TECHNICAL MEMORANDUM

TO: Rex Wait, Vice President
The Nevada Hydro Company, Inc.

FROM: Joseph J. Kulikowski, P.E., G.E.
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SUBJECT: Comments on Geotechnical Issues as Identified in the DEIS
Lake Elsinore Advanced Pumped Storage Project (LEAPS)
FERC Project No. 11858

DATE: March 30, 2006

This Technical Memorandum presents the results of a review of geotechnical issues for the proposed Lake Elsinore Advanced Pumped Storage Project (LEAPS) in Riverside County, California. The review was performed by GENTERRA Consultants, Inc. (GENTERRA) for The Nevada Hydro Company, Inc. (Nevada Hydro) in accordance with the scope of work authorized on February 20, 2006.

This review was undertaken in response to the Federal Energy Regulatory Commission's (FERC) "Draft Environmental Impact Statement – Lake Elsinore Advanced Pumped Storage Project, California, FERC Project No. 11858" (DEIS), dated February 2006. At the request of Nevada Hydro, GENTERRA was asked to discuss the validity of relevant statements made in the DEIS document, as related to geotechnical issues. This review included a re-examination of available background reports and information.

The two candidate upper reservoir sites are Morrell Canyon (proposed site) and Decker Canyon (alternate proposed site). These two sites are situated at the top of the steep northeast-facing slope of the Elsinore Mountains on the west side of Lake Elsinore.

The comments presented below are identified with the related section, page number and statement from the DEIS. The statements in quotes and italics are the actual wording from the DEIS, then our comments follow each quoted statement.

SECTION 2 – PROPOSED ACTION AND ALTERNATIVES

Page 2-9
"Project construction would be accompanied by drilling and blasting. All construction activities would be limited to daylight hours."

Comment:
This will apply to above-ground construction activities. The tunnel boring machine (TBM) will most likely work underground in two 10-hour shifts with four hours for maintenance each 24 hours. "Daylight hours" will not apply for underground construction.

SECTION 3 – ENVIRONMENTAL CONSEQUENCES

Page 3-12
"The areas indicated to have potential for debris flows in the area of proposed project facilities include a contiguous band along the steep eastern slopes of the Elsinore Mountains above the southwestern shores of Lake Elsinore. The mapping is general, but indicates the potential for debris flow to affect the proposed sites for the powerhouse and the proposed powerhouse laydown areas."

Comment:
The potential for debris flow would primarily impact the surface features of the project such as the switchyard and associated transmission towers, and would have little direct impact on the underground powerhouse. Surface features would be designed with appropriate setbacks and other mitigation features such as debris basins, diversion berms, diversion channels, and other measures to counter the potential for operational disruption or other adverse impacts due to debris flows.

Page 3-12
"Surficial instability in the form of slopewash and the accumulation of colluvium was observed during geologic reconnaissance."

Comment:
Slopewash and accumulation of colluvium are normal features in sloping terrain and are not geologic hazards as the subsection title would imply.

Page 3-19
"The presence or absence of a water table has a significant bearing on the difficulty and potential hazards associated with underground works. Seismic refraction data alone are insufficient to quantify groundwater depths or even the presence or absence of groundwater. There are significant unexplained differences between the subsurface seismic survey profile interpretations in the co-applicants' application. The seismic profile interpretations in the license application have not been confirmed ("proofed") by boreholes, down-hole logs, and

geologic information, all critical elements in limiting the range of uncertainties present in seismic survey profile interpretations."

Comment:
The purpose of the preliminary seismic refraction surveys was only to collect general seismic velocity profile data on the subsurface materials and to obtain an approximate estimate of depth to rock at each powerhouse site. It was not intended to provide definitive groundwater data. We concur that more detailed groundwater information is needed; this will be appropriately collected in a later design stage.

<u>Page 3-25</u>
"Faulting in the Lake Elsinore area has been relatively well documented. The Willard fault zone has been tentatively classified as active, however; the position of the fault zone is uncertain. Genterra Consultants (2003) indicate that the (single) fault lies between the proposed powerhouse and Lake Elsinore, and would be crossed by the tailrace tunnel(s). However, the description of the fault zone indicates that several fault strands are involved, and that surface expressions occur at elevation 1,450 feet msl, about elevation 1,700 feet msl, elevation 1,850 feet msl, and elevation 2,100 feet msl. The proposed Santa Rosa underground powerhouse is centered on the elevation 1,420 feet msl ground surface contour, which would place it between the lowest surface expression of the Willard fault strands and Lake Elsinore, and the series of faults would be crossed by the high pressure tunnel(s). The other alternative powerhouse sites appear to be either directly on (figure 5) or above the fault, indicating that the tailrace structure would need to traverse the series of faults."

