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Reference: 611011

May 8, 2012

Mr. Randy Dixon, Operations Superintendent
City of Coos Bay
500 Central Ave.
Coos Bay, OR 97420

Subject: Geotechnical Evaluation, Coos Bay Public Library, Coos Bay, Oregon

Dear Mr. Dixon:

This report presents the results of a phased geotechnical evaluation for the Coos Bay Public Library conducted by SHN Consulting Engineers & Geologists, Inc. (SHN). The purpose of our evaluation is to determine the cause of distress to interior walls and the floor slab, generally within the northern part of the structure. The scope of work was submitted for approval in two stages: the first phase for preliminary review was approved by the City Council in January 2012; the second phase for field exploration and analysis was approved by City Council in March 2012.

Background and Design Plans

The library structure was designed and constructed in 1965. Plans for the Library and Civic Center Facility were prepared by Kruse & Fitch, Architects. Drawing 2 of 20 (See Attachment 2) shows the foundation layout, consisting of 12 plan columns (PC1 through PC12, south to north) and 8 plan rows (PR-A through PR-H, east to west) on 16-foot centers. Each area between plan columns and rows is called a bay (Figure 2 included in Attachment 1). The original entrance to the library was on the north side, between PC11 and PC12, PR-D and PR-E. Two bays to the west (PC11 and PC12, PR-E through -G) were enclosed as part of the original library floor space. Two bays to the east (PC11 and PC12, PR-B through -D) were not enclosed and were covered by the entry canopy.

Nearly all perimeter foundations consisted of a two-pile cap (two foundations were designed with a 3-pile cap). The building corners at 6H[1], 11H, and 11A have single-pile support. The canopy-support columns at 12B, 12C, and 12D along the present north wall, are also supported by single piles. Foundations consist of 12-inch diameter timber piles, 45 to 50 feet long. Piles along PC1 and PC2 were designed to be 45 feet long; all other piles were to be 50 feet long. Interior columns are configured in 2- to 5-pile groups. Individual or group pile capacities could not be found on the plans.

In approximately 1998, the library was expanded to the present configuration. The plans for the expansion were prepared by Richard P. Turi, Architecture & Planning. Drawing 1 of 29 in Attachment 2 shows the piling and foundation plan for the expansion. The plan column and row designations used by Kruse & Fitch were continued for the expansion, which was extended west 96 feet from PR-G and 16 feet east from PR-B to PR-A and between PC2 and PC5. New foundations

[1] For ease in referring to specific locations, we have used a combination of numbers for columns and letters for rows (for example, 6H refers to PC6 at PR-H).

were to consist of 12-inch diameter pipe piles, 55 feet long. New foundations were positioned within 5 feet of existing foundations. The original entrance to the library on the north side was to be closed by infilling the steps and doorway.

The 1998 Turi plans show the existing library as enclosed on both sides of the original entrance. However, this is not indicated in the original Kruse & Fitch plans, which show this area as a canopy, not part of the original library footprint. Therefore, we surmise that sometime between 1965 and 1998, the canopy area was enclosed; new perimeter walls were erected along the north wall, east of the original entrance; and the floor elevation was raised to the same level as the main structure.

Preliminary Investigation

Our approach consisted of the following objectives, to be achieved in stages and depending on the findings of each previous step:

1. Determine the nature of the distress to the library by surveying the site; interview employees of long-standing who remembered the expansion; review all plans related to library design; and measure obvious distress.
2. Evaluate the cause and degree of the distress and obtain engineering properties of the soils that support the pile foundations.
3. Conduct an engineering analysis and make recommendations for remediation, where appropriate.

The two most noticeable areas of distress are in the northeast corner, in the area of the former canopy, which has since been enclosed. Cracking of the perimeter walls along PC12 is evident on the interior walls and around the emergency exit door (PRB between PC11 and PC12). The crack pattern is suggestive of settlement of the perimeter wall. We also noted elevation changes in the floor slab over the northernmost 16 feet of the library and east of the original entry. It appears that there is an east to west crack in the slab below the carpeting at the inner column, 11D, extending eastward. The slab appears to tilt down to the north.

