

# Environmental Health Implications of “Green Burials”

## A White Paper

By

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### Introduction

On March 2, 2015, the Baltimore County Council passed bill No. 6-15 which allows by special exception the permitting of conservation burial grounds in areas of the county that are zoned R.C. 8 on properties that are at least 60 acres in size. The bill defines a **Conservation Burial Ground** as “any property permanently protected under a conservation easement intended for use for the burial or permanent disposition of the remains of the dead, utilizing natural burial methods and biodegradable materials that permit the body to return naturally to the earth.” This concept is more commonly known as “green burial.”

According to the Green Burial Council, “green,” or “natural” burial is a way of caring for the dead with minimal environmental impact that aids in the conservation of natural resources, reduction of carbon emissions, protection of worker health, and the restoration and/or preservation of habitat. Green burial necessitates the use of non-toxic and biodegradable materials, such as caskets, shrouds, and urns.” Despite this claim by the Green Burial Council for “green” burials to have minimal environmental impacts, many residents in the area where the first conservation burial ground has been proposed in Baltimore County have expressed great concern as to whether there will be impacts to the groundwater, surface water and water supplies. Consequently, on July 6, 2015, the Baltimore County Council passed bill 50-15 which amended the original bill to specify requirements for ensuring that the location of any approved **conservation burial ground** was protective of public health and the environment. These requirements included a stipulation that no special exception approval may be granted until such times as regulations pertaining to conservation burial grounds are promulgated by the Baltimore County Department of Environmental Protection & Sustainability (EPS).

This paper was written to summarize the existing scientific and regulatory information available pertaining to the decomposition of the human body and potential environmental health impacts (from both traditional and “green” burial practices), and to provide explanation and justification for the proposed regulations for a conservation burial ground in Baltimore County, MD.

### Scientific Knowledge and Studies

To determine what protective measures will be most appropriate to ensure that a conservation burial ground will not impact groundwater and surface water, it is important to understand the composition of the human body and the processes that occur upon death. The typical human

body is composed of up to 75% water along with about 16,000 g carbon, 1800 g nitrogen, 1100 g calcium, 500 g phosphorous, 140 g sulfur, 140 g potassium, 100 g sodium, 95 g chlorine, 19 g magnesium and 4.2 g iron (Dent, 1998)). Upon death, degradation of the bodily tissues commences by two general processes, putrefaction (anaerobic degradation) and decay (aerobic degradation) (Micozzi, 1991). Through bacterial and enzymatic action, the soft tissues are gradually dissolved to gases, liquids and salts, followed by slower degradation of fats, skin, cartilage, hair and lastly bones. Munro (2001) reports that about 50% of the total fluid volume is lost from the body within the first week after death and the remaining bodily fluid is lost within 2 months. An unembalmed human body without a coffin may take as much as 10-12 years to skeletonize (Young, 2002). Although, the rate of decomposition will depend on a variety of factors including temperature, precipitation, depth of burial, soil type (Mann et al 1990), the majority of the pollutant load will be released into the subsurface within the first 5 years of decomposition (McDaniel, 1991). In general, it is consistently reported in the literature that more rapid decay will take place in shallower, more permeable soils in areas of greater precipitation and warmer climates. These conditions also equate with a higher potential risk for contaminants to impact ground water and surface waters.

Overall, there is a relative scarcity of scientific research concerning the potential impact of cemeteries on human health and the environment. The best compilation of studies on the topic to date is arguably the 2002 report entitled "The Pollution of Cemeteries" published by the United Kingdom's Environment Agency (Young, 2002). As summarized in this report, the primary pollutants of concern from a cemetery are bacteria, viruses, nitrogen, and to a lesser degree chlorides, sulfates, phosphates, iron, potassium and magnesium. These contaminants could potentially enter the ground water and surface water through the percolation of precipitation in and around a decomposing body. The factors governing whether these contaminants reach ground water or surface water include soil type, depth to ground water, depth to bedrock, slope (or topography), proximity to water bodies, wells, and management of the site (Morgan, 2004). The 2002 UK Environment Agency report states that the "soils and the unsaturated zone are the most important lines of defense of aquifers against pathogens." The unsaturated zone acts as both a filter and an absorbent. Üçisik and Rushbrook, (1998) report that the best soils for maximizing natural attenuation of contaminants is a clay-sand mix of low porosity and small to fine grain texture. Soils composed of gravel, or fractured rock should be avoided as they will maximize the migration of contaminants to the groundwater.