Comment:
Detailed fault studies will be performed during a later stage of the project once a site has been selected. The presently-mapped locations of strands of the Willard fault in the site area are conjectural and are primarily based on observations of geomorphic features indicative of geologically-recent faulting, and projections of fault strands into the site vicinity from outside the immediate area. The important consideration is that the selected powerhouse site should have flexibility for moving locations of critical structures if fault strands are discovered. The Santa Rosa and Evergreen sites have more flexibility to move structures to avoid faults than the Ortega Oaks site has due to the presence of Highway 74 on two sides of the Ortega Oaks site.

<u>Page 3-25</u>
"The Wildomar fault is classified as active. The latest USGS mapping shows its possible position beneath Lake Elsinore as being a short distance from the southwestern shore. The potential lateral displacement of this fault in a magnitude 7 to 7.5 earthquake as measured on the Richter scale is estimated to be in the order of 5 to 16 feet (Berger, 1997). The tailrace structure for the proposed and alternative powerhouse sites would likely cross this fault."

Comment:
Detailed fault studies will be performed during a later stage of the project once a site has been selected. While it is theoretically possible to postulate a magnitude 7 to 7.5 earthquake causing

lateral displacement of 5 to 16 feet at the tailrace tunnel, such an event may not be likely for the northerly extremity of the Wildomar fault (the site vicinity) compared with more southerly portions of the fault. For example, a 10-year study of microseismicity on the Elsinore fault zone shows an apparent absence of microseismicity associated with the northerly extremities of the Willard and Wildomar faults during the study period (Hull and Nicholson, 1992[1]). Stress release along the Elsinore fault zone during earthquakes apparently undergoes a right step from the Wildomar fault south of Lake Elsinore to the Glen Ivy North fault in the vicinity of the lake creating a "seismic gap" in the site vicinity. In any event, detailed studies will be needed to establish seismic design criteria for the tailrace tunnel, and these are appropriately done at a later stage of the project.

Page 3-26

"The direction of the Willard fault(s) is approximately parallel to the longitudinal axes of the powerhouse cavern, the transformer gallery, and the surge chamber (shaft). An active fault or extensive adjacent shear zone could not be tolerated in these excavations/facilities. Because of the lateral extent (upstream-downstream) of these facilities, positioning them to avoid the Willard fault zone may be extremely difficult, possibly requiring them to be moved deeper into the Elsinore Mountains or closer to the lake. The former move would seriously affect access, and the latter move would raise a concern as to the adequacy of the rock cover."

Comment:

See comment above for Page 3-25. We agree, and note that the Ortega Oaks site has the least flexibility to move into the hill due to the presence of Highway 74 on the uphill side of the site. The Ortega Oaks site also has the least amount of rock cover. For these reasons, the Santa Rosa and Evergreen sites offer more flexibility in avoiding strands of the Willard fault should they be discovered.

Page 3-27

"Review of sub-surface seismic survey profile interpretations for the proposed Santa Rosa powerhouse site reveals uncertainty regarding the presence of a water table (or a deeply weathered bedrock zone). A water table or zone of weathered bedrock is seen in other nearby profiles but is absent at the Santa Rosa site. Some structural geologic differences between the sites may explain this uncertainty; however, any uncertainty related to the presence of or depth to a water table translates to an unknown degree of complication for construction at the Santa Rosa site."

Comment:

This statement makes it appear that the Santa Rosa site conditions are more uncertain and therefore potentially more complicated than the other sites. The data for all three sites are preliminary in nature and each site involves some uncertainty. Each site will involve construction issues of groundwater seepage, dewatering, shoring, etc. to greater or lesser degrees. Detailed

[1] Hull and Nicholson, 1992. Seismotectonics of the Northern Elsinore Fault Zone, Southern California. Bulletin of the Seismological Society of America, Vol. 82, No. 2, pp. 800-818, April.

site studies to address these uncertainties are appropriately performed at a later stage of design to avoid needless expenditures on detailed studies at sites that will be eliminated.