We met with library personnel on January 24, 2012, and reviewed all available plans that were stored at the library. Personnel recalled the expansion in 1998 and closing the original north entrance. However, no recollection was made for enclosing the northeast corner, where the original canopy was located.

On about January 26, 2012, we performed a level survey to map the contours of the slab along the north wall, to a distance of at least 32 feet (2 bays) south to PC10. The results of the survey are shown on Figure 3 (included in Attachment 1). In general, the slab surface descends from east to west with relief on the order of 0.6 feet over 85 feet horizontally. The greatest elevation discrepancy occurs where the original library entrance was located. As part of the 1998 remodel, this area was to be infilled, presumably with concrete. We measured relief of 0.40 feet across this 16-foot wide

single bay. The survey shows a "ridge" along PC11 between PR-B and PR-D and the slab dipping down to the north nearly 0.10 feet across a distance of 16 feet. This "ridge" corresponds to the original north wall of the library before the canopy area was enclosed.

Based on the review of plans, the distress, and present conditions, our preliminary conclusion was that nearly all of the distress is due to inadequate pile capacities along the northeastern wall (PC12). The foundations that supported the canopy are single piles, extending to a depth of 50 feet. All other perimeter footing foundations consist of two piles, except at three corners. We found no plans that indicated additional piles were planned to support the new walls and roof loads. Therefore, we concluded that the columns at 12B, 12C, and 12D have inadequate foundations.

Field and Laboratory Investigation

A geologist from SHN conducted a field investigation at the subject site on April 6, 2012. We supervised one Cone Penetration Test (CPT) sounding near the northeast corner of the library (Figure 1 included in Attachment 1). The CPT sounding was performed to obtain a nearly continuous profile of the specific engineering properties of the soils and to compare them to those encountered at City Hall, about 350 feet to the north. SHN conducted a geotechnical evaluation of the subsurface conditions and existing piles at the City Hall, where foundations consisted of 12-inch diameter timber piles that were driven 80 feet. Reported pile capacity for design was 20 tons (SHN, May 26, 2011).

The CPT sounding was performed using an approximately 1¼-inch diameter electric cone penetrometer. The penetrometer was advanced using a truck-mounted hydraulic ram that weighs approximately 20 tons. Cone tip resistance (q_c) and sleeve friction (f_s) were recorded during advance of the CPT sounding. Data was recorded at approximately 10 centimeter intervals using an on-board computer to provide a continuous profile of the soil conditions encountered during penetration. In addition, shear wave velocities of the soft soils were measured.

Plots of the CPT sounding are included in Attachment 3.

Subsurface Conditions

In general, subsurface soil conditions at the library are comparable to conditions encountered at City Hall: highly plastic silt to a depth of at least 60 feet (110 feet at City Hall), identified as MH using the Unified Soil Classification System. This silt is highly compressible, having high moisture content and low dry density. The average soil data and engineering properties are summarized in Table 1 on the following page.

Table 1
Average Soil Engineering Properties

Property	Symbol	Value
Moisture Content	w	80 percent
Dry Density	γ_{dry}	32 pcf (pounds per cubic foot)
Moist (Saturated) Unit Weight	γ_{sat}	94 pcf
Effective Unit Weight	γ'_o	30 pcf
Angle of Internal Friction (triaxial)	φ	14°
Cohesion	c	225 psf (pounds per square foot)
Coefficient of Consolidation	c'_c	0.165

In all three explorations at City Hall and the single CPT at the library, subsurface conditions were found to be relatively uniform and consistent. Although there was minor variation in engineering properties, differences between exploration locations were insignificant.

Discussion and Analysis

The soil profile for the entire depth of exploration is consistent. Triaxial shear test results from City Hall samples at 20, 40, and 60 feet below grade were performed at confining pressures comparable to the effective overburden pressures. Accordingly, these results allow a relatively high degree of accuracy in analysis. For analysis, a relatively steady increase in overburden pressure is assumed, approximately 30 pounds per square foot per foot of depth increase. We assume that the high groundwater level is near (within 5 feet of) the surface.

