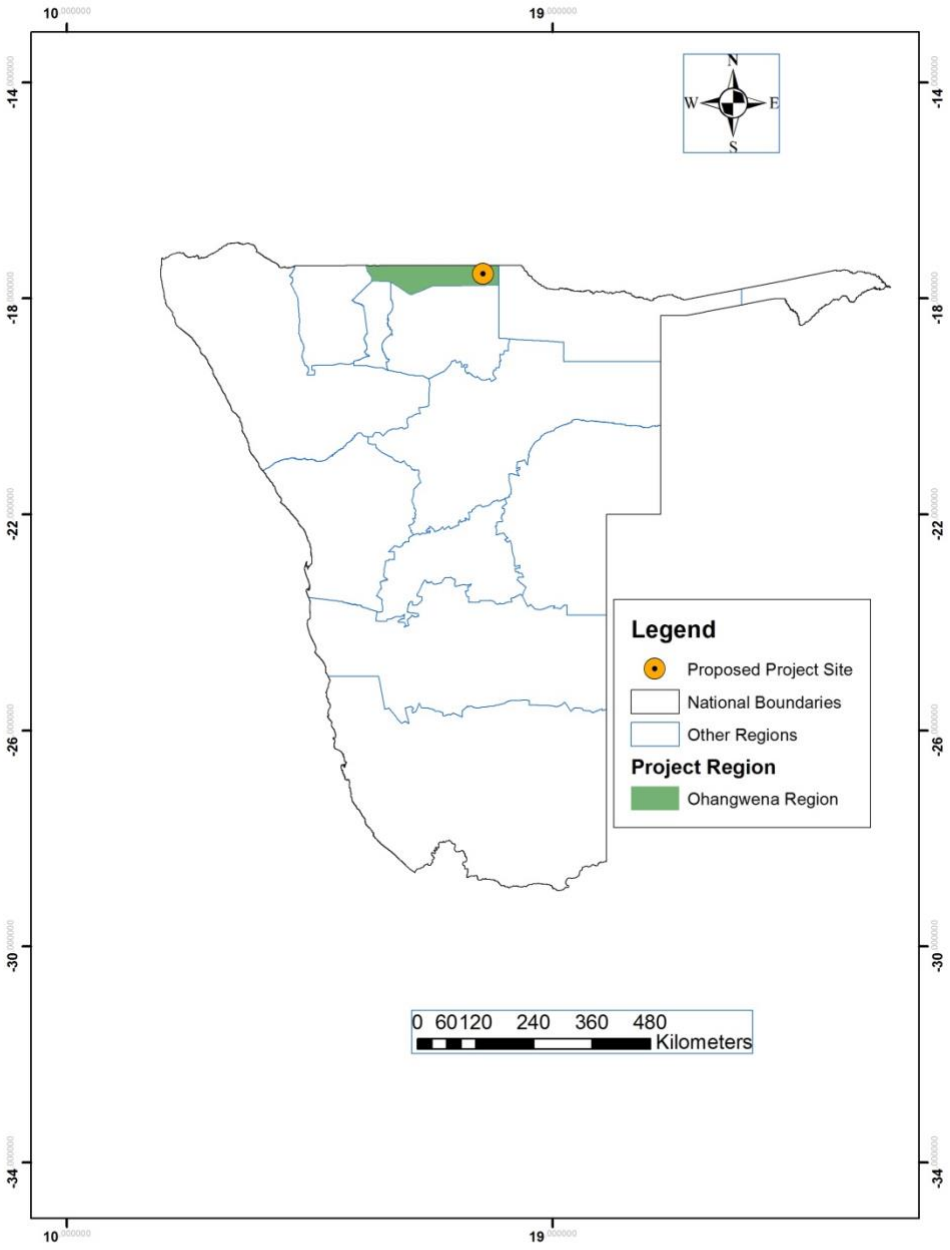

Figure 1: Project Location

1.4 GEOLOGY

The Cuvelai Basin, including Etosha Pan, is part of the much larger Kalahari Basin covering parts of Angola, Namibia, Zambia, Botswana and South Africa. It contains a very thick series of rocks of various ages. The basin floor consists of gneissic and granitic basement. Outcrops of this occur in the Kamanjab Inlier along the south-western rim of the basin (Fransfontein Granitic Suite and Khoabendus Group, 2 700 to 1700 Ma). Up to 8 000 m of sedimentary rocks of the Nosib, Otavi and Mulden groups of the late-Proterozoic Damara Sequence overlie this. Carbonatic rocks of the Otavi Group are found on the surface in the mountain ridges south and west of the basin. The Damara Sequence is followed by 360 m of Karoo Sequence rocks ranging from Lower Permian to Jurassic (300 -130 Ma) and up to 600 m of semi- to unconsolidated sediments of the Cretaceous to Recent (< 70 Ma) Kalahari Sequence.

