A Report Prepared for
Fort Bragg Improvement District No. 1
416 North Franklin Street
Fort Bragg, California 95437

GEOTECHNICAL INVESTIGATION
WASTEWATER TREATMENT PLANT IMPROVEMENTS
FORT BRAGG, CALIFORNIA

HLA Job No. 18,399,002.01

by

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December 7, 1987
INTRODUCTION

This report represents the results of Harding Lawson Associates' (HLA) geotechnical investigation for the proposed improvements to the wastewater treatment plant in Fort Bragg, California. Municipal Improvement District No. 1 plans to construct a compost storage building, grit chamber, and belt filter press building within the existing treatment facility.

The locations of these planned buildings are shown on the Site Plan, Plate 1. The grit chamber and filter press building will be built into existing slopes, and the grit chamber will extend approximately 17 feet below finish grade. The compost storage building will be constructed at the top of a 1.5:1 fill slope.

The purpose of our geotechnical investigation was to explore the site to develop conclusions and recommendations regarding the following:

1. Site grading including criteria for fill compaction, cut and fill slope inclination, and a discussion of potential excavation problems, if any.

2. Suitable foundation type(s) including design values and estimates of anticipated settlement.

3. Preparation of subgrade for slab-on-grade floors.

4. Lateral resistance values.

5. Characteristic site period ($T_s$) for seismic design in accordance with the Uniform Building Code design procedure.

SITE INVESTIGATION

HLA explored subsurface conditions at the site by drilling three test borings from 9 to 16 feet deep at the location shown on the Site Plan,
Plate 1. Samples from these borings were reviewed to interpret subsurface conditions.

The borings were drilled on October 13, 1987 using a 6-inch-diameter flight auger. During drilling, our field engineer logged the borings and obtained relatively undisturbed samples of the soils encountered. Logs of the borings are presented on Plates 2 and 3. The soil is classified in accordance with the Unified Soil Classification System described on Plate 4 and the rock in accordance with the Physical Properties Criteria shown on Plate 5.

Soil samples were obtained using a Sprague and Henwood (S&H) split-barrel sampler. The S&H sampler (2-1/2-inch inside diameter) was driven by a 150-pound hammer falling 27 inches. Blow counts required to advance the sampler were converted to the "equivalent" standard penetration blow counts presented on the boring logs. Samples were transported to our laboratory where they were reexamined to verify field classifications. Because of the soft, organic nature of the soil in the proposed compost storage area, we could visually determine that this soil is not suitable for use as a foundation bearing material or compacted fill. Due to the hard, fresh nature of the rock, we could visually determine that it had a high bearing capacity. On the basis of our observations, we decided it was unnecessary to perform laboratory tests to physically measure the engineering properties of these materials.

Ground-water levels were measured at the time of the drilling and are presented on the boring logs.
SURFACE AND SUBSURFACE CONDITIONS

Surface Conditions

The central portion of the existing facility is at an approximate elevation of +40 feet, \(^*\) or about 6 feet below the surrounding topography. The ground surface of the central portion is flat and paved with asphalt concrete. Ice plant covered slopes, inclined at about 2:1 (horizontal to vertical) surround the central area. The proposed grit chamber and filter press building will be constructed into the surrounding slopes. The compost storage building will be constructed at the top of the southern slope, approximately 8 feet above the central facility, as shown on Plate 1.

Subsurface Conditions

Our borings indicate that the site is underlain by Franciscan Formation bedrock. The sandstone is very little to moderately fractured, with variable hardness and strength, and little to deeply weathered. The elevation of the bedrock surface is at approximately +38 throughout the site. Above this bedrock, in the area of the proposed filter building, there is approximately 6 feet of fill. This material appears to be well compacted. At the proposed grit chamber there is approximately 2 feet of sandy clay overlain by asphalt concrete. At the top of the southern slope, in the area of the

\(^*\)Elevations referenced to Mean Sea Level Datum.
proposed compost storage building, there is approximately 13 feet of organic
fill above the bedrock. This fill is primarily composed of wood chips and
some gravel and silt.

Ground water was encountered in Boring 1 (drilled at the top of the
southern slope), approximately 13 feet below the ground surface. This
ground-water level was unstabilized when measured and will vary with the
season.

CONCLUSIONS AND RECOMMENDATIONS

On the basis of our investigation, we conclude the planned improvements
are feasible from a geotechnical standpoint. There are several specific
concerns to be addressed in design and construction. These are as follows:
the soft, organic material at the planned compost building site which is
unsuitable for foundation support or for use as fill, and the difficulty of
bedrock excavation. Our recommendations for addressing these concerns and
other geotechnical factors are discussed in the following sections.