Because shear strength of subsurface soil between the two sites is comparable and relatively uniform, we calculated that 20-ton piles 80 feet deep have a purely frictional component of support of about 500 pounds per foot of depth. On this basis, we calculated 50-foot timber piles at the library, as having an allowable capacity of 12.5 tons per pile. Assuming a factor of safety of 2.0, the ultimate single-pile capacity could be taken as 25 tons. The perimeter foundations at each column and row intersection consisted of at least two piles per cap. Based on interpolated allowable pile capacity of 12.5 tons per pile, each library pile cap could support 25 tons for design. This is the same value as the calculated ultimate downward capacity for a single pile, with no factor of safety, which is inadequate for design.

Based on the above assumptions and reasoning, it is likely that the single piles for perimeter building columns at 12B, 12C, and 12D are not providing adequate support for the intended design loads. Following the Kruse & Fitch design, these columns should be supported by a 2-pile group with a total allowable pile capacity of 25 tons.

Conclusions

Based on our preliminary review and findings, the field and laboratory data and our analysis, we conclude the following:

1. Columns at 12B, 12C, and 12D originally supported the entry canopy and were designed with a single pile estimated to have an allowable pile capacity of 12.5 tons.
2. Sometime between the original design of 1965 and the expansion in 1998, the north wall of the library was extended to the current configuration. This may have been at the time of original construction, although we found no "as-built" records indicating this change or a change in the number of piles driven at each of the three columns.
3. Nearly all perimeter column support is provided by a 2-pile foundation on 16-foot centers. Single piles should be considered inadequate for the roof and wall loads as designed.
4. The native soil in the area of the library is highly compressible under even light loads, which is why pile foundations were used. The infill of the original north entrance and subsequent raising of the floor in the area of the former canopy entrance to the library was likely achieved using concrete. This placed additional load on the soft soil, which resulted in settlement.
5. The "ridge" line 16 feet south of the existing north wall and extending 32 feet east wall from the column at 12D is likely the original north wall (according to the 1965 plans). Any expansion to move the original wall, which acts as a rigid beam, to a new north wall would have resulted in additional settlement unless design precautions were implemented. This seems unlikely.
6. When the north wall was moved, the additional dead and live loads imposed on the three columns at 12B, 12C, and 12D likely exceeded their foundation support and resulted in the settlement that is observed in the northeast corner of the structure.

The most obvious remediation measure is to provide additional foundation support for the three columns in question, where single piles supported the original canopy. This can be achieved in many different ways, although the most practical includes the use of multiple micro-piles that can be drilled adjacent to and surrounding the existing single-pile caps on the exterior. Friction-only support can be estimated based on the analysis in this report. Additional foundation support can also be measured by drilling equipment that has the capability of making that determination by resistance during installation.

Before any remediation measure is undertaken, we recommend that a structural engineer be consulted to verify the findings of this report, and analyze the column loads to be provided for any additional piling. We have assumed that single piles provide the support as shown on the original plans. This can be verified by demolishing the sidewalk surrounding the columns and excavating to expose the pile and pile cap. It may be possible to raise the columns where settlement has occurred as evidenced by cracked walls. SHN will work with a structural engineer of the City's choosing and coordinate corrective action with contractors who specialize in this type of work.

The distressed floor slab will require further investigation that will be more disruptive to library operations and will need to be carefully planned. We recommend that at least the following be undertaken in the interim:

1. Pull back the carpeting along the original north wall to expose the "ridge" and crack that can be felt through the carpet.
2. Obtain concrete cores within the two bays where the original canopy was located, to determine the thickness of the floor slab and to evaluate the soil or fill beneath the slab.
    a. If the infilling was done with concrete, the suspicion that the weight of the concrete induced additional settlement is verified.
    b. If there is a void or soil beneath the slab, then hand-auger borings should be completed to obtain relatively undisturbed samples of the fill to test for susceptibility to consolidation.

It may be possible to lift the depressed slab, but it will depend on the connection of the slab to the new perimeter north wall. Most mud-jacking operations add weight to a soil mass. These highly compressible soils may not be able to accommodate additional loading without further settlement.

