AN ENVIRONMENTAL ASSESSMENT OF THE PROPOSED MINNA CEMETERY LOCATED AT KPAKUNGU AREA ALONG MINNA-BIDA ROAD

A TECHNICAL REPORT (TR1-CLGA)

SUBMITTED TO

THE CHAIRMAN

CHANCHAGA LOCAL GOVERNMENT AREA

MINNA, NIGER STATE

BY

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Introduction

To site a cemetery or burial ground, there is the need to take into account the potential environmental and human health risks. However, this has not always been the case; existing burial facilities were often sited near population centres simply on the basis of religious and cultural believes. Entombed human remains begin to undergo decomposition soon after burial. Where the cemetery is underlain by porous materials such as sand and gravel, the seepage of resultant leachate into the groundwater system may be facilitated. In environments such as ours, where the population is dependent on boreholes and shallow wells as the major sources of water for drinking and other domestic purposes, this may result in an outbreak of epidemics. This is especially true if abstraction wells are constructed very close to the burial ground. Dent (1995) reported high salinity and elevated concentrations of chloride, nitrite, ammonium, orthophosphate, iron, sodium, potassium and sodium in water close to recent burial sites. Similarly, Trick and Klinck (xx) have found slightly elevated concentrations of chloride and sulphate in water close to a burial ground, along with faecal coliforms and streptococci at levels the World Health Organization (WHO) classes as highly contaminated. The recommended minimum safe distance between burial sites and water supply sources is 250m (WHO, 1998). It may be difficult to enforce this requirement in our societies because wells are indiscriminately sunk by individuals without proper planning.

Similarly, the location of cemeteries relative to surface water courses is a consideration to make when appraising the suitability of a site. Apart from possible contamination of the streams, the graveyards are vulnerable to flood risks, especially following intense rain storms. Flood waters have the potential to wash away the graves or where severe bank erosion is involved, the entire site may be devastated.

Considering the rapid growth of the population of Minna incident upon the migration of people from other parts of the country (Idris-Nda et al., 2013), demand for burial spaces has increased. This stretches the capacity of existing cemeteries within the city and necessitates the development of new sites to cater for the needs of the population. This work is therefore aimed at assessing the suitability of the site for the new cemetery along Minna-Bida road proposed by Chanchaga Local Government.

The Site

The proposed new cemetery is situated at the outskirts of Kpakungu, along the Minna-Bida highway. It lies along latitude 9° 34' 25" and 9° 34' 31" N and longitude 6° 30'17" and 6° 30'10" E, on a hill slope with a gradient of about 0.47 east of the road and NECO Headquarters (Figure 1) and is bounded to the northeast by the Talba Estate on the bank of a major stream (Figure 2). Several runoff channels flow through the site before discharging into the stream, which has a width of approximately 31 m. The overland runoff has aided the erosion of the deeply weathered bank materials.

Figure 1 Location of the proposed cemetery

Figure 2 Kpakungu bridge spanning the stream

Geology

The geology of Minna comprises mainly of rocks belonging to the Precambrian basement complex system of Nigeria (Truswell and Cope, 1963). It is mainly underlain by granites, migmatites, gneisses and schist. The granites range from coarse to fine grained biotite-muscovite granites while the schist are highly foliated with platy and elongated minerals that commonly include muscovite, biotite and amphiboles. The migmatites are the oldest rocks in the area and occur as high, extensive outcrops (Ajibade, 1976) and are composed mostly of quartz, feldspar and mica in varying proportions. Granite is widespread in the study area and occurs as elongated hills. The landscape especially in the Eastern to North-Eastern parts is represented by these hills forming the Minna Batholith. The specific rock type that underlies the area is granite gneiss, the rock occur as elongated outcrops along the river channel and also as flat lying bodies of rocks in the area. The rock is highly weathered with the weathering depth extending up to four meters (4m) in some places.

Figure 3 Elongated boulders of granite gneiss in the area

Methodology

In view of the aim of carrying out the studies, which is to determine the probable environmental effects posed by or to the proposed cemetery, a three pronged approached was adopted.

i. Preliminary studies
ii. Sample collection
iii. Laboratory analysis.

Preliminary studies: this involved compilation of existing data and literature on the general effects of cemetery on the environment and also assessing the site including the perennial stream that passes very close to the proposed cemetery. Information on the hydrology and stream characteristics of the stream was however not available and thus was not included in this report. At this stage also physiographic character of the area was determined through taking of the coordinates and elevation along profile lines at 10m intervals designed to cover the entire area. This was achieved with the use of a Global Positioning System (GPS).

The dimensions of the stream were determined using a tape to measure the width and also measure flood levels attained during flooding events. Erosional surfaces were also measured to determine the type of erosion, direction of propagation, susceptibility of the soil and the extent of the erosion.