The studies reviewed were conducted at cemeteries around the world and across a wide variety of hydrogeologic conditions. None of the studies specifically referenced the density of graves or the burial practices but based on the UK Environment Agency report, it is assumed that most cemeteries had typical burial densities of between 800 to 1,000 graves per acre. Overall, many of the studies found that cemeteries had measurable impacts on the groundwater immediately below the graves. However very few studies indicated that the impacts would be of a concern to public health and it was generally agreed in several studies that contaminant concentrations diminished rapidly with the distance from the graves. These conclusions were supported by a report entitled *Carcass Disposal: A Comprehensive Review* by the National Agricultural Biosecurity Center at Kansas State University (Nutsch, 2004) which summarized the available

information regarding the potential impacts of burying animals. None of these studies or reports identified a substantiated case of groundwater contamination from a cemetery that had a demonstrated human health or significant environmental impact.

The threat of disease from dead bodies was examined by Oliver (2004). He summarized that the majority of diseases are unable to survive long after death and with proper handling of the body and standardized burial practices the risk to health care workers and the general public is minimal.

### Existing Regulations, Guidelines and Practices

There are no federal regulations regarding siting of cemeteries or burial of human bodies. The Department of Veterans Affairs does have a list of “Basic Considerations” used in the selection of a National Cemetery Site (see list included in Appendix 1). Among the considerations is having a site where the slopes are between 2 and 15%, soils are well drained, and shallow groundwater is not present. Department of Veterans Affairs also indicated that they require at least 18 inches cover for all of their national cemeteries.<sup>1</sup>

The Code of Maryland Regulations (COMAR), Title 9, Section 34 addresses the licensing and operational requirements of cemeteries. However, there are no Maryland laws or regulations that specifically address the proper citing or standards for human burial. COMAR 26.04.05B(iv) does require that domestic water supplies in an unconfined aquifer be at least 100 feet from “identifiable sources of contamination” (50 feet in confined aquifers) and the EPS Ground Water Management Policy Manual specifically names cemeteries as a potential source of contamination along with septic systems, landfills, and underground fuel tanks.

According to the Maryland Department of Labor Licensing and Regulation, Office of Cemetery Oversight, the operating custom and practice is that the top of the vault should be 18-24 inches below the earth’s surface. (see <http://www.dlrr.maryland.gov/license/cem/cemfaqs.shtml> ). This practice was confirmed in a phone conversation with Mr. Victor March, President of the Maryland Board of Morticians and Funeral Directors.

According to Emily Taylor, of the Maryland Department of Agriculture there is no state prohibition to burying livestock that die on a farm. She also conveyed that there are no state regulations or guidelines for how to bury an animal, but indicated that individual counties may have regulations regarding this issue. In fact, Baltimore County Code 13-4-214 requires that animal carcasses shall be disposed through a rendering plant unless otherwise approved by EPS. However, in practice, the Baltimore County Department of Public Works, Bureau of Solid Waste accepts small animals (pets) for landfill disposal, but not livestock or large animals. According to the Baltimore County Department of Health, Animal Services division, residents can bury

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<sup>1</sup> Personal Communication on March 24, 2015 from Glenn Madderom, Chief of Cemetery and Improvement Service in the National Cemetery Administration of the Veterans Affairs Office.

pets on their property and it is recommended that the grave be at least 3 feet deep and 50 feet from any water source.

An internet search of regulations for other states revealed a wide variation in standards for human burial. Only 17 of 50 states were found to have a minimum burial cover ranging from 10 inches of soil cover in South Carolina to 72 inches of soil cover in New Mexico, however, the majority of states (11) require graves to have between 18 and 36 inches of soil cover. There are very few states that have setback requirements: Connecticut requires gravesites to be 350 ft. from dwellings, 600 ft. from ice ponds, and 2,640 ft. from reservoirs; New Hampshire requires gravesites to be 100 ft. from road right-of-ways, 100 ft. from dwellings and schools and 50 ft from a source of water; New Mexico requires gravesites to be 5 ft. from a property line and 150 ft. from a water body; and Vermont requires gravesites to be 100 ft. from a well and 150 ft. from a stream. New York State regulations stipulated setbacks from cemeteries to water supplies that varied from 150 ft to 500 feet.

