DRAFT EIR
Volume II (Appendices)
January 29, 2010

Seismic Life Safety, Modernization, and Replacement of General Purpose Buildings, Phase 2 Project

University of California at
Ernest Orlando Lawrence Berkeley National Laboratory
Berkeley, California

State Clearinghouse Number: 2008122030

BERKELEY LAB

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Appendix A

Notice of Preparation

University of California -Ernest Orlando Lawrence Berkeley National Laboratory

State of California
Office of Planning and Research
1400 Tenth Street
Sacramento, CA 95814

NOTICE OF PREPARATION
ENVIRONMENTAL IMPACT REPORT

Project Title: Seismic Life Safety Phase 2B Project

Lead Agency: University of California

Location: Lawrence Berkeley National Laboratory
One Cyclotron Road Berkeley, CA 94720

County: Alameda County

Contact: Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-234A
Berkeley, CA 94720

Project Description

The proposed Project would include demolition of outdated and seismically unsafe facilities, seismic improvements to existing facilities, and construction of a new General Purpose Laboratory building (General Purpose Lab) to replace demolished space. A more complete Project Description, including illustrations, is provided in Section 3 of this NOP. The primary project objectives include supporting Berkeley Lab's ongoing research mission through provision of seismically safe, modern life science research space, along with improving efficiency and consolidating functions.

Environmental Review Process

The University of California will be the state Lead Agency and will prepare an Environmental Impact Report (EIR) under the California Environmental Quality Act (CEQA) for the proposed Seismic Life Safety Phase 2B Project (the Project), described below. We are interested in the views of your agency as to the appropriate scope and content of the EIR's environmental information and analysis pertaining to your agency's statutory responsibilities in connection with the proposed Project.

The U.S. Department of Energy (DOE) will be the Federal Lead Agency for the Project. Because DOE funding would support this Project, the EIR will be prepared in tandem with an Environmental Assessment (EA), which will satisfy the requirements of the National Environmental Policy Act (NEPA). Although the combined EIR/EA will be simultaneously prepared and circulated as a single document for public review, the purpose of this NOP is exclusively to request comments as to the appropriate scope and content of the EIR under CEQA.

Based on Appendix G in the 2008 CEQA Guidelines and an environmental screening analysis completed for the Project in the summer and fall 2008, the University has prepared an environmental checklist form, which is presented in Section 6, to identify potential environmental impacts that will be addressed in the EIR. The preliminary determinations of impact significance presented in the checklist represent the conclusions made in the screening analysis. The checklist is not intended to provide a detailed analysis of potential project impacts. This analysis, including a discussion of relevant existing conditions, potentially significant impacts, mitigation measures, and a cumulative analysis will be included in the EIR.

As the checklist indicates, the Project may result in potentially significant impacts in relation to Aesthetics, Air Quality, Biological Resources, Cultural Resources, Geology and Soils, Hydrology and Water Quality, Noise, and Transportation and Traffic. Based on the environmental screening analysis, it is anticipated that all potentially significant impacts could be mitigated to a less than significant level. However, pending completion of the EIR, it is possible that the Project could result in one or more significant and unavoidable impacts, thereby warranting the preparation of an EIR in accordance with CEQA.

A copy of this Notice of Preparation (NOP), Environmental Checklist form, and public scoping meeting announcement will be placed on the following website: **http://lbnl.gov/community/seismicphase2/.**

The University will hold a public scoping meeting for the EIR for the Project at 6:30 PM on Wednesday, January 14, 2009 at the North Berkeley Senior Center, 1901 Hearst Street, Berkeley. More information regarding the scoping meeting is provided in Attachment A.

This notice is to solicit your views on the scope and contents of the forthcoming Seismic Life Safety Phase 2B EIR. Because of the coinciding holidays, the normal 30-day comment period has been extended to 50 days. Specifically, the period to provide comments on the scope of the Draft EIR extends from December 9, 2008, to January 27, 2009. Comments must be postmarked by January 27, 2009. Your name and a mailing address should be included with your comments. Please direct your comments to the attention of Jeff Philliber at the address above. Electronically mailed comments may be sent to planning@lbl.gov no later than January 27, 2009. Oral comments must be delivered at the January 14, 2009 Public Scoping Meeting, where they will be recorded and then transcribed.

If you have any questions regarding this NOP, please contact Jeff Philliber at the above address or via email at planning@lbl.gov.

Signature: _____ Date: 12-9-08

Jeff Philliber, Environmental Planner
University of California - Lawrence Berkeley National Laboratory

Attachments: Public Scoping Meeting Announcement
Initial Study

cc: UC-LBNL CEQA Agency and Public Mailing List

State Agencies

State Clearinghouse
CA Air Resources Board, Executive Officer
CA Department of Fish and Game, Director, Donald Koch
CA Department of Health Services, Chief, Radiological Health Branch, Edgar Bailey, et al.
CA Department of Parks & Recreation, Office of Historic Preservation, State Historic Preservation Officer, M. W. Donaldson, FAIA,
CA Department of Water Resources, Director, Lester Snow
CA Environmental Protection Agency, Secretary, Linda S. Adams, et al.
CA EPA, Department of Toxic Substances Control, Mohindar Sandhu et al
CA Regional Water Quality Control Board, Bruce H. Wolff, Executive Officer, Keith Lichten, Section Leader Environmental Compliance, et al
CA State Resources Agency, Mike Chrisman, Secretary
CA State Water Resources Control Board, Executive Director, Dorothy Rice, et al
CalTrans, Director, Will Kempton; Region 4 Director, Bijan Sartipi, et al

Federal Agencies

U.S. Environmental Protection Agency, Region 9 Administrator, Wayne Nastri; Radiation & Compliance Assurance, Michael Bandrowski, et al
U.S. Fish and Wildlife Service, Sacramento Field Office, Susan Moore, Chief Supervisor
U.S. Department of Energy, Berkeley Site Office, Aundra Richards, Site Manager, et al
U.S. Department of Energy, NEPA Compliance Officer – Oakridge Operations Office, Gary Hartman
U.S. Department of Energy, NEPA Representative - BSO, Kim Abbott
U.S. Department of Interior, National Park Service, Elaine Jackson-Retondo, Historian

Regional/County Agencies

Alameda County, Clerk-Recorder's Office, Patrick O'Connell
Alameda County, Supervisor District 5, Keith Carson
Alameda County, LAFCO, Executive Officer, Mona Palacios
Alameda County, County Administrator, Susan Muranishi,
Alameda County, Health Care Agency, Public Health Officer, Dr.Anthony Iton, et al
Alameda County, Clerk to Board of Supervisors, Sandy Hou
Alameda County, Planning Department, Agency Director, James Sorenson, et al
Metropolitan Transportation Commission, Executive Director, Steve Heminger,
Association of Bay Area Governments, Executive Director-Secretary Treasurer, Henry Gardner, et al
Bay Area Air Quality Management District, Executive Officer/APCO, Jack Broadbent, et al
Contra Costa County, Department of Health Services, Director of Public Health, Wendel Brunner,
East Bay Municipal Utilities District, General Manager, Dennis Diemer, et al
East Bay Regional Park District, General Manager, Pat O'Brien, et al

City of Berkeley

City of Berkeley, City Clerk, Dieanna Despam, Acting City Clerk
City of Berkeley, City Manager, Phil Kamlarz, and City Manager's Office et al
City of Berkeley, Acting City Attorney, Zach Cowan
City of Berkeley, Mayor Tom Bates
City of Berkeley, Council Members, Anderson, Capitelli, Maio, Moore, Olds, Worthington, Wozniak
City of Berkeley, Planning Department, Dan Marks, Director, et al
City of Berkeley, Toxics Management Division, Dr. Nabil Al-Hadithy
City of Berkeley, Energy Officer, Neal DeSnoo
City of Berkeley, Police Department, Douglas Hambleton, Chief of Police
City of Berkeley, Fire Department, Deby Pryor, Fire Chief, et al
City of Berkeley, Transportation Division Manager, Farid Javandel

City of Berkeley Commissions

City of Berkeley, Community Environmental Advisory Commission, Nabil Al-Hadithy, Secretary
City of Berkeley, Community Health Commission, Zandta Lee, Secretary
City of Berkeley, Landmarks Preservation Commission, Terry Blount, Senior Planner
City of Berkeley, Peace & Justice Commission, Eric Brenman, Secretary
City of Berkeley, Parks, Recreation & Waterfront Commission, Virginia Aiello, Secretary
City of Berkeley, Planning Commission, Jordan Harrison, Secretary
City of Berkeley, Public Works Commission, Jeff Egeberg, Secretary
City of Berkeley, Zero Waste Commission, Tania Levy, Secretary
City of Berkeley, Transportation Commission, Farid Javandel, Secretary

City of Oakland

City of Oakland, Mayor Ron Dellums
City of Oakland, District 1, Jane Brunner, Councilmember
City of Oakland, City Attorney John Russo
City of Oakland, Planning and Zoning Division, Eric Angstadt, Interim Planning & Zoning Director, et al
City of Oakland, City Clerk's Office, La Tonda Simmons, City Clerk
City of Oakland, City Administrator, Acting Dan Lindheim
City of Oakland, Fire Department, Daniel Farrell, Fire Chief, et al

City of Albany

City of Albany, City Clerk, Jacqueline Bucholz
City of Albany, Administrator, Beth Pollard

El Cerrito and Kensington

El Cerrito Fire Department & Kensington Fire District, Lance Maples, Fire Chief

University of California Office of the President (UCOP)

UCOP, External Relations, Dan Dooley, Interim Executive Vice President
UCOP, Laboratory Management, Bob Foley, VP, et al
UCOP, Facilities Management, George Getyen, Director, et al
UCOP, State Government Relations, Steve Juarez, Director
UCOP, Federal Government Relations, Carolyn Henrich, Director
UCOP, Physical and Environmental Planning, Charlotte Strem, Acting Director
UCOP, Office of General Counsel, Elisabeth Gunther, University Counsel

UC Berkeley

UC Berkeley, Chancellor Robert Birgeneau
UC Berkeley, Executive Vice Chancellor & Provost, George Breslauer
UC Berkeley, Interim Vice Chancellor for Research, Robert Price
UC Berkeley, Associate Chancellor and Chief of Staff, Linda Williams
UC Berkeley, Vice Chancellor Facilities Services, Edward Denton
UC Berkeley, Physical and Environmental Planning, Emily Marthinsen, Assistant Vice Chancellor, et al
UC Berkeley, EH&S Director, Mark Freiberg
UC Berkeley, Community Relations, Irene Hegarty, Director
UC Berkeley, Lawrence Hall of Science, Elizabeth Stage, Director, et al
UC Berkeley, Botanical Garden, Paul Licht, Director, et al
UC Berkeley, Police Department, Victoria Harrison, Chief of Police
UC Berkeley, Campus Landscape Architect, Jim Horner
UC Berkeley, Emergency Services Manager, Tom Klatt
UC Berkeley, Residence Hall Assembly, Oriana Madrigal Zamora, President

Organizations

Berkeley Association of Realtors, Association Executive, Sally Dunker,
Berkeley Chamber of Commerce, Chief Executive Officer, Ted Garrett, et al
Campus Parnassus Neighborhood Association, President, Eric Arens
Committee to Minimize Toxic Waste, Co-Chair, Pam Sihvola, et al
Council of Neighborhood Associations/BANA, President, Marie Bowman
Downtown Berkeley Association, Executive Director, Deborah Badhia
Euclid-LeConte Neighbors, Jim Sharp et al
League of Women Voters BAE, President, Jinky Gardner, et al
Nyingma Institute, Program Director, Abbe Blum
Oakland Metropolitan Chamber of Commerce, President & CEO, Joseph Haraburda
Panoramic Neighborhood Association, President, Jerry Wachtel
Sierra Club, Group Chair, Kent Lewandowski
Urban Creeks Council, UCC Vice Chair, Carole Schemmerling
Friends of Strawberry Creek, Work Programs, Jennifer Pearson
Save Strawberry Canyon, Janice Thomas

Individuals and Neighbors

(Various)

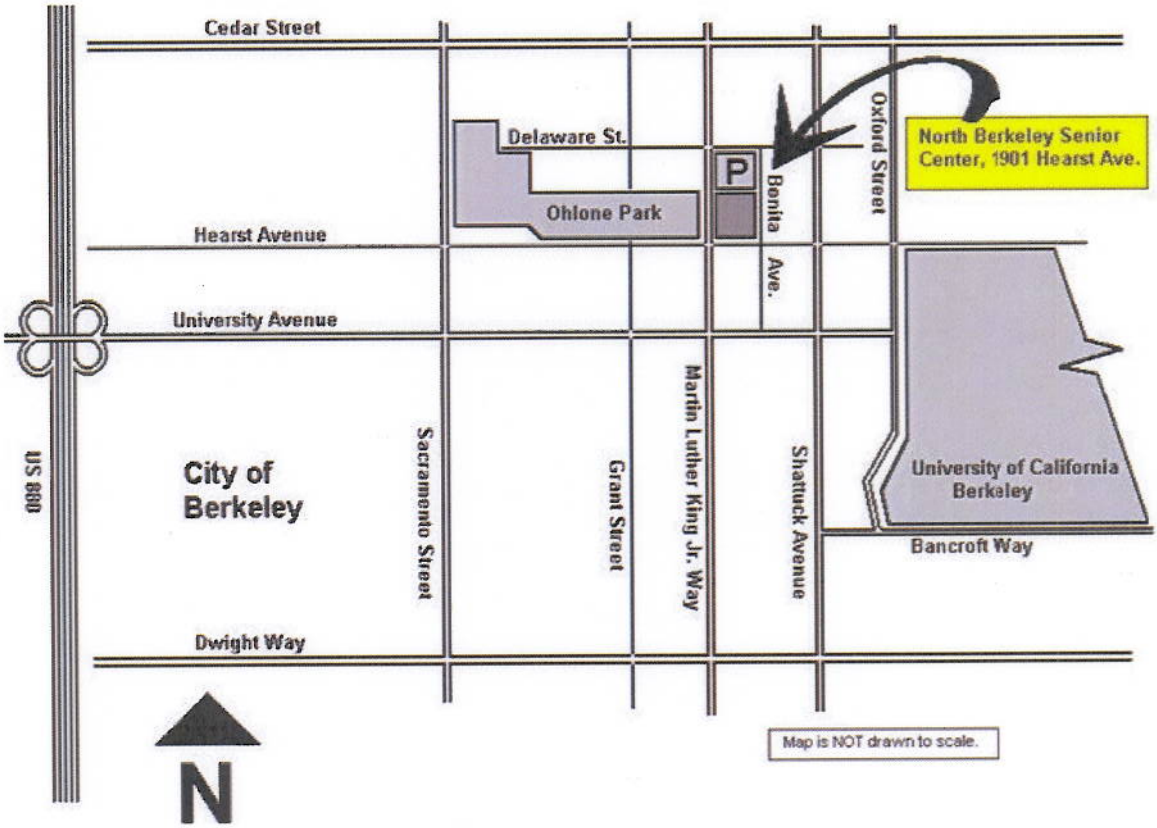
ATTACHMENT A: PUBLIC SCOPING MEETING

What: Scoping Meeting for the Seismic Life Safety Phase 2B Project Environmental Impact Report.

When: Wednesday, January 14, 2009 at 6:30 PM

Where: North Berkeley Senior Center, 1901 Hearst Street Berkeley, California 94709

Parking: Parking is available at the Senior Center and on surrounding streets.



Organization of this Notice of Preparation / Environmental Checklist

This Environmental Checklist is organized into the following sections:

Section 1 – Project Information: provides summary background information about the Project, including Project location, lead agency, and contact information.

Section 2 – Introduction: summarizes the scope of the document, the Project's review and approval processes, and the document's organization.

Section 3 – Project Description: presents a description of the Project and the Project's objectives.

Section 4 – Environmental Factors Potentially Affected: addresses whether the Environmental Checklist identifies any environmental factors that involve a significant impact that cannot be reduced to a less than significant level or potentially significant impacts requiring mitigation.

Section 5 – Determination: indicates whether impacts associated with the proposed project would be significant and what, if any, additional environmental documentation is required.

Section 6 – Evaluation of Environmental Impacts: contains the Environmental Checklist form for each resource area. The checklist is used to assist in evaluating the potential environmental impacts of the Project.

1. PROJECT INFORMATION

Project Title:	Seismic Life Safety Phase 2B Project
Lead Agency:	The University of California.
Location:	Lawrence Berkeley National Laboratory One Cyclotron Road Berkeley, CA 94720
Applicant:	The University of California. [1]
Existing LRDP Designation:	In accordance with the UC-LBNL LRDP Land Use Map, Buildings 4, 5, 14, 16, 17, 25, 55, the Building 71 Trailers, Building 74f, and the site for the General Purpose Lab are in the Research and Academic land use zone. Building 85 is located in the Support Services land use zone.
Existing On-site Land Use:	The Project would take place on the sites of: the parking lot to the southeast of Building 74; Building 85; Buildings 25, 25B, 74F, and the Building 71 Trailers; and Building 55 or one or more of buildings 4, 5, 14, 16, and 17. (See Figure 3).
Surrounding Land Use:	The General Purpose Lab would be constructed primarily on an existing surfaced parking lot located to the southeast of Building 74. Buildings 25, 25B, 55, the Building 71 trailers, 74F, 85, 4, 5, 14, 16, and 17 are also all located in close proximity to other existing LBL buildings, infrastructure, and roadways.
Description of Project:	See Project Description in Section 3 of this document.
Interested and Responsible Agencies[2]	Bay Area Air Quality Management District; California Department of Fish and Game; San Francisco Regional Water Quality Control Board

[1] As mentioned above, the US Department of Energy is the Federal Lead Agency and will prepare an Environmental Assessment pursuant to the National Environmental Policy Act (NEPA).

2 This NOP identifies Interested and Responsible Agencies pursuant to CEQA.

2. INTRODUCTION

2.1 Environmental Checklist

The Environmental Checklist presented in Section 6 of this document is the result of a preliminary environmental analysis of the Project conducted by UC-LBNL in summer and fall 2008. The preliminary determinations of impact significance presented in the checklist represent the outcome of that analysis. As the checklist indicates, the Project may result in impacts requiring mitigation in relation to several issues: Aesthetics, Air Quality, Biological Resources, Cultural Resources, Geology and Soils, Hydrology and Water Quality, Noise, and Transportation and Traffic.

2.2 EIR Process

The environmental checklist concludes that the proposed Project would result in the following categories of impacts, depending on the environmental issue involved: No Impact; Less than Significant impact; Less than Significant with Mitigation Incorporated; or a Potentially Significant Impact. As shown in the Determination Form in Section 6 of this document, the proposed Project may result in potentially significant impacts. As reflected in the checklist, it is anticipated that potentially significant impacts could be reduced to a less than significant level through mitigation. However, preparation of an EIR is warranted for the Project due to the possibility that one or more impacts may be significant and unavoidable. In such instances, there would be no feasible mitigation to reduce the impact to a less than significant level.

2.3 Public Agency and Review

In compliance with CEQA Guidelines, the environmental checklist and Notice of Preparation for the Project will be made available to the public and will be circulated for agency review between the dates of December 9, 2008 and January 27, 2009. Because of the coinciding holidays, the normal 30-day comment period has been extended to 50 days. Comment letters should be postmarked no later than January 27, 2009 and addressed to:

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-234A
Berkeley, CA 94720

Electronically mailed comments must be sent by January 27, 2009 to planning@lbl.gov. Oral comments must be delivered at the January 14, 2009 Public Scoping Meeting, where they will be recorded and then transcribed.

2.4 Project Approvals

As the CEQA Lead Agency, the University of California is responsible for certifying the adequacy of the environmental document and approving the Project. It is anticipated that the University's decision-making entity, The Board of Regents of the University of California (The Regents), will consider approval of the proposed Project in late 2009 or early 2010.

3. PROJECT DESCRIPTION

3.1 Introduction

Lawrence Berkeley National Laboratory is a multi-program research national laboratory operated and managed by the University of California, under contract with the U.S. Department of Energy (DOE). The purpose of the Project would be to address high-seismic life-safety risks in general-purpose research facilities and lab-wide resource buildings without resulting in a net decrease in such research space. In addition, the Project would seek to maintain or improve opportunities for scientific collaboration through proximal siting of research functions, and to improve LBNL operational efficiency and cost-effectiveness. Towards these ends, the Project would enable the move of approximately 100 research staff from leased facilities on Potter Street in Berkeley back to the main LBNL hill site

3.2 Project Summary

The Project would include demolition of approximately 43,000 gross square feet (gsf) of outdated and seismically unsafe facilities, seismic improvements to Building 85, and construction of an approximately 43,000 gsf General Purpose Laboratory facility. Each of these components is further described in this document.

3.3 Project Objectives

The Project objectives are to:

- Provide researchers with safe, modern, life science research space that is fully suitable for twenty-first-century science.
- Provide general-purpose research and institutional space that is upgradable and that may flexibly meet the high accuracy requirements of DOE's 21st Century missions. High accuracy laboratory space is essential for the continued development of DOE's key program areas.
- Increase efficiency of LBNL research operations and promote scientific adjacencies by offering modern, cost-effective, consolidated space at the Lab's main hill site.
- Co-locate researchers and graduate students within a cluster of life science research facilities to expand opportunities for instrument sharing and interacting among life scientists engaged in a wide range of research projects.
- Locate consolidated life science research functions adjacent to the Nanosciences/Molecular Foundry Research cluster to strengthen ties and interactions between these two emerging and related areas of research.
- Construct a General Purpose Lab that complies with DOE policy regarding LEED certification and thereby earns a LEED gold certification.

3.4 Project Location and Surrounding Uses

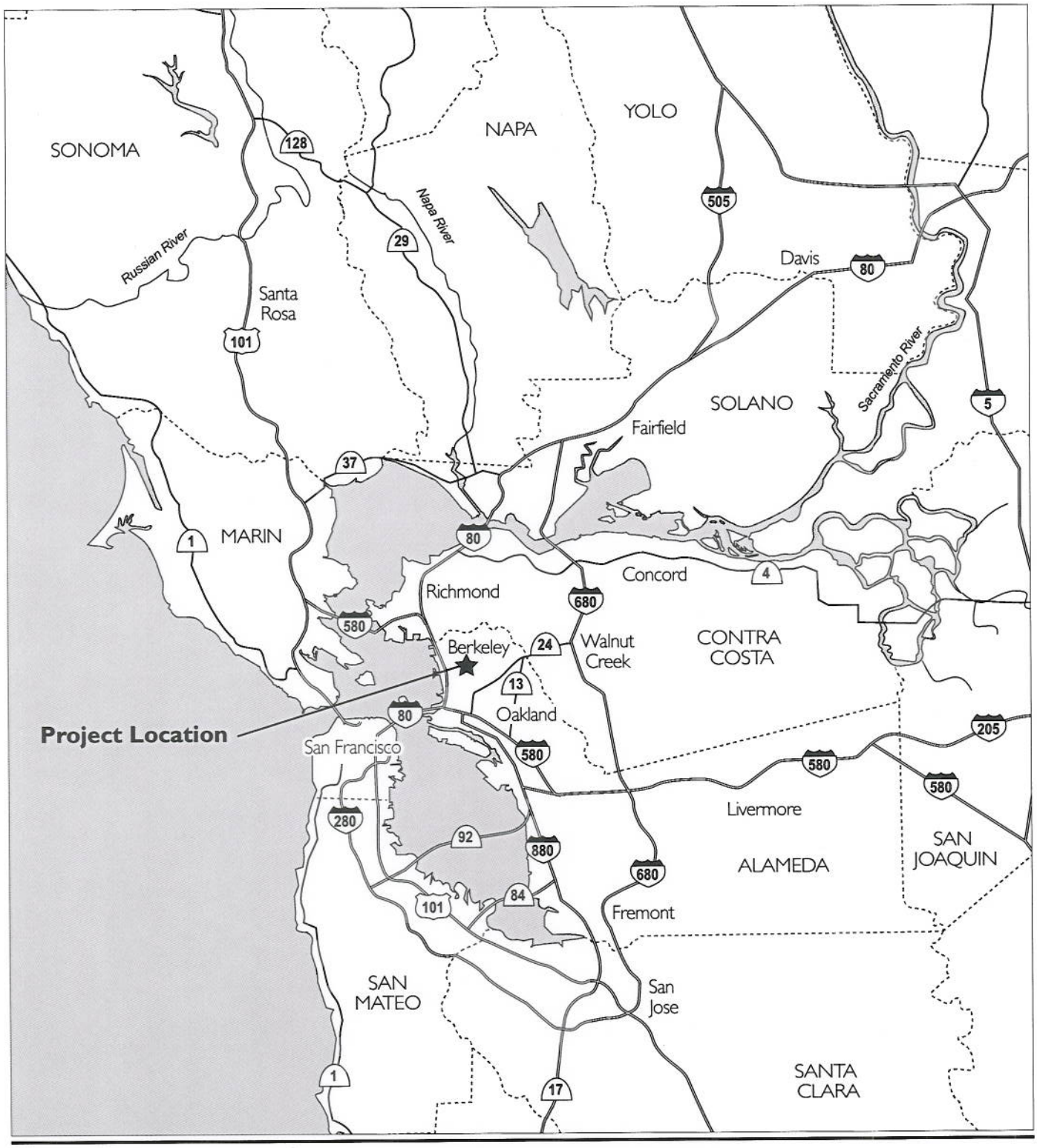
The Project would take place on various sites totaling approximately four acres within the LBNL main hill site in the cities of Berkeley and Oakland, in Alameda County, California. The LBNL location within the region and local vicinity are illustrated in Figures 1 and 2.

3.5 Project Characteristics

The proposed Project components would be located throughout the LBNL site, as illustrated in Figure 3. Buildings 25 and 25B, and the Building 71 trailers, which would be demolished, are located in the central-

western portion of the site. Demolition would also include either Building 55, located in the northeastern section of the site, or, if funding constraints prevented demolition of Building 55, one or more of the following buildings, located in the central portion of the site: 4, 5, 14, 16, and 17. The remaining elements would be located at the eastern end of the site and include the seismic upgrade to Building 85, demolition of Building 74F, and construction of a General Purpose Lab just southeast of Building 74. As shown on Figure 3, the site for the General Purpose Lab, Building 74F, and Building 85 are located in the City of Oakland, and the Building 71 trailers and Buildings 25 and 55 are located within the City of Berkeley. Buildings 4, 5, 14, 16, 17 and are also located in the City of Berkeley.

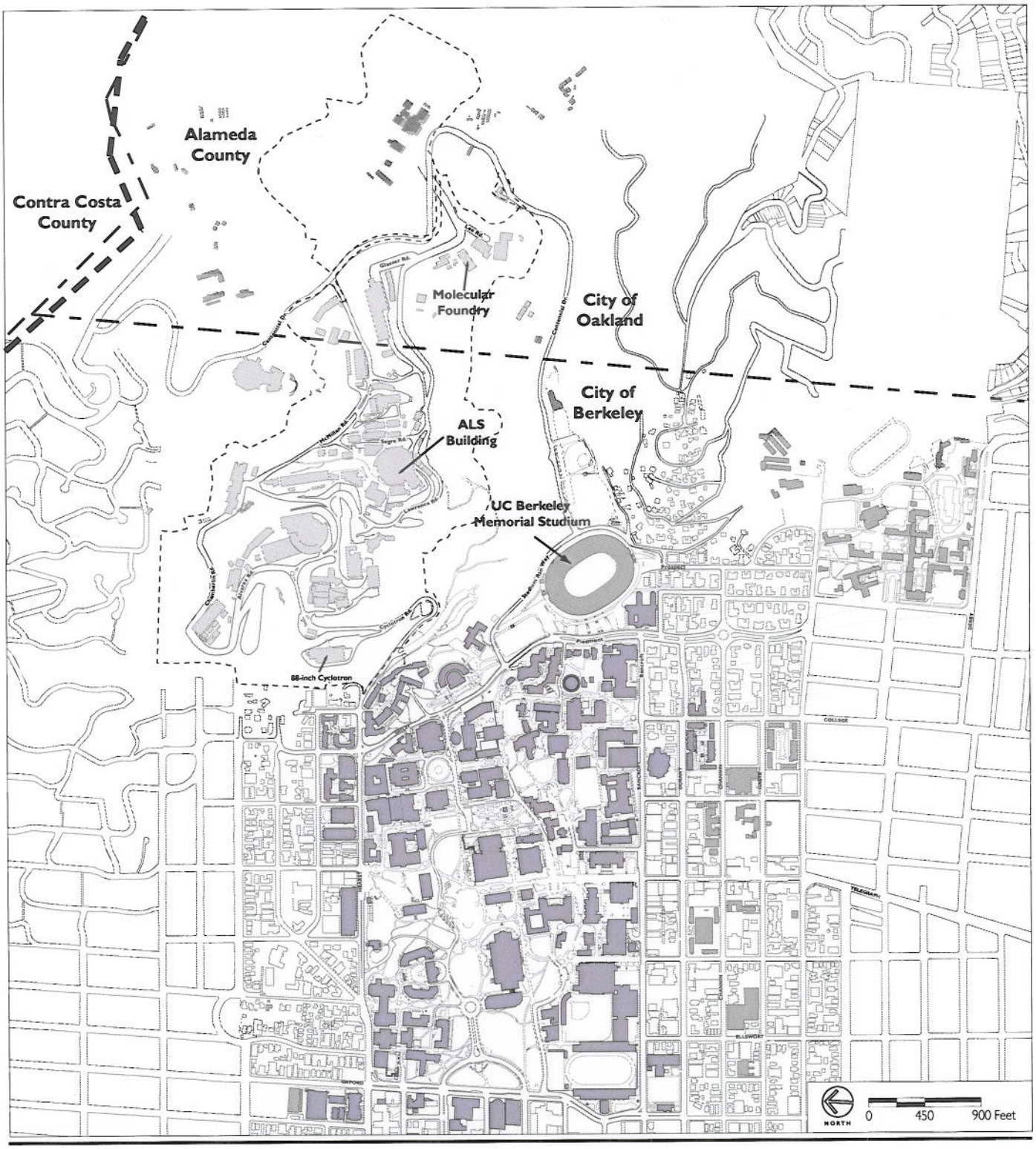
Approximately 43,000 gsf of new building space would be constructed and an equal or greater amount of existing space would be demolished, such that no net increase in space would result from the proposed Project. In almost all cases, the physical extent of demolition and construction work would be limited to sites that have already been disturbed by development. The one exception is the construction of the 43,000 gsf General Purpose Lab. The footprint of this new building and related improvements would be located in the UC-LBNL LRDP Research and Academic land use zone and the building would extend slightly uphill (east) and downhill (west) into currently undeveloped areas.



County Boundaries

FIGURE 1

REGIONAL LOCATION



LBNL Buildings
LBNL Boundary
UC Berkeley Buildings

FIGURE 2

LOCAL LOCATION

a) New Construction

General Purpose Lab

The Project would include construction of a three-story, approximately 43,000 gsf General Purpose Laboratory building in the Lab's LRDP-designated Research and Academic land use zone. The site plan for the Lab building is shown in Figure 4. This facility, which would consist of approximately 60 percent wet lab facilities and 40 percent office space, would be constructed primarily on an existing asphalt-surface parking lot to the southeast of existing Building 74.

The footprint of the building would be approximately 10,000 square feet, the entire building would be approximately 43,000 gsf, and the height would be approximately 48-52 feet on the building's southwest face and 32-36 feet on the northeastern face. Final building height will be determined through the final design process.

Utilities

Utility connections to existing lines would be provided for disposal of waste water and potable water supply. These connections would take place within areas that have already been disturbed by development. Three new fire hydrants would be installed around the exterior of the building. The General Purpose Lab building would require the addition of three at-grade storm drains in close proximity along its northern side.

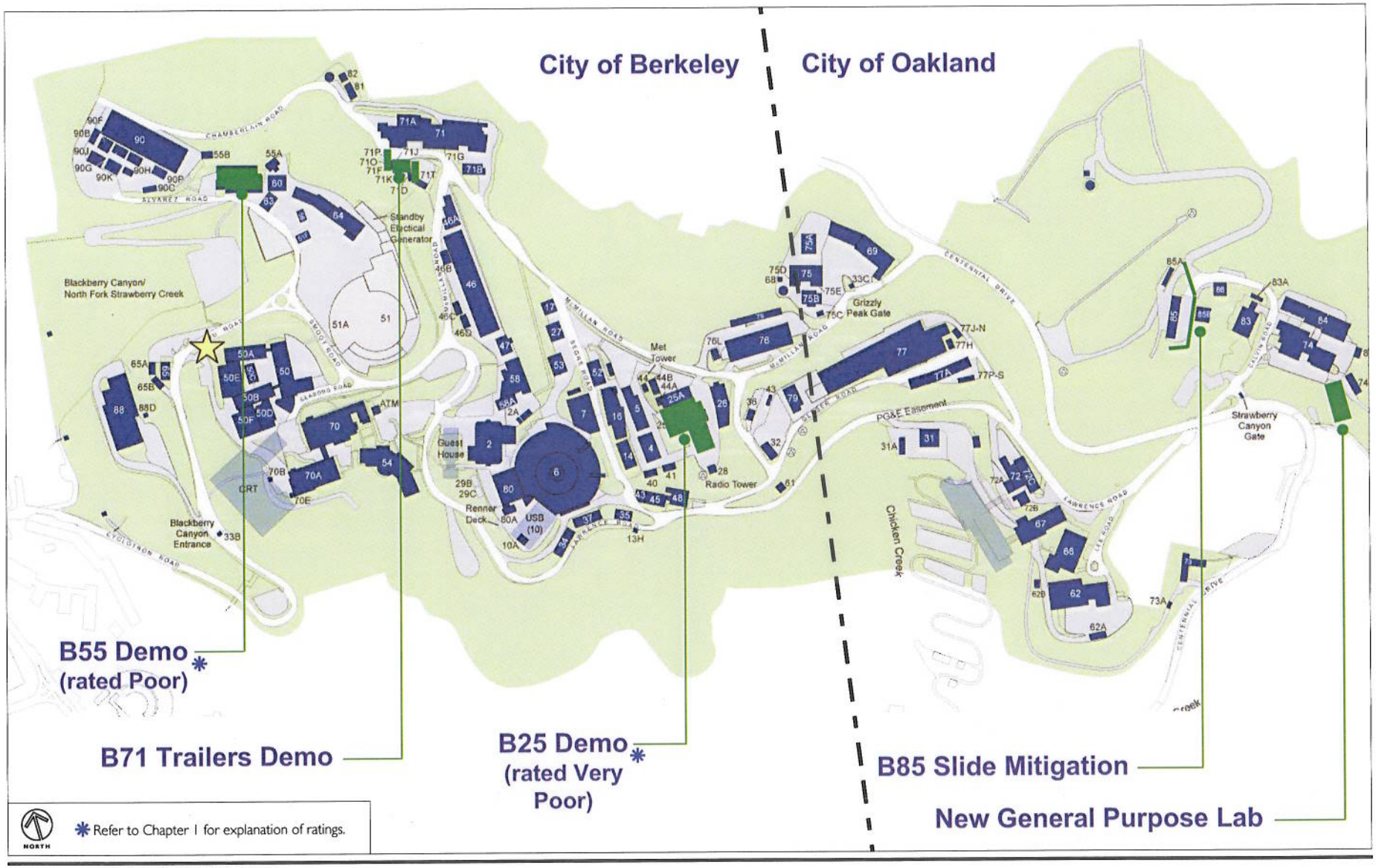
b) Building 85 Slide Mitigation

This Project component includes a seismic upgrade to Building 85, the Hazardous Waste Handling Facility (HWHF), which is a lab-wide operations building constructed in 1996. A subsequent geotechnical study prepared prior to construction of Building 86, which is the adjacent building to the southeast of Building 85, raised concerns that ancient landslide deposits could present a hazard to Building 85 during a major seismic event. Additional studies indicated that these landslide deposits may be subject to renewed movement in the event of a major earthquake, posing a potential hazard to Building 85. The upgrade project would install a below-grade system, such as pier foundations and tiebacks system to stabilize the landslide during a major earthquake. The Project would also seismically strengthen the building's first story shear walls and other lateral force systems.

c) Demolition

The Project would involve the demolition of Buildings 25, 25B, 55, modular trailers associated with Building 71, and Building 74F. (Or, in lieu of demolishing Building 55 for funding reasons, the Project might demolish one or more of Buildings : 4, 5, 14, 16, and 17.) Buildings 25 and 25B have been rated as "very poor" according to the University of California Seismic Rating System.[3] Building 55, is rated as "poor." The Building 71 trailers that would be demolished are over 30 years old and past their useful life

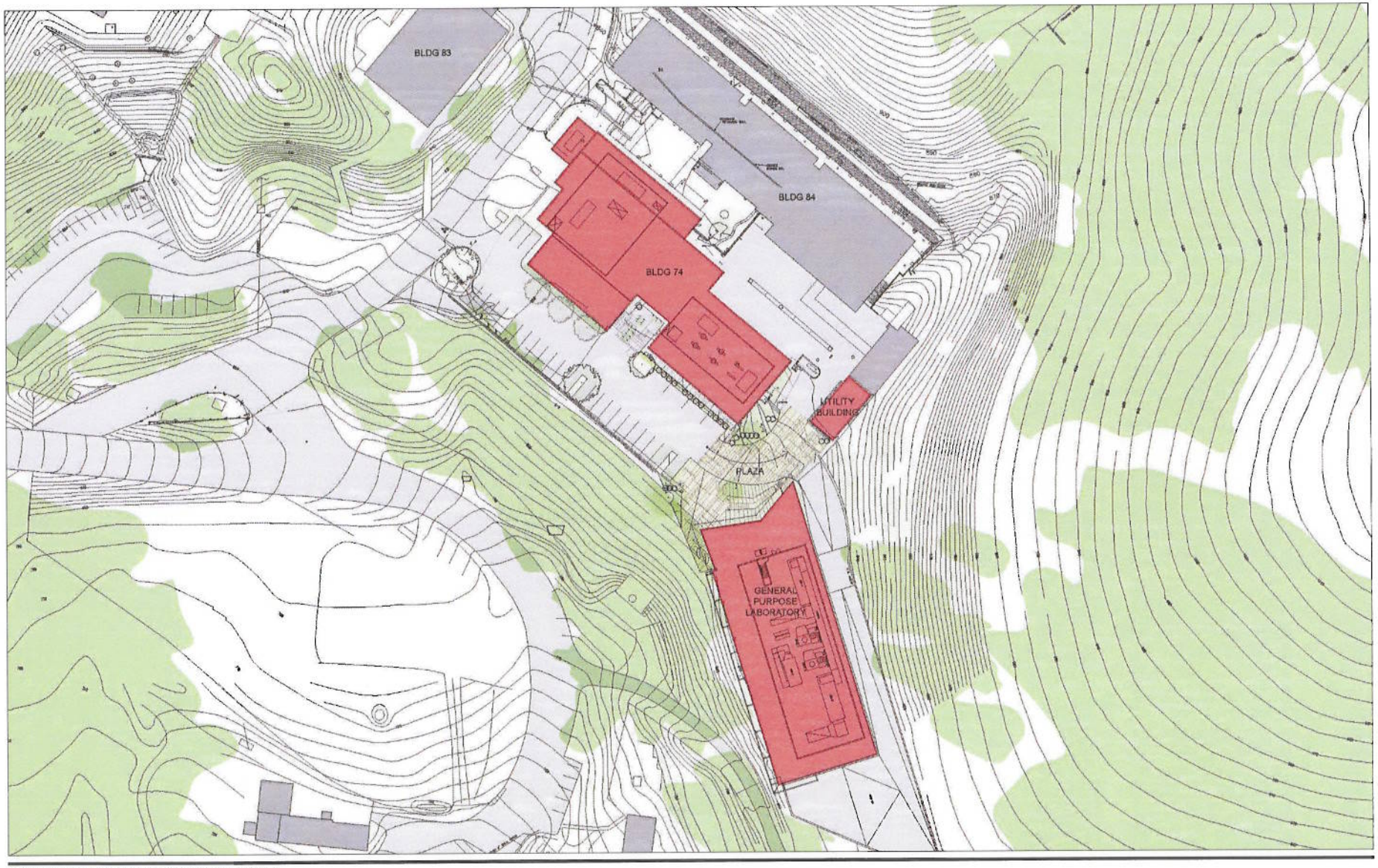
[3] University of California Seismic Rating: Established campus standards for seismic rehabilitation project for new construction using performance rating of Good, Fair, Poor, and Very Poor.



Source: Lawrence Berkeley National Laboratory

FIGURE 3

PROJECT COMPONENTS



Source: Lawrence Berkeley National Laboratory

FIGURE 4

NEW GENERAL PURPOSE LAB SITE PLAN

Buildings 25 and 25B house shop, lab, engineering, and other multi-program equipment, instruments, and material that are not accessed on a daily basis. Full-day occupants were moved from this building to temporary locations due to exceptionally high collapse risks, as indicated by its "Very Poor" seismic rating.

Building 55 is a 19,048 gsf wet laboratory and office building. Preliminary evaluation of a seismic upgrade and modernization of laboratory spaces project for this building has determined that an upgrade is not the most cost effective solution. It is intended that the occupants would be relocated to the General Purpose Lab, the current building would be demolished, and the site made available for potential future building projects.

As stated above, in the event that Building 55 is not demolished due to funding constraints, one or more of the following seismically deficient buildings may be demolished: 4,5,14, 16, and/or 17.

Trailers 71C, 71D, 71G, 71J, and 71P are office trailers that were installed in 1981 and have reached the end of their useful life. These trailers cannot be cost effectively upgraded, therefore, replacement space is required.

Building 74F is a vacant, one-story structure that was previously used to house animals utilized for research purposes. This building is located within the existing parking lot to the southeast of Building 74 and would be removed to accommodate new construction associated with the General Purpose Lab.

3.5.1 Project Design

Building Design

The discussion of design aesthetics is limited to the General Purpose Lab building because the exterior of Building 85 would not be altered through this project. The 2½- to 3-story General Purpose Lab would be terraced into the hillside in order to blend in with the surrounding environment and structures (Buildings 74 and 84). Furthermore, the design of the facility would reflect a balance between a modern office space and an institutional facility that is the dominant architectural style at LBNL. The Building is being designed and situated to provide for a mix of natural ventilation and solar exposure for energy efficiency. The arrangements of the common spaces within the facility provide opportunities for interaction and collaboration. The design would also take advantage of the site's natural features and existing facilities such as pedestrian and vehicular points of connection.

UC-LBNL has established a goal of a LEED "Gold" rating for the new General Purpose Laboratory Building. The design, construction, and operation of the building is being conceived in a manner to minimize the amount of non-renewable energy that would be consumed by the Project; design concepts include both common and innovative strategies to improve the environmental consequences of the facility's construction and use. The Building 85 Slide Mitigation and the proposed demolition work are not eligible for LEED ratings, but LBNL would incorporate sustainable practices in their design and implementation.

3.5.2 Access, On-Site Circulation and Parking

A drop-off area and ADA parking would be located near the entrance of the proposed General Purpose Lab building. Additionally, a stop for the free LBNL shuttle service is located on Calvin Road at the entrance to the Building 74 parking lot, which would be approximately 250 feet from the entrance to the facility.

The Project would result in the net loss of approximately 24 existing parking stalls due to the construction of the General Purpose Lab. The stalls to be removed are located within an existing surface parking lot, which is to the southeast of Building 74.

As required parking spaces for disabled guests would be provided in existing parking lots in the immediate vicinity of the General Purpose Lab.

The General Purpose Lab would meet American With Disabilities Act (ADA) requirements. At a minimum, disabled access would be provided through the main entrance on the west side of the building. Depending on final design, disabled access may be provided on other sides of the building.

Users of Building 85 and the General Purpose Lab could arrive at these facilities by the LBNL shuttle bus, which features a shuttle stop at the entrance of the driveway to Building 74. The shuttle provides connections to various points throughout Berkeley, including AC Transit stops and the Downtown Berkeley BART station. As provided in LBNL's ongoing Transportation Demand Management Program (TDMP), employees and visitors to these facilities could also access these facilities by carpool, vanpool, and bicycle.

LBNL guests, employees, and vendors would be provided access to the Building 85 and the General Purpose Lab under the existing LBNL entrance policies and procedures. No changes to LBNL's existing security and safeguards are anticipated. LBNL's entrance is monitored by security 24 hours a day, 7 days a week, and a security pass is required for site access.

Emergency (Fire) Access

Emergency vehicles would access the General Purpose Lab from the existing driveway located along the southwestern face of Building 74. A corridor providing sufficient clearance for emergency vehicle access would be established along the northeastern side of the building and would wrap around its southern end.

3.5.3 Research Materials and Chemicals On-Site

The operation of the General Purpose Lab would involve the storage and use of typical types and relatively small volumes of laboratory chemicals (many of which are classified as hazardous materials) and low-level radiological equipment associated with running a facility of this nature. The most common types would include formaldehyde, toluene, chloroform and acrylamide. The LBNL Environment, Health, and Safety Division maintains and oversees procedures for storage, handling, use, and disposal of hazardous materials, which are compliant with state and federal regulations.

3.6 Project Population

The Project would result in a net increase in approximately 100 personnel (part-time and full-time) at LBNL as staff would relocate from the LBNL Potter Street facility in Berkeley to the main hill site. This is consistent with the "Project Varient" analyzed in the UC-LBNL 2006 Long Range Development Plan EIR, which was certified by The Regents in July 2007.

3.7 Construction Schedule

Construction and demolition activities are anticipated to start in January 2011 and continue through March 2015.

4. ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project involving at least one impact that is a "Potentially Significant Impact" as indicated on the checklist on the following pages. As stated above, based on the environmental screening analysis completed for the Project in summer/fall 2008, it is not anticipated that the Project would cause any "Potentially Significant Impacts" that would result in significant and unavoidable impacts. Rather, it is anticipated that all potentially significant impacts could be reduced to a less than significant level through mitigation. Based on this preliminary conclusion, none of the boxes in Table 4-1 have been checked. However, an EIR is being prepared for the Project due to the possibility that a significant and unavoidable impact may be identified through the analysis therein.

TABLE 4-1 **Environmental Resources Potentially Affected by Seismic Life Safety Phase 2B Project**

	Aesthetics		Agricultural Resources
	Air		**Biological Resources**
	Cultural Resources		**Geology and Soils**
	Hazards		**Hydrology and Water Quality**
	Land Use		**Mineral Resources**
	Noise		**Population and Housing**
	Public Services		**Recreation**
	Transportation/ Circulation		**Utilities and Service Systems**
	Mandatory Findings of Significance		

5. DETERMINATION

DETERMINATION: (To be completed by the Lead Agency)

On the basis of the initial evaluation that follows:

_____ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

_____ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

X I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

_____ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. A TIERED ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

_____ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, no further environmental document is required. FINDINGS consistent with this determination will be prepared.

Signature _____ Date 12-9-08

JEFF PHILLIBER — UC-LBNL

Printed Name — For

6. EVALUATION OF ENVIRONMENTAL IMPACTS

Introduction

The following Environmental Checklist form is based on Appendix G of the 2008 CEQA Guidelines.

Project Impacts
The Environmental Checklist identifies potential project effects as corresponding to the following categories of impacts:

A. Potentially Significant Impact is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

B. Less than Significant with Mitigation Incorporated applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less-than-significant level (mitigation measures from earlier analyses may be cross-referenced).

C. Less Than Significant Impact applies where the project creates no significant impacts; or only Less than Significant impacts.

D. No Impact applies where a project does not create an impact in that category. "No Impact" answers do not require an explanation if they are adequately supported by the information sources cited by the lead agency which show that the impact simply does not apply to projects like the one involved (e.g. the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g. the project will not expose sensitive receptors to pollutants, based on a project specific screening analysis).

Thresholds of Significance	**Potentially Significant Impact**	**Less Than Significant with Mitigation Incorporated**	**Less Than Significant Impact**	**No Impact**
1. AESTHETICS – Would the project:				
a) Have a substantial adverse effect on a scenic vista?			X	
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a State scenic highway?				X
c) Substantially degrade the existing visual character or quality of the site and its surroundings?		X		
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?			X	

	Potentially Significant Impact	**Less Than Significant with Mitigation Incorporated**	**Less Than Significant Impact**	**No Impact**
2. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Resources Agency, to non-agricultural use?				
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland to non-agricultural use?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
3. AIR QUALITY – Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?				X
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?		X		
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?			X	
d) Expose sensitive receptors to substantial pollutant concentrations?			X	
e) Create objectionable odors affecting a substantial number of people?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
4. BIOLOGICAL RESOURCES – Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?				X
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?				X
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?			X	
e) Conflict with any local applicable policies protecting biological resources?			X	
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other applicable habitat conservation plan?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
5. CULTURAL RESOURCES – Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?				X
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?		X		
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?				X
d) Disturb any human remains, including those interred outside of formal cemeteries?			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
6. GEOLOGY AND SOILS – Would the project: a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to California Geological Survey Special Publication 42.				X
ii) Strong seismic ground shaking?			X	
iii) Seismic-related ground failure, including liquefaction?			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
iv) Landslides?			X	
b) Result in substantial soil erosion or the loss of topsoil?			X	
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?		X		
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?			X	
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
7. HAZARDS AND HAZARDOUS MATERIALS – Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?			X	
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?				X
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?				X
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?			X	
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
8. HYDROLOGY AND WATER QUALITY – Would the project:				
a) Violate any water quality standards or waste discharge requirements?			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g. the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?			X	
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?			X	
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?		X		
f) Otherwise substantially degrade water quality?				X
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				X
j) Inundation by seiche, tsunami, or mudflow?			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
9. LAND USE AND PLANNING – Would the project:				
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the LRDP, general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
10. MINERAL RESOURCES – Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
11. NOISE – Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in any applicable plan or noise ordinance, or applicable standards of other agencies?			X	
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?			X	
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?			X	
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?		X		
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?				X
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
12. POPULATION AND HOUSING – Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
13. PUBLIC SERVICES: a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
Fire protection?			X	
Police protection?			X	
Schools?				X
Parks?				X
Other public facilities?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
14. RECREATION –				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
15. TRANSPORTATION/TRAFFIC – Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e. result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?			X	
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?		X		

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that result in substantial safety risks?				X
d) Substantially increase hazards due to a design feature (e.g. sharp curves or dangerous intersections) or incompatible uses (e.g. farm equipment)?				X
e) Result in inadequate emergency access?				X
f) Result in inadequate parking capacity?			X	
g) Conflict with applicable policies, plans, or programs supporting alternative transportation (e.g. bus turnouts, bicycle racks)?			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
16. UTILITIES AND SERVICE SYSTEMS – Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				X
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?			X	
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?			X	
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?				X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?				X
g) Comply with applicable federal, State, and local statutes and regulations related to solid waste?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
17. MANDATORY FINDINGS OF SIGNIFICANCE –				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?			X	
b) Does the project have impacts that are individually limited, but cumulatively considerable?("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in			X	

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?				
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?			X	

Fish and Game Determination

Based on the information above, there is no evidence that the project has a potential for a change that would adversely affect wildlife resources or the habitat upon which the wildlife depends. The presumption of adverse effect set forth in 14 CCR 753.5 (d) has been rebutted by substantial evidence.

____ Yes (Certificate of "No Effect")

_X_ No (Pay fee)

APPENDIX B

AIR QUALITY AND GHG ANALYSIS

REPORT

AIR QUALITY TECHNICAL ANALYSIS

Air Quality Analysis Performed for the Seismic Phase 2 Project at the Lawrence Berkeley National Laboratory

Submitted To: Design, Community & Environment
1625 Shattuck Avenue, Suite 300
Berkeley, California 94709

Submitted By: Golder Associates Inc.
9 Monroe Parkway
Suite 270
Lake Oswego, Oregon 97035 USA

Date: January 26, 2010

Project No. 093-99021

A world of capabilities delivered locally

Golder Associates

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1.0 INTRODUCTION

The Seismic Life-Safety Phase 2 Project (Project) at the Lawrence Berkeley National Laboratory (LBNL) is proposed by the University of California and the U.S. Department of Energy. The LBNL site is an approximately 200-acre University-owned site in Berkeley and Oakland, California and is located adjacent to the University of California Berkeley (UCB) campus.

This report provides the estimated air emissions associated with the construction and operation of the General Purpose Lab (GPL) and other components of the Project. Associated air emissions of criteria pollutants (nitrogen oxides [NO_x], carbon monoxide [CO], particulate matter less than 10 microns [PM_{10}], sulfur dioxide [SO_2], and reactive organic gases [ROG]), toxic air contaminants (TACs), and carbon dioxide (CO_2; a greenhouse gas) were quantified.

In addition, potential human health impacts were estimated from the TAC emissions quantified.

1.1 Purpose

This air quality impact analysis was performed in support of a draft environmental impact report (DEIR) submitted for the proposed Project.

1.2 Project Overview

The proposed Project includes the demolition of some seismically “poor” and “very poor” structures and provides new space for the displaced occupants and functions elsewhere on the LBNL campus. The Project would also allow for the consolidation of life science personnel from various locations on and off the LBNL main hill site in a new facility to be constructed on the current Building 25/25B location, at the heart of the LBNL campus.

Building 85, constructed in 1996, was later discovered to have been built on two landslides. The landslides could be unstable in an earthquake. In addition, requirements for building performance in the event of an earthquake have been increased since that time.

Building 55 and the Building 71 trailers that would be demolished (71C, 71F, 71J, 71K, and 71P) are located in the northeastern section of the site. Building 25/25B and the site of the proposed GPL is in the central portion of the site.

As such, the Project consists of the following building demolition, construction, and upgrade activities:

Table 1-1. Proposed Project Actions

Action	Gross Square Footage	Footprint Square Footage
Building 25/25B Demolition	20,664	17,100
GPL Construction at B25/25B Site	43,000	14,000
Building 55 Demolition	19,048	14,327
Building 71 Trailers (71C, F, J, K and P) Demolition	3,348[1]	3,348[1]
Building 85 Seismic Strengthening	Not applicable	Not applicable

Based on the Project action descriptions in Table 1-1 above and additional information about the operation of the GPL building and volumes of truck traffic associated with these construction/ demolition activities, air pollutant emissions were estimated.

1.3 Analyses Performed

Activities for which air emissions were estimated were divided up into three categories:

1) Emissions from ongoing operation of the GPL once construction has been completed. These emissions are associated with research laboratory chemical use, natural gas combustion in water boilers, and a backup diesel generator included in the building design.

2) Emissions from off-road construction and demolition equipment used to demolish existing buildings and construct the GPL. These include emissions from internal fuel combustion and fugitive dust generated by these activities.

3) Emissions from on-road trucks travel associated with the construction and demolition phases of the Project. Only vehicle tailpipe emissions were considered in this analysis.

Maximum daily and annual criteria pollutant emissions were estimated, along with maximum CO_2 emissions.

[1] Note that after completion of the analyses discussed in this report, Golder was informed that an additional trailer was added to the Building 71 demolition list (71D), which would increase the square footage from 3,348 gsf to 3,842 gsf. Since this change adds only 1% to the total square footage demolished, it would have an inconsequential effect on the air quality impact assessment and was not considered in the analyses performed in this report.

TAC emissions from the emission sources listed above were used in conjunction with dispersion modeling to estimate potential maximum exposure concentrations at hypothetical human receptor locations, which were converted to estimates of maximum lifetime excess cancer risk and chronic health hazard.

For on-road truck travel and onsite, off-road equipment, TAC and $PM_{2.5}$ emissions associated with construction and demolition projects identified at both the LBNL and UCB (for those projects that might contribute cumulatively) facilities during the Project period (approximately August 2010 through April 2014) were quantified and used to estimate maximum lifetime excess cancer risk and non-cancer health hazard at hypothetical human receptor locations, as well as maximum annual average $PM_{2.5}$ concentrations in ambient air.

2.0 AIR EMISSION ESTIMATES

The following sections provide descriptions of the sources of air pollutant emissions currently anticipated as part of the Project.

2.1 General Purpose Lab Operations Emissions

Based on information provided by LBNL and its contractors, GPL project operations are expected to include the following sources of air emissions:

- Laboratory hood exhaust vented out of two stacks
- One backup diesel generator
- Two natural gas fired boilers
- Mobile emissions from employee vehicles

A summary of all GPL operation criteria pollutant and CO_2 emission estimates is presented in Table 2-1 and TAC emission estimates are presented in Table 2-2. The following sections detail how criteria pollutant, CO_2, and TAC emission estimates were determined for the GPL project.

2.1.1 Laboratory Emissions

A baseline emission inventory for the LBNL facility was developed for the 2006 LRDP HHRA study (SECOR, 2004). The baseline emissions inventory, along with toxicity factors, was then used in a screening process to identify chemicals of potential concern (COPCs) based on those chemicals representing at least 90% of the toxicity-weighted TAC emission from the facility. For purposes of this study, it was assumed that any COPCs emitted from a laboratory source in the 2006 LRDP HHRA study will be emitted by the laboratories in the GPL building.

The baseline emissions inventory for the laboratories was then used to develop TAC emission factors based on laboratory square footage. These emission factors were used to estimate TAC emissions from future laboratories in the LRDP for the facility, and were used in the current assessment to estimate TAC emissions from the GPL building. The GPL building is estimated to have 16,250 net square feet of laboratory space, which was used in conjunction with the emission factors to estimate TAC emissions.

Detailed calculations of laboratory TAC emission estimates are presented in Appendix A.

2.1.2 Backup Diesel Generator

One 350 kilowatt (kW) diesel-fired emergency backup generator is proposed for the GPL project. Based on data for a typical 350 kW diesel generator, the engine for this unit will have approximately 535 horsepower. The generator was assumed to operate up to 50 hours per year.

Emission factors for potential volatile organic TACs for the generator were taken from the California Air Toxics Emission Factors (CATEF) database.[1] Since neither this database nor information provided in the U.S. EPA AP-42 document included metals emissions, emission factors for metal TACs were obtained from the emission factors published by the Ventura County Air Pollution Control District for the AB2588 program[2].

Emissions of individual TACs form the diesel generator were calculated for informational purposes only. For the risk assessments conducted, only diesel particular matter (DPM) was used, as the toxicity factors for DPM account for the toxicity of all TAC components of diesel exhaust.

Criteria pollutant emissions, and CO_2, were based on emission factors from AP-42, generator specification sheet, and the engine specification sheet. Particulate emissions were not calculated since DPM was estimated under the TAC emission estimates. It was assumed that all particulate from the diesel generator would be DPM.

Detailed emission calculations for criteria pollutants and CO_2 from the backup diesel generator are presented in Appendix B.

2.1.3 Natural Gas Boilers

Two natural gas-fired boilers with a total combined maximum heat input of 3.3 million British thermal units (MMBTU) per hour are proposed for the GPL Project. Emission factors for potential TAC emissions for these boilers were taken from the following data sources, in descending order of preference:

- CATEF database
- U.S. EPA AP-42 document

Based on information provided by LBNL and its contractors, annual emissions for the boilers were based on a maximum annual fuel usage of 6,000 therms.

Criteria pollutant emissions, and CO_2, were based on AP-42 emission factors.

[1] See http://www.arb.ca.gov/ei/catef/catef.htm.

[2] See http://www.aqmd.gov/prdas/pdf/COMBEM2001.pdf.

Detailed emission calculations of for criteria pollutants, CO_2, and TACs from the natural gas fired boilers are presented in Appendix B.

2.1.4 Employee Vehicles

The URBEMIS (Urban Emissions) model, Version 9.2.4 (June 2007) was used to estimate emissions from employee vehicles associated with Project operations. URBEMIS accounts for tailpipe emissions for a project under the "operational emissions" section of the model. URBEMIS estimates emissions from vehicles based on the user selected "land use type" and an associated vehicle trip rate. For the GPL project, the "Junior College (2-year)" land use type was selected since trip rates could be based on the square footage of the GPL building (the "University/College (4-year) land use type did not allow for the trip rate to be based on square footage, only the total number of students).

A total area of 43,000 square feet (equal to the gross square footage of the GPL building) was input into URBEMIS under the Junior College land use type. The default vehicle trip rate of 27.49 vehicle trips per 1,000 square feet was modified to 4.65 vehicle trips per 1,000 square feet to yield a total daily vehicle trip rate of 200, which was estimated to account for both employee vehicles and delivery vehicles. All other values associate with emission estimates for employee vehicles were kept as the URBEMIS default values. URBEMIS summary tables, which present daily and annual emissions estimates for employee vehicles, are presented in Appendix C.

2.2 Project Construction/Demolition Off-Road Equipment Emissions

Several individual construction/demolition projects occur as part of the proposed Project. Based on information received from LBNL and its contractors, these projects (referred to as activities) are defined as follows:

- Building 25 Demolition
- Grading for GPL Building Construction
- GPL Building Construction
- Building 71 Trailer Demolition
- Building 55 Demolition

Each of these activities was explicitly modeled in URBEMIS to estimate the criteria pollutant, CO_2, and TAC emissions resulting from the use of off-road equipment and soil disturbances. For purposes of TAC emission estimates, only DPM was estimated as discussed in Section 2.1.2 above. It was assumed that DPM was equal to 100% of the PM_{10} emissions resulting from engine exhaust.

Output from the URBEMIS model is included in Appendix D. A summary of the criteria pollutant, CO_2, and DPM emission rates is presented in Table 2-3 and the following sections detail the basis of the emission estimates for each activity.

2.2.1 Building 25 Demolition

The demolition of Building 25 was modeled as a demolition activity using URBEMIS to estimate criteria pollutant, CO_2, and DPM emission rates. The demolition activity was defined as occurring 5 days a week from August 2, 2010 through January 28, 2011 for a total of six months.

URBEMIS estimates emissions for demolition activities by using the estimated volume of the building to be demolished. URBEMIS uses the length, width, and height input by the user of the building to be demolished to calculate a total building volume. Since URBEMIS does not account for the geometry of the building to be demolished, the length, width and height do not need to be representative of the physical geometry of the building, but rather the resulting volume should represent the actual volume of the building; therefore, building dimensions resulting in a total building volume of 343,220 cubic feet, approximately the volume of Building 25, were entered.

A maximum daily volume of buildings to be demolished concurrently is also defined in URBEMIS. Similar to the total building volume, a width, length and height (which do not need to represent the geometry of the actual building, but result in a representative building volume) are defined which are then used to calculate a maximum daily volume of buildings to demolished concurrently. For this demolition activity, building dimensions representing 8,384 cubic feet per day were entered.

The values used to define the maximum daily building volume to be demolished were selected so that the number of daily truck trips calculated by URBEMIS was approximately four. This number of daily truck trips is equal to, or slightly more than, the information provided by LBNL and its contractors indicated would occur for this activity.

For this activity, default URBEMIS values were used for all other data inputs including the number and type of equipment.

As stated above, URBEMIS output is included in Appendix D and summaries of the criteria pollutant, CO_2, and DPM emission rates are presented in Table 2-3.

2.2.2 Grading for GPL Building Construction

The site preparation for the construction of the GPL building includes grading. This grading was modeled as a “mass site grading” activity using URBEMIS to estimate criteria pollutant, CO_2, and DPM emission rates. The grading activity was defined as occurring 5 days a week from April 1, 2011 through April 29, 2011 for a total of one month.

URBEMIS estimates emissions for grading activities by using the user defined "total acreage to be graded" and the user defined "maximum daily acreage disturbed". For this activity, the following values were defined:

- Total acreage to be graded = 1.97
- Maximum daily acreage disturbed = 0.80

For this activity, the maximum daily acreage disturbed was set equal to the estimated total area of the activity site and the total acreage to be graded was the default value estimated by URBEMIS based on the gross square footage of the GPL building. Default URBEMIS values were used for all other data inputs including the number and type of equipment.

As stated above, URBEMIS output is included in Appendix D and summaries of the criteria pollutant, DPM, and CO_2 emission rates are presented in Table 2-3.

2.2.3 GPL Building Construction

The construction of the GPL building was modeled as a "construction" activity using URBEMIS to estimate criteria, DPM and greenhouse gas emission rates. The construction activity was defined as occurring 5 days a week from May 2, 2011 through April 26, 2013 for a total of 25 months.

For this activity, default URBEMIS values were used for all data inputs including the number and type of equipment. No input values were modified.

As stated above, URBEMIS output is included in Appendix D and summaries of the criteria pollutant, CO_2, and DPM emission rates are presented in Table 2-3.

2.2.4 Building 71 Trailer Demolition

Several trailers that are located adjacent to building 71 will be demolished. The trailers are 71C, F, J, K and P. The demolition of these trailers was modeled as a demolition activity using URBEMIS to estimate criteria pollutant, CO_2, and DPM emission rates. The demolition activity was defined as occurring 5 days a week from September 3, 2012 through April 26, 2013 for a total of eight months.

As noted in Section 2.2.1 above, URBEMIS estimates emissions for demolition activities by using the estimated volume of the building to be demolished. Since URBEMIS does not account for the geometry of the building to be demolished, the length, width and height do not need to be representative of the physical geometry of the building, but rather the resulting volume should represent the actual volume of the building; therefore, building dimensions resulting in a total building volume of 40,368 cubic feet, approximately the volume of the Building 71 trailers to be demolished, were entered.

As noted for Building 25, the maximum daily building volume to be demolished were selected so that the number of daily truck trips calculated by URBEMIS was approximately equal to the number of daily truck trips provided by LBNL and its contractors indicated for this activity (three trips per day [or 6,960 cubic feet] for the Building 71 trailer demolitions).

For this activity, default URBEMIS values were used for all other data inputs including the number and type of equipment.

As stated above, URBEMIS output is included in Appendix D and summaries of the criteria pollutant, CO_2, and DPM emission rates are presented in Table 2-3.

2.2.5 Building 55 Demolition

The demolition of Building 55 was modeled as a demolition activity using URBEMIS to estimate criteria pollutant, CO_2, and DPM emission rates. The demolition activity was defined as occurring 5 days a week from June 3, 2013 through April 25, 2014 for a total of 11 months.

As noted in Section 2.2.1 above, URBEMIS estimates emissions for demolition activities by using the estimated volume of the building to be demolished. Since URBEMIS does not account for the geometry of the building to be demolished, the length, width and height do not need to be representative of the physical geometry of the building, but rather the resulting volume should represent the actual volume of the building; therefore, building dimensions resulting in a total building volume of 288,000 cubic feet, approximately the volume of Building 55 to be demolished, were entered.

As noted for Building 25, the maximum daily building volume to be demolished were selected so that the number of daily truck trips calculated by URBEMIS was approximately equal to the number of daily truck trips provided by LBNL and its contractors indicated for this activity (four trips per day [or 8,400 cubic feet] for the Building 55 demolition).

For this activity, default URBEMIS values were used for all other data inputs including the number and type of equipment.

As stated above, URBEMIS output is included in Appendix D and summaries of the criteria pollutant, CO_2, and DPM emission rates are presented in Table 2-3.

2.2.6 Emission Rate Scenarios

Three different emission rate scenarios for construction/demolition off-road equipment emissions were necessary for conducting dispersion modeling assessments for lifetime excess cancer risk (LECR), chronic hazard, and $PM_{2.5}$ ambient concentrations. The three different emission rate scenarios are as follows:

1) Construction/Demolition total project DPM (PM_{10} exhaust) emissions [for LECR assessment]

2) Construction/Demolition maximum annual DPM (PM_{10} exhaust) emissions [for chronic hazard assessment].

3) Construction/Demolition maximum annual $PM_{2.5}$ (exhaust and fugitive) emissions [for $PM_{2.5}$ assessment]

For the total construction/demolition DPM emissions scenario (Scenario 1), the total mass emission rate for each activity across all years was determined. This constitutes the total mass emitted for each activity and is used in the LECR risk assessments described in Section 4.2 below.

For the construction/demolition maximum annual DPM emissions scenario (Scenario 2), the worst-case year resulting in the highest annual emission rates was determined. Table 2-3 presents emissions for each activity in each corresponding year and identifies the year which constitutes "worst-case". Based on the emissions modeling conducted with URBEMIS as described above, the worst-case year for DPM emissions was 2012. These emissions were used for the chronic hazard assessment described in Section 4.2 below.

The maximum annual $PM_{2.5}$ emission rate for both the construction/demolition scenario (Scenario 3) was determined similar to the maximum annual DPM emission rate in Table 2-3. Both exhaust and fugitive dust sources of $PM_{2.5}$ were analyzed on an annual basis in order to determine the "worst-case" year. Based on the emissions modeling conducted with URBEMIS as described above, the worst-case year for construction/demolition $PM_{2.5}$ emissions was 2013. These emissions were used for the $PM_{2.5}$ ambient concentration assessment described in Section 3.3.3 below.

2.3 Project Construction/Demolition On-Road Truck Emissions

Emissions of air pollutants were estimated for offsite, on-road truck traffic projected to be associated with demolition and construction activities defined for the Project. It should be noted that the projected truck traffic volumes were conservatively estimated for purposes of estimating air pollutant emissions, but should not be used for other purposes as these estimates are likely to be higher than actual values.

2.3.1 Criteria Pollutant and CO_2 Emissions

Maximum daily and annual emissions of ROG, NO_x, PM_{10}, $PM_{2.5}$, CO, SO_2, and CO_2 were estimated for offsite, on-road truck traffic associated with Project demolition and construction activities. Emissions of these pollutants were based on estimates of maximum daily or annual truck roundtrips, an estimated roundtrip distance of 15 miles, and emission factors (in units of pounds per thousand miles travelled) derived from the EMFAC2007 (version 2.3) emissions model.

A maximum single-day volume of truck trips associated with the Project for construction/demolition activities of 14 roundtrips was provided by LBNL. Based on average daily roundtrip data provided by LBNL, the maximum number of truck roundtrips in any 12-month period was estimated to be 1,671 (supporting information provided in Appendix E).

The EMFAC2007 emission model was executed for simulation year 2009 for the Bay Area. Two separate model runs had to be executed to obtain data for PM_{10} and $PM_{2.5}$ (model run outputs are provided in Appendix F). The model output was used to estimate pollutant emission factors in units of pounds per thousand miles travelled.

The emission calculations and results are summarized in Table 2-4.

2.3.2 Toxic Air Contaminant Emissions

TAC emissions from on-road trucks were represented by DPM emissions, as the health effects from all TAC subcomponents of DPM are represented in the toxicity values for DPM[3]. Total DPM emissions per mile of roadway travelled due to on-road truck traffic associated with construction/demolition projects were estimated for the following scenarios:

1) Maximum 12-month DPM emissions for Project construction/demolition activities (for assessment of Project-related chronic hazard).

2) Maximum total DPM emissions for Project construction/demolition activities (for assessment of Project-related LECR).

Estimated average daily truck trips per month were provided by LBNL over the life of the project. These data are provided in Appendix F. Maximum on-road truck trips for the two scenarios listed above were determined. DPM emissions, in units of grams per mile traveled, were estimated by multiplying the number of round trips estimated over the appropriate averaging period by two (to convert from round trips to single trips) and the exhaust PM_{10} emission factor determined by executing the EMFAC2007 emissions model for model year 2009 for the mix of trucks anticipated for the Project.

The associated calculations and results for these DPM emissions are provided in Table 2-5.

2.4 Overall Project Greenhouse Gas Emissions

As discussed in Section 2.1 above, Project operations will have direct greenhouse gas emissions (i.e. CO_2 emissions) from natural gas combustion in boilers and diesel fuel combustion in the backup

[3] See guidance from the California Office of Health Hazard Assessment in Appendix D of *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, California Environmental Protection Agency and Office of Environmental Health Hazard Assessment, August 2003

generator. Also, Project operations will have indirect CO_2 emissions resulting from employee commute trips, which were also quantified in Section 2.1.

In addition to these greenhouse gas emissions, electricity usage at the GPL building will result in indirect CO_2 emissions from the various electrical generating resources utilized by the electrical utility. LBNL estimates that the GPL building will require up to 4,700 megawatts of electricity annually to operate. The Climate Registry provides a greenhouse gas reporting protocol document that summarizes appropriate CO_2 emission factors associated with electricity usage in various regions within California.[4] This resource was used to estimate CO_2 emissions associated with electricity usage at the GPL building.

Estimated annual emissions of CO_2 from the Project are summarized in Table 2.6 for Onsite Stationary Sources (i.e. boilers and backup diesel generator), Worker Commuting (i.e. employee commute trips), and Offsite Electrical Generation (i.e. the 4,700 megawatts of annual electricity usage).

For comparison, CO_2 emissions from operations that are being replaced by the GPL building (i.e. offsetting emissions decreases) were estimated. This includes the displacement of electricity and natural gas usage at buildings to be demolished as part of the Project, as well as the shift of LBNL operations from the Potter Street building to the GPL building. LBNL provided data for historical electricity and natural gas usage at the buildings to be demolished, and electricity usage at the Potter Street building (historical natural gas usage was not available).

Such historical calculations were conducted for both 2004 and 2008 historical energy usage at the operations being displaced by the GPL building. The reason for this was that although 2008 provided the most recent complete calendar year of data, some operations had already begun to shut down in that year. 2004 operations were more representative of historical averages. Where exact calendar year data were not available, energy usage was estimated based on available data.

It was assumed that overall employee commute emissions would be relatively unchanged with the shift in location of operations, given the wide range of locations that such commutes would originate from.

Therefore, a comparison of Project CO_2 emissions to 2004 displaced CO_2 emissions is provided in Table 2-6 and a comparison of Project CO_2 emissions to 2008 displaced CO_2 emissions is provided in Table 2-7.

[4] Climate Registry General Reporting Protocol (Ver. 1.1, May 2008), http://www.theclimateregistry.org/downloads/GRP.pdf.

2.5 Cumulative Construction/Demolition Off-Road Equipment Emissions

Emissions estimates of DPM and $PM_{2.5}$ from construction/demolition off-road equipment were necessary to conduct cumulative impact assessments for LECR and health hazard, as well as ambient $PM_{2.5}$ concentrations.

This analysis started by determining those LBNL and UCB projects that might cumulatively contribute to impacts from the Project. For purposes of this analysis, only projects located within 1,000 feet of Project construction or demolition sites were considered to potentially contribute to cumulative impacts. As such, only other LBNL projects were included. The following LBNL projects that included building demolition, or new building construction, that had projected project construction/demolition timelines overlapping the Project period (estimated to be August 2010 through April 2014) were identified:

- Solar Energy Research Center Construction
- CRT Building Construction
- Building 51 & 51A Demolition
- Old Town Building Demolition

For each construction project, it was estimated that the first five percent of the project period was dedicated to site grading and the last one-third of the project was dedicated to building commissioning. Commissioning would not include significant off-road equipment emissions and therefore was not included in the analysis. The period of time between site grading and commissioning was considered the "construction" phase of the project. DPM (PM_{10} exhaust) and $PM_{2.5}$ emissions (exhaust and fugitive dust) were determined using the URBEMIS model for the site grading and construction phases of each construction project based on the gross square footage of the building being constructed. The URBEMIS output files are provided in Appendix D.

For each demolition project, DPM and $PM_{2.5}$ emissions were determined using the URBEMIS model using the Demolition phase designation based on the gross square footage of the building being demolished. The following emission estimates for each project assessed in the cumulative analysis were required:

1) Maximum total DPM emissions for all identified LBNL construction/demolition activities (for assessment of cumulative LECR).

2) Maximum 12-month DPM emissions for all identified LBNL construction/demolition activities (for assessment of cumulative chronic hazard).

3) Maximum 12-month $PM_{2.5}$ emissions for all identified LBNL construction/demolition activities (for assessment of maximum annual average $PM_{2.5}$ concentrations in ambient air).

DPM and $PM_{2.5}$ emissions for the identified projects to be included in the cumulative assessment (in addition to the Seismic Phase 2 project) are summarized in Table 2-8.

2.6 Cumulative Construction/Demolition On-Road Truck Emissions

Emissions estimates of DPM and $PM_{2.5}$ from construction/demolition on-road truck traffic were necessary to conduct cumulative impact assessments for LECR and health hazard, as well as ambient $PM_{2.5}$ concentrations.

Cumulative DPM and $PM_{2.5}$ emissions in this case were those emission associated not only with on-road construction/demolition truck traffic from the Project, but also with on-road construction/ demolition truck traffic from other identified construction and demolition projects at LBNL and UCB during the Project time period (estimated to be August 2010 through April 2014).

Estimated average daily truck trips per month were provided by LBNL and UCB for identified projects, over the life of the project. These data are provided in Appendix F. Maximum annual and project total on-road truck trips were determined for all identified projects combined (as shown in Appendix F). DPM and $PM_{2.5}$ emissions, in units of grams per mile traveled, were estimated by multiplying the number of round trips estimated over the appropriate averaging period by two (to convert from round trips to single trips) and the exhaust PM_{10} (for DPM) or total $PM_{2.5}$ emission factor determined by executing the EMFAC2007 emissions model for model year 2009 for the mix of trucks anticipated for the projects. The following emission estimates for each project assessed in the cumulative analysis were required:

1) Maximum total DPM emissions for all identified LBNL and UCB construction/demolition activities (for assessment of cumulative LECR).
2) Maximum 12-month DPM emissions for all identified LBNL and UCB construction/demolition activities (for assessment of cumulative chronic hazard).
3) Maximum 12-month $PM_{2.5}$ emissions for all identified LBNL and UCB construction/demolition activities (for assessment of maximum annual average $PM_{2.5}$ concentrations in ambient air).

DPM and $PM_{2.5}$ emissions for the identified projects to be included in the cumulative assessment are summarized in Tables 2-5 and 2-9 respectively.

3.0 DISPERSION MODELING FOR RISK ASSESSMENT

3.1 Overall Modeling Methodology

Estimated ambient concentrations of TACs and $PM_{2.5}$ were generated from source emissions using air dispersion modeling methods. The air quality dispersion model selected for this project was the U.S. EPA AERMOD dispersion model. This regulatory model represents a widely accepted, current technology near-field dispersion model that has been shown to outperform the previously accepted standard ISCST3 model in complex terrain situations (as is found at the LBNL site), thereby providing more accurate estimates of actual measured ambient concentrations (ENSR et al., 1998).

The AERMOD model processed data inputs such as estimated source emissions and release parameters, building structure data, surface meteorological data collected onsite at LBNL, and U.S. Geological Survey terrain elevation data to estimate ambient concentrations at specific locations in and around the LBNL facility property.

Version 09292 of AERMOD incorporating the Plume Rise Model Enhancements (PRIME) building downwash algorithms was used for this project.

The AERMOD View graphical user interface (version 6.4.0) developed by Lakes Environmental Software (Waterloo, Ontario, Canada) was used as a tool to aid in developing and entering model input data and visualizing model output results.

3.1.1 Meteorological Data

Surface meteorological data were taken from LBNL's 20-meter weather monitoring tower. LBNL began operating this tower in January 1994. Surface meteorological data taken from the LBNL tower consisted of hourly solar radiation, atmospheric pressure, wind speed, wind direction, wind direction standard deviation, and temperature.

For purposes of this evaluation, surface data for the years 1998 and 1999 were selected as they represented two years of data that had previously been developed for use in AERMOD modeling. These data were paired with upper air data collected at the Oakland International Airport, which was obtained from the National Climatic Data Center.

Although the surface and upper air meteorological data were previously processed with AERMET for prior dispersion modeling projects at LBNL, EPA has since updated the meteorological preprocessor, AERMET, (now version 06314) and changed guidance related to processing land use (land use types are used by AERMET to determine albedo, Bowen ratio, and surface roughness length). Also, EPA now recommends the use of AERSURFACE to process Land Use Land Classification (LULC) data provided by the USGS. In order to remain consistent with current EPA guidance, the most recent versions of

AERMET and AERSURFACE were used to re-process the meteorological data collected at LBNL for the years of 1998 and 1999. AERSURFACE was executed with user defined parameters and downloaded LULC data. The output from AERSURFACE was used as input for AERMET. Appendix G includes the AERSURFACE output, which includes all the user input.

Additional information about this meteorological data set collected at LBNL can be found in Golder, 2007.

3.2 Long-Term Project Operations

TAC and $PM_{2.5}$ emissions from long-term Project operation were modeled. Modeling of TAC emissions was conducted such that the California Air Resources Board (CARB) Hot Spots Analysis Reporting Program (HARP) On-Ramp program could be used to assess chronic hazard and LECR.

TAC modeling for acute hazard assessments was conducted for the laboratory stacks only. The rationale for this approach is that human health risk and hazard from combustion sources (such as the boilers and diesel generator) are expected to be dominated by chronic effects based on the types of pollutants emitted, and in particular to be dominated by LECR. Because laboratory fume hood vents could emit a more diverse variety of chemicals, this assumption could not necessarily be made. This approach has been utilized in previous EIR assessments for LBNL.

3.2.1 Source Representations

Point sources related to long-term project operations include:

- A backup diesel generator stack located on a small utility building to the south of the main GPL building
- Two natural gas-fired boiler stacks located on the roof of the main GPL building
- Two laboratory fume hood stacks located on the roof of the main GPL building

The locations of these sources are shown in Figure 3-1. The source parameters for these modeled point sources are provided in Table 3-1.

Source representations for employee commuting emissions were not included in the modeling of $PM_{2.5}$ due to the diffuse nature of these emissions.

Variable emission rates are defined in AERMOD through the use of a multiplier which, for this project, was defined for each hour of the day, each day of the week, and each season of the year. If the multiplier is zero, then the emission rate for the given source is multiplied by zero and is effectively “turned off”. If the multiplier is one then the emission rate for a given source is multiplied by one and the source is “turned on”.

Variable emission rates were utilized for sources that were expected to operate primarily during weekday business hours and for modeling which would be processed through the HARP On-Ramp. For long-term project operation, laboratory stacks are the only source that would not be expected to operate continuously throughout the year, but rather only during business hours (10 hours per day, 5 days per week).

While the backup diesel generator would not be expected to operate continuously throughout the year, it would be expected to operate at any given hour of any given day. Therefore, a variable emission rate was not used in favor of an annual averaged emission rate.

TAC modeling conducted for the HARP On-Ramp software (discussed in Section 4.1.1 below) requires that emission rates specified in the model be set to one gram per second. However, a consequence of using a variable emission rate, such as for the laboratory stacks, is that the one gram per second emission rate is no longer appropriate. The HARP On-Ramp documentation requires that any source with a variable emission rate have an emission rate such that a total of 31,536 kilograms would be emitted per year (equal to 1 gram per second x 3,600 seconds per hour x 8,760 hours per year). The laboratory stacks were modeled such that emissions would occur for 10 hours per day for 5 days a week. This equates to 50 hours per week out of a possible 168 hours per week. Dividing the total number of possible hours each week by the number of actual operating hours each week yields a ratio of 3.36. This ratio is synonymous with the emission rate (3.36 grams per second) needed to be input to the model such that the two laboratory stacks would emit 31,536 kilograms per year in total (3.36 grams per second x 3,600 second per hour x 50 hours per week x 52 weeks per year).

For the $PM_{2.5}$ modeling runs, sources were assigned the actual $PM_{2.5}$ emission rate, since the HARP On-Ramp was not used. Project operations result in emissions of $PM_{2.}5$ from combustion of diesel fuel in the backup diesel generator and the combustion of natural gas in the two boilers serving the GPL building

For the acute TAC modeling, a unit emission rate of one gram per second was modeled for each of the two laboratory stacks. When this approach is used, the resulting maximum 1-hour concentration predicted by the model can be multiplied by the TAC emission rate in grams per second for each stack (assuming emissions are equally distributed between the two stacks) to obtain the maximum TAC-specific concentration. This allows the calculation of maximum concentrations for all TACs emitted from a single model run.

3.2.2 Receptor Sets

Two separate receptor grids were created for this project: one grid contained only receptor locations on, or inside, the LBNL facility property boundaries (onsite grid), and one grid contained only receptor locations on, or outside of, the LBNL facility property boundaries (offsite grid).

The receptor grids were created by first overlaying a rectilinear grid of receptor locations extending approximately 1,000 meters out from the centroid of the GPL point sources with even 50-meter spacing between receptor locations. An additional grid of receptors with 100-meter spacing was extended 1,000 meters from the edge of the 50-meter grid.

A set of property boundary receptors was also generated by creating receptor locations every 25 meters along the LBNL facility property boundary.

The onsite receptor grid is shown in Figure 3-2 and the offsite receptor grid is shown in Figure 3-3.

Modeling was conducted for use with the HARP On-Ramp program using the onsite and offsite receptor grids separately. Acute TAC modeling was conducted using the offsite and onsite grids combined in one model run as exposure assumptions were the same over both grids. $PM_{2.5}$ modeling was conducted with the offsite grid only to assess concentrations in ambient air (typically defined as outside of the facility property boundary).

3.2.3 Dispersion Modeling Output

Summaries of output from AERMOD runs executed for purposes of importing into the HARP On-Ramp are not meaningful due to the use of unitized emission rates as described above that yield predicted concentrations that have no significance by themselves.. The only use of the modeling output is for identifying errors in the model execution and to ensure that the HARP On-Ramp software can import the data such that the modeling output is understood by HARP.

The output of the AERMOD modeling conducted to determine maximum 1-hour TAC concentrations for assessment of acute hazard impacts is summarized in Table 3-2.

$PM_{2.5}$ modeling runs were conducted for the 1998 and 1999 meteorology data set separately in order to obtain maximum annual averaged concentrations for each year. As discussed above, only the offsite grid was used for the $PM_{2.5}$ modeling. The results are presented in Table 3-3 (under Project Operations).

3.3 Project Construction/Demolition Off-Road Equipment

DPM and $PM_{2.5}$ emissions from Project construction/demolition off-road equipment were modeled using methods similar to the $PM_{2.5}$ modeling for Project operations. DPM modeling was performed to determine both the average ambient concentration over the entire Project period and to determine the maximum average concentration based on maximum annual emission rates. $PM_{2.5}$ modeling was conducted for 1998 and 1999 separately to determine the maximum annual average concentration.

Dispersion modeling was performed for Project construction/demolition activities alone, as well as in conjunction with contemporaneous cumulative projects as identified in Section 2.5 above.

3.3.1 Source Representations

Area sources were used in AERMOD to represent the emissions of DPM and $PM_{2.5}$ resulting from the use of off-road equipment for project construction/demolition activities. Each activity described in Section 2.2 above was represented by areas sources. Emissions for a given activity were evenly assigned to an area source which encompassed the area in which the emissions could occur. Area sources did not include areas occupied by existing adjacent buildings, existing roads, or extreme terrain since off-road equipment would not operate in these areas.

$PM_{2.5}$ emissions result from a combination of both fugitive dust and engine exhaust, and two separate area sources were used for each of these sources of $PM_{2.5}$. For area sources representing fugitive dust, the release height was set to zero meters (ground level release) and the initial vertical dispersion was set to two meters to account for turbulence created by a moving vehicle. For area sources representing exhaust emissions, the release height was set to three meters and the initial vertical dispersion was set to two meters.

Since DPM results from exhaust, modeling for DPM only included area sources that represented exhaust as described above.

Where appropriate, a single area source was used to represent emissions from GPL site grading and GPL building construction. While emissions from the two activities are estimated separately, they do not occur at different locations.

Source representations for worker commuting emissions were not included in the modeling of $PM_{2.5}$ due to the diffuse nature of these emissions.

The locations of these area sources are shown in Figure 3-4.

3.3.2 Receptor Sets

The same receptor grids described above in Section 3.2.2 were used for the project construction/demolition off-road equipment modeling. DPM modeling was conducted with the onsite grid and offsite grid separately while the $PM_{2.5}$ modeling was conducted with the offsite grid only. Model receptors located within any of the emissions source representations were removed.

3.3.3 Dispersion Modeling Output

DPM and $PM_{2.5}$ emissions from off-road equipment used in both Project and cumulative construction and demolition activities were modeled.

As discussed above in Section 2.2.6, both maximum annual emission rates and total project mass emission rates for DPM were modeled, the former for use in the chronic hazard assessment and the latter for use in the LECR assessment. Modeling was conducted using the onsite and offsite receptor grids separately, resulting in four different modeling runs (offsite LECR, onsite LECR, offsite chronic hazard and onsite chronic hazard) for both Project and cumulative emission scenarios, for a total of eight model runs. The maximum DPM concentrations (in μg/m³) for each of the modeling runs are summarized in Table 3-4.

Because the total period average DPM concentration was to be used for determining cancer risk, the locations of the highest predicted impacts were examined. In the case of the total period average concentration for Project emissions, it was determined that the highest impacts occurred south-southeast of the GPL building site at the LBNL property boundary, at the border with a portion of the UCB "Hill Campus". This hillside location well north of Centennial Drive does not have any nearby residences or buildings, and is not expected to ever have such occupants. Therefore, the three receptor locations with the highest predicted DPM concentrations (between 0.056 $\mu g/m^3$ and 0.052 $\mu g/m^3$), which occur at this location, were excluded from the analysis of cancer risk.

All $PM_{2.5}$ modeling was conducted with the offsite receptor grid. Each of the two years that comprise the meteorological data set (1998 and 1999) was modeled separately. Construction/demolition $PM_{2.5}$ emissions included exhaust particulate and fugitive dust, both of which were estimated using URBEMIS as discussed above. The maximum $PM_{2.5}$ concentrations (in μg/m³) for each year and emission scenario (Project and cumulative) are also presented in Table 3-3.

3.4 Project Construction/Demolition On-Road Truck Travel

DPM and $PM_{2.5}$ emissions from Project construction/demolition on-road truck traffic were modeled using methods similar to the $PM_{2.5}$ modeling for Project operations. DPM modeling was performed to determine both the average ambient concentration over the entire Project period and to determine the maximum average concentration based on maximum annual emission rates. $PM_{2.5}$ modeling was conducted for 1998 and 1999 separately to determine the maximum annual average concentration.

Dispersion modeling was performed for Project construction/demolition activities alone, as well as in conjunction with contemporaneous cumulative projects as identified in Section 2.6 above.

3.4.1 Source Representations

Area source representations were entered into the model along the proposed construction-related truck traffic routes. A release height of two meters and an initial vertical dispersion of two meters were assigned to all area sources to account for the release characteristics of a traveling vehicle. Estimated DPM emissions were apportioned to the area sources in units of grams per square meter per second

($g/m^2/sec$). As discussed in Section 2.3.2 above, there were two sets of on-road truck traffic DPM emissions used for modeling: those resulting from Project construction/demolitions activities and those resulting from all contemporaneous LBNL and UCB construction/demolition activities (i.e. cumulative emissions).

Figure 3-5 presents the area source arrangements in the vicinity of LBNL while Figure 3-6 presents all of the area sources used to represent the routes taken by the on-road trucks.

3.4.2 Receptor Sets

The receptor grid developed for purposes of capturing the maximum off-property ambient concentration started with the offsite receptor grid discussed in Section 3.2.2. Receptors were then added along both sides of the roadways where DPM emissions were assigned, maintaining a distance of five meters from any individual model area source. Any offsite grid receptor that was within 5 meters of any area source was then manually removed.

Figure 3-7 presents the receptors used in the construction/demolition on-road truck travel dispersion modeling.

3.4.3 Dispersion Modeling Output

AERMOD dispersion modeling of DPM emissions from on-road truck traffic from construction/demolition activities was conducted for four different emissions scenarios. Each of the four emissions scenarios were utilized for a different risk assessment, and are summarized as follows:

- Maximum 12-month DPM concentration for Project-related chronic hazard
- Maximum period (3.75 year) DPM concentration for Project-related LECR
- Maximum 12-month DPM concentration for cumulative chronic hazard
- Maximum period (3.75 year) DPM concentration for cumulative LECR

These DPM concentrations are summarized in Table 3-5.

4.0 HUMAN HEALTH RISK ASSESSMENT

Human health risk assessments (HHRAs) were completed based on the AERMOD dispersion modeling described in Section 3 above and the TAC emission rates described in Section 2 above.

HHRAs were performed for the following TAC emissions source groups, consistent with the dispersion modeling described in Section 3 above:

1) TAC emissions from stationary sources associated with the long-term operations of the GPL.

2) DPM emissions from onsite Project and cumulative construction/demolition activities (off-road equipment).

3) DPM emissions from offsite, on-road truck travel associated with Project and cumulative construction/demolition activities.

HHRAs for cumulative impacts from TAC emissions from stationary sources associated with the long-term operations of the GPL were not performed since such cumulative impacts were represented in the Long Range Development Plan for the LBNL facility (Golder 2007).

Because assessments 2 and 3 listed above were based on only DPM emissions, average DPM concentrations determined by the dispersion modeling were manually converted to LECR and hazard based on available toxicity factors provided by the California Office of Environmental Health Hazard Assessment (OEHHA) and risk assessment guidance provided by both OEHHA (OEHHA, 2003) and the Bay Area Air Quality Management District (BAAQMD, 2009).

However, for assessment 1 listed above, which was based on a wide variety of TAC emissions, the CARB HARP On-Ramp and HARP programs were used to conduct the HHRA in accordance with OEHHA guidance (OEHHA 2003). LECR values for residential receptors were then adjusted based on recent draft BAAQMD guidance (BAAQMD, 2009) as discussed further below.

Using the HARP On-Ramp, dispersion model output data and TAC emission rates were combined to produce files of TAC concentrations at model receptor locations. The HARP model (CARB 2003) uses these files to determine potential maximum human exposure to individual TACs, and applies toxicity factors and exposure assumptions provided by OEHHA to estimate maximum potential LECR and chronic/acute health hazard.

4.1 HHRA for Project Operations

The HHRA for long-term operation of the GPL was based on TAC emissions from the following sources:

- Laboratory fume hood roof exhaust vents.
- Natural gas-fueled building boilers.
- Maintenance/testing operation of a backup diesel generator.

Through the use of the HARP On-Ramp and HARP models, as described further below, the dispersion modeling results described in Section 3 above were used to assess LECR and chronic hazard at both onsite and offsite hypothetical human receptor locations. All onsite model receptors were conservatively assumed to represent human receptors with Worker exposure parameters as defined by OEHHA. All offsite model receptors were conservatively assumed to represent human receptors with Resident exposure parameters as defined by OEHHA.

Maximum 1-hour TAC concentrations predicted by the dispersion modeling were used to assess maximum acute hazard at all model receptors without use of the HARP model.

4.1.1 Use of HARP On-Ramp

The CARB HARP On-Ramp program (Version 1, released 2/3/2009) was executed in order to produce TAC concentrations appropriate for estimating LECR and chronic health hazard. Input files to the program included AERMOD plot files for period average concentrations at onsite or offsite receptor locations based on one gram per second emission rates for each source (adjusted as necessary in accordance with the HARP On-Ramp guidance) and annual TAC emission rates (in pounds per year).

4.1.2 Use of HARP Model

Using the output files from the HARP On-Ramp model runs described above, a Risk Analysis to determine a multi-pathway Point Estimate was conducted for each of the two sets of model receptors described in Section 3.2.2 above (i.e. a set of Onsite model receptor locations and a set of Offsite model receptor locations).

In all model runs, the inhalation exposure pathway was assessed. In addition, the following non-inhalation exposure pathways were allowed with default parameters:

- Ingestion of home-grown produce
- Dermal absorption from soil
- Ingestion of soil
- Ingestion of mother's milk

These were estimated to be the only significant non-inhalation exposure pathways that could be influenced by the maximum ambient air impacts from Project TAC emissions, and consideration of these pathways would in most cases be very conservative.

The following HARP risk assessment methodologies were utilized to determine LECR and chronic hazard:

- LECR for Offsite (Resident) Exposure – OEHHA Derived Method (70 years at period average TAC concentrations)
- LECR for Onsite (Worker) Exposure – Default exposure parameters (49 weeks/year, 5 days/week, 8 hours/day, 40 years of exposure at period average TAC concentrations).
- Chronic Hazard for Offsite (Resident) Exposure - OEHHA Derived Method (70 years at period average TAC concentrations).
- Chronic Hazard for Onsite (Worker) Exposure – Default exposure parameters (49 weeks/year, 5 days/week, 8 hours/day, 40 years of exposure at period average TAC concentrations).

The HARP model was initially run in each case to compute maximum LECR or chronic hazard at each model receptor location. Once the model receptor with the highest risk/hazard was identified, the HARP model was re-run to determine how much each emission source, pollutant, and exposure pathway contributed to the maximum value.

For the LECR estimated for offsite (Resident) receptors, draft BAAQMD guidance for the use of age sensitivity factors (ASFs) was implemented.[5] This methodology is based on the assumption that the carcinogenicity of toxicants are ten times higher than otherwise suggested by the available cancer slope factors for human exposure from the third trimester before birth through age two, and three times higher from age two through fifteen. The overall implication is that Resident LECR values should be multiplied by a factor of 1.7 to account for the ASFs. This was therefore done for the Offsite (Resident) MEI result from the HARP model. Because workers are assumed to be over the age of fifteen, ASFs were not applied to onsite (Worker) LECR results from HARP.

4.1.3 Risk Assessment Results

The HHRA results for exposure to TAC emissions from long-term GPL operations are presented in Table 4-1. The HARP output files for the onsite (Worker) receptors with the highest impacts (showing the

[5] BAAQMD Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidance – draft, December 2009, http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Public%20Hearings/2009/0205_RFC_102109/0205_hsraguide_111309.ashx, accessed on December 10, 2009.

breakdown by source and TAC) are provided in Appendix H. The HARP output files for the offsite (Resident) receptors with the highest impacts (showing the breakdown by source and TAC) are provided in Appendix I.

Estimated DPM emissions from the backup diesel generator were the TAC emissions most significantly contributing to the LECR for the hypothetical maximally exposed individual (MEI) onsite (Worker) and offsite (Resident).

Estimated chlorine emissions from the laboratory vent stacks were the TAC emissions most significantly contributing to the chronic hazard for the hypothetical MEI onsite (Worker) and offsite (Resident).

Taking the maximum modeled 1-hour TAC concentrations determined as described in Section 3.2.3 above, maximum acute hazard quotients were estimated for potential emissions from the laboratory vent stacks. The acute hazard quotient (HQ) is defined as:

$$HQ = \text{Maximum 1-Hour Concentration } (\mu g/m^3) \,/\, \text{Acute Reference Concentration } (\mu g/m^3) \qquad (1)$$

The TAC-specific acute reference concentrations were taken from values published by OEHHA [6]. Table 4-2 summarizes the resulting acute HQ values for those TACs emitted from the laboratory vent stacks having published acute reference concentrations. Individual HQ values were not summed into total hazard indices since the nature of laboratory chemical use does not lend itself to the likelihood that the maximum emissions of two or more chemicals would occur contemporaneously.

4.2 HHRA for Project Construction/Demolition Off-Road Equipment

The HHRA for onsite, off-road equipment associated with Project and cumulative construction/demolition activities was based on DPM emissions from engine exhaust for these sources. The cumulative assessment included the additional LBNL projects described in Section 2.5 above.

LECR and chronic hazard were assessed for both onsite and offsite hypothetical human receptor locations. All onsite model receptors were conservatively assumed to represent human receptors with Worker exposure parameters as defined by OEHHA. All offsite model receptors were conservatively assumed to represent human receptors with Resident exposure parameters as defined by OEHHA.

4.2.1 Methodology

The dispersion modeling results for off-road equipment exhaust DPM emissions described in Section 3.3.3 above were used to determine the maximum DPM concentration over both any given 12-month period and the average over the entire Project period (three years and nine months). The maximum 12-

[6] http://www.arb.ca.gov/toxics/healthval/acute.pdf, accessed December 2009.

month average DPM concentration was then used to determine the maximum chronic hazard and the maximum average DPM concentration over the entire Project period was then used to determine the maximum LECR. LECR and chronic hazard estimates were determined using methodologies recommended by OEHHA (OEHHA 2003).

For the LECR estimated for offsite (Resident) receptors, the draft BAAQMD guidance for the use of ASFs noted in Section 4.1.2 above was implemented. However, in this case, because construction/demolition emissions are limited in duration (three years and nine months), the ASFs were applied assuming an ASF factor of ten for the first 2.25 years of exposure (starting from third trimester) and an ASF factor of three for the last 1.50 years of exposure. This results in an overall weighted ASF adjustment factor of 7.20 over the exposure period.

Because workers are assumed to be over the age of fifteen, ASFs were not applied to onsite (Worker) LECR calculations.

The specific equations used to estimate LECR and chronic hazard are provided in the summary tables discussed in Section 4.2.2 below.

4.2.2 Risk Assessment Results

Table 4-3 summarizes the LECR and chronic hazard calculations and results for the hypothetical offsite (Resident) MEI. In accordance with guidance received from BAAQMD[7], a child breathing rate was applied across the entire exposure period.[8] Because ASFs were used, BAAQMD recommends that only the exposure period be considered (i.e. 3.75 years) instead of nine years as otherwise recommended by OEHHA guidance.

As discussed in Section 3.3.3 above, it was determined that the highest impacts in the dispersion modeling for the assessment of Project emissions occurred south-southeast of the GPL building site at the LBNL property boundary, at the border with a portion of the UCB “Hill Campus”. This hillside location well north of Centennial Drive does not have any nearby residences or buildings, and is not expected to ever have such occupants. Therefore, the three receptor locations with the highest predicted DPM concentrations (between 0.056 $\mu g/m^3$ and 0.052 $\mu g/m^3$), which occur at this location, were excluded from the analysis of LECR.

Table 4-4 summarizes the LECR and chronic hazard calculations and results for the hypothetical onsite (Worker) MEI. For this receptor type, a worker breathing rate is appropriate and consistent with OEHHA

[7] Phone conversation with Scott Lutz with BAAQMD by Brian Patterson with Golder Associates Inc. on November 23, 2009.

[8] An average daily breathing rate for a child was conservatively applied even though the exposure was assumed to occur primarily to an infant.

guidance. Because ASFs were not used for the worker receptors, standard OEHHA guidance recommending that exposures less than nine years in duration are assessed assuming nine years of exposure was used.

4.3 HHRA for Project and Cumulative Construction/Demolition On-Road Truck Travel

The HHRA for offsite, on-road truck travel associated with Project construction/demolition activities was based on DPM emissions from engine exhaust for these sources. In addition, a similar assessment was made for all on-road truck travel associated with all LBNL and UCB construction/demolition activities for projects estimated to occur during the Project period (approximately August 2010 through April 2014).

LECR and chronic hazard were assessed for offsite hypothetical human receptor locations assumed to be located as near as five meters to the roadways traveled. All offsite model receptors were conservatively assumed to represent human receptors with Resident exposure parameters as defined by OEHHA.

4.3.1 Methodology

The dispersion modeling results for on-road truck exhaust DPM emissions described in Section 3.4.3 above were used to determine the maximum DPM concentration over both any given 12-month period and the average over the entire Project period (three years and nine months). The maximum 12-month average DPM concentration was then used to determine the maximum chronic hazard and the maximum average over the entire Project period was then used to determine the maximum LECR. LECR and chronic hazard estimates were determined using methodologies recommended by OEHHA (OEHHA 2003).

For the LECR estimated for offsite (Resident) receptors, the draft BAAQMD guidance for the use of ASFs noted in Section 4.2.2 above was implemented.

The specific equations used to estimate LECR and chronic hazard are provided in the summary table discussed in Section 4.3.2 below.

4.3.2 Risk Assessment Results

Table 4-5 summarizes the LECR and chronic hazard calculations and results for the hypothetical offsite (Resident) MEI. Results were estimated for DPM emissions from just the Project, and from the Project along with all other contemporaneous construction/demolition projects at the LBNL and UCB facilities during the Project period. In accordance with guidance received from BAAQMD[9], a child breathing rate

[9] Phone conversation with Scott Lutz with BAAQMD by Brian Patterson with Golder Associates Inc. on November 23, 2009.

was applied across the entire exposure period.[10] Because ASFs were used, BAAQMD recommends that only the exposure period be considered (i.e. 3.75 years) instead of nine years as otherwise recommended by OEHHA guidance.

[10] An average daily breathing rate for a child was conservatively applied even though the exposure was assumed to occur primarily to an infant.

5.0 CLOSING

This report documents the estimated emissions of criteria pollutants, TACs, and CO_2 (the primary greenhouse gas emitted) associated with the proposed Seismic Phase 2 project at the LBNL facility and estimated potential maximum human health risks associated with TAC emissions. In addition, cumulative impacts for Project TAC and $PM_{2.5}$ emissions were evaluated for construction/demolition activities in conjunction with similar emission from other contemporaneous projects. These results are intended for use in a DEIR being prepared for the Project.

GOLDER ASSOCIATES INC.

Brian Patterson, Ph.D.
Associate

Geoff Scott, EIT
Senior Project Air Resources Engineer

6.0 REFERENCES

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(CARB 2003) – HARP User's Guide, California Air Resources Board, December 2003, most recent version of the model at http://www.arb.ca.gov/toxics/harp/downloads.htm.

(ENSR et al., 1998) – Model Evaluation Results for AERMOD, by R.J. Paine (ENSR) et al., December 17.

(Golder 2007) **-** *Site-Wide Air Quality Human Health Risk Assessment Component of Environmental Impact Report,* Golder Associates Inc., January 2007.

(OEHHA 2003) - *Air Toxics Hot Spots Program Risk Assessment Guidelines, The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, prepared by the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, August 2003.

(SECOR, 2004) – Baseline Air Emissions Inventory Toxic Compound Emissions – Lawrence Berkeley National Laboratory, SECOR International Incorporated, January 16, 2004.

TABLES

Table 2-1
Estimated Criteria Pollutants and CO_2 Emissions from Operations
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Chemical	Laboratory		Natural Gas Boiler		Diesel Generator		Employee Vehicles		Total	
	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)
Criteria Pollutants										
ROG	0.0	0.0	0.43	1.6E-03	0.09	1.18E-03	1.52	2.70E-01	2.04	2.73E-01
NO_x	0.0	0.0	7.76	2.9E-02	7.88	9.85E-02	1.48	3.10E-01	17.12	4.38E-01
PM_{10} (1)	0.0	0.0	0.59	2.2E-03	0.11	1.36E-03	2.47	4.50E-01	3.17	4.54E-01
$PM_{2.5}$ (2)	0.0	0.0	0.59	2.2E-03	0.11	1.36E-03	0.47	9.00E-02	1.17	9.36E-02
CO	0.0	0.0	6.52	2.5E-02	1.25	1.56E-02	14.71	2.77E+00	22.48	2.81E+00
SO_2	0.0	0.0	0.05	1.8E-04	1.39	1.74E-02	0.01	0.00E+00	1.45	1.76E-02
Greenhouse Gases										
CO_2	0	0	9,318	35.3	1,231	15.4	1,386	241	11,934	292

Notes:
(1) PM_{10} values are set equal to the $PM_{2.5}$ values. See note (2) below.
(2) It is assumed that all particulate emitted from the natural gas fired boilers and the diesel generator will be $PM_{2.5}$.

Table 2-2
Estimated Toxic Air Contaminent Emissions from Operations
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Chemical	CAS Number	Laboratory		Natural Gas Boiler		Diesel Generator		Employee Vehicles [1]		Total	
		Estimated Emissions (lbs/hr)	Estimated Emissions (lbs/yr)	Estimated Emissions (lbs/hr)	Estimated Emissions (lbs/yr)	Estimated Emissions (lbs/hr)	Estimated Emissions (lbs/yr)	Estimated Emissions (lbs/hr)	Estimated Emissions (lbs/yr)	Estimated Emissions (lbs/hr)	Estimated Emissions (lbs/yr)
ORGANICS											
1,3-Butadiene	106990	1.59E-04	6.14E-02	-- --	-- --	-- --	-- --			1.59E-04	6.14E-02
7,12-Dimethylbenz(a)anthracene	57976	-- --	-- --	4.53E-04	1.07E-09	-- --	-- --			4.53E-04	1.07E-09
Acetaldehyde	75070	9.63E-04	3.72E-01	2.51E-01	5.96E-07	9.92E-05	4.96E-03			2.52E-01	3.77E-01
Acrolein	107028	3.39E-04	1.31E-01	-- --	-- --	3.06E-05	1.53E-03			3.70E-04	1.33E-01
Acrylonitrile	107131	2.75E-04	1.06E-01	-- --	-- --	-- --	-- --			2.75E-04	1.06E-01
Benzaldehyde	100527	-- --	-- --	4.65E-01	1.10E-06	-- --	-- --			4.65E-01	1.10E-06
Benzene	71432	7.00E-03	2.70E+00	1.22E-01	2.89E-07	5.52E-03	2.76E-01			1.35E-01	2.98E+00
Boron Trifluoride	7637072	6.09E-04	2.35E-01	-- --	-- --	-- --	-- --			6.09E-04	2.35E-01
Butane	106978	-- --	-- --	5.95E+01	1.41E-04	-- --	-- --			5.95E+01	1.41E-04
Carbon Tetrachloride	56235	5.38E-03	2.08E+00	-- --	-- --	-- --	-- --			5.38E-03	2.08E+00
Chlorine	7782505	5.02E-03	1.94E+00	-- --	-- --	-- --	-- --			5.02E-03	1.94E+00
Chloroform	67663	4.13E-02	1.59E+01	-- --	-- --	-- --	-- --			4.13E-02	1.59E+01
Crotonaldehyde	4170303	2.88E-05	1.11E-02	-- --	-- --	-- --	-- --			2.88E-05	1.11E-02
Dibenz(a,h)anthracene	53703	-- --	-- --	-- --	-- --	2.35E-06	1.17E-04			2.35E-06	1.17E-04
Dichlorobenzene	25321226	-- --	-- --	3.40E-02	8.06E-08	-- --	-- --			3.40E-02	8.06E-08
Ethane	74840	-- --	-- --	8.79E+01	2.08E-04	-- --	-- --			8.79E+01	2.08E-04
Ethylbenzene	100414	-- --	-- --	-- --	-- --	1.93E-04	9.67E-03			1.93E-04	9.67E-03
Ethylene Dichloride	107062	4.84E-03	1.87E+00	-- --	-- --	-- --	-- --			4.84E-03	1.87E+00
Fluoranthene	206440	-- --	-- --	8.50E-05	2.01E-10	9.40E-06	4.70E-04			9.44E-05	4.70E-04
Formaldehyde	50000	5.07E-03	1.96E+00	6.26E+00	1.48E-05	1.45E-03	7.23E-02			6.27E+00	2.03E+00
HCl	7647010	4.62E-02	1.78E+01	-- --	-- --	-- --	-- --			4.62E-02	1.78E+01
Hexane	110543	-- --	-- --	5.10E+01	1.21E-04	3.98E-05	1.99E-03			5.10E+01	2.11E-03
Hydrazine	302012	7.73E-05	2.98E-02	-- --	-- --	-- --	-- --			7.73E-05	2.98E-02
Naphthalene	91203	-- --	-- --	1.73E-02	4.10E-08	4.56E-04	2.28E-02			1.77E-02	2.28E-02
Pentane	109660	-- --	-- --	7.37E+01	1.75E-04	-- --	-- --			7.37E+01	1.75E-04
Propane	74986	-- --	-- --	4.53E+01	1.07E-04	-- --	-- --			4.53E+01	1.07E-04
Propylene	115071	-- --	-- --	-- --		9.75E-03	4.88E-01			9.75E-03	4.88E-01
Toluene	108883	-- --	-- --	9.64E-02	2.28E-07	1.75E-03	8.75E-02			9.81E-02	8.75E-02
Vinyl Chloride	75014	3.43E-03	1.32E+00	-- --	-- --	-- --	-- --			3.43E-03	1.32E+00
Vinylidene Chloride	75354	2.37E-04	9.15E-02	-- --	-- --	-- --	-- --			2.37E-04	9.15E-02
Xylene (total)	1330207	-- --	-- --	-- --	-- --	5.99E-04	3.00E-02			5.99E-04	3.00E-02
METALS											
Arsenic	7440382	-- --	-- --	5.67E-03	1.34E-08	4.58E-05	2.29E-03			5.71E-03	2.29E-03
Barium	7440393	-- --	-- --	1.25E-01	2.95E-07	-- --	-- --			1.25E-01	2.95E-07
Beryllium	7440417	-- --	-- --	3.40E-04	8.06E-10	-- --	-- --			3.40E-04	8.06E-10
Cadmium	7440439	-- --	-- --	3.12E-02	7.39E-08	4.29E-05	2.15E-03			3.12E-02	2.15E-03
Chromium (hexavalent)	18540299	-- --	-- --	6.75E-03	1.66E-02	2.92E-06	1.46E-04			6.75E-03	1.68E-02
Cobalt	7440484	-- --	-- --	2.38E-03	5.64E-09	-- --	-- --			2.38E-03	5.64E-09
Copper	7440508	-- --	-- --	2.41E-02	5.71E-08	1.17E-04	5.86E-03			2.42E-02	5.86E-03
Lead	7439921	-- --	-- --	1.42E-02	3.36E-08	2.37E-04	1.19E-02			1.44E-02	1.19E-02
Manganese	7439965	-- --	-- --	1.08E-02	2.55E-08	8.87E-05	4.43E-03			1.09E-02	4.43E-03
Mercury	7439976	-- --	-- --	7.37E-03	1.75E-08	5.72E-05	2.86E-03			7.43E-03	2.86E-03
Molybdenum	7439987	-- --	-- --	3.12E-02	7.39E-08	-- --	-- --			3.12E-02	7.39E-08
Nickel	7440020	-- --	-- --	5.95E-02	1.41E-07	1.12E-04	5.58E-03			5.96E-02	5.58E-03
Selenium	7782492	-- --	-- --	6.80E-04	1.61E-09	6.29E-05	3.15E-03			7.43E-04	3.15E-03
Vanadium	7440622	-- --	-- --	6.52E-02	1.54E-07	-- --	-- --			6.52E-02	1.54E-07
Zinc	7440666	-- --	-- --	8.22E-01	1.95E-06	6.41E-04	3.20E-02			8.23E-01	3.20E-02
Diesel Particulate Matter [1]	DPM	-- --	-- --	-- --	-- --	5.43E-02	2.71E+00	3.09E-01	4.50E-01	3.63E-01	3.16E+00

Notes:
(1) Hourly DPM emissions for employee vehicles are based on daily emissions estimated by URBEMIS divided by 8 hours per day.

Table 2-3
Estimated Criteria Pollutants and CO_2 Emissions from Construction/Demolition Off-Road Equipment
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

	ROG		NO_x		PM_{10} Dust		PM_{10} (1) Exhaust		PM_{10} Total		$PM_{2.5}$ Dust	
	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)
2010												
Building 25 Demolition	1.2821	0.0705	9.3942	0.5167	3.5345	0.1944	0.6488	0.0357	4.1832	0.0357	3.5345	0.0405
2010 TOTAL	**1.2821**	**0.0705**	**9.3942**	**0.5167**	**3.5345**	**0.1944**	**0.6488**	**0.0357**	**4.1832**	**0.0357**	**3.5345**	**0.0405**
2011												
Building 25 Demolition	1.1819	0.0118	8.7518	0.0875	3.5345	0.0353	3.5345	0.0060	4.1378	0.0414	0.7369	0.0074
Grading for GPL Construction	2.8622	0.0301	23.4966	0.2467	8.2946	0.0871	1.1746	0.0123	9.4692	0.0994	1.7330	0.0182
Construction of GPL	1.2316	0.1078	8.9812	0.7859	0.0163	0.0014	0.5617	0.0492	0.5781	0.0506	0.0058	0.0005
2011 TOTAL	**5.2757**	**0.1496**	**41.2297**	**1.1201**	**11.8454**	**0.1239**	**5.2709**	**0.0675**	**14.1851**	**0.1914**	**2.4758**	**0.0261**
2012												
Construction of GPL	1.1408	0.1489	8.3008	1.0833	0.0163	0.0021	0.5026	0.0656	0.5189	0.0677	0.0058	0.0008
Building 71 Trailer Demolition	1.0844	0.0466	7.9064	0.3400	2.9350	0.1262	0.5362	0.0231	3.4712	0.1493	0.6121	0.0263
2012 TOTAL	**2.2251**	**0.1955**	**16.2072**	**1.4232**	**2.9513**	**0.1283**	**1.0387**	***0.0886***	**3.9901**	**0.2170**	**0.6179**	**0.0271**
2013												
Construction of GPL	1.0509	0.0441	7.6719	0.3222	0.0163	0.0007	0.4434	0.0186	0.4597	0.0193	0.0058	0.0002
Building 71 Trailer Demolition	1.0844	0.0423	7.3590	0.3091	2.9350	0.1233	0.4785	0.0201	3.4135	0.1434	0.6121	0.0257
Building 55 Demolition	1.0219	0.0777	7.5584	0.5744	3.5412	0.2691	0.4856	0.0369	4.0268	0.3060	0.7383	0.0561
2013 TOTAL	**3.1571**	**0.1641**	**22.5892**	**1.2057**	**6.4925**	**0.3931**	**1.4075**	**0.0756**	**7.9000**	**0.4687**	**1.3562**	**0.0821**
2014												
Building 55 Demolition	0.9405	0.0390	7.0197	0.2913	3.5412	0.1470	0.4288	0.0178	3.9701	0.1648	0.7383	0.0306
2014 TOTAL	**0.9405**	**0.0390**	**7.0197**	**0.2913**	**3.5412**	**0.1470**	**0.4288**	**0.0178**	**3.9701**	**0.1648**	**0.7383**	**0.0306**
Pollutant Totals	12.9	0.6	96.4	4.6	28.4	1.0	8.8	0.3	34.2	1.1	8.7	0.2

	$PM_{2.5}$ Exhaust		$PM_{2.5}$ (2) Total		CO		SO_2		CO_2	
	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)	Estimated Emissions (lbs/day)	Estimated Emissions (tons/yr)
2010										
Building 25 Demolition	0.5966	0.0328	1.334	0.0733	6.3664	0.3501	0.0032	0.0002	1037	57.0
2010 TOTAL	**0.5966**	**0.0328**	**1.334**	**0.0733**	**6.3664**	**0.3501**	**0.0032**	**0.0002**	**1037**	**57.0**
2011										
Building 25 Demolition	0.5548	0.0055	1.292	0.0129	6.1288	0.0613	0.0032	0.0000	1037	10.4
Grading for GPL Construction	1.0804	0.0113	2.813	0.0295	13.0280	0.1368	0.0010	0.0000	2349	24.7
Construction of GPL	0.5160	0.0452	0.5218	0.0457	7.8834	0.6898	0.0034	0.0003	1243	108.8
2011 TOTAL	**2.1512**	**0.0620**	**4.627**	**0.0881**	**27.0402**	**0.8879**	**0.0076**	**0.0003**	**4629**	**143.8**
2012										
Construction of GPL	0.4615	0.0602	0.4674	0.0610	7.5262	0.9822	0.0034	0.0004	1244	162.3
Building 71 Trailer Demolition	0.4930	0.0212	1.105	0.0475	5.8358	0.2509	0.0028	0.0001	997	42.9
2012 TOTAL	**0.9545**	**0.0814**	**1.572**	**0.1085**	**13.3620**	**1.2331**	**0.0062**	**0.0006**	**2241**	**205.2**
2013										
Construction of GPL	0.4071	0.0171	0.4130	0.0173	7.2112	0.3029	0.0034	0.0001	1244	52.2
Building 71 Trailer Demolition	0.4399	0.0185	1.052	0.0442	5.6320	0.2365	0.0028	0.1233	997	41.9
Building 55 Demolition	0.4465	0.0339	1.185	0.0900	5.6989	0.4331	0.0032	0.0002	1037	78.8
2013 TOTAL	**1.2935**	**0.0695**	**2.650**	***0.1516***	**18.5422**	**0.9725**	**0.0094**	**0.1237**	**3278**	**172.9**
2014										
Building 55 Demolition	0.3942	0.0164	1.133	0.0470	5.5227	0.2292	0.0032	0.0001	1037	43.0
2014 TOTAL	**0.3942**	**0.0164**	**1.133**	**0.0470**	**5.5227**	**0.2292**	**0.0032**	**0.0001**	**1037**	**43.0**
Pollutant Totals	5.4	0.3	11.3	0.5	70.8	3.7	0.03	0.12	12221.9	622.0

Notes
(1) It is assumed that 100% of PM_{10} Exhaust is DPM. Maximum annual DPM emission rate (occurs for in year 2012) is underlined, intalicized, and highlighted.
(2) Maximum annual $PM_{2.5}$ emission rate (occurs for in year 2013) is underlined, intalicized, and highlighted.

Table 2-4
Summary of Project Construction/Demolition On-Road Truck Criteria Pollutant and CO_2 Emissions Estimates
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Pollutant	Emission Factor (1) (lb/10^3 VMT)	Maximum Daily Truck Trips (2)	Maximum Annual Truck Trips (2)	Round-Trip Distance (3) (miles)	Maximum Daily Emissions (a) (lb/day)	Maximum Annual Emissions (b) (ton/yr)
ROG	1.35	14	1,671	15	0.3	0.017
NO_x	20.1	14	1,671	15	4.2	0.252
PM_{10}	0.70	14	1,671	15	0.1	0.009
$PM_{2.5}$	0.60	14	1,671	15	0.1	0.008
CO	5.6	14	1,671	15	1.2	0.070
SO_2	0.0220	14	1,671	15	0.005	0.0003

Pollutant	Emission Factor (1) (lb/10^3 VMT)	Maximum Daily Truck Trips (2)	Maximum Annual Truck Trips (2)	Round-Trip Distance (3) (miles)	Maximum Daily Emissions (a) (lb/day)	Maximum Annual Emissions (c) (metric ton/yr)
CO_2	2623.2	14	1,671	15	550.9	29.8

Notes:
VMT = Vehicle Miles Travelled
(a) Maximum Daily Emissions (lb/day) = [Maximum Daily Truck Trips x Round-Trip Distance (mi) x Emission Factor (lb/10^3 VMT)] / 1,000 (VMT/10^3 VMT)
(b) Maximum Annual Emissions (ton/yr) = [Maximum Annual Truck Trips x Round-Trip Distance (mi) x Emission Factor (lb/10^3 VMT)]/[1,000 (VMT/10^3 VMT) x 2,000 (lb/ton)]
(c) Maximum Annual Emissions (ton/yr) = [Maximum Annual Truck Trips x Round-Trip Distance (mi) x Emission Factor (lb/10^3 VMT)]/[1,000 (VMT/10^3 VMT) x 2,205 (lb/metric ton)]

(1) Taken from a 2009 EMFAC2007 model run for the Bay Area. Assumes the following vehicle mix: 20% T3 Medium Duty Trucks; 15% T4 Light-Heavy-Duty Trucks; 10% T5 Light-Heavy-Duty Trucks; Trucks 15% T6 Medium-Heavy-Duty Trucks; 40% T7 Heavy-Heavy-Duty
(2) Estimated by Lawrence Berkeley National Laboratory.
(3) Estimated by Golder Associates.

Table 2-5
Summary of Project and Cumulative Construction/Demolition On-Road Truck DPM Emissions Estimates
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Assessment	Maximum No. of Roundtrips (1) (12 months)	Total No. of Roundtrips (2) (total sum)	DPM Emission Factor (3) (g/mi)	Maximum 12-Month Total DPM Emissions (a) (g/mi)	Total DPM Emissions (b) (g/mi)	Maximum 12-Month Average DPM Emission Rate (c) (g/mi/sec)	Average DPM Emission Rate (d) (g/mi/sec)	Maximum 12-Month Average DPM Emission Rate (e) ($g/m^2/sec$)	Average DPM Emission Rate (f) ($g/m^2/sec$)
Seismic 2 Project Only	1,671	4,101	0.284	948	2,327	3.01E-05	1.97E-05	1.87E-09	1.22E-09
All LBNL Projects	4,969	12,195	0.284	2,820	6,920	8.94E-05	5.85E-05	5.56E-09	3.64E-09
Cumulative (4)	36,499	87,777	0.284	20,710	49,806	6.57E-04	4.21E-04	4.08E-08	2.62E-08

Notes:
(a) Maximum 12-Month Total DPM Emissions (g/mi) = 2 x Maximum No. of Roundtrips (12 months) x DPM Emission Factor (g/mi).
(b) Total DPM Emissions (g/mi) = 2 x Total No. of Roundtrips (total sum) x DPM Emission Factor (g/mi).
(c) 12-Month Average DPM Emission Rate (g/mi/sec) = Maximum 12-Month Total DPM Emissions (g/mi) / (8,760 hrs/yr x 3,600 sec/hr).
(d) Average DPM Emission Rate (g/mi/sec) = Total DPM Emissions (g/mi) / (3.75 years x 8,760 hrs/yr x 3,600 sec/hr).
This is the average DPM emission rate over the 3.75 year Project period.
(e) 12-Month Average Emission Rate ($g/m^2/sec$) = 12-Month Average DPM Emission Rate (g/mi/sec) / (16,093 m^2/mi). (5)
(f) Average Emission Rate ($g/m^2/sec$) = Average DPM Emission Rate (g/mi/sec) / (16,093 m^2/mi). (5)

References:
(1) The maximum number of construction/demolition on-road truck trips (roundtrip) estimated for any 12-month period.
(2) The total number of construction/demolition on-road truck trips (roundtrip) estimated for the entire project time period(s).
(3) Based on the followed distribution of estimated truck types and emission factors; taken from EMFAC run for Bay Area for model year 2009.

20% T3 Medium Duty Trucks @	0.000	g/mi (no diesel)
15% T4 Light-Heavy-Duty Trucks @	0.053	g/mi
10% T5 Light-Heavy-Duty Trucks @	0.074	g/mi
15% T6 Medium-Heavy-Duty Trucks @	0.259	g/mi
40% T7 Heavy-Heavy-Duty Trucks @	0.574	g/mi
Weighted average =	0.284	g/mi

(4) All quantified LBNL and UCB projects.
(5) Because road emissions are represented in the dispersion model using area sources 10 meters wide, a mile of road segment has 1,609.3 meters x 10 meters = 16,093 m^2.

Table 2-6
CO_2 Emissions: Comparison of Project Emissions to Displaced 2004 Historical Emissions
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Project Operations	CO_2 Emissions (tons/yr)
Onsite Stationary Sources [1]	51
Worker Commuting [2]	241
Offsite Electrical Generation [a]	2,065
Total	2357.0

2004 Replaced Energy Usage	CO_2 Emissions (tons/yr)
Onsite Stationary Sources [b]	62.6
Worker Commuting [7]	241
Offsite Electrical Generation [c]	519
Potter Street -Offsite Electrical Generation [d]	765
Total	1587.9

Notes:

(a) CO_2 Emissions (tons/yr) = Annual Electrical Usage (MW-hrs) x CO_2 Emission Factor (lbs CO_2/MW-hr) / 2,000 lb/ton

Annual Electrical Usage (MW-hrs) =	4,700	(3)
CO_2 Emission Factor (lbs CO_2/MW-hr) =	878.71	(4)

(b) CO_2 Emissions (tons/yr) = (Maximum annual fuel usage [therms/yr]) x (100,000 [Btu/therms]) x (scf/1,020 Btu) x (MMscf/1,000,000 scf) x (emission factor [lbs/MMscf]) x (1 ton/2,000 lbs)

Annual Natural Gas Usage (therms/yr) =	10,643	(5)
CO_2 Emission Factor (lbs CO_2/MMscf) =	120,000	(6)

(c) CO_2 Emissions (tons/yr) = Annual Electrical Usage (MW-hrs) x CO_2 Emission Factor (lbs CO_2/MW-hr) / 2,000 lb/ton

Annual Electrical Usage (MW-hrs) =	1,181.0	(8)
CO_2 Emission Factor (lbs CO_2/MW-hr) =	878.71	(4)

(d) CO_2 Emissions (tons/yr) = Annual Electrical Usage (MW-hrs) x CO_2 Emission Factor (lbs CO_2/MW-hr) / 2,000 lb/ton

Annual Electrical Usage (MW-hrs) =	1,742.1	(9)
CO_2 Emission Factor (lbs CO_2/MW-hr) =	878.71	(4)

References:

(1) Onsite stationary source emissions are from natural gas combustion in the heaters/boilers and diesel fuel usage in the backup diesel generator. From Table 2-1.
(2) From Table 2-1.
(3) Provided by LBNL.
(4) From the Climate Registry General Reporting Protocol (Ver. 1.1, May 2008) for the WECC California subregion.
(5) Provided by LBNL and/or its contractors. Based on Fiscal Year 2009 data.
(6) AP-42, Fifth Edition, Section 1.4 (July 1998), Table 1.4-2; Emission Factors For Criteria Pollutants and Greenhouse Gases From Natural Gas Combustion.
(7) Assumed to be equal to the Project Opertions emission rate. Assumes that workers in demolished bulidings will be relocated to GPL Building.
(8) Provided by LBNL and/or its contractors. Based on 2008 data and usage values for Building 55, Building 25 & 26, Buildings 71C,D,E,G,K,P and Buildings 71F,J
(9) Provided by LBNL and/or its contractors. Based on 2008 data and usage values for B977.

Table 2-7
CO_2 Emissions: Comparison of Project Emissions to Displaced 2008 Historical Emissions
Seismic Life-Safety Phase 2 Project
Lawarence Berkeley National Laboratory, Berkeley, California

Project Operations	CO_2 Emissions (tons/yr)
Onsite Stationary Sources [1]	51
Worker Commuting [2]	241
Offsite Electrical Generation [a]	2,065
Total	2357.0

2008 Replaced Energy Usage	CO_2 Emissions (tons/yr)
Onsite Stationary Sources [b]	62.6
Worker Commuting [7]	241
Offsite Electrical Generation [c]	309
Potter Street -Offsite Electrical Generation [d]	765
Total	1377.9

Notes:

(a) CO_2 Emissions (tons/yr) = Annual Electrical Usage (MW-hrs) x CO_2 Emission Factor (lbs CO_2/MW-hr) / 2,000 lb/ton

Annual Electrical Usage (MW-hrs) =	4,700	(3)
CO_2 Emission Factor (lbs CO_2/MW-hr) =	878.71	(4)

(b) CO_2 Emissions (tons/yr) = (Maximum annual fuel usage [therms/yr]) x (100,000 [Btu/therms]) x (scf/1,020 Btu) x (MMscf/1,000,000 scf) x (emission factor [lbs/MMscf]) x (1 ton/2,000 lbs)

Annual Naturdal Gas Usage (therms/yr) =	10,643	(5)
CO_2 Emission Factor (lbs CO_2/MMscf) =	120,000	(6)

(c) CO_2 Emissions (tons/yr) = Annual Electrical Usage (MW-hrs) x CO_2 Emission Factor (lbs CO_2/MW-hr) / 2,000 lb/ton

Annual Electrical Usage (MW-hrs) =	703.0	(8)
CO_2 Emission Factor (lbs CO_2/MW-hr) =	878.71	(4)

(d) CO_2 Emissions (tons/yr) = Annual Electrical Usage (MW-hrs) x CO_2 Emission Factor (lbs CO_2/MW-hr) / 2,000 lb/ton

Annual Electrical Usage (MW-hrs) =	1,742.1	(9)
CO_2 Emission Factor (lbs CO_2/MW-hr) =	878.71	(4)

References:

(1) Onsite stationary source emissions are from natural gas combustion in the heaters/boilers and diesel fuel usage in the backup diesel generator. From Table 2-1.
(2) From Table 2-1.
(3) Provided by LBNL.
(4) From the Climate Registry General Reporting Protocol (Ver. 1.1, May 2008) for the WECC California subregion.
(5) Provided by LBNL and/or its contractors. Based on Fiscal Year 2009 data.
(6) AP-42, Fifth Edition, Section 1.4 (July 1998), Table 1.4-2; Emission Factors For Criteria Pollutants and Greenhouse Gases From Natural Gas Combustion.
(7) Assumed to be equal to the Project Opertions emission rate. Assumes that workers in demolished bulidings will be relocated to GPL Building.
(8) Provided by LBNL and/or its contractors. Based on 2008 data and usage values for Building 55, Building 25 & 26, Buildings 71C,D,E,G,K,P and Buildings 71F,J
(9) Provided by LBNL and/or its contractors. Based on 2008 data and usage values for B977.

Table 2-8
Summary of Cumulative LBNL Project Emissions
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Project	2011 (ton/yr)			2012 (ton/yr)			2013 (ton/yr)			2014 (ton/yr)		
	PM_{10} Exhaust	$PM_{2.5}$ Exhaust	$PM_{2.5}$ Dust	PM_{10} Exhaust	$PM_{2.5}$ Exhaust	$PM_{2.5}$ Dust	PM_{10} Exhaust	$PM_{2.5}$ Exhaust	$PM_{2.5}$ Dust	PM_{10} Exhaust	$PM_{2.5}$ Exhaust	$PM_{2.5}$ Dust
Solar Energy Research Center (Construction)	-	-	-	6.83E-02	6.28E-02	6.00E-03	2.73E-02	2.51E-02	2.81E-04	-	-	-
CRT Building (Construction)	6.88E-02	6.32E-02	9.40E-04	1.55E-01	1.42E-01	2.22E-03	2.18E-02	2.00E-02	3.42E-04	-	-	-
Building 51 & 51A (Demolition)	3.24E-02	2.98E-02	1.25E-01	1.76E-02	1.62E-02	7.29E-02	-	-	-	-	-	-
Old Town (Demolition)	3.24E-02	2.98E-02	6.17E-03	7.15E-02	6.58E-02	1.46E-02	6.49E-02	5.96E-02	1.46E-02	3.37E-02	3.10E-02	8.53E-03

Does not include Seismic Phase 2 project.
Diesel particulate matter = PM_{10} Exhaust.
Emissions estimated using the URBEMIS emissions model (see report text).

Table 2-9
Summary of Construction/Demolition On-Road Truck $PM_{2.5}$ Emissions Estimates
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Assessment	Maximum No. of Roundtrips (1) (12 months)	Total No. of Roundtrips (2) (total sum)	$PM_{2.5}$ Emission Factor (3) (g/mi)	Maximum 12-Month Total $PM_{2.5}$ Emissions (a) (g/mi)	Maximum 12-Month Average $PM_{2.5}$ Emission Rate (b) (g/mi/sec)	Maximum 12-Month Average $PM_{2.5}$ Emission Rate (c) ($g/m^2/sec$)
Seismic 2 Project Only	1,671	4,101	0.272	908	2.88E-05	1.79E-09
All LBNL Projects	4,969	12,195	0.272	2,702	8.57E-05	5.32E-09
Cumulative (4)	36,499	87,777	0.272	19,843	6.29E-04	3.91E-08

Notes:

(a) Maximum 12-Month Total $PM_{2.5}$ Emissions (g/mi) = 2 x Maximum No. of Roundtrips (12 months) x $PM_{2.5}$ Emission Factor (g/mi).

(b) 12-Month Average $PM_{2.5}$ Emission Rate (g/mi/sec) = Maximum 12-Month Total $PM_{2.5}$ Emissions (g/mi) / (8,760 hrs/yr x 3,600 sec/hr).

(c) 12-Month Average Emission Rate ($g/m^2/sec$) = 12-Month Average $PM_{2.5}$ Emission Rate (g/mi/sec) / (16,093 m^2/mi). (5)

References:

(1) The maximum number of construction/demolition on-road truck trips (roundtrip) estimated for any 12-month period.
(2) The total number of construction/demolition on-road truck trips (roundtrip) estimated for the entire project time period(s).
(3) Based on the followed distribution of estimated truck types and emission factors; taken from EMFAC run for Bay Area for model year 2009.

20% T3 Medium Duty Trucks @	0.000	g/mi (no diesel)
15% T4 Light-Heavy-Duty Trucks @	0.053	g/mi
10% T5 Light-Heavy-Duty Trucks @	0.074	g/mi
15% T6 Medium-Heavy-Duty Trucks @	0.247	g/mi
40% T7 Heavy-Heavy-Duty Trucks @	0.548	g/mi
Weighted average =	0.272	g/mi

(4) All quantified LBNL and UCB projects.
(5) Because road emissions are represented in the dispersion model using area sources 10 meters wide, a mile of road segment has 1,609.3 meters x 10 meters = 16,093 m^2.

Table 3-1
Project Operations Point Source Parameters
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Source	Source ID	UTM-x (m)	UTM-y (m)	Base Elevation (m)	Height (ft) [m]	Diameter (in) [m]	Velocity (ft/min) [m/s]	Temperature (°F) [K]
Lab Stack 1	LAB1	566,255.5	4,192,340.3	289.5	90 [27.4]	44 [1.1]	1,800 [9.14]	72 [295.4]
Lab Stack 2	LAB2	566,255.8	4,192,338.9	289.5	90 [27.4]	44 [1.1]	1,800 [9.14]	72 [295.4]
Boiler Flue 1	BOIL1	566,246.5	4,192,350.0	289.5	63 [19.2]	10 [0.25]	800 [4.06]	200 [366.5]
Boiler Flue 2	BOIL2	566,245.0	4,192,349.7	289.5	63 [19.2]	10 [0.25]	800 [4.06]	200 [366.5]
Diesel Generator	DGEN	566,272.0	4,192,293.0	279.6	20 [6.1]	8 [0.20]	8,650 [43.9]	975 [797.0]

Table 3-2
Laboratory TAC Emissions Estimates
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

CAS	COPC (1)	Proposed Project Per Stack Maximum Hourly Emissions (2) (lbs/hr)	Exposure Concentration (a) (µg/m³)
106990	1,3-Butadiene	7.9E-05	0.004
75070	Acetaldehyde	4.8E-04	0.026
107028	Acrolein	1.7E-04	0.009
107131	Acrylonitrile	1.4E-04	0.007
71432	Benzene	3.5E-03	0.19
7637072	Boron Trifluoride	3.0E-04	0.016
56235	Carbon Tetrachloride	2.7E-03	0.14
7782505	Chlorine	2.5E-03	0.13
67663	Chloroform	2.1E-02	1.1
4170303	Crotonaldehyde	1.4E-05	0.001
107062	Ethylene Dichloride	2.4E-03	0.13
50000	Formaldehyde	2.5E-03	0.13
7647010	HCl	2.3E-02	1.2
302012	Hydrazine	3.9E-05	0.002
75014	Vinyl Chloride	1.7E-03	0.09
75354	Vinylidene Chloride	1.2E-04	0.006

Notes:

(a) Exposure concentration (µg/m³) = (maximum modeled concentration [µg/m³]) x (proposed project maximum hourly emissions [lbs/hr]) x (453.59 g/lbs) / (3,600 s/hr)

maximum modeled concentration (µg/m³) = 420.8 (3)

References:

(1) Chemicals of Potential Concern (COPC) list is taken from Baseline Air Emissions Inventory Toxic Compound Emissions for Lawrence Berkeley National Laboratory (SECOR 2004), Table 33. Only COPCs which were emitted by laboratory sources have been included in this table as determined by Table 29, SECOR 2004.

(2) Taken from emissions inventory. Emission rates are for a single lab stack. It is assumed that both lab stacks emit equally.

(3) Maximum concentration resulting from the AERMOD model assuming a unit emission rate of 1 g/s for each of the two lab sources.

Table 3-3
$PM_{2.5}$ Modeling Results
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Pollutant	Meteorological Year	Emissions Scenario	Maximum Annual Average Concentration (µg/m³)
$PM_{2.5}$	1998	Project Operations	0.0008
		Project Construction/Demolition (1)	0.14
		Project Construction/Demolition (2)	0.0045
		Cumulative Construction/Demolition (1)	0.31
		Cumulative Construction/Demolition (2)	0.073
	1999	Project Operations	0.0008
		Project Construction/Demolition (1)	0.15
		Project Construction/Demolition (2)	0.0046
		Cumulative Construction/Demolition (1)	0.30
		Cumulative Construction/Demolition (2)	0.073

(1) From onsite, off-road equipment emissions.
(2) From offsite, on-road truck emissions.

Table 3-4
Construction/Demolition DPM Modeling Results
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Pollutant	Emission Scenario	Receptor Grid	Maximum Annual Average Concentration (µg/m³)
DPM	Project Max 12-Month (Hazard Assessments)	Onsite	0.41
		Offsite	0.070
	Total Project (LECR Assessments)	Onsite	0.31
		Offsite (1)	0.046
	Cumulative Max 12-Month (Hazard Assessments)	Onsite	1.44
		Offsite	0.31
	Total Cumulative (LECR Assessments)	Onsite	0.69
		Offsite	0.14

Notes:
(1) Excludes the three model receptor locations with the highest predicted concentrations (between 0.056 ug/m^3 and 0.052 ug/m^3) which were inappropriate for LECR assessment. See report text.

Table 3-5
DPM Modeling Results for On-Road Truck Traffic from Construction/Demolition Acitivities
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Pollutant	Modeling Scenario	Emissions Scenario	Maximum Concentration (µg/m³)
DPM	Project Only	Maximum 12-Month	0.0048
		Maximum Period (3.75 year)	0.0031
	Cumulative	Maximum 12-Month	0.053
		Maximum Period (3.75 year)	0.034

Table 4-1
Maximum LECR and Chronic Hazard Estimates For Project Operations
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Assessment	MEI Result (1)
Onsite LECR	5.4E-07
Onsite Chronic Hazard	0.003
Offsite LECR	1.7E-07
Offsite Chronic Hazard	0.001

LECR = Lifetime Excess Cancer Risk
MEI = Maximally Exposed Individual

(1) From the HARP model. Offsite LECR multiplied by age sensitivity factor of 1.7 in accordance with Jan. 2010 BAAQMD guidance for assessment of air toxics.

Table 4-2
Summary of Acute Hazard Index Estimates for GPL Laboratory Operations
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

CAS	Toxic Air Contaminant (1)	Project Maximum Hourly Emissions (2) (lbs/hr)	Maximum 1-Hour Exposure Concentration (a) (µg/m³)	Acute Inhalation Reference Concentration (4) (µg/m³)	Acute Hazard Index (b)
106990	1,3-Butadiene	7.9E-05	0.0042	N/A	-- --
75070	Acetaldehyde	4.8E-04	0.026	470	0.0001
107028	Acrolein	1.7E-04	0.0090	2.5	0.004
107131	Acrylonitrile	1.4E-04	0.0073	N/A	-- --
71432	Benzene	3.5E-03	0.19	1,300	0.0001
7637072	Boron Trifluoride	3.0E-04	0.02	N/A	-- --
56235	Carbon Tetrachloride	2.7E-03	0.14	1,900	0.0001
7782505	Chlorine	2.5E-03	0.13	210	0.001
67663	Chloroform	2.1E-02	1.1	150	0.01
4170303	Crotonaldehyde	1.4E-05	0.0008	N/A	-- --
107062	Ethylene Dichloride	2.4E-03	0.1	N/A	-- --
50000	Formaldehyde	2.5E-03	0.13	55	0.002
7647010	HCl	2.3E-02	1.2	2,100	0.001
302012	Hydrazine	3.9E-05	0.0	N/A	-- --
75014	Vinyl Chloride	1.7E-03	0.091	180,000	0.000001
75354	Vinylidene Chloride	1.2E-04	0.006	N/A	-- --

Notes:

(a) Exposure concentration (µg/m³) = [maximum modeled concentration (µg/m³)] x [project maximum hourly emissions (lb/hr)] x [453.59 g/lb] / [3,600 s/hr]

maximum modeled concentration (µg/m³) = 420.8 (3)

(b) Acute hazard index = [maximum 1-hour concentration (ug/m^3)] / [acute inhalation reference concentration (ug/m^3)]

References:

(1) List of TACs potentially emitted from the laboratory fume hood vents. See Section 2 of this report.
No hazard index provided for TACs without acute reference concentrations published by OEHHA.

(2) Estimated maximum hourly emission rate for each of the two laboratory fume hood vents. See Section 2 of this report.

(3) Maximum concentration resulting from the AERMOD model assuming a unit emission rate of 1 g/s for each of the two lab sources. See Section 3 of this report.

(4) Values published by OEHHA (http://www.arb.ca.gov/toxics/healthval/acute.pdf) accessed Dec 2009.

Table 4-3
Risk Assessment for Off-Road Construction/Demolition Equipment Usage for Offsite Receptors
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Assessment	Averaging Period for Maximum Exposure Concentration (years)	Maximum Average DPM Concentration Over Averaging Period ($\mu g/m^3$)	Maximum Lifetime Excess Cancer Risk [(a)]
LECR (Project only)	3.75	0.046 [(3)]	8.4E-06
LECR (Cumulative)	3.75	0.140	2.6E-05

Assessment	Averaging Period for Maximum Exposure Concentration (years)	Maximum Average DPM Concentration Over Averaging Period ($\mu g/m^3$)	Maximum Chronic Hazard Quotient [(b)]
Chronic Hazard (Project Only)	1	0.070	0.014
Chronic Hazard (Cumulative)	1	0.310	0.062

Notes:
LECR = Lifetime Excess Cancer Risk; DPM = Diesel Particulate Matter

(a) Maximum LECR = Dose (mg/kg-day) x Slope Factor ($(mg/kg\text{-}day)^{-1}$) x Weighted Age Sensitivity Factor

Dose (mg/kg-day) = [Exposure Concentration ($\mu g/m^3$) x Daily Breathing Rate (L/kg-day) x Exposure Frequency (days/yr) x Exposure Duration (yrs) x 10^{-6} ($\mu g\text{-}L/mg\text{-}m^3$)]/Averaging Period (days)

Daily Breathing Rate (child; L/kg-day) = 452 (1)
Exposure Frequency (days/yr; resident) = 350 (1)
Exposure Duration (yrs) = 3.75 (1)
Averaging Period (days) = 25,550 (1)

Slope Factor (DPM; $(mg/kg\text{-}day)^{-1}$) = 1.1

Weighted Age Sensitivity Factor = 10 x 2.25 years of infant exposure + 3 x 1.50 years of child exposure / 3.75 years total exposure

= 7.20 (2)

(b) Maximum Hazard Quotient = Exposure Concentration ($\mu g/m^3$) / Reference Concentration ($\mu g/m^3$)

DPM Reference Concentration ($\mu g/m^3$) = 5

(1) Recommended values from *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments* , Cal EPA/OEHHA, August 2003 (http://www.oehha.org/air/hot_spots/pdf/HRAfinalnoapp.pdf).
(2) Age sensitivity factor usage from Jan. 2010 BAAQMD guidance for air toxics NSR program.
(3) Excludes three model receptor locations where residences were confirmed not to occur. See report text.

Table 4-4
Risk Assessment for Off-Road Construction/Demolition Equipment Usage for Onsite Receptors
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Assessment	Averaging Period for Maximum Exposure Concentration (years)	Maximum Average DPM Concentration Over Averaging Period ($\mu g/m^3$)	Maximum Lifetime Excess Cancer Risk [(a)]
LECR (Project only)	3.75	0.31	6.5E-06
LECR (Cumulative)	3.75	0.69	1.5E-05

Assessment	Averaging Period for Maximum Exposure Concentration (years)	Maximum Average DPM Concentration Over Averaging Period ($\mu g/m^3$)	Maximum Chronic Hazard Quotient [(b)]
Chronic Hazard (Project Only)	1	0.41	0.08
Chronic Hazard (Cumulative)	1	1.44	0.29

Notes:
LECR = Lifetime Excess Cancer Risk; DPM = Diesel Particulate Matter

(a) Maximum LECR = Dose (mg/kg-day) x Slope Factor ($(mg/kg\text{-}day)^{-1}$)

Dose (mg/kg-day) = [Exposure Concentration ($\mu g/m^3$) x Daily Breathing Rate (L/kg-day) x Exposure Frequency (days/yr) x Exposure Duration (yrs) x 10^{-6} ($\mu g\text{-}L/mg\text{-}m^3$)]/Averaging Period (days)

Daily Breathing Rate (worker; L/kg-day) = 149 (1)
Exposure Frequency (days/yr; worker) = 365 (1)
Exposure Duration (yrs) = 9 (1)
Averaging Period (days) = 25,550 (1)

Slope Factor (DPM; $(mg/kg\text{-}day)^{-1}$) = 1.1

(b) Maximum Hazard Quotient = Exposure Concentration ($\mu g/m^3$) / Reference Concentration ($\mu g/m^3$)

DPM Reference Concentration ($\mu g/m^3$) = 5

(1) Recommended values from *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments* , Cal EPA/OEHHA, August 2003 (http://www.oehha.org/air/hot_spots/pdf/HRAfinalnoapp.pdf).
Exposure frequency set to 365 days because model produces annual average concentration for all hours.

Table 4-5
Risk Assessment for On-Road Construction/Demolition Truck Traffic at Offsite Receptors
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Assessment	Averaging Period for Maximum Exposure Concentration (years)	Maximum Average DPM Concentration Over Averaging Period ($\mu g/m^3$)	Maximum Lifetime Excess Cancer Risk (a)
LECR (Project only)	3.75	0.00309	5.7E-07
LECR (Cumulative)	3.75	0.0487	9.0E-06

Assessment	Averaging Period for Maximum Exposure Concentration (years)	Maximum Average DPM Concentration Over Averaging Period ($\mu g/m^3$)	Maximum Chronic Hazard Quotient (b)
Chronic Hazard (Project Only)	1	0.00477	0.001
Chronic Hazard (Cumulative)	1	0.0758	0.02

Notes:
LECR = Lifetime Excess Cancer Risk; DPM = Diesel Particulate Matter

(a) Maximum LECR = Dose (mg/kg-day) x Slope Factor ($(mg/kg\text{-}day)^{-1}$) x Weighted Age Sensitivity Factor

Dose (mg/kg-day) = [Exposure Concentration ($\mu g/m^3$) x Daily Breathing Rate (L/kg-day) x Exposure Frequency (days/yr) x Exposure Duration (yrs) x 10^{-6} ($\mu g\text{-}L/mg\text{-}m^3$)]/Averaging Period (days)

Daily Breathing Rate (child; L/kg-day) = 452 (1)
Exposure Frequency (days/yr; resident) = 350 (1)
Exposure Duration (yrs) = 3.75 (1)
Averaging Period (days) = 25,550 (1)

Slope Factor (DPM; $(mg/kg\text{-}day)^{-1}$) = 1.1

Weighted Age Sensitivity Factor = 10 x 2.25 years of infant exposure + 3 x 1.50 years of child exposure / 3.75 years total exposure

= 7.20 (2)

(b) Maximum Hazard Quotient = Exposure Concentration ($\mu g/m^3$) / Reference Concentration ($\mu g/m^3$)

DPM Reference Concentration ($\mu g/m^3$) = 5

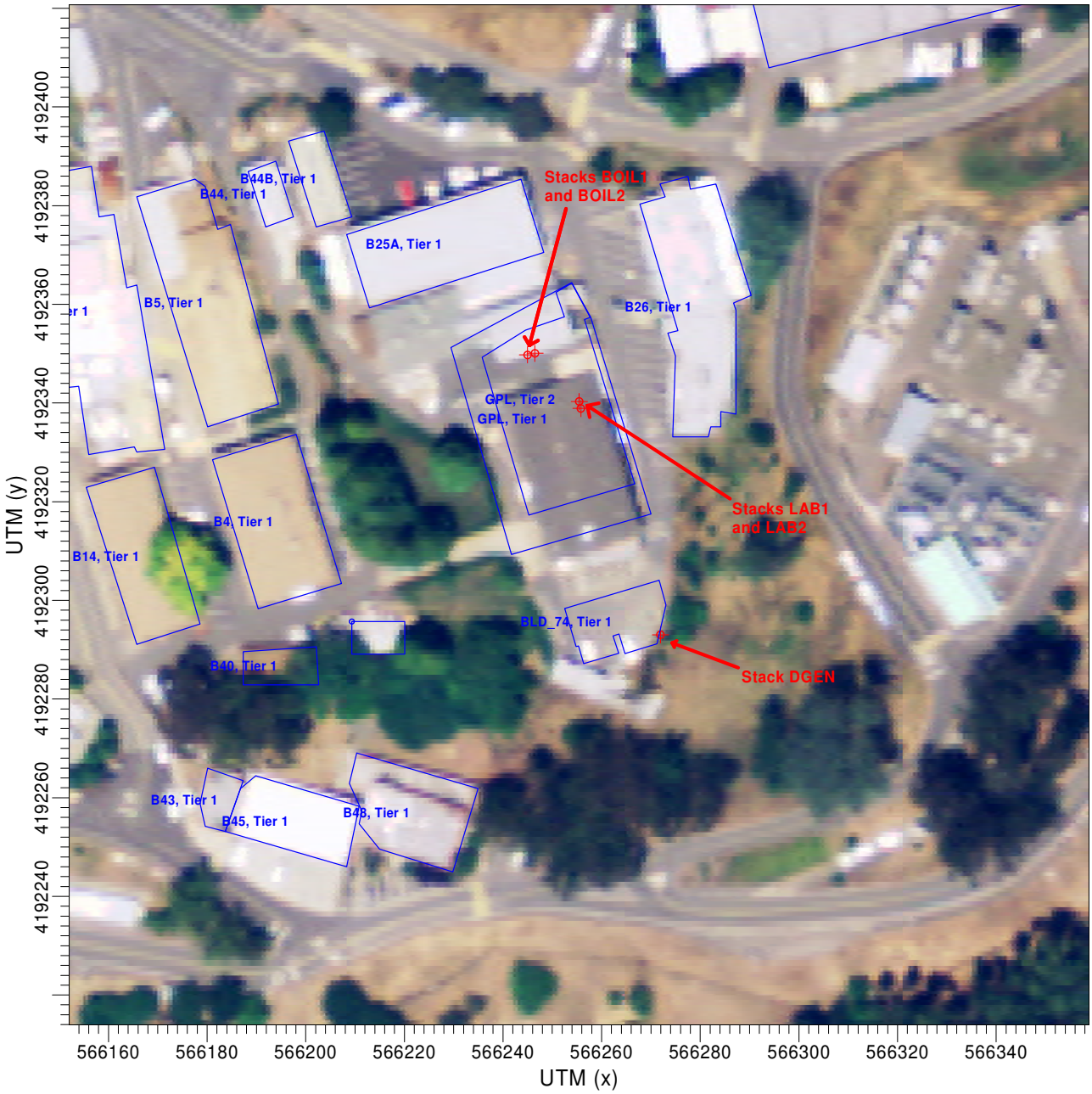
(1) Recommended values from *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments* , Cal EPA/OEHHA, August 2003 (http://www.oehha.org/air/hot_spots/pdf/HRAfinalnoapp.pdf).

(2) Age sensitivity factor usage from Jan. 2010 BAAQMD guidance for air toxics NSR program.