Limitations

This report has been prepared for the specific application to the geotechnical analysis of the Coos Bay Public Library as discussed herein. SHN prepared the findings, conclusions, and recommendations presented herein in accordance with generally accepted geotechnical engineering practices at the time and location that this report was prepared. No other warranty, express or implied, is made.

Soil materials are typically not homogeneous in type, strength, and other geotechnical properties, and can vary between points of observation and exploration. In addition, groundwater and soil moisture conditions can vary seasonally and for other reasons. SHN does not and cannot have a complete knowledge of the subsurface conditions underlying a site. The conclusions and recommendations presented in this report are based upon the findings at the points of exploration, interpolation, and extrapolation of information between and beyond the points of observation; and these are subject to confirmation of the conditions revealed during construction. The opinions and recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by our firm during the construction phase, if the project advances to that stage, so that we may evaluate compliance with our recommendations.

Findings of this report are valid as of the date of issuance; however, changes in condition of a property can and will occur with the passage of time. Furthermore, changes in applicable or appropriate standards occur whether they result from legislation or advancement in technology. Accordingly, findings of this report may be invalidated wholly or partially by changes outside of SHN's control. This report is subject to SHN's review and remains valid for a period of two years,

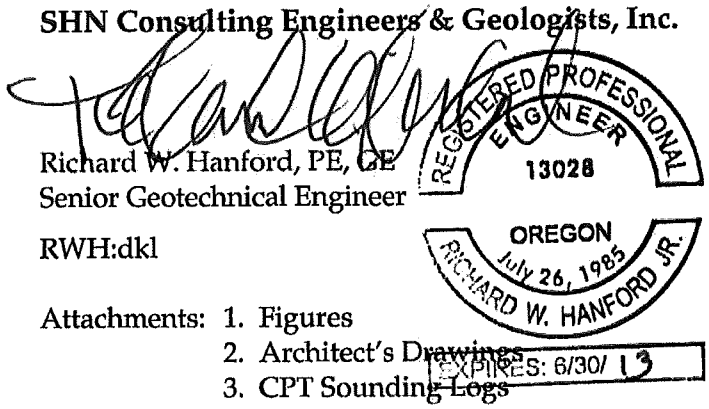
unless SHN issues a written opinion of its continued applicability thereafter. If the scope of the proposed construction, including the proposed loads, grades, or structural locations, changes from that described in this report, our recommendations should also be reviewed.

The scope of SHN's geotechnical services did not include any assessment for the presence or absence of any hazardous/toxic substances in the soil, groundwater, surface water, or atmosphere, or the presence of any environmentally sensitive habitats or culturally significant areas.

Thank you for the opportunity to assist you with this project. If you have any questions, please feel free to contact us at 707-441-8855.

Sincerely,

SHN Consulting Engineers & Geologists, Inc.



