GIBLIN ASSOCIATES

CONSULTING GEOTECHNICAL ENGINEERS

POST OFFICE BOX 6172 SANTA ROSA, CA 95406

TELEPHONE (707) 528-3078 FACSIMILE (707) 528-2837

Report
Soil Investigation
Lands of Baywood
Petaluma, California

Prepared for
Airport Business Center
414 Aviation Boulevard
Santa Rosa, CA 95403
Attention: Patrick Imbimbo

By

GIBLIN ASSOCIATES
Consulting Geotechnical Engineers

Dan J. Figoni
Project Manager

Jeffrey K. Reese
Civil Engineer No. 47753

REGISTERED PROFESSIONAL ENGINEER
JEFFREY K. REESE
No. C 047753
Exp. 12-31-09
CIVIL
STATE OF CALIFORNIA

Job No. 321.59.1
May 16, 2008

INTRODUCTION

This report presents the results of our soil investigation for the proposed future development to be constructed at the Lands of Baywood in Petaluma, California. The approximate 20 acre site is located at the south end of Casa Grande Road on property formerly occupied by the Royal Tallow & Soap Company. The site address is 2592 Casa Grande Road. The project area is further identified as Assessor's Parcel Nos. 005-060-041, 005-060-042 and 005-060-067.

We understand that the proposed future development will likely consist of the construction of multiple clusters of two- and/or three-story, wood-frame apartment buildings with concrete slab-on-grade floors. The development would be served internally by asphalt-paved driveway and parking areas and underground utilities. Foundation loads are not known at this time, but are expected to be normal for the type of construction proposed.

The object of our investigation, as outlined in our proposal dated March 3, 2008, was to review selected geologic references in our files, explore subsurface conditions, measure depth to groundwater, if encountered, and determine physical properties of the soils encountered. We then performed engineering analyses to develop conclusions and recommendations concerning:

1. Proximity of the site to active faults.
2. Site preparation and grading.
3. Foundation support and design criteria.

4. Retaining wall design criteria.

5. Support of concrete slab-on-grade floors.

6. Preliminary flexible pavement thicknesses based on our experience with similar projects and soils.

7. Soil engineering drainage.

8. Supplemental soil engineering services.

WORK PERFORMED

We reviewed selected, published, geologic information in our files including:

1. The "Geology for planning in Sonoma County" maps, Special Report 120, California Division of Mines and Geology, 1980.

2. The Petaluma River Quadrangle Sheet of the Alquist-Priolo Earthquake Fault Zone maps, California Division of Mines and Geology, 1983.

3. The "Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada," Uniform Building Code (UBC), 1997.

4. Association of Bay Area Governments website (www.abag.ca.gov), 2004, Liquefaction Susceptibility Map.

5. Flood Insurance Rate Map (FIRM), Sonoma County Panel No. 060379 0003 C revised September 29, 1989, Federal Emergency Management Agency (FEMA).

6. Association of Bay Area Governments (ABAG) website (www.abag.ca.gov), 2004, Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map.

7. The "Geologic Map of the Petaluma River Quadrangle California," State of California Department of Natural Resources, Bulletin 149, Plate 11, reprinted from Geologic Society of America Memoir 35, circa 1955.

8. Preliminary Geologic Map of Marin and San Francisco Counties and Parts of Alameda, Contra Costa and Sonoma Counties, California, Department of the Interior, United States Geologic Survey, 1974.

9. Historical Ground Failures in Northern California Associated with Earthquakes, Geological Survey Professional Paper 993, by T.L. Youd and S.N. Hoose, United States Department of the Interior, 1978, Plate 4.

On March 6, 13 and 18, 2008, we were at the site to observe conditions exposed and to explore subsurface conditions to the extent of fifteen test borings at the approximate locations indicated on Plate 1. The borings were drilled to depths ranging from about 12 to 33½ feet with track-mounted, auger equipment. Our representative located the borings, observed the drilling, logged the conditions encountered, and obtained samples for visual classification and laboratory testing. Relatively undisturbed samples were obtained with a 2.5-inch (inside-diameter) split-spoon sampler and a 2.0-inch (outside-diameter) Standard Penetration sampler. Both samplers were driven with a 140-pound drop hammer. The stroke during driving was about 30 inches. The blows required to drive the samplers were recorded and converted to equivalent Standard Penetration blow counts for correlation with empirical data. Logs of the borings showing soil classifications, sample depths, and converted blow counts are presented on Plates 2 through 16. The soils are classified in accordance with the Unified Soil Classification System explained on Plate 17.

Selected samples were tested in our laboratory to determine moisture content, dry density, classification (percent free swell, percent passing the No. 200 sieve, hydrometer analysis and Atterberg Limits), and strength characteristics. The test results are shown on the logs with the strength data shown in the manner described by the Key to Test Data, Plate 17. Detailed results of the Atterberg Limits and hydrometer analysis (particle size analysis) tests are presented on Plates 18 and 19.

The boring locations shown on Plate 1 were determined by visually estimating from existing surface features. The locations should be considered no more accurate than implied by the methods used to establish the data. At the completion of the exploration, the boring holes were backfilled with the soil cuttings. Test borings drilled to depths greater than about 15 feet were backfilled with bentonite chips.

SURFACE AND SUBSURFACE CONDITIONS

The site is bordered to the north by an existing apartment complex and to the west by the Rocky Dog Memorial Park. The Petaluma River marsh and open grassland areas generally border the site to the south and east. A tall, one- and/or two-story commercial building and surrounding paved areas are located adjacent to the northeast corner of the property. As previously indicated, the site was formerly occupied by the Royal Tallow & Soap Company. The factory building, surrounding outbuildings, barns, storage tanks, a workshop and a small dwelling, remain and will likely be removed as part of the site development. Asphalt- and concrete-paved areas are located adjacent to the south side of the factory building with additional concrete slabs located north and east of the structure about 25 and 100 feet, respectively. A tall concrete loading ramp is also present on the west side of the structure. Access to the existing residence located in the northwest corner of the site is provided by an asphalt-paved driveway approximately 180 feet in length. Debris piles consisting of several metal containers and cylindrical tanks that may have been associated with the processing of tallow were also noted west of the collapsed barn. Contour lines on a topographic map prepared by Stephen J. LaFranchi and Associates, Civil Engineers, indicate that the ground surface at the site generally slopes very gently downward to the south at a gradient of about 1 percent or less. South and east of the collapsed barn (see Plate 1) the terrain was generally uneven, and small concrete fragments were observed periodically throughout the area, suggestive of the presence of fill. The topography directly east of the factory building and in the vicinity of the previous railroad right-of-way in the northwest corner of the site also appeared to slope upward from the surrounding terrain also suggestive of the presence of fill. At the time of our exploration, the ground surface beyond the buildings and paved areas generally contained a low to moderate growth of annual grass and weeds with stands of eucalyptus trees present along the north and west property lines near the northwest corner of the site. The topographic map also indicates that a monitoring well is present in the east portion of the site in close proximity to the north property line.

The borings and laboratory tests indicate that the site is generally underlain by discontinuous layers of fill materials and natural clay, silt, and clayey and silty sand to the maximum depth explored. Clayey sand and sandy clay fill materials with varying amounts of gravel were encountered in Borings 1, 4, 10 through 13 and 15 to depths that varied from about 1 to 4 feet below the adjacent ground surface. The field and laboratory tests indicate that the fill materials in Borings 1, 4 and 10 exhibit a low to possibly moderate expansion potential, and the fills in Borings 11 through 13 and 15 exhibit a moderate to high expansion potential. That is, the soils would tend to undergo low to high strength and volume changes with seasonal variations in moisture content. The upper, natural soils encountered below the fill and in the remaining test borings generally consist of medium stiff to hard, plastic, sandy clay soils that exhibit a moderate to high expansion potential. The underlying soils typically consist of very stiff to hard sandy silts and clays and medium dense to very dense clayey sands. Relatively low strength materials consisting of medium stiff to stiff sandy clays and silts believed to be stiff bay mud were encountered in the southwest and southeast portions of the site (Borings 14 and 7, respectively). The approximate bottom of the bay mud varies from about 14 feet in the southeast portion of the site up to about 12 feet near the southwest corner of the property. The actual extent of the bay mud deposits is not known at this time, however, based on the data obtained during our investigation, we anticipate that the approximate limits are as indicated on the attached Plate 1. Relatively low strength natural sandy clay soils were also encountered below the existing fills in Test Boring 12 that extended to depths of about 6 to 7 feet below the adjacent ground surface. Below the existing fills, bay mud and locally occurring weak, near surface natural clays, the underlying soils typically consist of very stiff to hard sandy silts and clays and medium dense to very dense clayey sands.

Groundwater was encountered in Borings 1, 2, 3, 5, 7, 8, 9, 11, 12, 14 and 15 during our exploration. Water levels were initially recorded at depths that varied between approximately 4 to 15 feet below the ground surface. Borings 5, 9, 11, 14 and 15 were left open for time periods that varied from about 1 to 3 hours and Test Borings 1, 2, 3 and 8 were left open for time periods that varied up to about 19 to 24 hours. Prior to backfilling, water levels were remeasured at each boring location and found to have risen to depths varying from 0 to 5 feet below the adjacent grade. We believe that groundwater levels can vary seasonally, and can rise and fall several feet annually. Precise depth to groundwater, extent of seasonal water level fluctuations, and/or determination of a perched groundwater condition is beyond the scope of this investigation.

