Appendix D: Geotechnical Review

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Project No. 0386-SZ48-C41

Nolan, Zinn & Associates
1509 Seabright Avenue, Suite A2
Santa Cruz, CA 95062

Attention: Jeff Nolan

Subject: Geotechnical Engineering Peer Review
Bonny Doon Quarry Expansion and Liddell Spring Landslide

Dear Mr. Nolan,

As you have requested, we have provided a geotechnical engineering peer review of the documents that you provided to us concerning the expansion of the Bonny Doon Quarry and the characterization of the Liddell Creek Landslide. Our review was for consistency with generally accepted geotechnical principles and practices in data collection, analysis, and conclusions as well as providing alternate interpretations of the data for the geotechnical engineers to consider. Hydrology, geology, and engineering geology are not reviewed in this letter.

We have reviewed the following documents:

A. Jo Crosby & Associates, "Geology and Geotechnical Studies for the Planned Expansion of the Bonny Doon Limestone Quarry, Davenport, California". July 24, 1997. Project Number 3916B-27.

B. Jo Crosby & Associates, "Geology and Geotechnical Studies Regarding the Amendment to the Mining Plan for the Bonny Doon Limestone Quarry, Davenport, California". June 1, 1999. Project Number 3916B-27.

C. Woodward-Clyde, "Final Report: Phase I Geologic Investigation, Evaluation of Landslide; Bonny Doon Limestone Quarry; Santa Cruz, California". December 2, 1997. Project Number 937033NA.

D. Pacific Geotechnical Engineering, "Interim Geologic and Hydrogeologic Report: Liddell Spring Landslide, Bonny Doon Quarry, Santa Cruz County, California". January 30, 2001. Project Number 1769EG.

If you have any questions, please contact us at your convenience.

Very Truly Yours,

PACIFIC CREST ENGINEERING INC.

COPY

Steven M. Raas
Geotechnical Engineer
G.E. 2039
Exp. 6/30/06

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9. Pacific Geotechnical Engineering has stated that the landslide is active and marginally stable to unstable, depending upon the moisture conditions in the slide mass. The slide will likely continue to move episodically, especially during prolonged wet periods or as a result of seismic shaking. Slide movement may result in the destruction of the Liddell Spring Box and associated piping and utilities.

10. In the mitigation section of the report, Pacific Geotechnical Engineering has recommended installing various types of drains to lower the water level within the slide mass and increase the stability incrementally. These drainage systems will likely be destroyed or seriously damaged during periods of movement of the slide (associated with winter rains) and would be unavailable to provide drainage in continuing wet periods. Reinstalling the drainage during or soon after wet periods may be very difficult if not impossible.

11. A mitigation measure that Pacific Geotechnical Engineering did not suggest but that may be worth analyzing is the excavation of the landslide material and the replacement of the material as an engineered fill benched into the underlying bedrock. During the replacement, a comprehensive subsurface drainage system could be installed to dewater the slide area and protect the engineered fill. The subsurface drain system could drain into the Liddell Spring Box, potentially increasing the amount of water available to the spring. The spring box may need to be rebuilt as a part of this landslide repair. Although this repair may be expensive, it has the potential restore stability to the area, thus reducing the concern about the loss of the water supply from the spring. An analysis of the effect of removing the landslide mass, draining the area, and replacing the mass as an engineered fill on the spring flow would have to be provided.

Pacific Geotechnical Engineering January 22, 2003 Annual Data Report
This report presents the results of the monitoring of the instrumentation in the slide area. It is in general conformance with the generally accepted principles and practices of geotechnical engineering. The data shows that the slide is moving in the vicinity of the spring box at an approximate elevation of 10 feet below the existing ground surface, This movement is at the approximate elevation of the existing spring box and associated piping and, if it continues, may result in the destruction of the piping at least and potentially the spring box itself.

Our services consist of peer review services only and we have based our opinions on the documents provided by you, our knowledge of the geotechnical conditions in the area, and our visual reconnaissance. We have not generated subsurface information of our own nor have we provided nor will we be providing design or construction recommendations. In no way is Pacific Crest Engineering Inc. acting as the geotechnical engineer of record for this project nor are we responsible for the adequacy or completeness of any portion of the geotechnical design or construction.

5. Fill Slope Stability – The stability of the fill slope was modeled using a circular failure on a 40 foot high slope with no benches. The actual slope will be approximately 250 feet high with 20 foot wide benches every 40 vertical feet. The actual slope should be modeled, showing critical failure surfaces not only along the outer face of the fill between the benches but for the entire 250 foot plus height of the fill.