Richard W. Hanford, PE, GE
Senior Geotechnical Engineer

RWH:dkl

Attachments: 1. Figures
2. Architect's Drawings
3. CPT Sounding Logs

References

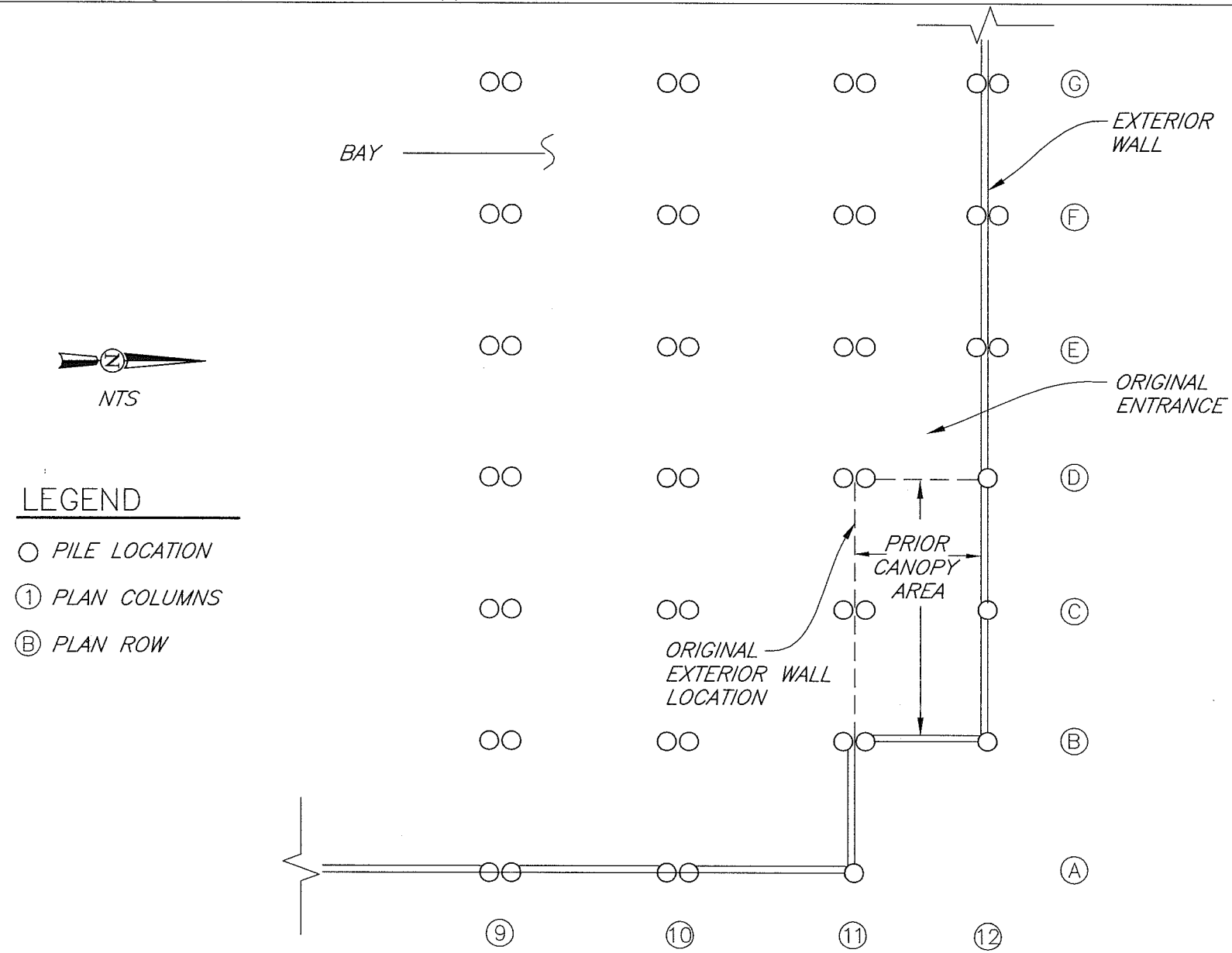
SHN Consulting Engineers & Geologists, Inc. (May 26, 2011). "City Hall Geotechnical Evaluation, Coos Bay, Oregon: Coos Bay:SHN.