The FIRM map reviewed indicates that the southern approximate one-half of the site is located in Zone AE, an area subject to inundation during a 100-year flood event. The north approximate one-half of the site is shown to be located in Zone X, areas determined to be outside the 500 year flood plain. The ABAG Flood Insurance Rate Map reviewed indicates that, with the exception of a mapped, previously existing, relatively narrow drainage running in an approximate east/west direction through the central portion of the site, the parcel is not located within an area that would be subject to inundation by a 100- or 500-year flood event.

CONCLUSIONS

Based on the results of our field exploration, laboratory testing and engineering analyses, we conclude that, from a soil engineering standpoint, the site can be used for the proposed development. The most significant soil engineering factors that must be considered in design and construction are the presence of existing fill materials, locally occurring upper and near surface bay mud deposits of low to moderate strength and moderate to high compressibility and, upper natural clayey soils that exhibit a moderate to high expansion potential.

We were not provided with documentation to indicate that the existing fills encountered were properly placed and compacted under soil engineering observation and testing services. We judge that such fills could be subject to significant amounts of total and/or differential settlement. Therefore, we conclude that the existing fills would not be suitable for new fill, foundation or slab support in their present condition. It will be necessary to remove (overexcavate) any existing fills for their full depth and replace the materials as properly compacted fill, as subsequently discussed.

The bay mud deposits encountered exhibit low strength and could be subject to significant settlements under new loading conditions. The amount and rate of settlement are influenced by several factors, including past loading history, thickness and weight of planned fills, new building loads and variations in the thickness and compressibility of the bay mud soils. Generally, maximum settlements will occur in areas of thickest new fills or heaviest structural loads overlying thickest bay mud deposits. Our experience indicates that fill loads are generally greatest below the central portion of a fill pad, and slightly less at the corners, resulting in "*dishing*" of pad surfaces. The magnitude of settlement from fill loads could be reduced by using imported lightweight materials to raise the ground elevation. Also, settlements from both fill and new building loads could be reduced by removing a portion of the existing soils and refilling the excavations with imported lightweight fill. Upgrading a portion of the weak upper materials by overexcavation and recompaction and utilizing a foundation system designed to tolerate potential differential settlements could also be considered. We should be consulted to further evaluate potential settlement and provide additional recommendations for site development and foundation support within areas underlain by bay mud as planning progresses.

Our experience indicates that weak, surface and near surface natural soils that exhibit relatively low strength, such as those encountered in Test Borings 12 within about 6 feet of the ground surface (approximately 2 feet below the bottom of the existing fill) can also undergo considerable strength loss and settlement when saturated under load. Where evaporation is inhibited by footings, slabs or fill, eventual saturation of the underlying soils can occur. Therefore, we conclude that locally occurring weak, upper natural soils are not suitable for new fill, foundation or slab support in their present condition. It will be necessary to remove the weak upper natural soils and replace the materials as properly compacted fill. The compacted fill pad would need to be sufficiently thick so as to help provide uniform support and to reduce the risk of total and/or differential settlements to an acceptable level.

Moderately to highly expansive soils, such as those encountered at the site, can undergo significant strength and volume changes with seasonal changes in moisture content and could heave and/or distress lightly loaded footings or slabs. Future shrink and swell of expansive soils can be substantially reduced by controlling soil moisture content. We have observed that significant seasonal changes in moisture content generally occur in the upper 2 to 3 feet. However, depending on factors such as seasonal rainfall totals, summer weather conditions and surface treatments, significant moisture variations in the soils can occur to substantially deeper depths. The risk of future building damage by shrinking and swelling of the expansive clays can be considerably reduced by initially moisture conditioning the soils to cause preswelling, then covering the soils with a blanket of approved on-site or imported fill of low expansion potential, as subsequently recommended. Alternative methods, such as lime-treatment, could also be considered. We can develop specific recommendations, if requested.

We believe that the existing fill materials will be suitable for reuse as compacted fill, however, moderately to highly expansive clayey soils should not be used within the upper 30 inches of the building envelope as subsequently recommended.

Provided the site is graded in conformance with our recommendations and footings are underlain by properly compacted fill of low expansion potential, satisfactory foundation support for the structure can be obtained from spread footings bottomed at relatively shallow depths. For footings designed and installed in accordance with our subsequent recommendations, we judge that total settlements will be about 1 inch or less. Post-construction settlements should be about ½ inch or less. As previously discussed, we should be consulted to develop specific recommendations for foundation support for structures located within areas underlain by bay mud as planning progresses.

In driveway, parking and exterior concrete flat work areas not adjacent to the buildings, we believe that pavements consisting of asphalt concrete, portland-cement concrete, aggregate base and possibly subbase material can be placed directly on properly prepared expansive site soils. However, pavements will be damaged where the expansive soils experience volume changes with seasonal changes in moisture content. Conventional curb and gutter with adjacent sidewalk and/or automatically irrigated landscaping capable of providing a regular, uniform distribution of moisture along the pavement edges and/or imported fill, as subsequently discussed, could reduce the risks of possible future pavement distress.

Liquefaction, a loss of shear strength, and densification, a reduction in void ratio, are phenomena associated with loose, cohesionless, sands and gravels subjected to ground shaking during earthquakes, and can result in unacceptable total and/or differential settlements. Whether such phenomena will actually occur depends on complicated factors such as duration and intensity of ground shaking, and the response characteristics of the materials underlying the site. Our analysis of the locally occurring sand layers encountered in our test borings indicates that the risk of liquefaction and resultant ground damage can be considered low because the sandy soils encountered are sufficiently dense and contain a significant quantity of soil fines.

We understand that imported soil and/or granular backfill materials up to about 10 to 12 feet deep or more have been placed west of the main factory building during removal of underground storage tanks and surrounding soils. Based on our conversations with the on-site property manager, we understand that the limits of the backfill area are approximately as indicated on the attached Plate 1. However, the actual depth, extent and consistency of the backfill materials are unknown at this time. Therefore, where future building or paved area improvements are planned within close proximity to the backfill zone we recommend that supplemental exploration be performed. We also understand that below grade tanks used in the processing of tallow are present beneath or adjacent to, slab-on-grade floor areas within the existing factory building that could be up to 20 feet deep or more. Specific recommendations for backfilling below grade tanks are provided in subsequent sections of this report. Following backfilling, we should be consulted to provide specific recommendations for support of structures or planned improvements located in close proximity to the backfill zones.

SEISMIC DESIGN PARAMETERS

The geologic maps reviewed did not indicate the presence of active faults at the site and, therefore, we judge that there is little risk of fault-related ground rupture during earthquakes. In a seismically active region such as Northern California, there is always some possibility for future faulting at any site. However, historical occurrences of surface faulting have generally closely followed the trace of the more recently active faults. The closest faults generally considered active are the Rodgers Creek fault zone located approximately 4.0 miles to the northeast, and the San Andreas fault zone located approximately 14.0 miles to the southwest. The Special Report 120 map indicates that a concealed trace of the Tolay Fault may be located about 1.7 miles to the northeast. However, the trace is not considered active and the site is not located within a presently designated Alquist-Priolo Earthquake Fault Zone.

Strong ground shaking will occur during earthquakes. The intensity at the site will depend on the distance to the earthquake epicenter, depth and magnitude of the shock, and the response characteristics of the materials beneath the site. Because of the proximity of active faults in the region and the potential for strong ground shaking, it will be necessary to design and construct the project in strict accordance with current standards for earthquake-resistant construction.

We have determined the seismic ground motion values in accordance with procedures outlined in Section 1613 of the 2007 California Building Code (CBC). Mapped acceleration parameters (S_S and S_1) were obtained by inputting approximate site coordinates[1] (latitude and longitude) into earthquake ground motion software made available for use by the United Stated Geological Survey (USGS) for the determination of CBC ground motion values. Based on our

1 Site coordinates used are approximate and were determined using USGS topographic map software.

review of available geologic maps and our knowledge of the subsurface conditions, we judge that the site can be classified as Site Class D, as described in Table 1613.5.2 of the 2007 CBC. Using corresponding values of site coefficients for Site Class D and procedures outlined in the CBC, the mapped acceleration parameters were adjusted to yield the design spectral response acceleration parameters S_{DS} and S_{D1}. The following earthquake design data summarize the results of the procedures outlined above.

Site Class	D
Mapped Spectral Response Accelerations:	
S_S	1.5g
S_1	0.6g
Design Spectral Response Parameters:	
S_{DS}	1.0g
S_{D1}	0.6g

RECOMMENDATIONS

Site Grading

The site should be cleared of debris and brush, where encountered. Dense growths of grass and vegetation should be removed. Designated structures should be demolished and old foundations, slabs and pavements completely removed. The resultant voids should be backfilled with compacted soil, as subsequently described. The areas to be graded then should be stripped of the upper soils containing root growth and organic matter. We anticipate that the depth of stripping, where needed, will average about 3 inches. The strippings should be removed from the site, stockpiled for reuse as topsoil, or mixed with at least five parts of soil and used as fill at least 10 feet away from structure, walkway and paved areas.