FIGURES

PROJECT TITLE:

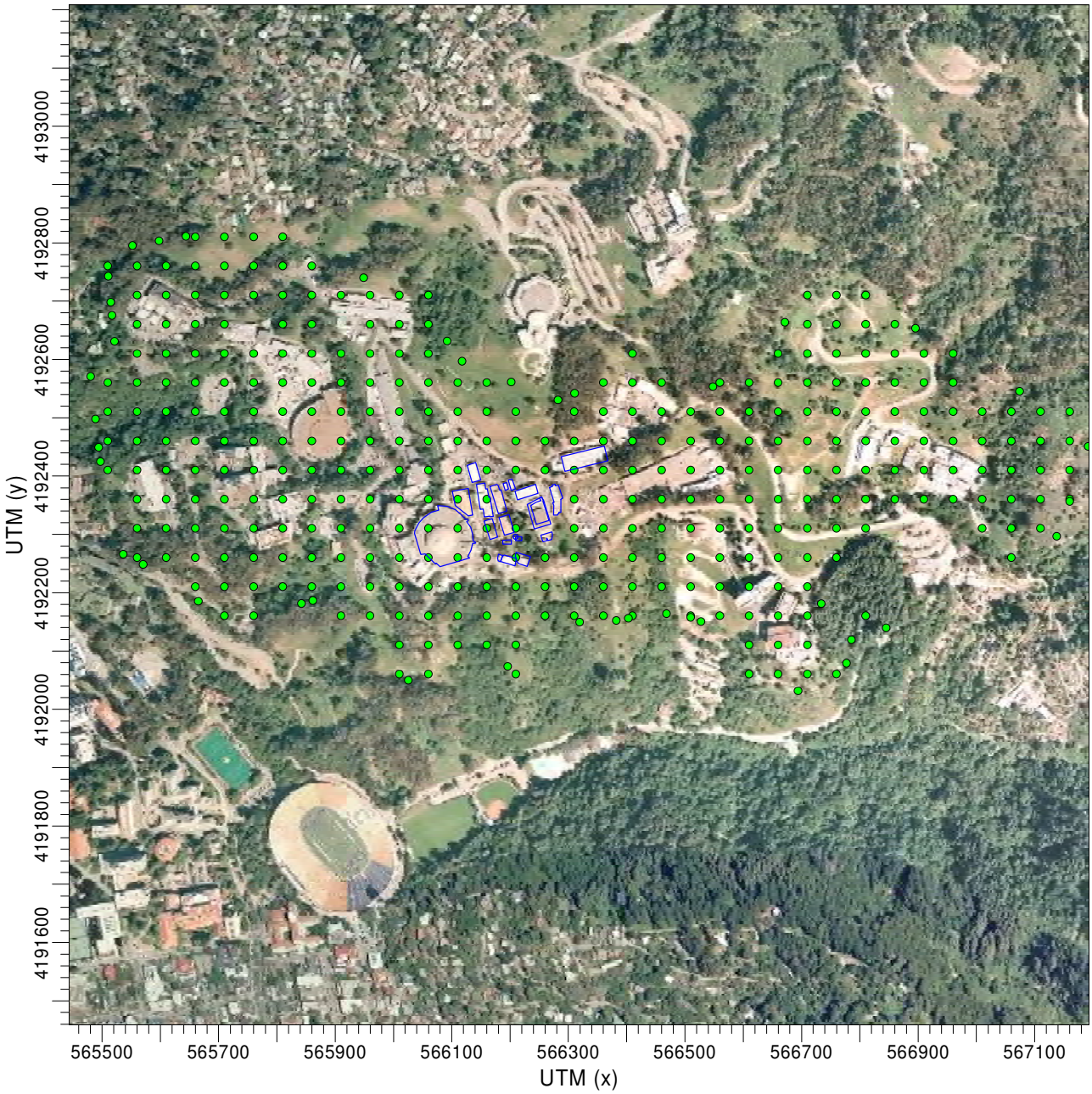
Figure 3-1. GPL Point Source Locations
Seismic Life-Safety Phase 2 Project; Lawrence Berkeley National Laboratory, Berkeley,



COMMENTS:	SOURCES:	COMPANY NAME:	
Buildings denoted in blue. Future GPL buliding shown. Sources denoted in red.	**5**	**Golder Associates Inc.**	
	RECEPTORS:	MODELER:	
	0	**Portland, OR**	
		SCALE: 1:1,300 0 0.04 km	
			PROJECT NO.:
			093-99021

AERMOD View - Lakes Environmental Software

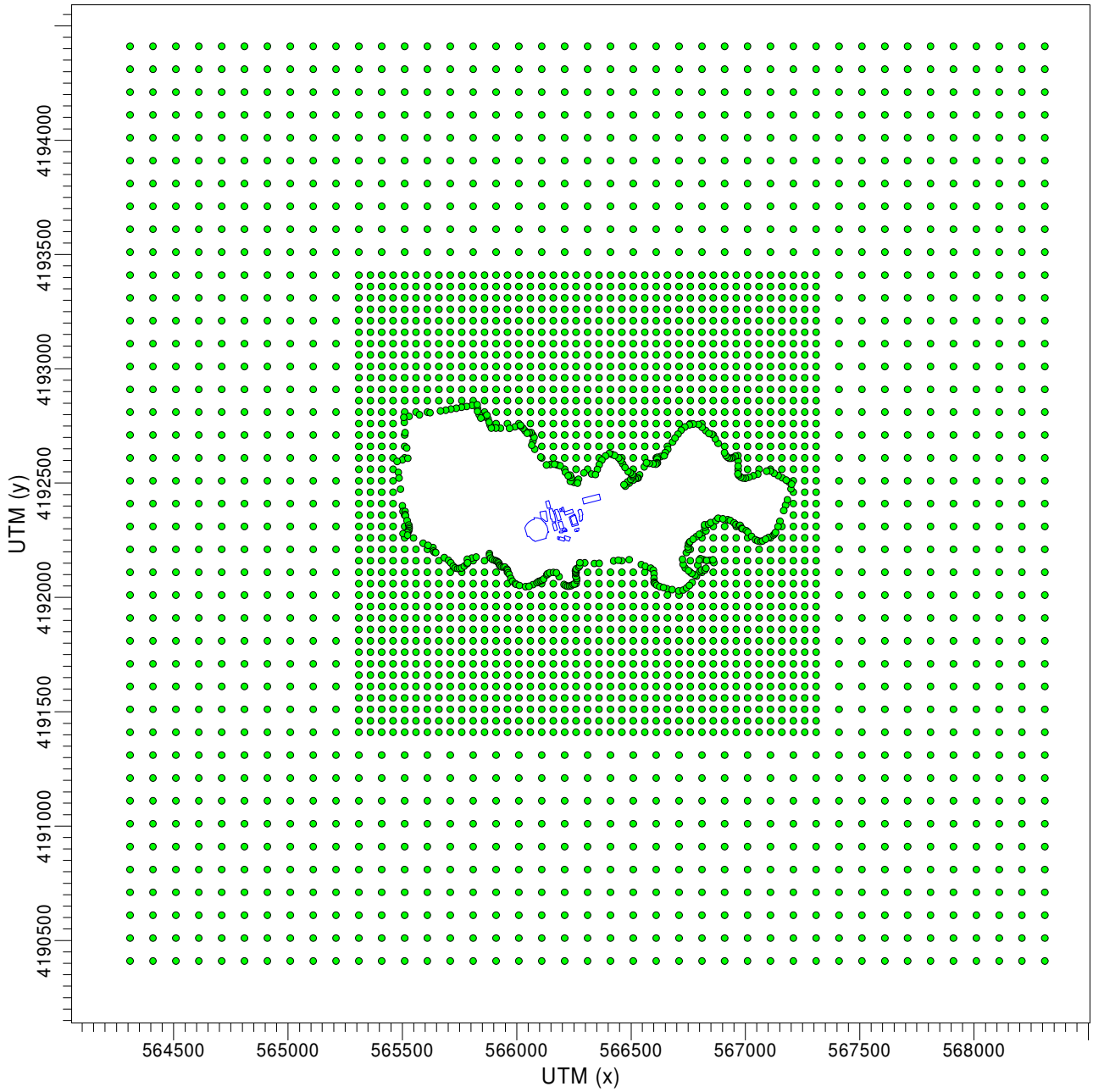
Figure 3-2. Onsite Receptor Grid
Seismic Life-Safety Phase 2 Project; Lawrence Berkeley National Laboratory, Berkeley,



COMMENTS:	SOURCES:	COMPANY NAME:	
Onsite receptors denoted with green circles. Blue denotes buildings near future GPL buliding location. Future GPL buliding is shown.	**0**	**Golder Associates Inc.**	
	RECEPTORS: **368**	MODELER: **Portland, OR**	Golder Associates
		SCALE: 1:11,000 0 0.4 km	
			PROJECT NO.: **093-99021**

AERMOD View - Lakes Environmental Software

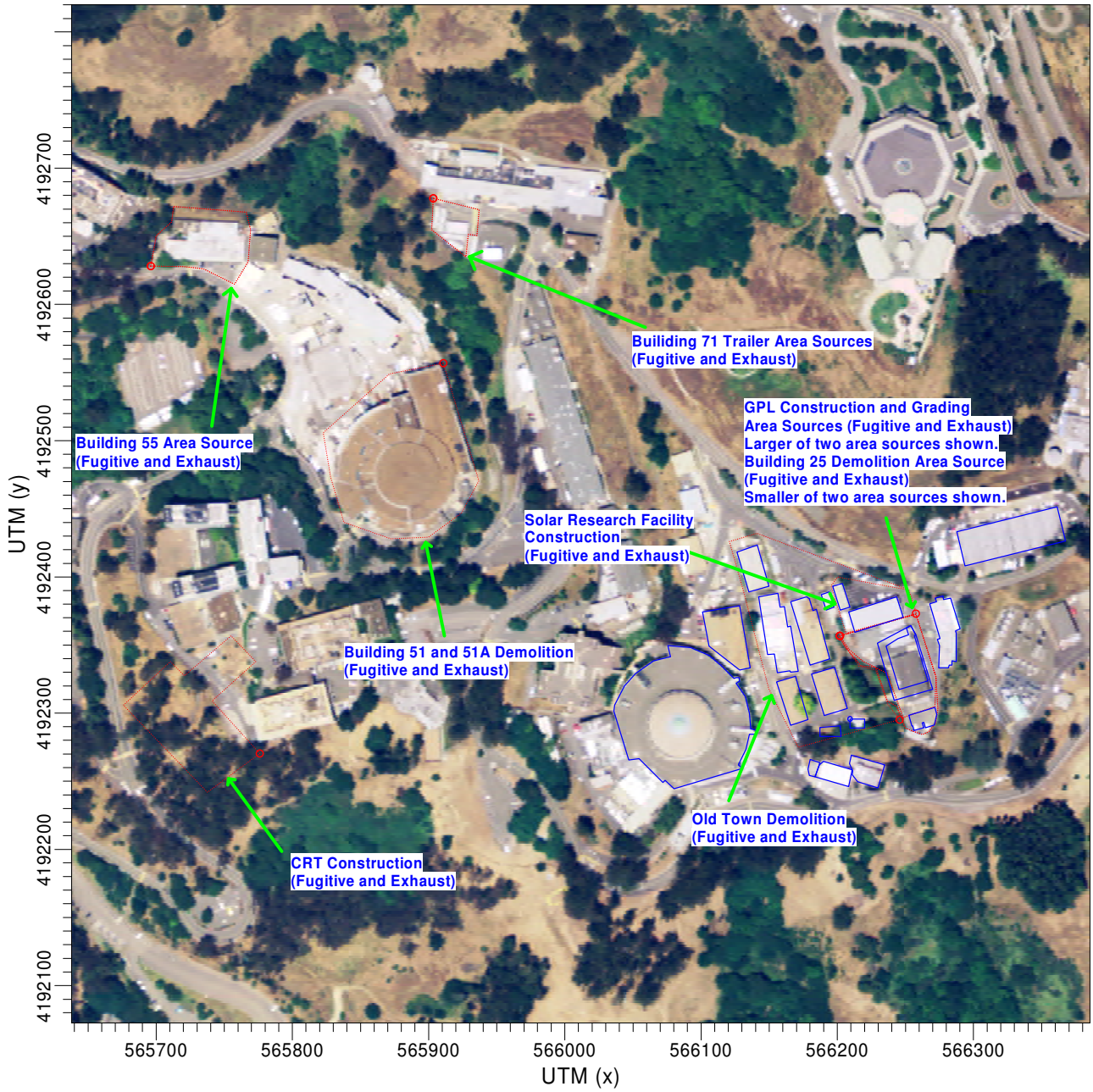
Figure 3-3. Offsite Receptor Grid
Seismic Life-Safety Phase 2 Project; Lawrence Berkeley National Laboratory, Berkeley,



COMMENTS:	SOURCES:	COMPANY NAME:	
Offsite receptors denoted with green circles. Blue denotes buildings near future GPL buliding location. Future GPL buliding is shown.	**0**	**Golder Associates Inc.**	
	RECEPTORS: **2911**	MODELER: **Portland, OR**	Golder Associates
		SCALE: 1:28,000 0 1 km	
			PROJECT NO.: **093-99021**

AERMOD View - Lakes Environmental Software

Figure 3-4. Area Source Locations for Construction/Demolition Modeling
Seismic Life-Safety Phase 2 Project; Lawrence Berkeley National Laboratory, Berkeley, CA



COMMENTS:	SOURCES:	COMPANY NAME:	
Area sources shown in red. Buildings entered into the model shown in blue. Future GPL building is shown.	**12**	**Golder Associates Inc.**	
	RECEPTORS: **0**	MODELER: **Portland, OR**	
		SCALE: 1:4,700 0 0.1 km	
			PROJECT NO.: **093-99021**

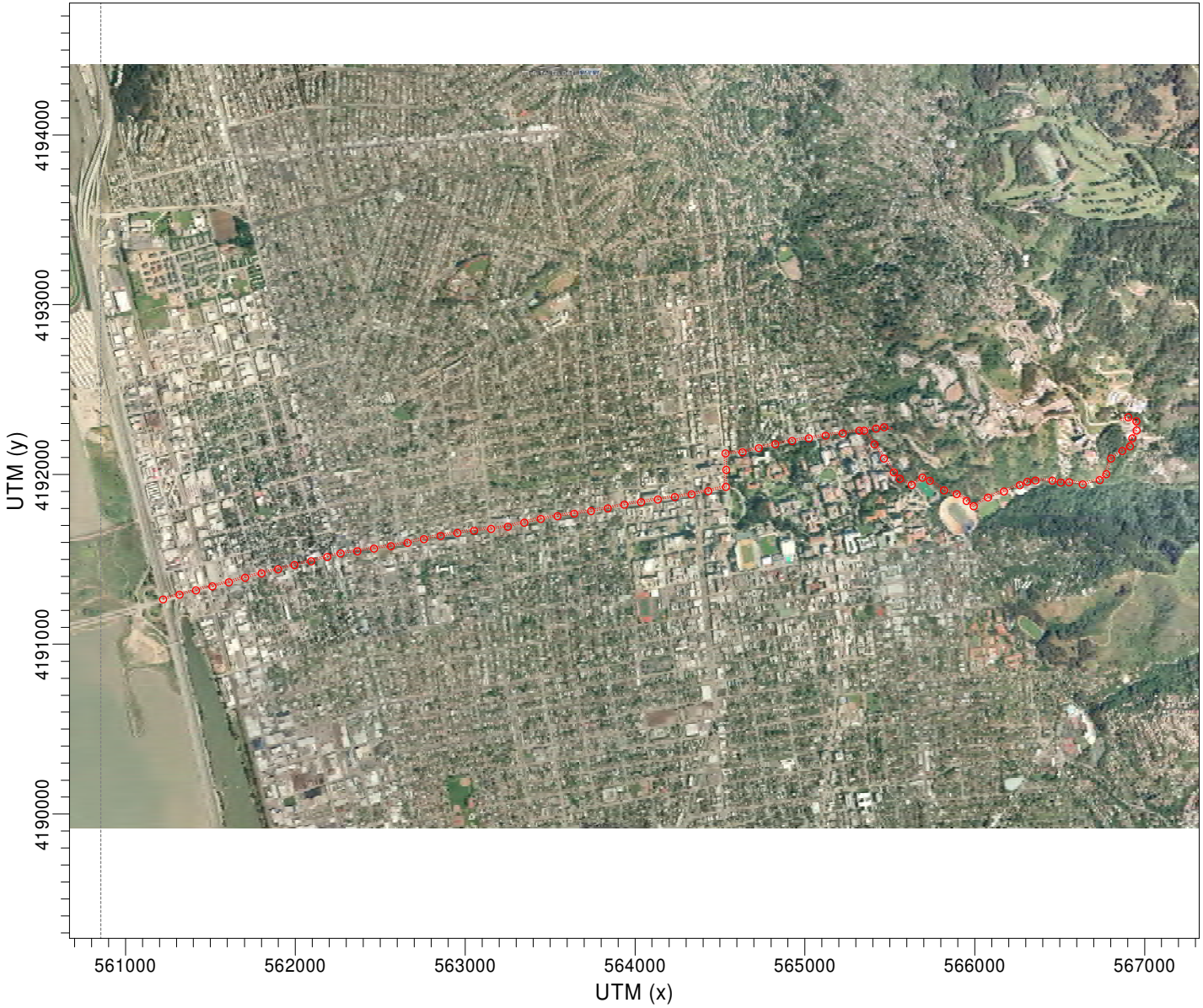
AERMOD View - Lakes Environmental Software

Figure 3-5. On-Road Construction/Demolition Truck Travel Area Sources - LBNL Vicinity Seismic Life-Safety Phase 2 Project; Lawrence Berkeley National Laboratory, Berkeley, CA

COMMENTS:	SOURCES:	COMPANY NAME:	
Red denotes area sources.	**77**	**Golder Associates Inc.**	
	RECEPTORS: **2634**	MODELER: **Portland, OR**	Golder Associates
		SCALE: 1:18,000 0 0.5 km	
			PROJECT NO.: **093-99021**

AERMOD View - Lakes Environmental Software

Figure 3-6. On-Road Construction/Demolition Truck Travel Area Sources - Entire Route Length
Seismic Life-Safety Phase 2 Project; Lawrence Berkeley National Laboratory, Berkeley, CA



COMMENTS:

Red denotes area sources.

SOURCES:

77

RECEPTORS:

2634

COMPANY NAME:

Golder Associates Inc.

MODELER:

Portland, OR

SCALE: 1:37,504

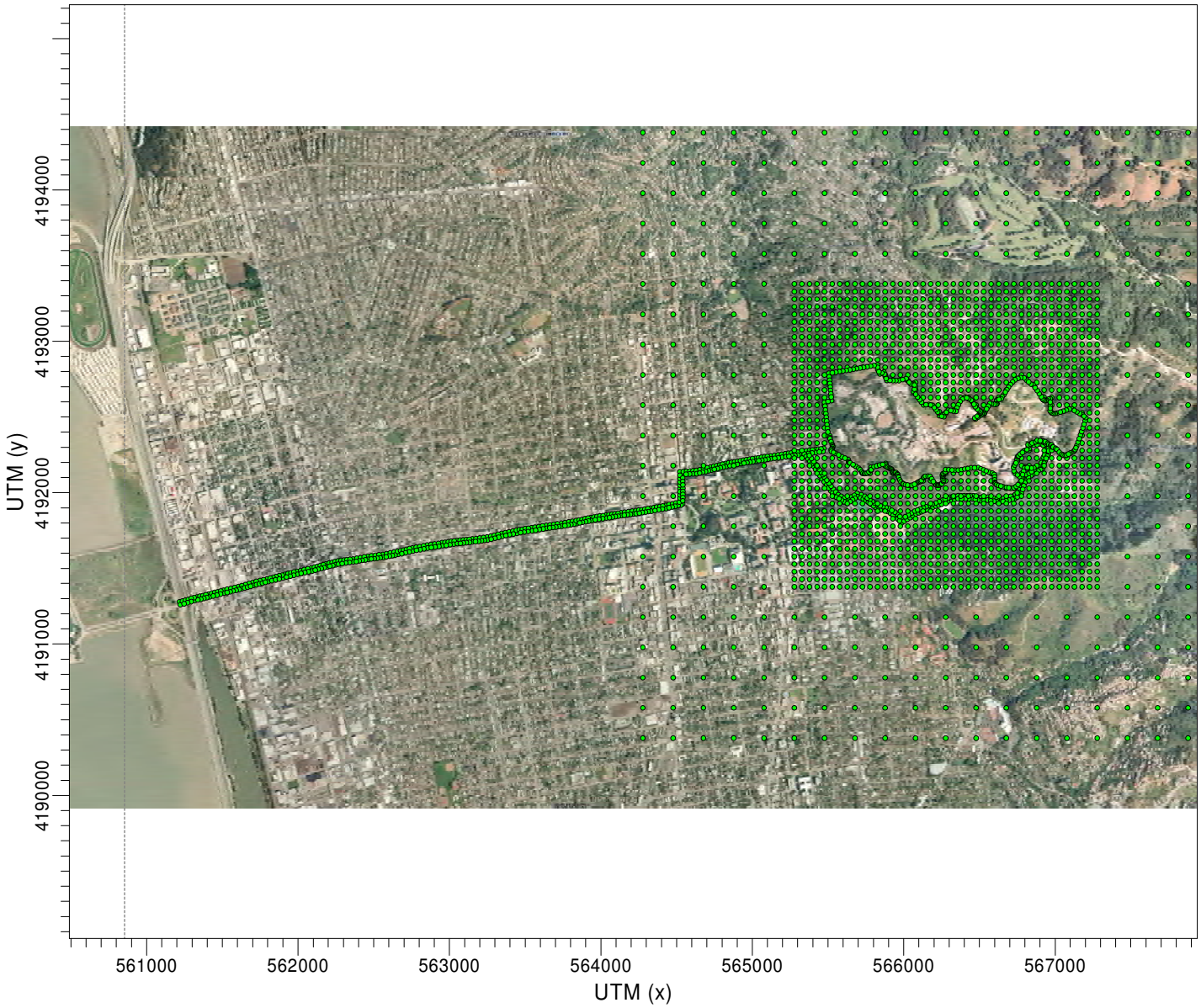
0 1 km

PROJECT NO.:

093-99021

AERMOD View - Lakes Environmental Software

Figure 3-7. On-Road Construction/Demolition Truck Travel Receptors - Entire Route Length
Seismic Life-Safety Phase 2 Project; Lawrence Berkeley National Laboratory, Berkeley, CA



COMMENTS:

Green circles denote receptor locations.

SOURCES:

77

RECEPTORS:

2634

COMPANY NAME:

Golder Associates Inc.

MODELER:

Portland, OR

SCALE: 1:42,000

0 1 km

PROJECT NO.:

093-99021

AERMOD View - Lakes Environmental Software

APPENDIX A

GPL LABORATORY CHEMICAL EMISSION ESTIMATE CALCULATIONS

Table A-1
Laboratory TAC Emissions Estimates
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

CAS	COPC (1)	Baseline Emissions (2) (lbs/yr)	Proposed Project Emissions (a) (lbs/yr)	Proposed Project Average Hourly Emissions (b) (lbs/hr)	Proposed Project Maximum Hourly Emissions (c) (lbs/hr)
106990	1,3-Butadiene	8.9E-01	6.1E-02	3.1E-05	1.59E-04
75070	Acetaldehyde	5.4E+00	3.7E-01	1.9E-04	9.6E-04
107028	Acrolein	1.9E+00	1.3E-01	6.6E-05	3.4E-04
107131	Acrylonitrile	1.5E+00	1.1E-01	5.3E-05	2.8E-04
71432	Benzene	3.9E+01	2.7E+00	1.4E-03	7.0E-03
7637072	Boron Trifluoride	3.4E+00	2.3E-01	1.2E-04	6.1E-04
56235	Carbon Tetrachloride	3.0E+01	2.1E+00	1.0E-03	5.4E-03
7782505	Chlorine	2.8E+01	1.9E+00	9.7E-04	5.0E-03
67663	Chloroform	2.3E+02	1.6E+01	8.0E-03	4.1E-02
4170303	Crotonaldehyde	1.6E-01	1.1E-02	5.6E-06	2.9E-05
107062	Ethylene Dichloride	2.7E+01	1.9E+00	9.4E-04	4.8E-03
50000	Formaldehyde	2.9E+01	2.0E+00	9.8E-04	5.1E-03
7647010	HCl	2.6E+02	1.8E+01	8.9E-03	4.6E-02
302012	Hydrazine	4.3E-01	3.0E-02	1.5E-05	7.7E-05
75014	Vinyl Chloride	1.9E+01	1.3E+00	6.6E-04	3.4E-03
75354	Vinylidene Chloride	1.3E+00	9.1E-02	4.6E-05	2.4E-04

Notes:

(a) Project emissions [lbs/yr] = (baseline emissions [lbs/yr]) / (baseline laboratory net square feet [nsf]) x (project laboratory net square feet [nsf])

Baseline laboratory net square feet (nsf) = 236,780 (3)

Project laboratory net square feet (nsf) = 16,250 (4)

(b) Proposed Project Average Hourly Emissions (lbs/hr) = (proposed project annual emissions [lbs/yr]) / (50 [weeks/yr]) x (40 [hrs/week])

(c) Proposed project maximum hourly emissions (lbs/hr) = (proposed project avergae hourly emissions [lbs/hr]) x (converstion factor)

conversion factor = 5.18 (5)

References:

(1) Chemicals of Potential Concern (COPC) list is taken from Baseline Air Emissions Inventory Toxic Compound Emissions for Lawrence Berkeley National Laboratory (SECOR 2004), Table 33. Only COPCs which were emitted by laboratory sources have been included in this table as determined by Table 29, SECOR 2004.

(2) Taken from SECOR 2004, Table 29.

(3) Taken from SECOR 2004, Appendix A, Page 6.

(4) Provided by Lawrence Berkeley National Laboratory.

(5) Based in studies comparing maximum to average emisson rates for laboratories. See text for further information.

APPENDIX B

GPL STATIONARY SOURCE POLLUTANT EMISSION ESTIMATE CALCULATIONS

Table B-1
Natural Gas Fired Boiler TAC Emissions Estimates
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Chemical	CAS Number	Emission Factor (lb/MMscf)		Estimated Emissions (lbs/hr)		Estimated Emissions (lbs/yr)	
ORGANICS							
Formaldehyde	50000	2.2E-01	(2)	6.3E+00	(a)	1.5E-05	(b)
7,12-Dimethylbenz(a)anthracene	57976	1.6E-05	(1)	4.5E-04	(a)	1.1E-09	(b)
Benzene	71432	4.3E-03	(2)	1.2E-01	(a)	2.9E-07	(b)
Ethane	74840	3.10	(1)	8.8E+01	(a)	2.1E-04	(b)
Propane	74986	1.60	(1)	4.5E+01	(a)	1.1E-04	(b)
Acetaldehyde	75070	8.9E-03	(2)	2.5E-01	(a)	6.0E-07	(b)
Naphthalene	91203	6.1E-04	(1)	1.7E-02	(a)	4.1E-08	(b)
Benzaldehyde	100527	1.6E-02	(2)	4.6E-01	(a)	1.1E-06	(b)
Butane	106978	2.10	(1)	6.0E+01	(a)	1.4E-04	(b)
Toluene	108883	3.4E-03	(1)	9.6E-02	(a)	2.3E-07	(b)
Pentane	109660	2.60	(1)	7.4E+01	(a)	1.7E-04	(b)
Hexane	110543	1.80	(1)	5.1E+01	(a)	1.2E-04	(b)
Fluoranthene	206440	3.0E-06	(1)	8.5E-05	(a)	2.0E-10	(b)
Dichlorobenzene	25321226	1.2E-03	(1)	3.4E-02	(a)	8.1E-08	(b)
METALS							
Lead	7439921	5.0E-04	(3)	1.4E-02	(a)	3.4E-08	(b)
Arsenic	7440382	2.0E-04	(4)	5.7E-03	(a)	1.3E-08	(b)
Barium	7440393	4.4E-03	(4)	1.2E-01	(a)	3.0E-07	(b)
Beryllium	7440417	1.2E-05	(4)	3.4E-04	(a)	8.1E-10	(b)
Cadmium	7440439	1.1E-03	(4)	3.1E-02	(a)	7.4E-08	(b)
Chromium (hexavalent)	18540299	1.4E-03	(4)	6.7E-03	(a),(c)	1.7E-02	(b),(c)
Cobalt	7440484	8.4E-05	(4)	2.4E-03	(a)	5.6E-09	(b)
Copper	7440508	8.5E-04	(4)	2.4E-02	(a)	5.7E-08	(b)
Manganese	7439965	3.8E-04	(4)	1.1E-02	(a)	2.6E-08	(b)
Mercury	7439976	2.6E-04	(4)	7.4E-03	(a)	1.7E-08	(b)
Molybdenum	7439987	1.1E-03	(4)	3.1E-02	(a)	7.4E-08	(b)
Nickel	7440020	2.1E-03	(4)	6.0E-02	(a)	1.4E-07	(b)
Selenium	7782492	2.4E-05	(4)	6.8E-04	(a)	1.6E-09	(b)
Vanadium	7440622	2.3E-03	(4)	6.5E-02	(a)	1.5E-07	(b)
Zinc	7440666	2.9E-02	(4)	8.2E-01	(a)	1.9E-06	(b)

Notes:

(a) Estimated emissions (lbs/hr) = (Boiler maximum heat input rating [MMBtu/hr]) / (1,020 MMBtu/MMscf) x (emission factor [lbs/MMscf])
Boiler maximum heat input rating (MMBtu/hr) = 3.3 (5)

(b) Estimated emissions (lbs/yr) = (Maximum annual fuel usage [therms/yr]) x (100,000 [Btu/therms]) x (1 MMBtu/1,000,000 MMBtu) / [(1,020 [MMBtu/MMscf]) x (8,760 hrs/yr)] x (emission factor [lbs/MMscf])
Maximum annual fuel usage (therms/yr) = 6,000 (5)

(c) Estimated chromium (hexavlent) emissions = (estimated emissions of total chromium) x (precent of hexavalent chromium [%] / 100)
percent of hexavalent chromium (%) = 17 (7)

References:

(1) AP-42, Fifth Edition, Section 1.4 (July 1998), Table 1.4-3; Emission Factors For Speciated Organic Compounds From Natural Gas Combustion.
(2) Taken from the California Air Toxics Emission Factors (CATEF) database located at http://www.arb.ca.gov/ei/catef/catef.htm. Mean CATEF emission factors were selected over AP-42 factors when both sources contained emission factors for the same pollutant.
(3) AP-42, Fifth Edition, Section 1.4 (July 1998), Table 1.4-2; Emission Factors For Criteria Pollutants and Green House Gases From Natural Gas Combustion.
(4) AP-42, Fifth Edition, Section 1.4 (July 1998), Table 1.4-4; Emission Factors For Metals From Natural Gas Combustion.
(5) Provided by vendor. Fuel usage is for one boiler.
(6) Provided by LBNL. The Helios project includes 4 identical boilers.
(7) Total chromium emissions were corrected by multiplying by 17% to estimate emissions of hexavalent chromium per the Plywood and Composite Wood Products (PCWP) MACT rule promulgated by EPA

Table B-2
Laboratory TAC Emissions Estimates
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Chemical	Emission Factor (lb/MMscf)		Estimated Emissions [(a)] (lbs/hr)	Estimated Emissions [(b)] (lbs/day)	Estimated Emissions [(c)] (tons/yr)
NO_X	100	(1)	0.3	7.8	2.9E-02
CO	84	(1)	0.3	6.5	2.5E-02
CO_2	120,000	(2)	388.2	9317.6	3.5E+01
Lead	0.0005	(2)	1.6E-06	3.9E-05	1.5E-07
PM (Total)	7.6	(2)	2.5E-02	5.9E-01	2.2E-03
SO_2	0.6	(2)	1.9E-03	4.7E-02	1.8E-04
VOC	5.5	(2)	1.8E-02	4.3E-01	1.6E-03

Notes:

(a) Estimated hourly emissions (lbs/hr) = (Boiler maximum heat input rating [MMBtu/hr]) / (1,020 MMBtu/MMscf) x (emission factor [lbs/MMscf])
Boiler maximum heat input rating (MMBtu/hr) = 3.3 (3)

(b) Estimated daily emissions (lbs/day) = (estimated hourly emissions [lbs/hr]) x (daily hours of operation [hrs/day])
daily hours of operation (hrs/day) 24.0 (3)

(c) Estimated annual emissions (lbs/yr) = (Maximum annual fuel usage [therms/yr]) x (100,000 [Btu/therms]) x (scf/1,020 Btu) x (MMscf/1,000,000 scf) x (emission factor [lbs/MMscf]) x (1 ton/2,000 lbs)
Maximum annual fuel usage (therms/yr) = 6,000 (3)

References:

(1) AP-42, Fifth Edition, Section 1.4 (July 1998), Table 1.4-1; Emission Factors For Nitrogen Oxides (NOX) and Carbon Monoxide (CO) From Natural Gas Combustion; Small Boilers (<100 MMBtu).
(2) AP-42, Fifth Edition, Section 1.4 (July 1998), Table 1.4-2; Emission Factors For Criteria Pollutants and Greenhouse Gases From Natural Gas Combustion.
(3) Provided by LBNL.

Table B-3
Estimated Toxic Air Contaminant Emissions From Diesel Genetrator
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Chemical	Emission Factor		Estimated Emissions (lbs/hr)		Estimated Emissions (lbs/day)		Estimated Emissions (tons/yr)	
NO_X	3.34 g/hp-hr	(1)	3.9	(a)	7.9	(c)	9.8E-02	(d)
CO	0.53 g/hp-hr	(1)	0.6	(a)	1.3	(c)	1.6E-02	(d)
CO_2	1.15 lbs/hp-hr	(2)	615.3	(b)	1,230.5	(c)	1.5E+01	(e)
PM_{10}	0.046 g/hp-hr	(1)	0.05	(a)	7.9	(c)	9.8E-02	(e)
$PM_{2.5}$	0.046 g/hp-hr	(6)	0.05	(6)	7.9	(6)	9.8E-02	(6)
SO_2	0.59 g/hp-hr	(4)	0.7	(a)	1.4	(c)	1.7E-02	(d)
VOC	0.04 g/hp-hr	(1)	0.0	(a)	0.1	(c)	1.2E-03	(d)

Notes:

(a) Estimated emissions(lbs/hr) = (rated horsepower of generator [hp]) x (emission factor [g/hp-hr]) / (453.59 g/lb)
rated horsepower of generator (hp) = 535 (4)

(b) Estimated emissions(lbs/hr) = (rated horsepower of generator [hp]) x (emission factor [lbs/hp-hr])
rated horsepower of generator (hp) = 535 (4)

(c) Estimated daily emissions(lbs/day) = (estimated hourly emissions [lbs/hr]) x (daily hours of operation [hrs/day])
daily hours of operation (hrs/day) 2.0 (3)

(d) Estimated emissions(lbs/yr) = (rated horsepower of generator [hp]) x (annual hours of operation [hrs/yr]) x (emission factor [g/hp-hr]) / (453.59 g/lb) / (2,000 lbs)
rated horsepower of generator (hp) = 535 (4)
annual hours of operation (hrs/yr) = 50 (5)

(e) Estimated emissions(lbs/yr) = (rated horsepower of generator [hp]) x (annual hours of operation [hrs/yr]) x (emission factor [lbs/hp-hr]) / (2,000 lbs)
rated horsepower of generator (hp) = 535 (4)
annual hours of operation (hrs/yr) = 50 (5)

References:

(1) Based on specifications for a Caterpillar STANDBY 350 ekW 438 kVA generator; assumed to represent a typical 350 ekW unit.
(2) AP-42, Fifth Edition, Section 3.3 (October 1996), Table 3.3-1; Emission Factors For Uncontrolled Gasoline and Diesel Industrial Engines.
(3) Particulate emissions are estimated in the Toxic Air Contaminant calculation page. All particulate emitted from this unit is assumed to be Diesel Particulate Matter (DPM).
(4) Based on specifications for a Cumins 350DFCC Diesel Engine; assumed to represent a typical engine used with the 350 ekW generator unit.
(5) Anticipated maximum operation of approximately twice the historical average - provided by LBNL.
(6) It is assumed that 100% of PM_{10} is $PM_{2.5}$.

Table B-4
Estimated Toxic Air Contaminant Emissions From Diesel Genetrator
Seismic Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Chemical	CAS Number/ID	Emission Factor [1]			Estimated Emissions (lbs/hr)		Estimated Emissions (lbs/yr)	
ORGANICS								
Acetaldehyde	75070	3.47E-03	lbs/Mgal	(2)	9.92E-05	(a)	4.96E-03	(c)
Acrolein	107028	1.07E-03	lbs/Mgal	(2)	3.06E-05	(a)	1.53E-03	(c)
Benzene	71432	1.93E-01	lbs/Mgal	(2)	5.52E-03	(a)	2.76E-01	(c)
Dibenz(a,h)anthracene	53703	8.22E-05	lbs/Mgal	(2)	2.35E-06	(a)	1.17E-04	(c)
Ethylbenzene	100414	6.76E-03	lbs/Mgal	(2)	1.93E-04	(a)	9.67E-03	(c)
Fluoranthene	206440	3.29E-04	lbs/Mgal	(2)	9.40E-06	(a)	4.70E-04	(c)
Formaldehyde	50000	5.06E-02	lbs/Mgal	(2)	1.45E-03	(a)	7.23E-02	(c)
Hexane	110543	1.39E-03	lbs/Mgal	(2)	3.98E-05	(a)	1.99E-03	(c)
Naphthalene	91203	1.60E-02	lbs/Mgal	(2)	4.56E-04	(a)	2.28E-02	(c)
Propylene	115071	3.41E-01	lbs/Mgal	(2)	9.75E-03	(a)	4.88E-01	(c)
Toluene	108883	6.12E-02	lbs/Mgal	(2)	1.75E-03	(a)	8.75E-02	(c)
Xylene (total)	1330207	2.10E-02	lbs/Mgal	(2)	5.99E-04	(a)	3.00E-02	(c)
METALS								
Arsenic	7440382	1.60E-03	lbs/Mgal	(3)	4.58E-05	(a)	2.29E-03	(c)
Cadmium	7440439	1.50E-03	lbs/Mgal	(3)	4.29E-05	(a)	2.15E-03	(c)
Chromium (hexavalent)	18540299	6.00E-04	lbs/Mgal	(3)	2.92E-06	(b)	1.46E-04	(d)
Copper	7440508	4.10E-03	lbs/Mgal	(3)	1.17E-04	(a)	5.86E-03	(c)
Lead	7439921	8.30E-03	lbs/Mgal	(3)	2.37E-04	(a)	1.19E-02	(c)
Manganese	7439965	3.10E-03	lbs/Mgal	(3)	8.87E-05	(a)	4.43E-03	(c)
Mercury	7439976	2.00E-03	lbs/Mgal	(3)	5.72E-05	(a)	2.86E-03	(c)
Nickel	7440020	3.90E-03	lbs/Mgal	(3)	1.12E-04	(a)	5.58E-03	(c)
Selenium	7782492	2.20E-03	lbs/Mgal	(3)	6.29E-05	(a)	3.15E-03	(c)
Zinc	7440666	2.24E-02	lbs/Mgal	(3)	6.41E-04	(a)	3.20E-02	(c)
Diesel Particulate Matter [5]	DPM	0.046	g/hp-hr	(4)	5.43E-02	(e)	2.71E+00	(f)

Notes:

(a) Estimated emissions (lbs/hr) = (fuel useage [Mgal/hr]) x (emission factor [lbs/Mgal])
fuel usage (Mgal/hr) = 0.0286 (4)

(b) Estimated emissions (lbs/hr) = (fuel useage [Mgal/hr]) x (emission factor [lbs/Mgal]) x (precent of hexavalent chromium [%] / 100)
fuel usage (Mgal/hr) = 0.0286 (4)
precent of hexavalent chromium (%) = 17 (7)

(c) Estimated emissions (lbs/yr) = (fuel useage [Mgal/hr]) x (annual hours of operation [hrs/yr]) x (emission factor [lbs/Mgal])
fuel usage (Mgal/hr) = 0.0286 (4)
annual hours of operation (hrs/yr) = 50 (6)

(d) Estimated emissions (lbs/yr) = (fuel useage [Mgal/hr]) x (annual hours of operation [hrs/yr]) x (emission factor [lbs/Mgal]) x (precent of hexavalent chromium [%] / 100)
fuel usage (Mgal/hr) = 0.0286 (4)
precent of hexavalent chromium (%) = 17 (7)
annual hours of operation (hrs/yr) = 50 (6)

(e) Estimated emissions(lbs/hr) = (rated horsepower of generator [hp]) x (emission factor [g/hp-hr]) / (453.59 g/lb)
rated horsepower of generator (hp) = 535 (4)

(f) Estimated emissions(lbs/yr) = (rated horsepower of generator [hp]) x (annual hours of operation [hrs/yr]) x (emission factor [g/hp-hr]) / (453.59 g/lb)
rated horsepower of generator (hp) = 535 (4)
annual hours of operation (hrs/yr) = 50 (6)

References:

(1) The California Air Toxics Emission Factor (CATEF) database (located at http://www.arb.ca.gov/emisinv/catef/catef.htm) was consulted for diesel fired IC Engine emission factors. There were no metal emission factors listed in CATEF or AP-42 for internal combustion engines so AB 2588 Combustion Emission Factors were used.

(2) Emission factors were taken from California Air Toxic Emission Factors (CATEF) database (located at http://www.arb.ca.gov/emisinv/catef/catef.htm). Emission factors are for internal combustion engines combusting diesel fuel with less than 13% oxygen in the exhaust. The database provides Maximum, Mean, and Median emission factors. The mean value for each entry was used. There were several chemicals that appeared in the database multiple times. The average emission factor of the duplicate chemical entries was used (the average of the "Mean" values). The database provided factors based on whether there was greater or less than 13% oxygen in the exhaust. Per vendor information, the percent oxygen in the exhaust ranges is less than 13% at loads greater than 50%. It was assumed that the generator would be run at 50% load or greater.

(3) Metal emission factors from AB 2588 Combustion Emission Factors, Diesel Combustion Factors (May 17, 2007).

(4) Based on specifications for a Caterpillar STANDBY 350 ekW 438 kVA generator; assumed to represent a typical 350 ekW unit. Fuel usage rate based on 100% load with fan. Horsepower rating is for Cummins 350DFCC diesel engine suitable for use with Caterpillar generator.

(5) Polycyclic Aromatic Hydrocarbons (PAHs) are assumed to be included in the particulate matter emission factor. PAHs that are not specifically listed in this table, but may be included in the particulate matter emission factor, include Acenaphthylene, Anthracene, Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene. For purposes of this inventory, it is assumed that all particulate is represented as Diesel Particulate Matter (DPM) (see section 1.1 of the document text for more information).

(6) Anticipated maximum operation of approximately twice the historical average - provided by LBNL.

(7) Total chromium emissions were corrected by multiplying by 17% to estimate emissions of hexavalent chromium per the Plywood and Composite Wood Products (PCWP) MACT rule promulgated by EPA

(8) Provided by LBNL.

APPENDIX C

URBEMIS OUTPUT FOR GPL OPERATION EMPLOYEE VEHICLE EMISSIONS

Appendix C-1
Detail Report for Annual Operational Unmitigated Emissions (Tons/Year)
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Urbemis 2007 Version 9.2.4

URBEMIS Model Executed On: 12/9/2009 4:08:26 PM

File Name: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\Emissions Inventory\URBEMIS\Seismic Life-Safety Phase 2.urb924
Project Name: Seismic Life-Safety Phase 2
Project Location: Bay Area Air District
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

OPERATIONAL EMISSION ESTIMATES (Annual Tons Per Year, Unmitigated)

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Junior college (2 yrs)	0.27	0.31	2.77	0.00	0.45	0.09	241.46
TOTALS (tons/year, unmitigated)	0.27	0.31	2.77	0.00	0.45	0.09	241.46

Includes correction for passby trips
Does not include double counting adjustment for internal trips
Analysis Year: 2011 Season: Annual
Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Junior college (2 yrs)		4.65	1000 sq ft	43.00	199.95	1,435.21
					199.95	1,435.21

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	53.8	0.9	98.7	0.4
Light Truck < 3750 lbs	12.8	1.6	95.3	3.1
Light Truck 3751-5750 lbs	19.8	0.5	99.5	0.0
Med Truck 5751-8500 lbs	6.6	0.0	100.0	0.0
Lite-Heavy Truck 8501-10,000 lbs	0.9	0.0	77.8	22.2
Lite-Heavy Truck 10,001-14,000 lbs	0.6	0.0	50.0	50.0
Med-Heavy Truck 14,001-33,000 lbs	1.0	0.0	20.0	80.0
Heavy-Heavy Truck 33,001-60,000 lbs	0.4	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	3.2	62.5	37.5	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.6	0.0	83.3	16.7

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.8	7.3	7.5	9.5	7.4	7.4
Rural Trip Length (miles)	16.8	7.1	7.9	14.7	6.6	6.6
Trip speeds (mph)	35.0	35.0	35.0	35.0	35.0	35.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land						
Junior college (2 yrs)				5.0	2.5	92.5

Operational Changes to Defaults

Appendix C-2
Detail Report for Summer Operational Unmitigated Emissions (Pounds/Day)
Life-Safety Phase 2 Project
Lawrence Berkeley National Laboratory, Berkeley, California

Urbemis 2007 Version 9.2.4

URBEMIS Model Executed On: 12/9/2009 4:08:48 PM

File Name: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\Emissions Inventory\URBEMIS\Seismic Life-Safety Phase 2.urb924
Project Name: Seismic Life-Safety Phase 2
Project Location: Bay Area Air District
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

OPERATIONAL EMISSION ESTIMATES (Summer Pounds Per Day, Unmitigated)

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Junior college (2 yrs)	1.52	1.48	14.71	0.01	2.47	0.47	1,385.64
TOTALS (lbs/day, unmitigated)	1.52	1.48	14.71	0.01	2.47	0.47	1,385.64

Includes correction for passby trips
Does not include double counting adjustment for internal trips
Analysis Year: 2011 Temperature (F): 85 Season: Summer
Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Junior college (2 yrs)		4.65	1000 sq ft	43.00	199.95	1,435.21
					199.95	1,435.21

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	53.8	0.9	98.7	0.4
Light Truck < 3750 lbs	12.8	1.6	95.3	3.1
Light Truck 3751-5750 lbs	19.8	0.5	99.5	0.0
Med Truck 5751-8500 lbs	6.6	0.0	100.0	0.0
Lite-Heavy Truck 8501-10,000 lbs	0.9	0.0	77.8	22.2
Lite-Heavy Truck 10,001-14,000 lbs	0.6	0.0	50.0	50.0
Med-Heavy Truck 14,001-33,000 lbs	1.0	0.0	20.0	80.0
Heavy-Heavy Truck 33,001-60,000 lbs	0.4	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	3.2	62.5	37.5	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.6	0.0	83.3	16.7

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.8	7.3	7.5	9.5	7.4	7.4
Rural Trip Length (miles)	16.8	7.1	7.9	14.7	6.6	6.6
Trip speeds (mph)	35.0	35.0	35.0	35.0	35.0	35.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land						
Junior college (2 yrs)				5.0	2.5	92.5

Operational Changes to Defaults

APPENDIX D

URBEMIS OUTPUT FOR PROJECT AND CUMULATIVE CONSTRUCTION/DEMOLITION OFF-ROAD EQUIPMENT EMISSIONS

Page: 1
12/8/2009 02:39:25 PM

Urbemis 2007 Version 9.2.4

Detail Report for Annual Construction Mitigated Emissions (Tons/Year)

File Name: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\Emissions Inventory\URBEMIS\Seismic Life-Safety Phase
Project Name: Seismic Life-Safety Phase 2
Project Location: Bay Area Air District
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Annual Tons Per Year, Mitigated)

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10 Total	PM2.5 Dust	PM2.5 Exhaust	PM2.5 Total	CO2
2010	0.07	0.52	0.35	0.00	0.19	0.04	0.23	0.04	0.03	0.07	57.01
Demolition 08/02/2010-01/28/2011	0.07	0.52	0.35	0.00	0.19	0.04	0.23	0.04	0.03	0.07	57.01
Fugitive Dust	0.00	0.00	0.00	0.00	0.06	0.00	0.06	0.01	0.00	0.01	0.00
Demo Off Road Diesel	0.06	0.42	0.26	0.00	0.00	0.03	0.03	0.00	0.03	0.03	38.52
Demo On Road Diesel	0.01	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.89
Demo Worker Trips	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.61
2011	0.15	1.12	0.89	0.00	0.12	0.07	0.19	0.03	0.06	0.09	143.84
Demolition 08/02/2010-01/28/2011	0.01	0.09	0.06	0.00	0.04	0.01	0.04	0.01	0.01	0.01	10.37
Fugitive Dust	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Demo Off Road Diesel	0.01	0.07	0.05	0.00	0.00	0.01	0.01	0.00	0.01	0.01	7.00
Demo On Road Diesel	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.34
Demo Worker Trips	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02
Mass Grading 04/01/2011-04/29/2011	0.03	0.25	0.14	0.00	0.09	0.01	0.10	0.02	0.01	0.03	24.67
Mass Grading Dust	0.00	0.00	0.00	0.00	0.09	0.00	0.09	0.02	0.00	0.02	0.00
Mass Grading Off Road Diesel	0.03	0.25	0.13	0.00	0.00	0.01	0.01	0.00	0.01	0.01	23.60
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
Building 05/02/2011-04/26/2013	0.11	0.79	0.69	0.00	0.00	0.05	0.05	0.00	0.05	0.05	108.80
Building Off Road Diesel	0.10	0.74	0.41	0.00	0.00	0.05	0.05	0.00	0.04	0.04	78.17
Building Vendor Trips	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.07
Building Worker Trips	0.01	0.01	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.56
2012	0.20	1.42	1.23	0.00	0.13	0.09	0.22	0.03	0.08	0.11	205.16
Building 05/02/2011-04/26/2013	0.15	1.08	0.98	0.00	0.00	0.07	0.07	0.00	0.06	0.06	162.29
Building Off Road Diesel	0.13	1.03	0.60	0.00	0.00	0.06	0.06	0.00	0.06	0.06	116.59
Building Vendor Trips	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.06
Building Worker Trips	0.01	0.02	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.64
Demolition 09/03/2012-04/26/2013	0.05	0.34	0.25	0.00	0.13	0.02	0.15	0.03	0.02	0.05	42.87
Fugitive Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demo Off Road Diesel	0.04	0.29	0.19	0.00	0.00	0.02	0.02	0.00	0.02	0.02	30.11
Demo On Road Diesel	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.37
Demo Worker Trips	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.39
2013	0.16	1.21	0.97	0.00	0.39	0.08	0.47	0.08	0.07	0.15	172.94
Building 05/02/2011-04/26/2013	0.04	0.32	0.30	0.00	0.00	0.02	0.02	0.00	0.02	0.02	52.24
Building Off Road Diesel	0.04	0.31	0.19	0.00	0.00	0.02	0.02	0.00	0.02	0.02	37.52
Building Vendor Trips	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.92
Building Worker Trips	0.00	0.01	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.80
Demolition 09/03/2012-04/26/2013	0.04	0.31	0.24	0.00	0.12	0.02	0.14	0.03	0.02	0.04	41.87
Fugitive Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demo Off Road Diesel	0.04	0.27	0.18	0.00	0.00	0.02	0.02	0.00	0.02	0.02	29.41
Demo On Road Diesel	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.17
Demo Worker Trips	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.29
Demolition 06/03/2013-04/25/2014	0.08	0.57	0.43	0.00	0.27	0.04	0.31	0.06	0.03	0.09	78.83
Fugitive Dust	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.01	0.00	0.01	0.00
Demo Off Road Diesel	0.07	0.48	0.33	0.00	0.00	0.03	0.03	0.00	0.03	0.03	53.22
Demo On Road Diesel	0.01	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.85
Demo Worker Trips	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.76
2014	0.04	0.29	0.23	0.00	0.15	0.02	0.16	0.03	0.02	0.05	43.05
Demolition 06/03/2013-04/25/2014	0.04	0.29	0.23	0.00	0.15	0.02	0.16	0.03	0.02	0.05	43.05
Fugitive Dust	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00
Demo Off Road Diesel	0.03	0.25	0.18	0.00	0.00	0.02	0.02	0.00	0.01	0.01	29.06
Demo On Road Diesel	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.75
Demo Worker Trips	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.24

Construction Related Mitigation Measures

The following mitigation measures apply to Phase: Mass Grading 4/1/2011 - 4/29/2011 - Grading for GPL Construction - 6 months
For Soil Stablizing Measures, the Water exposed surfaces 3x daily watering mitigation reduces emissions by:
PM10: 61% PM25: 61%

Phase Assumptions

Phase: Demolition 8/2/2010 - 1/28/2011 - Bldg 25 Demo - 6 Months
Building Volume Total (cubic feet): 343220
Building Volume Daily (cubic feet): 8384
On Road Truck Travel (VMT): 58.22
Off-Road Equipment:
1 Concrete/Industrial Saws (10 hp) operating at a 0.73 load factor for 8 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 1 hours per day
2 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 6 hours per day

Phase: Demolition 9/3/2012 - 4/26/2013 - Bldg 71 Trailer Demo - 8 Months
Building Volume Total (cubic feet): 40368
Building Volume Daily (cubic feet): 6960
On Road Truck Travel (VMT): 48.33
Off-Road Equipment:
1 Concrete/Industrial Saws (10 hp) operating at a 0.73 load factor for 8 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 1 hours per day
2 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 6 hours per day

Phase: Demolition 6/3/2013 - 4/25/2014 - Bldg 55 Demo - 7 Months
Building Volume Total (cubic feet): 288000
Building Volume Daily (cubic feet): 8400
On Road Truck Travel (VMT): 58.33
Off-Road Equipment:
1 Concrete/Industrial Saws (10 hp) operating at a 0.73 load factor for 8 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 1 hours per day
2 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 6 hours per day

Phase: Mass Grading 4/1/2011 - 4/29/2011 - Grading for GPL Construction - 6 months
Total Acres Disturbed: 1.97
Maximum Daily Acreage Disturbed: 0.8
Fugitive Dust Level of Detail: Default
20 lbs per acre-day
On Road Truck Travel (VMT): 0
Off-Road Equipment:
1 Graders (174 hp) operating at a 0.61 load factor for 6 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 6 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day

Phase: Building Construction 5/2/2011 - 4/26/2013 - Construction of GPL - 25 months
Off-Road Equipment:
1 Cranes (399 hp) operating at a 0.43 load factor for 4 hours per day
2 Forklifts (145 hp) operating at a 0.3 load factor for 6 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day

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Urbemis 2007 Version 9.2.4

Detail Report for Summer Construction Mitigated Emissions (Pounds/Day)

File Name: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\Emissions Inventory\URBEMIS\Seismic Life-Safety Phase
Project Name: Seismic Life-Safety Phase 2
Project Location: Bay Area Air District
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Summer Pounds Per Day, Mitigated)

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10 Total	PM2.5 Dust	PM2.5 Exhaust	PM2.5 Total	CO2
Time Slice 8/2/2010-12/31/2010 Active	1.28	9.39	6.37	0.00	3.53	0.65	4.18	0.74	0.60	1.33	1,036.62
Demolition 08/02/2010-01/28/2011	1.28	9.39	6.37	0.00	3.53	0.65	4.18	0.74	0.60	1.33	1,036.62
Fugitive Dust	0.00	0.00	0.00	0.00	3.52	0.00	3.52	0.73	0.00	0.73	0.00
Demo Off Road Diesel	1.14	7.68	4.68	0.00	0.00	0.59	0.59	0.00	0.54	0.54	700.30
Demo On Road Diesel	0.10	1.65	0.52	0.00	0.01	0.06	0.07	0.00	0.06	0.06	234.40
Demo Worker Trips	0.04	0.07	1.16	0.00	0.00	0.00	0.01	0.00	0.00	0.00	101.91
Time Slice 1/3/2011-1/28/2011 Active	1.18	8.75	6.13	0.00	3.53	0.60	4.14	0.74	0.55	1.29	1,036.68
Demolition 08/02/2010-01/28/2011	1.18	8.75	6.13	0.00	3.53	0.60	4.14	0.74	0.55	1.29	1,036.68
Fugitive Dust	0.00	0.00	0.00	0.00	3.52	0.00	3.52	0.73	0.00	0.73	0.00
Demo Off Road Diesel	1.05	7.22	4.58	0.00	0.00	0.55	0.55	0.00	0.50	0.50	700.30
Demo On Road Diesel	0.09	1.47	0.48	0.00	0.01	0.05	0.06	0.00	0.05	0.05	234.40
Demo Worker Trips	0.03	0.06	1.07	0.00	0.00	0.00	0.01	0.00	0.00	0.00	101.97
Time Slice 4/1/2011-4/29/2011 Active	2.86	23.50	13.03	0.00	8.29	1.17	9.47	1.73	1.08	2.81	2,349.29
Mass Grading 04/01/2011-	2.86	23.50	13.03	0.00	8.29	1.17	9.47	1.73	1.08	2.81	2,349.29
Mass Grading Dust	0.00	0.00	0.00	0.00	8.29	0.00	8.29	1.73	0.00	1.73	0.00
Mass Grading Off Road Diesel	2.83	23.44	11.96	0.00	0.00	1.17	1.17	0.00	1.08	1.08	2,247.32
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.03	0.06	1.07	0.00	0.00	0.00	0.01	0.00	0.00	0.00	101.97
Time Slice 5/2/2011-12/30/2011 Active	1.23	8.98	7.88	0.00	0.02	0.56	0.58	0.01	0.52	0.52	1,243.45
Building 05/02/2011-04/26/2013	1.23	8.98	7.88	0.00	0.02	0.56	0.58	0.01	0.52	0.52	1,243.45
Building Off Road Diesel	1.11	8.51	4.68	0.00	0.00	0.54	0.54	0.00	0.50	0.50	893.39
Building Vendor Trips	0.02	0.31	0.26	0.00	0.00	0.01	0.01	0.00	0.01	0.01	69.42
Building Worker Trips	0.10	0.16	2.95	0.00	0.01	0.01	0.02	0.00	0.01	0.01	280.63
Time Slice 1/2/2012-8/31/2012 Active	1.14	8.30	7.53	0.00	0.02	0.50	0.52	0.01	0.46	0.47	1,243.62
Building 05/02/2011-04/26/2013	1.14	8.30	7.53	0.00	0.02	0.50	0.52	0.01	0.46	0.47	1,243.62
Building Off Road Diesel	1.03	7.87	4.56	0.00	0.00	0.49	0.49	0.00	0.45	0.45	893.39
Building Vendor Trips	0.02	0.28	0.25	0.00	0.00	0.01	0.01	0.00	0.01	0.01	69.43
Building Worker Trips	0.09	0.15	2.72	0.00	0.01	0.01	0.02	0.00	0.01	0.01	280.80
Time Slice 9/3/2012-12/31/2012 Active	2.23	16.21	13.36	0.01	2.95	1.04	3.99	0.62	0.95	1.57	2,240.54
Building 05/02/2011-04/26/2013	1.14	8.30	7.53	0.00	0.02	0.50	0.52	0.01	0.46	0.47	1,243.62
Building Off Road Diesel	1.03	7.87	4.56	0.00	0.00	0.49	0.49	0.00	0.45	0.45	893.39
Building Vendor Trips	0.02	0.28	0.25	0.00	0.00	0.01	0.01	0.00	0.01	0.01	69.43
Building Worker Trips	0.09	0.15	2.72	0.00	0.01	0.01	0.02	0.00	0.01	0.01	280.80
Demolition 09/03/2012-04/26/2013	1.08	7.91	5.84	0.00	2.94	0.54	3.47	0.61	0.49	1.11	996.93
Fugitive Dust	0.00	0.00	0.00	0.00	2.92	0.00	2.92	0.61	0.00	0.61	0.00
Demo Off Road Diesel	0.98	6.77	4.49	0.00	0.00	0.49	0.49	0.00	0.45	0.45	700.30
Demo On Road Diesel	0.07	1.09	0.36	0.00	0.01	0.04	0.05	0.00	0.04	0.04	194.59
Demo Worker Trips	0.03	0.05	0.99	0.00	0.00	0.00	0.01	0.00	0.00	0.00	102.04
Time Slice 1/1/2013-4/26/2013 Active	2.06	15.03	12.84	0.01	2.95	0.92	3.87	0.62	0.85	1.46	2,240.76
Building 05/02/2011-04/26/2013	1.05	7.67	7.21	0.00	0.02	0.44	0.46	0.01	0.41	0.41	1,243.78
Building Off Road Diesel	0.95	7.29	4.48	0.00	0.00	0.43	0.43	0.00	0.39	0.39	893.39
Building Vendor Trips	0.02	0.25	0.23	0.00	0.00	0.01	0.01	0.00	0.01	0.01	69.43
Building Worker Trips	0.08	0.14	2.50	0.00	0.01	0.01	0.02	0.00	0.01	0.01	280.96
Demolition 09/03/2012-04/26/2013	1.01	7.36	5.63	0.00	2.94	0.48	3.41	0.61	0.44	1.05	996.98
Fugitive Dust	0.00	0.00	0.00	0.00	2.92	0.00	2.92	0.61	0.00	0.61	0.00
Demo Off Road Diesel	0.91	6.35	4.40	0.00	0.00	0.44	0.44	0.00	0.41	0.41	700.30
Demo On Road Diesel	0.07	0.96	0.32	0.00	0.01	0.03	0.04	0.00	0.03	0.03	194.59
Demo Worker Trips	0.03	0.05	0.91	0.00	0.00	0.00	0.01	0.00	0.00	0.00	102.09
Time Slice 6/3/2013-12/31/2013 Active	1.02	7.56	5.70	0.00	3.54	0.49	4.03	0.74	0.45	1.18	1,037.24
Demolition 06/03/2013-04/25/2014	1.02	7.56	5.70	0.00	3.54	0.49	4.03	0.74	0.45	1.18	1,037.24
Fugitive Dust	0.00	0.00	0.00	0.00	3.53	0.00	3.53	0.73	0.00	0.73	0.00
Demo Off Road Diesel	0.91	6.35	4.40	0.00	0.00	0.44	0.44	0.00	0.41	0.41	700.30
Demo On Road Diesel	0.08	1.16	0.39	0.00	0.01	0.04	0.05	0.00	0.04	0.04	234.85
Demo Worker Trips	0.03	0.05	0.91	0.00	0.00	0.00	0.01	0.00	0.00	0.00	102.09
Time Slice 1/1/2014-4/25/2014 Active	0.94	7.02	5.52	0.00	3.54	0.43	3.97	0.74	0.39	1.13	1,037.29

Demolition 06/03/2013-04/25/2014	0.94	7.02	5.52	0.00	3.54	0.43	3.97	0.74	0.39	1.13	1,037.29
Fugitive Dust	0.00	0.00	0.00	0.00	3.53	0.00	3.53	0.73	0.00	0.73	0.00
Demo Off Road Diesel	0.84	5.95	4.33	0.00	0.00	0.39	0.39	0.00	0.36	0.36	700.30
Demo On Road Diesel	0.07	1.03	0.35	0.00	0.01	0.04	0.04	0.00	0.03	0.04	234.85
Demo Worker Trips	0.03	0.04	0.84	0.00	0.00	0.00	0.01	0.00	0.00	0.00	102.14

Construction Related Mitigation Measures

The following mitigation measures apply to Phase: Mass Grading 4/1/2011 - 4/29/2011 - Grading for GPL Construction - 6 months
For Soil Stablizing Measures, the Water exposed surfaces 3x daily watering mitigation reduces emissions by:
PM10: 61% PM25: 61%

Phase Assumptions

Phase: Demolition 8/2/2010 - 1/28/2011 - Bldg 25 Demo - 6 Months
Building Volume Total (cubic feet): 343220
Building Volume Daily (cubic feet): 8384
On Road Truck Travel (VMT): 58.22
Off-Road Equipment:
1 Concrete/Industrial Saws (10 hp) operating at a 0.73 load factor for 8 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 1 hours per day
2 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 6 hours per day

Phase: Demolition 9/3/2012 - 4/26/2013 - Bldg 71 Trailer Demo - 8 Months
Building Volume Total (cubic feet): 40368
Building Volume Daily (cubic feet): 6960
On Road Truck Travel (VMT): 48.33
Off-Road Equipment:
1 Concrete/Industrial Saws (10 hp) operating at a 0.73 load factor for 8 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 1 hours per day
2 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 6 hours per day

Phase: Demolition 6/3/2013 - 4/25/2014 - Bldg 55 Demo - 7 Months
Building Volume Total (cubic feet): 288000
Building Volume Daily (cubic feet): 8400
On Road Truck Travel (VMT): 58.33
Off-Road Equipment:
1 Concrete/Industrial Saws (10 hp) operating at a 0.73 load factor for 8 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 1 hours per day
2 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 6 hours per day

Phase: Mass Grading 4/1/2011 - 4/29/2011 - Grading for GPL Construction - 6 months
Total Acres Disturbed: 1.97
Maximum Daily Acreage Disturbed: 0.8
Fugitive Dust Level of Detail: Default
20 lbs per acre-day
On Road Truck Travel (VMT): 0
Off-Road Equipment:
1 Graders (174 hp) operating at a 0.61 load factor for 6 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 6 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day

Phase: Building Construction 5/2/2011 - 4/26/2013 - Construction of GPL - 25 months
Off-Road Equipment:
1 Cranes (399 hp) operating at a 0.43 load factor for 4 hours per day
2 Forklifts (145 hp) operating at a 0.3 load factor for 6 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day

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Urbemis 2007 Version 9.2.4

Detail Report for Annual Construction Mitigated Emissions (Tons/Year)

File Name: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\Emissions Inventory\URBEMIS\Solar Energy Rsrch Cntr
Project Name: Solar Energy Rsrch Cntr
Project Location: Bay Area Air District
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Annual Tons Per Year, Mitigated)

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10 Total	PM2.5 Dust	PM2.5 Exhaust	PM2.5 Total	CO2
2011	0.15	1.14	0.89	0.00	0.03	0.07	0.10	0.01	0.06	0.07	144.89
Mass Grading 03/01/2011-03/31/2011	0.03	0.27	0.15	0.00	0.03	0.01	0.04	0.01	0.01	0.02	27.02
Mass Grading Dust	0.00	0.00	0.00	0.00	0.03	0.00	0.03	0.01	0.00	0.01	0.00
Mass Grading Off Road Diesel	0.03	0.27	0.14	0.00	0.00	0.01	0.01	0.00	0.01	0.01	25.84
Mass Grading On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass Grading Worker Trips	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17
Building 04/01/2011-05/31/2012	0.12	0.87	0.74	0.00	0.00	0.05	0.06	0.00	0.05	0.05	117.87
Building Off Road Diesel	0.11	0.83	0.46	0.00	0.00	0.05	0.05	0.00	0.05	0.05	87.55
Building Vendor Trips	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.01
Building Worker Trips	0.01	0.01	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.30
2012	0.06	0.45	0.39	0.00	0.00	0.03	0.03	0.00	0.03	0.03	65.56
Building 04/01/2011-05/31/2012	0.06	0.45	0.39	0.00	0.00	0.03	0.03	0.00	0.03	0.03	65.56
Building Off Road Diesel	0.06	0.43	0.25	0.00	0.00	0.03	0.03	0.00	0.02	0.02	48.69
Building Vendor Trips	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.34
Building Worker Trips	0.00	0.01	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.52

Construction Related Mitigation Measures

The following mitigation measures apply to Phase: Mass Grading 3/1/2011 - 3/31/2011 - Solar Energy Rsrch Cntr Grading
For Soil Stablizing Measures, the Water exposed surfaces 3x daily watering mitigation reduces emissions by:
PM10: 61% PM25: 61%

Phase Assumptions

Phase: Mass Grading 3/1/2011 - 3/31/2011 - Solar Energy Rsrch Cntr Grading
Total Acres Disturbed: 1.74
Maximum Daily Acreage Disturbed: 0.44
Fugitive Dust Level of Detail: Default
10 lbs per acre-day
On Road Truck Travel (VMT): 0
Off-Road Equipment:
1 Graders (174 hp) operating at a 0.61 load factor for 6 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 6 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day

Phase: Building Construction 4/1/2011 - 5/31/2012 - Solar Energy Rsrch Cntr Construction
Off-Road Equipment:
1 Cranes (399 hp) operating at a 0.43 load factor for 4 hours per day
2 Forklifts (145 hp) operating at a 0.3 load factor for 6 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day

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Urbemis 2007 Version 9.2.4

Detail Report for Annual Construction Unmitigated Emissions (Tons/Year)

File Name: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\Emissions Inventory\URBEMIS\CRT Construction.urb924
Project Name: CRT Construction
Project Location: Bay Area Air District
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Annual Tons Per Year, Unmitigated)

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10 Total	PM2.5 Dust	PM2.5 Exhaust	PM2.5 Total	CO2
2010	0.22	0.99	1.17	0.00	0.00	0.07	0.07	0.00	0.06	0.06	145.55
Building 08/02/2010-02/24/2012	0.22	0.99	1.17	0.00	0.00	0.07	0.07	0.00	0.06	0.06	145.55
Building Off Road Diesel	0.20	0.91	0.62	0.00	0.00	0.07	0.07	0.00	0.06	0.06	89.17
Building Vendor Trips	0.00	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.19
Building Worker Trips	0.02	0.03	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.20
2011	0.49	2.22	2.63	0.00	0.01	0.15	0.16	0.00	0.14	0.14	344.10
Building 08/02/2010-02/24/2012	0.49	2.22	2.63	0.00	0.01	0.15	0.16	0.00	0.14	0.14	344.10
Building Off Road Diesel	0.44	2.04	1.41	0.00	0.00	0.15	0.15	0.00	0.14	0.14	210.76
Building Vendor Trips	0.01	0.12	0.10	0.00	0.00	0.00	0.01	0.00	0.00	0.00	26.45
Building Worker Trips	0.04	0.06	1.12	0.00	0.01	0.00	0.01	0.00	0.00	0.00	106.90
2012	0.07	0.32	0.38	0.00	0.00	0.02	0.02	0.00	0.02	0.02	52.95
Building 08/02/2010-02/24/2012	0.07	0.32	0.38	0.00	0.00	0.02	0.02	0.00	0.02	0.02	52.95
Building Off Road Diesel	0.06	0.30	0.21	0.00	0.00	0.02	0.02	0.00	0.02	0.02	32.42
Building Vendor Trips	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.07
Building Worker Trips	0.01	0.01	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.46

Phase Assumptions

Phase: Building Construction 8/2/2010 - 2/24/2012 - CRT Construction
Off-Road Equipment:
1 Cranes (399 hp) operating at a 0.43 load factor for 6 hours per day
2 Forklifts (145 hp) operating at a 0.3 load factor for 6 hours per day
1 Generator Sets (49 hp) operating at a 0.74 load factor for 8 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day
3 Welders (45 hp) operating at a 0.45 load factor for 8 hours per day

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Urbemis 2007 Version 9.2.4

Detail Report for Annual Construction Unmitigated Emissions (Tons/Year)

File Name: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\Emissions Inventory\URBEMIS\Bldg 51 51A Demolition.urb924
Project Name: Bldg 51 51A Demolition
Project Location: Bay Area Air District
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Annual Tons Per Year, Unmitigated)

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10 Total	PM2.5 Dust	PM2.5 Exhaust	PM2.5 Total	CO2
2010	0.06	0.43	0.32	0.00	0.00	0.03	0.03	0.00	0.03	0.03	44.12
Demolition 08/02/2010-03/31/2011	0.06	0.43	0.32	0.00	0.00	0.03	0.03	0.00	0.03	0.03	44.12
Fugitive Dust	0.00	0.00	0.00	0.00	0.60	0.00	0.60	0.13	0.00	0.13	0.00
Demo Off Road Diesel	0.06	0.42	0.26	0.00	0.00	0.03	0.03	0.00	0.03	0.03	38.52
Demo On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demo Worker Trips	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.61
2011	0.03	0.23	0.18	0.00	0.00	0.02	0.02	0.00	0.02	0.02	25.67
Demolition 08/02/2010-03/31/2011	0.03	0.23	0.18	0.00	0.00	0.02	0.02	0.00	0.02	0.02	25.67
Fugitive Dust	0.00	0.00	0.00	0.00	0.35	0.00	0.35	0.07	0.00	0.07	0.00
Demo Off Road Diesel	0.03	0.23	0.15	0.00	0.00	0.02	0.02	0.00	0.02	0.02	22.41
Demo On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demo Worker Trips	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.26

Phase Assumptions

Phase: Demolition 8/2/2010 - 3/31/2011 - Bldg 51 51A Demolition
Building Volume Total (cubic feet): 4536171
Building Volume Daily (cubic feet): 0
On Road Truck Travel (VMT): 0
Off-Road Equipment:
1 Concrete/Industrial Saws (10 hp) operating at a 0.73 load factor for 8 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 1 hours per day
2 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 6 hours per day

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Urbemis 2007 Version 9.2.4

Detail Report for Annual Construction Unmitigated Emissions (Tons/Year)

File Name: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\Emissions Inventory\URBEMIS\Old Town Demolition.urb924
Project Name: Old Town Demolition
Project Location: Bay Area Air District
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Annual Tons Per Year, Unmitigated)

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10 Total	PM2.5 Dust	PM2.5 Exhaust	PM2.5 Total	CO2
2010	0.06	0.43	0.32	0.00	0.00	0.03	0.03	0.00	0.03	0.03	44.12
Demolition 08/02/2010-07/31/2013	0.06	0.43	0.32	0.00	0.00	0.03	0.03	0.00	0.03	0.03	44.12
Fugitive Dust	0.00	0.00	0.00	0.00	0.03	0.00	0.03	0.01	0.00	0.01	0.00
Demo Off Road Diesel	0.06	0.42	0.26	0.00	0.00	0.03	0.03	0.00	0.03	0.03	38.52
Demo On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demo Worker Trips	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.61
2011	0.14	0.95	0.73	0.00	0.00	0.07	0.07	0.00	0.07	0.07	104.30
Demolition 08/02/2010-07/31/2013	0.14	0.95	0.73	0.00	0.00	0.07	0.07	0.00	0.07	0.07	104.30
Fugitive Dust	0.00	0.00	0.00	0.00	0.07	0.00	0.07	0.01	0.00	0.01	0.00
Demo Off Road Diesel	0.14	0.94	0.60	0.00	0.00	0.07	0.07	0.00	0.07	0.07	91.04
Demo On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demo Worker Trips	0.00	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.26
2012	0.13	0.89	0.71	0.00	0.00	0.06	0.07	0.00	0.06	0.06	104.70
Demolition 08/02/2010-07/31/2013	0.13	0.89	0.71	0.00	0.00	0.06	0.07	0.00	0.06	0.06	104.70
Fugitive Dust	0.00	0.00	0.00	0.00	0.07	0.00	0.07	0.01	0.00	0.01	0.00
Demo Off Road Diesel	0.13	0.88	0.59	0.00	0.00	0.06	0.06	0.00	0.06	0.06	91.39
Demo On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demo Worker Trips	0.00	0.01	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.32
2013	0.07	0.49	0.40	0.00	0.00	0.03	0.03	0.00	0.03	0.03	60.98
Demolition 08/02/2010-07/31/2013	0.07	0.49	0.40	0.00	0.00	0.03	0.03	0.00	0.03	0.03	60.98
Fugitive Dust	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.01	0.00	0.01	0.00
Demo Off Road Diesel	0.07	0.48	0.33	0.00	0.00	0.03	0.03	0.00	0.03	0.03	53.22
Demo On Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demo Worker Trips	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.76

Phase Assumptions

Phase: Demolition 8/2/2010 - 7/31/2013 - Bldg 51 51A Demolition
Building Volume Total (cubic feet): 0
Building Volume Daily (cubic feet): 0
On Road Truck Travel (VMT): 0
Off-Road Equipment:
1 Concrete/Industrial Saws (10 hp) operating at a 0.73 load factor for 8 hours per day
1 Rubber Tired Dozers (357 hp) operating at a 0.59 load factor for 1 hours per day
2 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 6 hours per day

APPENDIX E

ON-ROAD TRUCK TRIP INFORMATION FOR PROJECT AND CUMULATIVE CONSTRUCTION/DEMOLITION

TABLE 1:
AVERAGE DAILY TRUCK TRIPS (ROUNDTRIPS) BY PROJECT BY MONTH

Project Name	Date Updated	2010 A	2010 S	2010 O	2010 N	2010 D	2011 J	2011 F	2011 M	2011 A	2011 M	2011 J	2011 J	2011 A	2011 S	2011 O	2011 N	2011 D	2012 J	2012 F	2012 M	2012 A	2012 M	2012 J	2012 J	2012 A	2012 S	2012 O	2012 N	2012 D	2013 J	2013 F	2013 M	2013 A	2013 M	2013 J	2013 J	2013 A	2013 S	2013 O	2013 N	2013 D	2014 J	2014 F	2014 M	2014 A
Bldg 71 BELLA	7/10/2009	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1																												
Guest House	7/10/2009																																													
Bldg 6 Seismic Upgrade	6/22/2009																																													
USB	7/10/2009	3	3																																											
Solar Energy Reasearch Center	6/18/2009												0	1	2	25	10	7	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1												
CRT Building	6/28/2009	2	2	2	1	1	2	2	3	5	1	2	7	10	7	2	2	1	7	4	4	2	2	2	1	1	1	1	1	1																
Bldg 51 & Bevatron	7/10/2009	10	10	10	10	10	2	2	2																																					
Old Town	11/9/2009	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	4	4	4	1	1	1	1	1	4	4	4	1	2	2									
Seismic Upgrades Ph 1	11/12/2009																																													
Bldg 50	11/12/2009																																													
Bldg 74	11/12/2009																																													
Bldg 74 (cont.)	11/12/2009	4	12	4	3	3	3	3	3	3	3	3	3	3	3	2	2	1	1	1	1	1	1																							
Seismic Upgrades Ph 2	11/12/2009																																													
71 Trailer Demo	11/12/2009																										2	2	2	2	2	2	2	1												
General Purpose Lab	11/12/2009									3	2	2	2	2	2	2	2	2	2	3	4	7	12	4	3	3	3	3	3	2	2	2	2	2	1	1	1	1	1	1					
Bldg 85 Slide	11/12/2009									3	3	3	3	3	3	3	3	3	3	3	3	3	2																							
Bldg 25 Demo	11/12/2009	3	4	3	3	3	3																																							
Bldg 55 Demo	11/12/2009																																			3	3	3	3	3	3	3	3	3	3	2
Student Athlete High Perf Ctr		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20																												
Law Infill		8	8	8	8	8	8	8	8	8																																				
Anna Head Housing			22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22																						
DHS Demolition																																														
Helios West		18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18																
Cal Mem Stadium Seismic						18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18																
Blum Center/Naval Architecture		4	4																																											
Berkeley Art Museum & PFA		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21										
Li Ka-shing Center Steps 1&3		30	30	30	30	30	30	30	30	30	30	30	30	30	30																															
Campbell Replacement							12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12					
Durant Hall		4	4																																											
Utilities & ROW Piedmont Ave		2																																												
SAHPC Tree Mitigation																																														
Sewer & Storm in Gayley Rd		2	2	2	2	2																																								

Total Average Daily Truck Trips

																																														Total Trips	Max
Seismic Phase 2 Truck Trips		3	4	3	3	3	3	0	0	6	5	5	5	5	5	5	5	5	5	6	7	10	14	4	3	3	5	5	5	4	4	4	4	3	1	4	4	4	4	4	3	3	3	3	3	2	4,101	14
																							^																									
All LBNL Truck Trips		25	35	23	21	21	14	11	12	18	13	14	18	22	20	37	21	16	16	14	15	16	20	12	10	10	9	9	8	7	6	9	9	8	2	6	6	4	4	4	3	3	3	3	3	2	12,195	37
All UCB Truck Trips		109	129	121	121	139	149	149	149	149	141	141	141	141	141	111	111	111	91	91	91	91	91	91	69	69	69	69	69	69	33	33	33	33	33	33	12	12	12	12	12	12	0	0	0	0	75,581	149
Cumulative Project Truck Trips		134	164	144	142	160	163	160	161	167	154	155	159	163	161	148	132	127	107	105	106	107	111	103	79	79	78	78	77	76	39	42	42	41	35	39	18	16	16	16	15	15	3	3	3	2	87,777	167
										^																																						

Maximum 12-Month Total Truck Trips (assumes 5 day/wk activity; i.e. 21.7 days/month)

																																														Max
Seismic Phase 2 Truck Trips		65	152	217	282	347	412	412	412	543	651	760	868	911	933	977	1,020	1,063	1,107	1,237	1,389	1,476	1,671	1,649	1,606	1,562	1,562	1,562	1,562	1,541	1,519	1,476	1,411	1,259	977	977	998	1,020	998	977	933	911	890	868	846	825	1,671
																							^																									
All LBNL Truck Trips		543	1,302	1,801	2,257	2,713	3,016	3,255	3,515	3,906	4,188	4,492	4,883	4,817	4,492	4,796	4,796	4,687	4,731	4,796	4,861	4,817	4,969	4,926	4,752	4,492	4,253	3,646	3,364	3,168	2,951	2,843	2,713	2,539	2,148	2,018	1,931	1,801	1,693	1,584	1,476	1,389	1,324	1,194	1,063	933	4,969
All UCB Truck Trips		2,365	5,165	7,790	10,416	13,432	16,666	19,899	23,132	26,366	29,425	32,485	35,545	36,239	36,499	36,282	36,065	35,458	34,199	32,941	31,682	30,423	29,338	28,253	26,691	25,129	23,566	22,655	21,743	20,832	19,573	18,315	17,056	15,798	14,539	13,280	12,044	10,807	9,570	8,333	7,096	5,859	5,143	4,427	3,711	2,995	36,499
Cumulative Project Truck Trips		2,908	6,467	9,591	12,673	16,145	19,682	23,154	26,648	30,272	33,613	36,977	40,427	41,056	40,991	41,078	40,861	40,145	38,930	37,736	36,543	35,241	34,308	33,179	31,443	29,621	27,819	26,300	25,107	24,000	22,525	21,158	19,769	18,337	16,687	15,299	13,975	12,608	11,262	9,917	8,572	7,248	6,467	5,620	4,774	3,928	41,078
																^																															

APPENDIX F

EMFAC2007 OUTPUT FILES FOR ON-ROAD TRUCK EMISSION FACTORS

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:08:08
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	LDT1-DSL	LDT1-TOT	LDT2-NCAT	LDT2-CAT	LDT2-DSL	LDT2-TOT	MDV-NCAT	MDV-CAT	MDV-DSL
Vehicles	34217	2870270	9347	2913830	13368	646582	21104	681053	7031	995712	2537	1005280	1495	329711	1675
VMT/1000	573	89677	207	90457	287	20981	628	21896	150	34033	71	34254	31	12291	53
Trips	135498	18069100	51177	18255800	54017	4013620	129111	4196750	28532	6296200	15008	6339740	6365	2098070	10406
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	0.06	5.56	1.13	3.95	0.01	5.09	0.29	1.61	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0	3.39	0.18	3.98	0	4.16	0.05	1.66	0
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	0.06	8.95	1.31	7.93	0.01	9.25	0.34	3.28	0
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0	0.68	0.04	0.57	0	0.6	0	0.14	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0	1.25	0.1	1.07	0	1.16	0.01	0.28	0
Running	2.72	10.09	0	12.81	0.65	5.71	0	6.35	0.32	5.61	0	5.93	0.03	1.35	0
Resting	0.11	1.1	0	1.21	0.04	0.35	0	0.39	0.02	0.34	0	0.36	0	0.09	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	0.06	17.62	1.79	15.5	0.01	17.31	0.39	5.14	0
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	0.43	114.9	13.01	102.9	0.05	115.97	4.6	35.56	0.03
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	4.52	112.17	0	116.69	1.81	38.33	0	40.14	0.95	47.66	0	48.61	0.38	17.47	0
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	0.43	155.03	13.96	150.56	0.05	164.58	4.98	53.03	0.03
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	1.05	11.71	0.74	15.21	0.12	16.07	0.24	6.11	0.09
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0	2.12	0.04	4.39	0	4.43	0.02	1.73	0
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	1.05	13.83	0.78	19.59	0.12	20.5	0.25	7.84	0.09
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	0.24	11.41	0.09	17.9	0.03	18.01	0.02	8.84	0.02
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0	0.41	0.01	0.63	0	0.63	0	0.28	0
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	0.24	11.82	0.09	18.53	0.03	18.65	0.02	9.12	0.02
PM10 Emissions															
Run Exh	0.02	1.06	0.03	1.11	0.01	0.33	0.04	0.38	0.01	0.92	0.01	0.93	0	0.33	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.11	0	0.11	0	0.03	0	0.03	0	0.09	0	0.09	0	0.03	0
Total Ex	0.02	1.17	0.03	1.22	0.01	0.36	0.04	0.41	0.01	1.01	0.01	1.02	0	0.36	0
TireWear	0.01	0.79	0	0.8	0	0.19	0.01	0.19	0	0.3	0	0.3	0	0.11	0
BrakeWr	0.01	1.24	0	1.25	0	0.29	0.01	0.3	0	0.47	0	0.47	0	0.17	0
Total	0.04	3.2	0.03	3.27	0.02	0.84	0.05	0.91	0.01	1.78	0.01	1.8	0	0.64	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0	0.12	0	0.18	0	0.18	0	0.09	0
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	0	1212.9	12.13	1923.25	0	1935.38	3.28	943.34	0
Diesel	0	0	7.4	7.4	0	0	21.62	21.62	0	0	2.48	2.48	0	0	1.83

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:08:08
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	MDV-TOT	LHDT1-NCAT	LHDT1-CAT	LHDT1-DSL	LHDT1-TOT	LHDT2-NCAT	LHDT2-CAT	LHDT2-DSL	LHDT2-TOT
Vehicles	34217	2870270	9347	2913830	13368	646582	332881	222	33624	11972	45818	239	17813	13424	31476
VMT/1000	573	89677	207	90457	287	20981	12375	5	1445	513	1963	5	632	492	1128
Trips	135498	18069100	51177	18255800	54017	4013620	2114850	7349	1111840	150592	1269780	7903	589010	168856	765770
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	1.91	0.04	0.36	0.12	0.52	0.04	0.42	0.17	0.62
Idle Exh	0	0	0	0	0	0	0	0	0.05	0	0.05	0	0.03	0	0.03
Start Ex	0.88	10.38	0	11.26	0.35	3.04	1.71	0.06	0.53	0	0.59	0.07	0.51	0	0.57
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	3.62	0.1	0.94	0.12	1.17	0.1	0.95	0.17	1.22
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0.15	0	0	0	0	0	0	0	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0.29	0.01	0.04	0	0.05	0.01	0.05	0	0.06
Running	2.72	10.09	0	12.81	0.65	5.71	1.38	0.04	0.54	0	0.58	0.04	0.83	0	0.86
Resting	0.11	1.1	0	1.21	0.04	0.35	0.09	0	0	0	0	0	0	0	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	5.53	0.14	1.53	0.12	1.8	0.15	1.83	0.17	2.15
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	40.2	0.74	3.69	0.59	5.02	0.74	4.45	0.65	5.84
Idle Exh	0	0	0	0	0	0	0	0	0.29	0.01	0.3	0	0.15	0.01	0.16
Start Ex	4.52	112.17	0	116.69	1.81	38.33	17.84	0.33	6.79	0	7.12	0.35	6.6	0	6.95
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	58.04	1.07	10.77	0.6	12.44	1.09	11.19	0.66	12.95
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	6.44	0.01	0.6	2.37	2.98	0.01	0.63	2.84	3.47
Idle Exh	0	0	0	0	0	0	0	0	0	0.03	0.04	0	0	0.04	0.04
Start Ex	0.22	7.24	0	7.45	0.08	2.04	1.75	0.01	1.92	0	1.92	0.01	1.19	0	1.19
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	8.18	0.02	2.52	2.4	4.94	0.02	1.81	2.88	4.71
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	8.88	0.01	1.54	0.29	1.84	0	0.68	0.29	0.97
Idle Exh	0	0	0	0	0	0	0	0	0.01	0	0.01	0	0.01	0	0.01
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0.29	0	0.05	0	0.05	0	0.02	0	0.03
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	9.17	0.01	1.6	0.3	1.91	0.01	0.7	0.29	1
PM10 Emissions															
Run Exh	0.02	1.06	0.03	1.11	0.01	0.33	0.33	0	0.02	0.03	0.05	0	0.01	0.04	0.05
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.11	0	0.11	0	0.03	0.03	0	0	0	0	0	0	0	0
Total Ex	0.02	1.17	0.03	1.22	0.01	0.36	0.36	0	0.02	0.03	0.05	0	0.01	0.04	0.05
TireWear	0.01	0.79	0	0.8	0	0.19	0.11	0	0.02	0.01	0.03	0	0.01	0.01	0.01
BrakeWr	0.01	1.24	0	1.25	0	0.29	0.17	0	0.02	0.01	0.03	0	0.01	0.01	0.02
Total	0.04	3.2	0.03	3.27	0.02	0.84	0.64	0	0.06	0.04	0.1	0	0.03	0.05	0.08
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0.09	0	0.02	0	0.02	0	0.01	0	0.01
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	946.62	0.89	166.19	0	167.08	0.9	74.25	0	75.15
Diesel	0	0	7.4	7.4	0	0	1.83	0	0	26.71	26.71	0	0	26.24	26.24

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:08:08
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	MHDT-NCAT	MHDT-CAT	MHDT-DSL	MHDT-TOT	HHDT-NCAT	HHDT-CAT	HHDT-DSL	HHDT-TOT	OBUS-NCAT
Vehicles	34217	2870270	9347	2913830	13368	646582	1188	9890	39734	50812	179	1714	18404	20296	52
VMT/1000	573	89677	207	90457	287	20981	9	413	2274	2696	2	145	2878	3025	0
Trips	135498	18069100	51177	18255800	54017	4013620	54241	451675	1114140	1620060	8156	78277	93131	179564	2357
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	0.07	0.3	0.6	0.97	0.03	0.49	3.58	4.1	0
Idle Exh	0	0	0	0	0	0	0	0.02	0.02	0.04	0	0	0.49	0.49	0
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0.67	0.81	0	1.48	0.17	0.37	0	0.54	0.03
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	0.74	1.13	0.62	2.49	0.2	0.86	4.07	5.13	0.03
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0	0	0	0	0	0	0	0	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0.03	0.02	0	0.05	0	0	0	0.01	0
Running	2.72	10.09	0	12.81	0.65	5.71	0.25	0.32	0	0.57	0.05	0.05	0	0.1	0.01
Resting	0.11	1.1	0	1.21	0.04	0.35	0	0	0	0	0	0	0	0	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	1.01	1.47	0.62	3.1	0.26	0.92	4.07	5.24	0.04
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	1.52	4.46	4.99	10.97	1.19	6.13	12.83	20.15	0.07
Idle Exh	0	0	0	0	0	0	0.02	0.13	0.11	0.26	0	0	1.74	1.74	0
Start Ex	4.52	112.17	0	116.69	1.81	38.33	3.64	13.56	0	17.2	2.22	5.32	0	7.54	0.16
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	5.17	18.16	5.1	28.43	3.41	11.45	14.58	29.44	0.22
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	0.03	1.21	21.35	22.6	0.05	1.91	46.73	48.69	0
Idle Exh	0	0	0	0	0	0	0	0	0.32	0.32	0	0	3.75	3.75	0
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0.06	1.45	0	1.5	0.04	0.68	0	0.72	0
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	0.09	2.66	21.67	24.43	0.09	2.59	50.48	53.15	0
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	0.01	0.31	3.77	4.09	0	0.09	5.81	5.91	0
Idle Exh	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0.22	0.22	0
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0.01	0.02	0	0.03	0	0	0	0	0
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	0.02	0.33	3.79	4.14	0	0.1	6.04	6.13	0
PM10 Emissions															
Run Exh	0.02	1.06	0.03	1.11	0.01	0.33	0	0	0.64	0.65	0	0	1.76	1.76	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.06	0
Start Ex	0	0.11	0	0.11	0	0.03	0	0	0	0	0	0	0	0	0
Total Ex	0.02	1.17	0.03	1.22	0.01	0.36	0	0.01	0.65	0.65	0	0	1.82	1.83	0
TireWear	0.01	0.79	0	0.8	0	0.19	0	0.01	0.03	0.04	0	0	0.11	0.12	0
BrakeWr	0.01	1.24	0	1.25	0	0.29	0	0.01	0.03	0.04	0	0	0.09	0.09	0
Total	0.04	3.2	0.03	3.27	0.02	0.84	0	0.02	0.71	0.73	0	0.01	2.03	2.04	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0	0	0.04	0.04	0	0	0.06	0.06	0
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	3.04	37.47	0	40.51	0.93	11.94	0	12.87	0.13
Diesel	0	0	7.4	7.4	0	0	0	0	341.13	341.13	0	0	543.19	543.19	0

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:08:08
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	OBUS-CAT	OBUS-DSL	OBUS-TOT	SBUS-NCAT	SBUS-CAT	SBUS-DSL	SBUS-TOT	UB-NCAT	UB-CAT
Vehicles	34217	2870270	9347	2913830	13368	646582	1920	2179	4151	81	509	4577	5167	37	578
VMT/1000	573	89677	207	90457	287	20981	88	126	215	3	21	185	209	4	70
Trips	135498	18069100	51177	18255800	54017	4013620	87673	61104	151134	326	2035	18306	20667	147	2313
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	0.06	0.03	0.09	0.03	0.03	0.06	0.12	0.05	0.2
Idle Exh	0	0	0	0	0	0	0	0	0.01	0	0.01	0.01	0.02	0	0
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0.13	0	0.16	0.01	0.01	0	0.01	0	0.01
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	0.2	0.03	0.26	0.04	0.04	0.07	0.15	0.05	0.21
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0	0	0	0	0	0	0	0	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0	0	0	0	0	0	0	0	0
Running	2.72	10.09	0	12.81	0.65	5.71	0.03	0	0.05	0	0	0	0.01	0	0.01
Resting	0.11	1.1	0	1.21	0.04	0.35	0	0	0	0	0	0	0	0	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	0.23	0.03	0.31	0.04	0.05	0.07	0.16	0.05	0.22
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	0.87	0.27	1.21	0.61	0.36	0.48	1.45	0.93	1.19
Idle Exh	0	0	0	0	0	0	0.02	0.01	0.03	0.01	0.04	0.07	0.12	0	0
Start Ex	4.52	112.17	0	116.69	1.81	38.33	2.3	0	2.46	0.03	0.1	0	0.13	0.01	0.17
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	3.2	0.28	3.7	0.65	0.5	0.55	1.69	0.94	1.35
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	0.31	1.23	1.54	0.01	0.06	2.04	2.1	0.02	0.29
Idle Exh	0	0	0	0	0	0	0	0.02	0.02	0	0	0.2	0.2	0	0
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0.29	0	0.29	0	0.01	0	0.01	0	0.02
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	0.6	1.25	1.85	0.01	0.06	2.24	2.31	0.02	0.31
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	0.07	0.21	0.28	0	0.02	0.31	0.33	0	0.06
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0	0	0	0	0	0	0	0	0
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	0.07	0.21	0.28	0	0.02	0.32	0.34	0	0.06
PM10 Emissions															
Run Exh	0.02	1.06	0.03	1.11	0.01	0.33	0	0.03	0.04	0	0	0.07	0.07	0	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.11	0	0.11	0	0.03	0	0	0	0	0	0	0	0	0
Total Ex	0.02	1.17	0.03	1.22	0.01	0.36	0	0.03	0.04	0	0	0.08	0.08	0	0
TireWear	0.01	0.79	0	0.8	0	0.19	0	0	0	0	0	0	0	0	0
BrakeWr	0.01	1.24	0	1.25	0	0.29	0	0	0	0	0	0	0	0	0
Total	0.04	3.2	0.03	3.27	0.02	0.84	0	0.04	0.04	0	0	0.08	0.08	0	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0	0	0	0	0	0	0	0	0
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	7.86	0	7.99	0.42	2.01	0	2.43	0.55	6.23
Diesel	0	0	7.4	7.4	0	0	0	18.88	18.88	0	0	28.61	28.61	0	0

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:08:08
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	UB-DSL	UB-TOT	MH-NCAT	MH-CAT	MH-DSL	MH-TOT	MCY-NCAT	MCY-CAT	MCY-DSL
Vehicles	34217	2870270	9347	2913830	13368	646582	4350	4965	1547	27627	3406	32581	111398	52620	0
VMT/1000	573	89677	207	90457	287	20981	531	606	14	311	40	364	811	506	0
Trips	135498	18069100	51177	18255800	54017	4013620	17399	19859	155	2764	341	3259	222774	105229	0
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	0.49	0.74	0.1	0.17	0.01	0.27	4.1	1.26	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0	0.01	0	0	0	0.01	0.71	0.28	0
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	0.49	0.75	0.1	0.17	0.01	0.28	4.8	1.54	0
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0	0	0	0.01	0	0.01	0.07	0.2	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0	0	0	0	0	0	0.09	0.08	0
Running	2.72	10.09	0	12.81	0.65	5.71	0	0.01	0	0.01	0	0.01	0.52	0.37	0
Resting	0.11	1.1	0	1.21	0.04	0.35	0	0	0	0	0	0	0.04	0.09	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	0.49	0.76	0.1	0.19	0.01	0.3	5.52	2.28	0
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	2.1	4.22	2.32	4.49	0.05	6.85	50.39	8.2	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	4.52	112.17	0	116.69	1.81	38.33	0	0.18	0.01	0.07	0	0.08	1.98	1.71	0
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	2.1	4.39	2.33	4.56	0.05	6.93	52.37	9.92	0
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	11.4	11.71	0.05	0.61	0.41	1.07	1.23	0.63	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0	0.02	0	0.01	0	0.01	0.09	0.03	0
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	11.4	11.72	0.05	0.62	0.41	1.08	1.31	0.66	0
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	1.56	1.63	0.01	0.23	0.07	0.31	0.1	0.1	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0	0	0	0	0	0	0.01	0	0
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	1.56	1.63	0.01	0.23	0.07	0.31	0.12	0.11	0
PM10 Emissions															
Run Exh	0.02	1.06	0.03	1.11	0.01	0.33	0.19	0.19	0	0	0.01	0.01	0.05	0	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.11	0	0.11	0	0.03	0	0	0	0	0	0	0.01	0	0
Total Ex	0.02	1.17	0.03	1.22	0.01	0.36	0.19	0.19	0	0	0.01	0.01	0.06	0	0
TireWear	0.01	0.79	0	0.8	0	0.19	0	0.01	0	0	0	0	0	0	0
BrakeWr	0.01	1.24	0	1.25	0	0.29	0.01	0.01	0	0	0	0.01	0.01	0	0
Total	0.04	3.2	0.03	3.27	0.02	0.84	0.2	0.21	0	0.01	0.01	0.02	0.06	0.01	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0.01	0.02	0	0	0	0	0	0	0
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	0	6.78	1.48	24.82	0	26.3	22.15	12.86	0
Diesel	0	0	7.4	7.4	0	0	140.81	140.81	0	0	5.93	5.93	0	0	0

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:08:08
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	MCY-TOT	ALL-TOT
Vehicles	34217	2870270	9347	2913830	13368	646582	164018	5292330
VMT/1000	573	89677	207	90457	287	20981	1316	170504
Trips	135498	18069100	51177	18255800	54017	4013620	328003	35265200
Total Organic Gas Emissions								
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	5.36	37.99
Idle Exh	0	0	0	0	0	0	0	0.64
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0.99	24.89
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Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	6.35	63.52
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0.27	3.81
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0.16	7.17
Running	2.72	10.09	0	12.81	0.65	5.71	0.9	29.56
Resting	0.11	1.1	0	1.21	0.04	0.35	0.13	2.19
	---	---	---	---	---	---	---	---
Total	8.61	35.5	0.04	44.16	3.46	14.09	7.8	106.24
Carbon Monoxide Emissions								
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	58.59	639.81
Idle Exh	0	0	0	0	0	0	0	2.62
Start Ex	4.52	112.17	0	116.69	1.81	38.33	3.7	268.64
	---	---	---	---	---	---	---	---
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	62.29	911.07
Oxides of Nitrogen Emissions								
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	1.86	154.64
Idle Exh	0	0	0	0	0	0	0	4.37
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0.11	21.53
	---	---	---	---	---	---	---	---
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	1.97	180.53
Carbon Dioxide Emissions (000)								
Run Exh	0.33	37.92	0.08	38.33	0.17	11	0.21	92.19
Idle Exh	0	0	0	0	0	0	0	0.28
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0.02	2.94
	---	---	---	---	---	---	---	---
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	0.23	95.41
PM10 Emissions								
Run Exh	0.02	1.06	0.03	1.11	0.01	0.33	0.05	5.62
Idle Exh	0	0	0	0	0	0	0	0.07
Start Ex	0	0.11	0	0.11	0	0.03	0.01	0.28
	---	---	---	---	---	---	---	---
Total Ex	0.02	1.17	0.03	1.22	0.01	0.36	0.06	5.97
TireWear	0.01	0.79	0	0.8	0	0.19	0.01	1.62
BrakeWr	0.01	1.24	0	1.25	0	0.29	0.01	2.4
	---	---	---	---	---	---	---	---
Total	0.04	3.2	0.03	3.27	0.02	0.84	0.07	9.98
Lead	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0	0.93
Fuel Consumption (000 gallons)								
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	35.01	8602.64
Diesel	0	0	7.4	7.4	0	0	0	1164.82

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:10:31
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	LDT1-DSL	LDT1-TOT	LDT2-NCAT	LDT2-CAT	LDT2-DSL	LDT2-TOT	MDV-NCAT	MDV-CAT	MDV-DSL
Vehicles	34217	2870270	9347	2913830	13368	646582	21104	681053	7031	995712	2537	1005280	1495	329711	1675
VMT/1000	573	89677	207	90457	287	20981	628	21896	150	34033	71	34254	31	12291	53
Trips	135498	18069100	51177	18255800	54017	4013620	129111	4196750	28532	6296200	15008	6339740	6365	2098070	10406
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	0.06	5.56	1.13	3.95	0.01	5.09	0.29	1.61	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0	3.39	0.18	3.98	0	4.16	0.05	1.66	0
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	0.06	8.95	1.31	7.93	0.01	9.25	0.34	3.28	0
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0	0.68	0.04	0.57	0	0.6	0	0.14	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0	1.25	0.1	1.07	0	1.16	0.01	0.28	0
Running	2.72	10.09	0	12.81	0.65	5.71	0	6.35	0.32	5.61	0	5.93	0.03	1.35	0
Resting	0.11	1.1	0	1.21	0.04	0.35	0	0.39	0.02	0.34	0	0.36	0	0.09	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	0.06	17.62	1.79	15.5	0.01	17.31	0.39	5.14	0
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	0.43	114.9	13.01	102.9	0.05	115.97	4.6	35.56	0.03
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	4.52	112.17	0	116.69	1.81	38.33	0	40.14	0.95	47.66	0	48.61	0.38	17.47	0
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	0.43	155.03	13.96	150.56	0.05	164.58	4.98	53.03	0.03
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	1.05	11.71	0.74	15.21	0.12	16.07	0.24	6.11	0.09
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0	2.12	0.04	4.39	0	4.43	0.02	1.73	0
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	1.05	13.83	0.78	19.59	0.12	20.5	0.25	7.84	0.09
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	0.24	11.41	0.09	17.9	0.03	18.01	0.02	8.84	0.02
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0	0.41	0.01	0.63	0	0.63	0	0.28	0
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	0.24	11.82	0.09	18.53	0.03	18.65	0.02	9.12	0.02
PM2.5 Emissions															
Run Exh	0.02	0.98	0.03	1.03	0.01	0.3	0.03	0.35	0	0.86	0.01	0.87	0	0.31	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.1	0	0.11	0	0.03	0	0.03	0	0.08	0	0.08	0	0.03	0
Total Ex	0.02	1.09	0.03	1.13	0.01	0.34	0.03	0.38	0	0.94	0.01	0.95	0	0.33	0
TireWear	0	0.2	0	0.2	0	0.05	0	0.05	0	0.08	0	0.08	0	0.03	0
BrakeWr	0	0.53	0	0.54	0	0.12	0	0.13	0	0.2	0	0.2	0	0.07	0
Total	0.02	1.82	0.03	1.87	0.01	0.51	0.04	0.56	0.01	1.21	0.01	1.22	0	0.43	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0	0.12	0	0.18	0	0.18	0	0.09	0
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	0	1212.9	12.13	1923.25	0	1935.38	3.28	943.34	0
Diesel	0	0	7.4	7.4	0	0	21.62	21.62	0	0	2.48	2.48	0	0	1.83

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:10:31
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	MDV-TOT	LHDT1-NCAT	LHDT1-CAT	LHDT1-DSL	LHDT1-TOT	LHDT2-NCAT	LHDT2-CAT	LHDT2-DSL	LHDT2-TOT
Vehicles	34217	2870270	9347	2913830	13368	646582	332881	222	33624	11972	45818	239	17813	13424	31476
VMT/1000	573	89677	207	90457	287	20981	12375	5	1445	513	1963	5	632	492	1128
Trips	135498	18069100	51177	18255800	54017	4013620	2114850	7349	1111840	150592	1269780	7903	589010	168856	765770
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	1.91	0.04	0.36	0.12	0.52	0.04	0.42	0.17	0.62
Idle Exh	0	0	0	0	0	0	0	0	0.05	0	0.05	0	0.03	0	0.03
Start Ex	0.88	10.38	0	11.26	0.35	3.04	1.71	0.06	0.53	0	0.59	0.07	0.51	0	0.57
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	3.62	0.1	0.94	0.12	1.17	0.1	0.95	0.17	1.22
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0.15	0	0	0	0	0	0	0	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0.29	0.01	0.04	0	0.05	0.01	0.05	0	0.06
Running	2.72	10.09	0	12.81	0.65	5.71	1.38	0.04	0.54	0	0.58	0.04	0.83	0	0.86
Resting	0.11	1.1	0	1.21	0.04	0.35	0.09	0	0	0	0	0	0	0	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	5.53	0.14	1.53	0.12	1.8	0.15	1.83	0.17	2.15
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	40.2	0.74	3.69	0.59	5.02	0.74	4.45	0.65	5.84
Idle Exh	0	0	0	0	0	0	0	0	0.29	0.01	0.3	0	0.15	0.01	0.16
Start Ex	4.52	112.17	0	116.69	1.81	38.33	17.84	0.33	6.79	0	7.12	0.35	6.6	0	6.95
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	58.04	1.07	10.77	0.6	12.44	1.09	11.19	0.66	12.95
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	6.44	0.01	0.6	2.37	2.98	0.01	0.63	2.84	3.47
Idle Exh	0	0	0	0	0	0	0	0	0	0.03	0.04	0	0	0.04	0.04
Start Ex	0.22	7.24	0	7.45	0.08	2.04	1.75	0.01	1.92	0	1.92	0.01	1.19	0	1.19
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	8.18	0.02	2.52	2.4	4.94	0.02	1.81	2.88	4.71
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	8.88	0.01	1.54	0.29	1.84	0	0.68	0.29	0.97
Idle Exh	0	0	0	0	0	0	0	0	0.01	0	0.01	0	0.01	0	0.01
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0.29	0	0.05	0	0.05	0	0.02	0	0.03
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	9.17	0.01	1.6	0.3	1.91	0.01	0.7	0.29	1
PM2.5 Emissions															
Run Exh	0.02	0.98	0.03	1.03	0.01	0.3	0.31	0	0.02	0.03	0.04	0	0.01	0.03	0.04
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.1	0	0.11	0	0.03	0.03	0	0	0	0	0	0	0	0
Total Ex	0.02	1.09	0.03	1.13	0.01	0.34	0.34	0	0.02	0.03	0.04	0	0.01	0.03	0.05
TireWear	0	0.2	0	0.2	0	0.05	0.03	0	0	0	0.01	0	0	0	0
BrakeWr	0	0.53	0	0.54	0	0.12	0.07	0	0.01	0	0.01	0	0	0	0.01
Total	0.02	1.82	0.03	1.87	0.01	0.51	0.44	0	0.03	0.03	0.06	0	0.02	0.04	0.06
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0.09	0	0.02	0	0.02	0	0.01	0	0.01
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	946.62	0.89	166.19	0	167.08	0.9	74.25	0	75.15
Diesel	0	0	7.4	7.4	0	0	1.83	0	0	26.71	26.71	0	0	26.24	26.24

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:10:31
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	MHDT-NCAT	MHDT-CAT	MHDT-DSL	MHDT-TOT	HHDT-NCAT	HHDT-CAT	HHDT-DSL	HHDT-TOT	OBUS-NCAT
Vehicles	34217	2870270	9347	2913830	13368	646582	1188	9890	39734	50812	179	1714	18404	20296	52
VMT/1000	573	89677	207	90457	287	20981	9	413	2274	2696	2	145	2878	3025	0
Trips	135498	18069100	51177	18255800	54017	4013620	54241	451675	1114140	1620060	8156	78277	93131	179564	2357
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	0.07	0.3	0.6	0.97	0.03	0.49	3.58	4.1	0
Idle Exh	0	0	0	0	0	0	0	0.02	0.02	0.04	0	0	0.49	0.49	0
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0.67	0.81	0	1.48	0.17	0.37	0	0.54	0.03
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	0.74	1.13	0.62	2.49	0.2	0.86	4.07	5.13	0.03
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0	0	0	0	0	0	0	0	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0.03	0.02	0	0.05	0	0	0	0.01	0
Running	2.72	10.09	0	12.81	0.65	5.71	0.25	0.32	0	0.57	0.05	0.05	0	0.1	0.01
Resting	0.11	1.1	0	1.21	0.04	0.35	0	0	0	0	0	0	0	0	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	1.01	1.47	0.62	3.1	0.26	0.92	4.07	5.24	0.04
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	1.52	4.46	4.99	10.97	1.19	6.13	12.83	20.15	0.07
Idle Exh	0	0	0	0	0	0	0.02	0.13	0.11	0.26	0	0	1.74	1.74	0
Start Ex	4.52	112.17	0	116.69	1.81	38.33	3.64	13.56	0	17.2	2.22	5.32	0	7.54	0.16
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	5.17	18.16	5.1	28.43	3.41	11.45	14.58	29.44	0.22
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	0.03	1.21	21.35	22.6	0.05	1.91	46.73	48.69	0
Idle Exh	0	0	0	0	0	0	0	0	0.32	0.32	0	0	3.75	3.75	0
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0.06	1.45	0	1.5	0.04	0.68	0	0.72	0
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	0.09	2.66	21.67	24.43	0.09	2.59	50.48	53.15	0
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	0.01	0.31	3.77	4.09	0	0.09	5.81	5.91	0
Idle Exh	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0.22	0.22	0
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0.01	0.02	0	0.03	0	0	0	0	0
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	0.02	0.33	3.79	4.14	0	0.1	6.04	6.13	0
PM2.5 Emissions															
Run Exh	0.02	0.98	0.03	1.03	0.01	0.3	0	0	0.59	0.6	0	0	1.62	1.62	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.06	0
Start Ex	0	0.1	0	0.11	0	0.03	0	0	0	0	0	0	0	0	0
Total Ex	0.02	1.09	0.03	1.13	0.01	0.34	0	0.01	0.59	0.6	0	0	1.68	1.68	0
TireWear	0	0.2	0	0.2	0	0.05	0	0	0.01	0.01	0	0	0.03	0.03	0
BrakeWr	0	0.53	0	0.54	0	0.12	0	0	0.01	0.02	0	0	0.04	0.04	0
Total	0.02	1.82	0.03	1.87	0.01	0.51	0	0.01	0.62	0.63	0	0.01	1.74	1.75	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0	0	0.04	0.04	0	0	0.06	0.06	0
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	3.04	37.47	0	40.51	0.93	11.94	0	12.87	0.13
Diesel	0	0	7.4	7.4	0	0	0	0	341.13	341.13	0	0	543.19	543.19	0

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:10:31
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	OBUS-CAT	OBUS-DSL	OBUS-TOT	SBUS-NCAT	SBUS-CAT	SBUS-DSL	SBUS-TOT	UB-NCAT	UB-CAT
Vehicles	34217	2870270	9347	2913830	13368	646582	1920	2179	4151	81	509	4577	5167	37	578
VMT/1000	573	89677	207	90457	287	20981	88	126	215	3	21	185	209	4	70
Trips	135498	18069100	51177	18255800	54017	4013620	87673	61104	151134	326	2035	18306	20667	147	2313
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	0.06	0.03	0.09	0.03	0.03	0.06	0.12	0.05	0.2
Idle Exh	0	0	0	0	0	0	0	0	0.01	0	0.01	0.01	0.02	0	0
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0.13	0	0.16	0.01	0.01	0	0.01	0	0.01
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	0.2	0.03	0.26	0.04	0.04	0.07	0.15	0.05	0.21
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0	0	0	0	0	0	0	0	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0	0	0	0	0	0	0	0	0
Running	2.72	10.09	0	12.81	0.65	5.71	0.03	0	0.05	0	0	0	0.01	0	0.01
Resting	0.11	1.1	0	1.21	0.04	0.35	0	0	0	0	0	0	0	0	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	0.23	0.03	0.31	0.04	0.05	0.07	0.16	0.05	0.22
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	0.87	0.27	1.21	0.61	0.36	0.48	1.45	0.93	1.19
Idle Exh	0	0	0	0	0	0	0.02	0.01	0.03	0.01	0.04	0.07	0.12	0	0
Start Ex	4.52	112.17	0	116.69	1.81	38.33	2.3	0	2.46	0.03	0.1	0	0.13	0.01	0.17
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	3.2	0.28	3.7	0.65	0.5	0.55	1.69	0.94	1.35
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	0.31	1.23	1.54	0.01	0.06	2.04	2.1	0.02	0.29
Idle Exh	0	0	0	0	0	0	0	0.02	0.02	0	0	0.2	0.2	0	0
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0.29	0	0.29	0	0.01	0	0.01	0	0.02
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	0.6	1.25	1.85	0.01	0.06	2.24	2.31	0.02	0.31
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	0.07	0.21	0.28	0	0.02	0.31	0.33	0	0.06
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0	0	0	0	0	0	0	0	0
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	0.07	0.21	0.28	0	0.02	0.32	0.34	0	0.06
PM2.5 Emissions															
Run Exh	0.02	0.98	0.03	1.03	0.01	0.3	0	0.03	0.03	0	0	0.07	0.07	0	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.1	0	0.11	0	0.03	0	0	0	0	0	0	0	0	0
Total Ex	0.02	1.09	0.03	1.13	0.01	0.34	0	0.03	0.03	0	0	0.07	0.07	0	0
TireWear	0	0.2	0	0.2	0	0.05	0	0	0	0	0	0	0	0	0
BrakeWr	0	0.53	0	0.54	0	0.12	0	0	0	0	0	0	0	0	0
Total	0.02	1.82	0.03	1.87	0.01	0.51	0	0.03	0.04	0	0	0.07	0.07	0	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0	0	0	0	0	0	0	0	0
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	7.86	0	7.99	0.42	2.01	0	2.43	0.55	6.23
Diesel	0	0	7.4	7.4	0	0	0	18.88	18.88	0	0	28.61	28.61	0	0

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:10:31
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	UB-DSL	UB-TOT	MH-NCAT	MH-CAT	MH-DSL	MH-TOT	MCY-NCAT	MCY-CAT	MCY-DSL
Vehicles	34217	2870270	9347	2913830	13368	646582	4350	4965	1547	27627	3406	32581	111398	52620	0
VMT/1000	573	89677	207	90457	287	20981	531	606	14	311	40	364	811	506	0
Trips	135498	18069100	51177	18255800	54017	4013620	17399	19859	155	2764	341	3259	222774	105229	0
Total Organic Gas Emissions															
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	0.49	0.74	0.1	0.17	0.01	0.27	4.1	1.26	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0	0.01	0	0	0	0.01	0.71	0.28	0
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	0.49	0.75	0.1	0.17	0.01	0.28	4.8	1.54	0
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0	0	0	0.01	0	0.01	0.07	0.2	0
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0	0	0	0	0	0	0.09	0.08	0
Running	2.72	10.09	0	12.81	0.65	5.71	0	0.01	0	0.01	0	0.01	0.52	0.37	0
Resting	0.11	1.1	0	1.21	0.04	0.35	0	0	0	0	0	0	0.04	0.09	0
Total	8.61	35.5	0.04	44.16	3.46	14.09	0.49	0.76	0.1	0.19	0.01	0.3	5.52	2.28	0
Carbon Monoxide Emissions															
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	2.1	4.22	2.32	4.49	0.05	6.85	50.39	8.2	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	4.52	112.17	0	116.69	1.81	38.33	0	0.18	0.01	0.07	0	0.08	1.98	1.71	0
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	2.1	4.39	2.33	4.56	0.05	6.93	52.37	9.92	0
Oxides of Nitrogen Emissions															
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	11.4	11.71	0.05	0.61	0.41	1.07	1.23	0.63	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0	0.02	0	0.01	0	0.01	0.09	0.03	0
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	11.4	11.72	0.05	0.62	0.41	1.08	1.31	0.66	0
Carbon Dioxide Emissions (000)															
Run Exh	0.33	37.92	0.08	38.33	0.17	11	1.56	1.63	0.01	0.23	0.07	0.31	0.1	0.1	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0	0	0	0	0	0	0.01	0	0
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	1.56	1.63	0.01	0.23	0.07	0.31	0.12	0.11	0
PM2.5 Emissions															
Run Exh	0.02	0.98	0.03	1.03	0.01	0.3	0.18	0.18	0	0	0.01	0.01	0.04	0	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.1	0	0.11	0	0.03	0	0	0	0	0	0	0	0	0
Total Ex	0.02	1.09	0.03	1.13	0.01	0.34	0.18	0.18	0	0	0.01	0.01	0.04	0	0
TireWear	0	0.2	0	0.2	0	0.05	0	0	0	0	0	0	0	0	0
BrakeWr	0	0.53	0	0.54	0	0.12	0	0	0	0	0	0	0	0	0
Total	0.02	1.82	0.03	1.87	0.01	0.51	0.18	0.18	0	0	0.01	0.01	0.05	0	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0.01	0.02	0	0	0	0	0	0	0
Fuel Consumption (000 gallons)															
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	0	6.78	1.48	24.82	0	26.3	22.15	12.86	0
Diesel	0	0	7.4	7.4	0	0	140.81	140.81	0	0	5.93	5.93	0	0	0

Title : LBNL - BAAQMD - Annual - 2010
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2009/11/20 16:10:31
Scen Year: 2010 -- All model years in the range 1966 to 2010 selected
Season : Annual
Area : Bay Area AQMD Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 43 San Francisco (SF)
Emissions: Tons Per Day
****

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	MCY-TOT	ALL-TOT
Vehicles	34217	2870270	9347	2913830	13368	646582	164018	5292330
VMT/1000	573	89677	207	90457	287	20981	1316	170504
Trips	135498	18069100	51177	18255800	54017	4013620	328003	35265200
Total Organic Gas Emissions								
Run Exh	4.27	8.32	0.04	12.63	2.18	3.32	5.36	37.99
Idle Exh	0	0	0	0	0	0	0	0.64
Start Ex	0.88	10.38	0	11.26	0.35	3.04	0.99	24.89
	---	---	---	---	---	---	---	---
Total Ex	5.15	18.7	0.04	23.89	2.53	6.36	6.35	63.52
Diurnal	0.17	1.93	0	2.1	0.07	0.61	0.27	3.81
Hot Soak	0.46	3.68	0	4.14	0.18	1.06	0.16	7.17
Running	2.72	10.09	0	12.81	0.65	5.71	0.9	29.56
Resting	0.11	1.1	0	1.21	0.04	0.35	0.13	2.19
	---	---	---	---	---	---	---	---
Total	8.61	35.5	0.04	44.16	3.46	14.09	7.8	106.24
Carbon Monoxide Emissions								
Run Exh	50.44	203.83	0.18	254.46	25.14	89.33	58.59	639.81
Idle Exh	0	0	0	0	0	0	0	2.62
Start Ex	4.52	112.17	0	116.69	1.81	38.33	3.7	268.64
	---	---	---	---	---	---	---	---
Total Ex	54.96	316.01	0.18	371.15	26.94	127.66	62.29	911.07
Oxides of Nitrogen Emissions								
Run Exh	2.91	21.15	0.34	24.4	1.42	9.24	1.86	154.64
Idle Exh	0	0	0	0	0	0	0	4.37
Start Ex	0.22	7.24	0	7.45	0.08	2.04	0.11	21.53
	---	---	---	---	---	---	---	---
Total Ex	3.13	28.39	0.34	31.85	1.51	11.28	1.97	180.53
Carbon Dioxide Emissions (000)								
Run Exh	0.33	37.92	0.08	38.33	0.17	11	0.21	92.19
Idle Exh	0	0	0	0	0	0	0	0.28
Start Ex	0.03	1.45	0	1.48	0.01	0.4	0.02	2.94
	---	---	---	---	---	---	---	---
Total Ex	0.36	39.36	0.08	39.81	0.18	11.4	0.23	95.41
PM2.5 Emissions								
Run Exh	0.02	0.98	0.03	1.03	0.01	0.3	0.04	5.17
Idle Exh	0	0	0	0	0	0	0	0.07
Start Ex	0	0.1	0	0.11	0	0.03	0	0.26
	---	---	---	---	---	---	---	---
Total Ex	0.02	1.09	0.03	1.13	0.01	0.34	0.04	5.5
TireWear	0	0.2	0	0.2	0	0.05	0	0.4
BrakeWr	0	0.53	0	0.54	0	0.12	0	1.03
	---	---	---	---	---	---	---	---
Total	0.02	1.82	0.03	1.87	0.01	0.51	0.05	6.93
Lead	0	0	0	0	0	0	0	0
SOx	0	0.38	0	0.39	0	0.11	0	0.93
Fuel Consumption (000 gallons)								
Gasoline	47.31	4086.31	0	4133.61	23.3	1189.6	35.01	8602.64
Diesel	0	0	7.4	7.4	0	0	0	1164.82

APPENDIX G
AERSURFACE OUTPUT FILE

```
** Generated by AERSURFACE, dated 08009
** Center Latitude (decimal degrees):     37.750000
** Center Longitude (decimal degrees):  -122.200000
** Datum: NAD83
** Study radius (km) for surface roughness:   1.0
** Airport? N, Continuous snow cover? N
** Surface moisture? Wet, Arid region? N
** Month/Season assignments? Default
** Late autumn after frost and harvest, or winter with no snow: 12 1 2
** Winter with continuous snow on the ground: 0
** Transitional spring (partial green coverage, short annuals): 3 4 5
** Midsummer with lush vegetation: 6 7 8
** Autumn with unharvested cropland: 9 10 11
**
  FREQ_SECT  SEASONAL 12
  SECTOR   1    0   30
  SECTOR   2   30   60
  SECTOR   3   60   90
  SECTOR   4   90  120
  SECTOR   5  120  150
  SECTOR   6  150  180
  SECTOR   7  180  210
  SECTOR   8  210  240
  SECTOR   9  240  270
  SECTOR  10  270  300
  SECTOR  11  300  330
  SECTOR  12  330  360
**          Season   Sect    Alb      Bo       Zo
  SITE_CHAR    1       1    0.17    0.55    0.613
  SITE_CHAR    1       2    0.17    0.55    0.623
  SITE_CHAR    1       3    0.17    0.55    0.733
  SITE_CHAR    1       4    0.17    0.55    0.747
  SITE_CHAR    1       5    0.17    0.55    0.740
  SITE_CHAR    1       6    0.17    0.55    0.485
  SITE_CHAR    1       7    0.17    0.55    0.664
  SITE_CHAR    1       8    0.17    0.55    0.242
  SITE_CHAR    1       9    0.17    0.55    0.246
  SITE_CHAR    1      10    0.17    0.55    0.273
  SITE_CHAR    1      11    0.17    0.55    0.660
  SITE_CHAR    1      12    0.17    0.55    0.618
  SITE_CHAR    2       1    0.16    0.52    0.637
  SITE_CHAR    2       2    0.16    0.52    0.639
  SITE_CHAR    2       3    0.16    0.52    0.744
  SITE_CHAR    2       4    0.16    0.52    0.749
  SITE_CHAR    2       5    0.16    0.52    0.748
  SITE_CHAR    2       6    0.16    0.52    0.559
  SITE_CHAR    2       7    0.16    0.52    0.686
  SITE_CHAR    2       8    0.16    0.52    0.297
  SITE_CHAR    2       9    0.16    0.52    0.320
  SITE_CHAR    2      10    0.16    0.52    0.350
  SITE_CHAR    2      11    0.16    0.52    0.679
  SITE_CHAR    2      12    0.16    0.52    0.662
  SITE_CHAR    3       1    0.16    0.53    0.653
```

SITE_CHAR	3	2	0.16	0.53	0.652
SITE_CHAR	3	3	0.16	0.53	0.749
SITE_CHAR	3	4	0.16	0.53	0.752
SITE_CHAR	3	5	0.16	0.53	0.753
SITE_CHAR	3	6	0.16	0.53	0.598
SITE_CHAR	3	7	0.16	0.53	0.699
SITE_CHAR	3	8	0.16	0.53	0.325
SITE_CHAR	3	9	0.16	0.53	0.359
SITE_CHAR	3	10	0.16	0.53	0.392
SITE_CHAR	3	11	0.16	0.53	0.692
SITE_CHAR	3	12	0.16	0.53	0.685
SITE_CHAR	4	1	0.16	0.55	0.653
SITE_CHAR	4	2	0.16	0.55	0.652
SITE_CHAR	4	3	0.16	0.55	0.749
SITE_CHAR	4	4	0.16	0.55	0.752
SITE_CHAR	4	5	0.16	0.55	0.753
SITE_CHAR	4	6	0.16	0.55	0.598
SITE_CHAR	4	7	0.16	0.55	0.699
SITE_CHAR	4	8	0.16	0.55	0.325
SITE_CHAR	4	9	0.16	0.55	0.359
SITE_CHAR	4	10	0.16	0.55	0.392
SITE_CHAR	4	11	0.16	0.55	0.692
SITE_CHAR	4	12	0.16	0.55	0.685

APPENDIX H

HARP MODEL OUTPUT FILES FOR ONSITE WORKER RECEPTORS

```
This file: c:\HARP\projects\Rep_Can_70yr_DerOEH_Rec181_AllSrc_AllCh_BySrc_ByChem_Site.txt

Created by HARP Version 1.4a  Build 23.07.00
Uses ISC Version 99155
Uses BPIP (Dated: 04112)
Creation date: 12/4/2009 2:06:05 PM


EXCEPTION REPORT
   (there have been no changes or exceptions)

INPUT FILES:
   Source-Receptor file: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\HARP\Onsite\ONSITE.SRC
   Averaging period adjustment factors file: not applicable
   Emission rates file: ONSITE.EMS
   Site parameters file: C:\HARP\PROJECTS\project.sit

Coordinate system: UTM NAD83

Screening mode is OFF

Exposure duration: 70 year (adult resident)
Analysis method:   Derived (OEHHA) Method
Health effect:     Cancer Risk
Receptor(s):       181
Sources(s):        All
Chemicals(s):      All

SITE PARAMETERS

DEPOSITION

   Deposition rate (m/s)             0.05

DRINKING WATER

*** Pathway disabled ***

FISH

*** Pathway disabled ***

PASTURE

*** Pathway disabled ***

HOME GROWN PRODUCE

   HUMAN INGESTION
   Fraction of ingested leafy vegetable
     from home grown source          0.15
   Fraction of ingested exposed vegetable
     from home grown source          0.15
   Fraction of ingested protected vegetable
```

```
     from home grown source          0.15
   Fraction of ingested root vegetable
     from home grown source          0.15

PIGS, CHICKENS AND EGGS

*** Pathway disabled ***

DERMAL ABSORPTION

*** Pathway enabled ***

SOIL INGESTION

*** Pathway enabled ***

MOTHER'S MILK

*** Pathway enabled ***
```

CHEMICAL CROSS-REFERENCE TABLE AND BACKGROUND CONCENTRATIONS

CHEM	CAS	ABBREVIATION	POLLUTANT NAME	BACKGROUND (ug/m^3)
0001	106990	1,3-Butadiene	1,3-Butadiene	0.000E+00
0002	57976	7,12-DB[a]anthr	7,12-Dimethylbenz[a]anthracene	0.000E+00
0003	75070	Acetaldehyde	Acetaldehyde	0.000E+00
0004	107028	Acrolein	Acrolein	0.000E+00
0005	107131	Acrylonitrile	Acrylonitrile	0.000E+00
0006	7440382	Arsenic	Arsenic	0.000E+00
0007	7440393	Barium	Barium	0.000E+00
0008	71432	Benzene	Benzene	0.000E+00
0009	7440417	Beryllium	Beryllium	0.000E+00
0010	7440439	Cadmium	Cadmium	0.000E+00
0011	56235	CCl4	Carbon tetrachloride	0.000E+00
0012	7782505	Chlorine	Chlorine	0.000E+00
0013	67663	Chloroform	Chloroform	0.000E+00
0014	18540299	Cr(VI)	Chromium, hexavalent (& compounds)	0.000E+00
0015	7440484	Cobalt	Cobalt	0.000E+00
0016	7440508	Copper	Copper	0.000E+00
0017	4170303	Crotonaldehyde	Crotonaldehyde	0.000E+00
0018	25321226	DiClBenzenes	Dichlorobenzenes (mixed isomers)	0.000E+00
0019	9901	DieselExhPM	Diesel engine exhaust, particulate matter (Diesel PM)	0.000E+00
0020	107062	EDC	Ethylene dichloride {EDC}	0.000E+00
0021	206440	Fluoranthene	Fluoranthene	0.000E+00
0022	50000	Formaldehyde	Formaldehyde	0.000E+00
0023	7647010	HCl	Hydrochloric acid	0.000E+00
0024	110543	Hexane	Hexane	0.000E+00
0025	302012	Hydrazine	Hydrazine	0.000E+00
0026	7439921	Lead	Lead	0.000E+00
0027	7439965	Manganese	Manganese	0.000E+00
0028	7439976	Mercury	Mercury	0.000E+00
0029	91203	Naphthalene	Naphthalene	0.000E+00
0030	7440020	Nickel	Nickel	0.000E+00

0031	7782492	Selenium	Selenium	0.000E+00
0032	108883	Toluene	Toluene	0.000E+00
0033	7440622	Vanadium	Vanadium (fume or dust)	0.000E+00
0034	75014	Vinyl Chloride	Vinyl chloride	0.000E+00
0035	75354	Vinylid Chlorid	Vinylidene chloride	0.000E+00
0036	7440666	Zinc	Zinc	0.000E+00

CHEMICAL HEALTH VALUES

CHEM	CAS	ABBREVIATION	CancerPF(Inh) (mg/kg-d)^-1	CancerPF(Oral) (mg/kg-d)^-1	ChronicREL(Inh) ug/m^3	ChronicREL(Oral) mg/kg-d	AcuteREL ug/m^3
0001	106990	1,3-Butadiene	6.00E-01	*	2.00E+01	*	*
0002	57976	7,12-DB[a]anthr	2.50E+02	2.50E+02	*	*	*
0003	75070	Acetaldehyde	1.00E-02	*	1.40E+02	*	4.70E+02
0004	107028	Acrolein	*	*	3.50E-01	*	2.50E+00
0005	107131	Acrylonitrile	1.00E+00	*	5.00E+00	*	*
0006	7440382	Arsenic	1.20E+01	1.50E+00	1.50E-02	3.50E-06	2.00E-01
0007	7440393	Barium	*	*	*	*	*
0008	71432	Benzene	1.00E-01	*	6.00E+01	*	1.30E+03
0009	7440417	Beryllium	8.40E+00	*	7.00E-03	2.00E-03	*
0010	7440439	Cadmium	1.50E+01	*	2.00E-02	5.00E-04	*
0011	56235	CCl4	1.50E-01	*	4.00E+01	*	1.90E+03
0012	7782505	Chlorine	*	*	2.00E-01	*	2.10E+02
0013	67663	Chloroform	1.90E-02	*	3.00E+02	*	1.50E+02
0014	18540299	Cr(VI)	5.10E+02	*	2.00E-01	2.00E-02	*
0015	7440484	Cobalt	*	*	*	*	*
0016	7440508	Copper	*	*	*	*	1.00E+02
0017	4170303	Crotonaldehyde	*	*	*	*	*
0018	25321226	DiClBenzenes	*	*	*	*	*
0019	9901	DieselExhPM	1.10E+00	*	5.00E+00	*	*
0020	107062	EDC	7.20E-02	*	4.00E+02	*	*
0021	206440	Fluoranthene	*	*	*	*	*
0022	50000	Formaldehyde	2.10E-02	*	9.00E+00	*	5.50E+01
0023	7647010	HCl	*	*	9.00E+00	*	2.10E+03
0024	110543	Hexane	*	*	7.00E+03	*	*
0025	302012	Hydrazine	1.70E+01	*	2.00E-01	*	*
0026	7439921	Lead	4.20E-02	8.50E-03	*	*	*
0027	7439965	Manganese	*	*	9.00E-02	*	*
0028	7439976	Mercury	*	*	3.00E-02	1.60E-04	6.00E-01
0029	91203	Naphthalene	1.20E-01	*	9.00E+00	*	*
0030	7440020	Nickel	9.10E-01	*	5.00E-02	5.00E-02	6.00E+00
0031	7782492	Selenium	*	*	2.00E+01	*	*
0032	108883	Toluene	*	*	3.00E+02	*	3.70E+04
0033	7440622	Vanadium	*	*	*	*	3.00E+01
0034	75014	Vinyl Chloride	2.70E-01	*	*	*	1.80E+05
0035	75354	Vinylid Chlorid	*	*	7.00E+01	*	*
0036	7440666	Zinc	*	*	*	*	*

EMISSIONS DATA SOURCE: Emission rates loaded from file: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\HARP\Onsite\ONSITE.EMS
CHEMICALS ADDED OR DELETED: none

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=1 NAME=BOIL1 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00
57976	7,12-Dimethylben	1	0	4.71E-06	2.59E-08
75070	Acetaldehyde	1	0	2.61E-03	1.43E-05
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	5.88E-05	3.24E-07
7440393	Barium	1	0	1.29E-03	7.12E-06
71432	Benzene	1	0	1.27E-03	6.97E-06
7440417	Beryllium	1	0	3.53E-06	1.94E-08
7440439	Cadmium	1	0	3.24E-04	1.78E-06
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00
18540299	Chromium (hexava	1	0	7.00E-05	3.85E-07
7440484	Cobalt	1	0	2.47E-05	1.36E-07
7440508	Copper	1	0	2.50E-04	1.38E-06
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	3.53E-04	1.94E-06
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	8.82E-07	4.85E-09
50000	Formaldehyde	1	0	6.50E-02	3.58E-04
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	5.29E-01	2.91E-03
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	1.47E-04	8.09E-07
7439965	Manganese	1	0	1.12E-04	6.15E-07
7439976	Mercury	1	0	7.65E-05	4.21E-07
91203	Naphthalene	1	0	1.79E-04	9.87E-07
7440020	Nickel	1	0	6.18E-04	3.40E-06
7782492	Selenium	1	0	7.06E-06	3.88E-08
108883	Toluene	1	0	1.00E-03	5.50E-06
7440622	Vanadium	1	0	6.76E-04	3.72E-06
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	8.53E-03	4.69E-05

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=2 NAME=BOIL2 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00
57976	7,12-Dimethylben	1	0	4.71E-06	2.59E-08
75070	Acetaldehyde	1	0	2.61E-03	1.43E-05
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	5.88E-05	3.24E-07
7440393	Barium	1	0	1.29E-03	7.12E-06
71432	Benzene	1	0	1.27E-03	6.97E-06
7440417	Beryllium	1	0	3.53E-06	1.94E-08
7440439	Cadmium	1	0	3.24E-04	1.78E-06
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00

18540299	Chromium (hexava	1	0	7.00E-05	3.85E-07
7440484	Cobalt	1	0	2.47E-05	1.36E-07
7440508	Copper	1	0	2.50E-04	1.38E-06
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	3.53E-04	1.94E-06
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	8.82E-07	4.85E-09
50000	Formaldehyde	1	0	6.50E-02	3.58E-04
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	5.29E-01	2.91E-03
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	1.47E-04	8.09E-07
7439965	Manganese	1	0	1.12E-04	6.15E-07
7439976	Mercury	1	0	7.65E-05	4.21E-07
91203	Naphthalene	1	0	1.79E-04	9.87E-07
7440020	Nickel	1	0	6.18E-04	3.40E-06
7782492	Selenium	1	0	7.06E-06	3.88E-08
108883	Toluene	1	0	1.00E-03	5.50E-06
7440622	Vanadium	1	0	6.76E-04	3.72E-06
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	8.53E-03	4.69E-05

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=3 NAME=LAB1 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	3.07E-02	7.95E-05
57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	1.86E-01	4.82E-04
107028	Acrolein	1	0	6.55E-02	1.70E-04
107131	Acrylonitrile	1	0	5.31E-02	1.38E-04
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	1.35E+00	3.50E-03
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	1.04E+00	2.69E-03
7782505	Chlorine	1	0	9.70E-01	2.51E-03
67663	Chloroform	1	0	7.96E+00	2.06E-02
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	5.56E-03	1.44E-05
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	9.35E-01	2.42E-03
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	9.79E-01	2.53E-03
7647010	HCl	1	0	8.92E+00	2.31E-02
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	1.49E-02	3.86E-05
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00

7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	6.62E-01	1.71E-03
75354	Vinylidene Chlor	1	0	4.57E-02	1.18E-04
7440666	Zinc	1	0	0.00E+00	0.00E+00

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=4 NAME=LAB2 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	3.07E-02	7.95E-05
57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	1.86E-01	4.82E-04
107028	Acrolein	1	0	6.55E-02	1.70E-04
107131	Acrylonitrile	1	0	5.31E-02	1.38E-04
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	1.35E+00	3.50E-03
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	1.04E+00	2.69E-03
7782505	Chlorine	1	0	9.70E-01	2.51E-03
67663	Chloroform	1	0	7.96E+00	2.06E-02
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	5.56E-03	1.44E-05
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	9.35E-01	2.42E-03
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	9.79E-01	2.53E-03
7647010	HCl	1	0	8.92E+00	2.31E-02
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	1.49E-02	3.86E-05
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00
7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	6.62E-01	1.71E-03
75354	Vinylidene Chlor	1	0	4.57E-02	1.18E-04
7440666	Zinc	1	0	0.00E+00	0.00E+00

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=5 NAME=DGEN EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00

57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	0.00E+00	0.00E+00
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	0.00E+00	0.00E+00
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	2.71E+00	1.09E-01
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	0.00E+00	0.00E+00
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00
7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	0.00E+00	0.00E+00

CANCER RISK REPORT

RECEPTOR 181

SOURCE 1 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	2.66E-10	2.88E-09	4.31E-10	0.00E+00	0.00E+00	0.00E+00	1.05E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-08	1.41E-08
0003	8.56E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.56E-12
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	1.60E-10	1.06E-09	5.18E-10	0.00E+00	0.00E+00	0.00E+00	9.78E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-09	2.72E-09
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	4.17E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.17E-11
0009	9.73E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.73E-12
0010	1.59E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E-09
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	1.17E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-08
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	4.48E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.48E-10
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	1.40E-12	2.23E-13	7.34E-12	0.00E+00	0.00E+00	0.00E+00	1.51E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.27E-11	2.41E-11
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	7.05E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.05E-12
0030	1.85E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E-10
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	1.44E-08	3.94E-09	9.57E-10	0.00E+00	0.00E+00	0.00E+00	1.15E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.64E-08	3.09E-08

SOURCE 2 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	2.64E-10	2.86E-09	4.28E-10	0.00E+00	0.00E+00	0.00E+00	1.04E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-08	1.40E-08
0003	8.50E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.50E-12
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	1.58E-10	1.06E-09	5.14E-10	0.00E+00	0.00E+00	0.00E+00	9.70E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-09	2.70E-09
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	4.13E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.13E-11
0009	9.65E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.65E-12
0010	1.58E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-09
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	1.16E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-08
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	4.44E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.44E-10
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	1.39E-12	2.21E-13	7.28E-12	0.00E+00	0.00E+00	0.00E+00	1.50E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-11	2.39E-11

0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	6.99E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.99E-12
0030	1.83E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-10
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	1.43E-08	3.91E-09	9.49E-10	0.00E+00	0.00E+00	0.00E+00	1.14E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-08	3.06E-08

SOURCE 3 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	1.19E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-09
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	1.20E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-10
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	3.43E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.43E-09
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	8.72E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.72E-09
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	1.01E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-08
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	9.77E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.77E-09
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	4.35E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.35E-09
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	1.33E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.33E-09
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	1.64E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.64E-08
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	1.16E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-08
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	6.69E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.69E-08

SOURCE 4 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL

0001	1.18E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-09
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	1.20E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-10
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	3.41E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.41E-09
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	8.67E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.67E-09
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	1.00E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-08
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	9.72E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.72E-09
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	4.33E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.33E-09
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	1.32E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-09
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	1.63E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-08
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	1.15E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-08
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	6.65E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.65E-08

SOURCE 5 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	3.43E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.43E-07
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	3.43E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.43E-07

Total risk of all sources

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	2.37E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.37E-09
0002	5.31E-10	5.73E-09	8.59E-10	0.00E+00	0.00E+00	0.00E+00	2.10E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.76E-08	2.81E-08
0003	2.57E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-10
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	6.84E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.84E-09
0006	3.18E-10	2.12E-09	1.03E-09	0.00E+00	0.00E+00	0.00E+00	1.95E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.10E-09	5.42E-09
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	1.75E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-08
0009	1.94E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.94E-11
0010	3.18E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.18E-09
0011	2.01E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.01E-08
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	1.95E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.95E-08
0014	2.33E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.33E-08
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	3.43E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.43E-07
0020	8.68E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.68E-09
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	3.54E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.54E-09
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	3.26E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.26E-08
0026	2.78E-12	4.44E-13	1.46E-11	0.00E+00	0.00E+00	0.00E+00	3.01E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.52E-11	4.79E-11
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0029	1.40E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-11
0030	3.68E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E-10
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	2.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E-08
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	5.05E-07	7.86E-09	1.91E-09	0.00E+00	0.00E+00	0.00E+00	2.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.27E-08	5.38E-07

```
This file: c:\HARP\projects\Rep_Chr_Wrk_PtEst_Rec189_AllSrc_AllCh_BySrc_ByChem_Site.txt

Created by HARP Version 1.4a  Build 23.07.00
Uses ISC Version 99155
Uses BPIP (Dated: 04112)
Creation date: 12/4/2009 2:08:10 PM


EXCEPTION REPORT
   (there have been no changes or exceptions)

INPUT FILES:
   Source-Receptor file: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\HARP\Onsite\ONSITE.SRC
   Averaging period adjustment factors file: not applicable
   Emission rates file: ONSITE.EMS
   Site parameters file: C:\HARP\PROJECTS\project.sit

Coordinate system: UTM NAD83

Screening mode is OFF


USER-DEFINED WORKER ADJUSTMENT AND EXPOSURE PARAMETERS
   GLC Adjustment Factor: 1
   Exposure Duration (years): 40
   Exposure Frequency (days/year): 245
   Explanatory Note: a

Analysis method:   Point estimate
Health effect:     Chronic HI
Receptor(s):       189
Sources(s):        All
Chemicals(s):      All

SITE PARAMETERS

DEPOSITION

   Deposition rate (m/s)             0.05

DRINKING WATER

*** Pathway disabled ***

FISH

*** Pathway disabled ***

PASTURE

*** Pathway disabled ***

HOME GROWN PRODUCE
```

```
   HUMAN INGESTION
   Fraction of ingested leafy vegetable
     from home grown source          0.15
   Fraction of ingested exposed vegetable
     from home grown source          0.15
   Fraction of ingested protected vegetable
     from home grown source          0.15
   Fraction of ingested root vegetable
     from home grown source          0.15

PIGS, CHICKENS AND EGGS

*** Pathway disabled ***

DERMAL ABSORPTION

*** Pathway enabled ***

SOIL INGESTION

*** Pathway enabled ***

MOTHER'S MILK

*** Pathway enabled ***
```

CHEMICAL CROSS-REFERENCE TABLE AND BACKGROUND CONCENTRATIONS

CHEM	CAS	ABBREVIATION	POLLUTANT NAME	BACKGROUND (ug/m^3)
0001	106990	1,3-Butadiene	1,3-Butadiene	0.000E+00
0002	57976	7,12-DB[a]anthr	7,12-Dimethylbenz[a]anthracene	0.000E+00
0003	75070	Acetaldehyde	Acetaldehyde	0.000E+00
0004	107028	Acrolein	Acrolein	0.000E+00
0005	107131	Acrylonitrile	Acrylonitrile	0.000E+00
0006	7440382	Arsenic	Arsenic	0.000E+00
0007	7440393	Barium	Barium	0.000E+00
0008	71432	Benzene	Benzene	0.000E+00
0009	7440417	Beryllium	Beryllium	0.000E+00
0010	7440439	Cadmium	Cadmium	0.000E+00
0011	56235	CCl4	Carbon tetrachloride	0.000E+00
0012	7782505	Chlorine	Chlorine	0.000E+00
0013	67663	Chloroform	Chloroform	0.000E+00
0014	18540299	Cr(VI)	Chromium, hexavalent (& compounds)	0.000E+00
0015	7440484	Cobalt	Cobalt	0.000E+00
0016	7440508	Copper	Copper	0.000E+00
0017	4170303	Crotonaldehyde	Crotonaldehyde	0.000E+00
0018	25321226	DiClBenzenes	Dichlorobenzenes (mixed isomers)	0.000E+00
0019	9901	DieselExhPM	Diesel engine exhaust, particulate matter (Diesel PM)	0.000E+00
0020	107062	EDC	Ethylene dichloride {EDC}	0.000E+00
0021	206440	Fluoranthene	Fluoranthene	0.000E+00
0022	50000	Formaldehyde	Formaldehyde	0.000E+00
0023	7647010	HCl	Hydrochloric acid	0.000E+00
0024	110543	Hexane	Hexane	0.000E+00

0025	302012	Hydrazine	Hydrazine	0.000E+00
0026	7439921	Lead	Lead	0.000E+00
0027	7439965	Manganese	Manganese	0.000E+00
0028	7439976	Mercury	Mercury	0.000E+00
0029	91203	Naphthalene	Naphthalene	0.000E+00
0030	7440020	Nickel	Nickel	0.000E+00
0031	7782492	Selenium	Selenium	0.000E+00
0032	108883	Toluene	Toluene	0.000E+00
0033	7440622	Vanadium	Vanadium (fume or dust)	0.000E+00
0034	75014	Vinyl Chloride	Vinyl chloride	0.000E+00
0035	75354	Vinylid Chlorid	Vinylidene chloride	0.000E+00
0036	7440666	Zinc	Zinc	0.000E+00

CHEMICAL HEALTH VALUES

CHEM	CAS	ABBREVIATION	CancerPF(Inh) (mg/kg-d)^-1	CancerPF(Oral) (mg/kg-d)^-1	ChronicREL(Inh) ug/m^3	ChronicREL(Oral) mg/kg-d	AcuteREL ug/m^3
0001	106990	1,3-Butadiene	6.00E-01	*	2.00E+01	*	*
0002	57976	7,12-DB[a]anthr	2.50E+02	2.50E+02	*	*	*
0003	75070	Acetaldehyde	1.00E-02	*	1.40E+02	*	4.70E+02
0004	107028	Acrolein	*	*	3.50E-01	*	2.50E+00
0005	107131	Acrylonitrile	1.00E+00	*	5.00E+00	*	*
0006	7440382	Arsenic	1.20E+01	1.50E+00	1.50E-02	3.50E-06	2.00E-01
0007	7440393	Barium	*	*	*	*	*
0008	71432	Benzene	1.00E-01	*	6.00E+01	*	1.30E+03
0009	7440417	Beryllium	8.40E+00	*	7.00E-03	2.00E-03	*
0010	7440439	Cadmium	1.50E+01	*	2.00E-02	5.00E-04	*
0011	56235	CCl4	1.50E-01	*	4.00E+01	*	1.90E+03
0012	7782505	Chlorine	*	*	2.00E-01	*	2.10E+02
0013	67663	Chloroform	1.90E-02	*	3.00E+02	*	1.50E+02
0014	18540299	Cr(VI)	5.10E+02	*	2.00E-01	2.00E-02	*
0015	7440484	Cobalt	*	*	*	*	*
0016	7440508	Copper	*	*	*	*	1.00E+02
0017	4170303	Crotonaldehyde	*	*	*	*	*
0018	25321226	DiClBenzenes	*	*	*	*	*
0019	9901	DieselExhPM	1.10E+00	*	5.00E+00	*	*
0020	107062	EDC	7.20E-02	*	4.00E+02	*	*
0021	206440	Fluoranthene	*	*	*	*	*
0022	50000	Formaldehyde	2.10E-02	*	9.00E+00	*	5.50E+01
0023	7647010	HCl	*	*	9.00E+00	*	2.10E+03
0024	110543	Hexane	*	*	7.00E+03	*	*
0025	302012	Hydrazine	1.70E+01	*	2.00E-01	*	*
0026	7439921	Lead	4.20E-02	8.50E-03	*	*	*
0027	7439965	Manganese	*	*	9.00E-02	*	*
0028	7439976	Mercury	*	*	3.00E-02	1.60E-04	6.00E-01
0029	91203	Naphthalene	1.20E-01	*	9.00E+00	*	*
0030	7440020	Nickel	9.10E-01	*	5.00E-02	5.00E-02	6.00E+00
0031	7782492	Selenium	*	*	2.00E+01	*	*
0032	108883	Toluene	*	*	3.00E+02	*	3.70E+04
0033	7440622	Vanadium	*	*	*	*	3.00E+01
0034	75014	Vinyl Chloride	2.70E-01	*	*	*	1.80E+05
0035	75354	Vinylid Chlorid	*	*	7.00E+01	*	*
0036	7440666	Zinc	*	*	*	*	*

EMISSIONS DATA SOURCE: Emission rates loaded from file: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\HARP\Onsite\ONSITE.EMS
CHEMICALS ADDED OR DELETED: none

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=1 NAME=BOIL1 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00
57976	7,12-Dimethylben	1	0	4.71E-06	2.59E-08
75070	Acetaldehyde	1	0	2.61E-03	1.43E-05
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	5.88E-05	3.24E-07
7440393	Barium	1	0	1.29E-03	7.12E-06
71432	Benzene	1	0	1.27E-03	6.97E-06
7440417	Beryllium	1	0	3.53E-06	1.94E-08
7440439	Cadmium	1	0	3.24E-04	1.78E-06
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00
18540299	Chromium (hexava	1	0	7.00E-05	3.85E-07
7440484	Cobalt	1	0	2.47E-05	1.36E-07
7440508	Copper	1	0	2.50E-04	1.38E-06
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	3.53E-04	1.94E-06
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	8.82E-07	4.85E-09
50000	Formaldehyde	1	0	6.50E-02	3.58E-04
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	5.29E-01	2.91E-03
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	1.47E-04	8.09E-07
7439965	Manganese	1	0	1.12E-04	6.15E-07
7439976	Mercury	1	0	7.65E-05	4.21E-07
91203	Naphthalene	1	0	1.79E-04	9.87E-07
7440020	Nickel	1	0	6.18E-04	3.40E-06
7782492	Selenium	1	0	7.06E-06	3.88E-08
108883	Toluene	1	0	1.00E-03	5.50E-06
7440622	Vanadium	1	0	6.76E-04	3.72E-06
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	8.53E-03	4.69E-05

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=2 NAME=BOIL2 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00
57976	7,12-Dimethylben	1	0	4.71E-06	2.59E-08
75070	Acetaldehyde	1	0	2.61E-03	1.43E-05
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	5.88E-05	3.24E-07
7440393	Barium	1	0	1.29E-03	7.12E-06

71432	Benzene	1	0	1.27E-03	6.97E-06
7440417	Beryllium	1	0	3.53E-06	1.94E-08
7440439	Cadmium	1	0	3.24E-04	1.78E-06
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00
18540299	Chromium (hexava	1	0	7.00E-05	3.85E-07
7440484	Cobalt	1	0	2.47E-05	1.36E-07
7440508	Copper	1	0	2.50E-04	1.38E-06
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	3.53E-04	1.94E-06
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	8.82E-07	4.85E-09
50000	Formaldehyde	1	0	6.50E-02	3.58E-04
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	5.29E-01	2.91E-03
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	1.47E-04	8.09E-07
7439965	Manganese	1	0	1.12E-04	6.15E-07
7439976	Mercury	1	0	7.65E-05	4.21E-07
91203	Naphthalene	1	0	1.79E-04	9.87E-07
7440020	Nickel	1	0	6.18E-04	3.40E-06
7782492	Selenium	1	0	7.06E-06	3.88E-08
108883	Toluene	1	0	1.00E-03	5.50E-06
7440622	Vanadium	1	0	6.76E-04	3.72E-06
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	8.53E-03	4.69E-05

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=3 NAME=LAB1 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	3.07E-02	7.95E-05
57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	1.86E-01	4.82E-04
107028	Acrolein	1	0	6.55E-02	1.70E-04
107131	Acrylonitrile	1	0	5.31E-02	1.38E-04
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	1.35E+00	3.50E-03
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	1.04E+00	2.69E-03
7782505	Chlorine	1	0	9.70E-01	2.51E-03
67663	Chloroform	1	0	7.96E+00	2.06E-02
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	5.56E-03	1.44E-05
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	9.35E-01	2.42E-03
206440	Fluoranthene	1	0	0.00E+00	0.00E+00

50000	Formaldehyde	1	0	9.79E-01	2.53E-03
7647010	HCl	1	0	8.92E+00	2.31E-02
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	1.49E-02	3.86E-05
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00
7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	6.62E-01	1.71E-03
75354	Vinylidene Chlor	1	0	4.57E-02	1.18E-04
7440666	Zinc	1	0	0.00E+00	0.00E+00

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=4 NAME=LAB2 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	3.07E-02	7.95E-05
57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	1.86E-01	4.82E-04
107028	Acrolein	1	0	6.55E-02	1.70E-04
107131	Acrylonitrile	1	0	5.31E-02	1.38E-04
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	1.35E+00	3.50E-03
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	1.04E+00	2.69E-03
7782505	Chlorine	1	0	9.70E-01	2.51E-03
67663	Chloroform	1	0	7.96E+00	2.06E-02
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	5.56E-03	1.44E-05
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	9.35E-01	2.42E-03
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	9.79E-01	2.53E-03
7647010	HCl	1	0	8.92E+00	2.31E-02
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	1.49E-02	3.86E-05
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00
7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	6.62E-01	1.71E-03
75354	Vinylidene Chlor	1	0	4.57E-02	1.18E-04

7440666	Zinc	1	0	0.00E+00	0.00E+00

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=5 NAME=DGEN EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00
57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	0.00E+00	0.00E+00
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	0.00E+00	0.00E+00
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	2.71E+00	1.09E-01
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	0.00E+00	0.00E+00
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00
7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	0.00E+00	0.00E+00

CHRONIC HI REPORT

RECEPTOR 189

SOURCE 1 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.32E-09	0.00E+00	0.00E+00	7.32E-09
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	1.30E-04	1.30E-04	0.00E+00	1.30E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-04	1.30E-04	0.00E+00	1.30E-04

0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	8.31E-09	0.00E+00	8.31E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.31E-09	8.31E-09
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.39E-09	1.98E-07	0.00E+00	0.00E+00	1.98E-07	0.00E+00	0.00E+00	1.98E-07
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.92E-06	0.00E+00	6.36E-06	0.00E+00	0.00E+00	7.92E-06
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-07	0.00E+00	1.27E-08	1.37E-07
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.84E-06	0.00E+00	0.00E+00	2.84E-06
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	2.97E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.97E-08
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	4.89E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.89E-07
0028	0.00E+00	8.53E-06	0.00E+00	8.53E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.53E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.53E-06
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-09	0.00E+00	0.00E+00	7.81E-09
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.47E-08	0.00E+00	0.00E+00	0.00E+00	4.85E-06	0.00E+00	4.85E-06	4.85E-06
0031	1.39E-10	1.39E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-10
0032	0.00E+00	1.31E-09	0.00E+00	1.31E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E-09	0.00E+00	0.00E+00	1.31E-09
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	1.30E-04	1.39E-04	0.00E+00	1.39E-04	0.00E+00	0.00E+00	1.01E-07	1.98E-07	1.65E-05	0.00E+00	1.45E-04	1.30E-04	4.87E-06	1.45E-04

SOURCE 2 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.25E-09	0.00E+00	0.00E+00	7.25E-09
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	1.29E-04	1.29E-04	0.00E+00	1.29E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-04	1.29E-04	0.00E+00	1.29E-04
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	8.23E-09	0.00E+00	8.23E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.23E-09	8.23E-09
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.33E-09	1.96E-07	0.00E+00	0.00E+00	1.96E-07	0.00E+00	0.00E+00	1.96E-07
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.85E-06	0.00E+00	6.30E-06	0.00E+00	0.00E+00	7.85E-06
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.36E-07	0.00E+00	1.26E-08	1.36E-07
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.81E-06	0.00E+00	0.00E+00	2.81E-06
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	2.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.94E-08
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	4.84E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.84E-07
0028	0.00E+00	8.45E-06	0.00E+00	8.45E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.45E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.45E-06
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.74E-09	0.00E+00	0.00E+00	7.74E-09
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.38E-08	0.00E+00	0.00E+00	0.00E+00	4.81E-06	0.00E+00	4.81E-06	4.81E-06
0031	1.37E-10	1.37E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-10
0032	0.00E+00	1.30E-09	0.00E+00	1.30E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-09	0.00E+00	0.00E+00	1.30E-09
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	1.29E-04	1.38E-04	0.00E+00	1.38E-04	0.00E+00	0.00E+00	1.00E-07	1.96E-07	1.63E-05	0.00E+00	1.43E-04	1.29E-04	4.83E-06	1.43E-04

SOURCE 3 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.84E-07	0.00E+00	0.00E+00	0.00E+00	3.84E-07
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.32E-07	0.00E+00	0.00E+00	3.32E-07
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.68E-05	0.00E+00	0.00E+00	4.68E-05
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.65E-06	0.00E+00	0.00E+00	2.65E-06
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	5.62E-06	0.00E+00	5.62E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.62E-06	5.62E-06
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	0.00E+00	6.50E-06	0.00E+00	6.50E-06	0.00E+00	0.00E+00	6.50E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.50E-06
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-03	0.00E+00	0.00E+00	1.21E-03
0013	0.00E+00	0.00E+00	0.00E+00	6.63E-06	0.00E+00	0.00E+00	6.63E-06	0.00E+00	6.63E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.63E-06
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.84E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.84E-07
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.72E-05	0.00E+00	0.00E+00	2.72E-05
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E-04	0.00E+00	0.00E+00	2.48E-04
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E-05	0.00E+00	1.86E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E-05
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-07
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	0.00E+00	1.21E-05	0.00E+00	1.88E-05	1.86E-05	0.00E+00	3.25E-05	0.00E+00	6.63E-06	3.84E-07	1.54E-03	0.00E+00	5.62E-06	1.54E-03

SOURCE 4 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.88E-07	0.00E+00	0.00E+00	0.00E+00	3.88E-07
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.36E-07	0.00E+00	0.00E+00	3.36E-07
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.73E-05	0.00E+00	0.00E+00	4.73E-05
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-06	0.00E+00	0.00E+00	2.68E-06
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	5.69E-06	0.00E+00	5.69E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.69E-06	5.69E-06
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	0.00E+00	6.57E-06	0.00E+00	6.57E-06	0.00E+00	0.00E+00	6.57E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.57E-06
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-03	0.00E+00	0.00E+00	1.23E-03
0013	0.00E+00	0.00E+00	0.00E+00	6.71E-06	0.00E+00	0.00E+00	6.71E-06	0.00E+00	6.71E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.71E-06
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.91E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.91E-07
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.75E-05	0.00E+00	0.00E+00	2.75E-05
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.51E-04	0.00E+00	0.00E+00	2.51E-04
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-05	0.00E+00	1.88E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-05
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-07
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	0.00E+00	1.23E-05	0.00E+00	1.90E-05	1.88E-05	0.00E+00	3.29E-05	0.00E+00	6.71E-06	3.88E-07	1.55E-03	0.00E+00	5.69E-06	1.55E-03

SOURCE 5 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-04	0.00E+00	0.00E+00	1.11E-04
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-04	0.00E+00	0.00E+00	1.11E-04

Total risk of all sources

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.72E-07	0.00E+00	0.00E+00	0.00E+00	7.72E-07
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.82E-07	0.00E+00	0.00E+00	6.82E-07
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.41E-05	0.00E+00	0.00E+00	9.41E-05
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.34E-06	0.00E+00	0.00E+00	5.34E-06
0006	2.59E-04	2.59E-04	0.00E+00	2.59E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-04	2.59E-04	0.00E+00	2.59E-04
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	1.13E-05	0.00E+00	1.13E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-05	1.13E-05
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E-08	3.94E-07	0.00E+00	0.00E+00	3.94E-07	0.00E+00	0.00E+00	3.94E-07
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-05	0.00E+00	1.27E-05	0.00E+00	0.00E+00	1.58E-05
0011	0.00E+00	1.31E-05	0.00E+00	1.31E-05	0.00E+00	0.00E+00	1.31E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E-05
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E-03	0.00E+00	0.00E+00	2.44E-03
0013	0.00E+00	0.00E+00	0.00E+00	1.33E-05	0.00E+00	0.00E+00	1.33E-05	0.00E+00	1.33E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.33E-05
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.74E-07	0.00E+00	2.52E-08	2.74E-07
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-04	0.00E+00	0.00E+00	1.11E-04
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-06
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.03E-05	0.00E+00	0.00E+00	6.03E-05

0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.98E-04	0.00E+00	0.00E+00	4.98E-04
0024	0.00E+00	5.91E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.91E-08
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.74E-05	0.00E+00	3.74E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.74E-05
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	9.73E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.73E-07
0028	0.00E+00	1.70E-05	0.00E+00	1.70E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.70E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.70E-05
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E-08	0.00E+00	0.00E+00	1.55E-08
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E-07	0.00E+00	0.00E+00	0.00E+00	9.66E-06	0.00E+00	9.66E-06	9.66E-06
0031	2.76E-10	2.76E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.76E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.76E-10
0032	0.00E+00	2.61E-09	0.00E+00	2.61E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.61E-09	0.00E+00	0.00E+00	2.61E-09
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.28E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.28E-07
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	2.59E-04	3.02E-04	0.00E+00	3.14E-04	3.74E-05	0.00E+00	6.56E-05	3.94E-07	4.61E-05	7.72E-07	3.49E-03	2.59E-04	2.10E-05	3.49E-03

APPENDIX I

HARP MODEL OUTPUT FILES FOR OFFSITE RESIDENT RECEPTORS

```
This file: c:\HARP\projects\Rep_Can_70yr_Avg_Rec2851_AllSrc_AllCh_BySrc_ByChem_Site.txt

Created by HARP Version 1.4a  Build 23.07.00
Uses ISC Version 99155
Uses BPIP (Dated: 04112)
Creation date: 12/4/2009 1:58:00 PM


EXCEPTION REPORT
   (there have been no changes or exceptions)

INPUT FILES:
   Source-Receptor file: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\HARP\Offsite\OFFSITE.SRC
   Averaging period adjustment factors file: not applicable
   Emission rates file: OFFSITE.EMS
   Site parameters file: C:\HARP\PROJECTS\project.sit

Coordinate system: UTM NAD83

Screening mode is OFF

Exposure duration: 70 year (adult resident)
Analysis method:   Average point estimate
Health effect:     Cancer Risk
Receptor(s):       2851
Sources(s):        All
Chemicals(s):      All

SITE PARAMETERS

DEPOSITION

   Deposition rate (m/s)             0.05

DRINKING WATER

*** Pathway disabled ***

FISH

*** Pathway disabled ***

PASTURE

*** Pathway disabled ***

HOME GROWN PRODUCE

   HUMAN INGESTION
   Fraction of ingested leafy vegetable
     from home grown source          0.15
   Fraction of ingested exposed vegetable
     from home grown source          0.15
   Fraction of ingested protected vegetable
```

```
     from home grown source          0.15
   Fraction of ingested root vegetable
     from home grown source          0.15

PIGS, CHICKENS AND EGGS

*** Pathway disabled ***

DERMAL ABSORPTION

*** Pathway enabled ***

SOIL INGESTION

*** Pathway enabled ***

MOTHER'S MILK

*** Pathway enabled ***
```

CHEMICAL CROSS-REFERENCE TABLE AND BACKGROUND CONCENTRATIONS

CHEM	CAS	ABBREVIATION	POLLUTANT NAME	BACKGROUND (ug/m^3)
0001	106990	1,3-Butadiene	1,3-Butadiene	0.000E+00
0002	57976	7,12-DB[a]anthr	7,12-Dimethylbenz[a]anthracene	0.000E+00
0003	75070	Acetaldehyde	Acetaldehyde	0.000E+00
0004	107028	Acrolein	Acrolein	0.000E+00
0005	107131	Acrylonitrile	Acrylonitrile	0.000E+00
0006	7440382	Arsenic	Arsenic	0.000E+00
0007	7440393	Barium	Barium	0.000E+00
0008	71432	Benzene	Benzene	0.000E+00
0009	7440417	Beryllium	Beryllium	0.000E+00
0010	7440439	Cadmium	Cadmium	0.000E+00
0011	56235	CCl4	Carbon tetrachloride	0.000E+00
0012	7782505	Chlorine	Chlorine	0.000E+00
0013	67663	Chloroform	Chloroform	0.000E+00
0014	18540299	Cr(VI)	Chromium, hexavalent (& compounds)	0.000E+00
0015	7440484	Cobalt	Cobalt	0.000E+00
0016	7440508	Copper	Copper	0.000E+00
0017	4170303	Crotonaldehyde	Crotonaldehyde	0.000E+00
0018	25321226	DiClBenzenes	Dichlorobenzenes (mixed isomers)	0.000E+00
0019	9901	DieselExhPM	Diesel engine exhaust, particulate matter (Diesel PM)	0.000E+00
0020	107062	EDC	Ethylene dichloride {EDC}	0.000E+00
0021	206440	Fluoranthene	Fluoranthene	0.000E+00
0022	50000	Formaldehyde	Formaldehyde	0.000E+00
0023	7647010	HCl	Hydrochloric acid	0.000E+00
0024	110543	Hexane	Hexane	0.000E+00
0025	302012	Hydrazine	Hydrazine	0.000E+00
0026	7439921	Lead	Lead	0.000E+00
0027	7439965	Manganese	Manganese	0.000E+00
0028	7439976	Mercury	Mercury	0.000E+00
0029	91203	Naphthalene	Naphthalene	0.000E+00
0030	7440020	Nickel	Nickel	0.000E+00

0031	7782492	Selenium	Selenium	0.000E+00
0032	108883	Toluene	Toluene	0.000E+00
0033	7440622	Vanadium	Vanadium (fume or dust)	0.000E+00
0034	75014	Vinyl Chloride	Vinyl chloride	0.000E+00
0035	75354	Vinylid Chlorid	Vinylidene chloride	0.000E+00
0036	7440666	Zinc	Zinc	0.000E+00

