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TO: Rhett Smart
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Dear Rhett

Thank you for your enquiry regarding the possible infectious hazards that could pose a public health threat as a consequence of intended excavation of and construction on land at Huddle Park.

*Bacillus anthracis*, the causative organism of anthrax, is a large, encapsulated, gram-positive, non-motile, spore-forming bacillus. The bacteria grow vegetatively within an infected host and appear as single cells or short chains in diagnostic blood or tissue smears. Sporulation only occurs when the vegetative form is exposed to the atmosphere and conditions are unfavorable for the continued multiplication of the vegetative form. As a result, *B anthracis* shed by infected animals at death is found in or on products from such animals, or in soil contaminated by them, as resistant spores that may persist for years. Indeed, viable spores have been recovered in South Africa from bones which have been dated to be more than 250 years old.

In South Africa, anthrax was first described by a historian / traveller in 1838, and confirmed scientifically in 1876. Incidence of the disease increased markedly in the early years of this century, reaching a peak in 1923 when an estimated 30 000-60 000 animals died of anthrax. Legislation to control anthrax was issued in 1911 and the Government decided to provide free vaccine to all livestock owners in 1923. Annual vaccination of cattle remained compulsory, with consequent decline of anthrax outbreaks in cattle from 1000 a year to < 3 a year. This was accompanied by a corresponding decline in human cases. Vaccination of livestock declined in 1987.

Anthrax is part of the natural ecology in places like the Kruger National Park, Botswana, Namibia, Zambia and Zimbabwe where large epizootics in game animals occur periodically. It is important to recognize that there are both strain-to-strain differences in virulence of *B anthracis* and host species and strain differences in susceptibility to infection. The incidence of notified human disease is presently very low. Humans are relatively resistant to anthrax. In industrially-exposed workforces, annual case rates were 0.6% to 1.4%. Workers suffered no ill effects from inhaling 600-1 300 spores per 8-hour shift, and cases in wildlife workers are very rare despite extensive exposure. Estimates of infectious doses are as follows: (i) cutaneous anthrax: required spore number is low (~ 10 spores) but a cut or abrasion is needed for disease to occur, (ii) pulmonary anthrax: the lethal dose to kill 50% of susceptible hosts ($LD_{50}$) for e.g. primates ranges from 2 500-10

000 spores. The US Defense Department consensus for pulmonary infection ranges from 8 000-10 000 spores. Inhaled particle size is very important: if they are < 5mm in size they are most infectious. Numbers of *B anthracis* colony forming units (CFUs) from soil and water samples around carcass sites are highly variable and decline rapidly to levels below the threshold of detection. The rapid decline may be attributed to efficient dispersal by carnivorous animals, vultures, insects, rainwater, and wind and/or to the relatively low viability of *B anthracis* vegetative cells and spores in the environment.

The presence of *B anthracis* spores in soil can be detected using appropriate microbiologic techniques. The landscape of the land should be examined carefully. When looking for viable anthrax spores, it is important to examine the soils in the lower lying areas. Spores are present in the more superficial layers in the soil where anthrax is active. In older (less active) areas it may be necessary to dig more deeply to recover the spores. Viability of anthrax spores varies according to the biological activity, pH of the soil, soil depth, moisture (high humidity), and temperature but spores can survive for long periods under dry conditions. Spore formation occurs only under aerobic conditions and extensive spores could only be formed in association with a human cadaver if blood containing the organism had been spilt at the time of death. Large numbers of spores are therefore unlikely to be found in human remains in old burial sites. Because humans are relatively resistant to anthrax they are unlikely to be infected even in contact with an infected cadaver.

Patterns of certain epizootics can be explained more easily when it is postulated that low levels of *B anthracis* contamination persist in soil and that outbreaks occur following bursts of spore germination and multiplication of bacilli under favorable environmental conditions. It has been speculated that before infection of livestock occurs, *B anthracis* propagates in soil in locations termed as “incubator areas”. According to Van Ness soil rich in calcium and organic matter and soil temperatures > 15°C favor multiplication of bacilli in topographically well-defined areas in which animals become infected and outbreaks of anthrax disease occur (Van Ness GB, 1971. Ecology of Anthrax. Science 172: 1203-1307).

In soil with a pH of 7, where the biological activity is deemed to be good, the spores can survive for many years. Review of the properties of *B anthracis* suggest that specific soil factors are reflected in important environmental conditions that aid the anthrax spores in causing epidemics. Specifically, high calcium levels in the soil may help to maintain spore viability for prolonged periods, thereby increasing the chance of spores encountering and infecting a new host. The number of foci of anthrax on neutral and weakly alkaline soils has proved to be considerably higher than in soils with low pH values.

