APPENDIX D

Preliminary Geotechnical Engineering Report

NORTH NATOMAS TOWN CENTER II

WKA No. 11032.02
August 3, 2016

Prepared For:
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Preliminary Geotechnical Engineering Report

NORTH NATOMAS TOWN CENTER II

Sacramento, California

WKA No. 11032.02

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NORTH NATOMAS TOWN CENTER II

Sacramento, California

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Preliminary Geotechnical Engineering Report
NORTH NATOMAS TOWN CENTER II
Del Paso Road and Town Center Drive
Sacramento, California
WKA No. 11032.02
August 3, 2016

INTRODUCTION

We have completed a preliminary geotechnical engineering investigation for the North Natomas Town Center II located northeasterly of Del Paso Road and Town Center Drive in Sacramento, California. Our work has been performed in accordance with the scope of services outlined in our proposal letter dated June 13, 2016 and authorized via email by Sam Miller of Lewis Management Corporation on June 19, 2016. Our office also prepared a *Phase I Environmental Site Assessment* (WKA No. 11032.01, dated July 15, 2016); that report has been provided under a separate cover.

Purpose and Scope of Services

The purpose of this report has been to describe the nature and general engineering properties of the soil and groundwater conditions at the site, and to provide findings and conclusions regarding the feasibility of developing the site. This report is preliminary in nature and describes the impacts of both soil and groundwater conditions on site development, but is not intended for use in specific design and construction of the project.

Our scope of services has included a site reconnaissance, review of available aerial photographs, topographic maps and geologic maps covering the site, and a review of the Department of Agricultural Natural Resources Conservation Service (NRCS) Soil Survey for Sacramento County. Undisturbed, disturbed, and bulk samples of surface and near-surface soils were obtained from two soil borings drilled at the locations shown in Figure 2. The samples were taken to our laboratory to determine various engineering characteristics of the on-site soils. The results of our field and laboratory work were then analyzed to develop preliminary geotechnical engineering conclusions regarding site preparation and fill placement, foundation design and interior floor slab support for the proposed three-story buildings, and pavement sections.

Related Experience

Supplemental information reviewed during the preparation of this report included the following reports:

- *Geotechnical Engineering Report* (WKA No. 4122.11, dated March 7, 2003) prepared for the North Natomas Town Center, located adjacent to the west of the subject property; and,
- *Geotechnical Engineering Report* (WKA No. 4980.03, dated December 20, 2001) prepared for the Town Center Educational Complex, located adjacent to the east of the subject property.

Figures

This report contains a Vicinity Map as Figure 1; a Site Plan showing approximate boring locations as Figure 2; and, Logs of Soil Borings as Figures 3 and 4. An explanation of the Unified Soil Classification System symbols used on the boring logs is presented in Figure 5. Appendix A contains general information regarding our field investigation and information regarding the laboratory testing program.

Project Description

We understand that the property consists of two parcels identified as Sacramento County Assessor Parcel Numbers 225-1780-010 and a portion of 225-0040-089. The property is irregular in shape and encompasses a total area of approximately 18.1 acres. Review of the preliminary site plan indicates that the property will be developed with two, three-story, medical office buildings and single-story, retail buildings. We assume that the buildings will be constructed of wood-framing with interior concrete slab-on-grade lower floors. Structural loads are anticipated to be relatively light to moderately heavy based on this type of construction. Associated development will include construction of underground utilities, landscaping, exterior flatwork, and asphalt concrete parking lots and drive aisles.

We also understand that the project is in its conceptual stages of design and that a design-level geotechnical report is not needed at this time.

FINDINGS

Site Description

The site is bounded to the north by vacant, grass-covered land, beyond which is the North Natomas Regional Park Off Leash Dog Park; to the east by Via Ingoglia Street, beyond which is Inderkum High School; to the south by Del Paso Road, beyond which is a business park; and, to the west by Town Center Drive, beyond which is North Natomas Town Center. The site is transected by a canal with the southwestern portion of the site elevated roughly 10 to 15 feet higher than the northeastern section of the site. Other than this difference in grade, the property is relatively flat with an average surface elevation of about +20 feet mean sea level (msl), based on review of the United States Geological Survey *7.5-Minute Topographic Map of the Taylor Monument Quadrangle, California*, dated 1967, photorevised 1980.

At the time of our field explorations on July 12, 2016, the site consisted of vacant land covered by dense, low-lying, volunteer weeds and grass. An unmaintained irrigation canal transected the central portion of the property from northwest to southeast resulting in a grade difference of about 10 to 15 feet. A property border was not observed to the north of the site and typical concrete sidewalks bordered the property to the east, south, and west. Several electrical utility boxes were observed along the southern property border as well as streetlights along the eastern and southern property borders.

Soil Conditions

The borings indicate the surface and near-surface soils generally consist of sandy, silty clay to a depth of about five feet below the ground surface. These surface and near surface soils are underlain by alternating layers of clayey sand, silty to sandy clay, and sandy silt to the maximum explored depth of 31½ feet below the ground surface. The upper soils in boring D2 contained about three to four feet of sandy, silty clay with gravel indicative of fill soils. An organic odor was observed in the soil samples collected in boring D2 from about 12 to 13 feet below the ground surface. For more information regarding soils at a particular location, please refer to the boring logs presented on Figures 3 and 4.

Site Geology

The site is located on the Great Valley geomorphic province of California, a 500 mile, northwest-trending structural trough, generally constrained to the west by the Coast Ranges and to the east by the foothills of the Sierra Nevada Range (Norris and Webb, 1990). The

Great Valley consists of two valleys lying end-to-end, with the Sacramento Valley to the north and the San Joaquin Valley to the south.

The Sacramento and San Joaquin Valleys have been filled to their present elevations with thick sequences of sediment derived from both marine and terrestrial sources. The sedimentary deposits range in thickness from relatively thin deposits along the eastern valley edge to more than 25,000 feet in the south central portion of the Great Valley (Norris and Webb, 1990). The sedimentary geologic formations of the Great Valley province vary in age from Jurassic to Quaternary, with the older deposits being primarily marine in origin. Younger sediments are continentally derived and were typically deposited in lacustrine, fluvial, and alluvial environments with their primary source being the Sierra Nevada Range.

The 1981 USGS *Geologic Map of the Sacramento Quadrangle, California*, shows the site to be underlain by Basin Deposits consisting of unconsolidated silt and clay, originally deposited as overbank flood deposits or floodplains.

Historical Aerial Photograph Review

We reviewed historical aerial photographs from 1937, 1947, 1957, 1964, 1966, 1972, 1984, 1993, 1998, and 2002 through 2015.

Review of a 1937 aerial photograph shows the site to be grass-covered land. A canal transecting the central portion of the site from northwest to southeast is visible. The ground markings in a 1947 aerial photograph indicate rice fields are visible to the northeast of the canal. A 1957 aerial photograph contains ground markings indicative of dry-farm crops to the northeast of the canal. A structure is visible on the southwestern portion and ground markings indicate irrigated crops are present on the southwestern portion of the property.

By 1964, the northeastern and southwestern portions of land appear to be fallow. A 1966 photograph contains ground markings indicative of rice fields present to the northeast of the canal. By 1972 fallow land is present northeast of the canal and by 1993 the previously noted structure has been removed from the site. The land appears to be cleared by 2005 and aerial photographs taken from 2005 through 2015 indicate the site to have remained essentially unchanged from previous years reviewed.

Natural Resources Conservation Service Soil Survey Conditions

The United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) has created a web-based service for accessing soil information. According to the NRCS Web Soil Survey (WSS), the majority of the near-surface soils at the site consist of Clear Lake clay, hardpan substratum, drained, 0 to 1 percent slopes; Jacktone clay, drained, 0 to 2 percent slopes; and, San Joaquin silt loam, 0 to 3 percent slopes.

The NRCS soil descriptions are generally consistent with our site observations and the soils observed in our auger borings.

Groundwater

Groundwater was encountered within the borings performed on July 12, 2016 at depths ranging from 21 to 26 feet below the ground surface. Please note that the borings may not have been left open long enough for groundwater to reach static equilibrium. To supplement the groundwater information obtained from the borings, we reviewed available California Department of Water Resources (DWR) records for wells in the vicinity of the project site. DWR monitored well identified as # 09N04E10C001M located approximately ½ mile southwesterly of the site. The ground elevation at the well is indicated to be approximately +19½ feet msl. The DWR has periodically monitored this well from October of 1979 to at least July of 2016. The “lowest” reported groundwater level in the well was measured on September 16, 2015 at an elevation of about 2 feet msl (or about 17½ feet below grade at the well). The “highest” reported groundwater level in the well was measured on March 21, 1983 at an elevation of about +16½ feet msl (or about 3 feet below the grade at the well). Over the last ten to fifteen years, the groundwater level at the well has fluctuated between 14 and 17½ feet below grade at the well.

CONCLUSIONS

Building Support

In our opinion, the native undisturbed soils are capable of supporting the planned three-story medical buildings, and single-story retail buildings, provided the near-surface soils are properly recompacted and engineered fill is properly placed and compacted during earthwork. However, undocumented fill is not considered suitable for support of buildings. The design-level geotechnical report should include test pit excavations to identify any on-site undocumented fill, especially in the southeastern portion of the site. Removal and proper backfilling of the resulting depressions will be essential for support of the proposed site improvements.

2013 CBC/ASCE 7-10 Seismic Design Criteria

Section 1613 of the 2013 edition of the California Building Code (CBC) references ASCE Standard 7-10 for seismic design. The following seismic parameters were determined based on the site latitude and longitude using the public domain computer program developed by the USGS. The following parameters summarized in Table 1 below may be used for seismic design of the proposed residential structures.

TABLE 1
2013 CBC/ASCE 7-10 SEISMIC DESIGN PARAMETERS

Latitude: 38.6569° N Longitude: 121.5206° W	ASCE 7-10 Table/Figure	2013 CBC Table/Figure	Factor/ Coefficient	Value
Short-Period MCE at 0.2 seconds	Figure 22-1	Figure 1613.3.1(1)	S_S	0.667 g
1.0 second Period MCE	Figure 22-2	Figure 1613.3.1(2)	S_1	0.292 g
Soil Class	Table 20.3-1	Section 1613.3.2	Site Class	D
Site Coefficient	Table 11.4-1	Table 1613.3.3(1)	F_a	1.266
Site Coefficient	Table 11.4-2	Table 1613.3.3(2)	F_v	1.816
Adjusted MCE Spectral Response Parameters	Equation 11.4-1	Equation 16-37	S_{MS}	0.845 g
	Equation 11.4-2	Equation 16-38	S_{M1}	0.531 g
Design Spectral Acceleration Parameters	Equation 11.4-3	Equation 16-39	S_{DS}	0.563 g
	Equation 11.4-4	Equation 16-40	S_{D1}	0.354 g
Seismic Design Category	Table 11.6-1	Section 1613.3.5(1)	Risk Category I to IV	D
	Table 11.6-2	Section 1613.3.5(2)	Risk Category I to IV	D

Notes: MCE – maximum considered earthquake
g – gravity

The site is not located within a designated Alquist-Priolo Earthquake Fault Zone (Jennings, 1994; Hart and Bryant, 1999). An evaluation of liquefaction was beyond the scope of this preliminary study; however, it is our opinion that liquefaction potential at the site is considered low.

Excavation Conditions

The soils at the site are anticipated to be excavatable with conventional earthwork and trenching equipment. A standard size backhoe and excavator should be suitable to excavate foundation and shallow utility trenches at this site.

Foundation excavations and the upper five feet of utility trenches should stand at near vertical inclinations, unless saturated soil conditions are encountered. Utility trench excavations deeper than five feet that will be entered by construction workers should be sloped or braced in accordance with current Cal/OSHA regulations.

Soil Expansion Potential

Laboratory test results on the near-surface soils indicate these materials possess a high expansion potential when tested in accordance with ASTM D4829 test method (see Figure A3). Based on the laboratory test results and our experience on nearby projects, we conclude the near surface clays are capable of exerting moderate to high expansion pressures on structural foundations and exterior flatwork. These soils are expected to experience volume changes with increasing or decreasing soil moisture contents. Therefore, it is our opinion that expansive soils must be considered in the design and construction of the planned improvements.

Material Suitability

The native soils are considered suitable for use as engineered fill, provided they do not contain significant vegetation or debris, are uncontaminated, and are at appropriate moisture contents to allow for proper compaction. Any undocumented fill found on-site would need to be tested prior to use as engineered fill, otherwise the fill would need to be removed from the site.

Pavement Subgrade Quality

Laboratory test results performed on a bulk sample of near-surface soil reveal the near-surface soils exhibit poor quality for support of asphalt concrete pavements. Laboratory tests indicate the soils possess a Resistance ("R") value of 8 when tested in accordance with California Test

301 (Figure A4). For preliminary design purposes, we have used an R-value of 5 for the calculation of alternate pavement sections.

Preliminary Soil Corrosion Potential

A sample of near-surface soil was submitted to Sunland Analytical Lab for testing to determine pH, chloride and sulfate concentrations, and minimum resistivity to help evaluate the potential for corrosive attack upon buried concrete. The results of the corrosivity testing are summarized in Table 2. A copy of the laboratory test reports are presented on Figure A5.

TABLE 2
SOIL CORROSIVITY TESTING

Analyte	Test Method	D2 (0 - 3')
pH	CA DOT 643 Modified*	7.51
Minimum Resistivity	CA DOT 643 Modified*	1340 ϑ-cm
Chloride	CA DOT 417	18.3 ppm
Sulfate	CA DOT 422	51.9 ppm
Sulfate-SO4	ASTM D516	53.78 mg/kg

* = Small cell method; ϑ-cm = Ohm-centimeters; ppm = Parts per million; mg/kg = milligram per kilogram

The California Department of Transportation Corrosion and Structural Concrete Field Investigation Branch, 2012 Corrosion Guidelines (Version 2.0), considers a site to be corrosive to foundation elements if one or more of the following conditions exists for the representative soil and/or water samples taken: has a chloride concentration greater than or equal to 500 ppm, sulfate concentration greater than or equal to 2000 ppm, or the pH is 5.5 or less. Based on this criterion, the on-site soils tested are not considered corrosive to steel reinforcement properly embedded within Portland cement concrete (PCC). However, the low resistivity value suggests the soils may be corrosive to unprotected buried metal.

Table 4.2.1 – *Exposure Categories and Classes*, American Concrete Institute (ACI) 318, Section 4.2, as referenced in Section 1904.1 of the 2013 CBC, indicates the severity of sulfate exposure for the sample tested is *Not Applicable*. Ordinary Type I-II Portland cement is considered suitable for use on this project, assuming a minimum concrete cover is maintained over the reinforcement.

Wallace-Kuhl & Associates are not corrosion engineers. Therefore, if it is desired to further define the soil corrosion potential at the site, a corrosion engineer should be consulted.

Groundwater and Seasonal Moisture

Our borings and information from nearby monitoring wells suggest that high groundwater has been measured at depths ranging from 3 to 26 feet below the ground surface. Groundwater levels will fluctuate due to seasonal variations, soil conditions, and local irrigation practices. Therefore, it is our opinion that groundwater may be encountered in utility line excavations that extend deeper than 10 feet below the existing ground surface. Sump pumps placed in trenches and additional crushed rock at the bottom of trench excavations could be required for construction of deeper utilities.

It should be noted that the near-surface soils will be in a near-saturated condition during and for a considerable period following the rainy season. Grading operations attempted following the onset of winter rains and prior to prolonged drying periods will be hampered by high soil moisture contents. Such soils, intended for use as engineered fill, will require considerable aeration to reach a moisture content that will permit the recommended compaction to be achieved.

PRELIMINARY RECOMMENDATIONS

Site Grading

Of special importance for earthwork operations for this site will be the adequate clearing of any undocumented fill. Excavations and depressions resulting from the removal of undocumented fill must be backfilled with engineered fill. A contingency plan should be provided to include a unit cost (per cubic yard) for over-excavation and recompaction as engineered fill.

Removal of surface organics would depend on the condition and quantity of the organics at the time grading is to begin. Discing of the organics may be suitable for construction, if the organic concentrations are not too heavy at the time of grading. Stripping of the organics likely would be required if organic concentrations are high, with strippings being completely removed from the site or used only in landscape areas.

Standard fill construction and compaction procedures, including uniform moisture conditioning of the on-site soils to an over optimum moisture content at the time of compaction, will be important for proper support of the planned structures and paved areas.

Foundation Design and Floor Slab Support

Our preliminary evaluation of the geotechnical aspects of the project reveals the soils on the site consist of highly expansive clays. Relatively shallow conventional continuous and isolated footings, 18 to 24 inches in depth, are anticipated to be suitable for the proposed structures. Minimum foundation widths of 12 inches for continuous foundations and 18-inches-wide for isolated spread foundations would be applicable. We anticipate bearing capacities on the order of 2000 to 3000 pounds per square foot (psf) for dead plus live loads will be applicable to native materials and engineered fill.

All foundations should be adequately reinforced to provide structural continuity, mitigate cracking and permit spanning of local soil irregularities. The structural engineer should determine final foundation reinforcing requirements.

Interior slab-on-grade concrete floors will be suitable for this site, provided slabs are properly designed and constructed with regard to moisture vapor penetration resistance and the slabs are adequately reinforced. Proper reinforcement of slabs-on-grade and moisture conditioning (i.e. pre-saturation) of upper 12 inches of subgrade soils prior to concrete placement will be particularly crucial.

Preliminary Pavement Sections

Laboratory test results indicate that near-surface soils exhibit poor support qualities for support of asphalt concrete pavements. Based on our experience, a Resistance value (R-value) of 5 is typical of subgrade soils consisting of a mixture of clay and silt. The following preliminary pavement sections summarized in Table 3 have been calculated based upon the procedures contained within Chapters 600 to 670 of the *California Highway Design Manual*, dated March 7, 2014, utilizing design Traffic Indices considered appropriate for the anticipated improvements.

TABLE 3
PRELIMINARY PAVEMENT DESIGN ALTERNATIVES, R-VALUE = 5

Traffic Index (TI)	Traffic Conditions	Type B Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)
4.5	Automobile Parking Areas Only	2½* 3*	9 8
5.0	Autos and Light Truck Traffic	2½* 3*	11 10
6.0	Autos and Light to Moderate Truck Traffic	2½ 3½*	15 13

* = Asphalt concrete thickness includes the Caltrans Safety Factor.

We emphasize that the performance of a pavement is critically dependent upon uniform compaction of the subgrade soils, as well as all engineered fill and utility trench backfill within the limits of the pavements. Materials used for pavement construction should conform to the appropriate sections of the most recent editions of the Caltrans Standard Specifications and any Sacramento City Standards, latest editions.

Efficient drainage of all surface water to avoid infiltration and saturation of the supporting aggregate base and subgrade soils is important to the performance of pavements. Where drop inlets or other surface drainage features are to be constructed, we recommend that weep holes should be considered at the base/subgrade level to allow free drainage of collected water.

Future Geotechnical Engineering Study

Prior to final design and the commencement of site grading, a design-level geotechnical investigation of the property should be conducted that includes additional borings or test pits with soil sampling, laboratory testing and additional engineering evaluation. The final report should present geotechnical engineering conclusions and specific recommendations regarding site preparation, foundation, floor support, site drainage and pavement design.

LIMITATIONS

The findings and conclusions contained in this report are intended as a general overview of geotechnical aspects of site development developed from our recent site reconnaissance, office analysis, and review of previous studies in the area. We have used prudent engineering judgment based upon the information provided and the data generated from the borings and laboratory testing.

This report has been prepared in conformance with generally accepted geotechnical engineering practices that exist in the area of the project at the time the report was prepared. No warranty, either express or implied, is provided.

We emphasize that this report is general in nature and intended for use in planning and budgeting for the project and is applicable only to the investigated site.