CHEMICAL HEALTH VALUES

CHEM	CAS	ABBREVIATION	CancerPF(Inh) (mg/kg-d)^-1	CancerPF(Oral) (mg/kg-d)^-1	ChronicREL(Inh) ug/m^3	ChronicREL(Oral) mg/kg-d	AcuteREL ug/m^3
0001	106990	1,3-Butadiene	6.00E-01	*	2.00E+01	*	*
0002	57976	7,12-DB[a]anthr	2.50E+02	2.50E+02	*	*	*
0003	75070	Acetaldehyde	1.00E-02	*	1.40E+02	*	4.70E+02
0004	107028	Acrolein	*	*	3.50E-01	*	2.50E+00
0005	107131	Acrylonitrile	1.00E+00	*	5.00E+00	*	*
0006	7440382	Arsenic	1.20E+01	1.50E+00	1.50E-02	3.50E-06	2.00E-01
0007	7440393	Barium	*	*	*	*	*
0008	71432	Benzene	1.00E-01	*	6.00E+01	*	1.30E+03
0009	7440417	Beryllium	8.40E+00	*	7.00E-03	2.00E-03	*
0010	7440439	Cadmium	1.50E+01	*	2.00E-02	5.00E-04	*
0011	56235	CCl4	1.50E-01	*	4.00E+01	*	1.90E+03
0012	7782505	Chlorine	*	*	2.00E-01	*	2.10E+02
0013	67663	Chloroform	1.90E-02	*	3.00E+02	*	1.50E+02
0014	18540299	Cr(VI)	5.10E+02	*	2.00E-01	2.00E-02	*
0015	7440484	Cobalt	*	*	*	*	*
0016	7440508	Copper	*	*	*	*	1.00E+02
0017	4170303	Crotonaldehyde	*	*	*	*	*
0018	25321226	DiClBenzenes	*	*	*	*	*
0019	9901	DieselExhPM	1.10E+00	*	5.00E+00	*	*
0020	107062	EDC	7.20E-02	*	4.00E+02	*	*
0021	206440	Fluoranthene	*	*	*	*	*
0022	50000	Formaldehyde	2.10E-02	*	9.00E+00	*	5.50E+01
0023	7647010	HCl	*	*	9.00E+00	*	2.10E+03
0024	110543	Hexane	*	*	7.00E+03	*	*
0025	302012	Hydrazine	1.70E+01	*	2.00E-01	*	*
0026	7439921	Lead	4.20E-02	8.50E-03	*	*	*
0027	7439965	Manganese	*	*	9.00E-02	*	*
0028	7439976	Mercury	*	*	3.00E-02	1.60E-04	6.00E-01
0029	91203	Naphthalene	1.20E-01	*	9.00E+00	*	*
0030	7440020	Nickel	9.10E-01	*	5.00E-02	5.00E-02	6.00E+00
0031	7782492	Selenium	*	*	2.00E+01	*	*
0032	108883	Toluene	*	*	3.00E+02	*	3.70E+04
0033	7440622	Vanadium	*	*	*	*	3.00E+01
0034	75014	Vinyl Chloride	2.70E-01	*	*	*	1.80E+05
0035	75354	Vinylid Chlorid	*	*	7.00E+01	*	*
0036	7440666	Zinc	*	*	*	*	*

EMISSIONS DATA SOURCE: Emission rates loaded from file: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\HARP\Offsite\OFFSITE.EMS
CHEMICALS ADDED OR DELETED: none

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=1 NAME=BOIL1 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00
57976	7,12-Dimethylben	1	0	4.71E-06	2.59E-08
75070	Acetaldehyde	1	0	2.61E-03	1.43E-05
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	5.88E-05	3.24E-07
7440393	Barium	1	0	1.29E-03	7.12E-06
71432	Benzene	1	0	1.27E-03	6.97E-06
7440417	Beryllium	1	0	3.53E-06	1.94E-08
7440439	Cadmium	1	0	3.24E-04	1.78E-06
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00
18540299	Chromium (hexava	1	0	7.00E-05	3.85E-07
7440484	Cobalt	1	0	2.47E-05	1.36E-07
7440508	Copper	1	0	2.50E-04	1.38E-06
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	3.53E-04	1.94E-06
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	8.82E-07	4.85E-09
50000	Formaldehyde	1	0	6.50E-02	3.58E-04
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	5.29E-01	2.91E-03
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	1.47E-04	8.09E-07
7439965	Manganese	1	0	1.12E-04	6.15E-07
7439976	Mercury	1	0	7.65E-05	4.21E-07
91203	Naphthalene	1	0	1.79E-04	9.87E-07
7440020	Nickel	1	0	6.18E-04	3.40E-06
7782492	Selenium	1	0	7.06E-06	3.88E-08
108883	Toluene	1	0	1.00E-03	5.50E-06
7440622	Vanadium	1	0	6.76E-04	3.72E-06
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	8.53E-03	4.69E-05

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=2 NAME=BOIL2 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00
57976	7,12-Dimethylben	1	0	4.71E-06	2.59E-08
75070	Acetaldehyde	1	0	2.61E-03	1.43E-05
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	5.88E-05	3.24E-07
7440393	Barium	1	0	1.29E-03	7.12E-06
71432	Benzene	1	0	1.27E-03	6.97E-06
7440417	Beryllium	1	0	3.53E-06	1.94E-08
7440439	Cadmium	1	0	3.24E-04	1.78E-06
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00

18540299	Chromium (hexava	1	0	7.00E-05	3.85E-07
7440484	Cobalt	1	0	2.47E-05	1.36E-07
7440508	Copper	1	0	2.50E-04	1.38E-06
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	3.53E-04	1.94E-06
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	8.82E-07	4.85E-09
50000	Formaldehyde	1	0	6.50E-02	3.58E-04
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	5.29E-01	2.91E-03
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	1.47E-04	8.09E-07
7439965	Manganese	1	0	1.12E-04	6.15E-07
7439976	Mercury	1	0	7.65E-05	4.21E-07
91203	Naphthalene	1	0	1.79E-04	9.87E-07
7440020	Nickel	1	0	6.18E-04	3.40E-06
7782492	Selenium	1	0	7.06E-06	3.88E-08
108883	Toluene	1	0	1.00E-03	5.50E-06
7440622	Vanadium	1	0	6.76E-04	3.72E-06
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	8.53E-03	4.69E-05

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=3 NAME=LAB1 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	3.07E-02	7.95E-05
57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	1.86E-01	4.82E-04
107028	Acrolein	1	0	6.55E-02	1.70E-04
107131	Acrylonitrile	1	0	5.31E-02	1.38E-04
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	1.35E+00	3.50E-03
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	1.04E+00	2.69E-03
7782505	Chlorine	1	0	9.70E-01	2.51E-03
67663	Chloroform	1	0	7.96E+00	2.06E-02
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	5.56E-03	1.44E-05
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	9.35E-01	2.42E-03
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	9.79E-01	2.53E-03
7647010	HCl	1	0	8.92E+00	2.31E-02
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	1.49E-02	3.86E-05
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00

7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	6.62E-01	1.71E-03
75354	Vinylidene Chlor	1	0	4.57E-02	1.18E-04
7440666	Zinc	1	0	0.00E+00	0.00E+00

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=4 NAME=LAB2 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	3.07E-02	7.95E-05
57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	1.86E-01	4.82E-04
107028	Acrolein	1	0	6.55E-02	1.70E-04
107131	Acrylonitrile	1	0	5.31E-02	1.38E-04
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	1.35E+00	3.50E-03
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	1.04E+00	2.69E-03
7782505	Chlorine	1	0	9.70E-01	2.51E-03
67663	Chloroform	1	0	7.96E+00	2.06E-02
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	5.56E-03	1.44E-05
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	9.35E-01	2.42E-03
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	9.79E-01	2.53E-03
7647010	HCl	1	0	8.92E+00	2.31E-02
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	1.49E-02	3.86E-05
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00
7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	6.62E-01	1.71E-03
75354	Vinylidene Chlor	1	0	4.57E-02	1.18E-04
7440666	Zinc	1	0	0.00E+00	0.00E+00

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=5 NAME=DGEN EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00

57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	0.00E+00	0.00E+00
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	0.00E+00	0.00E+00
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	2.71E+00	1.09E-01
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	0.00E+00	0.00E+00
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00
7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	0.00E+00	0.00E+00

CANCER RISK REPORT

RECEPTOR 2851

SOURCE 1 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	2.99E-11	1.91E-11	4.84E-11	0.00E+00	0.00E+00	0.00E+00	3.33E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E-10	4.30E-10
0003	6.63E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.63E-13
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	1.79E-11	7.07E-12	5.82E-11	0.00E+00	0.00E+00	0.00E+00	3.08E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.61E-11	1.14E-10
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	3.23E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.23E-12
0009	7.54E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.54E-13
0010	1.24E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-10
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	9.07E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.07E-10
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	3.47E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.47E-11
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	1.57E-13	2.50E-14	8.25E-13	0.00E+00	0.00E+00	0.00E+00	4.78E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.33E-12	1.48E-12
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	5.46E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.46E-13
0030	1.43E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.43E-11
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	1.13E-09	2.62E-11	1.07E-10	0.00E+00	0.00E+00	0.00E+00	3.64E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.98E-10	1.63E-09

SOURCE 2 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	2.98E-11	1.90E-11	4.83E-11	0.00E+00	0.00E+00	0.00E+00	3.32E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.99E-10	4.29E-10
0003	6.61E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.61E-13
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	1.79E-11	7.04E-12	5.80E-11	0.00E+00	0.00E+00	0.00E+00	3.07E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.58E-11	1.14E-10
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	3.22E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.22E-12
0009	7.51E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.51E-13
0010	1.23E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-10
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	9.05E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.05E-10
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	3.46E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.46E-11
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	1.56E-13	2.49E-14	8.22E-13	0.00E+00	0.00E+00	0.00E+00	4.76E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-12	1.48E-12

0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	5.44E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.44E-13
0030	1.42E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E-11
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	1.13E-09	2.61E-11	1.07E-10	0.00E+00	0.00E+00	0.00E+00	3.63E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.96E-10	1.63E-09

SOURCE 3 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	3.57E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.57E-10
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	3.61E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.61E-11
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	1.03E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E-09
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	2.62E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.62E-09
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	3.03E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.03E-09
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	2.93E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-09
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	1.31E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E-09
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	3.99E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.99E-10
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	4.91E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-09
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	3.47E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.47E-09
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	2.01E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.01E-08

SOURCE 4 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL

0001	3.50E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E-10
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	3.54E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.54E-11
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	1.01E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-09
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	2.57E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-09
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	2.97E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.97E-09
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	2.88E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.88E-09
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	1.28E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.28E-09
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	3.91E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.91E-10
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	4.82E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.82E-09
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	3.40E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.40E-09
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	1.97E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-08

SOURCE 5 RISK BY PATHWAY

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	5.70E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.70E-08
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	5.70E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.70E-08

Total risk of all sources

CHEM	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	7.08E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.08E-10
0002	5.98E-11	3.82E-11	9.67E-11	0.00E+00	0.00E+00	0.00E+00	6.64E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.99E-10	8.59E-10
0003	7.28E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.28E-11
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	2.04E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.04E-09
0006	3.58E-11	1.41E-11	1.16E-10	0.00E+00	0.00E+00	0.00E+00	6.16E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.92E-10	2.28E-10
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	5.19E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.19E-09
0009	1.51E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-12
0010	2.47E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-10
0011	5.99E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-09
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	5.81E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.81E-09
0014	1.81E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.81E-09
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	5.70E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.70E-08
0020	2.59E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-09
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	8.59E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.59E-10
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	9.73E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.73E-09
0026	3.13E-13	5.00E-14	1.65E-12	0.00E+00	0.00E+00	0.00E+00	9.54E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.65E-12	2.96E-12
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0029	1.09E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-12
0030	2.85E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.85E-11
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	6.87E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.87E-09
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	9.90E-08	5.23E-11	2.15E-10	0.00E+00	0.00E+00	0.00E+00	7.27E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.94E-10	1.00E-07

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This file: c:\HARP\projects\Rep_Chr_Res_DerOEH_Rec2850_AllSrc_AllCh_BySrc_ByChem_Site.txt

Created by HARP Version 1.4a  Build 23.07.00
Uses ISC Version 99155
Uses BPIP (Dated: 04112)
Creation date: 12/4/2009 2:02:55 PM


EXCEPTION REPORT
   (there have been no changes or exceptions)

INPUT FILES:
   Source-Receptor file: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\HARP\Offsite\OFFSITE.SRC
   Averaging period adjustment factors file: not applicable
   Emission rates file: OFFSITE.EMS
   Site parameters file: C:\HARP\PROJECTS\project.sit

Coordinate system: UTM NAD83

Screening mode is OFF

Exposure duration: resident
Analysis method:   Derived (OEHHA) Method
Health effect:     Chronic HI
Receptor(s):       2850
Sources(s):        All
Chemicals(s):      All

SITE PARAMETERS

DEPOSITION

   Deposition rate (m/s)             0.05

DRINKING WATER

*** Pathway disabled ***

FISH

*** Pathway disabled ***

PASTURE

*** Pathway disabled ***

HOME GROWN PRODUCE

   HUMAN INGESTION
   Fraction of ingested leafy vegetable
     from home grown source          0.15
   Fraction of ingested exposed vegetable
     from home grown source          0.15
   Fraction of ingested protected vegetable
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     from home grown source          0.15
   Fraction of ingested root vegetable
     from home grown source          0.15

PIGS, CHICKENS AND EGGS

*** Pathway disabled ***

DERMAL ABSORPTION

*** Pathway enabled ***

SOIL INGESTION

*** Pathway enabled ***

MOTHER'S MILK

*** Pathway enabled ***
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CHEMICAL CROSS-REFERENCE TABLE AND BACKGROUND CONCENTRATIONS

CHEM	CAS	ABBREVIATION	POLLUTANT NAME	BACKGROUND (ug/m^3)
0001	106990	1,3-Butadiene	1,3-Butadiene	0.000E+00
0002	57976	7,12-DB[a]anthr	7,12-Dimethylbenz[a]anthracene	0.000E+00
0003	75070	Acetaldehyde	Acetaldehyde	0.000E+00
0004	107028	Acrolein	Acrolein	0.000E+00
0005	107131	Acrylonitrile	Acrylonitrile	0.000E+00
0006	7440382	Arsenic	Arsenic	0.000E+00
0007	7440393	Barium	Barium	0.000E+00
0008	71432	Benzene	Benzene	0.000E+00
0009	7440417	Beryllium	Beryllium	0.000E+00
0010	7440439	Cadmium	Cadmium	0.000E+00
0011	56235	CCl4	Carbon tetrachloride	0.000E+00
0012	7782505	Chlorine	Chlorine	0.000E+00
0013	67663	Chloroform	Chloroform	0.000E+00
0014	18540299	Cr(VI)	Chromium, hexavalent (& compounds)	0.000E+00
0015	7440484	Cobalt	Cobalt	0.000E+00
0016	7440508	Copper	Copper	0.000E+00
0017	4170303	Crotonaldehyde	Crotonaldehyde	0.000E+00
0018	25321226	DiClBenzenes	Dichlorobenzenes (mixed isomers)	0.000E+00
0019	9901	DieselExhPM	Diesel engine exhaust, particulate matter (Diesel PM)	0.000E+00
0020	107062	EDC	Ethylene dichloride {EDC}	0.000E+00
0021	206440	Fluoranthene	Fluoranthene	0.000E+00
0022	50000	Formaldehyde	Formaldehyde	0.000E+00
0023	7647010	HCl	Hydrochloric acid	0.000E+00
0024	110543	Hexane	Hexane	0.000E+00
0025	302012	Hydrazine	Hydrazine	0.000E+00
0026	7439921	Lead	Lead	0.000E+00
0027	7439965	Manganese	Manganese	0.000E+00
0028	7439976	Mercury	Mercury	0.000E+00
0029	91203	Naphthalene	Naphthalene	0.000E+00
0030	7440020	Nickel	Nickel	0.000E+00

0031	7782492	Selenium	Selenium	0.000E+00
0032	108883	Toluene	Toluene	0.000E+00
0033	7440622	Vanadium	Vanadium (fume or dust)	0.000E+00
0034	75014	Vinyl Chloride	Vinyl chloride	0.000E+00
0035	75354	Vinylid Chlorid	Vinylidene chloride	0.000E+00
0036	7440666	Zinc	Zinc	0.000E+00

CHEMICAL HEALTH VALUES

CHEM	CAS	ABBREVIATION	CancerPF(Inh) (mg/kg-d)^-1	CancerPF(Oral) (mg/kg-d)^-1	ChronicREL(Inh) ug/m^3	ChronicREL(Oral) mg/kg-d	AcuteREL ug/m^3
0001	106990	1,3-Butadiene	6.00E-01	*	2.00E+01	*	*
0002	57976	7,12-DB[a]anthr	2.50E+02	2.50E+02	*	*	*
0003	75070	Acetaldehyde	1.00E-02	*	1.40E+02	*	4.70E+02
0004	107028	Acrolein	*	*	3.50E-01	*	2.50E+00
0005	107131	Acrylonitrile	1.00E+00	*	5.00E+00	*	*
0006	7440382	Arsenic	1.20E+01	1.50E+00	1.50E-02	3.50E-06	2.00E-01
0007	7440393	Barium	*	*	*	*	*
0008	71432	Benzene	1.00E-01	*	6.00E+01	*	1.30E+03
0009	7440417	Beryllium	8.40E+00	*	7.00E-03	2.00E-03	*
0010	7440439	Cadmium	1.50E+01	*	2.00E-02	5.00E-04	*
0011	56235	CCl4	1.50E-01	*	4.00E+01	*	1.90E+03
0012	7782505	Chlorine	*	*	2.00E-01	*	2.10E+02
0013	67663	Chloroform	1.90E-02	*	3.00E+02	*	1.50E+02
0014	18540299	Cr(VI)	5.10E+02	*	2.00E-01	2.00E-02	*
0015	7440484	Cobalt	*	*	*	*	*
0016	7440508	Copper	*	*	*	*	1.00E+02
0017	4170303	Crotonaldehyde	*	*	*	*	*
0018	25321226	DiClBenzenes	*	*	*	*	*
0019	9901	DieselExhPM	1.10E+00	*	5.00E+00	*	*
0020	107062	EDC	7.20E-02	*	4.00E+02	*	*
0021	206440	Fluoranthene	*	*	*	*	*
0022	50000	Formaldehyde	2.10E-02	*	9.00E+00	*	5.50E+01
0023	7647010	HCl	*	*	9.00E+00	*	2.10E+03
0024	110543	Hexane	*	*	7.00E+03	*	*
0025	302012	Hydrazine	1.70E+01	*	2.00E-01	*	*
0026	7439921	Lead	4.20E-02	8.50E-03	*	*	*
0027	7439965	Manganese	*	*	9.00E-02	*	*
0028	7439976	Mercury	*	*	3.00E-02	1.60E-04	6.00E-01
0029	91203	Naphthalene	1.20E-01	*	9.00E+00	*	*
0030	7440020	Nickel	9.10E-01	*	5.00E-02	5.00E-02	6.00E+00
0031	7782492	Selenium	*	*	2.00E+01	*	*
0032	108883	Toluene	*	*	3.00E+02	*	3.70E+04
0033	7440622	Vanadium	*	*	*	*	3.00E+01
0034	75014	Vinyl Chloride	2.70E-01	*	*	*	1.80E+05
0035	75354	Vinylid Chlorid	*	*	7.00E+01	*	*
0036	7440666	Zinc	*	*	*	*	*

EMISSIONS DATA SOURCE: Emission rates loaded from file: S:\Projects\2009\09 Air Group Projects\DC&E (093-99021) LBNL Seismic 2 Project\HARP\Offsite\OFFSITE.EMS
CHEMICALS ADDED OR DELETED: none

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=1 NAME=BOIL1 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00
57976	7,12-Dimethylben	1	0	4.71E-06	2.59E-08
75070	Acetaldehyde	1	0	2.61E-03	1.43E-05
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	5.88E-05	3.24E-07
7440393	Barium	1	0	1.29E-03	7.12E-06
71432	Benzene	1	0	1.27E-03	6.97E-06
7440417	Beryllium	1	0	3.53E-06	1.94E-08
7440439	Cadmium	1	0	3.24E-04	1.78E-06
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00
18540299	Chromium (hexava	1	0	7.00E-05	3.85E-07
7440484	Cobalt	1	0	2.47E-05	1.36E-07
7440508	Copper	1	0	2.50E-04	1.38E-06
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	3.53E-04	1.94E-06
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	8.82E-07	4.85E-09
50000	Formaldehyde	1	0	6.50E-02	3.58E-04
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	5.29E-01	2.91E-03
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	1.47E-04	8.09E-07
7439965	Manganese	1	0	1.12E-04	6.15E-07
7439976	Mercury	1	0	7.65E-05	4.21E-07
91203	Naphthalene	1	0	1.79E-04	9.87E-07
7440020	Nickel	1	0	6.18E-04	3.40E-06
7782492	Selenium	1	0	7.06E-06	3.88E-08
108883	Toluene	1	0	1.00E-03	5.50E-06
7440622	Vanadium	1	0	6.76E-04	3.72E-06
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	8.53E-03	4.69E-05

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=2 NAME=BOIL2 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00
57976	7,12-Dimethylben	1	0	4.71E-06	2.59E-08
75070	Acetaldehyde	1	0	2.61E-03	1.43E-05
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	5.88E-05	3.24E-07
7440393	Barium	1	0	1.29E-03	7.12E-06
71432	Benzene	1	0	1.27E-03	6.97E-06
7440417	Beryllium	1	0	3.53E-06	1.94E-08
7440439	Cadmium	1	0	3.24E-04	1.78E-06
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00

18540299	Chromium (hexava	1	0	7.00E-05	3.85E-07
7440484	Cobalt	1	0	2.47E-05	1.36E-07
7440508	Copper	1	0	2.50E-04	1.38E-06
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	3.53E-04	1.94E-06
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	8.82E-07	4.85E-09
50000	Formaldehyde	1	0	6.50E-02	3.58E-04
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	5.29E-01	2.91E-03
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	1.47E-04	8.09E-07
7439965	Manganese	1	0	1.12E-04	6.15E-07
7439976	Mercury	1	0	7.65E-05	4.21E-07
91203	Naphthalene	1	0	1.79E-04	9.87E-07
7440020	Nickel	1	0	6.18E-04	3.40E-06
7782492	Selenium	1	0	7.06E-06	3.88E-08
108883	Toluene	1	0	1.00E-03	5.50E-06
7440622	Vanadium	1	0	6.76E-04	3.72E-06
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	8.53E-03	4.69E-05

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=3 NAME=LAB1 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	3.07E-02	7.95E-05
57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	1.86E-01	4.82E-04
107028	Acrolein	1	0	6.55E-02	1.70E-04
107131	Acrylonitrile	1	0	5.31E-02	1.38E-04
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	1.35E+00	3.50E-03
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	1.04E+00	2.69E-03
7782505	Chlorine	1	0	9.70E-01	2.51E-03
67663	Chloroform	1	0	7.96E+00	2.06E-02
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	5.56E-03	1.44E-05
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	9.35E-01	2.42E-03
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	9.79E-01	2.53E-03
7647010	HCl	1	0	8.92E+00	2.31E-02
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	1.49E-02	3.86E-05
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00

7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	6.62E-01	1.71E-03
75354	Vinylidene Chlor	1	0	4.57E-02	1.18E-04
7440666	Zinc	1	0	0.00E+00	0.00E+00

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=4 NAME=LAB2 EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	3.07E-02	7.95E-05
57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	1.86E-01	4.82E-04
107028	Acrolein	1	0	6.55E-02	1.70E-04
107131	Acrylonitrile	1	0	5.31E-02	1.38E-04
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	1.35E+00	3.50E-03
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	1.04E+00	2.69E-03
7782505	Chlorine	1	0	9.70E-01	2.51E-03
67663	Chloroform	1	0	7.96E+00	2.06E-02
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	5.56E-03	1.44E-05
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	0.00E+00	0.00E+00
107062	Ethylene Dichlor	1	0	9.35E-01	2.42E-03
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	9.79E-01	2.53E-03
7647010	HCl	1	0	8.92E+00	2.31E-02
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	1.49E-02	3.86E-05
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00
7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	6.62E-01	1.71E-03
75354	Vinylidene Chlor	1	0	4.57E-02	1.18E-04
7440666	Zinc	1	0	0.00E+00	0.00E+00

EMISSIONS FOR FACILITY FAC=1 DEV=* PRO=* STK=5 NAME=DGEN EMS (lbs/yr)
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0.00E+00	0.00E+00

57976	7,12-Dimethylben	1	0	0.00E+00	0.00E+00
75070	Acetaldehyde	1	0	0.00E+00	0.00E+00
107028	Acrolein	1	0	0.00E+00	0.00E+00
107131	Acrylonitrile	1	0	0.00E+00	0.00E+00
7440382	Arsenic	1	0	0.00E+00	0.00E+00
7440393	Barium	1	0	0.00E+00	0.00E+00
71432	Benzene	1	0	0.00E+00	0.00E+00
7440417	Beryllium	1	0	0.00E+00	0.00E+00
7440439	Cadmium	1	0	0.00E+00	0.00E+00
56235	Carbon Tetrachlo	1	0	0.00E+00	0.00E+00
7782505	Chlorine	1	0	0.00E+00	0.00E+00
67663	Chloroform	1	0	0.00E+00	0.00E+00
18540299	Chromium (hexava	1	0	0.00E+00	0.00E+00
7440484	Cobalt	1	0	0.00E+00	0.00E+00
7440508	Copper	1	0	0.00E+00	0.00E+00
4170303	Crotonaldehyde	1	0	0.00E+00	0.00E+00
25321226	Dichlorobenzene	1	0	0.00E+00	0.00E+00
9901	DPM	1	0	2.71E+00	1.09E-01
107062	Ethylene Dichlor	1	0	0.00E+00	0.00E+00
206440	Fluoranthene	1	0	0.00E+00	0.00E+00
50000	Formaldehyde	1	0	0.00E+00	0.00E+00
7647010	HCl	1	0	0.00E+00	0.00E+00
110543	Hexane	1	0	0.00E+00	0.00E+00
302012	Hydrazine	1	0	0.00E+00	0.00E+00
7439921	Lead	1	0	0.00E+00	0.00E+00
7439965	Manganese	1	0	0.00E+00	0.00E+00
7439976	Mercury	1	0	0.00E+00	0.00E+00
91203	Naphthalene	1	0	0.00E+00	0.00E+00
7440020	Nickel	1	0	0.00E+00	0.00E+00
7782492	Selenium	1	0	0.00E+00	0.00E+00
108883	Toluene	1	0	0.00E+00	0.00E+00
7440622	Vanadium	1	0	0.00E+00	0.00E+00
75014	Vinyl Chloride	1	0	0.00E+00	0.00E+00
75354	Vinylidene Chlor	1	0	0.00E+00	0.00E+00
7440666	Zinc	1	0	0.00E+00	0.00E+00

CHRONIC HI REPORT

RECEPTOR 2850

SOURCE 1 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.74E-09	0.00E+00	0.00E+00	1.74E-09
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	5.48E-05	5.48E-05	0.00E+00	5.48E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.48E-05	5.48E-05	0.00E+00	5.48E-05
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	1.97E-09	0.00E+00	1.97E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-09	1.97E-09
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.26E-09	4.70E-08	0.00E+00	0.00E+00	4.70E-08	0.00E+00	0.00E+00	4.70E-08
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.07E-06	0.00E+00	1.51E-06	0.00E+00	0.00E+00	6.07E-06
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.26E-08	0.00E+00	6.41E-09	3.26E-08
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.73E-07	0.00E+00	0.00E+00	6.73E-07
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	7.04E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.04E-09
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	1.16E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-07
0028	0.00E+00	6.31E-06	0.00E+00	6.31E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.31E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.31E-06
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E-09	0.00E+00	1.85E-09
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.74E-08	0.00E+00	0.00E+00	0.00E+00	1.15E-06	0.00E+00	1.15E-06	1.15E-06
0031	3.29E-11	3.29E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-11
0032	0.00E+00	3.11E-10	0.00E+00	3.11E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.11E-10	0.00E+00	0.00E+00	3.11E-10
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	5.48E-05	6.12E-05	0.00E+00	6.11E-05	0.00E+00	0.00E+00	6.07E-08	4.70E-08	1.24E-05	0.00E+00	5.82E-05	5.48E-05	1.16E-06	6.12E-05

SOURCE 2 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.73E-09	0.00E+00	0.00E+00	1.73E-09
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	5.46E-05	5.46E-05	0.00E+00	5.46E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.46E-05	5.46E-05	0.00E+00	5.46E-05
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	1.97E-09	0.00E+00	1.97E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-09	1.97E-09
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.25E-09	4.69E-08	0.00E+00	0.00E+00	4.69E-08	0.00E+00	0.00E+00	4.69E-08
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.06E-06	0.00E+00	1.51E-06	0.00E+00	0.00E+00	6.06E-06
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.25E-08	0.00E+00	6.39E-09	3.25E-08
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.71E-07	0.00E+00	0.00E+00	6.71E-07
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	7.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.02E-09
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0027	0.00E+00	1.16E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-07
0028	0.00E+00	6.29E-06	0.00E+00	6.29E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-06
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E-09	0.00E+00	0.00E+00	1.85E-09
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.73E-08	0.00E+00	0.00E+00	0.00E+00	1.15E-06	0.00E+00	1.15E-06	1.15E-06
0031	3.28E-11	3.28E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.28E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.28E-11
0032	0.00E+00	3.10E-10	0.00E+00	3.10E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.10E-10	0.00E+00	0.00E+00	3.10E-10
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	5.46E-05	6.11E-05	0.00E+00	6.09E-05	0.00E+00	0.00E+00	6.06E-08	4.69E-08	1.23E-05	0.00E+00	5.81E-05	5.46E-05	1.16E-06	6.11E-05

SOURCE 3 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E-07	0.00E+00	0.00E+00	0.00E+00	1.25E-07
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-07	0.00E+00	0.00E+00	1.08E-07
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.52E-05	0.00E+00	0.00E+00	1.52E-05
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.62E-07	0.00E+00	0.00E+00	8.62E-07
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	1.83E-06	0.00E+00	1.83E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-06	1.83E-06
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	0.00E+00	2.11E-06	0.00E+00	2.11E-06	0.00E+00	0.00E+00	2.11E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.11E-06
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.94E-04	0.00E+00	0.00E+00	3.94E-04
0013	0.00E+00	0.00E+00	0.00E+00	2.15E-06	0.00E+00	0.00E+00	2.15E-06	0.00E+00	2.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E-06
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E-07
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.83E-06	0.00E+00	0.00E+00	8.83E-06
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.04E-05	0.00E+00	0.00E+00	8.04E-05
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.05E-06	0.00E+00	6.05E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.05E-06
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.30E-08
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	0.00E+00	3.94E-06	0.00E+00	6.09E-06	6.05E-06	0.00E+00	1.06E-05	0.00E+00	2.15E-06	1.25E-07	4.99E-04	0.00E+00	1.83E-06	4.99E-04

SOURCE 4 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX

0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-07	0.00E+00	0.00E+00	0.00E+00	1.22E-07
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E-07	0.00E+00	0.00E+00	1.06E-07
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.49E-05	0.00E+00	0.00E+00	1.49E-05
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.47E-07	0.00E+00	0.00E+00	8.47E-07
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	1.80E-06	0.00E+00	1.80E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.80E-06	1.80E-06
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	0.00E+00	2.07E-06	0.00E+00	2.07E-06	0.00E+00	0.00E+00	2.07E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-06
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.87E-04	0.00E+00	0.00E+00	3.87E-04
0013	0.00E+00	0.00E+00	0.00E+00	2.12E-06	0.00E+00	0.00E+00	2.12E-06	0.00E+00	2.12E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E-06
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E-07
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.68E-06	0.00E+00	0.00E+00	8.68E-06
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.91E-05	0.00E+00	0.00E+00	7.91E-05
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-06	0.00E+00	5.94E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-06
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.21E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.21E-08
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	0.00E+00	3.87E-06	0.00E+00	5.99E-06	5.94E-06	0.00E+00	1.04E-05	0.00E+00	2.12E-06	1.22E-07	4.91E-04	0.00E+00	1.80E-06	4.91E-04

SOURCE 5 HI BY ENDPOINT

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0006	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0013	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.67E-05	0.00E+00	0.00E+00	3.67E-05
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0031	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0032	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.67E-05	0.00E+00	0.00E+00	3.67E-05

Total risk of all sources

CHEM	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-07	0.00E+00	0.00E+00	0.00E+00	2.47E-07
0002	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0003	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.17E-07	0.00E+00	0.00E+00	2.17E-07
0004	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.01E-05	0.00E+00	0.00E+00	3.01E-05
0005	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.71E-06	0.00E+00	0.00E+00	1.71E-06
0006	1.09E-04	1.09E-04	0.00E+00	1.09E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-04	1.09E-04	0.00E+00	1.09E-04
0007	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0008	0.00E+00	3.62E-06	0.00E+00	3.62E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.62E-06	3.62E-06
0009	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.51E-09	9.38E-08	0.00E+00	0.00E+00	9.38E-08	0.00E+00	0.00E+00	9.38E-08
0010	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-05	0.00E+00	3.01E-06	0.00E+00	0.00E+00	1.21E-05
0011	0.00E+00	4.18E-06	0.00E+00	4.18E-06	0.00E+00	0.00E+00	4.18E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.18E-06
0012	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-04	0.00E+00	0.00E+00	7.81E-04
0013	0.00E+00	0.00E+00	0.00E+00	4.27E-06	0.00E+00	0.00E+00	4.27E-06	0.00E+00	4.27E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.27E-06
0014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.51E-08	0.00E+00	1.28E-08	6.51E-08
0015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0016	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0017	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0018	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0019	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.67E-05	0.00E+00	0.00E+00	3.67E-05
0020	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.76E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.76E-07
0021	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0022	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-05	0.00E+00	0.00E+00	1.88E-05
0023	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E-04	0.00E+00	0.00E+00	1.59E-04
0024	0.00E+00	1.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-08
0025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-05	0.00E+00	1.20E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-05
0026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0027	0.00E+00	2.32E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.32E-07
0028	0.00E+00	1.26E-05	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E-05

0029	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.70E-09	0.00E+00	0.00E+00	3.70E-09
0030	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-07	0.00E+00	0.00E+00	0.00E+00	2.30E-06	0.00E+00	2.30E-06	2.30E-06
0031	6.57E-11	6.57E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.57E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.57E-11
0032	0.00E+00	6.20E-10	0.00E+00	6.20E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.20E-10	0.00E+00	0.00E+00	6.20E-10
0033	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0034	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0035	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.05E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.05E-07
0036	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SUM	1.09E-04	1.30E-04	0.00E+00	1.34E-04	1.20E-05	0.00E+00	2.10E-05	9.38E-08	2.90E-05	2.47E-07	1.14E-03	1.09E-04	5.94E-06	1.14E-03

APPENDIX C.1

GEOTECHNICAL REPORTS: BUILDING 85

Appendix C1.A

Geo/Resource Consultants, Inc., March 1994

Fault Investigation, Building 85 Hazardous Waste Handling Facility, Lawrence Berkeley Laboratory, Berkeley, Califonria.

340

REPORT 1746-003

FAULT INVESTIGATION, BUILDING 85
HAZARDOUS WASTE HANDLING FACILITY

LAWRENCE BERKELEY LABORATORY
BERKELEY, CALIFORNIA

MARCH, 1994

Prepared for:

LAWRENCE BERKELEY LABORATORY
One Cyclotron Road
Berkeley, California 94720

Geo/Resource Consultants, Inc.

GEOLOGISTS / ENGINEERS / ENVIRONMENTAL SCIENTISTS
505 BEACH STREET, SAN FRANCISCO, CALIFORNIA 94133

UNIVERSITY OF CALIFORNIA
LAWRENCE BERKELEY LABORATORY

MAR 30 1994

FACILITIES DEPARTMENT

FAULT INVESTIGATION, BUILDING 85
HAZARDOUS WASTE HANDLING FACILITY

PREPARED FOR

LAWRENCE BERKELEY LABORATORY
ONE CYCLOTRON ROAD
BERKELEY, CALIFORNIA 94720

PREPARED BY

GEO/RESOURCE CONSULTANTS, INC.
505 BEACH STREET
SAN FRANCISCO, CALIFORNIA 94133

MARCH, 1994

JOB NUMBER: 1746-003

Geo/Resource Consultants, Inc.
GEOLOGISTS / ENGINEERS / ENVIRONMENTAL SCIENTISTS

Corporate Headquarters:
505 Beach Street
San Francisco, California 94133
(415) 775-3177 FAX (415) 775-2359

Regional Offices: Arizona California Hawaii Virginia

March 22, 1994
1746-003

Lawrence Berkeley Laboratory
Facilities Department
One Cyclotron Road, Bldg. 106
Berkeley, CA 94720

Attention: Mr. Steve Blair

RE: FAULT INVESTIGATION, BUILDING 85
HAZARDOUS WASTE HANDLING FACILITY

Gentlemen:

Geo/Resource Consultants (GRC) is pleased to submit the results of our geological and geophysical investigation into the potential for active faulting on the site of the proposed (Building 85) Hazardous Waste Handling Facility (HWHF).

Our investigation found no evidence of an active fault crossing the site. Please refer to the contents of the report for details.

We appreciate being of service on this project. If you have any questions about this report, please feel free to call.

Very truly yours,
GEO/RESOURCE CONSULTANTS, INC.

Alan D. Tryhorn

Alan D. Tryhorn, C.E.G. #1019
Senior Vice President and Principal

REGISTERED GEOLOGIST
ALAN TRYHORN
No. 1019
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

ADT:csc

5/BHL-5:1746-R

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FIGURES

FIGURE 1 Site Map

FIGURE 2 Log of Trench No. 1

FIGURE 3 Log of Trench No. 2

FIGURE 4 Log of Trench No. 3

FIGURE 5 Site Geologic Map

APPENDIX

Geophysical Surveys at Proposed Building 85

EXECUTIVE SUMMARY

Geo/Resource Consultants (GRC) conducted an investigation into the potential for the presence of active faults in the immediate vicinity of the proposed Hazardous Waste Handling Facility (HWHF). The investigation began in December, 1992, prior to any grading or construction at the site. Field exploration consisted of mapping, geophysical survey, and backhoe trench logging, and was conducted during December, 1992, through February, 1993. A draft report with logs and figures was delivered in June, 1993. At the time of analysis and report review, site grading and utilities installation began. During the period from May, 1993, to February, 1994, excavation activities exposed soils and bedrock, and afforded an opportunity to further observe potential fault locations. This report includes observations made during the sitework phase. Based on our investigation, we conclude that:

1. Geophysical evidence suggests there is a lineament beneath the site. The magnetic signature of bedrock within the survey revealed a roughly linear feature running south-southeast across the location of Building 85.

2. No evidence was found of Holocene fault activity. The western fault trace, mapped by Borg (1991), is considered to be inactive, and, therefore, poses no imminent danger to life or property due to tectonic fault movements on the Building 85 site. The eastern trace was not encountered and may not exist.

3. A spring was encountered during fault trenching operations, which has its source in the intensely fractured Pliocene-age andesitic agglomeratic and flow rocks of the Moraga Formation. The spring may be related to old (pre-Holocene) shearing of the bedrock along a now-inactive fault trace. A permanent subdrain was installed during sitework to remove flow to the storm drain system.

4. Flowing water in Trench 3 is related to a cobble and gravel zone beneath stiff to hard impermeable clays. The relatively modest flow of water is consistent with a local, perched aquifer.

1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of Geo/Resource Consultants, Inc.'s (GRC) geological and geophysical investigation for the proposed Building 85 - Hazardous Waste Handling Facility (HWHF). The location of the site is presented in Figure 1, Site Map. The facility will be used for processing and shipping of hazardous wastes generated at the Laboratory. The site is approximately 200 feet northwest of Building 83.

1.2 PURPOSE AND SCOPE

The purpose of our investigation was to establish the existence and location of two faults shown crossing the site (Harding-Lawson, 1975; Borg, 1991), and to determine the recency of movement on the faults. The faults are suspected to be splays of the inactive Wildcat fault, the trace of which is mapped about 320 feet to the east.

The scope of our investigation included the following:

1. A geophysical survey, including several magnetometer and seismic refraction lines across the site, and to the north and south of the site to attempt to identify and delineate the traces of the suspected faults.

2. Excavation of three fault trenches (T-1, T-2 and T-3) across suspected traces of the fault(s) using a CAT 215 excavator and a rubber tire backhoe.

3. Detailed trench logs of our excavations.

4. Preparation of this report summarizing the results of our investigation.

CAD maps at scales of one inch equals fifty feet, and one inch equals seventy-five feet were provided by Mr. Steve Blair, LBL Engineering, to be used as a base map.

2.0 INVESTIGATION METHODS

2.1 DATA REVIEW/AERIAL PHOTO REVIEW

The first phase of our investigation involved a review of existing, available data. Previous reports provided to us for this investigation included those by Harding-Lawson Associates (1974, 1975, 1980, 1982, 1985), Dames and Moore (1962), and Borg (1991). As well, air photos from 1939 and 1988 were reviewed and interpreted for geomorphic expression of possible fault traces on the site and in the vicinity. LBL geologic staff provided background data on the geology and history of the area, including the information that Borg's mapped fault trace followed a line of freshwater springs along the hills. The line of springs was presented in a map dating back to the late 19th century (Pat Williams, 1993, verbal communication).

2.2 GEOPHYSICAL EXPLORATION

A geophysical survey was performed across the proposed building site and the immediate vicinity consisting of five seismic refraction lines and thirteen magnetometer lines. The geophysical survey was performed in December, 1992, by GRC and by BCA Geophysics. The results of the geophysical survey are presented in Appendix A, Summary Report, Geophysical surveys at proposed Building 85, Lawrence Berkeley Laboratory.

2.3 FAULT TRENCHING

Backhoe and excavator trenching began several hundred feet north of the site at a location which was both accessible and where the traces of the faults were inferred to converge within a hundred feet of each other. Trench 1 was excavated in two segments (T1-A and T1-B), due to extreme caving. Two subsequent trenches were excavated on the site of the proposed Building 85. Logs of all three trenches are shown in Figures 2, 3, and 5. Trenching took place during the latter part of January and early February, 1993; operations were somewhat hampered by heavy rains. Field

operations were aided considerably by the assistance of several LBL geologists, under the direction of Pat Williams. Messrs. Williams and Preston Holland helped to log trenches, and to set shores, and all were generous with their time and extensive background in the geology of the Laboratory.

3.0 SITE CONDITIONS

3.1 SURFACE CONDITIONS

The site is located in the East Canyon area of Lawrence Berkeley Laboratory in the Berkeley hills. Elevations on the site range from about 830 feet to about 930 feet above mean sea level. The proposed HWHF is planned to occupy a graded site that previously occupied a slight clearing in an otherwise dense grove of eucalyptus trees, on slopes varying from 5 horizontal to 1 vertical (5h:1v) to 2 horizontal to 1 vertical (2h:1v). Pre-grading site conditions are shown on Figure 5, Site Geologic Map.

Prior to being contained within a storm drainage system, a somewhat sinuous seasonal stream channel passes through the site from north to south, along the front edge of the proposed building and through portions of the proposed yard. Near the northeast corner of the proposed building the channel was deeply incised, increasing in depth from about two feet to over fifteen feet deep. On the west side of the site, a steep-sided swale opens to the south-southeast.

3.2 REGIONAL GEOLOGIC SETTING

The Berkeley hills consist of a series of tightly-folded northwest-trending synclines and anticlines cut by numerous faults. Bedrock is primarily Jurassic-Cretaceous to Tertiary in age, of marine, terrestrial, and volcanic origin. The entire area has been extensively faulted and folded since the Cretaceous, with particularly intense deformation occurring during the Plio-Pleistocene.

3.3 SITE GEOLOGY

Bedrock underlying the proposed building location consists of units of the Miocene-Pliocene age Moraga Formation. The Moraga Formation is comprised of a varied suite of volcanic rocks including basalt and andesite flows, pyroclastic tuff units and agglomerate.

The agglomerates and tuffs are light brown (5 YR 5/6), moderate reddish orange (10R6/6) and grayish red (10 R 4/2) on weathered surfaces, and medium gray (N5) on fresh surfaces. Quartz, pyroxene, and plagioclase laths are scattered throughout the microcrystalline groundmass. The units are massive; however, in places, faint traces of layering are still visible. The agglomerates are crushed to closely fractured, weak to moderately strong, low hardness, and deeply weathered; locally, decomposed to gravelly, silty clay.

The andesitic flow rocks weather a grayish red (10 R 4/2), and are light olive gray (5 Y 6/1) on fresh surfaces. Euhedral plagioclase crystals, approximately 0.001 inch long, are plainly visible, with a slight suggestion of preferred orientation of the laths. The flows are massive, flaggy, weathering in tabulate, angular blocks approximately 5" x 4" x 2". They are intensely to closely fractured; the fractures are rough planar. There is generally little or no clay developed on the fracture surfaces. The rocks are deeply weathered, stained, and of moderate hardness and strength.

Basalt flows weather to a very dusky red (10 R 2/2) and dark yellowish brown (10 YR 4/2); fresh surfaces are medium light to medium dark gray (N6 to N4). Randomly oriented, euhedral plagioclase and pyroxene crystals are present in a microcrystalline groundmass. The flows are massive, weathering into angular, semi-spheroidal blocks about 5" x 3" x 3". The rock is very dense, little fractured, moderately strong to strong, moderately hard to hard, but brittle, and only moderately weathered. In the bottom of Trench 1A, the basalt was separated into nearly flat-lying cooling units which have fractured into slabs about two inches thick. At the west end of Trench 2A, the basalt has an apparent attitude of strike N63W, dip 65SW.

3.4 SEISMICITY

The site lies approximately 3,800 feet northeast of the active Hayward fault, and approximately 300 feet west of the Wildcat fault, which is not identified as active by the State of California, Department of Conservation, Division of Mines and Geology. The Wildcat fault is not known to be active within the Holocene (last 11,000 years). The two faults inferred to lie within the project site were considered to be potentially active splays of the Wildcat fault.

4.0 RESULTS OF FIELD INVESTIGATION

4.1 GEOPHYSICAL SURVEY

A combined magnetometer and seismic refraction survey was performed on and around the proposed site of Building 85. The survey was conducted on December 3 and 4, 1992.

The most interesting result of the magnetometer survey was a magnetic low that traversed the site in a north-south direction (See Figure 5, Appendix 1, Geophysical Surveys at Proposed Building 85, Lawrence Berkeley Laboratory). While a possible interpretation of this magnetic low was that it could be fault gouge (a zone of crushed rock at a fault contact), a more plausible explanation is that the low is due to colluvial soils within a former drainage location. This became apparent during subsequent grading activities at the site.

Data from the seismic refraction survey suggested possible vertical displacements near the western inferred fault trace. Based on the combined data of the survey, the decision was made to proceed with the fault trenching portion of the investigation.

4.2 FAULT TRENCHING

Trenches were excavated across the trend of suspected fault traces at three locations. The locations are presented on Figure 1, Site Map. The first trench was excavated in two stages

(Trench 1A and 1B) due to caving, and the other trenches were excavated continuously.

4.2.1 Trench 1

The first of three trenches (Trench 1A) was excavated immediately adjacent to the PG&E access road in a broad swale on the hillside, approximately 150 feet north of the building site. The trench proceeded to the west a total of 65 feet, to the drain culvert running under the road. Volcanic agglomerate of the Moraga Formation was intensely fractured, with numerous sub-parallel clay-filled shear zones. The walls of the trench failed nearly as fast as they were excavated; the trench could not be shored. Trench logs were prepared by visual inspection from the surface.

There was no clear evidence of a fault zone in the first trench; rocks were sheared and deformed across the entire width of the exposed sub-surface. The agglomerate was underlain at a depth of about 15 feet by andesitic flow rocks of the Moraga Formation (See Figure 2, Log of Trench No. 1).

Trench 1B began about 75 feet west from the end of Trench 1A and proceeded eastward, the intention being to join the two segments at the culvert. The western fault trace of Borg (1991) is inferred to pass within a few feet of that point, and it was hoped the trench would intercept it there. A northwest-trending shear zone comprised of several clay-filled, anastomosing splays was encountered almost immediately (See Figure 2, Trench 1B). The individual splays were about three inches wide, slightly sinuous, passing upward to the limits of the bedrock surface. The shears did not appear to extend into Holocene material, and there was no clear offsetting of colluvial soils.

Competent, hard basalt flow rock encountered at the western end of the trench was abruptly transitional to more of the same intensely fractured, very weak agglomeratic volcanic rock found at the east end of the trench. Shoring was not possible, as the trench walls failed soon after excavation.

The bedrock surface sloped gradually downward to the east, overlain by dark silty clay, to a location about 43 feet from the west end of the trench. At that location, a vertical, northerly-trending shear zone separated the agglomerate/flow rock and the colluvial soils. This was at a depth of fifteen feet; relations were not clearly visible, and access to the trench was not possible. However, it did not appear to be a Holocene feature, but rather a prior structure in the bedrock against which the colluvial material had been deposited.

The total excavated length of Trench 1 was a little over 130 feet, with a gap of about twenty-five feet between portions 1A and 1B. The extremely weak condition of the rock forestalled keeping the trenches open for any extended period of time; each section was backfilled the same day it was excavated.

4.2.2 Trench 2

Trench 2 was begun at the headward end of a sharply truncated swale at the western edge of the site. Bedrock was agglomerate of the Moraga Formation. A spring was encountered at a depth of seven feet, approximately at station 0+7.0 (See Figure 3, Trench 2). The trench quickly filled with water; operations became awkward as the flow of water and the amount of mud increased. Ultimately, the spring flowed at a rate of about 60 gpm for a couple of days before falling off to a fairly steady flow of about 6 to 10 gpm. The water table fell as the trench was excavated downslope.

LBL plant operations personnel placed 60 feet of 8-inch-diameter corrugated metal pipe from the open end of the trench out to the large north-south trending drainage on the site. The upper twenty feet of pipe was perforated; the perforations were covered with permeable membrane material to prevent clogging by silt and clay. Eventually, the perforated length of drain pipe was covered in base rock to ensure continued flow through the pipe after backfill of the trench.

At a point approximately 12 feet from the northwest end of the trench, there was a discontinuity in the bedrock (See Figure 3), dipping steeply to the northeast. Bedrock was in sharp contact

with a gravelly clay unit which appears to have infilled behind a grayish brown silty clay. We infer this gravelly clay to be colluvial, and was likely deposited on a pre-existing, steep exposed slope. The steep slope may have been simply a topographic break within fractured bedrock; however, the steepness of the contact, and general conformance with the orientation of an observed bedrock shear zone suggests its possible origin as the headwall scarp of a landslide. The possible landslide, of uncertain, but probable Holocene age, would have developed along a zone of weakness in the hillside possibly created by movement within a shear zone. The sheared and slickensided rock in the shear zone indicates previous movement; however, no slickensides indicative of definite landslide movement were observed, and evidence of shearing did not extend upward to the ground surface.

Abundant slickensides of varying orientation were observed in the bedrock units. In general, the orientation of the slickensides was between N10W and N15E. No slickensides were observed in any of the surficial soil units or along contacts between soil units.

The origin of spring activity appears to have been from damming behind the clay units within the sheared rock. Similar zones of seepage were observed in cribwall cutslopes during construction. The highly fractured volcanic unit has formed both reservoir and conduit for the entrapped water.

In spite of poor bedrock conditions, the trench was shored and detailed logging was possible. The total length of the trench was about 31 feet.

4.2.3 Trench 3

Trench 3 was begun north of the proposed building, extending approximately 100 feet to the southeast across the north end of the building (See Figure 4, Trench 3). Throughout the western 65 feet of the trench, stiff to hard clays displayed pervasive slickensides at varying orientations. This sheared rock suggests repeated movements over a wide zone. This may be related to complex landsliding, or a tectonic origin; however, the evidence is not suggestive of movement across a discrete fault zone.

At approximately 65 feet from the northwest end of the trench flowing water was encountered at about five and a half feet depth, apparently issuing from a gently east-southeast dipping zone of volcanic cobbles and gravels. The flow was relatively minor, less than four gpm, and apparently unrelated to faulting. Water level fell along the dip of the cobble and gravel beds to the floor of the trench.

Also, a former backhoe test pit was encountered at about 62 feet. The pit, the water, and the underlying relatively loose cobble and gravel zones caused the trench wall to cave severely for about ten feet along the trench wall.

The total length of Trench 3 was about 115 feet. The stiff to hard clays enabled shores to be placed for nearly the whole length of the trench, with the exception of the caving zone at about 60 to 70 feet.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Our investigation to determine the existence and recency of movement on two inferred fault traces in the East Canyon area of LBL found that:

The bedrock discontinuity seen in Trench 2 is, in our opinion, the possible western fault trace shown by Borg (1991). We found no evidence of Holocene movement on the fault, and we consider the fault to be inactive. As such, the threat to life or property at the proposed Building 85 due to tectonic movement on the fault is very remote. The spring encountered in Trench 2 is inferred to be one of the original five springs shown on maps from the 1870's.

We found no evidence of the eastern trace of Korbay (1982) in either Trench 1A or 3, where the trace might have been expected to be intercepted. The flowing water encountered in Trench 3 probably has its source in the cobble and gravelly zones beneath the stiff to hard clays and is unrelated to tectonic displacements of the bedrock.

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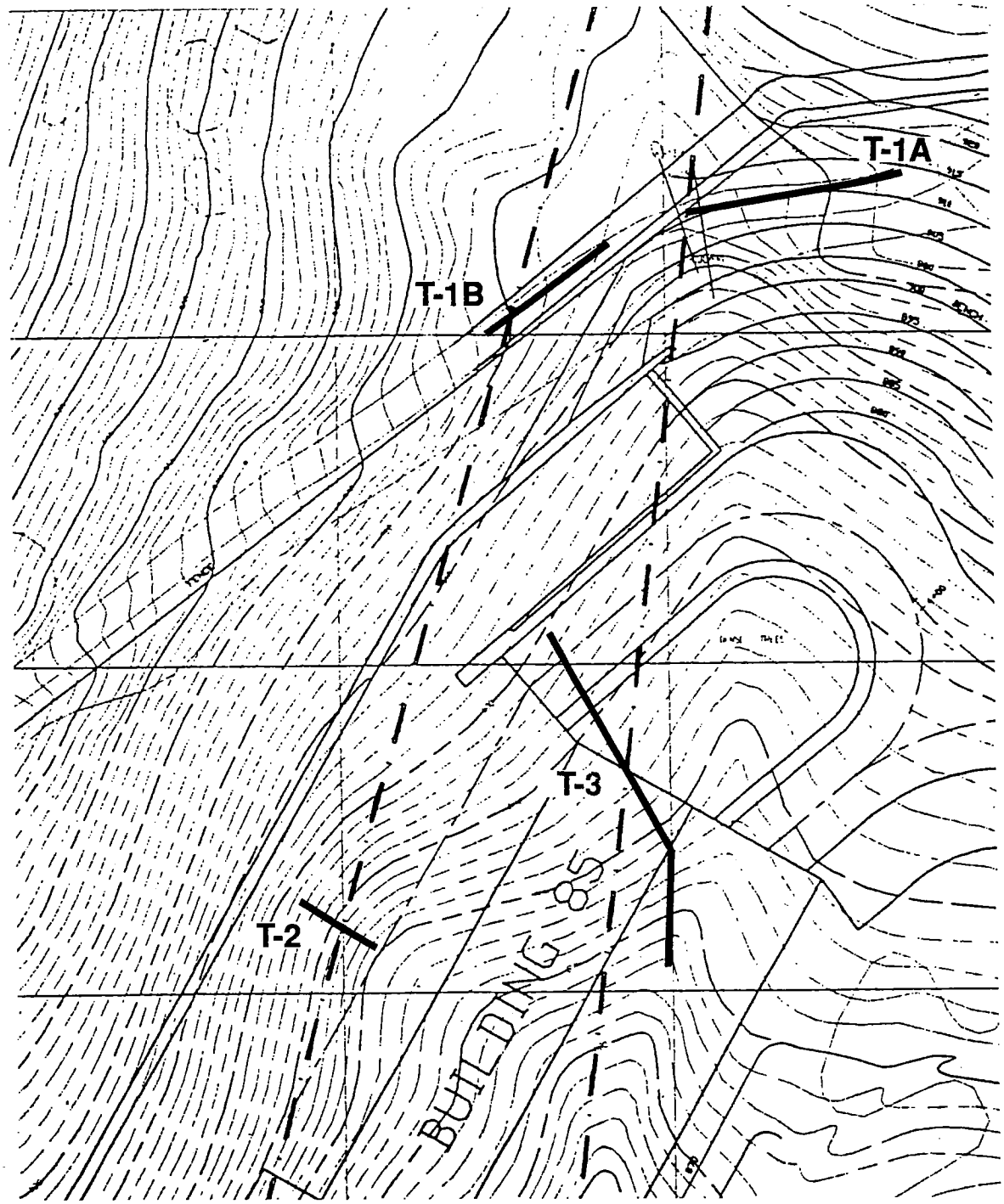
FIGURES



TRUE NORTH LBL GRID

0 50

SCALE IN FEET

-N-

EXPLANATION

— — INFERRED FAULT TRACE

T-1 TRENCH LOCATION

REFERENCE : Lawrence Berkeley Laboratory

Geo/ Resource Consultants, Inc.
GEOLOGISTS / ENGINEERS / ENVIRONMENTAL SCIENTISTS
505 BEACH STREET, SAN FRANCISCO, CALIFORNIA 94133

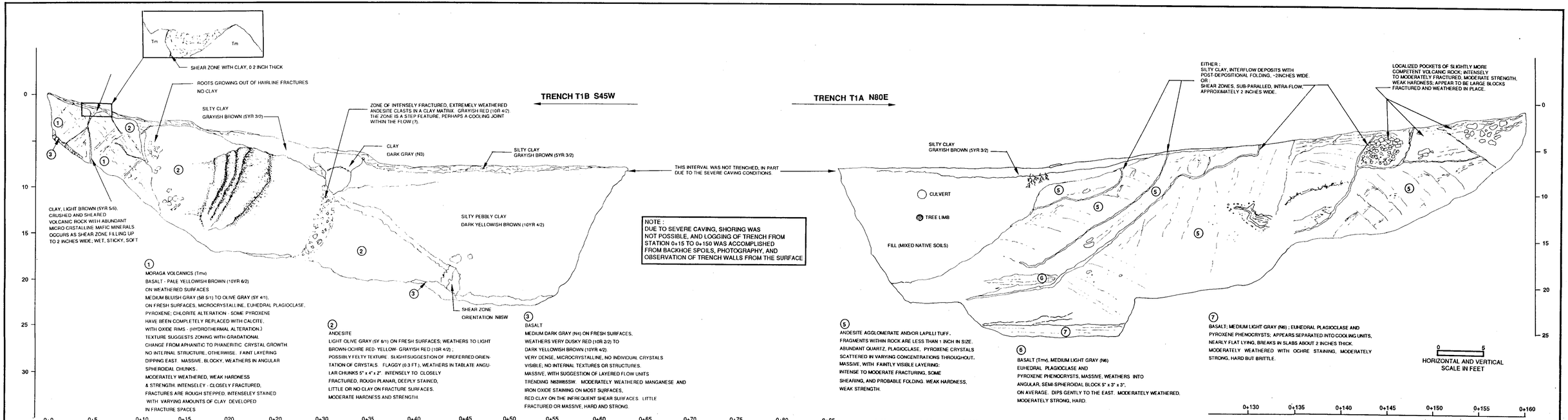
Job No. 1746-003 Appr. AOT Date 3/4/93

SITE MAP
PROPOSED
HAZARDOUS WASTE HANDLING FACILITY
LAWRENCE BERKELEY LABORATORY
BERKELEY, CALIFORNIA

FIGURE
1

340_00018

K&E 10 1283 11-90 MC1747e



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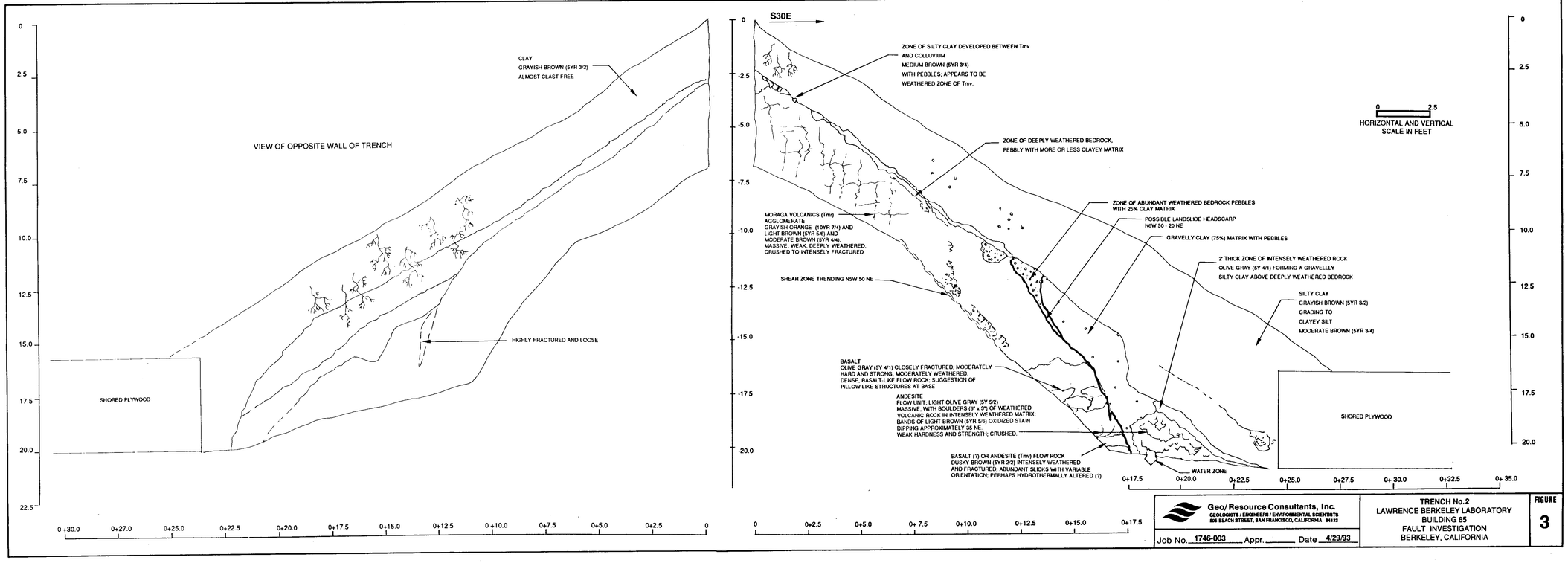
505 BEACH STREET, SAN FRANCISCO, CALIFORNIA 94133

Job No. 1746-003 Appr. _____ Date 4/29/93

TRENCH No.1
LAWRENCE BERKELEY LABORATORY
BUILDING 85
FAULT INVESTIGATION
BERKELEY, CALIFORNIA

FIGURE **2**


VIEW OF OPPOSITE WALL OF TRENCH
CLAY
GRAYISH BROWN (5YR 3/2)
ALMOST CLAST FREE
HIGHLY FRACTURED AND LOOSE
SHORED PLYWOOD
0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
0+30.0
0+27.0
0+25.0
0+22.5
0+20.0
0+17.5
0+15.0
0+12.5
0+10.0
0+7.5
0+5.0
0+2.5
0
S30E
ZONE OF SILTY CLAY DEVELOPED BETWEEN Tmv
AND COLLUVIUM
MEDIUM BROWN (5YR 3/4)
WITH PEBBLES; APPEARS TO BE
WEATHERED ZONE OF Tmv.
ZONE OF DEEPLY WEATHERED BEDROCK,
PEBBLY WITH MORE OR LESS CLAYEY MATRIX
MORAGA VOLCANICS (Tmr)
AGGLOMERATE
GRAYISH ORANGE (10YR 7/4) AND
LIGHT BROWN (5YR 5/6) AND
MODERATE BROWN (5YR 4/4),
MASSIVE, WEAK, DEEPLY WEATHERED,
CRUSHED TO INTENSELY FRACTURED
SHEAR ZONE TRENDING NSW 50 NE
ZONE OF ABUNDANT WEATHERED BEDROCK PEBBLES
WITH 25% CLAY MATRIX
POSSIBLE LANDSLIDE HEADSCARP
NSW 50 - 20 NE
GRAVELLY CLAY (75%) MATRIX WITH PEBBLES
2' THICK ZONE OF INTENSELY WEATHERED ROCK
OLIVE GRAY (5Y 4/1) FORMING A GRAVELLLY
SILTY CLAY ABOVE DEEPLY WEATHERED BEDROCK
SILTY CLAY
GRAYISH BROWN (5YR 3/2)
GRADING TO
CLAYEY SILT
MODERATE BROWN (5YR 3/4)
BASALT
OLIVE GRAY (5Y 4/1) CLOSELY FRACTURED, MODERATELY
HARD AND STRONG, MODERATELY WEATHERED.
DENSE, BASALT-LIKE FLOW ROCK; SUGGESTION OF
PILLOW-LIKE STRUCTURES AT BASE
ANDESITE
FLOW UNIT; LIGHT OLIVE GRAY (5Y 5/2)
MASSIVE, WITH BOULDERS (6" x 3") OF WEATHERED
VOLCANIC ROCK IN INTENSELY WEATHERED MATRIX;
BANDS OF LIGHT BROWN (5YR 5/6) OXIDIZED STAIN
DIPPING APPROXIMATELY 35 NE
WEAK HARDNESS AND STRENGTH; CRUSHED.
BASALT (?) OR ANDESITE (Tmv) FLOW ROCK
DUSKY BROWN (5YR 2/2) INTENSELY WEATHERED
AND FRACTURED; ABUNDANT SLICKS WITH VARIABLE
ORIENTATION; PERHAPS HYDROTHERMALLY ALTERED (?)
WATER ZONE
SHORED PLYWOOD
0
2.5
HORIZONTAL AND VERTICAL
SCALE IN FEET
0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
0+17.5
0+20.0
0+22.5
0+25.0
0+27.5
0+30.0
0+32.5
0+35.0
0
0+2.5
0+5.0
0+7.5
0+10.0
0+12.5
0+15.0
0+17.5
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GEOLOGISTS / ENGINEERS / ENVIRONMENTAL SCIENTISTS
508 BEACH STREET, SAN FRANCISCO, CALIFORNIA 94133
Job No. 1746-003 Appr. Date 4/29/93
TRENCH No.2
LAWRENCE BERKELEY LABORATORY
BUILDING 85
FAULT INVESTIGATION
BERKELEY, CALIFORNIA
FIGURE
3

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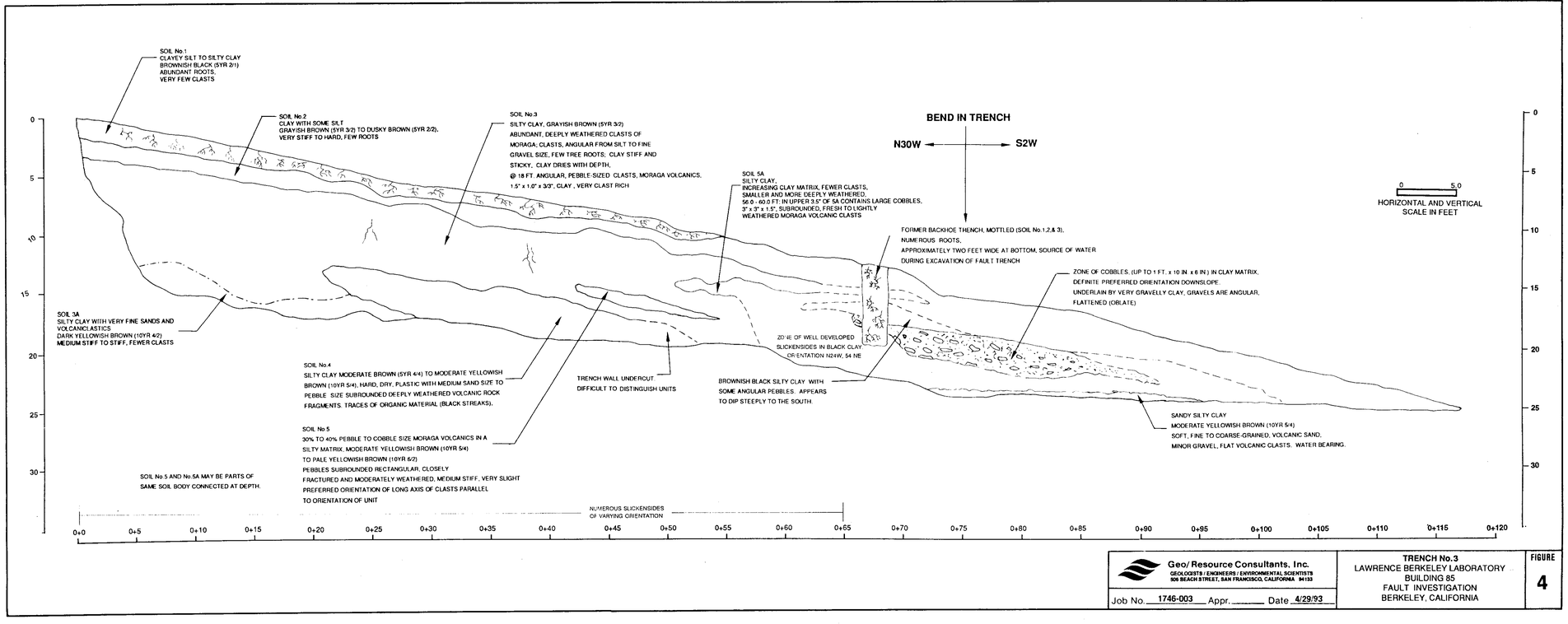

Geo/Resource Consultants, Inc.
GEOLOGISTS / ENGINEERS / ENVIRONMENTAL SCIENTISTS
506 BEACH STREET, SAN FRANCISCO, CALIFORNIA 94133

Job No. 1746-003 Appr. _____ Date 4/29/93

TRENCH No.3
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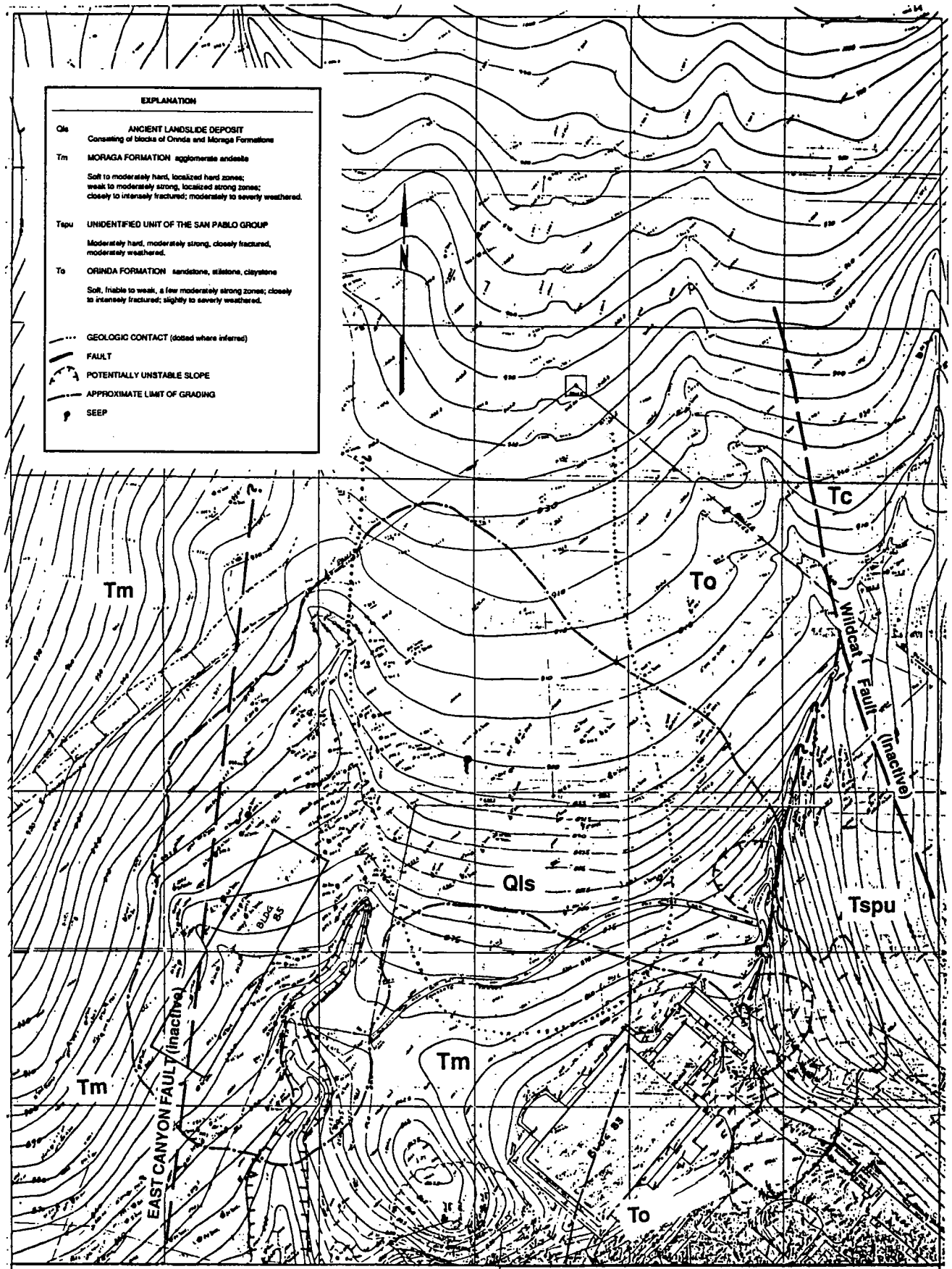
BUILDING 85
FAULT INVESTIGATION
BERKELEY, CALIFORNIA

FIGURE 4

340_00021



SITE GEOLOGIC MAP
Replacement of Hazardous Waste Handling Facility at
Lawrence Berkeley Laboratory - Berkeley, California

Reference: University of California Topographic Quadrangle- Drawing No. 4B00Q131		
Scale	Approved by AOT	Drawn by FPD

Geo/Resource Consultants, Inc.
GEOLOGISTS/ENGINEERS/ENVIRONMENTAL SCIENTISTS
505 BEACH STREET, SAN FRANCISCO, CALIFORNIA 94133

Job No. 1393-00	Date 12/22/83	Figure 5

APPENDIX

GRC/LBL
December 1992

092-B03

Report

GEOPHYSICAL SURVEYS AT PROPOSED BUILDING 85
LAWRENCE BERKELEY LABORATORY

Prepared For:

Geo/Resource Consultants
505 Beach Street
San Francisco, CA

Prepared By:

BCA Geophysics, Inc.
7 Palmer Avenus
Tiburon, CA 94920
(415) 435-5858

GEOPHYSICAL SURVEYS AT PROPOSED LBL BUILDING 85

Outline

1.0 Introduction

1.1 Summary

2.0 Magnetometer Survey

2.1 Field Procedure

2.2 Data Analysis

2.3 Results

3.0 Seismic Refraction Survey

3.1 Field Procedure

3.2 Data Analysis

3.3 Results

4. Conclusions

GEOPHYSICAL SURVEYS AT PROPOSED LBL BUILDING 85

1.0 Introduction

This report summarizes the data and results from magnetometer and seismic refraction surveys performed at Lawrence Berkeley Laboratories (LBL) during December, 1992. These surveys were performed by BCA Geophysics, Inc. for Geo/Resource Consultants (GRC) of San Francisco, California. The principal objective of these surveys was to determine the optimal locations for trenching two inferred fault related lineaments in the vicinity of proposed building 85 on the LBL facility in Berkeley, CA. Five seismic refraction lines and a grid of magnetometer data points were surveyed in the vicinity of the proposed building for the purpose of providing geophysical evidence for the existence of these faults. Figure 1 shows the location of the seismic refraction lines and Figure 2 shows the locations of the magnetometer stations. The area of investigation was limited on the North by the service road for the transmission towers, on the South by a parking lot, and on the East and West by the lineaments indicating possible faults. The following is a summary of the results of these surveys and descriptions of the field procedures, data analysis, and interpretations of these surveys.

1.1 Summary

Based on geophysical evidence, the western lineament at the north end of the study area and the eastern lineament at the south end of the study area are optimal locations to trench to determine the possible existence of faulting in the vicinity of the proposed construction.

2.0 Magnetometer Survey

The survey performed by BCA Geophysics at a site located on the LBL facilities near existing building 83 and around proposed building 85 was intended to aid in determining the optimal locations for trenching two lineaments that may be fault related. The "areas of main concern" as defined by Geo/Resource Consultants, were near the service road on the North and the projection of the western lineament near the parking lot on the south. The surveys were performed on 03 and 04 December 1992.

2.1 Field Procedure

The magnetometer survey used a Geometrics G856 proton precession magnetometer, a total field magnetometer, which measures the vector sum of the earth's magnetic field. An origin for the survey was arbitrarily chosen at LBL coordinates -5+00N, 46+00E. These coordinates correspond to the 0,0 origin of Figures 2 thru 5. All references in this report to distances on the site are made relative to this origin. For this study, a topographic base map was provided by LBL and used for locating the field surveys. Azimuths were corrected 16 degrees east of Magnetic North to coincide with the LBL base.

The magnetometer survey was comprised of magnetometer readings at 25 foot spacings co-linear with the seismic refraction lines as well as East-West lines on a grid with grid lines at 50 foot intervals as shown in Figure 2.

2.2 Data Analysis

The raw data from the magnetometer survey were recorded internally in the G856 magnetometer and downloaded into a PC using the MAGLOC program provided by Geometrics. During the course of the survey, several stations were reoccupied for the purpose of making diurnal corrections of the magnetic data. These data were used for linear corrections to the raw data, providing "corrected raw data". The corrected data are shown in Figure 2, along with the locations of the magnetometer station at which they were collected. The diurnal corrections were generally on the order of 10 to 15 gammas with most of the corrections less than 10 gammas. The corrected data were then used as input to the SURFER program from Golden Software where the topographic and orthographic figures were generated. All figures except Figure 4 were generated on an HP Laser Jet. Figure 4 was generated on a Roland DXY980 X-Y plotter.

2.3 Results

The results of the magnetometer survey are presented in Figures 3-5. Figure 3 shows the smoothed contours, at 100 Gamma intervals, of equal intensity magnetic lines in the study area at a scale of 1 inch =100 feet. Figure 4 shows the same data at a scale of 1 inch = 50 feet for a portion of the study area, as shown. Figure 4 was generated in order to provide an overlay at a scale of the LBL base map. Figure 5 shows the data from Figure 3 in an orthographic projection rotated 290 degrees and tilted 45 degrees.

There are three prominent features on the magnetometer figures: 1) the strong magnetic high from 250 to 400N at 450W; 2) the magnetic low approximately N-S at meridian 350E, and; 3) various localized highs and lows spread around the study area. The strong magnetic high is caused by a north-south trending chain link fence around the grounds of existing building 83. Some of the other localized highs and lows are due to fence posts from dismantled chain link fences, where the magnetometer grid crossed fences, the transmission tower, and other unidentified local magnetic disturbances.

Of most interest for this study is the magnetic low that traverses the site in a north-south direction along meridian 350 E. This magnetic low is most easily seen in the orthographic projection of Figure 5. Magnetic anomalies of this type are frequently associated with the zone of broken and weathered material at a fault contact. This material, commonly called "fault gouge", often will have a high clay content that displays a strong magnetic contrast with the surrounding native materials. The existence of "fault gouge" is one possible interpretation of this linear magnetic low that connects the western lineament on the north with the eastern lineament on the south.

3.0 Seismic Refraction Survey

Five seismic refraction lines were performed for this study. The seismic refraction lines are labelled SL-1 through SL-5 and their locations are shown in Figure 1. SL-4 was 100 feet long with 10 foot geophone spacing and the other four lines were each 300 feet long with 25 foot geophone spacing. A total of approximately 1300 linear feet of seismic refraction lines were performed for this study. As shown in Figure 1, there are two seismic refraction lines north of the site near one proposed trench location, one in the middle of the site, and two south of the site near a second potential trench location.

3.1 Field Procedure

Compressional energy for the seismic refraction surveys was introduced into the ground by vertically striking a metal plate, located on the ground, with a sledge hammer. The seismic refraction arrivals were recorded on a Geometrics Model ES-2401 digital recording Seismograph with an 80286 based CPU and floppy/hard disk

for data storage. Each seismic refraction line was shot at the end points and a center shot.

3.2 Data Analysis

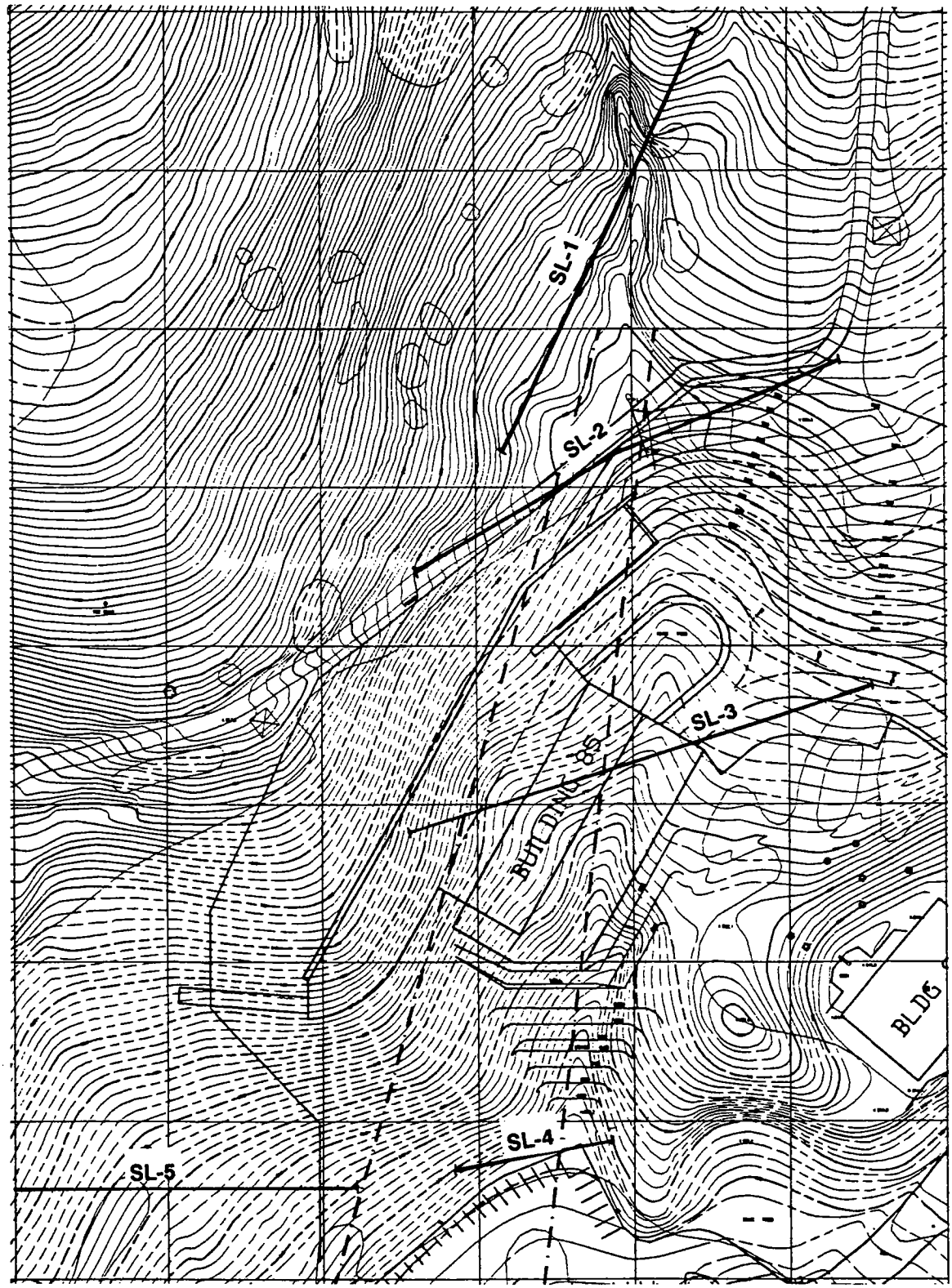
The seismic refraction data were played back from the floppy disk and analyzed for first arrivals at the office. The first arrivals were used as inputs for interpretation using the Generalized Reciprocal Method for seismic refraction interpretation. The travel-times for the seismic refraction data and interpreted cross-sections are shown in Figures 6-11.

3.3 Results

In general, the seismic refraction data showed a low velocity surface layer overlying a moderate velocity material. The low velocity material, probably alluvium, showed a velocity of approximately 1100+/-300fps and is from 0 to 25 feet thick in the areas of the seismic refraction lines. The moderate velocity material is probably the local weathered bedrock. Of the five seismic refraction lines, the only one to show any interesting features was SL-2 where the bedrock varies from near surface at the west end of the line to 20 feet deep in the center of the line and show possible vertical displacements near the center of the line at distances of from 80 to 150 feet as shown on Figure 7. These vertical offsets are in the vicinity of the western lineament and coincident with the magnetic low discussed above. There is no strong evidence of vertical offset an SL-4, which also crosses the magnetic low.

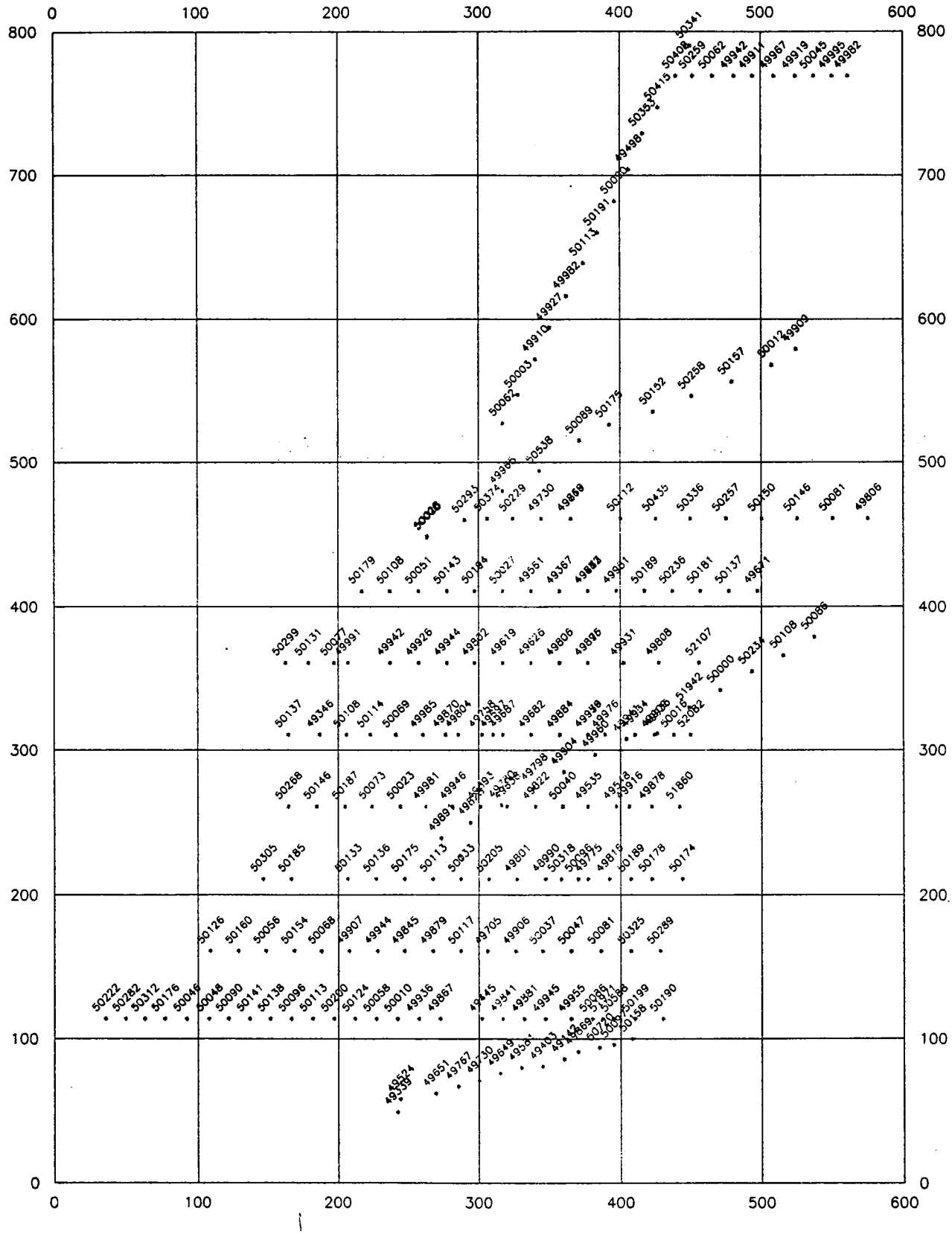
4. Conclusions

Based on the results of the magnetometer and seismic refraction surveys, there is geophysical evidence for the existence of possible faulting associated with the western lineament at the northern end of the site. The geophysical data indicate that there may be a connection between the two lineaments, passing north-south thru the center of the site. Trenching would be recommended at the north end of the site in the vicinity of the western lineament and at the southern end of the site in the vicinity of the eastern lineament.



Project No. 092-B03	**Geophysical Survey Near Proposed LBL Bldg 85**	Date: 18Dec92
Checked By: MHP	**Site Plan Showing Survey Lines**	Scale: As Shown
	Geo/Resource Consultants -- LBL	
Approved By: BCA	**BCA Geophysics, Inc.** Engineering Geophysics & Geotechnical Instrumentation	Fig. 1 / Rev.

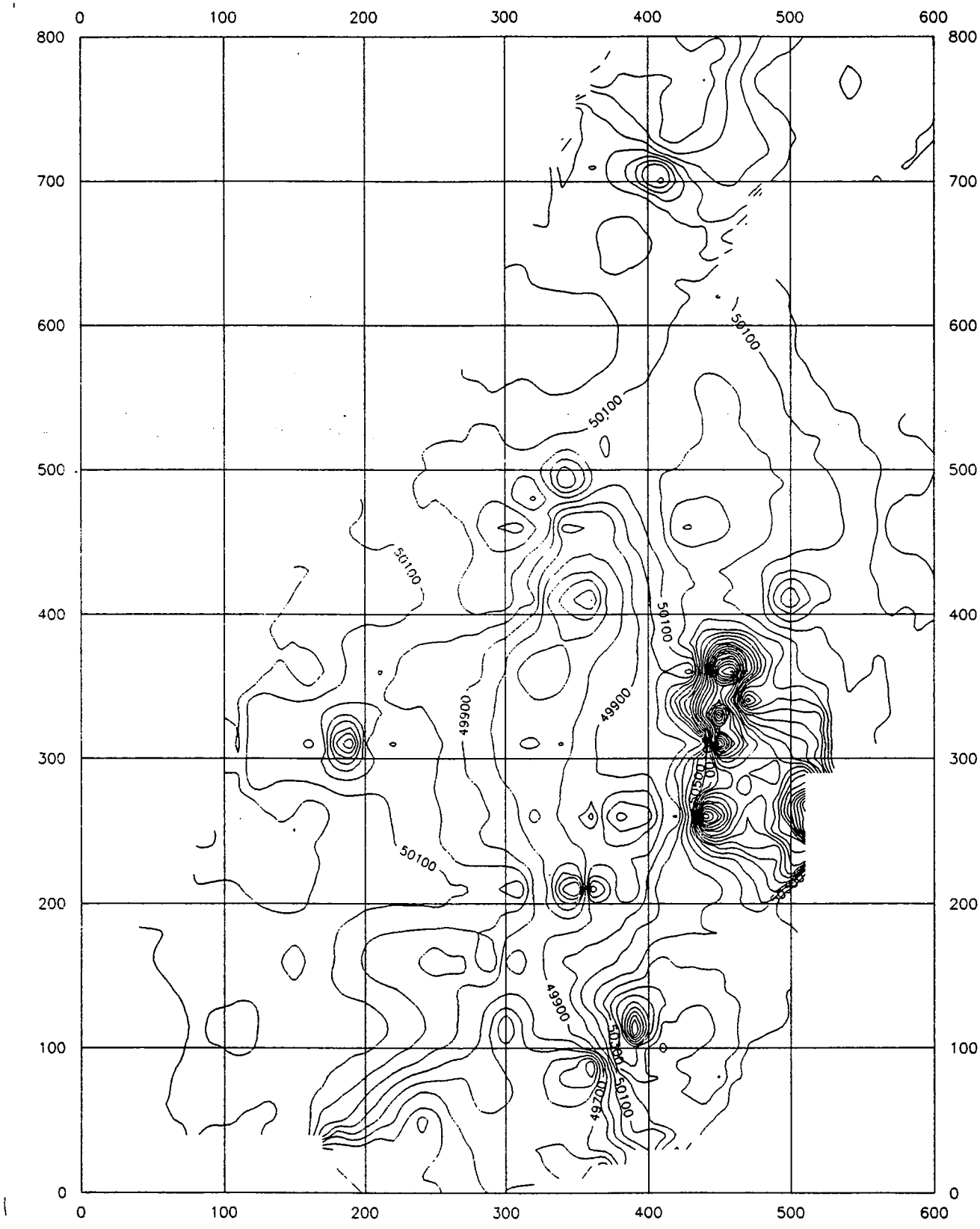
340_00030



Scale: 1in = 100 ft

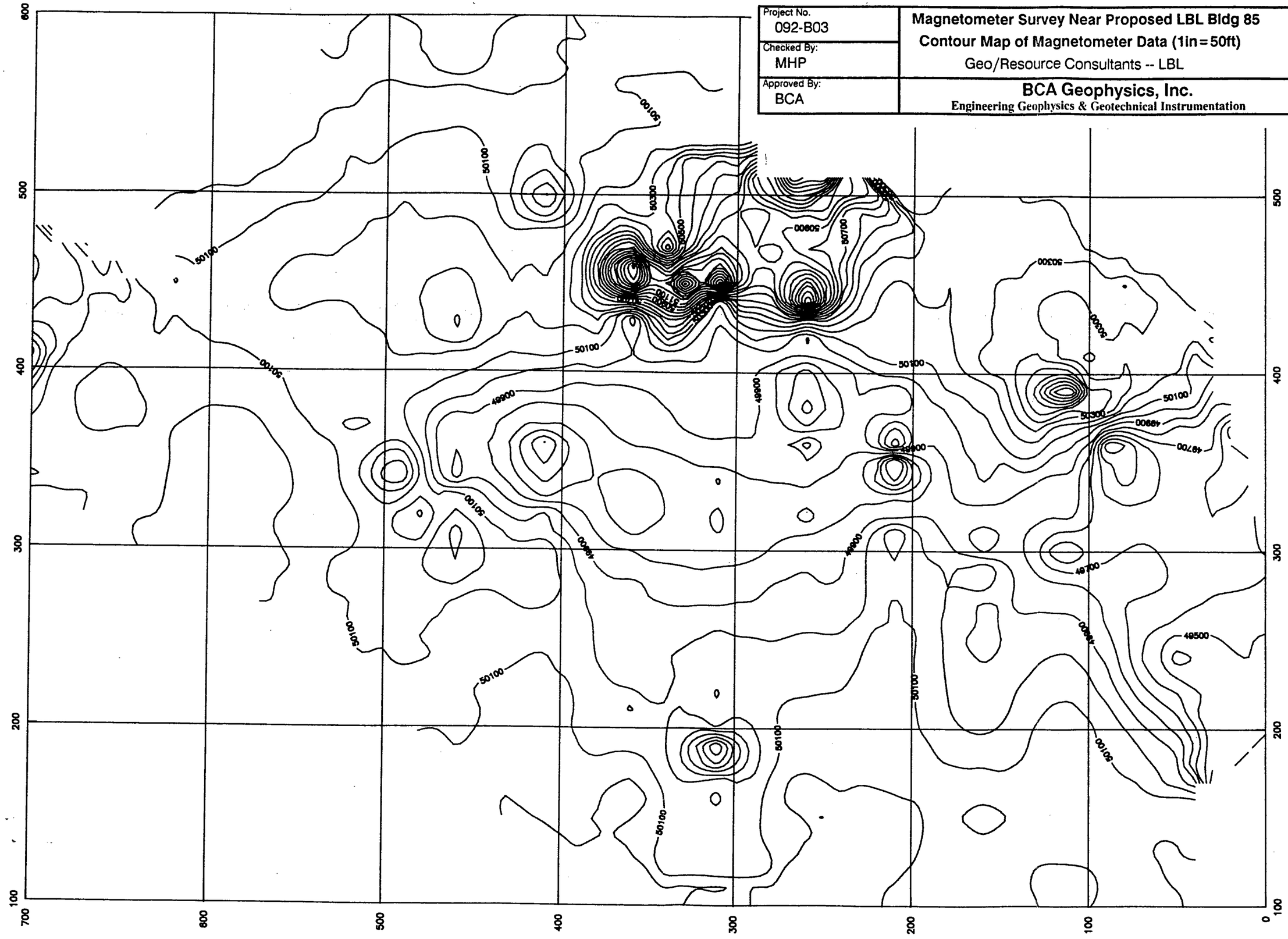
Project No. 092-B03	**Magnetometer Survey Near Proposed LBL Bldg 85**	Date: 18Dec92
Checked By: MHP	**Magnetometer Data with Diurnal Corrections**	Scale: As Shown
	Geo/Resource Consultants -- LBL	
Approved By: BCA	**BCA Geophysics, Inc.** Engineering Geophysics & Geotechnical Instrumentation	Fig. 2 / Rev.

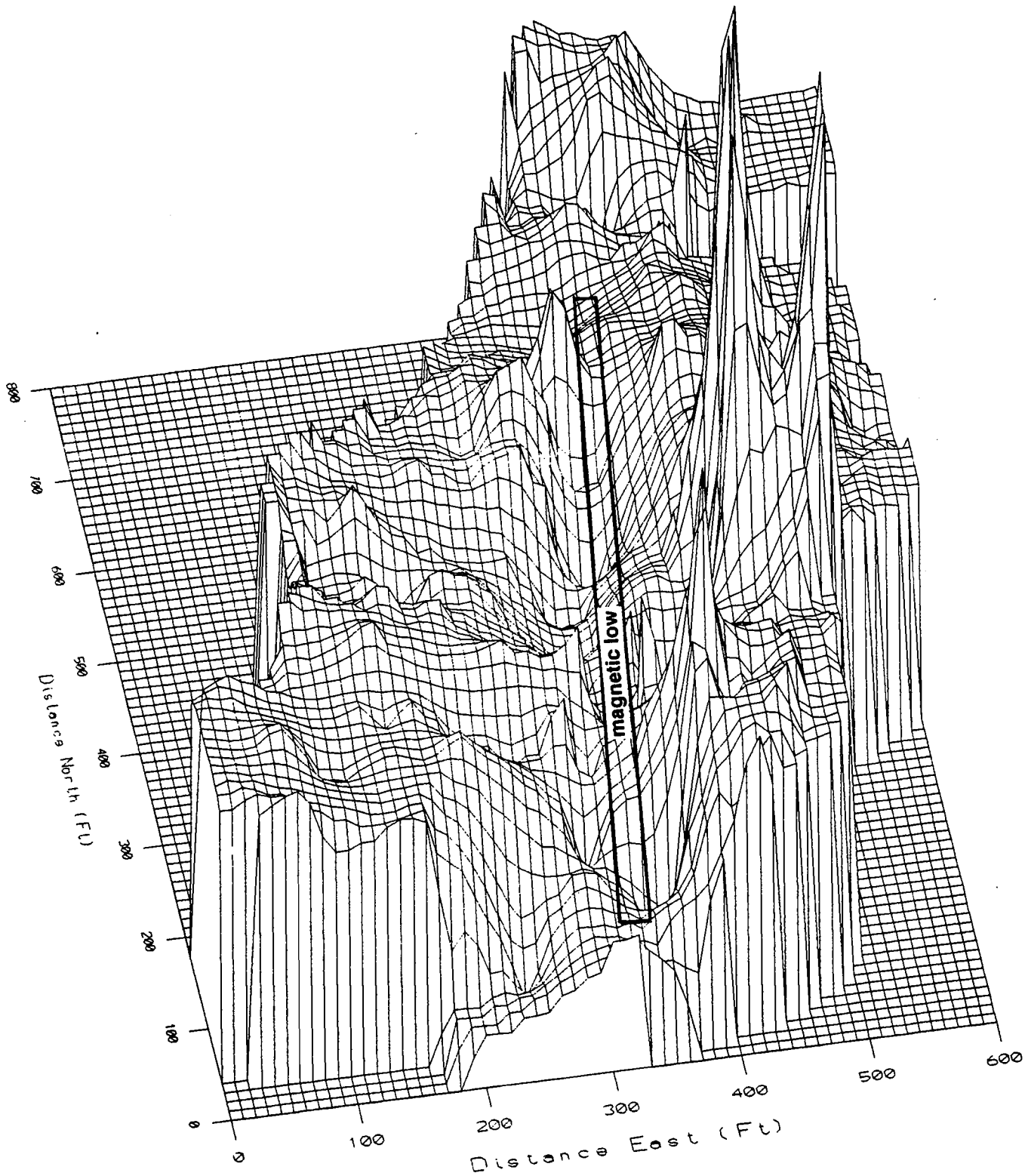
340_00031



Project No. 092-B03	**Magnetometer Survey Near Proposed LBL Bldg 85**	Date: 18Dec92
Checked By: MHP	**Contour Map of Magnetometer Data (1in=100ft)**	Scale: As Shown
	Geo/Resource Consultants -- LBL	
Approved By: BCA	**BCA Geophysics, Inc.** Engineering Geophysics & Geotechnical Instrumentation	Fig. 3 / Rev.

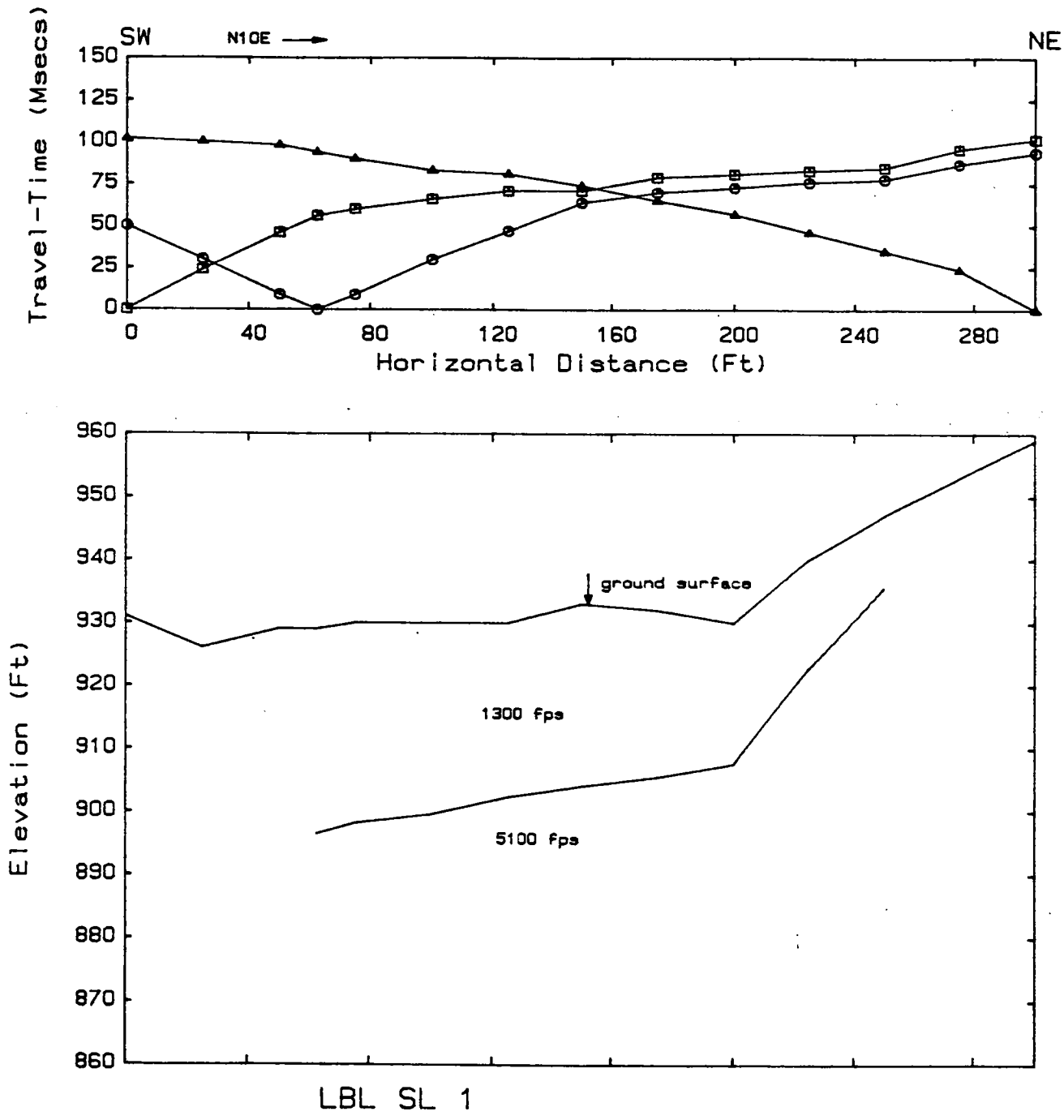
Project No. 092-B03	Magnetometer Survey Near Proposed LBL Bldg 85 Contour Map of Magnetometer Data (1in=50ft) Geo/Resource Consultants -- LBL	Date: 18Dec92	
Checked By: MHP		Scale: As Shown	
Approved By: BCA	BCA Geophysics, Inc. Engineering Geophysics & Geotechnical Instrumentation	Fig. 4	Rev.





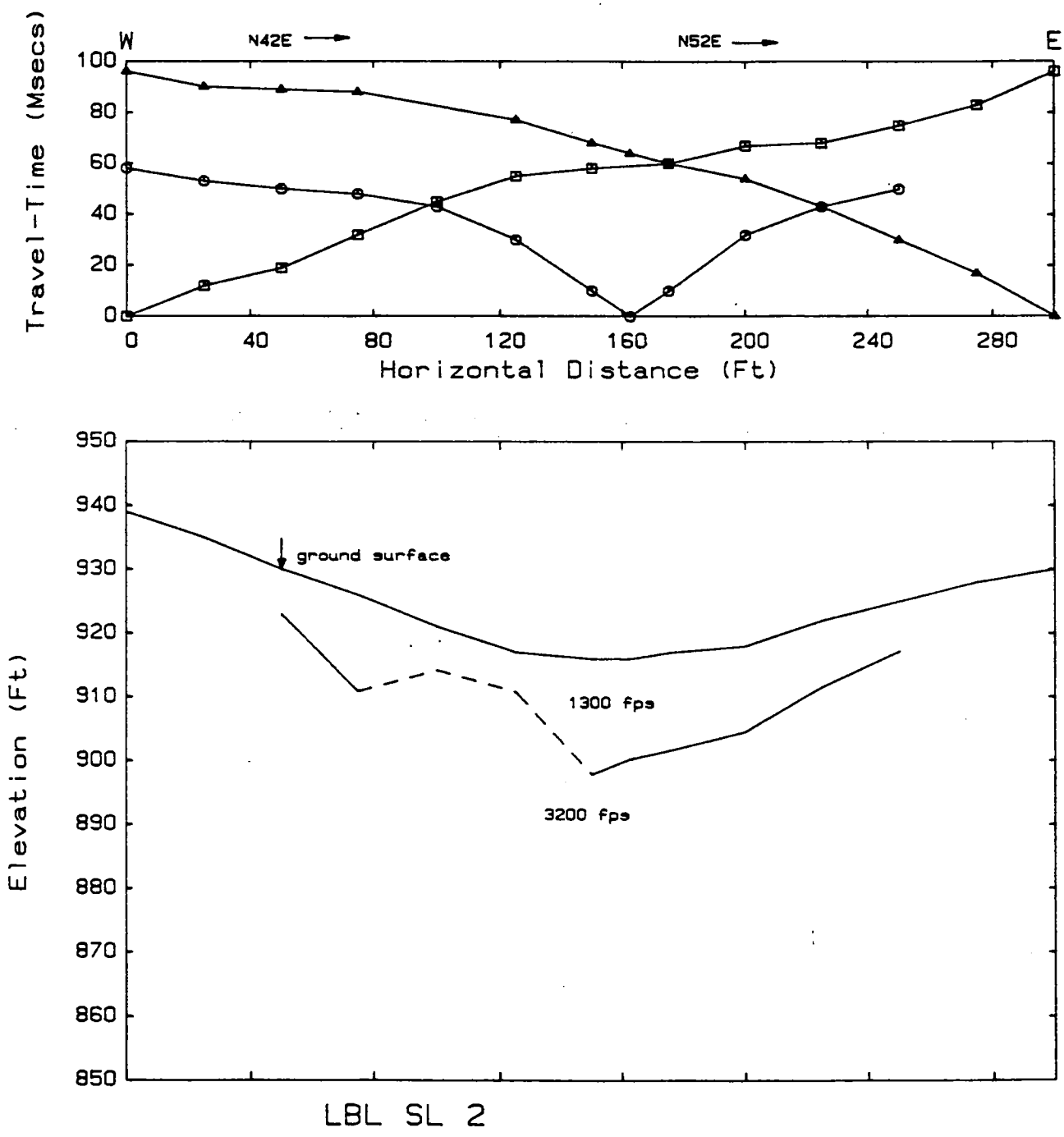
Project No. 092-B03	**Magnetometer Survey Near Proposed LBL Bldg 85**	Date: 18Dec92
Checked By: MHP	**Orthographic Projection of Magnetometer Data** Geo/Resource Consultants -- LBL	Scale: As Shown
Approved By: BCA	**BCA Geophysics, Inc.** Engineering Geophysics & Geotechnical Instrumentation	Fig. 5 / Rev.

340_00034



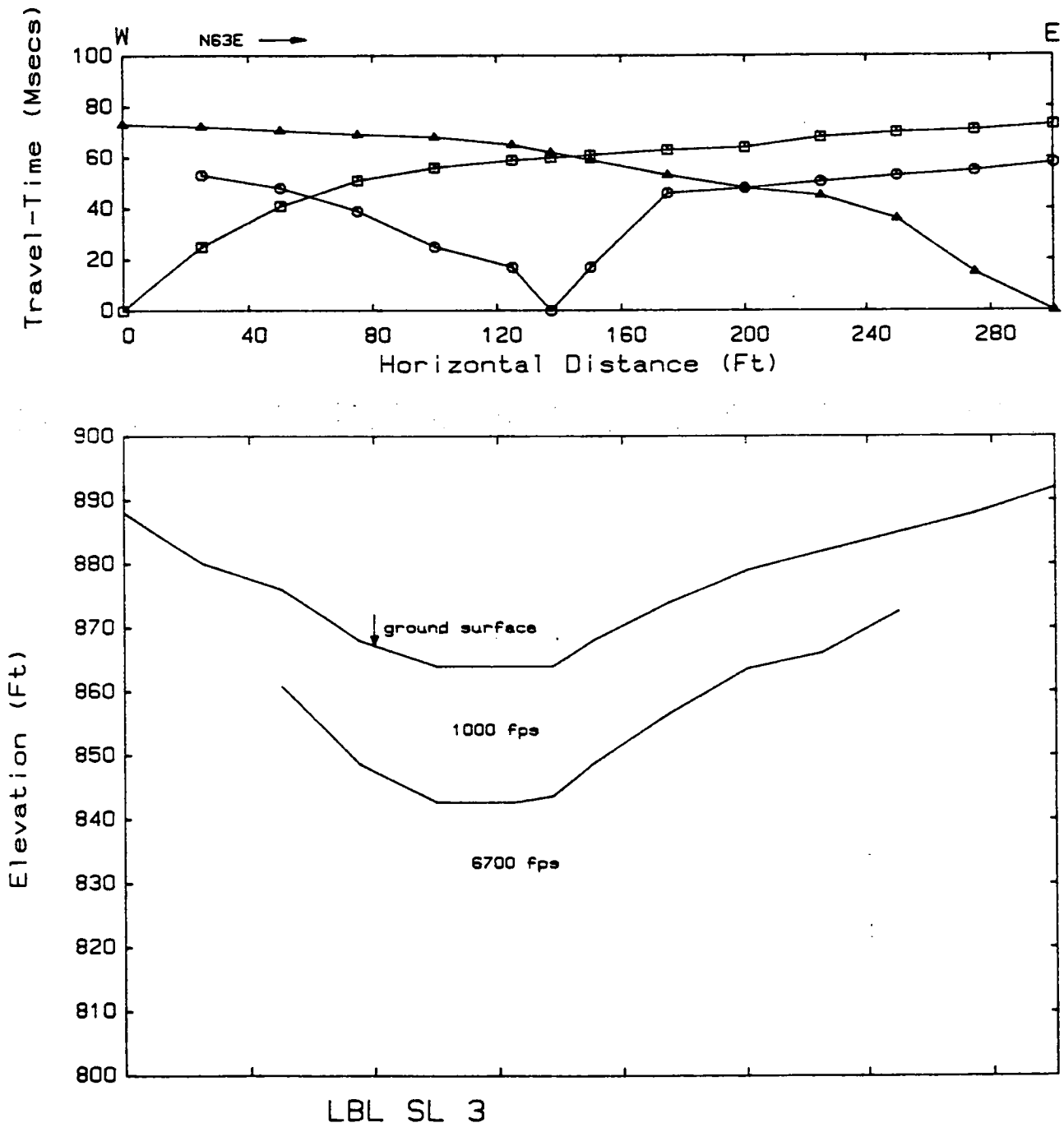
Project No. 092-B03	**Refraction Survey Near Proposed LBL Bldg 85**	Date: 18Dec92
Checked By: MHP	**Seismic Line 1**	Scale: As Shown
	Geo/Resource Consultants -- LBL	
Approved By: BCA	**BCA Geophysics, Inc.** Engineering Geophysics & Geotechnical Instrumentation	Fig. 6 / Rev.

340_00035



Project No. 092-B03	**Refraction Survey Near Proposed LBL Bldg 85**	Date: 18Dec92
Checked By: MHP	**Seismic Line 2**	Scale: As Shown
	Geo/Resource Consultants -- LBL	
Approved By: BCA	**BCA Geophysics, Inc.** Engineering Geophysics & Geotechnical Instrumentation	Fig. 7 / Rev.

340_00036



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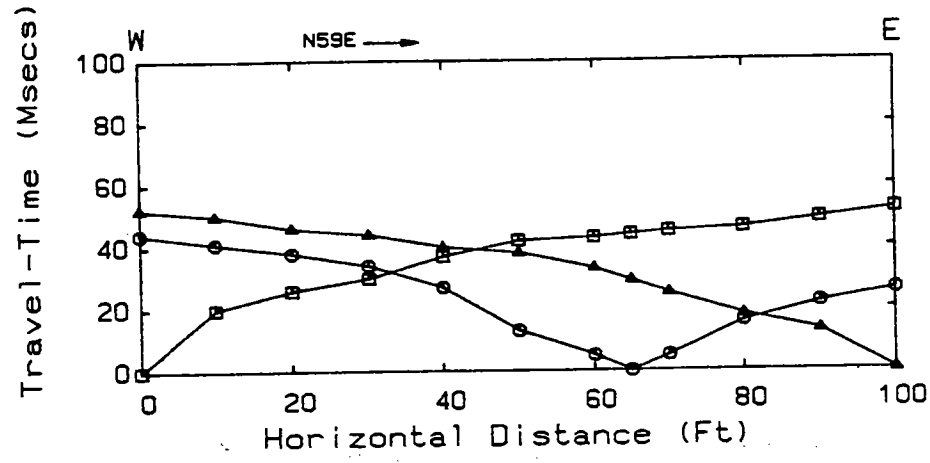
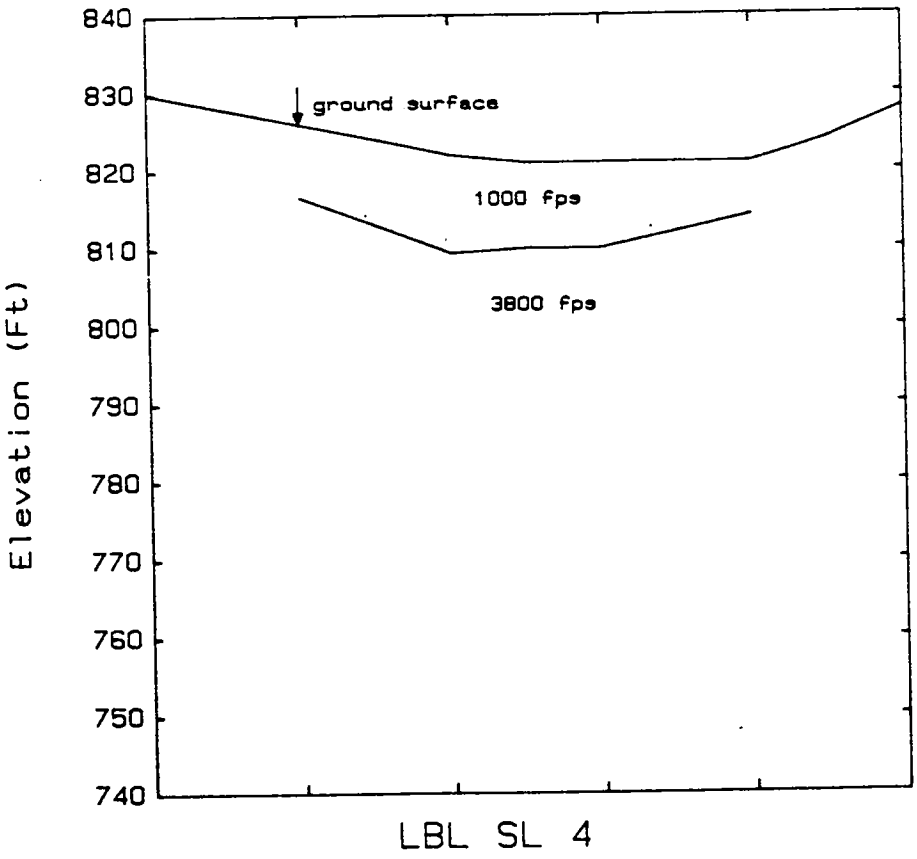
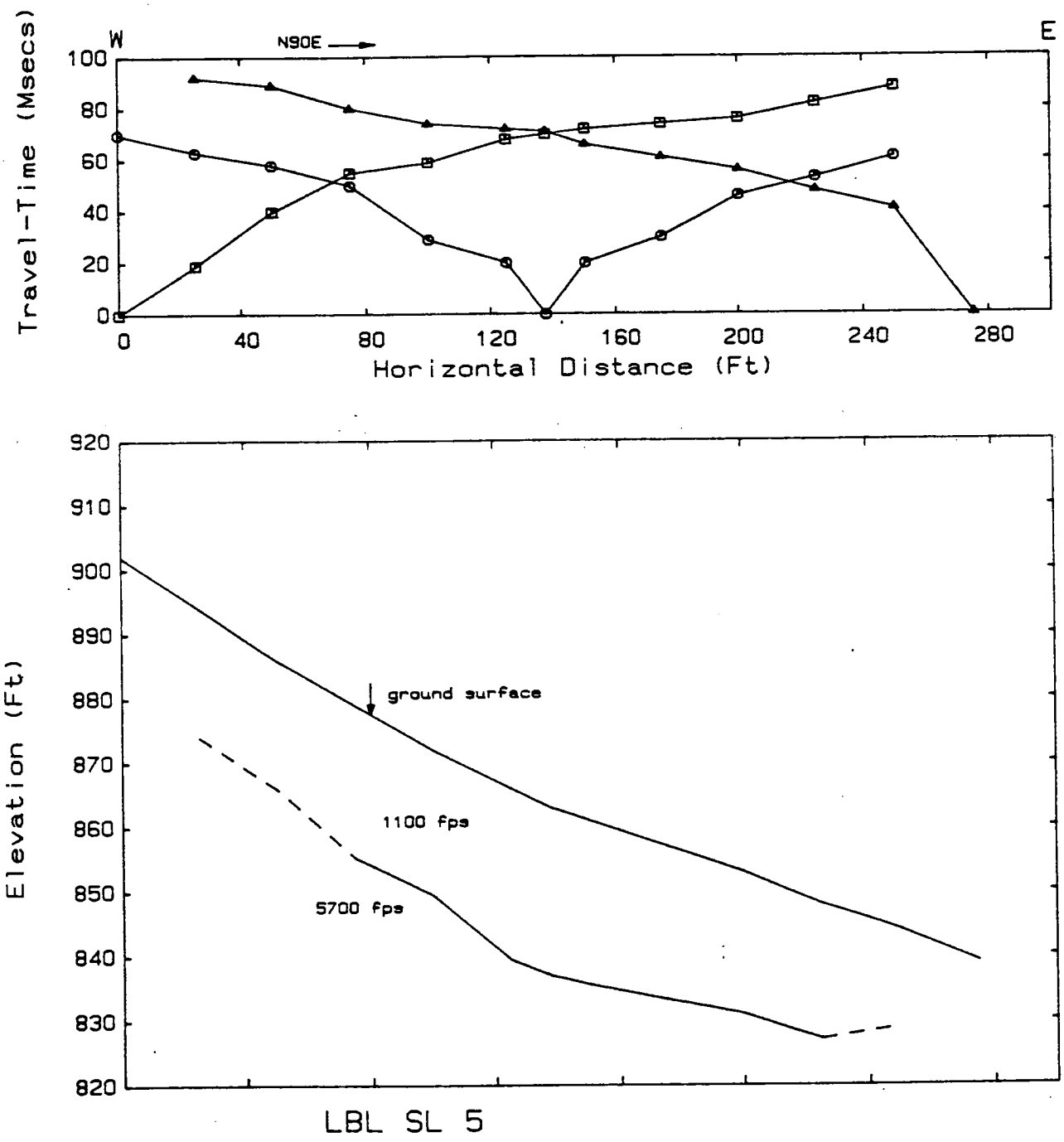
Checked By: MHP	**Seismic Line 3**	Scale: As Shown
	Geo/Resource Consultants -- LBL	
Approved By: BCA	**BCA Geophysics, Inc.** Engineering Geophysics & Geotechnical Instrumentation	Fig. 8 / Rev.

340_00037





Project No. 092-B03	**Refraction Survey Near Proposed LBL Bldg 85**	Date: 18Dec92
Checked By: MHP	**Seismic Line 4**	Scale: As Shown
Approved By: BCA	Geo/Resource Consultants -- LBL	Fig. 9 / Rev.
	BCA Geophysics, Inc. Engineering Geophysics & Geotechnical Instrumentation	



Project No. 092-B03	**Refraction Survey Near Proposed LBL Bldg 85**	Date: 18Dec92
Checked By: MHP	**Seismic Line 5**	Scale: As Shown
	Geo/Resource Consultants -- LBL	
Approved By: BCA	**BCA Geophysics, Inc.** Engineering Geophysics & Geotechnical Instrumentation	Fig. 10 / Rev.

340_00039

APPENDIX C1.B

ALAN KROPP & ASSOCIATES, INC., 2006A

GEOTECHNICAL INVESTIGATION REPORT, ANIMAL CARE FACILITY, LAWRENCE BERKELEY NATIONAL LABORATORY, BERKELEY, CALIFORNIA.

#428

GEOTECHNICAL INVESTIGATION REPORT
ANIMAL CARE FACILITY (BLDG 86)
LAWRENCE BERKELEY NATIONAL LABORATORY
BERKELEY, CALIFORNIA
(SUBCONTRACT 6715402)

ALAN KROPP
& ASSOCIATES, INC.

GEOTECHNICAL
CONSULTANTS

428

GEOTECHNICAL INVESTIGATION REPORT
ANIMAL CARE FACILITY (BLDG 86)
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BERKELEY, CALIFORNIA
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ALAN KROPP
& ASSOCIATES, INC.

GEOTECHNICAL
CONSULTANTS

ALAN KROPP, CE, GE
JAMES R. LOTT, CE, GE
MARLENE K. JACKSON, CE, GE
WAYNE MAGNUSEN, CE
DONALD L. IRBY, CE
THOMAS M. BRENCIC, CE

January 4, 2006
2335-2, L-27150

Mr. Steve Blair
One Cyclotron Road, MS B90K
Bldg. B90F, Room 101
University of California
Berkeley, California 94720

RE: Geotechnical Investigation Report
Animal Care Facility
Lawrence Berkeley National Laboratory
Berkeley, California
(Subcontract 6715402)

Dear Mr. Blair:

In accordance with your request, we have performed a geotechnical investigation for the proposed Animal Care Facility at the Lawrence Berkeley National Laboratory (LBNL). The accompanying report presents geologic and geotechnical data, geologic characterizations, the results of engineering analyses, and conclusions and recommendations for the design of the project. The report also presents the results of our screening-level investigation for landslide potential and discusses landslide-related risks for the project.

We note that the attached report is essentially unchanged from the draft document originally issued to you on September 30, 2004, and does not include the results of subsequent work conducted by our firm in the site vicinity. The conclusions and recommendations presented are based upon applicable standards of our profession at the time our report was prepared.

If you have any questions concerning our findings, please call us.

Very truly yours,

Wayne Magnusen, C.E.
Senior Engineer

Alan Kropp, G.E.
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
ALAN LEE KROPP
No. 487
Exp. 12/31/07
GEOTECHNICAL
STATE OF CALIFORNIA

letter of transmittal - FINAL

2140 SHATTUCK AVENUE BERKELEY, CA 94704 TEL 510.841.5095 FAX 510.841.8357 WWW.AKROPP.COM

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1.00 INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed new Animal Care Facility (ACF) at the Lawrence Berkeley National Laboratory (LBNL) in Berkeley, California. The project site is on the southwest side of Calvin Road between Buildings 83 and 85 in the East Canyon area of the LBNL facility. The approximate site location is shown on the Vicinity Map, Figure 1.

1.01 Project Description

As currently envisioned, the ACF will include an 11,500 square foot building that measures about 76 feet by 108 feet, in overall plan dimensions. The building will be constructed on a sloping site, much of which has been altered by grading to construct Building 83 and Calvin Road. The approximate location and configuration of the building is shown on the Site Plan, Figure 2. Note that the building descriptions in this report are based on a reference north aligned approximately 45 degrees from the direction of the exterior building walls.

Preliminary schematic drawings of the ACF building show a structure constructed on two levels. The upper floor level will be near Elevation +870 and will exist over the entire building footprint. The lower floor level will be near Elevation +855 and will only exist in the southeastern half of the building. A retaining wall is planned along the northwest side of the lower level, extending across the middle of the building footprint.

The northern corner of the building will extend into the current alignment of Calvin Road, which will be locally re-aligned as part of the proposed project. This modification will require cutting into the existing slope north of Calvin Road, where a retaining wall is currently planned to retain the cut. We have assumed that plans for the facility will also include various other site improvements such as subsurface utilities, exterior flatwork, equipment pads, and site retaining walls.

1.02 Special Project Consideration – Landslide Hazard

The site is located within an official State of California Earthquake-Induced Landslide Hazard Zone, as mapped by the California Geological Survey (CGS). This mapping, conducted under the Seismic Hazard Mapping Act of 1991, is intended to provide guidance to cities, counties and other lead agencies in their efforts to protect public health and safety. Similar to the Alquist-Priolo Earthquake Fault Zoning Act (A-P Act), the Seismic Hazard Mapping Act is directed at structures that are intended for human occupancy and requires "prior to approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard."

In 1997, the CGS issued Special Publication 117 (SP117), which presents guidelines for evaluating and mitigating seismic hazards in California. This publication is widely used by cities, counties and peer reviewers throughout California in determining the adequacy of geotechnical investigations conducted within the mapped seismic hazard zones. In our opinion, the landslide evaluation guidelines presented in SP117 generally constitute the current standard of practice for the evaluation of seismic hazards in California. This report includes the results of a screening investigation for landslide hazards, which we conducted in general accordance with guidelines presented in SP117.

1.03 Purpose and Scope of Services

The primary purpose of our geotechnical investigation was to evaluate the general suitability of the site for the proposed ACF and to provide geotechnical engineering recommendations for the work. As part of our study, we evaluated potential earthquake-induced landslide hazard risks for the ACF project in general accordance with the SP117 guidelines. William Lettis & Associates, Inc. (WLA), our engineering geology subconsultant, assisted us in our overall characterization of geologic conditions at the site and in preparing portions of this report.

Our scope of services was outlined in our proposal dated July 13, 2004 and consisted of the following:

- Compiling and reviewing existing subsurface data obtained from the previous geotechnical investigation reports by others;
- Conducting a field reconnaissance of the site area to provide relevant information on location, bedding attitude, and structure of existing bedrock, as well as information on the location of landslides, faults, and artificial fill in the direct vicinity of the site;
- Augmenting the available existing subsurface data by drilling two test borings near the northern and eastern corners of the planned ACF building. The northern boring was continuously sampled and logged using downhole televiewers to provide information on potential landslide slip surfaces at this location;
- Conducting geotechnical laboratory tests on samples of landslide slip surface materials to evaluate their residual strength and plasticity;
- Characterizing geologic and groundwater conditions in the direct vicinity of the site. This task included developing interpreted conceptual geometries of significant previous landslides in the area of the site;
- Analyzing site stability using 2-dimensional computer slope stability model. This task included calculating a factor of safety against slope failure under static and seismic conditions. The scope of our seismic stability analyses was limited to using a simplified pseudostatic model to calculate a factor of safety for a single level of seismic risk (a design-level earthquake having a 10 percent chance of exceedence in 50 years);
- Performing geotechnical engineering analyses to develop design-level recommendations for the project; and
- Preparing this geotechnical investigation report summarizing the results of our study.

We note that the site is not within an Alquist-Priolo Earthquake Fault Zone (A-P Zone) and that faults mapped near the site have been interpreted as inactive by previous LBNL consultants. Consequently, a site-specific surface fault rupture hazard evaluation was not included in our scope of services. Our scope of services also did not include an environmental assessment or investigation of the site for the presence of hazardous or toxic materials in the soil, groundwater, or air.

2.00 METHODS OF INVESTIGATION

2.01 Review of Existing Data

2.01.1 Oblique Photographs

AKA's reference library includes four historic photographs of the East Canyon area from 1885 and 1903. Two of these photographs were taken from upslope areas south of Strawberry Creek and show the East Canyon area prior to lab development. These two photographs are reproduced in this report on Figure 3. Examination of these photographs provides unique views of the geomorphology of the site, as briefly introduced below.

The vegetation of East Canyon at the time the photographs were taken consisted of mostly grasses with scattered conifers, oak trees, and low shrubs. The 1903 photograph shows the Such Dairy located at the base of the canyon, below the present-day LBNL campus. This later photograph also shows a shallow quarry within East Canyon, above the Such Dairy. A large oak tree can be seen above the quarry, which is also visible in the earlier 1895 photograph. The quarry cut and oak tree exist to the present day directly southwest of Building 83.

Both photographs show two roughly parallel drainages and a topographic bulge that extends from well above the oak tree and quarry to the bottom of East Canyon. This topographic bulge was considered by us to strongly suggest a landslide-related deposit. The approximate extent of this deposit is indicated in the 1903 oblique photograph at the top of Figure 4. During the course of our study, these photographs were re-examined to evaluate the extent and activity of landsliding within East Canyon. For comparison purposes, a current 2004 oblique photograph of the East Canyon area is presented on the bottom of Figure 4.

2.01.2 Aerial Photographs

Historic stereo aerial photographs from 1939 and 1947 were also examined in an attempt to evaluate the extent and activity of landsliding within East Canyon. Dense plantings of eucalyptus trees within the canyon precluded a detailed analysis of the geomorphology, and thus the aerial photographs were of limited usefulness. Similar statements regarding aerial photographs of later vintages appear in other geotechnical reports for the site.

A single, vertical aerial photograph of the East Canyon area from 2004, acquired in digital format from Mr. Steve Blair of LBNL, was analyzed for evidence of local slope instability (e.g., landslide morphology, springs, etc.). This photo also provided an overview of the extent of recent grading in areas upslope of the site.

2.01.3 Published Geologic References

We also reviewed published geologic maps and literature pertaining to geologic and seismic conditions in the project vicinity. These references were used primarily to determine site-to-source distances to principal active faults, and to check for previously-mapped landslides in the project vicinity. A list of selected references is presented in Appendix A.

2.01.4 Unpublished Consulting Reports

A substantial amount of information exists regarding geotechnical and geologic conditions within the East Canyon area from unpublished consulting reports relating to previous projects in the vicinity. As part of our study, we reviewed or consulted reports relating to:

- Cell Culture Facility, Building 83 (geotechnical investigation, 1977)
- Hazardous Waste Handling Facility, Building 85 (geotechnical investigation, 1994)
- Hazardous Waste Handling Facility, Building 85 (fault investigation, 1994)
- Human Genome Laboratory (geologic evaluation, 1994)
- Building 85 Slide (geotechnical investigation, 1995)
- Building 85 Modular Office Pad (geotechnical investigation, 1996)
- Road and Water Tank (geotechnical investigation, 2001)

We also consulted a variety of other unpublished reports and references pertaining to the geology and hydrogeology of the LBNL facility and for downslope areas surrounding Centennial Drive. A list of selected references is presented in Appendix A.

Some of the data contained in the referenced reports was used and relied upon during our geologic and geotechnical evaluations of conditions affecting the proposed ACF site. The locations of nearby borings and test pits used in our geotechnical evaluations are shown on the Site Plan, Figure 2. Logs of selected borings and test pits are attached at the end of Appendix B.

2.01.5 Personal Communications

WLA's engineering geologists conducted phone conversations, an office meeting, and a field meeting with Mr. Preston Jordan, LBNL geologist, regarding the geologic and engineering geologic conditions of the East Canyon area. Mr. Jordan was present during a significant portion of the grading operations for Buildings 84 and 85, and has logged numerous crib-wall and road cuts, trench exposures, and borings since 1993. He is familiar with the various geological investigations previously conducted in the East Canyon area and compiled geologic maps and cross sections for the RCRA Facilities Investigation (RFI) Final Report in 2000. WLA met with Preston Jordan at his LBNL office on September 2, 2004, and in the field on September 10, 2004.

We received written communication from him in the form of a summary letter, excerpts from the RFI Final Report (2000), and groundwater boring logs and monitoring well data for the areas surrounding Buildings 85, 83, and 74. A portion of an interpretive geologic map of the East Canyon area from the RFI report is reproduced on Figure 5.

2.02 <u>Field Investigation</u>

2.02.1 Geologic Mapping

WLA's engineering geologists conducted surface reconnaissance of the site on August 12, and September 10, 2004. The purposes of the visits were to: (1) conduct detailed mapping of geologic deposits and artificial fill, (2) ground truth landslides identified on aerial photographs and historical photographs, (3) preliminarily evaluate roads, curbs, and sidewalks for signs of slope instability, and (4) identify preferred boring locations for the evaluation of geologic conditions.

Detailed mapping of the upper East Canyon and proposed ACF site was performed on a 1:1,200 scale topographic base map with 2-foot and 10-foot contour intervals on August 12, 2004. The base map was provided by Mr. Steve Blair of LBNL in digital form in early August, 2004. Mapping focused on identifying bedrock units, surficial deposits, and artificial fill, and on evaluating fault and landslide contacts drawn from previous investigations (e.g., HLA, 1982; Borg, 1991; Collins, 1993; Gilpin, 1994; GRC, 1994a and b), and our interpretation of historical photography. The results of the geologic mapping are discussed in "Section 4.00, Local Geologic Conditions."

A primary motivation for evaluating the bedrock geology was to evaluate whether bedrock faults and folds were preferentially oriented so as to form local zones of instability for structurally-controlled bedrock-landsliding and to identify geomorphic features suggestive of past and recent landsliding. Efforts to delineate landslide margins within East Canyon based on surface morphology were severely limited in the region of the proposed ACF because of recent extensive grading and topographic modification.

2.02.2 Borings

We drilled two test borings (AKA-1 and AKA-2) between August 16 and 18, 2004. Pitcher Drilling Company of East Palo Alto, California, drilled the borings using track-mounted rotary wash drilling equipment. Borings AKA-1 and AKA-2 extended to depths of 74 feet and 33 feet, respectively. The approximate locations of the borings are shown on Figure 2.

AKA's Project Engineer, Ms. Janette Prosser, C.E., supervised the drilling operations, logged the soils and bedrock encountered, and obtained samples of the subsurface materials for subsequent evaluation and laboratory testing. Boring AKA-1 was continuously sampled in order to: (1) identify potential landslide slip surfaces, and (2) obtain samples of the slip surface materials for laboratory strength testing. Boring AKA-2 was sampled at 5-foot intervals with the purpose of evaluating geotechnical conditions and to provide additional information on the lateral continuity of landslide slip surfaces.

Samples of soil and highly weathered bedrock were obtained using a 2½-inch inside diameter Modified California split barrel drive sampler equipped with brass liners or a "Pitcher barrel" sampler equipped with 3-inch diameter steel Pitcher tubes. Harder bedrock was cored using rock coring equipment and was sampled using a core barrel. Core samples were carefully removed from the inside liner, washed and transferred to core boxes. Pitcher samples were extruded onsite and transferred to core boxes. Samples not in brass liners were covered with plastic wrap to protect them from moisture loss and breakage.

Logs of borings AKA-1 and AKA-2 are presented in Appendix B together with the Key to Exploratory Boring Logs, Figure B-1) . The subsurface conditions encountered in the borings are described in "Section 5.02.2, Geologic Logging of Borings AKA-1 and AKA-2."

The locations of the borings were approximately determined by pacing and tape measuring from cultural landmarks (e.g., building corners). Ground surface elevations at each boring location were approximately determined by interpolation between contours on the existing (circa 2003) LNBL topographic map (received from LBNL in August 2004). The locations and elevations of the borings should be considered accurate only to the degree implied by the methods used.

2.02.3 Geophysical Logging

Norcal Geophysical Consultants, Inc. (Norcal) of Petaluma, California, performed geophysical logging of boring AKA-1 on August 17, 2004. The geophysical logging instrumentation (console, computer, downhole tools, winch) consisted of a digital Robertson Geologging, Ltd. Model Videologger 2000 System. The downhole tools consisted of an optical televiewer and a high resolution acoustic televiewer.

The optical televiewer (OTV) is a downhole probe containing a charged coupled device (CCD) type analog to digital video camera. The optical televiewer can operate in either dry or water-filled portions of a boring providing the water-filled portion is optically clear. Downhole logging speeds ranged from 3 to 4 feet per minute. The data sampling rate for OTV logging was every 0.004 feet. The radial resolution was set to 0.5 degrees. The acoustic televiewer (ATV) is an ultrasonic device that can image the boring sidewall by measuring variations in travel time and amplitude of a reflected signal generated by a rotating ultrasonic transducer (center frequency of 1.0 MHz). Operation of this log requires the boring to be fluid-filled with a medium such as water or thinned slurry. Logging speed varied from 3 to 4 feet per minute. The data was sampled every 0.004 feet at a radial resolution of 1 degree.

Boring sidewall images are referenced to magnetic north as measured by onboard magnetometer sensors. The inclination of the boring was recorded by an omni-directional three-axis accelerometer. As a quality control procedure, the OTV and ATV tool's north reference (magnetic north) was verified with a *Brunton* compass prior to logging.

Orientations of discontinuities (fracture, bedding, etc.) were calculated with the computer reduction program RGLDIP Version 6.1 published by Robertson Geologging, Ltd. This program displays "unwrapped" 360 degree depth sections of borings on a computer screen allowing the interpreter to interactively select points along the trace of a boring discontinuity. Typically, 5 to 10 points are manually chosen along each discontinuity. After point selection, the program at this level calculates a "best fit" ellipse that represents the three-dimensional plane of the discontinuity in terms of dip direction and dip magnitude. The traces of most boring discontinuities were continuous (360 degrees) across the unwrapped image plot. However, in some complex zones or in high angle fracture zones, only portions of the discontinuity trace were observed. Though these traces are discontinuous, the program has the facility to extrapolate a reasonable dip magnitude and dip direction to these partial traces.

Interpreted OTV and ATV plots prepared by Norcal are presented in Appendix C. The OTV plot contains a "core-like" projection viewed from the northeast (N045 degrees) and a complete unwrapped (360 degree) 2-D image of the boring wall corrected to true north as a function of depth. This interpreted OTV plot contains a comment section which lists the orientation of each identified discontinuity in terms of dip direction and dip magnitude. The interpreted ATV plot shows an unwrapped, false color 2-D image of the boring wall. A comment section lists the orientation of each identified discontinuity in terms of dip direction and dip magnitude. The results of the geophysical logging are described in "Section 5.02.3, Optical/Acoustical Borehole Analysis."

2.03 Laboratory Testing

Soil and rock samples were examined in our laboratory for more detailed examination and to select specimens for laboratory analyses. The laboratory testing program was directed at evaluating the drained residual strength

of interpreted landslide slip surface materials for use in our slope stability analyses. One approximately 6-inch-long sample from AKA-1 at 24 feet to 24.5 feet in depth was judged to be a slippage zone likely related to landsliding (see Appendix B for boring log). This sample and a 6-inch-long sample of similar but less sheared material from directly below it were wrapped in plastic and delivered to Cooper Testing Laboratory in Menlo Park, California for laboratory analysis.

The drained residual shear strength of the upper sample was evaluated by performing a drained residual torsional ring shear test (ASTM D-6467). The test is performed by deforming a presheared, remolded specimen at a controlled displacement rate until the constant minimum drained shear resistance is obtained on a single shear plane determined by the configuration of the apparatus. An unlimited amount of continuous shear displacement can be achieved to obtain a residual strength condition. Three normal stresses were applied to determine the drained residual friction angle of the test specimen. We note that the resulting undrained strengths represent a conservative lower bound for slope stability analysis, as the in situ slide material likely has undergone some consolidation and aging effects that tend to increase the strength of the materials over time after initial failure of the slide.

Atterberg Limits determinations (ASTM D-4318) were also performed on both the upper and lower samples to evaluate their Plastic and Liquid Limits. The Liquid Limits were used in conjunction with published correlations (Stark and Eid, 1997) to provide a second estimate of the drained residual friction angle for these two samples.

The laboratory test results are presented in Appendix D.

3.00 GEOLOGIC/SEISMIC SETTING

3.01 Berkeley Hills Geology

The site is situated on the west side of the northwest-trending Berkeley Hills in an area characterized by gentle to steep hillside topography. Bedrock geology in the Berkeley Hills is complex and includes a variety of highly deformed sedimentary, volcanic and metamorphic rock units. These rock units range in age from Late Jurassic (135 to 150 million years ago) to Quaternary (the past 1.8 million years). The geologic units mapped in the general area of the site include Claremont Chert, Orinda Formation, Moraga Volcanics and San Pablo Group. The bedrock geology of the East Canyon area is discussed in greater detail in "Section 4.00, Local Geologic Conditions."

3.02 Bay Area Active Faults

The coastal areas of Northern California are tectonically located near the contact between the North American and Pacific crustal plates. This seismic regime is characterized by northwest-trending faults. These faults exhibit mainly right lateral strike-slip movement, (which means that the movement is predominantly horizontal and when viewed from one side of the fault, the opposite side of the fault is seen to move to the right). Faults that are defined as active exhibit one or more of the following: (1) evidence of Holocene-age (within about the past 11,000 years) displacement, (2) measurable tectonic creep along fault lines, and/or (3) close proximity to linear concentrations or trends of earthquake epicenters. Potentially active faults are defined as those that have evidence of Quaternary-age displacement (within the past 2 million years).

The locations of active and potentially active faults in California have been mapped by various researchers. The closest known active fault to the project site is the Hayward fault which has been mapped by Lienkaemper (1992) approximately 3,800 feet southwest of the site passing through Memorial Stadium. As part of the Alquist-Priolo Fault Evaluation Program, the State Geologist in conjunction with the California Division of Mines and Geology (CDMG) delineated Earthquake Hazard Zones around known active faults (e.g., A-P Zones). Recently, the CDMG has changed its name to the California Geological Survey (CGS), and the CGS continues to revise and update the A-P Zone maps.

The CGS also developed Active Fault Near-Source Zone maps to be used in conjunction with the Uniform Building Code (UBC). The Active Fault Near-Source Zone Maps are used with the UBC to characterize earthquake groundshaking for code-based structural design. The UBC methodology characterizes the more significant active faults as A or B based on the following: Seismic Source Type A refers to faults having a slip rate greater than 5mm per year that are capable of producing an earthquake having a maximum Moment Magnitude greater than 7. Source Type B refers to faults not included in Type A having a slip rate greater than 2mm per year capable of producing an earthquake having a maximum Moment Magnitude greater than 6.5. Faults that are deemed less significant are classified as Source Type C which signifies faults having a slip rate less than 2mm per year that are not thought to be capable of producing an earthquake having a maximum Moment Magnitude greater than 6.5. The following table shows approximate distances to major Bay Area active faults, the UBC seismic source type, and the UBC estimated maximum Moment Magnitude earthquake for each fault:

Table 1. Principal Bay Area Active Faults

Seismic Source	Approximate Distance from Site	Approximate Direction from Site	UBC Seismic Source Type	UBC Maximum Moment Magnitude
San Andreas	30 km	Southwest	A	7.9
San Gregorio	31 km	Southwest	A	7.3
Hayward/Rodgers Creek	1 km	Southwest	A	7.1
Calaveras	19 km	East	B	6.2
Concord-Green Valley	22 km	Northeast	B	6.9
West Napa	33 km	North	B	6.5

3.03 Regional Seismicity

The site is located in the San Francisco Bay Area, a region characterized by a high level of seismic activity. Movement normally occurs as right-lateral shear, along a series of northwest-trending, near-vertical, active strike-slip faults. These faults include the active San Andreas, Hayward, Rodgers Creek, Calaveras, San Gregorio, Concord, Green Valley, West Napa, and Greenville faults. Historically, this region has experienced strong ground shaking from large earthquakes, and will continue to do so in the future.

Since 1800, five earthquakes have occurred in the Bay Area having estimated Moment Magnitudes greater than 6. In 1836, an earthquake with a Moment Magnitude of approximately 6.3 occurred east of Monterey Bay. In 1838, an earthquake having a Moment Magnitude of about 7.5 occurred on the San Andreas fault. In 1868, an earthquake occurred on the southern section of the Hayward fault that had an estimated Moment Magnitude of 6.8. The San Francisco Earthquake of 1906 with an estimated Moment Magnitude of about 7.9 created a

250-mile-long surface rupture along the San Andreas fault extending from San Juan Bautista to Shelter Cove. The most recent earthquake to significantly affect the Bay Area was the 1989 Loma Prieta event with an estimated Moment Magnitude of 6.9.

In 2003, the Working Group on California Earthquake Probabilities (WG02), in conjunction with the United States Geological Survey (USGS), published an updated report evaluating the probabilities of significant earthquakes occurring in the Bay Area over the next three decades. WG02 finds that there is a 0.62 (62 percent) probability that at least one Moment Magnitude 6.7 or greater earthquake will occur in the San Francisco Bay region before 2032. This probability is an aggregate value that considers seven principal Bay Area fault systems and unknown faults (background values). The probability that a Moment Magnitude 6.7 or greater earthquake will occur in the San Andreas or Hayward faults in the next 30 years are 0.21 (21 percent) and 0.27 (27 percent), respectively. The WG02 published background value indicates that within the next 30 years, there is a 0.14 (14 percent) chance that an earthquake with a Moment Magnitude of greater than 6.7 may occur in the Bay Area on a fault system not characterized in the study.

4.00 LOCAL GEOLOGIC CONDITIONS

4.01 East Canyon Geology

The East Canyon portion of the LBNL campus is underlain by Tertiary sedimentary and volcanic bedrock, unconsolidated to semi-consolidated Quaternary colluvium, debris-flow deposits, landslide deposits, and artificial fill. The bedrock geology of the East Canyon consists of Tertiary sedimentary and volcanic rocks that are gently folded along the eastern limb of a south plunging syncline. The eastern limb of the syncline is cut by two north to northwest-striking faults: the Wildcat and East Canyon faults. Tertiary bedrock units encountered in the valley include from oldest to youngest: Claremont Chert, San Pablo Group, Orinda Formation, and Moraga Formation.

The Site Geologic Map presented on Figure 6 shows bedrock units, bedrock faults, and probable deep-seated, bedrock-involved landslide deposits in the direct vicinity of the ACF. For clarity, we do not delineate areas covered by Quaternary colluvium, shallow landslide deposits, debris-flow deposits, or artificial fill on Figure 6, but do so on the geologic cross sections (Figures 7 and 8). The site geologic map and cross sections are based on our compilation of previous borings, trenches, test pits, previous geologic studies (most notably those of Collins [1993] and the RFI Final Report [2000]), our geologic mapping and subsurface data collected for the proposed ACF, and personal and written communication with Preston Jordan. A list of published and unpublished references used to evaluate the geologic conditions of the East Canyon area are provided in Appendix A. The results of our evaluations are discussed in greater detail in the sections that follow.

4.02 Unconsolidated Deposits and Fill

4.02.1 Undifferentiated Surficial Deposits (Quaternary) – Symbol Qu

Quaternary colluvium, minor clay-rich alluvium, and debris-flow deposits exist in the ACF site vicinity; although much of the natural surficial deposits that once existed in the East Canyon have been removed by previous grading. A relatively thin mantle of surficial soil exists on the small hill that currently exists at the ACF site (Figure 7, Cross Section A-A'). Prior to grading, streams flowed down the east and west margins of East Canyon. Within and beneath these lateral channels are accumulations of clayey alluvium, mudflow, and debris-flow deposits (Figure 8, Cross Section B-B') derived from the head of the canyon and from steep, northeast-trending ravines along the east side of the canyon.

4.02.2 Artificial Fill – Symbol af

Development within the East Canyon has included the placement of artificial fill in areas to the west and north of the ACF site. Artificial fill was placed upslope and north of the ACF site to construct roadway embankments and to repair subsequent shallow slope failures (Figure 7, Cross Section A-A'). Artificial fill also exists within the former stream channel west of the ACF site and beneath portions of Building 85 (Figure 8, Cross Section B-B').

4.03 <u>Bedrock Units</u>

4.03.1 Claremont Chert (middle to late Miocene) – Symbol Tc

The oldest strata that crop out in the East Canyon campus are well-bedded, silicious shale and chert of the Claremont chert. Also called the Claremont shale, this resistant unit underlies the steep slope on the east side of the canyon, and dips moderately to steeply northeast. The unit is bound to the west by the steeply east-dipping Wildcat fault and a secondary strand of the Wildcat fault (Figure 6).

4.03.2 San Pablo Group (middle to late Miocene) – Symbol Tsp

Claystone, siltstone, and fine sandstone of the San Pablo Group lie west of the Wildcat fault in East Canyon (Figure 6). This unit has been mapped as the Orinda Formation in previous investigations. Exposures during grading for Buildings 84 and 85 revealed characteristics more consistent with facies of the shallow marine San Pablo Group (P. Jordan, pers. communication, 2004). Outcrop characteristics include fine-grained texture and a grey color, which are distinct from the more oxidized, and multi-colored beds and coarser-grained texture of the Orinda Formation rocks. Bedding exposed along a roadcut exposure directly north-northwest of the proposed ACF shows gentle (10° to 15°) dips to the northwest. The unit is bound to the east by the Wildcat fault (Jordan, 1997). The western extent of the San Pablo Group and the nature of the contact with rocks of the Orinda Formation are unclear, although previous investigations (Collins, 1993; RFI Final Report, 2000) show this contact as a sub-vertical fault.

4.03.3 Orinda Formation (late Miocene) – Symbol To

The Orinda Formation in the East Canyon area consists of non-marine, well to poorly bedded siltstone, fine lithic sandstone, and pebble conglomerate. The conglomerate contains a high percentage of detritus derived from the Franciscan complex (Graymer, et al., 1996). The Orinda Formation does not naturally crop out within the East Canyon, but exposures of slightly to moderately sheared Orinda Formation during grading and pier drilling for Building 85 and grading for Calvin Road directly north of the proposed ACF demonstrate that it is locally present beneath the western portion of East Canyon. Fault-bounded, discontinuous blocks of Orinda Formation mixed with blocks of Moraga Formation volcanic rocks were exposed during grading and slide repair of a cut-slope directly north of Building 83. These discontinuous blocks have been interpreted to be part of a mixed unit of landslide deposits (Harza, 1995; RFI Final Report, 2000; Preston Jordan, pers. communication, 2004). Although we interpret the contact between San Pablo Group and Orinda Formation as a concealed, sub-vertical fault (Figures 1 and 8), following Collins (1993) and RFI Final Report (2000), it is permissible that the Orinda Formation and San Pablo Group interfinger in a depositional contact beneath East Canyon (P. Jordan, pers. communication, 2004). Based on trench exposures at Building 85, the western margin of Orinda Formation is in fault contact with Moraga Formation volcanic rocks across the East Canyon fault (Figure 6).

4.03.4 Moraga Formation (late Miocene) – Symbol Tm

The Moraga Formation in East Canyon consists of andesite, basalt, and rhyolitic tuff. Regionally, the Moraga Formation depositionally overlies and locally interfingers with the Orinda Formation. Moraga Formation crops out in the hills along the west side of East Canyon, west of the East Canyon fault. Volcanic rocks within the lower part of East Canyon—found in outcroppings (e.g., at the old quarry directly south of Buildings 83 and 85B) and in borings—have a less certain origin. These rocks located east of the East Canyon fault delineate a 2500-foot-long and 200- to 400-foot-wide tongue of predominantly brecciated Moraga Formation that extends roughly north-south within the floor of the East Canyon. This section of Moraga Formation can be traced south to Strawberry Creek (RFI Final Report, 2000). This and similar zones of Moraga Formation in the central portion of the LBNL campus lie structurally below the main outcrop belt of Moraga Formation rocks regionally. The tongue of Moraga Formation in East Canyon has been interpreted to be either a fault-bounded block (e.g., Collins, 1993), or part of a planar block landslide deposit (e.g., RFI Final Report, 2000), as shown on Figure 8. We summarize evidence supporting a landslide origin of this block later in this section.

4.04 Bedrock Faults

The north- to north-northwest-striking, steeply dipping bedrock faults mapped previously in the East Canyon area of the proposed ACF include the Wildcat and East Canyon faults. These faults bound the margins of the East Canyon and possibly underlie it (Figure 6). Through review of existing data and geologic mapping, we evaluated these faults with respect to their structural control on landsliding in the valley. Both faults have been demonstrated by previous subsurface investigations to be inactive (that is, not active within the past 11,000 years). Numerous proposed fault traces within the East Canyon, in addition to those we show on Figure 6, are compiled by Collins (1993). A discussion of some of these postulated secondary faults is provided below, following a review of the Wildcat and East Canyon faults.

4.04.1 Wildcat Fault

The Wildcat fault is a regionally continuous, right-lateral strike-slip fault that locally separates Claremont chert (Tc) on the east against San Pablo Group (Tsp) on the west. The Wildcat fault is mapped about 90 feet east of the proposed ACF. The fault trace crosses the lower portion of the hills on the east side of East Canyon directly northeast of Building 84, and farther up the canyon it lies near the eastern margin of the East Canyon floor. West of the Wildcat fault lies a subparallel fault that locally separates Claremont chert and San Pablo Group rocks, that was exposed as a steeply west-dipping fault within San Pablo Group rocks during grading for Building 84. Neither of these eastern bedrock faults appears to influence the location of deep-seated landsliding within East Canyon, as the mapped eastern margin of the slide deposits cuts across the fault traces northeast of the proposed ACF (Figure 6). The gently north-dipping San Pablo Group beds east of the secondary fault likewise do not appear to control the orientation of landsliding.

4.04.2 East Canyon Fault

Aligned historical springs and subtle morphology define the trace of the East Canyon fault (Borg, 1991) and it is located about 200 feet west of the proposed ACF (Figure 6). This fault places Moraga Formation to the west against Orinda Formation to the east in the site vicinity (Figure 6; contacts shown are based on RFI Final Report, 2000 and P. Jordan, pers. communication, 2004). The fault is inferred to be sub-vertical, and has been interpreted as inactive based on trench exposures (GRC, 1994a). Sheared clay gouge between blocks of

andesite within Trenches 1 and 2 of GRC (1994a), and abrupt thickening of unconsolidated deposits in Trench 2 above a mapped "possible landslide headscarp" may be due to deep-seated landsliding. In a written communication, Preston Jordan clearly states that Orinda Formation rocks exposed during grading and pier drilling for Building 85 contained shears, and potentially are part of deep-seated translational slide blocks as well (P. Jordan, pers. communication, 2004). Thus, it is possible that the East Canyon fault locally controls the extent of deep-seated bedrock landsliding. In the absence of more conclusive evidence, our preferred geologic interpretation (Figures 6 and 8) shows the western margin of landslide deposits east of the East Canyon fault, and aligning with a former south-flowing drainage bounding the western side of the valley. The interpreted inactivity of the shears within Trenches 1 and 2 by GRC (1994a) implies that any deep-seated landsliding, if present and associated with these shears, is also inactive, at least under historical site conditions.

4.04.3 Secondary Faulting

As far as we know, there are not data to support or refute a fault contact between San Pablo Group and Orinda Formation rocks beneath East Canyon. Our location for this north-striking, steeply dipping fault is west of similar faults shown in Collins (1993) and RFI Final Report (2000), and is based on our interpretation of predominantly grey siltstone to fine sandstone as San Pablo Group in the borings AKA-1 and AKA-2 (Figure 8). Reddish layers of slightly coarser sands near the base of boring AKA-1 are similar to descriptions of the Orinda Formation (P. Jordan, pers. communication, 2004), and possibly indicate that the Orinda Formation interfingers with the San Pablo Group near the vicinity of boring AKA-1. Regardless, there is no evidence to support the notion that this previously inferred secondary fault provides a planar-preferred orientation for bedrock landsliding.

It is unclear whether folding or tilting of strata within the floor of East Canyon have oriented bedding plane discontinuities with down-canyon dips that may act as zones of enhanced slope instability. Examination of rock core from boring AKA-1 indicates that bedding is sub-horizontal, although the televiewer log was unable to capture these beds and definitively determine down-dip direction (Appendix C). We are unaware of any other bedding data within the Orinda Formation or San Pablo Group beneath the floor of East Canyon.

4.05 Landslides

4.05.1 Landslide Morphology and Deposits

Landsliding within East Canyon has occurred at a variety of scales and involves a variety of mass-wasting processes. Landslide deposits within the site are extensive, and are derived from several types of materials, including: (1) reworked Quaternary deposits, (2) mixed Orinda and Moraga Formation (symbol Qls[mo]), (3) largely homogeneous but brecciated Moraga Formation (symbol Qls[m]), and (4) San Pablo Group (symbol Qls[sp]). Landslide extent has been mapped based on both valley morphology and landslide-related deposits encountered during grading activities. Mapping of the East Canyon and compilation of existing geologic data indicate that sliding within the East Canyon is complex and consists of a nested sequence of individual slides that exhibit a variety of failure modes. The landslide areas shown on Figure 6 depict earthflows and rotational slumps at the scale of tens of feet long and wide, a larger, intermediate slide on the order of 400 feet long and 200 feet wide, and an extensive, translational block slide at least 900 feet long and up to 400 feet wide within a 2,500-foot-long locally extensive landslide deposit. In the section below, we describe the different scales of landsliding present in the East Canyon from smallest to largest. As mentioned above, Figure 6 shows bedrock units and bedrock-involved landslide deposits. We depict the limits, but not the deposits, of shallower landslides believed to involve unconsolidated soil, colluvium, and perhaps regolith (i.e., near-surface weathered bedrock).

4.05.2 Small Earthflows and Slumps

Several small-scale earthflows and slumps have formed in the site vicinity, occurring both on natural hillsides and graded slopes (Figure 6). The smaller slides likely involve reactivation of localized portions of the larger, older slides. At least four slope failures have occurred historically, and most have occurred during grading operations that temporarily removed support from the toe of the slope. Grading-related failures include a slide behind Building 84 (LBNL Plant Engineering Dept. Landslide #41), a landslide below the transmission tower by the water tank road, and repeated sliding of the slope behind the crib wall located directly north-northeast of the proposed ACF (e.g., Harza, 1995). Other small scale slope failures include a slump in the cut slope directly north of Building 83 near the proposed ACF, and a slump on the west side of East Canyon north-northwest of Building 85A. Signs of recent movement within this last slide include cracking and downdropping of an asphalt PG&E access road, although this failure may be partly within fill. The dimensions of these failures are typically tens of feet wide by up to 100 feet long, and the depths of these failures likely range from a few to perhaps 15 feet. Harza (1995) documented a maximum slide depth of 8 feet for one episode of the crib-wall failure directly north-northeast of the proposed building site. These failures are likely within unconsolidated Quaternary deposits or poorly consolidated, bedrock-involved slide debris (e.g., mixed landslide debris). In summary, because of slope stability mitigation to some of these shallow slope failures and their distance from proposed ACF, only the slump mapped on the southeast-facing steep cut slope appears to have the potential to directly affect the proposed ACF.

4.05.3 Intermediate Landslides

At least one landslide that we classify as "intermediate scale" has been mapped within the study area. The intermediate slide is a southeast-directed landslide south of Building 85, which crosses the Building 83 lot, and was previously identified as Landslide #40 on a 1981 LBNL Plant Engineering Dept. map (Figure 6, from Collins, 1993). Our field reconnaissance confirmed the presence of this landslide, which is expressed as slightly incised lateral margins and hummocky topography. This slide is approximately 400 feet long and up to 200 feet wide. The depth of sliding is likely on the order of several to tens of feet, and involves unconsolidated Quaternary deposits and poorly consolidated bedrock-involved landslide deposits and weathered bedrock. We call attention to this scale of landsliding because it is possible that this is the scale of individual earthflows or complex translational slides that typically fail within the larger landslide mass within East Canyon. For instance, pre-grading topography and historical photos show lobate, hummocky topography within the floor of East Canyon that collectively outlines an area of slope instability and landsliding (see Figures 4 and 5). The scale of individual earthflow or slide movements within this mass, however, is poorly defined, but the several hundred feet–scale of topographic undulations suggest that this may be an appropriate length-scale for earthflow movements within the larger slide body. As shown on Cross Sections A-A' and B-B', we interpret an intermediate-scale landslide (designated Upper Landslide on Figures 7 and 8) based on compilation of existing geologic and geotechnical data, our site reconnaissance, and subsurface investigation that encountered a clay gouge at about 10.5 feet in depth in boring AKA-1. In a later section, we discuss evidence for the possible extent and depth of sliding for an intermediate-scale slide mass (e.g., Upper Landslide) that underlies the proposed ACF.