1.5 HYDROGEOLOGY

All groundwater within the basin flows towards the Etosha Pan, due to the structure of the basin and because as the pan, as the deepest point, is the base level of the groundwater flow system. Groundwater, recharged in the fractured dolomites of the Otavi Mountain Land, flows northwards and feeds the aquifer system of the Karoo and Kalahari. The Kalahari Sequence comprises the Ombalantu, Beisib, Olukonda and Andoni formations. It is entirely of continental, aeolian to fluvial origin. The aeolian material consists of fine-grained, well-sorted sand, while the material deposited in a fluvial environment ranges from gravel to clay and often represents braided stream conditions, resulting in very variable lithologies both vertically and horizontally. Fluvial sedimentation dominates with some reworking of aeolian sand. The Kalahari Sequence Aquifers are split into an unconfined and a confined to artesian part. The Unconfined Kalahari Aquifers comprise two types of facies: the aquifer in the calcrete facies is classified as fractured, while the sand facies acts as a porous aquifer. The Unconfined Kalahari Aquifer is subdivided into the Discontinuous Perched Aquifer (DPA) above the Main Shallow Aquifer (MSAAN) in the north, the calcrete facies (UKAEL) in the south and west, and the sandy facies (UKAAN) in the centre around Oshivelo. The Discontinuous Perched Aquifer (DPA) is not a single aquifer, but consists of a series of small perched aquifers. The Main Deep Aquifer (MDAAN) is present in the eastern Ohangwena and northern Oshikoto regions. The groundwater flow is southward, towards the Etosha Pan, while the recharge area is

probably located in southern Angola. Within the proposed project area, the porous aquifer is expected to be intersected at 60-160m bgl. Water quality in the area is generally good.

1.6 HYDROCENSUS

A limited hydrocensus will be conducted in the area prior to siting activity. The purpose will be to evaluate ground water quality in the area. Figure 2 shows the location of some existing boreholes that are known in the area. Other borehole that might be located within 5km radius of the project area will be visited as well. Hydrocensus information will be compiled in the siting summary report.

The table below shows coordinates of the known existing boreholes in the area.

WW NUMBER	LONGITUDE	LATITUDE	ELEVATION
WW34248	17.71776	-17.53918	Unknown
WW41959	17.72001	-17.53846	Unknown
WW41960	17.71776	-17.53918	Unknown
WW61080	17.71911	-17.53924	Unknown
WW93438	17.7292	-17.53965	Unknown