Wallace - Kuhl & Associates

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Joseph D. Waltz
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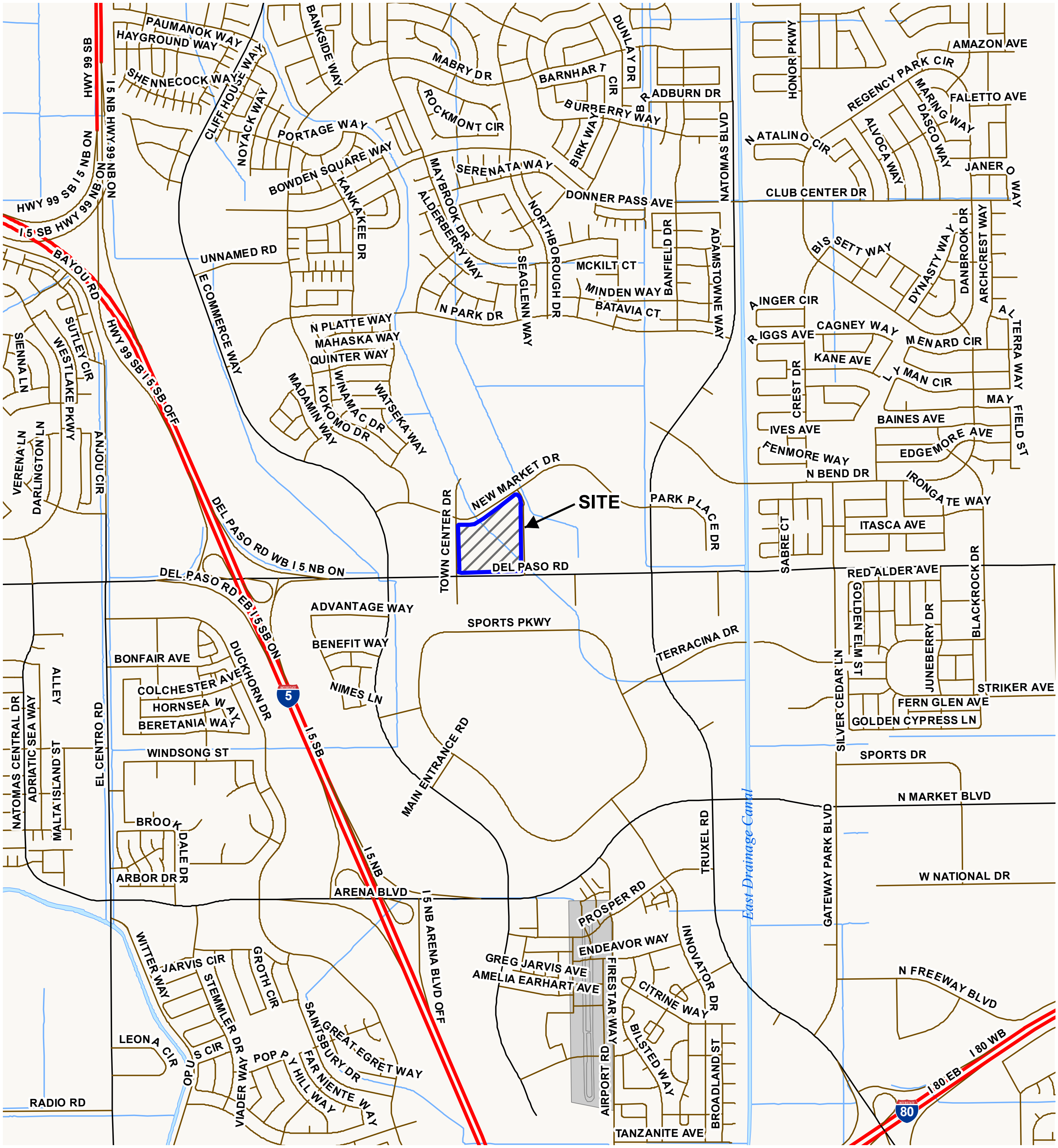
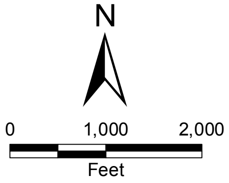


Street data courtesy of Sacramento County.
Hydrography courtesy of the U.S. Geological Survey
acquired from the GIS Data Depot, December, 2007.
Projection: NAD 83, California State Plane, Zone II



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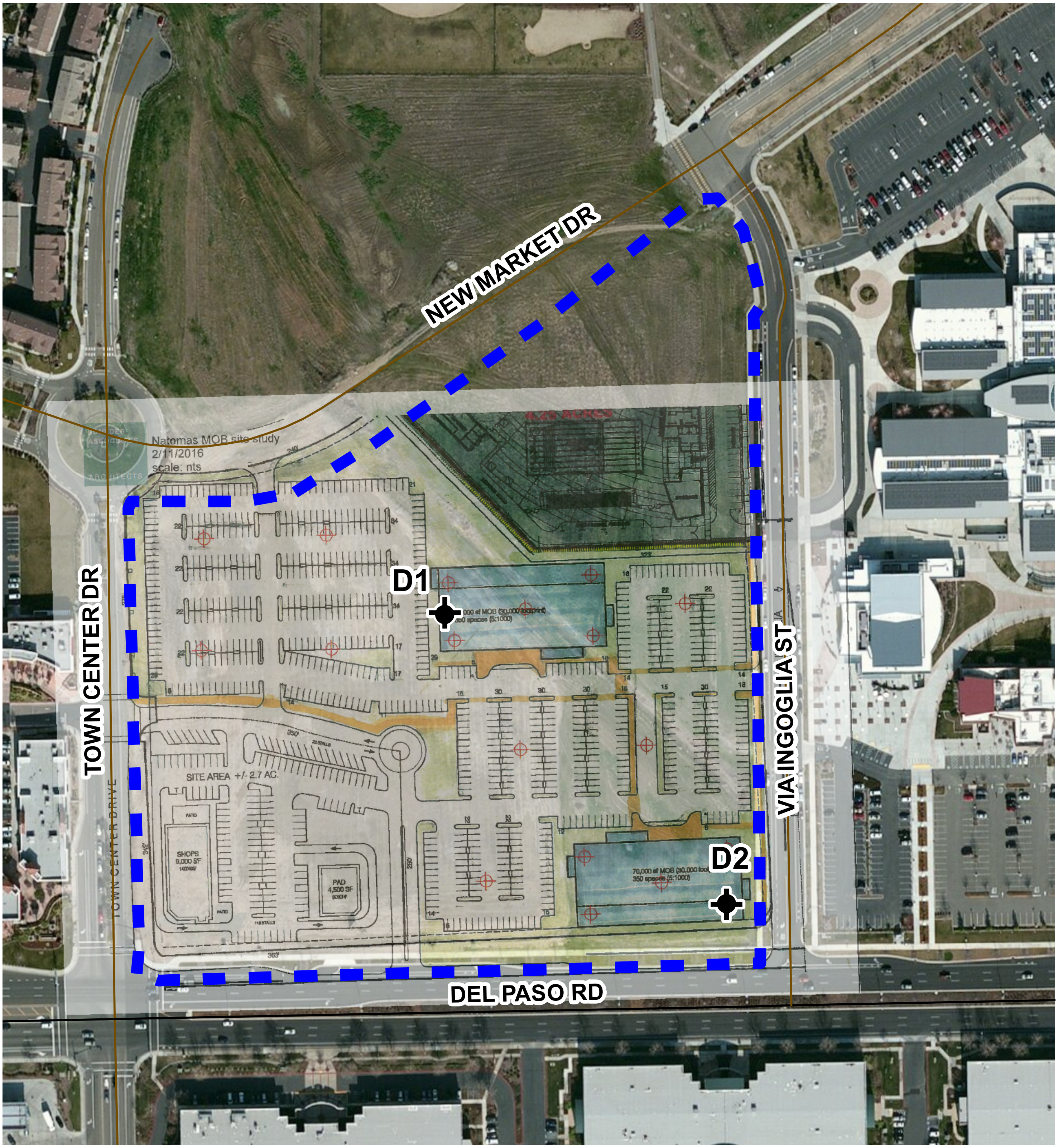
VICINITY MAP

NORTH NATOMAS TOWN CENTER II

Sacramento, California

FIGURE	1
DRAWN BY	RWO
CHECKED BY	JDW
PROJECT MGR	MMW
DATE	08/16

WKA NO. 11032.02



Aerial provided by ESRI.
Projection: NAD 83, California State Plane, Zone II

Legend

▭ Site Boundary

✦ Approximate Soil Boring Location

N

0 100 200
Feet

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SITE PLAN

NORTH NATOMAS TOWN CENTER II

Sacramento, California

FIGURE	2
DRAWN BY	RWO
CHECKED BY	JDW
PROJECT MGR	MMW
DATE	08/16

WKA NO. 11032.02

Project: North Natomas Town Center II
Project Location: Sacramento, CA
WKA Number: 11032.02

LOG OF SOIL BORING D1

Sheet 1 of 1

Date(s) Drilled	**7/12/16**	Logged By	**JDW**	Checked By	**MMW**
Drilling Method	**Solid Stem Auger**	Drilling Contractor	**V&W Drilling, Inc.**	Total Depth of Drill Hole	**31.5 feet**
Drill Rig Type	**CME-75**	Diameter(s) of Hole, inches	**6**	Approx. Surface Elevation, ft MSL	
Groundwater Depth [Elevation], feet	**21.0**	Sampling Method(s)	**California Modified**	Drill Hole Backfill	**Neat Cement**
Remarks	**Bulk (0 - 3'), R-value**			Driving Method and Drop	**140-lb hammer; 30-inch drop**

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA			TEST DATA		
				SAMPLE	SAMPLE NUMBER	NUMBER OF BLOWS	MOISTURE CONTENT, %	DRY UNIT WEIGHT, pcf	ADDITIONAL TESTS
	0		Red brown, moist, stiff, sandy, silty CLAY (CL)						
				■	D1-1I	14	17.8	100	UCC = 0.7 tsf
	5		Red brown, moist, medium dense, silty, clayey SAND (SC)	■	D1-2I	28	15.4	112	
	10		Light brown with orange and white mottling, slightly moist, very dense, sandy SILT (ML)	■	D1-3I	50/6	16.2	103	
	15			■	D1-4I	36			
	20		Light brown, wet, medium dense, silty, clayey SAND (SC) ▼	■	D1-5I	16			
	25		Light brown with gray and orange mottling, wet, hard, sandy, silty CLAY (CL)	■	D1-6I	43			
			Light brown, wet, dense, silty fine SAND (SM)						
	30		Light red brown, wet, hard, silty, sandy CLAY (CL)	■	D1-7I	38			

Boring terminated at 31.5 feet below existing site grade. Groundwater observed at 21 feet below existing site grade.

BORING LOG 11032.02 - NORTH NATOMAS TOWN CENTER II.GPJ WKA.GDT 7/27/16 3:35 PM

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FIGURE 3

Project: North Natomas Town Center II
Project Location: Sacramento, CA
WKA Number: 11032.02

LOG OF SOIL BORING D2

Sheet 1 of 1

Date(s) Drilled	7/12/16	Logged By	JDW	Checked By	MMW
Drilling Method	Solid Stem Auger	Drilling Contractor	V&W Drilling, Inc.	Total Depth of Drill Hole	30.0 feet
Drill Rig Type	CME-75	Diameter(s) of Hole, inches	6	Approx. Surface Elevation, ft MSL	
Groundwater Depth [Elevation], feet	26.0	Sampling Method(s)	Standard Penetration Test	Drill Hole Backfill	Neat Cement
Remarks	Bulk (3 - 5'), EI			Driving Method and Drop	140-lb hammer; 30-inch drop

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA			TEST DATA		
				SAMPLE	SAMPLE NUMBER	NUMBER OF BLOWS	MOISTURE CONTENT, %	DRY UNIT WEIGHT, pcf	ADDITIONAL TESTS
		▩	Light gray brown, slightly moist, stiff, sandy, silty CLAY with gravel (CL - Fill)	▧	D2-1I	9	13.3		
	5	▨	Red brown, moist, stiff, silty, sandy CLAY (CL)	▧	D2-2I	15			PI, GR
	10	▨	Brown to gray, silty clay	▧	D2-3I	15			
		▨	dark gray to black, organic scent						
	15	▨	brown with orange mottling, silty, sandy clay	▧	D2-4I	19	15.4		
	20	░	Brown, moist, medium dense, silty, clayey SAND (SC)	▧	D2-5I	29			
	25	▨	Light gray brown, moist, very stiff, sandy, silty CLAY (CL)	▧	D2-6I	17			
		▨	▼						
	30	▨	wet	▧	D2-7I	43			
			Boring terminated at 30 feet below existing site grade. Groundwater observed at 26 feet below existing site grade.						

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FIGURE 4

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYMBOL	CODE	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of soil > no. 200 sieve size)	GRAVELS (More than 50% of coarse fraction > no. 4 sieve size)	GW	▨	Well graded gravels or gravel - sand mixtures, little or no fines
		GP	▨	Poorly graded gravels or gravel - sand mixtures, little or no fines
		GM	▨	Silty gravels, gravel - sand - silt mixtures
		GC	▨	Clayey gravels, gravel - sand - clay mixtures
	SANDS (50% or more of coarse fraction < no. 4 sieve size)	SW	▨	Well graded sands or gravelly sands, little or no fines
		SP	▨	Poorly graded sands or gravelly sands, little or no fines
		SM	▨	Silty sands, sand - silt mixtures
		SC	▨	Clayey sands, sand - clay mixtures
FINE GRAINED SOILS (50% or more of soil < no. 200 sieve size)	SILTS & CLAYS LL < 50	ML	▨	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	▨	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	▨	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS LL ≥ 50	MH	▨	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	▨	Inorganic clays of high plasticity, fat clays
		OH	▨	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	▨	Peat and other highly organic soils
ROCK		RX	▨	Rocks, weathered to fresh
FILL		FILL	▨	Artificially placed fill material

OTHER SYMBOLS

▮ = Drive Sample: 2-1/2" O.D. Modified California sampler

▯ = Drive Sampler: no recovery

▯ = SPT Sampler

▽ = Initial Water Level

▼ = Final Water Level

— — — = Estimated or gradational material change line

——— = Observed material change line

Laboratory Tests

PI = Plasticity Index

EI = Expansion Index

UCC = Unconfined Compression Test

TR = Triaxial Compression Test

GR = Gradational Analysis (Sieve)

K = Permeability Test

GRAIN SIZE CLASSIFICATION

CLASSIFICATION	RANGE OF GRAIN SIZES	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL	3" to No. 4	76.2 to 4.76
coarse (c)	3" to 3/4"	76.2 to 19.1
fine (f)	3/4" to No. 4	19.1 to 4.76
SAND	No. 4 to No. 200	4.76 to 0.074
coarse (c)	No. 4 to No. 10	4.76 to 2.00
medium (m)	No. 10 to No. 40	2.00 to 0.420
fine (f)	No. 40 to No. 200	0.420 to 0.074
SILT & CLAY	Below No. 200	Below 0.074

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UNIFIED SOIL CLASSIFICATION SYSTEM

NORTH NATOMAS TOWN CENTER II

Sacramento, California

FIGURE	5
DRAWN BY	RWO
CHECKED BY	JDW
PROJECT MGR	MMW
DATE	08/16

WKA NO. 11032.02

APPENDIX A
General Information, Field and Laboratory Testing

APPENDIX A

A. GENERAL INFORMATION

The performance of a preliminary geotechnical engineering study for the proposed North Natomas Town Center II located northeasterly of Del Paso Road and Town Center Drive in Sacramento, California was authorized by Mr. Sam Miller of Lewis Management Corporation. Authorization was for a preliminary study as described in our proposal letter dated June 13, 2016, sent to our client, Lewis Management Corporation, whose mailing address is 9216 Kiefer Boulevard in Sacramento, California 95826; telephone (916) 313-0748.

In performing this study, we made reference to a *Natomas MOB Site Study* plan dated February 11, 2016 prepared by Boulder Associates Architects.

B. FIELD EXPLORATION

As part of our study, our field exploration included the drilling and sampling of two borings (D1 and D2) at the approximate locations shown in Figure 2.

The borings were drilled on July 12, 2016, utilizing a CME-75 truck-mounted, drill rig equipped with six-inch diameter, solid, helical-flight augers. Borings D1 and D2 were drilled to depths of approximately 31½ and 30 feet below existing site grades, respectively. At various intervals, soil samples were recovered with a 2½-inch outside diameter (O.D.), 2-inch inside diameter (I.D.), modified California sampler and a 2-inch O.D., 1-3/8-inch I.D. Standard Penetration Test (SPT) unlined sampler; both samplers were driven by an automatic 140-pound hammer freely falling 30 inches. The number of blows of the hammer required to drive the 18-inch long sampler each 6-inch interval was recorded. The sum of the blows required to drive the sampler the lower 12-inch interval, or portion thereof, is designated the penetration resistance or "blow count" for that particular drive.

The Modified California samples were retained in 2-inch diameter by 6-inch long thin-walled brass tubes contained within the sampler. Samples from the SPT were placed in plastic Ziplock™ bags. Immediately after recovery the soils in the samplers were visually classified by the field engineer and the ends of the tubes were sealed to preserve the natural moisture contents. All samples were taken to our laboratory for additional soil classification and selection of samples for testing.

The Boring Logs, Figures 3 and 4, contain descriptions of the soils encountered at each boring location. A Boring Legend explaining the Unified Soil Classification System and the symbols used on the logs is contained on Figure 5.

C. LABORATORY TESTING

Selected soil samples were tested to determine dry unit weight (ASTM D2937), natural moisture content (ASTM D4643), and unconfined compressive strength (ASTM D2166). The results of these tests are included on the boring logs at the depth each sample was obtained.

A sample of near-surface soil, considered to be representative of the on-site soils, was subjected to Plasticity Index testing (ASTM D4318). The test results are presented in Figure A1.

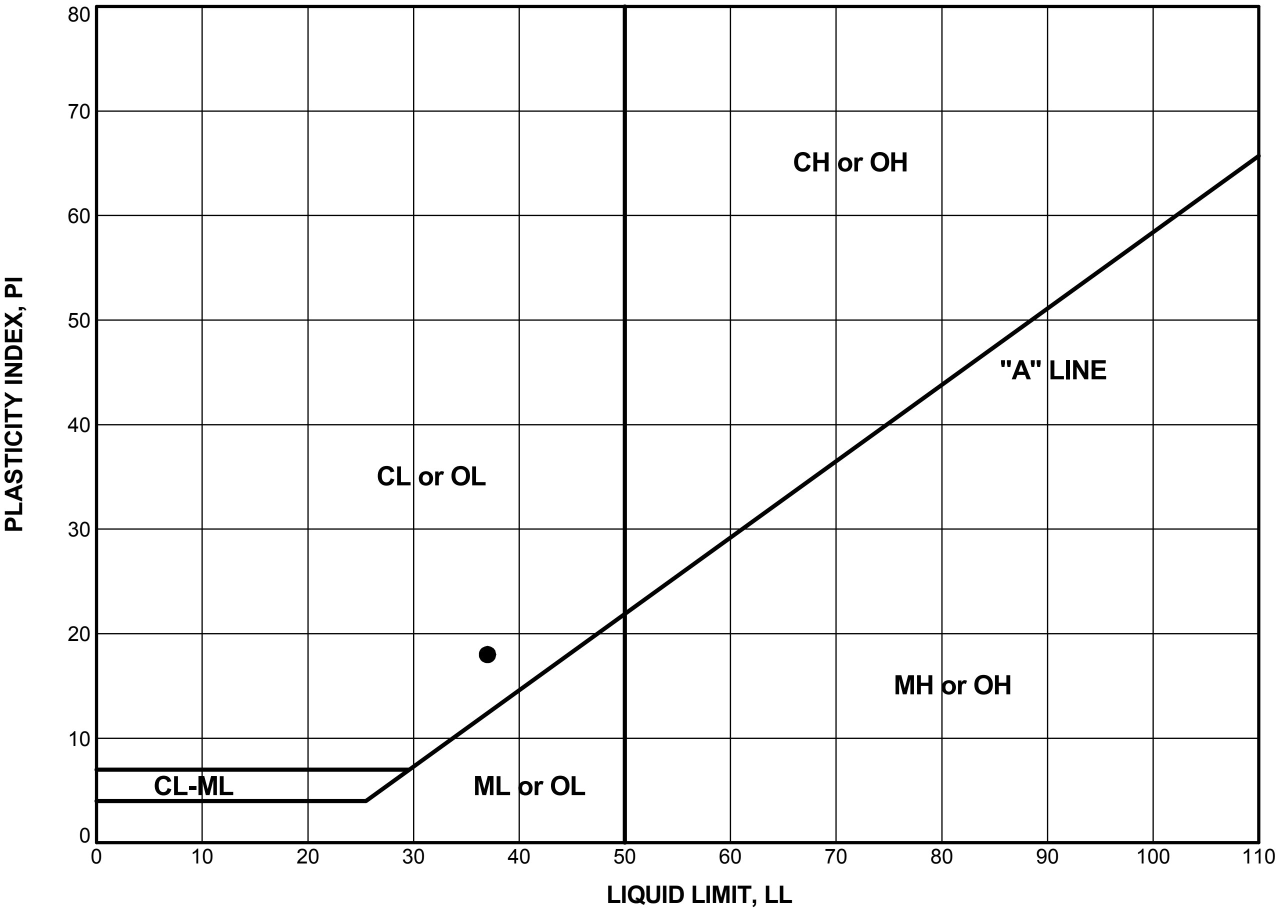
A representative sample of near-surface soil was tested for grain-size distribution (ASTM C136) and hydrometer analysis (ASTM D422). The results of the gradation tests are contained in Figure A2.