4.05.4 Large-Scale Landslides

The largest scale of landsliding observable in the East Canyon encompasses most of the canyon floor within and below this portion of the LBNL campus (Figures 5 and 6). Deposits related to this landslide mass include

Moraga Formation-derived volcanic breccia (Qls[m]) and areas of mixed Orinda Formation and Moraga Formation, or the "Mixed" unit (Qls[mo]). The limits of the slide deposits, and limits of large, bedrock-involved landslide deposits elsewhere on the LBNL campus, are described in the RFI Final Report (2000) and are shown on Figure 4.2-1 of that report.

Multiple lines of evidence support the Moraga Formation and Orinda-Moraga "Mixed" unit rocks in the canyon floor as being of landslide origin rather than having been emplaced by tectonic faults (RFI Final report, 2000; cf. Collins, 1993). The morphology of the canyon floor is one strong line of evidence supporting a Quaternary landslide origin for these deposits. Historical aerial photographs and oblique photographs, coupled with our geologic mapping of the upper East Canyon, show hummocky, lobate topography within the valley floor, roughly confined between two stream channels that follow the east and west sides of the valley. Stratigraphic lines of evidence include the presence of slickensides of a wide range of orientations within exposures of "mixed" deposits and the pervasive brecciation of the volcanic masses. Hydrologic properties of materials are an additional line of evidence supporting this origin. Moraga Formation-derived rocks of the landslide deposits are hydrologically distinct from Moraga Formation rocks within the main outcrop belt, perhaps indicative of pervasive fracture and brecciation during landsliding (P. Jordan, pers. communication, 2004). The composition and surface distribution of these landslide deposits indicates long cumulative transport. The farthest down-canyon extent of landslide-related Moraga Formation lies over 1000 feet from the closest in-place outcrop of Moraga Formation. Additionally, the "Mixed" unit of Orinda and Moraga formation rocks overlying San Pablo Group deposits indicates significant transport and internal deformation.

Constraints on the length and failure mechanisms of such large landslide masses within the East Canyon are poor because of the extensive topographic modifications in the area. However, based on pre-grading hummocky topography within the valley floor, and the presence of a landslide shear plane within moderately weathered, moderately hard bedrock within boring AKA-1 (Appendix B), we delineate a possible large landslide with poorly constrained length and width dimensions of about 900 feet and 400 feet long, respectively. This interpreted large landslide encompasses the proposed ACF footprint. The large landslide is shown as the "Lower Landslide" on Cross Sections A-A' and B-B' (Figures 7 and 8).

Note that the dimensions of the Lower Landslide shown are based on limited subsurface information, which we describe in subsequent sections of this report. We emphasize that this landslide extent is preliminary, and further work is recommended to evaluate this slide geometry. For instance, it is possible that deeper landslide planes have been active in the past, and that a deep large landslide could have mobilized as a coherent slide block.

5.00 SITE CONDITIONS

5.01 Surface Conditions

In general, the natural surface grades in the area of the site slope generally down to the south at approximately 5:1 (horizontal to vertical). These natural surface grades have been extensively modified to construct Buildings 83 and 85, which included grading for Calvin Road. The current site grades include 2:1 cut slopes adjacent to Building 83 and Calvin Road, and higher uncut areas in the central portion of the ACF site that are near original surface grades. The portion of Calvin Road directly north of the site slopes down toward the east at a grade of approximately 10 percent.

5.02 Subsurface Conditions

5.02.1 General

Our interpretation of subsurface conditions at the site is shown on the geologic cross sections (Figures 7 and 8) prepared from compiled geologic and geotechnical data for the East Canyon area. In general, the site is directly underlain by relatively thin surficial soils over disturbed and translated bedrock (landslide debris). In-place bedrock underlies the site at depth.

We obtained information on subsurface conditions in the general vicinity of the proposed ACF from a variety of sources including: (1) geologic logging of borings AKA-1 and AKA-2, (2) geophysical logging of borings AKA-1 and AKA-2, (3) previous test borings, (4) previous trenches and test pits, (5) previous geotechnical laboratory testing, and (6) previous groundwater monitoring data. A summary of subsurface conditions based on information obtained from these sources is presented in the following sections.

5.02.2 Geologic Logging of Borings AKA-1 and AKA-2

Borings AKA-1 and AKA-2 encountered landslide debris over rock comprised of predominantly intact, fine-grained sandstone and siltstone that extended to the maximum depth explored (74 feet). The landslide deposits and underlying rock are described below.

- Landslide deposits: In boring AKA-1, we recognize at least two distinct landslide deposits designated herein as the Upper Landslide deposit (shallow) and Lower Landslide deposit (deeper). In boring AKA-1, the Upper Landslide debris extends to about 10.5 feet in depth and separates highly weathered and fractured volcanic bedrock of the Moraga Formation from underlying fractured fine-grained claystone to siltstone of the Orinda Formation. The lower landslide debris is defined by weathered and weak reddish-brown fractured siltstone of the Orinda Formation and sheared bluish-gray siltstone and clay gouge of the San Pablo Group and extends across about a 4-foot-wide zone between 24 and 28 feet in depth, where it is underlain by relatively competent, moderately strong blocky fine-grained sandstone to siltstone of the San Pablo Group. Both the upper and lower landslide debris consisted of dense to very dense angular rock fragments within a seamy, clay-rich matrix. Distinct basal shear planes (slip zones) characterized by at least several inches of highly plastic clay gouge were observed at 10.5 feet (Upper Landslide) and 24.0 ft in depth (Lower Landslide), in boring AKA-1. No prominent basal shear planes were noted in boring AKA-2, although shear planes could exist between sampling intervals (unlike AKA-1, AKA-2 was not continuously sampled).

- Competent bedrock or possible ancient landslide debris/translated bedrock: Rock encountered beneath the lower landslide debris in borings AKA-1 and AKA-2 consists of competent bedrock or possible ancient landslide debris. In AKA-1, the rock consists mostly of bluish-gray fine-grained sandstone to sandy siltstone of the San Pablo Group with 1- to 3-foot-thick interbeds of bluish-gray to brown clayey siltstone to claystone at depth intervals of 44-45 feet, 62-65 feet, and 69.5-72 feet. The finer-grained interbeds frequently contain blocky fractures, shears, and crushed rock fragments, some of which are cemented. Although these clayey interbeds lack the penetrative shear fabric characteristic of the upper and lower basal landslide planes, it is possible that these sheared and fractured regions represent ancient landslide planes, thus our tentative classification of the deeper rock as possible ancient landslide debris. No attempt is made at this stage to assess the geometry of such a hypothetical ancient bedrock landslide. Alternatively, because these thin zones of claystone likely have lower strength than the bounding and thicker units of

sandstone and siltstone, the claystone may have accommodated deformation associated with regional tectonic deformation of the East Bay Hills. Thus, the observed deformation of the claystone may be of tectonic origin, rather than ancient landsliding.

The beds of competent, medium-strong sandstone and siltstone exhibit moderate to low-angle westerly or northerly dips (see section 5.02.3 below), and contain cross-bedded to planar sand laminations, as well as fine-granular channels noted by basal unconformities. The texture and color (brown to reddish brown) sand facies encountered in boring AKA-2 may indicate non-marine conditions that are consistent with the Orinda Formation. It is possible that these beds show interfingering of gray marine San Pablo Group and non-marine Orinda Formation.

Detailed descriptions of the materials encountered in the borings are provided on the boring logs (Appendix B). Please note that the boring logs depict subsurface conditions only at the specific locations of the borings shown on the Site Plan (Figure 2). Also, the passage of time may result in changes in the subsurface conditions due to environmental changes.

5.02.3 Optical/Acoustic Borehole Analyses

A borehole optical and acoustic televiewer survey was performed in boring AKA-1 to obtain bedding and structural information on the upper and lower landslide deposits and underlying bedrock. The televiewer/acoustic survey was performed in an uncased, open hole on August 17, 2004 by Norcal, under the direction of AKA engineers. The optical televiewer was used in the dry section of the boring between about 4.5 and 59 feet in depth. Where cloudy boring fluid was encountered between about 59 and 72.5 feet, Norcal switched to an acoustic televiewer to evaluate the bedrock conditions of boring AKA-1. The results of the acoustic televiewer log are very similar to the optical televiewer log, and show roughly the same features and conditions.

The purpose of the surveys was to locate and measure the strike and dip of bedding and joints in the in situ rock mass, examine the in situ tightness of the bedrock, locate and measure bedrock landslide failure surfaces, and evaluate any unusual conditions (e.g., dissolution voids, shears, etc.). Both the optical and acoustic televiewers obtain in situ orientation measurements (strike and dip) of bedding and joint planes, aiding in the evaluation of rock mass stability and in situ strength.

The optical televiewer images were relatively clear and of high resolution. However, because of water storage limitations at the site and environmental considerations, boring AKA-1 was not cleaned entirely of drilling residue (e.g., mud), therefore, some of the landslide slip surfaces and bedding planes recognized during detailed logging of retrieved core are obscured partly in the televiewer images. Despite these limitations, the televiewer/optical images recorded bedding on the basis of color and texture changes, as well as fractures and discontinuities by assessing void distribution. Rock beds ranged in thickness from about 2 inches (bedding laminations in San Pablo Group) to over 10 feet, averaging about 3 to 5 feet.

The primary discontinuities imaged in boring AKA-1 were bedding in the upper 30 feet, and fractures between 30 and 72.5 feet in depth. The fractures typically were tight and inclined at moderate to steep angles. Bedding planes also were tight and typically wavy, and of moderate to steeply west dipping (about 52 to 75 degrees). Measurements of bedding dips taken directly from the core yielded estimates ranging between 20 and 40 degrees, or slightly less than those interpreted from the televiewer image. The variability between observed and

interpreted bedding dips, indicates that bedding dips estimated by the televiewer techniques may be slightly high. However, where fractures were measured (>60 degrees) from the retrieved core, below a depth of about 30 feet, they tended to be consistent with the televiewer image estimates. In summary, on the basis of our geologic mapping, compilation of previously collected geologic and geotechnical data, coupled with the interpretation of optical televiewer images, bedding beneath the proposed ACF predominantly strikes northerly and dips westerly.

Where the Upper and Lower Landslide basal slideplanes are interpreted from direct characterization of the core, 10.5 feet (Upper Landslide) and between 24 and 28 feet (Lower Landslide), the televiewer images these discontinuities as apparent tonal contrasts with weak to moderate sinusoidal geometry; however, no distinct slide planes are observed, nor does the televiewer provide well constrained information on the orientation of the Upper Landslide. Based on the results of the optical televiewer, Norcal interprets the Lower Landslide as having a basal slide plane orientation of about N4°W, 59°SW (26 feet) and N9°W, 72°SW (28 feet). Our direct observations of the attitude of Upper and Lower landslide slip surfaces is actually closer to 20 degrees, or subparallel to overlying topography (see remarks made on the boring log of AKA-1).

The optical and acoustic televiewer images of boring AKA-1 agree well with the textural variations noted from the recovered core. Textural analyses of boring AKA-1 indicate less-dense, irregular to mixed, fractured rock (e.g., landslide debris) to a depth of about 30 feet. Below 30 to 35 feet in depth, the bedrock becomes more competent, and tighter, with the exception of a zone of fractured finer-grained claystone near the base of the boring. For instance, Norcal interprets disrupted bedrock between 66 and 72 feet in depth, similar to our detailed logging of retrieved core that showed several 1- to 3-foot-thick zones of crushed and highly fractured claystone near this depth interval.

To summarize, on the basis of retrieved core in AKA-1, coupled with optical/acoustic televiewer data, we interpret a basal shear plane associated with the active Lower Landslide between about 24 and 28 feet below the ground surface. The orientation of the lower slide plane is interpreted to dip southwest at about 20 degrees. Similarly, on the basis of geologic mapping, compilation of existing geologic and geotechnical data, and interpretation of optical televiewer images, bedding beneath the proposed ACF predominantly strikes northwest and dips gently to moderately southwest.

5.02.4 Laboratory Test Results

Drained residual torsional ring shear tests were performed on a sample of slip zone material obtained from Boring AKA-1 at a depth of 24.0 to 24.5 feet. Using these analyses, secant residual friction angles of 21, 22 and 24 degrees were obtained under normal stresses of 8,000, 4,000 and 2,000 pounds per square foot (psf), respectively.

In addition, Atterberg Limits determinations performed on samples of slip zone material obtained from Boring AKA-1 at depths of 24.0 to 24.5 feet and 24.5 feet to 25.0 feet resulted in Liquid Limits of 41 and 39, respectively. The Liquid Limits were compared to published correlations by Stark and Eid (1994) to provide a second estimate of the drained residual friction angle for these two samples. These published correlations show soils with a Liquid Limit of approximately 40 and estimated clay fractions greater than 25 percent as having secant residual friction angles between about 20 to 25 degrees.

5.02.5 Nearby Borings and Test Pits by Others

Much of this area has also been previously modified by grading, so it is useful to reference the soil and bedrock conditions encountered in previous borings and test pits by elevation rather than depth, so that comparisons with the design elevation of the bottom of the proposed ACF structure can be made. Based on the preliminary schematics provided and for general comparison purposes, we have initially assumed that the two levels of the structure will be founded near the following elevations:

Upper ACF Level	+870 feet
Lower ACF Level	+855 feet

The depth and elevation of the top of apparently translated rock based on data from nearby borings and test pits are summarized below:

Table 2. Depth and Elevation – Top of Translated Rock (Landslide Debris)

Location	Boring or Test Pit Number	Surface Elevation (feet)	Depth to Rock (feet)	Elevation of Rock (feet)	Rock vs. Building Elevation
Upper Level	***Assumed Building Elevation +870 feet***				
North Corner	AKA-1	+870	1	+869	1 foot below
West Corner	TP-3 (SCI, 1996)	+873	>12	<861	>9 feet below
Southwest Side	TP-2 (SCI, 1996)	+867	2	+865	5 feet below
Lower Level	***Assumed Building Elevation +855 feet***				
East Corner	AKA-2	+860	8	+852	3 feet below
South Corner	B-1 (HLA, 1975)	+862	3	+859	4 feet above
Southwest Side	TP-2 (SCI, 1996)	+867	2	+865	10 feet above

Review of these data suggests that most of the lower level of the building would be underlain by translated rock that is part of the Upper and Lower Landslides. An upper level founded near Elevation +870 would be underlain by dissimilar materials with translated bedrock beneath the north corner and soil beneath the west corner.

5.02.6 Previous Atterberg Limits Data

Atterberg limits data compiled from previous geotechnical reports by others are summarized in the following table. The locations of some of these data points are shown on the Site Geologic Map (Figure 6).

Table 3. Atterberg Limits Test Results

Location and Depth	Material Description/Classification	Liquid Limit	Plasticity Index
Building 85 (Geo-Resource Consultants, 1994b)			
B-1 @ 2 feet	Dark Brown Silty Clay (CH)	54	21
B-3 @ 3 feet	Dark Brown Silty Clay (CH)	65	23
B-8 @ 5 feet	Dark Brown Silty Clay (CH)	57	30
TP-7 @ 6 feet	Sandy Clayey Gravel (GC)	34	10
TP-9 @ 11 feet	Gravelly Clay (CL-GC)	46	18
Building 85 Slide Investigation (Harza, 1995)			
EB-3 (or EB-2) @ 2.5 feet	Clay (CL), medium brown mottled	47	33
Building 83 (Harding-Lawson Associates, 1975)			
B-4 @ 13.5 feet	Red-Brown Sandy Clay (CL)	56	28
Tank Road (Kleinfelder, 2001)			
B-1 @ 14.3	Light Brown and Light Gray Bedrock	36	17
B-2 @ 8.0	Dark Brown Sandy Clay (CH)	61	36
B-4 @ 4.0	Dark Blackish Brown Sandy Clay (CH)	66	41
B-4 @ 14.7	Light Brown Sandy Clay (CL)	40	17
B-5 @ 3.0	Light Brown Sandy Clay (CH)	67	44
B-6 @ 1.2	Dark Brown Sandy Clay (CH)	58	30
B-7 @ 5.4	Brown Sandy Clay (CL)	39	15
B-8 @ 4.2	Brown Clay w/ Sand (CH)	65	40

Review of the Atterberg Limits results presented above suggests that the near-surface materials in the vicinity of the site are predominantly expansive. Expansive soils shrink and swell in response to changes in moisture. In local practice "non-expansive" material is often defined as material having a Plasticity Index not exceeding 15 and a Liquid Limit not exceeding 40. Of the 15 test results presented above, only two meet these criteria.

5.02.7 Groundwater Data

Test borings AKA-1 and AKA-2 were drilled using rotary wash drilling methods, which generally obscured the depths at which groundwater was encountered during drilling. Groundwater was measured at a depth of 36 feet in Boring AKA-1 approximately 16 hours after drilling. Both borings were subsequently backfilled with grout. We note that the depth to groundwater measured in Boring AKA-1 may not have stabilized prior to backfilling and therefore may not be representative of equilibrium groundwater conditions at the time of drilling. We anticipate that groundwater levels at the site may vary substantially depending on variations in rainfall, surface runoff and other factors. In addition, we anticipate that locally perched groundwater and seepage conditions likely exist, particularly during and following periods of rainfall.

We also reviewed data from groundwater monitoring wells near Buildings 85, 83 and 74 to investigate past seasonal fluctuations in groundwater levels in the general vicinity of the ACF site. As part of the Environmental Restoration Program, LBNL installed groundwater monitoring wells and recorded groundwater levels in the East Canyon over a nine-year period (from July 1995 through July 2004) to evaluate potential contaminant transport mechanisms. Preston Jordan of LBNL provided us with copies of selected groundwater

monitoring data, which we have included in "Appendix D – Groundwater Data." The two records for Building 83 are from wells on the east and south sides of that building. In general, the data that we reviewed indicate a relatively stable groundwater table with seasonal fluctuations of about 5 feet or less. Average "wet season" groundwater depths range from about 5-6 feet (3 holes) to 10-15 feet (4 holes) to 22-25 feet (2 holes) to 30 feet (1 hole) relative to the original ground surface (thicknesses of deep fill have been subtracted). Typically, but not always, the shallowest groundwater occurs near the stream channels that used to flow along the east and west sides of the valley (now buried in culverts). The monitoring data closest to the proposed ACF site shows an average "wet season" groundwater depth of about 12 feet below the land surface.

Very little groundwater data exists in the previous geotechnical reports prepared for projects in the vicinity. However, a broader study of dewatering and slope stabilization by Converse Consultants (1984) includes information on groundwater depths in the area for the period between December 1982 and February 1984. Converse reports that water depths in the area of the Building 83 parking lot ranged from 15 to 23 feet below the ground surface. Near the LBNL guard shack (P-15), groundwater depths were measured between 7 and 16 feet below the ground surface. At other locations in the general vicinity, groundwater was measured at depths ranging from 5 to 20 feet below the ground surface.

6.00 CONCLUSIONS AND EVALUATIONS

6.01 Geotechnical and Geologic Feasibility

We conclude that the proposed project is generally feasible, from a purely geotechnical standpoint. However, the results of our screening-level evaluation of earthquake-induced landslide hazards do not demonstrate that the site has an adequate factor of safety against landsliding under earthquake conditions. We therefore necessarily conclude that the landslide deposits beneath the proposed ACF site could constitute a geologic hazard. In our opinion, it is crucial that the key decision makers within LBNL understand and accept the potential risks associated with earthquake-induced landsliding prior to proceeding with development at this site. Our evaluations of geologic hazards and a general discussion of geotechnical considerations for the project are presented in the following sections.

6.02 Geologic Hazards

6.02.1 Strong Groundshaking

As noted earlier, the subject site is located in the highly seismic San Francisco Bay Area, and there is a strong probability that a moderate to severe earthquake will occur during the life of the structure. Earthquakes occurring along the San Andreas fault or any number of other Bay Area faults have the potential to produce strong ground shaking at the site. Strong groundshaking will tend to decrease slope stability and increase the vertical and horizontal forces that structures will be required to resist. The effects of strong groundshaking on slope stability at the proposed ACF site are discussed in greater detail in subsequent sections of this report.

The structure should be designed to account for forces caused by strong ground shaking in accordance with local design practice. The Uniform Building Code (UBC) outlines standard procedures for seismic design intended to account for the effects of earthquake shaking. Recommended geotechnical parameters for use with the Static Lateral Force Procedure outlined in the 1997 Uniform Building Code (UBC) are presented in "Section 7.01, Building Code Seismic Design Parameters."

Earthquake shaking will also cause increased lateral pressures on retaining walls. In our experience, the permanent retaining walls that are an integral part of the building structure would typically be designed to account for the increases in lateral pressures caused by earthquake shaking. The design of free-standing retaining walls may or may not be designed for increases due to earthquake loading depending upon the consequences of wall movement or failure, structural designer's preference and LBNL's seismic performance requirements. Recommendations for the design of retaining walls are presented in "Section 7.03, Retaining Walls."

6.02.2 Landsliding

Based on our interpretation of previous subsurface information, the stratigraphy encountered in borings AKA-1 and AKA-2, mapping of landslide deposits, and valley morphology, we have preliminarily delineated the extent of probable landslides beneath the proposed ACF. We interpret two landslide configurations beneath the proposed ACF: an Upper Landslide, at the base of highly weathered rock of the "mixed" unit, and a Lower Landslide, within relatively intact, moderately to slightly weathered, moderately hard San Pablo Group (Figures 6, 7, 8). Both landslide bodies have poorly defined headscarp and toe regions, and both slide masses have been significantly altered from recent grading. Removal of material for road and building construction has significantly reduced the volume above the main body of the larger East Canyon landslide, and therefore the driving force. Additionally, it is possible that placement of engineered fill during a 2001 landslide repair below the transmission tower (S. Blair, pers. communication, 2004) removed a portion of the Upper Landslide (shown as Qls[u] on Figure 7). Thus, the present landslide hazard to the proposed ACF likely differs from that during pre-grading conditions.

The Upper Landslide material was encountered in Boring AKA-1 to a depth of about 10.5 feet (about 25 feet below the pre-grading land surface), and coincides with the contact between highly weathered rock and soil overlying more competent, moderately weathered bedrock below (Figures 7 and 8). We do not delimit the aerial extent of the Upper Landslide on Figure 6 because it is so poorly constrained and its limits are speculative. The upslope continuation of this slide is shown to coincide with a velocity boundary modeled from a seismic refraction profile (Kleinfelder, 2001). The headscarp of this slide is unclear, but could coincide with the headscarp of the slide mass that failed below the transmission tower. The downslope continuation of this slide, and the current toe of the slide, is constrained by Boring "1-77", or Boring 1 of HLA (1977). The boring log shows a 1.5-foot-thick layer of soft, moist clayey silt that separates intensely fractured, deeply weathered andesite above from moderately weathered siltstone and claystone below. We infer that this soft silt layer represents the shallow slide plane, and that the toe of the landslide currently lies at or near the base of the cut slope directly north of Building 83. The width of the shallow slide plane is poorly constrained (Figure 8). We show the slide plane to be undulatory in cross section, with a "high" point near the western margin of the proposed ACF—based on boring AKA-1—and low troughs offset from the eastern and western limits of the larger slide mass. The troughs may indicate that the upper slide may fail as two separate slide masses, an eastern and a western mass.

The Lower Landslide material extends as much as 28 feet in depth in boring AKA-2, or about 45 feet below the pre-grading land surface (Figures 7 and 8). The clayey seam and slide plane is within moderately weathered San Pablo Group siltstone. The upslope continuation of the slide is shown to project to the lower portion of a velocity boundary modeled from seismic-refraction data (Kleinfelder, 2001), which lies roughly subparallel to the pre-grading ground surface. Although the head of the landslide is unclear, we show it to follow an arcuate trace, coinciding with an inclined portion of a velocity boundary imaged from an adjacent seismic-refraction

profile (Kleinfelder, 2001) (Figure 7). The down-dip projection of the Lower Landslide is poorly constrained. We show the slide as projecting beneath boring "1-77" (HLA, 1977), and intersecting the ground surface south of Building 83, around Calvin Road. In plan view, we show this slide to encompass the volcanic breccia exposed in the quarry cut and on the hill behind it within the toe region (Figure 6). In cross section, the Lower Landslide is shown as having a subhorizontal basal plane (Figure 8). The western slide margin is based on the results of the RFI Final Report (2000) and personal communication with Preston Jordan (pers. communication, 2004). This margin extends about 20 feet west of the former stream channel, and the approximate lateral extent of hummocky topography on the aerial photographs. The eastern slide margin coincides with the eastern stream channel, and is constrained by road-cut exposures logged during grading for a road to Building 85 (P. Jordan, pers. communication, 2004). We emphasize that the extent of the large-scale landslide shown on Figure 6 has poorly constrained headscarp and toe regions. The slide mass we define, however, does show "toe bulge" morphology, defined by the resistant volcanic breccia hill above the quarry.

We did not find evidence of recent slope movement recorded by cracking of curbs and roads in the vicinity of the proposed ACF. We did note cracking and repair of asphalt in the Building 83 lot, although we did not evaluate the damage and repair. Additionally, we note the small slump at the northern end of the cut slope directly northwest of Building 83. This slump indicates the relative instability of the materials within the "mixed" landslide deposit.

6.02.3 Upslope Landslides/Debris Flows

Historical crib-wall failures and landslides during grading operations indicate that smaller-scale mass-wasting processes are still active on the site, and could potentially affect the ACF. The small, approximately 10-foot by 10-foot slump in the cut slope directly north of Building 83 occurs within "mixed" landslide deposits that underlie the proposed ACF building footprint. Failure of a crib wall directly north-northeast of the proposed site (Harza, 1985) also indicates the instability of the "mixed" landslide deposits. Reported seepage of groundwater near or at the base of the previous crib wall failure (Preston Jordan, pers. communication, 2004) indicates high groundwater levels and possible elevated pore pressures that can reduce material shear strength.

Debris flow is another mass wasting processes that could potentially impact the proposed ACF. Mud and/or debris flows emanating from the steep north-northeast-trending ravine directly northeast of the proposed ACF could affect the eastern portion of the building.

6.02.4 Fault Rupture

Geologic mapping by Lienkaemper (1992) indicates the closest mapped active fault is the Hayward fault, which is approximately 3,800 feet southwest of the site. The site is not within an Alquist-Priolo Special Study Zone (CDMG, 1982) and no mapped active fault traces pass through the site. As previously indicated, there is evidence that faults exist in close proximity of the site that have been deemed to be inactive based on the results of site-specific surface fault rupture hazard evaluations conducted by others. On this basis, we judge that the likelihood of surface fault rupture occurring at the site is low.

6.03 Slope Stability Analyses

6.03.1 Geometric Models

The slope geometries used in our analyses was based on the interpretive geologic cross section shown on Figure 7. We used four different geometric models for our analysis that we identified based on surface topography (future or past), the extent of landsliding (global or local), and the methods used to model landslide debris and slip zones (homogeneous or layered). Future topography was assumed to be the same as the current condition except with an excavated pad at the location of the planned ACF building (Elevation +870 feet). Past topography was based on topographic maps of this area prior to development. Each geometric model is described briefly below:

1. ***Future-Global-Homogeneous*** - A geometric model based on the planned surface topography that encompasses potential failure surfaces extending from the hills above the site to Snowberry Creek below the Centennial Drive loop. The entire section was assigned engineering properties (friction angle and unit weight) corresponding to landslide slip zone material and only specified non-circular failure surfaces were analyzed. See Table 5 below for the assigned engineering properties used in the four models. The geometry of the Lower Landslide (deepest) was estimated based on: (1) the depth of less weathered apparently in-place rock encountered in boring AKA-1, (2) the depth of apparently weak material underlying documented slope movement near the Centennial Drive overpass, (3) the inferred geometry of the apparent headscarp located upslope of the proposed ACF, and (4) the interpreted toe of the landslide near Snowberry Creek below the Centennial Drive loop. The Future-Global-Homogeneous model was used to evaluate the stability of potential non-circular failure surfaces affecting the proposed ACF.

2. ***Future-Local-Layered*** - A geometric model based on the planned surface topography that focuses on potential failure surfaces in the direct vicinity area of proposed ACF. Interpreted 5-foot-thick upper and lower landslide slip zones were defined and assigned the properties of slip zone material. Below the lower slip zone, material was assigned strengths judged appropriate for less weathered rock. Material outside of the 5-foot-thick slide slip zones comprising the body of the Upper and Lower Landslides was assigned strengths judged appropriate for disturbed rock (translated landslide debris). The Future-Local-Layered model was used to search for critical circular failure surfaces at the location of the proposed ACF.

3. ***Future-Local-Homogeneous*** - This geometric model was essentially the same as the Future-Local-Layered model described above except all landslide material (entire slide mass plus the interpreted 5-foot-thick slip zone of the Lower Landslide) was assigned engineering properties corresponding to landslide slip zone material.

4. ***Past-Global-Homogeneous*** - A geometric model based on the past surface topography (prior to development) that extends from the hills above the site to Snowberry Creek below the Centennial Drive loop. This geometric model was essentially the same as the Future-Global-Homogeneous model described above except for surface topography. With the Past-Global-Homogeneous model, we used pre-existing topography to back-calculate shear strength within the postulated slip zone of the lower landslide (assuming failure under static high-groundwater conditions).

6.03.2 Material Properties

We estimated geotechnical soil properties for the existing soil and bedrock layers based on the results of our geotechnical laboratory tests, the referenced previous geotechnical studies and engineering judgment. Much of our effort was directed at developing an estimate of the strength of weak and sheared landslide slip zone material. When soils are sheared beyond their peak values (as would occur along a landslide slip plane), the measured shear strength will generally decrease with increasing deformation until it reaches a constant minimum. This constant minimum is defined as the residual shear strength, and represents the shear strength along an existing shear surface (such as the landslide slip plane). The residual shear strength has two components: residual cohesion and residual friction angle. For conservative analysis, it is considered prudent to assume the residual cohesion to be nil. The residual shear strength can be directly measured by laboratory tests, correlated to index properties measured using laboratory tests, or calculated using back analysis of the landslide geometry.

As previously indicated, drained residual torsional ring shear tests were performed on samples of slip zone materials obtained from boring AKA-1 and compared to published correlations by Stark and Eid (1994). Based on these data, we used an estimated secant residual friction angle of 20 degrees to model the strength of landslide slip zone material under long-term, drained conditions. As a check, we back-calculated the strength along the Lower Landslide slip surface using the Past-Global-Homogeneous model assuming static high-groundwater conditions. In order to estimate an upper bound friction angle under static conditions, we assumed groundwater levels were coincident with the pre-existing ground surface topography. Our back-calculation (assuming zero cohesion) resulted in a friction angle of 19.6 which is in generally close agreement with the secant drained residual friction angle of 20 degrees used in our slope stability analyses.

Based on the recommendation of Blake, et al., (2002), the same drained residual friction angle was used as a first-order approximation of residual strength for rapid loading under undrained conditions. This recommendation is based on the observation that both increases and decreases in residual strength have been reported for rapid relative to "normal" loading conditions for materials with differing clay contents. The material properties used in our analyses are summarized in the following table:

Table 4. Engineering Properties of Soil and Bedrock

Material	Unit Weight (pcf)	Strength Parameters	
		Cohesion, c' (psf)	Friction, φ' (degrees)
Disturbed and Translated Bedrock	120	500	23
Landslide Slip Zone Material	120	0	20
In-Place Bedrock	120	1000	23

We note that use of the same value of unit weight for all three layers was deemed reasonable based on the inherent variability of the onsite materials and allows direct comparisons to be made between the layered and non-layered analytical models.

6.03.3 Groundwater Levels

We used three different assumed groundwater levels to model the effects of groundwater on slope stability, as described below:

Low – Assumes the slope is fully drained (without groundwater) to below the level of the Lower Landslide slip zone.

Intermediate – Groundwater is modeled at an intermediate elevation, which was estimated based on the available groundwater data, constraints imposed by the current slope geometry, and engineering judgment.

High – Groundwater is modeled at the ground surface based on the previous slope geometry (applicable only to the Past-Global-Homogeneous model).

6.03.4 Pseudostatic Coefficients

We conducted our seismic slope stability analyses using simplified pseudostatic procedures involving the use of a horizontal seismic coefficient (k) that represents the fraction of the weight of the sliding mass that is applied as an equivalent horizontal force. Two values of k were used to evaluate slope stability under earthquake conditions. A brief discussion describing the selection of seismic coefficients and their use in our stability analysis follows:

In geotechnical practice, a seismic coefficient of 0.15 is commonly used for pseudostatic slope stability analyses based on procedures recommended by Seed (1979). Using the Seed procedure, acceptable performance is considered to result if calculated Factors of Safety (FS) are greater or equal to 1.15. We understand that in Los Angeles County a FS $\geq$ 1.10 is considered acceptable. The Seed method is implicitly based on an allowable slope deformation of 1 meter during a Magnitude 8.25 earthquake. In our slope stability analyses, we used a k=0.15, FS $\geq$ 1.1 screen to evaluate a possible lower bound condition for seismic performance.

We also evaluated seismic performance using the screening procedures recommended by Blake, et al., (2002). In this method, a horizontal seismic coefficient (k) is determined based on a probabilistic estimate of Maximum Horizontal Acceleration (MHA) modified by factors that include the site-to-source distance (r) and the duration of shaking ($D_{5\text{-}95}$). The MHA of 0.70 g used in our analyses was estimated from the seismic hazard map for rock conditions contained in the CGS Seismic Hazard Evaluation Report for the Briones Quadrangle. This map is for a level of hazard associated with an earthquake having a 10 percent probability of exceedence in 50 years. The procedures recommended by Blake, et al., (2002) explicitly address anticipated slope deformations, as bracketed by 5 centimeter or 15 centimeter threshold displacements. We used the 5 centimeter threshold to obtain a seismic coefficient of 0.346. The Blake, et al., (2002) procedures for screening evaluations are based on an acceptable FS greater than or equal to 1.0. In our slope stability analyses, we used a k=0.346, FS $\geq$ 1.0 screen to evaluate a deformation-limited condition for seismic performance.

6.03.5 Analytical Results

We used the computer programs XSTABL to analyze slope stability under static and pseudostatic conditions. The Slope Stability Models used in our analyses are depicted on Figure 9. The results of our stability analyses are summarized in the following tables. Note that calculated factors of safety that do not pass the specified screening criteria are indicated with an asterisk.

Table 5. Results of Non-Circular Failure Surface Analyses (Future-Global-Homogeneous Model)

Case	Approximate Description	Groundwater	Calculated Factor of Safety		
			Static	$F_{eq} = 0.15$	$F_{eq} = 0.34$
1A	Complete Lower Slide	low	2.1	1.1	*0.67**
1B	(500 feet Upslope of ACF to Creek)	intermediate	1.5	*0.79**	*0.47**
1C	Partial Lower Slide	low	1.8	1.1	*0.63**
1D	(500 feet Upslope of ACF to Centennial)	intermediate	1.4	*0.78**	*0.48**
1E	Partial Lower Slide	low	2.5	1.2	*0.72**
1F	(130 feet Upslope of ACF to Centennial)	intermediate	2.0	*0.97**	*0.57**

Table 6. Results of Circular Failure Surface Analyses (Future-Local-Layered Model)

Case	Description	Groundwater	Calculated Factor of Safety
2A	Static	low	2.3
2B	$F_{eq} = 0.15$	low	1.3
2C	$F_{eq} = 0.34$	low	*0.77**
2D	Static	intermediate	2.3
2E	$F_{eq} = 0.15$	intermediate	1.1
2F	$F_{eq} = 0.34$	intermediate	*0.63**

Table 7. Results of Circular Failure Surface Analyses (Future-Local-Homogeneous Model)

Case	Approximate Description	Groundwater	Calculated Factor of Safety		
			Static	$F_{eq} = 0.15$	$F_{eq} = 0.34$
3A	Upper Slide	low	1.6	0.94	0.60
3B	(Shallow landslide involving ACF)	intermediate	1.6	*0.94**	*0.55**

Table 8. Backcalculation of Effective Friction Angle (Past-Global-Homogeneous Model)

Case	Groundwater	Effective Friction Angle (Φ')	Calculated Factor of Safety
4A	High	20	1.022
4B	High	19.6	1.000
4C	High	19	0.967

6.03.6 Anticipated Site Deformations

In our opinion, the landslide deposits that underlie the site are a significant geotechnical concern that will need to be addressed in the foundation design for the proposed structure. Our geologic characterization of the site suggests that the landslide deposits on which the proposed ACF is to be located have translated downslope a significant distance, perhaps tens or even hundred(s) of feet. This movement may have occurred incrementally over geologic time, or as a series of larger catastrophic events. Most of the large-scale downslope movement appears to have taken place prior to development of the site based on the lack of significant damage to the cultural features currently in place. No historical records were found that document when the landslide that underlies the ACF site last moved, or the nature or magnitude of the movement.

Our simplified analyses suggest that the site is currently stable statically, but that movement will occur as a result of earthquake shaking on all of the inferred failure plane depths and geometries. All of the non-circular failure surfaces analyzed fail the screening criteria recommended by Blake, et al., (2002) for 5 centimeters of movement, which, in their opinion, "likely distinguishes conditions in which very little displacement is likely from conditions in which moderate or higher displacements are likely."

We note that the analyses using the Seed procedure appear to predict slope deformations on the order of one meter (3 feet). However, in our opinion, this estimate is best viewed with caution considering a variety of factors including the site's proximity to the Hayward fault and the potential consequences of slope movement. The scope of our screening level investigation is insufficient to rule out the possibility that significantly larger global and/or local slope movements (i.e., greater than 3 feet) could occur as a result of earthquake shaking, prolonged heavy rainfall or other unforeseen circumstances. Consequently, future development at the site may result in LBNL accepting a largely unquantifiable amount of risk.

6.04 Mitigation Strategies

State regulations and the standards of local professional practice require that the minimum level of mitigation for a project should reduce the risk such that the collapse of buildings intended for human occupancy does not occur. This does not necessarily require that there be no future slope movement. Consequently, an approach could be developed that involves: (1) mitigating the potential for slope movement to the degree possible through drainage, excavation and grading, and (2) engineering a structure that will tolerate anticipated future site deformations without collapse. Most commonly, this involves founding the structure on a monolithic structural mat foundation designed to move as a unit.

We judge the general approach outlined above to be generally reasonable and appropriate for a single ACF building within a relatively large/thick landslide mass. We note, however, that it might be considered advantageous to consider evaluating stabilization strategies that more significantly limit future deformations, particularly if: (1) movement of existing nearby structures, utilities or other improvements is a concern, or (2) additional development in this area is planned. We note differential movement at the margins of the landslide deposit could be much more problematic in terms of possible structural engineering alternatives (such as a mat foundation). Also, multiple improvements within the landslide mass can likely be expected to move differentially with respect to each other. In our opinion, additional study and analysis could be performed to reduce the level of uncertainty regarding subsurface conditions and potentially allow the development of measures to mitigate future deformations to a less-than-significant level.

6.05 Foundation Support

In this report, we provide recommendations for the design of a mat foundation for the proposed ACF building. The factors we considered in developing our recommendations for the mat include:

- Based on the available data, it appears that soils at the site may extend as deep as +852 feet near the east corner of the building (adjacent to Building 83). Assuming a 2- to 3-foot-thick mat, we anticipate that translated bedrock will be exposed at subgrade elevation over most or all of the excavation area for the lower level.

- Excavation for an upper level would likely expose differing foundation conditions with translated bedrock exposed at the north end (near Boring AKA-1), and soil exposed at the south end.

- The slip zone for the upper landslide is thought to cross the site at varying depths. Boring 1 of HLA (1975) drilled south of the southern corner of the ACF encountered what we interpret to be a likely landslide slippage zone between Elevations +845 and +844 feet. Our interpretive subsurface profile suggests that slippage zone material may exist between Elevations +850 to +860 feet beneath the proposed ACF site.

- Structural detailing and construction of a stepped mat founded at two different levels can be more complex and costly than for a mat founded at a single level.

We understand that a stepped mat foundation may be preferred by LBNL based on architectural and programming considerations. In our opinion, a stepped mat is generally feasible, however, we suggest that a single level mat also be evaluated as a potential alternative. We note that a single level mat founded below the building lower level would remove most or all of the surficial soils at the site and would likely remove most or all of the slip zone for the upper landslide within the area of the ACF building. A potential alternative to a stepped mat could involve constructing a single level mat at the lower level and leaving half of the lower level of the building unoccupied. The first floor above the unoccupied portion of the lower level could be structurally supported or, alternatively, the unoccupied volume could be backfilled with lightweight granular material or another suitable backfill media. If a backfill alternative is selected, we should be consulted regarding appropriate backfill materials and design lateral pressures for retaining walls surrounding the unoccupied volume.

We estimate that the total and differential settlement of a mat foundation designed and constructed in accordance with the recommendations presented in this report should be less than about ½ and ¼ inch, respectively. The estimated differential settlement value can be assumed to occur over a horizontal distance of about 30 feet.

6.06 Expansive Soils and Rock

The results of Atterberg Limits determinations presented in previous geotechnical reports indicate that some of the soil and rock at the site are likely expansive, and therefore prone to volume changes (shrinkage and swelling) with seasonal fluctuations in moisture. Such shrink/swell behavior can damage near-surface improvements such as foundations, pavements and slabs-on-grade that are supported by these soils. For this reason, we recommend foundations, slabs-on-grade and other improvements that are relatively intolerant to movement be supported on relatively non-expansive bedrock or on engineered non-expansive fill.

Based on the available information, it appears that most or all of the surficial soils will be removed from beneath the planned lower level during excavation (below about Elevation +852). The results of the Atterberg Limits determinations conducted by others on samples of material from depths below 14 feet suggest that these materials may be "borderline" with respect to their expansion potential (both had a Plasticity Index [PI] of 17 whereas a PI of 15 or less is often considered "nonexpansive"). Consequently, we judge that a mat foundation founded below the elevation of the building lower level can likely be supported on predominantly non-expansive bedrock. We note, however, that localized overexcavation may be required to remove potentially expansive soils from beneath the portions of the mat where natural soil deposits extend to lower excavations.

If a stepped mat is used, the upper level mat will need to be supported on a layer of engineered nonexpansive fill. The non-expansive fill layer should underlie and extend several feet beyond the outside perimeter of the upper level mat. We note that construction of the recommended non-expansive fill layer will involve excavating both surficial expansive soil and bedrock. Overexcavation of bedrock is recommended to provide more uniform mat foundation support and partially mitigate concerns related to differing foundation conditions.

Recommendations for subgrade preparation and foundations are presented in "Section 7.04.3, Mat and Slab Subgrade Preparation" and "Section 7.02.1, Mat Foundation Design", respectively.

6.07 Construction Considerations

6.07.1 Temporary Shoring

We anticipate that temporary shoring may be required to protect adjacent streets and utilities, particularly on the north side of the site adjacent to Calvin Road. Based on the site conditions and local experience we anticipate that shoring will likely be comprised of conventional soldier piles and lagging. We note that all excavations deeper than 4 feet that will be entered by workers need to be shored or sloped for safety in accordance with the California Occupational Safety and Health Administration (Cal-OSHA) standards. The design, installation and maintenance of temporary shoring systems and temporary excavation slopes are generally considered to be the responsibility of the contractor.

6.07.2 Excavation

We anticipate that the soil and bedrock at the site can be excavated with conventional earth-moving equipment (such as excavators and backhoes). However, the contractor should anticipate that locally harder bedrock could exist that would require jackhammering or hoe-ramming to excavate. As indicated on the Site Geologic Map (Figure 6) and Cross Sections (Figures 7 and 8), portions of the site are underlain by volcanic rocks of the Moraga Formation. These harder rocks can be more resistant to excavation, particularly where less fractured.

Excavation could cause surrounding improvements to settle and move laterally, even where temporary shoring is used. We suggest that the contractor thoroughly document the condition of nearby buildings, streets, storm drains, and sewers by video or other means prior to excavation. The contractor should also perform regular surveys during excavation to monitor and document any observed settlement of nearby streets and structures.

6.07.3 Temporary Dewatering

Based on the available data, it appears that site excavations to construct the ACF building will likely not extend below the groundwater table. However, depending upon conditions at the time of excavation, seepage zones or locally perched groundwater, conditions could be encountered that would necessitate temporary dewatering. We anticipate that the excavation could likely be dewatered by pumping from within sumps or other low points within the excavation. However, the control of groundwater during excavation and construction is the responsibility of the contractor, who should install, operate and maintain all necessary temporary site drainage and dewatering systems.

6.07.4 Wet Weather Construction

Although it is possible that construction can proceed during or immediately following the wet winter months, a number of geotechnical problems may occur which may increase costs and cause project delays. Rises in groundwater levels, seepage, surface runoff, and rainfall will increase site dewatering requirements. Higher groundwater levels and seepage will also tend to decrease the stability of temporary excavation cuts. The water content of on-site soils will increase during the winter, making compaction difficult to achieve. If utility trenches are open during winter rains, then caving of the trench walls may occur. We should also note that it has been our general experience that increased clean-up costs will occur, and greater safety hazards will exist if the work proceeds during the wet winter months.

7.00 RECOMMENDATIONS

7.01 Building Code Seismic Design Parameters

The structure should be designed to resist the lateral forces generated by earthquake shaking in accordance with local design practice. We judge the following UBC criteria to be appropriate for the site:

Table 9. UBC Geotechnical Parameters

Seismic zone factor (Z)	0.40
Soil profile type	S_C
Near-source factors	$N_A = 1.5$ $N_V = 2.0$
Seismic Coefficients	$C_A = 0.40(N_A) = 0.60$ $C_V = 0.56(N_V) = 1.12$

The project site is approximately 1.2 kilometers from a Type A Seismic Source (the Hayward fault).

7.02 Building Foundations

7.02.1 Mat Foundation Design

We recommend the proposed ACF be supported on a reinforced concrete mat foundation (single level or stepped). The bottom of the mat should extend at least 18 inches below the lowest adjacent ground surface and the mat should be at least 24 inches in thickness. Mat foundations should be underlain by at least 24 inches of nonexpansive material. Where nonexpansive fill is used to isolate the mat foundation from adjacent and

underlying expansive material, we recommend that the nonexpansive layer extend at least 3 feet beyond the exterior of the building perimeter. Recommendations for subgrade preparation beneath mat foundations are presented in "Section 7.04.3, Mat and Slab Subgrade Preparation."

Mat foundations bearing upon nonexpansive soil or rock prepared in accordance with the geotechnical recommendations presented in this report can be designed using the following allowable bearing pressures:

Table 10. Allowable Foundation Bearing Capacity

Load Type	Allowable Bearing Capacity (pounds per square foot)
Dead Load (FS ≥ 3.0)	3,000
Dead plus Live Load (FS ≥ 2.5)	3,600
Total Loads including Wind or Seismic (FS ≥ 2.0)	4,500

The above allowable bearing pressures are net values; therefore, the weight of the mat can be neglected for design purposes. The mat should be integrally connected to all portions of the structure so that the entire foundation system moves as a unit. The mat should be reinforced with top and bottom steel in both directions to allow the foundation to span local irregularities that may result from potential differential settlement and/or landslide-related movement. At a minimum, we recommend: (1) all portions of the mat be designed to span an unsupported distance of at least 10 feet, and (2) the outside perimeter of the mat be designed to cantilever an unsupported distance of at least 5 feet.

7.02.2 Lateral Resistance

Resistance to lateral loads can be provided by friction along the base of foundations and by passive pressures developing on the sides of below-grade structural elements. Passive resistance can be estimated using an equivalent fluid weight of 300 pounds per cubic foot (pcf). These values can be increased by one-third for dynamic loading.

A friction coefficient of 0.35 times the dead load can be used to evaluate frictional resistance along the bottom of foundations. The above passive and frictional resistance values include a factor of safety of at least 1.5 and can be fully mobilized with deformations of less than ½- and ¼-inch, respectively.

7.02.3 Underdrainage and Capillary Break

We recommend that underdrains be installed beneath the lower level mat foundation drain rock on 20-foot centers and within 5 feet of the building perimeter to drain water that otherwise could become trapped within the capillary break. Underdrains should consist of 4-inch-diameter perforated plastic pipe (PVC Schedule 40, or equivalent) installed with perforations down below the capillary break on a 2-inch-thick bed of drain rock. Underdrain pipes should be sloped to drain by gravity to a suitable gravity discharge.

We recommend that a layer of drain rock, at least 4 inches thick, be placed beneath the mat foundation as a capillary moisture break. Drain rock should consist of clean angular crushed rock that conforms to the following gradation criteria:

Sieve Size	Percent Passing
1 inch	100
3/4 inch	90 - 100
#200	0 - 3

Following compaction by mechanical means, the capillary break rock should be covered by plastic sheeting (i.e., *visquene)* and a 2-inch-thick layer of clean sand should be placed above the plastic sheeting to protect it from damage during subsequent construction activities.

We also recommend that the specifications for the mat require moisture emission tests to be performed on the mat prior to the installation of the flooring. No flooring should be installed until safe moisture emission levels are recorded for the type of flooring to be used.

7.02.4 Special Design Considerations

Due to the possibility of localized differential movements between the ground around the ACF and the mat foundation, flexible utility connections should be installed to reduce the likelihood of utility pipes developing leaks or shearing over the years or during severe movements. We also note that differential vertical and horizontal movements may occur at the junction of the mat foundation and adjacent exterior flatwork. A structural gap should be provided and architectural masking should be considered at these locations.

7.03 Retaining Walls

7.03.1 Lateral Pressures

Retaining walls should be designed to resist lateral earth pressures and any additional lateral loads caused by surcharge loads on the adjoining ground surface. We recommend walls be designed to resist the equivalent fluid pressures indicated in the table below. The appropriate design values should be chosen based on the condition of the wall (restrained or unrestrained) and the angle of the slope behind the wall. Unrestrained wall pressures should only be considered applicable where it would be structurally and architecturally acceptable for the wall to laterally deflect 2 percent of the wall height.

Table 11: Lateral Earth Pressures for Retaining Walls

Condition	Backslope Inclination	Equivalent Fluid Weight	Seismic Increment (H_s = soil height in feet)
At-Rest (fixed)	level	60 pcf	$22H_s$ psf
	1.5:1	85 pcf	$32H_s$ psf
Active (free to rotate)	level	40pcf	$18H_s$ psf
	1.5:1	70 pcf	$32H_s$ psf

Linear interpolation can be used to determine design values for retaining walls where the slope behind the wall is flatter than 1.5:1.

For surcharge loads, increase the ultimate (non-factored) design pressures (surcharge) behind the wall by an additional uniform pressure equivalent to one-half (for restrained condition) or one-third (for unrestrained condition) of the maximum anticipated surcharge load applied to the surface behind the wall. Alternatively, our firm can calculate lateral load distributions for specific surcharge conditions, upon request.

The lateral pressures presented in this section are based on the assumption that permanent retaining walls will be fully drained to prevent the buildup of hydrostatic pressure. Recommendations for wall backdrainage are presented below.

7.03.2 Wall Backdrainage

Backdrainage should consist of either: (1) prefabricated drainage material (Miradrain or an approved alternative) installed in accordance with the manufacturer's recommendations, or (2) a drain rock layer at least 12 inches thick. Prefabricated drainage material should drain to a perforated plastic pipe or an approved prefabricated drainage conduit. Drain rock should drain into a perforated plastic pipe installed (with perforations down) along the base of the walls on a 2-inch-thick bed of drain rock. Plastic pipe should be sloped to drain by gravity to a sump, relief wells or other suitable discharge and a cleanout should be provided at the pipe's upslope end. Perforated and non-perforated plastic pipe used in the drainage system should consist of 4-inch-diameter Schedule 40 PVC or an approved equivalent. Drain rock should conform to Caltrans specifications for Class 2 permeable material. Alternatively, locally available, clean, ½- to ¾-inch maximum size crushed rock or gravel could be used, provided it is encapsulated in a non-woven geotextile filter fabric, such as Mirafi 140N or an approved alternative.

The upper 2 feet of retaining wall backfill (above backdrainage) should be comprised of low-permeability soil to limit surface water infiltration into the retaining wall backdrainage system. The ground surface upslope of the walls should be paved and sloped to direct water away from the back of the wall and toward a suitable gravity discharge.

7.03.3 Wall Moisture Barrier and Waterproofing

A moisture barrier or waterproofing should be applied to the exterior of retaining walls in all areas where seepage or moisture transmission through the walls would be considered objectionable. The specification of the type of moisture barrier or waterproofing and observation during its installation should be provided by the architect and/or structural engineer.

7.03.4 Foundations for Site Retaining Walls

Site retaining walls can be supported on spread footings designed using the allowable bearing pressures and lateral resistance values previously presented for the building mat foundation. Spread footings should be embedded at least 18 inches below the lowest adjacent grade and should be at least 12 inches wide. Footing excavations should be checked by our field engineer for proper depth, bearing and cleanout prior to the placement of reinforcing steel. All foundation excavations should be kept moist and free of loose material and standing water prior to concrete placement.

7.04 Site Preparation and Grading

7.04.1 Site Preparation

The areas of proposed new construction should be cleared. Existing surface and subsurface improvements such as structures, foundations, light standards, slabs-on-grade, pavements, v-ditches, curbs, and gutters that are within the construction area should be removed from the site. The existing underground improvements (e.g., electric, gas, telephone, storm drains, and sewers) in and surrounding excavation areas should be identified and properly abandoned or relocated if they would be impacted by proposed construction activities.

Areas to be graded should be cleared of trees and brush and soils containing vegetation and organic matter should be stripped. Any tree stumps and rootballs should be grubbed to the extent sufficient to remove organic-laden materials. Stripped and grubbed materials are not suitable for re-use as engineered fill and should be removed from the site or stockpiled for later use as landscape material.

7.04.2 General Earthwork

All fill should be free of perishable and 6-inch-plus material and contain no environmental contaminants or construction debris. Select nonexpansive fill should conform to the requirements for general fill and in addition, have a Liquid Limit not exceeding 40 and a Plasticity Index not exceeding 15. Fill should be placed in layers not exceeding 8 inches in loose thickness, moisture conditioned to near optimum moisture content and compacted to at least 90 percent relative compaction (based upon ASTM D-1557). The contractor should take appropriate precautions (such as temporary bracing or the use of lightweight equipment) when placing and compacting backfill behind retaining walls to avoid overstressing the wall.

7.04.3 Mat and Slab Subgrade Preparation

Exposed subgrades for the lower level mat foundation should be observed by AKA to check that firm natural non-expansive materials are exposed. Subgrade areas beneath the lower level mat foundation that are determined to be weak, unstable and/or expansive should be excavated to expose suitable bearing material and replaced with compacted fill. Following approval by AKA, the exposed lower level mat subgrade should be moisture conditioned, as appropriate, compacted to at least 90 percent relative compaction (based on ASTM D-1557), and rolled to create a uniform firm and non-yielding surface.

If an upper level mat foundation is used, it should be underlain and surrounded by a layer of select nonexpansive fill at least 2 feet thick that extends a minimum of 3 feet beyond the exterior building perimeter. Subgrade areas beneath areas to receive fill that are determined to be weak and/or unstable should be excavated to expose suitable bearing material and replaced with compacted fill. Following approval by AKA, exposed subgrade areas to receive fill should be moisture conditioned, as appropriate, and compacted to at least 90 percent relative compaction (ASTM D-1557). Material comprising the nonexpansive fill layer should be placed in 8-inch lifts, moisture conditioned (as appropriate) and compacted to at least 90 percent relative compaction (based upon ASTM D-1557). The completed upper level mat subgrade should be rolled to create a uniform firm and non-yielding surface. Please note that the contractor should take appropriate precautions (such as temporary bracing or the use of lightweight equipment) when placing and compacting behind retaining walls to avoid overstressing the wall.

In order to reduce the potential for heave and/or cracking, exterior flatwork should be underlain by a minimum thickness of 12 inches of compacted nonexpansive fill placed and compacted in general accordance with the recommendations presented above.

7.04.4 Surface Drainage and Erosion Control

Positive surface drainage should be provided adjacent to the ACF to direct surface water away from the foundations of the building into closed pipes that discharge downslope of the proposed facility. In addition, all roof water should be collected and routed to a suitable discharge. Ponding of surface water should not be allowed in any areas adjacent to the structure. Concentrated flows of water should not be allowed across graded slopes as erosion or weakening of slope could occur. Following construction, areas disturbed by construction activities should be fine-graded to conform to adjacent surface grades and planted or hydroseeded to resist erosion.

7.04.5 Trench Backfill

Utility trenches should be backfilled with fill placed in lifts not exceeding 8 inches in uncompacted thickness. Trenches should be filled by placing a granular shading layer beneath and around the pipe, then 6 to 12 inches of shading should be carefully placed and tamped above the pipe. The remaining portion of the trench should be backfilled with onsite or import soil. The backfill (above shading layers) should be placed and compacted to a minimum relative degree of compaction of 90% based on (ASTM D-1557). The compaction requirements given above should be considered minimum recommended requirements. If LBNL and/or utility company specifications require more stringent backfill requirements, then those specifications should be followed.

If imported granular soil is used, sufficient water should be added during the trench backfilling operations to prevent the soil from "bulking" during compaction. All compaction operations should be performed by mechanical means only. We recommend against jetting.

If granular backfill is used for utility trenches, we recommend an impermeable plug or mastic sealant be used where utilities enter the building to minimize the potential for free water or moisture to enter below the building. Finally, because of the potential for catastrophic collapse of trench walls, we recommend the contractor carefully evaluate the stability of all trenches and use temporary shoring, where appropriate. The design and installation of the temporary shoring should be wholly the responsibility of the contractor. In addition, all state and local regulations governing safety around such excavations should be carefully followed.

7.05 <u>Additional Services</u>

7.05.1 Additional Geologic and Geotechnical Study

This report presents the results of our screening-level evaluation of earthquake-induced landslide potential for the proposed ACF. The interpretations and analyses presented in this report are based largely on a review of previous subsurface data and a limited subsurface investigation program comprised of two test borings at the proposed ACF site.

Additional geologic and geotechnical study could be performed to better characterize potential risks to the ACF as well as to nearby existing and planned structures. Additional site investigation would: (1) better constrain the locations and geometries of postulated landslide slip surfaces; (2) obtain additional laboratory test data

regarding the physical properties and shear strengths of the subsurface materials; and (3) better constrain the lateral margins of landsliding with a possible emphasis on determining potential impacts on nearby existing Buildings 83 and 85. Additional engineering and engineering geologic analyses could refine the results of our screening-level study and more accurately characterize the potential for and magnitude of earthquake-induced site deformations. Tasks that could be performed as part of an expanded study include the following:

To better constrain landslide geometry and properties used in slope stability modeling:

1. Review existing geotechnical data from Centennial Drive overpass area;
2. Review existing data from Centennial Drive slope indicators and piezometers;
3. Drill a geologic test boring in the vicinity of the Quarry (southwest of Building 83);
4. Consider drilling a geologic test boring on tank road upslope of ACF; and
5. Conduct laboratory tests on samples of landslide debris and slip zone materials.

To better constrain lateral margins of landslide near Buildings 83 and 85:

1. Review construction records and pier drilling logs from Building 85;
2. Review other construction records and observations by Preston Jordan and others; and
3. Drill shallow geologic borings or excavate test pits near landslide margins.

To better constrain estimates of landslide potential and deformations:

1. Refine screening-level models with additional subsurface data;
2. Conduct Newmark-type time history analyses, if needed; and
3. Perform 2-D finite element modeling, if needed.

To assess potential mitigation strategies:

1. Evaluate drainage alternatives;
2. Evaluate earthwork alternatives; and
3. Evaluate structural alternatives.

We note that geologic test borings could consist of either continuously-sampled small-diameter borings with OTV logging or large-diameter boreholes with downhole logging by an engineering geologist.

In our opinion, an expanded geologic and geotechnical study would best be conducted under a phased approach specifically tailored to LBNL's project objectives and levels of risk tolerance. Based on our recent discussions with LBNL, we envision that Phase 1 of an expanded study would include reviewing additional data, drilling supplemental test borings and performing laboratory analyses. The scope of engineering and engineering geology analyses that would comprise Phase 2 of an expanded study would likely be best defined based on an evaluation of the data obtained during Phase 1.

We would be pleased to consult with LBNL and develop a written scope and fee estimate for additional geologic and geotechnical study tailored to your specific project requirements, if desired.

7.05.2 Geotechnical Plan Review and Services During Construction

AKA should review geotechnical aspects of the plans and specifications to check for conformance with the intent of our recommendations. In addition, AKA should review all submittals from contractors and/or subcontractors that are geotechnical in nature. Submittals that we recommend we review include those pertaining to shoring, waterproofing and drainage materials.

Our field engineer should check and/or observe the geotechnical aspects of construction, including the following:

- Soil conditions exposed during site excavation,
- Subgrades beneath mat foundations,
- Installation of backdrains and underdrains,
- Backfill placement and compaction, and
- Installation/restoration of improvements to surface drainage.

8.00 LIMITATIONS

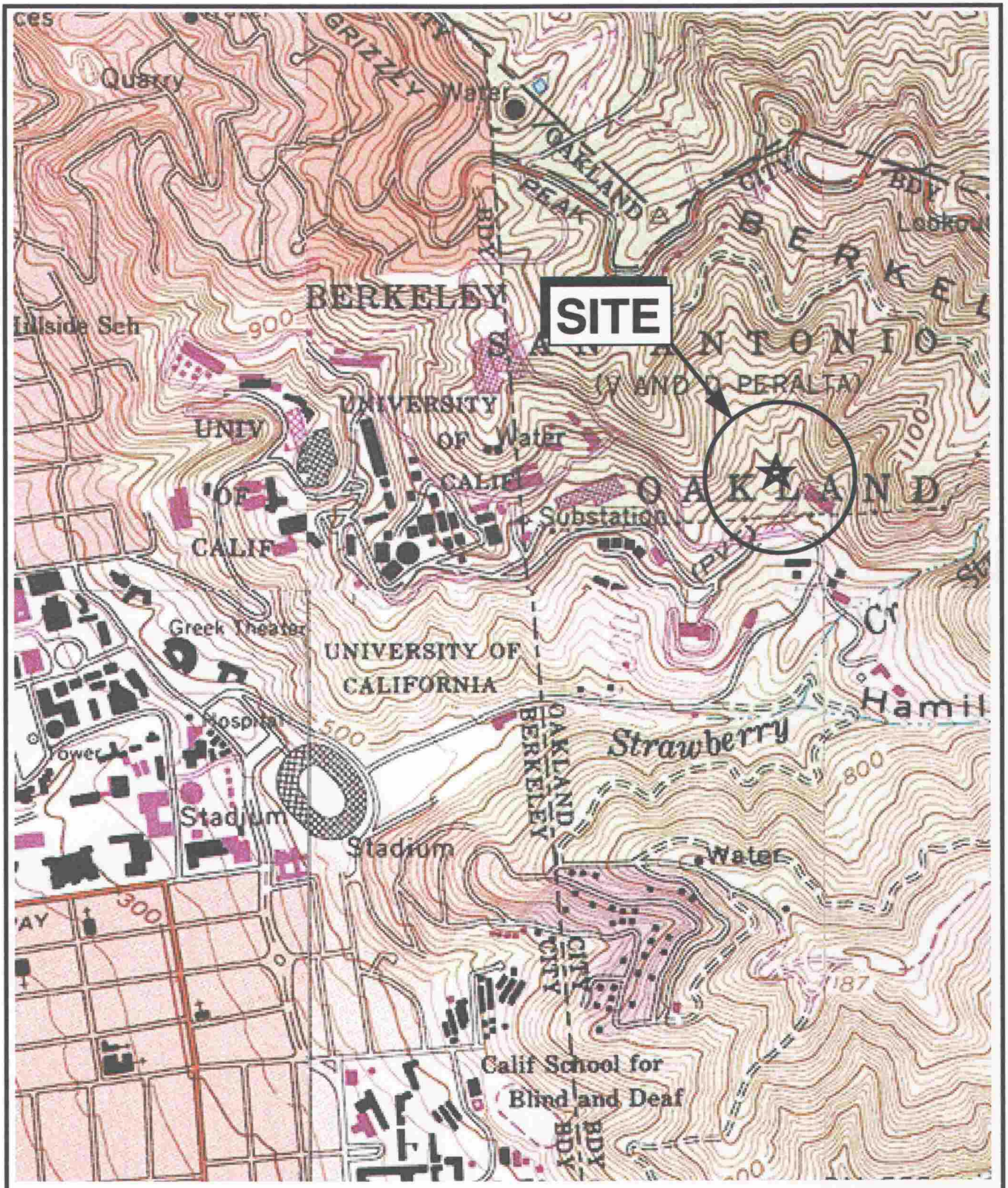
Existing geotechnical data exists for the site and vicinity from previous geotechnical and geologic investigations by others. The scope of our services was developed in consultation with LBNL representatives based on a review of the available data. On this basis, the scope of our field investigation focused primarily on conducting a screening evaluation for earthquake-induced landslide hazards. We note that the proposed ACF site is underlain mostly by bedrock materials that are thought to have translated downslope. In our judgment, the subsurface data from this investigation coupled with the nearby geotechnical reports by others are adequate to generally characterize the site for geotechnical purposes. However, we cannot vouch for the accuracy of information supplied by others. It is imperative that Alan Kropp and Associates (AKA) provide geotechnical consultation, observation and testing services during construction of the project to check design assumptions and to document that the construction conforms with the intent of our geotechnical recommendations.

As discussed in this report, there is the possibility that potentially significant site deformations may occur in response to earthquake groundshaking. The geotechnical recommendations presented herein are intended to result in a structure that will tolerate downslope site movements without collapse. If a higher level of structural performance is desired, additional geologic and geotechnical study should be performed (as discussed in "Section 7.05, Additional Services").

This report has been prepared for the exclusive use by LBNL and their consultants and contractors for specific application to the proposed development in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. In the event that there are any changes in the nature, design or location of the project, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing.

The findings of this report are valid as of the present date. However, the passing of time will likely change the conditions of the existing property due to natural processes or the works of man. In addition, due to legislation or the broadening of knowledge, changes in applicable or appropriate standards may occur. Accordingly, the findings of this report may be invalidated, wholly or partly, by changes beyond our control. Therefore, this report should not be relied upon after a period of three years without being reviewed by this office.

FIGURES



BASE: U.S. Geological Survey, 1959, Topographic Map of the Briones Valley Quadrangle. Photorevised 1968

NOT TO SCALE

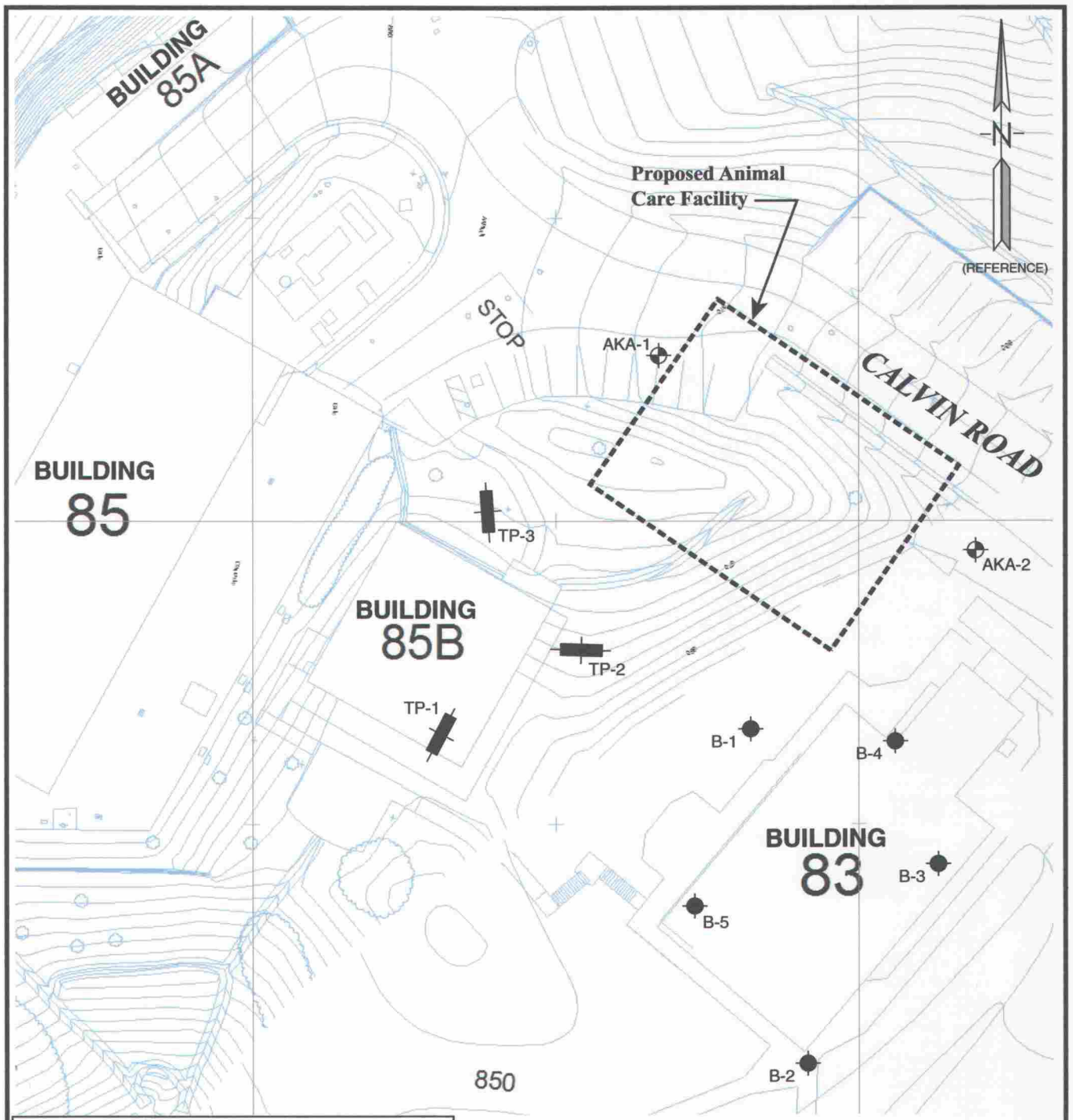
ALAN KROPP & ASSOCIATES

Geotechnical Consultants

VICINITY MAP

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	FIGURE
2335-2	September 2004	1



LEGEND

AKA-2 — Approximate Location of Exploratory Boring (Alan Kropp & Associates, 2004)

B-5 — Approximate Location of Exploratory Boring (Subsurface Consultants, Inc., 1996)

TP-3 — Approximate Location of Exploratory Test Pits (Harding-Lawson Associates, 1977)

25 0 50 100
APPROXIMATE SCALE FEET

BASE: Topographic Map supplied by LBNL Facilities Department, 2004

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

SITE PLAN

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	FIGURE 2
2335-2	September 2004	

View at the head of Strawberry Canyon, Grizzly Peak.

1885

The shacks of Pines are visible from Shattuck Avenue.

1903

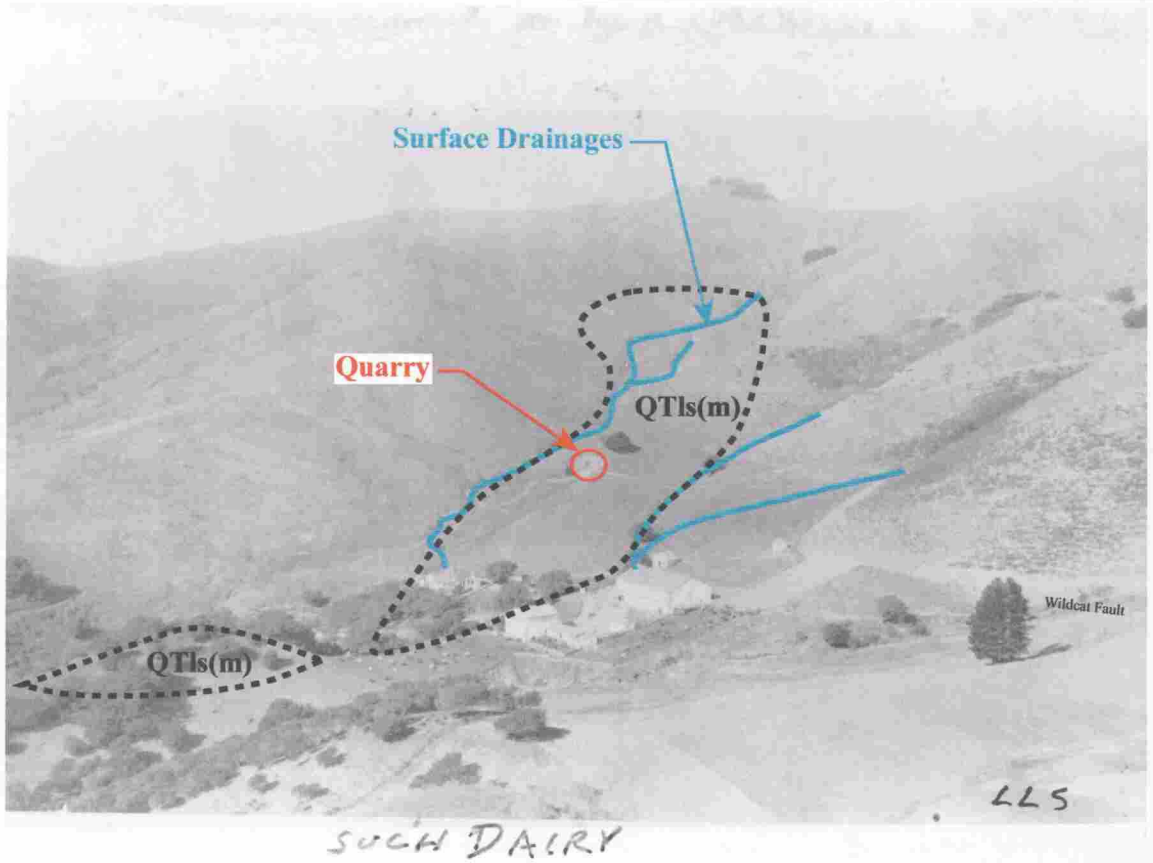
SUCH DAIRY

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

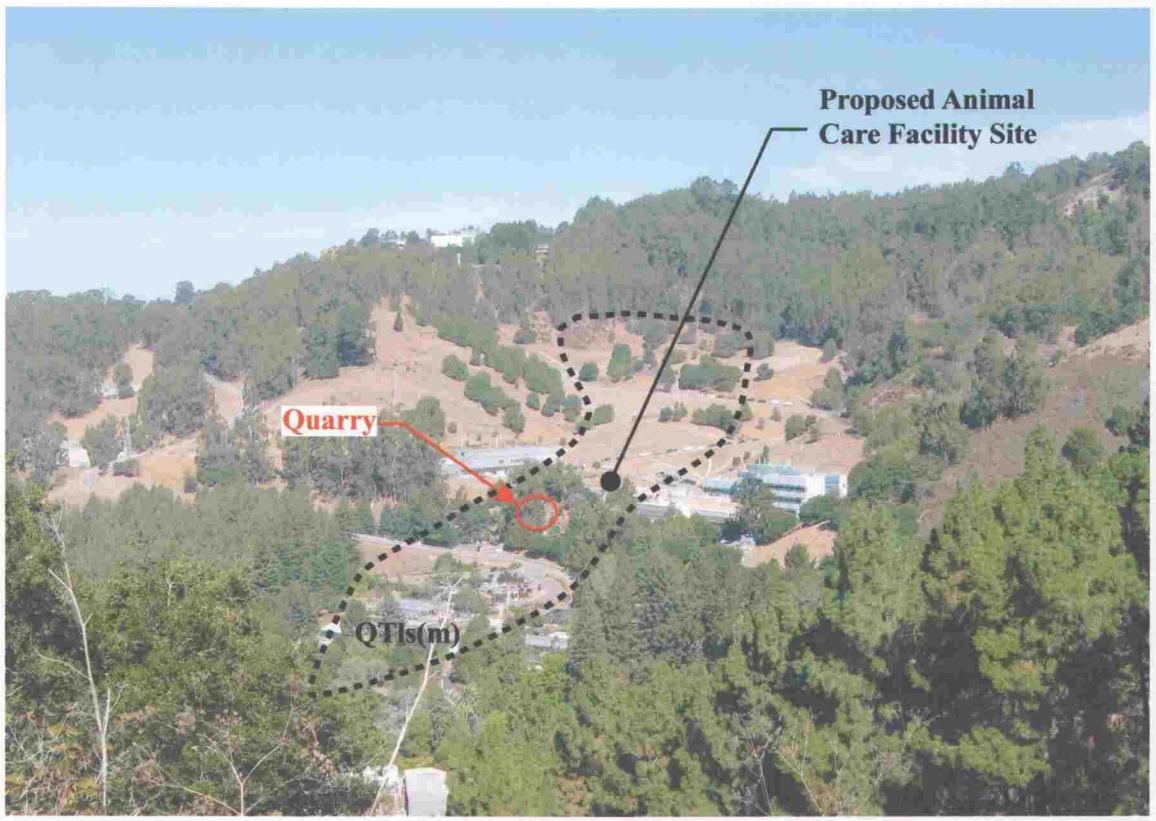
HISTORICAL OBLIQUE PHOTOGRAPHS

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	FIGURE 3
2335-2	September 2004	



1903



2004

ALAN KROPP & ASSOCIATES
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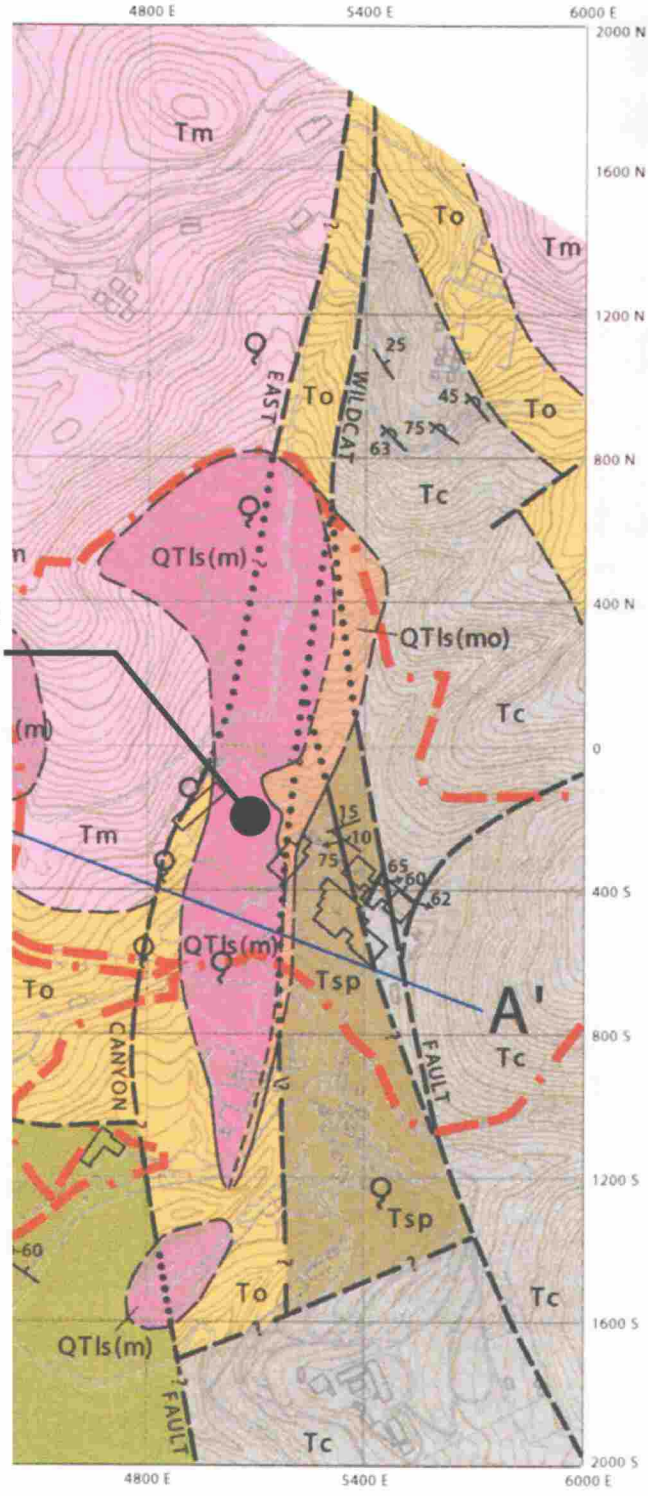
INTERPRETED OBLIQUE PHOTOGRAPHS

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	FIGURE 4
2335-2	September 2004	



QTls(m) Paleolandslide Deposit composed of Moraga Formation rocks

QTls(mo) Paleolandslide Deposit (Mixed Unit)

Tm Moraga Formation

To Orinda Formation

Tsp San Pablo Group

Tc Claremont Formation

Kgv Great Valley Group

JKf Franciscan Complex

Contact, showing dip
dashed where approximately located; dotted where concealed by other map units

Fault, showing dip
dashed where approximately located; dotted where concealed; queried where inferred

Strike and dip of beds

Strike and dip of overturned beds

Historic springs
(modified from Soule, 1875)

Boundary of Lawrence Berkeley National Laboratory

Reference: "Draft Final RCRA Facility Investigation Report," for the Lawrence Berkeley National Laboratory Environmental Restoration Program, dated September 29, 2000 (Figure 4.2-1. Bedrock Geologic Map)

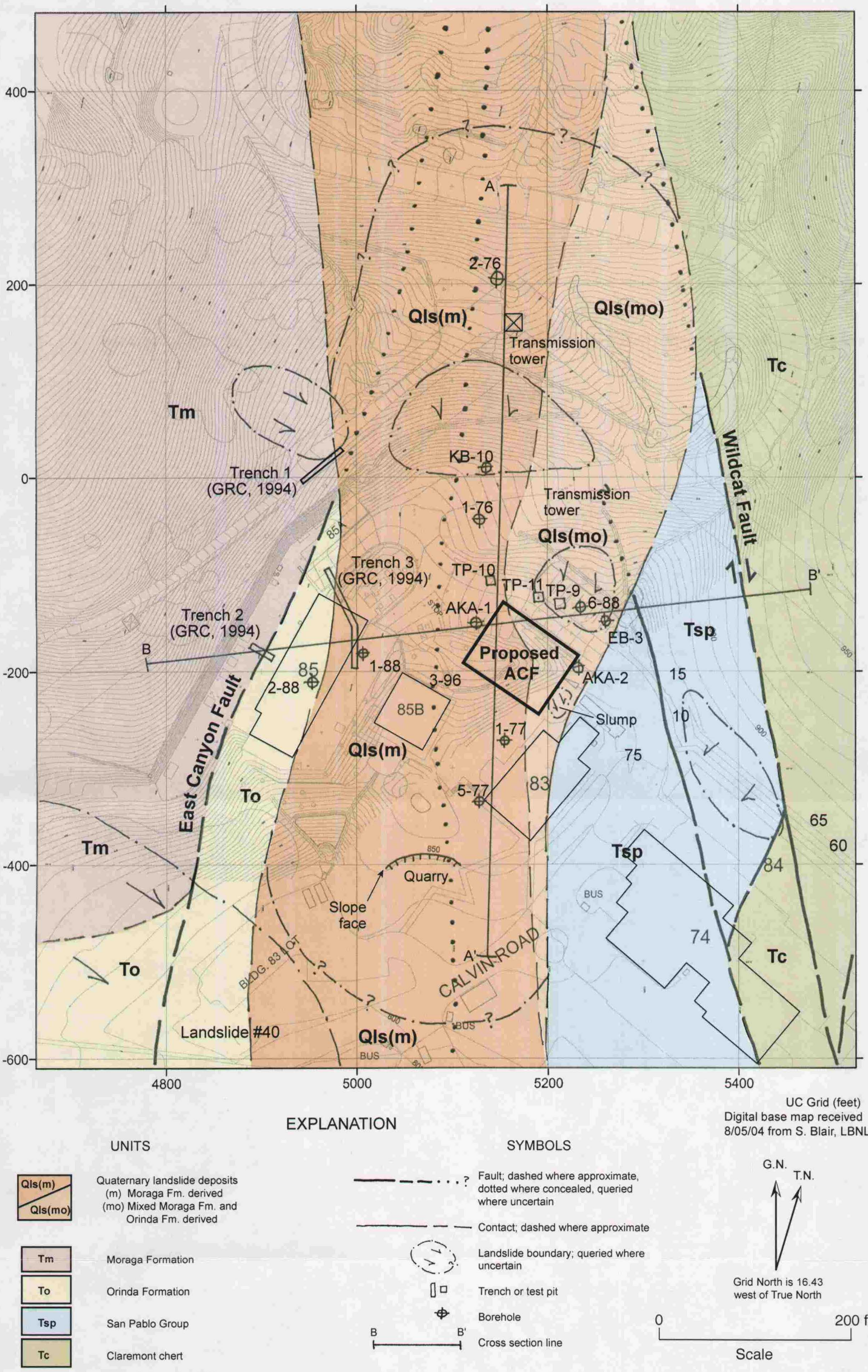
NOT TO SCALE

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

RFI GEOLOGIC MAP

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	FIGURE 5
2335-2	September 2004	



UC Grid (feet)
Digital base map received 8/05/04 from S. Blair, LBNL

EXPLANATION

UNITS

- Qls(m) / Qls(mo): Quaternary landslide deposits (m) Moraga Fm. derived (mo) Mixed Moraga Fm. and Orinda Fm. derived
- Tm: Moraga Formation
- To: Orinda Formation
- Tsp: San Pablo Group
- Tc: Claremont chert

SYMBOLS

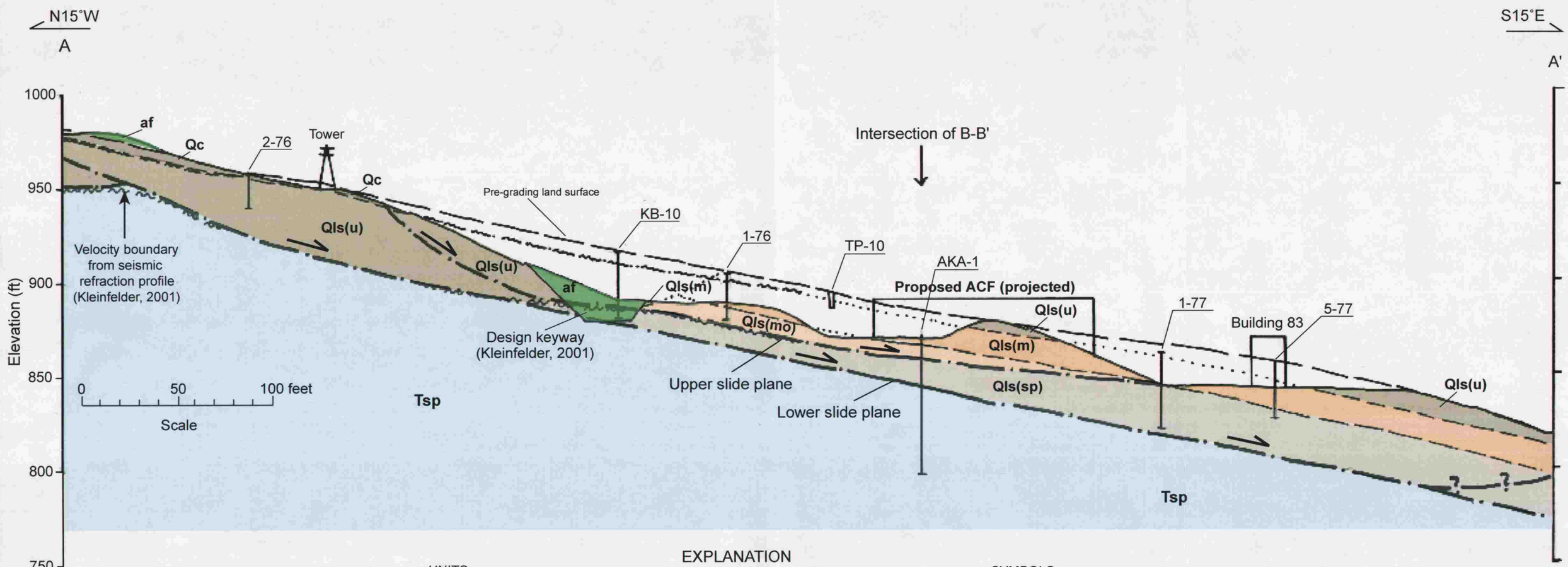
- Fault; dashed where approximate, dotted where concealed, queried where uncertain
- Contact; dashed where approximate
- Landslide boundary; queried where uncertain
- Trench or test pit
- Borehole
- B — B': Cross section line

G.N.
T.N.
Grid North is 16.43 west of True North

0 — 200 feet
Scale

Figure 6. Geologic map of the East Canyon area of the LBNL campus, including the proposed ACF. Base topography from S. Blair, LBNL, 2004. Map shows bedrock units and bedrock-involved landslide deposits, bedrock faults, and outlines of landslide bodies. Quaternary unconsolidated deposits and artificial fill are omitted for clarity, but are shown on cross sections A-A' and B-B'. Borehole, trench, and test pit sources used to construct cross sections are listed with the cross sections. Mapping based on field reconnaissance, borehole compilation and reinterpretation (including Gilpin, 1994), RFI Final Report (2000), as part of this study. Unpublished data from P. Jordan (pers. communication, 2004).

LBNL ANIMAL CARE FACILITY	
Preliminary Geologic Map	
WLA William Lettis & Associates, Inc.	Figure 6



EXPLANATION

UNITS

Unconsolidated deposits and fill

- af — Artificial fill
- Qc — Quaternary colluvium
- Qls(u) — Undifferentiated Quaternary landslide deposits

Semiconsolidated deposits and bedrock

Quaternary landslide deposits:

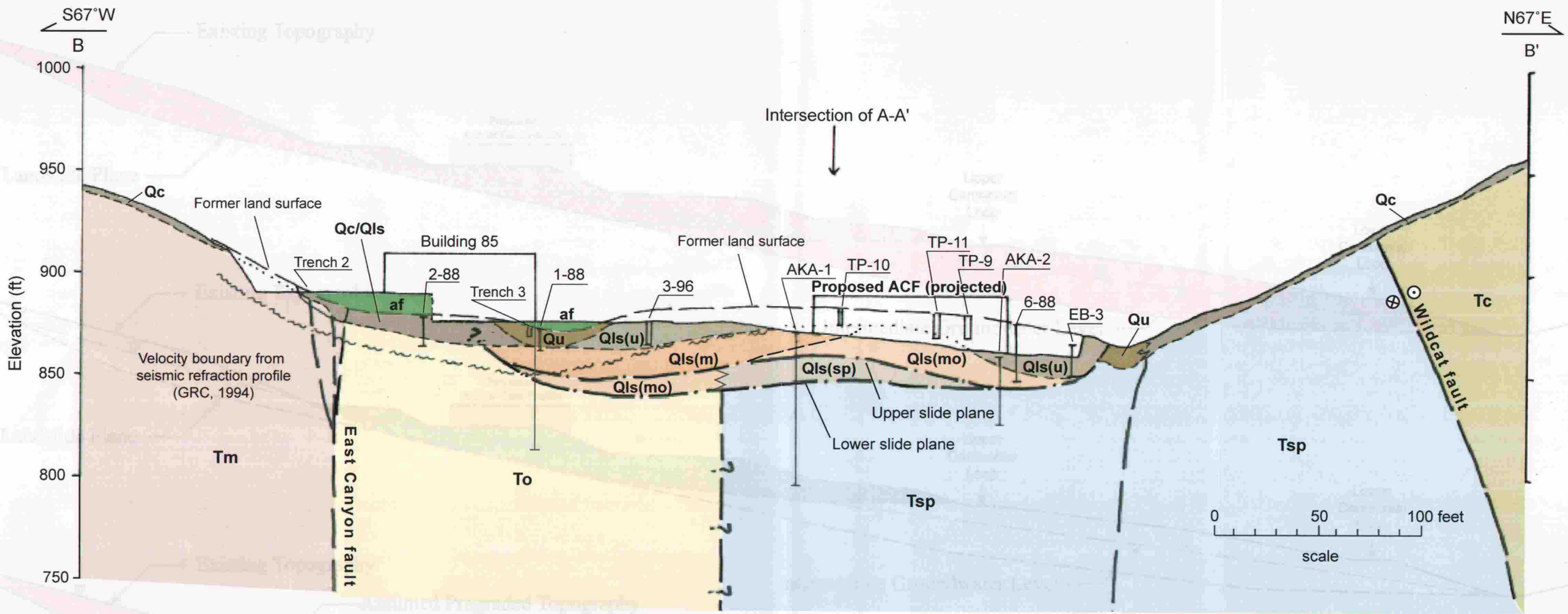
- Qls(m) — Moraga Fm. derived
- Qls(mo) — Mixed Moraga Fm. and Orinda Fm. derived
- Qls(sp) — San Pablo Group derived
- Tsp — Tertiary San Pablo Group

SYMBOLS

- Landslide plane, approximate; queried where uncertain
- Contact; dashed where approximate, dotted where projects above present-day land surface
- Seismic-refraction velocity boundary

Figure A-A'. Cross section A-A', showing possible landslide geometries and deposits. Boreholes and test pits used to construct the cross section: 2-76 (borehole 2 of HLA, 1976), KB-10 (Kleinfelder, 2001), 1-76 (borehole 1 of HLA,1976, TP-10 of GRC (1994), AKA-1 (this study), 1-77 and 5-77 (boreholes 1 and 5 of HLA, 1977). Artificial fill in keyway for road estimated from design in Kleinfelder (2001).

LBNL ANIMAL CARE FACILITY	
Geologic Cross Section A - A'	
WLA William Lettis & Associates, Inc.	Figure 7



EXPLANATION

UNITS

Unconsolidated deposits and fill

- af — Artificial fill
- Qu — Quaternary undifferentiated colluvium, alluvium, debris-flow, and mudflow deposits
- Qc/Qls — Quaternary colluvium, mixed colluvium and landslide deposits - undifferentiated

Quaternary landslide deposits

- Qls(u) — Undifferentiated
- Qls(m) — Moraga Fm. derived
- Qls(mo) — Mixed Moraga Fm. and Orinda Fm. derived
- Qls(sp) — San Pablo Group derived

Tertiary bedrock

- Tm — Moraga Formation
- To — Orinda Formation
- Tsp — San Pablo Group
- Tc — Claremont chert

SYMBOLS

- Landslide plane, approximate; querried where uncertain
- Fault contact, dashed where approximate; querried where uncertain
- Contact; dashed where approximate, dotted where projects above present-day land surface
- Seismic-refraction velocity boundary
- Motion away
- Motion toward

Figure 8. Cross Section B-B', showing possible landslide geometries and deposits. Boreholes, trenches, and test pits used to construct the cross section: Trench 2 and Trench 3 (GRC, 1994), 1-88, 2-88, and 6-88 (boreholes 1, 2, and 6 of Geo/Resource Consultants, 1989, 3-96 (Subsurface Consultants, 1996), AKA-1 and AKA-2 (this study), TP-9, TP-10, and TP-11 (Harza, 1995), EB-3 (Harza, 1995), 1-77 and 5-77 (boreholes 1 keyway for road estimated from design Kleinfelder (2001).

LBNL ANIMAL CARE FACILITY	
Geologic Cross Section B - B'	
WLA William Lettis & Associates, Inc.	Figure 8

APPENDIX A

APPENDIX A

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Aerial Photographs

Type	Date	Scale	Photo No.	Source
Black and White, Stereo Pair	08/02/39	1:20,000	BUT-BUU-289-67, 68	United States Soil Conservation Service
Black and White, Stereo Pair	03/24/47	1:20,000	AV-11-2-10, 11	Pacific Aerial Surveys

Appendix B

APPENDIX B

Logs of Borings

Alan Kropp & Associates
2004

DRILL RIG: Rotary Wash	SURFACE ELEVATION: ± 872 feet	LOGGED BY: JP
DEPTH TO GROUNDWATER: See Notes	BORING DIAMETER: 5 inches	DATE DRILLED: 08-16-04

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (feet)	SAMPLER	BLOWS / FT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
Asphaltic Concrete ~ 6 inches Baserock ~ 6.5 inches	--	--	--						
VOLCANICS, severely weathered, highly fractured, iron staining on partings; (LANDSLIDE DEBRIS)	Brown	Soft Hardness	ROCK	1 2 3 4					
-micro-chrystalline structure, interlocking, fractured 1-2 mm wide, stained, highly weathered, volcanics - basalt or andesite	Dark Gray to Brown			5 6	X	[34]			
-clay-rich matrix, highly fractured, weathered bedrock	Dark Brown to Olive Brown			7 8	X	[35]			
	Light Brown			9 10		19			
-crushed bedrock, 40°dip, interpreted slide plane at 10.5 feet, noted by yellowish brown clay, dip 40°	Dark Reddish Brown to Yellowish Brown			11 12					
-highly fractured bedrock with clay seams				13	X				
SILTSTONE, tight fractured with iron staining, no clay seams, fractures pervasive; (LANDSLIDE DEBRIS) -highly fractured siltstone with clay along seams, no apparent bedding, contact dip between color change 40° -carbonate along seams	Greenish Gray Dark Brown	Moderate Hardness	ROCK	14 15 16	X	[53]			
SILTSTONE to SANDSTONE, fine-grained, highly weathered, tight fractures; (LANDSLIDE DEBRIS)	Gray to Grayish Brown	Moderate Hardness	ROCK	17	X	[44]			
-reddish brown siltstone, tight fractures with clayey seams				18					
-19-21': highly weathered and fractured siltstone, silty clay matrix along larger blocks	Dark Reddish Brown	Soft Hardness		19 20		32			

(continued on next sheet)

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

EXPLORATORY BORING LOG

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	SHEET	BORING NO.
2335-2	September 2004	1 of 4	1

DRILL RIG: Rotary Wash	SURFACE ELEVATION: ± 872 feet	LOGGED BY: JP
DEPTH TO GROUNDWATER: See Notes	BORING DIAMETER: 5 inches	DATE DRILLED: 08-16-04

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (feet)	SAMPLER	BLOWS / FT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
SILTSTONE to SANDSTONE, fine-grained, highly weathered, fractured, silty clay matrix along larger blocks; (LANDSLIDE DEBRIS), (continued from previous sheet)	Dark Reddish Brown	Soft Hardness	ROCK	21					
-21-22': less fractured -22.5': contact dips 25°-30° between upper dark reddish brown clay rich siltstone and distinct bluish gray siltstone, pervasive blocky fractures	Bluish Gray			22 23		[37]			
CLAY, slickenslides, dips 20°, (interpreted slide plane)	Bluish Gray	Soft	CH	24		23			
SILTSTONE, abundant clay, blocky to seamy fractures, with anastomosing fabric, shiny surfaces, strongly sheared to crushed bluish gray siltstone;(LANDSLIDE DEBRIS)	Dark Reddish Brown to Bluish Gray	Stiff	ROCK	25 26 27					
-transition landslide to bedrock (LANDSLIDE DEBRIS ↑)				28		[73]			
SILTSTONE, highly weathered, fractured, less clay rich and losing seamy fabric, still abumdant fractures, becoming blue in color	Dark Reddish Brown	Soft Hardness	BED-ROCK	29					
-29.5-31.5': solid blocky fractures, no clay seams, fracture spacing 1 to 2 inches and blocky, no apparent bedding	Bluish Gray			30 31 32		77			
	Reddish Brown			33		[94]			
-34-37.5': weak to moderately strong material, fracture spacing 2 to 3 inches	Grayish Reddish Brown			34 35 36 37		82 [50]/5"			▽ 16 hours after drilling
SANDSTONE, very-fine-grained, silty, large blocky fractures, no clay seams, bedding dip 20°-40°, weak to moderately strong -39': prominent steep 60° dipping tight fracture, subhorizontal reddish brown weathered zone (continued on next sheet)	Bluish Gray	Moderate Hardness	BED-ROCK	38 39 40					

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EXPLORATORY BORING LOG

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	SHEET	BORING NO.
2335-2	September 2004	2 of 4	1

DRILL RIG: Rotary Wash	SURFACE ELEVATION: ± 872 feet	LOGGED BY: JP
DEPTH TO GROUNDWATER: See Notes	BORING DIAMETER: 5 inches	DATE DRILLED: 08-16-04

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (feet)	SAMPLER	BLOWS / FT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
SANDSTONE, very-fine-grained, silty, large blocky fractures, no clay seams, bedding dip 15°-20°, moderate to hard strong, thin sandy laminations (continued from previous sheet)	Dark Gray to Light Gray	Moderate Hardness	BED-ROCK	41, 42, 43, 44					
-44.5-45': highly fractured and crushed sandstone, with fine gravels, fractures at 45 feet, widely spaced with minor displacement (?)				45, 46					
-47': very-fine-to-medium-grained sandstone, fractured with mineralization dip 45°-50°, very small micro-faults, bedding dip between units 45°-50°,	Bluish Gray Green to Brown			47, 48, 49					
-50': siltstone with cemented gravel and coarse sand, erosional contact (paleochannel?) moderate to strong, few fractures tight				50, 51, 52					
-finer grained at 53' -53-53.5': thin lense of cemented fine gravel, fractures at 1" spacing	Gray			53					
-54': bedding dip 20° -54-56': excellent interbeds of cross-bedded and laminated sand and silt to claystone (erosional contacts)	Gray to Brown			54, 55					
-56-60': prominent sandstone and siltstone interbeds, interbedded siltstone bedding dips 20°, stong to very strong	Gray			56, 57, 58, 59, 60					

(continued on next sheet)

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Geotechnical Consultants

EXPLORATORY BORING LOG

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	SHEET	BORING NO.
2335-2	September 2004	3 of 4	1

DRILL RIG: Rotary Wash	SURFACE ELEVATION: ± 872 feet	LOGGED BY: JP
DEPTH TO GROUNDWATER: See Notes	BORING DIAMETER: 5 inches	DATE DRILLED: 08-16-04

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (feet)	SAMPLER	BLOWS / FT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
SANDSTONE, very-fine-grained, large blocky fractures, no clay seams, bedding dip 15°-20°, moderate to hard strong, thin sandy laminations (continued from previous sheet)	Gray	Moderate Hardness	BED-ROCK	61					
-62-65': interbedded siltstone to claystone and sandstone, very blocky, very hard, numerous sealed microfaults, highly fractures	Brown			62, 63, 64					
-65': very-fine-grained-sandstone with steep fractures, interbedded fine to coarse sand, dipping 15°, abundant sealed microfaults, highly fractured	Bluish Gray			65, 66, 67					
-68-69': fracture dipping 45°	Brown to Gray			68, 69					
CLAYSTONE, abundant blocky seamy fractures, very weak to weak, no clay seams along fractures	Dark Brown with Gray	Soft Hardness	BED-ROCK	70					
-70-72': pulverized and crushed				71, 72					
SANDSTONE, very-fine-grained, moderate to strong, bedding dip with claystone 30°	Gray	Hard Hardness	BED-ROCK	73					

Bottom of boring at 74 feet

NOTES

1. Groundwater was encountered at a depth of about 36 feet 16 hours after drilling. The boring was grouted following drilling. (See text for discussion.)

2. Stratification lines represent the approximate boundaries between material types and the transitions may be gradual.

3. Penetration resistance values (blow counts) enclosed in brackets ([ ]) were recorded with a 3.0-inch O.D. Modified California sampler; these are not standard penetration resistance values.

4. Elevations were determined from topographic map supplied by LBNL Facilities Department, 2004.

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

EXPLORATORY BORING LOG

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	SHEET	BORING NO.
2335-2	September 2004	4 of 4	1

DRILL RIG: Rotary Wash	SURFACE ELEVATION: ± 858 feet	LOGGED BY: JP
DEPTH TO GROUNDWATER: See Notes	BORING DIAMETER: 5 inches	DATE DRILLED: 08-18-04

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (feet)	SAMPLER	BLOWS / FT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
CLAY, silty, sandy, with fine to coarse gravels, dry; (LANDSLIDE DEBRIS)	Brown	Stiff	CL						
-highly weathered translated bedrock in clay matrix, material appears to be weathered sandstone				1, 2, 3					
- Andesite fragments in clay matrix; (Qc/Qls debris)	Yellowish Brown			4, 5, 6, 7		[27]			
CLAYSTONE, severely weathered, fractured, iron staining on partings; (POSSIBLE LANDSLIDE DEBRIS)	Brown	Soft Hardness	BED-ROCK	8, 9					
- rock fragments in a clayey matrix, sandstone, fractured; (weathered bedrock or landslide debris)	Reddish Brown			10, 11, 12, 13, 14		34			
- dark rock (basalt?) fragments with some clay, possible base of weathered bedrock, highly fractured; (Qc) (POSSIBLE LANDSLIDE DEBRIS ↑)	Black			15, 16, 17		50"/3			
SANDSTONE, very fine grained, moderately weathered, fractured, with clay matrix	Gray	Hard Hardness	BED-ROCK	18, 19, 20					

(continued on next sheet)

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

EXPLORATORY BORING LOG

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	SHEET	BORING NO.
2335-2	September 2004	1 of 2	2

DRILL RIG: Rotary Wash	SURFACE ELEVATION: ± 858 feet	LOGGED BY: JP
DEPTH TO GROUNDWATER: See Notes	BORING DIAMETER: 5 inches	DATE DRILLED: 08-18-04

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (feet)	SAMPLER	BLOWS / FT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
SANDSTONE, very-fine-grained, moderately weathered, fractured, with angular clasts of grayish brown fractured sandstone; (weathered bedrock) (continued from previous sheet)	Bluish Gray to Gray Black	Hard Hardness	BED-ROCK			[50]/5" 50/1"			
				21					
				22					
				23					
				24					
				25		50/2"			
- very-fine-to-medium-grained SANDSTONE	Gray			26					
				27					
				28					
				29					
				30					
- predominately fine-to-medium-grained SANDSTONE, laminated with fine-grained sandstone and siltstone, bedding dipping 35°, gravel lense with coarse sand between overlying fine sand and underlying coarse sand (31.5')	Grayish Light Brown			31					
				32					

Bottom of boring at 33 feet

NOTES

1. No groundwater was encountered at the time of drilling and the boring was grouted following drilling. (See text for discussion.)

2. Stratification lines represent the approximate boundaries between material types and the transitions may be gradual.

3. Penetration resistance values (blow counts) enclosed in brackets ([ ]) were recorded with a 3.0-inch O.D. Modified California sampler; these are not standard penetration resistance values.

4. Elevations were determined from topographic map supplied by LBNL Facilities Department, 2004.

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

EXPLORATORY BORING LOG

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	SHEET	BORING NO.
2335-2	September 2004	2 of 2	2

SOIL CLASSIFICATION CHART

PRIMARY DIVISIONS			SECONDARY DIVISIONS		
			CRITERIA *	GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS MORE THAN 50% RETAINED ON NO.200 SIEVE	GRAVELS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO.4 SIEVE	CLEAN GRAVELS LESS THAN 5% FINES	$Cu \geq 4$ AND $1 \leq Cc \leq 3$ [A]	GW	Well-graded gravel
			$Cu < 4$ AND/OR $1 > Cc > 3$	GP	Poorly-graded gravel
		GRAVELS WITH FINES - MORE THAN 12% FINES	FINES CLASSIFY AS ML OR MH	GM	Silty gravel
			FINES CLASSIFY AS CL OR CH	GC	Clayey gravel
	SANDS 50% OR MORE OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SANDS LESS THAN 5% FINES	$Cu \geq 6$ AND $1 \leq Cc \leq 3$	SW	Well-graded sand
			$Cu < 6$ AND/OR $1 > Cc > 3$	SP	Poorly-graded sand
		SANDS WITH FINES - MORE THAN 12% FINES	FINES CLASSIFY AS ML OR MH	SM	Silty sand
			FINES CLASSIFY AS CL OR CH	SC	Clayey sand
FINE-GRAINED SOILS 50% OR MORE PASSES THE NO.200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50%	INORGANIC	PI > 7 AND PLOTS ON OR ABOVE "A" LINE	CL	Lean clay
			PI < 4 OR PLOTS BELOW "A" LINE	ML	Silt
		ORGANIC	$\frac{\text{LIQUID LIMIT - OVEN DRIED}}{\text{LIQUID LIMIT - NOT DRIED}} < 0.75$	OL	Organic Clay & Organic Silt
	SILTS AND CLAYS LIQUID LIMIT 50% OR MORE	INORGANIC	PI PLOTS ON OR ABOVE "A" LINE	CH	Fat clay
			PI PLOTS BELOW "A" LINE	MH	Elastic silt
		ORGANIC	$\frac{\text{LIQUID LIMIT - OVEN DRIED}}{\text{LIQUID LIMIT - NOT DRIED}} < 0.75$	OH	Organic Clay & Organic Silt
	HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR	PT	Peat

REFERENCE: Unified Soil Classification System (ASTM D 2487-00)

* Criteria may be done on visual basis, not necessarily based on lab testing

A – $C_u = D_{60}/D_{100}$ & $C_c = (D_{30})^2 / (D_{10} \times D_{60})$

GRAIN SIZES

U. S. STANDARD SERIES SIEVE				CLEAR SQUARE SIEVE OPENINGS			
200	40	10	4	3/4"	3"	12"	
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

ABBREVIATIONS

INDEX TESTS

LL - Liquid Limit (%) (ASTM D 4318-00)

PI - Plasticity Index (%) (ASTM D 4318-00)

-200 - Passing No. 200 Sieve (%) (ASTM D 1140-00)

STRENGTH TESTS

PP - Field Pocket Penetrometer test of unconfined compressive strength (kips/sq.ft.)

TV - Field Torvane test of shear strength (kips/sq.ft.)

UC - Laboratory unconfined compressive strength (kips/sq.ft.) (ASTM D 2166-00)

TXUU - Laboratory unconsolidated, undrained triaxial test of undrained shear strength (kips/sq.ft.) (ASTM D 2850-03a)

MISCELLANEOUS

ATOD - At time of drilling

ksf - kips per square foot

psi - pounds per square inch (indicates relative force required to advance Shelby tube sampler)

SYMBOLS

Standard Penetration Test Split Spoon (2-inch O.D.)

Modified California Sampler (3-inch O.D.)

Thin-walled Sampler Tube (either Pitcher or Shelby) (3-inch O.D.)

Rock Core

Bag Sample

Groundwater Level

ALAN KROPP & ASSOCIATES

Geotechnical Consultants

KEY TO EXPLORATORY BORING LOGS

LBNL ANIMAL CARE FACILITY
Berkeley, California

PROJECT NO.	DATE	FIGURE
2335-2	September 2004	B-1

Kleinfelder
2001

Other Laboratory Tests	Dry Density (pcf)	Moisture Content (%)	Sample Interval (feet)	Blows/ Foot *	DEPTH (FEET)

EQUIPMENT: **Morooka MST-600** ELEVATION: **912.0 ****

LOGGED BY: **Ted Crump** START DATE: **3-27-01**

STATION: **1+10 L20** FINISH DATE: **3-27-01**

0

DARK BROWN SANDY GRAVELLY CLAY (CL), medium stiff, moist with abundant angular gravels (Colluvium)

5

10

15

20

DARK BROWN SANDY CLAY (CH), hard, moist with some small angular gravels and light blue clay seams

25

30

Blows/ Foot *
42
45
50+

MOTTLED LIGHT BLUE AND GRAY CLAY SAND GRAVEL (GC), very dense, wet
(Possible Orinda formation bedrock interface with colluvium)

BOTTOM OF BORING 33.5 FEET
No Groundwater Encountered

* Converted to equivalent standard penetration blow counts.

** Existing ground surface at time of drilling.

KLEINFELDER
Geotechnical, Materials and Environmental Engineering

PROJECT NUMBER 41-7631-01-001 DATE JUN 2001

LOG OF BORING KB10

LBNL TANK ROAD

Berkeley, California

PLATE A-12

Subsurface Consultants
1996

LOG OF TEST PIT 1

EQUIPMENT: BACKHOE (30" BUCKET)
DATE EXCAVATED: JUNE 5, 1996
ELEVATION: 862 FEET (MSL DATUM)

LABORATORY TESTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	OVM (PPM)	DEPTH (FEET)	SAMPLE	BLOWS PER FOOT	
				0			BROWN SILTY CLAY (CH) soft, dry, with roots (colluvium)
							BROWN SILTY CLAY (CH) medium stiff, moist (colluvium)
	28.7	93			■		
	27.7	93			■		
				5			BROWN SILTY CLAY (CL) stiff, moist, with cobbles (colluvium)
				10			No groundwater encountered
				15			

LOG OF TEST PIT 2

EQUIPMENT: BACKHOE (30" BUCKET)
DATE EXCAVATED: JUNE 5, 1996
ELEVATION: 867 FEET (MSL DATUM)

LABORATORY TESTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	OVM (PPM)	DEPTH (FEET)	SAMPLE	BLOWS PER FOOT	
				0			BROWN SILTY CLAY (CH) soft, dry, with roots (colluvium)
							BROWN SILTY CLAY (CH) medium stiff, moist (colluvium)
	26.3	97			■		
							RED-GRAY-BROWN AGGLOMERATE intensely fractured, friable, weak, deep weathering
	21.6	102		5	■		
				10			No groundwater encountered
				15			

Subsurface Consultants	BUILDING 85 MODULAR OFFICE PAD LAWRENCE BERKELEY NATIONAL LABORATORY			PLATE
	JOB NUMBER 658.040	DATE 8/19/96	APPROVED	2

LOG OF TEST PIT 3

EQUIPMENT: BACKHOE (30" BUCKET)
DATE EXCAVATED: JUNE 5, 1996
ELEVATION: 873 FEET (MSL DATUM)

LABORATORY TESTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	OVM (PPM)	DEPTH (FEET)	SAMPLE	BLOWS PER FOOT	
				0			BROWN SILTY CLAY (CH) soft, dry, with roots (colluvium)
							BROWN SILTY CLAY (CH) medium stiff, moist (colluvium)
	22.3	91		5			
				10			
							No groundwater encountered
				15			

Subsurface Consultants	BUILDING 85 MODULAR OFFICE PAD LAWRENCE BERKELEY NATIONAL LABORATORY	PLATE
	JOB NUMBER 658.040 / DATE 8/19/96 / APPROVED	3

GENERAL SOIL CATEGORIES			SYMBOLS	TYPICAL SOIL TYPES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	GRAVEL More than half coarse fraction is larger than No. 4 sieve size	Clean Gravel with little or no fines	GW	Well Graded Gravel, Gravel-Sand Mixtures
			GP	Poorly Graded Gravel, Gravel-Sand Mixtures
		Gravel with more than 12% fines	GM	Silty Gravel, Poorly Graded Gravel-Sand-Silt Mixtures
			GC	Clayey Gravel, Poorly Graded Gravel-Sand-Clay Mixtures
	SAND More than half coarse fraction is smaller than No. 4 sieve size	Clean Sand with little or no fines	SW	Well Graded Sand, Gravelly Sand
			SP	Poorly Graded Sand, Gravelly Sand
		Sand with more than 12% fines	SM	Silty Sand, Poorly Graded Sand-Silt Mixtures
			SC	Clayey Sand, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	SILT AND CLAY Liquid Limit Less than 50%		ML	Inorganic Silt and Very Fine Sand, Rock Flour, Silty or Clayey Fine Sand, or Clayey Silt with Slight Plasticity
			CL	Inorganic Clay of Low to Medium Plasticity, Gravelly Clay, Sandy Clay, Silty Clay, Lean Clay
			OL	Organic Clay and Organic Silty Clay of Low Plasticity
	SILT AND CLAY Liquid Limit Greater than 50%		MH	Inorganic Silt, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silt
			CH	Inorganic Clay of High Plasticity, Fat Clay
			OH	Organic Clay of Medium to High Plasticity, Organic Silt
HIGHLY ORGANIC SOILS			PT	Peat and Other Highly Organic Soils

UNIFIED SOIL CLASSIFICATION SYSTEM

Subsurface Consultants

BUILDING 85 MODULAR OFFICE PAD.
LAWRENCE BERKELEY NATIONAL LABORATORY

JOB NUMBER	DATE	APPROVED
658.040	8/19/96	

PLATE 4

BEDDING OF SEDIMENTARY ROCKS

Very thick-bedded	Greater than 4.0	Bed thickness in feet
Thick-bedded	2.0 to 4.0	
Thin-bedded	0.2 to 2.0	
Very thin-bedded	0.05 to 0.2	
Laminated	0.01 to 0.05	
Thinly laminated	less than 0.01	

FRACTURING

Very little fractured	Greater than 4.0	Size of pieces in feet
Occasionally fractured	1.0 to 4.0	
Moderately fractured	0.5 to 1.0	
Closely fractured	0.1 to 0.5	
Intensely fractured	0.05 to 0.1	
Crushed	less than 0.05	

HARDNESS

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

STRENGTH

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

WEATHERING

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

ROCK CLASSIFICATION CRITERIA

Subsurface Consultants

BUILDING 85 MODULAR OFFICE PAD
LAWRENCE BERKELEY NATIONAL LABORATORY

JOB NUMBER	DATE	APPROVED	PLATE
658.040	8/19/96		5

HARZA
1995

428_00076

DRILL RIG	Minuteman, CFA	SURFACE ELEVATION	865'	LOGGED BY	Mark Caruso
DEPTH TO GROUND WATER	Not Encountered	BORING DIAMETER	3-1/2-inch	DATE DRILLED	9/27/95

DESCRIPTION AND CLASSIFICATION: DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
CLAY (CL), mottled shades of brown, silty, with sand (fine to coarse, angular), some gravel (fine, angular), trace organics, dry (Recent Slide Debris)	Stiff				15	19	93		Compaction Test (see Fig.B-2) LL=47% PI=33% Passing #200 Sieve=82%
CLAY (CL), medium brown mottled rust, silty, some sand (fine to medium), damp (some sand (fine to coarse), trace gravel (fine, angular, siltstone and volcanic material), damp at 3 feet) (Recent Slide Debris)	Stiff				15	20			
	Stiff				20	23	100		
SILT (ML) light olive-gray, with clay, trace friable siltstone fragments, trace roots, damp (Recent Slide Debris)	Hard		5		74				
					80/6"	14	105		
CLAY (CL), medium brown, silty, some sand (fine to coarse), trace gravel (fine, angular, chert and basalt), trace MnO2 staining, damp (mottled brown, gray, olive and rust, with gravel (fine and coarse, angular basalt), some pockets of very soft clayey silt, damp to moist at 5-1/2 feet) (gravelly (basalt), damp at 6-1/2 feet) (Old Slide Debris ?)	Very Stiff				22				
					79	20	111		
	Very Dense		10						
SILT (ML), light brown and olive-gray, trace iron staining, with clay, trace sand (fine), damp (mottled light blue-gray and olive, clayey, no sand, trace organics, damp at 9-1/2 feet) (Old Slide Debris ?)					65				
					64				
SAND (SM/ML), olive-gray, very fine, silty, damp (fine, some pockets of blue-gray and dark gray clayey silt, trace caliche, damp at 14 feet) (Old Slide Debris ?)									

Bottom of Boring = 14-1/2 feet

Notes:

1. The stratification lines represent approximate boundaries between material types, the transition may be gradual.
2. The boring was backfilled with soil cuttings at the end of the day.
3. LL = Liquid Limit, PI = Plasticity Index.

HARZA
Consulting Engineers & Scientists

EXPLORATORY BORING LOG

LBL BUILDING 85 SLIDE INVESTIGATION
Lawrence Berkeley Laboratory, Berkeley, California

PROJECT NO.	DATE	BORING NO.
L343G	October 1995	EB-3

Geo/Resource Consultants
1989

* = 3.0" O. D. Modified California Sampler w/140 lb. hammer* falling 30".

LOG OF BORING B-1

Equipment: hollow stem auger

Elevation: 873 feet Date: 8/11/88

Laboratory Analyses	Blows/ft.	Moisture Content (%)	Dry density (pcf)	Depth (ft.)	Sample pnts.	Description
Atterberg Limits L.L. = 54, P.I. = 21	20	21.0		0		DARK BROWN SILTY CLAY (CH) dry to slightly moist
	31	15.1	95.6	5		BROWN SILTY CLAY (CL) moist, very stiff - contains clasts of friable sandstone
				10		LIGHT BROWN CLAYEY GRAVEL (GC) contains moist, dense friable sandstone and hard andesite fragments
	53	10.1	88.9			GRAY AGGLOMERATE (Moraga Formation) weak to moderately strong, friable, moderately weathered, closely fractured
	63			15		Bottom of hole 16'6"
				20		
				25		
				30		
				35		
				40		

Geo/Resource Consultants, Inc.
Consulting Engineers, Geologists, Geophysicists

Job No. 1393-00 Appr: [illegible] Date 10/16/89

LOG OF BORING B-1
REPLACEMENT OF HAZARDOUS WASTE HANDLING FACILITY AT LAWRENCE BERKELEY LABORATORY BERKELEY, CALIFORNIA

FIGURE A-12

LOG OF BORING B-2

Equipment: hollow stem auger

Elevation: 868 feet Date: 8/11/88

* = 3.0" O.D. Modified California Sampler w/140 lb. hammer* falling 30".

Laboratory Analyses	Blows/ft.	Moisture Content (%)	Dry density (pcf)
TXUU 7,800 (500)	34		
	30		
	39		
	90		

Depth (ft.): 0, 5, 10, 15, 20, 25, 30, 35, 40

Sample pnts.

0	DARK BROWN SILTY CLAY (CH) slightly moist, stiff
5	BROWN SILTY CLAY (CL-CH) moist, very stiff contains friable sandstone and siltstone clasts
10	BROWN GRAVELLY CLAY (CL) moist, very stiff contains andesite fragments
15	GRAY AGGLOMERATE (Moraga Formation) soft, weak, closely to intensely fractured deeply weathered becomes reddish brown, harder
20	Bottom of hole 21' 6"

Geo/Resource Consultants, Inc.
Consulting Engineers, Geologists, Geophysicists

Job No. 1393-00 Appr: ESJ Date 10/16/89

LOG OF BORING B-2
REPLACEMENT OF HAZARDOUS WASTE HANDLING FACILITY AT LAWRENCE BERKELEY LABORATORY
BERKELEY, CALIFORNIA

FIGURE A-13

* = 3.0" O.D. Modified California Sampler w/140 lb. hammer* falling 30".

LOG OF BORING B-6

Equipment hollow stem auger

Elevation 885 feet Date 8/11/88

Laboratory Analyses	Blows/ft.	Moisture Content (%)	Dry density (pcf)	Depth (ft.)	Sample pnts.	Description
				0		DARK BROWN SILTY CLAY (CH) moist, stiff
						BROWN SILTY CLAY (CL) moist, stiff contains some gravel
	26	19.0	92.7	5		BROWN SILTY CLAY (CL) moist, very stiff contains angular clasts of silicious siltstor
	34	18.1	97.7	10		
	34			15		
				20		GRAY CLAY (CL) maroon mottling moist, very stiff
				25		GRAY SILTSTONE (Orinda Fm) weak, friable, moderately fractured moderately weathered
	85					Bottom of Hole at 26' 6"
				30		
				35		
				40		

Geo/Resource Consultants, Inc.
Consulting Engineers, Geologists, Geophysicists

Job No. 1393-00 Appr: ESJ Date 10/16/89

LOG OF BORING B-6
REPLACEMENT OF HAZARDOUS WASTE HANDLING FACILITY AT LAWRENCE BERKELEY LABORATORY
BERKELEY, CALIFORNIA

FIGURE A-17

LOG OF TEST PIT TP-9

Equipment Backhoe

Elevation ±888 Date 8-10-88

Depth (ft.)

0

DARK BROWN SILTY CLAY (CH)
moist, very stiff

BROWN GRAVELLY SANDY CLAY (CL)
moist, very stiff
contains clasts of andesite, friable sandstone
(debris flow deposit)

5

BROWN CLAY (CL)
moist, very stiff to hard
contains small clasts of decomposed sandstone, some chert

GRAVELLY CLAY (CL-GC)
wet, very stiff
contains chert clasts

10

Total Depth: 11.5 ft
No Free Water

15

LOG OF TEST PIT TP-10

Equipment Backhoe

Elevation ±893 Date 8-11-88

Depth (ft.)

0

DARK BROWN SILTY CLAY (CH)
moist, very stiff

BROWN GRAVELLY CLAY (CL)
moist, very stiff to hard

ANDESITE (Moraga Fm)
closely fractured with intensely fractured zones
moderately weathered with deeply weathered zones
hard, strong on fresh surfaces
fractures stained and contain clay

5

Total Depth: 7.5ft
No Free Water

10

15

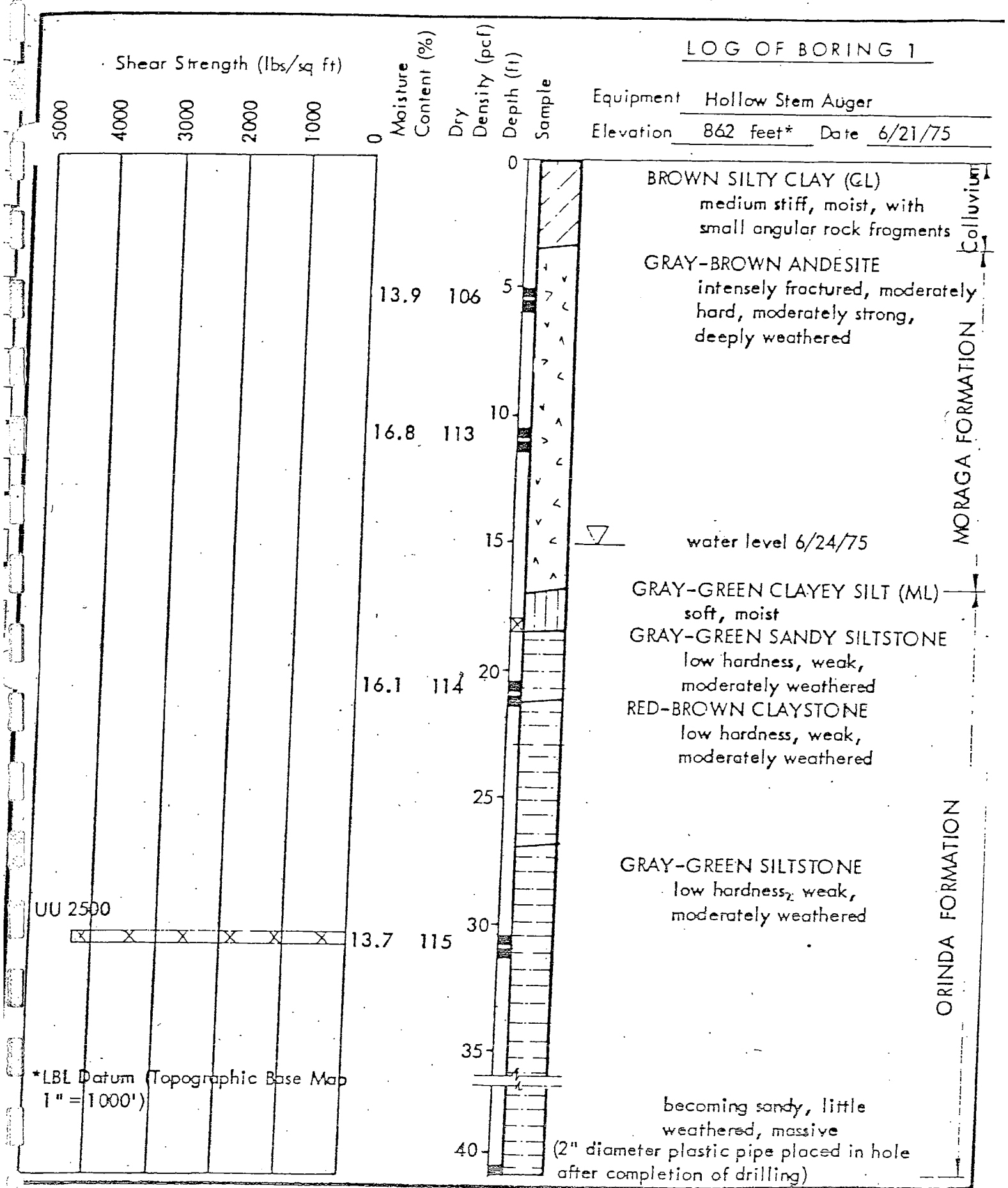
Geo/Resource Consultants, Inc.
Consulting Engineers, Geologists, Geophysicists

Job No. 1393-00 Appr: Date 10/16/89

LOGS OF TEST PITS TP-9 & TP-10
REPLACEMENT OF HAZARDOUS WASTE HANDLING FACILITY AT LAWRENCE BERKELEY LABORATORY
BERKELEY, CALIFORNIA

FIGURE A-5

Harding-Lawson Associates
1977



ARDING - LAWSON ASSOCIATES
Consulting Engineers and Geologists

Job No 2000.104.01 Appr AB Date 7/11/75

LOG OF BORING 1
Cell Culture Building
Lawrence Berkeley Laboratory

PLATE 2

428_00084

LOG OF BORING 2

Equipment: Hollow Stem Auger

Elevation: 842 feet* Date: 6/21/75

Shear Strength (lbs/sq ft)	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample	Description	
5000 4000 3000 2000 1000 0			0		DARK BROWN SANDY CLAY (CL) stiff, dry	PROBABLE SLIDE DEBRIS
	21.0	101	5		MOTTLED BROWN SANDY CLAY (CL) - stiff, moist, with abundant angular rock	
	16.9	110	10		BROWN CLAYEY GRAVEL (GC) dense, moist (Predominantly Andesite Fragments)	
					RED-BROWN SILTY CLAY (CH) stiff, moist, with occasional rock fragments	COLLUVIUM
			15		Elev. 827 Bottom of Excavation	
					MOTTLED RED-BROWN & GREEN CLAYSTONE - crushed and sheared, soft, weak, deeply weathered	ORINDA FORMATION
UU 2000	17.2	111	20			
			25		GRAY-GREEN SANDY SILTSTONE - moderately fractured, low hardness, weak, little weathered	
			30			
			35		(2" diameter plastic pipe placed in hole after completion of drilling)	
			40		No free water encountered	

HARDING - LAWSON ASSOCIATES

Consulting Engineers and Geologists

LOG OF BORING 2

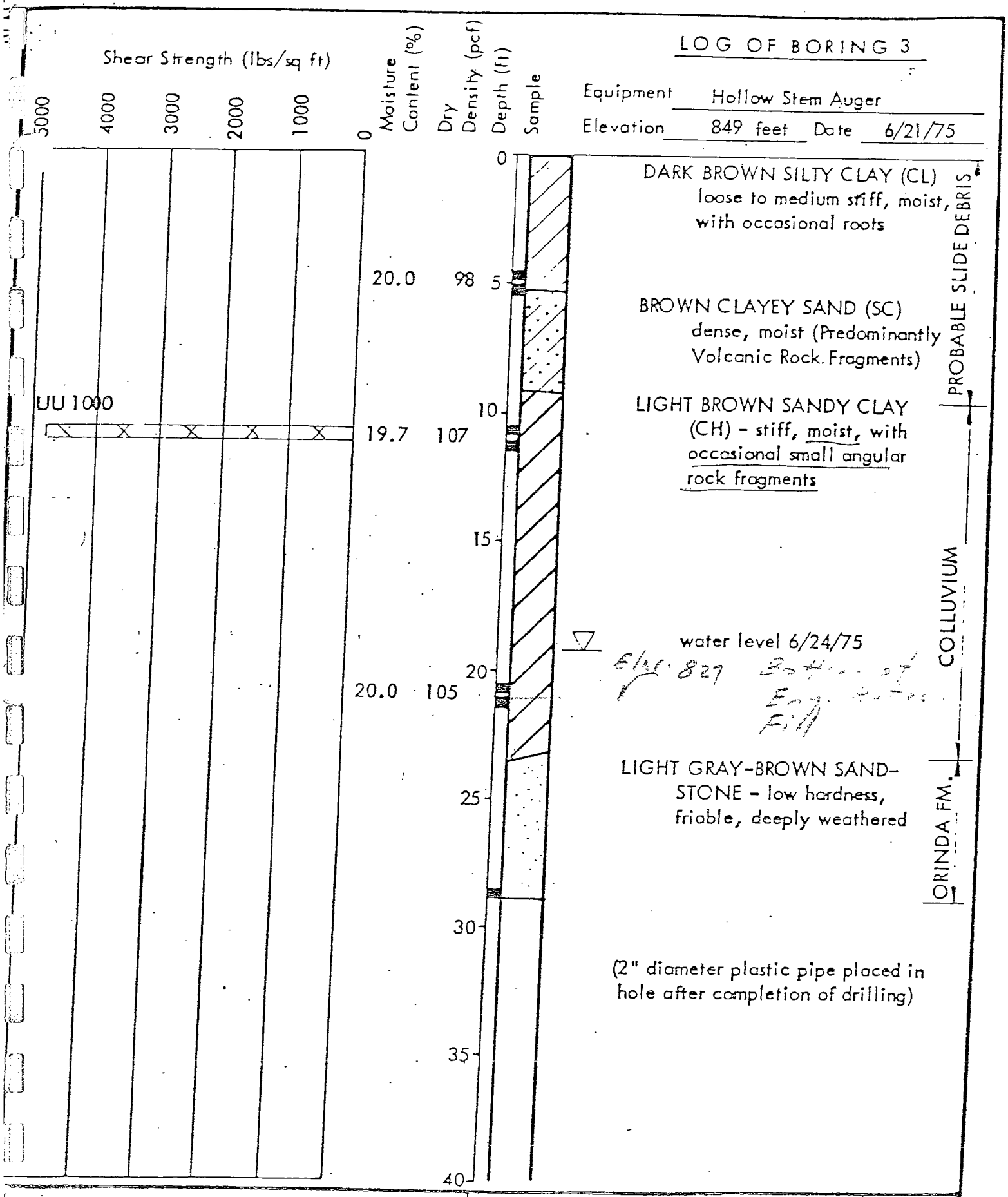
Cell Culture Building

Lawrence Berkeley Laboratory

PLATE 3

2000 104 01 MR 7/21/75

428_00085



RDING - LAWSON ASSOCIATES
Consulting Engineers and Geologists

No 2000,104.01 Appr. KB Date 7/11/75

LOG OF BORING 3
Cell Culture Building
Lawrence Berkeley Laboratory

PLATE 4

428_00086

LOG OF BORING 4

Equipment 6" Flight Auger

Elevation 856 feet Date 2/1/77

Shear Strength (lbs/sq ft)	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample	Description	
	16.7	110	0		DARK BROWN SANDY CLAY (CL) very stiff, moist, with roots and occasional rounded gravel	Colluvium
	22.4	89	5			
			10		RED-BROWN SANDY CLAY (CL)	
Liquid Limit = 56 Plastic Limit = 28 Plasticity Index = 28			15			
	20.6	105	20		GRAY-GREEN SILTSTONE low hardness, friable, moderately weathered MOTTLED RED-BROWN CLAYSTONE - low hardness, friable, deeply weathered	Orinda Formation
			25		GRAY FINE SANDSTONE low hardness, friable, moderately weathered, occasionally sheared GRAY FINE SANDSTONE moderately hard, friable, little weathered	
			30			
			35		(no free water encountered)	
			40			

ARDING-LAWSON ASSOCIATES
Consulting Engineers and Geologists

No. 2000,104.01 Appr: JB Date 4/8/77

LOG OF BORING 4
Cell Culture Building
Lawrence Berkeley Laboratory

PLATE 5

LOG OF BORING 5

Equipment 6" Flight Auger

Elevation 857 feet Date 2/1/77

Shear Strength (lbs/sq ft)	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample	Description	
			0		DARK BROWN SANDY SILT (ML) loose, moist, with roots	Colluvium
	13.3	99			BROWN GRAVELLY CLAY (CL) stiff, moist, with abundant angular sandstone and siltstone rock fragments	
			5			
	14.0	106				
			10			
UU 1000	18.9	106			BROWN CLAYEY GRAVEL (GC) stiff, moist, with abundant volcanic rock fragments	Moraga Formation
			15		drills easily	
	13.9	122			sandy, wet	
			20		BROWN ANDESITE BRECCIA closely fractured, moderately hard, moderately strong, deeply weathered purple clay alteration at 25'	
			25		MOTTLED RED-BROWN SILTSTONE - moderately fractured, low hardness, friable, deeply weathered	Orinda Formation
			30			
			35		(no free water encountered)	
			40			

HARDING-LAWSON ASSOCIATES
Consulting Engineers and Geologists

No. 2000,104.01 Appr: JB Date 4/8/77

LOG OF BORING 5

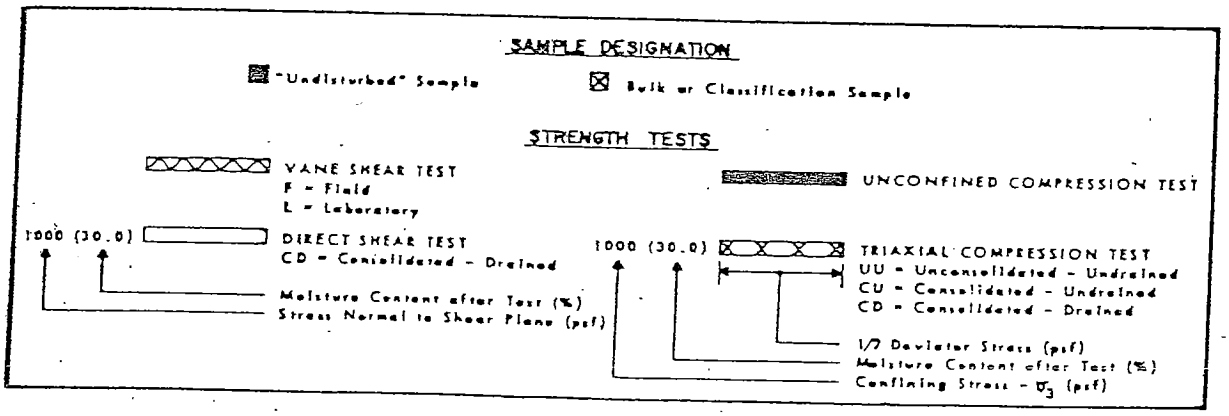
Cell Culture Building
Lawrence Berkeley Laboratory

PLATE 6

428_00088

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

UNIFIED SOIL CLASSIFICATION SYSTEM



KEY TO TEST DATA

RDING-LAWSON ASSOCIATES *Consulting Engineers and Geologists*	SOIL CLASSIFICATION CHART AND KEY TO TEST DATA Cell Culture Building	PLATE 7
2000,104.01 Appr: VB Date 6/15/77		

428_00089

Harding-Lawson Associates
1976

LOG OF BORING #1106

Equipment: Spin Auger

Elevation: 905 Date: 12/5/75

Shear Strength (lbs/sq ft)	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample		
			0		MORAGA FORMATION AND/OR COLLUVIUM	DARK BROWN SANDY CLAY (CL) stiff, moist, with occasional rock fragments
			5			BROWN GRAVELLY SILT (ML) stiff, dry, with occasional volcanic rock fragments
						BROWN SANDY GRAVEL (GM) dense, dry, (weathered volcanic agglomerate), moderately hard, moderately strong, deeply weathered
			10			GRAY BROWN AGGLOMERATE closely fractured, moderately hard, moderately strong, moderately weathered, with occasional andesite fragments
			15			LIGHT BROWN AND YELLOW TUFFACEOUS AGGLOMERATE moderately hard, moderately strong, moderately weathered slightly moist
			20		ORINDA FORMATION	MOTTLED GREEN-BROWN CLAYEY SILT (ML) - stiff, moist, with rock fragments
			25			GREEN SILTY SANDSTONE low hardness, friable, deeply weathered
			30			(no free water encountered)
			35			
			40			

HARDING - LAWSON ASSOCIATES

Consulting Engineers and Geologists

Job No. 2000,106.01 Appr: [illegible] Date 1/7/76

LOG OF BORING #1106

East Canyon - Biomedical Area
Lawrence Berkeley Laboratory

PLATE 3

LOG OF BORING ~~2~~ 2,106

Equipment: Spin Auger

Elevation: 952 Date: 12/5/75

Shear Strength (lbs/sq ft)	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample	Description
			0		DARK BROWN SANDY CLAY (CL) medium stiff, moist, with occasional rock fragments
			5		LIGHT BROWN SILTY SANDY GRAVEL (GM) – medium dense, dry, with abundant weathered volcanic rock fragments hole caving at 6' and at 15'
			10		COLLUVIUM
			15		GRAY SANDY SILT (ML) soft, moist, with shear planes, decayed vegetation
			20		BROWN GRAVEL (GP) loose, moist
			25		(no free water encountered)
			30		
			35		
			40		

HARDING - LAWSON ASSOCIATES

Consulting Engineers and Geologists

Job No. 2000,106.01 Appr: SRK Date 1/7/76

LOG OF BORING ~~2~~ 2,106

East Canyon – Biomedical Area
Lawrence Berkeley Laboratory

PLATE 4

Appendix C

APPENDIX C

Geophysical Logs

NORCAL GEOPHYSICAL CONSULTANTS, INC.

OPTV DATA PROCESSING
RGLDIP vsn 6.1
INTERPRETED OPTV DIPS LOG

23 Aug 2004

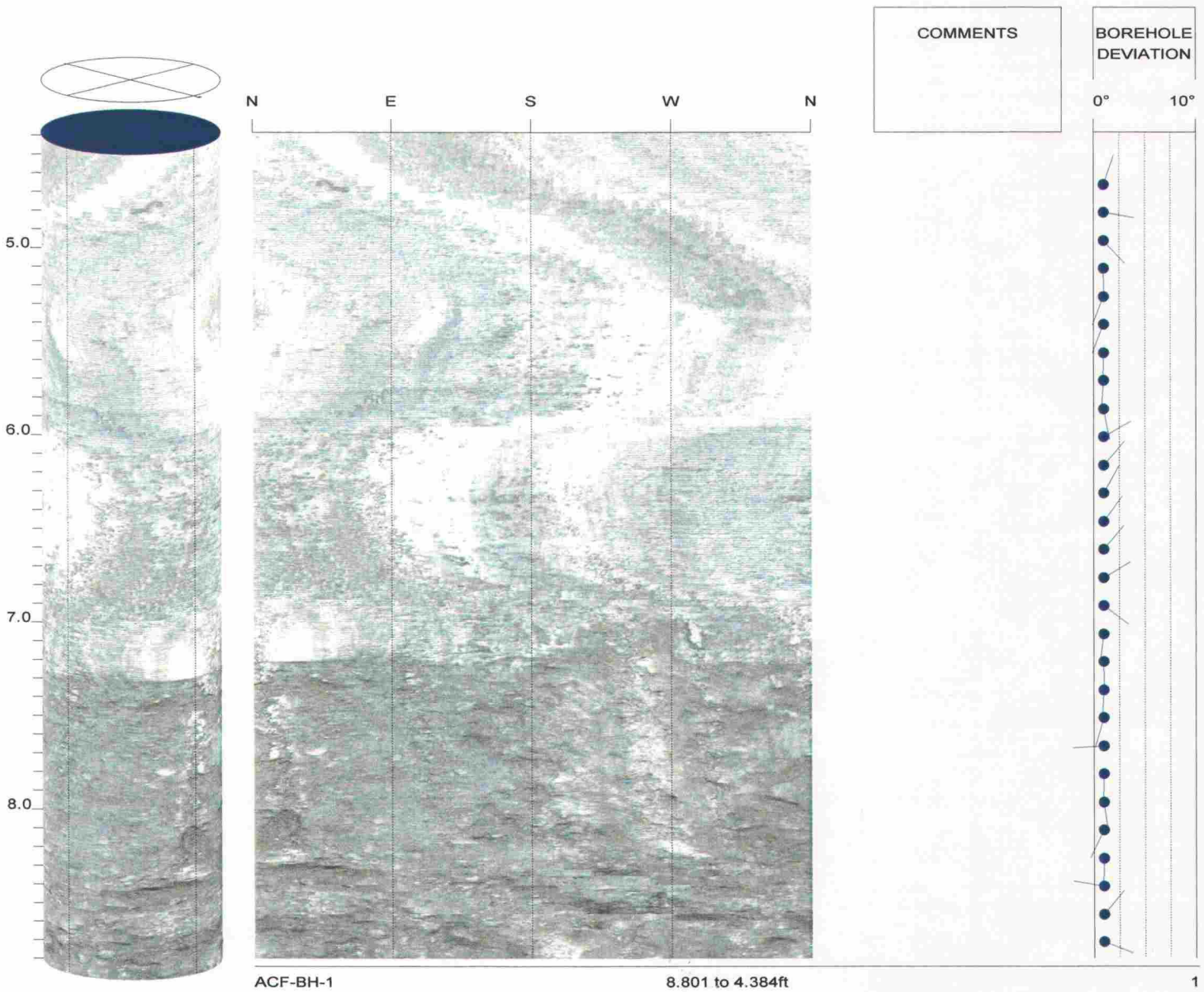
KROPP

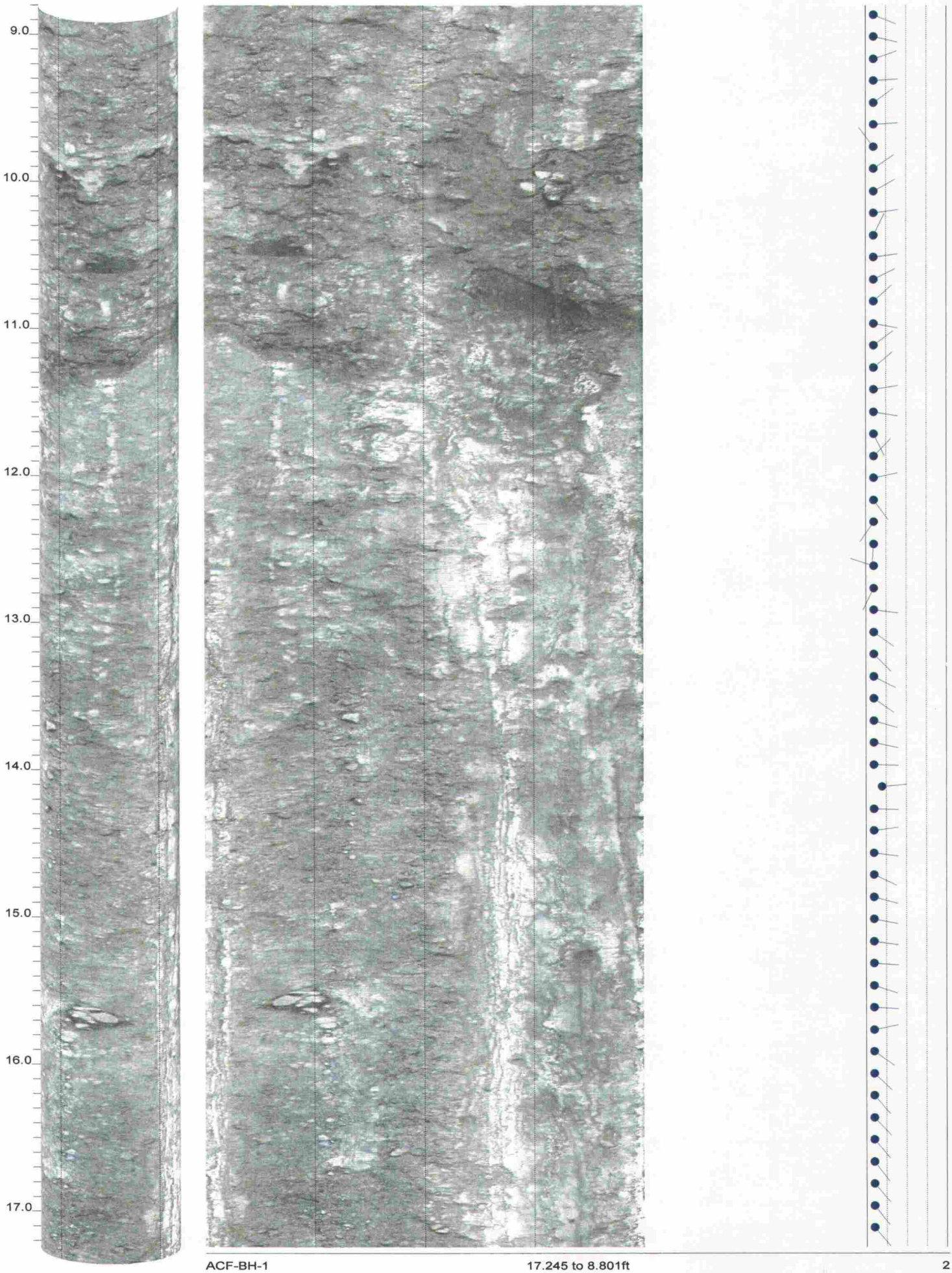
Borehole: ACF-BH-1

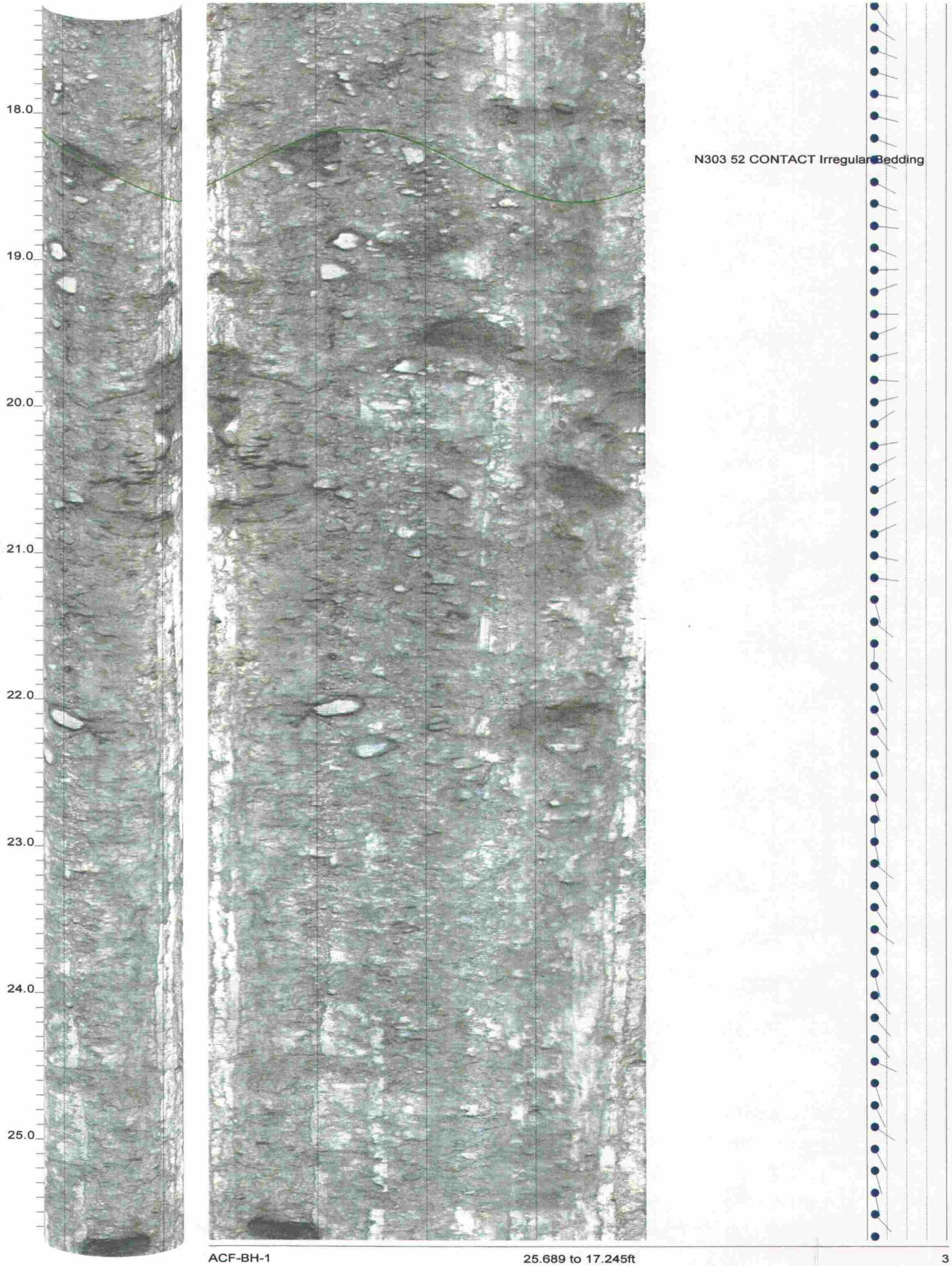
LBL, BUILDG 85

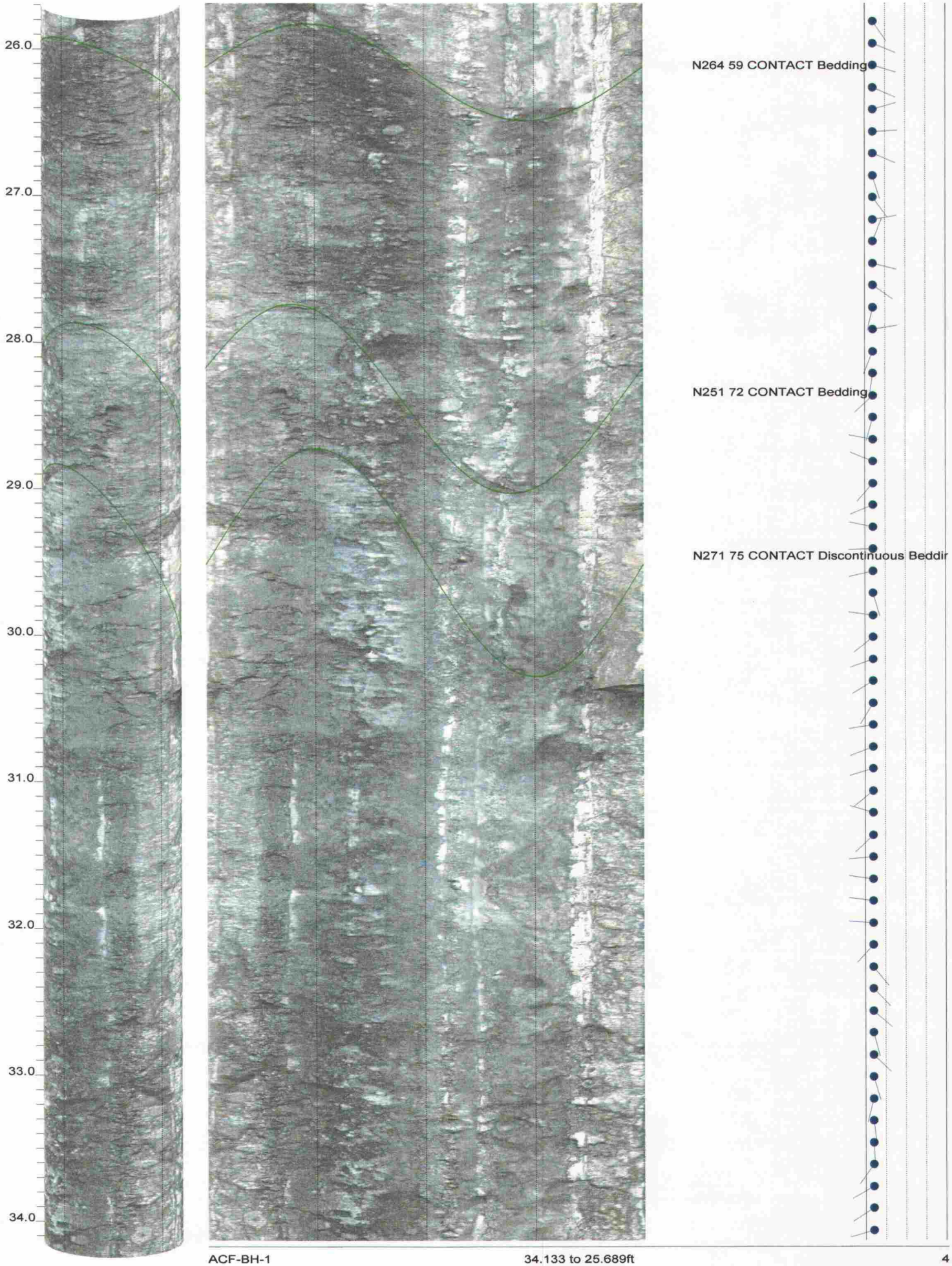
top of borehole.....	North ref. is true
East:	Depth units are feet
North:	Vertical scale: 1/10
Alt:	Horiz scale = fixed format

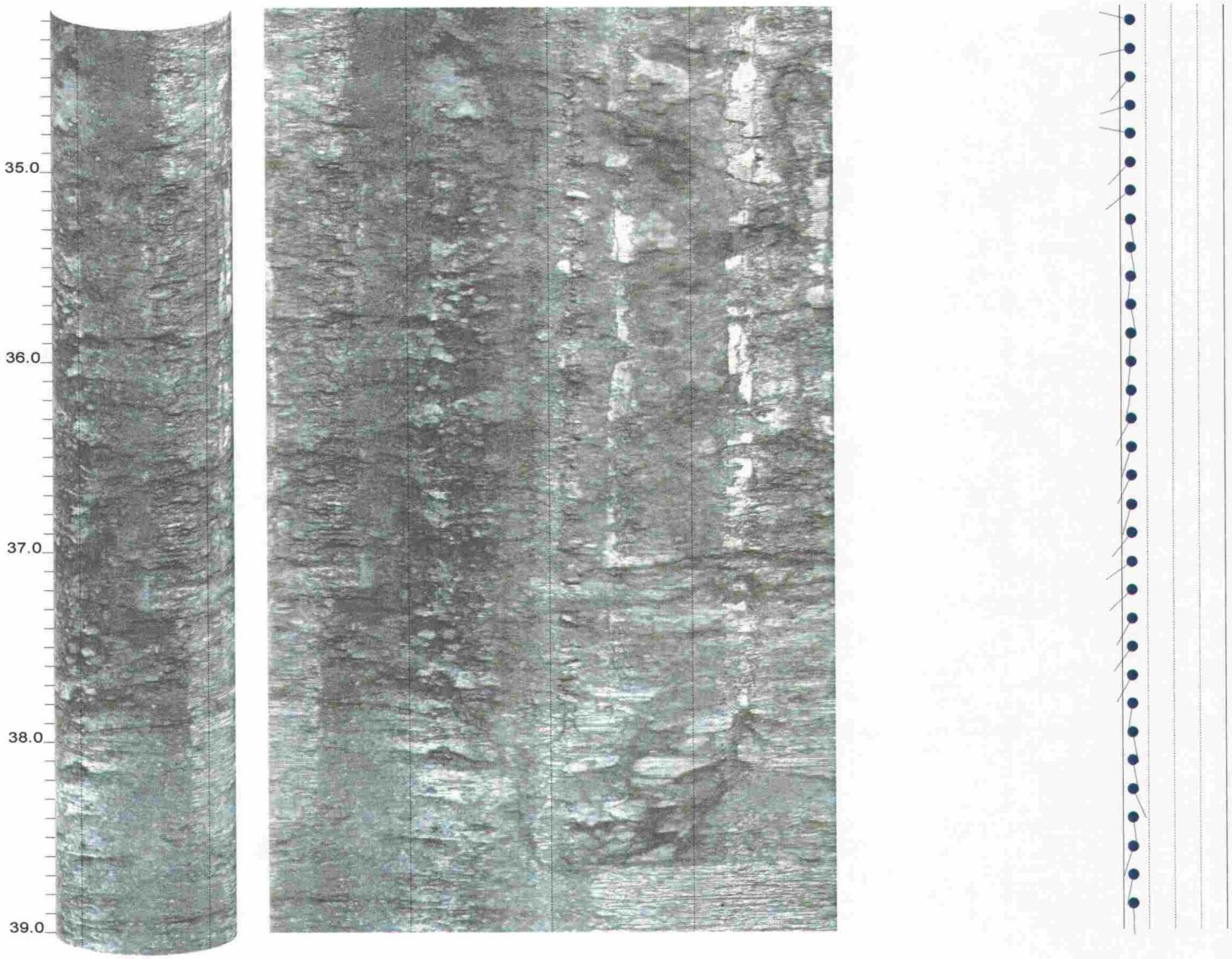
Zone from 39.000 to 4.384ft	Borehole diam: 4.824inch
Format: BHTV-NESWN	




9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0


18.0
19.0
20.0
21.0
22.0
23.0
24.0
25.0
N303 52 CONTACT Irregular Bedding


26.0
27.0
28.0
29.0
30.0
31.0
32.0
33.0
34.0
N264 59 CONTACT Bedding
N251 72 CONTACT Bedding
N271 75 CONTACT Discontinuous Beddir


35.0
36.0
37.0
38.0
39.0

OPTV DATA PROCESSING
RGLDIP vsn 6.1
INTERPRETED OPTV DIPS LOG

22 Aug 2004

ROBERTSON GEOLOGGING TECHNOLOGY

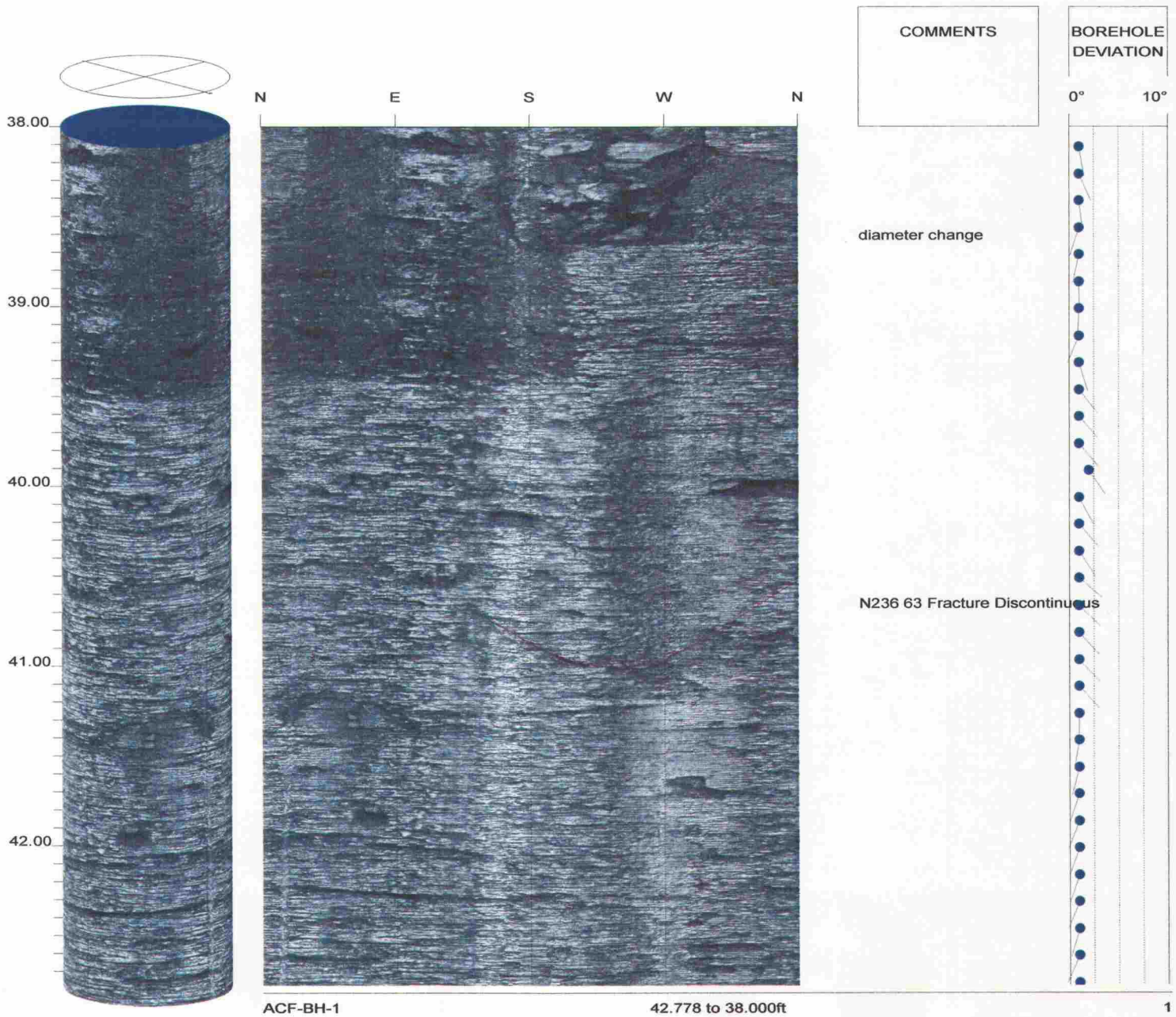
Borehole: ACF-BH-1

LBL

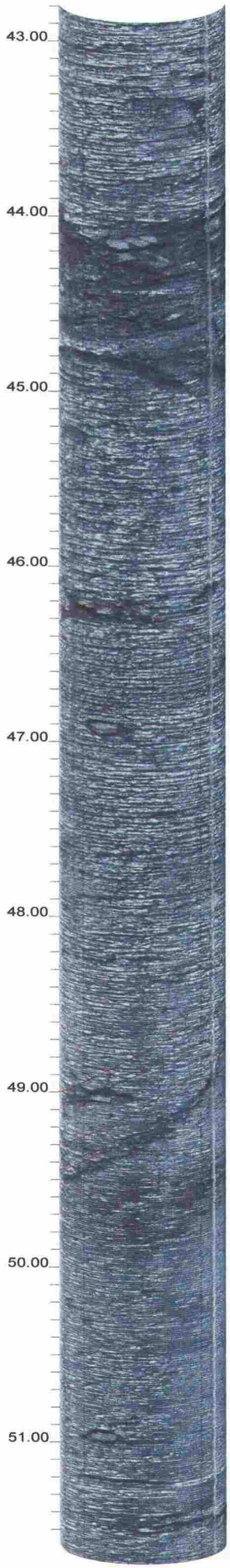
top of borehole.....	North ref. is true
East:	Depth units are feet
North:	Vertical scale: 1/10
Alt:	Horiz scale = fixed format

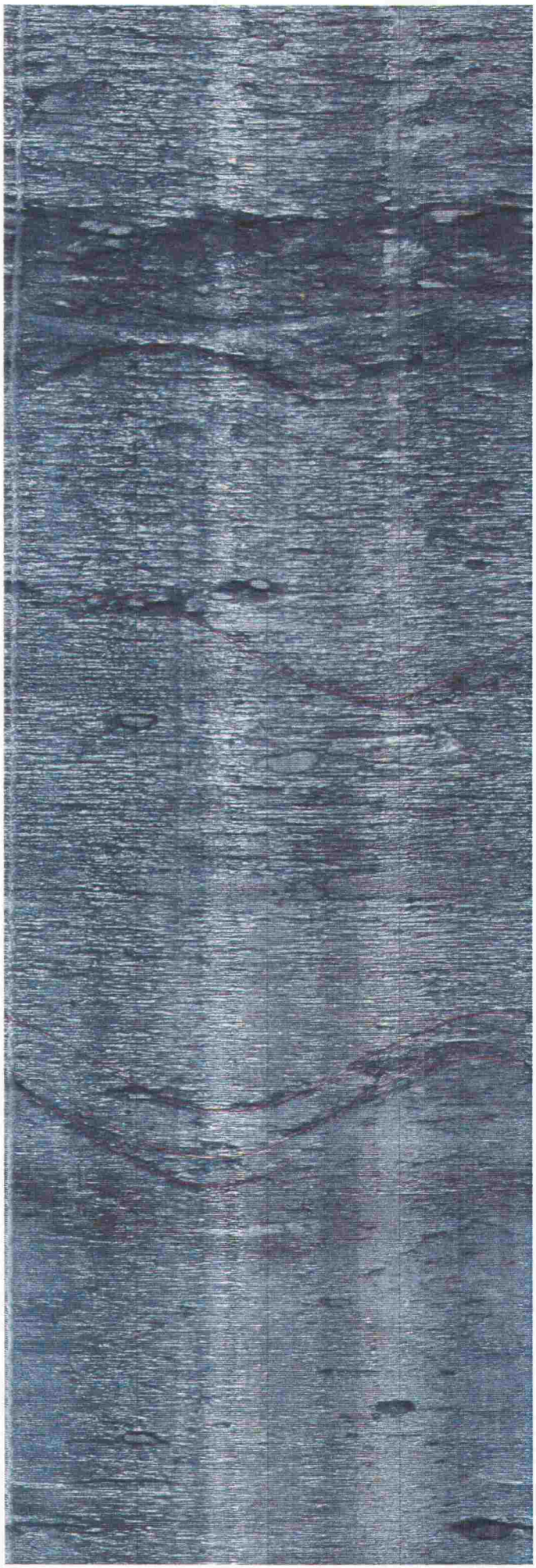
Zone from 59.004 to 38.000ft	Borehole diam: 3.750inch
Vertical = borehole-axis	

BEDDING
FRACTURE
Identified units



ACF-BH-1 42.778 to 38.000ft 1





weak shale bed

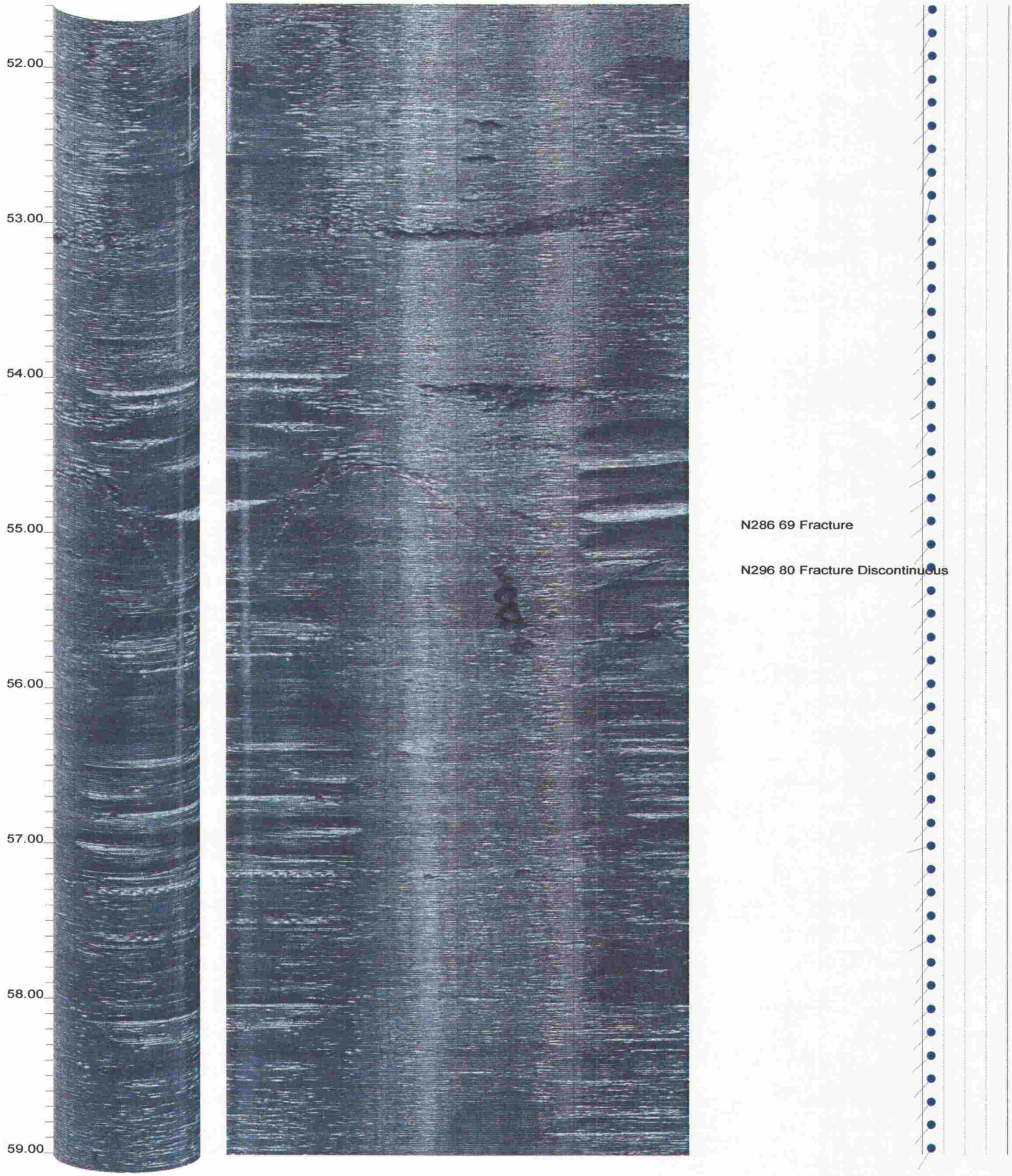
N283 53 Fracture Discontinuous

N252 61 Fracture

N154 60 Fracture

N141 61 Fracture

N142 64 Fracture Discontinuous


52.00
53.00
54.00
55.00
56.00
57.00
58.00
59.00
N286 69 Fracture
N296 80 Fracture Discontinuous

NORCAL
NORCAL GEOPHYSICAL CONSULTANTS, INC.