Satellite imageries of the area were also downloaded from Google Earth and also from Global Land Cover Facilities (GLCF) using the geographical coordinates of the area.

Sample collection: samples of soil for various analyses in the laboratory were collected using two methods; the first involved shallow sampling to 0.5m using a hand auger (Figure 4a) and the second method involved digging of a trial pit for deeper level sampling, 1.5m, (figure 4b). Samples were collected in polythene bags, carefully labelled and taken to the laboratory for analysis.

Figure 4 Fieldwork at the site: a, sampling using a hand auger; b, digging of the trial pit and c, taking of samples from the trial pit.

Laboratory Analysis: The main analysis carried out on the samples was particle size distribution or gradation test. A sieve analysis (or gradation test) is a practice or procedure used to assess the particle size distribution (also called gradation) of a granular material.

The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common. The gradation test was performed on the sample obtained from the trial pit in the area using a nested column of sieves with wire mesh cloth (screen). A representative weighed sample was poured into the top sieve which has the largest screen openings. Each lower sieve in the column has smaller openings than the one above at the base was the receiver. The column was placed in a mechanical shaker which shook the column for 25 minutes. After the shaking was complete the material on each sieve was weighed. The weight of the sample of each sieve was then divided by the total weight to give a percentage retained on each sieve.

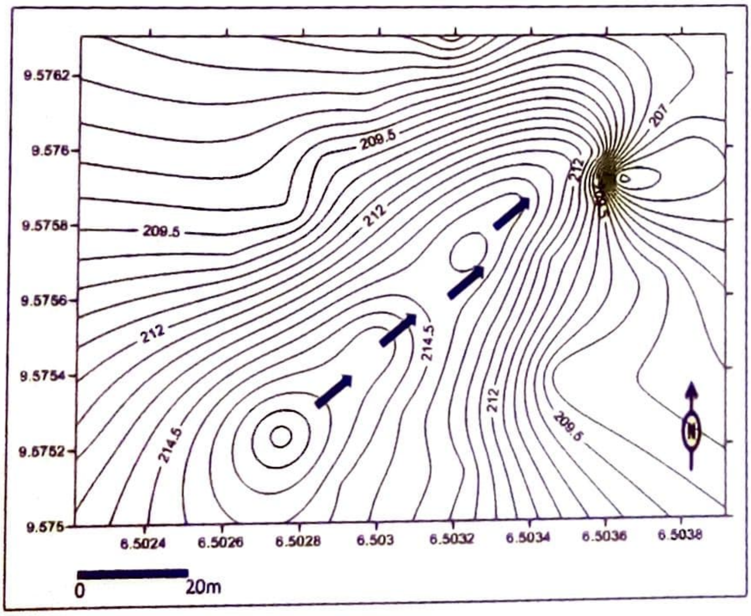
The results of this test were used to describe the properties of the soil in the area in terms of its effective size, porosity, permeability which in turn will determine the susceptibility of the soil to erosion and also its behavioural pattern in ground/surface water contamination. The result was also used to determine the probable behaviour of the soil in times of flooding.

Results and Discussion

Presently the total width of the river from bank to bank is 31.45m; the height of the stream is 4m from the top of the bank. As at the time of the studies the stream has shrunk to a flow width of 6.2m. However judging from erosional features along the banks of the River, (figures 5a, b) it shows that at certain periods the river tends to overflow its banks and flood the entire area. The flood prone zone has been estimated to extend to sixty meters (60m) from the river channel; this is halfway into the proposed cemetery.

Due to the slope of the ground high runoff has been observed with water running from higher ground through the proposed cemetery discharging into the stream. The runoff has created a channel through the cemetery on its way to the stream. Figure 6 is the contour map of the area prepared from the coordinates and elevation values using Surfer 9 contouring software. The arrows indicate the direction of surface water flow towards the stream forming a channel. The point of entry of this channel into the stream has already resulted into the formation of a gully which propagating in the direction of the cemetery. The gully (figure 5a) is 4m deep and 3m wide with a 2m propagation head. The rate of advancement of the gully was however not part of this study since it will require information from another rainy season.

igure 5 Gully erosion on the banks of the stream ("a" is towards the proposed site hile "b" is on the opposite bank to the northeast)



gure 6 Contour map of the proposed cemetery showing direction of surface water w

A 3D surface map of the area (figure 7) also shows that there is a slightly higher ground in the middle part of the converging towards a center, this center represents the channel that has been cut through by the runoff.