One bulk sample of near-surface soil was subjected to Expansion Index testing (ASTM D4829); the results of the test are presented in Figure A3.

Resistance ("R") value testing (California Test 301) was performed on a representative bulk sample of near-surface soil. Results of the R-value testing, which were used in the pavement design, are presented in Figure A4.

One sample of representative surface and near-surface soils was submitted to Sunland Analytical to determine the soil pH and minimum resistivity (California Test 643), Sulfate concentration (California Test 417 and ASTM D516) and Chloride concentration (California Test 422). The test results are presented in Figure A5.

/



Boring Number	Sample Number	USCS	Depth (feet)	Test Symbol	Water Content (%)	LL	PL	PI	Classification
D2	D2-2I	CL	4.5 - 5	●	-	37	19	18	Red brown, silty, sandy clay

ATTERBERG LIMITS (ASTM D4318)

Project: North Natomas Town Center II
WKA No. 11032.02

FIGURE A1

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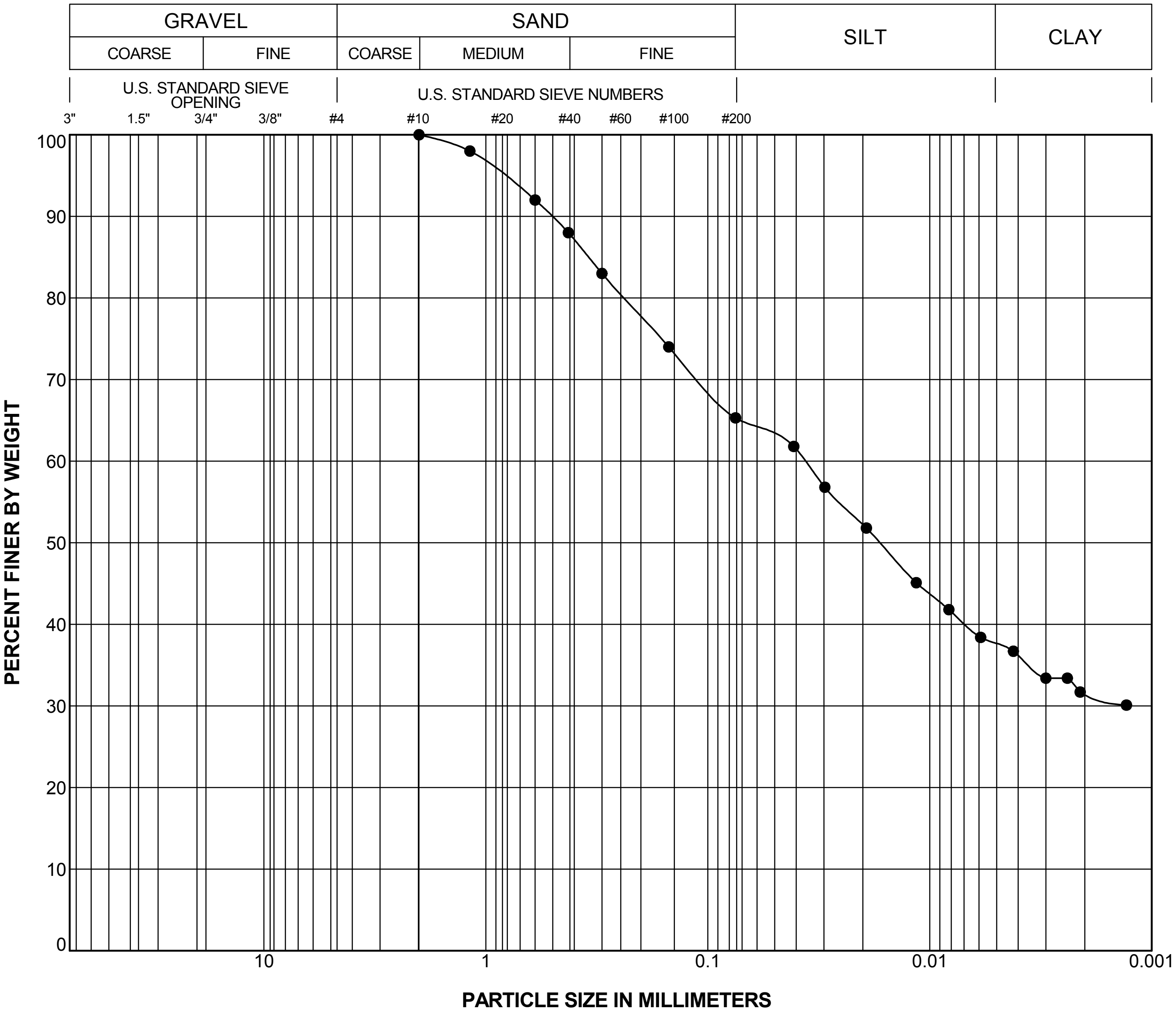

Boring Number	Sample Number	USCS	Depth (feet)	Symbol	LL	PI	Classification
D2	D2-2I	CL	4.5 - 5	●	37	18	Red brown, silty, sandy clay

PARTICLE SIZE DISTRIBUTION

Project: North Natomas Town Center II
WKA No. 11032.02

FIGURE A2

Wallace Kuhl & Associates

EXPANSION INDEX TEST RESULTS

ASTM D4829

MATERIAL DESCRIPTION: Brown, silty clay

LOCATION: D2 (3' - 5')

Sample Depth	Pre-Test Moisture (%)	Post-Test Moisture (%)	Dry Density (pcf)	Expansion Index
(3' - 5')	13.6	29.4	99.3	**103**

CLASSIFICATION OF EXPANSIVE SOIL *

EXPANSION INDEX	POTENTIAL EXPANSION
0 - 20	Very Low
21 - 50	Low
51 - 90	Medium
91 - 130	**High**
Above 130	Very High

* From ASTM D4829, Table 1

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EXPANSION INDEX

NORTH NATOMAS TOWN CENTER II

Sacramento, California

FIGURE	A3
DRAWN BY	RWO
CHECKED BY	JDW
PROJECT MGR	MMW
DATE	08/16

WKA NO. 11032.02

RESISTANCE VALUE TEST RESULTS

(California Test 301)

MATERIAL DESCRIPTION: Brown Silty Sand w/ Clay

LOCATION: D1 (0’ - 3’)

Specimen No.	Dry Unit Weight (pcf)	Moisture @ Compaction (%)	Exudation Pressure (psi)	Expansion		R Value
				(dial, inches x 1000)	(psf)	
1	119	15.4	480	20	87	29
2	115	16.6	331	3	13	10
3	111	17.6	275	2	9	8

R-Value at 300 psi exudation pressure = **8**

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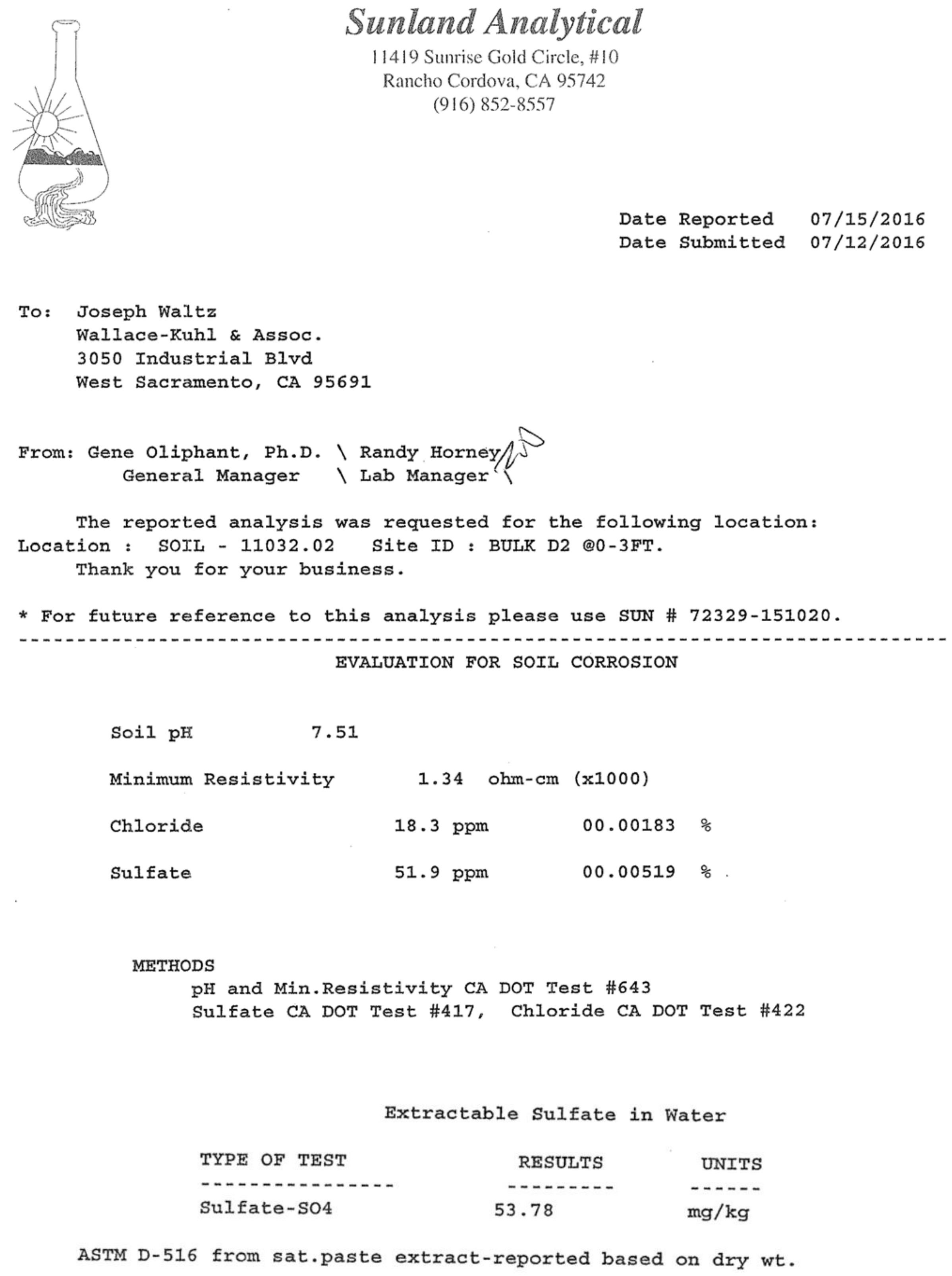
RESISTANCE VALUE TEST RESULTS

NORTH NATOMAS TOWN CENTER II

Sacramento, California

FIGURE	A4
DRAWN BY	RWO
CHECKED BY	JDW
PROJECT MGR	MMW
DATE	08/16
WKA NO.	11032.02



Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported	07/15/2016
Date Submitted	07/12/2016

To: Joseph Waltz
Wallace-Kuhl & Assoc.
3050 Industrial Blvd
West Sacramento, CA 95691

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager \

The reported analysis was requested for the following location:
Location : SOIL - 11032.02 Site ID : BULK D2 @0-3FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 72329-151020.

EVALUATION FOR SOIL CORROSION

Soil pH	7.51	
Minimum Resistivity	1.34 ohm-cm (x1000)	
Chloride	18.3 ppm	00.00183 %
Sulfate	51.9 ppm	00.00519 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Extractable Sulfate in Water

TYPE OF TEST	RESULTS	UNITS
Sulfate-SO4	53.78	mg/kg

ASTM D-516 from sat.paste extract-reported based on dry wt.

CORROSION TEST RESULTS

NORTH NATOMAS TOWN CENTER II

Sacramento, California

FIGURE	A5
DRAWN BY	RWO
CHECKED BY	JDW
PROJECT MGR	MMW
DATE	08/16
WKA NO.	11032.02

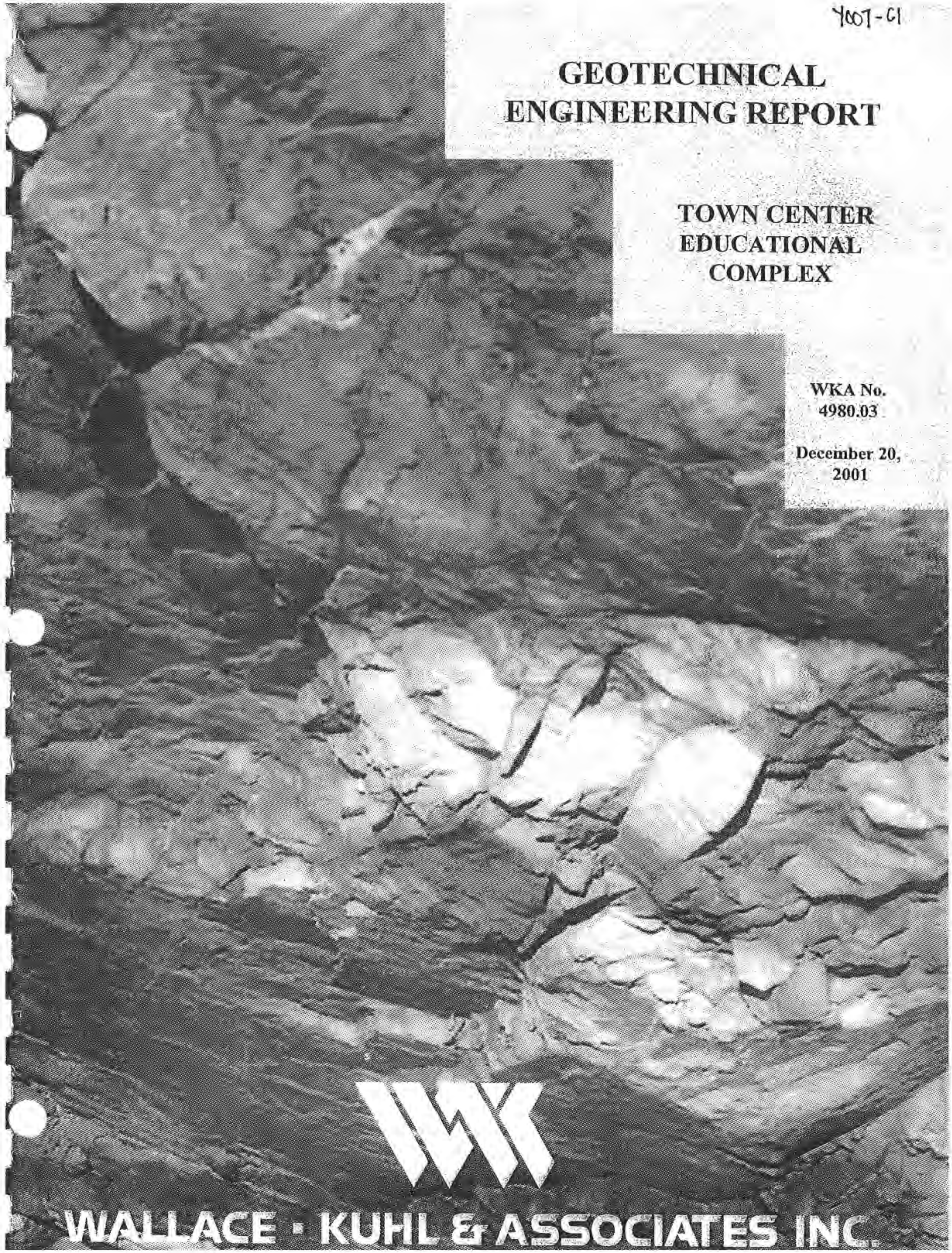
Y007-C1

GEOTECHNICAL ENGINEERING REPORT

TOWN CENTER EDUCATIONAL COMPLEX

WKA No.
4980.03

December 20,
2001



WALLACE · KUHL & ASSOCIATES INC.

Y007-C1

GEOTECHNICAL ENGINEERING REPORT

TOWN CENTER EDUCATIONAL COMPLEX

WKA No.
4980.03

December 20,
2001

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& ASSOCIATES INC.

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Engineering Geology

Environmental Consulting

Remediation Services

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Fax 916.435.9822

Geotechnical Engineering Report

TOWN CENTER EDUCATIONAL COMPLEX

Del Paso Road and Natomas Boulevard
Sacramento, California
WKA No. 4980.03
December 20, 2001

INTRODUCTION

We have completed a geotechnical engineering investigation for the proposed Town Center Educational Complex, to be located northwesterly of the intersection of Del Paso Road and Natomas Boulevard in Sacramento, California (see Plate No. 1). The purposes of our work have been to explore the existing site, soil and ground water conditions across the property, and to provide geotechnical engineering conclusions and recommendations for the design and construction of the planned educational facilities. This report represents the results of our work.

Scope of Work

Our scope of work has included the following:

1. site reconnaissance;
2. review of adjacent and nearby geotechnical reports prepared by our firm;
3. review of aerial photographs, geologic maps and available ground water contour maps;
4. subsurface investigation, including the drilling and sampling of 14 soil borings to a maximum depth of about 25 feet below existing site grades;
5. bulk sampling of anticipated pavement subgrade soils;
6. bulk sampling of near-surface soils within landscape areas;
7. laboratory testing of selected soil samples;
8. engineering analyses; and,
9. preparation of this report.

Previous reports prepared by our firm that were reviewed to assist in the preparation of this report are as follows.

- *Geotechnical Engineering Report* (WKA No. 3425.03, dated April 4, 1997), prepared for the Northborough Subdivisions, located north of the subject site.
- *Geotechnical Engineering Report* (WKA No. 4122.03, dated November 19, 1999), prepared for the Creekside Development, located west of the subject site.
- *Geotechnical Engineering Report* (WKA No. 4455.02, dated May 10, 2000), prepared for the Park Place Shopping Center, located to the east at the intersection of Del Paso Road and Natomas Boulevard.
- *Geotechnical Engineering Report* (WKA No. 3918.01, dated September 30, 1998), prepared for the Arena Corporate Center – Sites I to IV, located south of the project site.
- *Geotechnical Engineering Report* (WKA No. 3425.02, dated June 23, 2001), prepared for the North Natomas Detention Basin No. 1, located to the north of the site.

Our office is presently preparing the Environmental Site Assessment (WKA No. 4980.01) for the subject site, and the Geologic Hazards Report (WKA No. 4980.02). These reports have been or will be provided under separate cover.

Plates and Attachments

This report contains a Site Vicinity Map as Plate No. 1; a Boring Location Plan as Plate No. 2; and, Logs of Borings as Plates No. 3 through 16. An explanation of the symbols and classification system used on the borings is contained on Plate No. 17. Appendix A contains information of a general nature regarding project concepts, exploratory methods used during the field exploration phase of our investigation, an explanation of laboratory testing accomplished, and further laboratory test results that are not presented on the boring logs. Appendix B contains *Guide Earthwork Specifications,* which may be used in the preparation of project plans and specifications. Appendix C contains copies of the landscape fertility testing performed on surface soils within the upper two feet in probable landscape areas.

Proposed Development

The Town Center Educational Complex is proposed at the southwest corner of Del Paso Road and Natomas Boulevard in Sacramento, California. The irregular-shaped site covers a total area of about 49 acres. The complex is to consist of a new Natomas Unified School District (USD) high school; a Los Rios Community College District (CCD) satellite campus; a City of Sacramento library; and, a future parking structure.

Natomas USD High School

The proposed high school will be a large, irregular-shaped two-story structure that encompasses a total floor area of approximately 215,000 square feet. Discussions with the structural engineer (Buehler and Buehler Associates) indicates the structure likely will be steel-frame with and interior concrete slab-on-grade lower floor. Structural loads are unknown, but expected to be moderate and typical for the type of construction. Associated development for the high school campus will include an at-grade amphitheater; hard courts for tennis and basketball; grass athletic fields for baseball, softball and soccer; a football stadium and track; and, parking for students and staff.

Los Rios CCD Satellite Campus

The satellite campus will be south of the high school and will consist of three separate single-story buildings covering 12,000, 16,000 and 18,000 square feet. The structures likely will be steel frame, although possibly wood-frame, with interior concrete slab-on-grade floors. Structural loads are unknown but anticipated to be light to moderate. Associated development will include parking and access drives for students and staff.

City Library

The library is to be located southwest of the high school and will service the community as well as the adjacent high school and satellite campus. We understand the building will be a tall, single-story building covering about 73,000 square feet. The structure likely will be steel-frame or concrete tilt-up construction with a concrete slab-on-grade floor. Loads are anticipated to be light to moderate.