BHTV DATA PROCESSING
RGLDIP vsn 6.1
INTERPRETED BHTV DIPS LOG

29 Aug 2004

KROPP AND ASSOCIATES

Borehole: ACF-BH-1

LBL, BUILDING 85

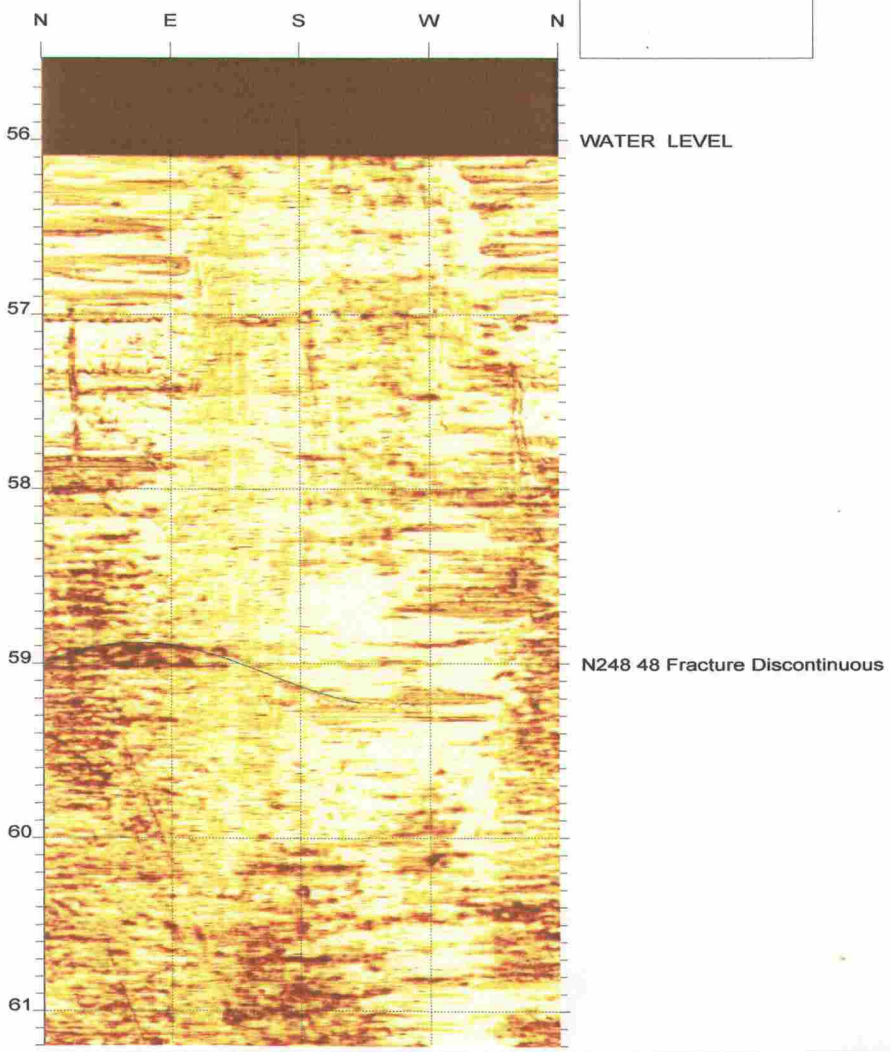
top of borehole.....
East:_
North:
Alt: _

North ref. is true
Depth units are feet
Vertical scale: 1/13
Horiz scale = 3 x vert scale

Zone from 72.896 to 55.532ft
Format: BHTV-NESWN

Borehole diam: 3.800inch
Vertical = borehole-axis
Amplitude

COMMENTS



ACF-BH-1 61.200 to 55.532ft 1

428_00103

N214 7 Fracture

N244 53 Fracture

N272 58 Hairline-fracture

N273 41 Fracture

FRACTURE ZONE
66.2 TO 68 FEET

N235 57 Fracture

FRACTURE ZONE
68.6 TO 69.7 FEET

N207 60 Fracture

N216 51 Fracture

HIGHLY FRACTURED ZONE
70-73 FEET

N228 58 Fracture Discontinuous

N052 66 Fracture

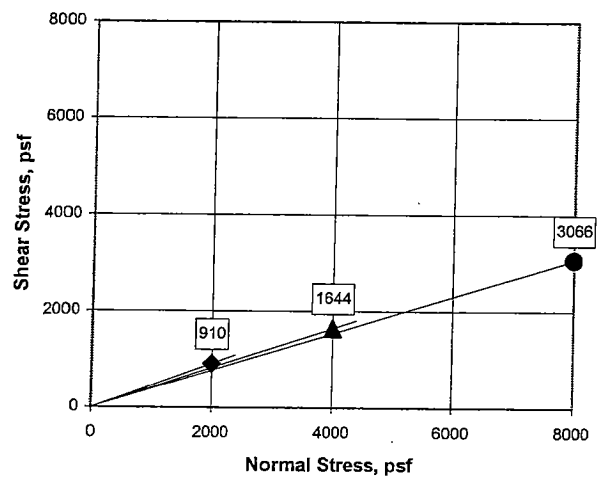
APPENDIX D

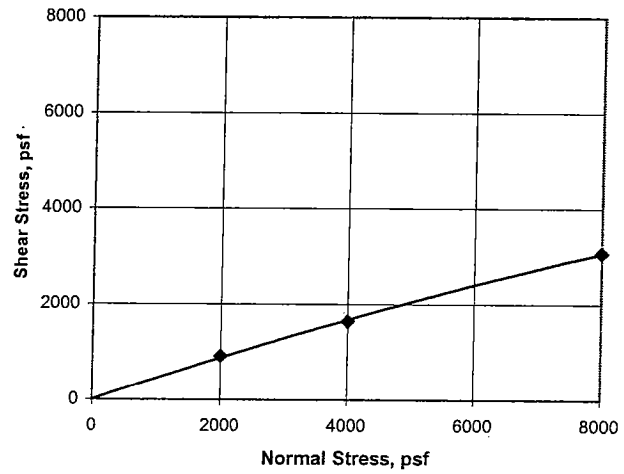
APPENDIX D

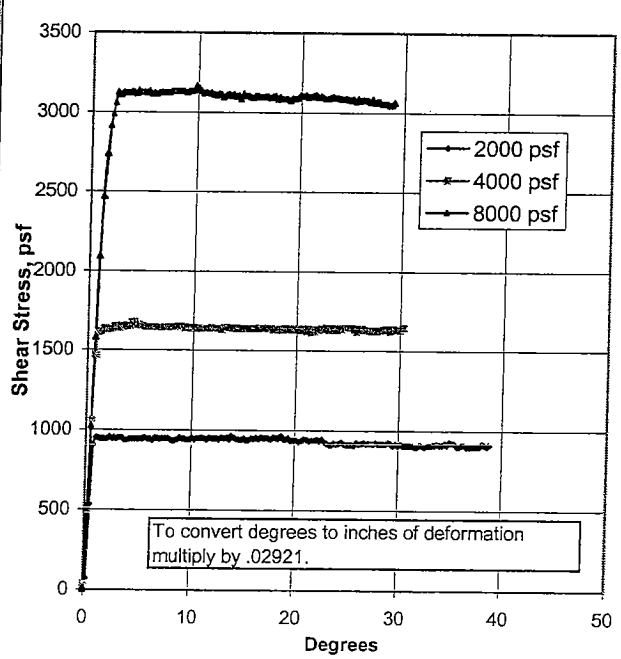
Laboratory Test Results

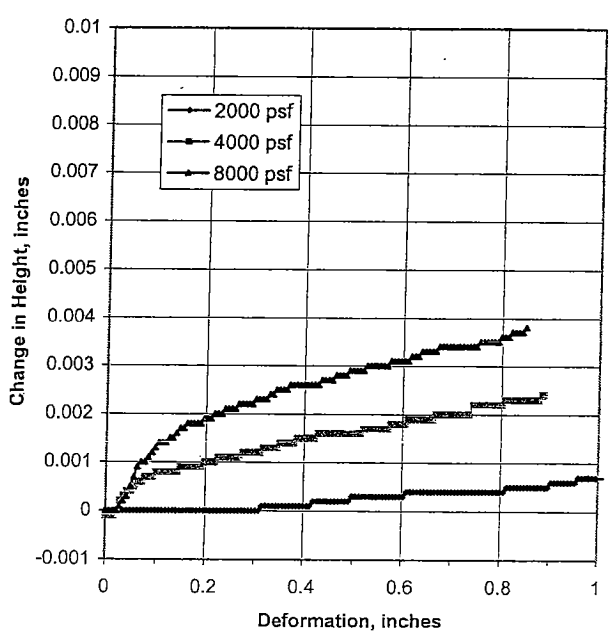
Drained, Residual Torsional Ring Shear Test ASTM D 6467

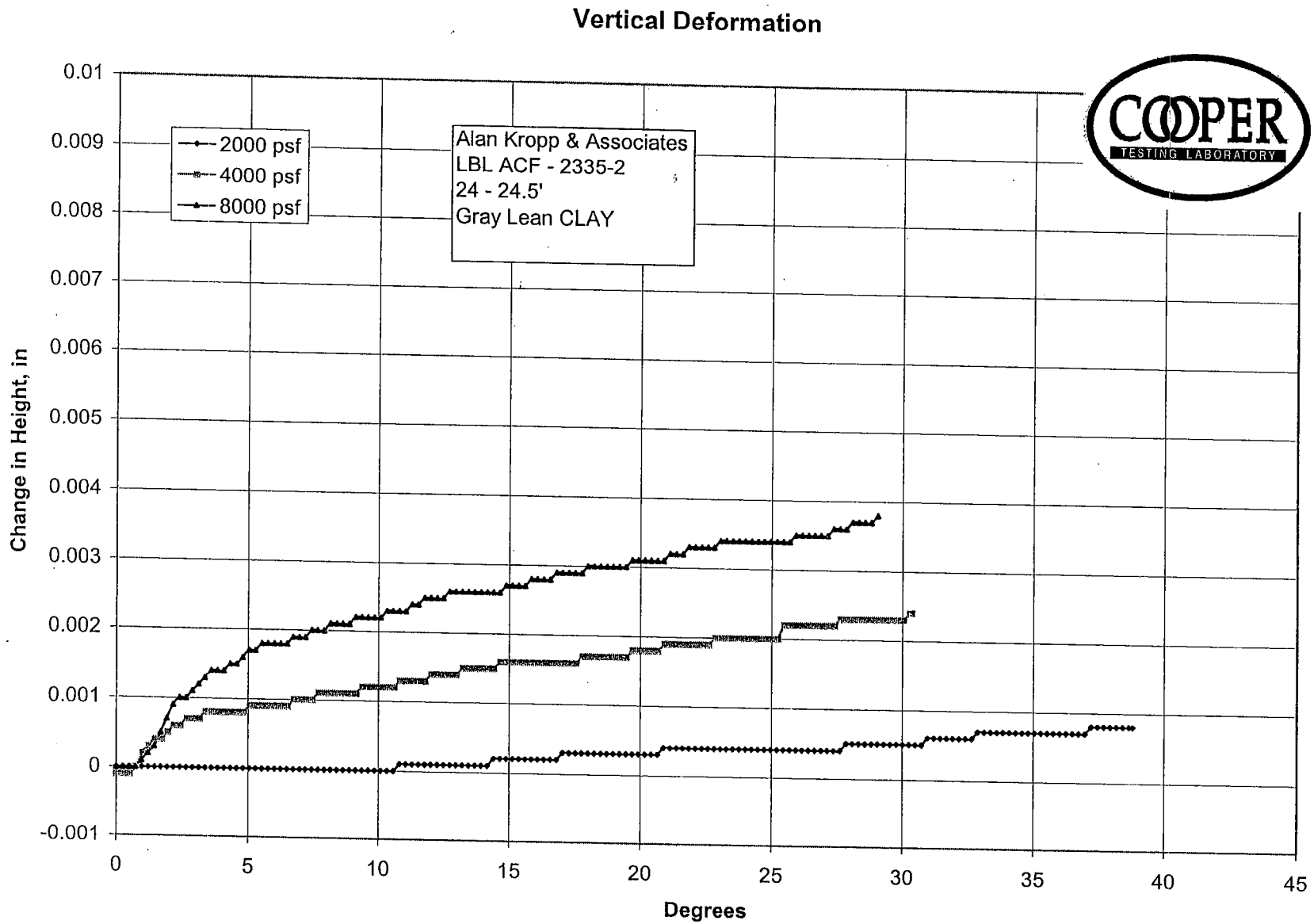
Job No.:	254-058	**Boring:**		**Date:**	9/13/04	**Undisturbed:**	
Client:	Alan Kropp & Assoc.	**Sample:**		**By:**	PJ	**Peak:**	
Project:	LBL ACF 2335-2	**Depth:**		**Checked:**	DC	**Residual:**	
Soil:	Gray Lean CLAY			**Clay, %:**		**Fully Softened:**	X
Remarks:				**LL:**		**Peak:**	
Normal Stress, psf	2000	4000	8000	**PL:**		**Residual:**	X
Secant Phi, deg.	24	22	21				



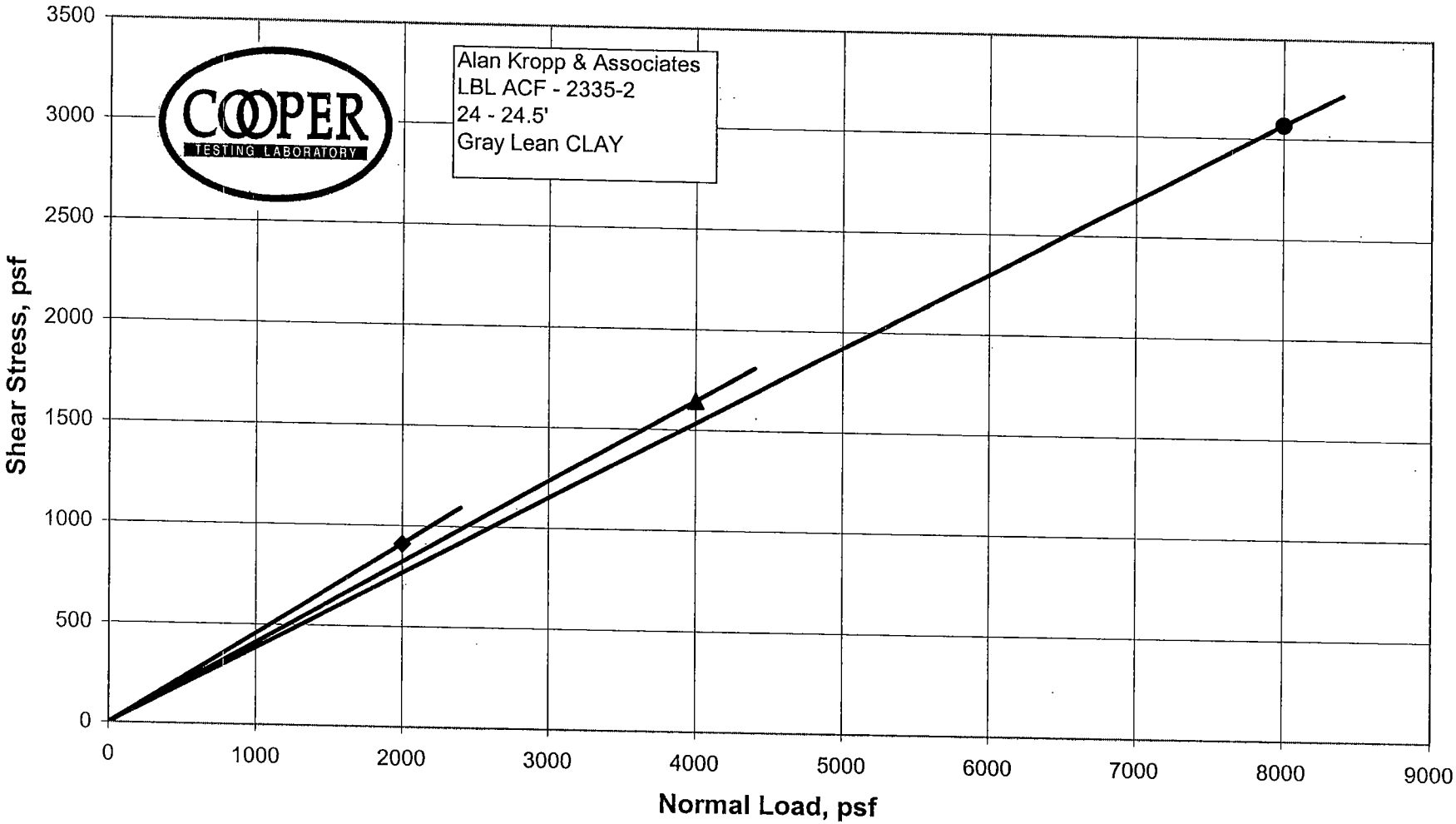




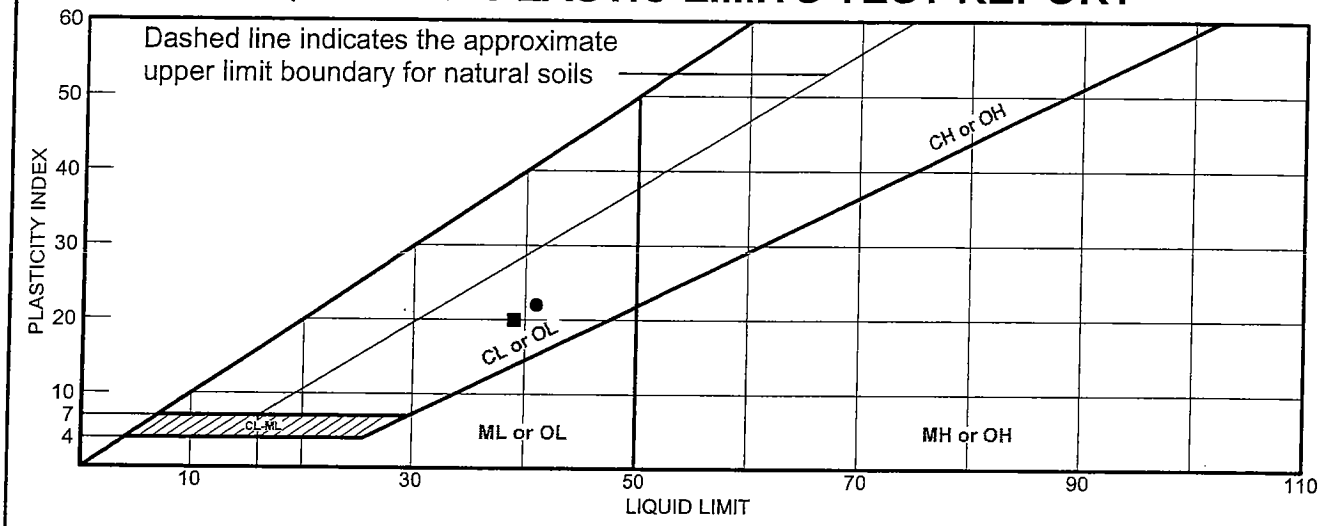


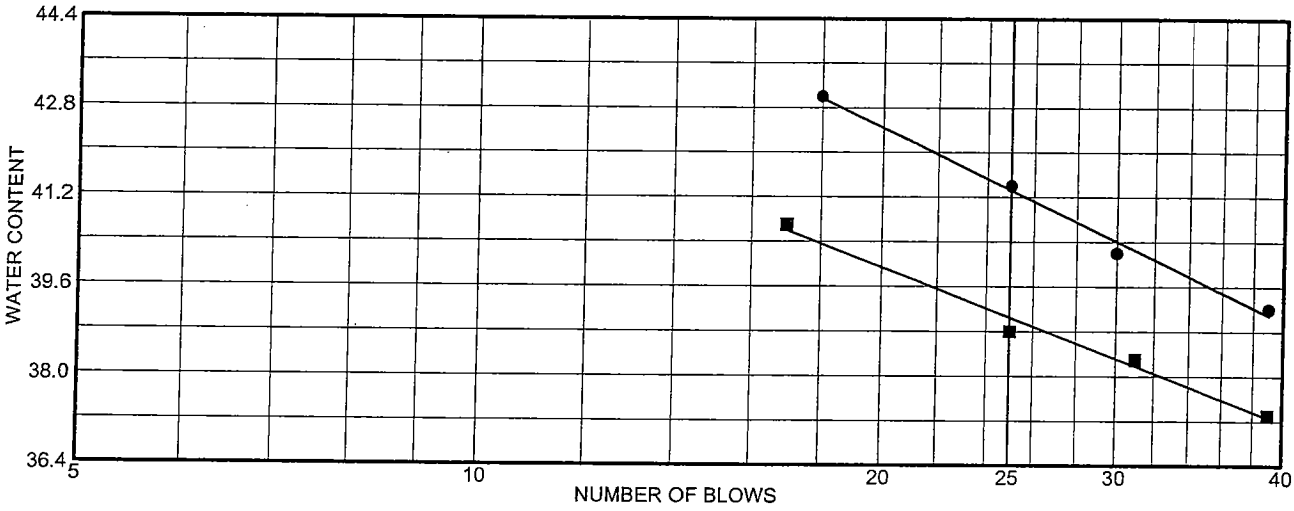

Vertical Deformation
2000 psf
4000 psf
8000 psf
Alan Kropp & Associates
LBL ACF - 2335-2
24 - 24.5'
Gray Lean CLAY
COOPER
TESTING LABORATORY
Change in Height, in
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
-0.001
0
5
10
15
20
25
30
35
40
45
Degrees

Secant Residual Friction Angle



LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray CLAY	41	19	22			
■	Greenish Gray CLAY (weathered Claystone) and Dusky Red CLAY	39	19	20			

Project No. 254-058 **Client:** Alan Kropp & Associates

Project: 2335-2 LBL ACF

2335-2 LBL ACF

● **Source:** **Elev./Depth:** 24-24.5'

■ **Source:** **Elev./Depth:** 24.5-25'

Remarks:

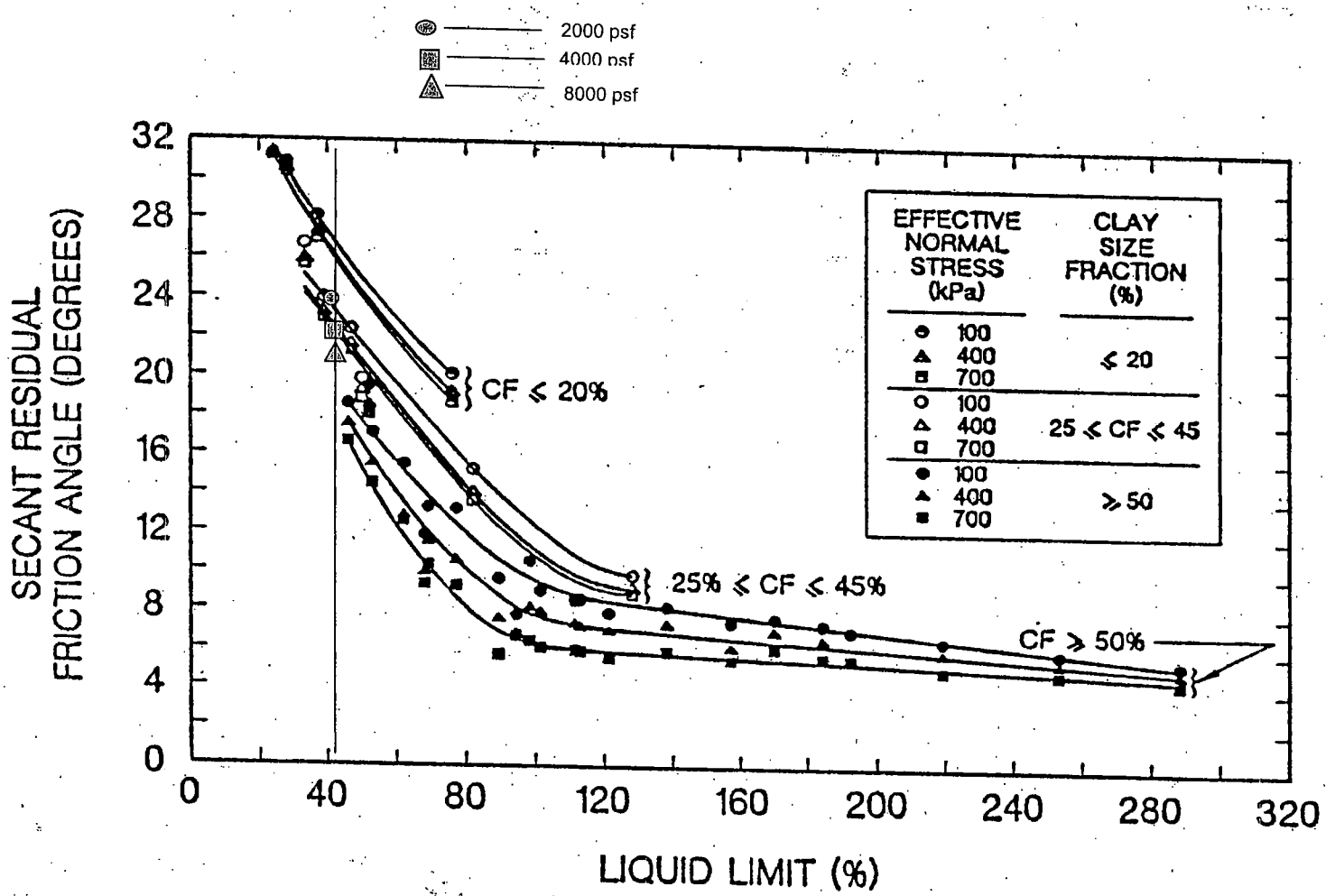
●

■

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

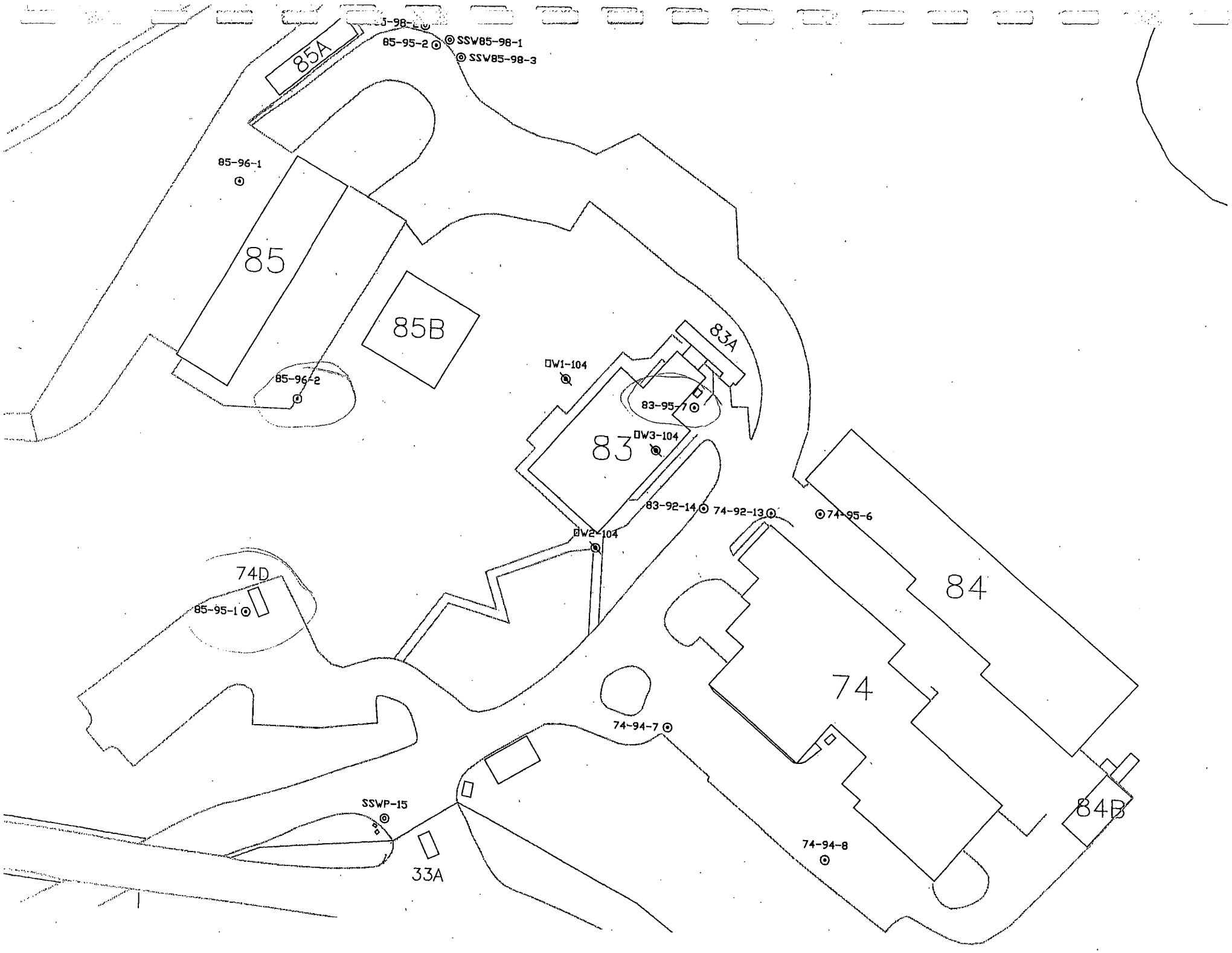
Figure

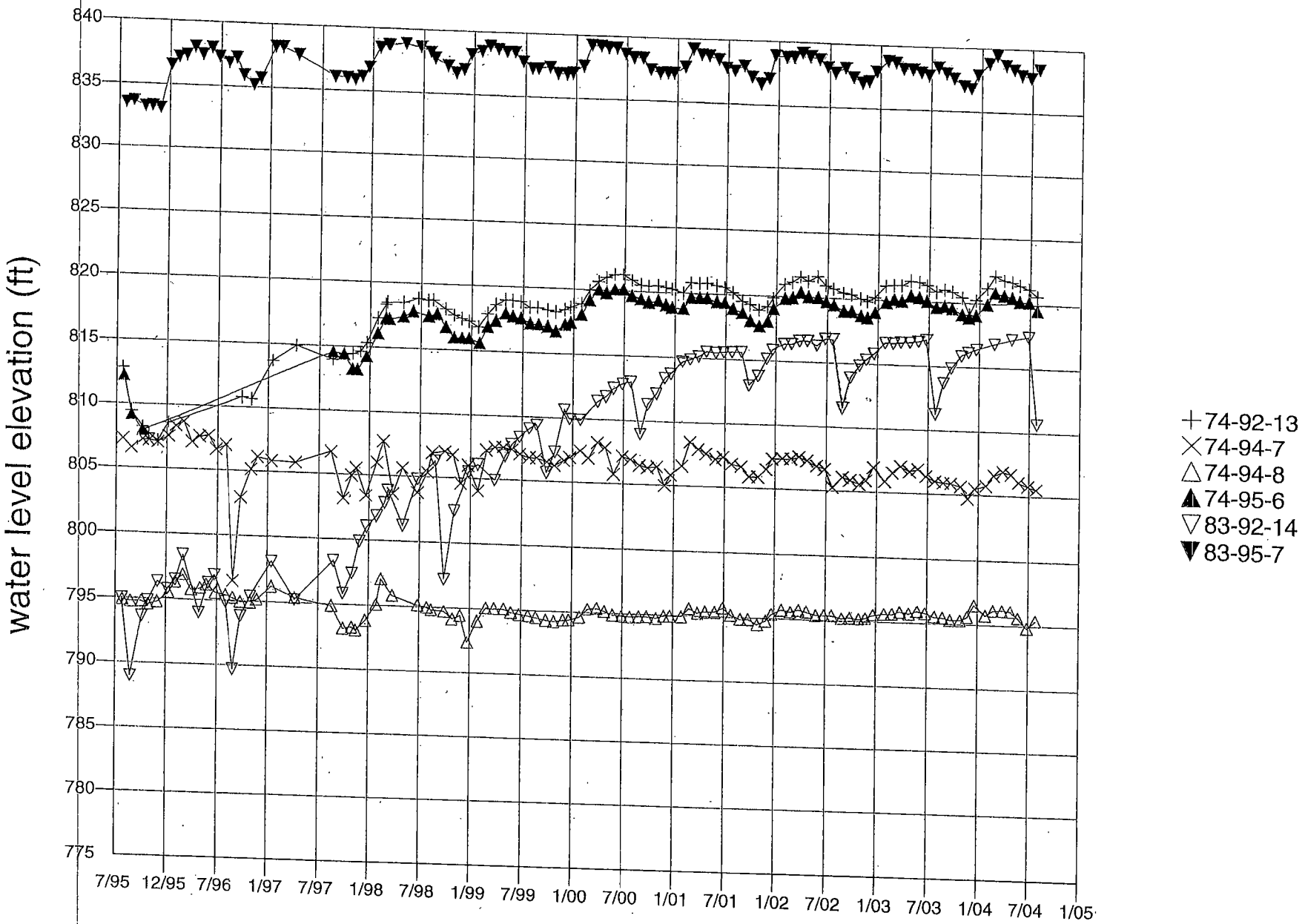

2000 psf
4000 psf
8000 psf
SECANT RESIDUAL FRICTION ANGLE (DEGREES)
LIQUID LIMIT (%)
0
4
8
12
16
20
24
28
32
0
40
80
120
160
200
240
280
320
CF ≤ 20%
25% ≤ CF ≤ 45%
CF ≥ 50%
EFFECTIVE NORMAL STRESS (kPa)
CLAY SIZE FRACTION (%)
100
400
700
≤ 20
100
400
700
25 ≤ CF ≤ 45
100
400
700
≥ 50

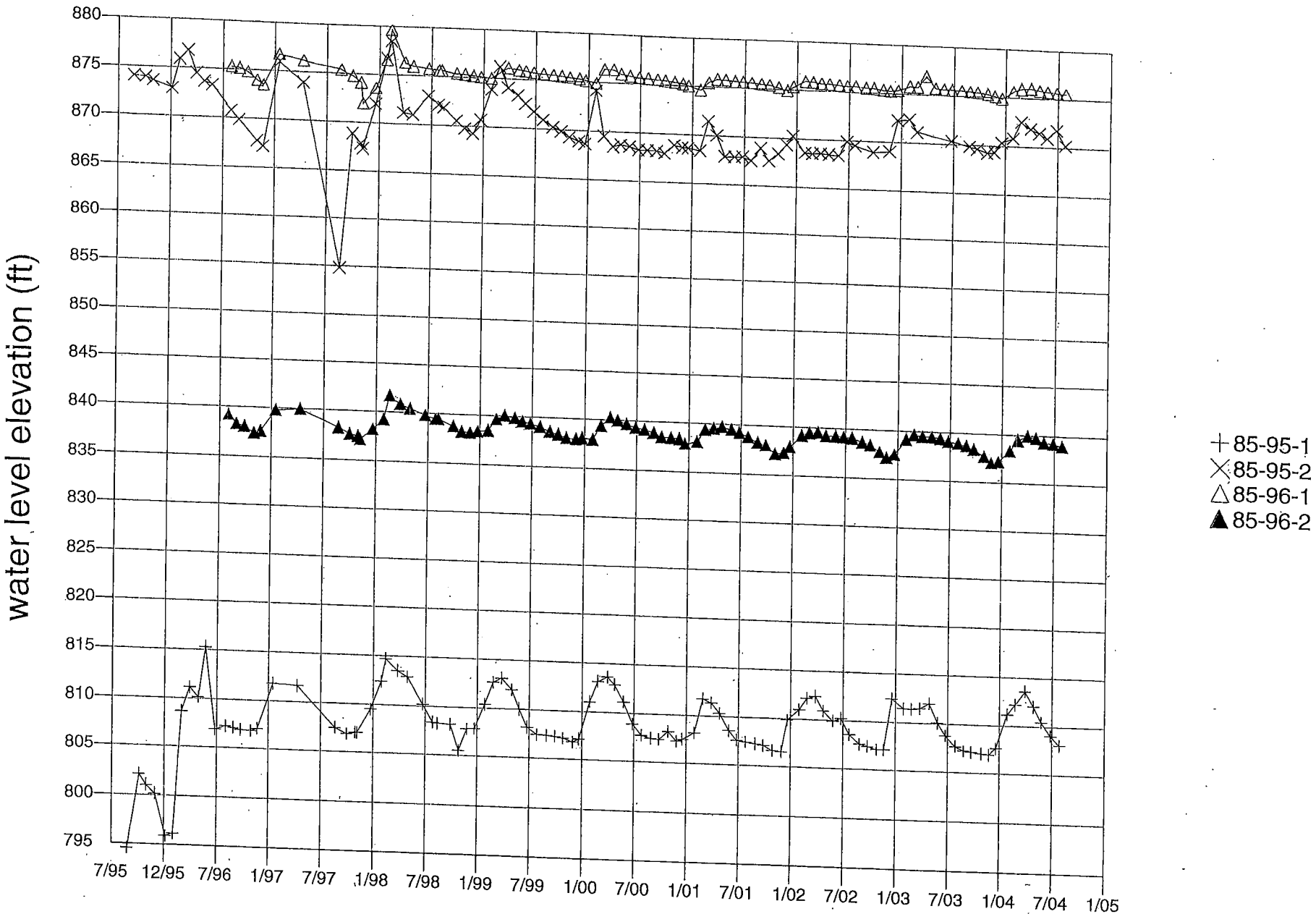
APPENDIX E

APPENDIX E

RFI Groundwater Data


85A
85-95-2
SSW85-98-1
SSW85-98-3
85-96-1
85
85B
85-96-2
W1-104
83A
83-95-7
83
W3-104
83-92-14
74-92-13
74-95-6
W2-104
74D
85-95-1
84
74
74-94-7
SSWP-15
33A
74-94-8
84B


water level elevation (ft)
840
835
830
825
820
815
810
805
800
795
790
785
780
775
7/95
12/95
7/96
1/97
7/97
1/98
7/98
1/99
7/99
1/00
7/00
1/01
7/01
1/02
7/02
1/03
7/03
1/04
7/04
1/05
74-92-13
74-94-7
74-94-8
74-95-6
83-92-14
83-95-7


water level elevation (ft)
880
875
870
865
860
855
850
845
840
835
830
825
820
815
810
805
800
795
7/95
12/95
7/96
1/97
7/97
1/98
7/98
1/99
7/99
1/00
7/00
1/01
7/01
1/02
7/02
1/03
7/03
1/04
7/04
1/05
85-95-1
85-95-2
85-96-1
85-96-2

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusiv

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-1	8/24/1995	818.30	00:00	23.76	NA	794.54
85-95-1	10/4/1995	818.30	00:00	16.23	7.53	802.07
85-95-1	10/30/1995	818.30	00:00	17.25	-1.02	801.05
85-95-1	11/28/1995	818.30	00:00	18.12	-0.87	800.18
85-95-1	1/5/1996	818.30	00:00	22.43	-4.31	795.87
85-95-1	1/31/1996	818.30	00:00	22.15	0.28	796.15
85-95-1	2/28/1996	818.30	00:00	9.65	12.50	808.65
85-95-1	3/27/1996	818.30	00:00	7.19	2.46	811.11
85-95-1	4/26/1996	818.30	00:00	8.15	-0.96	810.15
85-95-1	5/20/1996	818.30	00:00	3.00	5.15	815.30
85-95-1	6/25/1996	818.30	00:00	11.42	-8.42	806.88
85-95-1	7/31/1996	818.30	00:00	11.04	0.38	807.26
85-95-1	8/28/1996	818.30	00:00	11.20	-0.16	807.10
85-95-1	9/23/1996	818.30	00:00	11.37	-0.17	806.93
85-95-1	10/30/1996	818.30	00:00	11.47	-0.10	806.83
85-95-1	11/21/1996	818.30	00:00	11.20	0.27	807.10
85-95-1	1/13/1997	818.30	00:00	6.51	4.69	811.79
85-95-1	4/9/1997	818.30	00:00	6.65	-0.14	811.65
85-95-1	8/19/1997	818.30	00:00	10.83	-4.18	807.47
85-95-1	9/30/1997	818.30	00:00	11.45	-0.62	806.85
85-95-1	10/29/1997	818.30	00:00	11.25	0.20	807.05
85-95-1	11/5/1997	818.30	00:00	11.26	-0.01	807.04
85-95-1	12/22/1997	818.30	00:00	8.78	2.48	809.52
85-95-1	1/28/1998	818.30	00:00	5.88	2.90	812.42
85-95-1	2/12/1998	818.30	00:00	3.58	2.30	814.72
85-95-1	3/26/1998	818.30	00:00	4.76	-1.18	813.54
85-95-1	4/29/1998	818.30	00:00	5.35	-0.59	812.95
85-95-1	6/23/1998	818.30	00:00	8.11	-2.76	810.19
85-95-1	7/28/1998	818.30	00:00	9.92	-1.81	808.38
85-95-1	8/14/1998	818.30	00:00	10.04	-0.12	808.26
85-95-1	9/28/1998	818.30	00:00	10.07	-0.03	808.23
85-95-1	10/27/1998	818.30	00:00	12.80	2.73	805.50
85-95-1	11/25/1998	818.30	00:00	10.50	2.30	807.80
85-95-1	12/21/1998	818.30	00:00	10.45	0.05	807.85
85-95-1	1/27/1999	818.30	00:00	7.90	2.55	810.40
85-95-1	2/25/1999	818.30	00:00	5.60	2.30	812.70
85-95-1	3/26/1999	818.30	00:00	5.14	0.46	813.16
85-95-1	4/30/1999	818.30	00:00	6.30	-1.16	812.00
85-95-1	5/26/1999	818.30	00:00	8.27	-1.97	810.03
85-95-1	6/24/1999	818.30	00:00	10.13	-1.86	808.17
85-95-1	7/27/1999	818.30	00:00	10.85	-0.72	807.45
85-95-1	8/30/1999	818.30	00:00	10.90	-0.05	807.40
85-95-1	9/29/1999	818.30	00:00	10.95	-0.05	807.35
85-95-1	10/27/1999	818.30	00:00	11.13	-0.18	807.17
85-95-1	11/29/1999	818.30	00:00	11.51	-0.38	806.79
85-95-1	12/20/1999	818.30	00:00	11.17	0.34	807.13
85-95-1	1/27/2000	818.30	00:00	7.25	3.92	811.05

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-1	2/25/2000	818.30	00:00	5.15	2.10	813.15
85-95-1	3/29/2000	818.30	00:00	4.64	0.51	813.66
85-95-1	4/25/2000	818.30	00:00	5.44	-0.80	812.86
85-95-1	5/26/2000	818.30	00:00	7.16	-1.72	811.14
85-95-1	6/27/2000	818.30	00:00	9.41	2.25	808.89
85-95-1	7/27/2000	818.30	00:00	10.54	-1.13	807.76
85-95-1	8/29/2000	818.30	00:00	10.83	-0.29	807.47
85-95-1	9/26/2000	818.30	00:00	10.92	-0.09	807.38
85-95-1	10/30/2000	818.30	00:00	10.06	0.86	808.24
85-95-1	11/27/2000	818.30	00:00	11.05	-0.99	807.25
85-95-1	12/18/2000	818.30	00:00	10.82	0.23	807.48
85-95-1	1/29/2001	818.30	00:00	10.11	0.71	808.19
85-95-1	2/26/2001	818.30	00:00	6.55	3.56	811.75
85-95-1	3/28/2001	818.30	00:00	6.93	-0.38	811.37
85-95-1	4/25/2001	818.30	00:00	7.97	-1.04	810.33
85-95-1	5/29/2001	818.30	00:00	9.76	-1.79	808.54
85-95-1	6/26/2001	818.30	00:00	10.73	-0.97	807.57
85-95-1	7/26/2001	818.30	00:00	10.88	-0.15	807.42
85-95-1	8/29/2001	818.30	00:00	11.03	-0.15	807.27
85-95-1	9/27/2001	818.30	00:00	11.18	-0.15	807.12
85-95-1	10/29/2001	818.30	00:00	11.68	-0.50	806.62
85-95-1	11/28/2001	818.30	00:00	11.77	-0.09	806.53
85-95-1	12/19/2001	818.30	00:00	8.42	3.35	809.88
85-95-1	1/30/2002	818.30	00:00	7.29	1.13	811.01
85-95-1	2/26/2002	818.30	00:00	6.10	1.19	812.20
85-95-1	3/27/2002	818.30	00:00	5.87	0.23	812.43
85-95-1	4/24/2002	818.30	00:00	7.36	-1.49	810.94
85-95-1	5/28/2002	818.30	00:00	8.40	-1.04	809.90
85-95-1	6/26/2002	818.30	00:00	8.07	0.33	810.23
85-95-1	7/24/2002	818.30	00:00	9.74	-1.67	808.56
85-95-1	8/29/2002	818.30	00:00	10.70	-0.96	807.60
85-95-1	9/26/2002	818.30	00:00	10.92	-0.22	807.38
85-95-1	10/29/2002	818.30	00:00	11.22	-0.30	807.08
85-95-1	11/22/2002	818.30	00:00	11.22	0.00	807.08
85-95-1	12/19/2002	818.30	00:00	5.87	5.35	812.43
85-95-1	1/29/2003	818.30	00:00	6.84	-0.97	811.46
85-95-1	2/26/2003	818.30	00:00	6.86	-0.02	811.44
85-95-1	3/26/2003	818.30	00:00	6.76	0.10	811.54
85-95-1	4/28/2003	818.30	00:00	6.25	0.51	812.05
85-95-1	5/28/2003	818.30	00:00	8.24	-1.99	810.06
85-95-1	6/25/2003	818.30	00:00	9.54	-1.30	808.76
85-95-1	7/29/2003	818.30	00:00	10.63	-1.09	807.67
85-95-1	8/27/2003	818.30	00:00	11.07	-0.44	807.23
85-95-1	9/23/2003	818.30	00:00	11.18	-0.11	807.12
85-95-1	10/29/2003	818.30	00:00	11.31	-0.13	806.99
85-95-1	11/24/2003	818.30	00:00	11.40	-0.09	806.90
85-95-1	12/19/2003	818.30	00:00	10.71	0.69	807.59

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SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-1	1/28/2004	818.30	00:00	7.10	3.61	811.20
85-95-1	2/25/2004	818.30	00:00	6.05	1.05	812.25
85-95-1	3/29/2004	818.30	00:00	4.67	1.38	813.63
85-95-1	4/28/2004	818.30	00:00	6.23	-1.56	812.07
85-95-1	5/26/2004	818.30	00:00	7.83	-1.60	810.47
85-95-1	6/28/2004	818.30	00:00	9.24	-1.41	809.06
85-95-1	7/28/2004	818.30	00:00	10.24	-1.00	808.06
85-95-2	8/24/1995	878.74	00:00	4.72	NA	874.02
85-95-2	10/4/1995	878.74	00:00	4.82	-0.10	873.92
85-95-2	10/30/1995	878.74	00:00	5.15	-0.33	873.59
85-95-2	11/28/1995	878.74	00:00	O	NA	NA
85-95-2	1/4/1996	878.74	00:00	5.90	-5.90	872.84
85-95-2	1/31/1996	878.74	00:00	2.84	3.06	875.90
85-95-2	2/28/1996	878.74	00:00	1.95	0.89	876.79
85-95-2	3/29/1996	878.74	00:00	4.27	-2.32	874.47
85-95-2	4/26/1996	878.74	00:00	5.10	-0.83	873.64
85-95-2	5/23/1996	878.74	00:00	5.40	-0.30	873.34
85-95-2	6/25/1996	878.74	00:00	O	NA	NA
85-95-2	7/31/1996	878.74	00:00	8.00	-8.00	870.74
85-95-2	8/28/1996	878.74	00:00	8.92	-0.92	869.82
85-95-2	9/23/1996	878.74	00:00	O	NA	NA
85-95-2	10/30/1996	878.74	00:00	10.98	-10.98	867.76
85-95-2	11/21/1996	878.74	00:00	11.52	-0.54	867.22
85-95-2	1/15/1997	878.74	00:00	2.82	8.70	875.92
85-95-2	4/9/1997	878.74	00:00	4.88	-2.06	873.86
85-95-2	8/20/1997	878.74	00:00	23.95	-19.07	854.79
85-95-2	9/30/1997	878.74	00:00	9.92	14.03	868.82
85-95-2	10/29/1997	878.74	00:00	10.89	-0.97	867.85
85-95-2	11/5/1997	878.74	00:00	11.40	-0.51	867.34
85-95-2	12/19/1997	878.74	00:00	6.79	4.61	871.95
85-95-2	1/27/1998	878.74	00:00	2.10	4.69	876.64
85-95-2	2/11/1998	878.74	00:00	0.30	1.80	878.44
85-95-2	3/26/1998	878.74	00:00	7.61	7.31	871.13
85-95-2	4/29/1998	878.74	00:00	7.76	-0.15	870.98
85-95-2	6/22/1998	878.74	00:00	5.80	1.96	872.94
85-95-2	7/27/1998	878.74	00:00	6.67	-0.87	872.07
85-95-2	8/14/1998	878.74	00:00	6.93	-0.26	871.81
85-95-2	9/28/1998	878.74	00:00	8.25	-1.32	870.49
85-95-2	10/27/1998	878.74	00:00	9.00	-0.75	869.74
85-95-2	11/25/1998	878.74	00:00	9.47	-0.47	869.27
85-95-2	12/21/1998	878.74	00:00	8.05	1.42	870.69
85-95-2	1/27/1999	878.74	00:00	4.90	3.15	873.84
85-95-2	2/25/1999	878.74	00:00	2.50	2.40	876.24
85-95-2	3/26/1999	878.74	00:00	4.64	-2.14	874.10
85-95-2	4/30/1999	878.74	00:00	5.38	-0.74	873.36
85-95-2	5/26/1999	878.74	00:00	6.22	-0.84	872.52

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-2	6/24/1999	878.74	00:00	7.00	-0.78	871.74
85-95-2	7/27/1999	878.74	00:00	7.82	-0.82	870.92
85-95-2	8/30/1999	878.74	00:00	8.50	-0.68	870.24
85-95-2	9/29/1999	878.74	00:00	8.91	-0.41	869.83
85-95-2	10/27/1999	878.74	00:00	9.46	-0.55	869.28
85-95-2	11/29/1999	878.74	00:00	9.86	-0.40	868.88
85-95-2	12/20/1999	878.74	00:00	10.08	-0.22	868.66
85-95-2	1/27/2000	878.74	00:00	4.60	5.48	874.14
85-95-2	2/25/2000	878.74	00:00	9.25	-4.65	869.49
85-95-2	3/29/2000	878.74	00:00	10.30	-1.05	868.44
85-95-2	4/25/2000	878.74	00:00	10.06	0.24	868.68
85-95-2	5/26/2000	878.74	00:00	10.21	-0.15	868.53
85-95-2	6/27/2000	878.74	00:00	10.50	-0.29	868.24
85-95-2	7/27/2000	878.74	00:00	10.53	-0.03	868.21
85-95-2	8/29/2000	878.74	00:00	10.57	-0.04	868.17
85-95-2	9/26/2000	878.74	00:00	10.77	-0.20	867.97
85-95-2	10/30/2000	878.74	00:00	9.92	0.85	868.82
85-95-2	11/27/2000	878.74	00:00	10.09	-0.17	868.65
85-95-2	12/18/2000	878.74	00:00	10.15	-0.06	868.59
85-95-2	1/29/2001	878.74	00:00	10.35	-0.20	868.39
85-95-2	2/26/2001	878.74	00:00	7.27	3.08	871.47
85-95-2	3/28/2001	878.74	00:00	8.74	-1.47	870.00
85-95-2	4/25/2001	878.74	00:00	10.88	-2.14	867.86
85-95-2	5/29/2001	878.74	00:00	10.85	0.03	867.89
85-95-2	6/25/2001	878.74	00:00	10.82	0.03	867.92
85-95-2	7/26/2001	878.74	00:00	11.19	-0.37	867.55
85-95-2	8/29/2001	878.74	00:00	9.86	1.33	868.88
85-95-2	9/27/2001	878.74	00:00	11.17	-1.31	867.57
85-95-2	10/29/2001	878.74	00:00	10.38	0.79	868.36
85-95-2	11/28/2001	878.74	00:00	9.42	0.96	869.32
85-95-2	12/19/2001	878.74	00:00	8.48	0.94	870.26
85-95-2	1/30/2002	878.74	00:00	10.18	-1.70	868.56
85-95-2	2/26/2002	878.74	00:00	10.22	-0.04	868.52
85-95-2	3/27/2002	878.74	00:00	10.17	0.05	868.57
85-95-2	4/24/2002	878.74	00:00	10.27	-0.10	868.47
85-95-2	5/28/2002	878.74	00:00	10.35	-0.08	868.39
85-95-2	6/26/2002	878.74	00:00	8.88	1.47	869.86
85-95-2	7/24/2002	878.74	00:00	9.24	-0.36	869.50
85-95-2	9/26/2002	878.74	00:00	9.86	-0.62	868.88
85-95-2	11/22/2002	878.74	00:00	9.73	0.13	869.01
85-95-2	12/19/2002	878.74	00:00	6.48	3.25	872.26
85-95-2	1/29/2003	878.74	00:00	6.34	0.14	872.40
85-95-2	2/26/2003	878.74	00:00	7.61	-1.27	871.13
85-95-2	6/25/2003	878.74	00:00	8.41	-0.80	870.33
85-95-2	8/27/2003	878.74	00:00	8.92	-0.51	869.82
85-95-2	9/23/2003	878.74	00:00	9.13	-0.21	869.61
85-95-2	10/29/2003	878.74	00:00	9.51	-0.38	869.23

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SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-2	11/24/2003	878.74	00:00	9.43	0.08	869.31
85-95-2	12/19/2003	878.74	00:00	8.38	1.05	870.36
85-95-2	1/28/2004	878.74	00:00	7.92	0.46	870.82
85-95-2	2/25/2004	878.74	00:00	6.20	1.72	872.54
85-95-2	3/29/2004	878.74	00:00	6.88	-0.68	871.86
85-95-2	4/28/2004	878.74	00:00	7.30	-0.42	871.44
85-95-2	5/26/2004	878.74	00:00	7.79	-0.49	870.95
85-95-2	6/28/2004	878.74	00:00	6.94	0.85	871.80
85-95-2	7/28/2004	878.74	00:00	8.54	-1.60	870.20
85-96-1	7/31/1996	890.25	00:00	15.00	NA	875.25
85-96-1	8/29/1996	890.25	00:00	15.10	-0.10	875.15
85-96-1	9/26/1996	890.25	00:00	15.49	-0.39	874.76
85-96-1	10/30/1996	890.25	00:00	16.31	-0.82	873.94
85-96-1	11/21/1996	890.25	00:00	16.76	-0.45	873.49
85-96-1	1/13/1997	890.25	00:00	13.55	3.21	876.70
85-96-1	4/9/1997	890.25	00:00	14.12	-0.57	876.13
85-96-1	8/20/1997	890.25	00:00	14.93	-0.81	875.32
85-96-1	9/30/1997	890.25	00:00	15.52	-0.59	874.73
85-96-1	10/29/1997	890.25	00:00	16.17	-0.65	874.08
85-96-1	11/5/1997	890.25	00:00	18.32	-2.15	871.93
85-96-1	12/19/1997	890.25	00:00	16.71	1.61	873.54
85-96-1	1/27/1998	890.25	00:00	13.72	2.99	876.53
85-96-1	2/11/1998	890.25	00:00	10.64	3.08	879.61
85-96-1	3/30/1998	890.25	00:00	13.99	-3.35	876.26
85-96-1	4/29/1998	890.25	00:00	14.30	-0.31	875.95
85-96-1	6/23/1998	890.25	00:00	14.52	-0.22	875.73
85-96-1	7/27/1998	890.25	00:00	14.64	-0.12	875.61
85-96-1	8/7/1998	890.25	00:00	14.64	0.00	875.61
85-96-1	9/28/1998	890.25	00:00	14.90	-0.26	875.35
85-96-1	10/27/1998	890.25	00:00	14.96	-0.06	875.29
85-96-1	11/25/1998	890.25	00:00	15.07	-0.11	875.18
85-96-1	12/21/1998	890.25	00:00	15.18	-0.11	875.07
85-96-1	1/27/1999	890.25	00:00	15.25	-0.07	875.00
85-96-1	2/26/1999	890.25	00:00	14.62	0.63	875.63
85-96-1	3/26/1999	890.25	00:00	14.12	0.50	876.13
85-96-1	5/3/1999	890.25	00:00	14.30	-0.18	875.95
85-96-1	5/26/1999	890.25	00:00	14.40	-0.10	875.85
85-96-1	6/24/1999	890.25	00:00	14.53	-0.13	875.72
85-96-1	7/27/1999	890.25	00:00	14.60	-0.07	875.65
85-96-1	8/30/1999	890.25	00:00	14.70	-0.10	875.55
85-96-1	9/29/1999	890.25	00:00	14.76	-0.06	875.49
85-96-1	10/27/1999	890.25	00:00	14.86	-0.10	875.39
85-96-1	11/29/1999	890.25	00:00	14.96	-0.10	875.29
85-96-1	12/20/1999	890.25	00:00	15.11	-0.15	875.14
85-96-1	1/27/2000	890.25	00:00	15.35	-0.24	874.90
85-96-1	2/25/2000	890.25	00:00	13.88	1.47	876.37

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-96-1	3/29/2000	890.25	00:00	13.89	-0.01	876.36
85-96-1	4/25/2000	890.25	00:00	14.33	-0.44	875.92
85-96-1	5/26/2000	890.25	00:00	14.48	-0.15	875.77
85-96-1	6/27/2000	890.25	00:00	14.61	-0.13	875.64
85-96-1	7/27/2000	890.25	00:00	14.68	-0.07	875.57
85-96-1	8/30/2000	890.25	00:00	14.75	-0.07	875.50
85-96-1	9/26/2000	890.25	00:00	14.82	-0.07	875.43
85-96-1	10/30/2000	890.25	00:00	14.94	-0.12	875.31
85-96-1	11/27/2000	890.25	00:00	15.07	-0.13	875.18
85-96-1	12/18/2000	890.25	00:00	15.27	-0.20	874.98
85-96-1	1/29/2001	890.25	00:00	15.66	-0.39	874.59
85-96-1	2/26/2001	890.25	00:00	14.84	0.82	875.41
85-96-1	3/28/2001	890.25	00:00	14.48	0.36	875.77
85-96-1	4/25/2001	890.25	00:00	14.51	-0.03	875.74
85-96-1	5/29/2001	890.25	00:00	14.62	-0.11	875.63
85-96-1	6/26/2001	890.25	00:00	14.66	-0.04	875.59
85-96-1	7/26/2001	890.25	00:00	14.73	-0.07	875.52
85-96-1	8/29/2001	890.25	00:00	14.80	-0.07	875.45
85-96-1	9/27/2001	890.25	00:00	14.87	-0.07	875.38
85-96-1	10/29/2001	890.25	00:00	15.08	-0.21	875.17
85-96-1	11/28/2001	890.25	00:00	15.36	-0.28	874.89
85-96-1	12/19/2001	890.25	00:00	14.95	0.41	875.30
85-96-1	1/30/2002	890.25	00:00	14.36	0.59	875.89
85-96-1	2/26/2002	890.25	00:00	14.42	-0.06	875.83
85-96-1	3/27/2002	890.25	00:00	14.51	-0.09	875.74
85-96-1	4/24/2002	890.25	00:00	14.55	-0.04	875.70
85-96-1	5/28/2002	890.25	00:00	14.60	-0.05	875.65
85-96-1	6/26/2002	890.25	00:00	14.70	-0.10	875.55
85-96-1	7/24/2002	890.25	00:00	14.70	0.00	875.55
85-96-1	8/29/2002	890.25	00:00	14.78	-0.08	875.47
85-96-1	9/26/2002	890.25	00:00	14.82	-0.04	875.43
85-96-1	10/29/2002	890.25	00:00	14.95	-0.13	875.30
85-96-1	11/22/2002	890.25	00:00	15.04	-0.09	875.21
85-96-1	12/19/2002	890.25	00:00	14.93	0.11	875.32
85-96-1	1/29/2003	890.25	00:00	14.48	0.45	875.77
85-96-1	2/26/2003	890.25	00:00	14.52	-0.04	875.73
85-96-1	3/26/2003	890.25	00:00	13.38	1.14	876.87
85-96-1	4/28/2003	890.25	00:00	14.57	-1.19	875.68
85-96-1	5/28/2003	890.25	00:00	14.67	-0.10	875.58
85-96-1	6/25/2003	890.25	00:00	14.68	-0.01	875.57
85-96-1	7/29/2003	890.25	00:00	14.73	-0.05	875.52
85-96-1	8/27/2003	890.25	00:00	14.77	-0.04	875.48
85-96-1	9/23/2003	890.25	00:00	14.83	-0.06	875.42
85-96-1	10/29/2003	890.25	00:00	14.98	-0.15	875.27
85-96-1	11/24/2003	890.25	00:00	15.18	-0.20	875.07
85-96-1	12/19/2003	890.25	00:00	15.38	-0.20	874.87
85-96-1	1/28/2004	890.25	00:00	14.65	0.73	875.60

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-96-1	2/25/2004	890.25	00:00	14.34	0.31	875.91
85-96-1	3/29/2004	890.25	00:00	14.28	0.06	875.97
85-96-1	4/28/2004	890.25	00:00	14.45	-0.17	875.80
85-96-1	5/26/2004	890.25	00:00	14.56	-0.11	875.69
85-96-1	6/28/2004	890.25	00:00	14.65	-0.09	875.60
85-96-1	7/28/2004	890.25	00:00	14.73	-0.08	875.52
85-96-2	7/31/1996	877.40	00:00	38.20	NA	839.20
85-96-2	8/29/1996	877.40	00:00	39.10	-0.90	838.30
85-96-2	9/26/1996	877.40	00:00	39.37	-0.27	838.03
85-96-2	10/30/1996	877.40	00:00	39.97	-0.60	837.43
85-96-2	11/22/1996	877.40	00:00	39.77	0.20	837.63
85-96-2	1/13/1997	877.40	00:00	37.61	2.16	839.79
85-96-2	4/9/1997	877.40	00:00	37.41	0.20	839.99
85-96-2	8/21/1997	877.40	00:00	39.15	-1.74	838.25
85-96-2	9/30/1997	877.40	00:00	39.74	-0.59	837.66
85-96-2	10/29/1997	877.40	00:00	39.93	-0.19	837.47
85-96-2	11/6/1997	877.40	00:00	40.20	-0.27	837.20
85-96-2	12/19/1997	877.40	00:00	39.20	1.00	838.20
85-96-2	1/27/1998	877.40	00:00	38.14	1.06	839.26
85-96-2	2/17/1998	877.40	00:00	35.70	2.44	841.70
85-96-2	3/26/1998	877.40	00:00	36.56	-0.86	840.84
85-96-2	4/29/1998	877.40	00:00	36.98	-0.42	840.42
85-96-2	6/22/1998	877.40	00:00	37.62	-0.64	839.78
85-96-2	7/27/1998	877.40	00:00	37.96	-0.34	839.44
85-96-2	8/6/1998	877.40	00:00	37.94	0.02	839.46
85-96-2	9/28/1998	877.40	00:00	38.60	-0.66	838.80
85-96-2	10/27/1998	877.40	00:00	39.10	-0.50	838.30
85-96-2	11/25/1998	877.40	00:00	39.20	-0.10	838.20
85-96-2	12/21/1998	877.40	00:00	39.05	0.15	838.35
85-96-2	1/27/1999	877.40	00:00	38.90	0.15	838.50
85-96-2	2/25/1999	877.40	00:00	37.72	1.18	839.68
85-96-2	3/26/1999	877.40	00:00	37.36	0.36	840.04
85-96-2	4/30/1999	877.40	00:00	37.52	-0.16	839.88
85-96-2	5/26/1999	877.40	00:00	37.90	-0.38	839.50
85-96-2	6/24/1999	877.40	00:00	38.07	-0.17	839.33
85-96-2	7/27/1999	877.40	00:00	38.38	-0.31	839.02
85-96-2	8/30/1999	877.40	00:00	38.80	-0.42	838.60
85-96-2	9/29/1999	877.40	00:00	39.04	-0.24	838.36
85-96-2	10/27/1999	877.40	00:00	39.33	-0.29	838.07
85-96-2	11/29/1999	877.40	00:00	39.41	-0.08	837.99
85-96-2	12/20/1999	877.40	00:00	39.29	0.12	838.11
85-96-2	1/27/2000	877.40	00:00	39.40	-0.11	838.00
85-96-2	2/25/2000	877.40	00:00	38.02	1.38	839.38
85-96-2	3/29/2000	877.40	00:00	37.13	0.89	840.27
85-96-2	4/25/2000	877.40	00:00	37.38	-0.25	840.02
85-96-2	5/26/2000	877.40	00:00	37.75	-0.37	839.65

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-96-2	6/27/2000	877.40	00:00	38.06	-0.31	839.34
85-96-2	7/27/2000	877.40	00:00	38.23	-0.17	839.17
85-96-2	8/29/2000	877.40	00:00	38.48	-0.25	838.92
85-96-2	9/26/2000	877.40	00:00	38.87	-0.39	838.53
85-96-2	10/30/2000	877.40	00:00	38.92	-0.05	838.48
85-96-2	11/27/2000	877.40	00:00	39.01	-0.09	838.39
85-96-2	12/18/2000	877.40	00:00	39.48	-0.47	837.92
85-96-2	1/29/2001	877.40	00:00	39.23	0.25	838.17
85-96-2	2/26/2001	877.40	00:00	37.98	1.25	839.42
85-96-2	3/28/2001	877.40	00:00	37.83	0.15	839.57
85-96-2	4/25/2001	877.40	00:00	37.65	0.18	839.75
85-96-2	5/29/2001	877.40	00:00	37.90	-0.25	839.50
85-96-2	6/26/2001	877.40	00:00	38.15	0.25	839.25
85-96-2	7/26/2001	877.40	00:00	38.58	-0.43	838.82
85-96-2	8/29/2001	877.40	00:00	39.07	-0.49	838.33
85-96-2	9/27/2001	877.40	00:00	39.34	-0.27	838.06
85-96-2	10/29/2001	877.40	00:00	40.16	-0.82	837.24
85-96-2	11/28/2001	877.40	00:00	40.04	0.12	837.36
85-96-2	12/19/2001	877.40	00:00	39.42	0.62	837.98
85-96-2	1/30/2002	877.40	00:00	38.20	1.22	839.20
85-96-2	2/26/2002	877.40	00:00	37.91	0.29	839.49
85-96-2	3/27/2002	877.40	00:00	37.85	0.06	839.55
85-96-2	4/24/2002	877.40	00:00	38.15	-0.30	839.25
85-96-2	5/28/2002	877.40	00:00	38.15	0.00	839.25
85-96-2	6/26/2002	877.40	00:00	38.22	-0.07	839.18
85-96-2	7/24/2002	877.40	00:00	38.28	-0.06	839.12
85-96-2	8/29/2002	877.40	00:00	38.62	-0.34	838.78
85-96-2	9/26/2002	877.40	00:00	38.92	-0.30	838.48
85-96-2	10/29/2002	877.40	00:00	39.60	-0.68	837.80
85-96-2	11/22/2002	877.40	00:00	40.16	-0.56	837.24
85-96-2	12/19/2002	877.40	00:00	39.81	0.35	837.59
85-96-2	1/29/2003	877.40	00:00	38.22	1.59	839.18
85-96-2	2/26/2003	877.40	00:00	37.75	0.47	839.65
85-96-2	3/26/2003	877.40	00:00	37.86	-0.11	839.54
85-96-2	4/28/2003	877.40	00:00	37.88	-0.02	839.52
85-96-2	5/28/2003	877.40	00:00	38.02	-0.14	839.38
85-96-2	6/25/2003	877.40	00:00	38.26	-0.24	839.14
85-96-2	7/29/2003	877.40	00:00	38.44	-0.18	838.96
85-96-2	8/27/2003	877.40	00:00	38.66	-0.22	838.74
85-96-2	9/23/2003	877.40	00:00	39.00	-0.34	838.40
85-96-2	10/29/2003	877.40	00:00	39.68	-0.68	837.72
85-96-2	11/24/2003	877.40	00:00	40.32	-0.64	837.08
85-96-2	12/19/2003	877.40	00:00	40.22	0.10	837.18
85-96-2	1/28/2004	877.40	00:00	39.02	1.20	838.38
85-96-2	2/25/2004	877.40	00:00	37.91	1.11	839.49
85-96-2	3/29/2004	877.40	00:00	37.44	0.47	839.96
85-96-2	4/28/2004	877.40	00:00	37.64	-0.20	839.76

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-96-2	5/26/2004	877.40	00:00	38.07	-0.43	839.33
85-96-2	6/28/2004	877.40	00:00	38.15	-0.08	839.25
85-96-2	7/28/2004	877.40	00:00	38.42	-0.27	838.98

BORING #	SURF ELEV:	UC EAST:	UC NORTH:	LOGGED BY:	DATE DRILLED:	PAGE:
MW85-95-1	≈820 feet			Preston Holland	5/8-10/95	1/1

DEPTH TO GROUNDWATER:	DRILLING CONTRACTOR:	BORING EQUIPMENT:	DRILL RIG:
15.0 feet (5/10/95)	Western Strata Exploration	7 3/4" cryo rotary tri-cone reamed with 10" hollow stem auger	B-61

DESCRIPTION AND CLASSIFICATION		DEPTH (FEET)	SAMPLE	Penetration Resistance (Blows/ft)	PID readings (ppm)	REMARKS	Well Construction
DESCRIPTION AND REMARKS	SOIL TYPE						
ASPHALT/ CONCRETE						Traffic-grade well cover with locking cap	
GRAVEL, base rock							
SANDY SILT (ML), brown, stiff, dry to damp, minor fine-grained angular to subangular mudstone gravel (fill?).		5		35		Cement grout seal	
						2" PVC solid casing, Sch. 40, 10' sections, O-ring seals	
CLAYEY SILT (ML), dark brown, stiff, damp, minor, fine-grained, subangular, andesitic and basaltic gravel.		10		33			
ANDESITE, brown, intensely fractured, moderately strong, hard, deeply to moderately weathered, saturated, includes minor basalt.						Bentonite pellets seal	
		15		47/11"		No. 2/12 sand filter pack	
CLAYSTONE, red brown, crushed, plastic to friable, soft to little hardness, little weathered, saturated, subhorizontally sheared with laminae and boudins of greenish gray fine sandstone with intermittent calcite cementation.		20				Machine-slotted PVC well screen, slot size 0.010"	
Total drilled depth = 25.0 ft		25				Silt trap	
		30					
		35					
		40					
		45					
		50					

all samples taken with 2 inch internal diameter split spoon sampler

note blows converted, raw counts available

LAWRENCE BERKELEY NATIONAL LABORATORY	EXPLORATORY BORING LOG		
	PROJECT # Site Restoration Project	DATE: 9/19/95	BORING # MW85-95-1

Post-it® Fax Note 7671

Date 9-1	# of pages ▶ 4
To Preston Jordan	From Lax
Co./Dept.	Co.
Phone # 6774	Phone # 6653
Fax # 5686	Fax # 6608

BORING #	SURF ELEV:	UC EAST:	UC NORTH:	LOGGED BY:	DATE DRILLED:	PAGE:
MW85-95-2	~878 feet			Preston Holland	5/10/95	1/1

DEPTH TO GROUNDWATER:	DRILLING CONTRACTOR:	BORING EQUIPMENT:	DRILL RIG:
not equilibrated	Western Strata Exploration	8" hollow stem auger	B-61

DESCRIPTION AND CLASSIFICATION		DEPTH (FEET)	SAMPLE	Penetration Resistance (Blows/ft)	PID readings (ppm)	REMARKS	Well Construction
DESCRIPTION AND REMARKS	SOIL TYPE						
ASPHALT/ CONCRETE						Traffic-grade well cover with locking cap	
GRAVEL, base rock						Cement grout seal	
SILTY GRAVEL (GM), yellow brown, medium dense, wet, medium, angular andesite gravel (deeply weathered andesite).		5		28		2" PVC solid casing, Sch. 40	
• saturated at 8 ft		10		48/6"		Bentonite pellets seal	
						No. 2/12 sand filter pack	
FINE SANDY SILTSTONE, red brown with blue gray silty fine sandstone zones and laminae, crushed, plastic, soft to little hardness, little weathered, saturated, subvertical shear planes.		15		40/11"		Machine-slotted PVC well screen, slot size 0.010"	
		20		44		Silt trap	
Total drilled depth = 19.0 ft		25					
		30					
		35					
		40					
		45					
		50					

all samples taken with 2 inch internal diameter split spoon sampler

LAWRENCE BERKELEY NATIONAL LABORATORY	EXPLORATORY BORING LOG		
	PROJECT # Site Restoration Project	DATE: 9/19/95	BORING # MW85-95-1

BORING #	SURF ELEV:	UC EAST:	UC NORTH:	LOGGED BY:	DATE DRILLED:	PAGE:
MW85-96-1				Preston Holland	6/13/96	1/1

DEPTH TO GROUNDWATER:	DRILLING CONTRACTOR:	BORING EQUIPMENT:	DRILL RIG:
22.5 feet (11:00)	Gregg	8" hollow stem auger	M-11

DESCRIPTION AND CLASSIFICATION							
DESCRIPTION AND REMARKS	SOIL TYPE	DEPTH (FEET)	SAMPLE	Penetration Resistance (Blows/ft)	ambient PID readings (ppm)	REMARKS	Well Construction
CONCRETE							
GRAVELLY CLAY (CL), brown to dark brown, stiff, moist, angular to subangular volcanic gravel predominantly, faint subhorizontal structure (fill).		5		29		Cement grout seal	
CLAYEY SILT (ML), brown to dark brown, stiff, moist to wet, rootlets with discoloration zones, occasional clay coated volcanic gravel.		10		10		2" PVC solid casing Sch. 40, 10' sections, O-ring seals	
SANDY SILT (ML), grayish brown with bluish gray mottling, medium stiff, wet, mottling along roots.		15		6		Bentonite pellets seal	
• bluish gray mottling increasing with depth		20		23		No. 2/12 sand filter pack	
SILTY SAND (SM), grayish brown with bluish gray mottling, loose to medium dense, saturated. • harder drilling at 27 ft • easier drilling at 28 ft		25		26		Machine-slotted PVC well screen, slot size 0.020"	
CLAYEY SILTSTONE AND SILTSTONE, greenish gray and gray, crushed, friable, little hardness, little weathered, saturated, subvertical black shear zones separate lithologies.		30		30		Silt trap Slough	
Total Depth = 30.5 feet		35					
		40					
		45					
		50					

all samples taken with 2 inch internal diameter split spoon sampler

LAWRENCE BERKELEY NATIONAL LABORATORY	EXPLORATORY BORING LOG		
	PROJECT # Site Restoration Project	DATE: 6/18/96	BORING # MW85-96-1

428_00130

BORING #	SURF ELEV:	UC EAST:	UC NORTH:	LOGGED BY:	DATE DRILLED:	PAGE:
MW85-96-2				Preston Holland	6/28/96	1/1

DEPTH TO GROUNDWATER:	DRILLING CONTRACTOR:	BORING EQUIPMENT:	DRILL RIG:
38.7 feet (11:40)	Gregg	8" hollow stem auger	B-61

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	SOIL TYPE	DEPTH (FEET)	SAMPLE	Penetration Resistence (Blows/ft)	ambient PID readings (ppm)	REMARKS	Well Construction
SANDY SILT (ML), brown and dark brown, medium stiff to stiff, moist, sand coarse, composed primarily of volcanics, faint, irregular, subhorizontal bedding (fill).		5		7			
CLAYEY SILT (ML), black, medium stiff, wet (fill).		10				Cement grout seal	
GRAVELLY SILT (ML), brown, stiff to very stiff, wet to saturated, fine, angular, volcanic gravel, occasional woody debris with blue gray coloration surrounding, no soil structure (fill).		15		19		2" PVC solid casing Sch. 40, 10' sections, O-ring seals	
CLAYEY SILT (ML), dark gray brown, stiff, wet (fill).		20					
SANDY SILT (ML), brown with orange brown mottles, stiff to very stiff, moist to wet, angular, coarse, volcanic sand (fill).		25		17			
SILT (ML), black with blue gray and orange brown mottles, stiff, wet, minor coarse, angular, volcanic sand, no soil structure (fill).		30					
SILTY GRAVEL (GM), brown and dark gray brown mottled, very stiff, moist to wet, medium, angular volcanic gravel (fill). • smooth drilling at 37 ft		35		48/11"		Bentonite pellets seal	
SILTY CLAY (CL), dark brown with brown mottles, medium stiff, wet, rootlets, minor charcoal and subangular, coarse, volcanic sand, no soil structure. • gravelly layers, saturated at 47 ft		40		14		No. 2/12 sand filter pack	
SANDY SILTSTONE, purplish brown with greenish gray mottling, closely fractured, friable to weak, little to moderate hardness, little weathered, saturated, occasional shear zones with coarse sand of red brown scoria, andesite and other volcanics, minor clasts of blue gray sandstone, roots and rootlets.		45				Machine-slotted PVC well screen, slot size 0.020"	
		50		23		Silt trap Slough	

all samples taken with 2 inch internal diameter split spoon sampler

Total Depth = 50.5 feet

LAWRENCE BERKELEY NATIONAL LABORATORY	EXPLORATORY BORING LOG		
	PROJECT # Site Restoration Project	DATE: 7/29/96	BORING # MW85-96-2

Appendix F

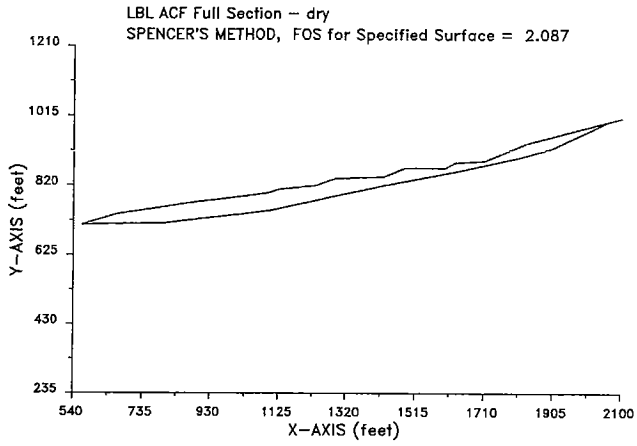
APPENDIX F

Results of Stability Analyses

CASE 1A: SPECIFIED FAILURE SURFACE - COMPLETE LOWER SLIDE
Low Groundwater

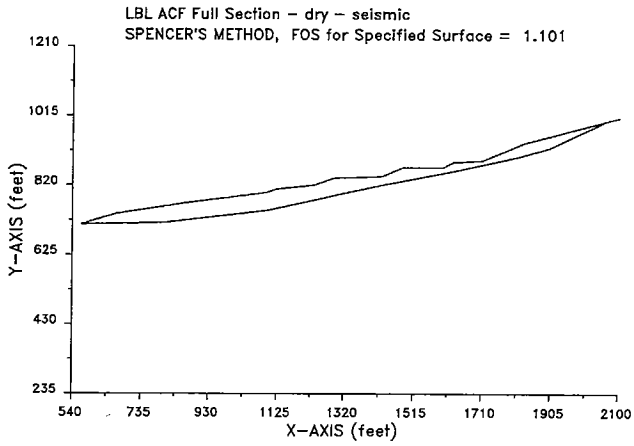
Static

SEC_1 9-15-** 20:26



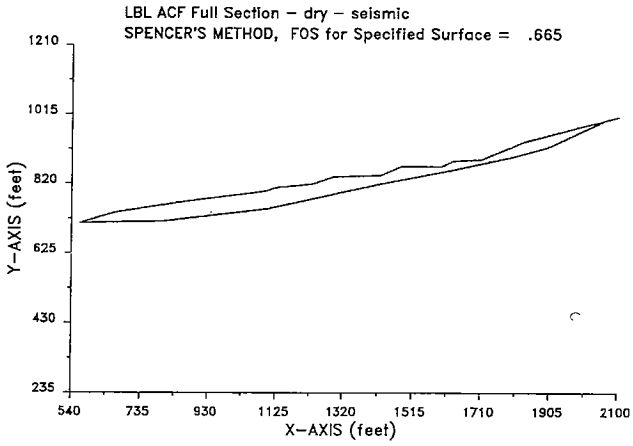
F_{eq}=0.15

SEC_1A2 9-23-** 17:59



F_{eq}=0.34

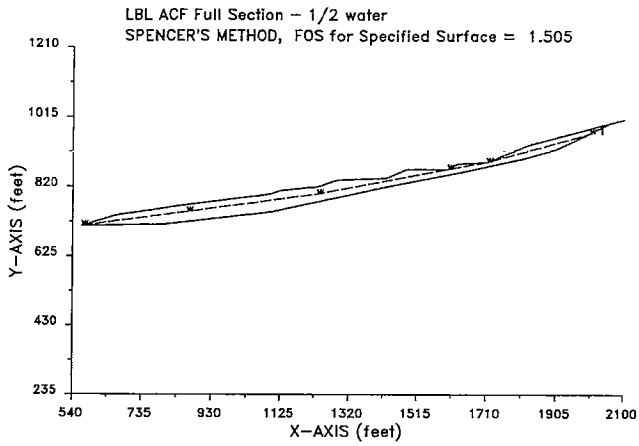
SEC_1A2 9-23-** 18:00



CASE 1B: SPECIFIED FAILURE SURFACE - COMPLETE LOWER SLIDE
Intermediate Groundwater

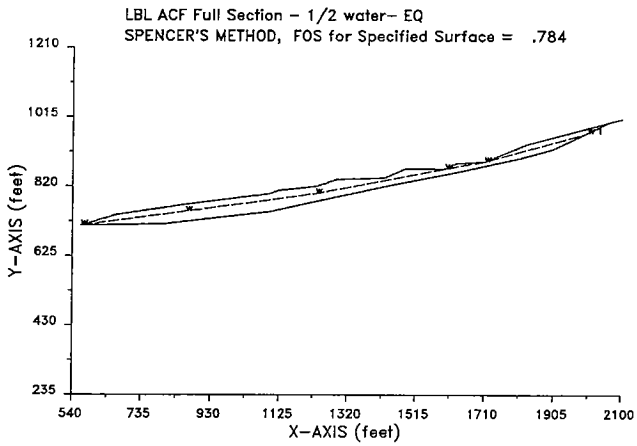
Static

SEC_1B 9-15-** 20:32



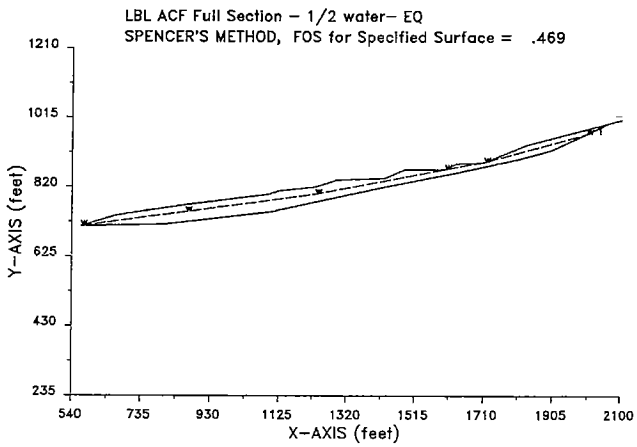
F_{eq}=0.15

SEC_1B2 9-23-** 18:01



F_{eq}=0.34

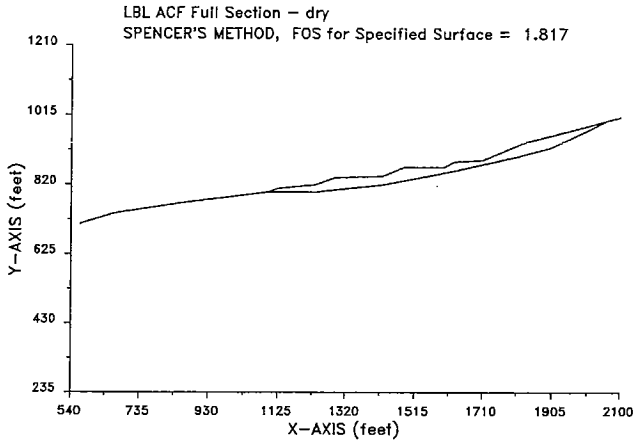
SEC_1B2 9-23-** 18:01



CASE 1C: SPECIFIED FAILURE SURFACE - PARTIAL LOWER SLIDE
Low Groundwater

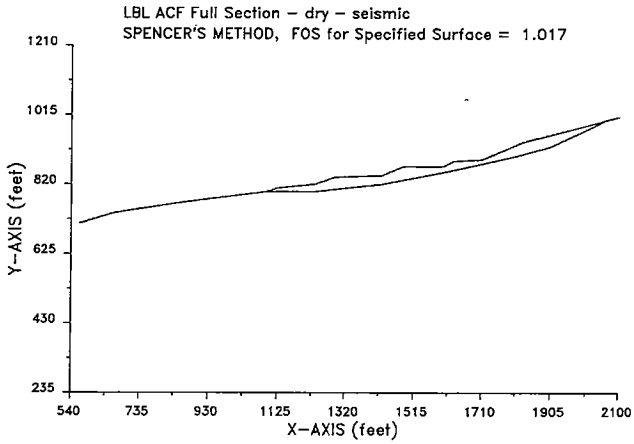
Static

SEC_2A 9-15-** 20:36



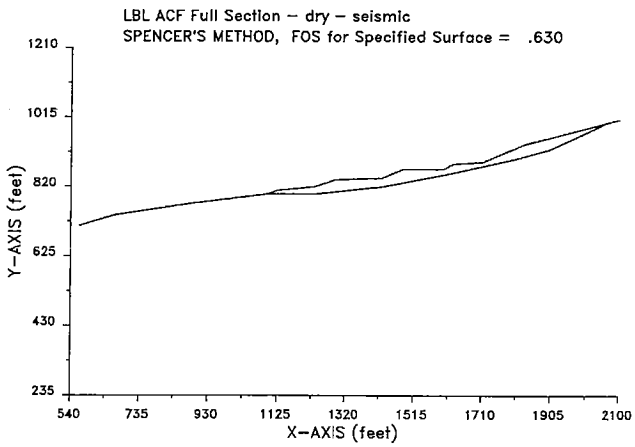
F_{eq}=0.15

SEC_2A2 9-23-** 18:02



F_{eq}=0.34

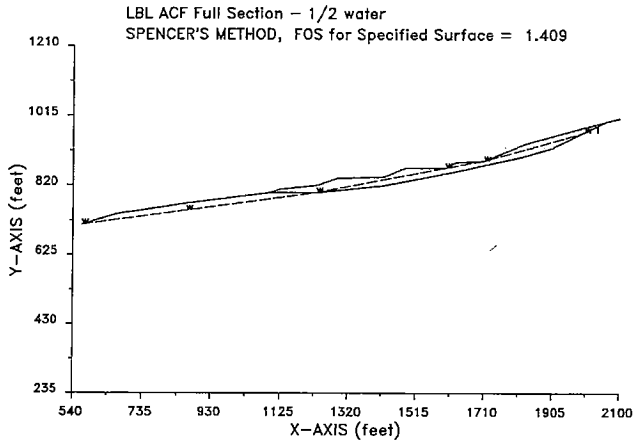
SEC_2A2 9-23-** 18:03



CASE 1D: SPECIFIED FAILURE SURFACE - PARTIAL LOWER SLIDE
Intermediate Groundwater

Static

SEC_2B 9-15-** 20:36



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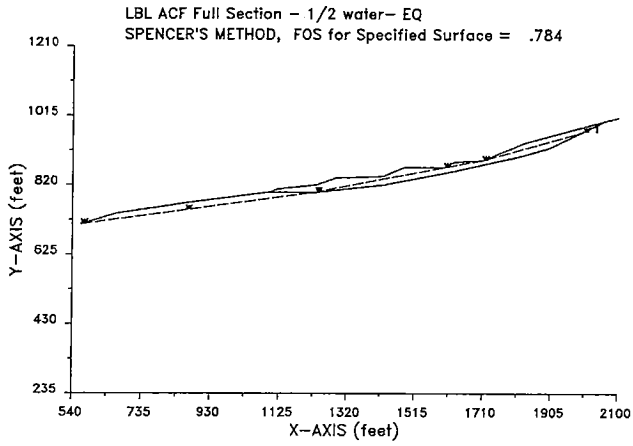

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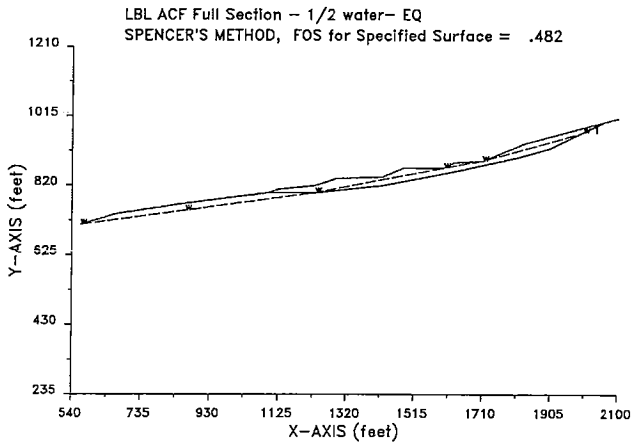
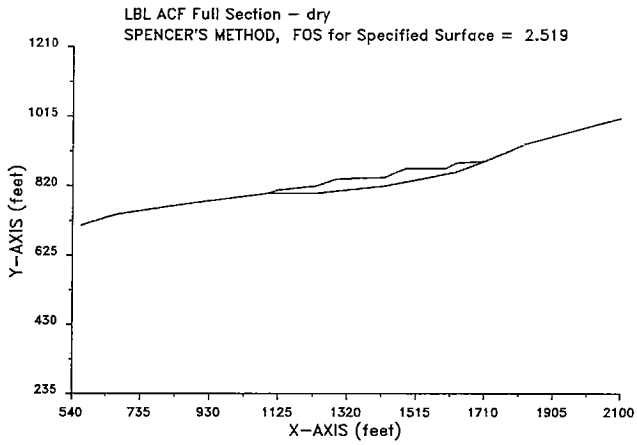


CASE 1E: SPECIFIED FAILURE SURFACE -PARTIAL LOWER SLIDE
Low Groundwater

Static

SEC_2C 9-15-** 20:38



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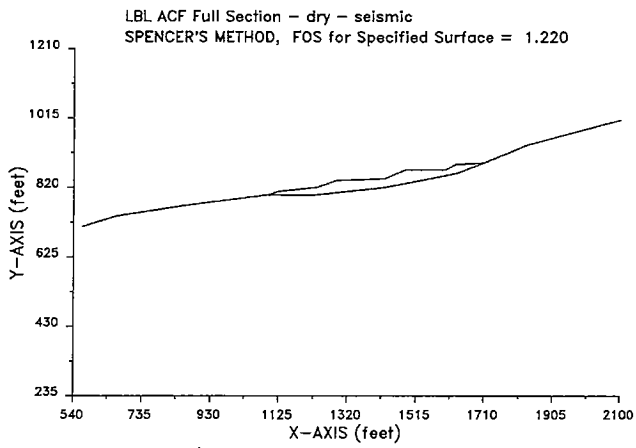
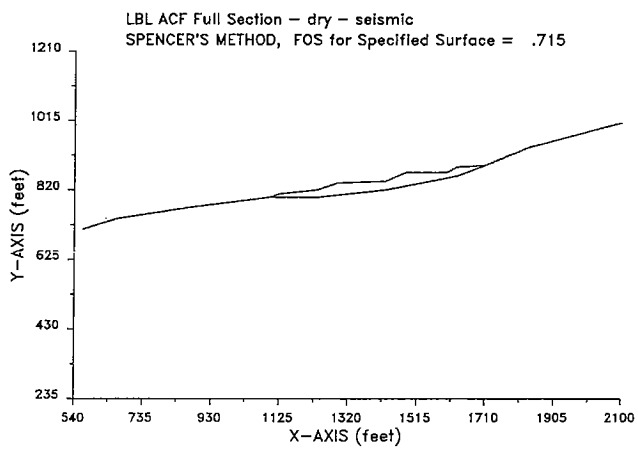


F_{eq}=0.34

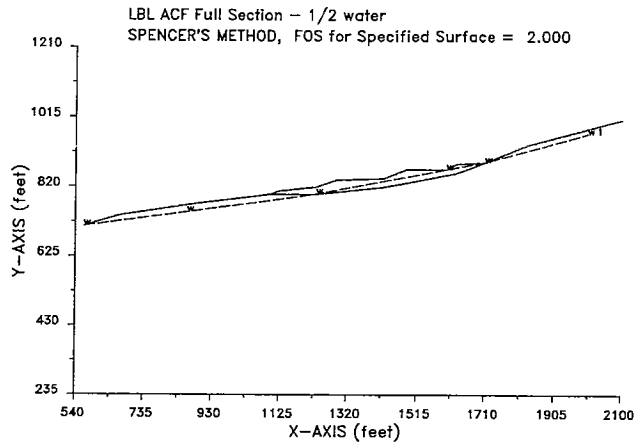
SEC_2C2 9-23-** 18:09



CASE 1F: SPECIFIED FAILURE SURFACE - PARTIAL LOWER SLIDE
Intermediate Groundwater

Static

SEC_2D 9-15-** 20:39



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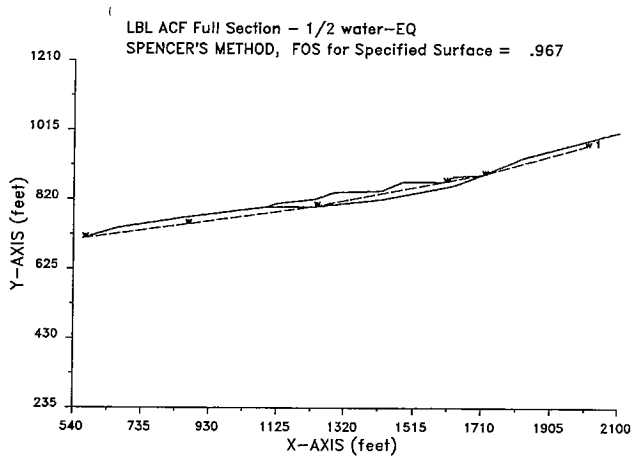
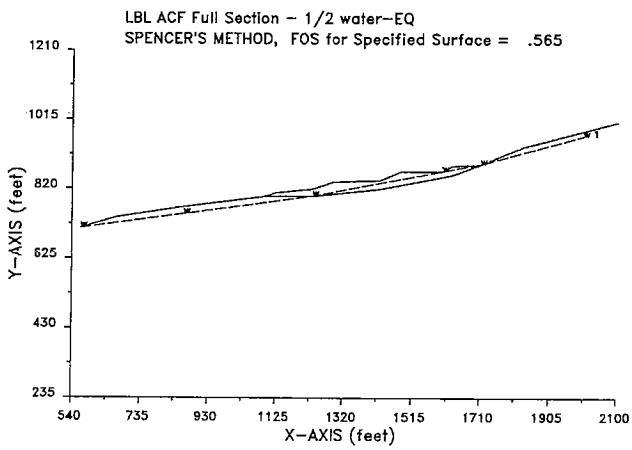


F_{eq}=0.34

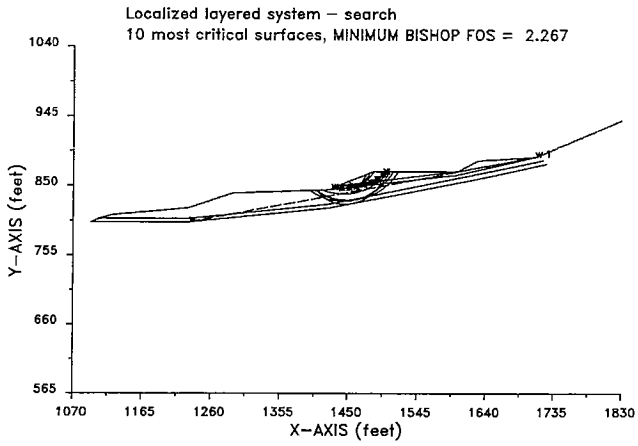
SEC_2D2 9-23-** 18:11



CASE 2: CIRCULAR FAILURE LOCAL LAYERED MODEL
Low Groundwater

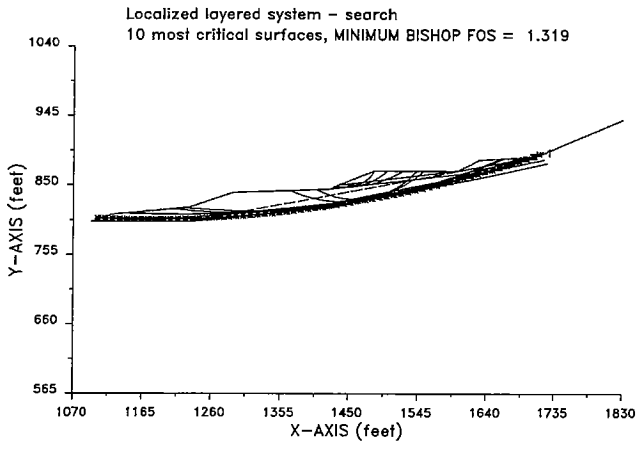
CASE 2A: Static

SEC2 9-22-** 19:23



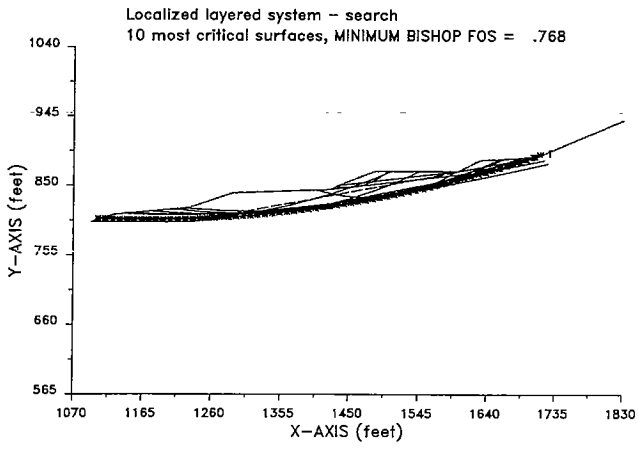
CASE 2B: F_{eq}=0.15

SEC2C 9-22-** 19:31



CASE 2C: F_{eq}=0.34

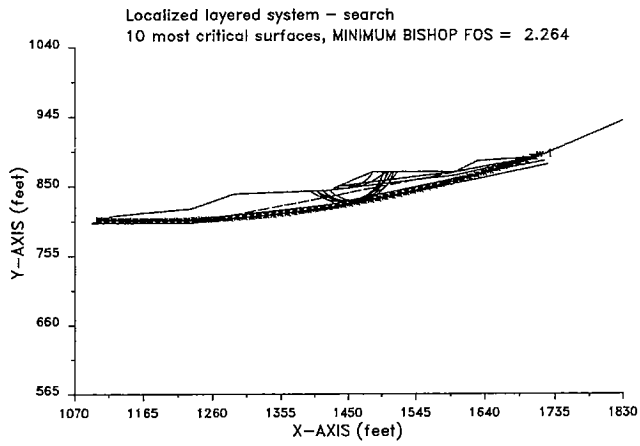
SEC2C 9-22-** 19:30



CASE 2 (Continued): CIRCULAR FAILURE LOCAL LAYERED MODEL
Intermediate Groundwater

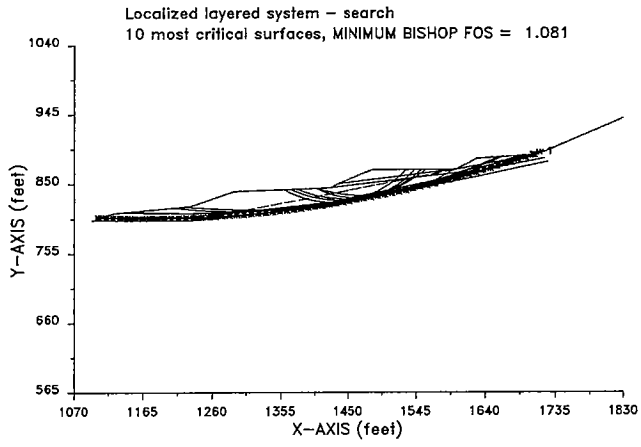
CASE 2D: Static

SEC2C 9-22-** 19:32



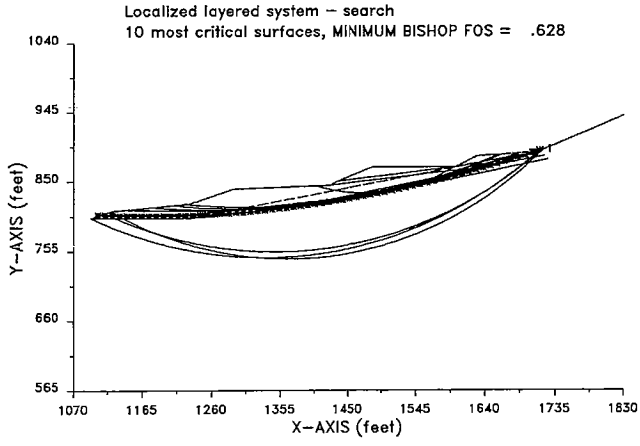
CASE 2E: F_{eq}=0.15

SEC2C 9-22-** 19:28



CASE 2F: F_{eq}=0.34

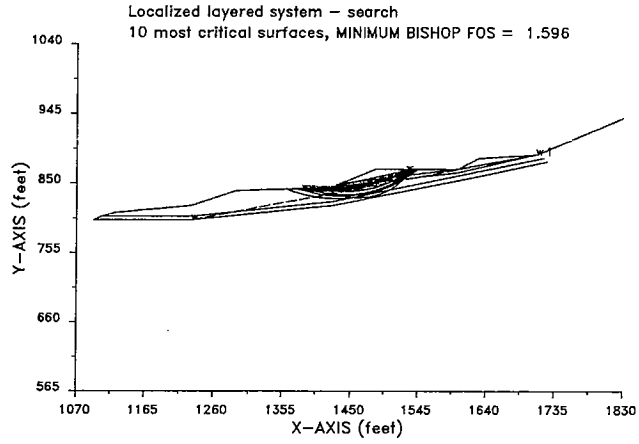
SEC2C 9-22-** 19:29



CASE 3A: CIRCULAR FAILURE – LOCAL HOMOGENEOUS MODEL
Low Groundwater

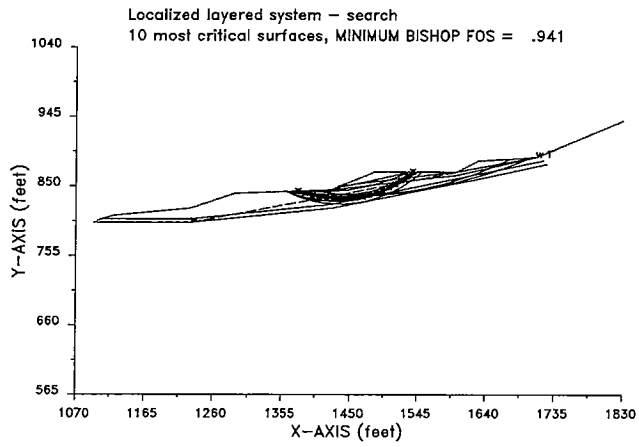
Static

SEC2D 9-22-** 19:50



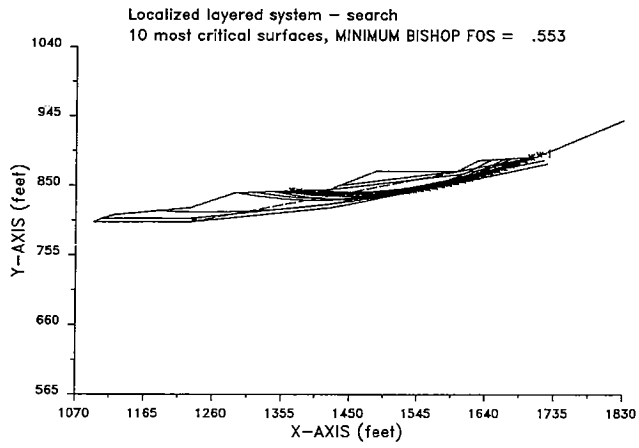
F_{eq}=0.15

SEC2D 9-22-** 19:42



F_{eq}=0.34

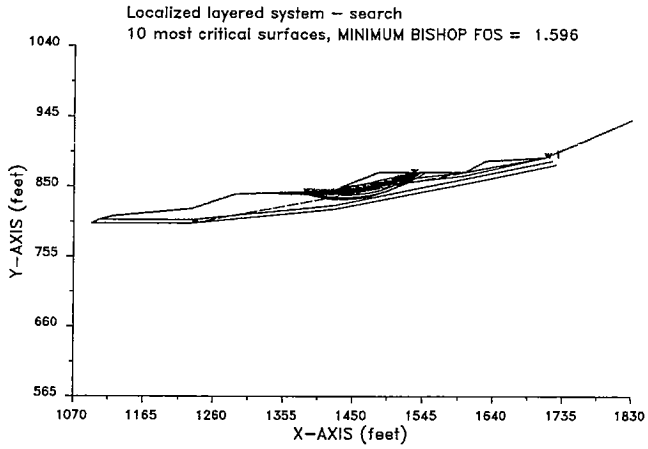
SEC2D 9-22-** 19:45



CASE 3B: CIRCULAR FAILURE – LOCAL HOMOGENEOUS MODEL
Low Groundwater

Static

SEC2D 9-22-** 19:48



F_{eq}=0.15

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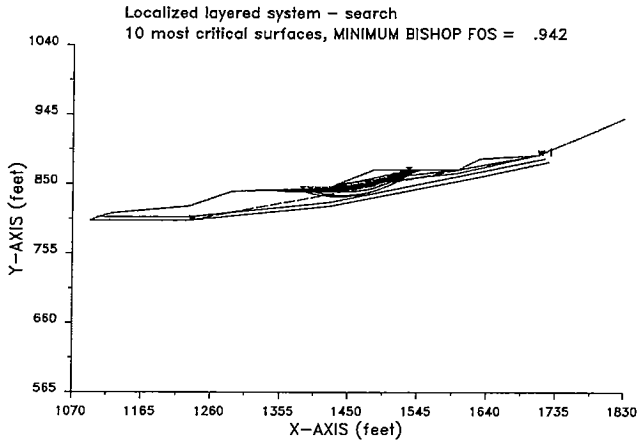
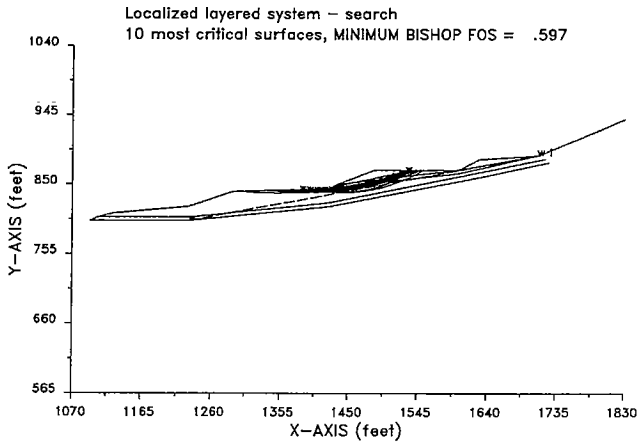


F_{eq}=0.34

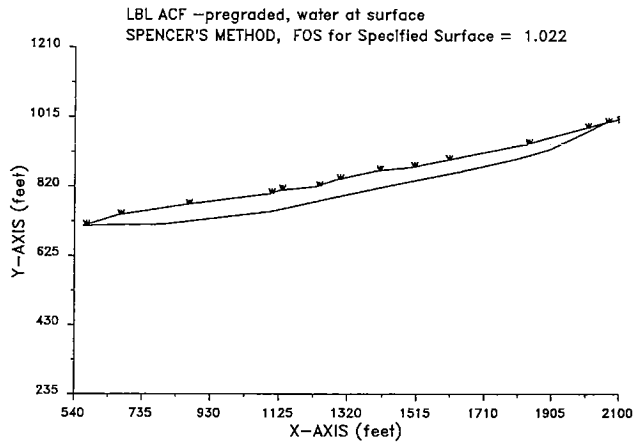
SEC2D 9-22-** 19:46



CASE 4: BACK-CALCULATION OF EFFECTIVE FRICTION ANGLE
Static, High Groundwater

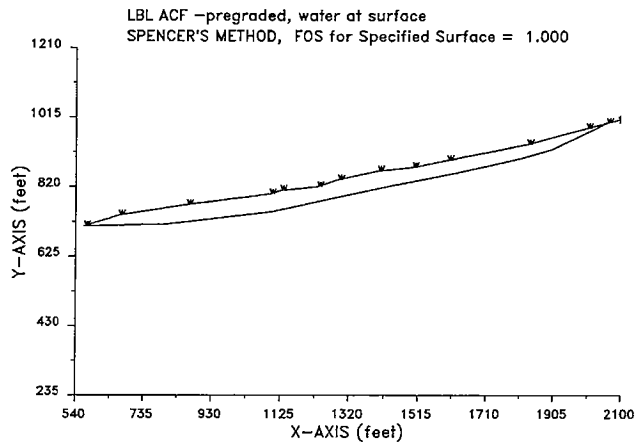
CASE 4A: Φ=20

SEC_1C 9-23-** 17:55



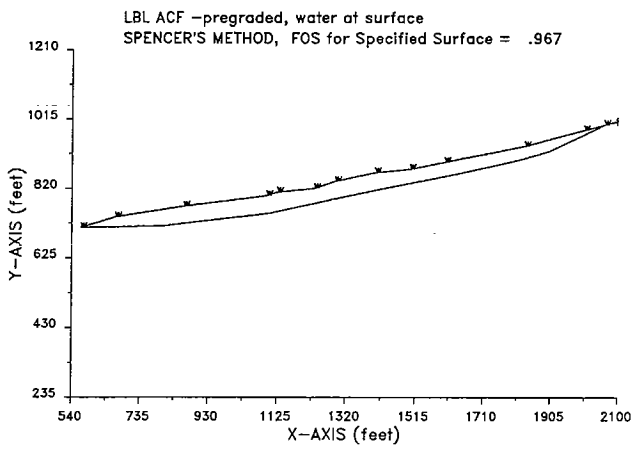
CASE 4B: Φ=19.6

SEC_1C 9-23-** 17:56



CASE 4B: Φ=19

SEC_1C 9-23-** 17:56



Appendix C1.C

Alan Kropp & Associates, Inc., 2006b

Summary Report, Initial Landslide Characterization Study, East Canyon - Buildings 85 and 85A, Lawrence Berkeley National Laboratory, Berkeley, California.

442

SUMMARY REPORT
INITIAL LANDSLIDE CHARACTERIZATION STUDY
EAST CANYON - BUILDINGS 85 AND 85A
LAWRENCE BERKELEY NATIONAL LABORATORY
BERKELEY, CALIFORNIA

ALAN KROPP
& ASSOCIATES, INC.

GEOTECHNICAL
CONSULTANTS

ALAN KROPP, CE, GE
JAMES R. LOTT, CE, GE
WAYNE MAGNUSEN, CE, GE
DONA K. MANN, CE
DONALD L. IRBY, CE
THOMAS M. BRENCIC, CE

July 31, 2006
2335-4A, L-27525

Ms. Nancy M. Ware
Lawrence Berkeley National Laboratory
1 Cyclotron Road, MS 50A4112
Berkeley, CA 94720

RE: Summary Report
Initial Landslide Characterization Study
East Canyon - Buildings 85 and 85A
Lawrence Berkeley National Laboratory
Berkeley, California

Dear Ms. Ware:

In accordance with your requests, Alan Kropp & Associates, Inc. (AKA) and William Lettis & Associates, Inc. (WLA) have conducted an initial phase of geotechnical and geologic study relating to landslide deposits within the East Canyon of the Lawrence Berkeley National Laboratory. The initial phase of study summarized in the accompanying report was intended as a first step toward evaluating concerns that landslide deposits could present a hazard to Buildings 85 and/or 85A. Our study included a review of available information, three exploratory trenches, six exploratory borings, geologic analyses and interpretations by WLA, and qualitative engineering evaluations by AKA.

If you have any questions concerning this report, please call us.

Very truly yours,

ALAN KROPP & ASSOCIATES, INC.

Wayne Magnusen
Associate Engineer
Geotechnical Engineer 2705

REGISTERED PROFESSIONAL ENGINEER
WAYNE DAVID MAGNUSEN
No. 2705
Exp. 6/30/10
GEOTECHNICAL
STATE OF CALIFORNIA

WILLIAM LETTIS & ASSOCIATES, INC.

John N. Baldwin
Principal Geologist
Certified Engineering Geologist 2167

letter of transmittal - final report

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1.00 INTRODUCTION

This report summarizes the findings of an initial geotechnical and geologic landslide characterization study performed by Alan Kropp and Associates, Inc. (AKA) and William Lettis & Associates, Inc. (WLA) for the East Canyon area of the Lawrence Berkeley National Laboratory (LBNL). Previous work in this area by our two firms and other researchers has identified landslide deposits within the East Canyon that potentially underlie portions of existing LBNL buildings. Two buildings that could potentially be affected by the presence of the landslide deposits are Buildings 85 and 85A; these two buildings are the focus of this initial geotechnical and geologic study.

1.01 Site Location

LBNL is situated east of downtown Berkeley in the hills overlooking the University of California at Berkeley campus. Centennial Drive, which provides the most direct access to the site, extends from the rear of the University's Memorial Stadium through Strawberry Canyon and up to the Lawrence Hall of Science and Grizzly Peak Boulevard. Within the lower portion of East Canyon, Centennial Drive takes a sweeping, almost 180 degree turn (occasionally referred to as the Centennial Drive Loop), and passes over Cyclotron Road. Also within this portion of East Canyon are the University's Botanical Gardens and the LBNL's Strawberry Canyon Gate. Inside the Strawberry Canyon Gate is Cyclotron Road, which becomes Calvin Road as one proceeds north toward the upper portion of the East Canyon. Buildings 85 and 85A are located west of Calvin Road, where it makes a sweeping bend leading up to the upper portions of the canyon.

The approximate site location is shown on the Vicinity Map, Figure 1 and the locations of Buildings 85 and 85A relative to Calvin Road are shown on the Site Plan, Figure 2. As shown on Figure 2, several other LBNL buildings exist in this portion of the East Canyon: Buildings 74, 83, 85B, and 86. Building 86 is also referred to as the Animal Care Facility (ACF) and is currently under construction.

1.02 Context and Background

AKA and WLA previously conducted a geotechnical and geologic study for the ACF project (AKA, 2006) that identified landslide deposits within the central portion of the East Canyon. This section presents a brief discussion of some of the key findings presented in the ACF report.

The existence of landslide deposits within the East Canyon was suspected based on AKA's initial review of historic oblique photographs of the area. Two photographs of the East Canyon area from 1885 and 1903 were presented in the ACF report (AKA, 2006); a comparison between the 1903 photograph and a 2004 photograph taken from a similar vantage point was also presented. These photographs are reproduced in this report as Figures 3 and 4. The vegetation of East Canyon at the time the 1885 and 1903 photographs were taken consisted of mostly grasses with scattered conifers, oak trees, and low shrubs. The 1903 photograph shows the Such Dairy located at the base of the canyon, below the present-day LBNL campus. This later photograph also shows a shallow quarry within East Canyon, above the Such Dairy. A large tree can be seen above the quarry, which is also visible in the earlier 1885 photograph. The quarry cut and tree exist to the present day directly southwest of Building 83. Both photographs show two roughly parallel drainages and a topographic bulge that extends from well above the oak tree and quarry to the bottom of East Canyon. This topographic bulge was considered by AKA (2006) to strongly suggest a landslide-related deposit. An interpretation of the possible extent of this deposit is shown on the 1903 oblique photograph at the top of Figure 4. For comparison, a current 2004 oblique photograph of the East Canyon area is presented on the bottom of Figure 4.

Our previous study for the ACF included one geologic boring (AKA-1), which was continuously sampled and imaged using both optical and acoustic televiewers to evaluate whether landslide deposits were present at that one location. As documented in our previous ACF report (AKA, 2006), Boring AKA-1 encountered landslide deposits and a prominent shear zone at a depth between 24 and 28 feet. A preliminary evaluation on the extent of landsliding was based on the new borehole data (from AKA-1 and AKA-2), geologic field mapping, and an initial review of existing subsurface, historic, and construction-related information provided by LBNL. No new subsurface data were developed at that time to explore the overall extent of landsliding, and considerable uncertainty remained regarding the specific geometric relationship between the landslide deposits identified in Boring AKA-1 and Buildings 85 and 85A. Based on the available data, interpretive geologic maps and cross-sections were developed by WLA for the ACF study report (AKA, 2006) that showed landslide deposits extending beneath portions of Buildings 85 and 85A. In the same figures, Buildings 85B and the proposed ACF site were shown to be underlain entirely by landslide deposits, and Building 83 was shown to be partially underlain by landslide deposits. The latest study for Buildings 85 and 85A refines the landslide delineation; the findings are discussed in Section 4.00.

The ACF report (AKA, 2006) also included the results of a preliminary screening analysis of seismic slope stability. Several analytical cross sections were developed based on different headscarp and toe geometries judged as reasonable considering the geomorphology of the East Canyon and the available subsurface data. Pseudostatic analyses of slope stability performed by AKA (2006) using these analytical cross sections indicated that the landslide deposits within East Canyon could experience renewed movement as a result of strong earthquake groundshaking.

1.03 Purpose

The purpose of this initial phase of study was to further evaluate:

1. The likely lateral extent and depth of previous landsliding in the area of Buildings 85 and 85A;
2. The nature of possible future earthquake-induced slope movements in the area of these two buildings; and
3. Potential effects of possible future slope movements on these two buildings.

We note that it was specifically not a purpose of this study to further analyze the stability of the landslide deposits identified in our previous study for the ACF. Instead, the study described herein was directed at refining our geologic model in the vicinity of Buildings 85 and 85A in order to qualitatively evaluate whether renewed movement of the landslide deposits within East Canyon might pose a hazard to these two specific buildings.

1.04 Scope of Services

The scope of services comprising this study was outlined in our proposals dated July 15 and November 21, 2005 and consisted of the following:

- Review of existing data;
- Geologic field reconnaissance and mapping;
- Exploratory trenching;
- Test borings and downhole imaging;
- Laboratory testing of physical properties;

- Geologic characterization;
- Qualitative evaluation of potential landslide-related effects;
- Consultation; and
- Geotechnical and Geologic Report.

Portions of this report include materials that were originally presented in our previous geotechnical and geologic study report for the ACF (AKA, 2006). These materials generally provide context and focus on the geologic and historic setting of Buildings 85 and 85A. We also refer to the results of our previous slope stability analyses, which are discussed in greater detail in the referenced ACF report. The intent of this geotechnical and geologic landslide characterization study is to provide an initial evaluation of the likelihood that Buildings 85 and 85A are underlain by landslide deposits, and to preliminarily assess the potential impacts of renewed landslide movement on these two specific buildings. We emphasize that this study is not meant to be a complete characterization of the landsliding hazard for these two buildings or within the East Canyon as a whole.

2.00 METHODS OF INVESTIGATION

2.01 Review of Existing Data

2.01.1 Oblique and Aerial Photographs

AKA's reference library includes four oblique photographs of the East Canyon area from 1885 and 1903, two of which are shown on Figure 3. During the course of our study, the photographs were re-examined to evaluate the extent and activity of landsliding within East Canyon.

Historic stereo aerial photographs from 1939 and 1947 were also examined in an attempt to evaluate the extent and activity of landsliding within East Canyon. Dense plantings of eucalyptus trees within the canyon precluded a detailed analysis of the geomorphology, and thus the aerial photographs were of limited usefulness. Similar statements regarding aerial photographs of later vintages appear in other geotechnical reports for the site.

A single, vertical aerial photograph of the East Canyon area from 2003, acquired in digital format from Mr. Steve Blair of LBNL, was analyzed for evidence of local slope instability (e.g., landslide morphology, springs, etc.). This photo also provided an overview of the extent of recent grading in areas upslope of the site.

2.01.2 Published Geologic References

We reviewed published geologic maps and literature pertaining to geologic and seismic conditions in the general area. These references were used primarily to determine site-to-source distances to principal active faults, and to check for previously-mapped landslides in the vicinity of the East Canyon. A list of selected references is presented in Appendix A.

2.01.3 Unpublished Consulting Reports

A substantial amount of information exists regarding geotechnical and geologic conditions within the East Canyon area from unpublished consulting reports relating to previous projects in the vicinity. As part of our study, we reviewed or consulted reports relating to:

- Centennial Drive Overpass (geotechnical investigations, 1963, 1982)
- Preliminary geologic investigation of the East Canyon Area (geological investigation, 1976)
- Cell Culture Facility, Building 83 (geotechnical investigations, 1977, 1978)
- Geology of Lawrence Berkeley Laboratory (geological investigation, 1982)
- Proposed East Canyon Corporation Yard (geotechnical investigation, 1985)
- Hazardous Waste Handling Facility, Building 85 (fault investigation, 1994a)
- Hazardous Waste Handling Facility, Building 85 (geotechnical investigation, 1994b)
- Human Genome Laboratory (geologic evaluation, 1994c)
- Building 85 Slide (geotechnical investigation, 1995)
- Building 85 Modular Office Pad (geotechnical investigation, 1996)
- Road and Water Tank (geotechnical investigation, 2001)

Data from borings or trenches in these reports are represented on the maps and cross sections (Figures 6-10) with a designation that indicates boring (or trench) number and year (e.g., 5-94b). We also consulted a variety of other unpublished reports and references pertaining to the geology and hydrogeology of the LBNL facility and for downslope areas surrounding Centennial Drive. A list of selected references is presented in Appendix A.

In addition, plates and figures from previous reports that included the topography in the site vicinity prior to extensive grading in East Canyon and prior to construction of Buildings 85 and 85A were reviewed and interpreted. These data are pertinent to the evaluation of landslide morphology and were used and relied upon during our geologic and geotechnical evaluations of conditions affecting Buildings 85 and 85A.

2.01.4 Personal Communications

WLA's engineering geologists conducted phone conversations, office meetings, and a field meeting with Mr. Preston Jordan of LBNL, regarding the geologic and engineering geologic conditions of the East Canyon area. Mr. Jordan is trained as a geologist and intermittently observed certain specific investigations and site development activities within the East Canyon. He also previously compiled geologic maps and cross sections for LBNL's "Draft Final RCRA Facilities Investigation Report" (RFI Final Report, Parsons, 2000), portions of which included the East Canyon area. The data and information provided by Mr. Jordan included:

- Text excerpts and an interpretive geologic map from LBNL's RFI Final Report (Parsons, 2000);
- A report by LBNL's Earth Sciences Division pertaining to East Canyon geology (Collins, 2003);
- Photographs, field maps and sketch logs of cut slopes from various East Canyon grading operations;
- A map with Building 85 drilled pier locations and sketch geologic logs for selected piers; and
- Environmental boring logs and monitoring well data from areas surrounding Buildings 85, 83 and 74.

The field maps and sketch logs from grading observations were received as 11 oversized sheets. In the text, maps and cross-sections, we refer to these field observations with a code that identifies the sheet number and year of observation. For example, observation E1-94d corresponds to field notes and mapping on Sheet 1 of 11. Field observations were made during grading activities in 1994.

A portion of the interpretive geologic map of the East Canyon area from the RFI Final Report is reproduced on Figure 5.

2.01.5 Construction Plans

We reviewed a copy of plans for the construction of Buildings 85 and 85A, which was loaned to us by Mr. Steve Blair of LBNL's facilities department. The plans we reviewed consisted of 135 pages issued by Brown and Caldwell, Consultants, of Pleasant Hill, California and are dated June 1994.

2.02 <u>Field Investigation</u>

2.02.1 Geologic Mapping

WLA's engineering geologists conducted surface reconnaissance of the site in order to revise and expand on previous reconnaissance mapping (1:1,200 scale) performed in August and September, 2004, as part of the evaluation of the proposed ACF site (AKA, 2006). The surface reconnaissance included: (1) verification of previous mapping of geologic deposits, artificial fill and landslides, (2) evaluation of roads, curbs and sidewalks in the direct vicinity of Buildings 85 and 85A for signs of slope instability, and (3) identification of preferred trench and boring locations to evaluate geologic conditions and landsliding in the direct vicinity of Buildings 85 and 85A.

More detailed geologic mapping was performed near Buildings 85 and 85A and the Centennial Drive overpass using a topographic base map constructed from ground conditions surveyed in 2003 and provided by Mr. Steve

Blair of LBNL (hereafter referred to as the "2003 LBNL base map", or simply "base map"). The 1:240-scale base map is in the U.C. Grid projection (units in feet), with Grid North oriented about 16.7 degrees west of True North, and has 2-foot and 10-foot contour intervals. As part of the mapping, we also reviewed and interpreted pre-grading topographic maps for parts of East Canyon that exist as paper copies in older consultant reports. Interpretation of landslide morphology and former drainage locations were compiled as part of the geologic mapping phase.

A primary motivation for evaluating the surficial geology was to evaluate whether bedrock faults (including the East Canyon fault of Borg (1991) were preferentially oriented so as to form local zones of instability for structurally-controlled bedrock landsliding and to identify geomorphic features suggestive of past and recent landsliding. Efforts to delineate landslide margins within East Canyon based on present-day surface morphology were limited due to extensive grading and topographic modification.

2.02.2 Exploratory Trenching

WLA's engineering geologists excavated and logged three trenches (WLA-1, WLA-2 and WLA-3) between August 8 and 29, 2005. The primary motivation of the trenching was to locate and characterize the western margin of landsliding relative to Buildings 85 and 85A. A secondary motivation was to locate and characterize the East Canyon fault and evaluate its potential role as a western limit to landsliding in the site vicinity, as was suggested in the final ACF report (AKA, 2006). Goebel Paving, Grading & Underground, Inc. of Petaluma, California, excavated the trenches using a track excavator with a 36-inch bucket. Trenches WLA-1 (28-ft long; 8- to 15-ft deep), WLA-2 (88-ft long; 3.5- to 12-ft deep), and WLA-3 (54-ft long; 5- to 8-ft deep) were located on the southeast-facing slope directly south of Building 85, as shown on Figures 2 and 6. Logs of Trenches WLA-1, WLA-2 and WLA-3 are presented in Appendix B.

Prior to excavation, a safety meeting was held to review the trenching plan and discuss safety elements during the course of the investigation. Two large eucalyptus trees were removed by LBNL personnel prior to excavation. The trenches were benched or shored with aluminum hydraulic shoring according to OSHA regulations, and daily safety inspections were conducted by WLA and LBNL personnel prior to entering the trenches. One wall of each trench was cleaned entirely to expose fresh materials, and stratigraphic and structural features were flagged and logged at 1 inch = 1 meter (~1:40) scale. Orientations of prominent structural features were recorded based on exposures in a single wall and, where feasible, across the trench where correlated with a feature on the opposite trench wall. The trenches were backfilled with excavated material and were compacted by wheel rolling and tamping by the backhoe bucket. Due to logistical and safety constraints, we were unable to excavate across the exact mapped trace of the East Canyon fault as mapped in the RFI Final Report (Parsons, 2000).

During backfilling of the trenches, a pothole was excavated at the southeast (downslope) end of WLA-2 to a maximum depth of 20 feet below ground surface in order to characterize the geologic conditions and provide a direct comparison with geologic materials encountered in LBNL monitoring well 85-95-1, located about 30 feet east-southeast. Deposits were described based on visual observations from the ground surface and samples brought up by the excavator bucket.

The locations of the trenches were determined by pacing and tape measuring from cultural landmarks (e.g., the Building 83 parking lot, fence lines, storm drains) and are shown on Figures 2, 6 and 7. Ground surface elevations at the ends of each trench were approximately determined by interpolation between 2-ft contours on the 2003 LBNL base map. The locations and elevations of the trenches should be considered accurate only to the degree implied by the methods used.

2.02.3 Exploratory Boreholes

Between September 1, 2005 and March 10, 2006, we explored subsurface conditions in the vicinity of Buildings 85 and 85A by drilling a total of six test borings (AKA-3, AKA-4, AKA-5, AKA-5A, AKA-6, and AKA-7). The approximate locations of the borings are shown on Figure 2. All of the borings were drilled by Pitcher Drilling Company of East Palo Alto, California, using rotary wash drilling equipment. Borings AKA-3 through AKA-7 extended to depths between 53.1 feet and 94.5 feet; Boring AKA-5A was drilled to a depth of only 25 feet because its purpose was to sample an interval of poor recovery from adjacent Boring AKA-5.

During drilling, geologists with AKA and WLA logged the soils and bedrock encountered. With the exception of Boring AKA-5A, all of the exploration boreholes were continuously sampled. Samples of soil and highly weathered bedrock were obtained using: (1) a 2½-inch inside diameter Modified California split barrel drive sampler equipped with brass liners; (2) a 101 Geobarrel sampler equipped with 2.4-inch diameter stainless steel inner barrel; or (3) a "Pitcher barrel" sampler equipped with 3-inch diameter steel thin-walled Pitcher tubes. Harder bedrock was cored using rock coring equipment and was sampled using a core barrel. Core samples were carefully removed from the inside liner, washed and transferred to core boxes. The 101 Geobarrel and Pitcher samples were extruded onsite and transferred to core boxes. Samples not in brass liners were covered with plastic wrap to protect them from moisture loss and breakage. Logs of the six borings drilled for this study are presented in Appendix C.

The locations of the borings were approximately determined by pacing and tape measuring from cultural landmarks (e.g., building corners) and are shown on Figures 2, 6 and 7. Ground surface elevations at each boring location were approximately determined by interpolation between 2-ft contours on the 2003 LBNL base map. The locations and elevations of the borings should be considered accurate only to the degree implied by the methods used.

2.02.4 Geophysical Logging of Exploratory Boreholes

Norcal Geophysical Consultants, Inc. (Norcal) of Petaluma, California, performed geophysical logging with an optical televiewer (OTV) of borings AKA-5A, AKA-6 and AKA-7 on March 8 and March 10, 2006. The OTV obtains in-situ orientation measurements (dip direction and dip) of bedding, joints and other discontinuity planes. The geophysical logging instrumentation (console, computer, optical televiewer, winch) consisted of a digital Robertson Geologging, Ltd. Model Videologger 2000 System. The OTV is a downhole probe containing a charged coupled device (CCD) type analog to digital video camera. The optical televiewer can operate in either dry or water-filled portions of a boring providing the water-filled portion is optically clear. Downhole logging speeds ranged from 3 to 4 feet per minute. The data sampling rate for OTV logging was every 0.004 feet. The radial resolution was set to 0.5 degrees.

Boring sidewall images are referenced to magnetic north as measured by onboard magnetometer sensors. The inclination of the boring was recorded by an omni-directional three-axis accelerometer. As a quality control procedure, the OTV tool's north reference (magnetic north) was verified with a *Brunton* compass prior to logging.

Orientations of discontinuities (fracture, bedding, etc.) were calculated with the computer reduction program RGLDIP Version 6.1 published by Robertson Geologging, Ltd. This program displays "unwrapped" 360 degree depth sections of borings on a computer screen allowing the interpreter to interactively select points along the trace of a boring discontinuity. Typically, 5 to 10 points are manually chosen along each discontinuity. After point selection, the program at this level calculates a "best fit" ellipse that represents the

three-dimensional plane of the discontinuity in terms of dip direction and dip magnitude. The traces of most boring discontinuities were continuous (360 degrees) across the unwrapped image plot. However, in some complex zones or in high angle fracture zones, only portions of the discontinuity trace were observed. Though these traces are discontinuous, the program has the facility to extrapolate a reasonable dip magnitude and dip direction to these partial traces.

Interpreted OTV plots prepared by Norcal are presented in Appendix D. The OTV plots for AKA-6 and AKA-7 include a "core-like" projection viewed from the northeast (N045 degrees) and a complete unwrapped (360 degree) 2-D image of the boring wall corrected to true north as a function of depth. A comment section lists the orientation of each identified discontinuity in terms of dip direction and dip magnitude.

2.03 Laboratory Testing

Our laboratory testing program was directed at evaluating the drained residual strength of interpreted landslide slip surface materials. Cooper Testing Laboratory of Menlo Park, California, performed laboratory tests on two samples taken from the core of AKA-6 at depths of approximately 58 feet and 65 feet (see Appendix C for boring log). Three-point drained residual torsional ring shear tests (ASTM-D6467) and Atterberg Limits determinations (ASTM D-4318) were performed on both samples. A single three-point drained peak torsional ring shear test was performed on the upper sample only. The laboratory test results are presented in Appendix E.

3.00 EAST CANYON GEOLOGY

3.01 Setting

LBNL's East Canyon is underlain by Tertiary sedimentary and volcanic bedrock, unconsolidated to semi-consolidated Quaternary colluvium, alluvium, debris-flow deposits, landslide deposits, and artificial fill. Regional mapping shows the Tertiary rocks of East Canyon gently folded along the eastern limb of a south-plunging syncline. The eastern limb of the syncline is cut by two north- to northwest-striking faults: the Wildcat and East Canyon faults. The Wildcat fault is located along the eastern side of East Canyon, and places Claremont Formation on the east against San Pablo Group and/or Orinda Formation siltstone and sandstone on the west. The East Canyon fault, as mapped originally by Borg (1991) based on aligned historical springs, is located along the western margin of East Canyon. Geologic mapping in the RFI Final Report (Parsons, 2000) shows the East Canyon fault juxtaposing Moraga Formation volcanics on the west against Orinda Formation siltstone and sandstone on the east in the direct vicinity of Buildings 85 and 85A (Figure 5). The Wildcat and East Canyon faults have been interpreted as inactive by previous LBNL consultants. The closest known active fault to Buildings 85 and 85A is the Hayward fault, which has been mapped by Lienkaemper (1992) as passing through Memorial Stadium, approximately 3,800 feet to the southwest.

3.02 Geologic Maps and Cross Sections

We prepared revised interpretive geologic maps and cross sections of the East Canyon based on our analysis of new data from this study together with: (1) previous geologic mapping and subsurface data collected for the proposed ACF (AKA, 2006); (2) a compilation of previous borings, trenches, test pits, previous geologic studies (most notably those of Collins [1993] and the RFI Final Report [2000]); and (3) personal and written communication with Preston Jordan (2004 and 2006). These interpretive maps and cross sections are presented on Figures 6 through 10.

The approximately 1:2,400-scale Geologic Map presented on Figure 6 shows the bedrock units, bedrock faults, small landslides, and probable deep-seated, bedrock-involved landslide deposits in East Canyon. The 1:1,200-scale Geologic Map presented on Figure 7 shows these same features but focuses on the general area surrounding Buildings 85 and 85A. Figure 8 presents an interpretive longitudinal cross section (Section A-A') that trends parallel to the central axis of the East Canyon. Figures 9 and 10 present interpretive transverse cross sections (Sections B-B' and C-C') that trend across the slope roughly perpendicular to the central axis of the East Canyon. For clarity, we do not delineate areas covered by Quaternary colluvium, debris-flow deposits, or artificial fill on the geologic maps (Figures 6 and 7), but locally delineate fill on the geologic cross sections (Figures 8 through 10).

The bedrock units and overlying Quaternary deposits mapped within East Canyon are introduced in the sections that follow. Much more detailed discussions of the landslide deposits within East Canyon and their interpreted relationship to Buildings 85 and 85A are presented in "Section 4.00, Landslide Characterization."

3.03 Bedrock Units

3.03.1 Claremont Formation, Middle to Late Miocene (Symbol Tc)

The oldest strata that crop out in the East Canyon are well-bedded, silicious shale and chert of the Claremont Formation. Also called the Claremont chert or shale, this resistant unit underlies the steep slope on the east side of the canyon, and dips moderately to steeply northeast. The unit is bound to the west by the steeply east-dipping Wildcat fault and a secondary strand of the Wildcat fault (Figures 5 and 6).

3.03.2 San Pablo Group, Middle to Late Miocene (Symbol Tsp)

Claystone, siltstone, and fine sandstone of the San Pablo Group lie west of the Wildcat fault in the East Canyon (Figures 5 and 6). This unit has been mapped as the Orinda Formation in previous investigations. Exposures during grading for Buildings 83 and 85 revealed characteristics more consistent with facies of the shallow marine San Pablo Group (P. Jordan, personal communication, 2004). Outcrop characteristics include fine-grained texture and a grey color, which are distinct from the more oxidized, and multi-colored beds and coarser-grained texture of the Orinda Formation rocks. Bedding exposed along a roadcut exposure directly north-northwest of Building 83 shows gentle (10° to 15°) dips to the northwest. The unit is bound to the east by the Wildcat fault. The western extent of the San Pablo Group and the nature of the contact with rocks of the Orinda Formation are unclear, although previous investigations (Collins, 1993; RFI Final Report, 2000) show this contact as a sub-vertical fault.

3.03.3 Orinda Formation, Late Miocene (Symbol To)

The Orinda Formation in the East Canyon area consists of non-marine, well to poorly bedded siltstone, fine lithic sandstone, and pebble conglomerate. The conglomerate contains a high percentage of detritus derived from the Franciscan complex (Graymer, et al., 1996). The Orinda Formation does not naturally crop out within the East Canyon, but numerous borings, trenches, and exposures during grading demonstrate that it is present beneath the western and central portion of East Canyon. Discontinuous blocks of Orinda Formation mixed with blocks of Moraga Formation volcanic rocks were exposed in several locations, including along the Building 85 utility trench that follows Calvin Road and during grading and slide repair of a cut-slope directly north of Building 83. These discontinuous blocks have been interpreted to be part of a mixed unit of landslide deposits (Harza, 1995; RFI Final Report, 2000; Preston Jordan, personal communication, 2004).

More intact and less weathered examples of Orinda Formation were encountered in our borings, trench WLA-2, and in a few prior borings. Based on a review of these borehole data, the Orinda Formation consists of moderately to poorly bedded siltstone, clayey sandstone, and claystone that is sheared, fractured, slightly to moderately weathered, and soft to moderately hard. Joint, fracture, and shear partings were planar to irregular, open to tight, and commonly had mineralized (quartz) infills. Locally, discontinuities are clay-lined, very closely spaced, or penetrative to the point of brecciation.

The subsurface extent of Orinda Formation beneath East Canyon is not defined clearly. Although we interpret the contact between San Pablo Group and Orinda Formation as a concealed, sub-vertical fault (Figures 6, 8-9), following Collins (1993) and RFI Final Report (2000), it is permissible that the Orinda Formation and San Pablo Group interfinger in a depositional contact beneath East Canyon (P. Jordan, personal communication, 2004). At its western limit, the RFI Final Report (2000) shows Orinda Formation in fault contact with Moraga Formation volcanic rocks across the East Canyon fault (Figure 5). However, trench WLA-2 exposes Orinda Formation underlying Moraga Formation in depositional contact directly south of Building 85 (Appendix B, Figure B2), and additional exposures and borings suggest a depositional contact also defines the western limit of Orinda Formation strata.

3.03.4 Moraga Formation, Late Miocene (Symbol Tm)

The Moraga Formation in East Canyon consists of andesitic and basaltic flows, tuffs and volcaniclastics (locally described as agglomerate, or volcanic breccia). Moraga Formation crops out in the hills along the west side of East Canyon, west of the East Canyon fault (Figure 6). Based on trench exposures from this study, in-place Moraga Formation consists of volcanic conglomerate along the southeast-facing slope east of the East

Canyon fault and directly south of Building 85 (Appendix B). These rocks consist of highly fractured and weathered, subangular to subrounded cobble to large boulder-size conglomerate with a predominantly silty to fine gravelly matrix with minor weathered and altered ash. The material is sheared, with the shears dipping moderately to steeply southeast with strikes of N40°E to N65°E in the vicinity of the mapped East Canyon fault. The trench exposures from this study show the Moraga Formation in depositional contact above Orinda Formation siltstone and sandstone. This contact dips moderately west based on boring data from a monitoring well (3-84) west of Building 85A (Figures 7 and 9). Other volcanic rocks encountered in borings or exposed in outcrops within the floor of East Canyon (including the prominent quarry exposure directly south of Buildings 83 and 85B) are interpreted to be displaced blocks of Moraga Formation incorporated into landslide deposits (RFI Final Report, 2000), as shown on Figures 5 through 8.

3.04 Bedrock Structure

3.04.1 Bedrock Faults

The north- to north-northwest-striking, steeply dipping bedrock faults mapped previously in the East Canyon area include the Wildcat and East Canyon faults and other secondary faults. The Wildcat and East Canyon faults bound the margins of the East Canyon and possibly underlie it (Figure 6). Through review of existing data and geologic mapping, we evaluated these faults with respect to their structural control on landsliding in the valley (AKA, 2006). Both faults have been demonstrated by previous subsurface investigations to be inactive (that is, not active within the past 11,000 years) (Gilpin, 1994; GRC, 1994a). Numerous proposed fault traces within the East Canyon, in addition to those we show on Figure 6, are compiled by Collins (1993). We briefly review the information available on the East Canyon fault, as this fault has been mapped directly west of Buildings 85 and 85A and has been identified as a possible lateral margin of deep-seated bedrock landslides beneath East Canyon (AKA, 2006).

Aligned historical springs and subtle morphology define the trace of the East Canyon fault (Borg, 1991) (Figure 5). The East Canyon fault is believed to be a near-vertical, right-lateral, strike-slip fault striking about N-S to N10°E. Higher degrees of oxidization and alteration of Moraga Formation rocks on the west side of the fault compared with rocks east of the fault and the historical alignment of springs suggest that the East Canyon fault has been a major groundwater barrier. Mapping conducted prior to this study showed the fault juxtaposing Moraga Formation to the west against Orinda Formation to the east in the site vicinity (Figure 5; Parsons, 2000). Trenches WLA-2 and WLA-3, located about 130 feet south of Building 85, expose mafic volcanic conglomerate west and east of the mapped trace (Figure 6; Appendix B, Figures B2 and B3). As mentioned previously, WLA-2 exposed Moraga Formation overlying Orinda Formation in depositional contact about 80 feet east of the mapped trace. Shears present within the volcanic conglomerate in the vicinity of the mapped East Canyon fault dipped moderately to steeply southeast and northwest and have strikes of N40°E to N70°E, which are rotated 30° to 70° from the approximately N-S trend of the mapped trace. Based on our trenching, the East Canyon fault (or the structure controlling the location of historical springs) must be located either upslope of trench WLA-3 or between trenches WLA-2 and WLA-3 (Figures 6 and 7).

It is uncertain whether the East Canyon fault locally forms the western lateral margin for large-scale landsliding in the East Canyon, as suggested in the Final Report for the proposed ACF (AKA, 2006). The East Canyon fault, based on our trenching and the trenching of GRC (1994a), is located upslope on the western margin of the East Canyon, and thus the geomorphic evidence for large-scale landsliding (the hummocky topography on the floor of the East Canyon) has no correlation with the fault trace. In contrast, the western landslide margin must be located east of WLA-2, based on the gently dipping, depositional contact between Moraga Formation and underlying Orinda Formation at the south end of that trench (Figures 6 and 7). A major reason for previously suggesting that the East Canyon fault may act as a landslide margin was based on the prior

mapping, which showed the juxtaposition of the Moraga Formation volcanics to the west against the weaker, more slide-prone Orinda Formation rocks to the east. Our trenching, as well as the shears mapped within volcanic rock in GRC trench T-2 directly west of Building 85 (GRC, 1994a), indicates that the East Canyon fault is located within Moraga Formation west and south of Building 85.

A keyway excavated directly north of Building 85A exposed a subplanar clay zone within volcanic rock that may be the northern continuation of the East Canyon fault, and/or the local margin of large-scale landsliding. The keyway, observed by P. Jordan in 1994, exposed a 1- to 24-inch-thick zone of stiff silty clay gouge within volcanic rocks with a N11-19°W strike (measured with respect to U.C. Grid North) and a subvertical to steep easterly dip. The orientation of this clay zone—about 30° clockwise from the trend of the East Canyon fault—makes it unlikely to be the fault, which we now infer probably lies farther west. Because the location coincides closely to the western margin of East Canyon and because the dip was noted to be steep to the east, we consider it likely that the clay gouge defines the lateral margin of large-scale landsliding (see Section 4.00).

3.04.2 Bedrock Discontinuities

Bedding, joint, fracture, and other bedrock discontinuities measured from rock cores and optical televiewer data collected during this study show variable orientations both below and above the interpreted landslide deposits (Appendices C and D). Joints, fractures, shears, clay seams, and zones of intense fracture referred to as "crushed" or "brecciated" zones were encountered throughout the cores. Commonly, partings measured on the recovered rock core were inclined between about 15° and 70°, with most partings around 45°± 10°.

Examination of rock core from this study and our previous study for the proposed ACF (AKA-1 and AKA-2; AKA, 2006) indicates that bedding is moderately inclined between about 15° and 45°, with occasional dips of up to 70° (Appendix C). Note that most bedding measurements are from rock interpreted to be within landslide debris. The OTV results indicate that bedding within the bedrock landslide mass dips southerly to westerly at moderate (21° to 56°) angles, approximately consistent with the overall westerly to southwesterly regional dip of bedding in the East Canyon area. For those few borings that extend below the inferred depth of sliding, "in-situ" bedding dips westerly to southerly between about 25° and 55°, with a single bedding dip of up to 70°. In AKA-6, OTV-determined measurements of bedding below the deep landslide of Qls-2 suggest southerly to southwesterly bedding dips between 26° and 37° at depths between 82 and 91 feet within the Orinda Formation. These OTV-determined dip magnitudes are less than the 40° and 55° dips that were measured directly from the rock core at the same depth interval; however, we believe the general southerly to southwesterly dip direction is probable. Other in-situ bedding measurements include an exposure from trench WLA-2 that shows gentle folding of Orinda Formation sandstone beds dipping subhorizontally to gently to the west and northeast (Figure B2). The gently inclined beds exposed in trench WLA-2 are interpreted as parasitic folds on the broad limb of the regional-scale East Canyon syncline.

In summary, a review of bedding data from cores and OTV logs indicates that there is variability in dip magnitude and direction with a general pattern of moderate dips to the southwest, both above and below interpreted slide planes. No simple, homogeneous bedding orientation is present, indicating that the strata are folded or rotated either due to prior tectonic deformation or from landsliding.

3.05 Landslide Deposits

3.05.1 Landslide Processes and Extent

Landsliding within East Canyon has occurred at a variety of scales and involves a variety of mass-wasting processes. Landslide deposits in East Canyon are extensive, and are derived from several types of materials, including: (1) reworked Quaternary deposits, (2) deposits containing mixed blocks of Orinda and Moraga Formation, and (3) homogeneous blocks of Moraga Formation or Orinda Formation. The mapped landslide extent is based on: (1) valley morphology, (2) landslide-related deposits encountered during grading activities, and (3) geological and geophysical features encountered during site investigations. The delineation of the landslide margins and data used to support these interpretations are shown graphically on Figures 6 through 10. Mapping and compilation of existing geologic data indicate that sliding within East Canyon is complex and in places consists of nested sequences of distinct slide masses. The landslides depicted on Figure 6 include those defined as small-scale (in orange and tan where repaired) and large-scale (in light and dark brown).

The small-scale slides range in aerial extent from about 600 ft^2 to 50,000 ft^2 and include two slide masses derived from the western slopes of the East Canyon and one slide mass derived from the eastern slope. The remaining small-scale slides are located within the floor of the East Canyon and are failures that have occurred within slide debris of the large-scale landslides. The large-scale landslides occupy significant portions of the East Canyon, and are about 100,000 ft^2 to as much as 1,000,000 ft^2 in aerial extent. The largest slide mass encompasses the limits of the hummocky topography of the East Canyon floor interpreted from historical, pre-development photography and local topographic surveys. We note that the large-scale slides mapped in Figure 6 are less-well-defined along the north, east, and southern margins, where fewer data are available.

3.05.2 Small-Scale Landsliding, Historic (no symbol)

Several small earthflows and slumps have formed in the site vicinity, occurring both on natural hillsides and graded slopes (Figure 6). The smaller slides likely involve reactivation of localized portions of the larger, older slides. At least six slope failures have occurred historically, and most have occurred during grading operations that temporarily removed support from the toe of the slope. Grading-related failures include a slide behind Building 74 (LBNL Plant Engineering Dept. Landslide #41), a landslide below the transmission tower by the water tank road, repeated sliding of the slope behind the cribwall located directly north-northeast of the proposed ACF (e.g., Harza, 1995), repeated sliding below the Centennial Drive overpass (e.g., Converse Consultants, 1982), and a recent small rotational/translational slide on the south side of Centennial Drive below Building 73, west of the U.C. Botanical Garden (Figure 6). Other small-scale slope failures include a slump in the cut slope directly north of Building 83, and a slump on the west side of East Canyon north-northwest of Building 85A. Signs of recent movement within this last slide include cracking and minor vertical displacement of an asphalt-paved PG&E access road, although this failure may be partly within fill.