Attachment 1

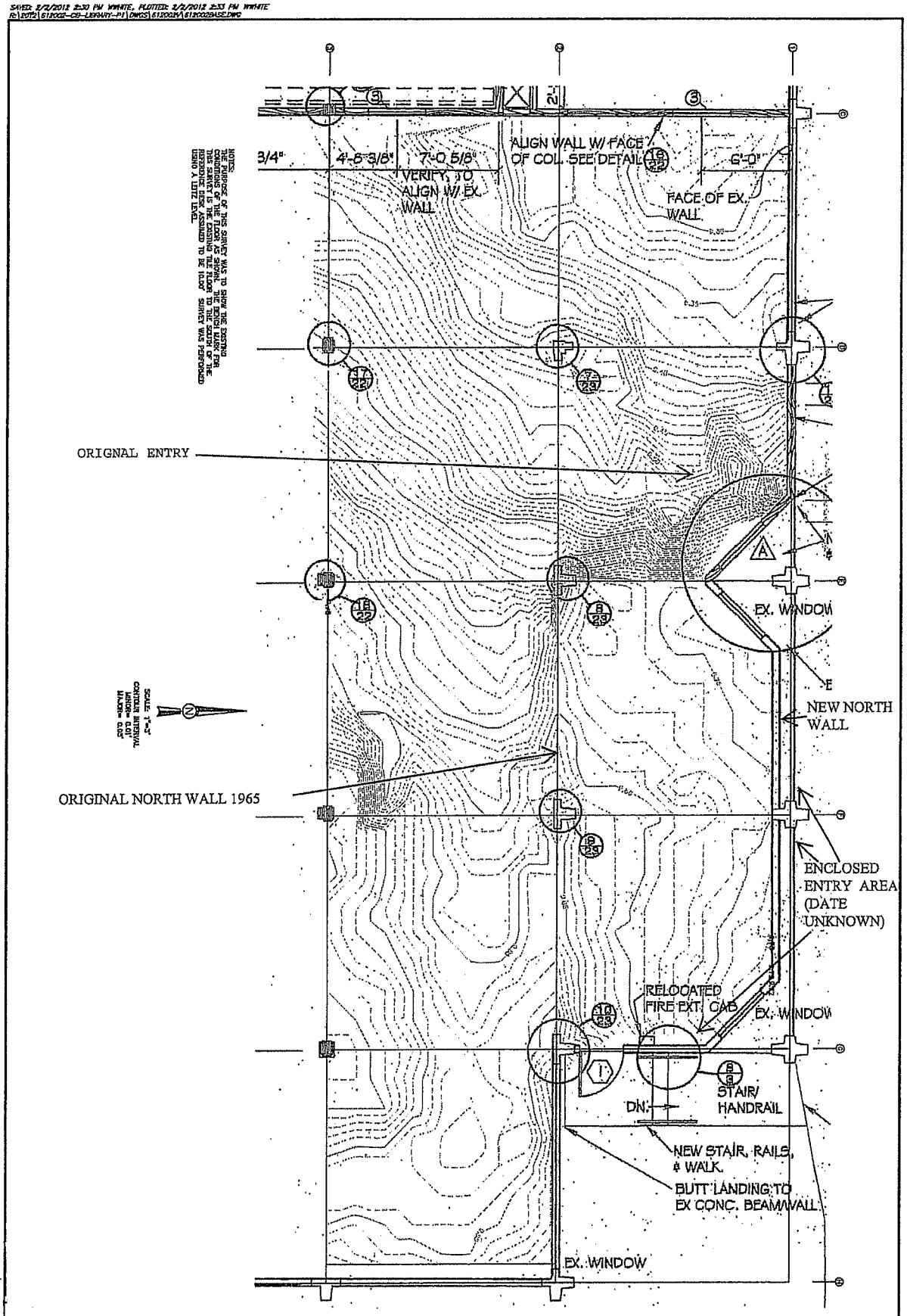
Figures

N NTS

Consulting Engineers & Geologists, Inc.	City of Coos Bay Coos Bay Library Coos Bay, Oregon		CPT SOUNDING LOCATION 612002
	May 2012	612002FIG-1	Figure 1



Consulting Engineers & Geologists, Inc.	City of Coos Bay Coos Bay Library Coos Bay, Oregon	Plan Column and Row Map 612002
	May 2012 | 612002FIG	Figure 2



DATE: 2/2012	Figure 3	City of Coos Bay Coos Bay Library Coos Bay, OR **Existing Conditions Survey**	DSGN: RN DR: WEW CHK: JMD APVD:	NO.	DATE	REVISION	BY	SHN CONSULTING ENGINEERS & GEOLOGISTS, INC. 275 MARKET AVENUE (541)266-9260 COOS BAY, OR 97420 FAX (541)266-9408	VERIFY SCALES BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY
PROJ. NO. 612002									