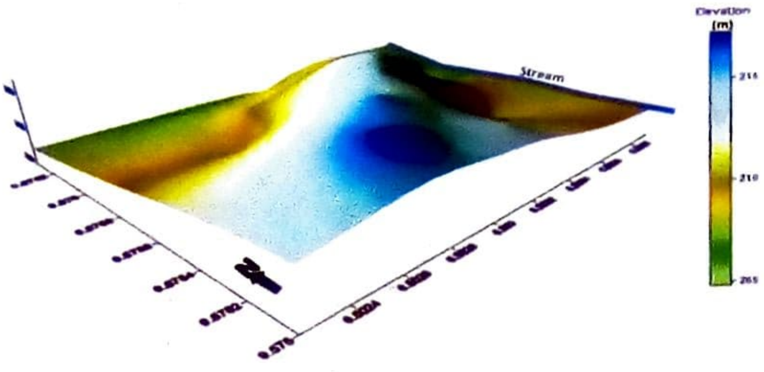


Figure 7 3D surface map of the proposed cemetery

Figure 7 is a satellite imagery of the area, the dull nature of the image was as result of the cloud cover that was present when the image was captured. The information contained in the image is however not masked. The area susceptible to flooding is clearly shown using colouration shades obtained from land cover facility. This indicates the areas the stream extends to when in full flood, the flood prone area has been clearly demarcated in the figure and labelled 'susceptible area'. This shows that over a half of the proposed area is susceptible to flooding.

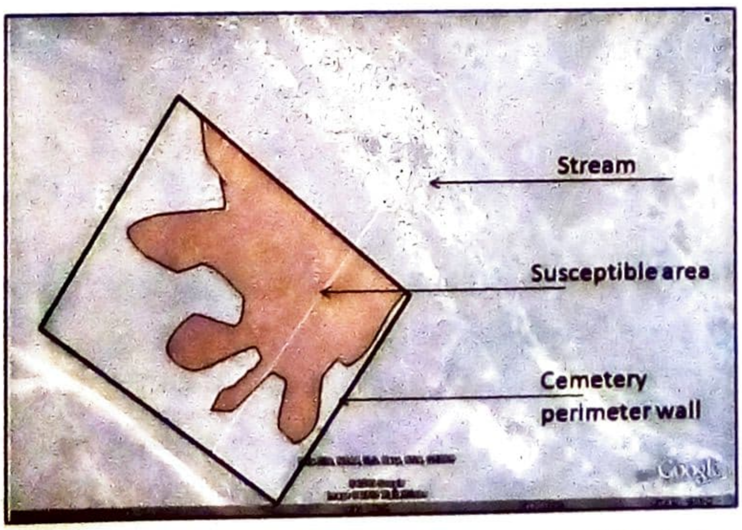


Figure 7 Satellite imagery of the area showing susceptibility to flooding

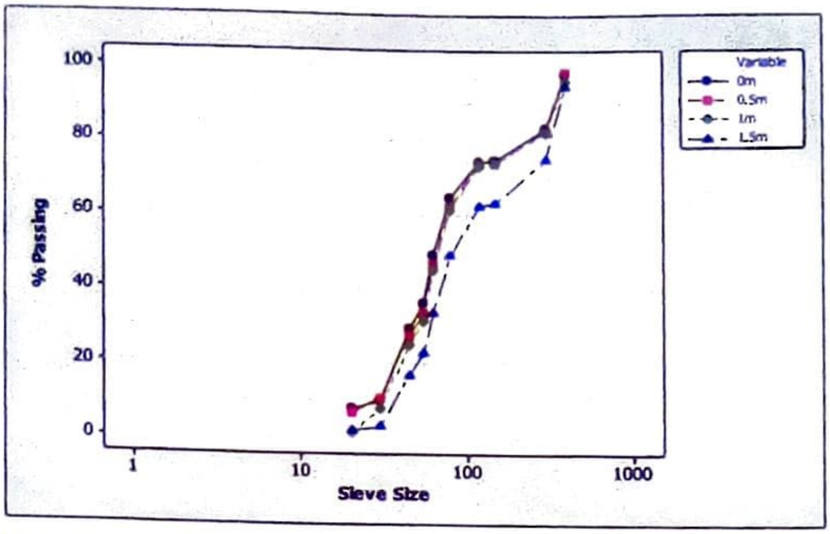


Figure 8 Plot of sieve analysis result in the proposed new Minna cemetery

Sieve analysis results, figure 8, indicate that all samples plotted within the coarse to medium grained sand range with very low clay content. The effective size, which is an indication of the mean grain size, from the surface to 1.0m is 50μm while at 1.5m it is 60μm. This implies that grain size increases with depth up to the underlying bedrock. Infiltration of water into the ground from the surface will therefore be low leading to ponding on the surface and higher rates of runoff and higher erodability of the surface layers. Permeability increases with depth which consequently will lead to a higher groundwater flow rate. The coefficient of uniformity is1.7 for the surface layers and 1.75 at deeper levels. This value is generally considered to be low, meaning that the grain sizes are not evenly distributed. The coefficient of gradation from 0 – 1.0m is 1.5 while at 1.5m depth the coefficient of gradation is 1.7, this is indicative of a well graded soil, meaning all grain sizes are represented in the analysis.