In addition to the three phases described above, a future parking structure is proposed at the southwest corner of the property. At this time the design is very preliminary, however, a three-story reinforced concrete structure is being considered. Until developed, the area for the parking garage will be an at-grade parking lot.

In addition to the structures discussed above, a ground loop geothermal system is being considered for providing heating and cooling for the educational complex. Exploration for this type of system involves 200 to 300 foot deep borings and thermal conductivity measurements of the soil. This phase of work will be provided by another consultant and is beyond the scope of our services.

Grading plans for the project have not yet been developed; however, based on the existing site topography, we have assumed maximum excavations and fills on the order of three to four feet with the exception of fills within the existing irrigation canals, which could be seven to eight feet in depth.

FINDINGS

Site Description

The irregular-shaped property encompasses a total area of approximately 49 acres, located northwesterly of the intersection of Del Paso Road and Natomas Boulevard in Sacramento, California. The property is bounded to the north by undeveloped land (future New Market Drive); to the east by Natomas Boulevard; to the south by Del Paso Road; and, to the west by a portion of the Creekside Development. The future alignment of Library Street will form the western site boundary. Average surface elevation across the site is approximately +15 feet relative to mean sea level (msl), based on topographic information on the CAD drawing provided by Psomas and Associates.

At the time of our investigation, October 24 and 25, 2001, the major portion of the site was undeveloped, fallow land covered with a sparse growth of volunteer weeds and grasses. The site appeared to have been recently disced for weed abatement resulting in relatively loose surface soil conditions. Dried vegetation, consisting mainly of volunteer oats, star-thistle and weeds up to about three feet high occurred randomly near the property boundary and along the irrigation ditches, in areas inaccessible to discing operations. Scattered debris consisting of wood, paper, etc., was observed on the site. Three water irrigation ditches cross the site trend in a general north to south direction. At the time of our investigation, no water was present in the canal ditches. The area west of the eastern ditch is generally flat trending gently downward in a southwest direction. East of the eastern irrigation ditch the ground is approximately four to five feet lower in elevation relative to the western side. The eastern portion is also relatively flat with a gentle slope downward to the south. The irrigation canals typically have berms built on either side that are several feet higher than the original ground surface.

No buildings or building remnants were present at the time of our field exploration. However, review of aerial photographs dating back to 1951 indicate structures were present near the south-center of the site, just east of the center irrigation ditch. These buildings appear to be a homestead, barns, sheds, and possibly a trailer associated with the agricultural use of the property. The photos suggest the buildings were removed from the property sometime after 1980 (latest photo available).

Site Geology

The proposed school site is located within the Great Valley geomorphic province of California. The geology in the Great Valley is characterized by thick sequences of alluvial and flood plain deposits consisting of sedimentary material derived from the Coast Ranges to the west and the Sierra Nevada mountain range to the east. According to the DMG (Wagner, 1981; Helley, 1985), the site is predominantly underlain by undivided Quaternary-aged basin deposits of fine-grained silt and clay laid down by the Sacramento River during flood stage.

A geologic hazards report has been prepared for this site (WKA No. 4980.02, dated December 20, 2001). A detailed description and discussion of the geologic and seismic setting of this site is contained in that report.

Subsurface Soil Conditions

The test borings encountered stiff silty clays over a majority of the site, to depths of approximately one to four feet. The upper foot of the clays were disturbed and loose due to recent discing activities. The underlying soils are dense, silty fine sands to slightly clayey, fine sandy silts. Relatively clean, poorly graded sands were observed in numerous borings below an average depth of about 10 feet. Blow counts recorded during sampling operations indicate the sands are relatively dense.

Engineered fills at the southwest corner consist of a stiff mixture of silty sands and silty clays. Our firm observed the fill placement and provided compaction testing during the work. The depth of the fill varies from approximately 3½ feet to 8 feet across the parking lot area. The fill is generally deeper nearer to the westernmost irrigation canal. Underlying the fill are the native soils, consisting of a layer of dark brown silty clay a maximum of five feet in thickness. Fine sandy silts to silty fine sands underlie the clays to the bottom of the borings.

The boring logs should be consulted (Plates No. 3 through 16) for more detailed subsurface soil conditions.

Ground Water Conditions

Ground water was encountered only in Borings D1 and D6 at depths of approximately 15 to 17 feet below the existing ground surface. During our previous geotechnical investigations of the Northborough and Northpointe developments and surrounding properties, ground water has been encountered within three feet of original ground surface; however, it has been our experience that ground water levels in the area have dropped due to the decline of irrigation flooding of nearby rice fields. It should be noted that the test borings may not have been left open long enough to advise full equilibrium. All borings were grout backfilled on completion to confirm with Sacramento County requirements.

The subject property is located within the Sacramento River Hydraulic Basin, as defined by the California Department of Water Resources (DWR). Ground water elevations in the vicinity of the property are estimated using depth-to-ground water measurements taken at one DWR-monitored well (#9N/4E-11E01), located approximately 1800 feet south of the subject property (ground elevation of about +10 feet msl). Ground water elevations measured in the well have fluctuated from a minimum of –1.4 feet msl during the spring of 1976 to a maximum of +6.7 feet msl during the spring of 1978.

A second DWR-monitored well (#9N/4E-1001) located about 2600 feet to the west (at Del Paso Road and I-5) revealed a minimum reading of +0.5 feet msl in the fall of 2000 and a maximum of +14 feet msl in the spring of 1978.

CONCLUSIONS

Seismic Code Parameters

Review of the *Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada*, dated February 1998, prepared by the State of California Department of Conservation - Division of Mines and Geology to be used with the 1997 Uniform Building Code (UPC) indicates that there are no Type "A" or "B" faults located within 15 kilometers of the site.

The following parameters may be used for seismic design of structures with the education complex using the 1998 CBC:

	1998 UBC Table/Figure	Factor/Coefficient	Value
Seismic Zone	Figure 16A-2	Zone	3
Seismic Zone Factor	Table 16A-I	Z	0.30
Soil Profile Type	Table 16A-J	S_D	- -
Seismic Coefficient	Table 16A-Q	C_a	0.36
Seismic Coefficient	Table 16A-R	C_v	0.54
Near Source Factor	Table 16A-S	N_a	1.0
Near Source Factor	Table 16A-T	N_v	1.0
Seismic Source Type	Table 16A –U	B	- -

Bearing Capacity

The upper 12 inches of surface soils across the site, excluding areas where fill had been placed, are in a relatively loose condition due to discing and will require thorough recompaction to be suitable for support of the proposed structures and pavements. Specific recommendations to moisture condition and recompact the surface soils are provided in the Site Preparation section of this report. The existing berms along the ditches are not considered suitable for support of buildings or pavements, and should be removed to expose firm native ground and recompacted as engineered fill. Our work also indicates that native undisturbed soils and engineered fill composed of native soils or approved imported soils, which are placed and compacted in accordance with the recommendations of this report, will be capable of supporting the proposed structures and pavements.

The existing fill that has been place at the southwest corner of the site (future parking structure) has been observed by a representative from our office and is considered to be engineered fill that is capable of supporting the proposed structures and pavements.

Soil Expansion Potential

Laboratory test results on near-surface clays indicate these materials possess a moderate to high expansion potential when tested in accordance with ASTM D4829 (UBC 29-2) test method (see Plates No. A1 and A2). Based on the laboratory test results and our extensive local experience, we conclude the native clays are capable of exerting significant expansion pressures on building foundations, interior floor slabs and exterior flatwork. Recommendations to mitigate the effects of potentially expansive clays, such as pads constructed with granular import, on-site granular soils, or lime-treatment of the pads, are provided in later sections of this report.

Excavation Conditions

The native soils at the site should be readily excavatable with conventional construction equipment. Foundation excavations and shallow trenches for utilities less than five feet in depth should stand vertically for the short period of time for construction. Excavations or trenches that exceed five feet in depth and entered by workers must be sloped, braced, or shored to conform to current Cal/OSHA requirements.

Pavement Subgrade Qualities

Previous experience in the North Natomas area indicates the pavement subgrade soils are poor quality materials for support of asphalt concrete pavements, and will require relatively thick pavement sections to compensate for the low quality of the soils. Laboratory tests indicate that the near-surface clays possess a Resistance ("R") value of 5 when tested in accordance with

California Test 301 (see Plates No. A5 through A6). The underlying sandy soils are fair quality materials (R-value of 15). If these materials are present at subgrade level, reduced pavement sections would be appropriate, subject to verification by our representative.

Our experience indicates the native clay soils will react favorably with the addition of quicklime (either dolomitic or high-calcium). The lime-treatment of native clays can be an effective and economical method to increase the capability of the clay soil to support pavements; to reduce the moisture content of near-saturated soils, enabling construction to proceed during or shortly after the rainy season; and, to reduce the expansive characteristics of the clays for interior slab-on-grade and exterior flatwork construction.

The performance of chemically stabilized soils is very dependent on uniform mixing of the quicklime into the subgrade soils, and providing a proper curing period following compaction. An experienced soil stabilization contractor combined with a comprehensive quality control program are essential to achieve the best results with lime stabilized subgrades.

Soils Corrosion Potential

Three samples of near-surface clayey soils were submitted for analysis of resistivity, pH, chloride and sulfate concentrations. Copies of the analytical results are presented on Plates No. A7 through A9 in Appendix A. The results of the corrosivity testing are summarized as follows:

SOIL CORROSIVITY TESTING

Analyte	Test Method	Bulk Sample R3	Bulk Sample R2	Bulk Sample R13
pH	CA DOT 643 Modified*	7.41	7.40	7.18
Minimum Resistivity	CA DOT 643 Modified*	1340 Ω-cm	1050 Ω-cm	880 Ω-cm
Chloride	CA DOT 417	7.6 ppm	15.1 ppm	9.8 ppm
Sulfate	CA DOT 422	2.9 ppm	3.5 ppm	8.8 ppm

* = Small cell method
Ω-cm = Ohm-centimeters
ppm = Parts per million

The corrosivity test results suggest that the site soils will be corrosive to exposed metal and moderately corrosive to reinforced concrete. However, ordinary Type II Portland cement is considered suitable for use on this project, assuming a minimum cover is maintained over the reinforcement. To further define the soil corrosion potential at this site or to design a cathodic protection system, a corrosion engineer could be consulted.

Landscape Fertility Testing

Five soil samples collected from within the upper two feet in proposed landscape areas were submitted for analysis of landscape fertility testing. The results of this testing, as well as recommendations for amending the soil with organic matter and fertilizers, are provided in Appendix C.

Ground Water

Based upon the ground water depths encountered during our field exploration, we conclude that a permanent ground water level should not be a significant factor in the design or construction of proposed structures and shallow utilities. However, it has been our experience that ground water in this area is somewhat variable due to seasonal changes, subsurface soil conditions, and local irrigation flooding practices. Therefore, it is conceivable that ground water could be encountered during construction of deep utilities or excavations exceeding a depth of 8 to 10 feet. Dewatering, if required, should be designed to lower the ground water at least two feet below the bottom of the excavation. The dewatering system should be designed and constructed by a dewatering contractor with local experience in the immediate vicinity of the site.

Seasonal Water

The near-surface soils will be in a near-saturated condition during and for a considerable period following the rainy season. Grading operations attempted following the onset of winter rains and prior to prolonged periods of drying will be hampered by high soil moisture contents. Such soils, intended for use as engineered fill, will require considerable aeration or an extended period of drying to reach a moisture content to allow the specified degree of compaction to be achieved. This should be considered in the construction schedule.

RECOMMENDATIONS

General

The proposed education complex site is variable in elevation; therefore, we have assumed maximum excavations and fills on the order of three to four feet for development of the property with the exception of the irrigation ditches. The recommendations in this report are based upon this assumption. In addition, the recommendations presented below are appropriate for typical construction in the late spring through fall months. The on-site soils likely will be saturated by rainfall in the winter and early spring months, and will not be compactable without drying by aeration or the addition of lime (or a similar product) to dry the soils. Should the construction schedule require work to continue during the wet months, additional recommendations can be provided, as conditions warrant.

Site Preparation

Initially, the site should be cleared of surface rubble and debris; this material should be removed from the site. Following clearing operations, the site should be stripped of remaining surface vegetation and organically contaminated topsoil. Strippings may be stockpiled for later use or disposed of off-site. *Strippings should not be used in general fill construction, but may be used in landscaped areas (e.g. playfields), provided they are kept at least five feet from any structures, moisture conditioned and compacted.* Discing of the organics into the surface soils may be a suitable alternate to stripping, depending on the condition and quantity of the organics at the time of grading. ***The decision to utilize discing in lieu of stripping should be made by our representative at the time of earthwork construction.*** Discing operations, if approved, should be observed by our representative and be continuous until the organics are adequately mixed into the surface soils to provide a compactable mixture of soil containing minor amounts of organic matter. Pockets or concentrations of organics will not be allowed.

Irrigation canals should be cleared of all organics and saturated soils, scarified and recompacted as described below prior to any fill placement. The irrigation berms should be removed to expose the original ground surface, which should then be scarified and recompacted as described below. The berm materials are suitable for use as engineered fill provided they are free of organics, rubble, deleterious debris and are near the optimum moisture content.

Following site clearing and stripping (or discing) operations, areas designated to receive fill and at-grade areas should be scarified to a depth of at least 12 inches, moisture conditioned to at least two percent above the optimum moisture content and compacted to not less than 90 percent of the maximum dry density as determined by ASTM D1557. **Due to the loose nature of the surface soils, we will insist upon full compliance with this recommendation.**

Compaction of the existing ground surface should be performed using a heavy, self-propelled, sheepsfoot compactor (Caterpillar 815 or equivalent) and must be performed in the presence of our representative who will evaluate the performance of the subgrade under compactive load and identify any loose or unstable soil conditions that could require additional excavation. All excavations should be restored to grade with engineered fill compacted in accordance with the recommendations of this report.

If construction begins during the summer or fall, there is a potential that the surface clay soils may be desiccated deeper than the recommended depth of scarification. Should this condition exist, the site should be continuously watered for a sufficient period of time to close the desiccation cracks to within 12 inches of the surface. Prewatering of the site should not be necessary if grading operations begin in the early spring months prior to the soils having a chance to dry significantly.

On-site soils are considered suitable for use in engineered fill construction, if free of significant concentrations of organic materials, rubble or debris. Imported fill materials ideally should be granular materials with a Plasticity Index not exceeding 15 and a three-inch maximum particle size. Imported soils should be approved by our office prior to being transported to the site.

Engineered fill should be placed in lifts that do not exceed six inches in compacted thickness. Native clayey materials should be thoroughly moisture conditioned to at least two percent above the optimum moisture content and uniformly compacted to at least 90 percent of maximum dry density, as defined above. On-site granular soils and approved imported fill materials should be thoroughly moisture conditioned to at least the optimum moisture content and uniformly compacted to at least 90 percent relative compaction. The exception to this would be ditch backfill within the high school building footprint, which should be compacted to at least 95 percent of the maximum dry density, at the optimum moisture content or above. The increased compaction should extend at least 10 feet beyond the building perimeter. This recommendation is intended to reduce differential.

It is possible the ditch backfill could result in a fill differential in excess of five feet for support of the building. If so, overexcavation of at least a portion of the building pad could be required. Therefore, it is crucial that our office review the grading plans, when available, to evaluate this potential and to provide modified or additional recommendations, as needed.

The upper 12 inches of final building pad subgrades, including exterior flatwork areas, should consist of granular on-site or import soils compacted to at least 90 percent of the maximum dry density to minimize the problems associated with constructing on expansive clay soils. Alternatively, the upper 12 inches may consist of lime-treated native clays compacted to at least 92 percent relative compaction at a moisture content of at least the optimum moisture content.

The upper six inches of pavement subgrade should be uniformly compacted to at least 90 percent of the maximum dry density at a moisture content of at least the optimum moisture, and must be stable under construction traffic prior to placement of aggregate base.

Permanent excavation and fill slopes should be constructed no steeper than two horizontal to one vertical (2:1). Revegetation of the slopes as soon as possible following grading will help reduce erosion.

Site preparation should be accomplished in accordance with the recommendations of this section and the *Guide Earthwork Specifications* contained in Appendix B. A representative from our office should be present during site preparation and all grading operations to observe and test the fill to verify compliance with our recommendations and the job specifications.

Utility Trench Backfill

We recommend only native soils (in lieu of select sand backfill) be used as backfill for utility trenches located within building footprints and extend at least five feet beyond to perimeter foundations to minimize water transmission beneath the structures. Clayey trench backfill should be thoroughly moisture conditioned to at least two percent above the optimum moisture content and mechanically compacted to at least 90 percent of the ASTM D1557 maximum dry density.

Backfill for the upper 12 inches of trenches must match the adjacent materials. That is, if the upper 12 inches of the building pad consists of granular fill materials, the top 12 inches of trench backfill should consist of the same materials or Class 2 aggregate base. If the top 12 inches of the building pad or pavement areas consisting of lime-treated soils, the upper foot of trench backfill should consist of recompacted lime-treated soils or Class 2 aggregate base.

Building Foundation Design Alternatives

The proposed library and school buildings may be supported upon continuous and isolated spread foundations embedded at least 18 inches into the compacted building pads. All continuous foundations should maintain a minimum width of 12 inches; spread foundations should be at least 24 inches in plan dimension. Foundations so established may be sized for a maximum allowable soil bearing pressures of 2000 pounds per square foot (psf) for dead load, 3000 psf for dead plus live load, and 4000 psf for total load, including wind or seismic forces. The weight of the foundation concrete extending below lowest adjacent soil grade may be disregarded in sizing computations.

Continuous foundations should be reinforced with a minimum of two No. 4 reinforcing bars, placed one each at top and bottom to allow the foundations the ability to span isolated soil irregularities. The structural engineer should evaluate the need for additional reinforcement.

Lateral resistance of foundations may be computed using an allowable friction factor of 0.30 that may be multiplied by the vertical load on the foundation. Additional lateral resistance may be assumed to develop against the vertical face of the foundations and may be computed using a "passive" equivalent fluid pressure of 300 psf per foot of depth. These two modes of resistance should not be added unless the frictional component is reduced by 50 percent, since full mobilization of the passive resistance requires some horizontal movement, which significantly diminishes the frictional resistance.

To resist uplift, the design of conventional foundation may utilize the unit weight of concrete (150 pounds per cubic foot (pcf)), and an allowable total skin friction value of 300 psf applied to the sides of the foundation.

Parking Structures

The future parking structure has not been designed at this time; therefore, the following design parameters are preliminary in nature and only intended for planning purposes. A more detailed analysis, possibly including additional borings and laboratory testing, should be performed in the future, after the design concepts for the parking structure are better defined.

The parking structure could be supported upon continuous and isolated spread foundations extending roughly 18 to 24 inches below grade. Foundations should be properly reinforced. Bearing capacities on the order of 3000 psf likely may be suitable for sizing foundations. Deepening of foundations may be possible methods to increase the allowable bearing capacity to reduce foundation sizes. Improved bearing capacity and reduced potential for differential settlement also could be achieved by over-excavation and recompaction of near-surface soils.

The parking structure also could be supported on short drilled pier or deepened spread foundation system extending to bear in stiff silty clays or cemented sandy soils. Bearing pressures in the range of about 5000 psf (dead plus live load) could be suitable for piers or deepened foundations, depending upon the results of further investigations.

Another alternate would be to support the parking structure on deep drilled piers or driven piling. Drilled piers could encounter ground water and would be more difficult to construct, but could be designed as friction piers. The use of end bearing piers extended below the ground water would not be advisable because determining the suitability of the pier bottom would be very difficult. Cast-in-place piers could be constructed with tremie methods without having to dewater the pier holes.

Driven piling for large structures could consist of 12-inch square precast, prestressed concrete piles. We anticipate the piles would need to extend to depths greater than 25 feet below existing grades, and could develop dead plus live load capacities on the order of 45 to 70 tons.

Interior Floor Slab Support

Concrete slabs-on grade can be suitably supported upon the soil subgrades prepared in accordance with the recommendations in this report and maintained in that condition (optimum moisture). Interior concrete slab-on-grade floors should be at least four inches thick and, as a minimum, should contain 6 x 6/W2.9 x W2.9 flat sheets of welded wire reinforcement, located at mid-slab depth, or chaired No. 3 rebar placed on maximum 18-inch centers throughout the slab. This slab reinforcement is suggested as a guide "minimum" only; final reinforcement and joint spacing should be determined by the structural engineer based on anticipated slab loading.