A report entitled *Carcass Disposal: A Comprehensive Review* by the National Agricultural Biosecurity Center at Kansas State University (Nutsch, 2004) discussed the available information regarding the potential impacts of burying animals. Among this information was a table (Table 1A) that summarized the regulatory and recommended standards for selecting animal carcass disposal sites from 19 states, Canada and the United Kingdom. The reported minimum soil cover requirement ranged from 6 inches to 3 feet with the vast majority requiring 3 feet of cover. Minimum separation distance between the bottom of the excavation and the water table ranged from 1 to 5 feet. Minimum separation distance from animal burial sites to drinking water supplies ranged from 75 feet to 820 feet with most requiring 100-200 feet. Minimum separation distance from animal burial sites to surface water bodies ranged from 100 to 333 feet. Other criteria included not allowing animal to be buried in a floodplain, drainage swales, or on or near steep slopes.

A 2004 policy document from the Institute of Cemetery and Crematorium Management (ICCM) references a law in the United Kingdom that requires a minimum of 3 feet of cover over any gravesite. It was further noted in the policy that for a grave that is to be used or a single interment, the minimum depth of the grave should be no less than 4 ft, 3 inches (allowing for 1 ft, 3 inches for a coffin and 3 feet of soil cover).

In the United Kingdom, the Policy and Practice for the Protection of Groundwater (PPPG) (Environment Agency, 1998) includes consideration of standards which are recommended by the Ministry of Agriculture Fisheries and Food (MAFF) for the disposal of farm animals. These include:

- Burials should be at least 250 metres away from any well, borehole or spring that supplies water for human consumption or to be used in farm dairies;
- Burials should be at least 30 metres away from any other spring or watercourse, and at least 10 metres from any field drain;

- Burials should have at least one metre of subsoil below the bottom of the burial pit, allowing a hole deep enough for at least one metre of soil to cover the carcass;
- When first dug the hole must be free of standing water (which may be interpreted to indicate that it must be above the local water table).

It is noted that this guidance relates to cadavers some 5 to 10 times greater mass than the average human corpse, and that the distances and depths differ from those attached to aquifer and groundwater protection guidance or from legally enforceable standards.

The World Health Organization (Üçisik, 1998) summarized findings from a number of studies regarding the impacts of cemeteries on the environment and human health and concluded that the pollution potential from a well-managed cemetery located on suitable soils is minimal. The report recommended the following design guidelines:

- Human or animal remains should not be buried within 250 metres (820 feet) of a drinking water supply;
- Graves should not be located within 30 metres (100 feet) of a spring or water body;
- The bottom of a burial pit should be at least 1 metre (3 feet) above the water table or bedrock; and
- Graves should have at least 1 metre (3 feet) of cover.

A joint publication by the Pan American Health Organization and World Health Organization entitled “Management of Dead Bodies after disasters: A Field Manual for First Responders” recommends the following guidelines:

- Burial sites should be at least 200 metres away from water bodies
- Burial sites should be between 200 and 350 metres away from drinking water wells depending on the density of bodies.
- Graves should be between 1.5 and 3 metres deep
- Graves should have at least 2 metres between the seasonal high water table and the bottom of the grave.

Morgan (2004) points out that there are no universally accepted standards and that distances are best chosen based on local hydrogeologic conditions.

### Discussion of Findings and Recommended Regulations

Considering the long-standing practice of burying human (and animal) remains it is surprising to the author that there is relatively little scientific study or regulations regarding the potential human health or environmental impacts from cemeteries. That being said, the lack of study and regulation on the topic does correspond with the lack of known cases where the operation of a cemetery (“green” or otherwise) has resulted in significant ground water or surface water contamination (i.e., the author found no documented disease outbreaks from water supplies

contaminated by cemeteries or mass burial of bodies). So perhaps the perceived problem may not be of great concern especially if certain precautions are followed. This is consistent with the World Health Organization report (Üçisik, 1998) which concluded that the pollution potential from a properly cited, well-managed cemetery is “slight.”