Wells, septic tanks, leach fields, or other underground obstructions should be removed, filled with compacted soil or compacted granular material or capped with concrete as determined by the appropriate regulatory agency or the soil engineer. Similarly, any existing fills or stockpiles encountered within building or improvement areas should be removed for their full depth. We anticipate overexcavation depths to remove old fills will vary from about 1½ to 4 feet below the existing ground surface. Deeper overexcavation could be needed if deeper fills are encountered. Because the actual depth of excavation to remove the existing fill could vary, we suggest contract documents contain provisions to account for such variations.

Prior to placing fill within the underground storage tanks located within the factory building, the tanks should be prepared by cleaning out all debris, soil or water and perforating the bottom of the tanks in several areas to expose the underlying natural materials. The top of the tanks should be broken off at least 5 feet or more below the proposed finish pad grade elevations so as not to be encountered in subsequent utility trench or other planned excavations. Backfill materials should consist of imported granular materials such as waste pea and sand, gravel or crushed rock, placed in 12- to 18-inch-thick loose lifts and thoroughly compacted with vibratory compaction equipment. Small diameter concrete fragments, less than about 6 to 12 inches in size, could also be used within the backfill materials provided the materials are not allowed to nest and proper compaction can be obtained in the surrounding fill materials and all exposed reinforcing steel is removed prior to placement. Granular backfill materials should be covered with a nonwoven geotextile fabric weighing at least 4 ounces per square yard (such as Mirafi 140N or other approved equivalent) and capped with at least 5 feet of properly compacted approved on-site or imported soil, placed in lifts and compacted as outlined below.

We anticipate that, with the exception of organic matter and rocks or hard fragments larger than 4 inches in diameter, the on-site soils will generally be suitable for reuse as compacted fill, as discussed below.

Within footing areas, and extending to at least 3 feet on either side, and concrete slab-on-grade floor areas, and extending to at least 5 feet beyond the perimeter and at least 3 feet beyond adjacent exterior slabs (building envelopes), the depth of the excavation should be adjusted so as to provide space for at least 12 and 30 inches of properly compacted fill of low expansion potential below the bottom of all footings and floor slabs, respectively. In addition, because of the presence of the weak, surface and near surface natural soils that exhibit relatively low strength, the depth of excavation should also be adjusted so as to remove at least 2 feet of natural ground in the vicinity of Boring 12 prior to placement of any new fill (see attached Plate 1). The actual depth and extent of overexcavation in the vicinity of Boring 12 should be determined in the field by the soil engineer during the site rough grading.

The surface exposed by stripping or overexcavation should be scarified to a depth of at least 6 inches, moisture conditioned to at least 4 percentage points above optimum, and so as to close any shrinkage cracks for their full depth, and compacted to at least 87 percent relative compaction.[2] Such moisture conditioning should be performed in all planned improvement areas (building envelope, asphalt- and concrete-paved areas, concrete walkway areas, etc.). Where expansive soils have dried and cracked after initial preparation, additional moisture conditioning would be needed to close shrinkage cracks for their full depth before covering with aggregate base, subbase, concrete, and/or other improvements.

Approved on-site or imported fill materials of low expansion potential then should be spread in 8-inch-thick loose lifts, moisture conditioned and similarly compacted. Only approved on-site or imported soils of low expansion potential should be used as fill in the upper 30 inches of the building envelope.

Imported fill material should be low in expansion potential and have a Plasticity Index of 15 or less. Imported materials should be free of organic matter and rocks or hard fragments larger than 4 inches in diameter. Material proposed for use as imported fill of low expansion potential should be tested and approved by the soil engineer prior to delivery to the site.

Trench backfill materials within 5 feet of building envelopes should consist of similar imported fill. The backfill should be placed in layers and compacted to at least 87 percent relative compaction, except the upper 30 inches should be compacted to at least 90 percent.

---

2 Relative compaction refers to the in-place dry density of fill expressed as a percentage of maximum dry density of the same material determined in accordance with the ASTM 1557 laboratory compaction test procedure. Optimum moisture content refers to the moisture content at maximum dry density.

Granular imported backfill that could allow evaporation of moisture from the on-site soils adjacent to and below the building envelope should not be used within 5 feet of the perimeter.

Should lime treatment of the on-site soils be proposed, we recommend that laboratory testing be performed prior to the site rough grading to help evaluate the amount and type of lime needed to satisfactorily reduce the shrink/swell characteristics of the soils to be treated. The laboratory tests would need to be performed on samples of the on-site soil mixed with lime from the selected source.

Finished cut and fill slopes should be trimmed to expose firm material and should be no steeper than two horizontal to one vertical (2:1). Slopes over 3 feet high should be planted with fast- growing, deep-rooted ground cover to help reduce erosion.

It is our experience that weak clayey surface soils can tend to trap considerable amounts of water into the late spring or early summer. Therefore, we believe that site grading during winter months or early in the construction season could require more than normal effort to satisfactorily excavate and/or compact the materials.

For grading performed in the driest time of the year, especially after winters of significantly less than normal total or springtime rainfall, shrinkage cracks in the near surface expansive soils may be deep. Prolonged watering or controlled flooding with the possible use of wetting agents may be necessary to moisture condition the expansive soils to the high initial moisture content needed to close shrinkage cracks for their full depth. As a construction expediency, the grading contractor could elect to overexcavate a portion of the expansive soils to reduce the amount of moisture conditioning time needed. The overexcavated soils could be moisture conditioned and then replaced as properly compacted fill. Accordingly, we recommend that contract documents contain provisions to account for such possible additional costs.

Foundation Support

Provided the building pads are graded in conformance with our recommendations, minimum depth spread footings can be used for foundation support. Spread footings should be at least 12 inches wide and should be underlain by at least 12 inches of properly compacted fill of low expansion potential. Footings should be bottomed at least 12 inches below the lowest adjacent compacted pad grade. Spread footings can be designed to impose dead plus code live load and total design load (including wind or seismic forces) bearing pressures of 2,000 and 3,000 pounds per square foot (psf), respectively.

Resistance to lateral loads can be obtained from a combination of passive earth pressures and soil friction. We recommend the following criteria for design:

Passive Earth Pressure	=	300 pounds per cubic foot (pcf) equivalent fluid, neglect the upper 1 foot unless confined by pavement or slab
Soil Friction Factor	=	0.3

Slab-on-Grade

Provided the site is prepared as recommended above, floor slabs should be underlain by at least 30 inches of properly compacted approved on-site or imported fill of low expansion potential. Slab-on-grade subgrade should not be allowed to dry prior to concrete placement. In addition, slabs should be underlain by a capillary moisture break and cushion layer consisting of at least 4 inches of free-draining, crushed rock or gravel at least 1/4 inch and no larger than 3/4 inch in size. Crushed rock should be used where the slabs would be subjected to heavy vehicular traffic such as fork lifts or delivery trucks. Moisture vapor will condense on the underside of slabs. Where passage of moisture vapor through slabs would be detrimental, an impermeable moisture vapor barrier should be provided between the drainrock and the slabs. Two inches of clean moist sand should be placed over a plastic membrane, if used, to aid in curing and help provide puncture protection.

The slabs should be at least 4 inches thick and be reinforced to reduce cracking and help keep closed those cracks that do appear. The actual slab thickness and amount of reinforcing used should be determined by the structural design engineer based on anticipated use and performance.

Where at least 30 inches of compacted fill of low expansion potential is provided, slabs could be tied to perimeter foundations. Frequent joints should be provided in the slabs to permit movements to occur and reduce the potential for slab distress.

Retaining Walls

Retaining walls that are free to rotate slightly and support a backslope up to 3:1 should be designed to resist an active equivalent fluid pressure of 45 pcf acting in a triangular pressure distribution. If the backslope is steeper than 3:1, an active pressure of 60 pcf should be used. If the wall is constrained at the top and cannot tilt, the above design pressures should be increased to 60 pcf and 75 pcf, respectively. Where retaining wall backfill is subject to vehicular traffic, the walls should be designed to resist an added surcharge pressure equivalent to 1½ feet of additional backfill. In addition to the static earth pressure component for retaining walls, we recommend that retaining walls be designed to resist an additional dynamic component of total thrust induced on the wall. The dynamic component of total thrust induced on the wall can be assumed to be a force equal to 15 times the height of the retaining wall square (i.e. $15H^2$, in pounds per linear foot). This force should be applied at a height of 0.6H above the base of the retaining wall.

Wall footings can be designed in accordance with the criteria above for building foundations. Where the wall backfills are subjected to heavy storage and/or vehicular loads, the walls should be designed for a surcharge pressure equal to 2½ feet of additional backfill.

The walls should be fully backdrained. The backdrains should consist of 4-inch-diameter perforated pipe sloped to drain to outlets by gravity and free-draining crushed rock or gravel (drainrock). The crushed rock or gravel should extend to within 1 foot of the surface. The drainrock should conform to the quality requirements for Class 2 Permeable Materials per

Caltrans Standard Specifications. As an alternative, any clean drainrock could be used if the rock is covered and separated from the soil bank by a nonwoven, geotextile fabric[3] weighing about 4 ounces per square yard. The upper 1 foot should be backfilled with compacted soil to exclude surface water. The ground surface behind retaining walls should be sloped to drain. Where migration of moisture through retaining walls would be detrimental, the walls should be waterproofed.

Pavement Thicknesses

For planning purposes, based on our experience with similar projects and soils, we recommend the following minimum pavement sections for driveways and parking areas:

Material	Parking Areas	Driveway Areas
Class II Aggregate Base	6"	8"
Asphalt Concrete	2½"	2½"

Such pavements should be suitable for auto and light pickup truck traffic. Where heavier truck loadings are anticipated, the pavement thickness should be increased to at least 3 inches of asphalt and about 10 to 14 inches of aggregate base. Because of concentrated heavy wheel loads at dumpster lift points, reinforced concrete slabs should be used at those locations.