Floor slabs may be underlain by a layer of free-draining gravel serving as a deterrent to migration of capillary moisture. The gravel layer should be at least four inches thick and should be graded such that 100 percent passes a one-inch sieve and none passes a No. 4 sieve. Additional moisture protection may be provided by placing a plastic sheet membrane directly over the gravel. An optional, thin layer of damp, clean sand above the membrane is acceptable, as an aid to curing of the slab concrete. *Temporary loads exerted during construction from vehicle traffic, cranes, forklifts, and storage of palletized construction materials should be considered in the design of the slab-on-grade floors.*

If heavier floor loads are anticipated with construction, the crushed rock thickness beneath interior slab-on-grade floors could be increased or replaced with Class 2 aggregate base compacted to at least 95 percent of the maximum dry density.

The recommendations presented above should mitigate any significant soils-related cracking of the slab-on-grade floors. Also important to the performance and appearance of a Portland cement concrete slab is the quality of the concrete, the workmanship of the concrete contractor, the curing techniques utilized and the spacing of control joints.

Floor Slab Moisture Penetration Resistance

It is considered likely that floor slab subgrade soils will become wet to near-saturated at some time during the life of the structures. This is a certainty when slabs are constructed during the wet seasons, or when constantly wet ground or poor drainage conditions exist adjacent to structures. For this reason, it should be assumed that all slabs intended for moisture-sensitive floor coverings or materials, require protection against moisture or moisture vapor penetration. Standard practice includes the gravel, plastic membrane and sand as suggested above. However, the gravel and plastic membrane offer only a limited, first line of defense against soil-related moisture. Recommendations contained in this report concerning foundation and floor slab design are presented as *minimum* requirements, only from the geotechnical engineering standpoint.

It is emphasized that we are not slab moisture proofing or moisture protection experts. We are expressly stating that we make no guarantee nor provide any assurance that use of the sub-slab gravel and sheet plastic will reduce slab moisture penetration to any specific amount or level, particularly those required by floor covering manufacturers. The builder and designers should consider all available measures for slab moisture protection. It is commonly accepted that the quality and thickness of the concrete slab are of primary importance to reducing moisture and moisture vapor penetration.

Exterior Flatwork

Areas to receive exterior concrete flatwork (i.e., sidewalks, patios, etc.) should be underlain by at least 12 inches granular, non-expansive soils or native soils that are lime-treated and recompacted prior to the placement of the concrete. *Proper moisture conditioning of the subgrade soils is considered essential to the performance of exterior flatwork.* Expansion joints should be provided to allow for minor vertical movement of the flatwork. Exterior flatwork should be constructed independent of perimeter building foundations and isolated column foundations by the placement of a layer of felt material between the flatwork and the foundation.

Consideration should be given to thickening the edges of sidewalks to at least twice the slab thickness. Irrigated landscaping adjacent to concrete flatwork will help maintain a more uniform moisture in the soils and reduce the amount of differential movement.

Retaining Wall Design

Retaining walls that will be allowed to slightly rotate about their base (unrestrained at the top or sides) should be capable of resisting "active" lateral earth pressures equal to an equivalent fluid pressure of 50 psf per foot of wall backfill for horizontal backfill conditions. Retaining walls that a fixed at the top should be capable of resisting "at-rest" lateral earth pressures equal to an equivalent fluid pressure of 70 psf per foot of wall backfill. Walls supporting sloping backfill up, to a 2:1 inclination, should be designed adding an additional 20 psf per foot of wall to the pressures presented above.

Retaining wall foundations should extend at least 18 inches below soil grade and may be designed in accordance with the parameters contained in the Foundation Design section of this report.

Retaining walls constructed near parking areas could experience additional surcharge loading if vehicles or equipment are parked or stored within a one horizontal to one vertical (1:1) projection from the bottom of the retaining walls. Surcharge loading under these circumstances should be evaluated on a case-by-case basis.

Backfill behind retaining walls should be fully drained to prevent the build-up of hydrostatic pressures behind the wall. Retaining walls should be provided with a drainage blanket (Class 2 permeable material (Caltrans Specification Section 68-1.025) at least one foot wide extending from the base of wall to within one foot of the top of the wall. The top foot above the drainage layer should consist of compacted on-site materials, unless covered by a slab or pavement. Weep holes or perforated PVC pipe should be provided at the base of the wall to collect accumulated water. Drain pipes, if used, should slope to discharge at no less than a one percent fall to suitable drainage facilities. Open-graded ½- to ¾-inch crushed rock may be used in lieu of the Class 2 permeable material, if the rock and drain pipe are completely enveloped in an approved non-woven geotextile filter fabric.

We anticipate the excavations behind the retaining walls will be backfilled with native soils. Structural backfill materials for retaining walls (other than the drainage layer) should be free of rubbish, rubble, organics and rock over six inches in size. Retaining wall backfill should be placed in lifts not exceeding 12 inches in compacted thickness, and should be mechanically compacted to at least 90 percent relative compaction.

Light Pole Foundations

We recommend end-bearing, cast-in-place drilled piers be used to support pole-mounted lights used near walkways or parking areas. Piers should be at least 24 inches in diameter and extend at least three feet below lowest adjacent soil grade. Drilled piers may be sized utilizing an allowable end-bearing pressure of 3000 psf for dead plus live load to include the effects of wind or seismic forces. The weight of foundation concrete extending below lowest adjacent soil grade may be disregarded in sizing computations. The light pole foundations should be structurally isolated from any adjacent concrete flatwork by a felt strip or similar material.

Uplift capacity of the piers can be evaluated using the weight of the pier and frictional resistance of 200 psf applied over the shaft area of the pier. Increased uplift resistance can be achieved by increasing the diameter of the pier or increasing the length.

Lateral resistance may be evaluated by applying a *passive* earth pressure equivalent to a fluid weight of 300 psf per foot of depth applied over an area equal to 1.5 times the pier diameter multiplied by the length of the pier. Available passive forces can be assumed to develop downward from the ground surface. If concrete flatwork will completely surround the piers, a "constrained" condition may be assumed for design.

Surface Drainage

Due to the expansive nature of the native clay soils, performance of the building foundations, slab-on-grade floors and exterior flatwork is critically dependent upon proper control of surface water on the site. The ground adjacent to the structures should be sloped away from the structures at a gradient no less than two percent for a distance of at least five feet, where possible. Consideration should be given to using full roof gutters, with downspouts from roof drains discharging onto paved surfaces leading away from the structural foundations or connected to solid PVC piping directed to an appropriate drainage point away from the structures. Ponding of surface water should be avoided near foundations.

Pavement Design

Traffic indices were not specified for the project; therefore, we have assumed typical traffic indices of 4.5, 6.0 and 7.0. The following pavement sections have been calculated based on the assumed traffic indices, results of R-value testing (see Plate No. A2), and the procedures contained within Chapter 600 of the *California Highway Design Manual*, dated July 1, 1990.

PAVEMENT DESIGN ALTERNATIVES

		Untreated Subgrades R-value = 5		Chemically-Treated Subgrades Soils(a) R-value = 50+	
Traffic Index (TI)	Traffic Condition	Type B Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)	Type B Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)
4.5	Automobile Parking Only	2½	9	2½	4
		3*	8	---	---
6.0	Fire Lanes, Driveways	3	14	3	6
		3½*	13	3½	5
7.0	Bus Lanes	3	18	3	7
		3½	17	3½	6
		4*	16	4*	6

* = Asphalt thickness includes Caltrans Factor of Safety.

(a)= Lime-treated subgrade should be at least 12 inches thick and possess a minimum R-value of 50 when tested in accordance with California Test 301 and a minimum unconfined compressive strength of 400 psi when tested in accordance with California Test 373.

If the underlying sandier soils (minimum R-value of 15) are exposed at pavement subgrade level, the aggregate base sections for an untreated subgrade may be reduced by two inches. This reduction would not apply to the lime treatment pavement sections. Our representative would need to verify the soils at subgrade level and perform appropriate tests to verify the suitability of a reduced aggregate base section.

We emphasize that the performance of the pavement is critically dependent upon uniform and adequate compaction of the soil subgrade, as well as all engineered fill and utility trench backfill within the limits of the pavements. We recommend that pavement subgrade preparation, i.e. scarification, moisture conditioning and compaction, be performed after underground utility construction is completed and just prior to aggregate base placement. The upper six inches of pavement subgrade soils should be compacted to at least 90 percent relative compaction at no less than the optimum moisture content. All aggregate base should be compacted to at least 95 percent of the maximum dry density. Materials quality and construction of the structural section of the pavements should conform to these applicable provisions of the latest edition of the *Caltrans Standard Specifications.*

The native clay soils are anticipated to react well with the addition of quicklime (high-calcium or dolomitic) and could enhance the support characteristics of the subgrade and allow for a reduction in the aggregate base section. Typical spread rates will vary from three to five percent based on dry soil weight. For estimating purposes only, we recommend a minimum spread rate of at least four percent (4½ pounds) of quicklime per square foot per foot of mixing depth.

If chemical treatment alternates are selected for use at this school site, additional testing should be performed during construction to verify that the design parameters are achieved in the field. Samples of the field-mixed soil and lime should be collected and tested for unconfined compressive strength (California Test 373) and Resistance value (California Test 301). This additional testing will either verify the design parameters or provide the opportunity to modify the pavement sections based upon the test results.

We are recommending the use of an aggregate section to act as a rock cushion beneath all pavements, i.e., no pavement directly upon the chemically treated subgrades. Our experience indicates cracking problems usually occur with asphalt concrete placed directly on a treated subgrade. Even when the treated soils are properly cured, cracks tend to develop over time, and without the use of the rock cushion, these cracks propagate up through the asphalt concrete.

In the summer heat, high axle loads coupled with shear stresses induced by sharply turning tire movements can lead to failure in asphalt concrete pavements. Therefore, we recommend that consideration be given to using a Portland cement concrete (PCC) section in areas subjected to concentrated heavy wheel loading, such as entry driveways, bus maneuvering areas, and in front of trash enclosures. As a minimum, the concrete section should consist of at least 6 inches of PCC underlain by at least 6 inches of Class 2 aggregate base compacted to not less than 95 percent relative compaction. We recommend concrete slabs be constructed with thickened edges, at least twice the slab thickness and 12 inches wide. Reinforcing for crack control, if desired, should consist of at least 6 x 6/W2.9 x W2.9 flat sheets of welded wire fabric or No. 4 reinforcing bars placed on maximum 24-inch centers each way throughout the slab. Reinforcement must be located at mid-slab depth to be effective. Joint spacing and details should conform with the current Portland Cement Association or American Concrete Institute guidelines. Portland cement concrete should achieve a minimum compressive strength of 3500 pounds per square inch at 28 days.

Efficient drainage of all surface water to avoid infiltration and saturation of the supporting aggregate base and subgrade soils is important to pavement performance. We suggest considering the use of full-depth curbs where pavements abut landscaped areas to serve as a cut-off against water migrating into the pavement base materials. Weep holes also could be provided at drop inlets, located at the subgrade-base interface, to allow accumulated water to drain from beneath the pavements.

Geotechnical Engineering Observation and Testing During Earthwork

Site preparation should be accomplished in accordance with the recommendations of this section and the *Guide Earthwork Specifications* provided in Appendix B. Representatives of Wallace-Kuhl & Associates, Inc., should be present during site preparation and all grading operations to observe and test the fill to verify compliance with our recommendations and the job specifications. These services are beyond the scope of work authorized for this investigation. .

In the event that Wallace-Kuhl & Associates, Inc., is not retained to provide geotechnical engineering observation and testing services during construction, the Geotechnical Engineer retained to provide this service in conformance with Section 3317.1, 3317.3 and 3317.8 of the 1998 edition of the CBC, should indicate in writing that they agree with the recommendations of this report, or prepare supplemental recommendations as necessary. A final report by the "Soils Engineer" should be prepared upon completion of the project as required by the CBC Section 3318.2. Please be aware that the title Soils Engineer is restricted in the State of California to a Civil Engineer authorized by the State of California to use the title "Geotechnical Engineer".

LIMITATIONS

Our recommendations are based upon the information provided regarding the proposed development combined with our analysis of site conditions revealed by the field exploration and laboratory testing programs. We have used our best engineering judgment based upon the information provided and the data generated from our investigation. If the proposed construction is modified or re-sited; or, if it is found during construction that subsurface conditions differ from those we encountered at the boring locations, we should be afforded the opportunity to review the new information or changed conditions to determine if our conclusions and recommendations must be modified.

We recommend Wallace - Kuhl & Associates, Inc. be retained to review the final plans and specifications to determine if the intent of our recommendations has been implemented in those documents.

We emphasize that this report is applicable only to the proposed school, college, library and parking structures and the investigated site and should not be utilized for construction on any other site. This report is considered valid for the proposed construction for a period of two years following the date of this report. If construction has not started within two years, we must re-evaluate the recommendations of this report and update the report, if necessary.

Wallace - Kuhl & Associates, Inc.

Jeffrey D. Kuhl

Jeffrey D. Kuhl
Staff Engineer

Stephen L. French

No. 323
Exp. 3-31-02

Stephen L. French
Senior Engineer

JDK:SLF

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Adapted from the Thomas Guide
Sacramento and Solano Counties
Street Guide and Directory, 2001 edition.

0 950 1900
Scale in Feet

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GEOTECHNICAL ENGINEERING
GEOLOGIC & ENVIRONMENTAL SERVICES

TOWN CENTER EDUCATIONAL COMPLEX

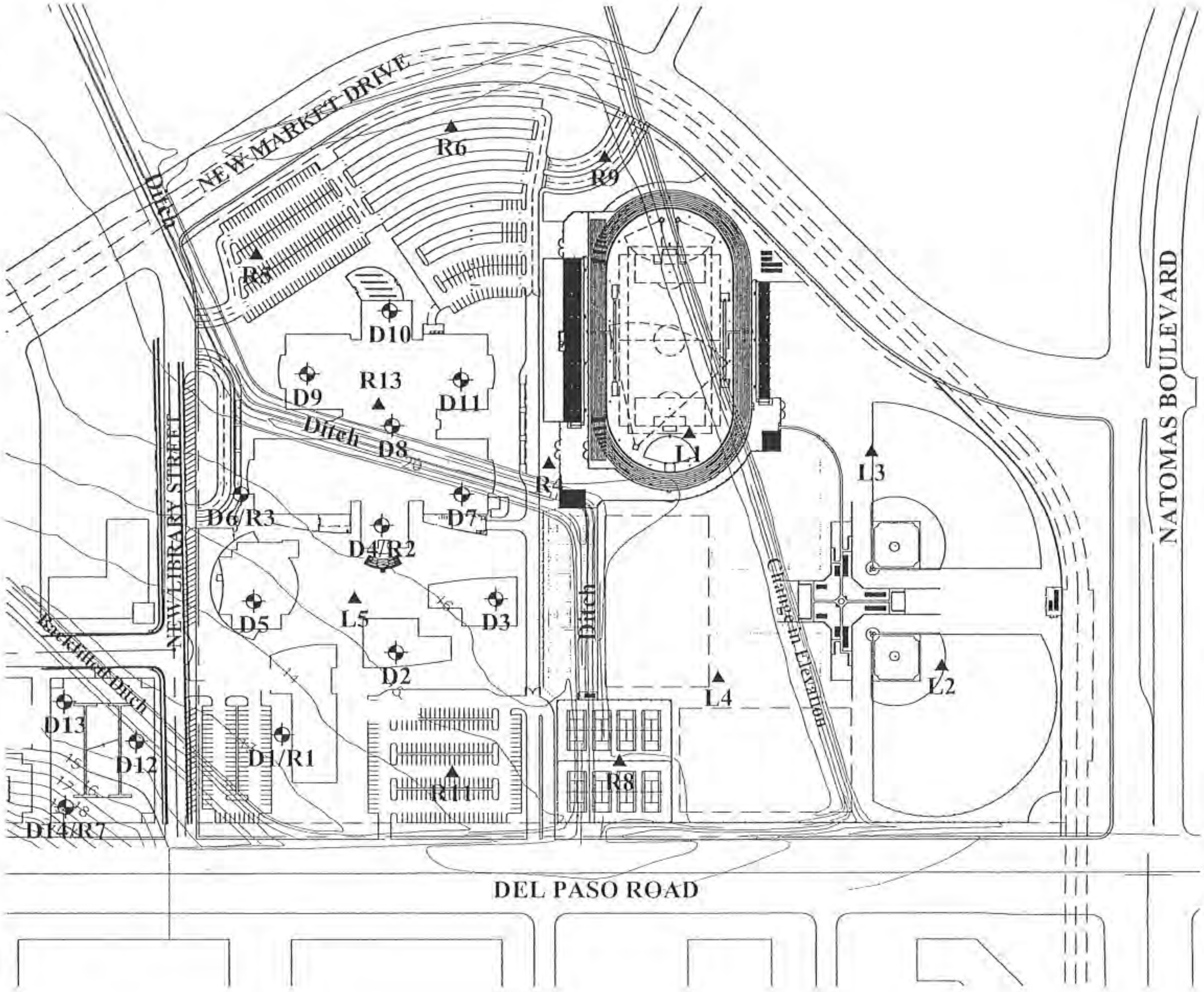
Del Paso Road and Natomas Boulevard

Sacramento, California

WKA NO: 4980.03

DATE: 12/01

PLATE NO: 1



Legend:

⊕ -Approximate bulk sample (R1) and/or soil boring (D1) location

▲ R1 -Approximate bulk sample location

▲ L1 -Approximate landscape sample location

Note:

Adapted from a CAD drawing
provided by Psomas.

0 150 300
Scale in Feet

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TOWN CENTER EDUCATIONAL COMPLEX

Del Paso Road and Natomas Boulevard

Sacramento, California

WKA NO: 4980.03

DATE: 12/01

PLATE NO: 2

BORING NUMBER: D1
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							CL/ CH	▨	Brown, slightly moist, loose, silty clay stiff at 1 foot
	◩	D1-1I	12	97	16.7			▨	
								▨	moist
5	◩	D1-2I	16			4.9 (TSF) UCC		▨	
							SM	▥	Brown, moist, medium dense, silty sand
10	◩	D1-3I	26	110	12.8			▥	
								▥	less silt
	◩	D1-4I	28	111	17.3			▥	∇i
							SP	░	Brown and gray, wet, medium dense, fine to medium sand
20	◩	D1-5I	36					░	
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. For an explanation of the symbols used in the boring log, see Plate No. 17.

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TOWN CENTER EDUCATIONAL COMPLEX
Del Paso Road and Natomas Boulevard
Sacramento, California

WKA NO: 4980.03
DATE: 12/01
PLATE NO: 3

BORING NUMBER: D2
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							CL/ CH		Brown, slightly moist, loose, silty clay stiff at 1 foot
	◩	D2-1I	14	107	15.7				
							ML		Gray to light brown, moist, very stiff, slightly clayey silt
5	◩	D2-2I	33						
							SM		Gray, moist, very dense, slightly silty fine sand
10	◩	D2-3I	77	100	10.1				
							SP		Gray, moist, dense, fine to medium sand
	◩	D2-4I	48	109	3.2				
							SP		Gray, wet, dense, fine to coarse sand
20	◩	D2-5I	49	116	13.2				
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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TOWN CENTER EDUCATIONAL COMPLEX
Del Paso Road and Natomas Boulevard
Sacramento, California

WKA NO: 4980.03
DATE: 12/01
PLATE NO: 4

BORING NUMBER: D3
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							CH	▨	Light brown, slightly moist, loose, silty clay very stiff at 1 foot
	◪	D3-1I	21			1.3 (TSF) UCC		▨	
							SM	░	Brown, moist, dense, silty fine sand
5	◪	D3-2I	57	103	15.3			░	
10	◪	D3-3I	54	102	14.1			░	
	◪	D3-4I	35					░	
20									
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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TOWN CENTER EDUCATIONAL COMPLEX

Del Paso Road and Natomas Boulevard

Sacramento, California

WKA NO: 4980.03

DATE: 12/01

PLATE NO: 5

BORING NUMBER: D4
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
0							CL/ CH	▨	Dark brown, slightly moist, loose, silty clay very stiff at 1 foot
	◪	D4-1I	22	105	14.8				
							SM	▤	Brown with white mottling, moist, very dense, silty fine sand
5	◪	D4-2I	81	106	19.5				
10	◪	D4-3I	29						
									less silt, fine to medium sand
	◪	D4-5I	39						
20									
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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TOWN CENTER EDUCATIONAL COMPLEX
Del Paso Road and Natomas Boulevard
Sacramento, California

WKA NO: 4980.03
DATE: 12/01
PLATE NO: 6

BORING NUMBER: D5
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							CL/ CH	▨	Dark brown, moist, loose, silty clay stiff at 1 foot
	◪	D5-1I	13	96	21.1				
							ML	▥	Light brown, moist, medium firm, slightly clayey silt white mottling at 3½ feet
5	◪	D5-2I	50						
							SM	▥	Brown, moist, medium dense, slightly silty, fine to medium sand
10	◪	D5-3I	41	98	18.0				
20									
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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TOWN CENTER EDUCATIONAL COMPLEX

Del Paso Road and Natomas Boulevard

Sacramento, California

WKA NO: 4980.03
DATE: 12/01
PLATE NO: 7

BORING NUMBER: D6
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
0							CL/ CH		Dark brown, slightly moist, loose, silty clay
							SM		Light brown, slightly moist, medium dense, silty fine sand
	◪	D6-1I	27	97	17.9				
	◪	D6-2I	60						
5									
10	◪	D6-3I	33						
							SP		Brown, moist, medium dense, fine sand
	◪	D6-4I	30	94	8.2				
									▽i
							SP		Gray, moist, dense, fine to medium sand
20	◪	D6-5I	44	109	17.1				
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. For an explanation of the symbols used in the boring log, see Plate No. 17.