Given the decades of experience that the state of Maryland has had with regulating the discharge of domestic wastewater, the author is inclined to consider many of the standards and setbacks found in the Code of Maryland Regulations (COMAR 26.04.02) for onsite sewage disposal systems OSDS, which are intended to protect against many of the same constituents as a decomposing body. As indicated by the USEPA Onsite Wastewater Treatment Systems Manual 2002, Chapter 3.7.2, the soil zone can provide a very efficient media that can remove or attenuate human health and environmental threats posed by pollutants in wastewater. Indeed the importance of suitable soils above and below a gravesite is echoed by many of the studies reviewed. While it is acknowledged that the decomposition of a human body may likely result in higher concentration of contaminants than typical wastewater at the gravesite itself, the density and rate of burial is expected to be relatively low<sup>2</sup> and the total volume of waste is relatively small.

The Maryland OSDS regulations require a minimum 4-foot soil treatment zone above the water table or bedrock. In Baltimore County, a 6-foot soil treatment zone is required for new construction. As referenced earlier, COMAR regulations require a 100-foot setback from an OSDS to a domestic well, but county regulations also state that wells are not to be located immediately downgradient of an OSDS. Our office has found these setback restrictions to be effective in protecting groundwater and domestic water supplies. Most of the groundwater contamination problems in Baltimore County have resulted from leaking underground storage tanks, failing septic systems, or landfills that pre-dated the current regulatory practices.

Another set of regulations that this author is inclined to defer to regarding protection of our water resources are the Baltimore County forest buffer regulations (Article 33, Title 3 of the Baltimore County Code), which have been implemented for nearly 25 years. These regulations establish a scientifically based protocol that considers site specific conditions including stream type, soil type, slope, and vegetative cover to develop a protective setback (or buffer) between proposed development and/or disturbance and the nearest water body.

With these existing regulations and standards in mind, along with consideration given to the scientific studies and recommendations cited above, it is recommended that new regulations be adopted that would require the owner/operator of proposed conservation burial ground to perform the following:

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<sup>2</sup> According to the Draft Operating Plan for Resh Mill Preserve, the proposed conservation burial ground will have less than 100 bodies per acre and 10-20 burials/year. As noted in the literature review, traditional cemeteries have densities between 800 to 100 bodies per acre.

1. At the time of submission for an application of zoning special exception, a hydrogeologic study completed by a hydrogeologist or similarly qualified consultant must be submitted to EPS that includes the following:
  - a. A scaled site plan showing the proposed location of the areas to be used for burial, property boundaries, topography, water bodies, USDA soil type, existing and proposed wells and septic systems on and within 200 feet of the property line, and existing and proposed structures on and within 200 feet of the property line;
  - b. A forest buffer delineated in accordance with BCC Article 33-3, Protection of Water Quality, Streams, Wetlands and Floodplains. A forest stand delineation as described in BCC Article 33-6, Forest Conservation.
  - c. A determination of the soil type, depth to bedrock and depth and flow direction of groundwater beneath the areas proposed as a burial ground. This determination must be based on conducting a reasonable number of soil borings, excavation pits or other investigatory method approved by EPS in the area proposed as a burial ground. Depth of groundwater and bedrock may be inferred if it is determined to exceed the minimum standards required.
  - d. An assessment of the proposed burial practices, density of burials and potential impacts of the buried remains on groundwater quality, surface water quality and domestic water supplies as it relates to human health and the environment. This assessment should include consideration of the site specific findings for soil type, slope, depth to ground water, bedrock, and groundwater flow direction.
  - e. Recommendations as to whether there should be any additional restrictions over and above the minimum regulatory standards or burial density allowed by law.
  