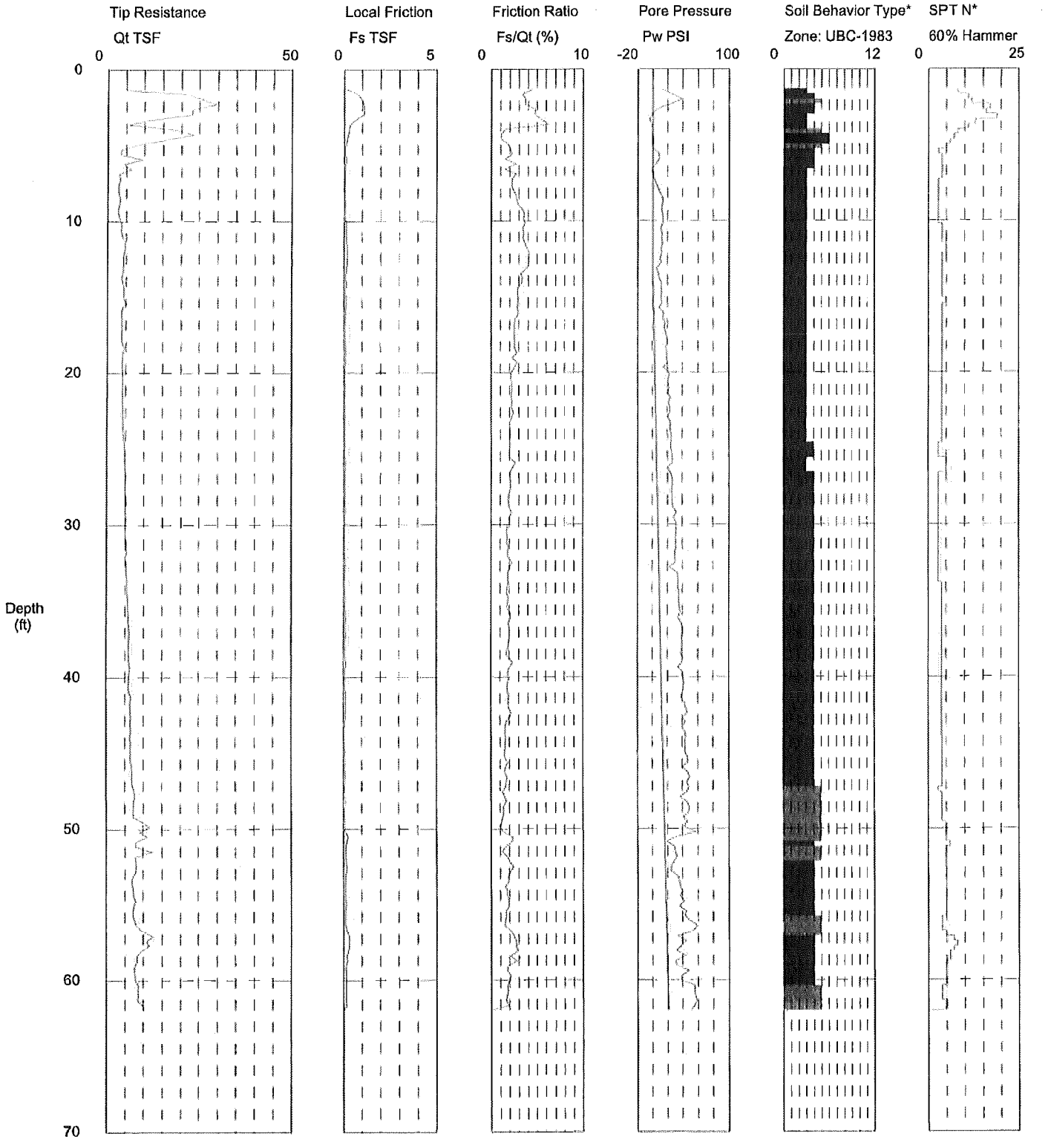
Attachment 2

Architect's Drawings

Subsurface Technologies

Operator: SAM
Sounding: CPT-1
Cone Used: DSG0457

CPT Date/Time: 4/6/2012 10:54:02 AM
Location: COOS BAY LIBRARY
Job Number: COOS BAY LIBRARY