Page 3-27
"The co-applicants propose to support the intake/outlet structure on piles. Whether this is an appropriate solution depends on the nature of the materials and on the depth to bedrock. If the nature of the materials and/or the potential for liquefaction is such that end-bearing piles are required to support the structure, and if the depth to bedrock is such that the piles would have to be of excessive diameter to prevent buckling, or toppling, piling would not provide a solution. A solution might not be available in such a situation."

Comment:
Detailed studies to address this question are planned for a later design stage of the project. At the present stage, it is appropriate to assume that an adequately-engineered foundation design approach, possibly including ground improvement techniques, will be used, rather than to suggest that a solution to foundation design of the intake/outlet structure may not be available.

SECTION 4 – DEVELOPMENTAL ANALYSIS

Page 4-3
"Although the proposed concrete-faced rock fill dam is not one of the conceptual designs presented by the co-applicants in exhibit F (figure F-2), it is probably the most suitable dam type for a seismically active region and for a reservoir subject to the rapid filling and drawdown associated with a pumped storage facility. Our review questions the co-applicants' proposed use of a random earth fill dam because of the risk of settlement and cracking of the facing."

Comment:

Alternative types of dam design will be studied in the later design stages of the project. It will be the objective in the site investigation and the engineering analyses to develop a design that integrates the best utilization of on-site materials and provide a safe, stable structure for the full reservoir, rapid filling and frequent reservoir drawdown conditions. As suggested in the DEIS, a concrete-faced rockfill dam can certainly be considered in the final design of the dam, but pore pressure developing behind the facing needs to be considered in the design. The facing on the upstream slope of the dam must be designed to remain intact during an earthquake event, and must also be designed to either positively prevent seepage that will develop pore pressure during reservoir filling and steady seepage, or provide dissipation of that pore pressure during drawdown. In any type of design, a subdrainage system would be provided behind the facing as a backup measure that would dissipate pore pressures behind the facing during rapid drawdown.

A properly designed and constructed zoned earthfill dam, most likely with rockfill zones in the upstream and downstream portions of the dam, will be considered during the design phase of the project because it can be designed with zones of properly placed and compacted impervious, semipervious and pervious materials to withstand seismic shaking without excessive deformation or settlement, and can provide the drainage necessary under full reservoir, rapid filling and rapid drawdown conditions. A zoned earthfill dam is a conventional type of design for dams in high seismic areas, and is a common type of modern dam design in California. Several large and medium-sized dams have been designed in this manner over the past one-half century. Genterra Consultants, the geotechnical consultant to Nevada Hydro for the LEAPS project and design of the dams, is currently designing two dams of this type in southern California with full review from the State Division of Safety of Dams. A zoned earthfill and rockfill combination is one variation of this type of design. One of the largest and most recent projects using this type of dam is the Diamond Valley Reservoir near Hemet, less than 20 miles east of the project site.

SECTION 5 – STAFF CONCLUSIONS

Page 5-2
"Table 53. Summary of key differences in the potential effects of the co-applicants' proposal and the staff alternative.(Source: Staff)"

Seismic hazards	*Faults may control surface flows at the Morrell Canyon site*	*No faults have been identified at the Decker Canyon site and subsurface flow does not appear to controlled by the presence of faults*

Comment:
Faults or other structures such as fractures and joints within the granitic rock at either site may control subsurface (not surface) groundwater flow. Since no information suggests that faults in the upper reservoir are active, this would not seem to qualify as a "seismic hazard."

Page 5-19
"Our analysis of the available information indicates that construction and operation at all three powerhouse locations could potentially be affected by faults and seismic considerations; therefore, seismic considerations should not be a determining factor in selecting among the proposed and alternative powerhouse locations."

Comment:
As stated above in the comment for a statement on Page 3-25, the important consideration is that the selected powerhouse site should have flexibility for moving locations of critical structures if fault strands are discovered. The Santa Rosa and Evergreen sites have more flexibility to move structures to avoid faults than the Ortega Oaks site has due to the presence of Highway 74 on two sides of the Ortega Oaks site.

Thank you for this opportunity to provide these additional comments and clarifications of geotechnical issues.

Please contact me, Soma Balachandran, Ph.D., P.E., or Michael Wolff, C.E.G. at 949-753-8766 with any questions or comments.

Respectfully Submitted,
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