Site Grading

The soft organic fill in the area of the proposed compost storage
building is unsuitable for use as compacted fill. Use of the material as
fill would result in settlement as the organic material decays. Therefore,
we recommend that all this fill be removed and be replaced by properly
compacted fill, to the planned elevation of the building. The filter press
building will most likely be on bedrock but there may be some fill below grade. If fill is encountered at footing grade, it should be removed and footings extended to bedrock.

All areas to be graded should be cleared of concrete, asphalt pavement, and debris and surface soil should be stripped of vegetation. Soil in these areas should be scarified to at least 6 inches, moisture conditioned near optimum moisture content, and compacted to at least 90 percent relative compaction. If bedrock is encountered, it does not need to be scarified.

Fill material should be free of organic material and should satisfy the following criteria: liquid limit less than 40 percent, plasticity index less than 15, maximum rock size 4 inches. Asphalt concrete that is cleared from graded areas can be broken up and used in fill material.

Fill and backfill should be placed in layers not exceeding 8 inches in uncompacted thickness, moisture conditioned as necessary, and compacted to at least 90 percent relative compaction.

Cut and fill slopes should be 2:1 (horizontal to vertical) or flatter. Fill slopes should be free of loose soil. Slopes should be planted to reduce erosion.

Foundations

We recommend that spread footings be used to support the proposed buildings. The spread footings should bear in bedrock or compacted fill overlying bedrock. Footings should be designed using the values:
<table>
<thead>
<tr>
<th>Load Condition</th>
<th>Allowable Bearing Pressure (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compacted Fill</td>
</tr>
<tr>
<td>Dead load</td>
<td>2500</td>
</tr>
<tr>
<td>Dead plus live load</td>
<td>3200</td>
</tr>
<tr>
<td>Total load, including</td>
<td>4000</td>
</tr>
<tr>
<td>wind or seismic forces</td>
<td></td>
</tr>
</tbody>
</table>

Lateral loads can be resisted by friction on footing bottoms and by passive pressure against footing sides. Friction resistance should be computed using a factor of 0.3 in fill and 0.4 in bedrock. Passive pressure should be computed using a value of 1000 psf with a rectangular distribution in fill and 2000 psf in bedrock.

Footings should be bottomed at least 12 inches below the lowest adjacent grade if in fill or at least 6 inches if in bedrock. Footing excavations should be free of all debris, loose soil, and free-standing water prior to concrete placement. Settlement of properly installed footings should be less than 1/4 inch.

Retaining Walls

For design of basement walls, we recommend using an equivalent fluid weight of 40 pcf in calculating lateral earth pressures. This value assumes walls will be fully backdrained. For basement walls where backdrains are not feasible (such as in the grit chamber), 70 pcf should be used. If backdrains are used, they should be placed behind basement walls and consist of 4-inch-diameter perforated plastic pipe surrounded by drain rock. Drain rock should consist of a layer 12 inches thick of 3/4-inch-diameter crushed
rock. The drain rock layer should extend to within 24 inches of the ground surface, and should be surrounded by filter fabric satisfying the criteria set forth in the current Caltrans Standard Specifications. A 24-inch-thick cap of clayey soil (at least 20 percent passing the No. 200 sieve) should be used as the upper 2 feet of drain backfill to prevent infiltration of surface water. The drain pipe should be installed with perforations down and should slope to drain into an appropriate collection area. At least 4 inches of drain rock should be placed beneath the pipe to reduce the likelihood of clogging. Basement walls should be waterproofed with an impermeable membrane to prevent water damage.

Excavations

The excavation for the proposed grit chamber will extend approximately 17 feet below existing grade. Rock cuts of nearly 15 feet will be necessary. During exploratory drilling, the drill rig met refusal in the bedrock at Boring 3. Thus the excavation of this bedrock may be difficult.

The sides of the excavation can be sloped or retained by a properly designed and installed shoring system. If shoring is not used, for planning purposes only, we suggest temporary slopes in the rock be no steeper than 1/2:1. Actual slopes, shoring design, and maintenance should be the contractor’s responsibility.

