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Jim Russell, PMP
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Dear Jim:

In response to your request for comments on liquefaction hazard at the proposed prison relocation site in Salt Lake City, I offer the following observations on liquefaction hazard at the site, the only aspect of the site investigation for which I have the expertise to comment. In preparing these comments, I reviewed the following two documents:

1. Epic Engineering: Preliminary Geotechnical Investigation
2. Letter from William J. Gordon, Gordon Geotechnical Engineering, Inc.

Comments on Epic Engineering Preliminary Report

My first comment is that I generally agree with the following statement by Bill Gordon: "Our experience, however, indicates that the magnitude of liquefaction-induced settlements provided in the preliminary reports and the concern of lateral spread although present are over emphasized."

The Epic report is listed as preliminary and thus the results should be considered as preliminary and incomplete. The report lacks some essential information necessary for an independent review to check the analyses and findings from CPT data. Although logs from 10 boreholes with SPT tests are listed in the report, no analyses of settlement and lateral spread displacement are reported from the SPT data. Very little grainsize data is listed on the logs, information that is required for calculation of liquefaction resistance, ground settlement and lateral spread displacement from SPT data. Some additional that is needed, but unreported is the energy ratio of the donut hammer used in SPT tests and the drilling method used--hollow-stem auger or rotary drilling with mud filled holes.

Notes on plots in Appendix B indicate that CPT data were analyzed to determine ground settlement using a computer program developed by Peter Robertson (1998 (Zhang and Robertson 2002?)) for estimation of ground settlement. The procedure to estimate lateral spread displacement is unreferenced; however, the displacement procedure applied is presumably that published by Zhang and Robertson (2004). These ground settlement and lateral spread prediction programs are known to yield conservative or over predicted results. Peter Robertson subsequently developed corrective procedures

to reduce over predictions of ground settlements and lateral spread displacements. The first correction is to account for the influence of depth; the second is to correct for the influence of thin layers in the sediment column. The Epic report does not discuss these corrections nor indicate whether or not they were applied. Both corrections are needed for the prison relocation site because much of the ground settlement comes from deep (>20 ft.) soil layers and from spread displacement originating from thin granular layers in the sediment profile.

Corrections for geologic age are not addressed in the Epic report. As I indicated in my review of liquefaction hazard at the Westpointe site, sediments older than a few thousand years are not likely to contribute significantly to ground settlements (or lateral spread displacements). Thus, I suggest that a geologic study be made to estimate the depth and thickness of Holocene-age sediment and Lake Bonneville deposits beneath the prison site. I further suggest that the Utah Geological Survey (UGS) be enlisted to develop age estimates. I have read a recent UGS report Hylland and others, 2015) on trenches excavated across the Granger fault at a field site just west of Salt Lake City Airport and just north of the International Center (about 2 miles east of the prison site). That investigation found that sediments at the base of the trenches (about 10 ft. deep) were Pleistocene in age or more 12,000 years old. Sediments of that age are generally immune to liquefaction, ground settlement or lateral spread displacement.

Ground Settlement and Lateral Spread Displacement

The Epic report contains analyses of the data from three CPT soundings to estimate amounts of expected ground settlement and lateral spread displacement. The predicted settlements are 7 in., 5 in. and 9 in., and predicted lateral spread displacements are 59.7 in., 46.5 in., and 78.4 in., respectively for CPT 1, SCPT 2, and CPT 3 (Appendix B). (No reference is given in the Epic report for procedures applied to calculate lateral displacements, but I presume the procedure used was that of Zhang, Robertson and Brachman (2004). Such large settlements and displacements are capable of inflicting severe structural damage to structures. As a consequence, the Epic report proposes multimillion dollar remedial measures to prevent such large deformations from developing (Table 10 p. 26).

My recommendation is that the remedial work suggested in Table 10 should not be implemented based only on the Epic preliminary investigation. I believe that further and more rigorous analyses will indicate much smaller settlements and displacements that most likely could safely be accommodated by well-designed and built buildings with little or no remedial deep ground improvement to mitigate liquefaction hazard.

Recommended additional investigations and analyses

More information is necessary to prepare a complete analysis for the site:

1. Age-dating of sediment beneath the site needs to be conducted using geologic procedures. UGS personnel have the expertise and capability to make such determinations. I recommend that DFCM contact Michael D. Hylland at UGS to initiate a program to perform these age determinations; Emphasis should be on determining depths and thicknesses of Holocene and Lake Bonneville sediments beneath the site.
2. The following information is needed from Epic Engineering for future analyses:
    a. What procedure were used to drill Boreholes 1 through 10 (p. 39-58)?

b. What is the hammer energy transfer ratios for hammers used to conduct the SPT tests?
c. Were corrections for depth and for thin layers applied in calculation of liquefaction-induced ground settlements and lateral spread displacements from CPT data?
d. Were predictions made of ground settlements and lateral spread displacements developed from SPT data? could these calculations yet be made?

Further analyses

The geotechnical data collected from the site appear to be sufficient to analyze liquefaction hazard, My hypothesis is that further analysis will conclude that tolerable ground settlements and lateral spread displacements are to be expected at the site. To prove this hypothesis, the geotechnical data needs to be reanalyzed. I have outlined above analyses that are needed. The CPT data should be reanalyzed with applied corrections for depth and for thin granular layers. Correction for age of sediment, similar to that which I did for the Westpointe site, also need to be applied. As a further check, the SPT data should be analyzed for prediction of ground settlement and lateral displacement to further verify the hazard. Such analyses are beyond the scope of this review. However, I have experience with such analyses and have developed a procedure I would recommend for prediction of lateral spread displacement from SPT data. I would be willing to confer with the analysists contracted to do these analyses.

If you have questions or need more information about my comments in this review, please feel free to ask for additional input from me.

Sincerely yours

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References cited:

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