October 13, 2016

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Subject: **Response to SCDHEC comments – Vulcan Lexington, SC Quarry**
Schnabel Project 15619049.00

Dear Mr. Hodge:

Schnabel Engineering LLC (Schnabel) has reviewed SCDHEC's comments, dated October 10, 2015, on our August 25, 2016 letter report analysis of potential drawdown associated with operation of the proposed Vulcan Lexington Quarry. The analysis included the development of a ground water flow model for the area. SCDHEC requested clarification on how the assumption of saturated conditions across the model domain caused the model to be conservative.

The model domain covered an area 11,000 feet by 11,000 feet (approximately 4.3 square miles). It is impracticable to know the hydrogeologic conditions at each point in the domain. A model is used to estimate those properties based on the extrapolation of known data. If the model can replicate the known data at known points using extrapolated data, the model is deemed calibrated and may then be used to estimate values such as water levels under proposed development conditions (pumping rates and locations for instance).

Based on the drilling completed at the site to support development of the model several locations were noted to not have saturated conditions above bedrock. By definition if an area is unsaturated (i.e. dry) there can be no drawdown in that area as there is no ground water to affect.

If an unsaturated area exists between the proposed quarry and a known well, then there is no way for the quarry to affect the well. Rather than attempt to estimate or assume where all the unsaturated areas across the model domain may naturally occur, it was decided to ignore the fact that some areas were dry to the top of bedrock and instead assume saturated conditions existed. This assumption, continuous saturated conditions across the model domain, was selected to make the model conservative. If continuous saturated conditions are assumed, then the potential effect of developing the quarry on nearby wells could be evaluated.

If continuous saturated conditions were not assumed, then the challenge would be to decide where the surficial aquifer was absent and where it was present. The density of the data points available could not

support such a decision across four square miles. So the conservative approach was to assume a continuous aquifer.

Modeling with that condition provides a worse case or conservative prediction. It may predict drawdown in areas where saturated conditions do not exist, but identifies areas of potential concern that may warrant monitoring. With the proposed ground water monitoring plan it will be possible to further calibrate the model against actual water levels in the coming years.

The Section is correct in its assumption that greater concentrations of radium and/or radon gas is associated with brittle mylonite, cataclasite, and gouge. Such rocks were not detected at the site. In other studies, radium has been generally been associated with emanation from aquifer rocks as opposed to being a weathering product. Dissolved radium can be a result of greater grain contact in fractured mylonite and granite; however, groundwater chemistry controls whether such dissolution occurs as well as the degree of dissolution.

We appreciate the opportunity to be of service for this project. Please contact the undersigned if clarification is needed for any aspect of this request.

Sincerely,
SCHNABEL ENGINEERING, LLC.

Raymond L. Knox, PG (SC#311)
Senior Vice President