Slab-on-Grade Floors

Slab-on-grade floors can be supported on either bedrock or compacted fill. In areas where slabs will be supported on existing fill (possibly the
filter press building), the subgrade should be scarified to 6 inches and compacted to at least 90 percent relative compaction. Compaction of subgrade is not necessary for slabs on bedrock; however, loose soil and rock should be removed prior to concrete placement. If vapor migration through the floor slabs is unacceptable, they should be underlain by at least 4 inches of 3/4-inch crushed rock to provide a capillary break, and an impermeable membrane should be placed over the rock. If work is performed in wet conditions, slabs should be underlain by 6 inches of 3/4-inch drain rock to provide a clean working surface.

Seismic Design

This site is located in a seismically active region of California classified as Zone 4, the highest seismic risk zone according to the Uniform Building Code (UBC) seismic zone map of the United States. Thus, this site will likely experience ground shaking during the life of the structures.

The proposed structures should be designed to resist the effects of lateral loads resulting from earthquake shaking. In accordance with the Uniform Building Code, we recommend using a characteristic site period ($T_s$) of 0.5 second for design.

Additional Soil Engineering Services

We recommend that HLA check final plans and specifications for conformance with our recommendations. During construction, we should:

1. Observe excavation of shallow spread footings.
2. Observe placement of all fills.
3. Perform field density tests on all fill and backfill.
PLATES

Plate  1  Site Plan
Plates  2  Logs of Borings 1 through 3
through 3
Plate  4  Soil Classification Chart and Key to Test Data
Plate  5  Physical Properties Criteria for Rock Description
DISTRIBUTION

GEOTECHNICAL INVESTIGATION
WASTEWATER TREATMENT PLANT IMPROVEMENTS
FORT BRAGG, CALIFORNIA
December 7, 1987

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San Rafael, California 94901

1 copy: Job File
1 copy: Q/C Bound Report File

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KAN/HH/bht

QUALITY CONTROL REVIEWER

Barbara L. Potter
Civil Engineer
**LOG OF BORING 1**

Equipment 6” Solid Auger - Truck Mounted

Elevation +48.5’ Date 10/13/87

Laboratory Tests

<table>
<thead>
<tr>
<th>Blows/foot</th>
<th>Moisture Content(%)</th>
<th>Dry Density(pcf)</th>
<th>Core Recov. %/ROD</th>
<th>Drilling Rate (min/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50/0’’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DARK BROWN SILT WITH SAND (MH)
soft, moist, with wood ships

DARK BROWN SANDY SILT WITH GRAVEL (ML) moist, with organics

BROWN-GRAY GRAVELLY ORGANIC
fill (Pt) soft, moist
gravel at 6’

water level during drilling

YELLOW-BROWN SANDSTONE
occasionally fractured, hard, moderately strong, weathered
bottom of boring at 16.5 feet

**LOG OF BORING 2**

Equipment 6” Solid Auger - Truck Mounted

Elevation +46.0’ Date 10/13/87

<table>
<thead>
<tr>
<th>Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

ASPHALT/GRAVEL

CLAYEY GRAVEL (GC)

BROWN CLAYEY SAND WITH GRAVEL (SC) medium dense, moist

BROWN SANDY SILT WITH GRAVEL (ML) dense, moist

YELLOW-BROWN SANDSTONE
moderately fractured, low hardness, weak, deeply weathered

bottom of boring at 12.0 feet

no water encountered during drilling

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Harding Lawson Associates
Engineers, Geologists & Geophysicists

Fort Bragg Wastewater Plant
Fort Bragg, California

DRAWN: JAS  JOB NUMBER: 18,399,002.01  APPROVED: N/A  DATE: 11/87

Log of Borings 1 and 2

PLATE 2
LOG OF BORING  3

Equipment  6" Solid Auger - Truck Mounted
Elevation  +40.0  Date  10/13/87

50/3"

ASPHALT/CONCRETE
BROWN CLAYEY SAND WITH GRAVEL
(SC)  medium dense, moist

BROWN SANDSTONE
very little fracturing, hard, strong,
little weathering

refusal at 8.5 feet
no water encountered during drilling
### Unified Soil Classification - ASTM D2487-85

<table>
<thead>
<tr>
<th>Perm</th>
<th>Consol</th>
<th>LL</th>
<th>PI</th>
<th>Gs</th>
<th>MA</th>
<th>MA</th>
<th>MA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permeability</td>
<td>Consolidation</td>
<td>Liquid Limit (%)</td>
<td>Plastic Index (%)</td>
<td>Specific Gravity</td>
<td>Particle Size Analysis</td>
<td>&quot;Undisturbed&quot; Sample</td>
<td>Bulk or Classification Sample</td>
</tr>
</tbody>
</table>