Future wetting and drying of the on-site expansive soils along pavement edges can occur. Pavement maintenance, especially repair of edge cracking, should be anticipated.

3 Mirafi 140 is a brand name of a suitable fabric that may be locally available.

Increased pavement performance and reduced future maintenance can be accomplished by underlying the paved areas with at least 12 inches of imported fill of low expansion potential. The fill, if used, should extend at least 3 feet beyond pavement edges, where attainable. Conventional curb and sidewalk and/or landscaping with an automatic sprinkler system can also provide some benefit in reducing future maintenance. Periodic patching or sealing of the asphalt-concrete pavement should be performed to reduce shrink/swell movements of the underlying expansive clays, should cracks occur. Future edge cracking could also be reduced by installation of a perimeter moisture vapor cutoff. We can provide specific recommendations, if desired.

Prior to subgrade preparation, underground utilities in the paved areas should be installed and properly backfilled. Subgrade soils in highly expansive material areas should be prepared by scarifying to a depth of at least 6 inches, uniformly moisture conditioning to at least 4 percent above optimum and compacting to at least 93 percent relative compaction. The moisture conditioning should be sufficient so as to close all shrinkage cracks for their full depth. This may require scarifying and recompacting, and/or overexcavation and replacement to achieve uniformity and proper moisture conditioning. Subgrade soils in other areas should be similarly prepared to moisture contents of slightly above optimum and relative compactions of at least 95 percent. Finished subgrade should be smooth, firm, uniform and nonyielding. Approved aggregate base materials should be spread in layers, moisture conditioned and compacted to at least 95 percent relative compaction. The aggregate base surface should also be firm and nonyielding.

The materials and methods used should conform to the requirements of the State of California Caltrans Standard Specifications, current edition, and the requirements of the City of Petaluma.

Pavements on expansive soils can heave and settle. Gently sloping surfaces could allow water to stand with only minor displacements and should be avoided. Also, valley gutters in paved areas could need subgrade subdrains as determined during final design.

Soil Engineering Drainage

Ponding water will cause swelling of the expansive soils and would be detrimental to foundations. It is important that the area adjacent to the buildings be sloped to drain away from foundations. Good, positive surface drainage away from the buildings consisting of at least 1/4 inch per foot extending at least 4 feet out should be provided. The roofs should be provided with gutters or roof drain inlets with downspouts. The downspouts should either discharge onto paved areas or splash blocks draining at least 30 inches away from foundations, or be connected to rigid-wall nonperforated plastic pipelines that outlet into planned or existing storm drain facilities.

Where irrigated landscape areas abut the buildings, excess water can be introduced into soil layers along the edge of the building, tending to soften soils in the footing areas and increase the risk of potential migration of moisture beneath floor slabs. We believe that the installation of the recommended compacted fill pad that extends to at least 5 feet beyond the buildings should provide an effective barrier to the infiltration of excess water from landscape areas. However, we recommend that hot-mopping or other methods of waterproofing the exterior sides of below-grade cold joints in perimeter foundations be performed. Also, as an added precaution, landscape planters that abut the building could be lined with a plastic membrane (6-mil visqueen or equivalent) and be provided with a subdrain that outlets into planned site drainage systems (gutters, storm drains, etc.).

Supplemental Geotechnical Services

We should review grading and foundation plans for conformance with the intent of our recommendations and further evaluate the need for additional measures for planned improvements in areas underlain by compressible bay mud deposits. During site grading and foundation excavation operations, the soil engineer should provide intermittent observation and testing. The soil engineer should observe the conditions encountered, confirm needed overexcavation depths and modify our recommendations, if warranted. Field and laboratory tests should be performed to ascertain that the recommended moisture contents and degrees of compaction are being attained. Concrete placement and reinforcing should be checked as stipulated on the project plans or as required by the Building Department. It is our understanding that approval from the Building Department must be obtained prior to the placement of concrete in foundation elements.

LIMITATIONS

We have performed the investigation and prepared this report in accordance with generally accepted standards of the soil engineering profession. No warranty, either express or implied, is given.

It should be understood that our services were limited to the scope of work outlined above and specifically excluded other services including, but not limited to, an evaluation or analysis of soil chemistry, corrosivity, mold and soil/groundwater contamination.

Subsurface conditions are complex and may differ from those indicated by surface features or encountered at test boring locations. Therefore, variations in subsurface conditions not indicated on the logs could be encountered. If the project is revised, or if conditions different from those described in this report are encountered during construction, we should be notified immediately so that we can take timely action to modify our recommendations, if warranted.

Supplemental services as recommended herein are performed on an as-requested basis. These services are in addition to this investigation, and are charged for on an hourly basis in accordance with our Standard Schedule of Charges. We can accept no responsibility for items we are not notified to check, nor for use or interpretation by others of the information contained herein.

Site conditions and standards of practice change. Therefore, we should be notified to update this report if construction is not performed within 24 months.

LIST OF PLATES

DISTRIBUTION

Copies submitted: 5

Airport Business Center
414 Aviation Boulevard
Santa Rosa, CA 95403
Attention: Patrick Imbimbo

DF/JKR.sc/NN/HD/bound/df/Job No. 321.59.1

▽ groundwater first encountered at time of drilling

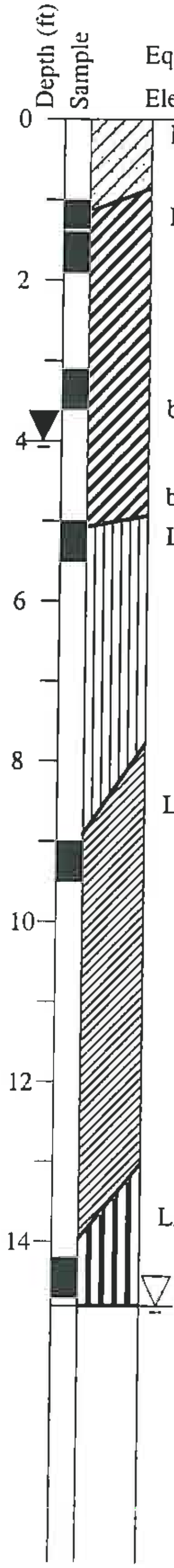
▼ groundwater at time of backfilling

LOG OF BORING 1

Equipment: 6" FLIGHT AUGER

Elevation: 10.3 Date: 3-6-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Description
				MOTTLED LIGHT BROWN AND DARK BROWN VERY CLAYEY SAND (SC), loose, wet (FILL)
Percent Free Swell = 50	11			BLACK SANDY CLAY (CH), stiff, wet
Percent Free Swell = 100 LL = 50 PL = 21 PI = 29				
UC(P) = 2500 Percent Free Swell = 100	31	23.4	99	becomes very stiff to hard
				becomes light gray
TxUU = 2700 (750)	50+	21.0	100	LIGHT GRAY/GREEN SANDY SILT (ML), hard, wet, with occasional 1-1/2-inch-diameter gravel
UC(P) = 4000	50+	30.0	92	LIGHT BROWN SANDY CLAY (CL), hard, wet
UC(P) = 4400	36	35.6	86	LIGHT BROWN SANDY SILT (MH), hard, wet to saturated



GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: GKR

LOG OF BORING 1

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 2

LOG OF BORING 2

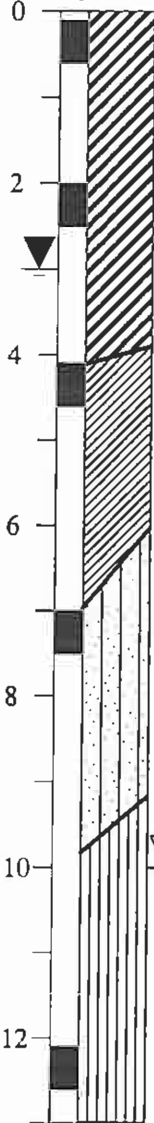
▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

Equipment: 6" FLIGHT AUGER

Elevation: 8.8 Date: 3-6-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Description
Percent Free Swell = 90	6			0	DARK GRAY SANDY CLAY (CH), medium stiff, wet to saturated, with fine roots in upper 3 inches
UC(P) = 2400 Percent Free Swell = 90	19	23.1	97	2	
				▼	becomes very stiff
UC(P) = 2600	31	32.8	87	4	GRAY BROWN SANDY CLAY (CL), hard, wet
TxUU = 1170 (1000) Percent Passing No. 200 Sieve = 23.0	50+	18.5	111	6	LIGHT BROWN SILTY SAND (SM), very dense, wet, cemented
				10 ▽	LIGHT BROWN SANDY SILT (ML), hard, saturated
	34	26.6	98	12	



GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

App'd: JKR

LOG OF BORING 2

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 3

LOG OF BORING 3

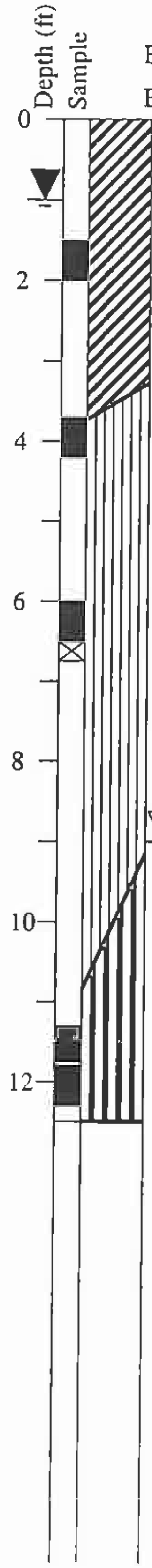
▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

Equipment: 6" FLIGHT AUGER

Elevation: 6.6 Date: 3-6-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)
Percent Free Swell = 85	11	26.8	96
TxUU = 3800 (600)	31	29.0	93
UC(P) = 4500+	50+	26.9	90
UC(P) = 3700	28	32.7	89



BLACK SANDY CLAY (CH), stiff, saturated

LIGHT BROWN SANDY SILT (ML), hard, wet, cemented

OLIVE BROWN SANDY SILT (MH), very stiff, saturated

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: JKR

LOG OF BORING 3

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE

4

▽ groundwater first encountered at time of drilling

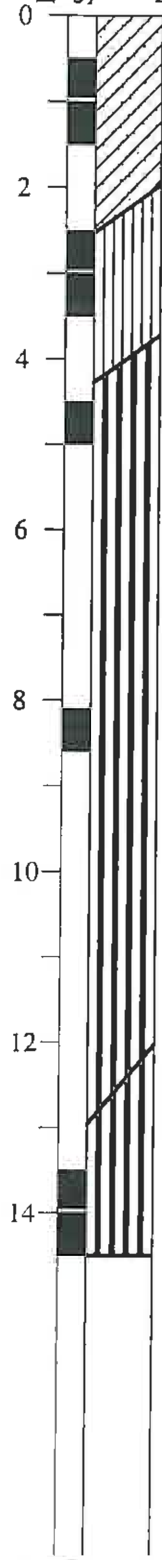
▼ groundwater at time of backfilling

LOG OF BORING 4

Equipment: 6" FLIGHT AUGER

Elevation: 9.5 Date: 3-6-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)
Percent Free Swell = 55	13	19.0	107
Percent Free Swell = 40			
	11	19.4	106
TxUU = 3350 (750)	50+	30.4	91
UC(P) = 4500+	50+	31.7	89
UC(P) = 2600	24	32.2	89



MOTTLED LIGHT BROWN AND ORANGE CLAYEY SAND (SC), medium dense, saturated, with occasional gravel (FILL)

becomes dark brown with depth

DARK GRAY BROWN SANDY SILT (ML), stiff, wet

GRAY BROWN SANDY SILT (ML-MH), hard, wet, cemented

GRAY BROWN SANDY SILT (MH), very stiff, wet

(No free water encountered)

LOG OF BORING 5

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

Equipment: 6" FLIGHT AUGER

Elevation: 5.9 Date: 3-6-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Description
				0	DARK GRAY SANDY CLAY (CH), medium stiff, saturated
UC(P) = 1200 Percent Free Swell = 80	8	29.0	91		
				2	
					LIGHT GRAY SANDY SILT (ML), very stiff, wet, weakly cemented
UC(P) = 3600	25	28.8	92		
				4	
TxUU = 4120 (1500)	50+	24.2	99		becomes hard
				6	
				8	
					▽ LIGHT BROWN CLAYEY MEDIUM FINE SAND (SC), very dense, wet to saturated
UC(P) = 4000	50+	24.2	97		
				10	GRAY BROWN SILTY MEDIUM COARSE SAND (SM), very dense, saturated
Percent Passing No. 200 Sieve = 20.2	50+				
Percent Passing No. 200 Sieve = 6.1	34	21.4	104		BROWN CLAYEY SAND (SC-SP), dense, saturated
				12	
					LIGHT BROWN SANDY CLAY (CL), hard, saturated
	42	30.2			
				14	becomes cemented
TxUU = 1370 (2000)	14.3	27.4	96		
				16	
				18	

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: JHR

LOG OF BORING 5

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE
6a

LOG OF BORING 5

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

Equipment: 6" FLIGHT AUGER

Elevation: 5.9   Date: 3-6-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Description
				18	OLIVE BROWN SANDY SILT (ML/MH), hard, saturated
UC(P) = 3700	40	24.5	99		
				20	
				22	MOTTLED LIGHT BROWN AND ORANGE SANDY CLAY (CL), hard, saturated
				24	
UC(P) = 4200	50+	23.4	104		
				26	
				28	
				30	BLUE GRAY SANDY CLAY (CH), hard, saturated
				32	
UC(P) = 3500	32	22.0	107		

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: [illegible]

LOG OF BORING 5

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 6b

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

LOG OF BORING 6

Equipment: 6" FLIGHT AUGER

Elevation: 6.8 Date: 3-6-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Description
Percent Free Swell = 80	6	32.6	84	0	DARK BROWN SANDY CLAY (CH), soft, saturated, porous to a depth of 1-1/2 feet, with fine roots
Percent Free Swell = 85	14	27.0	97	2	becomes light gray brown, stiff
				4	LIGHT BROWN SANDY SILT (ML), hard, wet
TxUU = 2590 (1200)	44	25.7	97		
				6	
UC(P) = 3700	34	24.0	100		LIGHT BROWN VERY CLAYEY SAND (SC), dense, wet
				8	LIGHT BROWN SANDY CLAY (CL), hard, wet
				10	
					LIGHT BROWN SANDY CLAY (CH), hard, wet
UC(P) = 4000	32	31.2	92	12	LIGHT BROWN SANDY SILT/SANDY CLAY (ML/CL), hard, wet
					(No free water encountered)

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: JKR

LOG OF BORING 6

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 7

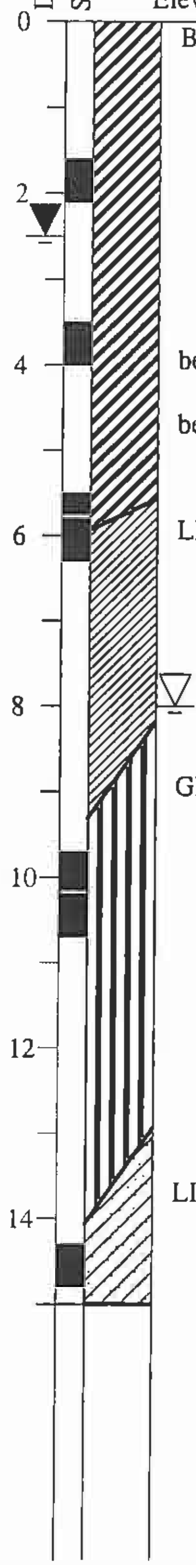
▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

LOG OF BORING 7

Equipment: 6" FLIGHT AUGER

Elevation: 6.7 Date: 3-6-08



Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Description
				0	BLACK SANDY CLAY (CH), stiff, wet to saturated, with occasional fine roots
Percent Free Swell = 120	12	41.2	78	2	
UC(P) = 2000	23	28.7	94	4	becomes very stiff
					becomes light gray, stiff
TxUU = 750 (1000)	14	38.2	81	6	LIGHT GRAY BROWN SANDY CLAY (CL), stiff, wet
				8	
					GRAY BROWN SANDY SILT (MH), very stiff, saturated, with carbonate staining
	20	35.6	86	10	
				12	
				14	LIGHT BROWN VERY CLAYEY FINE SAND (SC), medium dense, saturated
Percent Passing No. 200 Sieve = 29.9	29	25.2	101		

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

App: GKR

LOG OF BORING 7

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 8

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

LOG OF BORING 8

Equipment: 6" FLIGHT AUGER

Elevation: 5.2 Date: 3-6-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Description
				0	DARK GRAY SANDY CLAY (CH), medium stiff, saturated, with occasional fine roots
				▼	
				2	
Percent Free Swell = 95					
	10	27.8	95		becomes light gray, stiff
					GRAY BROWN SANDY CLAY (CL), very stiff, wet
				4	
TxUU = 810 (750) Percent Passing No. 200 Sieve = 30.0	30	25.2	99		BLUE GRAY CLAYEY FINE SAND (SC), medium dense to dense, wet
				6	
	41				
Percent Passing No. 200 Sieve = 31.3	46				
				8	
Percent Passing		23.9	100		▽
No. 200 Sieve = 34.5 UC(P) = 3500	40	23.0	104		LIGHT BROWN SANDY CLAY (CL), hard, moist, cemented
		24.5	100	10	
					LIGHT BROWN SANDY CLAY (CL/CH), hard, saturated
		31.0	91	12	
UC(P) = 4400	34	26.2	98		

▽ groundwater first encountered at time of drilling

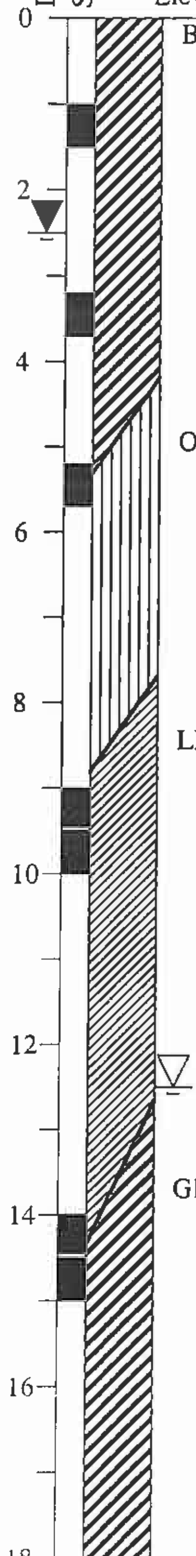
▼ groundwater at time of backfilling

LOG OF BORING 9

Equipment: 6" FLIGHT AUGER

Elevation: 8.5 Date: 3-13-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)
Percent Free Swell = 120	16	40.2	79
UC(P) = 2400 Percent Free Swell = 100	26	29.2	92
TxUU = 1110 (750)	24	30.7	90
UC(P) = 4500+	43	33.9	88
UC(P) = 4400	40	30.1	93