The dimensions of these failures are typically tens of feet wide by up to 100 feet long, with depths on the order of several feet to 15 feet. Harza (1995) documented a maximum slide depth of 8 feet for one episode of the cribwall failure directly north-northeast of the proposed building site. These smaller failures are likely within unconsolidated Quaternary deposits or poorly consolidated, bedrock-involved slide debris (e.g., mixed landslide debris). The Centennial Drive overpass slide is probably part of a larger southeast-directed landslide south of Building 85, which crosses the Building 83 lot, and was previously identified as Landslide #40 on a 1981 LBNL Plant Engineering Dept. map (Figure 6, from Collins, 1993). Our field reconnaissance confirmed the presence of this landslide, which is expressed as slightly incised lateral margins and hummocky topography. This slide is approximately 400 feet long and up to 200 feet wide. The depth of sliding is likely on the order of several to tens of feet, and involves unconsolidated Quaternary deposits and poorly consolidated bedrock-involved landslide deposits and weathered bedrock.

3.05.3 Large-Scale Landsliding, Quaternary (Symbols Qls-1 and Qls-2)

Large-scale landsliding in the East Canyon encompasses significant portions of the canyon floor within and below the LBNL campus. As shown on the Geologic Map presented on Figure 6, we specifically delineate two large-scale landslide masses, which we have designated Qls-1 and Qls-2. The smaller (and shallower) landslide mass designated Qls-1, is nested within the larger (and deeper) landslide mass designated Qls-2. We note that other distinct landslides comparable in scale to Qls-1 are probably nested within the larger Qls-2 landslide that have not been identified or mapped.

The deposits associated with the large-scale landslide in the East Canyon are mostly confined between two stream channels that historically followed the east and west sides of the valley. Upper and lower limits (the head scarp and toe regions) of the large-scale landslide deposits approximately coincide with the broad, curvilinear head of the East Canyon floor and the downslope extent of broad, hummocky topography near the confluence of the East Canyon drainages with Strawberry Creek. The hummocky, lobate morphology of the canyon floor, as seen in pre-grading topographic maps and historical oblique and aerial photographs (Figures 3 and 4), supports a Quaternary age for these deposits (younger than about 1.6 Million years). However, whether these larger landslide masses have moved as coherent units in Holocene time (within the last 11,000 years) is not known. To our knowledge, there is no evidence that suggests these larger landslide masses have moved as coherent units in historic time (i.e. since the late 1800s).

The two large-scale landslide masses delineated in this study (Qls-1 and Qls-2) have distinct lithologic characteristics and lateral continuities. Our interpretive mapping of these two landslides is based on: (1) pre-grading topography seen on historic oblique photographs and old topographic drawings and maps; and (2) available geologic and geotechnical data. We note that western lateral margin of the larger and deeper Qls-2 deposit extends beyond the historic location of the creek bounding the western side of the canyon floor. This mapping is based in part on geologic data that suggests the prehistoric creek channel (paleochannel) was farther to the west, relative to its historic location. The deep landslide is based on the geomorphology of the East Canyon and landslide planes identified in several borings in this latest study (AKA-3, AKA-5, AKA-6, AKA-7). Specific evidence for the location, texture, thickness, and orientation of the landslide plane(s) beneath Buildings 85 and 85A is presented in "Section 4.00, Landslide Characterization."

The presence of landslide debris within the central and eastern portions of the East Canyon has been noted in previous consultant reports for Building 83 (HLA, 1977), Buildings 85 and 85A (GRC, 1994b), and Building 85B (SCI, 1996). Landslide deposits were also noted east of Buildings 85 and 85A in excavation cuts to construct Calvin Road (P. Jordan, personal communication, 2004) and during the investigation (Harza, 1995) and repair of a shallow slope failure that occurred in the vicinity of the cribwall northeast of the ACF. With respect to the possible western margin of landsliding, either no information was given (HLA, 1977; Harza, 1995; SCI, 1996) or the landslide deposits were mapped to be east of the future locations of Buildings 85 and 85A (GRC, 1994b). GRC (1994a) suggested the possibility of a landslide-related origin for shears observed in fault evaluation trenches for Buildings 85 and 85A; however, no recommendations or concerns were documented in their report with respect to this tentative finding. Previous mapping by HLA (1982) and Gilpin (1994) shows extensive large-scale deposits of colluvium and/or Quaternary landslide materials within East Canyon. The western margins of these deposits were mapped by Gilpin and HLA in the vicinity of the historic drainage channel that is near what is now the eastern ends of Buildings 85 and 85A.

3.06 Unconsolidated Deposits and Fill

3.06.1 Undifferentiated Surficial Deposits, Quaternary (Symbol Qu)

Quaternary colluvium, minor clay-rich alluvium, and debris-flow deposits underlie portions of East Canyon, although much of the natural surficial deposits that once existed have been removed by previous grading. Prior to grading, streams flowed down the east and west margins of the East Canyon. Within and beneath these lateral channels are accumulations of clayey colluvium, alluvium, mudflow, and debris-flow deposits. These deposits were derived from the head of the canyon, the canyon slopes, and steep, northeast-trending ravines along the east side of the canyon.

3.06.2 Artificial Fill, Historic (Symbol af)

Development within the East Canyon has included the placement of artificial fill directly beneath and surrounding portions of Buildings 85, 85A and 85B, including within the former stream channel (Figures 9 and 10). Artificial fill was placed upslope and east of the Building 85 and 85A sites to construct roadway embankments and to repair subsequent shallow slope failures (Figures 8 and 9).

4.00 LANDSLIDE CHARACTERIZATION

4.01 General

Physical and operational constraints associated with Buildings 85 and 85A make direct geologic observation of the lateral margins of landsliding in this area difficult. However, the results of our data compilation, site reconnaissance and subsurface borehole and trench information provide some constraints on the inferred lateral extent and depth of landsliding near these two buildings (Figures 6-10). There are numerous direct observations delimiting landslide Qls-1. However, landslide Qls-2 is supported by broad geomorphic and geophysical observations with few specific, direct observations. The interpretive geologic maps and cross sections presented on Figures 6 through 10 show that the western landslide margins of landslides Qls-1 and Qls-2 underlie Buildings 85 and 85A. Bedrock interpreted as in-place underlies Building 85 at a maximum depth of about 65 feet (Figure 10) and underlies Building 85A at a maximum depth of about 35 feet (Figure 9). Near Buildings 85 and 85A, field mapping did not find evidence of recent slope movement recorded by cracking of curbs and roads associated with either landslide Qls-1 or Qls-2; however, smaller zones of reactivation have in the past developed as a result of previous site grading activities (i.e. Calvin Road expansion up to the water tank above Building 85A).

4.02 Landslide Qls-1

4.02.1 Estimated Dimensions of Landslide Qls-1

On the basis of geologic and geomorphic mapping, coupled with borehole data, we interpret landslide Qls-1 to be about 550-ft long and 200- to 250-ft wide, covering an aerial extent of about 111,000 ft^2 (Figure 6). The headscarp is poorly defined morphologically, but probably is located north (upslope) of the transmission tower and Boring 2-76 (HLA, 1977). For instance, in Boring 2-76 from 17 to 18 feet in depth, we interpret the presence of a gray, soft, sandy silt layer with shear planes as evidence for the base of landslide Qls-1. The eastern margin of Qls-1 is inferred from pre-grading topography and a set of shallow west-dipping shears cutting across highly weathered blocks of Orinda Formation that were mapped by P. Jordan and colleagues east of Building 85 during the grading for Calvin Road (Exposure E1-94d). The toe of landslide Qls-1 probably is located beneath or directly south of Building 85B, based on a preferred longitudinal geometry that locates the toe upslope of the prominent hill near Building 85B and the former rock quarry (Figure 8). Based on the multiple slide planes encountered in borings AKA-1, AKA-4 and AKA-6 within landslide Qls-1 (Figure 9 and Appendix C), and the broad zone of shearing mapped during the grading of the road, it is possible that the toe of landslide Qls-1 contains multiple shear planes. At least two inferred-end member-based slide planes are depicted in Figure 6.

Information that constrains the western lateral margin of landslide Qls-1 near Buildings 85 and 85A includes: (1) exposures described in logs of excavation cuts made during grading operations for Building 85, (2) exposures described in logs of exploratory trenches excavated for a fault investigation prior to construction of Building 85, and (3) exploratory boreholes drilled during this study (Figures 6-10). Beneath Building 85A, the western margin of landslide Qls-1 is based on interpretations of cut-slope excavations for the present-day retaining walls north of and on the southeast side of Building 85A. As described in section 3.04.1, the keyway cut north of building 85A exposed a 1- to 24-inch-thick zone of stiff clay gouge within volcanic rocks striking N 11-19° W and dipping steeply east (Exposure E4-94d). This gouge zone aligns with other features to the south and is interpreted as a slide margin.

The sketches of the excavation on the southeast side of Building 85A show several features consistent with landslide debris and a landslide margin (Exposures E10-94d and E11-94d). The sketch logs depict dilated and

weathered basalt and colluvium subhorizontally overlying weathered and apparently folded siltstone and fine sandstone in the southwestern end of the excavation. The northeast end of the cut exposed sheared siltstone/sandstone and a subvertical to moderately east-dipping and curved contact between the siltstone/sandstone and overlying dilated basalt. Thin, discontinuous ash layers were present near the contact and within the dilated basalt mass. We interpret the retaining wall excavation sketches as showing, from southwest to northeast: (1) Moraga Formation in depositional contact over Orinda Formation (probably displaced by Qls-2), (2) sheared and deformed Orinda Formation delineating the western margin of landslide Qls-1, and (3) a displaced and rotated depositional contact between Moraga Formation and Orinda Formation with minor landslide-related mixing between the two bedrock units and colluvium. The presence of sheared Orinda Formation and a displaced but otherwise preserved depositional contact between Moraga Formation and Orinda Formation is similar to the bedrock discontinuities and bedding observed in Borings AKA-5A and AKA-7 located directly east of the retaining wall. The gouge zone in volcanic rocks in the keyway north of Building 85A aligns well with the shears in Orinda Formation in the retaining wall exposure. The retaining wall excavations and boreholes indicate that the western margin of landslide Qls-1 is not delineated by a bedding contact between two separate lithologic bodies, but lies primarily within volcanic rocks north of Building 85A and with the Orinda Formation beneath and south of Buildings 85 and 85A.

Near Building 85, the western margin of landslide Qls-1 is inferred based on a review and interpretation of trench T-3 (GRC, 1994a), that was previously excavated as part of a fault hazard study for Buildings 85 and 85A (Figure 7). The log of trench T-3 depicts a grayish brown to yellowish brown silty clay with varying amounts of deeply weathered volcanic clasts. At Station 65 feet, the log notes a "zone of well developed slickensides in black clay, orientation N24°W, 54°NE," and notes "numerous slickensides of varying orientation" northwest of Station 65 feet to the end of the trench. South of Station 65 feet, the log shows a thickening of grayish brown to brownish black silty clay to the east. We interpret these descriptions of trench T-3 (GRC, 1994a), including the apparent thickening of deposits in the southeastern end of the trench as evidence of landslide-related deformation, and furthermore, the approximate location of the western margin of landslide Qls-1. GRC (1994a) also interprets these anomalous slickensides as being of a non-tectonic origin and possibly landslide-related.

The base of landslide Qls-1 is estimated from a review of pre-existing topographic maps and re-construction of the canyon's former topography coupled with information from boreholes that encountered the landslide deposits (Appendix C). Our preferred geometry of landslide Qls-1 includes a basal slide plane dipping up to 20° south near the inferred headscarp, and shallowing downslope to about 13° and 8° south directly east of Buildings 85A and 85, respectively (Figure 8). Comparing the present-day depth of landslide Qls-1 to pre-grading topography suggests that prior to site development, the landslide ranged between 30 and 50 feet thick, compared to the present-day maximum thickness of about 35 feet (Figures 8-10). On the basis of the transverse geologic cross sections developed from borehole data and direct observations recorded during the excavation of the retaining wall structure of Building 85A, the western margin of landslide Qls-1 is interpreted as a moderate east-dipping feature (Figures 9 and 10).

4.02.2 Composition of Qls-1 Deposits

The geologic composition of landslide Qls-1 is highly variable, consisting of clayey unconsolidated deposits (colluvium) mixed with small gravel-size to large blocks of weathered and fractured volcanic rock, claystone, siltstone, and sandstone. Landslide Qls-1 debris ranges from dark brown to reddish brown and bluish gray in color, is moderately to extremely weathered, friable to moderately hard, and is often highly fractured and sheared. The base of the landslide deposit frequently contains multiple zones of subplanar to gently dipping highly plastic clay and intensely fractured (brecciated to crushed) rock that range in thicknesses from less than

1 inch to about 1 foot. The multiple zones of shearing within landslide Qls-1 strongly suggests that landsliding and/or internal shear deformation has occurred at multiple levels within the slide mass. This finding is consistent with the findings of the geologic and geotechnical investigation for the proposed ACF directly to the east of Building 85 (AKA, 2006). All borings drilled for this study, with the possible exception of Boring AKA-3, clearly penetrate landslide Qls-1 and encounter the basal slide plane. Exploratory Boring AKA-3, located within 5 feet of the northeast corner of Building 85, encountered mixed clayey and sandy debris to a depth of about 19.5 feet. Based on the bedding and presence of laminated light gray, gravelly sand encountered between 16 and 17 feet, we interpret this upper material as artificial fill to at least 17 feet, with fill or soil to a depth of about 19.5 feet. Regardless, no clear Qls-1 landslide plane is present in AKA-3. Based on geometric relations between borings to the east and observations from previous trenches and excavations to the west, it is probable that the upper part of landslide Qls-1 intersects this region of Building 85.

Specific evidence from the borings interpreted to be the landslide plane or part of a landslide shear zone are presented as notes on the cross sections (Figures 8-10) and on the boring logs (Appendix C).

4.02.3 Summary of Landslide Qls-1 Location Relative to Buildings 85 and 85A

Based on the data compilation and interpretation, as well as the stratigraphic and structural relations encountered in the exploratory borings and trenches (WLA-1 to WLA-3) evaluated for this study, we interpret the lateral and vertical extent of landslide Qls-1, and delineate the approximate western margin of landslide Qls-1 where it intersects the eastern portions of Buildings 85 and 85A (Figure 7). Landslide Qls-1 has a relatively poorly defined headscarp, but moderately defined lateral and toe regions despite significant landscape alteration from recent grading. Direct observations of the western margin of the landslide in the direct vicinity of Buildings 85 and 85A are based on exposures provided in previous trench T-3 (T3-94a, GRC, 1994a), the cut-slope for the Building 85A retaining wall (Exposures E10-94d and E11-94d, P. Jordan, personal communication, 2004), and Boring AKA-5A (this study; Appendix C) (Figures 9 and 10). Based on interpretation of these data, and geometric relations developed from the transverse cross sections, the western margin of the landslide plane dips moderately to steeply east-southeast beneath Buildings 85 and 85A along a nearly north-south orientation (measured from U.C. Grid North), and has maximum depths of about 20 and 15 feet beneath Buildings 85 and 85A, respectively (Figures 9 and 10).

4.03 <u>Landslide Qls-2</u>

4.03.1 Estimated Dimensions of Landslide Qls-2

The dimensions of landslide Qls-2 are estimated from compiling geologic, geophysical, and geomorphic data, coupled with the findings of this subsurface investigation. On the basis of these data, landslide Qls-2 is up to about 2,400-ft long and 350- to 440-ft wide (and possibly up to 670-ft wide near the toe) (Figure 6). All margins should be considered approximately located, with the exception of the western margin adjacent to and south of Building 85; in this area the margin is located with some confidence to within about 10 feet.

The headscarp of landslide Qls-2 is defined by a smoothed interpretation of the more gently inclined, lobate topography present in the upper reaches of the East Canyon. We define the eastern margin of landslide Qls-2 by interpreting landslide morphology from pre-grading topographic maps, locating historic landslide failures (e.g., Harza, 1995), and compiling engineering geologic observations of utility trenches excavated along Calvin Road (Exposure E8-94d). Constraints on the location of the landslide toe are relatively poor, and are based entirely on pre-existing morphology and landslide dimensions (i.e., ratio between length and width; Figures 6 and 8). We tentatively infer at least two landslide toes: (1) an upper toe located below the former quarry, and (2) a lower toe located downslope of the Centennial Drive loop. The inferred upper toe is mapped as crossing

Calvin Road directly north of the East Canyon LBNL gate and is reflected in the pre-grading topography as a bulge near the former quarry. The lower toe is mapped below the LBNL facility, near the confluence of the two East Canyon creeks (which lead to Strawberry Creek), and is consistent with downslope extent of landsliding reported in the RFI final report (2000) (Figure 5). As described previously, portions of landslide Qls-2 have failed historically as smaller slides in at least two locations: (1) south of the Centennial Drive overpass, and (2) at the landslide's southern end where the deposits cross Centennial Drive (Figure 6).

Information and interpretations that constrain the western lateral margin of landslide Qls-2 include: (1) interpretations of the historical margin of the East Canyon and a buried paleovalley margin, (2) exposures described during grading operations, (3) logging of cuttings during pier hole drilling for Building 85, (4) a geophysical anomaly, and (5) our exploratory trenches (WLA T-1 to T-3) and borings (AKA-3 to AKA-7) (Figure 7). Direct evidence for the western lateral margin is absent, but can be inferred from a compilation and interpretation of the above-mentioned data. For instance, a previous magnetic geophysical survey across much of the Building 85 footprint delineated a north- to northwest-trending geophysical lineament (i.e., magnetic low). The geophysical lineament appears to represent a region of anomalously thick unconsolidated alluvium (GRC, 1994). We interpret this region of thick alluvium as a buried paleovalley, and by extension infer the former paleovalley margin of East Canyon as the western extent of landslide Qls-2. This interpretation is consistent with the findings of trench WLA T-1 to the south of Building 85 and a former retaining wall excavation on the southeast side of Building 85A (Exposures E10-94d and E11-94d). These excavations exposed thick alluvial and debris-flow deposits and paleochannels west of the pre-grading creek that flowed along the western side of the East Canyon in historic time (Figure 3). In our prior study for the ACF, the approximate location of the historical creek was inferred as the margin of landsliding in East Canyon. However, we now interpret that the western limit of landsliding may be located farther west, coincident with the buried paleovalley interpreted from trench and geophysical data.

South of Building 85, the western margin of landslide Qls-2 is constrained between trench WLA-2 and groundwater monitoring well MW 85-95-1 (Figures 5, 6 and 7). These exposures constrain the western extent of landslide Qls-2 based on an apparent vertical displacement of the geologic contact between the Moraga and Orinda Formations. In trench WLA-2, the elevation of depositional contact between the Moraga and Orinda Formations is about 823 feet, whereas in MW 85-95-1 the same contact is estimated at about 804 feet. This apparent vertical separation between these two data points suggests that the western margin of landslide Qls-2 lies between the southeast end of trench WLA T-2 and monitoring well MW 85-95-1. We note that deepening of the southeast end of trench WLA-2 to about an 804-ft elevation exposed continuous Orinda Formation sandstone and siltstone with apparent subhorizontal bedding.

The basal slide plane of landslide Qls-2 is defined as a concave-up to planar surface that dips about 15° to 20° near the inferred headscarp and shallows to about 6° directly east of Buildings 85 and 85A, possibly maintaining an approximately 6° dip downslope to where it daylights near the creek south of the Centennial Drive loop (Figure 8). With respect to present-day topography, the base of landslide Qls-2 is at maximum depths of about 65 and 35 feet, respectively, beneath Buildings 85 and 85A.

4.03.2 Composition of Qls-2 Deposits

Landslide Qls-2 material consists predominantly of intact, fine-grained sandstone and siltstone that is nearly indistinguishable from underlying in-situ bedrock. Landslide Qls-2 debris is described in all borings drilled for this study and for the proposed ACF (AKA, 2006). The predominantly bluish to greenish gray and minor reddish brown colors in the bedrock encountered suggests that much of landslide Qls-2 consists of Orinda Formation, although the grayish color of some intervals may be more consistent with marine rocks of the San

Pablo Group. The deep landslide debris is moderately to slightly weathered and weak to moderately hard, and contains discontinuities including open joints and fractures, closed, mineralized fractures, clay-lined joints and shears (clay seams), and brecciated zones of crushed rock. Much of the localized fracturing and brecciation, as well as intervals of weak to friable rock, coincide with finer-grained (claystone) intervals. Bedding and other rock parting inclinations and orientations generally are similar to those measured beneath the deep landslide plane.

The Qls-2 slide plane found in Borings AKA-3, 5, 6, and 7 consists of soft to stiff clay layers and highly fractured and brecciated zones (See notes on Figures 8-10 and on boring logs in Appendix C). The slide plane generally was encountered within claystone beds of the Orinda Formation, and probably cuts across bedding that dips moderately to the southwest.

4.03.3 Summary of Landslide Qls-2 Location Relative to Buildings 85 and 85A

In summary, the western margin of landslide Qls-2 likely intersects Buildings 85 and 85A along an approximate trend of N6°E (U.C. Grid North) or N11°W (True North) (Figure 6). Direct observations of the probable landslide plane in the direct vicinity of Buildings 85 and 85A come from pier hole B29, Boring AKA-3 (this study; Appendix C), and a cut slope exposure directly north of Building 85A within a retaining wall excavation (P. Jordan, personal communication, 2004). Indirect evidence for the western margin of the deep landslide comes from a north-south trending magnetic low imaged in a geophysical survey during the fault investigation for Building 85 (GRC, 1994a) and the cut slope for the Building 85A retaining wall (P. Jordan, personal communication, 2004) (Figures 8 and 9). On the basis of the geologic cross section, we interpret the western margin of the landslide as a moderately to steeply east dipping plane. The basal slide plane is inferred to be at a maximum depth of about 65 feet and 35 feet, respectively, below Buildings 85 and 85A (Figure 9).

4.04 Slide Plane Strength Data

The results of torsional ring shear tests performed on remolded samples of inferred slide plane materials are summarized in Table 1.

Table 1. Results of Drained Torsional Ring Shear Tests

Location and Depth	Slide	Type of Test	Normal Stress (psf)	Secant Residual Friction Angle (degrees)
AKA-1 @ 24.0-24.5 feet	Qls-1	Residual	2000 4000 8000	24 22 21
AKA-6 @ 57.5-58.5 feet	Qls-2	Residual	4000 8000 12000	6 6 6
AKA-6 @ 65 feet	Qls-2	Residual	4000 8000 12000	20 19 20
AKA-6 @ 57.5-58.5 feet	Qls-2	Peak	4000 8000 12000	21 21 21

The results of Atterberg Limits determinations performed on samples of inferred slide plane materials are summarized in Table 2.

Table 2. Results of Atterberg Limits Determinations

Location and Depth	Slide	Plasticity Index	Liquid Limit
AKA-1 @ 24.0-24.5 feet	Qls-1	22	41
AKA-1 @ 24.5-25.0 feet	Qls-1	20	39
AKA-6 @ 57.5-58.5 feet	Qls-2	35	53
AKA-6 @ 65.0-65.5 feet	Qls-2	32	47

The laboratory test data sheets for tests performed on samples from Boring AKA-6 are included in Appendix E. The laboratory test results from Boring AKA-1 are from our previous ACF study (AKA, 2006).

4.05 Groundwater Data

All test borings for this study were drilled using rotary wash drilling methods, which generally obscured the depths at which groundwater was encountered during drilling. All borings were backfilled with grout soon after drilling was completed. Groundwater was measured at a depth of 36 feet in Boring AKA-1 approximately 16 hours after drilling. We note that the depth to groundwater measured in Boring AKA-1 may not have stabilized prior to backfilling and therefore may not be representative of equilibrium groundwater conditions at the time of drilling. We anticipate that groundwater levels at the site may vary substantially depending on variations in rainfall, surface runoff and other factors. In addition, we anticipate that locally perched groundwater and seepage conditions likely exist, particularly during and following periods of rainfall.

We also reviewed data from groundwater monitoring wells near Building 85 to investigate past seasonal fluctuations in groundwater levels in the general vicinity of Buildings 85 and 85A. As part of the Environmental Restoration Program, LBNL installed groundwater monitoring wells and recorded groundwater levels in the East Canyon over a nine-year period (from July 1995 through July 2004) to evaluate potential contaminant transport mechanisms. Copies of selected groundwater monitoring data are included in "Appendix F – Existing Groundwater Data." The two records for Buildings 85 and 85A are from wells 85-95-2 (60 feet east of Building 85A), 85-96-2 (30 feet east of the south corner of Building 85), and 85-95-1 (150 feet south of Building 85) (Figure 6). In general, the data that we reviewed indicate a relatively stable groundwater table with seasonal fluctuations of about 5 feet or less. Average "wet season" groundwater depths range from about 5-6 feet (3 holes) to 10-15 feet (4 holes) to 22-25 feet (2 holes) to 30 feet (1 hole) relative to the original ground surface (thicknesses of deep fill have been subtracted). Typically, but not always, the shallowest groundwater occurs near the stream channels that used to flow along the west side of the valley (now buried in culverts).

Very little groundwater data exists in the previous geotechnical reports prepared for Buildings 85 and 85A or other projects in the vicinity. However, a broader study of dewatering and slope stabilization by Converse Consultants (1984) includes information on groundwater depths in the area for the period between December 1982 and February 1984. During this time interval, Converse Consultants reports that water depths in the area of the Building 83 parking lot ranged from 15 to 23 feet below the ground surface. Near the LBNL guard shack (P-15), groundwater depths were measured between 7 and 16 feet below the ground surface. At other locations in the vicinity, groundwater was measured at depths ranging from 5 to 20 feet below the ground surface.

5.00 ENGINEERING EVALUATION

5.01 Facility Description

5.01.1 Site Description

Site grading for Buildings 85 and 85A included cutting into the existing east-facing hillslope along the western and northern site margins and placing fill within a former natural drainage on the western side of the East Canyon. Building 85 is a two-story structure with an approximately 15-foot-high (14 feet 7½ inches) difference in elevation between the first and second floor levels. The first floor of Building 85 is near the elevation of Calvin Road and the adjacent Building 85B, and is accessed by means of a paved driveway that runs along the east side of the building. The second floor of Building 85 is accessed by a sloping driveway that runs along the south side of Building 85A and leads to a wide paved concrete apron on the west side of Building 85. Cribwall-type upslope retaining walls exist west of the apron and north of Building 85A. An exposed concrete retaining wall also exists along the south side of Building 85A adjacent to the sloping access driveway.

5.01.2 Building 85

Building 85 measures approximately 40 feet by 160 feet in overall plan dimensions. The plans for Building 85 show the steel frame structure is supported on sixty-nine 3-foot-diameter drilled piers. Fifty-one of the piers are 35 feet in length, and eighteen of the piers are 54 feet in length. The piers are tied together at their tops by 4-foot-high grade beams and a 1-foot-thick floor slab that is occasionally interrupted by containment trenches and pits up to about 6½ feet deep. Interior retaining walls also exist along the western side and part of the northern side of Building 85 due to the approximately 15-foot difference in elevation between the first and second floor entrances.

5.01.3 Building 85A

Building 85A measures approximately 10 feet by 82 feet in overall plan dimensions and is identified on the 1994 plans as the Flammable Liquid Storage Building. These plans show that Building 85A is a relatively simple steel-frame structure supported on twelve 2-foot-diameter drilled piers that are 35 feet in length. The piers are tied together at their tops by 4-foot-high grade beams and a recessed 1-foot-thick floor slab.

The below grade foundation elements supporting Building 85A are designed to cantilever over the exterior retaining wall that underlies the southern side of the building. The retaining wall was installed prior to the construction of Building 85A as part of previous site development activities that included the construction of Calvin Road. The heel of retaining wall footing extends approximately 6 feet beyond the upslope face of the retaining wall and underlies the Building 85A superstructure.

5.02 Slope Stability

5.02.1 Previous Analysis for the Proposed Animal Care Facility

Previous screening analyses performed by AKA (2006) for the ACF study showed various postulated slide geometries to be stable statically, but unstable (i.e., have a calculated factor of safety of less than one) under seismic loading. The methods used and results of our previous analyses are briefly discussed below.

The drained residual friction angle of the slide plane material was evaluated by:

- Performing drained residual torsional ring shear tests on samples of slip zone materials obtained from Boring AKA-1 at a depth of 24.0-24.5 feet;

- Performing Atterberg Limits determinations on samples of slip zone materials obtained from Boring AKA-1 at depths of 24.0-24.5 and 24.5-25.0 feet and using the correlations published by Stark and Eid (1994); and
- Back-calculating the strength along the postulated Qls-1 slip surface (specific to the ACF study and subsequently revised during this latest evaluation) assuming high-groundwater conditions coincident with pre-existing (prior to grading) ground surface topography.

These methods all produced a secant drained residual friction angle of approximately 20 degrees. Based on the procedure described in Blake, et al. (2002), this drained residual friction angle was used as a first-order approximation of residual strength for rapid loading under undrained conditions. We used two assumed groundwater levels for the analyses: (1) a "low" groundwater level below the assumed surface of landsliding; and (2) an "intermediate" approximately parallel to the pre-graded ground surface but passing through the base of the road cut upslope of the ACF. Other material properties used in our analyses (e.g., unit weights) were estimated based on the available test data and engineering judgment.

We used the computer programs XSTABL to analyze slope stability under static and seismic conditions. We evaluated seismic performance using the screening procedures recommended by Blake, et al. (2002). In this method, a horizontal seismic coefficient (k) is determined based on a probabilistic estimate of Maximum Horizontal Acceleration (MHA) modified by factors that include the site-to-source distance (r) and the duration of shaking (D_{5-95}). The MHA of 0.70 g used in our analyses was estimated from the seismic hazard map for rock conditions contained in the CGS Seismic Hazard Evaluation Report for the Briones Quadrangle. This map is for a level of hazard associated with an earthquake having a 10 percent probability of exceedence in 50 years. The procedures recommended by Blake, et al. (2002) explicitly address anticipated slope deformations, as bracketed by 5 centimeter (approximately 2-inch) or 15 centimeter (approximately 6-inch) threshold displacements. We used the 5 centimeter (2-inch) threshold to obtain a seismic coefficient of 0.346. The Blake, et al. (2002) procedures for screening evaluations are based on an acceptable FS greater than or equal to 1.0. In our slope stability analyses, we used a k=0.346, FS $\geq$ 1.0 screen to evaluate seismic performance. We note that this k value is approximately 50 percent of the MHA.

We also evaluated seismic performance using the earlier procedures recommended by Seed (1979). Using the Seed method, acceptable performance is considered to result if calculated Factors of Safety (FS) are greater or equal to 1.15 using a k of 0.15. The discussion presented in Blake, et al. (2002) indicates that a k=0.15, FS $\geq$ 1.1 screen is also frequently used. The Seed method is implicitly based on an allowable slope deformation of 1 meter during a Magnitude 8.25 earthquake. In our slope stability analyses, we used a k=0.15, FS $\geq$ 1.1 screen to evaluate seismic performance. We note that this k value is approximately 20 percent of the MHA.

The results of the screening analyses presented in our ACF report (AKA, 2006) suggested that the ACF site is stable under static conditions, but that movement could occur on any/all of the postulated failure plane geometries as a result of earthquake shaking. All of the non-circular failure surfaces used to model existing slide plane geometries failed the screening criteria recommended by Blake, et al. (2002) for 5 centimeters (2 inches) of displacement. Seismic slope stability analyses performed for our ACF study (AKA, 2006) using the Seed (1979) procedure suggested that displacements on the order of one meter (3.3 feet) could occur.

5.02.2 Applicability of Previous Findings

Limitations on the direct applicability of the ACF (2006) study results towards evaluating the hazard to Buildings 85 and 85A include the following:

- The slip surface of landslide Qls-1 was encountered in Boring AKA-1; however, the location of the landslide headscarp and toe were poorly constrained, given the available data. Several hypothetical geometries of landslide Qls-1 were analyzed for slope stability, as discussed in the previous section. However, all of the landslide geometries previously modeled differ in some respects from the landslide Qls-1 geometry depicted in Figure 8;

- The basal plane of landslide Qls-2 was not encountered in the previous borings for the ACF (AKA, 2006). Material below the depth of landslide Qls-1 did not exhibit clear evidence of landsliding and, thus, was interpreted as in-place. Consequently, our previous analyses did not include modeling a deeper landslide, such as the Qls-2 geometry depicted in Figure 8;

- The proposed ACF site is located near the central axis of the East Canyon and has been designed to tolerate earthquake-induced ground deformations associated with large-scale translational landslide movements. However, Buildings 85 and 85A straddle the margins of both landslides Qls-1 and Qls-2 (as depicted in Figures 6, 7, 9, and 10), and the possibility of landslide-related movements were not in all likelihood considered in the design of Building 85 and 85A; and

- The seismic slope stability analyses performed for the ACF were based on simplified procedures commonly used for screening-level studies (i.e., to determine whether a seismically-induced landslide hazard potentially exists; see Blake, et al., 2004). The analyses previously performed are based on a simplified two-dimensional cross section of the landslide to which a uniform horizontal acceleration is applied. More rigorous analytical procedures exist that, together with additional subsurface data constraining possible headscarp and toe geometries, would be expected to more accurately model possible earthquake-induced site deformations.

For the above reasons, it is our opinion that the previous analyses performed for the ACF have limited usefulness in evaluating the hazard to Buildings 85 and 85A other than as a screen indicating that a seismically-induced landslide hazard potentially exists. However, it is our opinion that this finding, together with the interpretation that geologically similar deposits extend beneath portions of Building 85 and 85A, should be viewed as a significant concern warranting further study and/or mitigation.

5.02.3 Supplemental Stability Analyses

As discussed in the previous section, our previous study for the ACF did not include evaluating the stability of landslides Qls-1 and Qls-2 cross sections depicted in Figure 8. To check basic assumptions, we elected to perform a similar screening-level evaluation of seismic slope stability for these landslide geometries, using the same physical parameters used in our previous study:

- An average unit weight of 120 pounds per cubic foot (pcf) for soil and landslide debris; and
- An average drained residual friction angle of 20 degrees for slip zone materials of both landslides Qls-1 and Qls-2.

In performing our analyses, we assumed a groundwater surface roughly parallel to the former ground surface and passing through the toe of the roadcut near Boring AKA-7 (See Figure 8). The results of our analyses are discussed briefly below.

Qls-1 results – The results of our simplified two-dimensional analyses suggest that the shallower Qls-1 landslide is statically stable with a calculated factor of safety (FS) of almost 2. Applying a uniform 0.35g horizontal acceleration (equivalent to a k value of half of the MHA) to the Qls-1 landslide results in a FS

of 0.59. This calculated value is significantly less than 1.0, indicating that the landslide is not stable for this level of earthquake groundshaking. The k value for which we calculate a FS equal to 1.0 is commonly termed the yield acceleration. Using our simplified model, we calculate a yield acceleration of 0.15g (about 20 percent of the MHA) for the Qls-1 landslide.

Qls-2 results – We calculate a static FS of 1.26 for the deeper Qls-2 landslide. Although considered statically stable, this value is significantly less than the value calculated for the Qls-1 landslide. Applying a uniform 0.35g horizontal acceleration (equivalent to a k value of half of the MHA) to the Qls-2 landslide results in a FS of 0.40. Using our simplified model, we calculate a yield acceleration of 0.05g (about 7 percent of the MHA) for the Qls-2 landslide.

These results discussed above suggest that both landslides are stable statically but may experience movement as a result of strong earthquake groundshaking. In addition, the results suggest that the deeper Qls-2 landslide is less stable than the shallower Qls-1 landslide. This preliminary finding appears reasonable to us based on our inspection of the landslide geometries depicted on Figures 8 and 11. We note, however, that the upper and lower regions of the Qls-2 landslide are at this time poorly constrained and that, due to past grading, different longitudinal cross sections have significantly different ground surface profiles. Consequently, different factors of safety could be calculated for the Qls-1 and Qls-2 landslides using different assumptions with respect to headscarp and toe geometries and by analyzing different longitudinal sections. However, in our judgment, it appears unlikely that seismic stability could be demonstrated by performing additional pseudostatic analyses based on our current East Canyon landslide models.

5.03 Qualitative Evaluation of Landslide Effects

5.03.1 Effects on Building 85

As shown on Figure 7, the interpreted lateral margins of landslides Qls-1 and Qls-2 pass diagonally beneath Building 85. The shallower Qls-1 landslide passes beneath the eastern corner of the building, involving about 8 percent of the building's floor area. The deeper Qls-2 landslide underlies about 60 percent of the building's floor area (Figure 7). The interpreted cross-sectional relationships of landslides Qls-1 and Qls-2 with respect to Building 85 are shown on Figure 10. This figure also shows several pier hole logs that give an indication of the depths of these drilled piers. The piers shown are about 35 feet in length. As previously discussed, piers that are 54 feet in length also exist beneath the structure.

By inspection it appears to us that the reactivation of the Qls-2 landslide would present a significant hazard to Building 85. It appears that reactivation of only the Qls-1 landslide would possibly constitute a lesser hazard; however, this scenario is potentially less likely based on the results of simplified slope stability analyses performed for this study (see "Section 5.02.3, Supplemental Stability Analyses"). The potential hazard to Building 85 would include deformation and possible structural damage caused by unbalanced lateral pressures and shear forces applied by the landslide materials as they translate downslope. The magnitude of these effects is difficult to estimate as they would depend upon the specific properties of the subsurface materials in the zone beneath and upslope of the building foundations. Landslide materials that are stronger and more massive can be expected to exert greater forces on the structure relative to materials that are weaker and more disturbed. In general, we judge that unbalanced horizontal pressures in the range of many hundreds up to several thousands of pounds per square foot could be exerted on the below-grade portions of the structure as a result of landslide re-activation.

Evaluating the effects of unbalanced landslide-related forces on the Building 85 foundations is outside the scope of this geotechnical and geologic study. However on a qualitative basis, we anticipate these effects could potentially include:

- Clockwise horizontal rotation of some or all of the building structure;
- Shearing of drilled pier foundations that pass through the landslide slip zone;
- Locally concentrated shear, tensile and compressive stresses in reinforced concrete floor slabs, grade beams and containment pits/trenches (particularly near the lateral margin of the re-activated landslide).

We note that the anticipated magnitude of seismically-induced landslide movement is likely to be the largest factor in evaluating possible effects to Building 85. It is possible that small amounts of landslide movement (inches or less) may result in negligible or acceptable amounts of structural damage. On the other hand, larger landslide movements (feet or more) are likely to result in markedly increased unbalanced forces that would lead to unacceptable levels of structural damage. The simplified analyses discussed in this report seem to suggest that landslide movement on the order of several feet could occur as a result of strong earthquake shaking. However it is possible that through additional investigation and more refined analytical procedures, the magnitude of estimated movement could be shown to be less.

5.03.2 Effects on Building 85A

As shown on Figure 7, the interpreted lateral margins of landslides Qls-1 and Qls-2 also pass diagonally beneath Building 85A. The shallower landslide Qls-1 passes beneath the eastern end of the building, involving about 30 percent of the building's floor area. The deeper Qls-2 landslide underlies about 75 percent of the building's floor area (Figure 7). The interpreted cross-sectional relationships of landslides Qls-1 and Qls-2 with respect to Building 85A are shown on Figure 9. Building 85A is supported on twelve drilled piers that are about 35 feet in length. Information on the geotechnical conditions encountered during the drilling of piers for Building 85A is not available.

If landslide re-activation occurs, the below-grade portions of Building 85A would be subjected to similar unbalanced lateral pressures as those previously discussed for Building 85. We anticipate that Building 85A would also experience similar effects to those previously discussed. We note however that Building 85A is much narrower in the direction of slope movement and has fewer structural elements. Based on these general observations, we anticipate that Building 85A foundations would also be less tolerant of renewed movements of landslides Qls-1 and/or Qls-2.

5.04 Summary Discussion

The results our engineering evaluation can be briefly summarized a follows:

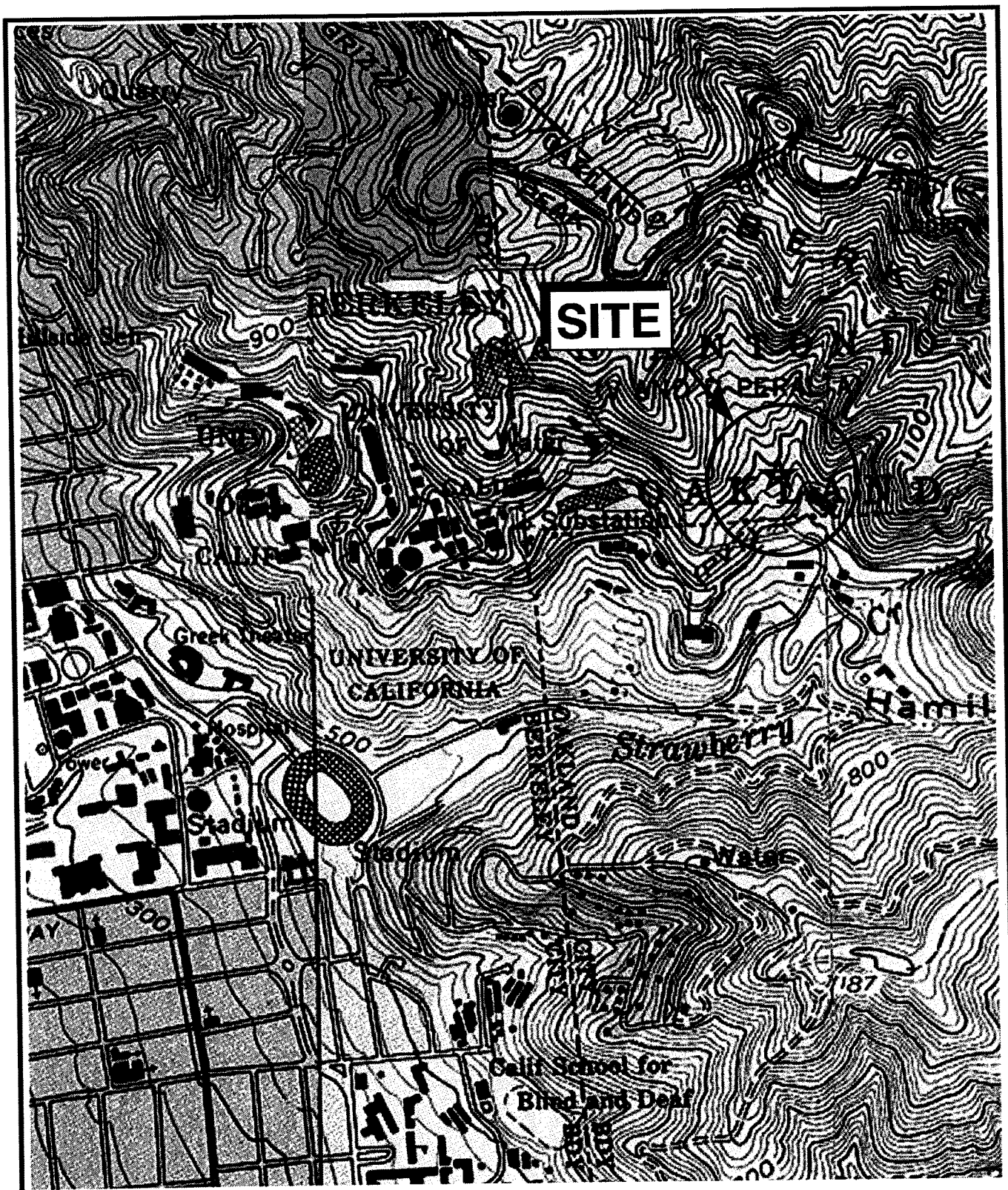
1. Based on the available data, the Qls-1 and Qls-2 landslides depicted on Figures 6 through 10 cannot be assumed to be stable under seismic conditions;
2. Previous analyses performed for the ACF, although not directly applicable to the Qls-1 and Qls-2 landslides depicted on Figures 6 through 10, appear to predict several feet of seismically-induced landslide movement;
3. Supplemental stability analyses performed for this study suggest that the deeper Qls-2 landslide may be less stable than the shallower Qls-1 landslide;

4. Renewed movement of the Qls-2 landslide would likely present a significant hazard to Buildings 85 and 85A;
5. Renewed movement of the Qls-1 landslide alone would likely present a significant hazard to Building 85A, and potentially a lesser hazard to Building 85;
6. In our opinion, these hazards warrant further study and/or mitigation; and
7. Additional investigation and more rigorous engineering analyses could potentially show the hazard to be less than that predicted using the simplified methods described in this report.

We would be pleased to participate in future discussions with LBNL regarding the contents of this report, the possible scope of future geotechnical and geologic study and/or potential landslide mitigation strategies, as appropriate.

6.00 LIMITATIONS

This report has been prepared for the exclusive use by LBNL for specific application to Buildings 85 and 85A in accordance with generally accepted geologic and geotechnical engineering practices. No other warranty, expressed or implied, is made. The interpretations and conclusions presented in this report are based, in part, on a review of existing information provided to us by LBNL. Please note that we cannot vouch for the accuracy of the interpretations and data developed by others.



BASE: U.S. Geological Survey, 1959, Topographic Map of the Briones Valley Quadrangle. Photorevised 1968

NOT TO SCALE

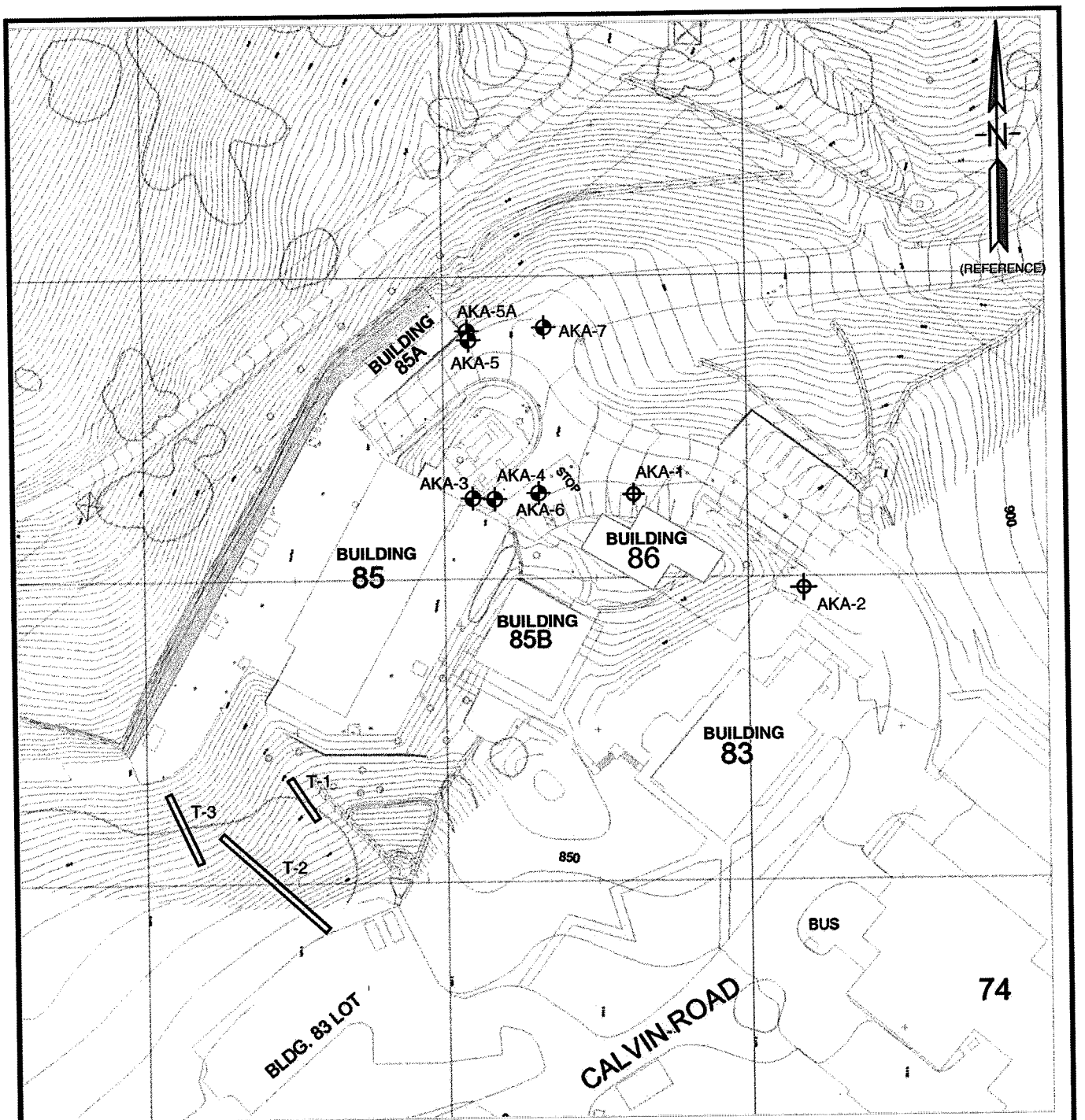
ALAN KROPP & ASSOCIATES

Geotechnical Consultants

VICINITY MAP

LBNL BUILDINGS 85 AND 85A
Berkeley, California

PROJECT NO.	DATE	FIGURE 1
2335-4A	July 2006	



LEGEND

AKA-7	Approximate location of exploratory boring, this study
AKA-1	Approximate location of previous exploratory boring (Alan Kropp & Associates, 2006)
T-2	Approximate location of exploratory trench location, this study

50 0 100 200
APPROXIMATE SCALE FEET

BASE: Topographic Map supplied by LBNL Facilities Department, 2004

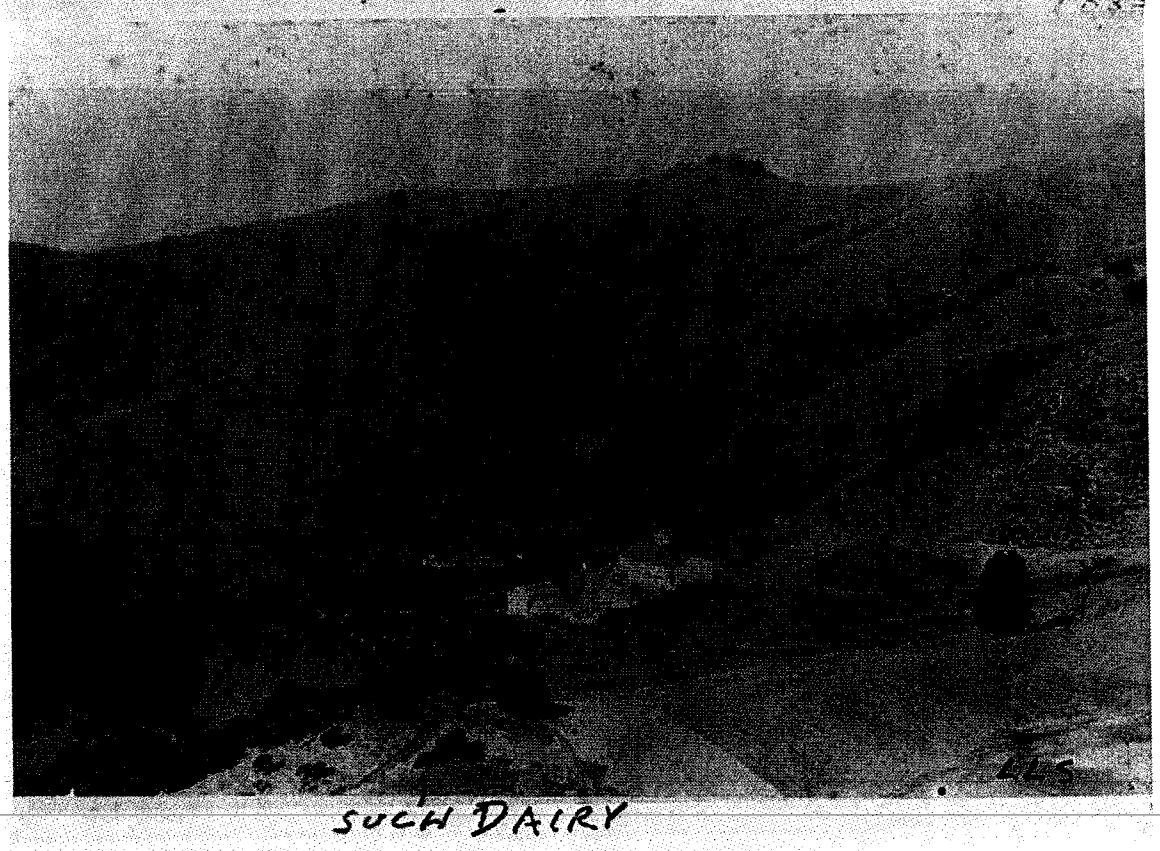
ALAN KROPP & ASSOCIATES
Geotechnical Consultants

SITE PLAN

LBNL BUILDINGS 85 AND 85A
Berkeley, California

PROJECT NO.	DATE	FIGURE 2
2335-4A	July 2006	

1885



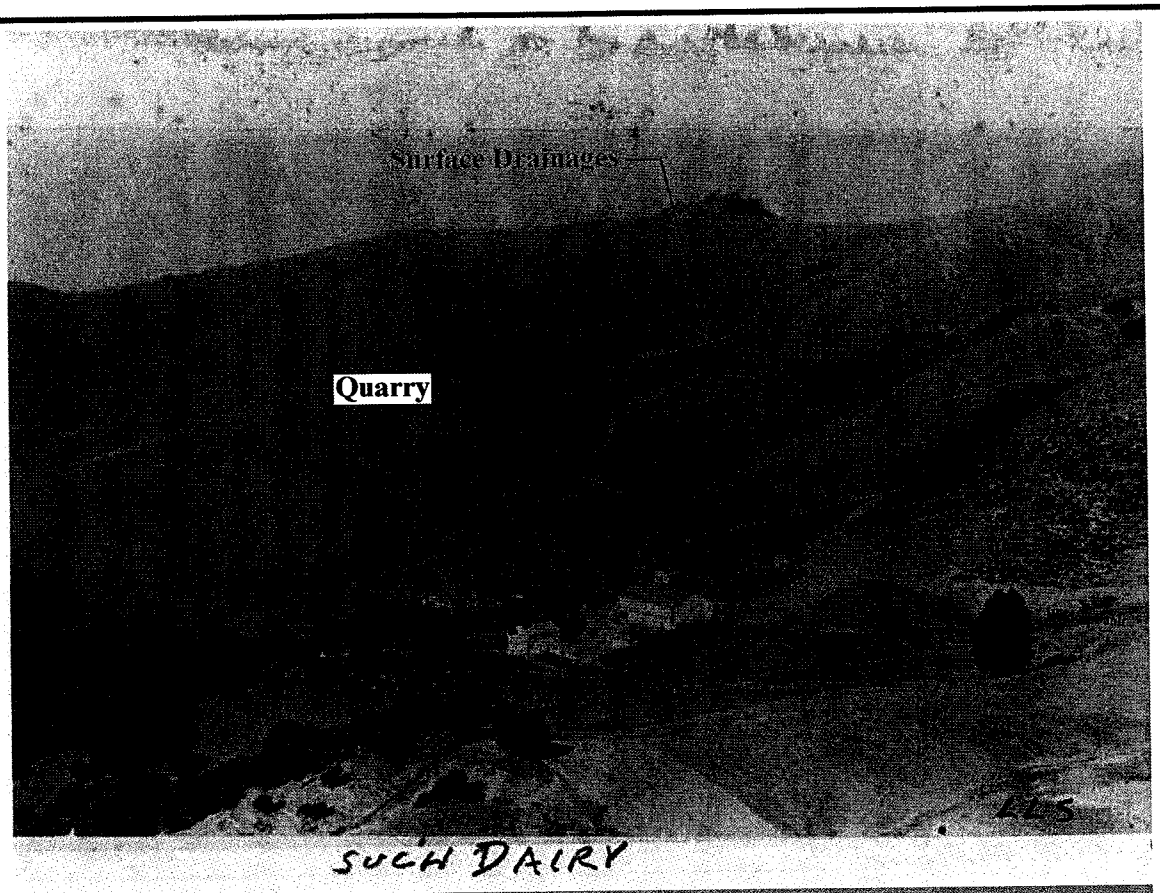
1903

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

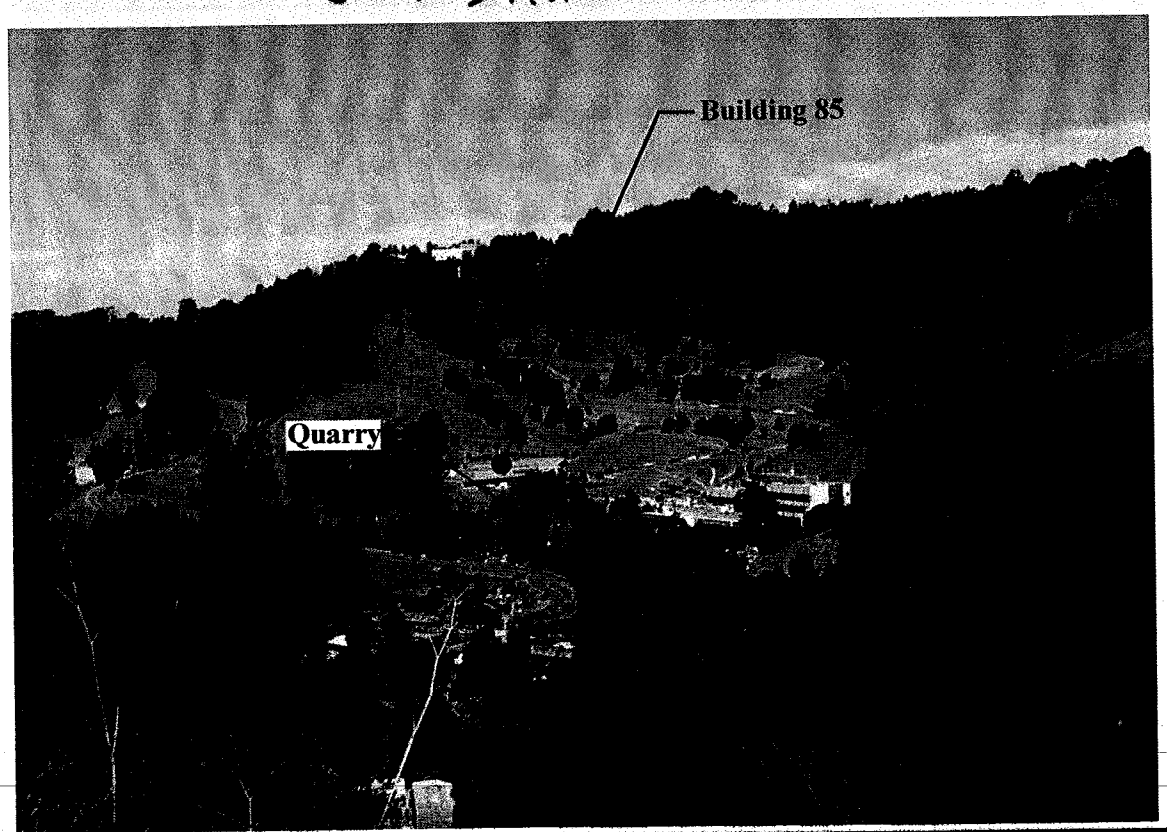
HISTORICAL OBLIQUE PHOTOGRAPHS

LBNL BUILDINGS 85 AND 85A
Berkeley, California

PROJECT NO.	DATE	FIGURE 3
2335-4A	July 2006	



1903



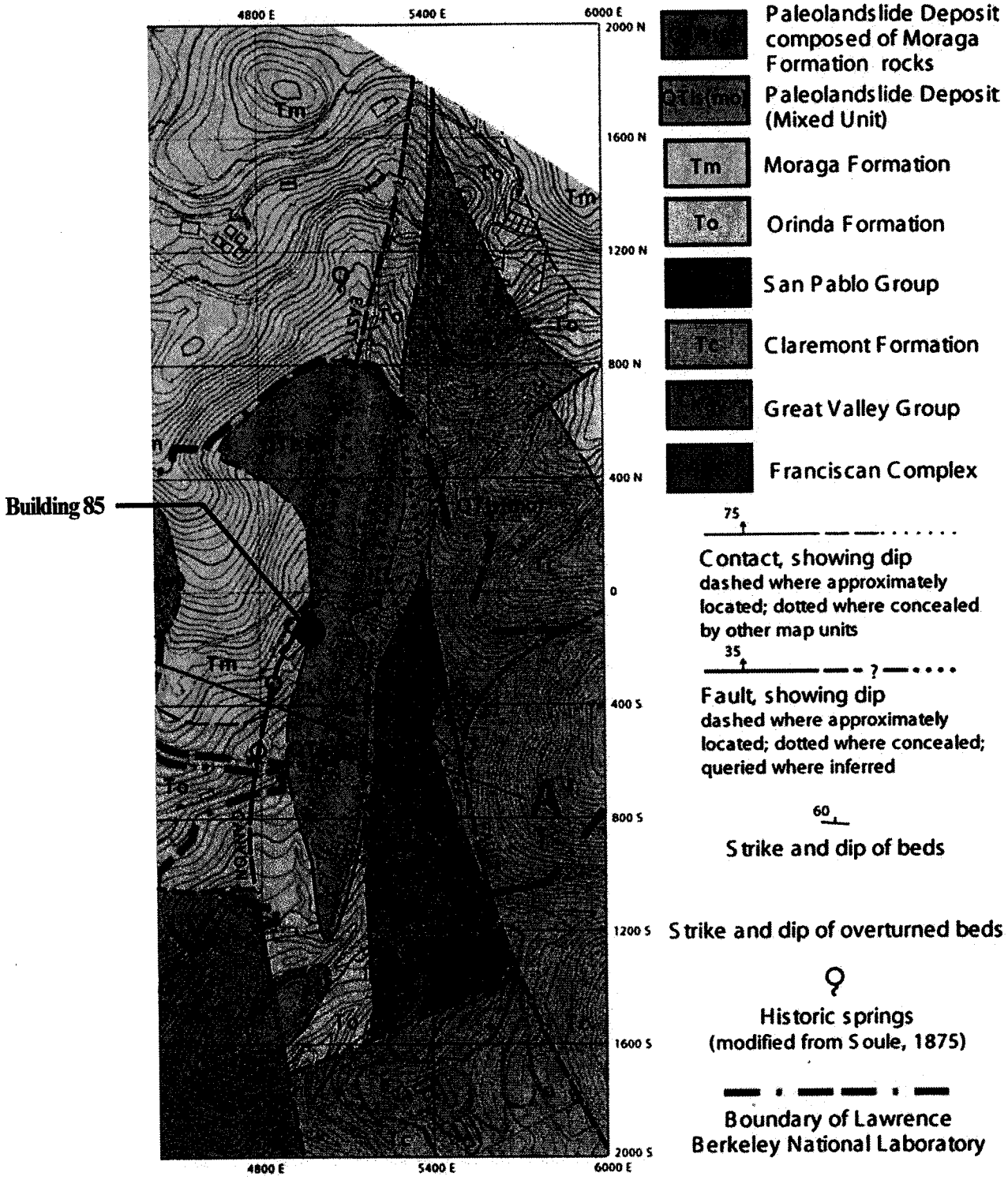
2004

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

INTERPRETED OBLIQUE PHOTOGRAPHS

LBNL BUILDINGS 85 AND 85A
Berkeley, California

PROJECT NO.	DATE	FIGURE 4
2335-4A	August 2006	



Reference: "Draft Final RCRA Facility Investigation Report," for the Lawrence Berkeley National Laboratory Environmental Restoration Program, dated September 29, 2000 (Figure 4.2-1. Bedrock Geologic Map)

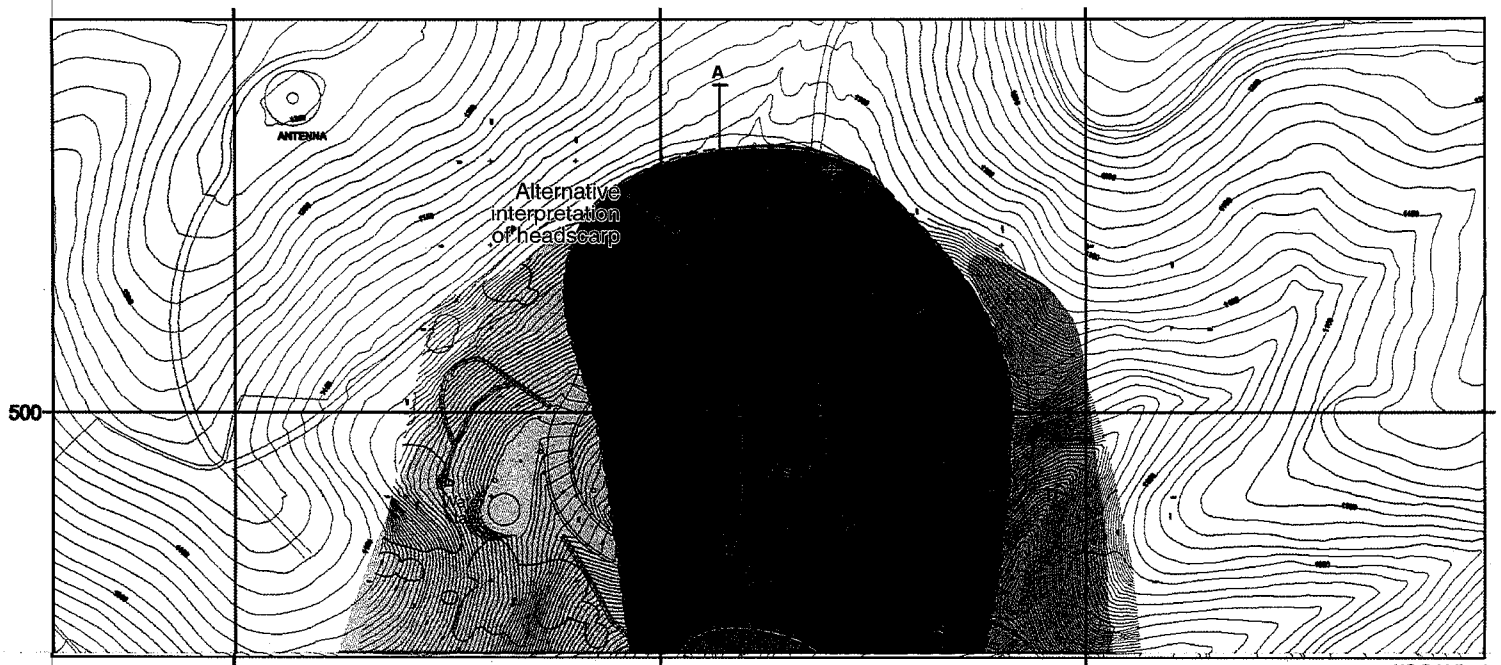
NOT TO SCALE

ALAN KROPP & ASSOCIATES
Geotechnical Consultants

RFI GEOLOGIC MAP

LBNL BUILDINGS 85 AND 85A
Berkeley, California

PROJECT NO.	DATE	FIGURE 5
2335-4A	July 2006	



UC Grid (feet)
Digital base map received 8/05/04 from S. Blair, LBNL
Contour intervals 2 feet and 10 feet

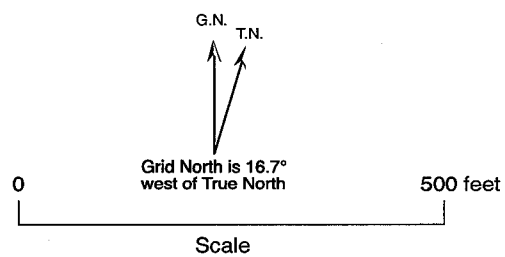
Explanation

Unit Descriptions

- Qls-1 / Qls-2 — Quaternary landslide deposits
- Tm — Moraga Formation
- To — Orinda Formation
- Tsp — San Pablo Group
- Tc — Claremont Formation

Symbols

- Fault; dashed where approximate, dotted where concealed, queried where uncertain
- Contact; dashed where approximate
- Active landslide boundary; dashed where uncertain
- Active or former location of slide, which has been removed or mitigated
- T-1A — Trench or test pit
- WLA-1 to WLA-3 — Trench (this study)
- E1-94d — Utility excavation/retaining wall cut (P. Jordan, pers. communication)
- B-3 — Borehole
- A — A' — Cross-section line
- T-9A — Test pit
- P-15 — Piezometer
- AKA-3 — AKA boring (this study)
- Creek prior to grading (near B 85 only)



LBNL BUILDINGS 85 AND 85A

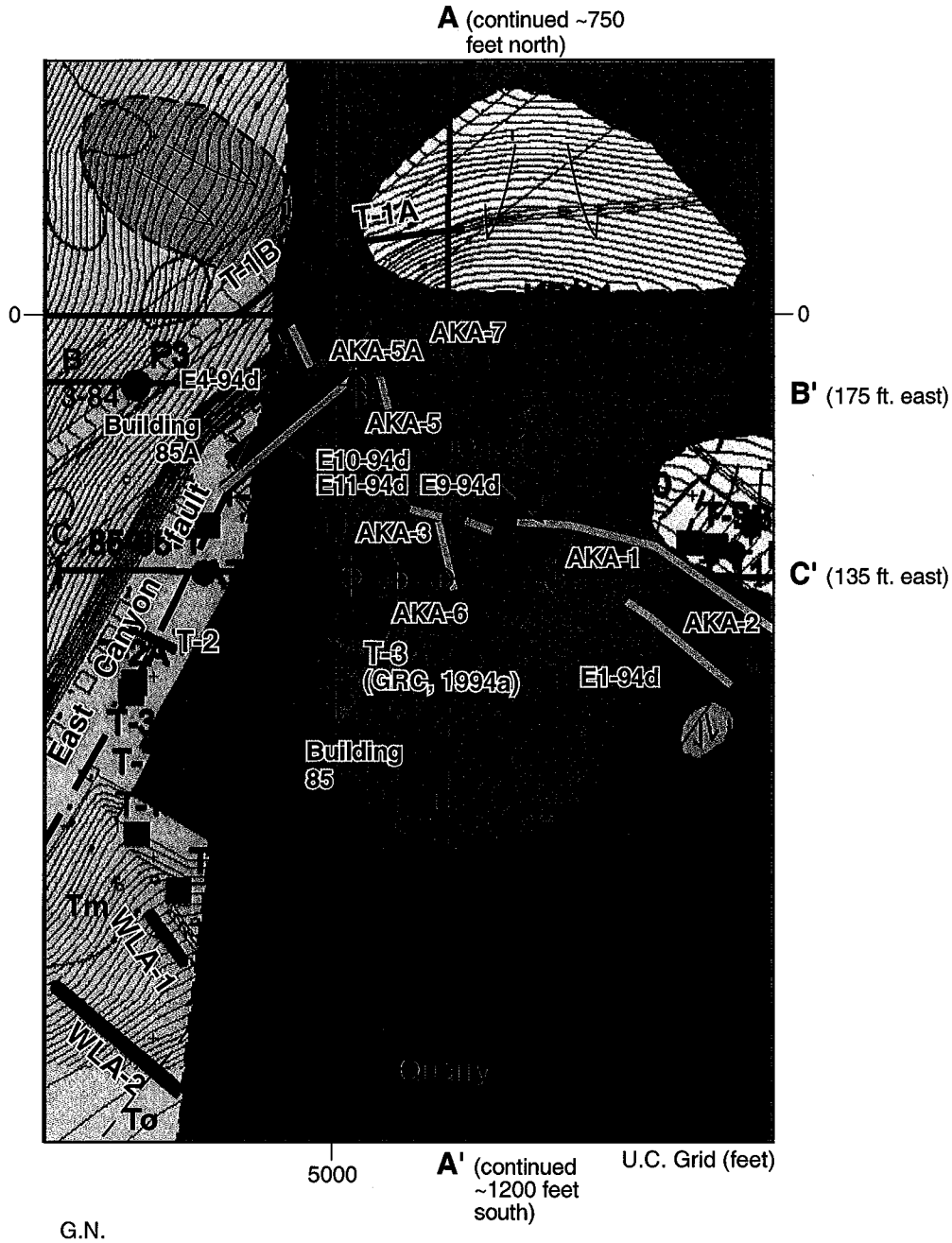
Geologic Map

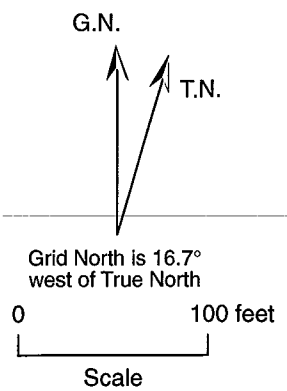
WLA — William Lettis & Associates, Inc.

Figure 6

Revised 3/14/07

1717 LBNL





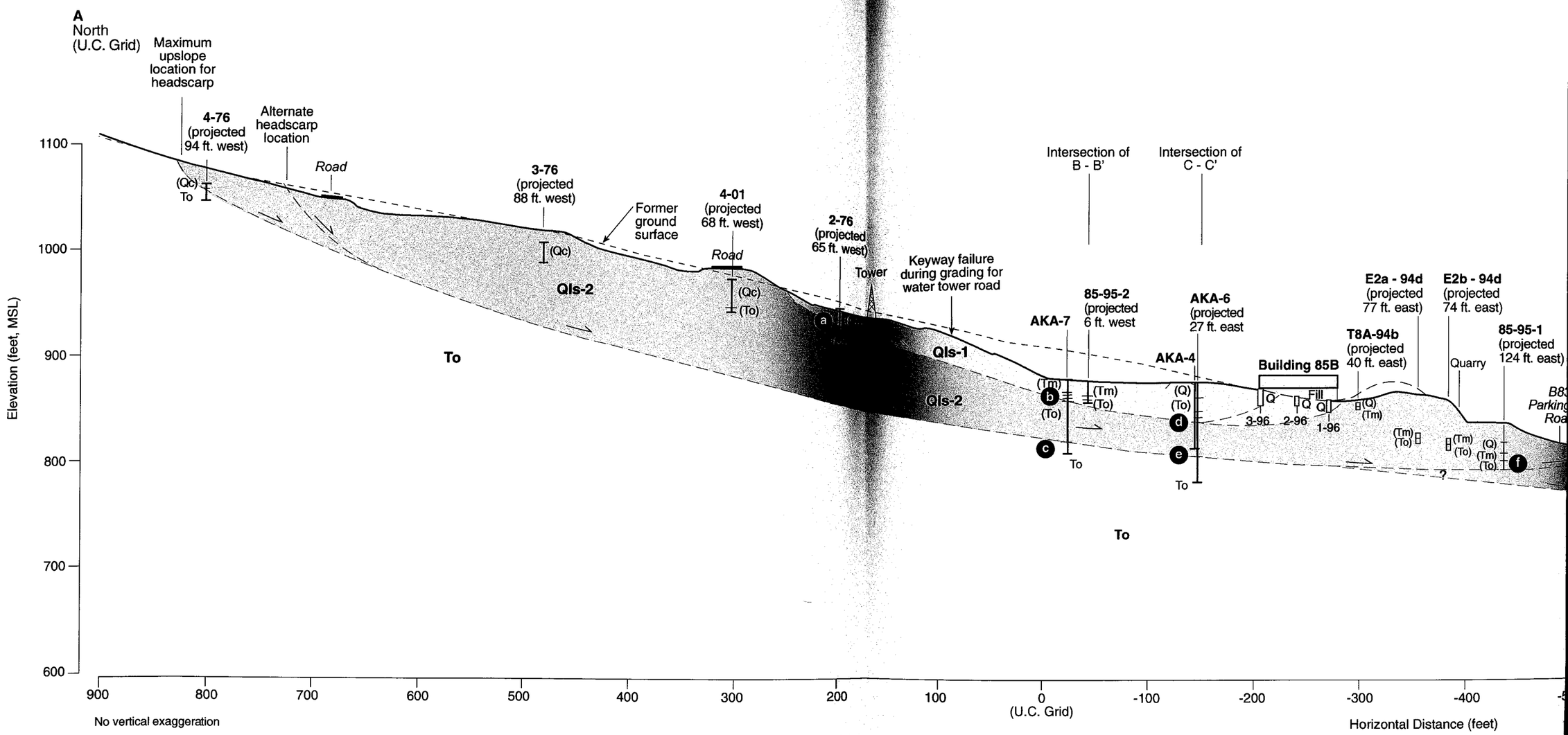
Note: See Figure 6 for explanation.

LBNL BUILDINGS 85 AND 85A

Geologic Map of Building 85 and 85A Area

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 7

Revised 3/14/07 | 1717 LBNL



Explanation

Symbols

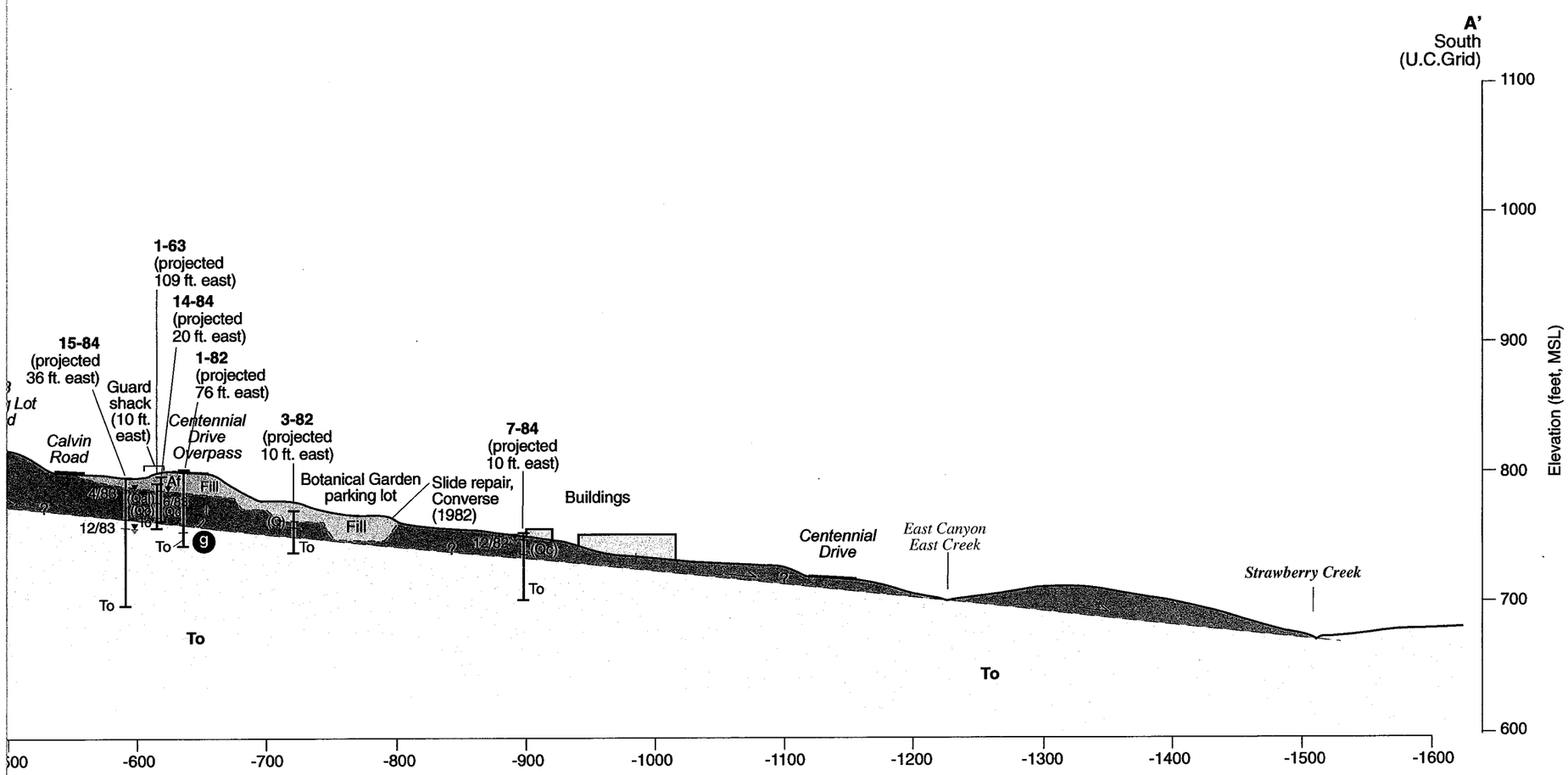
- Ground surface - present day (8/5/04 S. Blair)
- Former ground surface from K/J/C Buillding 85 drawings 4/15/91 from 150 feet north to 360 feet south) and "Site Plan" for B83 observation well overpass slope stability well revision dated 1/29/91 (paper map at 1"=100' scale) (from 900 feet to 150 feet north)
- Landslide plane
- Depth to groundwater
- Test pit or exposure location
- AKA-3 Borehole location and designation; black bar = soil or rock contact; red bar = interpreted landslide plane

Unit Descriptions

- Fill — Artificial fill
- Qls-1 — Shallow landslide deposits
- Qls-2 — Deep landslide deposits
- To — Orinda Formation
- (To)/(Tm) — Predominant composition of landslide debris

Notes

- a Silt layer with shear planes and decayed vegetation
- b 3-inch and 1-inch clay layers within sheared claysto
- c Clay with rock fragments between 57 and 58 feet in
- d 2.5-inch clay layer at 37 feet in AKA-4 with few volcan
- e 3-inch clay layer, numerous clay seams and crushe
- f Northern (upper) deep landslide plane drawn to coi landslide toe) between Building 85B and Calvin Ro
- g Maximum depth of creep to southeast is 43 feet in and intensely weathered rock in boring 1-82 (Conv



at 17 feet in 2-76 (HLA, 1976).

ıe between 16 and 18.5 feet in AKA-7.

AKA-7; OTV log shows basal plane dipping 34¡ to WSW.

ic clasts above; highly fractured and crushed siltstone below.

l rock between 65 and 67 feet in AKA-6.

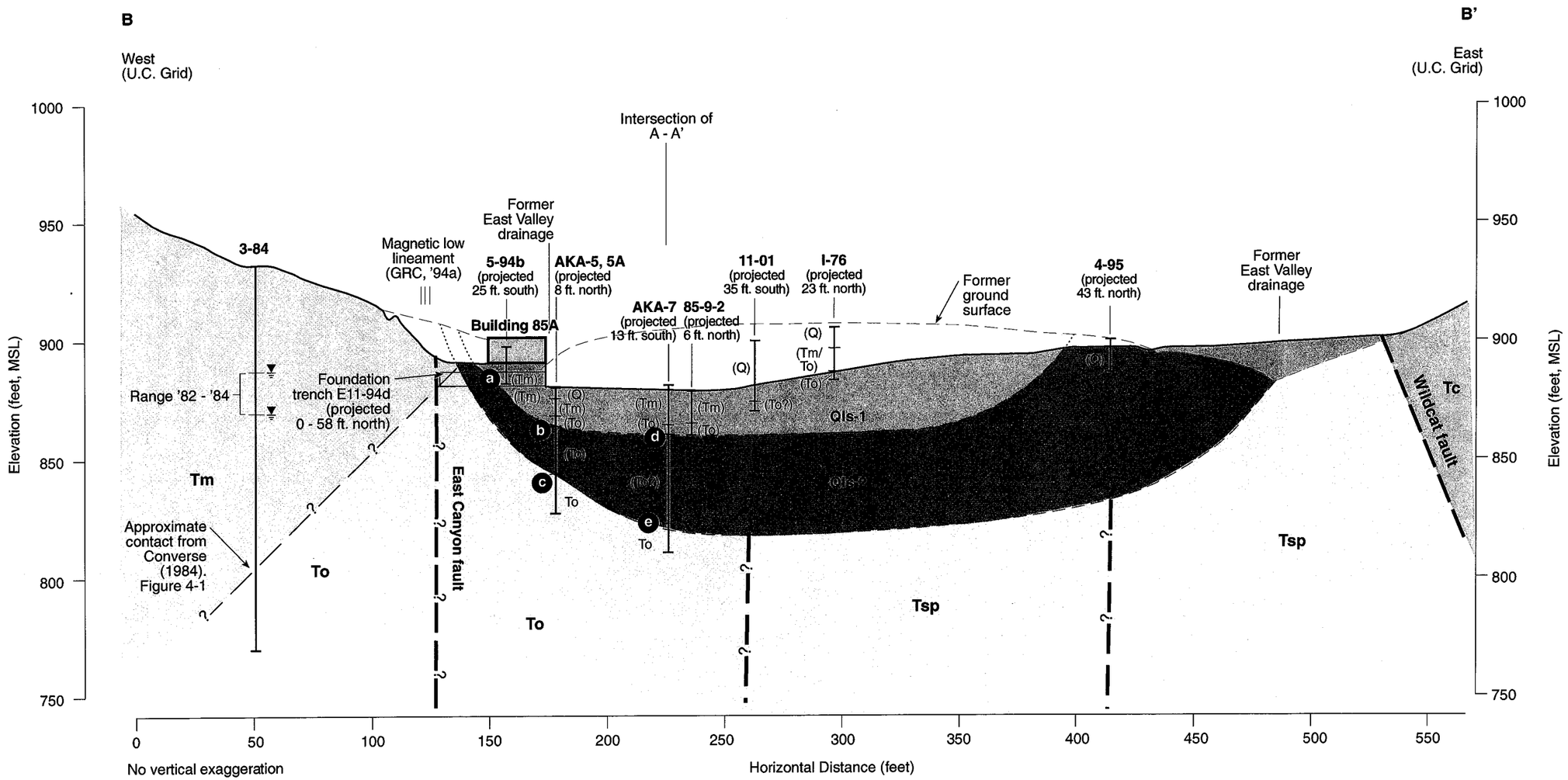
cide with the base of a topographic bulge (and potential
d.

clinometer, coinciding with base of unconsolidated debris
se, 1982).

LBNL BUILDINGS 85 AND 85A	
Cross Section A - A'	
WLA WILLIAM LETTIS & ASSOCIATES, INC.	Figure 8

Revised 3/14/07

1717 LBNL



Explanation

Symbols

- Ground surface - present day (8/5/04 S. Blair)
- Former ground surface from K/J/C Building 85 drawings 4/15/91 (from 150 feet north to 360 feet south) and "Site Plan" for B83 observation well overpass slope stability well revision dated 1/29/91 (paper map at 1"=100' scale) (from 900 feet to 150 feet north)
- Fault, approximately located
- Landslide plane, dotted where projected
- Depth to groundwater
- I-76 — Borehole location and designation; black bar = soil or rock contact; red bar = landslide plane
- E11-94d — Exposure location

Unit Descriptions

- Fill — Artificial fill
- Qls-1 — Shallow landslide deposits
- Qls-2 — Deep landslide deposits
- Tm — Moraga Formation
- To — Orinda Formation
- Tsp — San Pablo Group
- Tc — Claremont Formation
- (To)/(Tm) — Predominant composition of landslide debris

Notes

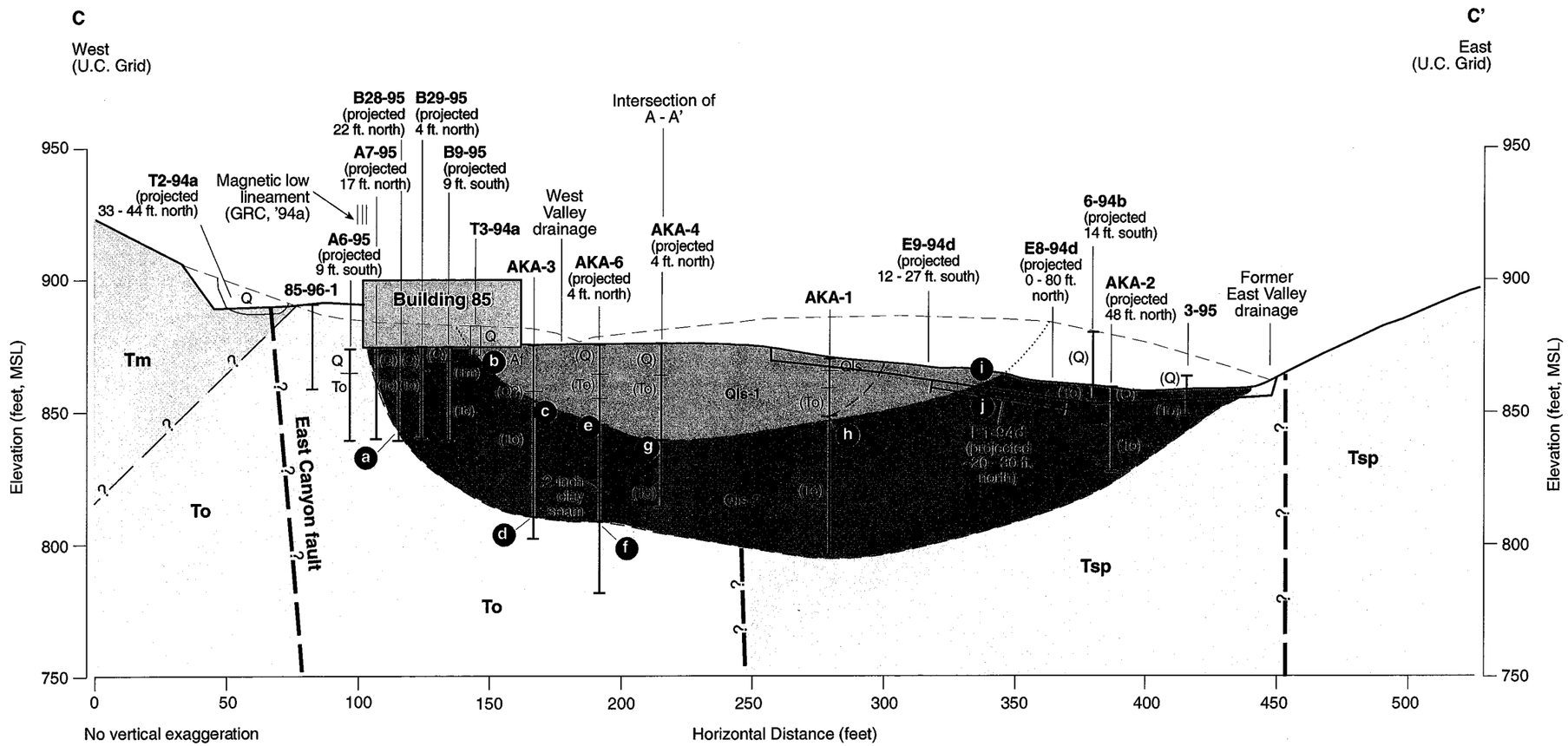
- a — Steeply east-dipping shears within siltstone near warped contact with dilated basalt and basalt mixed with siltstone in B85A retaining wall foundation trench (E11-94d, P. Jordan, pers. communication).
- b — 1.5-inch gently dipping clay layer within zone of sheared siltstone with numerous clay seams between 16.5 and 18.7 feet in AKA-5A.
- c — 3-inch clay layer at 36 feet in AKA-5.
- d — 3-inch and 1-inch clay layers within sheared claystone between 16 and 18.5 feet in AKA-7.
- e — Clay with rock fragments between 57 and 58 feet in AKA-7; OTV log shows basal plane dipping 34¡ to WSW.

LBNL BUILDINGS 85 AND 85A

Cross Section B - B'

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 9

Revised 3/14/07 | 1717 LBNL



Explanation

Symbols

- Ground surface - present day (8/5/04 S. Blair)
- Former ground surface from K/J/C Bldg. 85 drawings 4/15/91 (from 150 feet north to 360 feet south) and "Site Plan" for B83 observation well overpass slope stability well revision dated 1/29/91 (paper map at 1"=100' scale) (from 900 feet to 150 feet north)
- Fault, approximately located
- Landslide plane, dotted where projected
- Depth to groundwater
- Trench or exposure
- AKA-3 — Borehole location and designation; black bar = soil or rock contact; red bar = landslide plane

Unit Descriptions

- Fill — Artificial fill
- Qls-1 — Shallow landslide deposits
- Qls-2 — Deep landslide deposits
- Tm — Moraga Formation
- To — Orinda Formation
- Tsp — San Pablo Group
- (To)/(Tm) — Predominant composition of landslide debris

Notes

- (a) Sheared silty sandstone in Pier B28 log (P. Jordan, pers. communication).
- (b) Slickensides in clay dipping ENE near Station +65 in T-3 (GRC, 1994a).
- (c) Fill to at least 17 feet in AKA-3; possible that slide plane was removed during over-excavation.
- (d) Clay horizons at 64 and 65 ft in AKA-3; moderate inclinations of lower clay boundaries.
- (e) Heavily sheared claystone and clay horizons between 28 and 32 feet in AKA-6; a few volcanic clasts noted above slide plane.
- (f) 3-inch clay layer, numerous clay seams and crushed rock between 65 and 67 feet in AKA-6.
- (g) 2.5-inch clay layer at 37 ft in AKA-4 with few volcanic clasts above; highly fractured and crushed siltstone below.
- (h) 6-inch clay layer at 24 feet in AKA-1 with highly fractured and crushed siltstone below.
- (i) Lateral margin of numerous subvertical, irregular bands of alternating volcanics and siltstone/sandstone noted in E9-94d (P. Jordan, pers. communication).
- (j) West-dipping shears separating volcanic and distinct sandstone and siltstone beds noted in hillside exposure during B85 grading (E1-94d, P. Jordan, pers. communication).

LBNL BUILDINGS 85 AND 85A

Cross Section C - C'

WLA William Lettis & Associates, Inc. | Figure 10

Revised 3/14/07 | 1717 LBNL

APPENDIX A

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Aerial Photographs

Type	Date	Scale	Photo No.	Source
Black and White, Stereo Pair	08/02/39	1:20,000	BUT-BUU-289-67, 68	United States Soil Conservation Service
Black and White, Stereo Pair	03/24/47	1:20,000	AV-11-2-10, 11	Pacific Aerial Surveys

2335-4_summary report

APPENDIX B

Logs of Exploratory Trenches

Unit descriptions apply to all trenches except where noted.

Unit 70 (Present in T-1 only): Gravelly SAND with silt (SW); light grayish brown, dry; massive; loose granular to platy structure; clear and smooth lower boundary [ARTIFICIAL FILL related to grading for Building 85].

Unit 60 (Present at southeast end of T-2 only): CLAY, silty with sand (CL); very dark grayish brown (10YR 3/2); about 3% subangular to subrounded fine gravel; dry; massive; granular; upper ~10-20 cm of unit is modern dark brownish gray granular soil A horizon; clear and inclined lower boundary [ARTIFICIAL FILL related to grading for Building 83 parking lot].

Unit 50 (Present at southeast end of T-2 only): CLAY, silty with sand and gravel (CL); brown (10YR 4/3); est. 60% fines, 30% fine to coarse sand, 10% fine gravel, subangular to subrounded; dry, hard, massive; bioturbaded with fine to medium roots; subangular fine blocky peds; upper 30 cm of unit is modern dark brownish gray granular soil A horizon subparallel to ground surface; clear and inclined lower boundary. [HOLOCENE(?) ALLUVIUM (channel fill deposits) or ARTIFICIAL FILL (related to grading of Building 83 parking lot)].

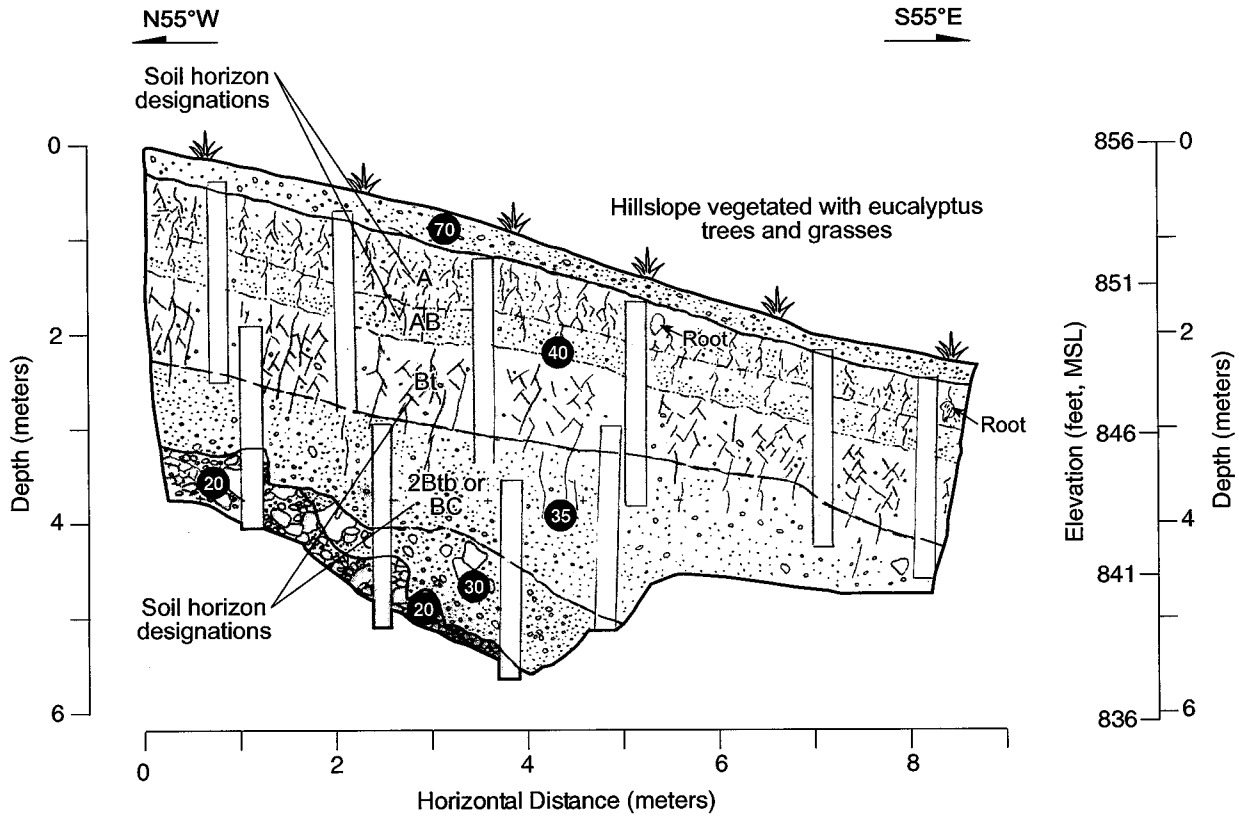
Unit 40 CLAY, silty with sand (CL); dark brown; est. <5% fine gravel, 30% sand, 20% silt, 50% clay; gravel is fine, subangular to subrounded; sand is fine to coarse, subangular to subrounded; dry; massive; some bioturbation with fine to large roots. Prominent soil developed on the deposit in trenches T-1 and T-2 consists of an A/AB/Bt profile: A = dark brown, granular peds; AB = granular to small blocky peds; Bt = dark brown (7.5YR 3/3), subrounded, medium blocky peds with clay films on ped faces and lining pores; clear to diffuse and smooth to wavy lower boundary. [LATE QUATERNARY YOUNGER COLLUVIUM].

Unit 35 CLAY, silty with sand (CL); dark yellowish brown (10YR 4/4); est. <5% fine gravel, 10-20% sand, 20-40% silt, 50% clay; gravel is fine, subangular to subrounded, with some granules of highly weathered yellowish silt (in trench T-1); sand is fine to coarse, subangular to subrounded; dry; massive; some bioturbation with fine to large roots. Buried Bt2b or BC soil developed on the deposit in trenches T-1 and T-2 where underlying Unit 40 has a fine to medium subangular to subrounded blocky ped structure with clay films on ped faces and on clasts. Modern A soil horizon developed on top of unit in trench T-3; clear to diffuse and irregular lower boundary. [LATE QUATERNARY OLDER COLLUVIUM].

Unit 30 CLAY, gravelly to sandy (CL) to GRAVEL, clayey with silt (GC); dark yellowish brown (10YR 4/4); 20-40% gravel, 20-30% sand, 50% fines (clay > silt); gravel is fine to coarse, angular to subrounded; clasts 2-15 cm, rare to 40 cm, of mafic volcanics; sand is fine to coarse; dry; hard; massive; some bioturbation with few small roots; soil has subangular fine to medium blocky peds; thin clay films lining pores and ped faces with some staining of gravel; clear and wavy to irregular lower boundary. Modern A soil horizon developed on top of unit in northwestern part of trench T-2 where unit is as the ground surface. Trench T-3 has a few isolated pockets of sandy clay with minor gravel overlying Unit 20 and underlying the more typical gravelly clay. The southeastern end of trench T-2 has a few lens- and irregular-shaped deposits of varying amounts of gravel and sand – these isolated subunits are grouped into Unit 30. [LATE QUATERNARY OLDER COLLUVIUM].

Unit 20 Volcanic conglomerate; pale olive to dark gray, matrix- to clast-supported conglomerate with fine gravel to large boulder size clasts of fine-grained mafic and minor vesicular tuffaceous volcanics (basalt). Clasts are subrounded to subangular, slightly to moderately weathered (thin weathering rinds and manganese oxide stained), hard to extremely hard, moderately to very closely spaced fractures with rough, irregular, and open discontinuities. Matrix is sand to silt, yellowish brown, moderately to severely weathered, friable to low strength, locally moderately well lithified. Few possible silt- to lipilli-sized ash beds interbedded within conglomerate. Local shears identified in T-2 and T-3 as subplanar to wavy discontinuities with polished faces and subparallel wavy shear fabric; shears lack clay gouge. Southeast end of T-2 exposed clear and smooth lower boundary of volcanic conglomerate depositionally overlying a 8-10 cm-thick white silt ash(?) layer. Ash(?) layer, in turn overlies siltstone, claystone, and sandstone of Unit 10. [TERTIARY MORAGA FORMATION].

Unit 10 (Present at southeast end of T-2 only): Siltstone, claystone, sandstone, and minor pebble conglomerate; reddish brown, light greenish gray, bluish gray, pale yellow, purple, and white; crudely layered with mainly coarse beds of predominantly silt, clay, silty sand, or sandy gravel; sandy and gravelly beds contain fine to coarse sand and fine gravel clasts, typically poorly sorted, subangular to subrounded grains of quartz, feldspar, lithics, associated with local, discontinuous channel forms in upper part of exposure but appear to form more continuous beds within pothole; slightly to moderately weathered; friable to low strength; samples from the pothole brought up in the backhoe bucket locally contained closely spaced fractures (open to tight) and shears with common slickensided surfaces of multiple orientations. [TERTIARY ORINDA FORMATION].



Explanation

Symbols

- Contact, depositional: solid line - sharp to clear (<5 cm); dashed - diffuse (5 - 10 cm)
- Contact, pedogenic (soil horizon boundary)
- Prismatic to blocky soil structure
- Gravel and sand content
- Fractured volcanic conglomerate

Unit Descriptions

- 70 Artificial fill
- 40 Younger colluvium, silty CLAY (CL) with A/AB/Bt soil profile
- 35 Older colluvium, silty CLAY (CL) with 2Btb or BC soil horizon
- 30 Older colluvium, clayey GRAVEL (GC)
- 20 Moraga Fm. volcanic conglomerate

Notes

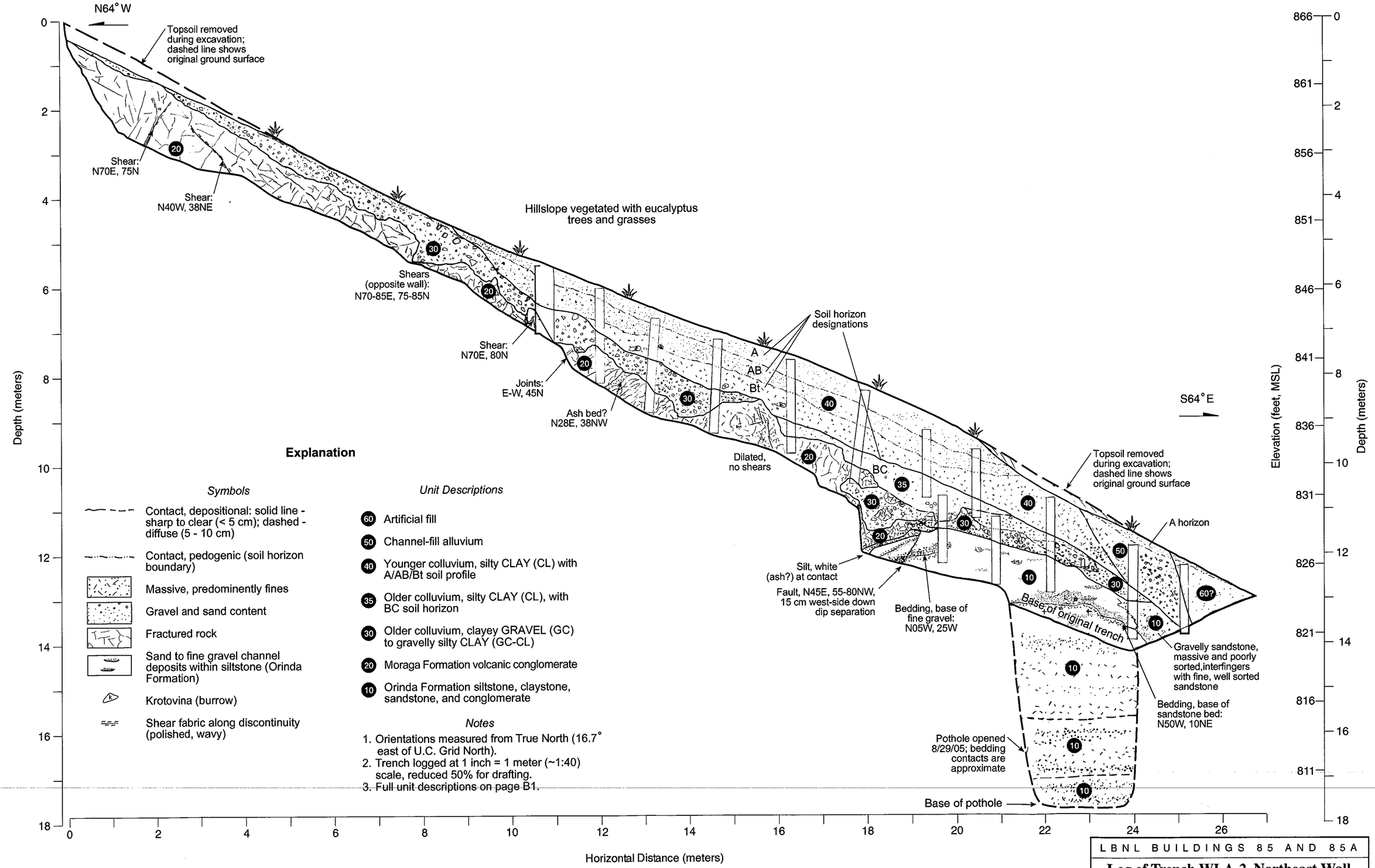
1. Orientations measured from True North (16.7° east of U.C. Grid North).
2. Trench logged at 1 inch = 1 meter (~1:40) scale, reduced 50% for drafting.
3. Full unit descriptions on page B1.

LBNL BUILDINGS 85 AND 85A

Log of Trench WLA-1
Northeast Wall

WLA William Lettis & Associates, Inc. | Figure B1

Revised 3/14/07 | 1717 LBNL

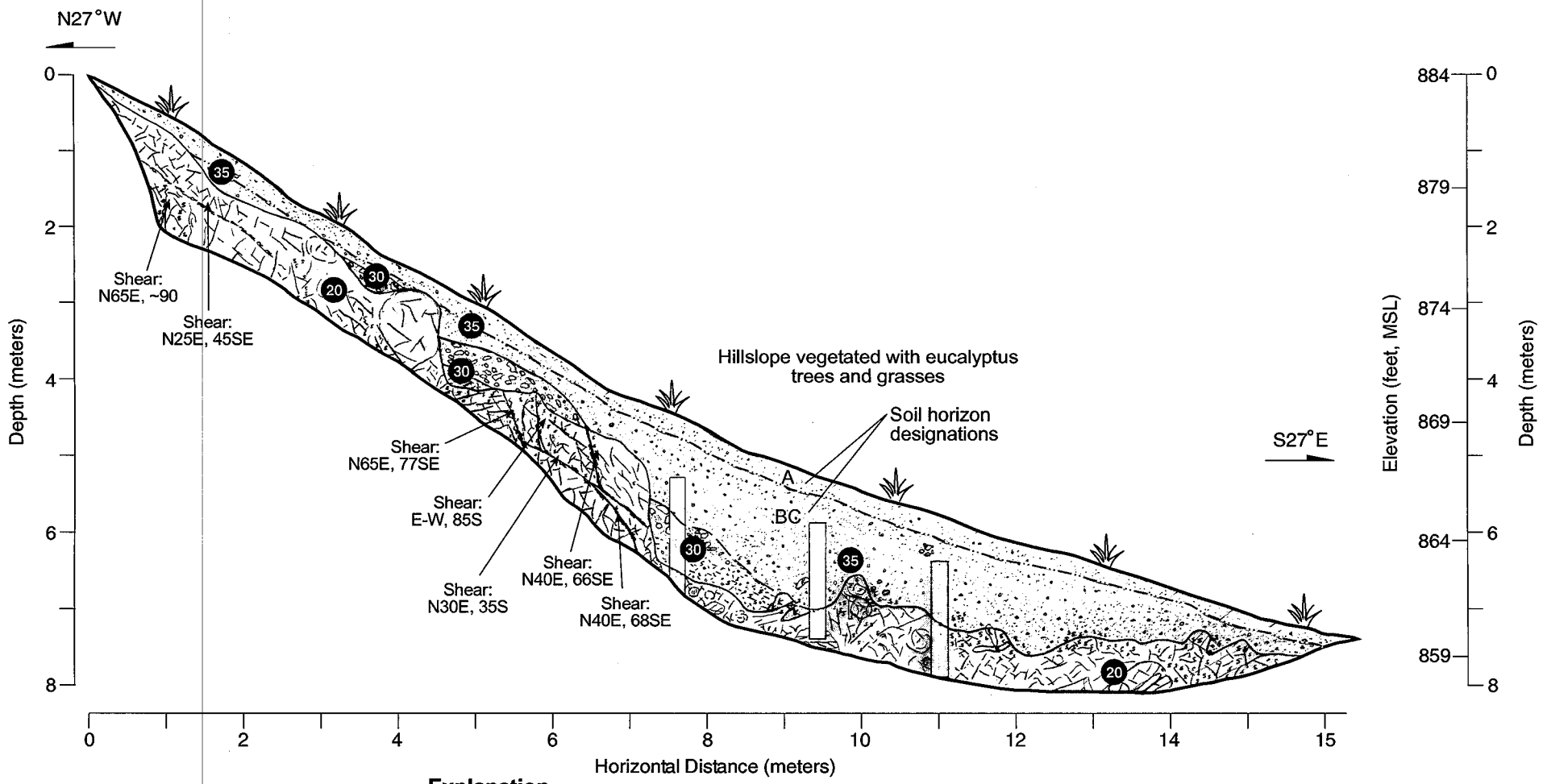


LBNL BUILDINGS 85 AND 85A

Log of Trench WLA-2, Northeast Wall

WLA William Lettis & Associates, Inc. | Figure B2

Revised 3/14/07 | 1717 LBNL



Explanation

Symbols

- Contact, depositional; solid line - sharp to clear (< 5 cm); dashed - diffuse (5 -10 cm)
- Contact, pedogenic (soil horizon boundary)
- Gravel and sand content
- Fractured rock
- Powdery to filamentous precipitate (carbonate and/or salts)
- Krotovina (burrow)
- Shear fabric along discontinuity (polished, wavy)

Unit Descriptions

- 35 Older colluvium, silty CLAY (CL), with A/BC soil profile
- 30 Older colluvium, clayey GRAVEL (GC)
- 20 Moraga Fm. volcanic conglomerate

Notes

1. Orientations measured from True North (16.7° east of U.C. Grid North).
2. Trench logged at 1 inch = 1 meter (~1:40) scale, reduced 50% for drafting.
3. Full unit descriptions on page B1.

LBNL BUILDINGS 85 AND 85A

Log of Trench WLA-3
Northeast Wall

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure B3

Revised 3/14/07 | 1717 LBNL

APPENDIX C

Logs of Borings

ROCK LOG - Boring No. AKA-3

Project Name and Job Number LBNL BUILDINGS 85 AND 85A WLA: 1717-B, AKA: 2335-4a			WLA
Type and Diameter of Boring HQ wireline	Boring Location Building 85, ~5 feet north of northeast corner		Total Depth 74.5 feet
Drilling Contractor and Rig Pitcher Drilling, Inc.; Faeling 1500	Elevation and Datum 876.5 feet, MSL	Ground Water Depth ---	Depth to Bedrock 65.5 feet
Casing Size and Depth 4.5-inch diameter, 10 feet	Length of Core Barrel and Bit 3 feet Pitcher and 5 feet coring	No. of Core Boxes ---	Date Started 9/1/05
	Borehole Inclination 90°	Logged by STS (WLA)	Date Completed 9/2/05

Reviewed by/Date JNB 3/22/06

Depth (feet.)	Lithology	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Soil Samples/ Borehole Tests	Discontinuity Log	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
0												Hand-dug pit to 6 feet to clear utility lines	876.5
1												drillers reamed and augered to 6.5 feet	
2													
3													
4													
5													871.5
6												drillers reamed and augered to 6.5 feet	
7											CLAY, with silt, minor fine sand; dark gray to reddish brown; very stiff to stiff; low plasticity; poorly bedded; common calcium carbonated nodules [Artificial fill]	dry Shelby tube	
8			S_1	$\frac{2.5}{2.5}$								gradual increase 100 - 350 psi	
9											same as above, with minor amounts of charcoal and rootlets; lenses of sand up to 4 inches thick, grayish	good circulation	
10			P_2	$\frac{2.0}{2.5}$									866.5
11											11.5 to 12.2 feet: CLAY with fine gravel; gravel is gray to reddish brown sandstone	200 - 250 psi	
12		3:18/2.5 ft.									CLAY; reddish brown with grayish mottles; medium plasticity; white fine nodules of calcium carbonate common at 12.2 feet, rare by 15 feet		
13			P_3	$\frac{1.7}{2.5}$									
14			P_4	$\frac{1.5}{1.5}$						randomly oriented fractures with polished faces	with 10% fine gravel, massive		
15													861.5

See page 2 for abbreviations of terms related to weathering, strength, and sample method.

ROCK LOG - Boring No. AKA-3

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
15		P_4						same as above		861.5
16	5:18/1.5 ft.	P_5	1.5/1.5				low angle bedding	SAND, gravelly with clay; light gray; bedded with laminated fines; fine subrounded gravel, medium to coarse sand; medium dense; moist		
17								CLAY, silty with minor sand; reddish brown to dark gray; medium stiff; low plasticity [Quaternary colluvium and Landslide debris]		
18	4:15/2.2 ft.	P_6	2.2/2.2							
19								trace charcoal (?)		
20		P_7	1.7/1.8			R1	45° bedding dips, top and base of claystone bed	SILTSTONE and fine SANDSTONE; reddish brown to gray mottled; appears brecciated and mixed with light yellow pebbles above 21.8 feet; damp [Landslide debris - shallow landslide?]		856.5
21		P_8	1.5/1.5		HW					
22							45° contact, thin clayey silt	CLAYSTONE, laminated; reddish brown [Landslide debris - deep landslide]		
23		P_9	2.0/2.0		MW	R2	fractures, high angle, tight, polished faces; 60° bedding	SILTSTONE to fine SANDSTONE; gray; with minor dark reddish brown siltstone beds		
24						R1	fractures random, no mineralization			
25		P_{10}	2.0/2.0				35° bedding	CLAYSTONE to SILTSTONE; reddish brown to pale olive-brown; damp; stiff		851.5
26					MW	R2	abundant fractures and shears, smooth, polished fracture faces open vertical to subhorizontal			
27		P_{11}	2.0/2.0			R1	30° clay seam 1/2-inch thick; numerous fractures with polished surfaces		more difficult drilling	
28	7:15/1.5 ft.	P_{12}	1.3/1.5		MW SW	R2	30° bedding; fractures have mineralization	SILTSTONE to fine SANDSTONE; grayish brown to bluish bray; increase in competence		
29		P_{13}	1.2/2.0				abundant fractures			
30										846.5

Undisturbed sample
S = Shelby, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-3

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
30										846.5
						R2	abundant fractures, steeply dipping, mineralization	same as above		
31	4:37/1:5 ft.	P_{14}	1.7/1.5		MW	R1	abundant fracture surfaces, subvertical	SILTSTONE to CLAYSTONE, light gray to reddish brown; very weak		
32										
33	4:05/2.0 ft.	P_{15}	2.0/2.0			R2		SILTSTONE, grayish brown to light greenish gray to reddish brown; weak		
34										
35	4:39/1:5 ft.	P_{16}	1.5/1.5				CLAY seam, brown, 1-inch thick			841.5
36	3:27/1:5 ft.	P_{17}	1.5/1.5				fractures, steeply dipping, tight, mineralization			
37										
38	5:35/2.0 ft.	P_{18}	2.0/2.0				<30° CLAY seam, dark grayish brown, 1-inch thick			
39					MW	R2	fractures, random striations, tight, some reddish brown fracture faces; common polished and striated surfaces			
40		P_{19}	2.5/2.5							836.5
41							brecciated zone			
42							abundant fractures			
43		P_{20}	2.5/2.5				brecciated zone, steeply dipping, clay seams along zone			
44										
45							abundant fractures, tight			831.5

Undisturbed sample
S = Shelby, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-3

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
45								same as above		831.5
							50° fractures, tight, polished faces			
46		P_{21}	2.5/2.5							
								SILTSTONE, light green-gray to gray-brown		
47						R2-R3				
48		P_{22}	2.5/2.5		MW-SW		fractures, high angle, tight, mineralization			
49							abundant fractures, steeply dipping, tight		9/1/05 stop drilling at 49.5 feet 9/2/05 resume drilling	
50	11:29/2.2 ft.	P_{23}	2.2/2.2				30° contact with brecciated zone			826.5
51										
52	5:13/1:3 ft.	P_{24}	1.3/1.3				fractures, tight			
53		P_{25}	0.3							
54	6:15/1:7 ft.	P_{26}	1.7/1.7				fractures, tight; some polished faces			
55										821.5
56		P_{27}	2.0/2.0		MW-SW	R2	50° fractures, tight, mineralization			
57							fractures, steeply dipping to subvertical, tight, mineralized, polished fracture faces			
58		P_{28}	1.5/1.5							
59		P_{29}	1.8/1.8				fractures, tight			
60										816.5

Undisturbed sample
S = Shelby, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-3

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
60							fractures, tight	same as above		816.5
61	7:10/2.2 ft.	P_{30}	2.2/2.2		MW	R2				
62							45° to 50° faults and shears, tight, in brecciated zone	ferrous oxide-stained breccia zone		
63		P_{31}	1.5/1.5			R2	fractures, tight, with occasional clay seams	brecciated, crushed, gray-brown siltstone		
64	2:59/1.1 ft.	P_{32}	1.1/1.1			R0 R2	30° shear, 1.5 inches clay gouge, soft	at 64 feet: CLAY, soft, 1.5-inch thick [Landslide plane] SILTSTONE, green-gray	slight circulation loss	
65	5:44/1.4 ft.	P_{33}	1.4/1.4		MW	R0 R2	SILTSTONE/CLAY contact is steeply dipping and sheared; lower CLAY/SILTSTONE contact is gradual and contains brecciated siltstone fragments	CLAY, medium bluish gray, soft to very soft; high to medium plasticity [Landslide plane] SILTSTONE, clayey with minor sand; light green-gray to dark gray; hard [Orinda Formation or San Pablo Group]		811.5
66										
67	7:42/2.0 ft.	P_{34}	1.9/2.0				subvertical fractures, polished surfaces			
68							30° fractures, with minor crushing and rare clay seams, polished faces with dip-slip striae	Fine SANDSTONE to sandy SILTSTONE		
69	5:40/1.2 ft.	P_{35}	1.1/1.2						refusal with pitcher barrel; switched to rock coring at 69.7 feet	
70	26:07/4.8 ft.	C_{36}	4.8/4.8		SW	R3		SILTSTONE, light greenish gray to gray		806.5
71							~75° bedding, on pebble bed	zones of fine gravel, subrounded		
72										
73								fine SANDSTONE to SILTSTONE, competent		
74										
75								Bottom of hole 74.5 feet.		801.5

Undisturbed sample
S = Shelby, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-4

Project Name and Job Number LBNL Building 85 WLA: 1717-B, AKA: 2335-4a			
Type and Diameter of Boring Rotary wash, 4 7/8-inch diameter	Boring Location In road, ~50 feet east of northeast corner of Building 85		Total Depth 62.5 feet
Drilling Contractor and Rig Pitcher Drilling, Inc., Faeling 1500	Elevation and Datum 877.5 feet MSL	Ground Water Depth ---	Depth to Bedrock >62.5 feet
Casing Size and Depth 5-inch diameter, advanced to 12 feet	Length of Core Barrel and Bit 8 feet with bit; 5-ft. inner barrel	No. of Core Boxes ---	Date Started 9/24/05
	Borehole Inclination 90°	Logged by J. Goodman (AKA)	Date Completed 9/24/05

Reviewed by/Date JNB 3/20/06

Depth (feet.)	Lithology	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Soil Samples/ Borehole Tests	Discontinuity Log	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
0											Asphalt pavement over brown aggregate base rock [Artificial fill]		877.5
1													
2										2.2 to 4.2 feet numerous mechanical breaks	Gravelly lean CLAY with fine to coarse sand, dark brown, very stiff; gravel is angular and grades from fine to cobble-sized; moisture content increases with depth [Quaternary alluvium]		
3			S_1	1.1/2.0								S_1: tip of Shelby tube is bent	
4													
5											1-inch thick dark brown fat CLAY layer		872.5
6			P_2	1.5/3.0								P_2: 200 psi	
7		3	P_3	1.3/1.5							Clayey fine to coarse SAND, and fine to coarse sandy CLAY, dark brown, loose to medium dense/firm, with isolated soft zones, trace angular fine gravel, wet	P_3: 100 - 125 psi; loss of fluid circulation	
8													
9		3	S_4	0.6/2.0								S_4: 50 - 225 psi	
10													867.5
11			S_5	0.5/0.5						10.4 to 11.0 feet numerous horizontal mechanical breaks	SILTSTONE clast, dark gray, in tip of Shelby tube	S_5: 225 psi; loss of fluid circulation casing pushed to 12 feet	
		Interval not sampled											
12		6	P_6	2.0/2.0		HW	R1-R2				SILTSTONE, CLAYSTONE, and SANDSTONE, dark brown to gray-brown, highly weathered, crude bedding [Landslide debris - shallow landslide]	P_6: 250 - 200 psi	
13										44° lithologic contact dark brown SILTSTONE over gray-brown SAND-STONE			
14		2	P_7	1.4/1.5								P_7: 250 psi	
15													862.5

See page 2 for abbreviations of terms related to weathering, strength, and sample method.

ROCK LOG - Boring No. AKA-4

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
15								same as above	P_8: 250 - 300 psi	862.5
16	4	P_8	2.2/2.5		HW	R1		2-inch thick CLAYSTONE layer, brown, polished, intensely fractured, free water visible on fracture planes		
17										
18	3	P_9	2.1/2.0				parting face has slickensides and polishing 80°: clay-filled joint; tight	SANDSTONE, clayey, dark brown and gray; material has mixed texture	P_9: 250 - 300 psi	
19										
20	5	P_{10}	1.7/1.5		HW	R1-R2			P_{10}: 300 psi	857.5
21							30°: clay-filled joint; tight			
22	7	P_{11}	1.9/2.5						P_{11}: 300 - 400 psi	
23							~50°: clay-filled joint; tight			
24	7	P_{12}	1.5/1.5						P_{12}: 300 - 500 psi	
25								gravel-sized clasts of basalt mixed with SANDSTONE		852.5
26	6	P_{13}	2.1/2.5		HW	R2			P13: 250 - 400 psi	
27							50°: clay horizon, polished to striated			
	10	P_{14}	0.5/0.5						driller reports hard layer	
28							50°: 0.3-inch clay seam at fine sandstone over siltstone contact	zone of clay seams		
29	20	C_{15}	2.5/2.5		MW-HW	R2	30° - 35°: healed joint with mineralized infilling; underlain by a well-cemented zone	Fine SANDSTONE, silty, slightly mottled brown, gray, and blue-gray; contact demarcated by a 4-inch thick well cemented zone	C_{15}; 200 - 225 psi	
30										847.5

Undisturbed sample
S = Shelby, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-4

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
30	5	C_{15}						same as above		847.5
	6				MW	R2			switch to Pitcher barrel	
31		P_{16}	1.0/2.0						P_{16}: 350 - 425 psi	
32	16				HW		35°: joint, smooth, highly weathered	color change to dark gray		
33	15						55°: clay seam 1/4-inch thick; high plasticity, sticky, separates yellow-brown siltstone and blue-gray to reddish brown siltstone	CLAYSTONE, mottled blue-gray, red-brown, and dark brown with poorly to moderately cemented fine sand and silt horizons, highly weathered	switch to rock coring	
34	4	C_{17}	3.5/4.0		HW	R1-R2			C_{17}: 200 - 250 psi	
35	7						45°: planar to stepped clay film on hard cemented discontinuous surface			842.5
36	11									
37							25°: contact of slide-plane clay over bluish gray siltstone	Gravelly, sandy CLAY, reddish brown to blue-gray, volcanic and sandstone clasts		
					HW	R1		37.0 - 37.2 feet: CLAY with minor silt, dark gray to brown, soft [Landslide plane]		
38	4							CLAYSTONE and SILTSTONE, dark gray, bluish gray, over CLAYSTONE, highly fractured/ crushed, angular to subrounded gravel, soft rock fragments with lighter gray/greenish gray matrix; highly weathered to moderately weathered [Landslide debris - deep landslide]		
39	9	C_{18}	2.9/5.0		MW	R1-R2			C_{18}: 150 - 250 psi	
40	10									837.5
41	5									
42	16	C_{19}	0/1.5						C_{19}: no recovery	
	8									
43	8								driller reports loss of fluid circulation	
44	6	C_{20}	0.8/3.0		MW	R1-R2			C_{20}: 200 psi	
45										832.5

Undisturbed sample
S = Shelby, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-4

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
45										832.5
	5	C_{20}						same as above	poor recovery with rock coring	
46										
47		MC_{21}			SW-MW	R2	45°: bedding? zone of very closely spaced, tight fractures	SILTSTONE and very fine SANDSTONE; notable increase in rock strength and coherence	good recovery below 47.5 feet with Pitcher barrel	
48										
49		P_{22}	2.4/2.5		SW	R3			P_{22}: 250 - 400 psi	
50							polishing and faint slickensides on fracture faces			827.5
51	3	P_{23}	2.6/2.5						P_{23}: 300 - 450 psi	
52								Fine SANDSTONE, gray, weakly cemented, slightly silty, locally graded		
53	2	P_{24}	2.0/2.0				60°: joint		P_{24}: 300 - 450 psi	
54										
55	10	P_{25}	2.5/2.5		SW	R3	54 to 57 feet: joint set, randomly oriented, open with some mineralized infilling - some - 40° to 50°		P_{25}: 300 - 400 psi	822.5
56										
57										
58	5	P_{26}							P_{26}: 300 - 550 psi	
59										
60	6	P_{27}							P_{27}: 300 - 450 psi	817.5

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Driven (2.5 to 3.0 inch) with liners
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Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-4

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Lithology	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Soil Samples/ Borehole Tests	Discontinuity Log	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
60			P_{27}	1.5/1.5						48°: parting	same as above		817.5
61													
62			P_{28}										
63											Bottom of hole at 62.5 feet.		
64													
65													812.5
66													
67													
68													
69													
70													
71													
72													
73													
74													
75													

Undisturbed sample
S = Shelby, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-5

Project Name and Job Number LBNL BUILDINGS 85 AND 85A WLA: 1717-B, AKA: 2335-4a			WLA
Type and Diameter of Boring HQ wireline	Boring Location In road, ~8 feet off southeast corner of Building 85A		Total Depth 53.1 feet
Drilling Contractor and Rig Pitcher Drilling, Inc. Faeling 1500	Elevation and Datum 882.5 feet (LBNL, 2003)	Ground Water Depth ---	Depth to Bedrock 36.3 feet
Casing Size and Depth 4.5-inch diameter, 7 feet	Length of Core Barrel and Bit 3 feet Pitcher and 5 feet coring	No. of Core Boxes ---	Date Started 9/24/05
	Borehole Inclination 90°	Logged by SCT (WLA)	Date Completed 9/24/05

Reviewed by/Date JNB 3/20/06

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
0								Asphalt over GRAVEL; with sand (GP); gray-brown [Artificial fill]	Asphalt road surface	882.5
1										
2							2.2 to 4.2 feet numerous mechanical breaks	CLAY; gravelly with sand (CH); dark yellowish brown to brown; 10 to 30% subangular to subrounded volcanic and sandstone clasts [Quaternary alluvium and possible landslide debris]		
3		S1	1.0/2.5							
4										
5	3:08/2.0 feet								some circulation loss extend casing to 7 feet	877.5
6		P2	0.9/2.0					6 to 7 feet: same as above with angular gravel in clay matrix, clasts moderately to severely weathered volcanics [Landslide debris - shallow landslide]	hard drilling - Pitcher tube bent on rock	
7					HW	R1-R2	fractures, rough, very close, open			
	Interval not sampled								7 to 8 feet: drill advanced under own weight in soft material	
8		P5	0.3/0.5	0	MW	R3	fractures, rough, close to very close, open	MAFIC VOLCANIC ROCK; very dark brown; weathers to reddish brown with clasts of blue, olive, red, gray, purple; basalt and volcaniclastic rock with sandy matrix [Moraga Formation - derived landslide debris - shallow landside]		
9	17:30/2.5 feet				MW	R3	50° joint, rough, wavy			
		C4	2.2/2.5	0			crushed zone			
10							50° joint, rough			872.5
					MW	R2	fractures close to very close			
11					MW		40° joint, rough, wavy, tight			
12	27:30/3.0 feet	C5	2.8/3.0	1.2/2.8			40° joint, rough, wavy, tight			
13					SW	R3	35° joint, rough, wavy, tight			
							55° joint, rough			
14							50° joints, rough			
		C6		0	MW	R3	crushed zone			867.5
15										

See page 2 for abbreviations of terms related to weathering, strength, and sample method.

ROCK LOG - Boring No. AKA-5

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
15								15 to 16 feet: CLAY with gravel (CL); dark brown to dark bluish gray; subangular to subrounded gravel; fine-grained volcanics [Base of Moraga Formation - derived landslide debris]		867.5
16	15:00/4.0 feet	C_6	2.3/4.0	0					soft drilling 16 to 18 feet	
17									poor recovery missing Tm/To contact	
18							25° 1-inch clay seam	SANDSTONE and SILTSTONE; bluish gray; fine sand [Orinda Formation-derived landslide debris - deep landslide]		
							80° joint		soft drilling 18 to 22 feet	
					SW	R1	40° fracture, tight			
19							40° bedding?, tight	coarsens to medium sand, well graded, with subrounded to subangular coarse sand and fine gravel, dark grayish brown	some circulation loss (~20%)	
					MW					
						R0	60° joint, wavy, rough, open			
20					HW					862.5
21	31:00/5.0 feet	C_7	2.1/5.0	1.1/2.1						
22										
23							crushed rock zone, 1-inch thick, subhorizontal	fine- to medium-grained SANDSTONE; dark brown; in steeply dipping to irregular depositional contact with SILTSTONE		
					SW-MW					
24										
						R1				
25							45° joint, wavy, rough, open			857.5
	23:50/5.0 feet	C_8	4.7/5.0	4.2/4.7					some circulation loss (~20%)	
26										
					MW-HW	R0		CLAYSTONE and SILTSTONE, dark reddish brown to purple and bluish gray; with local subrounded to subangular "clasts" (corestones?) of siltstone		
27							50° shear, wavy, very rought, open, some polished and striated surfaces			
28					MW					
29		C_9				R0				
							10° fracture, wavy, very rough, open			
30										852.5

Lithology

Undisturbed sample
S = Shelby, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-5

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
30								same as above		852.5
31	23:50/5.0 feet	C_8	4.7/5.0	4.2/4.7	MW	R0	60° joint, planar, mineralized filling	SILTSTONE to fine SANDSTONE; minor claystone interbeds; bluish gray	slight circulation loss	
32					SW	R1	60° joint, tight 45° joint/fracture			
33					MW		fracture: several orientations, tight, closely spaces			
34					SW		subhorizontal interbed contacts			
35	11:00/5.0 feet	C_{10}	4.6/5.0	4.0/4.6	MW	R1	45° fractures, tight, very thin mineralization	SANDSTONE; fine; reddish, grayish brown		847.5
36						R0	20° bedding contacts	CLAY (CH); dark reddish brown; 3 to 4 inches thick; moist [Landslide plane]		
37					MW	R0	fractures, tight, closely spaced	SILTSTONE; bluish gray; subangular; gravel-sized clasts of siltstone; either old; annealed; breccia zone or corestones from in-situ weathering [Orinda Formation]		
38							fractures, several orientations, tight, closely spaced			
39	24:40/5.0 feet						55° bedding?	CLAYSTONE to SILTSTONE; reddish brown to bluish gray; moderately bedded with minor fine sandstone beds		
40					MW	R0	50° bedding? fractures, several orientations, tight			842.5
41		C_{11}	4.4/5.0	4.4/4.4	SW	R1	40° bedding, facies contact 80° joint/fracture, tight			
42					SW		45° bedding, facies contact			
43						R0	30° bedding			
44		C_{12}					45° bedding fractures, many orientations, tight to open, few polished surfaces			
45						R1				837.5

Lithology column: Drill Rate, Run No., Recovery/Cut, RQD, Weathering, Strength, Soil Samples/Borehole Tests, Discontinuity Log

Undisturbed sample
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Driven (2.5 to 3.0 inch) with liners
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Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-5

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Lithology	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Soil Samples/ Borehole Tests	Discontinuity Log	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
45											same as above		837.5
46		22:50/5.0 feet	C_{12}	4.1/5.0	<2/4.1		R0-R1			fracture, low angle, tight, very closely spaced			
47													
48						SW					with fine sandstone interbeds 1 to 6 inches thick		
49										35° bedding, planar to irregular, smooth to rough, open			
50		30:00/5.0 feet	C_{13}	5.1/5.0	4/5.1		R1					slight circulation loss	832.5
51													
52						SW	R1						
53											Bottom of hole 53.1 feet.		829.4
54													
55													
56													
57													
58													
59													
60													

Undisturbed sample
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Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-5A

Project Name and Job Number LBNL BUILDINGS 85 AND 85A WLA: 1717-B, AKA: 2335-4a			
Type and Diameter of Boring HQ wireline	Boring Location In road, ~7 feet off southeast corner of Building 85A		Total Depth 25 feet
Drilling Contractor and Rig Pitcher Drilling, Inc. Faeling 1500	Elevation and Datum 882 feet, MSL	Ground Water Depth ---	Depth to Bedrock >25 feet
Casing Size and Depth 4.5-inch diameter, 5 feet	Length of Core Barrel and Bit 3 feet Pitcher	No. of Core Boxes ---	Date Started 3/10/06
	Borehole Inclination 90°	Logged by J. Goodman (AKA)	Date Completed 3/10/06

Reviewed by/Date JNB 3/20/06

Depth (feet.)	Lithology	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Soil Samples/ Borehole Tests	Discontinuity Log	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
0													882.5
1													
2													
3													
4													
5													877.5
6												Drilling advanced to 12.5 feet to sample basalt-siltstone contact zone	
7													
8													
9													
10													872.5
11													
12											MAFIC VOLCANIC ROCK; heavily fractured/crushed in a matrix of angular gravel and fine to coarse sand; crude layering; moist [Moraga Formation - Landslide debris - shallow landslide]		
13		3	P_1	1.0/1.0		HW	R1			fractures abundant, clay-lined 30° joint, planar, slightly rough		600 psi	
14		4	P_2	1.7/2.0						45° bedding, reddish-yellowish brown silt (ash)	CLAY with variable amounts of sand and silt; colors range from pale yellow to brown to olive; soft; highly mixed [Landslide debris - shallow landslide]	soft drilling at 13.5 feet 400 psi	
15													867.5

See page 2 for abbreviations of terms related to weathering, strength, and sample method.

ROCK LOG - Boring No. AKA-5A

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
15		P_2					60° bedding	SAND; clayey; black; 10% fine gravel; some white calcium carbonate nodules [Paleosol and landslide debris - shallow landslide]		867.5
16	6	P_3	1.75/2.0	0			subhorizontal contact, Paleosol over siltstone	16.5 to 18.7 feet: SILTSTONE with CLAY SEAMS; red to gray; medium to high plasticity [Landslide shear zone]	400 psi	
17								18 feet: CLAY; dark brown; soft; 1.5 inches thick [Landslide plane]		
18	3	P_4	0.8/1.0		HW	R1	<5° shear, 1.5 inches soft clay	18.7 feet: CLAY; stiff; 1.5 inch thick [Old landslide plane]	500 psi	
							12° shear, 1.5 inches stiff clay, old slide plane			
19	4	P_5	1.6/1.5		MW	R2	bedding, irregular, subhorizontal	SANDSTONE; greenish gray; fine to medium; weakly cemented; [Landslide debris - deep landslide]	1000 psi	
20								coarse sand and fine gravel		862.5
21	4	P_6	0.9/1.5	1.1/2.1	HW-SW	R2	55° bedding	SILTSTONE, clayey to sandy, crushed		
22									not sampled below 21.5 feet	
23										
24										
25								Bottom of hole at 25 feet.		857.5
26										
27										
28										
29										
30										852.5

Undisturbed sample
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Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-6

Project Name and Job Number LBNL BUILDINGS 85 AND 85A WLA: 1717-B, AKA: 2335-4a			WLA
Type and Diameter of Boring Rotary wash, 4 7/8-inch diameter	Boring Location In road 26 feet east of northeast corner of Building 85		Total Depth 94.5 feet
Drilling Contractor and Rig Pitcher Drilling, Inc.; Faeling 1500	Elevation and Datum 876.5 feet MSL	Ground Water Depth ---	Depth to Bedrock 67 feet
Casing Size and Depth 5-inch diameter, 6.5 feet	Length of Core Barrel and Bit 8 feet with bit; 5-ft. inner barrel	No. of Core Boxes ---	Date Started 3/6/06
	Borehole Inclination 90°	Logged by J. Goodman (AKA)	Date Completed 3/8/06

Reviewed by/Date JNB 3/20/06

Depth (feet.)	Run No.	Recovery/Cut	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
0						Asphalt pavement - 6 inches thick overlying brown aggregate base 11 inches thick	Pilot hole hand augered to 5 feet below grade and subsequently reamed	876.5
1								
2					2.2 to 4.2 feet numerous mechanical breaks	Fat CLAY; mottled gray-green and olive-brown; trace silt and fine gravel; very moist [Artificial fill]		
3								
4								
5						SILT, clayey within minor fine sand; greenish gray; stiff; moist [Quaternary colluvium and landslide debris - shallow landslide]		871.5
6	MC1	1.5/1.5						
7	101₂	1.75/2.5				CLAY, silty, with fine gravel; brown; gravel is angular and weathered, reddish brown, consisting of siltstone and volcanics; massive; some decomposed charcoal	101₂: 300 psi	
8								
9						completley weathered bedrock and soil ; numerous angular rock faces; contains zones of clayey sand; fine charcoal, rootlets		
10	101₃	1.75/2.5	CW	R0	40° - 45°: fat CLAY 40° - 45°: thin clay seam separates rock from sandy clay soil, fractured, crushed; some polished faces	clay rich at base of unit	101₃: 300 psi	866.5
11						SANDSTONE; greenish gray, with some claystone fragments; generally massive [Landslide debris - shallow landslide]		
12	101₄	2.0/2.0	HW	R2			101₄: 300 psi	
13					20°: joint, rough, stepped, polished surfaces on clay fragments 30°: joint, clay face with slickensides	CLAYSTONE; gray to dark green; very moist; highly fractured and sheared; with numerous slickensides		
14	101₅	1.67/3.5	HW	R1	20°: joint, polished surface		101₅: 300 psi	
15								861.5

See page 2 for abbreviations of terms related to weathering, strength, and sample methods.

ROCK LOG - Boring No. AKA-6

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
15										861.5
	2	101_5	1.67/3.5				abundant fractures	same as above		
16							16 feet: clay seam, abundant fractures and random with polished faces			
17	2	101_6	1.67/3.5		MW	R1	65°: clay seam, polished		101_6: 300 psi	
18							25°: clay seam, polished 15°: joint, irregular	gray to grayish green, less crushed than above, but still prominent fractures		
19	3	101_7	1.5/1.5		MW	R1	30°: clay seams, polished rootlets along surface		101_7: 300 psi	
20										856.5
21	3	101_8	1.5/1.5		MW	R1	zone of irregular mechanical breaks high-angle quartz vein with slickensides	not as clay-rich along fractures	101_8: 300 psi	
22	3	101_9	1.5/1.5		MW	R1	17°:contact defined by prominent shear zone, clay-rich, gray and red-brown (~1 to 2 inches thick)			
23								CLAYSTONE; reddish brown; possible volcanic clasts		
24	2	101_{10}	2.0/2.0		HW	R1	30°:joint, polished, clay-lined		101_{10}: 300 psi	
25								25 to 28.25 feet: inclusions of gray-green sandstone clasts silicified pebbles (volcanics?)		851.5
26	2	101_{11}	2.0/2.0		HW	R1			101_{11}: 300 psi	
27										
28	3	101_{12}	2.0/2.0		HW	R1	20°: contact: defined by 1-inch thick gray-brown clay, plastic and firm, sheared	CLAYSTONE; gray-green; with isolated fine sand zones; heavily sheared to 30 feet [Landslide shear zone]	101_{12}: 300 psi	
29							28.2 to 32 feet: distinct shear zones, soft and plastic clay, very sticky gouge			
30	4	101_{13}	0.84/2.0						101_{13}: 300 psi	846.5

Undisturbed sample
101 = 101 sampler, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-6

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
30	4	101_{13}	0.84 / 2.0		HW-MW	R1		CLAY; gray-brown; soft; plastic [Landslide plane]	101_{13}: 300 psi	846.5
31	4	101_{14}	0.84 / 2.0		HW	R1	numerous mechanical breaks		101_{14}: 300 psi	
32	3	101_{15}	0.5 / 0.5		MW			SILTSTONE, finely laminated, brown and fine SANDSTONE, blue-gray, with polished greenish gray clay seams [Landslide debris - deep landslide]	32.5 to 33 feet: driller reports hard zone	
33	4	101_{16}	1.25 / 2.0		HW	R1	55°: joint; polished		101_{16}: 300 - 500 psi	
35										841.5
36	6	101_{17}	2.0 / 2.0				numerous high-angle polished clay faces	CLAYSTONE; gray-green; sheared	101_{17}: 500 - 1500 psi	
37							joint, subhorizontal, polished clay faces			
38	6	101_{18}	2.0 / 2.0						101_{18}: 300 - 500 psi	
39							depositional contact	Fine SANDSTONE; greenish gray		
40	5	101_{19}	2.67 / 3.0		HW	R2	CLAY seam; gray-green; 1-inch thick	CLAYSTONE; brown with minor SANDSTONE; greenish gray; sheared	101_{19}: 600 psi	836.5
41										
42	3	101_{20}	2.0 / 2.0		MW	R1-R2	contact is irregular	Fine, sandy SILTSTONE; dark gray and silty fine SANDSTONE; lightly gray; weakly cemented	stop drilling at 42 feet. 3/7/06 resume drilling 101_{20}: 1000 psi	
43							numerous mechanical breaks			
44	2	101_{21}	1.25 / 2.0		MW				101_{21}: 300 psi	
45										831.5

Undisturbed sample
101 = 101 sampler, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-6

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
45	2	101_{21}	1.25/2.0		MW	R2		contains thin layers of poorly sorted fine to coarse sand; weak to moderate cementation		831.5
46							common polished fracture faces	CLAYSTONE; gray-green; crushed and sheared; cemented		
47										
48	6	101_{22}	3.0/3.0		MW	R1-R2		fine sandy SILTSTONE; blue-gray; faint laminations	101_{22}: 300 psi	
49							numerous fractures, subhorizontal, irregular, rough			
50								CLAYSTONE; grayish brown, massive; with few clay seams		826.5
51	4	101_{23}	3.0/3.0		MW	R2				
52	4	101_{24}	0.75/1.0				rock mass has "disaggregated" quality numerous shears, polished faces	slight increase in sand content		
53								Silty fine SANDSTONE; blue-gray; massive; hard	switch to pitcher tube sampler	
54	9	P_{25}	2.42/3.5		SW	R2			P_{25}: 1500 psi	
55								increase in silt content		821.5
56	7	P_{26}	2.0/2.0				45°: bedding	medium-grained SANDSTONE; gray to reddish brown		
57							at 57.5 feet: shears: upper 35°, lower: 55°	58 ft.: 2-inch thick CLAY layer; dark gray; soft; sticky; within component SANDSTONE		
58							50°: clay layer, undulating			
59	6	P_{27}	2.5/2.5						P_{27}: 1500 psi	
60										816.5

Undisturbed sample
101 = 101 sampler, P = Pitcher, C = rock core

Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

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Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-6

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
60							25°: bedding	CLAYSTONE bed; green; polished and slickensided; indurated; 5 inches thick		816.5
61	5	P_{28}	2.5		MW	R2		SANDSTONE to SILTSTONE, blue-gray	P_{28}: 1200 psi	
62							several high-angle fractures clay lined			
63	5	P_{29}	2.5/2.5		MW	R2			P_{29}: 1200 psi	
64										
65							65 feet: shear, low angle, 3 inches thick	CLAY; blue-gray; with clasts of SILTSTONE; clay is highly plastic [Landslide plane]		811.5
66	8	P_{30}	2.25/2.5		MW	R1		zone of numerous, saturated clay seams bounded by crushed rocks [Landslide shear zone]	P_{30}: 1000 psi	
67							67 feet: 3/4- to 1-inch-thick clay seam at contact	Fine sandy SILTSTONE to silty fine SANDSTONE; blue-gray to gray; moderately cemented [Orinda Formation]		
68	11	P_{31}	2.0/2.0		MW	R2			P_{31}: 1500 psi	
69										
70										806.5
71	12	P_{32}	2.67/2.5		MW	R2-R3			P_{32}: 2000 psi	
72										
73	8	P_{33}	0.75/2.0		MW	R2-R3	several fractures, high angle; clay lined		P_{33}: 1500 psi	
74	9	P_{34}	1.42/1.5		MW			1.5-inch thick CLAYSTONE layer; green; sheared	P_{34}: 2000 psi	
75										801.5

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ROCK LOG - Boring No. AKA-6

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
75	9	P_{34}	1.42 / 1.5				43°: joint, minor mineralization	same as above		801.5
								increase in cementation to well cemented; numerous high-angle mineralized fractures		
76	10	P_{35}	1.33 / 2.0		MW	R2-R3	45°: joint, mineralized		P_{35}: 2000 psi	
77										
78	13	P_{36}	1.5 / 1.5		SW-MW	R3	55°: 2 subparallell shear planes, slickensided		P_{36}: 2000 psi	
79	6	P_{37}	0.5 / 1.0		SW	R3	60°: shear, slickensided		P_{37}: 2000 psi	
80	39	C_{38}	3.0 / 3.0		SW	R3	55°: intersecting joint set 60°: shear, tight	graded bed of fine to pebbly sandstone, 6 inches thick	switch to rock coring	796.5
81								charcoal fragment, green	C_{38}: 100- 200 psi	
82							40°: bedding, 1-inch thick pebble layer	few pebble layers		
83							41°: clay seam/laminae, tight	CONGLOMERATE; gray-green; fine gravel; moderately cemented		
84										
85	39	C_{39}	4.5 / 4.5		SW	R4			C_{39}: 100 - 200 psi	791.5
86										
87							60°: clay seam		stop drilling at 87.5 feet	
88								CLAYSTONE; dark gray; sheared; weak minearalized veins	resume drilling 3/8/06	
89	42	C_{40}	3.0 / 3.0		MW	R1			C_{40}: 300 - 500 psi	
90							70°: clay seam			786.5

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ROCK LOG - Boring No. AKA-6

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Lithology	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Soil Samples/ Borehole Tests	Discontinuity Log	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
90			C_{40}								same as above		786.5
91													
92			C_{41}	3.7/4.0						55°: lithology contact, lined with 1/8-inch thick red-brown clay numerous vertical shear planes with slickensides oriented at 60° to 70° contact is gradational	Clayey SILTSTONE; dark gray to brownish gray with inclusions of SILTSTONE; light gray	C_{41}:500 psi	
93													
94											Fine SANDSTONE; dark gray, moderately cemented		
95											Bottom of hole at 94.5 feet		781.5
96													
97													
98													
99													
100													
101													
102													
103													
104													
105													

Undisturbed sample
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Driven (2.5 to 3.0 inch) with liners
MC = Modified California, O = other

Standard Penetration Test (SPT) sampler

Weathering: Fr - Fresh, SW - Slight, MW - Moderate, HW - Highly, CW - Completely, and RS - Residual soil. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak.

ROCK LOG - Boring No. AKA-7

Project Name and Job Number LBNL BUILDINGS 85 AND 85A WLA: 1717-B, AKA: 2335-4a			WLA
Type and Diameter of Boring Rotary wash, 4 7/8-inch diameter	Boring Location In road, 50 feet east of north corner, Building 85A		Total Depth 69.5 feet
Drilling Contractor and Rig Pitcher Drilling, Inc., Faeling 1500	Elevation and Datum 880.5 feet MSL	Ground Water Depth ---	Depth to Bedrock 58 feet
Casing Size and Depth 5-inch diameter, 6.5 feet	Length of Core Barrel and Bit 8 feet with bit; 5-ft. inner barrel	No. of Core Boxes ---	Date Started 3/8/06
	Borehole Inclination 90°	Logged by J. Goodman (AKA)	Date Completed 3/9/06

Reviewed by/Date JNB 3/20/06

Depth (feet.)	Lithology	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Soil Samples/ Borehole Tests	Discontinuity Log	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
0											Asphalt pavement 4 inches thick over CLAY; with medium to coarse sand and fine subangular gravel; firm; increase in gravel content below 1 foot, moist [Artificial fill]	Pilot hole hand augered to 5 feet below grade and subsequently reamed	880.5
1													
2										2.2 to 4.2 feet numerous mechanical breaks	CLAY; orange to red-brown; abundant fine angular gravel; trace fine sand; moist [Landslide debris - shallow landslide]		
3													
4													
5													875.5
6		Interval not sampled										6.5 to 8.5 feet: caving	
7		2	P_1	2.0/2.0		HW	R1				Mafic volcanic rock; reddish brown; crushed; with randomly oriented clay along fragments; crudely layered [Moraga Formation-derived landslide debris - shallow landslide]	P_1: 50 - 100 psi	
8		Interval not sampled											
9													
10		4	P_2	1.5/2.0							color change to olive-brown; increase in clay content; minor medium to coarse sand and charcoal (?) crumbly to crushed mafic volcanic gravel	P_2: 100 - 500 psi	870.5
11		2	P_3	0.67/1.0						stiff clay marks distinct contact between volcanics and siltstone; no evidence of recent shearing	11.2 - 11.5 feet: CLAY; dark brown; very stiff [older slide plane?]	P_3: 500 psi	
12		6	P_4	1.5/1.5		MW-HW	R2				CLAYSTONE; olive-brown and gray-green; locally sandy [Orinda Formation-derived landslide debris - shallow landslide]	P_4: 600 psi	
13										10° - 35° dark brown clay seam, 1 inch thick, stiff, polished, but no straie	SANDSTONE; dark gray; locally clayey; weaky cemented		
14		8	P_5	0.75/1.5		SW-MW	R2				13.3 feet: series of very thin clay seams; subparallel to bedding; appear to offset a thin gray-white sandstone bed	P_5: 1100 psi	
15													865.5

See page 2 for abbreviations of terms related to weathering, strength, and sample method.

ROCK LOG - Boring No. AKA-7

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
15										865.5
16	4	P_6	2.0/2.0		MW-HW	R1	16 ft: 2- to 4-inch thick clay seam with crushed clasts, stiff, dry	Fine to coarse SANDSTONE; mottled; moderately cemented with pockets of stiff clay and 2-inch diameter rounded gravel clasts; chaotic appearance; disaggregated	P_6: 600 psi	
17								CLAY; gray; stiff; 2 to 4 inches thick with crushed clasts [Landslide plane?]		
18	13	P_7	1.5/2.5		HW	R1	contact is irregular/erosive	CLAYSTONE with interbedded clayey SILTSTONE [Landslide debris]	P_7: 1200 psi	
19							5°: 1-inch thick clay seam 60°: lithologic contact, slightly irregular	CLAY; dark brown; stiff; 1-inch thick [Landslide plane?] CLAYSTONE, SILTSTONE and fine SANDSTONE; gray; brown; and reddish brown [Landslide debris - lower landslide]		
20	6	P_8	1.75/1.5		MW	R1-R2	45°: competent SANDSTONE bedding?		P_8 : 1200 psi	860.5
21							60°: brown clay seam, slightly mineralized			
22	4	P_9	1.33/1.5		SW	R1-R2			P_9: 1100 psi	
23							rock mass becomes increasinly fractured, numerous high angle fractures			
24	7	P_{10}	1.16/2.0		HW	R1			P_{10}: 800 psi	
25										855.5
26	7	P_{11}	1.08/1.5		MW	R1	30°: bedding, brown clay layer	CLAYSTONE and SILTSTONE; gray to gray-brown; increasingly crushed and sheared with clay-rich fractures	P_{11}: 800 psi	
27	3	P_{12}	1.08/1.5		MW	R1		26.5 to 27 feet: clay-filled fractures [older shear zone?]	P_{12}: 600 psi	
28							40°: bedding brown clay layer	CLAYSTONE; dark brown		
29	2	P_{13}	1.5/1.5		MW	R1			P_{13}: 600 psi	
30	4	P_{14}	1.0/1.5				40°: lamination		P_{14}: 1000 psi	850.5

Undisturbed sample
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ROCK LOG - Boring No. AKA-7

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
30										850.5
	4	P_{14}	1.0/1.5							
31										
	?	P_{15}	2.0/1.5		MW	R1	70°: clay seam 60°: joint; adjacent material is crushed with angular blocks/ fragments	color change to dark brown	P_{15}: 800psi	
32										
33										
	6	P_{16}	2.5/3.0		MW	R2		very fine sandy SILTSTONE bed; dark gray; weakly to moderately cemented	P_{16}: 800psi	
34										
35										845.5
36					MW			rock mass becomes increasingly weathered		
	6	P_{17}	2.5/2.5			R1			P_{17}: 800 psi	
37										
38					HW					
	4	P_{18}	1.5/2.0		HW	R1			P_{18}: 600 psi	
39										
40							clay seam, subhorizontal, irregular surface, slickensided	1-inch thick layer of CLAY; brown; very stiff, encapsulating rock fragments		840.5
	8	P_{19}	2.5/2.0		HW	R1			P_{19}: 600 psi	
41										
42										
	6	P_{20}	1.5/1.5			R1			P_{20}: 1000 psi	
43										
							no clay gouge or shears at contact			
44										
	9	P_{21}	1.84/2.0		SW	R2-R3	55° to 60° - quartz veins, subparallel	Fine SANDSTONE; brown; well sorted; moderately cemented	P_{21}: 700 psi	
45										835.5

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ROCK LOG - Boring No. AKA-7

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
45		P_{21}						same as above		835.5
46	5	P_{22}	2.0/1.5		SW	R2-R3	40°: joint; rough; clay lined with slickensides		P_{22}: 600 psi	
47							contact is crushed with fractures and polishing, no clay gouge,	Clayey SILTSTONE; green; sheared; numerous very thin shears - old tectonic features?		
48	8	P_{23}	2.0/2.5		MW	R1	70°: 1/8-inch thick clay seams; very closely spaced		P_{23}: 1200 psi	
49								Silty fine SANDSTONE; gray to greenish gray; moderately cemented; rock is generally highly fractured		
50	10	P_{24}	2.5/2.0		SW	R2-R3			P_{24}: 1600 psi	830.5
51							50°: brown clay seam			
52								increase in weathering; numerous subvertical fractures; some with recrystallization; no distinct clay seams		
53	10	P_{25}	2.33/3.0		HW	R1-R2			P_{25}: 1500 psi	
54							52°: clay seam, tight 45°: quartz vein			
55	9	P_{26}	2.42/1.5		HW	R1	25° - 35°: lithologic contact	CLAYSTONE and SILTSTONE; green; sheared; with mineralized veins	P_{26}: 1300 psi	825.5
56										
57	10	P_{27}	2.25/2.0					CLAY; reddish brown; with rock fragments; medium stiff with some soft zones; within fracture clasts [Landslide plane]	P_{27}: 1600 psi 57.5 ft. - driller reports soft zone	
58							45°: quartz vein	Fine SANDSTONE with SILTSTONE; gray, weakly cemented [Orinda Formation]		
59	6	P_{28}	2.08/2.5					clean SANDSTONE; tight and competent; no dilation; coarsens with depth	P_{28}: 500 psi	
60					SW		45°: quartz vein			820.5

Undisturbed sample
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ROCK LOG - Boring No. AKA-7

Project Name and Job Number
LBNL BUILDINGS 85 AND 85A
WLA: 1717-B, AKA: 2335-4a

WLA

Depth (feet.)	Drill Rate (min/ft)	Run No.	Recovery/Cut	RQD	Weathering	Strength	Discontinuity Description	Lithology	Remarks	Elevation (feet.)
60		P_{28}						same as above		820.5
61	10	P_{29}	2.16/2.0		HW	R1	45°: quartz vein 25°: joint, planar, smooth	CLAYSTONE; sheared with numerous slickensides, no gouge	P_{29}: 1500 psi	
62										
63	10	P_{30}	2.42/2.5				55°: bedding 63°: quartz vein	Fine SANDSTONE and SILTSTONE; dark gray, weakly cemented with well-cemented zones at fractures; isolated layers of green CLAYSTONE; no gouge; fractures show occasional polished faces	P_{30}: 1000 psi	
64										
65										815.5
66	11	P_{31}	2.75/2.5		HW	R1-R2			P_{31}: 1600 psi	
67										
68	7	P_{32}	2.16/2.0		MW	R3			P_{32}: 700 psi	
69										
70								Bottom of hole at 69.5 feet.		810.5
71										
72										
73										
74										
75										

Undisturbed sample
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Driven (2.5 to 3.0 inch) with liners
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Weathering: Fr - Fresh, Sl - Slight, Mo - Moderate, Se - Severe, and VS - Very Severe. Strength: R6 - Extremely strong, R5 - Very strong, R4 - Strong, R3 - Medium strong, R2 - Weak, R1- Very weak, and R0 - Extremely weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be - Bedding, Fa - Fault, Fo - Foliation, Jo - Joint, Me - Mechanical break, Sh - Shear, and Ve - Vein. Joint Descriptions: Dip, Surface shape (Pl - Planar, St - Stepped, or Wa - Wavy), Roughness (Sm - Smooth, Sl - Slightly Rough, Ro - Rough, and VR - Very Rough), Aperture (Fi - Filled, He - Healed, Op - Open and Ti - Tight), type and amount of infilling, slickensides, etc. Remarks: Drill water return and losses, drill water color, drill cuttings, rapid or slow drilling, etc.

APPENDIX D

Geophysical Logs

NORCAL

NORCAL GEOPHYSICAL CONSULTANTS, INC.

