April 18, 1988

Portland State University
Physical Plant
P.O. Box 751
Portland, OR 97207-0751

Attn: Mr. Dick Piekenbrock
Staff Architect

GEOTECHNICAL INVESTIGATION
MILLAR LIBRARY ADDITION
PORTLAND STATE UNIVERSITY

Gentlemen:

In accordance with our proposal of February 5, 1988, and Supplement No. 4 to the Agreement dated February 27, 1986, we have completed a geotechnical investigation for the referenced project. This letter report describes our investigation and presents our comments and recommendations for foundation design and construction.

This report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only, i.e., field boring logs and samples. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the formal boring logs, or discussion of subsurface conditions contained herein.

SITE AND PROJECT DESCRIPTION

The existing Millar Library on the Portland State University campus is located on the east half of the block bounded by S.W. Park Avenue and S.W. 10th Avenue on the east and west, and S.W. Harrison Street and S.W. Hall Street on the north and south. All of the streets except S.W. 10th Avenue are presently vacated. Prior to construction of the existing library, the block housed one and two story wood frame buildings, most with basements.
The existing library contains a partial subbasement, a basement and 5 stories above ground, with provisions for 5 additional floors in the future. The ground level floor is at an elevation of 168.08 feet with the basement and subbasement floors at elevations of 155.33 feet and 139.33 feet respectively. The structure is constructed of reinforced concrete with column loads up to 2600 kips for the ultimate development. Design soil bearing pressures range from 6 to 10 kips per square foot (kps) for the ultimate design.

The present east half of the block where the addition will be located is predominantly a landscaped area with lawn, shrubs and walkways in a hummocky topography. Ground surface elevation ranges from 163 feet to 169 feet. In the center of the east part of the area is a large, 100(+) year old copper beach tree.

The present plan is to add an 86,000 square foot, 5 story plus basement, concrete frame addition to the east side of the existing library. The structure will be designed so as to preserve the copper beach tree as a focal point. The present addition is a first phase, and a second phase is planned which will add 5 floors over the entire structure.

Anticipated column loads for the first phase addition will be in the range of 1255 kips. Ultimately the column loads will be in the range of 1785 kips.

FIELD EXPLORATIONS AND LABORATORY TESTING

The field explorations consisted of 3 borings at the locations shown on the site plan, Figure 1. Also shown on the Site Plan are the borings drilled for the existing library in 1965. The present borings, designated B-1, B-2 and B-3 were drilled on March 1 and 2, 1988, by Greg Vandehey Soil Sampling of Forest Grove, Oregon, using a trailer mounted solid flight auger. A Shannon & Wilson, Inc. representative was present throughout the exploration work.
Samples were obtained in the borings at intervals of 2-1/2 to 5 feet
predominantly using a 2 inch O.D. split spoon standard Penetration sampler.
A few samples were obtained using a 3 inch O.D. thin walled Shelby tube
sampler. The locations of the samples and generalized soil descriptions are
shown on the summary boring logs presented on Figures 2, 3 and 4. Soil
descriptions and interfaces are interpretive, and actual changes may be
gradual.

All samples were visually examined in our laboratory in order to refine the
field classifications. The laboratory program consisted of water content
determinations on samples obtained in the field exploration. Two
consolidation tests were conducted for this project and the results
presented on Figures 5 and 6. No strength tests were conducted for this
project.

SUBSURFACE CONDITIONS

The analyses, conclusions, and recommendations contained in this report are
based on site conditions as they presently exist and assume the exploratory
borings are representative of the subsurface conditions throughout the site.
If, during construction, subsurface conditions different from those
encountered in the exploratory borings are observed or appear to be present
beneath excavations, we should be advised at once so that we may review
these conditions and reconsider our recommendations where necessary.