   This report speaks mainly about geology but, from a geotechnical engineering standpoint, is in general accordance with generally accepted geotechnical engineering principles and practices.

Woodward-Clyde December 2, 1997 Report
Pacific Geotechnical Engineering January 30, 2001 Interim Report
This report is an progress report containing little actual data, interpretation or conclusions.

Pacific Geotechnical Engineering October 22, 2001 Report
This comprehensive report on the Liddell Spring Landslide is in general accordance with accepted geotechnical engineering principles and practices with the following comments:

6. Drill hole DH-4-P is logged as encountering "moderately severely weathered marble" from 20 to 40 feet below the existing ground surface. Blow counts are presented for differing sampler diameters and types so it is difficult to compare the blow counts at different sample locations. If the blow counts are all roughly correlated to a 2"OD Standard Penetrometer, the blow counts go from approximately 16 from 21 to 31 feet, drop to 12 at 36 feet, and rise to 45 at 40 feet. In our extensive experience with the marble in the Santa Cruz Mountains, it is very unusual for a weathered zone to be more than one to two feet in depth. We have never encountered marble bedrock that can have any significant sample penetration, much less 20 feet of relatively easy penetration. It is our opinion that this material logged as severely weathered marble may be another geologic unit. The logging of the marble encountered in DH-6-SI and DH-7-T is more representative of the marble encountered in the Santa Cruz Mountains.

7. An alternate interpretation of the "completely weathered Schist" encountered in DH-7-T and the completely weathered schist with "pockets of relic rock fabric" encountered in LD-1 is that this material is doline infill material. The "pockets of relic rock fabric" could be consistent with schist clasts that were incorporated within the doline infill soil. In addition, the material is logged in DH-7-T as "soft to very soft" but the blow counts recorded are for medium stiff to very stiff material.

8. Slope Stability Analysis- The strength data for the landslide debris soil can be reasonable derived from the torsoinal ring shear tests presented in the report. It is unclear how the direct shear tests were used, if at all. There is no strength testing presented for the weathered schist, the weathered granodiorite, or the weathered marble. No basis for nor discussion of the strength of these materials is presented although the strengths were used in the slope stability analysis.

E. Pacific Geotechnical Engineering, "Landslide Investigation, Liddell Creek Landslide, Bonny Doon Quarry, Santa Cruz County, California". Draft Copy. October 22, 2001. Project Number 1769EG

F. Pacific Geotechnical Engineering, "Annual Data Report, Geotechnical Monitoring, 2001-2001 (Water Year 2002), Liddell Spring Landslide, Bonny Doon Quarry, Santa Cruz County, California". January 22, 2003. Project Number 1769/2EG.

Our review of the above reports is below:

Jo Crosby & Associates July 24, 1997 Report
It is our opinion that the report is in general accordance with generally accepted geotechnical engineering principles and practices with the following comments:

1. Rock slope stability – Back calculations showed the need for a cohesion of 700 psf along the fracture and/or joint surfaces to develop the required factor of safety for stability of the finished rock quarry slopes. No data is presented showing the measured or estimated cohesion along these potential failure surfaces. Since there is no data presented showing the required strengths exist for stability, no conclusion can be drawn that the slopes are stable.

2. Sandstone stability – Although Crosby did not obtain actual samples of the sandstone that was analyzed for slope stability, the assumed strength values of a friction angle of 32 degrees and a cohesion of 250 psf are reasonable for this material. Since the stability of these slopes is an important feature of the project, it may be that samples should be obtained or the development of the strength parameters documented in some manner to verify the assumptions used in the stability analysis.

Jo Crosby Associates June 1, 1999 Report
It is our opinion that the report is in general accordance with generally accepted geotechnical engineering principles and practices with the following comments:

3. Rock Slope Stability – the rock slope analysis showed, through back calculations, that a cohesive strength along the planar failure surfaces of 1,150 psf would be needed for stability. No data is presented showing the measured or estimated cohesion along these potential failure surfaces. Since there is no data presented showing the required strengths exist for stability, no conclusion can be drawn that the slopes are stable.

4. Fill Slope Stability – Fill slope stability is analyzed using "strength data .... Obtained from triaxial test procedures on remolded limestone quarry screened rock fines". The strength test data is not presented. No data is presented for the remolded sandstone overburden material that Crosby says is also adequate for use in the fill. No data is presented for a mix of these two materials. Documentation of the strength parameters of the soil used in the construction of this very large fill should be presented.