BLACK SANDY CLAY (CH), very stiff, wet, slightly porous, with occasional fine roots

OLIVE BROWN SANDY SILT (ML), very stiff, wet

LIGHT GRAY BROWN SANDY CLAY (CL), hard, wet, cemented

GRAY SANDY CLAY (CH), hard, saturated, cemented

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: GWR

LOG OF BORING 9

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 10a

▽ groundwater first encountered at time of drilling

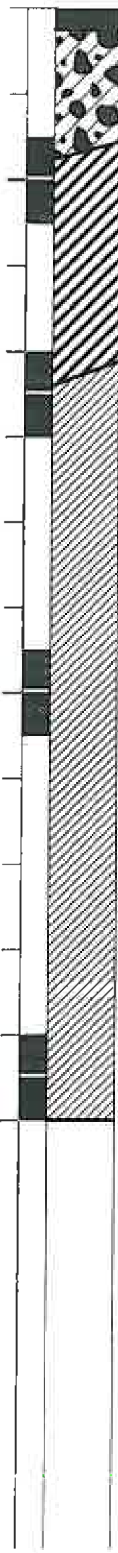
▼ groundwater at time of backfilling

LOG OF BORING 10

Equipment: 6" FLIGHT AUGER

Elevation: 8.0 Date: 3-13-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Description
				0	ASPHALT CONCRETE
					RED BROWN CLAYEY GRAVEL (GC), dense, wet (FILL)
					BLACK SANDY CLAY (CH), stiff, wet
Percent Free Swell = 80 UC(P) = 2000	10	27.7	93	2	
Percent Free Swell = 120				4	
UC = 910	23	30.0	91		MOTTLED GRAY SANDY CLAY (CL), very stiff, wet
				6	
UC(P) = 3500					
Percent Passing No. 200 Sieve = 70.1	31	25.4	99	8	becomes light brown, very sandy, hard
				10	
				12	
UC(P) = 4500+	50+	30.0	94		
					(No free water encountered)



GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: JKR

LOG OF BORING 10

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE
11

▽ groundwater first encountered at time of drilling

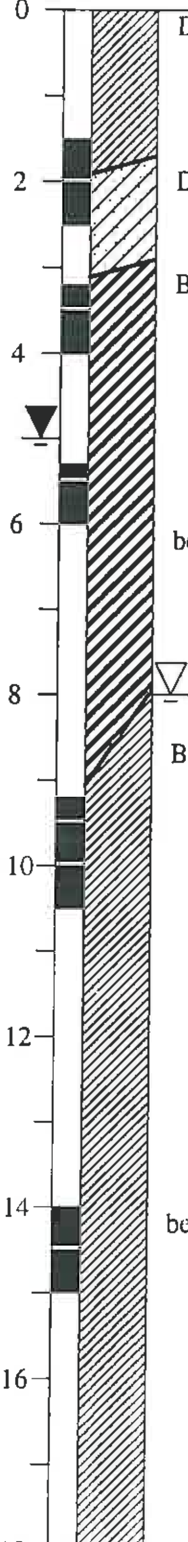
▼ groundwater at time of backfilling

LOG OF BORING 11

Equipment: 6" FLIGHT AUGER

Elevation: 9.1 Date: 3-13-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Description
				0	DARK BROWN VERY SANDY CLAY (CL), stiff, wet (FILL)
Percent Free Swell = 70	12	14.6	109	2	DARK BROWN CLAYEY SAND (SC), medium dense, wet (FILL)
Percent Free Swell = 115 UC(P) = 2500	24	35.8	83	4	BLACK SANDY CLAY (CH), very stiff, wet, with occasional fine roots
UC = 1180	18	40.4	80	6	becomes saturated
				8	BROWN VERY SANDY CLAY (CL), very stiff, saturated, with occasional gravel
Percent Passing No. 200 Sieve = 68.3 UC(P) = 2500	17	24.1	100	10	
				12	
UC(P) = 2700 Percent Free Swell = 70	21	27.3	97	14	becomes blue gray
				16	
				18	



GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

App: JKR

LOG OF BORING 11

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 12a

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

LOG OF BORING 11

Equipment: 6" FLIGHT AUGER

Elevation: 9.1 Date: 3-13-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Description
				18	BLUE GRAY CLAYEY FINE SAND (SC), medium dense, saturated
	24				BLUE GRAY SANDY CLAY (CL), very stiff, saturated
UC(P) = 3500		25.6	99		
				20	
				22	
				24	GRAY BROWN SANDY CLAY (CH), hard, saturated
UC(P) = 3250	50+	25.1	100		
				26	
				28	
				30	BLUE GRAY SANDY CLAY (CL), very stiff, saturated
	26	26.7	98		
				32	

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: GKR

LOG OF BORING 11

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE **12b**

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

LOG OF BORING 12

Equipment: 6" FLIGHT AUGER

Elevation: 6.5 Date: 3-18-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Description
				0	DARK BROWN SANDY CLAY (CL/CH), soft, wet, with porcelain fragments and occasional cobble-size angular rock (FILL)
					RED BROWN SILTY SAND (SM), medium dense, saturated (FILL)
Percent Free Swell = 40	27				
	27	28.5	93	2	ORANGE BROWN VERY SANDY SILT (ML), very stiff, saturated, with occasional 2-inch size angular rock fragments (FILL)
Percent Free Swell = 55	3	63.5	101		
		47.7	73	4	DARK GRAY SANDY CLAY (CH), very soft, saturated, with occasional fine roots
UC = 710 Percent Free Swell = 95	4	31.6	91		becomes lighter gray with depth, soft
				6	becomes very stiff to hard at about 6 feet
UC(P) = 2500	50+	22.9	104	8	becomes light gray brown, hard
				10	
UC(P) = 4000	50+	28.6	96	12	becomes cemented

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: JKR

LOG OF BORING 12

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 13

LOG OF BORING 13

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

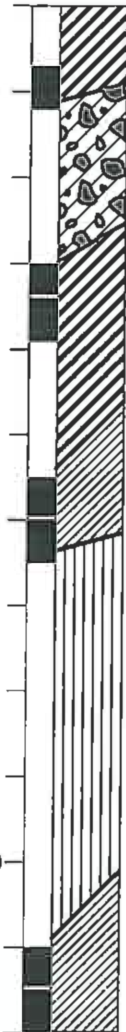
Equipment: 6" FLIGHT AUGER

Elevation: 7.0 Date: 3-18-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)
Percent Free Swell = 90	41	13.0	114
Percent Free Swell = 80 UC(P) = 1500	6	23.0	99
TxUU = 1240 (1000)	34	37.5	83
UC(P) = 4500+	50+	25.8	99

Depth (ft): 0, 2, 4, 6, 8, 10, 12

Sample



GRAY BROWN SANDY CLAY (CH), very stiff, saturated, with abundant gravel-size rock fragments (FILL)

LIGHT BROWN AND DARK GRAY CLAYEY GRAVEL (GC), dense, wet (FILL)

DARK GRAY SANDY CLAY (CH), medium stiff, wet

becomes light gray and less plastic with depth

LIGHT BROWN SANDY CLAY (CL), stiff, wet

LIGHT BROWN SANDY SILT (ML), hard, wet, cemented

GRAY BROWN SANDY CLAY (CL), hard, wet, cemented

(No free water encountered)

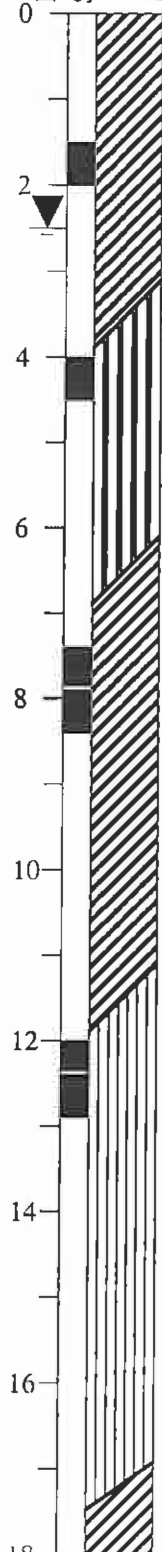
LOG OF BORING 14

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

Equipment: 6" FLIGHT AUGER

Elevation: 6.0 Date: 3-18-08



Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Description
				0	BLACK SANDY CLAY (CH), stiff, wet
LL = 67 PL = 28 PI = 39 Percent Free Swell = 90	9	32.5		2	
UC(P) = 1000 Percent Free Swell = 110	7	54.3	66	4	DARK GRAY SANDY SILT (MH), medium stiff, saturated
				6	GRAY SANDY CLAY (CH), medium stiff to stiff, wet
UC = 340	8	37.5	84	8	
				10	
Percent Passing No. 200 Sieve = 75.4	34	26.0	105	12	GRAY BROWN VERY SANDY SILT (ML), hard, wet, becomes weakly cemented with depth
				14	
				16	
				18	MOTTLED LIGHT GRAY BROWN AND ORANGE SANDY CLAY (CH), hard,