The borings drilled for this phase disclosed surficial fills consisting of
clayey silt, sandy silt and silty fine sand with occasional gravel and some
charcoal. The fill was found to be about 7 feet thick at Boring B-2 and is
probably the result of regrading of the site after demolition of the
residences prior to construction of the existing library. At Boring B-3,
the fill was found to be 13.5 feet thick and probably represents backfill
for the basements of the existing library.

Below the fill is a deposit of loose, brown sandy silt to silty fine sand to
an elevation of 145 to 150 feet. The loose deposit is underlain by medium
dense, silty to slightly silty fine sand to the maximum depth explored for
this phase at elevation 96.5 feet at Boring B-3. The 1965 borings also terminated in this stratum at an elevation of 72 feet. Gravel has been encountered in explorations for Smith Memorial Center and Science Building I at an elevation of about 40 feet.

The groundwater table was not encountered in any of the borings; however, based on nearby projects, the static groundwater table is estimated to be at a depth of approximately 100 to 150 feet.

GEOTECHNICAL DESIGN RECOMMENDATIONS

Foundations
The existing library structure is founded on spread footings in the medium dense, silty to slightly silty fine sand underlying the site below an elevation of 145 to 150 feet. The footings were sized for the ultimate development with soil bearing pressures on the order of 7.6 kips per square foot. Calculated soil bearing pressures of the library as it exists now are on the order of 5 to 6 kips per square foot.

In general, the bearing capacity of cohesionless soils such as the soils underlying the site are based on the amount of settlement that a structure can tolerate. In addition, settlement in cohesionless soils are basically elastic so that settlement occurs as load is applied. Using the calculated loads of the existing structure, it is estimated that the structure has undergone a total settlement of the order of 1.4 inches. The addition of 5 floors in the future will create an additional 0.5 inches of settlement.

On the east side of the existing structure, several footings will have additional loads due to the new addition. Settlement of these footings due to the new loads are estimated to be about 0.25 inches. With the ultimate development, these footings will undergo an additional settlement of 0.4 inches.

In determining the bearing capacity of the footings for the addition, the settlement resulting from the future floors was considered so that the future settlement of both the existing and present addition will be similar.
Using this criteria and taking into account that the new footings will be founded in the upper loose sandy silt to silty fine sand, it is recommended that the footings be proportioned using an allowable bearing pressure of 5 kips per square foot. Estimated settlement under the first phase loads will be 1.12 inches with an additional 0.5 inches due to the addition of the 5 future floors. Because of the 1.12 inches of settlement due to the first phase loads, consideration should be given to the differential settlement between the existing and new structure.

Because the exact size, shape and locations of new footings are not known at the present time, it is recommended that a review be made when this information is available.

The estimates of settlement assume that no disturbance to the foundation soils would be permitted during footing excavation and construction. To minimize the potential for disturbance, it is recommended that the footing excavations be made with a smooth bucket (no teeth) backhoe or that the final 3 to 4 inches be excavated by hand. Alternatively, the exposed subgrade could be compacted to a dry density of at least 95 percent of the standard Proctor maximum dry density (ASTM D 698).

All concrete floor slabs on grade should be founded on a minimum 6-inch layer of free-draining well-graded sand and gravel or crushed rock with a maximum particle size of 1-1/2 inches and not more than 2 percent passing the No. 200 sieve (based on a wet sieve analysis). This underslab granular material should be compacted to a dry density of at least 98 percent of the standard Proctor maximum dry density (ASTM D 698).

Basement walls below grade as well as small cantilever retaining walls should be designed to resist lateral earth pressures. The lateral pressure will depend on the ability of the walls to yield. Conventional retaining walls should be designed for an equivalent fluid weighing 35 pounds per cubic foot (pcf). Non-yielding walls should be designed using an equivalent fluid weighing 45 pounds per cubic foot (pcf). These values assume that the wall is properly drained to prevent the buildup of hydrostatic pressures. It is our opinion that the wall in this situation should be considered as a
non-yielding wall. These recommendations assume that the backfill slope is horizontal. Higher lateral pressures may be anticipated for up-slope backfills, and we recommend that we be allowed to review these lateral pressures if a sloping backfill is required. In addition, the new footings may create additional lateral loads on the existing subbasement wall, and this possibility should be reviewed.