2. It is recommended that the minimum standards for approving a conservation burial ground include the following:
  - a. The bottom of a burial pit must be at least 6 feet above the seasonal high water table or bedrock.
  - b. Graves must have at least 3 feet of cover.
  - c. The delineated area to be used for burial shall not include the delineated forest buffer or any forest stand described as Priority Area 1: High, in the Baltimore County Forest Conservation Technical Manual.
  - d. Proposed conservation burial grounds must meet the following minimum setbacks:

Feature	Setback from a Conservation Burial Ground (ft)
Building Foundations	20
Steep Slopes (> 25%)	25
Drainage Ways and Gullies	25

Rock Outcrops	25
Property Lines	50
Water Wells in Confined Aquifers (Coastal Plain)	50
Water Wells in Unconfined Aquifers (Piedmont) that are hydrogeologically upgradient	100
Stormwater Facilities	100
Water Wells in Unconfined Aquifers (Piedmont) that are hydrogeologically downgradient	300

The minimum cover of 3 feet should be sufficient to deter disturbance of the graves by animals; this amount of cover is more than the reported current standard practice in Maryland and seems to be generally agreed upon internationally as a safe amount of cover. There should also be a provision that requires the cemetery management to maintain the graves at the natural grade and add soil as necessary for any subsidence that occurs over the grave following burial.<sup>3</sup> The 6-foot soil treatment zone below the bottom of the grave should be more than adequate to attenuate and filter microbial and viral contaminants emanating from each grave. Based on all the scientific evidence, available case studies, the restriction on grave density, and local experience, a 300-foot setback from a grave to any downgradient domestic water supply should be more than adequate to protect against any contaminants that are not removed by the unsaturated soil. It is anticipated that relatively low volume of waste generated from a typical human body and the hydrogeologic processes of dilution and dispersion in the groundwater system will not result in any measureable human health or environmental impacts if these regulations and standards are followed.

References:

Dent, B.B & Knight, M.J. "Cemeteries: A Special Kind of Landfill," in *Proceedings of IAH Sustainable Solutions Conference, Melbourne, February 1998*. Kenilworth International Association of Hydrologists, 1998.

Environment Agency, "Policy and Practice for the Protection of Groundwater" (Second Edition). 57 pp. 1 map. HMSO, London. ISBN 0-11-310145 7, 1998.

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<sup>3</sup> Subsidence in this context is the natural process of the settlement of unearthed soils that occurs by gravity and infiltration of precipitation. Most subsidence will occur in the first 3-6 months after backfilling depending on weather conditions. Mounding of the back-fill 6-10 inches above the grave may significantly reduce the need to add soil following subsidence.

Institute of Cemetery and Crematorium Management, "Policy Relating to Shallow Grave Depths," London, 2004.

Mann, R.W., Bass, W.M., and Meadows, L., "Time Since the Decomposition of the Human Body: Variables and Observations in Case and Experimental Field Studies," *Journal of Forensic Science* 35(1): 103-111, 1990.

Micozzi, M.S., "Postmortem Change in Human and Animal Remains: A Systematic Approach." Springfield, Illinois: Charles C Thomas, 1991.

McDaniel, H.A., "Environmental Protection During Animal Disease Eradication Programmes." *Revue scientifique et technique Office international des Épizooties*, 10 (3), 867-884, 1991.

Morgan, O., "Infectious Disease Risks from Dead Bodies Following Natural Disasters," *Rev Panam Salud Publica*, 15(5): 307-312, 2004

Munro R., "Decomposition of Farm Animals Corpses in Mass Burial Sites", Veterinary Laboratories Agency report, United Kingdom, 2001, p. 1-9.

Nutsch, A., Spire, M. "Carcass Disposal: a Comprehensive Review; Chapter 1, Burial." National Agricultural Biosecurity Center Consortium, Kansas State University, 2004

Pan American Health Organization. "Management of Dead Bodies after Natural Disasters: A Field Manual for First Responders." Washington, D.C.: PAHO; 2000

Üçisik, A. S. and Rushbrook, P. "The Impact of Cemeteries on the Environment and Public Health: An Introduction Briefing." World Health Organization, Copenhagen, 1998.

US EPA, "Onsite Wastewater Treatment System Manual," EPA/625/R-00/008, Washington D.C., 2002

Young, C.P., Blackmore, Leavens, A., and Reynolds, P.J., "Pollution Potential from Cemeteries," Environment Agency, United Kingdom, 2002.