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: JKE

LOG OF BORING 14

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE **15a**

▽ groundwater first encountered at time of drilling

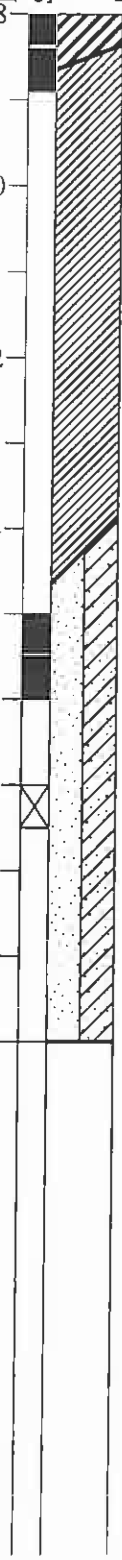
▼ groundwater at time of backfilling

LOG OF BORING 14

Equipment: 6" FLIGHT AUGER

Elevation: 6.0 Date: 3-18-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)
				18
Percent Passing No. 200 Sieve = 62.4	30	25.2	100	
				20
				22
				24
Percent Passing No. 200 Sieve = 9.1	33			
				26
Percent Passing No. 200 Sieve = 9.0	48			
				28
				30



saturated

MOTTLED LIGHT GRAY BROWN AND ORANGE VERY SANDY CLAY (CL), hard, saturated

BLUE GRAY CLAYEY COARSE SAND (SP-SC), dense, saturated, with occasional 1-inch-diameter subrounded gravel

LOG OF BORING 15

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

Equipment: 6" FLIGHT AUGER

Elevation: 8.2 Date: 3-18-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Description
Percent Free Swell = 60 LL = 45 PL = 20 PI = 25	12	16.5	110	0	MOTTLED DARK GRAY AND BROWN GRAVELLY CLAY (CL), stiff, moist (FILL)
Percent Free Swell = 50				2	RED BROWN SANDY SILT (ML), stiff, wet (possible fill)
Percent Free Swell = 70	6	31.3	86		GRAY BROWN SANDY CLAY (CH), stiff, wet
UC(P) = 4500+	50+	21.2	91	4	LIGHT BROWN SANDY CLAY (CL), hard, moist, weakly cemented
				6	
TxUU = 4120 (1500)	50+	26.7	96	8	GRAY BROWN SANDY CLAY (CL), hard, wet, weakly cemented
				10	
UC(P) = 4500+	40	35.3	86	12	BROWN SANDY SILT (ML), hard, wet, weakly cemented
				14	
				16	
				18	

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: GKR

LOG OF BORING 15

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 16a

∇ groundwater first encountered at time of drilling

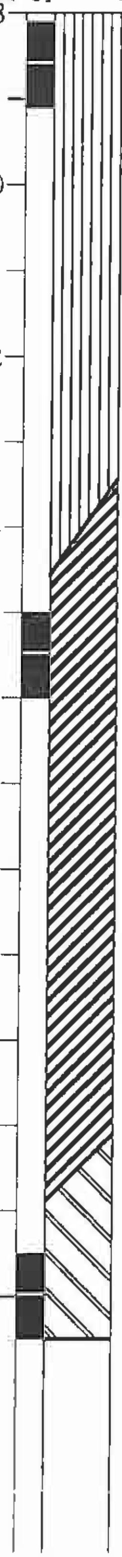
▼ groundwater at time of backfilling

LOG OF BORING 15

Equipment: 6" FLIGHT AUGER

Elevation: 8.2 | Date: 3-18-08

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Description
				18	
TxUU = 1530 (3000)	37	31.7	81		slight increase in plasticity
				20	
				22	
				24	LIGHT BROWN SANDY CLAY (CH), hard, saturated, becomes blue gray with depth
UC(P) = 3000	47	29.0	95	26	
				28	
				30	
				32	GRAY BROWN VERY SANDY CLAY (CL-CH), hard, saturated
UC(P) = 2700 Percent Passing No. 200 Sieve = 55.5	30	23.4	104		becomes very sandy with depth



GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

Appr: JKR

LOG OF BORING 15

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE **16b**

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAN No. 200 SIEVE)	GRAVEL (MORE THAN HALF OF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE)	CLEAN GRAVEL WITH LESS THAN 5% FINES	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURE
			GP	POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURE
		GRAVEL WITH OVER 12% FINES	GM	SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURE
			GC	CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURE
	SAND (MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN No. 4 SIEVE SIZE)	CLEAN SAND WITH LESS THAN 5% FINES	SW	WELL GRADED SAND, GRAVELLY SAND
			SP	POORLY GRADED SAND, GRAVELLY SAND
		SAND WITH OVER 12% FINES	SM	SILTY SAND, GRAVEL-SAND-SILT MIXTURE
			SC	CLAYEY SAND, GRAVEL-SAND-CLAY MIXTURE
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN No. 200 SIEVE)	SILT AND CLAY (LIQUID LIMIT LESS THAN 50)		ML	INORGANIC SILT, ROCK FLOUR, SANDY OR CLAYEY SILT WITH LOW PLASTICITY
			CL	INORGANIC CLAY OF LOW TO MEDIUM PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAY (LEAN)
			OL	ORGANIC CLAY AND ORGANIC SILTY CLAY OF LOW PLASTICITY
	SILT AND CLAY (LIQUID LIMIT GREATER THAN 50)		MH	INORGANIC SILT, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOIL, ELASTIC SILT
			CH	INORGANIC CLAY OF HIGH PLASTICITY, GRAVELLY, SANDY OR SILTY CLAY (FAT)
			OH	ORGANIC CLAY OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILT
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

KEY TO TEST DATA

				Shear Strength, psf	Confining Pressure, psf
EI — Expansion Index		TxUU	— Unconsolidated Undrained Triaxial	320	(2600)
Consol — Consolidation		TxCU	— Consolidated Undrained Triaxial	320	(2600)
LL — Liquid Limit (in %)		DSCD	— Consolidated Drained Direct Shear	2750	(2000)
PL — Plastic Limit (in %)		FVS	— Field Vane Shear	470	
PI — Plasticity Index		LVS	— Laboratory Vane Shear	700	
SA — Sieve Analysis		UC	— Unconfined Compression	2000 *	
G_s — Specific Gravity		UC(P)	— Laboratory Penetrometer	700 *	
■ "Undisturbed" Sample					
⊏ Bulk Sample					

Notes: (1) All strength tests on 2.8" or 2.4" diameter samples unless otherwise indicated * Compressive Strength

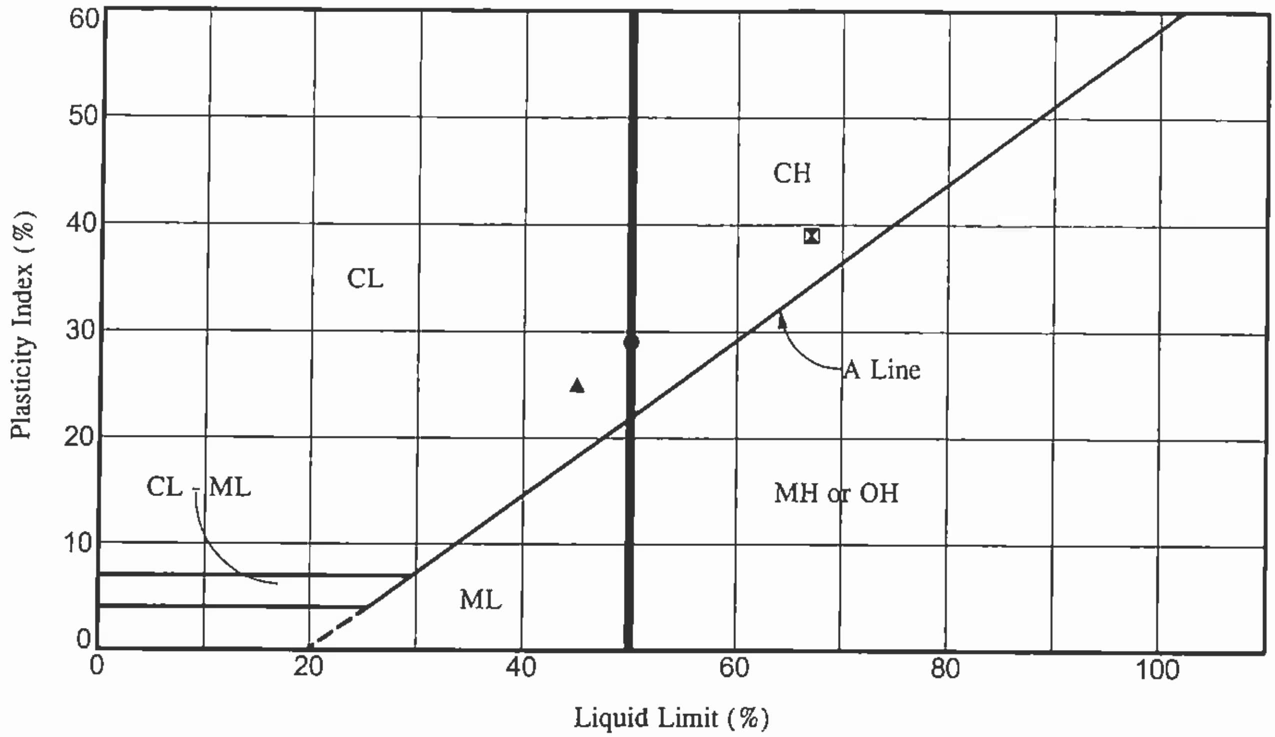
GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1
Date: 05-16-08
Appr: JKR