OPTV LOG

CO KROPP
WELL AKA-5
FLD LBL
CTY BERKELEY
STE CA
FILING No

COMPANY KROPP AND ASSOCIATES
WELL ID AKA-5
FIELD LBL
COUNTRY STATE CA

LOCATION
LBL, BUILDING 85

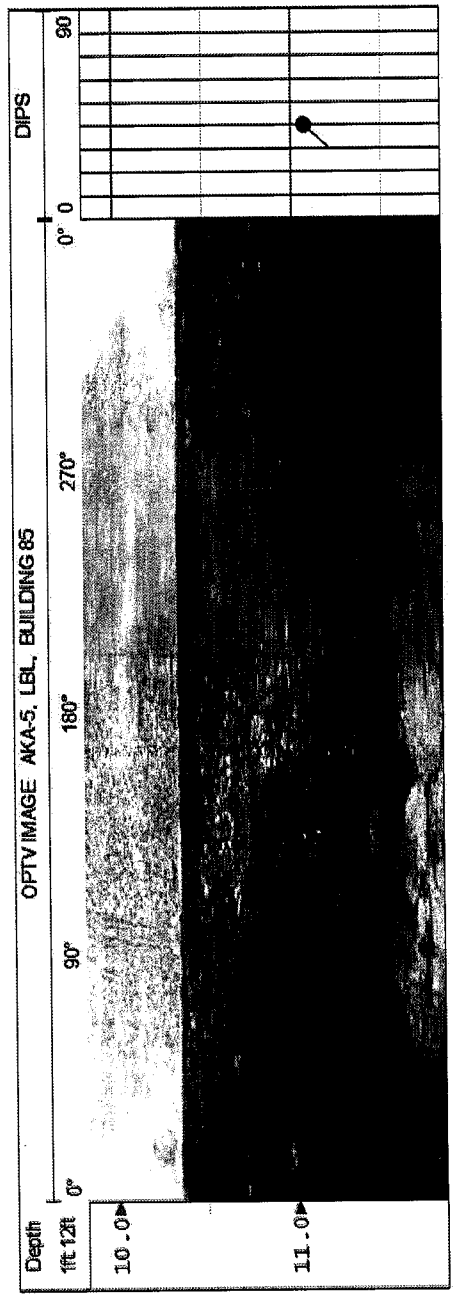
SEC TWP RGE

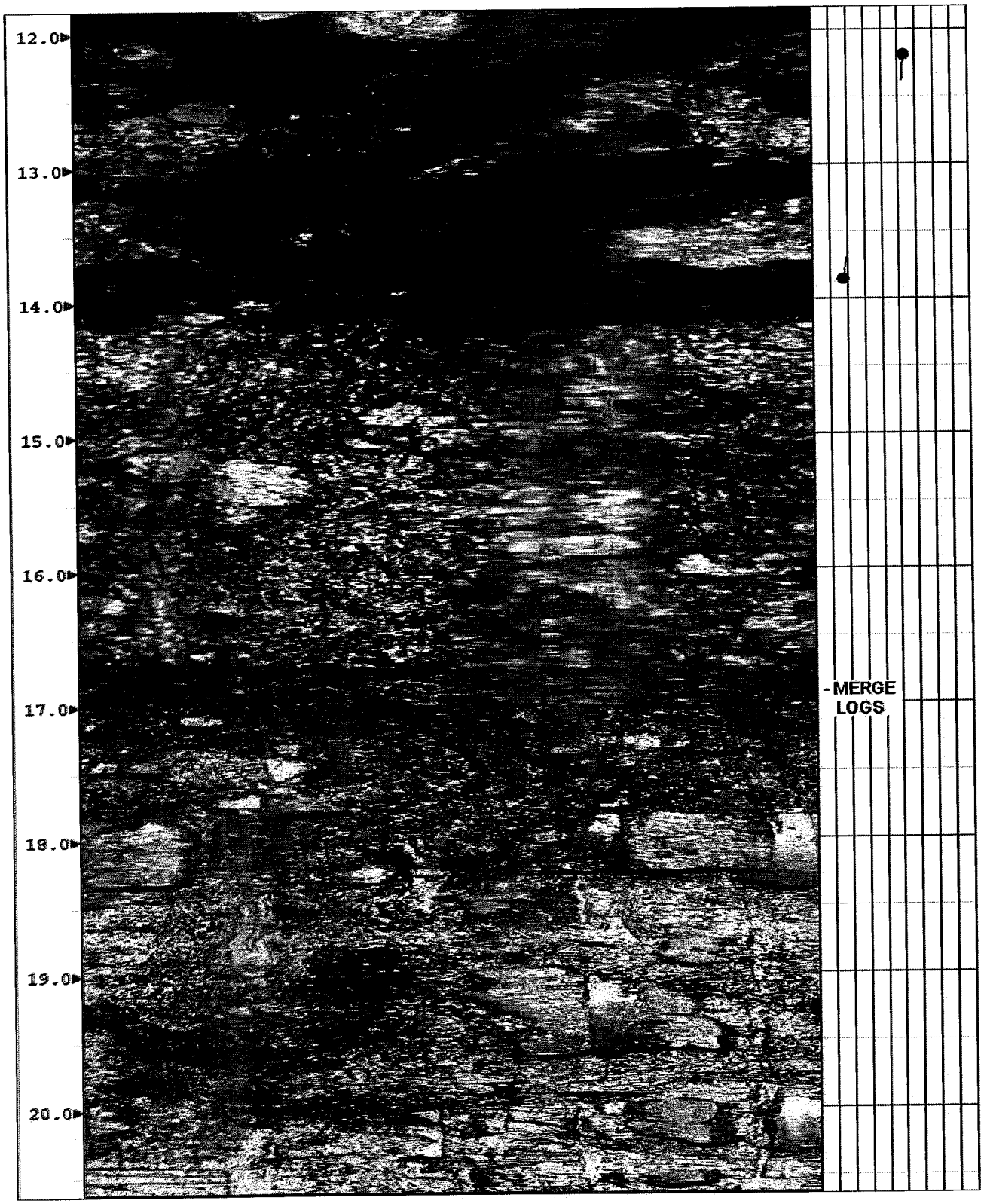
OTHER SERVICES

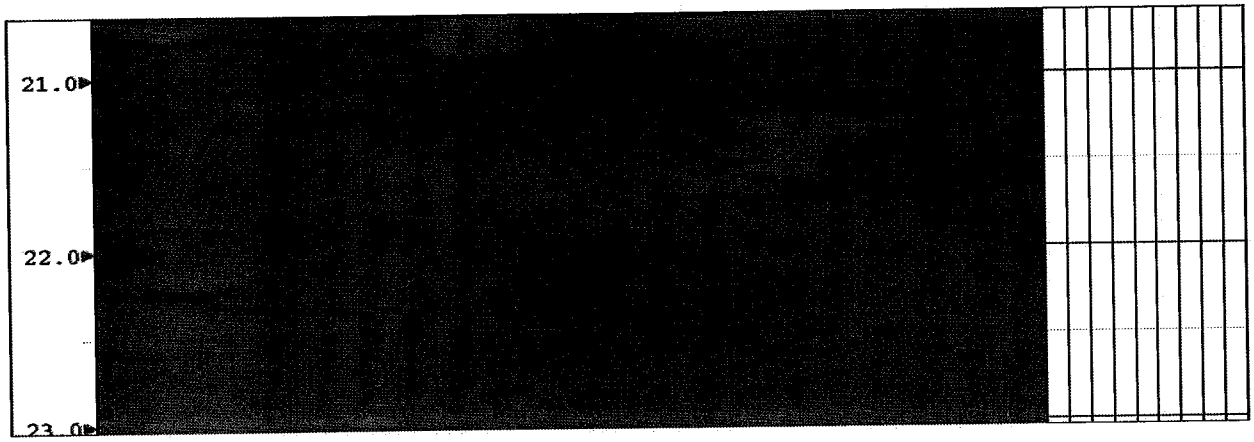
PERMANENT DATUM ELEVATION K.B.
LOG MEAS. FROM ABOVE PERM. DATUM D.F.
DRILLING MEAS. FROM G.L.

DATE	MARCH 10, 2006	TYPE FLUID IN HOLE	
RUN No	1 AND 2	SALINITY	
TYPE LOG	OPTV	DENSITY	
DEPTH-DRILLER	25	LEVEL	20.7
DEPTH-LOGGER	23	MAX. REC. TEMP.	
BTM LOGGED INTERVAL	23		
TOP LOGGED INTERVAL	10		
OPERATING RIG TIME	30 MIN		
RECORDED BY	W HENRICH		
WITNESSED BY	J GOODMAN		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
1	4 5/8	0	25	5	STEEL	0	10




12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0
-MERGE
LOGS


21.0
22.0
23.0

NORCAL

OPTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED OPTV DIPS LOG

24 Jul 2006

KROPP & ASSOCIATES

Borehole: AKA-6

LBL BUILDING 85

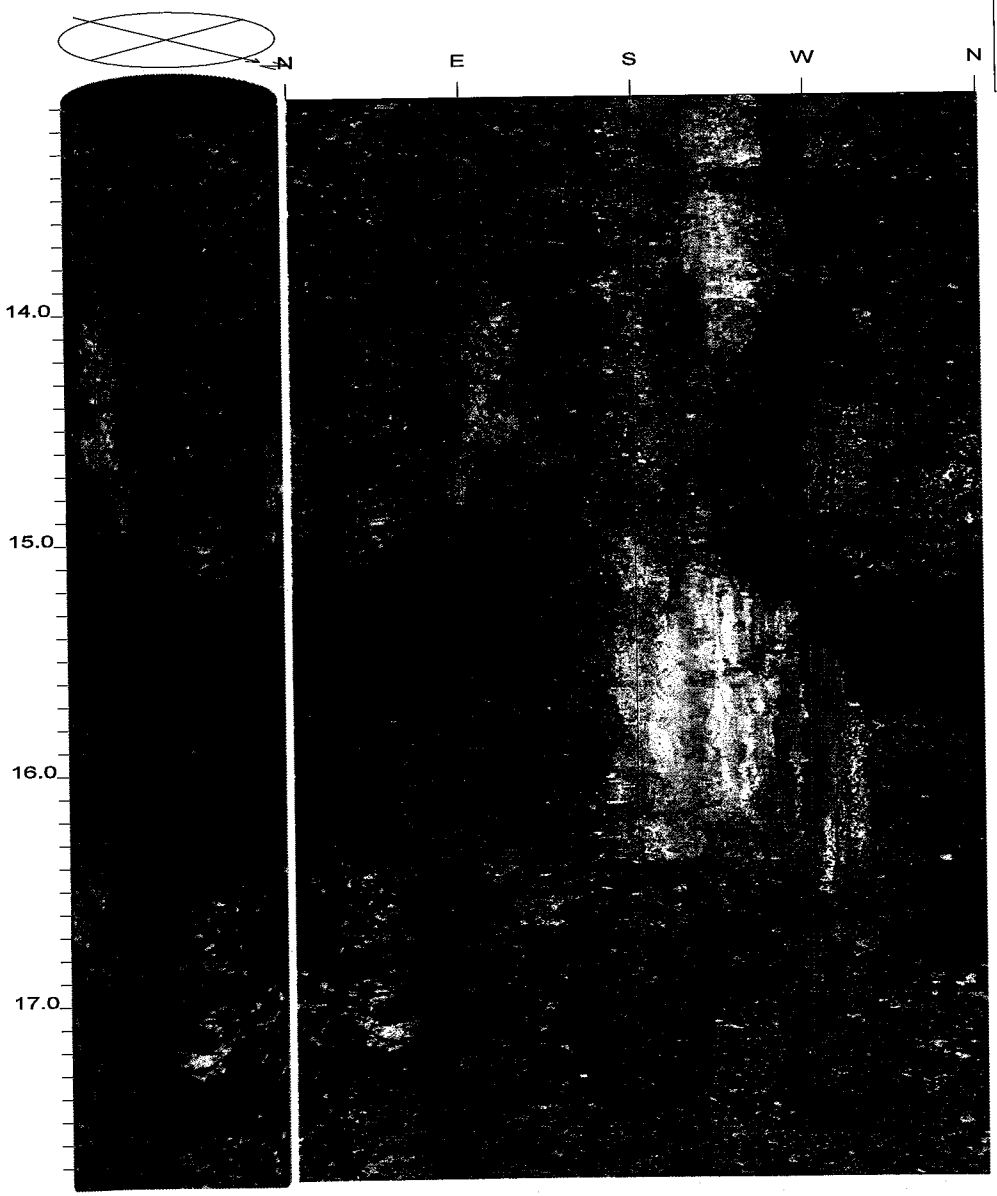
top of borehole.....
East:
North:
Elev:NA

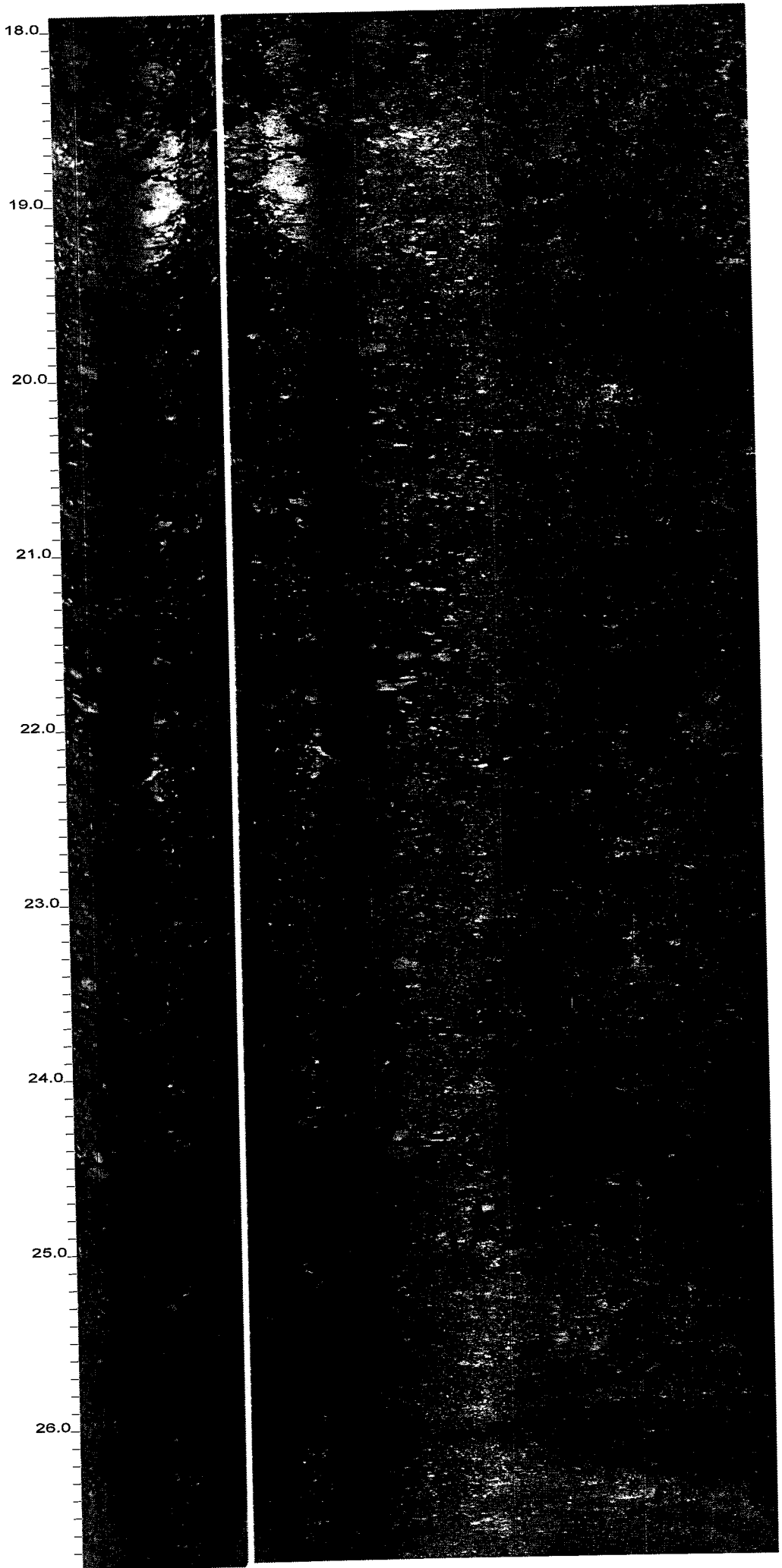
North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = fixed format

Zone from 92.904 to 13.072ft
Format: BHTV-NESWN

Borehole diam: 5.220inch
Vertical = borehole-axis

COMMENTS

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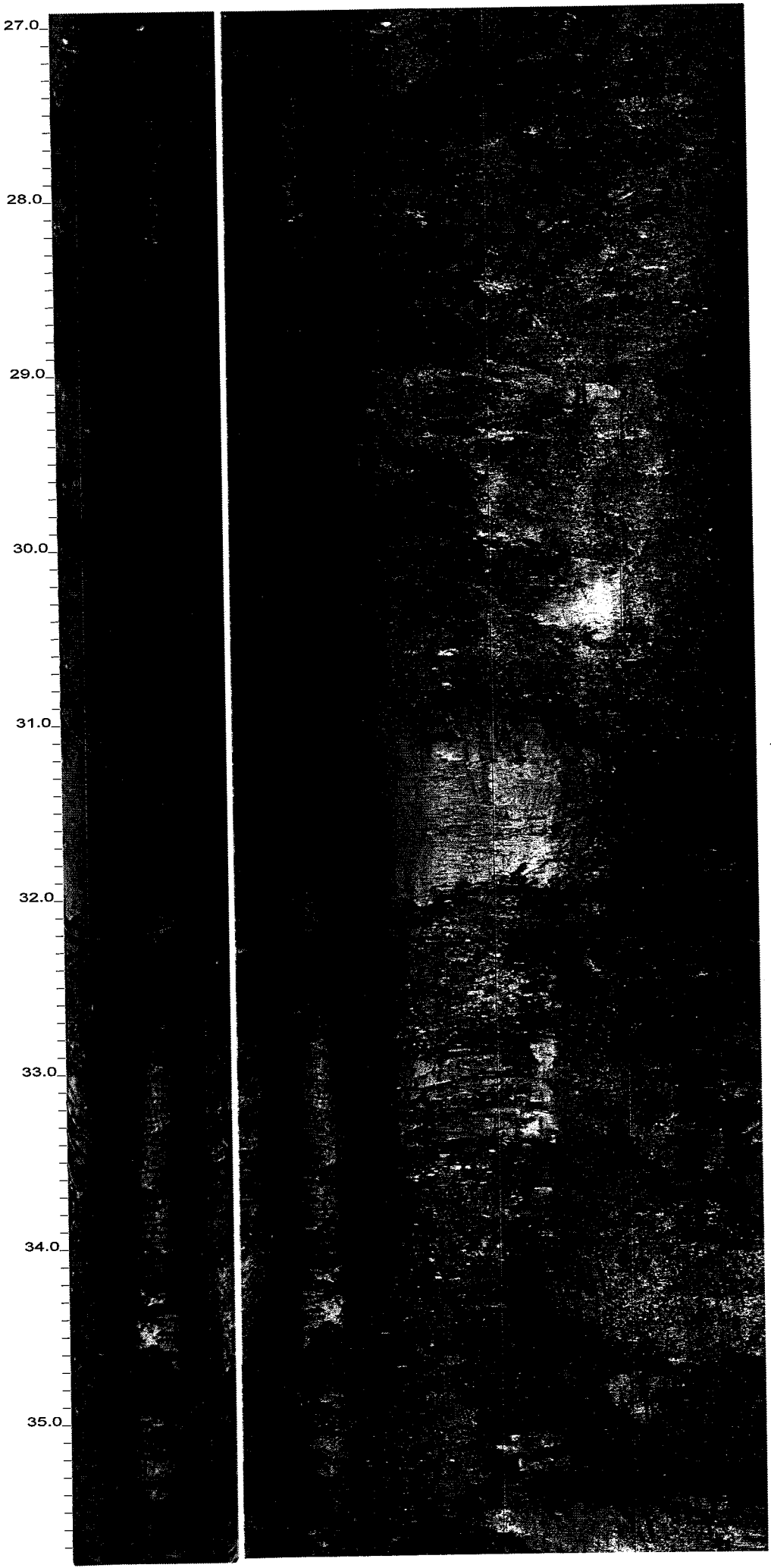
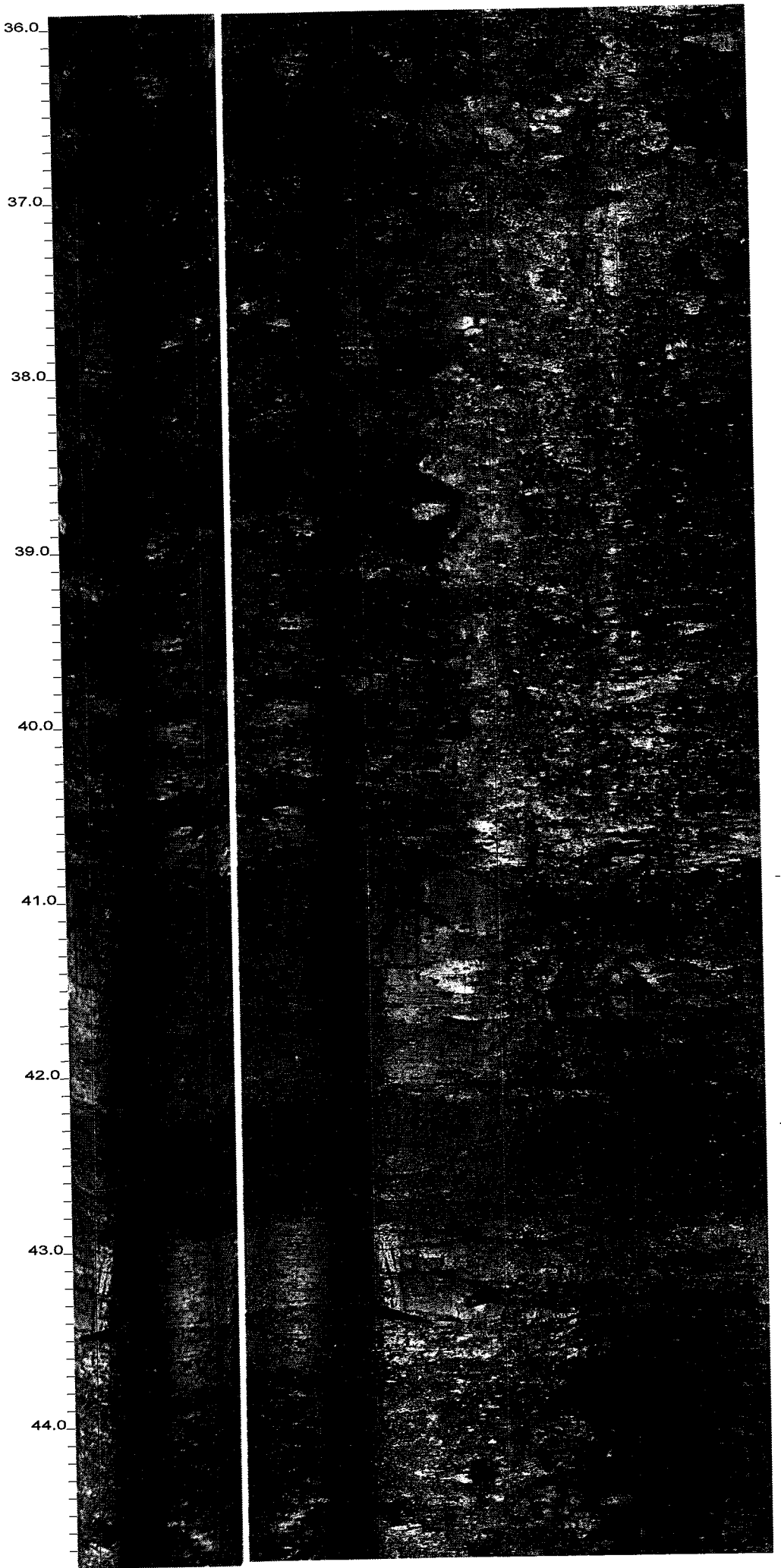
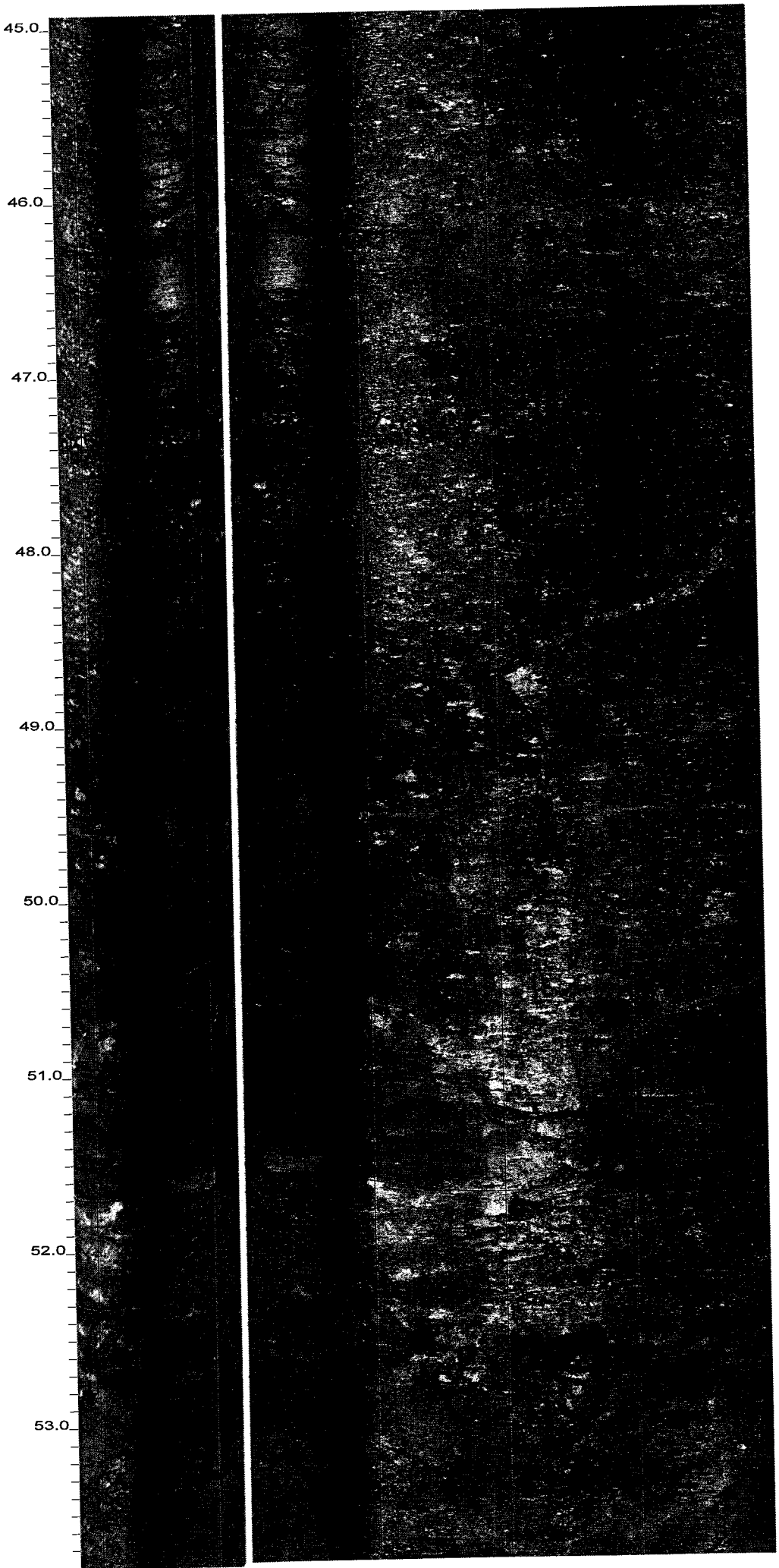
23.0
24.0
25.0
26.0

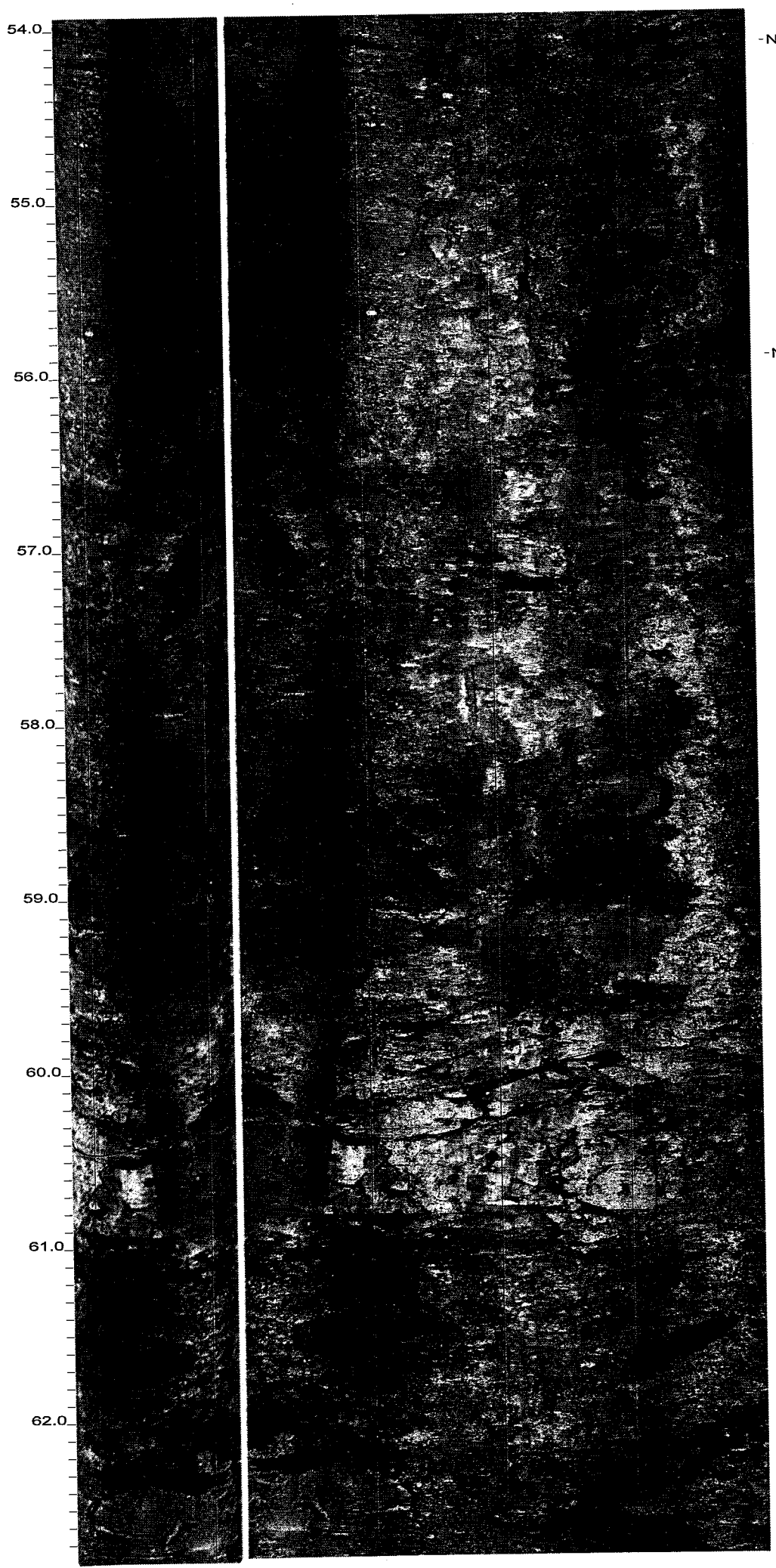

27.0
28.0
29.0
30.0
31.0
32.0
33.0
34.0
35.0
-N334 56 CONTACT
-N113 25 Discontinuity Irregular
-N006 46 Bedding
-N001 47 Bedding
-N358 54 Bedding
,N312 38 Bedding

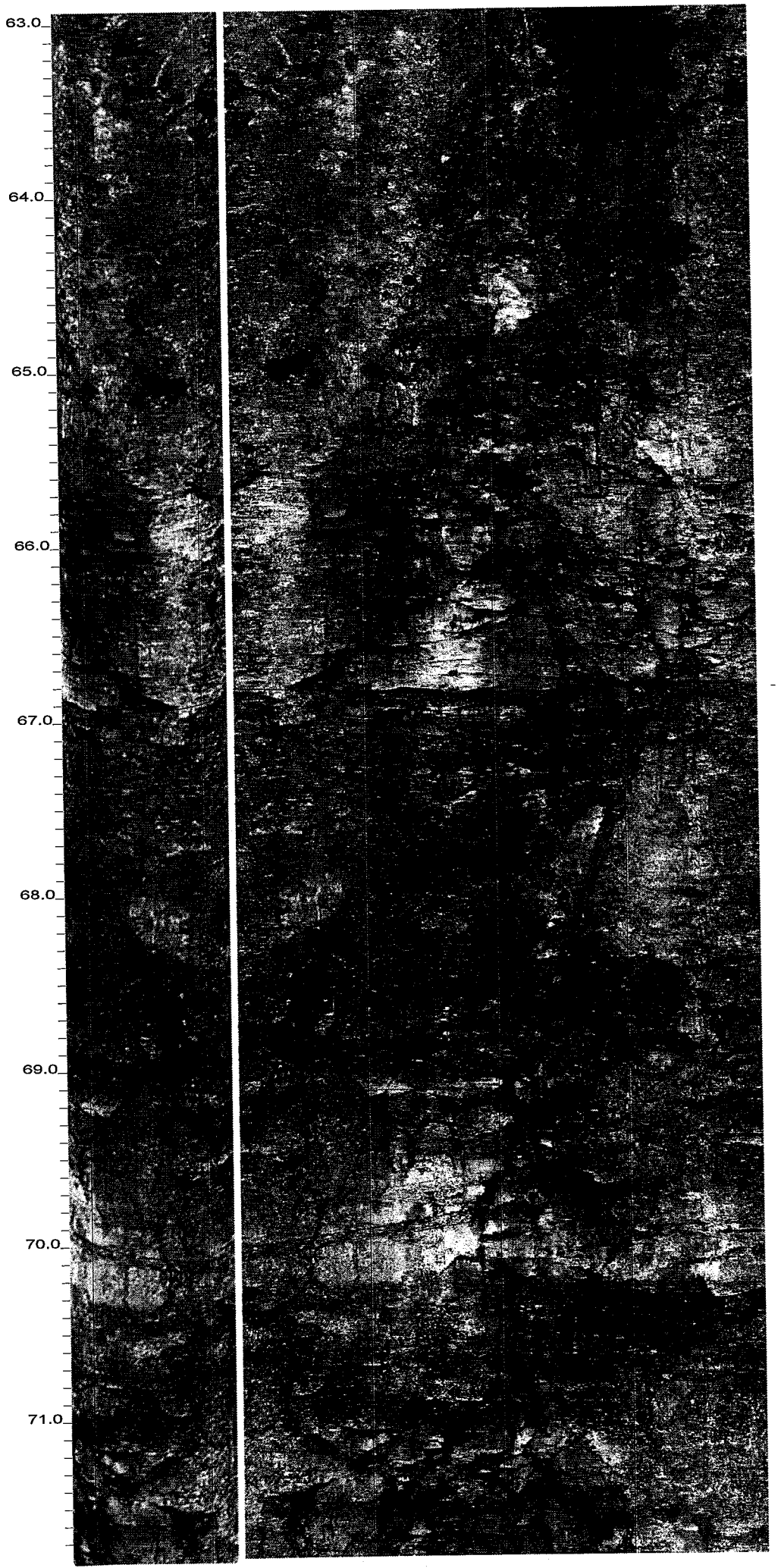

36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0
44.0
-N258 51 CONTACT
-N105 47 Fracture Discontinuous
-N194 15 Fracture Discontinuous
-N141 38 Fracture Discontinuous
-N116 34 Fracture Discontinuous



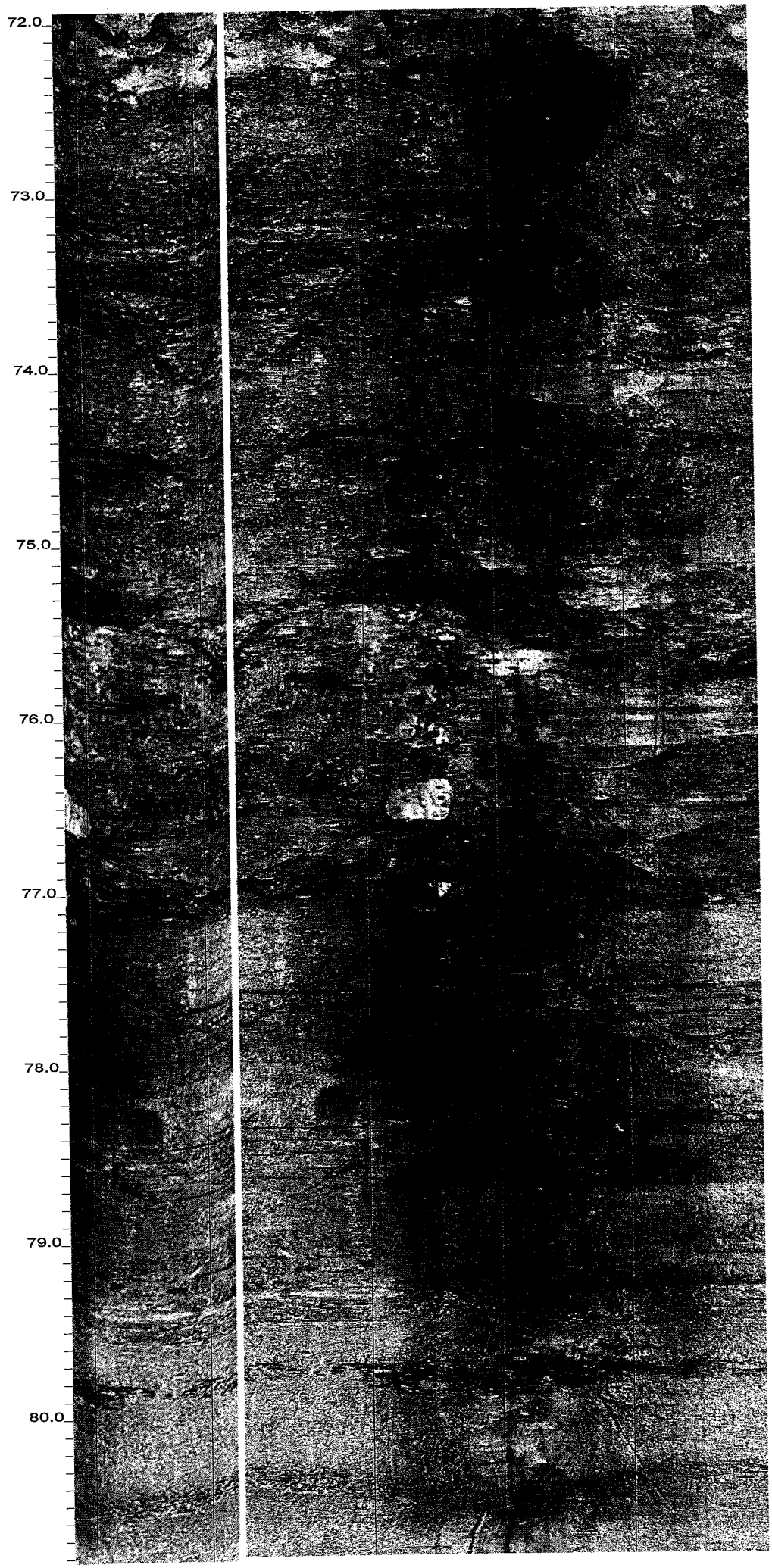
-N175 21 Irregular Bedding

-N160 17 Bedding


54.0
55.0
56.0
57.0
58.0
59.0
60.0
61.0
62.0
-N198 25 Bedding
-N165 27 Bedding
-N099 34 Fracture Irregular
-N113 40 Fracture Irregular



-N153 6 Discontinuity



-N307 41 Fracture Discontinuous
-N320 37 Hairline-fracture

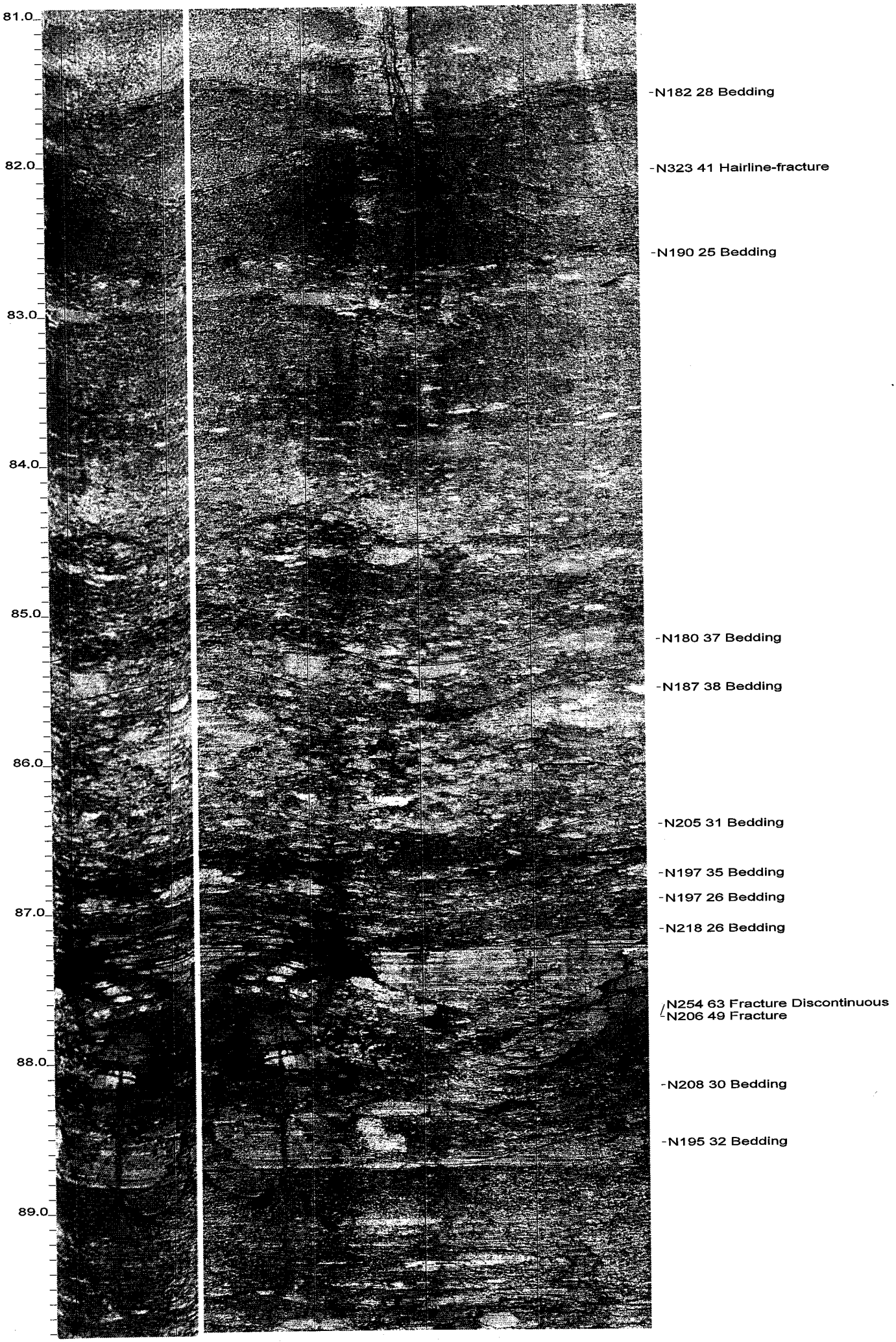
-N319 69 Fracture Discontinuous

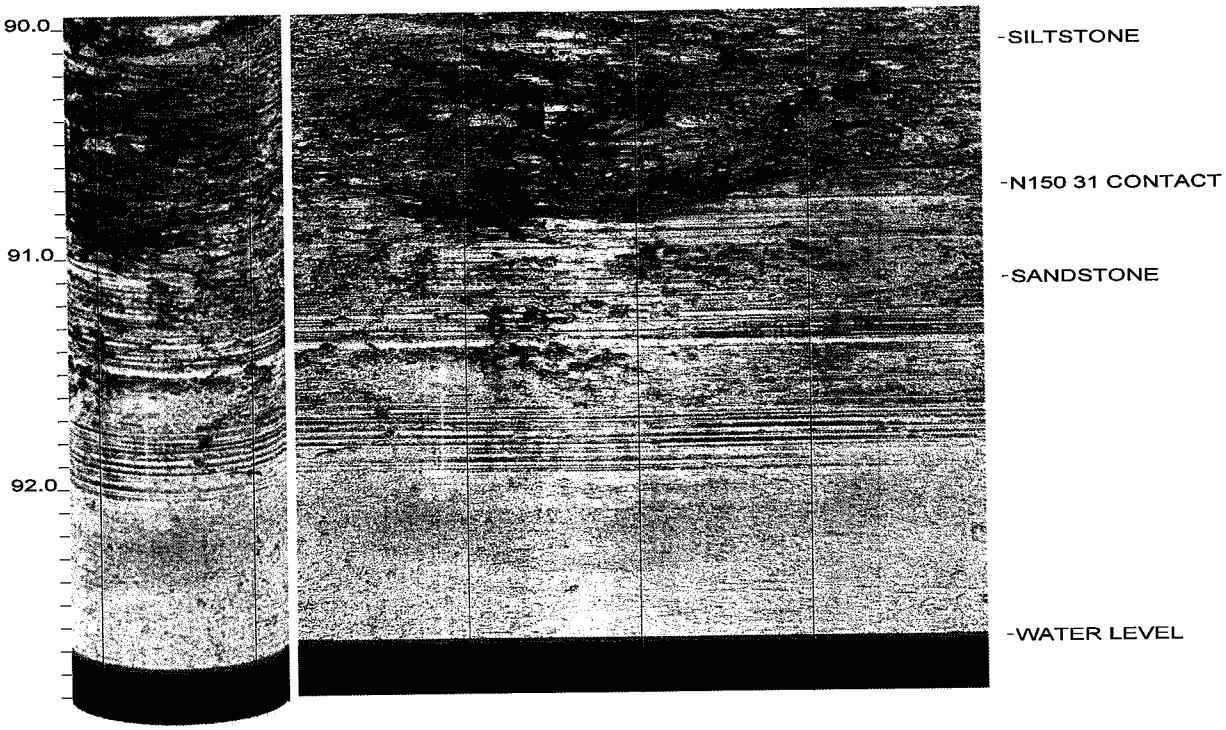
N278 59 Fracture Discontinuous
N281 51 Fracture Discontinuous

-N266 58 Discontinuous Hairline-fracture

-N286 65 Discontinuous Hairline-fracture

-N174 29 Bedding


81.0
82.0
83.0
84.0
85.0
86.0
87.0
88.0
89.0
-N182 28 Bedding
-N323 41 Hairline-fracture
-N190 25 Bedding
-N180 37 Bedding
-N187 38 Bedding
-N205 31 Bedding
-N197 35 Bedding
-N197 26 Bedding
-N218 26 Bedding
N254 63 Fracture Discontinuous
N206 49 Fracture
-N208 30 Bedding
-N195 32 Bedding


90.0
91.0
92.0
-SILTSTONE
-N150 31 CONTACT
-SANDSTONE
-WATER LEVEL

NORCAL

OPTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED OPTV DIPS LOG

24 Jul 2006

KROPP AND ASSOCAITES

Borehole: AKA-7

BUILDING 85

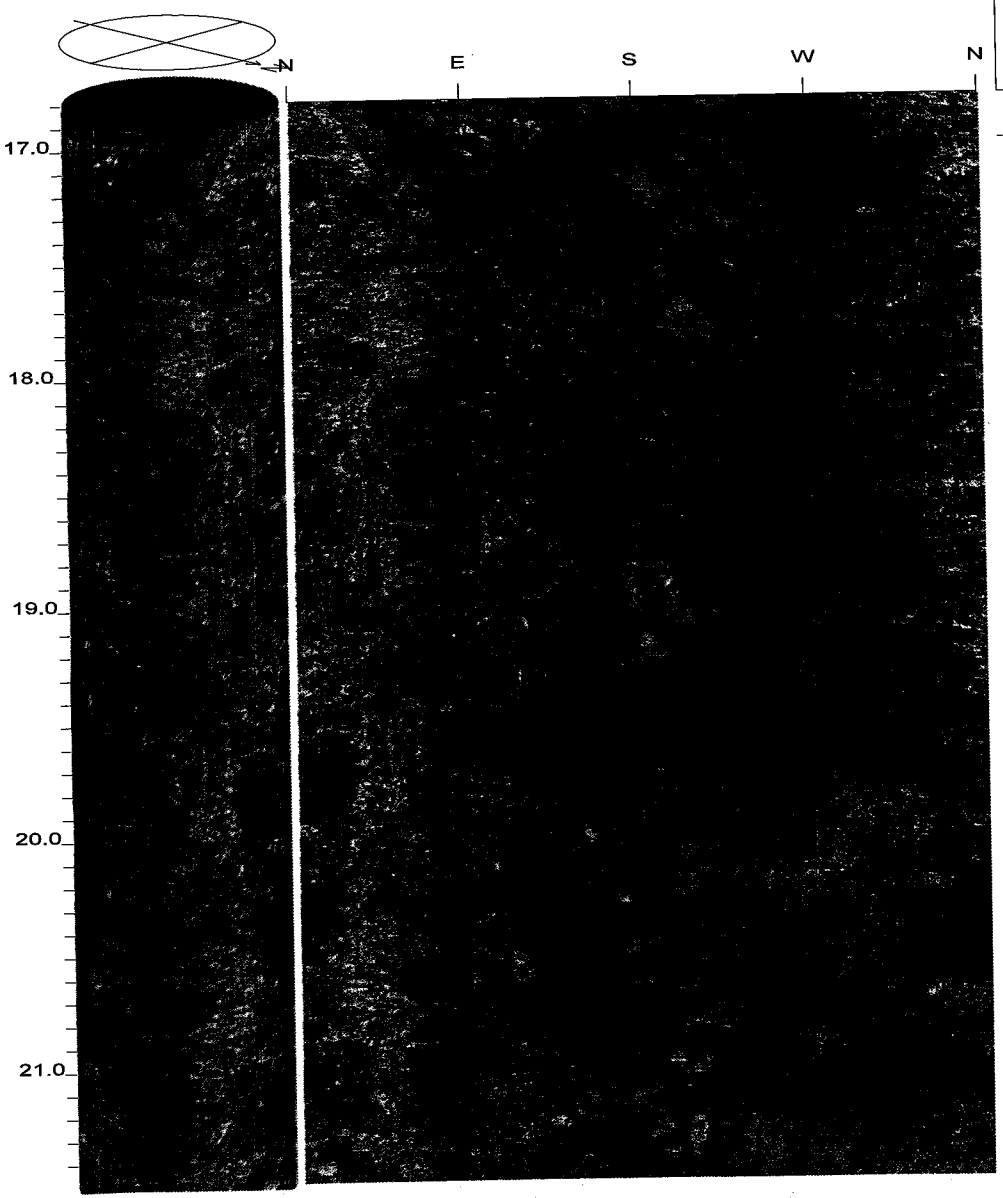
top of borehole.....
East:
North:
Elev:NA

North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = fixed format

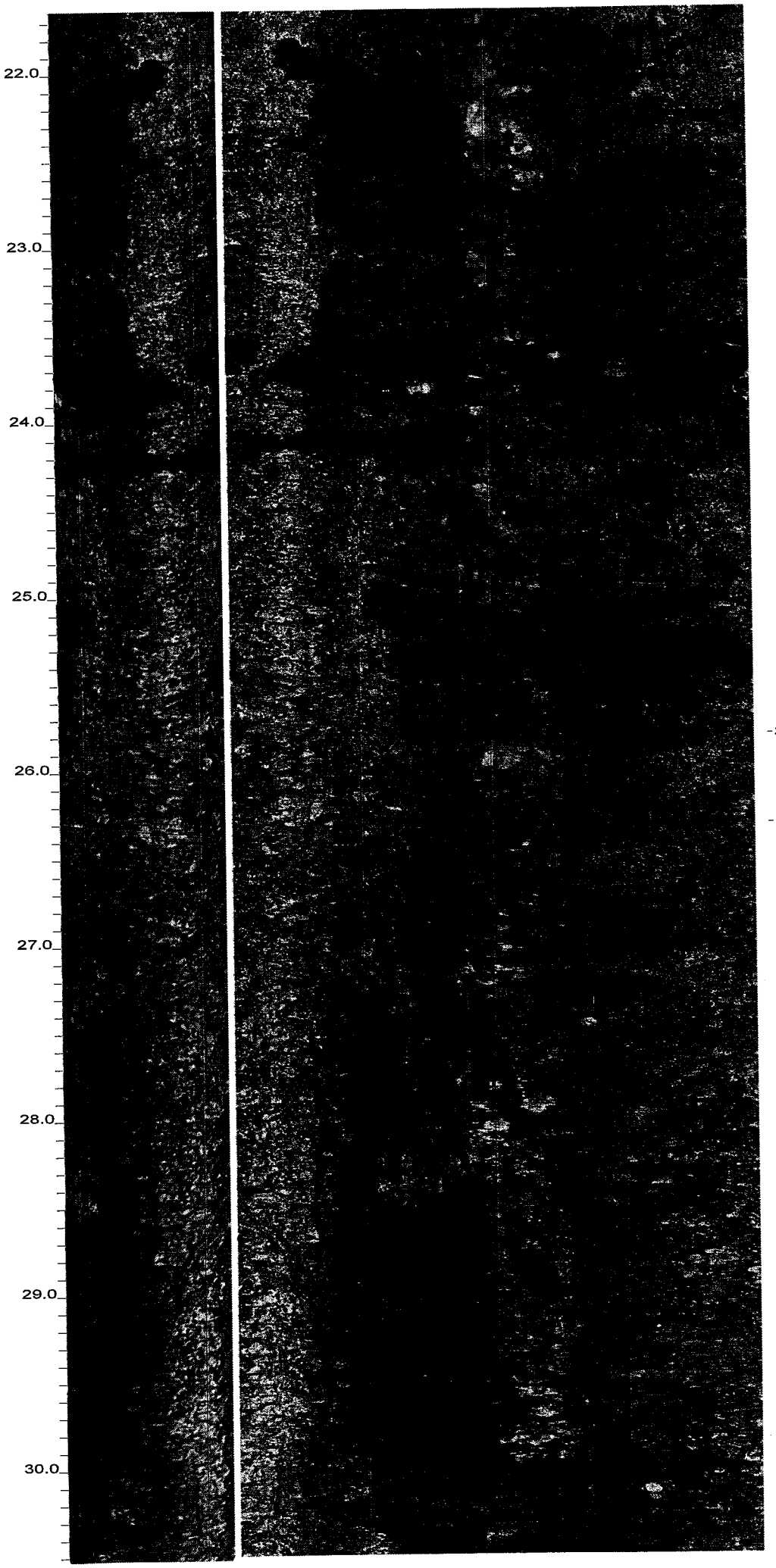
Zone from 67.580 to 16.796ft
Format: BHTV-NESWN

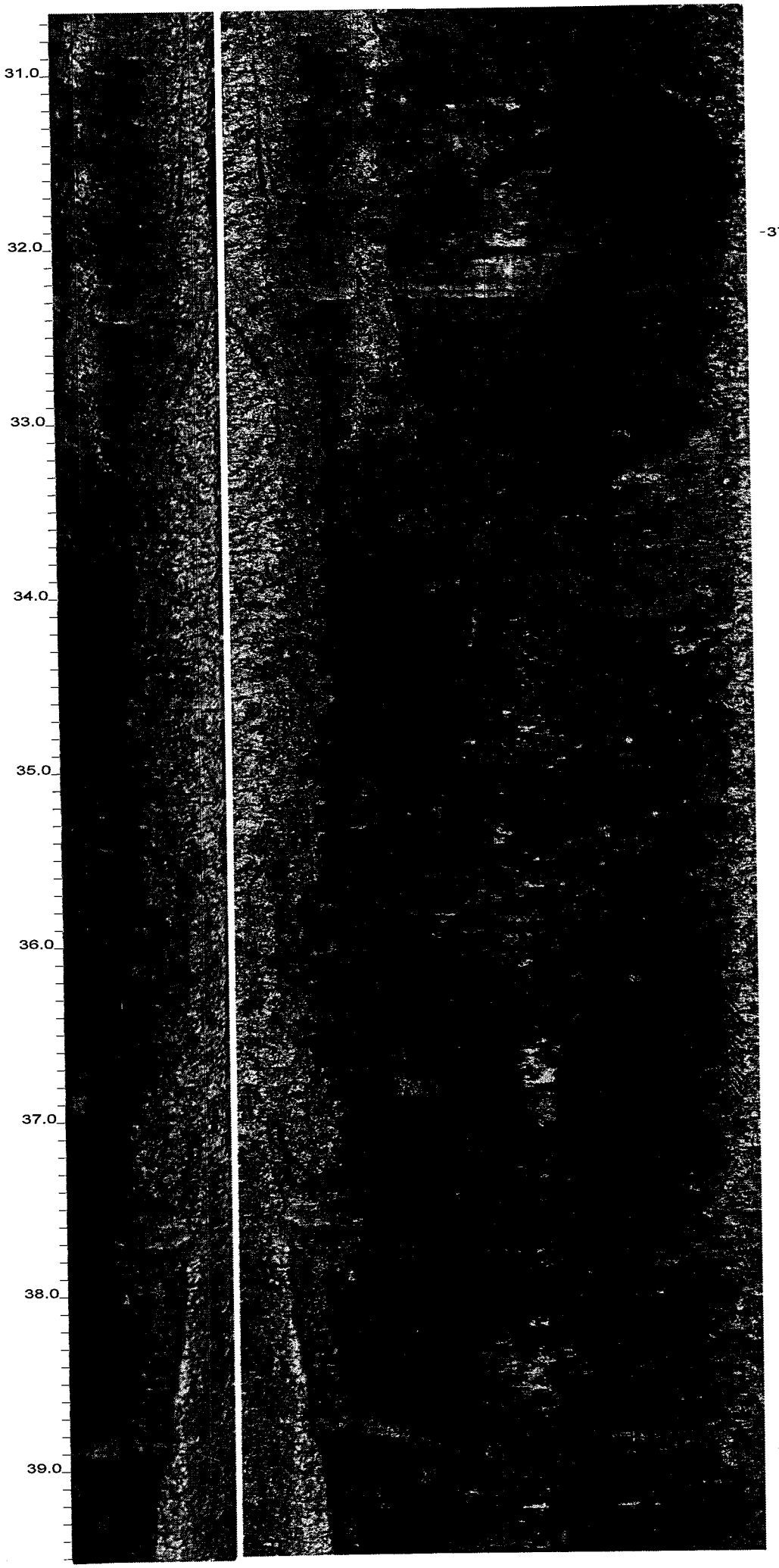
Borehole diam: 4.980inch
Vertical = borehole-axis

COMMENTS



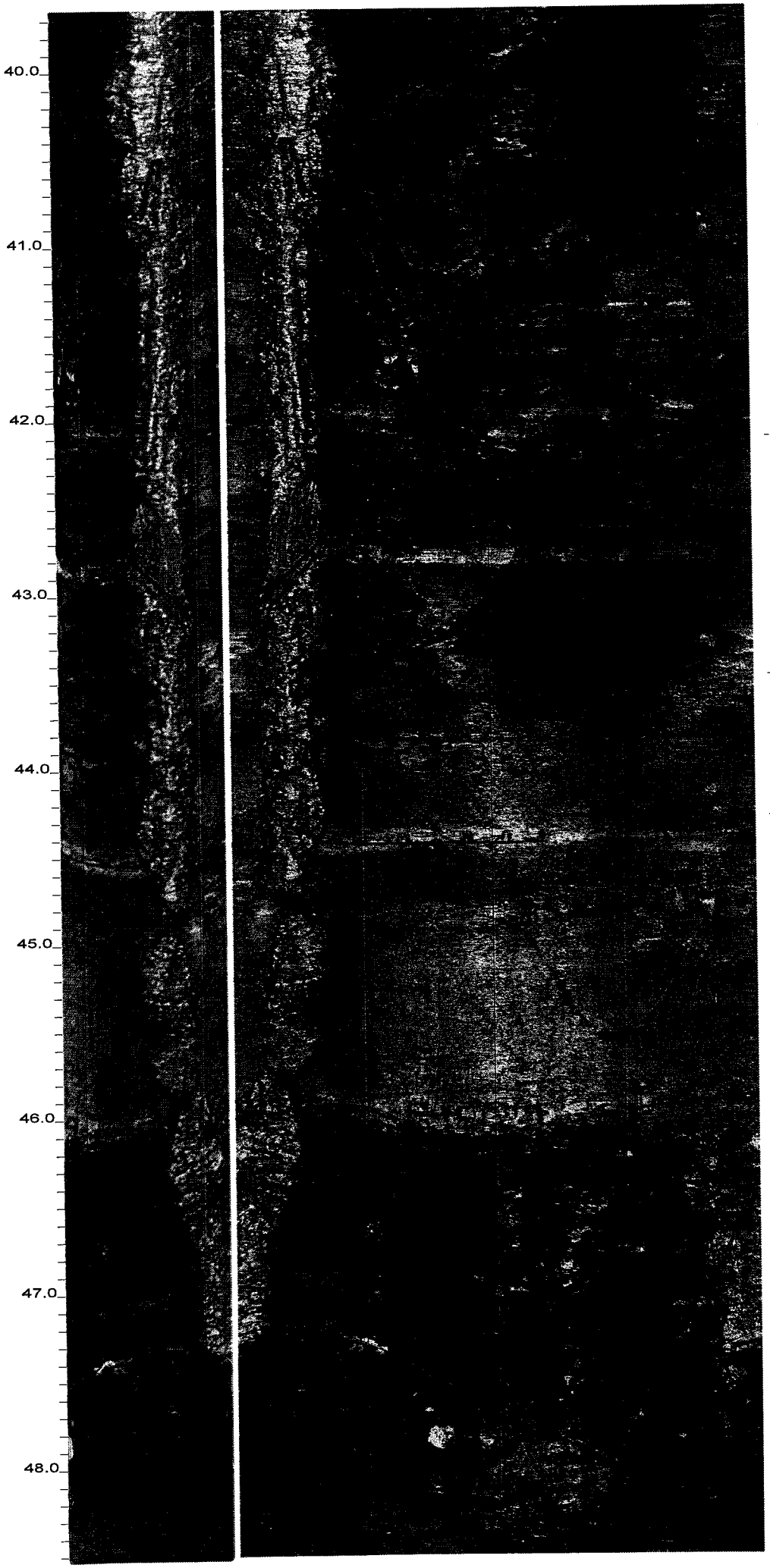
-IMAGE DISTORTION


22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0
-39. N260 32 Bedding
-38. N251 31 Bedding



-37. N191 19 Fracture Discontinuous

-36. N250 49 clay seam?



-35. N217 37 Fracture Discontinuous

-34. N217 43 Fracture Discontinuous

-33. N262 83 Fracture Discontinuous

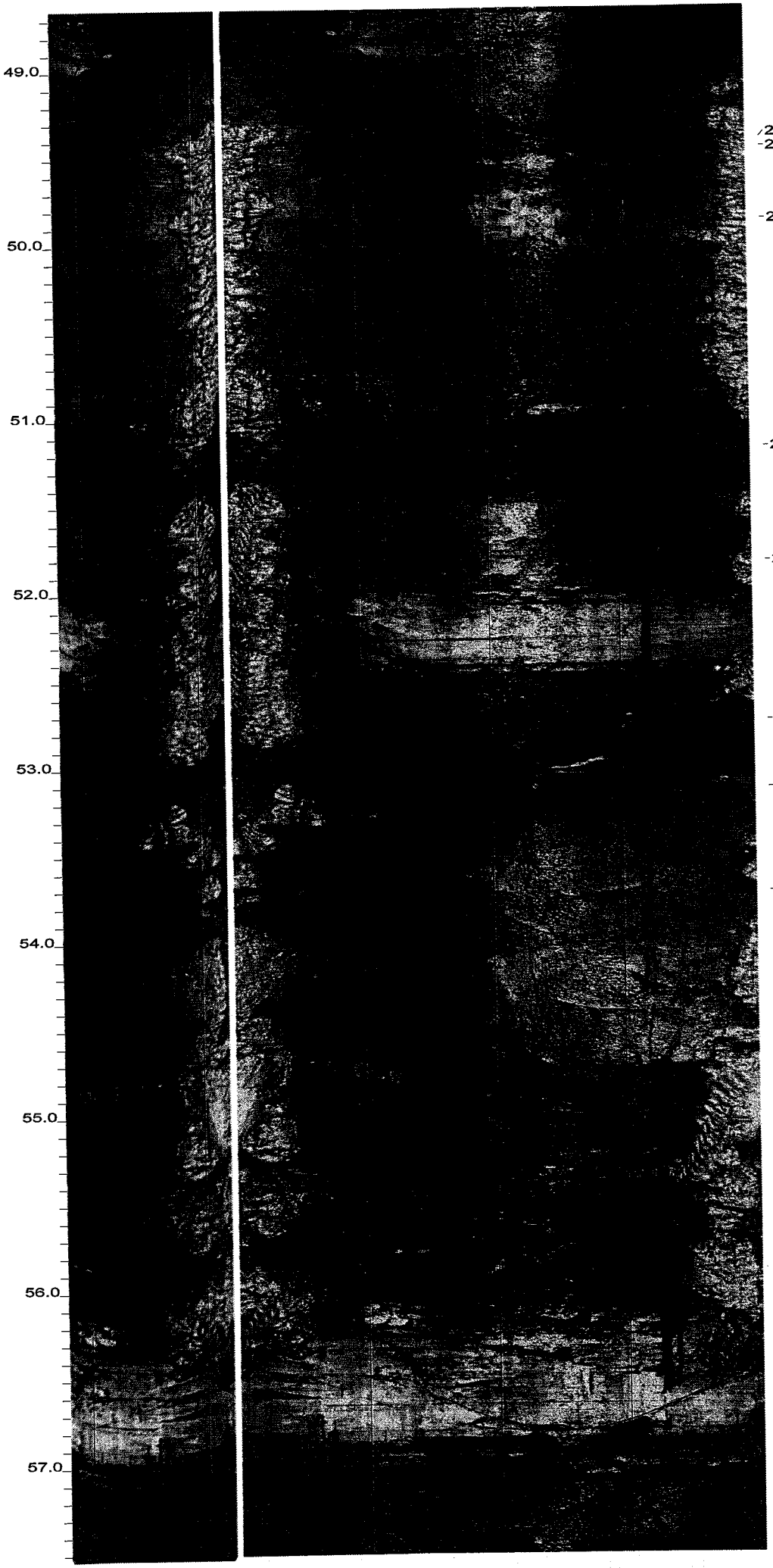
-32. N184 34 Bedding

-31. N209 45 Bedding

-30. N206 40 Bedding

-29. N218 52 Bedding

-28. N207 61 Bedding



27. N246 53 Fracture Discontinuous
26. N235 42 Fracture Discontinuous

25. N223 83 Fracture Discontinuous

24. N221 47 Fracture Discontinuous

23. N200 50 Fracture

22. N226 54 Fracture

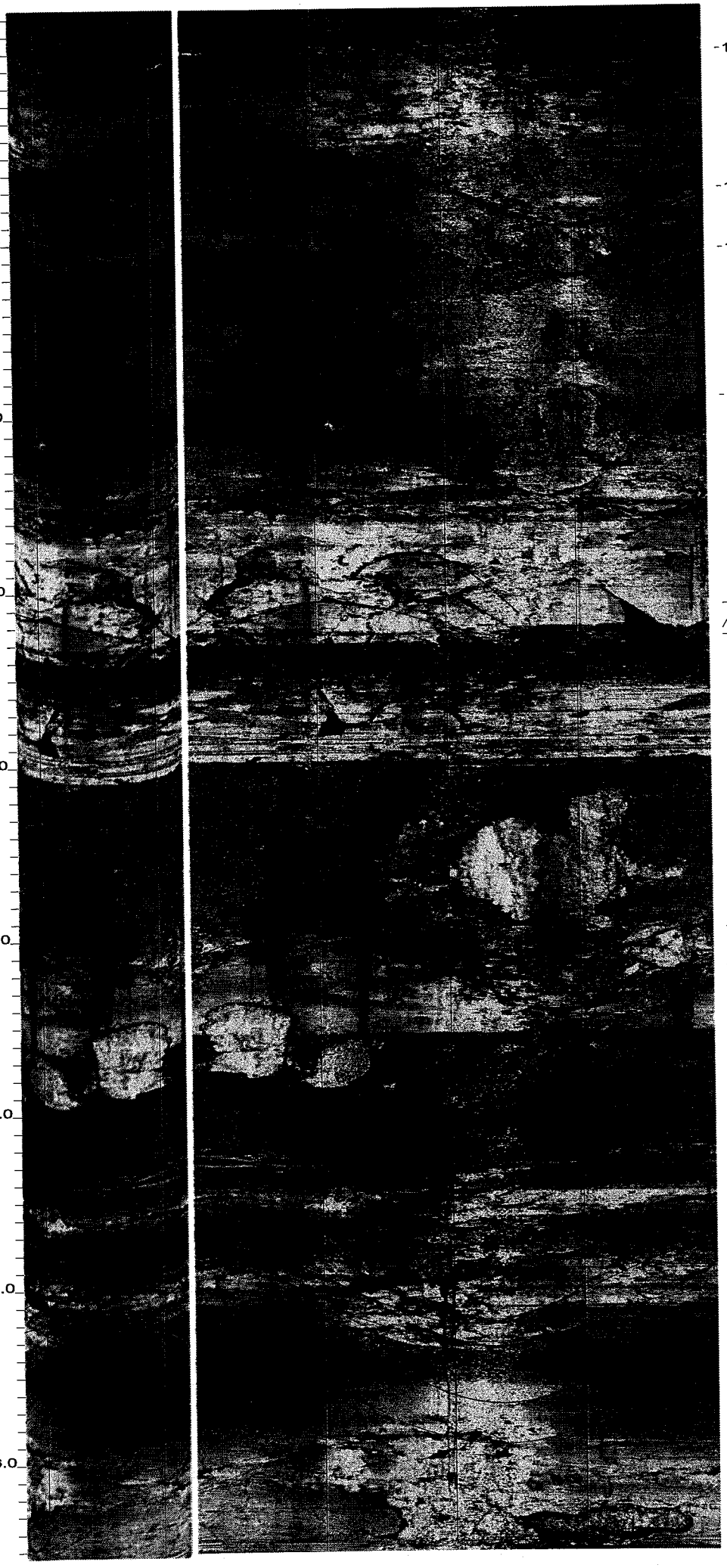
21. N219 38 Bedding

20. N246 54 Fracture

19. N200 34 Bedding

18. N225 46 Fracture Discontinuous

17. N244 47 Fracture Discontinuous
16. N228 41 Bedding



-15. N254 34 Discontinuity slide-plane

-14. N279 46 Bedding

-13. N274 39 Bedding

-12. N251 71 Fracture Discontinuous

-11. N289 58 Fracture Discontinuous

-10. N275 41 Fracture Discontinuous

-9. N335 68 Fracture Discontinuous

-8. N247 42 Fracture Discontinuous

-7. N254 49 Bedding

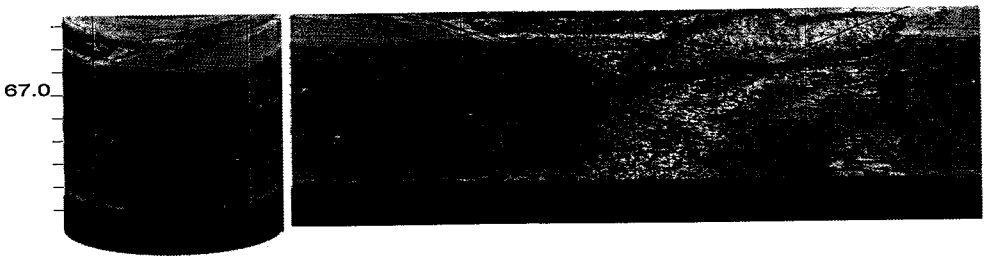
-6. N214 63 Fracture Discontinuous

-5. N192 48 Bedding

-4. N199 38 Bedding

-3. N213 54 Hairline-fracture

-2. N213 44 Bedding



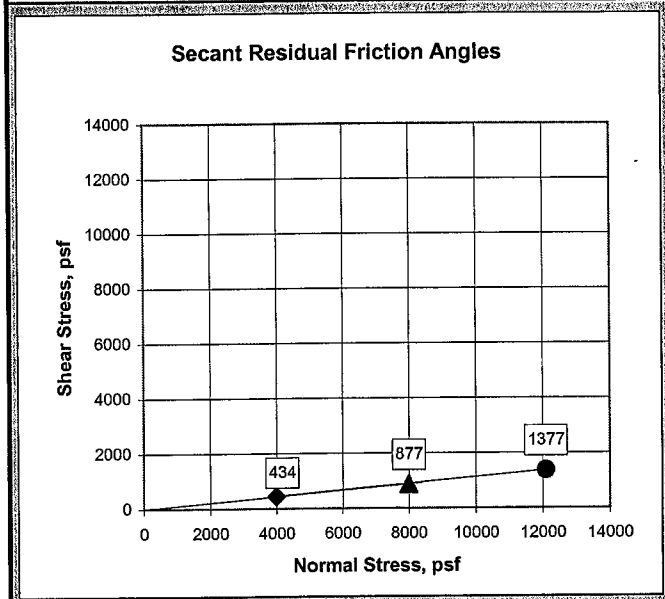
-1. N195 43 Bedding

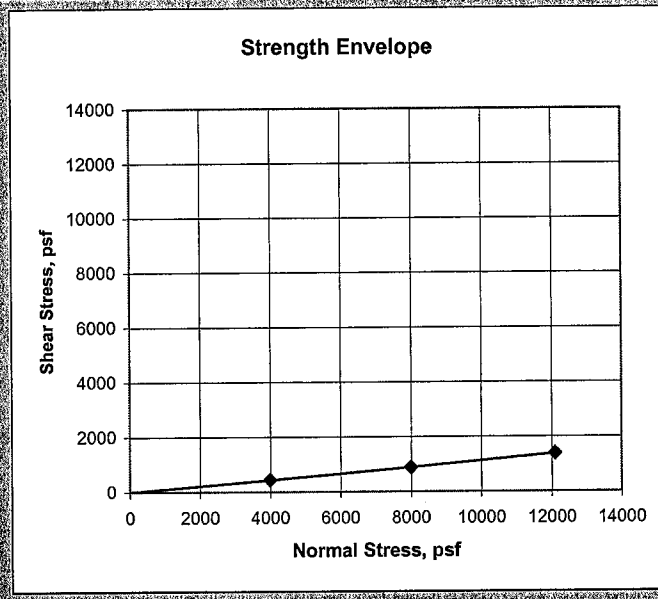
APPENDIX E

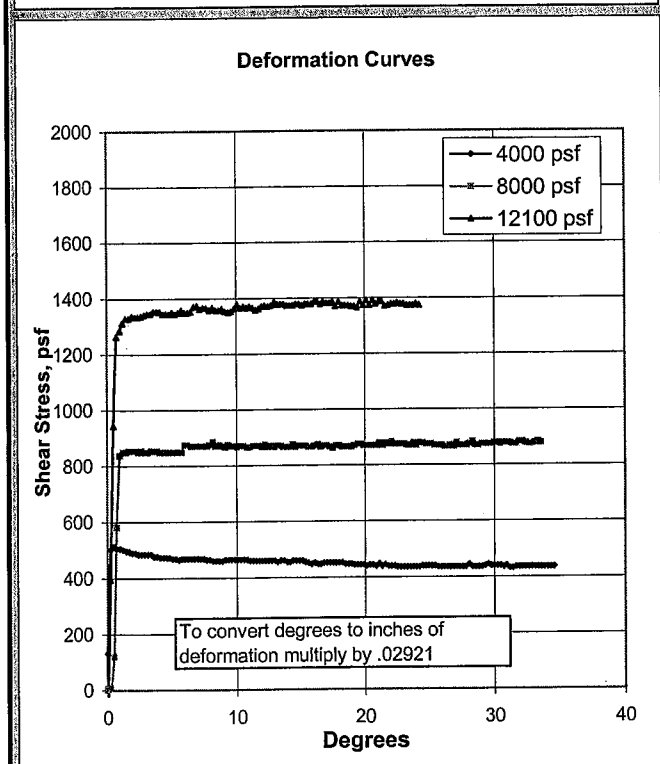
Laboratory Test Results

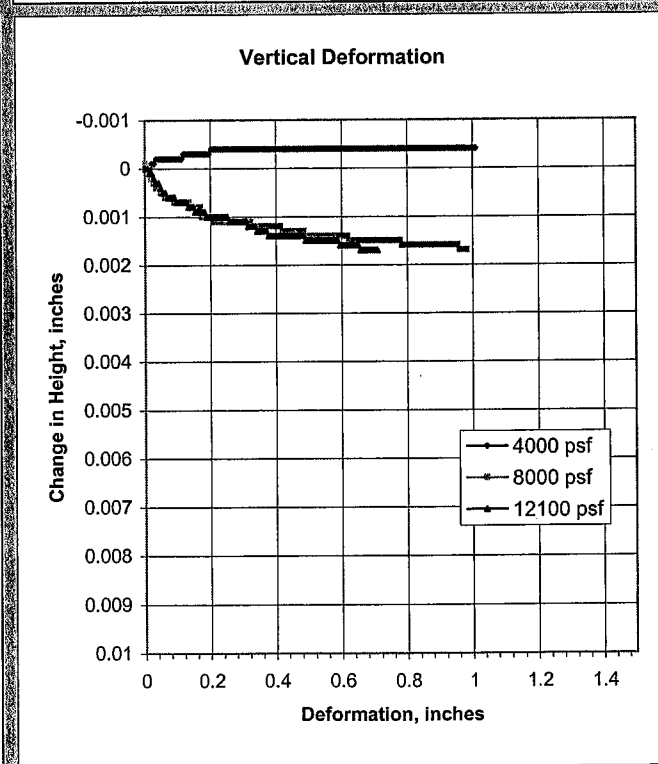
Drained, Residual Torsional Ring Shear Test ASTM D 6467

Job No.:	254-086b	**Boring:**	AKA-6	**Date:**	7/27/2006	**Undisturbed:**	
Client:	Alan Kropp	**Sample:**		**By:**	PJ	**Peak:**	
Project:	LBNL-2335-4A	**Depth:**	57.5-58.5'	**Checked:**	DC	**Residual:**	
Soil Type:	Bluish Gray CLAY w/Sand, (Silty)			**Clay, %:**		**Fully Softened:**	X
Remarks:	A small friction correction was applied to the high point.			**LL:**	53	**Peak:**	
Normal Stress, psf	4000	8000	12100	**PL:**	18	**Residual:**	X
Secant Phi, deg.	6	6	6				



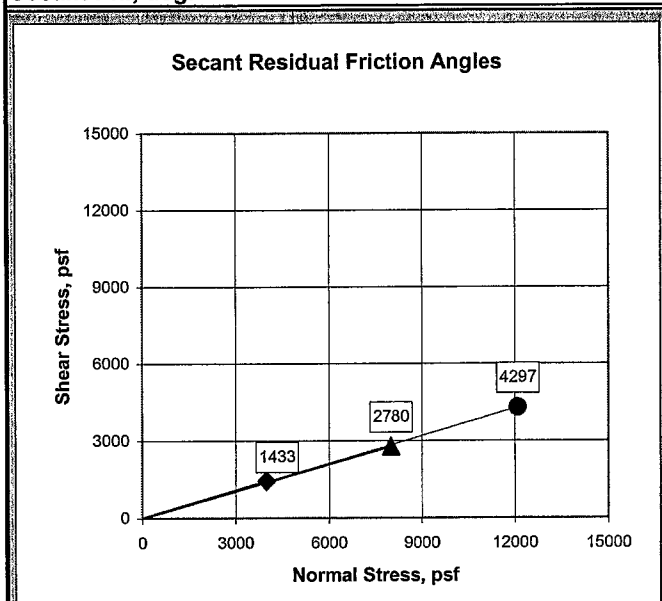


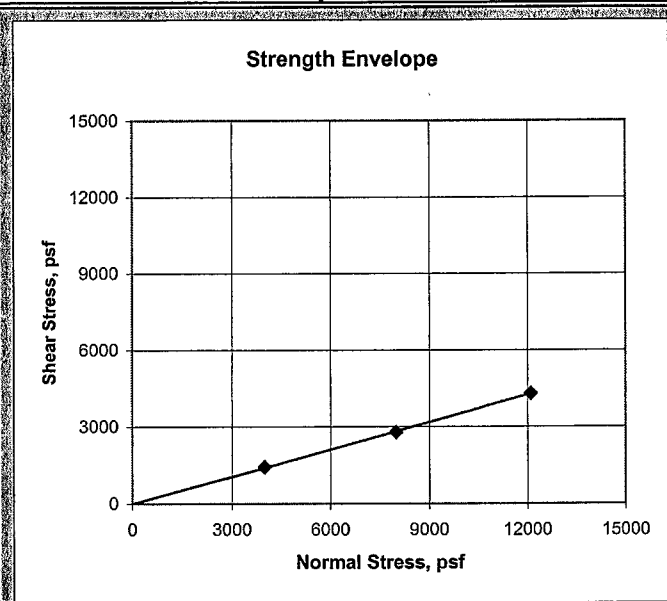


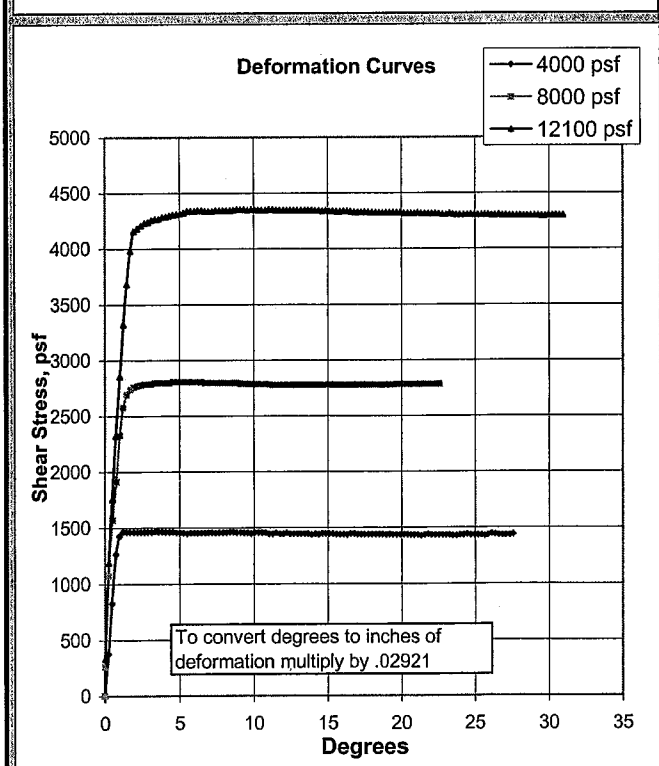


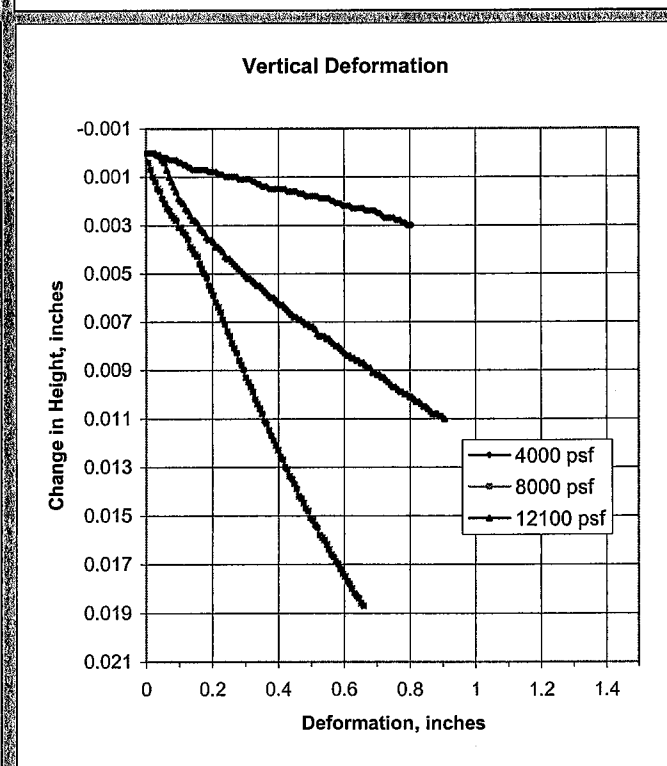
Drained, Residual Torsional Ring Shear Test ASTM D 6467

Job No.:	254-086b	**Boring:**	AKA-6	**Date:**	7/27/2006	**Undisturbed:**	
Client:	Alan Kropp & Assoc.	**Sample:**		**By:**	PJ	**Peak:**	
Project:	2335-4A	**Depth:**	65'	**Checked:**	DC	**Residual:**	
Soil Type:	Bluish Gray Lean CLAY, trace Sand			**Clay, %:**		**Fully Softened:**	X
Remarks:	A small friction correction was applied to two points.			**LL:**	47	**Peak:**	
Normal Stress, psf	4000	8000	12100	**PL:**	15	**Residual:**	X
Secant Phi, deg.	20	19	20				



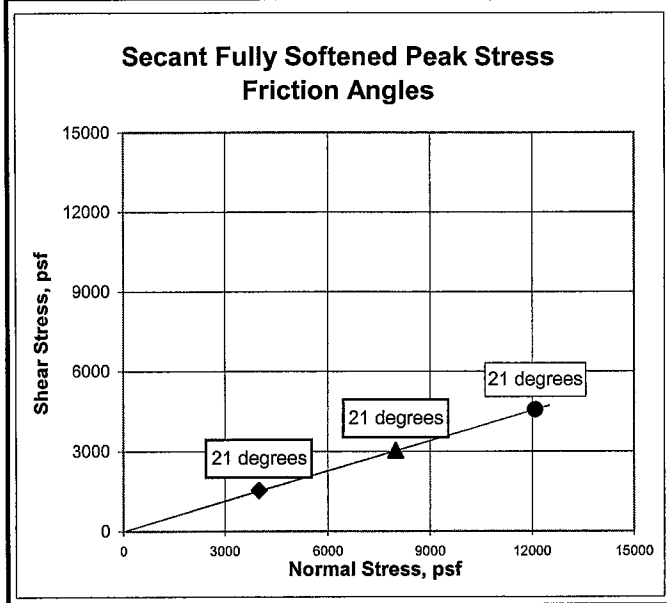


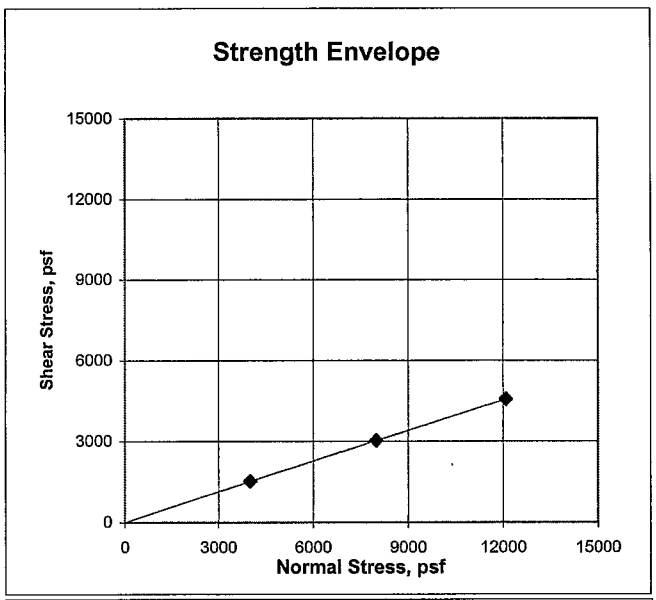


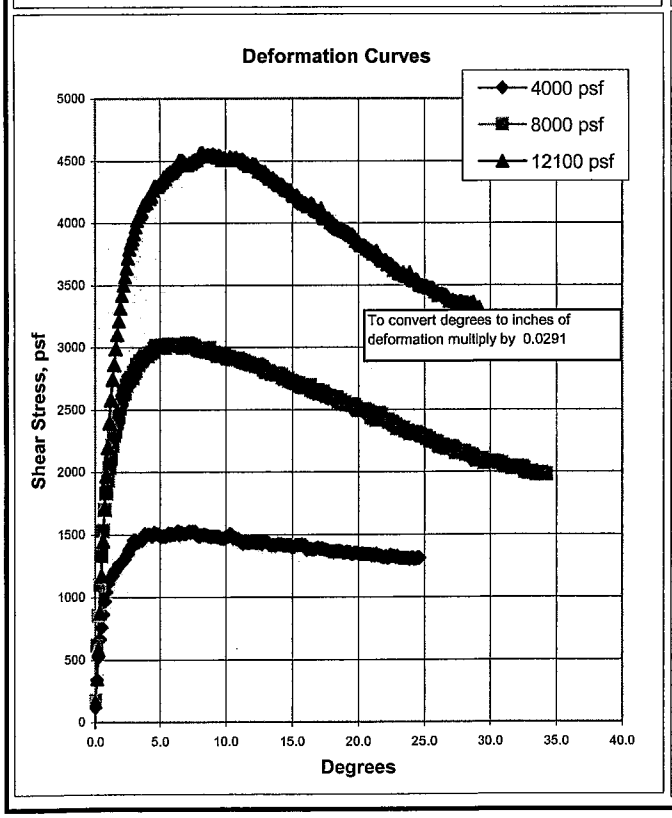


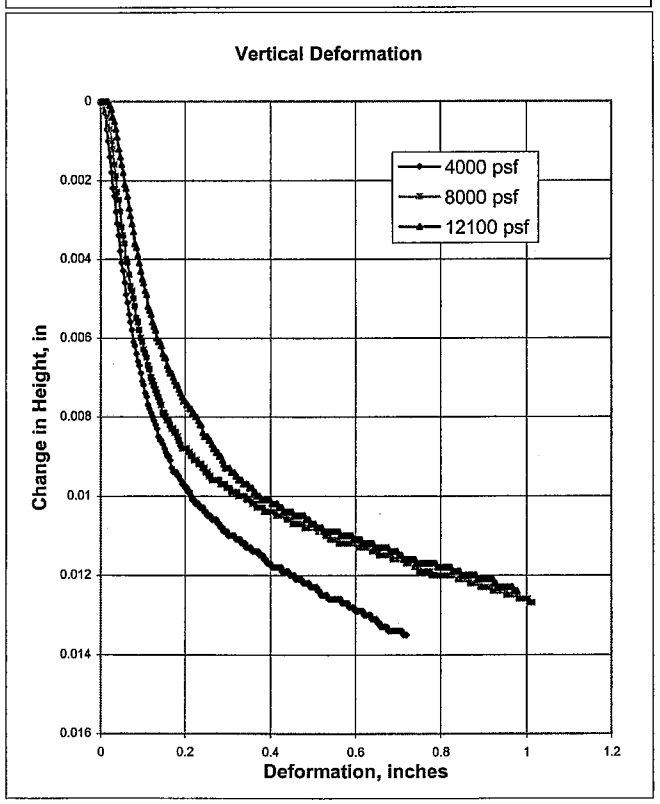
Drained, Peak Torsional Ring Shear Test ASTM D 6467

Job No.:	254-086	**Boring:**	AKA-6	**Date:**	7/27/2006	**Undisturbed:**	
Client:	Alan Kropp& Associates	**Sample:**		**By:**	PJ	**Peak:**	
Project:	LBNL- 2335-4A	**Depth:**	57.5-58.5'	**Checked:**	DC	**Residual:**	
Soil Type:	Bluish Gray CLAY w/ Sand (silty)			**Clay, %:**		**Fully Softened:**	X
Remarks:				**LL:**	53	**Peak:**	X
Normal Stress, psf	4000	8000	12100	**PL:**	18	**Residual:**	
Secant Phi, deg.	21	21	21				

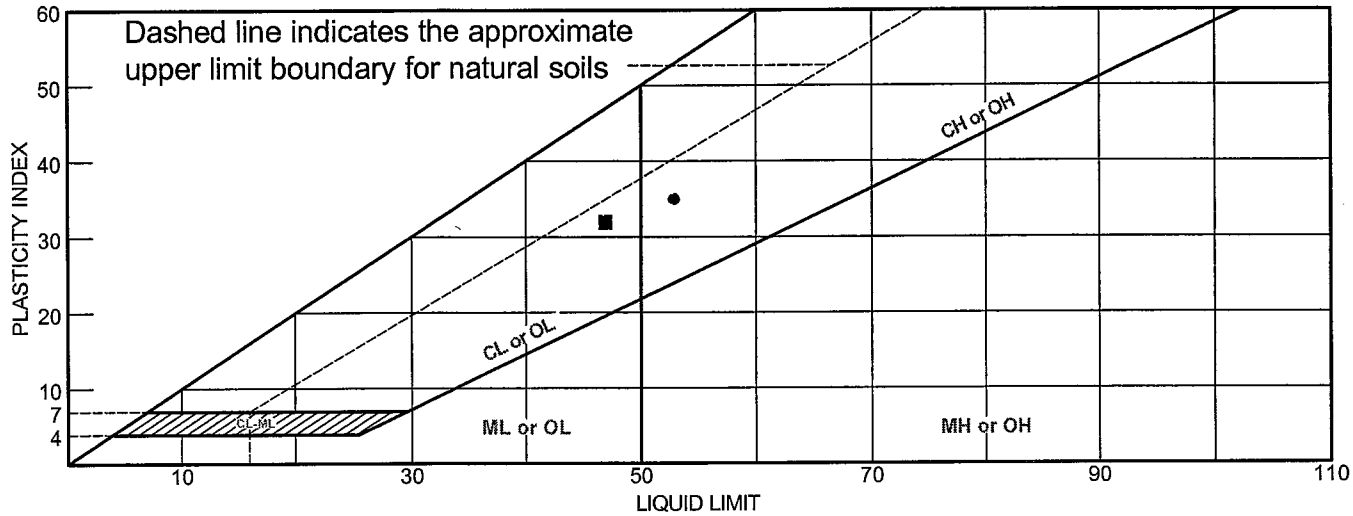


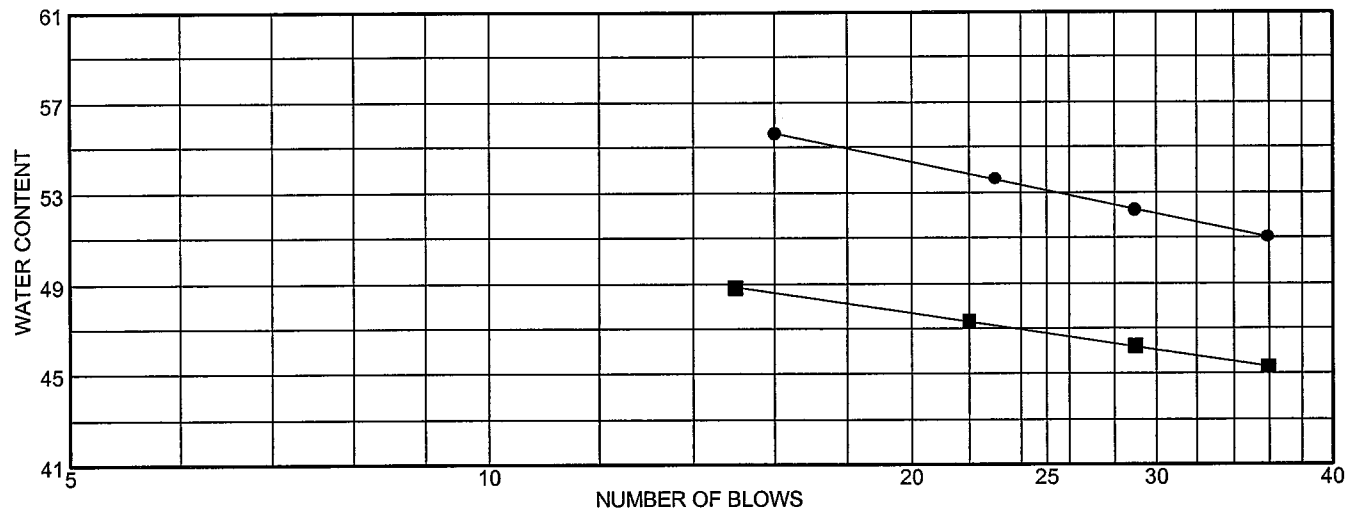






LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Bluish Gray Fat CLAY w/ Sand	53	18	35			
■	Bluish Gray Lean CLAY, trace Sand	47	15	32			

Project No. 254-086 **Client:** Alan Kropp & Associates

Project: LBNL - 2335-4A

● **Source:** AKA-6 **Elev./Depth:** 57.5-58.5'

■ **Source:** AKA-6 **Elev./Depth:** 65-65.5'

Remarks:

●

■

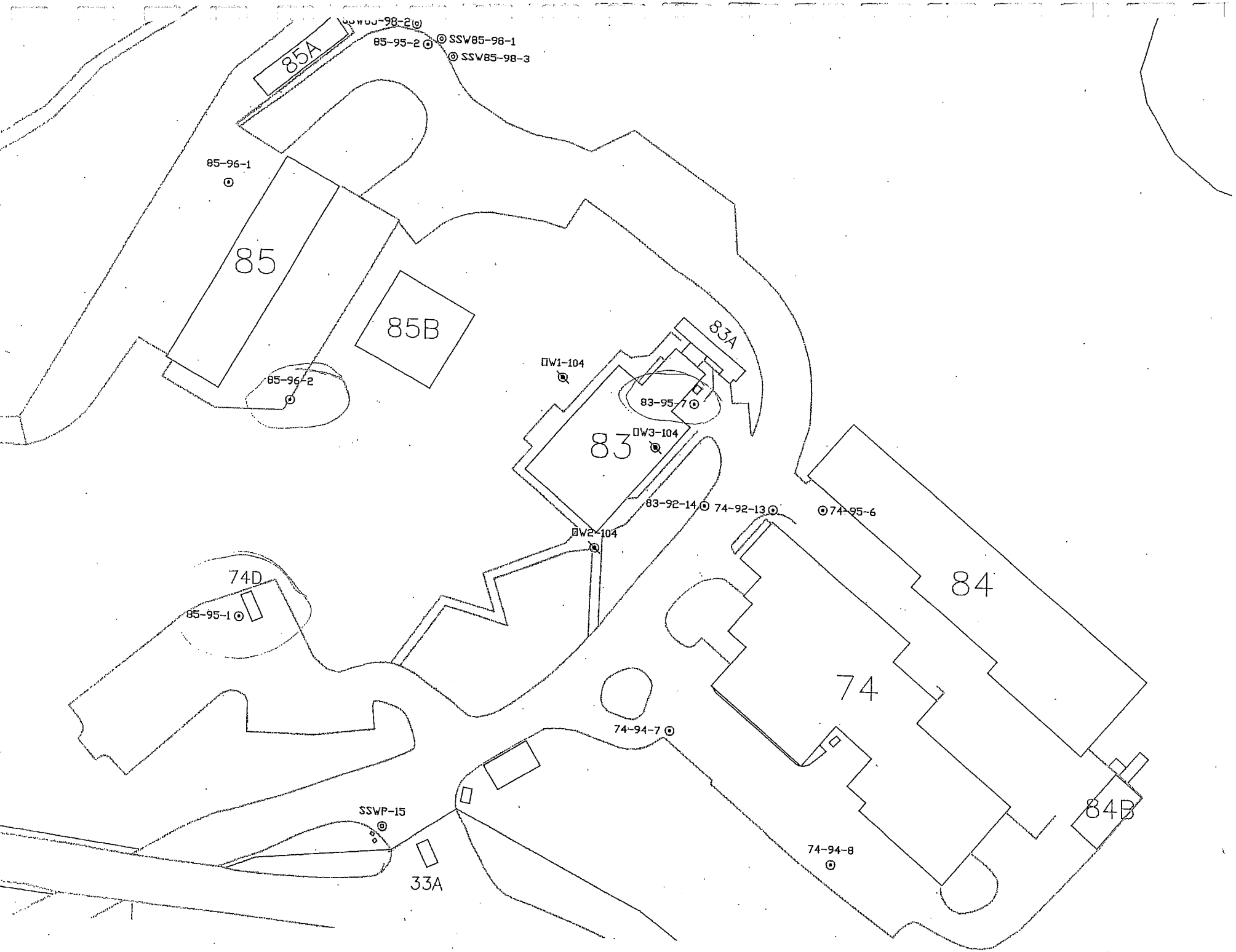
LIQUID AND PLASTIC LIMITS TEST REPORT

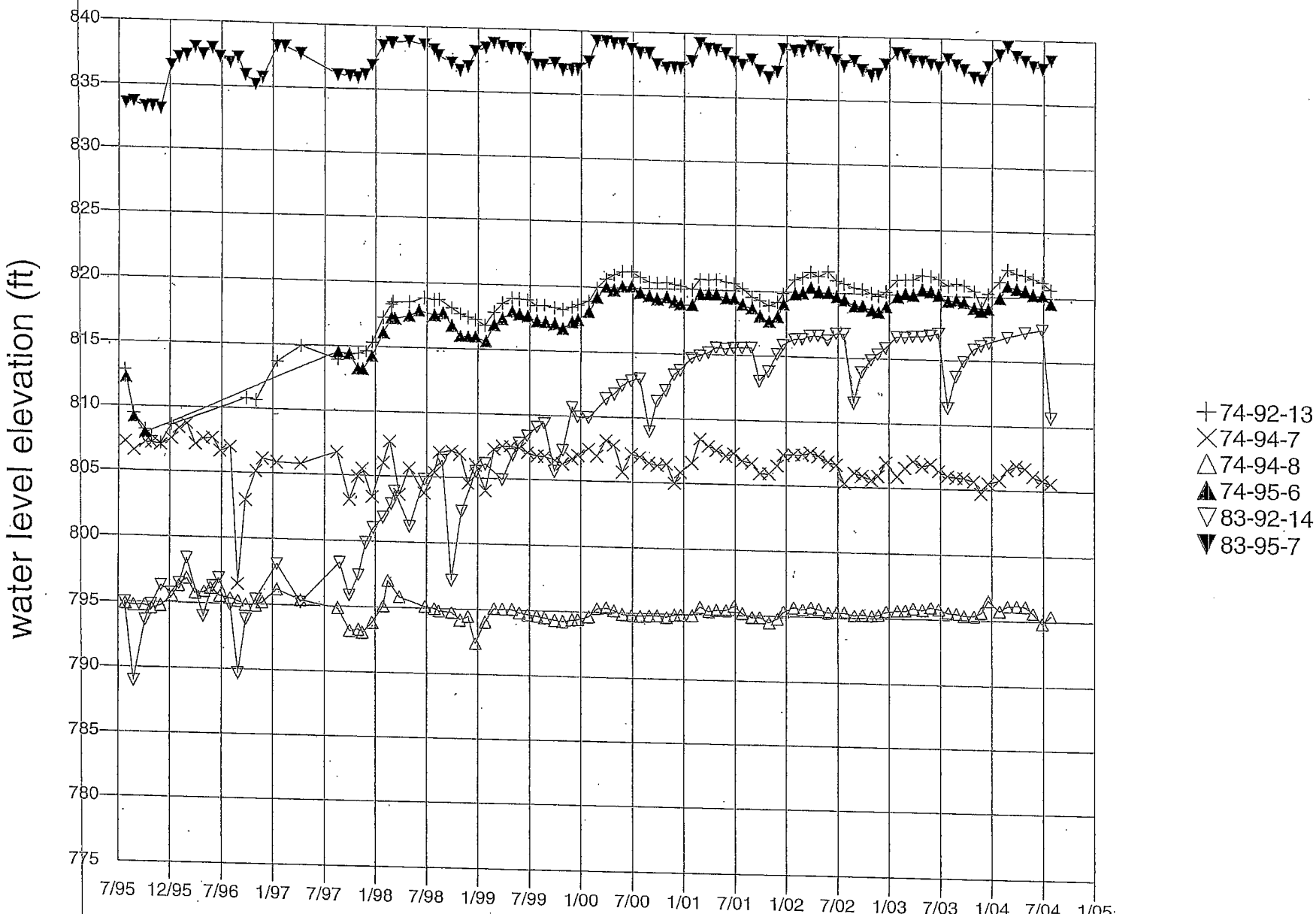
COOPER TESTING LABORATORY

Figure

APPENDIX F

Existing Groundwater Data


85A
85-95-2
SSW85-98-1
SSW85-98-3
85-96-1
85
85B
85-96-2
W1-104
83A
83-95-7
83
W3-104
83-92-14
74-92-13
74-95-6
W2-104
84
74D
85-95-1
74
74-94-7
SSWP-15
33A
74-94-8
84B


water level elevation (ft)
840
835
830
825
820
815
810
805
800
795
790
785
780
775
7/95
12/95
7/96
1/97
7/97
1/98
7/98
1/99
7/99
1/00
7/00
1/01
7/01
1/02
7/02
1/03
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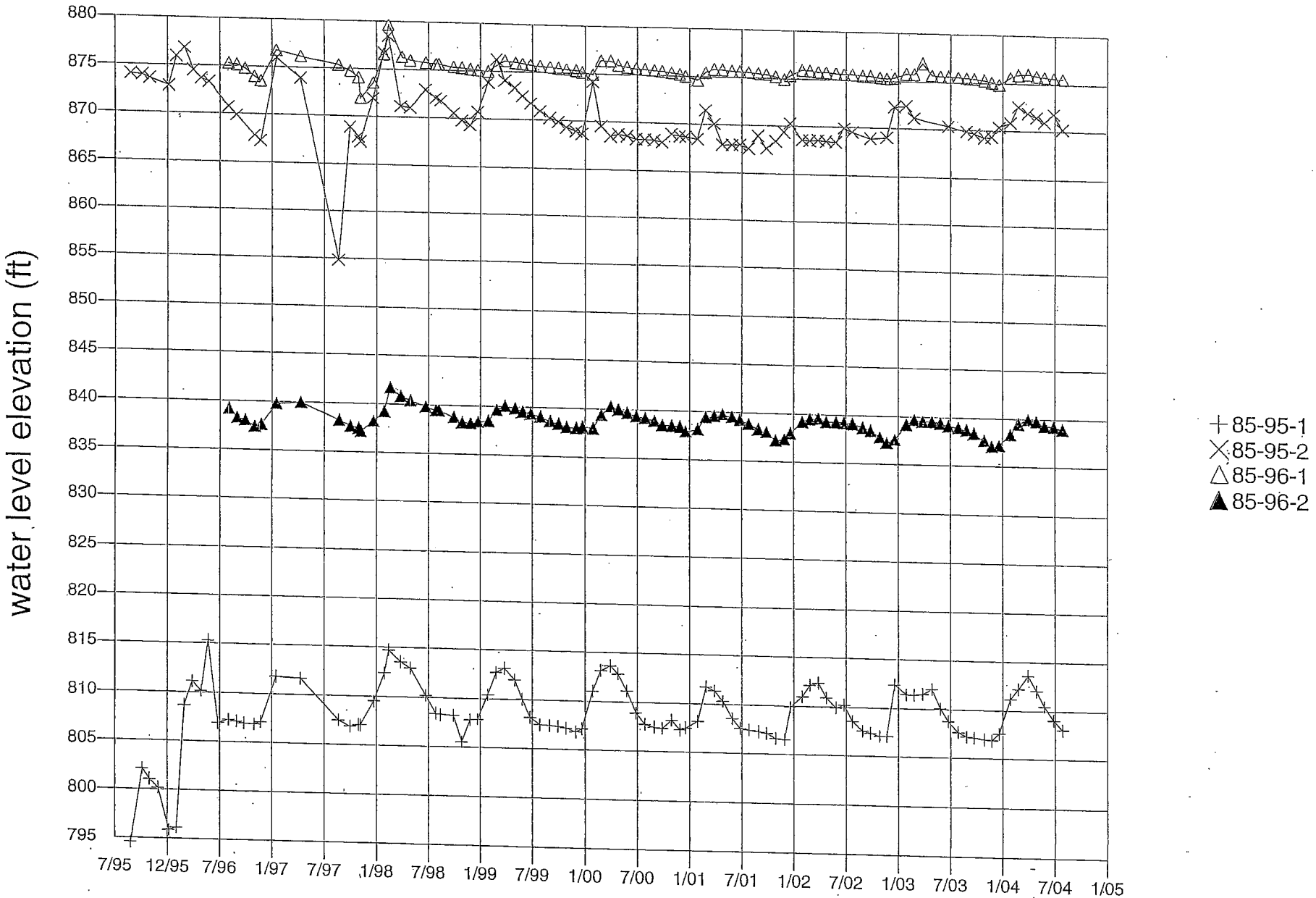
1/05
74-92-13
74-94-7
74-94-8
74-95-6
83-92-14
83-95-7


water level elevation (ft)
880
875
870
865
860
855
850
845
840
835
830
825
820
815
810
805
800
795
7/95
12/95
7/96
1/97
7/97
1/98
7/98
1/99
7/99
1/00
7/00
1/01
7/01
1/02
7/02
1/03
7/03
1/04
7/04
1/05
85-95-1
85-95-2
85-96-1
85-96-2

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusiv

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-1	8/24/1995	818.30	00:00	23.76	NA	794.54
85-95-1	10/4/1995	818.30	00:00	16.23	7.53	802.07
85-95-1	10/30/1995	818.30	00:00	17.25	-1.02	801.05
85-95-1	11/28/1995	818.30	00:00	18.12	-0.87	800.18
85-95-1	1/5/1996	818.30	00:00	22.43	-4.31	795.87
85-95-1	1/31/1996	818.30	00:00	22.15	0.28	796.15
85-95-1	2/28/1996	818.30	00:00	9.65	12.50	808.65
85-95-1	3/27/1996	818.30	00:00	7.19	2.46	811.11
85-95-1	4/26/1996	818.30	00:00	8.15	-0.96	810.15
85-95-1	5/20/1996	818.30	00:00	3.00	5.15	815.30
85-95-1	6/25/1996	818.30	00:00	11.42	-8.42	806.88
85-95-1	7/31/1996	818.30	00:00	11.04	0.38	807.26
85-95-1	8/28/1996	818.30	00:00	11.20	-0.16	807.10
85-95-1	9/23/1996	818.30	00:00	11.37	-0.17	806.93
85-95-1	10/30/1996	818.30	00:00	11.47	-0.10	806.83
85-95-1	11/21/1996	818.30	00:00	11.20	0.27	807.10
85-95-1	1/13/1997	818.30	00:00	6.51	4.69	811.79
85-95-1	4/9/1997	818.30	00:00	6.65	-0.14	811.65
85-95-1	8/19/1997	818.30	00:00	10.83	-4.18	807.47
85-95-1	9/30/1997	818.30	00:00	11.45	-0.62	806.85
85-95-1	10/29/1997	818.30	00:00	11.25	0.20	807.05
85-95-1	11/5/1997	818.30	00:00	11.26	-0.01	807.04
85-95-1	12/22/1997	818.30	00:00	8.78	2.48	809.52
85-95-1	1/28/1998	818.30	00:00	5.88	2.90	812.42
85-95-1	2/12/1998	818.30	00:00	3.58	2.30	814.72
85-95-1	3/26/1998	818.30	00:00	4.76	-1.18	813.54
85-95-1	4/29/1998	818.30	00:00	5.35	-0.59	812.95
85-95-1	6/23/1998	818.30	00:00	8.11	-2.76	810.19
85-95-1	7/28/1998	818.30	00:00	9.92	-1.81	808.38
85-95-1	8/14/1998	818.30	00:00	10.04	-0.12	808.26
85-95-1	9/28/1998	818.30	00:00	10.07	-0.03	808.23
85-95-1	10/27/1998	818.30	00:00	12.80	-2.73	805.50
85-95-1	11/25/1998	818.30	00:00	10.50	2.30	807.80
85-95-1	12/21/1998	818.30	00:00	10.45	0.05	807.85
85-95-1	1/27/1999	818.30	00:00	7.90	2.55	810.40
85-95-1	2/25/1999	818.30	00:00	5.60	2.30	812.70
85-95-1	3/26/1999	818.30	00:00	5.14	0.46	813.16
85-95-1	4/30/1999	818.30	00:00	6.30	-1.16	812.00
85-95-1	5/26/1999	818.30	00:00	8.27	-1.97	810.03
85-95-1	6/24/1999	818.30	00:00	10.13	-1.86	808.17
85-95-1	7/27/1999	818.30	00:00	10.85	-0.72	807.45
85-95-1	8/30/1999	818.30	00:00	10.90	-0.05	807.40
85-95-1	9/29/1999	818.30	00:00	10.95	-0.05	807.35
85-95-1	10/27/1999	818.30	00:00	11.13	-0.18	807.17
85-95-1	11/29/1999	818.30	00:00	11.51	-0.38	806.79
85-95-1	12/20/1999	818.30	00:00	11.17	0.34	807.13
85-95-1	1/27/2000	818.30	00:00	7.25	3.92	811.05

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SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-1	2/25/2000	818.30	00:00	5.15	2.10	813.15
85-95-1	3/29/2000	818.30	00:00	4.64	0.51	813.66
85-95-1	4/25/2000	818.30	00:00	5.44	-0.80	812.86
85-95-1	5/26/2000	818.30	00:00	7.16	-1.72	811.14
85-95-1	6/27/2000	818.30	00:00	9.41	-2.25	808.89
85-95-1	7/27/2000	818.30	00:00	10.54	-1.13	807.76
85-95-1	8/29/2000	818.30	00:00	10.83	-0.29	807.47
85-95-1	9/26/2000	818.30	00:00	10.92	-0.09	807.38
85-95-1	10/30/2000	818.30	00:00	10.06	0.86	808.24
85-95-1	11/27/2000	818.30	00:00	11.05	-0.99	807.25
85-95-1	12/18/2000	818.30	00:00	10.82	0.23	807.48
85-95-1	1/29/2001	818.30	00:00	10.11	0.71	808.19
85-95-1	2/26/2001	818.30	00:00	6.55	3.56	811.75
85-95-1	3/28/2001	818.30	00:00	6.93	-0.38	811.37
85-95-1	4/25/2001	818.30	00:00	7.97	-1.04	810.33
85-95-1	5/29/2001	818.30	00:00	9.76	-1.79	808.54
85-95-1	6/26/2001	818.30	00:00	10.73	-0.97	807.57
85-95-1	7/26/2001	818.30	00:00	10.88	-0.15	807.42
85-95-1	8/29/2001	818.30	00:00	11.03	-0.15	807.27
85-95-1	9/27/2001	818.30	00:00	11.18	-0.15	807.12
85-95-1	10/29/2001	818.30	00:00	11.68	-0.50	806.62
85-95-1	11/28/2001	818.30	00:00	11.77	-0.09	806.53
85-95-1	12/19/2001	818.30	00:00	8.42	3.35	809.88
85-95-1	1/30/2002	818.30	00:00	7.29	1.13	811.01
85-95-1	2/26/2002	818.30	00:00	6.10	1.19	812.20
85-95-1	3/27/2002	818.30	00:00	5.87	0.23	812.43
85-95-1	4/24/2002	818.30	00:00	7.36	-1.49	810.94
85-95-1	5/28/2002	818.30	00:00	8.40	-1.04	809.90
85-95-1	6/26/2002	818.30	00:00	8.07	0.33	810.23
85-95-1	7/24/2002	818.30	00:00	9.74	-1.67	808.56
85-95-1	8/29/2002	818.30	00:00	10.70	-0.96	807.60
85-95-1	9/26/2002	818.30	00:00	10.92	-0.22	807.38
85-95-1	10/29/2002	818.30	00:00	11.22	-0.30	807.08
85-95-1	11/22/2002	818.30	00:00	11.22	0.00	807.08
85-95-1	12/19/2002	818.30	00:00	5.87	5.35	812.43
85-95-1	1/29/2003	818.30	00:00	6.84	-0.97	811.46
85-95-1	2/26/2003	818.30	00:00	6.86	-0.02	811.44
85-95-1	3/26/2003	818.30	00:00	6.76	0.10	811.54
85-95-1	4/28/2003	818.30	00:00	6.25	0.51	812.05
85-95-1	5/28/2003	818.30	00:00	8.24	-1.99	810.06
85-95-1	6/25/2003	818.30	00:00	9.54	-1.30	808.76
85-95-1	7/29/2003	818.30	00:00	10.63	-1.09	807.67
85-95-1	8/27/2003	818.30	00:00	11.07	-0.44	807.23
85-95-1	9/23/2003	818.30	00:00	11.18	-0.11	807.12
85-95-1	10/29/2003	818.30	00:00	11.31	-0.13	806.99
85-95-1	11/24/2003	818.30	00:00	11.40	-0.09	806.90
85-95-1	12/19/2003	818.30	00:00	10.71	0.69	807.59

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SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-1	1/28/2004	818.30	00:00	7.10	3.61	811.20
85-95-1	2/25/2004	818.30	00:00	6.05	1.05	812.25
85-95-1	3/29/2004	818.30	00:00	4.67	1.38	813.63
85-95-1	4/28/2004	818.30	00:00	6.23	-1.56	812.07
85-95-1	5/26/2004	818.30	00:00	7.83	-1.60	810.47
85-95-1	6/28/2004	818.30	00:00	9.24	-1.41	809.06
85-95-1	7/28/2004	818.30	00:00	10.24	-1.00	808.06
85-95-2	8/24/1995	878.74	00:00	4.72	NA	874.02
85-95-2	10/4/1995	878.74	00:00	4.82	-0.10	873.92
85-95-2	10/30/1995	878.74	00:00	5.15	-0.33	873.59
85-95-2	11/28/1995	878.74	00:00	O	NA	NA
85-95-2	1/4/1996	878.74	00:00	5.90	-5.90	872.84
85-95-2	1/31/1996	878.74	00:00	2.84	3.06	875.90
85-95-2	2/28/1996	878.74	00:00	1.95	0.89	876.79
85-95-2	3/29/1996	878.74	00:00	4.27	-2.32	874.47
85-95-2	4/26/1996	878.74	00:00	5.10	-0.83	873.64
85-95-2	5/23/1996	878.74	00:00	5.40	-0.30	873.34
85-95-2	6/25/1996	878.74	00:00	O	NA	NA
85-95-2	7/31/1996	878.74	00:00	8.00	-8.00	870.74
85-95-2	8/28/1996	878.74	00:00	8.92	-0.92	869.82
85-95-2	9/23/1996	878.74	00:00	O	NA	NA
85-95-2	10/30/1996	878.74	00:00	10.98	-10.98	867.76
85-95-2	11/21/1996	878.74	00:00	11.52	-0.54	867.22
85-95-2	1/15/1997	878.74	00:00	2.82	8.70	875.92
85-95-2	4/9/1997	878.74	00:00	4.88	-2.06	873.86
85-95-2	8/20/1997	878.74	00:00	23.95	-19.07	854.79
85-95-2	9/30/1997	878.74	00:00	9.92	14.03	868.82
85-95-2	10/29/1997	878.74	00:00	10.89	-0.97	867.85
85-95-2	11/5/1997	878.74	00:00	11.40	-0.51	867.34
85-95-2	12/19/1997	878.74	00:00	6.79	4.61	871.95
85-95-2	1/27/1998	878.74	00:00	2.10	4.69	876.64
85-95-2	2/11/1998	878.74	00:00	0.30	1.80	878.44
85-95-2	3/26/1998	878.74	00:00	7.61	-7.31	871.13
85-95-2	4/29/1998	878.74	00:00	7.76	-0.15	870.98
85-95-2	6/22/1998	878.74	00:00	5.80	1.96	872.94
85-95-2	7/27/1998	878.74	00:00	6.67	-0.87	872.07
85-95-2	8/14/1998	878.74	00:00	6.93	-0.26	871.81
85-95-2	9/28/1998	878.74	00:00	8.25	-1.32	870.49
85-95-2	10/27/1998	878.74	00:00	9.00	-0.75	869.74
85-95-2	11/25/1998	878.74	00:00	9.47	-0.47	869.27
85-95-2	12/21/1998	878.74	00:00	8.05	1.42	870.69
85-95-2	1/27/1999	878.74	00:00	4.90	3.15	873.84
85-95-2	2/25/1999	878.74	00:00	2.50	2.40	876.24
85-95-2	3/26/1999	878.74	00:00	4.64	-2.14	874.10
85-95-2	4/30/1999	878.74	00:00	5.38	-0.74	873.36
85-95-2	5/26/1999	878.74	00:00	6.22	-0.84	872.52

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-2	6/24/1999	878.74	00:00	7.00	-0.78	871.74
85-95-2	7/27/1999	878.74	00:00	7.82	-0.82	870.92
85-95-2	8/30/1999	878.74	00:00	8.50	-0.68	870.24
85-95-2	9/29/1999	878.74	00:00	8.91	-0.41	869.83
85-95-2	10/27/1999	878.74	00:00	9.46	-0.55	869.28
85-95-2	11/29/1999	878.74	00:00	9.86	-0.40	868.88
85-95-2	12/20/1999	878.74	00:00	10.08	-0.22	868.66
85-95-2	1/27/2000	878.74	00:00	4.60	5.48	874.14
85-95-2	2/25/2000	878.74	00:00	9.25	-4.65	869.49
85-95-2	3/29/2000	878.74	00:00	10.30	-1.05	868.44
85-95-2	4/25/2000	878.74	00:00	10.06	0.24	868.68
85-95-2	5/26/2000	878.74	00:00	10.21	-0.15	868.53
85-95-2	6/27/2000	878.74	00:00	10.50	-0.29	868.24
85-95-2	7/27/2000	878.74	00:00	10.53	-0.03	868.21
85-95-2	8/29/2000	878.74	00:00	10.57	-0.04	868.17
85-95-2	9/26/2000	878.74	00:00	10.77	-0.20	867.97
85-95-2	10/30/2000	878.74	00:00	9.92	0.85	868.82
85-95-2	11/27/2000	878.74	00:00	10.09	-0.17	868.65
85-95-2	12/18/2000	878.74	00:00	10.15	-0.06	868.59
85-95-2	1/29/2001	878.74	00:00	10.35	-0.20	868.39
85-95-2	2/26/2001	878.74	00:00	7.27	3.08	871.47
85-95-2	3/28/2001	878.74	00:00	8.74	-1.47	870.00
85-95-2	4/25/2001	878.74	00:00	10.88	-2.14	867.86
85-95-2	5/29/2001	878.74	00:00	10.85	0.03	867.89
85-95-2	6/26/2001	878.74	00:00	10.82	0.03	867.92
85-95-2	7/26/2001	878.74	00:00	11.19	-0.37	867.55
85-95-2	8/29/2001	878.74	00:00	9.86	1.33	868.88
85-95-2	9/27/2001	878.74	00:00	11.17	-1.31	867.57
85-95-2	10/29/2001	878.74	00:00	10.38	0.79	868.36
85-95-2	11/28/2001	878.74	00:00	9.42	0.96	869.32
85-95-2	12/19/2001	878.74	00:00	8.48	0.94	870.26
85-95-2	1/30/2002	878.74	00:00	10.18	-1.70	868.56
85-95-2	2/26/2002	878.74	00:00	10.22	-0.04	868.52
85-95-2	3/27/2002	878.74	00:00	10.17	0.05	868.57
85-95-2	4/24/2002	878.74	00:00	10.27	-0.10	868.47
85-95-2	5/28/2002	878.74	00:00	10.35	-0.08	868.39
85-95-2	6/26/2002	878.74	00:00	8.88	1.47	869.86
85-95-2	7/24/2002	878.74	00:00	9.24	-0.36	869.50
85-95-2	9/26/2002	878.74	00:00	9.86	-0.62	868.88
85-95-2	11/22/2002	878.74	00:00	9.73	0.13	869.01
85-95-2	12/19/2002	878.74	00:00	6.48	3.25	872.26
85-95-2	1/29/2003	878.74	00:00	6.34	0.14	872.40
85-95-2	2/26/2003	878.74	00:00	7.61	-1.27	871.13
85-95-2	6/25/2003	878.74	00:00	8.41	-0.80	870.33
85-95-2	8/27/2003	878.74	00:00	8.92	-0.51	869.82
85-95-2	9/23/2003	878.74	00:00	9.13	-0.21	869.61
85-95-2	10/29/2003	878.74	00:00	9.51	-0.38	869.23

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SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-95-2	11/24/2003	878.74	00:00	9.43	0.08	869.31
85-95-2	12/19/2003	878.74	00:00	8.38	1.05	870.36
85-95-2	1/28/2004	878.74	00:00	7.92	0.46	870.82
85-95-2	2/25/2004	878.74	00:00	6.20	1.72	872.54
85-95-2	3/29/2004	878.74	00:00	6.88	-0.68	871.86
85-95-2	4/28/2004	878.74	00:00	7.30	-0.42	871.44
85-95-2	5/26/2004	878.74	00:00	7.79	-0.49	870.95
85-95-2	6/28/2004	878.74	00:00	6.94	0.85	871.80
85-95-2	7/28/2004	878.74	00:00	8.54	-1.60	870.20
85-96-1	7/31/1996	890.25	00:00	15.00	NA	875.25
85-96-1	8/29/1996	890.25	00:00	15.10	-0.10	875.15
85-96-1	9/26/1996	890.25	00:00	15.49	-0.39	874.76
85-96-1	10/30/1996	890.25	00:00	16.31	-0.82	873.94
85-96-1	11/21/1996	890.25	00:00	16.76	-0.45	873.49
85-96-1	1/13/1997	890.25	00:00	13.55	3.21	876.70
85-96-1	4/9/1997	890.25	00:00	14.12	-0.57	876.13
85-96-1	8/20/1997	890.25	00:00	14.93	-0.81	875.32
85-96-1	9/30/1997	890.25	00:00	15.52	-0.59	874.73
85-96-1	10/29/1997	890.25	00:00	16.17	-0.65	874.08
85-96-1	11/5/1997	890.25	00:00	18.32	-2.15	871.93
85-96-1	12/19/1997	890.25	00:00	16.71	1.61	873.54
85-96-1	1/27/1998	890.25	00:00	13.72	2.99	876.53
85-96-1	2/11/1998	890.25	00:00	10.64	3.08	879.61
85-96-1	3/30/1998	890.25	00:00	13.99	-3.35	876.26
85-96-1	4/29/1998	890.25	00:00	14.30	-0.31	875.95
85-96-1	6/23/1998	890.25	00:00	14.52	-0.22	875.73
85-96-1	7/27/1998	890.25	00:00	14.64	-0.12	875.61
85-96-1	8/7/1998	890.25	00:00	14.64	0.00	875.61
85-96-1	9/28/1998	890.25	00:00	14.90	-0.26	875.35
85-96-1	10/27/1998	890.25	00:00	14.96	-0.06	875.29
85-96-1	11/25/1998	890.25	00:00	15.07	-0.11	875.18
85-96-1	12/21/1998	890.25	00:00	15.18	-0.11	875.07
85-96-1	1/27/1999	890.25	00:00	15.25	0.07	875.00
85-96-1	2/26/1999	890.25	00:00	14.62	0.63	875.63
85-96-1	3/26/1999	890.25	00:00	14.12	0.50	876.13
85-96-1	5/3/1999	890.25	00:00	14.30	-0.18	875.95
85-96-1	5/26/1999	890.25	00:00	14.40	-0.10	875.85
85-96-1	6/24/1999	890.25	00:00	14.53	-0.13	875.72
85-96-1	7/27/1999	890.25	00:00	14.60	-0.07	875.65
85-96-1	8/30/1999	890.25	00:00	14.70	-0.10	875.55
85-96-1	9/29/1999	890.25	00:00	14.76	-0.06	875.49
85-96-1	10/27/1999	890.25	00:00	14.86	-0.10	875.39
85-96-1	11/29/1999	890.25	00:00	14.96	-0.10	875.29
85-96-1	12/20/1999	890.25	00:00	15.11	-0.15	875.14
85-96-1	1/27/2000	890.25	00:00	15.35	-0.24	874.90
85-96-1	2/25/2000	890.25	00:00	13.88	1.47	876.37

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SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-96-1	3/29/2000	890.25	00:00	13.89	-0.01	876.36
85-96-1	4/25/2000	890.25	00:00	14.33	-0.44	875.92
85-96-1	5/26/2000	890.25	00:00	14.48	-0.15	875.77
85-96-1	6/27/2000	890.25	00:00	14.61	-0.13	875.64
85-96-1	7/27/2000	890.25	00:00	14.68	-0.07	875.57
85-96-1	8/30/2000	890.25	00:00	14.75	-0.07	875.50
85-96-1	9/26/2000	890.25	00:00	14.82	-0.07	875.43
85-96-1	10/30/2000	890.25	00:00	14.94	-0.12	875.31
85-96-1	11/27/2000	890.25	00:00	15.07	-0.13	875.18
85-96-1	12/18/2000	890.25	00:00	15.27	-0.20	874.98
85-96-1	1/29/2001	890.25	00:00	15.66	-0.39	874.59
85-96-1	2/26/2001	890.25	00:00	14.84	0.82	875.41
85-96-1	3/28/2001	890.25	00:00	14.48	0.36	875.77
85-96-1	4/25/2001	890.25	00:00	14.51	-0.03	875.74
85-96-1	5/29/2001	890.25	00:00	14.62	-0.11	875.63
85-96-1	6/26/2001	890.25	00:00	14.66	-0.04	875.59
85-96-1	7/26/2001	890.25	00:00	14.73	-0.07	875.52
85-96-1	8/29/2001	890.25	00:00	14.80	-0.07	875.45
85-96-1	9/27/2001	890.25	00:00	14.87	-0.07	875.38
85-96-1	10/29/2001	890.25	00:00	15.08	-0.21	875.17
85-96-1	11/28/2001	890.25	00:00	15.36	-0.28	874.89
85-96-1	12/19/2001	890.25	00:00	14.95	0.41	875.30
85-96-1	1/30/2002	890.25	00:00	14.36	0.59	875.89
85-96-1	2/26/2002	890.25	00:00	14.42	-0.06	875.83
85-96-1	3/27/2002	890.25	00:00	14.51	-0.09	875.74
85-96-1	4/24/2002	890.25	00:00	14.55	-0.04	875.70
85-96-1	5/28/2002	890.25	00:00	14.60	-0.05	875.65
85-96-1	6/26/2002	890.25	00:00	14.70	-0.10	875.55
85-96-1	7/24/2002	890.25	00:00	14.70	0.00	875.55
85-96-1	8/29/2002	890.25	00:00	14.78	-0.08	875.47
85-96-1	9/26/2002	890.25	00:00	14.82	-0.04	875.43
85-96-1	10/29/2002	890.25	00:00	14.95	-0.13	875.30
85-96-1	11/22/2002	890.25	00:00	15.04	-0.09	875.21
85-96-1	12/19/2002	890.25	00:00	14.93	0.11	875.32
85-96-1	1/29/2003	890.25	00:00	14.48	0.45	875.77
85-96-1	2/26/2003	890.25	00:00	14.52	-0.04	875.73
85-96-1	3/26/2003	890.25	00:00	13.38	1.14	876.87
85-96-1	4/28/2003	890.25	00:00	14.57	-1.19	875.68
85-96-1	5/28/2003	890.25	00:00	14.67	-0.10	875.58
85-96-1	6/25/2003	890.25	00:00	14.68	-0.01	875.57
85-96-1	7/29/2003	890.25	00:00	14.73	-0.05	875.52
85-96-1	8/27/2003	890.25	00:00	14.77	-0.04	875.48
85-96-1	9/23/2003	890.25	00:00	14.83	-0.06	875.42
85-96-1	10/29/2003	890.25	00:00	14.98	-0.15	875.27
85-96-1	11/24/2003	890.25	00:00	15.18	-0.20	875.07
85-96-1	12/19/2003	890.25	00:00	15.38	-0.20	874.87
85-96-1	1/28/2004	890.25	00:00	14.65	0.73	875.60

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-96-1	2/25/2004	890.25	00:00	14.34	0.31	875.91
85-96-1	3/29/2004	890.25	00:00	14.28	0.06	875.97
85-96-1	4/28/2004	890.25	00:00	14.45	-0.17	875.80
85-96-1	5/26/2004	890.25	00:00	14.56	-0.11	875.69
85-96-1	6/28/2004	890.25	00:00	14.65	-0.09	875.60
85-96-1	7/28/2004	890.25	00:00	14.73	-0.08	875.52
85-96-2	7/31/1996	877.40	00:00	38.20	NA	839.20
85-96-2	8/29/1996	877.40	00:00	39.10	-0.90	838.30
85-96-2	9/26/1996	877.40	00:00	39.37	-0.27	838.03
85-96-2	10/30/1996	877.40	00:00	39.97	-0.60	837.43
85-96-2	11/22/1996	877.40	00:00	39.77	0.20	837.63
85-96-2	1/13/1997	877.40	00:00	37.61	2.16	839.79
85-96-2	4/9/1997	877.40	00:00	37.41	0.20	839.99
85-96-2	8/21/1997	877.40	00:00	39.15	-1.74	838.25
85-96-2	9/30/1997	877.40	00:00	39.74	-0.59	837.66
85-96-2	10/29/1997	877.40	00:00	39.93	-0.19	837.47
85-96-2	11/6/1997	877.40	00:00	40.20	-0.27	837.20
85-96-2	12/19/1997	877.40	00:00	39.20	1.00	838.20
85-96-2	1/27/1998	877.40	00:00	38.14	1.06	839.26
85-96-2	2/17/1998	877.40	00:00	35.70	2.44	841.70
85-96-2	3/26/1998	877.40	00:00	36.56	-0.86	840.84
85-96-2	4/29/1998	877.40	00:00	36.98	-0.42	840.42
85-96-2	6/22/1998	877.40	00:00	37.62	0.64	839.78
85-96-2	7/27/1998	877.40	00:00	37.96	-0.34	839.44
85-96-2	8/6/1998	877.40	00:00	37.94	0.02	839.46
85-96-2	9/28/1998	877.40	00:00	38.60	-0.66	838.80
85-96-2	10/27/1998	877.40	00:00	39.10	-0.50	838.30
85-96-2	11/25/1998	877.40	00:00	39.20	-0.10	838.20
85-96-2	12/21/1998	877.40	00:00	39.05	0.15	838.35
85-96-2	1/27/1999	877.40	00:00	38.90	0.15	838.50
85-96-2	2/25/1999	877.40	00:00	37.72	1.18	839.68
85-96-2	3/26/1999	877.40	00:00	37.36	0.36	840.04
85-96-2	4/30/1999	877.40	00:00	37.52	-0.16	839.88
85-96-2	5/26/1999	877.40	00:00	37.90	-0.38	839.50
85-96-2	6/24/1999	877.40	00:00	38.07	-0.17	839.33
85-96-2	7/27/1999	877.40	00:00	38.38	-0.31	839.02
85-96-2	8/30/1999	877.40	00:00	38.80	-0.42	838.60
85-96-2	9/29/1999	877.40	00:00	39.04	-0.24	838.36
85-96-2	10/27/1999	877.40	00:00	39.33	-0.29	838.07
85-96-2	11/29/1999	877.40	00:00	39.41	-0.08	837.99
85-96-2	12/20/1999	877.40	00:00	39.29	0.12	838.11
85-96-2	1/27/2000	877.40	00:00	39.40	-0.11	838.00
85-96-2	2/25/2000	877.40	00:00	38.02	1.38	839.38
85-96-2	3/29/2000	877.40	00:00	37.13	0.89	840.27
85-96-2	4/25/2000	877.40	00:00	37.38	-0.25	840.02
85-96-2	5/26/2000	877.40	00:00	37.75	-0.37	839.65

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-96-2	6/27/2000	877.40	00:00	38.06	-0.31	839.34
85-96-2	7/27/2000	877.40	00:00	38.23	-0.17	839.17
85-96-2	8/29/2000	877.40	00:00	38.48	-0.25	838.92
85-96-2	9/26/2000	877.40	00:00	38.87	-0.39	838.53
85-96-2	10/30/2000	877.40	00:00	38.92	-0.05	838.48
85-96-2	11/27/2000	877.40	00:00	39.01	-0.09	838.39
85-96-2	12/18/2000	877.40	00:00	39.48	-0.47	837.92
85-96-2	1/29/2001	877.40	00:00	39.23	0.25	838.17
85-96-2	2/26/2001	877.40	00:00	37.98	1.25	839.42
85-96-2	3/28/2001	877.40	00:00	37.83	0.15	839.57
85-96-2	4/25/2001	877.40	00:00	37.65	0.18	839.75
85-96-2	5/29/2001	877.40	00:00	37.90	-0.25	839.50
85-96-2	6/26/2001	877.40	00:00	38.15	-0.25	839.25
85-96-2	7/26/2001	877.40	00:00	38.58	-0.43	838.82
85-96-2	8/29/2001	877.40	00:00	39.07	-0.49	838.33
85-96-2	9/27/2001	877.40	00:00	39.34	-0.27	838.06
85-96-2	10/29/2001	877.40	00:00	40.16	-0.82	837.24
85-96-2	11/28/2001	877.40	00:00	40.04	0.12	837.36
85-96-2	12/19/2001	877.40	00:00	39.42	0.62	837.98
85-96-2	1/30/2002	877.40	00:00	38.20	1.22	839.20
85-96-2	2/26/2002	877.40	00:00	37.91	0.29	839.49
85-96-2	3/27/2002	877.40	00:00	37.85	0.06	839.55
85-96-2	4/24/2002	877.40	00:00	38.15	-0.30	839.25
85-96-2	5/28/2002	877.40	00:00	38.15	0.00	839.25
85-96-2	6/26/2002	877.40	00:00	38.22	-0.07	839.18
85-96-2	7/24/2002	877.40	00:00	38.28	-0.06	839.12
85-96-2	8/29/2002	877.40	00:00	38.62	-0.34	838.78
85-96-2	9/26/2002	877.40	00:00	38.92	-0.30	838.48
85-96-2	10/29/2002	877.40	00:00	39.60	-0.68	837.80
85-96-2	11/22/2002	877.40	00:00	40.16	-0.56	837.24
85-96-2	12/19/2002	877.40	00:00	39.81	0.35	837.59
85-96-2	1/29/2003	877.40	00:00	38.22	1.59	839.18
85-96-2	2/26/2003	877.40	00:00	37.75	0.47	839.65
85-96-2	3/26/2003	877.40	00:00	37.86	-0.11	839.54
85-96-2	4/28/2003	877.40	00:00	37.88	-0.02	839.52
85-96-2	5/28/2003	877.40	00:00	38.02	-0.14	839.38
85-96-2	6/25/2003	877.40	00:00	38.26	-0.24	839.14
85-96-2	7/29/2003	877.40	00:00	38.44	-0.18	838.96
85-96-2	8/27/2003	877.40	00:00	38.66	-0.22	838.74
85-96-2	9/23/2003	877.40	00:00	39.00	-0.34	838.40
85-96-2	10/29/2003	877.40	00:00	39.68	-0.68	837.72
85-96-2	11/24/2003	877.40	00:00	40.32	-0.64	837.08
85-96-2	12/19/2003	877.40	00:00	40.22	0.10	837.18
85-96-2	1/28/2004	877.40	00:00	39.02	1.20	838.38
85-96-2	2/25/2004	877.40	00:00	37.91	1.11	839.49
85-96-2	3/29/2004	877.40	00:00	37.44	0.47	839.96
85-96-2	4/28/2004	877.40	00:00	37.64	-0.20	839.76

PERIOD: From 08/24/1995 thru 07/28/2004 - Inclusive

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	DELTA WATER ELEV (feet)	WATER ELEV (feet)
85-96-2	5/26/2004	877.40	00:00	38.07	-0.43	839.33
85-96-2	6/28/2004	877.40	00:00	38.15	-0.08	839.25
85-96-2	7/28/2004	877.40	00:00	38.42	-0.27	838.98

BORING #	SURF ELEV:	UC EAST:	UC NORTH:	LOGGED BY:	DATE DRILLED:	PAGE:
MW85-95-1	=820 feet			Preston Holland	5/8-10/95	1/1

DEPTH TO GROUNDWATER:	DRILLING CONTRACTOR:	BORING EQUIPMENT:	DRILL RIG:
15.0 feet (5/10/95)	Western Strata Exploration	7 3/4" cryo rotary tri-cone reamed with 10" hollow stem auger	B-61

DESCRIPTION AND CLASSIFICATION: DESCRIPTION AND REMARKS	SOIL TYPE	DEPTH (FEET)	SAMPLE	Penetration Resistance (Blows/ft)	PID readings (ppm)	REMARKS	Well Construction
ASPHALT/ CONCRETE						Traffic-grade well cover with locking cap	
GRAVEL, base rock							
SANDY SILT (ML), brown, stiff, dry to damp, minor fine-grained angular to subangular mudstone gravel (fill?).		5		35		Cement grout seal	
CLAYEY SILT (ML), dark brown, stiff, damp, minor, fine-grained, subangular, andesitic and basaltic gravel.		10		33		2" PVC solid casing, Sch. 40, 10' sections, O-ring seals	
ANDESITE, brown, intensely fractured, moderately strong, hard, deeply to moderately weathered, saturated, includes minor basalt.		15		47/11"		Bentonite pellets seal	
CLAYSTONE, red brown, crushed, plastic to friable, soft to little hardness, little weathered, saturated, subhorizontally sheared with laminae and boudins of greenish gray fine sandstone with intermittent calcite cementation.		20				No. 2/12 sand filter pack	
		25				Machine-slotted PVC well screen, slot size 0.010"	
		30				Silt trap	
		35					
		40					
		45					
		50					

Total drilled depth = 25.0 ft

all samples taken with 2 inch internal diameter split spoon sampler

note blows converted, raw counts available

Post-it® Fax Note 7671

Date 9-1	# of pages ▶ 4
To Preston Holland	From Jax
Co./Dept.	Co.
Phone # 6774	Phone # 6653
Fax # 5686	Fax # 6608

LAWRENCE BERKELEY NATIONAL LABORATORY	EXPLORATORY BORING LOG		
	PROJECT # Site Restoration Project	DATE: 9/19/95	BORING # MW85-95-1

BORING #	SURF ELEV:	UC EAST:	UC NORTH:	LOGGED BY:	DATE DRILLED:	PAGE:
MW85-95-2	≈878 feet			Preston Holland	5/10/95	1/1

DEPTH TO GROUNDWATER:	DRILLING CONTRACTOR:	BORING EQUIPMENT:	DRILL RIG:
not equilibrated	Western Strata Exploration	8" hollow stem auger	B-61

DESCRIPTION AND CLASSIFICATION: DESCRIPTION AND REMARKS	SOIL TYPE	DEPTH (FEET)	SAMPLE	Penetration Resistance (Blows/ft)	PID readings (ppm)	REMARKS	Well Construction
ASPHALT/ CONCRETE						Traffic-grade well cover with locking cap	
GRAVEL, base rock						Cement grout seal	
SILTY GRAVEL (GM), yellow brown, medium dense, wet, medium, angular andesite gravel (deeply weathered andesite).		5		28		2" PVC solid casing, Sch. 40	
* saturated at 8 ft		10		48/6"		Bentonite pellets seal	
						No. 2/12 sand filter pack	
FINE SANDY SILTSTONE, red brown with blue gray silty fine sandstone zones and laminae, crushed, plastic, soft to little hardness, little weathered, saturated, subvertical shear planes.		15		40/11"		Machine-slotted PVC well screen, slot size 0.010"	
		20		44		Silt trap	
Total drilled depth = 19.0 ft		25					
		30					
		35					
		40					
		45					
		50					

all samples taken with 2 inch internal diameter split spoon sampler

LAWRENCE BERKELEY NATIONAL LABORATORY	EXPLORATORY BORING LOG		
	PROJECT # Site Restoration Project	DATE: 9/19/95	BORING # MW85-95-1

BORING #	SURF ELEV:	UC EAST:	UC NORTH:	LOGGED BY:	DATE DRILLED:	PAGE:
MW85-96-1				Preston Holland	6/13/96	1/1

DEPTH TO GROUNDWATER:	DRILLING CONTRACTOR:	BORING EQUIPMENT:	DRILL RIG:
22.5 feet (11:00)	Gregg	8" hollow stem auger	M-11

DESCRIPTION AND CLASSIFICATION							
DESCRIPTION AND REMARKS	SOIL TYPE	DEPTH (FEET)	SAMPLE	Penetration Resistance (Blows/ft)	ambient PID readings (ppm)	REMARKS	Well Construction
CONCRETE							
GRAVELLY CLAY (CL), brown to dark brown, stiff, moist, angular to subangular volcanic gravel predominantly, faint subhorizontal structure (fill).		5		29		Cement grout seal	
CLAYEY SILT (ML), brown to dark brown, stiff, moist to wet, rootlets with discoloration zones, occasional clay coated volcanic gravel.		10		10		2" PVC solid casing Sch. 40, 10' sections, O-ring seals	
SANDY SILT (ML), grayish brown with bluish gray mottling, medium stiff, wet, mottling along roots.		15		6		Bentonite pellets seal	
• bluish gray mottling increasing with depth		20		23		No. 2/12 sand filter pack	
SILTY SAND (SM), grayish brown with bluish gray mottling, loose to medium dense, saturated. • harder drilling at 27 ft • easier drilling at 28 ft		25		26		Machine-slotted PVC well screen, slot size 0.020"	
CLAYEY SILTSTONE AND SILTSTONE, greenish gray and gray, crushed, friable, little hardness, little weathered, saturated, subvertical black shear zones separate lithologies.		30		30		Silt trap Slough	
Total Depth = 30.5 feet		35					
		40					
		45					
		50					

all samples taken with 2 inch internal diameter split spoon sampler

LAWRENCE BERKELEY NATIONAL LABORATORY	EXPLORATORY BORING LOG		
	PROJECT # Site Restoration Project	DATE: 6/18/96	BORING # MW85-96-1

BORING #	SURF ELEV:	UC EAST:	UC NORTH:	LOGGED BY:	DATE DRILLED:	PAGE:
MW85-96-2				Preston Holland	6/28/96	1/1

DEPTH TO GROUNDWATER:	DRILLING CONTRACTOR:	BORING EQUIPMENT:	DRILL RIG:
38.7 feet (11:40)	Gregg	8" hollow stem auger	B-61

DESCRIPTION AND CLASSIFICATION		DEPTH (FEET)	SAMPLE	Penetration Resistance (Blows/ft)	ambient PID readings (ppm)	REMARKS	Well Construction
DESCRIPTION AND REMARKS	SOIL TYPE						
SANDY SILT (ML), brown and dark brown, medium stiff to stiff, moist, sand coarse, composed primarily of volcanics, faint, irregular, subhorizontal bedding (fill).		5		7			
CLAYEY SILT (ML), black, medium stiff, wet (fill).		10				Cement grout seal	
GRAVELLY SILT (ML), brown, stiff to very stiff, wet to saturated, fine, angular, volcanic gravel, occasional woody debris with blue gray coloration surrounding, no soil structure (fill).		15		19		2" PVC solid casing Sch. 40, 10' sections, O-ring seals	
CLAYEY SILT (ML), dark gray brown, stiff, wet (fill).		20					
SANDY SILT (ML), brown with orange brown mottles, stiff to very stiff, moist to wet, angular, coarse, volcanic sand (fill).		25		17			
SILT (ML), black with blue gray and orange brown mottles, stiff, wet, minor coarse, angular, volcanic sand, no soil structure (fill).		30					
SILTY GRAVEL (GM), brown and dark gray brown mottled, very stiff, moist to wet, medium, angular volcanic gravel (fill). • smooth drilling at 37 ft		35		48/11"		Bentonite pellets seal	
SILTY CLAY (CL), dark brown with brown mottles, medium stiff, wet, rootlets, minor charcoal and subangular, coarse, volcanic sand, no soil structure. • gravelly layers, saturated at 47 ft		40		14		No. 2/12 sand filter pack	
SANDY SILTSTONE, purplish brown with greenish gray mottling, closely fractured, friable to weak, little to moderate hardness, little weathered, saturated, occasional shear zones with coarse sand of red brown scoria, andesite and other volcanics, minor clasts of blue gray sandstone, roots and rootlets.		45				Machine-slotted PVC well screen, slot size 0.020"	
		50		23		Silt trap Slough	
Total Depth = 50.5 feet							

all samples taken with 2 inch internal diameter split spoon sampler

LAWRENCE BERKELEY NATIONAL LABORATORY	EXPLORATORY BORING LOG		
	PROJECT # Site Restoration Project	DATE: 7/29/96	BORING # MW85-96-2

Appendix C1.D

Alan Kropp & Associates, Inc., 2007

Conceptual-Level Design and Cost Estimate, Buildings 85 and 85A Landslide Mitigation, Lawrence Berkeley National Laboratory, Berkeley, California

44.3

ALAN KROPP
& ASSOCIATES, INC.

GEOTECHNICAL
CONSULTANTS

ALAN KROPP, CE, GE
JAMES R. LOTT, CE, GE
WAYNE MAGNUSEN, CE, GE
DONA K. MANN, CE
DONALD L. IRBY, CE
THOMAS M. BRENCIC, CE

April 27, 2007
2335-7, L-28443

Ms. Nancy M. Ware
Lawrence Berkeley National Laboratory
1 Cyclotron Road, MS 50A4112
Berkeley, CA 94720

RE: Executive Summary and Transmittal of Study Results
Conceptual-Level Design and Cost Estimate
Buildings 85 and 85A Landslide Mitigation
Lawrence Berkeley National Laboratory
Berkeley, California

Dear Ms. Ware:

This letter summarizes and transmits to you the results of a conceptual-level study by Alan Kropp & Associates, Inc. (AKA) for the mitigation of a landslide in the East Canyon area of the Lawrence Berkeley National Laboratory (LBNL). The information presented is intended for use by LBNL technical personnel, stakeholders and decision-makers in their evaluation of risk management options pertaining to LBNL Buildings 85 & 85A. The services described herein were provided in general accordance with our scope and fee estimate dated November 13, 2006 and were authorized under Subcontract No. 6814976.

The results of our study are presented in three Appendices. Appendix A provides a narrative describing the services we provided and the limitations of our study; Appendix B presents engineering drawings of our conceptual-level mitigation design; and Appendix C presents our conceptual-level cost estimate. The principal findings, conclusions and recommendations of our study are as follows:

- We conclude that a structural mitigation scheme involving drilled piers and tiebacks is the most reasonable means of mitigating potentially excessive seismically-induced earth movements beneath LBNL Buildings 85 & 85A.

- We conclude that it is probably not feasible to protect the existing emergency generator and external fire suppression system located to the northeast of Building 85 due to the thickness of the landslide deposits in this area. We therefore recommend that the emergency generator and external fire suppression system be relocated to an area unlikely to be affected by earthquake-induced landsliding.

- We estimate that the cost of implementing the conceptual mitigation presented in Appendix B to be on the order of $3.8 Million. This does not include the cost of relocating the emergency generator and external fire suppression system or the cost of structural upgrades to Buildings 85 & 85A.

2140 SHATTUCK AVENUE BERKELEY, CA 94704 TEL 510.841.5095 FAX 510.841.8357 WWW.AKROPP.COM

Please note that all of the materials presented herein are intended to be conceptual in nature and that additional subsurface investigations, laboratory and field tests and engineering analyses would be needed prior to developing a final design. More information on the scope and limitations of our study is presented in Appendix A.

We were assisted in our conceptual study by Dr. Jonathan Bray, professor in the Department of Civil and Environmental Engineering at the University of California, Berkeley; Mr. Tim Mathison, a Professional Engineer and Vice President of Tuan & Robinson Structural Engineers; and Mr. Brad Saylor, a cost estimator and Managing Director of the Saylor Consulting Group.

We trust that this letter and the attached materials provide the information that you require at this time. Should you have questions or comments regarding the results of our study, please do not hesitate to call.

Very truly yours,

Wayne Magnusen, G.E.
Associate Engineer

REGISTERED PROFESSIONAL ENGINEER
WAYNE DAVID MAGNUSEN
No. 2705
Exp. 6/30/10
GEOTECHNICAL
STATE OF CALIFORNIA

WM/sa

2335-7_executive summary & transmittal - Final

APPENDIX A
Conceptual-Level Design and Cost Estimate
Buildings 85 and 85A Landslide Mitigation

BACKGROUND

From August 2005 through July 2006, Alan Kropp & Associates, Inc. (AKA) conducted an initial phase of a geotechnical and geologic study pertaining to landslide deposits within the central portion of LBNL's East Canyon. This previous study, which was performed in conjunction with William Lettis & Associates, Inc. (WLA), engineering geologists, was intended as a first step toward evaluating concerns that landslide deposits could present a hazard to LBNL Buildings 85 & 85A. As part of this previous study, exploratory trenches were excavated and test borings were drilled to investigate the geometric relationship of the landslide deposits relative to both buildings. Based on the results of these targeted onsite investigations, a detailed review of existing geotechnical, geologic and historic information, and onsite geologic mapping, WLA developed an updated geologic map and interpretive cross sections that show landslide deposits underlying portions of Buildings 85 & 85A. Simplified slope stability and deformation analyses performed by AKA indicated that these landslide deposits may be subject to renewed movement in the event of an earthquake. Based on these findings, it was concluded that earthquake-induced landsliding poses a potential hazard to both buildings.

In October 2006, LBNL requested that we develop a scope and fee estimate for a conceptual-level engineering study to mitigate the potential for earthquake-induced landslide movements beneath Buildings 85 & 85A. In preparing our November 13, 2006 proposal, we performed an initial screening analysis of potentially feasible landslide mitigation concepts as we developed our proposed scope of work. Various site constraints were considered during our preliminary analyses, including geometric relationships between the landslide deposits and the subject buildings; locations of existing underground utilities and their potential impacts on construction; and operational constraints involving existing LBNL facilities in the East Canyon. Based on these and other limiting factors, we judged that structural mitigation would be the most realistic means of limiting earthquake-induced movement of the landslide deposits beneath the subject buildings. Two basic structural mitigation concepts were identified:

Alternative 1 (Local Stabilization) – This general concept utilizes drilled piers and tiebacks to locally restrain landslide deposits only in the direct vicinity of Buildings 85 & 85A. Adjacent landslide deposits within the East Canyon would *not* be restrained and would potentially move downslope as a result of an earthquake.

Alternative 2 (Global Stabilization) – This general concept utilizes drilled piers and tiebacks to globally restrain landslide deposits across the width of the East Canyon, including those in the direct vicinity of Buildings 85 & 85A.

We discussed these two basic structural mitigation concepts in our pre-proposal scoping discussions with LBNL facilities personnel. Based on their input, we developed the scope of services outlined in our November 13, 2006 proposal, which was directed at the evaluation and costing of Alternative 2 (Global Stabilization).

SCOPE OF SERVICES

In December 2006, we were issued a subcontract (No. 6814976) based on our November 13, 2006 proposal. Subcontract 6814976 defines the primary scope of our current work as follows: "Perform conceptual level geotechnical, civil and/or structural engineering to design realistic, cost effective mitigation to prevent seismically-induced movement of the landslide deposits beneath Buildings 85 &

85A during the maximum credible earthquake for the LBNL site." The scope of services presented in our November 13, 2006 proposal included the following tasks, to be conducted under a phased approach involving a "preliminary", 50 percent, 90 percent and "final" conceptual-level design:

- Review existing data, conduct a site reconnaissance and select a "most promising" alignment for the cross-valley below-grade drilled pier structural buttress.
- Prepare geotechnical engineering profiles, sections and estimates of geotechnical properties for the selected buttress alignment.
- Evaluate seismic loading on potential sliding masses through one-dimensional dynamic analyses (using the acceleration time histories) and two-dimensional limit equilibrium analyses.
- Develop conceptual-level geotechnical design criteria for structural buttress design.
- Perform conceptual-level structural engineering analyses to evaluate the layout and sizing of structural elements for cost estimating purposes.
- Perform conceptual-level cost estimating.

Our initial phase of geotechnical and geologic study did not include developing earthquake acceleration time histories needed for one-dimensional dynamic analyses. As part of our study, we provided consultation and recommendations to LBNL Facilities personnel during the evaluation of appropriate earthquake ground motions and performance criteria to be used in our conceptual-level design (as discussed later in this appendix).

PROJECT AND CONSULTANT TEAM

The key AKA technical personnel that participated in this study are: Wayne Magnusen, G.E. (Project Manager); Jeffrey Wisniewski, C.E. (Project Engineer); and Alan Kropp, G.E. (Technical Reviewer). We were assisted in our study by the following consultants:

- Dr. Jonathan Bray, P.E., professor in the Department of Civil and Environmental Engineering at the University of California, Berkeley, provided consultation and review during the development of the conceptual designs and the evaluation of the earthquake ground motions and seismic loadings described in this appendix (Appendix A).

- Mr. Tim Mathison, P.E., Vice President of Tuan & Robinson Structural Engineers, performed conceptual-level structural engineering analyses to evaluate the layout and sizing of structural elements and prepared the preliminary conceptual plans presented in Appendix B.

- Mr. Brad Saylor, Managing Director of the Saylor Consulting Group, performed conceptual-level cost estimating and developed the concept documents estimate presented in Appendix C.

APPENDIX A
Conceptual-Level Design and Cost Estimate
Buildings 85 and 85A Landslide Mitigation

DESIGN GROUND MOTIONS AND PERFORMANCE CRITERIA

We considered the following approaches for developing earthquake ground motions for conceptual design:

1. Independently developing estimates of the maximum credible earthquake (MCE) for the controlling fault (the Hayward fault) and estimating simplified ground motion parameters to develop site-specific acceleration time histories.
2. Utilizing the seismic design criteria developed for the LBNL facility in 1992 by Dr. Bruce Bolt.
3. Utilizing the current (2003) seismic design criteria developed by URS for the UC Berkeley main campus.

It was our opinion that it would be best to utilize the 2003 criteria developed for the UC Berkeley main campus, as it is considerably more up to date than the 1992 LBNL criteria and better accounts for near-fault forward-directivity ground motion effects. It also has the advantage of having been recently peer-reviewed and accepted for use at the UC Berkeley campus. We note, however, that even newer ground attenuation models have been developed by seismologists that can be used to evaluate earthquake ground motions. For sites at UC Berkeley and LBNL, use of the new ground attenuation models (NGA models) generally results in earthquake ground motions that are lower than those obtained using the 2003 UCB criteria. However, the apparent conservatism afforded by using the 2003 UCB criteria was judged to be acceptable, in part due to the uncertainties inherent in conceptual-level design and the importance of the Building 85 facility. Formal permission was obtained by LBNL for the use of the 2003 UC Berkeley criteria for our conceptual-level study, prior to the start of our analyses.

The target spectrum used in our study was the 975-year return period fault-normal spectrum presented on Figure 33 of URS's 2003 report. The 975-year return period is equivalent to a 10 percent in 100 years probability of exceedence. This level of hazard was initially selected by LBNL facilities personnel to be consistent with the criteria currently being used to evaluate the structural performance of Building 85 & 85A and it was this level of hazard that was used in this study to evaluate the forces that the structures developed in our conceptual-level design would need to resist. The proposed future adoption of an alternative multi-level hazard/performance approach has merit, and is briefly discussed in the final section of this appendix.

INPUT GROUND MOTIONS

We developed a suite of seven input ground motions based largely on the time histories recommended for use on the UC Berkeley main campus by URS. They consisted of three spectrally-matched motions provided by URS and four recorded ground motions that were modified by intensity scaling factors so the geometric mean of the seven spectra matches the target UCB 975-year return period fault-normal (forward-directivity) spectrum over the period of interest. The seven motions, and applied scaling factor (if any), are as follows:

1. Los Gatos Presentation Center, Loma Prieta Earthquake, scaled 1.8 times.
2. Gavilan College, Loma Prieta Earthquake, scaled 3.1 times.
3. Saratoga Aloha Avenue, Loma Prieta Earthquake, scaled 3.35 times.
4. Lucerne, Landers Earthquake, scaled 1.7 times.

5. Corralitos, Loma Prieta Earthquake, spectrally-matched.
6. Erzincan, Erzincan Earthquake, spectrally-matched.
7. Kofu, Tottori Earthquake, spectrally-matched.

EVALUATION OF SEISMIC LOADING – GLOBAL STABILIZATION

One-Dimensional Dynamic Analyses

We utilized the computer program SHAKE2000 to evaluate the dynamic response of the principal landslide masses shown on the interpretive longitudinal geologic cross section developed by WLA during our initial phase of geotechnical and geologic study. The interpretive cross section used is roughly aligned along the central axis of the landslide deposits. This alignment was deemed appropriate for evaluating the maximum forces that would be exerted on the proposed cross-valley structural buttress envisioned under the Global Stabilization concept.

The interpretive cross section used in our analysis depicts a shallower landslide (designated by WLA as Qls2) nested within much larger and deeper landslide (designated as Qls1). We developed one-dimensional soil "columns" for two general cases:

- Locations where only the deeper landslide mass (Qls1) exists; and
- Locations where the deeper landslide mass (Qls1) is overlain by shallower more disrupted landslide deposits (Qls2).

We estimated the geophysical properties of the landslide materials using information obtained from previous studies, published information, and engineering judgment. To capture ground motion incoherency in the vertical direction, we used the computer program SHAKE2000 and the suite of seven input ground motions previously developed to calculate a horizontal shear stress time history at the depth of sliding in each soil column.

For each soil column and time-history combination, we divided shear stress time histories by their respective total vertical stress at the depth of sliding to calculate horizontal equivalent acceleration (HEA) time-histories at the depths of the landslide planes. A suite of seven HEA time-histories for the landslide mass as a whole were then calculated by using the weighted averages of the total cross-sectional areas represented by each soil column. The resulting time-histories were scaled by a length reduction factor (LRF) to capture ground motion incoherency in the second (i.e. horizontal) dimension and obtain the seven HEA time-histories that we used in our conceptual-level analyses.

The HEA time-histories were input into the SHAKE2000 Newmark displacement utility to develop plots of seismic displacement versus yield acceleration. The results of the seven plots were then averaged to get the median seismic displacement versus yield acceleration plot for the selected suite of input time-histories.

Two-Dimensional Limit Equilibrium Analyses

We utilized the computer program Slide (v5.0) to evaluate the yield acceleration of the principal landslide masses shown on the interpretive longitudinal geologic cross section prepared by WLA during our initial phase of geotechnical and geologic study. We estimated geotechnical material properties for the landslide deposits, slide plane materials, and bedrock based on the results of the geotechnical laboratory tests from previous studies (which included Atterberg limits and drained torsional ring shear tests performed on samples of slide plane material) and engineering judgment. Groundwater levels used in our analyses were selected to model high (i.e. winter rainy season) conditions. Pseudostatic stability analyses were performed using Slide v5.0 for a range of horizontal acceleration values until the value associated with a Factor of Safety of 1.0 was obtained. This horizontal acceleration value is termed the yield acceleration.

Once the yield acceleration was obtained, we entered the median seismic displacement versus yield acceleration plot obtained from the Shake2000 Newmark utility to evaluate seismic displacement. The results of this exercise for the landslide as a whole indicated greater than one meter of displacement; which is essentially consistent with the results of simplified analyses performed in 2006 as part of our initial phase of geotechnical and geologic study.

We then modified the interpretive cross section to model the case where a cross-valley structural buttress would retain the upslope landslide deposits. Assuming an acceptable seismic displacement threshold of 3 to 12 inches for the structural buttress, we re-entered the median seismic displacement versus yield acceleration plot to evaluate what would be the corresponding yield acceleration.