Table 1: Existing boreholes coordinates

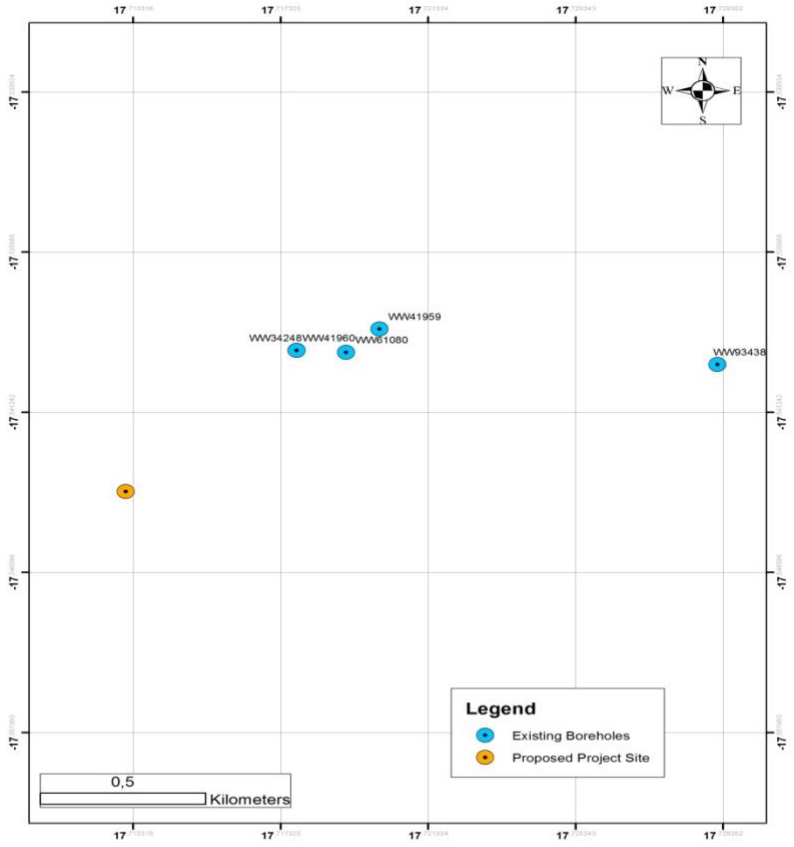

Figure 2: Location of existing boreholes

2. BOREHOLE SITING

The communal areas of the Ohangwena region are to large extent covered by unconsolidated sediments of the Kalahari sequence. Metamorphic and igneous rocks of the damara basement underlie the Kalahari sequence sediments. Groundwater is hosted into two distinct aquifer systems, Kalahari aquifers and fractured bedrock aquifers. Kalahari aquifers hold water in intergranular pore spaces, whereas in fractured bedrock aquifers is held in cracks and fractures in otherwise impermeable strata. No bedrock fractured aquifers have been reported in the project area. Thanks to the porous nature of the aquifer in the Okongo-Omauni-Mpungu areas borehole siting is not a critical factor and successful boreholes depend mainly on drilling depth and a proper borehole design and construction. The drill depth in the Omauni area is determined by red clay of lower Kalahari sequence which is considered as an aquitard. Nevertheless, for this project siting of the borehole will be carried out based on the

hydrocensus results, satellite image interpretation and under consideration vegetation, surface features identified on site and also geophysical survey profiling using the FDEM8 equipment.

PROJECT REF	LONGITUDE	LATITUDE	ELEVATION(m)
OM-01	17.713113	-17.543893	1611

Table 2: Pre-selected site

3. DRILLING, TESTING PUMPING AND BOREHOLE INSTALLATION SPECIFICATIONS

The specification as well as schedules of quantities area given in cost estimate document provided to the client. Testing and installation specifications are summarised below.

3.1 DRILLING

The drilling in the saturated, unconsolidated sediments of the Kalahari Sequence must be carried out applying Mud Rotary drilling method.

3.1.1 GENERAL

The drilling contractor (GTC) shall drill the borehole at the exact location designated by its geologist or the supervisor. Cuttings of the strata penetrated shall be collected on site at 1m interval. Representative samples from the cuttings will be put into containers, well labelled with the borehole location, number and depth interval and stored in a position where they will not be contaminated by site conditions and drilling operations. A completion of documentation of the borehole shall be compiled, including a detailed driller's geological log as well as borehole design and installation details. The borehole shall be numbered in such a way that the marking is permanent.

3.1.2 MUD ROTARY DRILLING

The first 6m shall be drilled with diameter of 311mm and installed with 220mm stand pipe (steel casing). This will also depend on the formation. The following meters to the end depth shall be drilled with a diameter of 254mm. UPVC casings and screens (slot size 1mm) with a diameter of 165mm and equipped with centralisers shall be installed from top to the bottom of the hole. UVPC screens shall be installed where distinct water strikes were observed while plain UVPC casings and screens shall alternate below water table (1/3 of the borehole shall be installed with screen casings). A gravel pack (2-3mm grain size) must be uniformly emplaced in the annular space between the casing and the borehole wall.

3.2 TEST PUMPING

The successful borehole shall be test pumped as follows:

1. A multi rate test with three 1-hour steps with increasing yields and three hours of water level recovery is followed by a constant discharge test.

2. 8-hour constant discharge tests should be carried out. The duration for the constant discharge tests has to be prolonged if advised by the supervisor.

3. After the tests, a recovery measurement has to be done. The recovery period is normally as long as the duration of the discharge. Until stable water level, conditions have been achieved.

4. Groundwater total dissolved solids (TDS) and, -temperature must be measured regularly during testing.

5. Two 1-litre samples must be taken towards the end of the constant discharge test

4. REFERENCES

1. Miller (2008): The Geology of Namibia. Vol 1. Kalahari sequence. Minstry of Mines and Energy, Namibia
2. DWA (2001): Groundwater in Namibia. An explanation to the Hydrogeological Map. Department of Water Affairs, Namibia

Author: Immanuel Ambata **Project Manager:** S Nalusha