Maximum Depth = 62.01 feet

Depth Increment = 0.328 feet

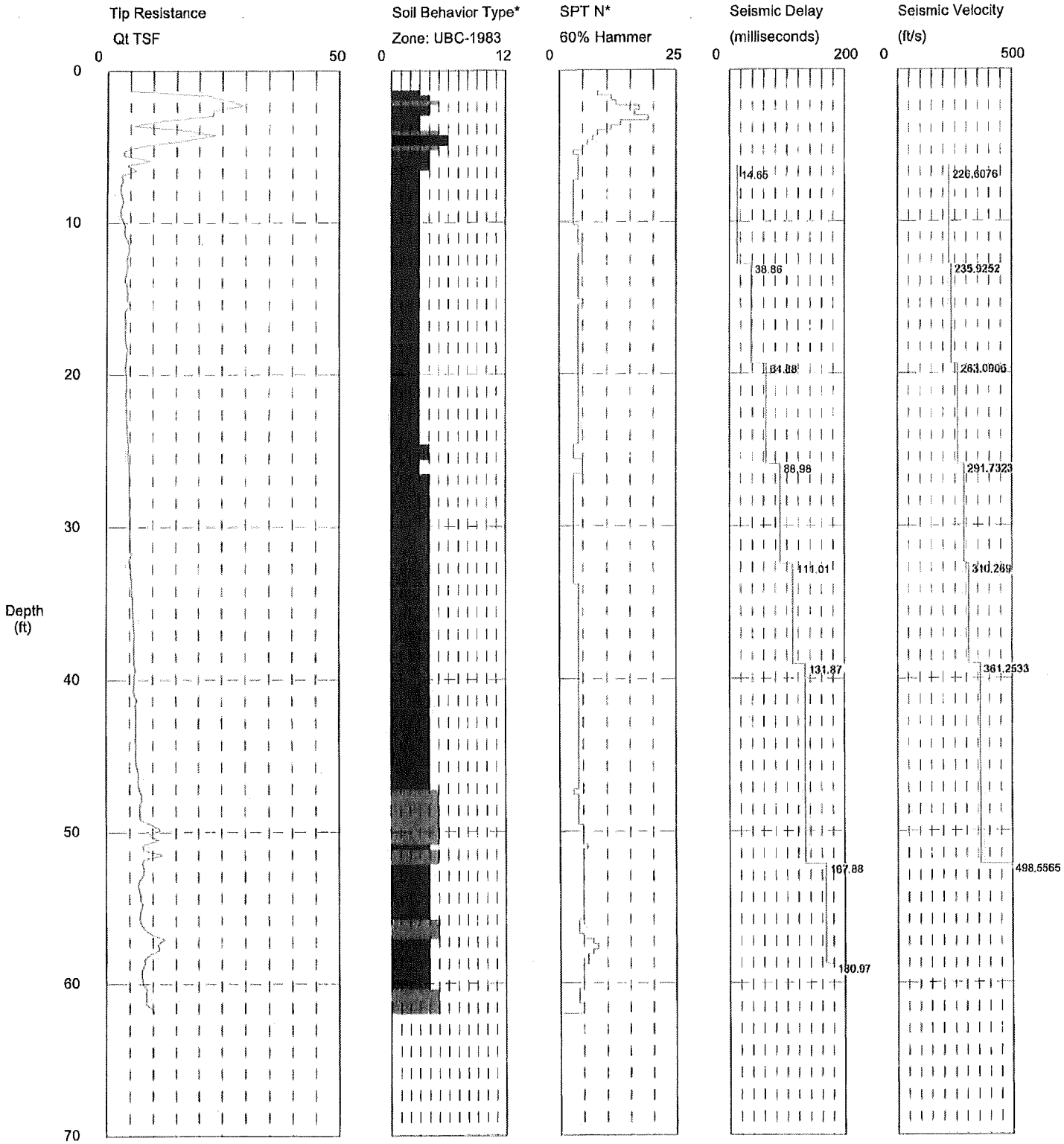
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Subsurface Technologies

Operator: SAM
Sounding: CPT-1
Cone Used: DSG0457

CPT Date/Time: 4/6/2012 10:54:02 AM
Location: COOS BAY LIBRARY
Job Number: COOS BAY LIBRARY



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Attachment 3

CPT Sounding Logs