In case of construction on a site previously known to harbor *B anthracis*, the need for soil treatment or special precautions for the construction workers is not thought to be required if a reasonable risk assessment is carried out. This is because humans are relatively resistant to anthrax and the inhalational dose for pulmonary anthrax is high. Another consideration is airflow. Outdoor construction is assumed to be accompanied by high air

flow. Regrettably, it is not known precisely which areas in [Rietfontein / Sandringham / Huddle Park] were specifically used for the burial of large numbers of anthrax spore - contaminated carcasses. Erratic soil sampling procedures could miss hot foci of anthrax spores. In theory such areas could constitute a threat and should, ideally, not be used until a risk assessment exercise has been carried out. For example, walking through an area containing contaminated dust may not pose a threat to public health, whereas extensive excavation or soil disruption of the same area may result in airborne concentrations high enough to cause pulmonary anthrax if respiratory precautions are not taken.

What is more important is survival of spores in soil and their reaching the surface. Thus, when the disease is infrequent, one begins to see sporadic outbreaks in relation to earth-moving events, such as disc plowing, scrub clearing, bull-dozing, trench digging and clearing and river/stream bed disturbances from flooding. It is also possible that heavy rains can loosen up the soil surface allowing spores to float up into the root mass of the grasslands.

Humans may acquire the disease via three routes: cutaneous inoculation via a cut or abrasion (risk minimized by covering and protecting skin breached), ingestion of contaminated meat (avoiding consumption), or the inhalation (risk minimized by using respiratory protection) of spores.

Estimating the infective dose of local *B anthracis* spores in humans is only the first step in assessing the risk to the public, or workers, from individual contamination purposes. To fully assess the risks to human health the level of contamination would have to be quantified, the virulence of the anthrax strain determined and all the possible scenarios listed. Only then could the situations in which individuals may be exposed to the critical dose be identified.

Consideration of the results of a risk assessment exercise would allow recommendations to be made regarding the need for decontamination of the site, the use of protective clothing and apparatus or a vaccination program for workers. Occupational groups at high risk may benefit from vaccination with protective antigen.

The overall risk of contracting anthrax is probably very low. However, it is important that you are seen as having taken all the possible steps in assessing the risks of anthrax infection. In my opinion, the final decision on whether construction should proceed must ultimately be taken after having taken into account all the above considerations.

<u>Precautionary measures:</u>

Consideration of a risk assessment exercise would allow recommendations to be made regarding the need for decontamination of the site, the use of protective clothing with or without a vaccination program for workers.

During World War II, Gruinard Island, which lies off the West Coast of Scotland, was the site for the well-known scientific trial of *B anthracis* as a potential biological warfare agent. Despite enormously high spore concentration levels of certain "hot spots" for 40 years afterwards there is no reason to believe that transmission to the mainland with resulting infection ever occurred. The island was finally contaminated in 1986 using formaldehyde and seawater. A 5% solution of formaldehyde is deemed to be an effective decontamination strategy.

Immunization of at-risk persons can be achieved with a cell-free vaccine prepared from a culture infiltrate containing the protective antigen. Evidence indicates that this vaccine is effective in preventing cutaneous and inhalational anthrax; it is recommended for laboratory workers who routinely work with ***B anthracis*** and workers who handle potentially contaminated (raw) materials. It may also be used to protect military personnel against potential exposure to anthrax used as a biological warfare agent Annual booster injections are recommended if the risk of exposure continues.

Rapid and effective detection of anthrax spores in soil by PCR. One cell of *B anthracis* in soil 1 gram of contaminated can be detected by nested and real-time PCR. If desired, the Division of Hospital Epidemiology and Infection Control, National Health Laboratory Services (NHLS) and the School of Pathology of the University of the Witwatersrand, Johannesburg, South Africa can employ this method that has been shown to be a useful method for detecting anthrax-spore contaminated soil with high sensitivity.

<u>Comments received following the public participation process:</u>

Ms Barbara Judelowitz (Email from Jessica De Beer to Rhett Smart, dated 30 May 2006, 13h05). Ms Judelowitz states that "we fought at Government level to halt a proposed development of some 4000 mixed income group houses" on the site due the unknown threat of the anthrax victims". Comment: I was approached in 1998 by Dr Liz Floyd from the Gauteng Directorate of Health and concluded in my report, that the risk of human acquisition of anthrax was low. At the time, I was informed by several sources that there was resistance from the landowners in the Rietfontein / Linksfield district at the prospect that mixed income housing could devaluate prices of property in the area. The possibility of a re-emergence of human anthrax and smallpox was cited as being a legitimate concern by individuals who had a very definite agenda to oppose such construction for their own self-interest. Ms Judelowitz's comment in the second paragraph, that Alexandra Township (allegedly) "suffered a major anthrax outbreak (1923)" is of interest. The fact that for decades there have been no confirmed cases of human anthrax in this densely populated, dusty area suggests that human cases of anthrax would still be unlikely to occur.