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TOWN CENTER EDUCATIONAL COMPLEX

Del Paso Road and Natomas Boulevard

Sacramento, California

WKA NO: 4980.03
DATE: 12/01
PLATE NO: 8

BORING NUMBER: D7
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							CL/ CH	▨	Dark brown, slightly moist, loose, silty clay
							SM	▦	Light brown, slightly moist, very dense, silty fine sand
	◩	D7-1I	73					▦	slightly cemented at 2 feet
								▦	decrease in silt
	◪	D7-2I	60	112	17.5			▦	
5								▦	
							SM	▦	Brown, moist, dense, slightly silty, fine to medium sand
10	◪	D7-3I	59					▦	
20									
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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Sacramento, California

WKA NO: 4980.03
DATE: 12/01
PLATE NO: 9

BORING NUMBER: D8
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							CL/CH		Dark brown, slightly moist, loose, silty clay
							SM		Light brown, slightly moist, dense, silty fine sand
	◢	D8-1I	47						
									color change to brown
	◢	D8-2I	64	108	19.2				
5									
							SM		Brown, moist, medium dense, slightly silty fine sand
10	◢	D8-3I	27	92	7.0				
							SM		Gray, moist, medium dense, silty sand
	◢	D8-4I	30						
20									
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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WKA NO: 4980.03
DATE: 12/01
PLATE NO: 10

BORING NUMBER: D9
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							CL/CH	▨	Dark brown, slightly moist, loose, silty clay
	◢	D9-1I	18	102	20.4		ML	▥	Brown, slightly moist, medium dense, fine sandy silt
5	◢	D9-2I	32				SM	░	Brown, moist, medium dense, silty fine sand
									rust mottling at 8½ feet
10	◢	D9-3I	51						
20									
25									
30									

Notes:

1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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Del Paso Road and Natomas Boulevard

Sacramento, California

WKA NO: 4980.03
DATE: 12/01
PLATE NO: 11

BORING NUMBER: D10
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							CL/ CH	▨	Dark brown, slightly moist, loose silty clay
									moist, medium firm at 1 foot
	◪	D10-1I	7						
							SM	▥	Brown, moist, dense, silty fine sand
5	◪	D10-2I	57	100	12.4				
									decrease in silt
10	◪	D10-3I	37						
									increase in moisture
	◪	D10-4I	34						
20									
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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WKA NO: 4980.03
DATE: 12/01
PLATE NO: 12

BORING NUMBER: D11
DATE DRILLED: 10/24/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT.-(PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							CL/ CH		Dark brown, slightly moist, silty clay moist, medium firm at 1 foot
	◪	D11-1I	29	105	17.1		SM		Brown with white mottling, moist, medium dense, silty fine sand
5	◪	D11-2I	63						dense
10	◪	D11-3I	28						medium dense
15	◪	D11-4I	32	96	4.4				
									∇ i
									wet, increase in silt content
20	◪	D11-5I	62						
25									
30									

Notes:

1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. For an explanation of the symbols used in the boring log, see Plate No. 17.

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Sacramento, California

WKA NO: 4980.03

DATE: 12/01

PLATE NO: 13

BORING NUMBER: D12
DATE DRILLED: 10/25/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
0							CL/CH	▨	Dark brown, slightly moist, silty clay
								▨	moist, very stiff at 1 foot
	◪	D12-1I	30	105	15.0			▨	
								▨	stiff
5	◪	D12-2I	20					▨	
								▨	FILL
							CL/CH	▨	Dark brown, moist, stiff, silty clay
10	◪	D12-3I	17					▨	
							ML	▥	Brown with white mottling, moist, cemented, dense, fine sandy silt
15	◪	D12-4I	63	91	20.5			▥	
								▥	decrease in sand
20	◪	D12-5I	59					▥	
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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Sacramento, California

WKA NO: 4980.03
DATE: 12/01
PLATE NO: 14

BORING NUMBER: D13
DATE DRILLED: 10/25/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
0							CL/ ML		Brown and gray, moist, stiff, silty clay/sandy silt
		D13-1I	34						
							CL/ CH		Dark brown, moist, stiff, silty clay
5		D13-2I	23	105	19.9				
							ML		Brown, slightly moist, medium dense, sandy silt FILL
10		D13-3I	19				CL/ CH		Brown, moist, stiff, silty clay
							SM		Brown, slightly moist, medium dense, slightly clayey, silty fine to medium sand
		D13-4I	36	115	14.3				
20		D13-5I	38						
25									
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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WKA NO: 4980.03
DATE: 12/01
PLATE NO: 15

BORING NUMBER: D14
DATE DRILLED: 10/25/01
LOGGED BY: JK

DRILL RIG/METHOD:
CME-55/4-INCH
CONTINUOUS FLIGHT AUGERS

DEPTH (feet)	SAMPLER	SAMPLE NUMBER	BLOWS/FT.	DRY UNIT WT. (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	USCS	GRAPHIC LOG	SOIL DESCRIPTION AND REMARKS
							SM/CL		Brown to dark brown, moist, stiff, silty sand and clay
		D14-1I	22						FILL
							SM		Brown, slightly moist, medium dense, silty sand
5		D14-2I	22	105	19.9				
							ML		Light brown, slightly moist, very dense, fine sandy silt
		D14-3I	50						
10									
									decrease in sands, dense
		D14-4I	58	115	14.3				
							SP		Brown, moist, very dense, silty fine sand
20		D14-5I	73						
							ML		Tan, moist, stiff, fine sandy silt
25		D14-6I	32						
30									

Notes:
1. This log depicts conditions only at the boring location, see Plate No. 2, and only on the date of field exploration.
2. Ground water was not encountered in the boring.
3. For an explanation of the symbols used in the boring log, see Plate No. 17.

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WKA NO: 4980.03
DATE: 12/01
PLATE NO: 16

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYMBOL	CODE	TYPICAL NAMES
COARSE GRAINED SOILS (More than 1/2 of soil > no. 200 sieve size)	GRAVELS (More than 1/2 of coarse fraction > no. 4 sieve size)	GW	○	Well graded gravels or gravel - sand mixtures, little or no fines
		GP	○	Poorly graded gravels or gravel - sand mixtures, little or no fines
		GM	▥	Silty gravels, gravel - sand - silt mixtures
		GC	▨	Clayey gravels, gravel - sand - clay mixtures
	SANDS (More than 1/2 of coarse fraction < no. 4 sieve size)	SW	░	Well graded sands or gravelly sands, little or no fines
		SP	░	Poorly graded sands or gravelly sands, little or no fines
		SM	▥	Silty sands, sand - silt mixtures
		SC	▨	Clayey sands, sand - clay mixtures
FINE GRAINED SOILS (More than 1/2 of soil < no. 200 sieve size)	SILTS & CLAYS LL < 50	ML	▥	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	▨	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	▤	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS LL > 50	MH	┆	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	▧	Inorganic clays of high plasticity, fat clays
		OH	▧	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	┄	Peat and other highly organic soils

OTHER SYMBOLS

◪ = Drive Sample: 2-1/2" O.D. Modified California sampler

▱ = Drive Sample: no recovery

▽ i = Initial Water Level

▼ f = Final Water Level

— — — = Estimated or gradational material change line

——— = Observed material change line

Laboratory Tests

PI = Plasticity Index
EI = Expansion Index
UCC = Unconfined Compression Test
TR = Triaxial Compression Test
GR = Gradational Analysis (Sieve)
CON = Consolidation Test
CV = Compaction Test

GRAIN SIZE CLASSIFICATION

CLASSIFICATION	RANGE OF GRAIN SIZES	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL coarse (c) fine (f)	3" to No. 4 3" to 3/4" 3/4" to No. 4	76.2 to 4.76 76.2 to 19.1 19.1 to 4.76
SAND coarse (c) medium (m) fine (f)	No. 4 to No. 200 No. 4 to No. 10 No. 10 to No. 40 No. 40 to No. 200	4.76 to 0.074 4.76 to 2.00 2.00 to 0.420 0.420 to 0.074
SILT & CLAY	Below No. 200	Below 0.074

CONSISTENCY CLASSIFICATION

COHESIVE SOILS		GRANULAR SOILS	
Description	Blows/ft.*	Description	Blows/ft.*
Very Soft	< 3	Very Loose	< 5
Soft	3 - 5	Loose	5 - 15
Medium (firm)	6 - 10	Medium Dense	16 - 40
Stiff	11 - 20	Dense	41 - 65
Very Stiff	21 - 40	Very Dense	> 65
Hard	> 40		* SPT

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WKA NO: 4980.03
DATE: 12/01
PLATE NO: 17

APPENDIX A

APPENDIX A

A. GENERAL INFORMATION

The performance of a geotechnical engineering investigation and pavement design for the proposed Town Center Educational Complex to be constructed northwesterly of Del Paso Road and Natomas Boulevard in Sacramento, California, was authorized by Mr. David Jones on October 15, 2001. Authorization was for an investigation as described in our proposal letter of October 12, 2001, sent to our client, Natomas Unified School District, whose mailing address is 1901 Arena Boulevard, Sacramento, California 95834; telephone (916) 567-5466; facsimile (916) 567-5470.

The project civil engineer is Psomas and Associates, whose mailing address is 5 Sierra Gate Plaza, Roseville, California 95678; telephone (916) 788-8122; facsimile (916) 788-0600.

The project architectural consultant is Nacht & Lewis Architects, whose mailing address is 7300 Folsom Boulevard, Suite 200, Sacramento, California 95826; telephone (916) 381-0127; facsimile (916) 381-0310.

The project structural engineer is Buehler and Buehler Associates, whose mailing address is 2237 Douglas Boulevard, Suite 120, Roseville, California 95661; telephone (916) 778-7171; facsimile (916) 778-7474.

In performing this investigation, we made reference to an undated CAD drawing and a 1" = 60' *Overall Site Plan* provided by Nacht & Lewis Architects.

B. FIELD EXPLORATION

Test borings were drilled on October 24 and 25, 2001, utilizing a CME 55 truck-mounted drill rig. At the locations indicated on Plate No. 2, fourteen exploratory borings were drilled and sampled to a maximum depth of approximately 25 feet using four-inch diameter solid flight helical augers. Bulk samples of anticipated pavement subgrade soils also were collected for subgrade analysis, and bag samples of soil were collected from landscape areas for landscape evaluation. At various intervals, relatively undisturbed soil samples were recovered from the borings using a 2½-inch O.D., 2-inch I.D. California sampler driven by an automatic 140-pound hammer freely falling 30 inches. The number of blows of the hammer required to drive the 18-inch long sampler each 6-inch interval was recorded with the sum of the blows required to drive the sampler the lower 12-inch interval being designated the penetration resistance or "blow count" for that particular drive.

The samples were retained in 2-inch diameter by 6-inch long thin-walled brass tubes contained within the sampler. Immediately after recovery, the soils in the tubes were visually classified by the field engineer and the ends of the tubes were sealed to preserve the natural moisture contents. All samples were taken to our laboratory for additional soil classification and selection of samples for testing. The Boring Logs, Plates No. 3 through 16, contain descriptions of the soils encountered in each boring. A Boring Legend explaining the Unified Soil Classification System and the symbols used on the logs is contained on Plate No. 17.

C. LABORATORY TESTING

Selected undisturbed samples of the soils were tested to determine dry unit weight (ASTM D2937), natural moisture content (ASTM D2216) and shear strength parameters from unconfined compressive tests (ASTM D2166). The results of these tests are included on the boring logs at the depth each sample was obtained.

An Expansion Index test was performed on bulk samples of near-surface soils; the results of these tests are presented on Plate No. A1 and A2.

The shear strengths of two undisturbed soil samples were determined by triaxial compression testing (ASTM D4767). The results of the triaxial compression tests are presented on Plates No. A3 and A4.

Three bulk samples of anticipated pavement subgrade soils were subjected to Resistance-value testing in accordance with California Test 301. Results of the R-value tests, which were used in the pavement design, are contained on Plate No. A5, and A6.

Three samples of near-surface soils were submitted to Sunland Analytical of Rancho Cordova, California, for corrosivity testing in accordance with California Test (CT) Nos. 643 (Modified Small Cell), CT 532, CT 422 and CT 417. Copies of the analytical results are provided on Plate No. A7, A8, and A9.

Five representative samples of near-surface soils in landscape areas also were submitted to Sunland Analytical for landscape evaluation and testing. Copies of the test results, including recommendations for soil ammendments, are contained in Appendix C.

EXPANSION INDEX TEST RESULTS

UBC Standard No. 29-2

ASTM D4829-88

MATERIAL DESCRIPTION: Brown silty clay

LOCATION: R1

Sample Depth	Pre-Test Moisture (%)	Post-Test Moisture (%)	Dry Density (pcf)	Expansion Index *
1'-3'	12.9	28.4	102	**98**

CLASSIFICATION OF EXPANSIVE SOIL **

EXPANSION INDEX	POTENTIAL EXPANSION
0 - 20	Very Low
21 - 50	Low
51 - 90	Medium
91 - 130	**High**
Above 130	Very High

* Corrected to 50% Saturation

** From UBC Table 29-C

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DATE: 12/01

PLATE NO: A1

EXPANSION INDEX TEST RESULTS

UBC Standard No. 29-2

ASTM D4829-88

MATERIAL DESCRIPTION: Brown silty clay/silty fine sand

LOCATION: R3

Sample Depth	Pre-Test Moisture (%)	Post-Test Moisture (%)	Dry Density (pcf)	Expansion Index *
1'-3'	14.4	37.1	93	**14**

CLASSIFICATION OF EXPANSIVE SOIL **

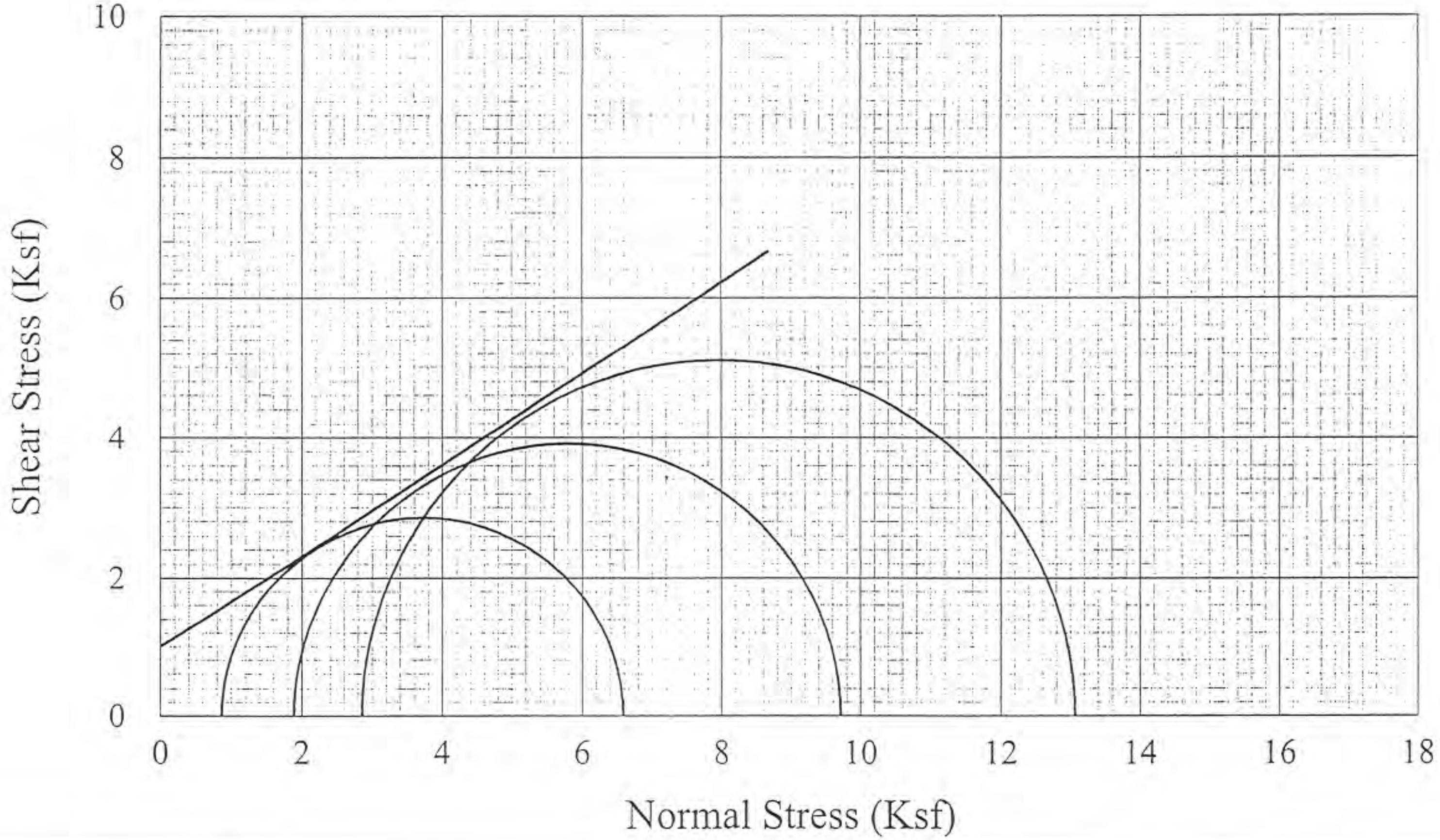
EXPANSION INDEX	POTENTIAL EXPANSION
0 - 20	**Very Low**
21 - 50	Low
51 - 90	Medium
91 - 130	High
Above 130	Very High

* Corrected to 50% Saturation

** From UBC Table 29-C

TRIAXIAL COMPRESSION TEST

ASTM D4767-88



SAMPLE NO. : D2-2I
SAMPLE CONDITION : Undisturbed
SAMPLE DESCRIPTION : Gray to light brown, slightly clayey, fine sandy silt

DRY DENSITY (PCF) : 96
INITIAL MOISTURE (%) : 28.6
FINAL MOISTURE (%) : 28.9

ANGLE OF INTERNAL FRICTION (ø) : 32°
COHESION (PSF) : 1007

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Drawn By: BPM
Checked By: JK