#### Shear Strength (psf)

- **TuxU**: 3200 (2600) — Unconsolidated Undrained Triaxial Shear (field moisture or saturated)
- **TxCU**: 3200 (2600) — Consolidated Undrained Triaxial Shear (with or without pore pressure measurement)
- **TxCQ**: 3200 (2600) — Consolidated Drained Triaxial Shear
- **SSCU**: 3200 (2600) — Simple Shear Consolidated Undrained (with or without pore pressure measurement)
- **SSCD**: 3200 (2600) — Simple Shear Consolidated Drained
- **DSCD**: 2700 (2000) — Consolidated Drained Direct Shear
- **UC**: 470 — Unconfined Compression
- **LVS**: 700 — Laboratory Vane Shear

#### Confining Pressure

- **(psf)** — Pressure in pounds per square foot

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### Key to Test Data

**Harding Lawson Associates**
Engineers and Geoscientists

Unified Soil Classification and Key to Test Data
Fort Bragg Wastewater Plant
Fort Bragg, California

DRAWN

18,399,002.01

APPROVED

KAN

PLATE 4

DRAWN

11/87

REVISED

DATE

PLATE

4
I CONSOLIDATION OF SEDIMENTARY ROCKS; usually determined from unweathered samples. Largely dependent on cementation.

U = unconsolidated
P = poorly consolidated
M = moderately consolidated
W = well consolidated

II BEDDING OF SEDIMENTARY ROCKS

<table>
<thead>
<tr>
<th>Splitting Property</th>
<th>Thickness</th>
<th>Stratification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massive</td>
<td>Greater than 4.0 ft.</td>
<td>very thick bedded</td>
</tr>
<tr>
<td>Blocky</td>
<td>2.0 to 4.0 ft.</td>
<td>thick-bedded</td>
</tr>
<tr>
<td>Slabby</td>
<td>0.2 to 2.0 ft.</td>
<td>thin-bedded</td>
</tr>
<tr>
<td>Flaggy</td>
<td>0.05 to 0.2 ft.</td>
<td>very thin-bedded</td>
</tr>
<tr>
<td>Shaly or platy</td>
<td>0.01 to 0.05 ft.</td>
<td>laminated</td>
</tr>
<tr>
<td>Papery</td>
<td>less than 0.01 ft.</td>
<td>thinly laminated</td>
</tr>
</tbody>
</table>

III FRACTURING

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Size of Pieces in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very little fractured</td>
<td>Greater than 4.0</td>
</tr>
<tr>
<td>Occasionally fractured</td>
<td>1.0 to 4.0</td>
</tr>
<tr>
<td>Moderately fractured</td>
<td>0.5 to 1.0</td>
</tr>
<tr>
<td>Closely fractured</td>
<td>0.1 to 0.5</td>
</tr>
<tr>
<td>Intensely fractured</td>
<td>0.05 to 0.1</td>
</tr>
<tr>
<td>Crushed</td>
<td>Less than 0.05</td>
</tr>
</tbody>
</table>

IV HARDNESS

1. Soft — Reserved for plastic material alone
2. Low hardness — can be gouged deeply or carved easily with a knife blade
3. Moderately hard — can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and is readily visible after the powder has been blown away.
4. Hard — can be scratched with difficulty; scratch produces little powder and is often faintly visible.
5. Very hard — cannot be scratched with knife blade; leaves a metallic streak.

V STRENGTH

1. Plastic or very low strength
2. Friable — crumbles easily by rubbing with fingers
3. Weak — An unfractured specimen of such material will crumble under light hammer blows.
4. Moderately strong — Specimen will withstand a few heavy hammer blows before breaking.
5. Strong — Specimen will withstand a few heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.
6. Very strong — Specimen will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.

VI WEATHERING — The physical and chemical disintegration and decomposition of rocks and minerals by natural processes such as oxidation, reduction, hydration, solution, carbonation, and freezing and thawing.

D. Deep — Moderate to complete mineral decomposition; extensive disintegration; deep and thorough discoloration; many fractures; all extensively coated or filled with oxides, carbonates and/or clay or silt.
M. Moderate — Slight change or partial decomposition of minerals; little disintegration; cementation little or unaffected. Moderate to occasionally intense discoloration. Moderately coated fractures.
L. Little — No megascopic decomposition of minerals; little or no effect on normal cementation. Slight and intermittent, or localized discoloration. Few stains on fracture surfaces.
F. Fresh — Unaffected by weathering agents. No disintegration or discoloration. Fractures usually less numerous than joints.