To resist lateral loads, passive earth pressure may be computed using an equivalent fluid pressure of 350 pounds per cubic feet. This value does not have a factor of safety nor does it consider the amount of movement necessary to develop the passive pressure.

Drainage behind the basement wall is considered necessary to protect against saturation of the backfill due to leakage from broken water or sewer lines or surface water percolating into the backfill. Recommendations concerning backfill and drainage requirements behind basement and small cantilever retaining walls are shown in Figure 7. The perimeter drain lines should be adequately sloped to allow the water to drain under gravity. Failure to adequately dispose of the water behind a wall could lead to significantly higher lateral pressures than anticipated.

If the basement wall is constructed directly against the temporary shoring, we recommend vertical chimney drains between the permanent wall and shoring consisting of "AmerDrain", "Alidrain", "Miradrain" or similar geodrain. At the bottom of the drain, a detail needs to be developed to carry any water out of the system.

SEISMIC CONSIDERATIONS

For seismic design, a value of Characteristic Site Period, Ts, of 0.6 seconds is recommended. This value of Ts is based on a boring and study accomplished at Cramer Hall. The site coefficients should be taken as Type S2 with an S Factor of 1.2.
GRADING

If grading or construction operations occur during the wet season, it may be necessary to place a 12-inch thick granular workpad on the subgrade of the excavation. The workpad should consist of a well graded material having a maximum size of 3 or 4 inches and less than 5 percent passing the No. 200 sieve based on a wet sieve analysis. The workpad should be placed over the site in two lifts; the bottom 8 inches should be nominally compacted and the top 4 inches should be compacted to 95 percent of the standard Proctor maximum dry density (ASTM D 698).

Any soil that is free of organic or other deleterious matter would be suitable as fill or backfill, if it is placed during dry warm weather and it is aerated (to lower the water content) before it is placed. If grading work is accomplished during the wet time of the year, then a clean (not more than 5 percent passing the No. 200 sieve, based on a wet sieve analysis) granular material is recommended.

Fills should be placed in 9-inch loose lifts and compacted to a dry density of at least 90 percent of the standard Proctor maximum dry density (ASTM D 698) within the building area. All landscape fills outside of this limit could be compacted to 90 percent of the maximum dry density.

Temporary cut slopes above the water table may be made at 1H:1V slopes provided the slopes are adequately protected from becoming overly wet or dry and not more than 10 feet in height. In addition, no structures should be on or at the edge of the slope.

TEMPORARY SHORING

Where temporary open cut slopes are not possible, temporary shoring will be required, and for temporary sheeting and braced walls, it is recommended that the strut or tie-back loads be proportioned by the simple area method using the lateral pressure diagram shown by Figure 8. The lateral pressures shown by Figure 8 are not intended to estimate a true distribution of soil stress, but provides a conservative estimate of maximum strut/tie-back
loads. If temporary shoring is required, criteria for the design of a shoring system can be presented in a separate letter. We recommend that we be allowed to review the final shoring system design.

CLOSURE

It is recommended that close quality control be exercised during the preparation and construction of building foundations and pavement sections. In addition, we also advise that the subgrade preparation and the footing excavations be inspected by a geotechnical engineer.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, if conditions have changed due to natural causes of construction operations at or adjacent to the site, or if the basic project scheme is significantly modified from that assumed, it is recommended that this report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples, or drilling test borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra cost.

Very truly yours,

SHANNON & WILSON, INC.

By /s/ K. Frank Fujitani
K. Frank Fujitani, P.E.
Senior Associate

Enclosures

cc: Skidmore, Owings & Merrill
    Moffatt, Nichol & Bonney, Inc.

KFF/dla