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE 17



ASTM D 4318-98

Symbol	Classification and Source	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Free Swell (%)
●	**BLACK SANDY CLAY (CH)** **Test Boring 1 at 1.4 feet**	50	21	29	100
⊠	**BLACK SANDY CLAY (CH)** **Test Boring 14 at 1.5 feet**	67	28	39	90
▲	**DARK BROWN GRAVELLY CLAY (CL)** **Test Boring 15 at 0.3 feet**	45	20	25	60

GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1

Date: 4-21-08

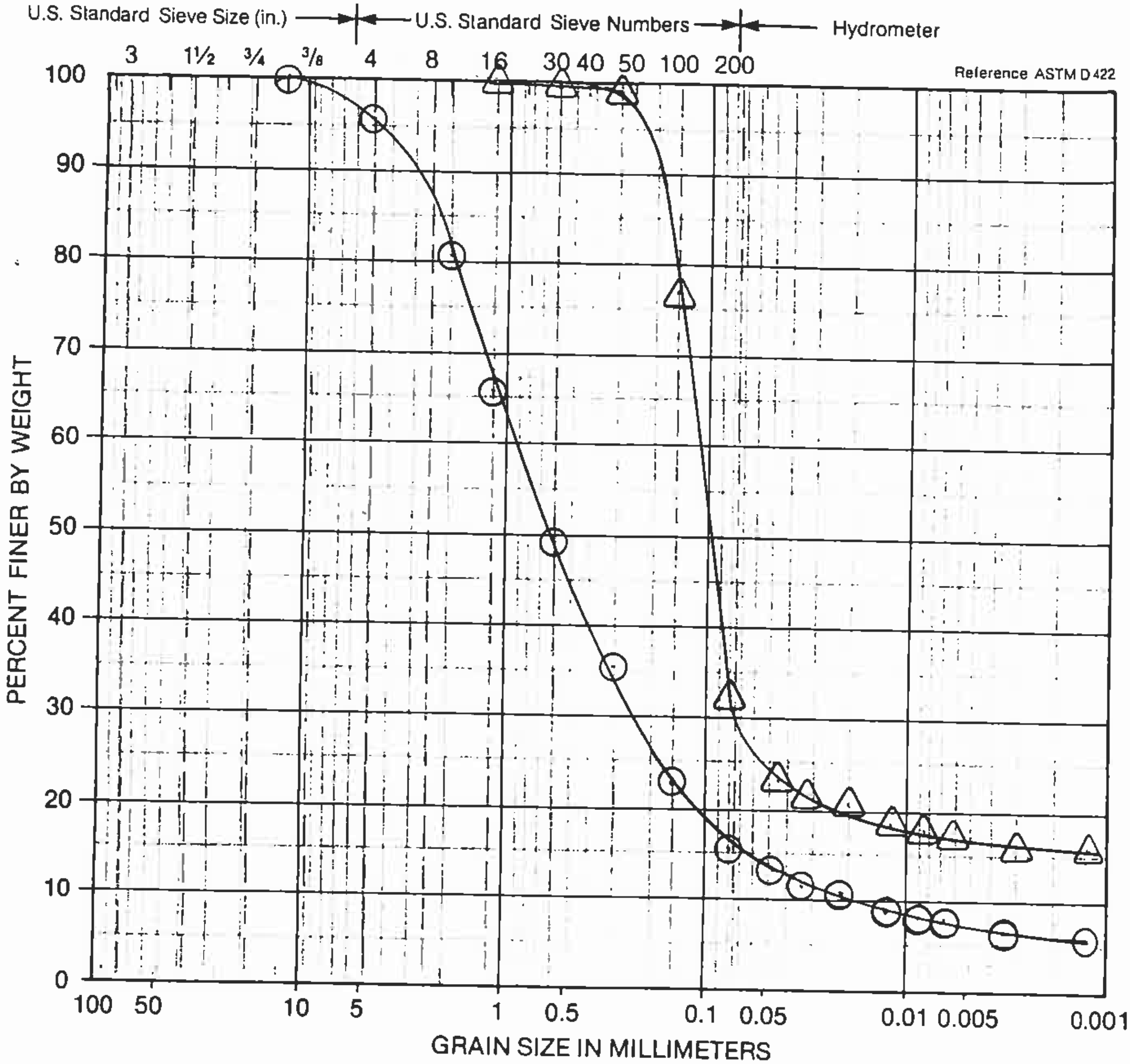
Appr: JKR

ATTERBERG LIMITS TEST RESULTS

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE

18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	Boring 5 at 10 feet	BROWN SILTY SAND (SM)
△	Boring 8 at 4.9 feet	GRAY CLAYEY VERY FINE SAND (SC)

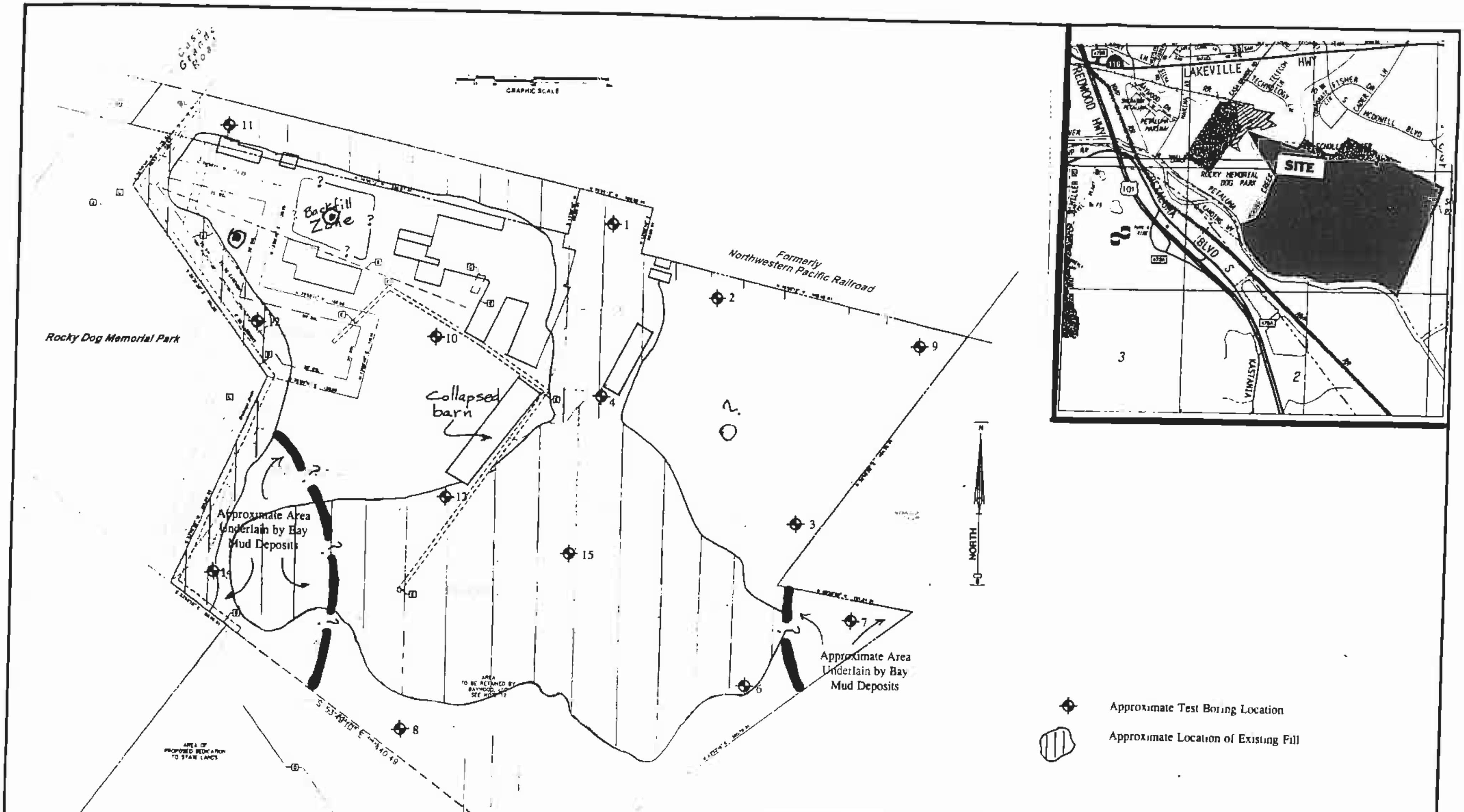
GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321.59.1
Date: 05-16-08
Appr: JKR

PARTICLE SIZE ANALYSIS

LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE **19**



GIBLIN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Job No: 321 59 1
Date: 05-16-08
Appr: JKR

TEST BORING LOCATION PLAN
AND SITE VICINITY MAP
LANDS OF BAYWOOD
PETALUMA, CALIFORNIA

PLATE
1