Groundwater contamination can occur as a result of the proximity of graveyards to water sources, especially streams, rivers and wells. Decomposed bodies in graveyards produce fluids that can leak to underlying groundwater. Groundwater in areas with high rainfall and high water tables is most vulnerable to this type of contamination. Historical cases range from a higher incidence of typhoid fever among people living near cemeteries, to "sweetish taste and infected odour" of water from wells close to cemeteries. Decomposing bodies in the cemetery may release unwanted substances into the groundwater which in turns conveys it to the stream and subsequently back into wells and improperly designed boreholes as the stream contributes water to the groundwater system.

Figure 9 shows a model of the proposed cemetery with relation to the stream, present water level, flood level and the adjoining Talba estate. The figure summarises the environmental problems posed to the cemetery by the stream and that posed to the stream by the cemetery.

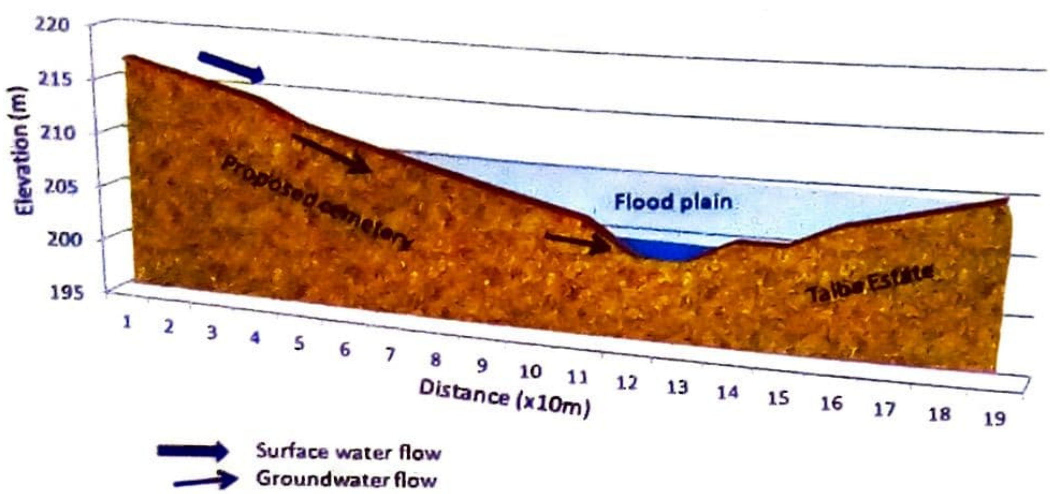


Figure 9 Model of the proposed cemetery

Conclusion

The soil in this area will not easily permit water to infiltrate into the subsoil while at deeper level it favours a high groundwater flow in the NE-SW direction. Water can easily pond on the surface if the rainfall amount and duration is not sufficient enough to cause runoff, the ponded water will have sufficient time to dissolve substances out of decomposing bodies into the stream. High runoff could lead to washing away of the finer surface materials and transporting them towards the stream, thus exposing the subsurface to further erosion. The susceptibility of the area to flooding is very high, over 50 percent of the proposed cemetery is prone to flooding. The implication of this is that flooding damage may involve sinkholes (where sections of the cemetery may simply disappear), heavy trash and mud deposits (as the flood waters recede, they will leave everything they were carrying with them -- and this can be quite disgusting), and damage to human remains which may be displaced considerable distances from the cemetery. Some of these damages may pose public health threats and will involve various agencies tasked with the recovery, identification, and reburial of human remains.

Recommendation

In view of the obvious environmental problems posed by this proposed cemetery, it is strongly recommended that the cemetery should be relocated to another location that does not have these environmental problems. The new cemetery should be located on a relatively flat ground with no prospect of ponding of water, good drainages should be provided to convey storm water away from the cemetery and far it should be located far away from human settlements and water bodies.

Remediation factors that can be considered in the present site will include;

i. Channel diversion; this is virtually impossible as it will involve the construction of birns to convey flood water away from the site.
ii. Channel improvement; this will involve construction of expanded drainages just like the 'Julius Berger' drainages within Minna town.
iii. Construction of high perimeter walls all around the cemetery to protect against both runoff from higher ground and flood water from the river.
iv. Construction of drainages around the perimeter walls to direct storm water away from the cemetery.
v. Construction of interceptor wells at the downstream side of the cemetery to intercept groundwater and pump it away from the stream to a treatment facility or to be conveyed to areas where it can undergo natural treatment system before being allowed to rejoin the stream or groundwater system.

All these remediation factors are costly and not easy to maintain. In view of the flood that occurred in year 2012 and virtually cut off the bridge that spanned the stream leading to disruption of transportation for days along the road, it is easier to relocate the cemetery than take remedial actions.

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