Mrs Judelowitz's concerns that there could be an environmental (anthrax) and cultural/ impact on burial sites are addressed in the Cultimatrix comments and report. A recommendation is made by them that developers should be sensitive to the fact that, and aware of, hidden / covered heritage features which only become visible when bull-dozers move in must be reported to an archaeologist (and, in my opinion to an Infection Control

Specialist) for further investigation. Animal bones in burial pits for livestock can be collected and placed in heavy-duty plastic bags, under the supervision of an infection control specialist and be tested for anthrax. It is noteworthy that the late Dr Bennie Miller, Superintendent of the Rietfontein (now Sizwe) Fever Hospital, had submitted a bag of bones from the Rietfontein site for microbiological investigation to detect anthrax in the 1990s. Tests for anthrax on these bones were carried out by Dr John Frean and his Staff at the South African Institute for Medical research (SAIMR), now called the National Health Laboratory Service, and yielded negative results (personal communication, Dr John Frean, National Institute for Communicable Diseases).

The issues and response report (SEF code 1093) is interesting to peruse: comments on concerns for bio-physical impact of this project were registered by 33 individuals / attendees of the Focus Group meetings. 60 comments were registered by individuals / focus group attendees registering concerns on traffic/roads impact. 32 comments on general/social issues (it is interesting to note that Ms B Judelowitz, on page 22, raises an Email concern on 21/09/2005 on the impact of property value in Club Street). 33 comments regarding public open space concerns / issues. 43 comments were registered by individuals / focus group attendees regarding crime. 38 comments were registered by individuals / focus group attendees regarding the geohydrological impact of the proposed development. 7 comments were registered by individuals / focus group attendees regarding visual issues. 9 comments were registered by individuals / focus group attendees regarding heritage/cultural impact (including comment by Ms Judelowitz, E mail dated 13/10/2005) mentioning the suspected cemetery site on and around Huddle Park with the possibility of "anthrax graves". 32 comments were registered by individuals / focus group attendees regarding infrastructure, >100 comments were registered by individuals / focus group attendees regarding the EIA process.

In essence, it seems as if concerns about an anthrax outbreak, resulting from land development and construction, from the resident's point of view are minimal.

<u>Recommendations:</u>

1. Systematic soil sampling (firstly, analytical and secondly microbiological) using a grid system, looking at physical and biological properties of soil can be carried out. This would be a costly exercise and, although every effort would be made to identify "incubator areas or hot spots" there is no guarantee that foci of soil containing viable anthrax spores would not be missed.
2. Controlled construction activities, providing staff with appropriate personal protective clothing and infection control education from a Specialist Unit such as The Infection Control Division, Department of Clinical Microbiology and Infectious Disease of the NHLS and Wits School of Pathology, could be considered. Any skeletal remains that are dug up during the bull-dozing and excavation processes could be tested for the presence of anthrax.
3. Close monitoring and evaluation of Staff health during the construction using the criteria appended at the end of this report could be instituted.

4 The ground could be treated with 5% formaldehyde, according to appropriate protocols, as this has been shown to effectively kill anthrax spores. The environmental & ecological impact of this strategy would, however, have to be discussed with experts in this field.

5 Additional recommendations are made in the appended MMWR Weekly Report, September 2, 2003/51(35); 786-789. The most relevant ones must be linked to a continuous risk assessment as the land development project proceeds.

Kindly contact me if you require additional information.

Yours sincerely,

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HOD: CMID, NHLS & WITS SCHOOL OF PATHOLOGY

Conclusion:

Finally, it is pertinent to note that in the early 1900s, many areas in Gauteng were farmlands. Cattle and livestock would most certainly have been kept and some may well have succumbed to the 1923 anthrax outbreak. Construction projects have continued unabated and, to the best of my knowledge, there have been no reported human cases of anthrax consequent to the many land development and construction activities that have occurred to date. Furthermore extensive housing developments have taken place in Sandringham and Linksfield and these have not resulted in human cases of anthrax infection.

The risk of exposure to anthrax, although relatively small, cannot be ignored. Infection Control strategies, under the guidance of an expert, could be employed to reduce the risk of human anthrax to negligible levels during the construction process.