



August 15, 2016

**To:** Green Acres, LLC.  
P.O. Box 6528  
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**Attention:** Mr. Bruce McBride

**From:** W. Richard Laton, PhD, CHg

**Subject:** Potential Groundwater Impacts from Embalming Agents, Proposed Malibu Memorial Park Tract Map 69653, 4000 Malibu Canyon Road, Malibu, California

Based on our previous work on the Project Site and adjacent properties, the depth to groundwater beneath the site is known to be greater than 60 feet (EFI, 2015 and EFI, 2016). It was determined that the potential for *irrigation water* to daylight around the Project Site appears to be negligible due to depth of the groundwater and overall permeability of the soils (GeoSoils Consultants, Inc., 2012). Additionally, all on-site generated wastewater will be sent off-site to the City of Malibu treatment plant for processing.

Based upon the above site information Earth Forensics reviewed multiple research papers and studies to evaluate the potential for groundwater impacts as a result of naturally decaying bodies, both embalmed and putrefied (Beebe, W., 1993; Burke, P. and Sheffner, A.L., 1976; LaKind, J.S. and Bouwer, E.J., 2003; and State of Ohio, Department of Public Health, 1993). As the onsite generated wastewater will be disposed of offsite at the City of Malibu wastewater treatment plant, therefore there is no potential source of contamination from wastewater. This leaves only one potential source of contact, vadose zone water intrusion into the cement vaults.

### **Embalming**

Embalming is usually required only for bodies that will be viewed or kept for visitation. Embalming fluid is designed to inhibit autolysis, kill bacteria, harden tissues, and neutralize the malodorous products of putrefaction. Formaldehyde, the principal ingredient in embalming fluid, converts the enzymes of autolysis into hard solid products which are unable to remain in solution, destroying the enzyme's activity.

### **Putrefaction**

Putrefaction is the decomposition of organic matter, especially protein, by microorganisms, resulting in production of foul-smelling matter. Putrefaction is a complex phenomenon involving a range of chemical reactions. Putrefaction is not possible under conditions that prohibit the development of living organisms. Many of the products of putrefaction are powerful poisons, and are called cadaveric poisons. The end products of putrefaction are *ammonia and ammonia compounds; hydrogen sulfide and hydrogen phosphide; mercaptans; methane; hydrogen; nitrogen; carbon dioxide; and water*. Although the rate of decomposition is influenced by many variables, unembalmed bodies exposed to air begin to decompose within one to three days and become well advanced in three to six months.

Also part of the putrefaction process, autolysis is a self-digestion of the body tissues by substances produced within those tissues. The agents that cause this form of post mortem tissue disintegration are called enzymes, which persist after death and eventually destroy all cells and tissues.

### **On-site impacts of burial**

There is little harm caused by the natural decomposition of a human body. The composition of a typical human body is, by weight, 64% water, 20% protein, 1% carbohydrate, 5% mineral salts, and 10% fats. The elemental components of the human body are *carbon, nitrogen, calcium, magnesium, sodium, potassium, phosphorus, sulphur, chloride, iron, and trace heavy metals*.

The primary process governing the production, release and potential migration of pollutants from a buried corpse is microbial decay. The rate of decay depends on several factors. These include:

- availability of nutrients and moisture which encourages degradation
- pH levels
- climate - warm temperatures accelerate decomposition
- soil lithology where well drained soil will accelerate decay
- burial practice - the depth and coffin construction which determine the ease of access by vertebrates and invertebrates

Pathogens may also be present, but typically die off rapidly and reduce in concentration with increasing distance from the grave (Sponberg, A.L, and P.M. Becks, 2000).

In regards to embalmed cadavers, it appears that there is little potential for the formaldehyde in the embalming solution to be a source of pollution. This is based upon the following facts, (1) formaldehyde binds to proteins in tissue, (2) upon degradation, the bound protein breaks down to carbon dioxide, water, and amines, and (3) there should be no free formaldehyde in the embalmed bodies, therefore no formaldehyde should leach from cadavers, and there would be no contamination (Sponberg, A.L, and P.M. Becks, 2000).

Further, prior correspondence from Dodge Chemical Company states that embalmed tissue immersed in water would most certainly not release formaldehyde. "Formaldehyde combines with protein into a very stable new hydrocarbon chain. Simple contact with water is not sufficient to cause an additional reaction liberating the formaldehyde." (Mirza, S. and Dodge, D., 2016)

It is proposed that at Malibu Memorial that concrete vaults will be used exclusively, this will limit the potential transfer of leachates from the remains to the surrounding soil. In order for leachates to escape the vaults, water would have to move through the concrete vault, into the casket and back out. This scenario would require the water table to reach the top of the vault, find its way through the lid's seal and then also get into the casket (which would require the entire vault to fill up with water). As the depth of groundwater onsite is in excess of 60 feet this is highly unlikely. In order for this leachate to escape, the vault would again have to fill completely with water and then the water would have to find its way out. Therefore, the use of the concrete vault will greatly limit the potential of leachate contaminating the surrounding soils.

The above analysis of the Malibu Memorial Park, which is based on a literature review and various site visits, indicates little potential significant cumulative impact on groundwater from contaminated leachate emanating from the casket and through the cement vault.

Respectfully submitted  
**EARTH FORENSICS, Inc.**



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