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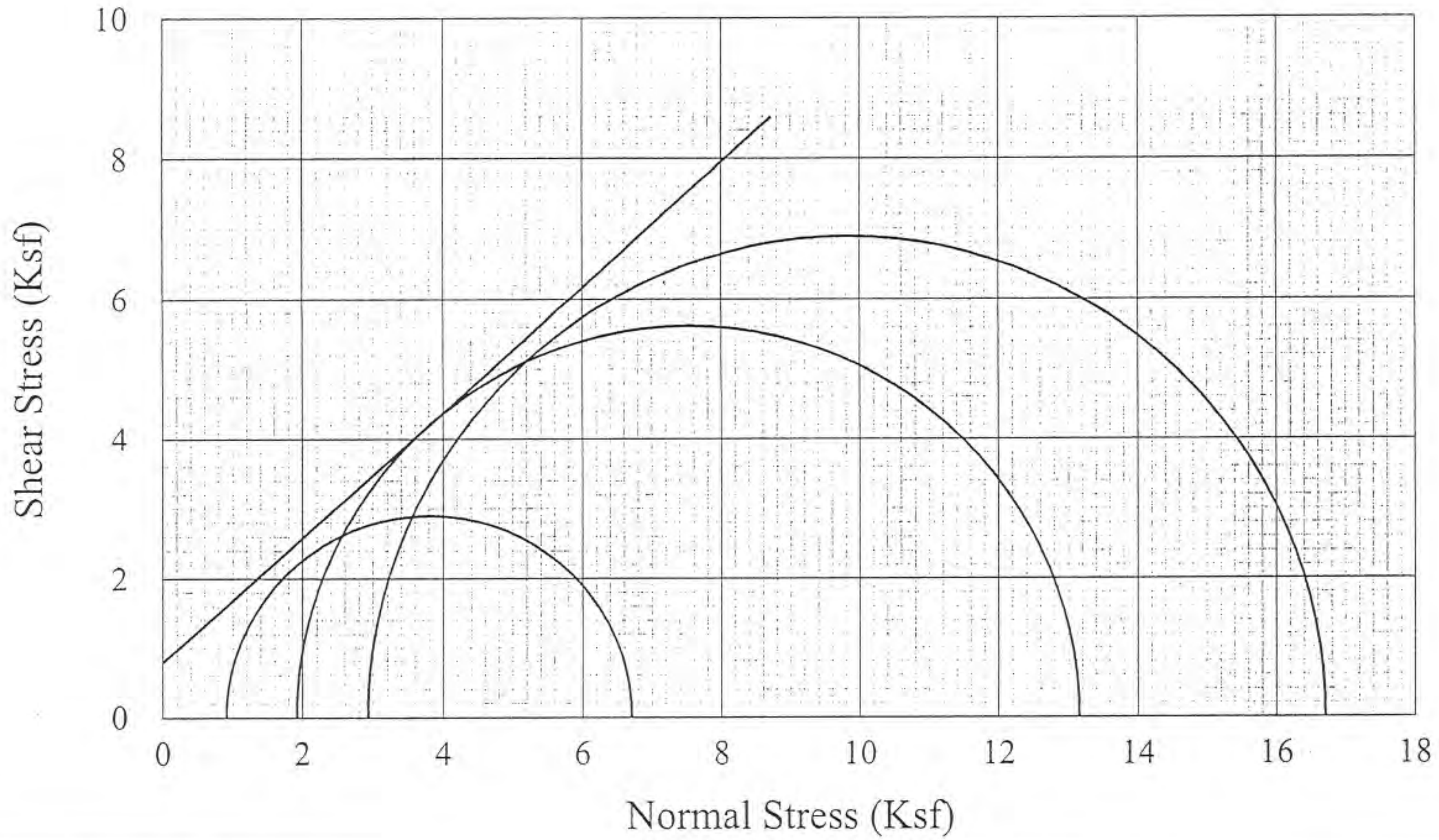
WKA NO: 4980.03
DATE: 12/01
PLATE NO: A3

TRIAXIAL COMPRESSION TEST

ASTM D4767-88



SAMPLE NO. : D8-1I

SAMPLE CONDITION : Undisturbed

SAMPLE DESCRIPTION : Light brown, silty fine sand

DRY DENSITY (PCF) : 101

INITIAL MOISTURE (%) : 23.5

FINAL MOISTURE (%) : 25.1

ANGLE OF INTERNAL FRICTION (ø) : 41°

COHESION (PSF) : 794

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Drawn By: BPM

Checked By: JK

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WKA NO: 4980.03

DATE: 12/01

PLATE NO: A4

RESISTANCE VALUE TEST RESULTS
(CT 301)

Material Description: Brown silty caly

Location: R2

Specimen No.	Dry Unit Weight (pcf)	Moisture @ Compaction (%)	Exudation Pressure (psi)	Expansion Pressure (dial)	Expansion Pressure (psf)	R Value
1	103	22.6	764	51	221	12

Sample extruded, therefore R-Value = 5

Material Description: Brown silty clay

Location: R3

Specimen No.	Dry Unit Weight (pcf)	Moisture @ Compaction (%)	Exudation Pressure (psi)	Expansion Pressure (dial)	Expansion Pressure (psf)	R Value
1	113	22.3	565	92	398	8

Sample extruded, therefore R-Value = 5

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WKA NO: 4980.03
DATE: 12/01
PLATE NO: A5

RESISTANCE VALUE TEST RESULTS
(CT 301)

Material Description: Brown clayey silt

Location: R7

Specimen No.	Dry Unit Weight (pcf)	Moisture @ Compaction (%)	Exudation Pressure (psi)	Expansion Pressure (dial)	(psf)	R Value
1	98	25.3	287	49	212	13
2	100	24.4	366	110	476	28
3	102	23.4	446	172	745	40

R-Value at 300 psi exudation pressure = 15

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 10/31/2001
Date Submitted 10/25/2001

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 4980.03P/NATOMAS HS Site ID : R3.
Your purchase order number is 3395.
Thank you for your business.

* For future reference to this analysis please use SUN # 36153-69053.

EVALUATION FOR SOIL CORROSION

Soil pH	7.41	
Minimum Resistivity	1.34	ohm-cm (x1000)
Chloride	7.6 ppm	00.00076 %
Sulfate	2.9 ppm	00.00029 %

METHODS
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

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TOWN CENTER EDUCATIONAL COMPLEX
Del Paso Road and Natomas Boulevard
Sacramento, California

WKA NO: 4980.03
DATE: 12/01
PLATE NO: A7

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 10/31/2001
Date Submitted 10/25/2001

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 4980.03P/NATOMAS HS Site ID : R2.
Your purchase order number is 3395.
Thank you for your business.

* For future reference to this analysis please use SUN # 36153-69055.

EVALUATION FOR SOIL CORROSION

Soil pH	7.40		
Minimum Resistivity	1.05	ohm-cm (x1000)	
Chloride	15.1 ppm	00.00151	%
Sulfate	3.5 ppm	00.00035	%

METHODS
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

WALLACE • KUHL & ASSOCIATES, INC. GEOTECHNICAL ENGINEERING GEOLOGIC & ENVIRONMENTAL SERVICES	TOWN CENTER EDUCATIONAL COMPLEX Del Paso Road and Natomas Boulevard Sacramento, California	WKA NO: 4980.03 DATE: 12/01 PLATE NO: A8

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 10/31/2001
Date Submitted 10/25/2001

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 4980.03P/NATOMAS HS Site ID : R13.
Your purchase order number is 3395.
Thank you for your business.

* For future reference to this analysis please use SUN # 36153-69054.

EVALUATION FOR SOIL CORROSION

Soil pH	7.18		
Minimum Resistivity	0.88	ohm-cm (x1000)	
Chloride	9.8 ppm	00.00098	%
Sulfate	8.8 ppm	00.00088	%

METHODS
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

WALLACE • KUHL & ASSOCIATES, INC. GEOTECHNICAL ENGINEERING GEOLOGIC & ENVIRONMENTAL SERVICES	TOWN CENTER EDUCATIONAL COMPLEX Del Paso Road and Natomas Boulevard Sacramento, California	WKA NO: 4980.03 DATE: 12/01 PLATE NO: A9

APPENDIX B

APPENDIX B

GUIDE EARTHWORK SPECIFICATIONS

TOWN CENTER EDUCATIONAL COMPLEX

Del Paso Road and Natomas Boulevard
Sacramento, California
WKA No. 4980.03

PART 1: GENERAL

1.1 SCOPE

a. General Description

This item shall include all clearing of existing surface rubble, debris, organics and associated items; preparation of surfaces to be filled, filling, spreading, compaction, observation and testing of the fill; and all subsidiary work necessary to complete the grading of the site to conform with the lines, grades and slopes as shown on the accepted Drawings.

b. Related Work Specified Elsewhere

(1) Trenching and backfilling for sanitary sewer system: Section ___.

(2) Trenching and backfilling for storm drain system: Section ___.

(3) Trenching and backfilling for underground water, natural gas, and electric supplies: Section ___.

c. Geotechnical Engineer

Where specific reference is made to "Geotechnical Engineer" this designation shall be understood to include either him or his representative.

1.2 PROTECTION

a. Adequate protection measures shall be provided to protect workers and passers-by at the site. Streets and adjacent property shall be fully protected throughout the operations.

b. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.

c. Any construction review of the Contractor's performance conducted by the Geotechnical Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site.

d. Adjacent pavements and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.

e. Surface drainage provisions shall be made during the period of construction in a manner to avoid creating a nuisance to adjacent areas.

f. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance.

1.3 GEOTECHNICAL REPORT

a. A Geotechnical Engineering Report (WKA No. 4980.03P; dated December 20, 2001) has been prepared for this site by Wallace - Kuhl & Associates, Inc., Geotechnical Engineers of West Sacramento, California [(916) 372-1434]. A copy is available for review at the office of Wallace - Kuhl & Associates, Inc.

b. The information contained in this report was obtained for design purposes only. The Contractor is responsible for any conclusions the Contractor may draw from this report; should the Contractor prefer not to assume such risk, the Contractor should employ experts to analyze available information and/or to make additional borings upon which to base conclusions drawn by the Contractor, all at no cost to the Owner.

1.4 EXISTING SITE CONDITIONS

The Contractor shall become acquainted with all site conditions. If unshown active utilities are encountered during the work, the Architect shall be promptly notified for instructions. Failure to notify will make the Contractor liable for damage to these utilities arising from Contractor's operations subsequent to the discovery of such unshown utilities.

1.5 SEASONAL LIMITS

Fill material shall not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rains, fill operations shall not be resumed until field tests indicate that the moisture contents of the subgrade and fill materials are satisfactory.

PART 2: PRODUCTS

2.1 MATERIALS

a. All fill shall be of approved local materials from required excavations, supplemented by imported fill, if necessary. Approved local materials are defined as uncontaminated, local soils free from significant quantities or rubble, rubbish and vegetation, and having been tested and approved by the Geotechnical Engineer prior to use. Clods, rocks, hard lumps or cobbles exceeding six inches (6") shall be removed from any fill supporting the buildings.

b. Imported fill materials shall be approved by the Geotechnical Engineer; they shall meet the above requirements; shall have Plasticity Indices not exceeding fifteen (15); and, shall be of three-inch (3") maximum particle size.

c. Capillary barrier material under floor slabs shall be provided to the thickness shown on the Drawings. This material shall be clean gravel or crushed rock of one-inch (1") maximum size, with no material passing a Number four (#4) sieve.

PART 3: EXECUTION

3.1 LAYOUT AND PREPARATION

Lay out all work, establish grades, locate existing underground utilities, set markers and stakes, set up and maintain barricades and protection of utilities--all prior to beginning actual earthwork operations.

3.2 CLEARING, GRUBBING AND PREPARING BUILDING PADS AND PAVEMENT AREAS

a. All vegetation to be removed, rubble, rubbish, loose and/or saturated materials shall be removed and disposed of so as to leave the areas that have been disturbed with a neat and finished appearance, free from unsightly debris. Excavations and depressions resulting from the removal of such items, as well as any existing excavations or loose soil deposits, as determined by the Geotechnical Engineer, shall be cleaned out to firm, undisturbed soil and backfilled with suitable materials in accordance with these specifications.

b. Following site clearing operations, areas designated to receive fill and at-grade areas shall be scarified to a depth of at least twelve inches (12"), uniformly moisture conditioned to at least two percent (2%) above the optimum moisture content, and compacted to not less than ninety percent (90%) as determined by the ASTM D1557 Compaction Test.

c. Compaction operations shall be performed in the presence of the Geotechnical Engineer who will evaluate the performance of the materials under compactive load. Unstable soil deposits, as determined by the Geotechnical Engineer, shall be excavated to expose a firm base and grades restored with engineered fill in accordance with these specifications.

d. When the moisture content of the subgrade is less than the specified moisture content, water shall be added until the minimum moisture content is achieved.

e. When the moisture content of the subgrade is too high to permit the specified compaction to be achieved, the subgrade shall be aerated by blading or other methods until the moisture content is satisfactory for compaction.

3.3 PLACING, SPREADING AND COMPACTING FILL MATERIAL

a. The selected soil fill material shall be placed in layers that, when compacted, shall not exceed six inches (6") in thickness. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to promote uniformity of material in each layer.

b. When the moisture content of the fill material is below the specified moisture content, water shall be added until the proper moisture content is achieved.

c. When the moisture content of the fill material is too high to permit the specified degree of compaction to be achieved, the fill material shall be aerated by blading or other methods until the moisture content is satisfactory.

d. After each layer has been placed, mixed and spread evenly, native clayey materials shall be uniformly compacted to not less than ninety percent (90%) as determined by the ASTM D1557 Compaction Test. Imported fill materials shall be uniformly compacted to at least ninety percent (90%) as determined by the ASTM D1557 Compaction Test. Compaction shall be undertaken with equipment capable of achieving the specified density and shall be accomplished while the fill material is at the required moisture content. Each layer shall be compacted over its entire area until the desired density has been obtained.

e. Fill placed within the center irrigation ditch that is within the high school building footprint, and ten feet (10') beyond, shall be compacted to not less than ninety-five percent (95%) at a moisture content of at least the optimum moisture content.

f. The filling operations shall be continued until the fills have been brought to the finished slopes and grades as shown on the accepted Drawings.

3.4 FINAL SUBGRADE PREPARATION

a. The upper twelve inches (12") of final building pad subgrades, including exterior flatwork areas, shall consist of granular import soils or granular on-site soils compacted to not less than ninety percent (90%) as determined by ASTM D1557 Compaction Test. Alternatively, the upper twelve inches (12") may consist of lime-treated native clays.

b. The upper six inches (6") of final pavement subgrade shall be brought to a uniform moisture content of at least the optimum moisture content, and shall be uniformly compacted to not less than ninety percent (90%) as determined by ASTM D1557 Compaction Test, regardless of whether final subgrade elevations are attained by filling, excavation or are left at existing grades.

3.5 TESTING AND OBSERVATION

a. Grading operations shall be observed by the Geotechnical Engineer, serving as the representative of the Owner.

b. Field density tests shall be made by the Geotechnical Engineer after compaction of each layer of fill. Additional layers of fill shall not be spread until the field density tests indicate that the minimum specified density has been obtained.

c. Earthwork shall not be performed without the notification or approval of the Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least two (2) working days prior to commencement of any aspect of the site earthwork.

d. If the Contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, the necessary readjustments shall be made by the Contractor until all work is deemed satisfactory, as determined by the Geotechnical Engineer and the Architect/Engineer. No deviation from the specifications shall be made except upon written approval of the Geotechnical Engineer or Architect/Engineer.

APPENDIX C

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 10/31/2001
Date Submitted 10/25/2001

To: Doug Kuhn
Wallace-Kuhl & Assoc., Inc.
P.O. Box 1137
West Sacramento, CA 95691

From: Gene Oliphant, Ph.D. \ Randy Horney RH
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 4980.03P/NATOMAS HS Site ID : L1
Your purchase order number is 3395. Thank you for your business.

* For future reference to this analysis please use SUN # 36153-69057.

SOIL ANALYSIS

```
Saturation Percent (SP)              69                  Soil Texture   Clay
pH                                    7.35
E.C.                                  1.06  mmho/cm
Tot.Dissolved Salts                 678.4   ppm
Infiltration Rate (0% Slope)          0.13  in/hr
% Organic Matter                      6.5
C.E.C.                               50.3   meq/100g
Sodium Absorption Ratio (SAR)         2.2
Exchangable Sodium Percent (ESP)      1.9
Gypsum Req. (CaSO4*2H20)             None Required
est. Nitrogen Release                 3.5   #/1000 sq.ft.

                                    '    '        '             '        '
     Nitrate       3.04  ppm        '*
     Phosphorus   26.21  ppm        '********************
     Potassium   302.40  ppm        '************************
     Sulfur       12.00  ppm        '***************
     Chloride     No Test           '
     Carbonates   No Test           '
     Sodium      218.04  ppm        '
     Calcium    7502.43  ppm        '****************************
     Magnesium  1345.80  ppm        '*************************
     Boron         0.14  ppm        '****
     Copper       No Test           '
     Iron         No Test           '
     Manganese    No Test           '
     Zinc         No Test           '
                                    '____'________'_____________'________'
                                    Very  Low      Adequate      Excessive
                                    Low
```

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

DATE 10/31/2001
SUN NUMBER 69057

Information requested by:	Information for:
Doug Kuhn	4980.03P/NATOMAS HS
Wallace-Kuhl & Assoc., Inc.	Sample ID: L1

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL pH (Acidity and Alkalinity)

The pH of this sample indicates the soil is in a range for normal growth of most plants. No modification is required.

DISSOLVED SALTS (Indicated by E.C. & TDS)

These conditions are in the normal range for plant growth.

SOIL TEXTURE AND RATE OF WATER INFILTRATION

The infiltration rate for all soil textures decreases with increasing ground slope. At 0 to 4%, 5 to 8%, 9 to 12%, 13 to 16% and above 16% the infiltration rate of this sample decreases from 0.13 to 0.10, 0.08, 0.05, 0.03, respectively. Infiltration rate also decreases with percent of ground cover and by compaction.

WATER PENETRATION OF SOIL DUE TO CHEMICAL CHARACTERISTICS

When exchangable Sodium increases in the soil, water penetration decreases. Based on SAR and ESP values this sample has no penetration problem due to soil Sodium. No Gypsum required.

ORGANIC MATTER

Organic matter provides a slow nitrogen release and aids water retention. This sample has a moderate Organic Matter content.
To maintain moisture and provide sustained nitrogen release a level of 10% organic matter is recommended. Use amending material that is approximately 75% organic matter (i.e. many ground fir barks). Based on the analysis of this soil sample apply 2 yards per 1000 sq.ft. Spread evenly and blend into the top six inches of soil. It is a reasonable practice to apply a top dressing of 3 inches of organic mulches to aid water penetration and retention.

SOIL BORON

Boron concenration is below adequate level. Apply 0.5 (1/2) oz./1000 sq.ft. of boric acid. Dissolve in 2 gallons of water and apply by spraying. Apply carefully because excess boron is toxic to plants !!

DATE 10/31/2001
SUN NUMBER 69057

Information requested by:
Doug Kuhn
Wallace-Kuhl & Assoc., Inc.

Information for:
4980.03P/NATOMAS HS
Sample ID: L1

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL MACRONUTRIENTS : NITROGEN-PHOSPHORUS-POTASSIUM (N-P-K)

GENERAL N-P-K RECOMMENDATION

Use ONE of these NPK preparations for the first fertilizer application.

Standard NPK Fertilizer Preparations	6-20-20	5-20-10	16-16-16	0-10-10	28-3-4	21-0-0	Customer Choice None
#/1000 sq.ft.	19	22	7	N/A	N/A	N/A	**

GRASS OR SOD PREPARATION

Till in organic matter, N,P,K and micro nutrients in addition to any lime gypsum or sulfur as directed above. Smooth soil surface and follow seed or sod producers direction for moisture and product application.

TREES AND SHRUBS

Excavate holes for planting shrubs and trees to at least twice the volume of the container. Prepare backfill for tree and shrub planting holes by mixing three parts of native soil (or imported top soil) with one part organic amendment (preferably nitrogen and iron fortified) and 2.5 pounds of 6-20-20 per yard of mix. For extended fertilization, place slow release fertilizer tablets in each hole per manufacturer's instructions. If 6-20-20 was not directly added to backfill mix, during backfill apply uniformly 1/2 oz of 6-20-20 per gallon containers, 2.5 oz per 5 gallons, 6 oz per 24 inch boxes.

Summary and Suggested Sequence of Soil Improvements (#/1000 Sq.Ft.)

Organic Amendment	2	Yd./1000 Sq.Ft. Bulk organic amendment (nitrofied).
N-P-K Fertilizer	See above chart	
Boron	0.5	oz Boric Acid - excess TOXIC !!!
Sulfate-Sulfur	1	# Ammonium Sulfate

Maintenance Fertilization

Apply 5 pounds of Ammonium sulfate (21-0-0) per 1000 sq.ft.every month until plants become established. After established, apply 28-3-4 (or similar preparation) to provide desired growth rate and color.

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 10/31/2001
Date Submitted 10/25/2001

To: Doug Kuhn
Wallace-Kuhl & Assoc., Inc.
P.O. Box 1137
West Sacramento, CA 95691

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 4980.03P/NATOMAS HS Site ID : L2
Your purchase order number is 3395. Thank you for your business.

* For future reference to this analysis please use SUN # 36153-69056.

SOIL ANALYSIS

Saturation Percent (SP)	72		Soil Texture	Clay
pH	6.60			
E.C.	0.69	mmho/cm		
Tot.Dissolved Salts	441.6	ppm		
Infiltration Rate (0% Slope)	0.13	in/hr		
% Organic Matter	8.1			
C.E.C.	38.8	meq/100g		
Sodium Absorption Ratio (SAR)	2.3			
Exchangable Sodium Percent (ESP)	2.1			
Gypsum Req. (CaSO4*2H2O)	None Required			
est. Nitrogen Release	4.2	#/1000 sq.ft.		

```
                              |    |        |             |        |
Nitrate         2.71  ppm     |*
Phosphorus     15.33  ppm     |*************
Potassium     203.52  ppm     |************************
Sulfur          8.67  ppm     |***********
Chloride      No Test         |
Carbonates    No Test         |
Sodium        186.22  ppm     |
Calcium      4402.28  ppm     |************************
Magnesium    1890.49  ppm     |****************************
Boron           0.59  ppm     |*****************
Copper        No Test         |
Iron          No Test         |
Manganese     No Test         |
Zinc          No Test         |
                              |    |        |             |        |
                              |____|________|_____________|________|
                               Very   Low       Adequate    Excessive
                               Low
```

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

DATE 10/31/2001
SUN NUMBER 69056

Information requested by:
Doug Kuhn
Wallace-Kuhl & Assoc., Inc.

Information for:
4980.03P/NATOMAS HS
Sample ID: L2

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL pH (Acidity and Alkalinity)

The pH of this sample indicates the soil is in a range for normal growth of most plants. No modification is required.

DISSOLVED SALTS (Indicated by E.C. & TDS)

These conditions are in the normal range for plant growth.

SOIL TEXTURE AND RATE OF WATER INFILTRATION

The infiltration rate for all soil textures decreases with increasing ground slope. At 0 to 4%, 5 to 8%, 9 to 12%, 13 to 16% and above 16% the infiltration rate of this sample decreases from 0.13 to 0.10, 0.08, 0.05, 0.03, respectively. Infiltration rate also decreases with percent of ground cover and by compaction.

WATER PENETRATION OF SOIL DUE TO CHEMICAL CHARACTERISTICS

When exchangable Sodium increases in the soil, water penetration decreases. Based on SAR and ESP values this sample has no penetration problem due to soil Sodium. No Gypsum required.

ORGANIC MATTER

Organic matter provides a slow nitrogen release and aids water retention. This sample has a moderate Organic Matter content.
To maintain moisture and provide sustained nitrogen release a level of 10% organic matter is recommended. Use amending material that is approximately 75% organic matter (i.e. many ground fir barks). Based on the analysis of this soil sample apply 1 yards per 1000 sq.ft. Spread evenly and blend into the top six inches of soil. It is a reasonable practice to apply a top dressing of 3 inches of organic mulches to aid water penetration and retention.

SOIL BORON

Boron concenrations are in a range allowing normal plant growth.

DATE 10/31/2001
SUN NUMBER 69056

Information requested by:
Doug Kuhn
Wallace-Kuhl & Assoc., Inc.

Information for:
4980.03P/NATOMAS HS
Sample ID: L2

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL MACRONUTRIENTS : NITROGEN-PHOSPHORUS-POTASSIUM (N-P-K)

GENERAL N-P-K RECOMMENDATION

Use ONE of these NPK preparations for the first fertilizer application.

Standard NPK Fertilizer Preparations	6-20-20	5-20-10	16-16-16	0-10-10	28-3-4	21-0-0	Customer Choice None
#/1000 sq.ft.	19	23	N/A	N/A	N/A	N/A	**

GRASS OR SOD PREPARATION

Till in organic matter, N,P,K and micro nutrients in addition to any lime gypsum or sulfur as directed above. Smooth soil surface and follow seed or sod producers direction for moisture and product application.

TREES AND SHRUBS

Excavate holes for planting shrubs and trees to at least twice the volume of the container. Prepare backfill for tree and shrub planting holes by mixing three parts of native soil (or imported top soil) with one part organic amendment (preferably nitrogen and iron fortified) and 2.5 pounds of 6-20-20 per yard of mix. For extended fertilization, place slow release fertilizer tablets in each hole per manufacturer's instructions. If 6-20-20 was not directly added to backfill mix, during backfill apply uniformly 1/2 oz of 6-20-20 per gallon containers, 2.5 oz per 5 gallons, 6 oz per 24 inch boxes.

Summary and Suggested Sequence of Soil Improvements (#/1000 Sq.Ft.)

Organic Amendment	1	Yd./1000 Sq.Ft. Bulk organic amendment (nitrofied).
N-P-K Fertilizer	See above chart	
Sulfate-Sulfur	1	# Ammonium Sulfate

Maintenance Fertilization

Apply 5 pounds of Ammonium sulfate (21-0-0) per 1000 sq.ft.every month until plants become established. After established, apply 28-3-4 (or similar preparation) to provide desired growth rate and color.

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 10/31/2001
Date Submitted 10/25/2001

To: Doug Kuhn
Wallace-Kuhl & Assoc., Inc.
P.O. Box 1137
West Sacramento, CA 95691

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 4980.03P/NATOMAS HS Site ID : L3
Your purchase order number is 3395. Thank you for your business.

* For future reference to this analysis please use SUN # 36153-69058.

SOIL ANALYSIS

Saturation Percent (SP)	71		Soil Texture	Clay
pH	7.03			
E.C.	0.80	mmho/cm		
Tot.Dissolved Salts	512	ppm		
Infiltration Rate (0% Slope)	0.13	in/hr		
% Organic Matter	8.9			
C.E.C.	37.6	meq/100g		
Sodium Absorption Ratio (SAR)	3.0			
Exchangable Sodium Percent (ESP)	3.1			
Gypsum Req. (CaSO4*2H2O)	None Required			
est. Nitrogen Release	4.6	#/1000 sq.ft.		

```
                             ¦    ¦        ¦             ¦        ¦
Nitrate          2.55  ppm   ¦*
Phosphorus      10.69  ppm   ¦*********
Potassium      229.18  ppm   ¦************************
Sulfur          10.10  ppm   ¦*************
Chloride      No Test        ¦
Carbonates    No Test        ¦
Sodium         264.90  ppm   ¦
Calcium       4154.26  ppm   ¦************************
Magnesium     1845.95  ppm   ¦****************************
Boron            0.54  ppm   ¦****************
Copper        No Test        ¦
Iron          No Test        ¦
Manganese     No Test        ¦
Zinc          No Test        ¦
                             ¦____¦________¦_____________¦________¦
                              Very   Low      Adequate    Excessive
                              Low
```

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

DATE 10/31/2001
SUN NUMBER 69058

Information requested by:	Information for:
Doug Kuhn	4980.03P/NATOMAS_HS
Wallace-Kuhl & Assoc., Inc.	Sample ID: L3

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL pH (Acidity and Alkalinity)

The pH of this sample indicates the soil is in a range for normal growth of most plants. No modification is required.

DISSOLVED SALTS (Indicated by E.C. & TDS)

These conditions are in the normal range for plant growth.

SOIL TEXTURE AND RATE OF WATER INFILTRATION

The infiltration rate for all soil textures decreases with increasing ground slope. At 0 to 4%, 5 to 8%, 9 to 12%, 13 to 16% and above 16% the infiltration rate of this sample decreases from 0.13 to 0.10, 0.08, 0.05, 0.03, respectively. Infiltration rate also decreases with percent of ground cover and by compaction.

WATER PENETRATION OF SOIL DUE TO CHEMICAL CHARACTERISTICS

When exchangable Sodium increases in the soil, water penetration decreases. Based on SAR and ESP values this sample has no penetration problem due to soil Sodium. No Gypsum required.

ORGANIC MATTER

Organic matter provides a slow nitrogen release and aids water retention. This sample has a moderate Organic Matter content.
To maintain moisture and provide sustained nitrogen release a level of 10% organic matter is recommended. Use amending material that is approximately 75% organic matter (i.e. many ground fir barks). Based on the analysis of this soil sample apply 1 yards per 1000 sq.ft. Spread evenly and blend into the top six inches of soil. It is a reasonable practice to apply a top dressing of 3 inches of organic mulches to aid water penetration and retention.

SOIL BORON

Boron concenrations are in a range allowing normal plant growth.

DATE 10/31/2001
SUN NUMBER 69058

Information requested by:
Doug Kuhn
Wallace-Kuhl & Assoc., Inc.

Information for:
4980.03P/NATOMAS HS
Sample ID: L3

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL MACRONUTRIENTS : NITROGEN-PHOSPHORUS-POTASSIUM (N-P-K)
GENERAL N-P-K RECOMMENDATION

Use ONE of these NPK preparations for the first fertilizer application.

Standard NPK Fertilizer Preparations	6-20-20	5-20-10	16-16-16	0-10-10	28-3-4	21-0-0	Customer Choice None
#/1000 sq.ft.	19	23	N/A	N/A	N/A	N/A	**

GRASS OR SOD PREPARATION

Till in organic matter, N,P,K and micro nutrients in addition to any lime gypsum or sulfur as directed above. Smooth soil surface and follow seed or sod producers direction for moisture and product application.

TREES AND SHRUBS

Excavate holes for planting shrubs and trees to at least twice the volume of the container. Prepare backfill for tree and shrub planting holes by mixing three parts of native soil (or imported top soil) with one part organic amendment (preferably nitrogen and iron fortified) and 2.5 pounds of 6-20-20 per yard of mix. For extended fertilization, place slow release fertilizer tablets in each hole per manufacturer's instructions. If 6-20-20 was not directly added to backfill mix, during backfill apply uniformly 1/2 oz of 6-20-20 per gallon containers, 2.5 oz per 5 gallons, 6 oz per 24 inch boxes.

Summary and Suggested Sequence of Soil Improvements (#/1000 Sq.Ft.)

Organic Amendment	1	Yd./1000 Sq.Ft. Bulk organic amendment (nitrofied).
N-P-K Fertilizer	See above chart	
Sulfate-Sulfur	1	# Ammonium Sulfate

Maintenance Fertilization

Apply 5 pounds of Ammonium sulfate (21-0-0) per 1000 sq.ft.every month until plants become established. After established, apply 28-3-4 (or similar preparation) to provide desired growth rate and color.

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 10/31/2001
Date Submitted 10/25/2001

To: Doug Kuhn
Wallace-Kuhl & Assoc., Inc.
P.O. Box 1137
West Sacramento, CA 95691

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 4980.03P/NATOMAS HS Site ID : L4
Your purchase order number is 3395. Thank you for your business.

* For future reference to this analysis please use SUN # 36153-69059.

SOIL ANALYSIS

```
Saturation Percent (SP)            66                     Soil Texture   Clay
pH                                  6.95
E.C.                                0.83  mmho/cm
Tot.Dissolved Salts               531.2   ppm
Infiltration Rate (0% Slope)        0.13  in/hr
% Organic Matter                    6.9
C.E.C.                             39.0   meq/100g
Sodium Absorption Ratio (SAR)       1.6
Exchangable Sodium Percent (ESP)    1.1
Gypsum Req. (CaSO4*2H2O)           None Required
est. Nitrogen Release               3.7   #/1000 sq.ft.

                                      |   |        |             |        |
     Nitrate        3.22  ppm         |*
     Phosphorus    17.64  ppm         |**************
     Potassium    295.34  ppm         |************************
     Sulfur        10.00  ppm         |************
     Chloride     No Test             |
     Carbonates   No Test             |
     Sodium        97.74  ppm         |
     Calcium     5642.36  ppm         |**************************
     Magnesium   1177.94  ppm         |***********************
     Boron          0.24  ppm         |*******
     Copper       No Test             |
     Iron         No Test             |
     Manganese    No Test             |
     Zinc         No Test             |
                                      |___|________|_____________|________|
                                       Very  Low      Adequate    Excessive
                                       Low
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Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

DATE 10/31/2001
SUN NUMBER 69059

Information requested by:
Doug Kuhn
Wallace-Kuhl & Assoc., Inc.

Information for:
4980.03P/NATOMAS HS
Sample ID: L4

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL pH (Acidity and Alkalinity)

The pH of this sample indicates the soil is in a range for normal growth of most plants. No modification is required.

DISSOLVED SALTS (Indicated by E.C. & TDS)

These conditions are in the normal range for plant growth.

SOIL TEXTURE AND RATE OF WATER INFILTRATION

The infiltration rate for all soil textures decreases with increasing ground slope. At 0 to 4%, 5 to 8%, 9 to 12%, 13 to 16% and above 16% the infiltration rate of this sample decreases from 0.13 to 0.10, 0.08, 0.05, 0.03, respectively. Infiltration rate also decreases with percent of ground cover and by compaction.

WATER PENETRATION OF SOIL DUE TO CHEMICAL CHARACTERISTICS

When exchangable Sodium increases in the soil, water penetration decreases. Based on SAR and ESP values this sample has no penetration problem due to soil Sodium. No Gypsum required.

ORGANIC MATTER

Organic matter provides a slow nitrogen release and aids water retention. This sample has a moderate Organic Matter content.

To maintain moisture and provide sustained nitrogen release a level of 10% organic matter is recommended. Use amending material that is approximately 75% organic matter (i.e. many ground fir barks). Based on the analysis of this soil sample apply 2 yards per 1000 sq.ft. Spread evenly and blend into the top six inches of soil. It is a reasonable practice to apply a top dressing of 3 inches of organic mulches to aid water penetration and retention.

SOIL BORON

Boron concenrations are in a range allowing normal plant growth.

DATE 10/31/2001
SUN NUMBER 69059

Information requested by:
Doug Kuhn
Wallace-Kuhl & Assoc., Inc.

Information for:
4980.03P/NATOMAS HS
Sample ID: L4

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL MACRONUTRIENTS : NITROGEN-PHOSPHORUS-POTASSIUM (N-P-K)
GENERAL N-P-K RECOMMENDATION

Use ONE of these NPK preparations for the first fertilizer application.

Standard NPK Fertilizer Preparations	6-20-20	5-20-10	16-16-16	0-10-10	28-3-4	21-0-0	Customer Choice None
#/1000 sq.ft.	19	22	8	N/A	N/A	N/A	**

GRASS OR SOD PREPARATION

Till in organic matter, N,P,K and micro nutrients in addition to any lime gypsum or sulfur as directed above. Smooth soil surface and follow seed or sod producers direction for moisture and product application.

TREES AND SHRUBS

Excavate holes for planting shrubs and trees to at least twice the volume of the container. Prepare backfill for tree and shrub planting holes by mixing three parts of native soil (or imported top soil) with one part organic amendment (preferably nitrogen and iron fortified) and 2.5 pounds of 6-20-20 per yard of mix. For extended fertilization, place slow release fertilizer tablets in each hole per manufacturer's instructions. If 6-20-20 was not directly added to backfill mix, during backfill apply uniformly 1/2 oz of 6-20-20 per gallon containers, 2.5 oz per 5 gallons, 6 oz per 24 inch boxes.

Summary and Suggested Sequence of Soil Improvements (#/1000 Sq.Ft.)

Organic Amendment	2	Yd./1000 Sq.Ft. Bulk organic amendment (nitrofied).
N-P-K Fertilizer	See above chart	
Sulfate-Sulfur	1	# Ammonium Sulfate

Maintenance Fertilization

Apply 5 pounds of Ammonium sulfate (21-0-0) per 1000 sq.ft.every month until plants become established. After established, apply 28-3-4 (or similar preparation) to provide desired growth rate and color.

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 10/31/2001
Date Submitted 10/25/2001

To: Doug Kuhn
Wallace-Kuhl & Assoc., Inc.
P.O. Box 1137
West Sacramento, CA 95691

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 4980.03P/NATOMAS HS Site ID : L5
Your purchase order number is 3395. Thank you for your business.

* For future reference to this analysis please use SUN # 36153-69060.

SOIL ANALYSIS

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Saturation Percent (SP)              70                   Soil Texture   Clay
pH                                    6.13
E.C.                                  0.95  mmho/cm
Tot.Dissolved Salts                 608     ppm
Infiltration Rate (0% Slope)          0.13  in/hr
% Organic Matter                      6.0
C.E.C.                               39.2   meq/100g
Sodium Absorption Ratio (SAR)         2.6
Exchangable Sodium Percent (ESP)      2.4
Gypsum Req. (CaSO4*2H2O)             None Required
est. Nitrogen Release                 3.3   #/1000 sq.ft.

                                    |    |        |             |        |
     Nitrate        2.40  ppm       |*
     Phosphorus    74.29  ppm       |*************************
     Potassium    231.04  ppm       |************************
     Sulfur         2.67  ppm       |****
     Chloride     No Test           |
     Carbonates   No Test           |
     Sodium       220.84  ppm       |
     Calcium     4402.28  ppm       |************************
     Magnesium   1911.04  ppm       |****************************
     Boron          0.28  ppm       |********
     Copper       No Test           |
     Iron         No Test           |
     Manganese    No Test           |
     Zinc         No Test           |
                                    |____|________|_____________|________|
                                     Very  Low      Adequate     Excessive
                                     Low
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Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

DATE 10/31/2001
SUN NUMBER 69060

Information requested by:
Doug Kuhn
Wallace-Kuhl & Assoc., Inc.

Information for:
4980.03P/NATOMAS HS
Sample ID: L5

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL pH (Acidity and Alkalinity)

The pH of this sample indicates the soil is moderately acid and should be modified for non acid-tolerant plants. Apply 55 pounds of Lime per 1000 sq.ft. and work into ground before planting.

DISSOLVED SALTS (Indicated by E.C. & TDS)

These conditions are in the normal range for plant growth.

SOIL TEXTURE AND RATE OF WATER INFILTRATION

The infiltration rate for all soil textures decreases with increasing ground slope. At 0 to 4%, 5 to 8%, 9 to 12%, 13 to 16% and above 16% the infiltration rate of this sample decreases from 0.13 to 0.10, 0.08, 0.05, 0.03, respectively. Infiltration rate also decreases with percent of ground cover and by compaction.

WATER PENETRATION OF SOIL DUE TO CHEMICAL CHARACTERISTICS

When exchangable Sodium increases in the soil, water penetration decreases. Based on SAR and ESP values this sample has no penetration problem due to soil Sodium. No Gypsum required.

ORGANIC MATTER

Organic matter provides a slow nitrogen release and aids water retention. This sample has a moderate Organic Matter content.
To maintain moisture and provide sustained nitrogen release a level of 10% organic matter is recommended. Use amending material that is approximately 75% organic matter (i.e. many ground fir barks). Based on the analysis of this soil sample apply 2 yards per 1000 sq.ft. Spread evenly and blend into the top six inches of soil. It is a reasonable practice to apply a top dressing of 3 inches of organic mulches to aid water penetration and retention.

SOIL BORON

Boron concenrations are in a range allowing normal plant growth.

DATE 10/31/2001
SUN NUMBER 69060

Information requested by:
Doug Kuhn
Wallace-Kuhl & Assoc., Inc.

Information for:
4980.03P/NATOMAS HS
Sample ID: L5

SOIL RECOMMENDATIONS FOR LANDSCAPE GARDENING

SOIL MACRONUTRIENTS : NITROGEN-PHOSPHORUS-POTASSIUM (N-P-K)

GENERAL N-P-K RECOMMENDATION

Use ONE of these NPK preparations for the first fertilizer application.

Standard NPK Fertilizer Preparations	6-20-20	5-20-10	16-16-16	0-10-10	28-3-4	21-0-0	Customer Choice None
#/1000 sq.ft.	N/A	N/A	7	N/A	4	5	**

GRASS OR SOD PREPARATION

Till in organic matter, N,P,K and micro nutrients in addition to any lime gypsum or sulfur as directed above. Smooth soil surface and follow seed or sod producers direction for moisture and product application.

TREES AND SHRUBS

Excavate holes for planting shrubs and trees to at least twice the volume of the container. Prepare backfill for tree and shrub planting holes by mixing three parts of native soil (or imported top soil) with one part organic amendment (preferably nitrogen and iron fortified) and 2.5 pounds of 6-20-20 per yard of mix. For extended fertilization, place slow release fertilizer tablets in each hole per manufacturer's instructions. If 6-20-20 was not directly added to backfill mix, during backfill apply uniformly 1/2 oz of 6-20-20 per gallon containers, 2.5 oz per 5 gallons, 6 oz per 24 inch boxes.

Summary and Suggested Sequence of Soil Improvements (#/1000 Sq.Ft.)

Lime	55	#
Organic Amendment	2	Yd./1000 Sq.Ft. Bulk organic amendment (nitrofied).
N-P-K Fertilizer	See above chart	
Sulfate-Sulfur	1	# Ammonium Sulfate

Maintenance Fertilization

Apply 5 pounds of Ammonium sulfate (21-0-0) per 1000 sq.ft.every month until plants become established. After established, apply 28-3-4 (or similar preparation) to provide desired growth rate and color.