Using Slide v5.0, we than calculated the overall force that would need to be provided (per unit width) to produce the "acceptable" yield acceleration value. The required resisting force was then reviewed and found to be unacceptably large and not feasible to retain using a drilled pier and tieback system. This key finding was discussed with LBNL Facilities personnel and the global stabilization alternative was abandoned.

DEVELOPMENT OF LOCAL STABILIZATION DESIGN CONCEPT

In developing our design concept for local stabilization, we conducted a detailed site reconnaissance and reviewed East Canyon utility drawings that were provided to us by LBNL. The conceptual-level design that we developed consists of the following main components:

1. A structural restraint system for Building 85.
2. A structural restraint system for Building 85A.
3. Relocating the Building 85 emergency generator and fire suppression system.
4. A supplemental structural system intended to absorb energy and control deformations.

The structural restraint systems envisioned in our conceptual designs for Buildings 85 & 85A (Items 1 and 2, above) consist primarily of drilled piers and tiebacks; which are augmented with micropiles, in the case of Building 85A. It was our team's consensus that it is not feasible to design a structural restraint system to protect the existing Building 85 emergency generator and fire suppression system due to the thickness of the landslide deposits in that area; consequently, we recommend that these elements be moved outside of the area affected by landsliding (Item 3, above). The supplemental structural systems that will ultimately be needed to absorb energy upslope of Building 85A and

control deformations at the margins of landsliding (Item 4, above) cannot be fully developed based on the available existing data. The remainder of this appendix discusses the development and limitations of our conceptual-level local stabilization design in greater detail.

EVALUATION OF SEISMIC LOADING – LOCAL STABILIZATION

We developed five additional interpretive cross sections in order to evaluate seismic loadings on the structural restraint systems for Buildings 85 & 85A. We note that both Buildings 85& 85A are oriented obliquely with respect to the principal axis of the landslide deposits *and* straddle the landslide margins. The drilled pier restraint systems shown on the conceptual plans (Appendix B) are generally aligned with the faces of these two buildings and include tiebacks that pass beneath the buildings to be anchored within in-place bedrock beneath the west side of the East Canyon. These orientations greatly increase the complexity of the analyses required. We developed the following interpretive sections to analyze the local stabilization alternative:

- Three for the proposed Building 85 restraint system
  - Parallel to the longitudinal axis of the landslide deposits
  - Perpendicular to the long axis of Building 85 at the midpoint of the system
  - Perpendicular to the long axis of Building 85 at the deep end of the system

- Two for the proposed Building 85A restraint system
  - Parallel to the longitudinal axis of the landslide deposits
  - Perpendicular long axis of Building 85A

For each interpretive section, we utilized the computer program Slide v5.0 (in the manner described previously in the Section titled "Two-Dimensional Limit Equilibrium Analyses") to calculate the overall force per unit width that the restraint system would need to provide. In our conceptual-level analyses, we assumed that "acceptable" performance would result with a calculated seismic displacement of approximately 6 inches or less. As a means to bound our forces, we also evaluated restraint system forces using conventional Mononobe-Okabe analyses. In these analyses, we used an adjusted kmax value equal to two-thirds of the maximum HEA time-history value. We also evaluated kmax by the Japanese method (one-third of the expected PGA raised to the one-third).

The largest force calculated was the force parallel to the main axis of the landslide deposits upon the uppermost (Building 85A) wall. It was our team's consensus that the resulting force was too great to retain using a simple drilled-pier and tieback structural system. (This conclusion was generally similar to the one made previously for the global stabilization case.) However, we also concluded that for the local stabilization case it was likely feasible to create a preferred failure mechanism to cause the landslide to move around the locally-stabilized zone. In the conceptual-level design, this is accomplished by: (1) an array of sacrificial drilled piers located upslope of Building 85A to reinforce the ground and absorb energy; and (2) a line of drilled piers along the outside edge of Building 85A to help direct the failure away from Buildings 85 and 85A. We concluded that it was likely *not* feasible to extend this locally-stabilized zone the additional distance into the landslide that would be needed to stabilize the existing emergency generator pad and fire suppression system located to the northeast of Building 85A.

The restraining forces calculated for the Building 85 structural system are on the order of 250 to 350 kips per lineal foot at the deep end of the system (approximately 65 feet deep) and on the order of 40 to 50 kips per lineal foot at the midpoint of the system (approximately 20 feet deep). The restraining forces calculated for the Building 85A structural system are on the order of 130 to 160 kips per lineal foot.

LIMITATIONS OF CONCEPTUAL-LEVEL STUDY

This report has been prepared for the exclusive use by LBNL for specific application to Buildings 85 and 85A in accordance with generally-accepted geotechnical engineering principles and practices. No other warranty, expressed or implied, is made.

Our scope of services was limited to the evaluation and costing of a conceptual mitigation option based on available existing data and the geologic mapping and cross sections previously developed. Since previous studies by AKA and others within the East Canyon were not directed specifically at characterizing earthquake site response or global landslide geometry, no reliable data currently exists regarding:

- Shear wave velocity and other parameters needed for the evaluation of seismic response and the possibility of site resonance.
- Landslide geometry upslope of Building 85A needed for the evaluation of seismic loading and the design of critical structural elements.
- Overall landslide head and toe geometries needed for the evaluation of global stability and deformations for the unrestrained portion(s) of the landslide.

Our conceptual mitigation design and cost estimate were developed to the extent deemed reasonable, considering the lack of certain critical data. However, a greater or lesser degree of mitigation may be warranted depending upon the findings of subsequent design-level investigations and analyses.

The analyses performed for this study were based on an initial LBNL requirement that the design ground motions be based on a 975-year return period with the performance standard that the buildings be fully operational following the event. This is a very strict standard. During the latter stage of our study, we were advised that LBNL was now considering reducing the ground motions to the 475-year return period with the performance standard that there be no release to the environment of the contents of 85/85A, a safe shutdown of the facility, and basic life safety. Under these criteria, the resulting design forces would be reduced and there is the possibility that our conceptual design would be significantly altered. Additional conceptual-level study could be performed using the less stringent criteria to re-evaluate possible project costs; however, such additional study would still be subject to the limitations previously outlined involving the absence of certain critical data.

As a final note, we emphasize that all of the materials presented or discussed in this bound document are intended to be conceptual in nature and that additional subsurface investigations, laboratory and field tests and engineering analyses would be needed prior to developing a final design.

CONCEPTUAL SLOPE IMPROVEMENT
EAST CANYON - BUILDING 85 AND 85A
LAWRENCE BERKELEY NATIONAL LABORATORY
BERKELEY, CALIFORNIA.

DRILLED SHAFTS (CIDH)

BLDG. 85

QTY	DIA.	DEPTH	EST. REINFORCEMENT	TOT. LENGTH
4	48"	50'	18#/14 = 1122#/LF	200LF
4	60"	60'	32#/14 = 2448#/LF	240LF
5	60"	70'	42#/14 = 3008#/LF	350LF

BLDG. 85A

QTY	DIA.	DEPTH	EST. REINFORCEMENT	TOT. LENGTH
3	36"	50 avg	18#/14 = 1122#/LF	150LF
4	60"	60'	32#/14 = 2448#/LF	240LF
8	10"	70'	1 #14 MICROPILE	560LF
7	48"	60'		420LF

"SUPPORT" OF BLDG. 85A

QTY	DIA.	DEPTH	REINFORCEMENT	TOT. LENGTH
20	48"	80' avg		1200LF

REINFORCEMENT WEIGHT IS FOR LONGITUDINAL BARS ONLY
ADD EST. #SPIRAL@12"PITCH FOR ALL PIERS

TIEBACKS

BLDG. 85

QTY	TEST LOAD (WORKING LOAD)	#STRAND	UNBOND LENGTH	BOND LENGTH	BOND LENGTH	TOT. LENGTH	TOTAL LF	DIA.
8	220kip	5	15'	45'	60'		480 LF	8"
15	290kip	7	25'	60'	85'		1360 LF	10"
18	290kip	7	30'	60'	90'		1620 LF	10"

BLDG. 85A

QTY	TEST LOAD (WORKING LOAD)	#STRAND	UNBOND LENGTH	BOND LENGTH AVG.	BOND LENGTH	TOT. LENGTH	TOTAL LF	DIA.
45	290kip	7	30' AVG.	60 AVG.	90'		4050 LF	10"

ALL TIEBACKS ARE DOUBLE CORROSION PROTECTED (PT. CLASS 1 ENCAPSULATED)
STRANDS ARE SEVEN WIRE LOW RELAXATION STRAND GRADE 150 STEEL, PER ASTM A416

TIEBACK ANCHORAGE (EA. PER TIEBACK)
12"x12"x2" PLATE WITH 4-FOOT LONG STEEL PIPE TRUMPET.
ANCHOR HEAD WEDGE PLATE AND GREASE COVER PER MANUFACTURER

GRADE BEAMS - CONCRETE WORK AT TOP OF PIERS (AS SHOWN)

TOP OF PIERS (AS SHOWN)
D=4'-0", MAPIER DIA=48"
REINFORCEMENT 26#11 WITH #7 TIES AT 12"OC

CONCEPTUAL CONSTRUCTION SEQUENCE

BLDG. 85

1. SITE PREPARATION
   A. REMOVE PAVING AT BLDG. 85 FOR DRILL ACCESS
   B. REMOVE BLDG. 85 PAVING AND EXCAVATE 5' DEEP BY 20' WIDE BENCH FOR TIEBACK INSTALLATIONS NORTH OF BUILDING LINE 5. EXISTING POWER AND WATER UTILITIES TO BE LEFT IN PLACE
   C. INSTALL TEMPORARY CONTAINMENT AS NEEDED
2. INSTALL CAST IN DRILLED HOLE (CIDH) REINFORCED PIERS
   A. PLACE BLOCKOUT FOR TIEBACK THROUGH TOP OF PIER
3. INSTALL CONCRETE GRADE BEAMS.
   A. CONTRACTOR'S OPTION TO INSTALL TIEBACK PRIOR TO GRADE BEAM OR THROUGH BLOCKOUTS IN GRADE BEAMS
4. TEST ALL TIEBACKS
5. REPLACE EXCAVATED SOIL, PAVING AND AREA DRAINS
6. REPLACE PAVING

BLDG. 85A

1. SITE PREPARATION
   A. EXCAVATE AND DISPOSE FACE OF EXISTING RETAINING WALL AT ROAD
   B. DEMOLISH FOOTING AT LOCATION OF NEW MICROPILES
   C. CORE EXISTING WALL/FOOTING FOR NEW TIEBACKS
2. INSTALL MICROPILES WITH "TEAR HAUNCH" TO SUPPORT EXISTING RETAINING WALL
3. DEMOLISH PORTION OF EXISTING FOOTING BEYOND FACE OF WALL
4. INSTALL AND TEST TIEBACKS
5. INSTALL NEW CONCRETE GRADE BEAM AND STEM WALL IN FRONT OF EXISTING WALL
6. REPAIR ROAD

100% CONCEPTUAL DESIGN

ISSUE
4/11/07
100% CONCEPT

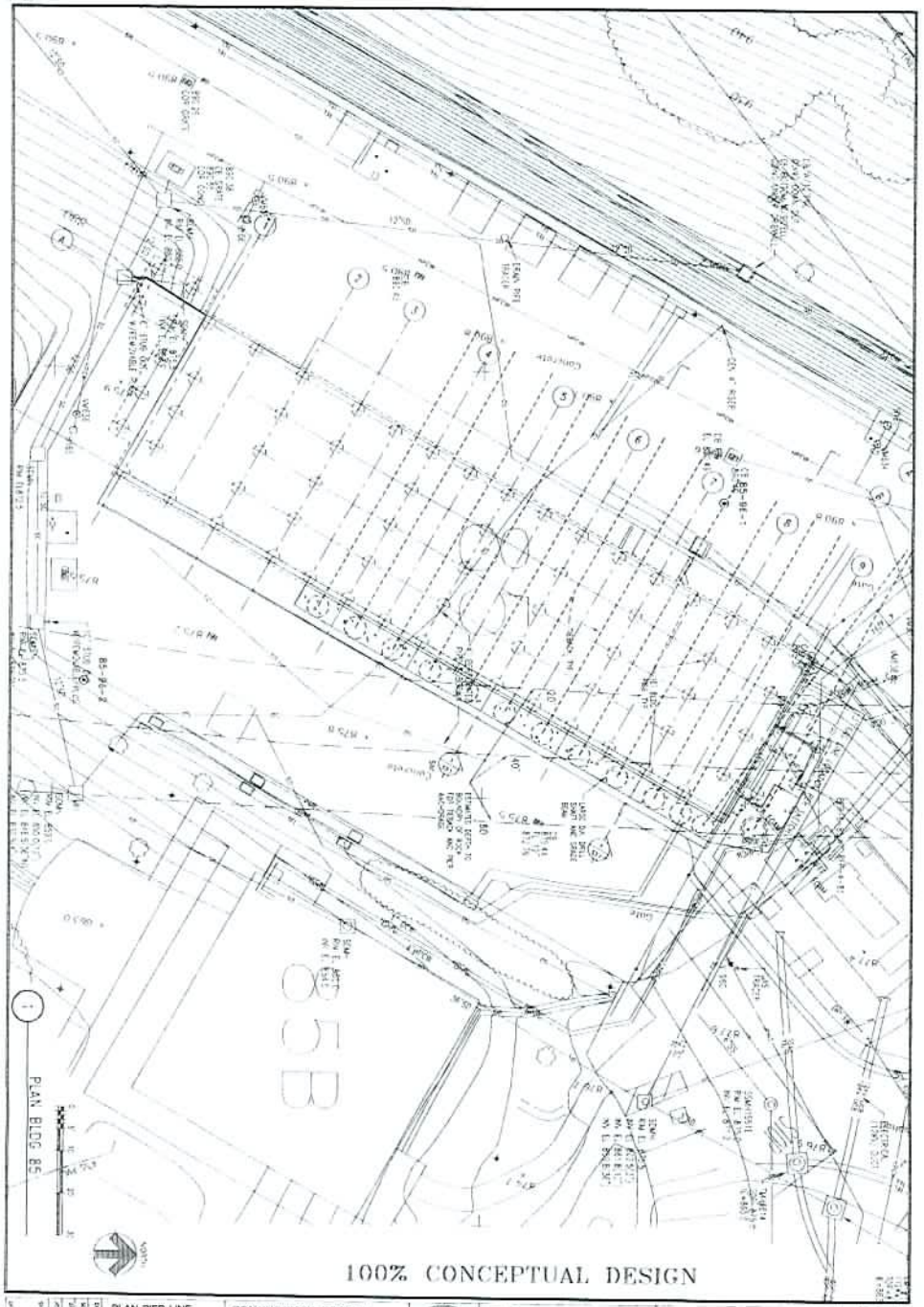
ALAN KROPP & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS
Berkeley, CA

Tuan & Robinson
Structural Engineers, Inc.
227 Main Street, Suite 100
Pleasanton, CA 94566
Tel: 925 846 9400 Fax: 925 847 3885

CONCEPTUAL DESIGN
LBNL EAST CANYON
BLDG 85 and 85A
Berkeley, CA

PLAN PIER LINE
BLDG 85

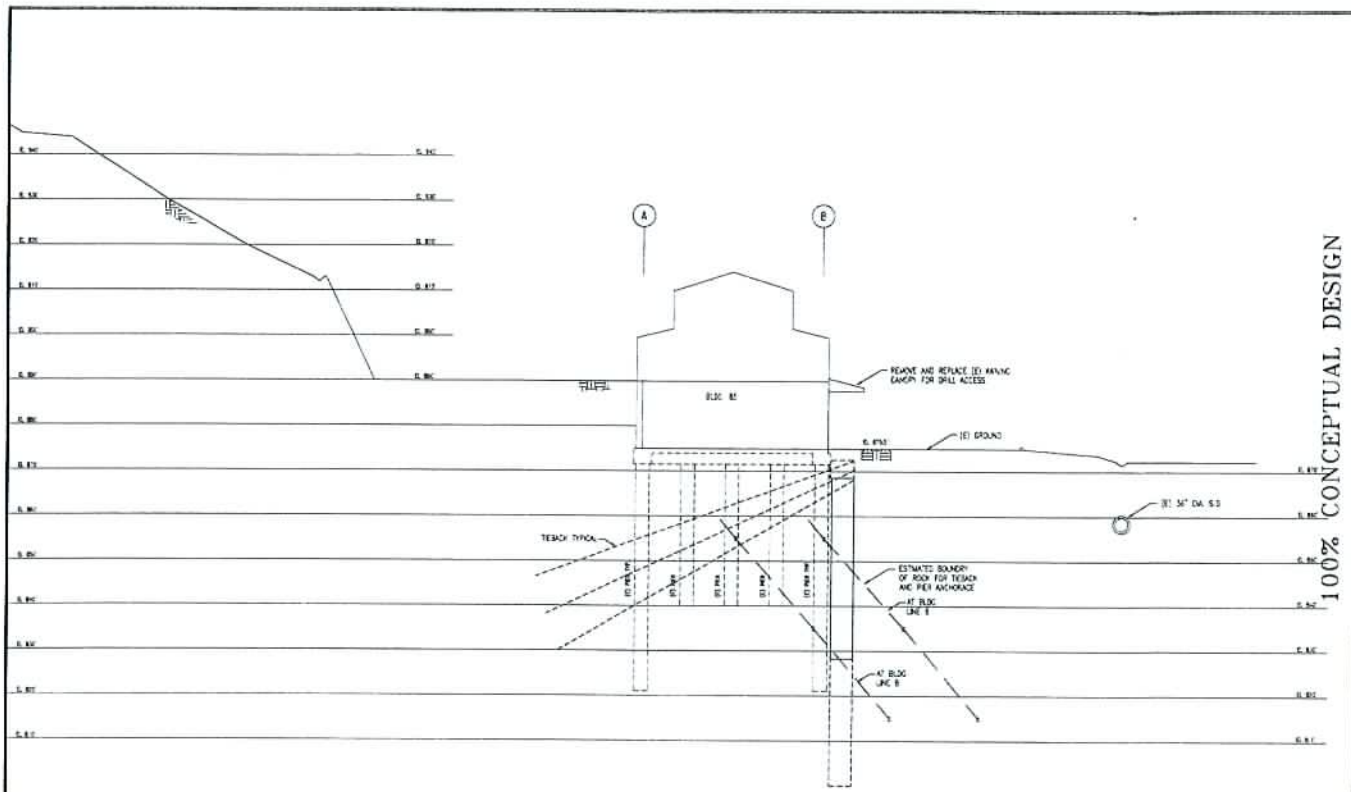
DATE 4/11/07
SCALE
DRAWN
JOB 2007.004
SHEET S1.0
OF 5



100% CONCEPTUAL DESIGN

S20	PLAN PIER LINE BLDG 85	CONCEPTUAL DESIGN LBNL EAST CANYON BLDG 85 and 85A Berkeley, CA	Tuan & Robinson Structural Engineers, Inc.	ALAN KROPP & ASSOCIATES, INC. GEOTECHNICAL CONSULTANTS Berkeley, CA	

100% CONCEPTUAL DESIGN
1 PLAN UPPER WALL - BLDG 85A
NORTH
85-95-2
CONCEPTUAL DESIGN
LBNL EAST CANYON
BLDG 85 and 85A
Berkeley, CA
PLAN - BLDG 85A
S2.1
Tuan & Robinson
ALAN KROPF & ASSOCIATES, INC.



A BLDG. 85 SECTION TYP

0 5' 10' 20' 30'

100% CONCEPTUAL DESIGN

ISSUE
4/11/07
100% CONCEPT

ALAN KRUPP & ASSOCIATES, INC.
ARCHITECTS CONSULTANTS
Berkeley, CA

Tuan & Robinson
Structural Engineers, Inc.
1901 Harrison Street, Suite 1100
Oakland, CA 94612-3501
Tel: (510) 271-2000 Fax: (510) 271-2001

CONCEPTUAL DESIGN
LBNL EAST CANYON
BLDG 85 and 85A
Berkeley, CA

SECTION - BLDG 85

DATE 3/28/07
SCALE
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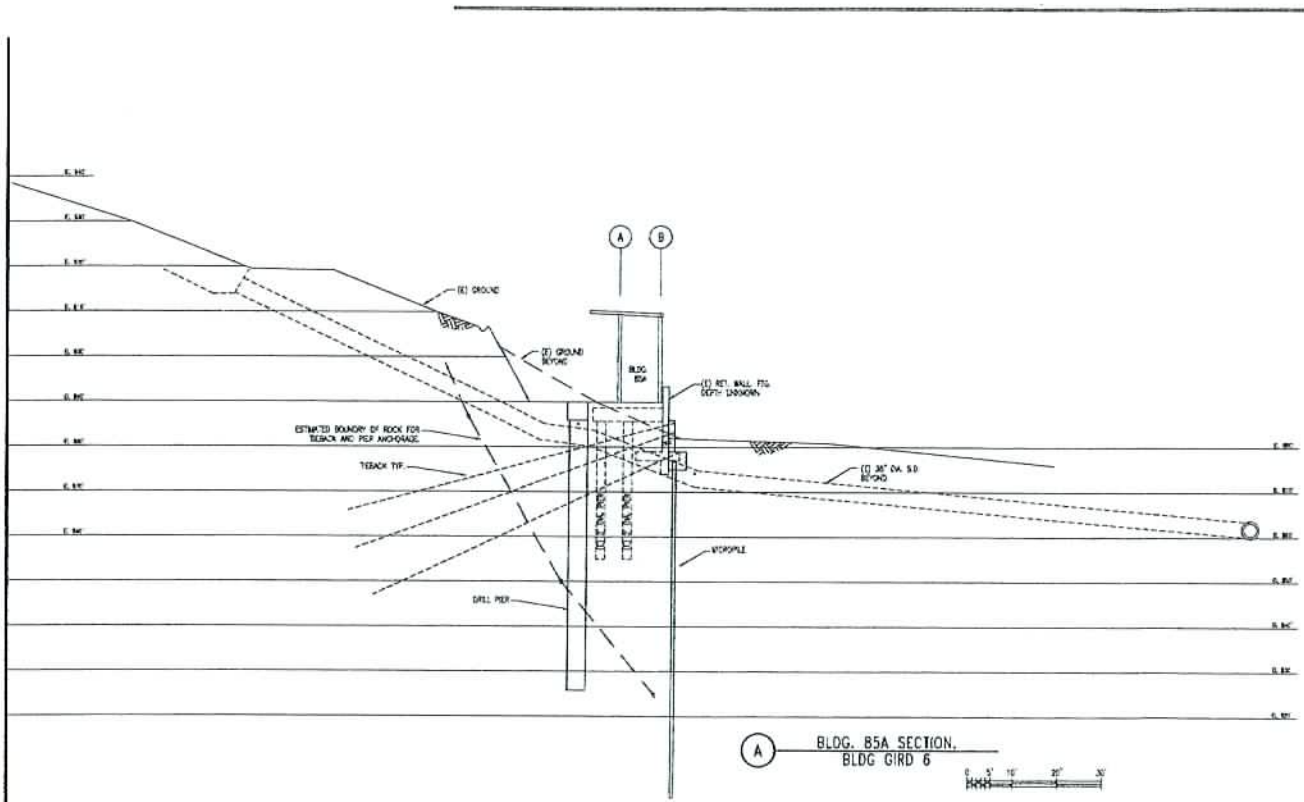
JOB 2007.004
SHEET S3.1
OF 5 SHEETS



A BLDG. 85A SECTION, BLDG GIRD 6

0 5' 10' 20' 30'

100% CONCEPTUAL DESIGN

4/11/07
DATE CONCEPT

ALAN KROPP & ASSOCIATES, INC.
CONSULTING ENGINEERS
Berkeley, CA

Tuan & Robinson
Structural Engineers, Inc.
Tel. (510) 525-1000 Fax (510) 525-1001
Tel. (510) 525-1000 Fax (510) 525-1001 email

CONCEPTUAL DESIGN
LBNL EAST CANYON
BLDG 85 and 85A
Berkeley, CA

TYPICAL SECTION
BLDG. 85A

DATE 3/1/07
SCALE
DRAWN
JOB 2007.004
SHEET SH3.2

Leland Saylor
Associates
A Certified DVBE

CONCEPT DOCUMENTS ESTIMATE

Conceptual Slope Improvement B85 and B85a

Berkeley, Ca

LSA JOB NUMBER:
07-058

April 18, 2007
r-3 6/14/07

PREPARED FOR
A Kropp Engineers
BY LELAND SAYLOR ASSOCIATES

425 Market Street, Suite 2200 | San Francisco | California | 94105
415-955-0545 | 415-989-3450 (f) | www.lelandsaylor.com

Leland Saylor Associates
A Certified DVBE

PROJECT:	**Conceptual Slope Improvement B85 and B85a**	JOB NUMBER:	**07-058**
LOCATION:	**Berkeley, Ca**	PREPARED BY:	**bss/mk**
CLIENT:	**A Kropp Engineers**	BID DATE:	
DESCRIPTION:	**new drilled pier installation and utility relocations**	ESTIMATE DATE:	**4/18/2007**
		rev	6/14/2007

PREFACE AND NOTES TO THE ESTIMATE

1.0 PROJECT SYNOPSIS

1.1 TYPE OF STUDY:

CONCEPTUAL DOCUMENTS ESTIMATE

1.2 PROJECT DESCRIPTION:

Construction Type:	TYPE II
Foundation Type:	CONTINUOUS GRADE BEAM & DRILLED PIERS; CONCRETE SLAB AT BLDG YARDs
Exterior Wall Type:	
Roof Type:	
Stories Below Grade:	NONE
Stories Above Grade:	NONE
Site work:	MASS EXCAVATION & GRADING, CLEAR & GRUB, SITE UTILITIES, PAVING
Plumbing System:	
Mechanical System:	NONE
Fire Protection System:	
Electrical Service:	

Leland Saylor Associates
A Certified DVBE

PROJECT:	**Conceptual Slope Improvement B85 and B85a**	JOB NUMBER:	**07-058**
LOCATION:	**Berkeley, Ca**	PREPARED BY:	**bss/mk**
CLIENT:	**A Kropp Engineers**	BID DATE:	
DESCRIPTION:	**new drilled pier installation and utility relocations**	ESTIMATE DATE:	**4/18/2007**
		rev	6/14/2007

PREFACE AND NOTES TO THE ESTIMATE

1.3 GENERAL NOTES REGARDING PROJECT:

THE SCOPE IS CONFIDENTIAL SEE OWNER

2.0 DEFINITIONS

2.1 ESTIMATE OF COST:

An Estimate of Cost is prepared from a survey of the quantities of work - items prepared from written or drawn information provided at the design-development, working drawing or bid-documents stage of the design. Historical costs, information provided by contractors and suppliers, plus judgmental evaluation by the Estimator are used as appropriate as the basis for pricing. Allowances as appropriate will be included for items of work which are not indicated on the design documents provided that the Estimator is made aware of them, or which, in the judgment of the Estimator, are required for completion of the work. We cannot, however, be responsible for items or work of an unusual nature of which we have not been informed.

2.2 BID:

An offer to enter a contract to perform work for a fixed sum, to be completed within a limited period of time.

Leland Saylor Associates
A Certified DVBE

PROJECT:	**Conceptual Slope Improvement B85 and B85a**	JOB NUMBER:	**07-058**
LOCATION:	**Berkeley, Ca**	PREPARED BY:	**bss/mk**
CLIENT:	**A Kropp Engineers**	BID DATE:	
DESCRIPTION:	**new drilled pier installation and utility relocations**	ESTIMATE DATE:	**4/18/2007**
		rev	6/14/2007

PREFACE AND NOTES TO THE ESTIMATE

3.0 BIDS & CONTRACTS

3.1 MARKET CONDITIONS:

In the current market conditions for construction, our experience shows the following results on competitive bids, as a differential from Leland Saylor Associates final estimates:

Number of Bids		Percentage Differential
1	.....	+25 to 100%
2 - 3	.....	+10 to 25%
4 - 5	.....	0 to +10%
6 - 7	.....	0 to -10%
8 or more	.....	-10 to -20%

Accordingly, it is extremely important to ensure that a minimum of 4 to 5 valid bids are received. Since LSA has no control over the bid process, there is no guarantee that proposals, bids or construction cost will not vary from our opinions or our estimates. Please see Competitive Bidding Statement in the estimate detail section for more information.

4.0 ESTIMATE DOCUMENTS

4.1 This Estimate has been compiled from the following documents and information supplied:

Take off based on the 50% documents , with 100% documents used for reference only
Qty of CIDH IN 100% concept design was developed by engineer consultant, as design is preliminary. LSA has relied on the engineers estimate of cidh linear footage to prepare its estimate.
QUANTITIES AND PRICES ARE SUBJECT TO CHANGE BASED ON FINAL DESIGN.

DRAWINGS:

Architectural	**Mechanical**	**Landscaping**
Structural *SH2.0-SH3.3*	**Plumbing**	**Accessibility Standards**
Civil	**Electrical**	**Other**

Leland Saylor Associates
A Certified DVBE

PROJECT:	**Conceptual Slope Improvement B85 and B85a**	JOB NUMBER:	**07-058**
LOCATION:	**Berkeley, Ca**	PREPARED BY:	**bss/mk**
CLIENT:	**A Kropp Engineers**	BID DATE:	
DESCRIPTION:	**new drilled pier installation and utility relocations**	ESTIMATE DATE:	**4/18/2007**
		rev	6/14/2007

PREFACE AND NOTES TO THE ESTIMATE

Leland Saylor Associates
A Certified DVBE

PROJECT:	**Conceptual Slope Improvement B85 and B85a**	JOB NUMBER:	**07-058**
LOCATION:	**Berkeley, Ca**	PREPARED BY:	**bss/mk**
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		rev	6/14/2007

PREFACE AND NOTES TO THE ESTIMATE

SPECIFICATIONS / PROJECT MANUAL:

COSTS PROVIDED BY OTHERS:

4.2 The user is cautioned that significant changes in the scope of the project, or alterations to the project documents after completion of the conceptual documents estimate can cause major cost changes. In these circumstances, Leland Saylor Associates should be notified and an appropriate adjustment made to the conceptual documents estimate.

5.0 GROSS FLOOR AREA

BUILDING	GSF
. new drilled pier installation and utility relocations	12,696
TOTAL GROSS SQUARE FEET	12,696

6.0 WAGE RATES

6.1 This Estimate is based on market wage-rates and conditions currently applicable in Berkeley, Ca.

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		rev	6/14/2007

PREFACE AND NOTES TO THE ESTIMATE

7.0 PRORATE ADDITIONS TO THE ESTIMATE

7.1 GENERAL CONDITIONS: 10.00%

An allowance based on 10.00% of the construction costs subtotal has been included for Contractor's General Conditions.

7.2 CONTINGENCY: 15.00%

An allowance based on 15.00% of the construction costs subtotal has been included for Design/Estimating Contingency.

NOTE: This allowance is intended to provide a Design Contingency sum only, for use during the design process. It is not intended to provide for a Construction Contingency sum.

7.3 ESCALATION: 0.00%

An allowance of 0.00% has been included in this estimate for construction material & labor cost escalation up to the anticipated mid-point of construction, based on the following assumptions:

Construction start date:	**Owner to escalate at 9%/yr**
Construction period:	
Mid-point of construction:	
Annual escalation rate:	
Allowance for escalation:	**not included**

No allowance has been made for Code Escalation or Technological Escalation.

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LOCATION:	**Berkeley, Ca**	PREPARED BY:	**bss/mk**
CLIENT:	**A Kropp Engineers**	BID DATE:	
DESCRIPTION:	**new drilled pier installation and utility relocations**	ESTIMATE DATE:	**4/18/2007**
		rev	6/14/2007

PREFACE AND NOTES TO THE ESTIMATE

7.4 GEOGRAPHICAL FACTOR: **5.00%**

A Geographical Location Factor of 5.00% has been included in the prorates section of the estimate.

7.5 MARKET FACTOR: **0.00%**

We do not anticipate that market conditions applying at the projected bidding date for the project will be significantly different from current market conditions. No adjustments are therefore required for Market Factor.

7.4 SMALL JOB FACTOR **0.00%**

A Small Job Factor is included on jobs that total less than $1 million, therefore no Small Jobs Factor has been included in the estimate.

7.4 PHASING ALLOWANCE **0.00%**

No Phasing Allowance is needed for this job.

7.6 BONDS: **2.00%**

An allowance of 2.00% of the construction cost subtotal is included to provide for the cost of Payment and Performance Bonds, if required.

7.7 CONTRACTOR'S FEE: **8.00%**

An allowance based on 8.00% of the construction cost subtotal is included for Contractor's office Overhead and Profit. Office overhead of the contractor is always included with the fee.

All field overhead of the contractor is included in the General Conditions section of the estimate.

Leland Saylor Associates
A Certified DVBE

PROJECT:	**Conceptual Slope Improvement B85 and B85a**	JOB NUMBER:	**07-058**
LOCATION:	**Berkeley, Ca**	PREPARED BY:	**bss/mk**
CLIENT:	**A Kropp Engineers**	BID DATE:	
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		rev	6/14/2007

PREFACE AND NOTES TO THE ESTIMATE

8.0 SPECIAL NOTES PERTAINING TO THIS ESTIMATE

8.1 SPECIFIC INCLUSIONS:

The following items are specifically included in this estimate:

NONE

8.2 SPECIFIC EXCLUSIONS:

The following items are specifically excluded from this estimate:
112KV line relocation or obstruction
HAZMAT
SOIL REMEDIATION
RELOCATION OF GENERATOR, TANKS
TIEBACKS AT TEMPORARY BENCH ABOVE B85 AND 85 a

PROJECT: **Conceptual Slope Improvement B85 and B85a**

JOB NUMBER: **07-058**

LOCATION: **Berkeley, Ca**

CLIENT: **A Kropp Engineers**

PREPARED BY: **bss/mk**

DESCRIPTION: **new drilled pier installation and utility relocations**

ESTIMATE DATE: **4/18/2007**

GSF : **12,696**

CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
1.10	DEMOLITION			8.07	102,461
1.11	ASBESTOS ABATEMENT			-	NONE
1.25	SITE, SERVICE, GRADING, GENERAL & PAVING			4.59	58,213
1.26	SITE UTILITIES			12.68	161,042
1.27	GENERAL SITE			6.99	88,686
1.28	OFF SITE			-	NONE
1.29	SITE MISCELLANEOUS			3.46	43,935
	SITE SUBTOTAL			**35.79**	**454,337**
2.13	FOUNDATIONS			153.26	1,945,785
2.17	SLAB ON GRADE, FILL SLAB, LEVEL			1.12	14,224
3.01	STRUCTURE, VERTICAL			1.56	19,800
3.02	STRUCTURE, HORIZONTAL			5.65	71,680
3.03	FIREPROOFING			-	NONE
3.06	SHEARWALLS			-	NONE
4.11	EXT. WALLS/PARAPETS, WALL SYSTEMS, EXPANSION JOINTS			-	NONE
4.12	FENESTRATION, EXTERIOR			-	NONE
4.13	DOORS WITH FRAME AND HARDWARE, EXTERIOR			-	NONE
4.21	ROOF, INSULATION, SOUNDPROOFING, EXPANSION JOINTS			-	NONE
4.31	MISC. IRON, SHEET METAL, GUTTERS AND DOWNSPOUTS			-	NONE
4.32	SKYLIGHTS			-	NONE
4.36	PAINTING			-	NONE
5.11	WALLS, INTERIOR			-	NONE
5.12	DOORS WITH FRAMES AND HARDWARE, INTERIOR			-	NONE
5.13	FENESTRATION, INTERIOR			-	NONE
5.21	CEILING FINISHES, PATCH/ACOUSTIC, TILE, GYPBOARD, ETC			-	NONE
5.22	FLOOR FINISHES, CARPET, RESILIENT TILE & SHEET GOODS			0.08	1,016

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DESCRIPTION: **new drilled pier installation and utility relocations**

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CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
5.31	TILE, FLOOR & WALL			-	NONE
5.32	OTHER SPECIAL FINISHES			-	NONE
5.40	INTERIORS			-	NONE
5.41	CABINETS AND TOPS, FURNITURE			-	NONE
6.10	GENERAL BUILDING SPECIALTIES			-	NONE
7.00	EQUIPMENT			-	NONE
8.00	SPECIAL CONSTRUCTION			-	NONE
9.00	CONVEYING			-	NONE
10.11	PLUMBING			-	NONE
10.15	HVAC			-	NONE
10.17	FIRE PROTECTION			0.35	4,480
11.00	ELECTRICAL, GENERAL			-	NONE
11.02	ELECTRICAL SPECIAL SYSTEMS			-	NONE
	SUBTOTAL BUILDING			162.02	2,056,985
	TOTAL SITE AND BUILDING			197.80	2,511,322

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DESCRIPTION: **new drilled pier installation and utility relocations**

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CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
	PRORATE DETAIL				
	General Conditions	10.00%			**251,132**
	Design Contingency	15.00%			**376,698**
	Escalation - NONE, PLEASE ALLOW 9%/YR	0.00%			**-**
	Geographical Location Factor	5.00%			**125,566**
	Market Factor	0.00%			**-**
	Small Job Factor	0.00%			**-**
	Phasing Allowance	0.00%			**-**
	SUBTOTAL			**257.15**	**3,264,718**
	Bonds	2.00%			**65,294**
	Overhead and Profit	8.00%			**261,177**
	TOTAL PROJECT COSTS			**282.86**	**3,591,190**

PROJECT: **Conceptual Slope Improvement B85 and B85a**

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DESCRIPTION: **new drilled pier installation and utility relocations**

ESTIMATE DATE: **4/18/2007**

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CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL

Competitive Bidding

The prices in this Estimate are based on Competitive Bidding. Competitive Bidding is receiving responsive bids from at least five (5) or more General Contractors and three (3) or more responsive bids from Major Subcontractors or Trades. Major Subcontractors are Structural Steel, Plaster / EIFS Contractors, Mechanical, Plumbing and Electrical Subcontractors.

Without Competitive Bidding, Contractor bids can and have ranged from 25%-to 100% over the prices in this Estimate, depending on the size of the job.

We urge you to notify your client of the existing difficult bidding climate, and work with them to ensure that the project is adequately publicized so that they can get the minimum number of bids for competitive bidding. Please contact LSA if you need ideas about how to publicize your project.

PROJECT: **Conceptual Slope Improvement B85 and B85a**

JOB NUMBER: **07-058**

LOCATION: **Berkeley, Ca**

CLIENT: **A Kropp Engineers**

PREPARED BY: **bss/mk**

DESCRIPTION: **new drilled pier installation and utility relocations**

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CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
1.10	**DEMOLITION**				
	REMOVAL				
	SAWCUT (E) CONCRETE SLAB, 12" THICK	125	LF	11.32	**1,415**
	REMOVE & OFF HAUL OF CONCRETE SLAB	1,120	SF	1.47	**1,646**
	SAWCUT (E) AC PAVING, 2-1/2" THICK	565	LF	2.13	**1,203**
	DEMOLISH AWNING, CAP SERVICES	1,344	SF	10.00	
					13,440
	TEMP POSITIVE PRESSURE CURTAIN	1,344	SF	7.00	**9,408**
	REMOVE (E) CONCRETE CURB @ BLDG 85	112	LF	4.00	**448**
	REMOVE (E) CATCH BASIN & PIPE	4	EA	350.00	**1,400**
	EXCAVATE & REMOVE PIPING	600	LF	50.00	**30,000**
	EXCAVATE & REMOVE STORM DRAINS	350	LF	60.00	**21,000**
	PROTECTION				**-**
	PROTECT (E) building	1	ls	7,500.00	**7,500**
	PROTECT (E) utilities	1	ls	15,000.00	**15,000**
	SUBTOTAL 1.10				**102,461**
1.11	**ASBESTOS ABATEMENT**				
	NONE				
	SUBTOTAL 1.11				**NONE**
1.25	**SITE, SERVICE, GRADING, GENERAL & PAVING**				
	PAVING				
	(N) AC PAVING, 2-1/2"	8,288	SF	4.42	**36,633**
	REGRADE THE EDGE OF DRIVE	2,500	SF	2.00	**5,000**
	JOINTS				
	#4 DOWEL x 1'-0" @ 32" O.C. IN 3/4 DRILLED HOLES W/EPOXY GROUT, SEALANT	224	ea	45.00	**10,080**
	EROSION CONTROL				
	DUST CONTROL - ALLOWANCE	1	LS	1,500.00	**1,500**
	EROSION CONTROL	1	LS	5,000.00	**5,000**
	SUBTOTAL 1.25				**58,213**

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DESCRIPTION: **new drilled pier installation and utility relocations**

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CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
1.26	**SITE UTILITIES**				
	MECHANICAL SYSTEM				
	SANITARY SEWER SYSTEM				
FROM ORIGINAL DWG	SANITARY SEWER POC 6"Ø W/EXCAVATION	1	EA	950.00	**950**
"	6" CLEAN-OUT TO GRADE	2	EA	400.00	**800**
"	6" CAST IRON 1-HUB PIPING W/TRENCH	50	LF	64.50	**3,225**
"	4" CAST IRON 1-HUB PIPING W/TRENCH	20	LF	41.05	**821**
					-
	DOMESTIC WATER SYSTEM				**-**
	HOT TAP 4"Ø PIPE W/EXCAVATION	1	EA	1,200.00	**1,200**
	4" SHUT-OFF VALVE IN VALVE BOX	1	EA	335.00	**335**
	4" COPPER PIPE 'K' HARD & TRENCH	25	LF	80.00	**2,000**
	OTHER WATER LINES	1	LS	6,500.00	**6,500**
	NATURAL GAS SYSTEM				**-**
	REROUTE GAS LINES	1	LS	5,000.00	**5,000**
	GAS SHUT-OFF VALVE IN VALVE BOX	1	EA	650.00	**650**
	GAS DUCTILE IRON PIPE & TRENCH	45	LF	35.00	**1,575**
					-
	STORM DRAINAGE SYSTEM				**-**
	12"Ø SDR-35 PVC PIPE W/TRENCHING	156	LF	42.00	**6,552**
	6"Ø SDR-35 PVC PIPE W/TRENCHING	150	LF	25.26	**3,789**
	REWORK EXISTING SUB DRAIN SYSTEM	125	LF	35.00	**4,375**
	4"Ø SDR-35 PVC PIPE W/TRENCHING	150	LF	20.45	**3,068**
	CLEAN-OUT TO GRADE (COTG)	3	EA	400.00	**1,200**
	36" SD RCP	125	LF	248.00	**31,000**
	SPRING BOX	1	EA	5,500.00	**5,500**
					-
	FIRE WATER SERVICE				**-**
	TAP / P.O.C. 8"Ø PIPE W/EXCAVATION	1	EA	600.00	**600**
	8" BLK STL SCH. 40 PIPE & TRENCH	25	LF	40.10	**1,003**
	CUT & PATCH PAVING/CONCRETE	35	LF	75.00	**2,625**

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CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
					-
	ELECTRICAL SYSTEM				-
	LO/TO ELECTRIC SYSTEM	1	LS	1,200.00	**1,200**
em gen set	PVC & COPPER WIRE TO 600A	200	LF	115.35	**23,070**
em gen set	PVC & COPPER WIRE TO 400A	200	LF	72.20	**14,440**
em gen set	PVC & COPPER WIRE TO 225A	200	LF	39.00	**7,800**
	LIGHTING FIXTURE 500W FIXTURE ON BLDG	4	EA	800.00	**3,200**
	LIGHTING FIXTURE 1500W FIXTURE ON A 20' POLE W/GROUNDING	2	EA	4,500.00	**9,000**
					-
	PVC & COPPER WIRE TO 40A	700	LF	7.00	**4,900**
	PVC & COPPER WIRE TO 30A	700	LF	5.95	**4,165**
	TRENCHING, BACKFILL & COMPACTION	700	LF	15.00	**10,500**
	SUBTOTAL 1.26				**161,042**
1.27	**GENERAL SITE**				
	CLEARING & GRUBBING	10,500	SF	0.15	**1,575**
	BENCH CUT PREPARATION	3,111	CY	28.00	**87,111**
	SUBTOTAL 1.27				**88,686**
1.28	**OFF SITE**				
	SUBTOTAL 1.28				**NONE**
1.29	**SITE MISCELLANEOUS**				
	LANDSCAPING & IRRIGATION				
	IRRIGATION SYSTEM, ALLOWANCE	1	LS	2,400.00	**2,400**
	GATE				
	METAL FENCE GATE 6'-0" x 12' (PAIR) & 3" x 2" STEEL TUBE FRAME, W/ TYPICAL PICKETS 3 15/6 CLEAR BETWEEN PICKETS, LOCKABLE SIDE BOLT	1	EA	5,500.00	**5,500**
	METAL GATE 2'-6" x 7'-8" (PAIR) & 3" x 2" STEEL TUBE FRAME, W/ TYPICAL PICKETS 3 15/6 CLEAR BETWEEN PICKETS, LOCKABLE SIDE BOLT	1	EA	3,500.00	**3,500**
	PANIC BAR AND HARDWARE	2	EA	900.00	**1,800**

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ESTIMATE DATE: **4/18/2007**

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CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
					-
	FENCE				-
	FENCE, SCREEN WALL AT BLADDER TANK, W/ 4" SQUARE POST @ 8'-0" MAXIMUM O.C.	78	LF	125.00	**9,750**
	2'-0" DEEP FOUNDATION	78	LF	50.00	**3,900**
	REPLACE / RELOCATE SECURITY FENCE @ BLDG 85A	209	LF	65.00	**13,585**
					-
	OTHER MISCELLANEOUS				-
	BOLLARD, 3" DIA PIPE PAINTED COLOR, 3' ABOVE SLAB, SET POST IN 12" DIA CONCRETE FOOTING W/ 2'-6" DEEP	5	EA	700.00	**3,500**
	SUBTOTAL 1.29				**43,935**
2.13	**FOUNDATIONS**				
	EXCAVATION				
	EXCAVATION FOR GRADE BEAM & TIEBACKS	375	CY	21.81	**8,181**
	UNDERPIN GRID B	1,792	CF	40.00	**71,680**
	BACK FILLING W/ EXCAVATED MATERIAL	375	CY	27.49	**10,312**
	SOIL DISPOSAL	83	CY	10.00	**830**
					-
BLDG 85	DRILL CAISSONS, 48", 200lf	93	CY	40.00	**3,723**
BLDG 85	DRILL CAISSONS, 60", 590 lf	429	CY	40.00	**17,162**
BLDG 85A	DRILL SHAFT , FILL WITH GRAVEL, 360 ll	168	CY	60.00	**10,053**
BLDG 85A	DRILL CAISSONS, 36", 150LF	39	CY	40.00	**1,571**
BLDG 85A	DRILL CAISSONS,60", 240LF	175	CY	40.00	**6,981**
BLDG 85A	MICRO PILE	560	LF	20.00	**11,200**
BLDG 85A	DRILL CAISSONS, 48", 420LF	195	CY	40.00	**7,819**
UPSLOPE	DRILL CAISSONS, 48", 1200 LF	558	CY	40.00	**22,340**
	BACKFILL	400	CY	25.00	**10,000**

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ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
	REINFORCED CONCRETE				
BLDG 85	REINFORCED CONCRETE GRADE BEAM , PILE CAPS	101	CY	675.00	**68,000**
BLDG 85A	REINFORCED CONCRETE GRADE BEAM , PILE CAPS	89	CY	675.00	**60,000**
	CIDH CAISSONS, INCL BAR	1,490	CY	750.00	**1,117,414**
	INSTALL MICRO PILE	560	LF	47.00	**26,320**
	TIEBACKS				
	TIEBACKS 290KIP X 90'	79	EA	5,800.00	**458,200**
	TIEBACKS 200KIP X 60'	8	EA	4,250.00	**34,000**
	SUBTOTAL 2.13				**1,945,785**
2.17	**SLAB ON GRADE, FILL SLAB, LEVEL**				
	SLAB ON GRADE @ YARD 12" THICK REINFORCED CONCRETE, SAND, VAPOR BARRIER, CRUSHED ROCK, COMPACTED SUBGRADE	1,016	SF	14.00	**14,224**
	SUBTOTAL 2.17				**14,224**
3.01	**STRUCTURE, VERTICAL**				
	RETAINING FOR TIEBACKS AT BLDG 85A	440	SF	45.00	**19,800**
	SUBTOTAL 3.01				**19,800**
3.02	**STRUCTURE, HORIZONTAL**				
	NEW BLDG AWNING	896	SF	80.00	**71,680**
	SUBTOTAL 3.02				**71,680**
3.03	**FIREPROOFING**				
	SUBTOTAL 3.03				**NONE**

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CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
3.06	SHEARWALLS				
	SUBTOTAL 3.06				NONE
4.11	EXT. WALLS/PARAPETS, WALL SYSTEMS, EXPANSION JOINTS				
	SUBTOTAL 4.11				NONE
4.12	FENESTRATION, EXTERIOR				
	SUBTOTAL 4.12				NONE
4.13	DOORS WITH FRAME AND HARDWARE, EXTERIOR				
	SUBTOTAL 4.13				NONE
4.21	ROOF, INSULATION, SOUNDPROOFING, EXPANSION JOINTS				
	SUBTOTAL 4.21				NONE
4.31	MISC. IRON, SHEET METAL, GUTTERS AND DOWNSPOUTS				
	SUBTOTAL 4.31				NONE

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ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
4.32	SKYLIGHTS				
	SUBTOTAL 4.32				NONE
4.36	PAINTING				
	SUBTOTAL 4.36				NONE
5.11	WALLS, INTERIOR				
	SUBTOTAL 5.11				NONE
5.12	DOORS WITH FRAMES AND HARDWARE, INTERIOR				
	SUBTOTAL 5.12				NONE
5.13	FENESTRATION, INTERIOR				
	SUBTOTAL 5.13				NONE
5.21	CEILING FINISHES, PATCH/ACOUSTIC, TILE, GYPBOARD, ETC				
	SUBTOTAL 5.21				NONE

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CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
5.22	FLOOR FINISHES, CARPET, RESILIENT TILE & SHEET GOODS CONCRETE SEALER	1,016	SF	1.00	1,016
	SUBTOTAL 5.22				1,016
5.31	TILE, FLOOR & WALL				
	SUBTOTAL 5.31				NONE
5.32	OTHER SPECIAL FINISHES				
	SUBTOTAL 5.32				NONE
5.40	INTERIORS				
	SUBTOTAL 5.40				NONE
5.41	CABINETS AND TOPS, FURNITURE				
	SUBTOTAL 5.41				NONE
6.10	GENERAL BUILDING SPECIALTIES				
	SUBTOTAL 6.10				NONE
7.00	EQUIPMENT				
	SUBTOTAL 7.00				NONE

PROJECT: Conceptual Slope Improvement B85 and B85a

JOB NUMBER: 07-058

LOCATION: Berkeley, Ca

CLIENT: A Kropp Engineers

PREPARED BY: bss/mk

DESCRIPTION: new drilled pier installation and utility relocations

ESTIMATE DATE: 4/18/2007

GSF : 12,696

CONCEPT DOCUMENTS ESTIMATE

ITEM #	DESCRIPTION	QUANTITY	UNIT	COST	TOTAL
8.00	SPECIAL CONSTRUCTION				
	SUBTOTAL 8.00				NONE
9.00	CONVEYING				
	SUBTOTAL 9.00				NONE
10.11	PLUMBING SANITARY WASTE / DRAINAGE / VENT SYSTEMS DOMESTIC WATER SYSTEMS GAS SYSTEMS				
	SUBTOTAL 10.11				NONE
10.15	HVAC NONE				
	SUBTOTAL 10.15				NONE
10.17	FIRE PROTECTION SPRINKLERS@ NEW AWNING	896.0	sf	5.00	4,480
	SUBTOTAL 10.17				4,480
11.00	ELECTRICAL, GENERAL PANELS				
	SUBTOTAL 11.00				NONE
11.02	ELECTRICAL SPECIAL SYSTEMS				
	SUBTOTAL 11.02				NONE

Appendix C1.E

Lettis & Associates, 2008

Surface-fault Rupture Hazard Investigation of the Wildcat Fault, Proposed General Purpose Laboratory, Lawrence Berkeley National Laboratory, Berkeley, California

WILLIAM LETTIS & ASSOCIATES, INC.

Surface-fault Rupture Hazard Investigation of the Wildcat Fault Proposed General Purpose Laboratory Lawrence Berkeley National Laboratory Berkeley, California

Submitted to:

Ms. Nancy M. Ware
Project Manager, Facilities Division
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 50A4112
Berkeley, CA 94720

Submitted by:

William Lettis & Associates, Inc.
1777 Botelho Drive, Suite 262
Walnut Creek, CA 94596

November 19, 2008

Surface-fault Rupture Hazard Investigation of the Wildcat Fault Proposed General Purpose Lab Lawrence Berkeley National Laboratory Berkeley, California

Submitted to:

Ms. Nancy M. Ware

Project Manager, Facilities Division
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 50A4112
Berkeley, CA 94720
NMWare@lbl.gov

Prepared by:

William Lettis & Associates, Inc.
1777 Botelho Drive, Suite 262
Walnut Creek, CA 94596

November 19, 2008

SIGNATURE PAGE

Surface-fault Rupture Hazard Investigation of the Wildcat Fault, Proposed General Purpose Lab, Lawrence Berkeley National Laboratory, Berkeley, California

William Lettis & Associates, Inc. Project No. 2023.001

This investigation and report were prepared by the following qualified William Lettis & Associates, Inc. personnel:

11-19-08

John N. Baldwin, C.E.G. 2167
Principal Geologist
Project Manager

Date

11-19-08

Robert W. Givler, P.G. 8274
Senior Project Geologist

Date

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1.0 INTRODUCTION

William Lettis & Associates, Inc. (WLA), under subcontract to Alan Kropp and Associates, Inc. (AKA), presents the results of a surface-fault rupture hazard investigation for the proposed General Purpose Laboratory (GPL) in the East Canyon of Lawrence Berkeley National Laboratory (LBNL). The approximate site location is shown on Figure 1 and on the detailed geologic map (Plate 1) several other LBNL buildings are shown that exist in this portion of the East Canyon: Buildings 74, 83, 85, 84A, 85B and 86.

1.1 Project Description

The GPL project will be constructed in the East Canyon portion of the LBNL facility in an area of hilly terrain. The proposed GPL project includes a laboratory building, an access driveway and parking area, retaining walls, and various drainage and utility improvements. As currently envisioned, the footprint of the new GPL site overlaps the mapped location of the northwest-striking Wildcat fault (Figure 2). The purpose of this investigation is to assess the presence or absence of active faulting on the Wildcat fault at the GPL site, and to determine if the fault poses a surface-fault rupture hazard to the planned development.

The faults that exist in the direct vicinity of the site, including the Wildcat fault, are not zoned as active by the California Geological Survey (CGS) and the site is not within a previous or current State of California Earthquake Fault Zone, as delineated under the Alquist-Priolo Earthquake Fault Zoning Act (A-P Act; 1972, California Public Resources Code, Chapter 7.5, Division 2). The A-P Act states that new buildings designed for human occupancy, and existing buildings to be renovated above 50% of their value, may not be located above an active fault. The A-P Act defines an active fault as one that has ruptured the ground surface within the past approximately 11,000 years (the Holocene Epoch). The main purposes of the A-P Act are to prevent the construction of buildings used for human occupancy on active faults, and to prevent loss of life due to building collapse from surface-fault rupture (Hart and Bryant, 1997; California Division of Mines and Geology [CDMG], 1999). The A-P Act is designed specifically to mitigate "by avoidance" the hazard associated with surface-fault rupture during earthquakes. Although the Wildcat fault is not recognized by the State as an active fault (CDMG, 1982), the LBNL stakeholders have requested that we evaluate the activity of the fault and any potential surface-fault rupture hazard associated with it.

1.1.1 General Purpose Laboratory Building

The GPL will be located on a west-facing hillslope directly southeast of Building 74, in an area presently occupied by the Building 74 parking lot and an undeveloped slope along the southern margin of the proposed building (Plate1). The 100% Conceptual Design drawings show the GPL building having maximum plan dimensions of about 80 feet by 170 feet. The geologic and geotechnical investigation of the proposed site is presented in a separate report prepared by AKA (2008). The building will be aligned with its long axis parallel to the hillside and it will be partially benched into to the west-facing slope. The lowest level of the building will be stepped into two levels, as described below:

> ***First Floor -*** The lowest (first) floor of the building will be at Elevation + 818 feet, which is near the existing grade at the northern end of the proposed building. The first floor will extend across approximately the western two-thirds of the building. Below the west side of the first floor level there will be a retaining wall of variable height that meets the existing grade down slope. At the east side of the first floor level there will be a 16-foot-high wall that extends up to the second floor level.
>
> ***Second Floor –*** The second floor of the building will be at Elevation +834 feet. The floor level may be structurally-supported and/or supported "on-grade" (on backfill placed behind the retaining wall along the eastern side of the first floor level).

1.1.2 GPL Site Improvements

As currently planned, the eastern site margin will be bordered by a service drive that leads from the existing B74 area to a new parking area south of the GPL. The service drive will slope up from its northern entrance at Elevation +827.5 feet to a rear second floor entrance at Elevation +834 feet and then down to the parking area at the southern end of the GPL building.

The service drive will be cut into the slope and will be retained on its upslope (eastern) side by a 4-foot- to 24-foot-high retaining wall.

1.2 Purpose

The Wildcat fault is mapped through the proposed GPL site (Figure 2 and Plate 1). The purpose of the study documented in this report is to: (1) investigate the presence or absence of the Wildcat fault in its previously mapped location, and (2) if present beneath the proposed site, determine the activity of the fault. This investigation follows the methodology outlined in WLA's proposal submitted July 31, 2008.

This investigation conforms with the intent of the A-P Act, specifically to mitigate the hazard of surface-fault rupture by placing buildings away from active faults. Our approach follows guidance provided by the California Geological Survey (CGS) Note 49, *Guidelines for Evaluating the Hazard of Surface Fault Rupture* (CGS, 2002), and Special Publication 117, *Guidelines for Evaluating and Mitigating Seismic Hazards in California* (CGS, 1997), which recommend methodologies for assessing seismic hazards in California. The investigation is designed to intersect the previously mapped location(s) of the Wildcat fault, but is not intended to evaluate the presence or absence of active faulting beneath the entire footprint of the proposed GPL site.

1.3 Previous AKA/WLA Investigations

The geologic interpretations presented in this study build upon previous research and investigations conducted by AKA and WLA at other nearby areas within the LBNL facility. Prior to the initiation of this investigation, AKA and WLA collaborated on more than a half-dozen geotechnical and geologic studies for LBNL and UCB projects within the East Canyon. These previous projects have allowed us to: (1) augment the available existing East Canyon data through our own exploratory borings, trenches and geologic field mapping; and (2) develop an overall geologic interpretation of East Canyon geology, which is directly relevant to the understanding of the GPL site (Plate 1). This previous work includes exploratory trenching within the southern part of the GPL site (trenches WLA T-1 to T-3, shown on Plate 1). Selected AKA/WLA reports used or referred to during this study are listed in Section 8.0 (References).

1.4 Limitations

This report has been prepared specifically for LBNL and their design consultants for the proposed GPL project, and is to be used solely for their planning purposes. No other warranty, expressed or implied, is

made as to the professional advice included in this report. This report has not been prepared for use by other parties, and may not contain sufficient information for purpose of other parties or other uses. Note that this study does not constitute a geotechnical investigation for foundation design or an evaluation of other potential geologic hazards (e.g., strong ground motion, liquefaction, and landsliding) potentially impacting the subject site. These issues were evaluated and discussed in AKA (2008), a geologic and geotechnical investigation for the site.

2.0 SCOPE OF WORK

Based on a letter of authorization dated September 18, 2008, WLA and AKA were retained by LBNL to evaluate possible fault rupture hazards at the proposed GPL site. The investigation focused on new exploratory trenching to complement previous fault trenching (Harding-Lawson Associates [HLA], 1980) geotechnical boreholes, and cut-slope and slide repair investigations in the direct site vicinity that either constrain the fault location or activity (e.g., P. Jordan, 1997). The scope of work was designed to comply, in part, with the intent of the A-P Act to: (1) document the presence or absence of active faults at the site, and (2) develop recommendations on suitable building setbacks, if any, to mitigate the hazard from surface fault rupture. Our scope of work included the following tasks:

- Compilation and review of existing published and unpublished geologic information, including consultants reports, stereo-pair aerial photographs, and historical topographic maps and photographs;
- Personal communication with Dr. Russ Graymer of the U.S. Geological Survey and Mr. William Bryant of the California Geological Survey;
- Site reconnaissance and geologic mapping;
- Excavation and documentation of trenches totaling about 100 lineal feet;
- Perform relative age dating of trench deposits using soil profile development;
- Data analysis to assess the location and activity of the Wildcat fault;
- Undergo technical peer review of the trenches that included Mr. Steve Korbay of Mactec, LBNL geologist Mr. Preston Jordan, GPL stakeholders, and Mr. Wayne Magnusen of AKA; and,
- Report preparation and submittal.

2.1 Data Review, Site Reconnaissance, and Geologic Mapping

WLA geologists conducted an initial review of pre-construction aerial photographs (Table 1), historical photographs (Figures 4 and 5), topographic maps, geologic and engineering reports, and logs from existing site borings and trenches (HLA, 1980; HLA, 1975; Borg, 1991; Collins, 1993; Gilpin, 1994;

Parsons, 2000; AKA, 2006a and 2006b; AKA, 2008). WLA conducted field reconnaissance between Building 74 and the U.C. Botanical Gardens to evaluate local bedrock exposures, surficial deposits, and fault contacts mapped previously (e.g., HLA, 1982; Borg, 1991; Collins, 1993; Gilpin, 1994; Graymer et al., 1996; Graymer, 2000). We met with LBNL Facilities personnel to discuss possible trenching options, logistical constraints, and Health and Safety concerns for excavating operations.

Table 1. Aerial Photography Reviewed

Type	Date	Scale	Photo No.	Source
Black and White, Stereo Pair	08/02/1939	1:20,000	BUT-BUU-289-67,68	United States Soil Conservation Service

Historic oblique and vertical aerial photographs were examined to check for geomorphic indicators of faults and/or landsliding within the area of the proposed GPL site. The oldest photographs reviewed were a set of four oblique photographs of the site area from circa 1885 and 1903, which were obtained from AKA's historical reference library. Representative photographs of the site from 1903 are presented in Figures 4 and 5. The figures are annotated to show the approximate location of the planned GPL site. The earliest stereo-pair vertical aerial photographs of the site are from 1939 and show the East Canyon area with relatively thick vegetation that obscures much of the geomorphology of the site.

We also reviewed published geologic maps and literature pertaining to geologic and seismic conditions in the project vicinity. These references were used primarily to determine site-to-source distances to principal active faults, and to review the previously-mapped location(s) of the Wildcat fault in the project vicinity. A substantial amount of information exists regarding geotechnical and geologic conditions within the East Canyon area from unpublished consulting reports relating to previous projects in the vicinity.

Some of the data contained in the referenced reports was used and relied upon during our geologic and geotechnical evaluations of conditions affecting the proposed GPL site (AKA, 2008). The locations of nearby borings, test pits, and trenches used in this report are shown on Plate 1 and Figure 3.

2.2 Personal Communications

WLA's engineering geologists conducted a phone interview with Russell Graymer of the U.S. Geological Survey, on October 16, 2008, regarding his mapping of Berkeley Hills and the Wildcat fault (Graymer et al. 1996; Graymer, 2000). Dr. Graymer is a research geologist and an expert on the local geology of the area and provides an 'independent' perspective on the local geology and seismic hazard in the proposed GPL site vicinity. We reference this conversation below as Graymer (2008) personal communication. In addition, we checked with William Bryant of the CGS to check whether there have been recent studies on the Wildcat fault that may shed light on its activity. Mr. Bryant stated he was not aware of any and that the fault is not zoned by CGS as an active fault. We also spoke with officials at East Bay Municipal Utility District and geologists with other local consulting firms regarding any recent explorations of the Wildcat fault. None were known to have been performed.

2.3 Subsurface Exploration

WLA geologists excavated and documented WLA trenches T-1, T-2, and T-3 between September 19 and 30, 2008 (Figure 3). Goebel Paving, Grading, & Underground, Inc. (Goebel) excavated the trenches using a track-mounted excavator with a 36-inch-wide bucket. The north wall of the trench was completely cleaned to expose fresh material. Structural and stratigraphic features were flagged and logged at 1 inch = 1 meter (~1:40) scale. Attitudes and orientations of structural features were measured and logged on the north wall after correlating with similar features on the south wall. Detailed soil profiles were prepared by Dr. Janet Sowers of WLA.

WLA trenches T-1, T-2, and T-3 extended generally perpendicular to the mapped trace of the Wildcat fault south of Building 74 and the abandoned dog kennels (Figure 3). These trenches were used to characterize the presence or absence of faulting along a southeastern projection of the Wildcat fault from Building 74. Between the previous trenches and boreholes and the new excavations, this study investigates reasonable orientations of the Wildcat fault, as well as previously mapped locations, intersecting the proposed GPL site. Previous explorations by Subsurface Consultants, Inc. (SCI, 1998; trenches T1-98 to T3-98 as shown on Figure 3) provide limited constraint on the absence of Holocene faulting along the western margin of the proposed GPL.

Trenches T-1, T-2, and T-3 were 62 ft (19 m), 21 ft (6.5 m), and 21 ft (6.5 m) long, respectively, and as much as 12 ft deep (3.5 m). The trenches were oriented approximately east-northeast perpendicular to a gravel access road accessible from the Building 74 parking lot (Figure 3). Trench T-1 extends uphill from the access road. WLA trenches T-2 and T-3 are offset from trench T-1 and extend across the access road (Figures 6 and 7). Trench T-2 extended a short distance down a steep west-facing slope bounding Centennial Drive and the GPL site. Trench T-3 extended trench T-2 farther east and was excavated to better document the location of the western trace of the Wildcat fault.

Prior to excavation, a site-safety meeting was held with WLA, LBNL, and Goebel employees to review the excavation plan and discuss safety elements of the trenching investigation. The trenches used aluminum hydraulic shoring in accordance with OSHA regulations. Daily site safety inspections were performed by the WLA competent person and LBNL safety personnel (Mr. Tom Reese) prior to entering the trenches. The trench locations were surveyed by Bates & Bailey Land Surveyors, Inc., on September 30, 2008, prior to backfilling the trenches. Upon completion of the investigation and a formal review of the findings, trenches were backfilled in 12-inch lifts using an excavator-mounted vibratory plate and the addition of water. The trench backfill was compacted visually without laboratory testing and specified backfill conditions or limits. The site was restored to previous grade using dozer equipment. Because the trench backfilling was not controlled by a specification and testing, there is a potential for future settlement of backfill soil that needs to be considered with respect to future grading and foundations for the Helios project. The survey by Bates & Bailey will help accurately define the limits of the trench for future geotechnical/foundation assessment.

3.0 REGIONAL GEOLOGIC AND SEISMIC SETTING

In the following sections, we discuss regional geologic and seismic information obtained from our review of published and unpublished geologic information. More detailed discussions of local geologic conditions are presented in Section 4.00, "Local Geology."

3.1 Berkeley Hills Geology

The proposed GPL building site is situated on the west side of the northwest-trending Berkeley Hills, and is characterized by gentle to steep topography. Bedrock geology in the Berkeley Hills is complex and includes a variety of moderately to highly deformed (faulted and folded) sedimentary, volcanic and metamorphic rock units that have been subjected to a long history of regional uplift, folding, and landsliding. These rock units range in age from Late Jurassic to Cretaceous (135 to 150 million years ago) to Tertiary (66.5 to 1.6 million years ago).

The simplified regional geology map presented on Figure 2 is based on a published geologic map of this area from the United States Geological Survey (Graymer, 2000). Bedrock units mapped in the site area include the Cretaceous Great Valley Group (Ku), Miocene Orinda Formation (Tor), Miocene Moraga Volcanics (Tmb) and Miocene Claremont Chert (Tcc). Regional geologic mapping shows the Tertiary sedimentary and volcanic rocks are folded into a south-plunging syncline at LBNL. The Hayward fault (considered a major active fault) also trends northwest and runs along the western side of the Berkeley Hills near its base (Figures 1 and 2).

3.2 Bay Area Active Faults

The San Francisco Bay Area lies within a broad region of deformation that defines the boundary between the North American and Pacific tectonic plates. This seismic regime includes a series of major active northwest-trending faults, which include the San Andreas, Hayward, Rodgers Creek, Calaveras, San Gregorio, Concord-Green Valley, West Napa, and Greenville faults. These major faults are near-vertical and generally exhibit right-lateral strike-slip movement (which means that the movement is predominantly horizontal and when viewed from one side of the fault, the opposite side of the fault is observed as being displaced to the right). There are numerous active and potentially active faults within the Bay Area that are secondary to the major strike-slip faults. Faults that are defined as active exhibit

one or more of the following: (1) evidence of Holocene-age (within about the past 11,000 years) displacement, (2) measurable seismic fault creep, (3) close proximity and alignment with linear concentrations or trends of earthquake epicenters, and (4) tectonic-related geomorphology. Potentially active faults are defined as those that have evidence of Quaternary-age displacement (within about the past 2 million years), but have not been definitively shown to lack Holocene movement.

Various researchers and government agencies have mapped the locations of active and potentially active faults in California. The closest known active fault to the project site is the Hayward fault, which has been mapped by Lienkaemper (1992), Geomatrix (2006), and WLA (2007) approximately 2,600 feet southwest of the site on the UCB Campus (Figure 1). The State of California has designated official Special Studies Zones (later renamed Earthquake Fault Zones) around known active faults. These official State Earthquake Fault Zones were initially delineated by the State Geologist in conjunction with the California Division of Mines and Geology (CDMG, now the CGS) as part of the Alquist-Priolo Fault Evaluation Program, and are commonly referred to as A-P Zones. The CGS continues to revise and update the A-P Zone maps. The GPL site is not within a State Earthquake Fault Zone.

The CGS has also developed Active Fault Near-Source Zone maps to be used in conjunction with previous (pre-2008) versions of the Uniform Building Code (UBC). The Active Fault Near-Source Zone Maps are used with the UBC to characterize earthquake groundshaking for code-based structural design. Table 2 shows approximate distances and direction from the site to major Bay Area active faults, based on the CGS/UBC mapping.

Table 2. Principal Bay Area Active Faults: Site to Seismic Source Distances

Seismic Source	Approximate Distance from Site	Approximate Direction from Site
San Andreas	31 km	Southwest
San Gregorio	33 km	Southwest
Hayward/Rodgers Creek	0.8 km	Southwest
Northern Calaveras	21 km	East
Concord-Green Valley	23 km	Northeast
West Napa	34 km	North

3.3 Bay Area Seismicity

The greater San Francisco Bay Area region is characterized by a high level of seismic activity. Historically, this region has experienced strong ground shaking from large earthquakes, and will continue to do so in the future. A map showing the locations and magnitudes of historical earthquakes in the San Francisco Bay Area is presented in Figure 8. Since 1800, five earthquakes of magnitude (M)≥ 6.5 have occurred in the Bay Area (Bakun, 1999). These include the: 1836 M6.5 event east of Monterey Bay; 1838 M6.8 event on the Peninsula section of the San Andreas fault; 1868 M6.8-7.0 Hayward event on the southern Hayward fault; 1906 M7.9 San Francisco earthquake on the San Andreas fault; and 1989 M6.9 Loma Prieta event in the Santa Cruz Mountains.

In 2003, The Working Group on California Earthquake Probabilities (WGCEP, 2003), in conjunction with the United States Geological Survey (USGS), published an updated report evaluating the probabilities of significant earthquakes occurring in the Bay Area over the next three decades, (2002-2031), which has since been updated on a state wide scale in 2008 for the time span of 2007-2036 (WGCEP, 2008). The WGCEP (2008) report indicates that there is a 0.63 (63 percent) probability that at least one magnitude 6.7 or greater earthquake will occur in the San Francisco Bay region before 2037. This probability is an aggregate value that considers seven principal Bay Area fault systems and unknown faults (background values-WGCEP, 2003). The findings of the WGCEP (2008) report are summarized in the Table 3.

Table 3. WGCEP (2008) Probabilities

Fault System	Probability of At Least One Magnitude 6.7 or Larger Earthquake in 2007-2036
Hayward/Rodgers Creek	0.31
San Andreas	0.21
Calaveras	0.07
San Gregorio	0.07
Concord-Green Valley	0.03
Greenville	0.03
Mount Diablo Thrust	0.01
Background *(2002-2031)	0.14*

The published background values are not explicitly stated in the WGCEP (2008) and thus the WGCEP (2003) values were used. The background values indicate that between 2002 and 2031 there is a 14 percent chance that an earthquake with a magnitude of greater than 6.7 may occur in the Bay Area on a fault system not characterized in the study. It should be noted differences between the 2008 and 2003 WGCEP generally fall within the magnitude of error, and major differences in background values are not expected.

3.4 Wildcat Fault

The Berkeley Hills includes numerous mapped faults that are not recognized as active (Figure 2). The Wildcat fault, which crosses the proposed GPL site, is one of these faults (Figures 2, 3, and Plate 1). Several geologic studies performed at LBNL have investigated the location and character of faulting along the Wildcat fault. Only one study has directly assessed the activity of the fault (HLA, 1980). A compilation of existing site and regional geologic data by Gilpin (1994) did not find any compelling evidence to dispute the State's and HLA's characterization of the fault, and therefore, also considered the Wildcat fault as inactive. However, a more recent compilation of existing site data suggests that the location and activity of the Wildcat fault are poorly constrained and additional studies were recommended (Collins, 2007).

The approximately 20-to 25-km-long Wildcat fault is located within the Berkeley Hills and extends northwest-southeast from Richmond to Oakland, subparallel to the Hayward fault (Figure 2; Graymer, 2000). The Wildcat fault was first identified by Lawson and Palache (1900), and was later named by Untermann (1935) who identified the fault in the Claremont and San Pablo water tunnels. In the tunnel exposures, the fault offsets the Monterey Formation (Claremont tunnel), and both the Orinda Formation (west) and Monterey Formation (east) (San Pablo tunnel). Untermann (1935) interpreted the fault as accommodating both strike-slip and vertical components of displacement. More recent studies by Curtis (1989) characterize the Wildcat fault as a right-lateral strike-slip fault that dips near vertical to steeply southwest. The fault is interpreted to have accommodated as much as 7 km of horizontal displacement over the last 9.6 million years (Ma) (Curtis, 1989). Jones and Curtis (1992) later characterize the fault, in the region of the LBNL, as a laterally continuous thrust fault between Berkeley and Oakland.

The Wildcat fault can be separated into northern and southern sections with the boundary between the

sections coinciding approximately with the GPL site (Figure 2). The southern section of the fault intersects the eastern part of East Canyon where it offsets Claremont Chert on the east against Orinda Formation and/or San Pablo Group on the west (Figures 2 and 3). Through East Canyon, the Wildcat fault traverses steep bedrock ridges and slopes along a sinuous trend and does not exhibit distinct youthful tectonic-related geomorphology (Gilpin, 1994). Roughly two miles southeast of East Canyon, a zone of faulting at the Orinda/Claremont Formational contact was exposed in the Broadway Tunnel (Page, 1950). Page (1950) identified the Orinda Formation/Claremont Chert contact as a gentle angular unconformity along which minimal slippage had occurred. Radbruch (as referenced in Smith, 1980) identified but did not name a fault separating undivided Cretaceous units on the southwest from the Sobrante Formation on the northeast and continuing to the northeast of the site. Radbruch (in Smith, 1980) does not map the Orinda Formation and Claremont Chert as faulted south of East Canyon.

The northern section of the fault was mapped by Bishop et al. (1973), Dibblee (1980) and Graymer (2000), among others. Bishop et al. (1973) show the Wildcat fault offsetting undifferentiated Orinda, Moraga, and Siesta Valley Formations for the entire length of the Richmond Quadrangle, north of and including the northern extent of the project site. Northwest of the site, Dibblee (1980) maps the fault as offsetting Pliocene basalts (southwest) against Moraga basalts (northeast) and continuing for the length of the Wildcat Canyon up toward El Cerrito and San Pablo in the northwest. The northern part of the fault is defined geomorphically by the linear topography of the Wildcat Canyon, although more recently Graymer (2008, personal communication) interprets the linearity of Wildcat Canyon as a result of bedding within the bedrock rather than the Wildcat fault (Graymer, 2000).

Early studies along the fault linked observations suggestive of active deformation (e.g., aseismic creep) at the northern terminus of the Wildcat fault where it lies within close proximity to the Hayward fault (Bishop, et al., 1973). For instance, Bishop et al. (1973) interpreted sag ponds, offset drainages and en echelon cracks in pavement coincident with the Wildcat fault. These early interpretations of activity resulted in the northern most Wildcat fault being zoned as potentially active by the State and associated with a special studies zone on the initial AP map of the Richmond and Mare Island quadrangles (CDMG, 1974). The Wildcat fault at the proposed GPL site has never been included as part of a special study zone. Later, after closer examination by Smith (1980), the features suggestive of active faulting were reinterpreted as due to other processes and were not considered strong evidence for supporting the Wildcat fault as Holocene active. The re-analysis resulted in the California Division of Mines and

Geology reclassifying the Wildcat fault as inactive (CDMG, 1982; Smith, 1980).

4.0 LOCAL GEOLOGIC CONDITIONS

4.1 East Canyon Geology

The East Canyon portion of the LBNL campus is underlain by Tertiary sedimentary and volcanic bedrock, unconsolidated to semi-consolidated Quaternary colluvium, debris-flow deposits, landslide deposits, and artificial fill (Plate 1). Tertiary sedimentary and volcanic rocks are gently folded along the eastern limb of a south-plunging syncline. Various researchers and consultants have mapped faults within the East Canyon area that are not currently zoned as active. These faults include the Wildcat fault and inferred East Canyon fault, which generally trend north to northwest through the East Canyon (Plate 1). The eastern limb of the syncline is cut by the Wildcat fault. Tertiary bedrock units encountered in East Canyon include from oldest to youngest: Claremont Chert, San Pablo Group, Orinda Formation, and Moraga Formation.

The Geologic Map compiled for this study (Plate 1) shows bedrock units, bedrock faults, and probable deep-seated, bedrock-involved landslide deposits in the direct vicinity of the GPL site. The geologic map shows that the GPL site is underlain by Tertiary sedimentary bedrock of the Claremont Chert and San Pablo Group. The geologic map in Plate 1 is based on our compilation of previous borings, trenches, test pits, previous geologic studies, geologic mapping and subsurface data collected for many of the AKA and WLA investigations performed in the East Canyon. A list of published and unpublished references used to evaluate the geologic conditions of the East Canyon area are provided in the reference section (Section 8.0). The geologic map was prepared to delineate geologic features relevant to our evaluation of the potential hazards, and therefore surficial fill, colluvium and alluvium generally are not shown for clarity. The results of our evaluations are discussed in greater detail in the sections that follow.

4.2 Unconsolidated Deposits

4.2.1 Undifferentiated Surficial Deposits (Quaternary) – Symbol Qu

Quaternary colluvium, minor clay-rich alluvium, and debris-flow deposits underlie portions of East Canyon. The GPL site overlies a former paleodrainage filled with variable amounts of Quaternary

colluvium, alluvium and debris flow material derived from an existing drainage located east of LBNL Buildings 84 and 74. This swale also contains colluvium from adjacent areas directly upslope (east) of the site. Accumulations of clayey colluvium, alluvium, mudflow, and debris-flow deposits interfinger and are overlain by colluvium derived from the steep slopes east of the site. The undifferentiated Quaternary material and artificial fill are not shown on the geologic map for clarity. Based on borehole exploration for the GPL site, the unconsolidated materials are inferred to be as much as 10- to 20-feet-thick below the northern part of the GPL, with an approximately 40-foot-thick section of undifferentiated surficial deposits in the approximate center of the GPL (AKA, 2008). At the southern part of the site where the fault investigation was performed, the undifferentiated colluvium and alluvium is about 10 feet thick.

4.2.2 Quaternary Landslide Deposits

Landsliding within East Canyon has occurred at a variety of scales and involves a variety of mass-wasting processes. Landslide deposits in East Canyon are extensive, and are derived from several types of materials, including: (1) reworked Quaternary deposits, (2) deposits containing mixed blocks of Orinda and Moraga Formation, and (3) homogeneous blocks of Moraga Formation or Orinda Formation (AKA, 2006a; AKA, 2006b). The mapped landslide extent is based on: (1) valley morphology, (2) landslide-related deposits encountered during grading activities, and (3) geological and geophysical features encountered during site investigations. Mapping and compilation of existing geologic data indicate that sliding within East Canyon is complex and in places consists of nested sequences of distinct slide masses.

The small-scale slides (in orange and tan where repaired, but not labeled on the Geologic Map) range in aerial extent from about 600 ft^2 to 50,000 ft^2. The large-scale landslides occupy significant portions of East Canyon and are about 100,000 ft^2 to as much as 1,000,000 ft^2 in aerial extent (in light and dark brown colors of Plate 1). The largest slide mass encompasses the limits of hummocky topography of the East Canyon floor and is designated landslide Qls-2. Landslide Qls-1 is the smaller (and shallower) of the large landslides and is located directly northeast of the site. The eastern margin of landslide Qls-2 lies about 300 ft west of the proposed GPL site (Plate 1). None of these large landslides appear to underlie the proposed GPL site.

4.2.3 Artificial Fill, Historic

Development within the East Canyon has included the placement of artificial fill directly beneath and surrounding portions of Buildings 84, 74, parking lots for 74 and 84, Building 83, Building 85 access road, 85, 84A, and 85B, including within the former stream channels.

4.3 Bedrock Units

Bedrock units in the GPL site vicinity include the Cretaceous Great Valley Group, Tertiary Claremont Chert, Tertiary San Pablo Group, and Tertiary Orinda Formation (Plate 1). The bedrock units within the proposed GPL footprint are described in detail below and include the Claremont Chert, San Pablo Group, and Orinda Formation. Other bedrock units in the East Canyon Area are described in the GPL geotechnical study (AKA, 2008).

4.3.1 Claremont Chert (middle to late Miocene) – Symbol Tcc

The oldest strata in the site vicinity are well-bedded, siliceous shale and chert, and occasional sandstone of the Claremont Chert (Tcc). The Claremont Chert forms a resistant unit that underlies the steep slope on the east side of the canyon, and dips moderately to steeply northeast. These beds commonly are folded and overturned in the Berkeley Hills. In the direct vicinity of the site, the unit is bound to the west by the Wildcat fault. Existing geotechnical borehole data and geologic mapping indicate that the Claremont Chert likely exists along the eastern margin of the GPL site. The Claremont Chert was encountered by previous subsurface investigations at about 5 to 11 feet below the ground surface at Building 84, and at depths of 22 feet or more south of the building where it intersects a buried drainage (Figure 3). Where encountered, it consists predominantly of brown to light-brown, thinly bedded chert and siliceous shale with interbeds of sandstone exposed south of the site (Plate 1).

4.3.2 San Pablo Group (middle to late Miocene) – Symbol Tsp

Claystone, siltstone, and fine sandstone of the San Pablo Group (Tsp) lie west of the Wildcat fault in the East Canyon (Figure 3). This unit has been mapped previously as the Orinda Formation. More recent

studies associated with the grading of Buildings 83 and 85 suggest that this deposit (P. Jordan, personal communication, 2008) contains facies consistent with a shallow marine setting, distinct from the subaerial alluvial and fluvial environment of the Orinda Formation. Outcrop characteristics include a fine-grained texture and a grey color, which are distinct from the commonly more oxidized and multi-colored beds and coarser-grained texture of the Orinda Formation. Bedding exposed along a road-cut exposure directly north-northwest of Building 83 shows gentle (10° to 15°) dips to the northwest. The western extent of the San Pablo Group and the nature of the contact with rocks of the Orinda Formation are unclear, although previous investigations (Collins, 1993; Parsons, 2000) show this contact as a sub-vertical fault that strikes north-northwest through the central axis of East Canyon. The western contact has not been observed and is obscured by colluvium and landslide deposits (AKA, 2006b).

Across much of the site, the San Pablo Group is about 25 to 45 feet below the ground surface. The top of bedrock dips southerly and increases in depth toward East Canyon, with the shallowest encounter of San Pablo Group being at approximately 24 feet (in borehole AKA-3) near the center of the site (AKA, 2008). The San Pablo Group is as much as 44 feet below the ground surface along the western margin of the site. Based on borehole data collected for this study, the San Pablo Group is defined by fine-grained silty massive to bedded sandstone having a low hardness and friable to weak strength, and variable coloration between blue-grey to grey.

4.3.3 Orinda Formation (late Miocene) – Symbol To

The Orinda Formation in the East Canyon area consists of non-marine, well to poorly bedded siltstone, fine lithic sandstone, and pebble conglomerate. The conglomerate contains a high percentage of detritus derived from the Franciscan complex (Graymer, et al., 1996). The Orinda Formation was previously interpreted to underlie portions of Building 74 and 84, but recently has been re-interpreted as the San Pablo Group (Parsons, 2000). Graymer (2000) shows that the eastern part of East Canyon is underlain by Orinda Formation and that it is in fault contact with the Claremont Chert (Figure 2). Siltstone and sandstone encountered in trenches T-2 and T-3 for the GPL fault hazard study are similar to other borehole descriptions and exposures of Orinda Formation in the site vicinity, but for the purpose of consistency and to honor the Parsons (2000) report we adopt the San Pablo Group designation for these deposits.

4.4 Bedrock Faults

Several north- to northwest-striking bedrock faults have been mapped previously in the East Canyon area, none of which are considered active by the CGS. Of greatest significance to the GPL is the Wildcat fault, which crosses the proposed project site (Figure 3 and Plate 1). The other closest fault to the site is an inferred contact between the San Pablo Group and Orinda Formation beneath the central axis of East Canyon and is approximately 300 ft west of the GPL site (Plate 1). This unnamed inferred fault does not intersect the GPL site and is not discussed further. The fault with the potential for direct implications to site development is the Wildcat fault.

4.4.1 Wildcat Fault in the LBNL East Canyon

Multiple locations of the Wildcat fault have been interpreted in the East Canyon (e.g. Borg, 1991; Collins, 1993; Graymer et al., 1996; Graymer, 2000; Parsons, 2000), yet the fault has been directly observed in only four studies, all of which are north of the proposed GPL site. A fifth study (Collins, 2007) speculates on the findings of these earlier studies. Main results and interpretations from the five studies are summarized below:

1. HLA, 1975 (HLA field notes discussed in Gilpin, 1994; LBNL File #396/421-page 78). An eastern trace of the Wildcat fault was documented in a bedrock bench-cut east of Building 84. The fault strikes approximately N15˚W and dips between 65˚E to 70˚E. The exposure showed sandstone on the west against chert on the east and is constrained within the Claremont Chert. The fault is shown as extending beneath Building 84 and lies along the southeastern boundary of a slide that was repaired in 1982 (Figure 5).

2. HLA, 1980 (HLA Job #2000.145; LBNL File #35). On the basis of trench exposures, borehole and pier data, HLA (1980) concluded that in the area of Building 74 the dominant sense of displacement on the Wildcat fault is vertical with east-side-up displacement. HLA excavated a trench in the northern part of East Canyon about 1,300 feet north of the GPL (Trench A) (Plate 1). Trench A exposed a near-vertical fault striking approximately N06˚W, with Orinda Formation on the west against fractured Claremont shale and sandstone (with faint bedding dipping to the north) on the east. In Trench A, the Wildcat fault is defined as a 5-ft-wide subvertical zone striking N06˚W, and is characterized by red and green clay gauge, shearing, fractured rock and black clay seams. The fault terminates at the base of a 10-ft-thick section of colluvium. On the basis of the absence of offset across the contact between bedrock and Quaternary colluvium, HLA (1980) interpreted the fault as inactive. Furthermore, HLA (1980) interpreted a northeast-striking fault ("cross fault") that offsets and displaces the Wildcat fault near Building 84 suggesting that the minor northeast-striking fault is younger than the Wildcat

fault (Plate 1 and Figure 3). Trench B, excavated across a southwest projection of the cross fault, demonstrated the absence of Holocene displacement. Collectively, these data suggest the absence of Holocene activity along the Wildcat fault.

3. Preston Jordan, 1997 (LBNL #359). Jordan (1997) observed a second set of bench cuts east of Building 84 that exposed a 12-ft-wide fault zone that displaced San Pablo Group sandstone on the west and Claremont Chert and shale on the east. The fault is oriented N10°W with a 65° dip to the northeast. The bedrock fault is described as being overlain by unfaulted colluvium and a ferricite horizon developed in bedrock across the fault. Ferricite is a mineral stated to take thousands of years to form. Based on the presence of the unfaulted ferricite horizon, Jordan (1997) characterized the Wildcat fault as inactive.

4. Preston Jordan, 2004 (written communication; no official LBNL file). Documented exposures of a western strand of the Wildcat fault during grading of Calvin Road at or near the tight curve that encloses Building 83. The fault trace dips in the opposite direction of the faults identified to the east of Building 85, and has an orientation of approximately N14˚W and dip of 75˚SW.

5. Laurel Collins, 2007. Collins (2007) believes that there is insufficient information available to confidently determine the activity of the Wildcat fault shear zone, which may be as much as 600 feet wide. Map compilations prepared by Collins (2007) show multiple fault traces and locations for the Wildcat fault prompting Collins (2007) to argue there is no general consensus on its location and width. Collins (2007) recommends that further investigation be performed to assess the nature of faulting and geology in this part of LBNL.

Based on our data compilation and review of existing literature from LBNL, the Wildcat fault is characterized as a northwest-striking fault zone composed of multiple fault traces and possible northeast-striking "cross-faults" where the Wildcat fault enters a bend (i.e., the right step near Building 74; see Plate 1 and Figure 3). Boring logs from HLA (1980), Dames and Moore (1960), and SCI (1994) were used with the findings from recent GPL geotechnical boreholes AKA-1 to AKA-4 (AKA, 2008), and WLA trenches T-1 to T-3 (this study), to constrain the location of the Wildcat fault trace(s) at the site. The Wildcat fault is interpreted as a broad curvilinear zone that on the west is defined by sandstone and siltstone of the San Pablo Group in fault contact with the Claremont Chert along the western trace. The western fault trace is shown intersecting the northern part of the GPL building footprint at a slight left-bend where it then projects southeast at or near the base of the steep hill along the eastern part of the site (Figure 3). The eastern trace is mapped directly east of the site near the middle of the steep hill and is constrained within the Claremont Chert (Figure 3).

5.0 RESULTS OF SUBSURFACE INVESTIGATION

Graphic logs of trenches WLA T-1 to T-3 are provided in Plates 2 through 4 in Appendix A. Collectively, these trenches intersect the previously mapped location(s) of the inferred Wildcat fault and provide direct evidence for the presence of a laterally continuous bedrock fault zone along the eastern margin of East Canyon.

We divided the geologic material encountered in our subsurface investigation into six main units: (1) Claremont Chert, (2) highly-weathered Claremont Chert, (3) San Pablo Group, (4) Pleistocene and (5) Holocene colluvium, and (6) artificial fill. These units are further subdivided in our logging of the trenches, where possible. For the purpose of discussing and assessing fault location and activity, a reference to the general units is sufficient. More detailed descriptions of geologic materials and soil characteristics observed in trenches are provided on the trench logs in Appendix A and soil profile descriptions in Appendix B. Further discussion of the age of these units and their relationship to bedrock structure is in Section 5.1.2.

5.1 Exploratory Trenches WLA T-1 to T-3

5.1.1 Geologic Units

Trenches T-1 to T-3 exposed well-bedded, north-striking and east- to west-dipping Claremont Chert (unit 80), and in the western parts of trenches T-2 and T-3 San Pablo Group siltstone and sandstone (units 60 and 61). The Claremont Chert contains 5-to 20-cm thick beds of chert separated by sandy to silty shale interbeds. Unit 80 is generally weak and slightly to moderately weathered with a blocky and seamy rock fabric with common joints (≤ 1 inch spacing) perpendicular to bedding (Figure 9). Variations in bedding inclination are common and are due to active down-slope soil creep processes, ancient tectonic folding, and ancient deformation in the hanging wall of the Wildcat fault. Down-slope translation of angular chert clasts parallel to joint sets and bedding suggests that the upper several feet of Unit 80 are affected by soil and slope creep processes. Relict tectonic deformation is preserved as open S-folds and tight Chevron folds in the upper part of trench T-1. For example, bedding changes between stations 10 and 14 m (west to east) from generally west-dipping (20 to 41º) to north- to southeast-dipping (5º to 14º). Large variations in bedding are typical within the Claremont Chert regionally, some of which can be attributed

to uplift of the Berkeley Hills (Graymer personal communication, 2008), and pinch and swell structures. Pinch and swell structures at outcrop scale are present to the south of the site (Figure 10).

Within trenches T-1 to T-3 an angular gravel unit (units 70 and 75) is interpreted as highly- to moderately-weathered in-situ Claremont Chert that has undergone minor downslope soil creep and soil development processes. It consists entirely of a Claremont Chert-derived dense sandy gravel matrix with angular to subrounded chert clasts. Near the base of unit 75 in trench T-1, weak bedrock structure (similar to unit 80) and bedding are still apparent, and the unit grades upward into a more massive matrix and clast-supported gravel (see note E in Plate 2). In WLA trenches T-2 and T-3, unit 75 was further subdivided into a weathered Claremont Chert having faint, discontinuous remnant bedding (unit 70), and characteristics that at times resemble near-source colluvium similar to the eastern part of unit 75 in trench T-1. Unit 75 contains discrete blocks of folded Claremont Chert and laterally discontinuous bedding. In trench T-1, between stations 6 m and 13 m, a reddish-brown, clay-rich weathering horizon is developed in units 75 and 80 (i.e., notes D and F in Plate 2). Where exposed the lower boundary of the weathering horizon is clear and planar.

Within trenches T-2 and T-3, a mottled grayish green to dark reddish brown, fined-grained silty sand (unit 60) that is interpreted as San Pablo Group is faulted against Claremont Chert (units 65 [fault zone material] and 70) (Plates 3 and 4). The San Pablo Group is generally massive with fine-grained sand and stringers of clay and silt similar in texture and appearance to bedrock encountered in exploratory boreholes AKA-1 to AKA-4 (AKA, 2008). Unit 60 is cut by a series of <0.5-cm-wide, east-dipping, low-angle bedrock shears with occasional carbonate coatings and polished clay-rich surfaces. The bedrock shears do not project upward and across the overlying buried paleosol (unit 35) and colluvial contacts (unit 20).

A distinct dark reddish-brown buried Bt-soil horizon (unit 35) is developed into unit 60 in trench T-2 (see Appendix B for the soil profile description). Unit 35 consists of pedologic prismatic fractures ("peds") near the base and a bleached soil horizon up-section near the overlying contact with the colluvial deposit (unit 20). The bleached horizon is similar to a pedologic E-horizon (i.e., a zone stripped of clay accumulation), or a leached zone from perched groundwater. The contact between units 35 and 20 strikes N76ºW dips 24º south, and represents the approximate former ground surface before being buried by colluvium. Unit 35 transitions from an angular blocky soil upward into a well-developed prismatic soil.

Unit 20 overlies the bleached soil horizon. This distinct paleosol Bt-horizon is not present in trench T-3; however, remnants of a similar but less-developed clay-rich soil horizon are present in the weathered Claremont Chert (unit 70) and the fault zone material (unit 65).

In trench WLA T-3, a north-striking and east-dipping fault, similar to the fault exposed in trench WLA T-2, juxtaposes San Pablo Group sandstone (unit 60) on the west against weathered Claremont Chert (unit 70) on the east (Plate 4). An additional north-striking, east-dipping (N30ºW to N20ºW, 40º to 42ºE) fault is located near station 4 m and is characterized by a massive fine-grained sandstone (unit 61) bounded by Claremont Chert on both sides. Unit 61 contains blocks of intact sandstone supported by a matrix of less indurated brecciated sandstone of the same composition. The western boundary of unit 61 is marked by a prominent clay seam that varies in thickness from 1 to 6 centimeters. Unit 61 is bounded by clear and wavy contacts. We interpret unit 61 as a fault-bounded sliver of San Pablo Group material, or possibly a brecciated sandstone lense within the Claremont Chert.

Four colluvial deposits, designated units 40, 30, 20 and 10 from oldest to youngest, contain gravel- to cobble-sized chert clasts and unconformably overlie Claremont Chert (units 80, 70, and 75) and San Pablo Group (unit 60). The west-dipping colluvial packages are roughly 0.4 m to 0.25 m thick, and are subparallel to the present-day ground surface. Units 40 and 30 are preserved in a buried swale between stations 4 m and 14 m in trench T-1. The four packages of colluvium are generally massive and contain subrounded to angular fine to coarse gravel, and exhibit a larger concentration of clasts near the basal contacts. In places, large oblate clasts are oriented parallel to the present-day slope and form distinct 1- to 3-m-long stone lines in the trenches. The distinction between the colluvial units is based on soil development, upward fining sequences, stone lines, and clast percentages. Units 40 and 30 are defined by prominent clay films within the matrix and surrounding pebbles, as well as a subangular blocky soil structure (buried soil Bt-horizon). Unit 20 is finer grained than units 40 and 30, and has a transitional AB-horizon with granular to subangular blocky ped structures that are significantly less developed than those encountered in units 40 and 30. The youngest colluvial deposit (unit 10) consists of sandy silt with gravel (10-15%) and is the finest of the three colluvial packages. Unit 10 is overprinted by an A-horizon. On the basis of the soil development in the colluvial deposits, we infer ages of late Pleistocene for units 40 and 30, and Holocene for units 20 and 10 (see Section 5.2.1 for further discussion).

Artificial fill (unit 5) consists of dark grayish brown sand with silt and gravel that is concentrated in the vicinity of the access road near trench T-2. These loose, poorly-sorted deposits contain subangular chert clasts, large pieces of wood, pores and rootlets, and at least two fill 'lifts'. Fill logged in trench T-3 represents back-filled portions of trench T-2. The lower boundary of Unit 5 is typically marked by a buried duff layer composed of plant material and represents the ground surface before burial by fill.

5.1.2 Estimated Ages of Deposits

A key means of assessing fault activity is to estimate the ages of deposits that overlie a fault trace. Age estimates can be made by: (1) direct dating of materials sampled from within the deposit (e.g. radiocarbon dating of charcoal); (2) dating of deposits based on fossil assemblages; (3) correlating deposits with deposits of known age in the site vicinity based on lithologic characteristics and geomorphology; or (4) evaluating the degree of soil profile development in the deposits. We use detailed soil profiles and models of depositional processes and paleo-landscapes to evaluate the ages of colluvium in trenches WLA T-1 and T-2 because detrital charcoal and fossils were not found in the trench exposures.

Based on geomorphology and soil characteristics in trench WLA T-1, colluvial units 30 and 40 are interpreted to be late Pleistocene in age based on two lines of evidence. First, the soil is developed in a bedrock depression filled with Claremont Chert-colluvial deposits, yet the slope is presently not shaped to rapidly collect colluvium. Thick colluvium is typically deposited either as part of a landslide mass, or by a slow, steady accumulation within a hollow on the hillside. The slope is presently smooth and planar, and is located on a nose instead of in a hollow. There is no morphology to suggest the deposits may represent landslide debris or that the slope has been historically modified. A present-day geomorphic setting incompatible with rapid accumulation of colluvium argues for some antiquity to the colluvial deposit. Large-scale landscape evolution requires on the order of tens to hundreds of thousands of years, thus these thick colluvial deposits are not likely to be Holocene.

Second, colluvial units 30 and 40 in trench WLA T-1 exhibit soil-profile development consistent with a late Pleistocene age. The blocky ped structure, distinct to prominent clay films, and rubification (colors changed to redder hues) in the Bt-horizon hosted by units 30 and 40 is characteristic of pre-Holocene soils. In contrast, the prominent clay films within unit 25 likely developed more quickly (since early to middle Holocene) because the parent material had a high clay-content and finer grain size (see below for

further discussion). Thus, based on the characterization of the Bt-horizon, colluvial units 30 and 40 are likely late Pleistocene in age.

Colluvial units 10 and 20 blanket the hillslope and are exposed in all three trenches. They unconformably overlie bedrock (units 80, 70, 75, 60 and 61) and colluvial units 30 and 40 of trench T-1. As they are within one meter of the ground surface, Holocene and modern soil processes such as creep, bioturbation, accumulation of organic matter, and elluviation of cations and clay, continue to act on these deposits. These two units have A-horizon characteristics typical of early to middle Holocene soils.

Similarly in trench T-2, the A-horizon developed in unit 10 and the AB-horizon developed in unit 20 are interpreted to be early to middle Holocene in age. The colluvial units unconformably overlie a weathering profile on the San Pablo Group represented by units 35 and 60 (Plate 3). The well-developed Bt-horizon containing distinct clay films and prismatic soil structure in unit 35, coupled with the strong angular blocky structure in the top 40 cm of unit 60, are in keeping with a late Pleistocene age for unit 35. The bleaching of the top of the prismatic peds directly below the unconformity with unit 20 may represent leaching of this older Bt-horizon that took place after stripping of the original upper horizons of this soil and subsequent deposition of units 20 and 10. The high clay content of the old Bt horizon may have created a permeability barrier at the unconformity where aggressive water would have perched and chemically leached the top of the Bt-horizon. The slow sedimentation rate of colluvial soils and the thick (0.6-1.3 m) colluvial A-horizon (unit 10) developed on top of unit 35 support the interpretation that the unfaulted soil profile in trenches T-2 and T-3 is early to middle Holocene in age.

In summary, based on soil profile development and the geomorphic model, units 30 and 40 are estimated to be late Pleistocene in age, whereas colluvial units 20 and 10 are estimated to be early to middle Holocene in age. The difference in age and soil characteristics is likely the result of early Holocene erosion that produced the unconformity between units 35 and 20 in trench T-2 and between units 20 and 30 in trench T-1. This erosional event likely stripped the colluvial deposits (units 30 and 40) along the paleo-slope, except where preserved between station 4 and 15 m. Then hillslope colluvial deposition processes continued resulting in the deposition of units 10 and 20 in the early to middle Holocene. The hillslope is judged to have been relatively stable through the late Holocene.

5.1.3 Faults

Near-surface structures exposed in trenches include several bedrock faults that juxtapose Claremont Chert and San Pablo Group, or displace bedding contacts within the Claremont Chert. Throughout these trenches sufficient exposures were available to accurately identify faults in exposed bedrock. Five areas of significant faulting were identified in trenches T-1 to T-3, and are labeled fault zone F1 through F5 on Plates 2 to 4. Secondary low-angle faults exposed in bedrock in trench T-2 are discussed separately.

Fault F1 is located from stations 12 to 14 m in the eastern end of trench T-1(Plate 2). The north-northwest striking and east-dipping (N23ºW 20ºE) fault is present in both the north and south walls as a clayey to brecciated bedrock fault zone. Fault zone F1 separates well-bedded and folded Claremont Chert (unit 80) from highly weathered and fractured Claremont Chert (unit 75). A distinct bedding truncation in the Claremont Chert defines the low-angle shear. The fault contains several seamy shale- to clay-rich laminae that likely formed as a result of fault movement. Distinct shear fabrics (i.e., kinematic indicators such as straie) were not present along fault F1. Fault F1 becomes indistinct and diffuse up-section where it encounters weathered bedrock, but clearly does not offset the basal contact of the Pleistocene colluvium (unit 40). A minor, west-dipping antithetic fault present in the hanging wall of F1 disrupts chert bedding and, similarly to fault F1, does not offset overlying Holocene colluvium (unit 20). Along its length, fault F1 exhibits dip inclination changes that flatten near the ground surface and dip westerly consistent with downslope soil creep processes. These same soil creep processes also are affecting the bedrock bedding. Fault F1 coincides with the southerly projection of the previously mapped north-northwest striking east-dipping eastern fault trace of the Wildcat fault (Jordan, 1997) (Figure 3). The absence of Holocene displacement along the eastern trace is consistent with past studies near Building 84 (Jordan, 1997).

The northwest-striking west-dipping (N55ºW, 68ºSW) F2 fault zone is mapped from stations 8 to 9 m in trench T-1 (Plate 2). The fault is mapped in both the north and south walls juxtaposing Claremont Chert (unit 80) and weathered Claremont Chert (unit 75) with approximately 1.1 meters of west-side-down vertical separation. The fault zone is 20-to 35-cm-wide, and contains rotated and aligned angular blocks of chert. With the exception of the apparent rotated and aligned chert blocks, the F2 fault zone is not well-organized and contains fine granulated seams along indistinct fractures. In the hanging wall of fault F2 well-bedded Claremont Chert exhibits an increase in inclination of 5º near the fault. The tilting of the weathered bedrock units is consistent with subtle drag folding, hanging wall deformation associated with

a west-dipping listric fault, or alternatively a landslide feature. Fault F2 does not offset the oldest bedrock derived colluvium (unit 40), nor a deeply weathered zone traceable within unit 75 above the fault.

The northeast- to northwest- striking, west-dipping faults encountered between stations 2 and 6 m in trench T-2 (Plate 3), and between stations 1 and 5 m in trench T-3 (Plate 4), respectively, are interpreted as shears associated with the Wildcat fault zone. This 6.5-meter-wide fault zone is composed of three principle faults (F3, F4, and F5) that separate different geologic units (Claremont Chert against San Pablo Group), as well as small distinct shears developed within the San Pablo Group.

Fault F3 is mapped at station 5 m in trench WLA T-2, and consists of a 0.3-m-thick silt with gravel (unit 65) that separates San Pablo Group (unit 60) from slightly weathered Claremont Chert and shale (unit 70, Plate 3 and Figure 11). Unit 65 is interpreted as fault zone material that contains both San Pablo Group and Claremont Chert-derived bedrock. This northeast-striking, low-angle east-dipping (N50ºE, 20ºE) fault zone (F3) contains mottled clay that supports the chert-rich matrix. No visible shearing or fault zone fabric is visible along or across the lower boundary but is represented by horizontal platy fractures and mixing of bedrock material. This fault is mapped in the floor of trench T-2 and within trench T-3 and appears to increase in inclination toward the east near station 4 m in trench T-3 at faults F4 and F5. Fault F3 does not offset the base of units 20 or 35, or the soil developed in units 35, 60, or 70 (Plates 3 and 4).

Two additional northwest-striking (Nº17 to 40ºW) east-dipping (40º-42ºE) faults (F4 and F5) that separate a brownish sandstone (San Pablo Group[?]; unit 61) from Claremont Chert are present in trench WLA T-3 between stations 2.5 and 5. Fault F4 separates weakly-bedded and weathered Claremont Chert (unit 80) on the west from the San Pablo Group(?) (unit 61) along a distinct bedrock shear. Fault F4 is characterized by a 1-to 6-cm-thick clay seam. No kinematic indicators indicative of displacement direction were observed along fault F4. Fault F5 truncates steeply east dipping, well-bedded Claremont Chert (unit 80) on the east against San Pablo Group (?) (unit 61) on the west. The fault exposures of trenches WLA T-2 and T-3 indicate faults F3 to F5 likely merge at depth into a main western fault strand that bounds San Pablo Group on the west and Claremont Chert on the east (see note G in Plate 4) with occasional thin slivers of fault zone material. The orthogonal strike of fault F3 to the eastern trace of the Wildcat fault suggests fault F3 is a small fault splay that joins faults F2 and F3. The western trace is located at or directly east of the dirt access road south of the proposed GPL footprint.

Secondary low-angle, east-dipping bedrock shears also lie directly west of faults F3 to F5 in trench WLA T-2 indicating the presence of a complex low-angle flower structure associated with the Wildcat fault (Figure 12). The secondary bedrock shears (up to 2 cm thick) are lined with dark reddish brown stiff clay and calcium carbonate filaments and nodules developed within a greenish gray sandstone (Plate 3). The orientation of these shears varies between N25ºE to N55ºW. The dip of the east-dipping shears varies from low-angle (23ºE) to more steeply dipping (63ºE). None of the shears offset the base of colluvium (unit 20), or the Bt horizon (unit 35) developed in units 60 and 65.

6.0 DISCUSSION

In this investigation, WLA excavated three trenches across the southeastern projection of the Wildcat fault zone in the southern part of the proposed GPL footprint. The trenches exposed Claremont Chert, sandstone and siltstone of the San Pablo Group, and fault zone material, all of which are overlain by unfaulted colluvium ranging in age from late Pleistocene to Holocene. The subsurface exploration delineates an approximately 100-ft-wide north- to northwest-striking fault zone characterized by at least two main fault traces: an eastern and a western fault trace that align, in part, with previously mapped locations of the Wildcat fault (Figure 3). We identify five distinct faults designated F1 (eastern trace) to F5 (F3 to F5 are with the western trace) in trenches WLA T-1 to T-3. Fault F1 is along projection and is coincident with an east-dipping eastern fault trace mapped previously by Jordan (1997) during a cut-slope excavation and slide repair behind Building 84 (Plate 1). This same fault appears to continue northward along the eastern margin of East Canyon where it was encountered as a prominent near-vertical fault in trench T-A (Plate 1; HLA, 1980). In trench WLA T-1, the eastern trace is constrained to the Claremont Chert and is defined by truncated bedding and clay gouge along an east-dipping shear plane.

The western trace of the Wildcat fault is present in trenches WLA T-2 and T-3, and is associated with faults F3 to F5. The generally east-dipping western trace juxtaposes San Pablo Group on the west against Claremont Chert on the east (Plate 1). The fault zone is about 15-to 20-ft-wide and includes a number of low-angle bedrock shears lined with clay gouge and calcium carbonate filaments and nodules. In places, the fault forms a weak clay-rich, cherty breccia bounded by the two bedrock units. Although previous investigators suggest an uncertainty with the mapped location of the Wildcat fault (Collins, 1993; 2007), the new trench data, coupled with the compilation of borehole data, indicate the two fault traces of the Wildcat fault are reasonably well-located in the GPL site vicinity and, as suspected, the western trace intersects the GPL building footprint (Figure 4).

This subsurface study provides direct evidence for the absence of deformation since early to middle Holocene time along the western trace of the Wildcat fault. To the east of the proposed GPL, Latest Pleistocene colluvium overlying the eastern fault trace of the Wildcat fault also is unfaulted. The new trench data demonstrate that Pleistocene colluvium (units 30 and 40) and early to middle Holocene colluvium (units 20 and 10) are not displaced by the eastern Wildcat fault in trench T-1. Early to middle Holocene colluvium (units 20 and 10) exposed in trench T-2 and T-3 across the western Wildcat fault are

also unfaulted. Neither this study nor previous investigations in the East Canyon have identified fault-related features associated with the Wildcat fault that are consistent with a youthful appearance or recent activity (HLA, 1975; HLA, 1980; Gilpin, 1994; Collins, 1993; 2007). Furthermore, a comprehensive analysis of existing data by Gilpin (1994) which included a review of very similar local and regional data met the same conclusion. Therefore, we conclude from the recent trench findings, absence of youthful tectonic geomorphology along the fault, and results from previous studies (HLA, 1980, Jordan, 1997), it is highly unlikely that the Wildcat fault is active and the hazard associated with surface-fault rupture is low.

The origin of fault F2 in trench T-1 could be interpreted as a normal fault located within the east dipping hanging wall of the Wildcat fault, or alternatively, as a Pleistocene landslide feature. The orientation of fault F2 (N55ºW) is more northwesterly than faults clearly associated with the Wildcat fault (e.g. F1, F3 to F5), and the southwest-side-down normal separation is consistent with landsliding or hanging wall deformation. The small (1.1 m) amount of vertical separation is more consistent with landsliding. We note that the orientation of fault F2 is parallel to the late Pleistocene paleo-erosional surface between units 35 and 20 in trench T-2 (Figure 3 and Plate 3), and is acute to the present-day ground surface. These observations suggest antiquity to the feature, if related to landsliding. If fault F2 is the result of landsliding, it must have formed in a former geomorphic setting when the paleo-slope was south-facing toward the U.C. Botanical Gardens. This headscarp could have created a depression that preserved the thick weathered rock (unit 75) and unfaulted colluvial packages (units 30 and 40) preserved above fault F2. The extent of the possible landslide is difficult to estimate because the present-day geomorphology shows no sign of bedrock landsliding in the vicinity of trench WLA T-1 nor was it encountered in trenches WLA T-2 and T-3. In addition, review of historical aerial photography does not suggest the presence of a landslide in this location. Regardless, if interpreted as a fault or landslide, fault F2 does not displace Pleistocene-aged colluvial packages, and is considered an old feature.

7.0 CONCLUSIONS

Based on the findings of this study, we conclude that the western trace of the Wildcat fault is located beneath the proposed GPL site, but the surface fault rupture hazard is low (Figure 4). The location of the Wildcat fault is reasonably well-constrained from existing borehole (AKA, 2006b; 2008) and trench data (HLA, 1975; 1980; Jordan, 1997), rock outcrops (Collins, 1993), and trenching data from this study (Plates 1 through 4). The subsurface investigation of the Wildcat fault at the GPL site provides direct evidence for the absence of activity since early to middle Holocene time along the western trace, and the absence of activity since latest Pleistocene time along the eastern fault traces. These findings are consistent with past studies at LBNL (HLA, 1980; Jordan, 1997) and discussions with experts at the CGS and USGS. On the basis of this data compilation and fault study, we conclude that the Wildcat fault is likely inactive and the surface-fault rupture hazard associated with the Wildcat fault is low. Thus, the existence of the western trace of the Wildcat fault beneath the proposed GPL site does not present a fatal flaw for future development. The nearest known active fault trace to the site is the Hayward fault, located approximately 0.8 mile southwest of the site. No building setbacks for surface-fault rupture hazard are required for this site.

The following recommendations are based on this investigation:

- The presence of soil creep features and closely-spaced joints developed into Claremont Chert should be considered for foundation stability.
- Destabilized slope conditions may exist east of the site where the bedrock bedding of the Claremont Chert dips west out of the slope.
- Trench T-1 suggests that ancient bedrock material may be present directly south of the site and could be encountered during grading operations. If fault F2 is landslide-related a simple projection of the feature indicates it would intersect the southern part of the GPL footprint. It was not encountered in trenches T-2 and T-3.
- A qualified geologist under the direction of a Certified Engineering Geologist (CEG) should be present during grading and excavation activities at the GPL site to confirm the location of the western trace of the Wildcat fault, and to assess adverse bedrock conditions from unfavorable bedding orientations and possible ancient landslide masses.

- The trenches were not backfilled to engineering design specifications. Any proposed buildings or structures that intersect the trenches should include removal and re-compaction of the trench backfill.

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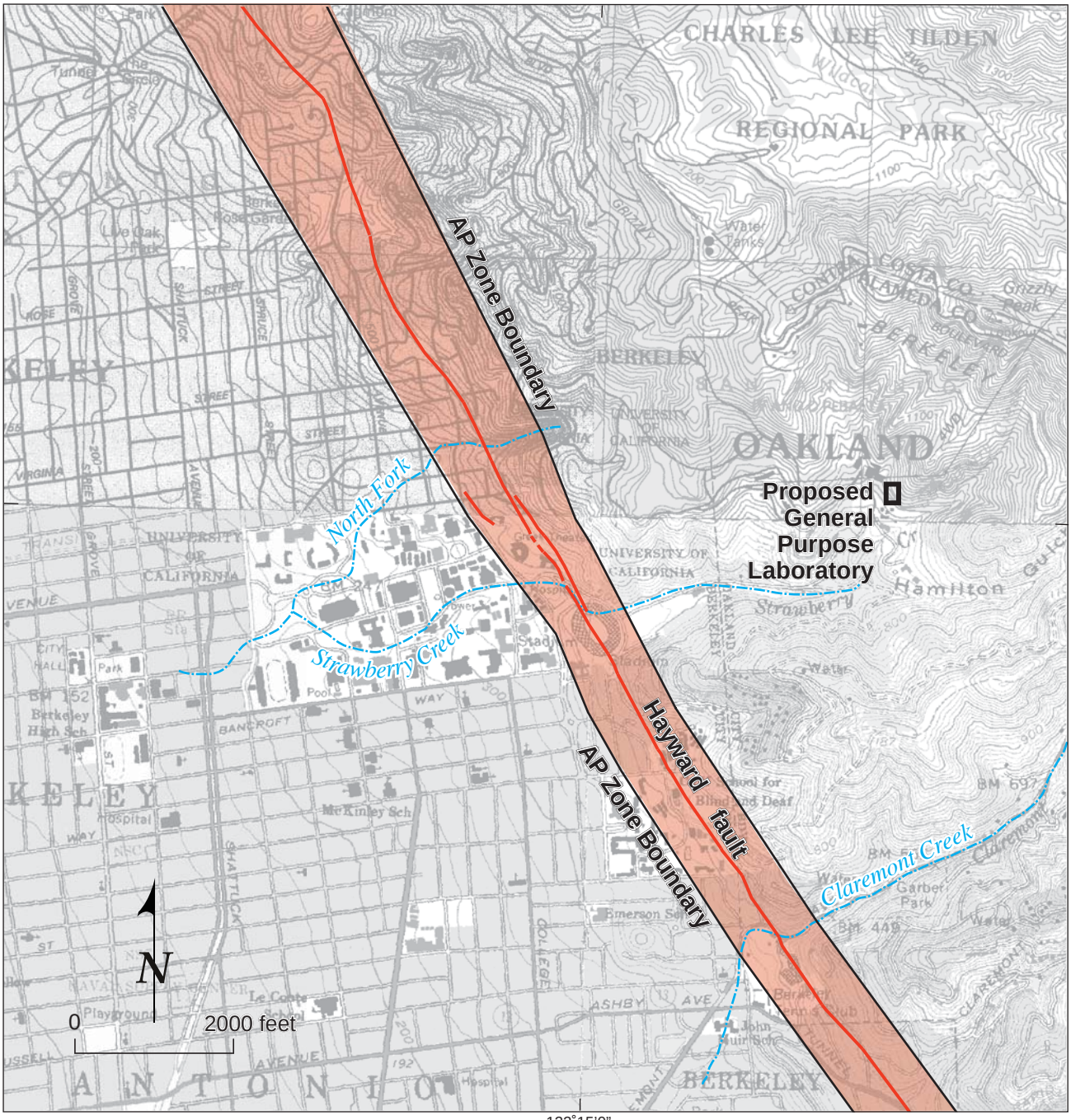


Base map: USGS 24,000 scale quadrangles

Explanation

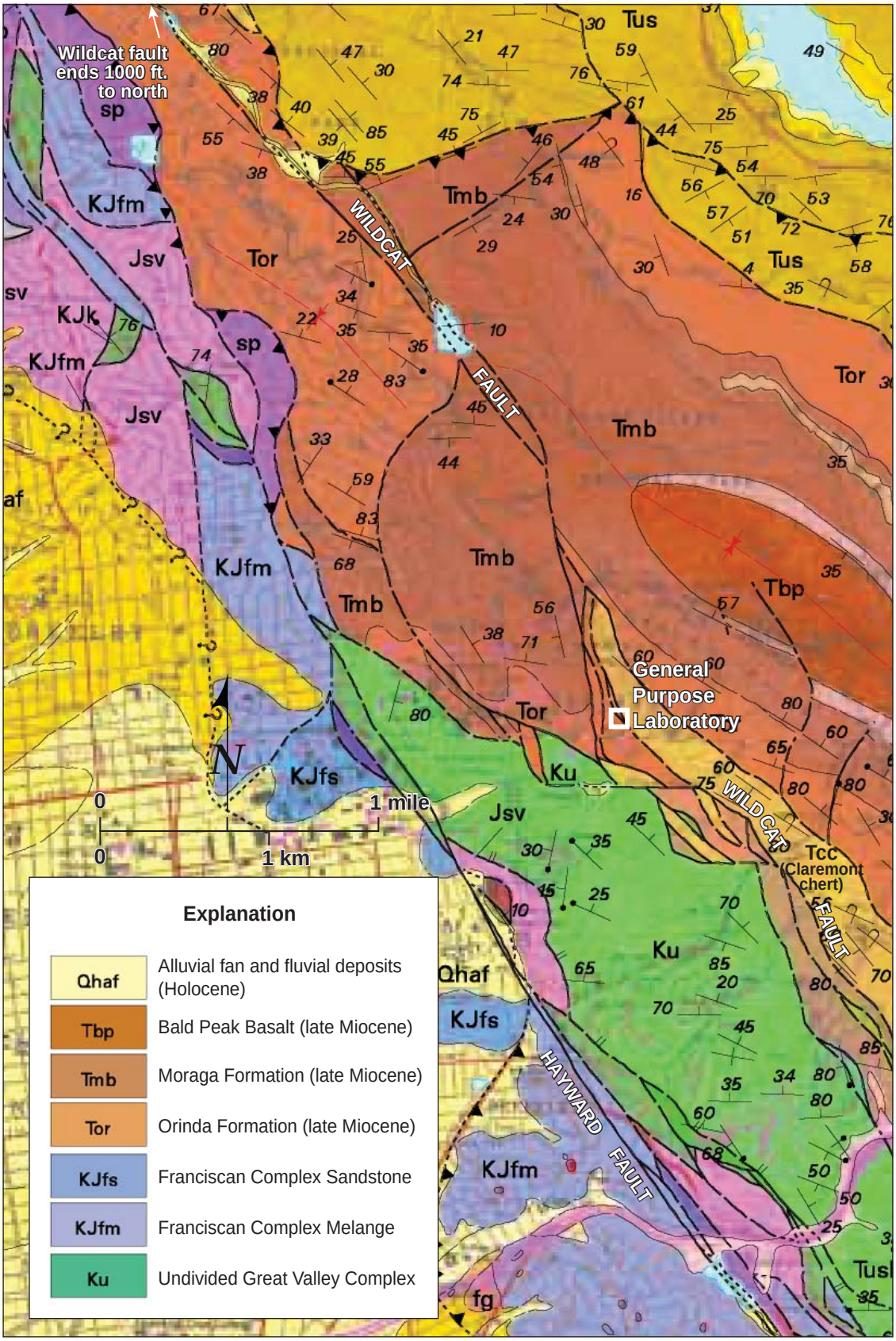
Hayward fault, Lienkaemper (2006)

AP Earthquake Fault Zone (CDMG, 1982)

WILDCAT FAULT STUDY	
Location Map	
WLA William Lettis & Associates, Inc.	Figure 1

Modified 11.18.08

2023.001 Wildcat Fault



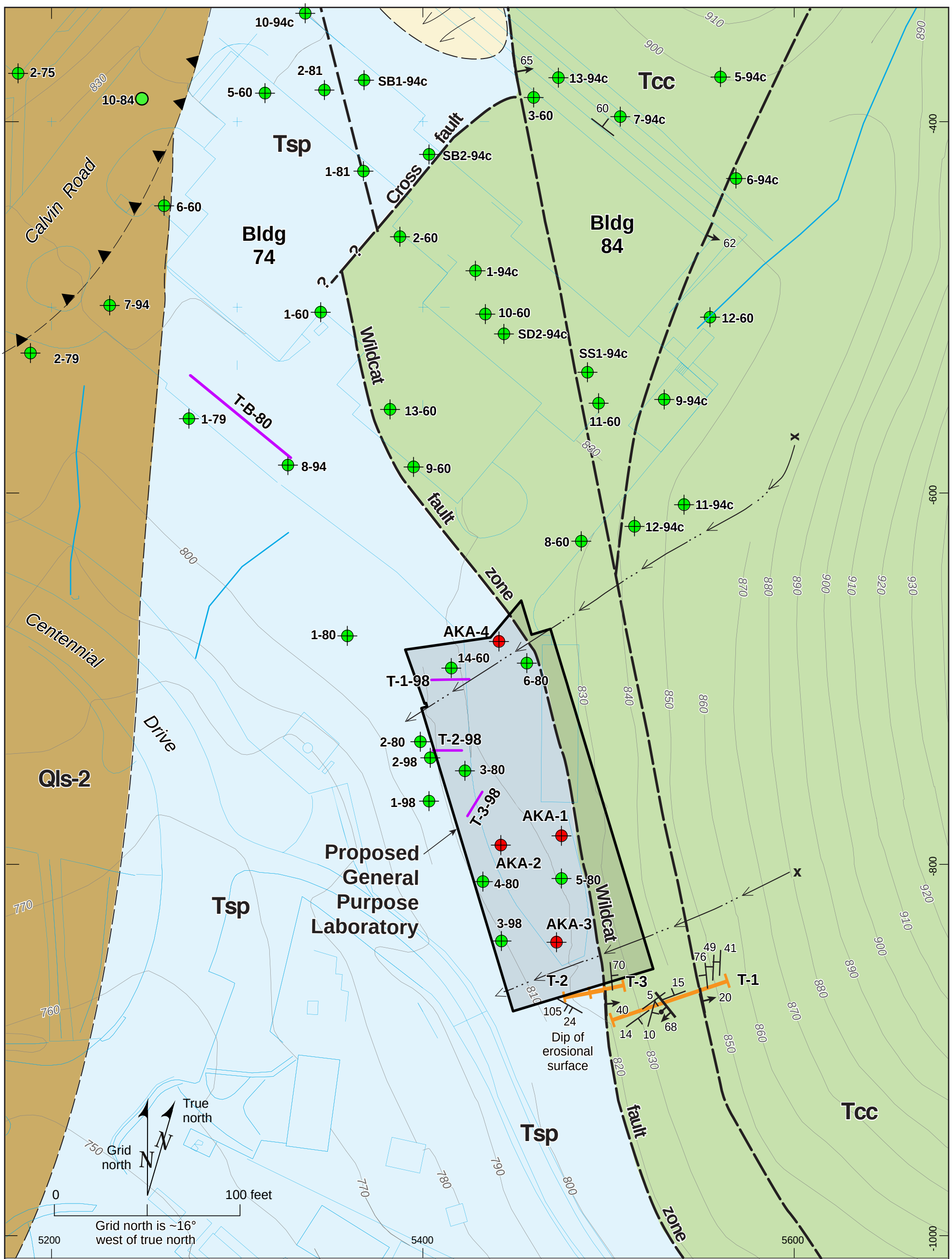
Modified from Graymer (2000)

WILDCAT FAULT STUDY

Simplified Regional Geology Map

WLA William Lettis & Associates, Inc.

Figure 2



Explanation

Unit Descriptions

- **Qls-2** Quaternary landslide deposits
- **Tsp** Tertiary San Pablo Group
- **Tcc** Tertiary Claremont chert and shale

- Active or former location of slide, which has been mitigated
- 62 Strike and dip of bedding
- 65 Fault strike and dip
- Contact, dashed where approximate
- Inferred toe to landslide (AKA, 2006b)
- Fault, dashed where approximate (modified from Parsons, 2000)

Symbols

- Contour, 10-foot interval (2003)
- Active drainage/drainpipe
- Buildings, roads, vegetation (2003)
- X Topographic swale (Collins, 1993)
- **T-3** Trench (this study)
- **T-B-80** Trench (previous study)

- **1-75** Borehole, previous studies
- **15-84** Piezometer (previous studies)
- **AKA-1** Borehole (AKA, 2008)

WILDCAT FAULT STUDY

Site Geologic Map

WLA William Lettis & Associates, Inc. | Figure 3

Modified 11.18.08

2023.001 Wildcat Fault

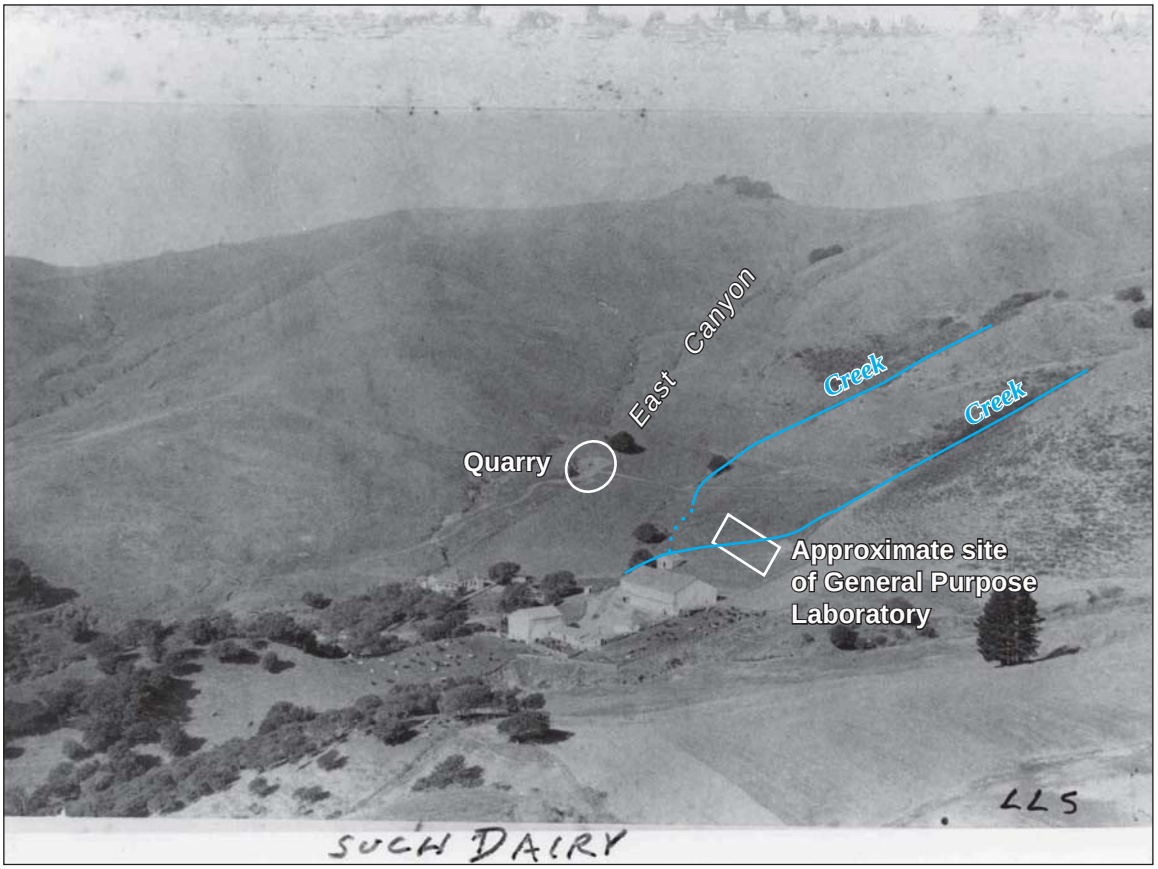
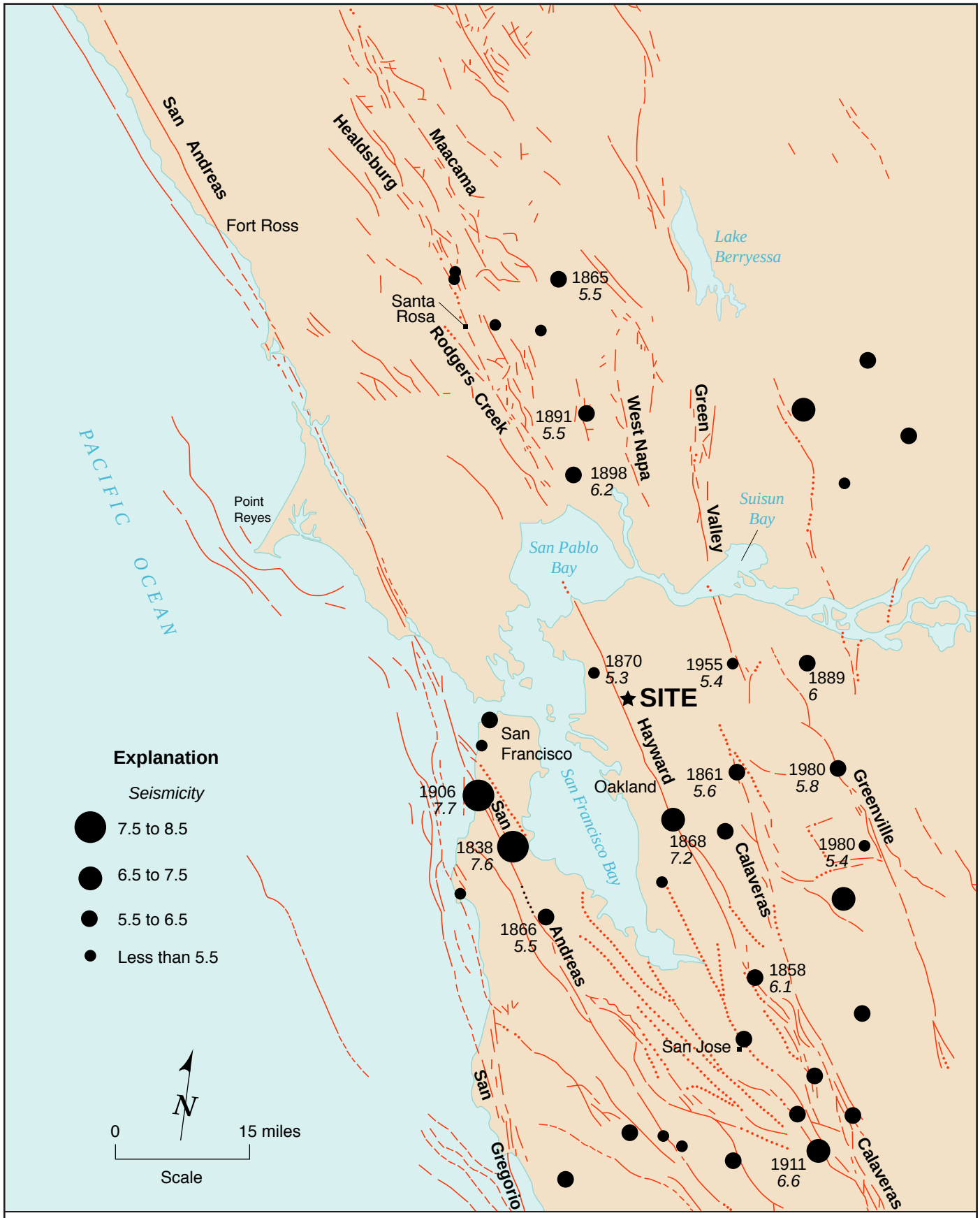


Figure 4. Photograph from 1903 facing north showing the hummocky topography of the East Canyon and the relatively resistant bedrock ridge of the proposed General Purpose Laboratory site. Strawberry Creek is in the foreground.

Figure 5. View to the northwest across East Canyon. Photograph from 1903 looking northwest across to East Canyon and the proposed General Purpose Laboratory site.

Figure 6. Field photograph of WLA Trench T-1. View is to the northeast.

Figure 7. Field photograph of WLA Trench T-2. View is to the south. Dashed black line approximates location of WLA Trench T-3. WLA Trench T-2 was extended during backfilling and is delineated by the outline for WLA Trench T-3.



Notes: 1. Modified from "Fault Activity Map of California and Adjacent Areas" by Jennings, dated 1994.
2. Seismicity data from EZ-Frisk (version 5.7).

WILDCAT FAULT STUDY

Historical Seismicity of San Francisco Bay Area

WLA William Lettis & Associates, Inc.

Figure 8

Modified 11.18.08

2023.001 Wildcat Fault

Figure 9. Field photograph of Claremont chert in WLA Trench T-1. Note closely-spaced joints and rotated blocks. Colored flags are about 1 inch wide for scale.

Figure 10. Field photograph from outcrop. Location shown on Plate 1. Note fewer joints than in Figure 9.

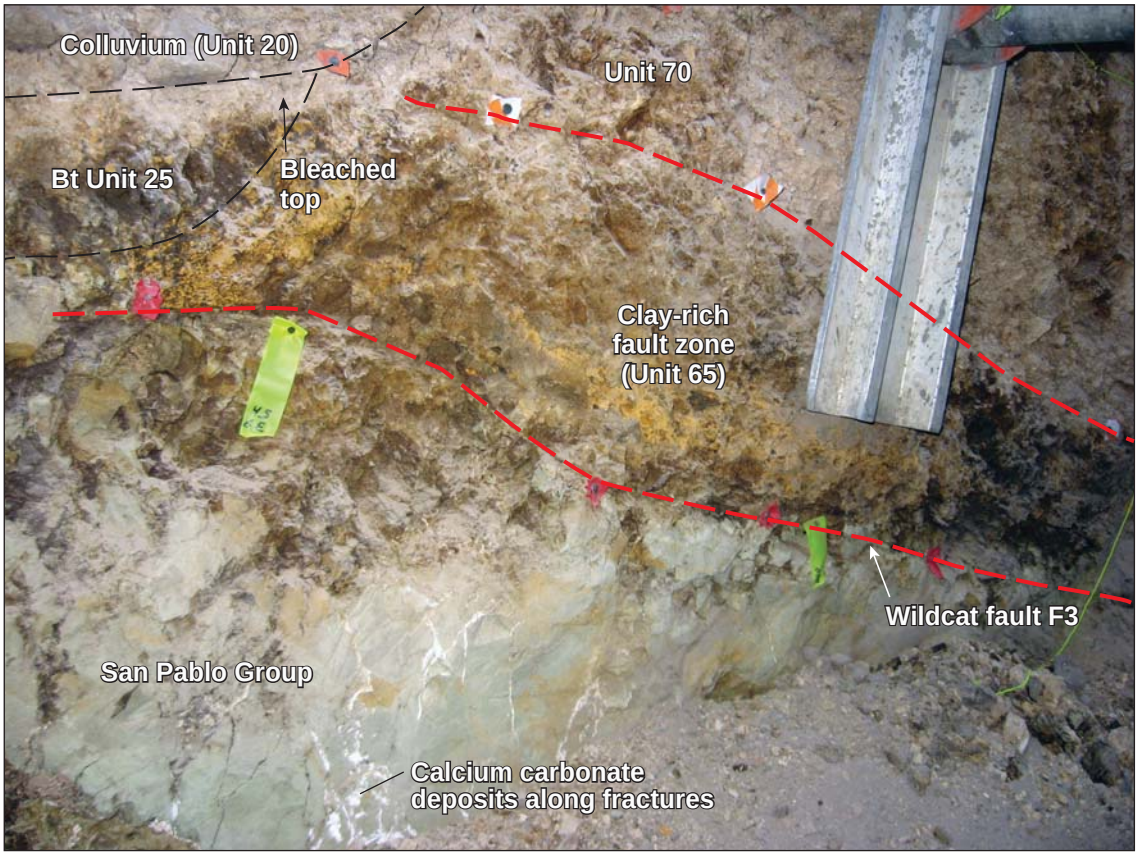
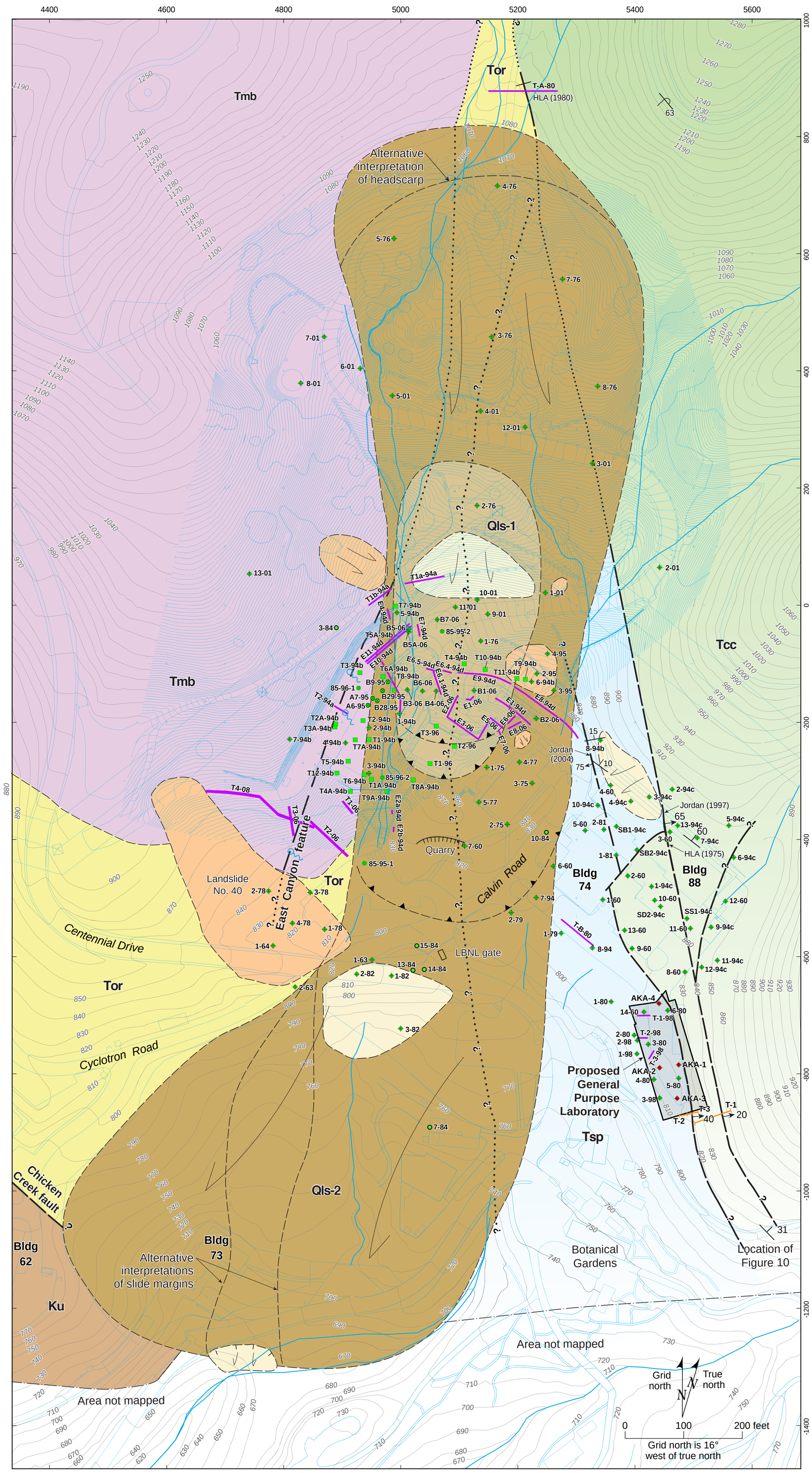


Figure 11. Photograph of Wildcat fault F3 in WLA Trench T-2 between Stations 4.5 and 5.5 m. View is of the north wall. Contacts considered approximate.

Figure 12. Photograph of secondary shears in WLA Trench T-2 west of fault F3 and between Stations 3.5 to 4.5 m. View is of the north wall and shows calcium carbonate-lined shears in San Pablo Group. Contacts considered approximate.

APPENDIX A

Plates



Explanation

Unit Descriptions

- Qls-1 / Qls-2 — Quaternary landslide deposits
- Tmb — Moraga Formation
- Tor — Orinda Formation
- Tsp — San Pablo Group
- Tcc — Claremont Formation
- Ku — Great Valley Group

- Borehole, previous studies
- Monitoring well
- PH
- Piezometer
- Test pit
- Borehole (AKA, 2008)
- Strike and dip of bedding
- Overturned stike and dip
- Fault strike and dip
- Vertically dipping fault

Symbols

- Contour, 10-foot interval (2003)
- Contour 2-foot interval (2003)
- Buildings, roads, vegetaion (2003)
- Contact, dashed where approximate
- Fault, dashed where approximate, dotted where concealed; queried where uncertain

- Active landslide boundary; dashed where uncertain
- Active or former location of slide, which has been removed or mitigated
- Spring (Collins, 1993)
- Active drainage/drainpipe
- T-3 — Trench (this study)
- E5-06 — Trench (previous study)

WILDCAT FAULT STUDY

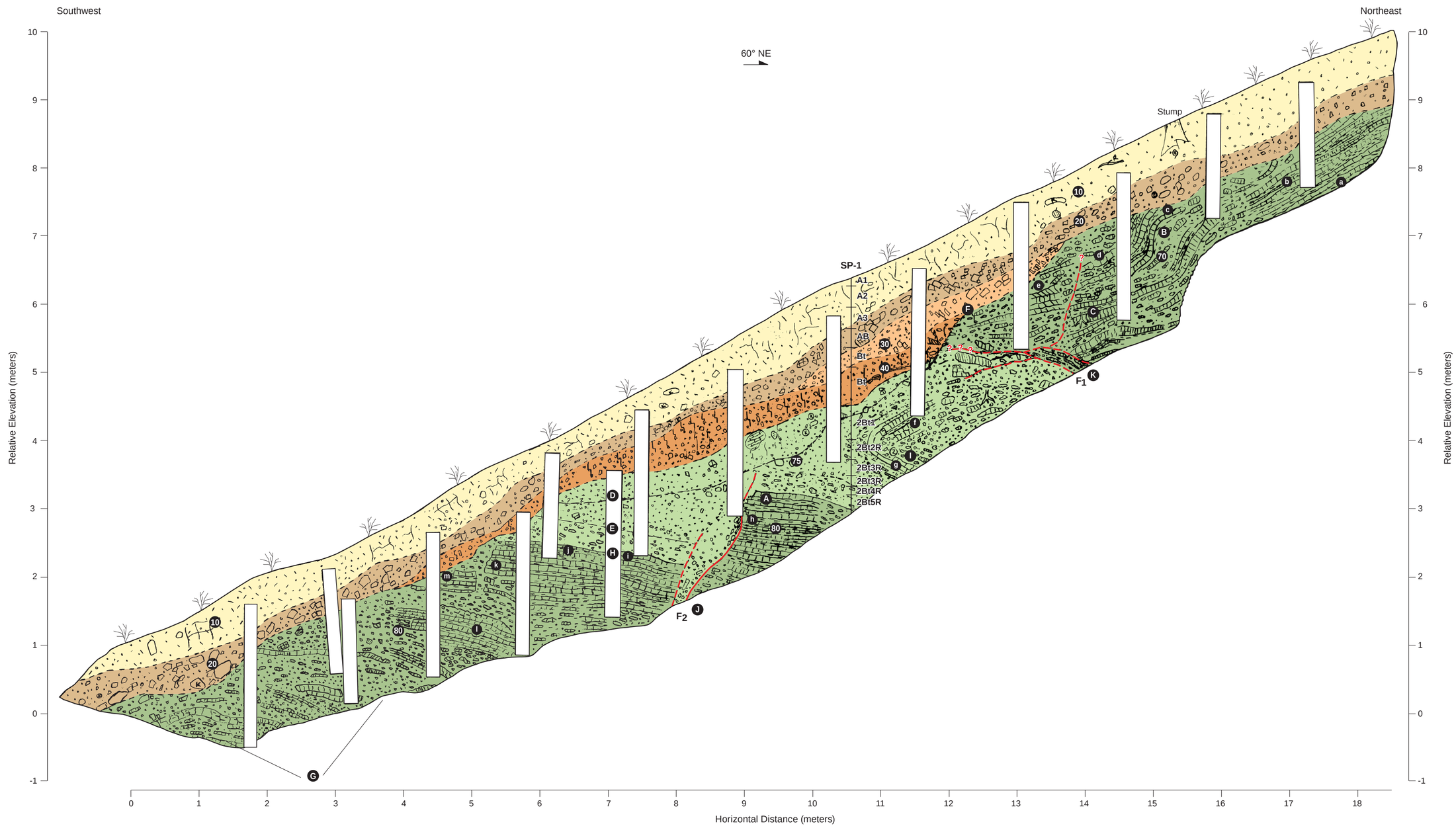
Geologic Map

WLA William Lettis & Associates, Inc.

Plate 1

Modified 11.18.08

2023.001 Wildcat Fault



Explanation

Symbols

Fault, solid where well located, dashed where approximate, queried where uncertain

Contact, solid where well located, dashed where approximate

SP-1 — Soil profile

A1, A2 — Soil boundaries explained in Appendix B

Unit Descriptions

10 — SILT sandy with gravel grayish brown (10 YR 5/2), dry, component percentages: ~ 70% silt, 15 to 20% fine to medium sand, 10 to 15% gravel; fine blocky structure (3 to 5 mm blocks); sand is subangular to subrounded, predominately fine; gravel is angular to subangular, 0.3 to 19 cm, chert, predominately 0.3 to 1 cm; very thin clay films; high dry strength, moderate plasticity, dry, many fine rootlets. Lower boundary is clear and wavy. [HOLOCENE COLLUVIUM]

20 — GRAVEL light brownish gray (2.5 Y 6/2), dry, component percentage: ~ 55 to 65% gravel, 20 to 25% sand, 10% silt, trace clay; massive structure; sand is subrounded to subangular, fine to coarse; gravel is angular to subangular, chert, 0.5 cm to 16 cm predominately 3 to 6 cm, prolate, 'flat' clasts tend to be oriented parallel to the modern slope surface although all orientations are observed; thin clay films on blocks in matrix; matrix (silt and sand) supported; moderate dry strength, low to no plasticity, many fine rootlets. Lower boundary is clear and wavy [HOLOCENE COLLUVIUM]

30 — GRAVEL light olive-brown (2.5 Y 6/4), dry, component percentage: ~70 to 75% gravel, 15 to 20% sand, 5 to 10% silt; clast supported; weak indication of slope parallel bedding to massive; sand is subangular to angular, fine to coarse; gravel is subangular to angular, 0.4 cm to 15 cm, predominately 2 to 8 cm, chert, equidimensional blocks, thin clay films, low to moderate dry strength, no plasticity, some fine rootlets, lower contact is clear to gradual and wavy. [PLEISTOCENE COLLUVIUM]

Unit Descriptions (continued)

40 — GRAVEL clayey brownish yellow (10 YR 6/6), slightly damp, component percentages: ~65 to 80% gravel, 10% clay, 5 to 10% sand, 5% silt; massive to columnar; clast supported; sand is angular, medium to coarse; gravel is subangular to angular, 0.5 to 3 cm, predominately 1 to 2 cm chert; clay films, grades to no clay films; gravel becomes more abundant past ~10 m; moderate dry strength, low plasticity, lower boundary is clear and wavy [PLEISTOCENE COLLUVIUM]

75 — Weathered CHERT sandy silty; strong brown (7.5 YR 5/8); damp; component percentages: ~55 to 70% gravel, 15 to 25% sand, 5 to 10% silt; massive; sand is subrounded to angular, fine to coarse, predominately coarse, gravel is 0.5 to 12 cm, predominately 0.5 to 2 cm; chert, contains folded chert boulders, subrounded to angular; well sorted, matrix supported; low dry strength; no plasticity, few large roots/root casts, lower boundary is clear to abrupt and planar. [In-situ DECOMPOSED and WEATHERED CLAREMONT CHERT]

80 — CHERT, dry to slightly damp, weak, well-bedded chert beds are 5 to 20 cm thick with 1 to 2 cm thick beds of silty chert and minor sand. Joints are perpendicular to bedding, joint spacing is as close as 3 cm and some chert clast are rotated parallel to joints/fractures, bedding preservation varies throughout unit, in places massive with only subtle indications of bedding, lower boundary is not visible. [TERTIARY CLAREMONT CHERT]

Notes*

A — 3 to 5 cm thick folded chert beds interlayered with 1 to 2 cm thick beds of crushed silty chert, slightly folded many tension cracks perpendicular to bedding – no clay gouge. Some oriented clasts subparrallel to discontinuities more rocky at contact. Top corner is subtly rounded.

B — Open s-fold within chert beds.

C — 5 to 20 cm thick chert beds.

D — Weathering horizon localized within Unit 75 – marks increase in clay, bioturbation, clay films, oxidization, and MnO_2 staining. Old cemented krotovinas, very near surface [weathered rock partially mobilized]. This weathered horizon is not faulted.

E — Schematic contact represents gradual transition into highly weathered rock.

F — Soil boundary east of Unit 40 is diffuse and continues into rock soil, just less prominent at 12.5 meters.

G — Weak bedrock fabric.

H — Minor folding into fault zone (?).

I — No discrete fault bounding chevron fold. Fold can not be found in south wall. Interpreted as folded block of chert within weathered chert (Unit 75).

J — F2 - 125º 59° to 68º SW - No clay gouge; brecciated zone with rotated clasts. Not well organized fault zone with very fine granulated seams along fractures. Present on both north and south wall. Vertical separation across F2 1.1 meters. Does not offset Unit 40 or weather horizon in Unit 75. See Note D.

K — F1 - 157º 20º E - Fault clearly truncates chert at low angle. Fault has several seamy shale and clayey units accommodating shearing (?). At 12.5 meters contact becomes diffuse. Fault mapped in north and south wall. Fault does not offset oldest bedrock derived colluvium.

Structural Measurements Bedding Orientations*

- **a** 171º, 41º NW
- **b** 165º, 49º W
- **c** 155º, 76º W
- **d** 165º, 36º W
- **e** 204º, 20º W
- **f** 120º, 36º W
- **g** 275º, 48º N
- **h** 050º, 15º W
- **i** 215º, 5º E
- **j** 005º, 10º E
- **k** 155º, 06º E
- **l** 016º, 45º E
- **m** 040º, 14º E

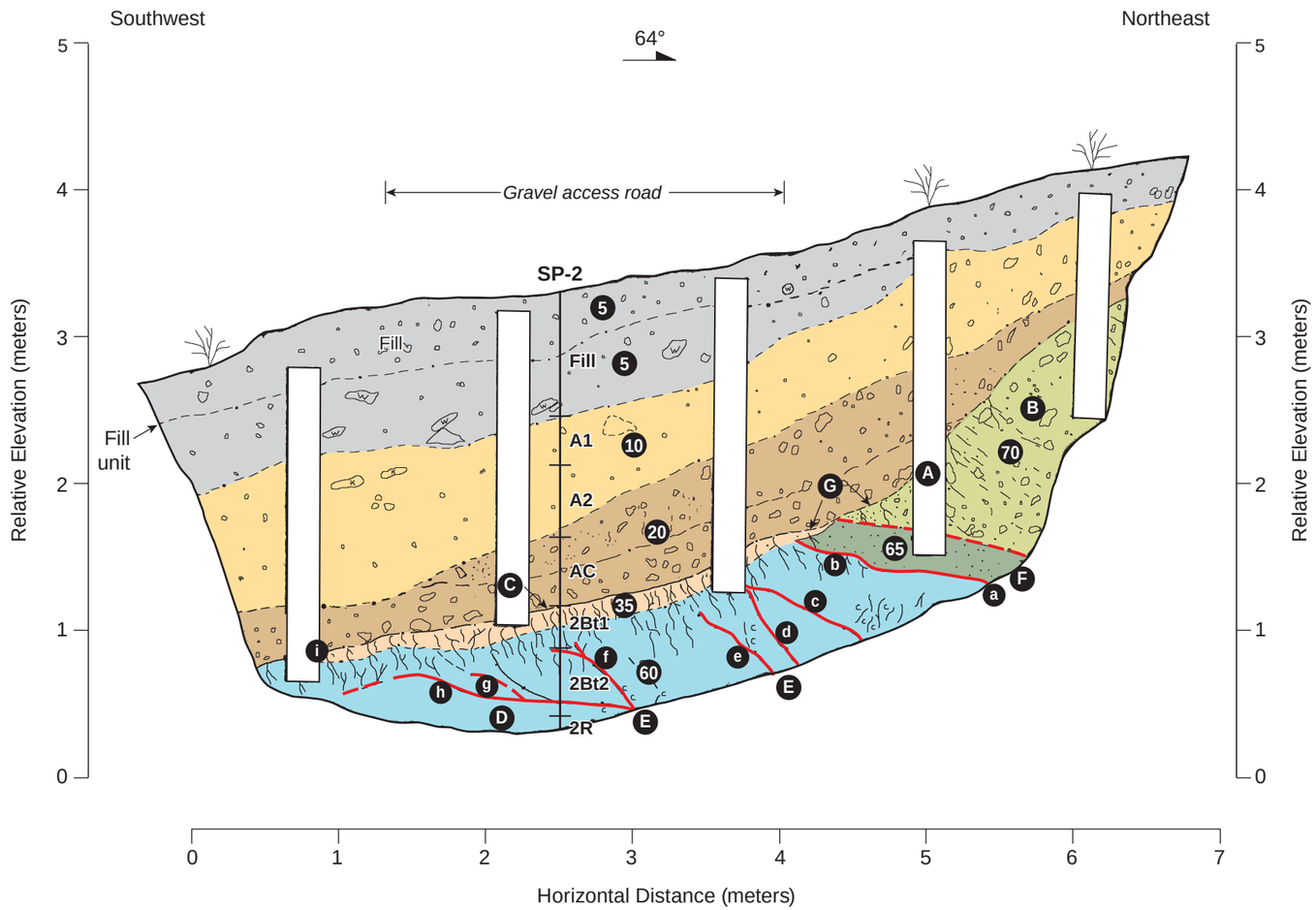
*Orientations are relative to true north and not corrected for the LBNL grid system.

WILDCAT FAULT STUDY

Trench T-1
North Wall

WLA William Lettis & Associates, Inc. | Plate 2

Modified 11.18.08 | 2023.001 Wildcat Fault



Explanation

Symbols

- Fault, solid where well located, dashed where approximate
- Contact, solid where well located, dashed where approximate
- C — Area where carbonate is coating shears
- k — Krotovina
- w — Wood fragment
- SP-2 — Soil profile
- A1, A2 — Soil boundaries explained in Appendix B

Unit Descriptions

5 SAND with silt and gravel, dark brown (10 YR 3/3); dry, loose; poorly sorted; fine-grained sand with silty matrix; 10% gravels mostly <5 to 10 cm wide, subangular chert, large pieces of wood <30 cm wide at base of unit, many pores and rootlets, lower boundary is clear. [FILL]

10 SILT with fine sand and gravel; dark grayish brown (10 YR 4/2), dry, soft to medium stiff; slightly weathered; 20% angular gravels <5 cm, mostly 1 cm wide of chert with white carbonate (?) rinds; many small to large pores from rootlets and roots, fairly massive and homogeneous throughout, lower boundary clear. [HOLOCENE COLLUVIUM]

20 GRAVEL with silt and fine sand; dark yellowish brown (10 YR 4/4); dry, moderately weathered; moderately dense; ~40% angular chert gravels <20 cm wide, nearly clast supported, no preferred orientation or fabric; poorly sorted, some rootlets, lower boundary clear to abrupt marked by white bleaching. [HOLOCENE COLLUVIUM]

35 CLAY with fine sand; dark reddish brown (10 YR 3/3), dry, slightly weathered; hard; massive; prominent prismatic pedogenic structure; slow dilatency, high dry strength; moderate plasticity, high strength, occasional rootlet, lower boundary clear to diffuse. [PLEISTOCENE Bt-horizon developed in SAN PABLO GROUP/ORINDA FORMATION]

65 SILT, clayey with gravel and sand, yellowish brown (10 YR 5/8) dry; very stiff; component percentages: ~60% silt, ~25% gravel, ~10% sand, ~5 % clay; poorly sorted, gravels are angular chert clasts <5 cm wide with random orientation abundant highly weathered pebbles and silt orange with oxidation; matrix supported, weathering rinds on most clasts, rounded clasts near upper and lower contacts; zone is ~30 cm wide with slightly wavy clear to abrupt boundaries. [FAULT ZONE MATERIAL]

60 SANDSTONE with silt and clay; grayish green (GLEY 1 5/2) to dark reddish brown (2.5 YR 3/4); dry, slightly weathered; dense; fairly massive fine-grained sand with bands of silt and clay, many wavy, very thin, oxidized and/or calcium carbonate-infilled, low angle shears; several well-developed slickensides raking ~90º (reverse motion?), occasional <1 cm wide wavy, semi-vertical calcium carbonate veins, clayey blebs have slightly mottled appearance; lower boundary not visible. [SAN PABLO GROUP/ORINDA FORMATION]

70 Weathered CHERT with sand and silt; dark yellowish brown (10 YR 4/6), dry to slightly damp, moderately weathered; dense; ~40% angular to subangular chert clasts <30 cm wide; silty matrix; random to broken bedded orientation of blocky chert clasts, very few rootlets, slight oxidation staining on clast surfaces, moderate cohesion, lower boundary clear/wavy and in fault contact with Unit 65. [In-situ DECOMPOSED CLAREMONT CHERT]

Notes

- **A** Faults do not offset colluvium or soil developed in Units 35, 60, and 70.
- **B** Relict black chert bedding dipping east
- **C** Contact is erosional and wavy with coarse colluvium sharply on top of Unit 35. Top of Unit 35 is bleached white.
- **D** Varigated colors (brown to green) within Unit 60. Brown regions contain more clay and represent clay films on weathered soil peds. Orange oxidized mottling along fault.
- **E** Localized and discontinuous carbonate on shear bands; not present on all shears.
- **F** Fault F3 is poorly organized. Clay increases below fault. Zone contains clasts of chert and mottled clay.
- **G** Soil developed in Unit 35 continues into Unit 70, but is less pronounced because of a more rocky parent material. Unconformity marking top of Unit 70 still has bleached tops.

*Structural Measurements**

- **a** 230º, 20º E – fault F3 measured at back wall - floor of trench Unit 65 over Unit 60
- **b** 45º, 6º E – fault F3
- **c** 25º, 35º E – shear
- **d** 306º, 65º E – shear
- **e** 165º, 35º E – shear
- **f** 143º, 43º E – shear
- **g** 125º, 38º E – shear
- **h** 175º, 23º E – shear with slickensides raking 90º E
- **i** 105º, 24º S – unconformity top of Unit 35 less pronounced because of a more rock parent material. Unconformity at top of Unit 70 still has bleached tops.

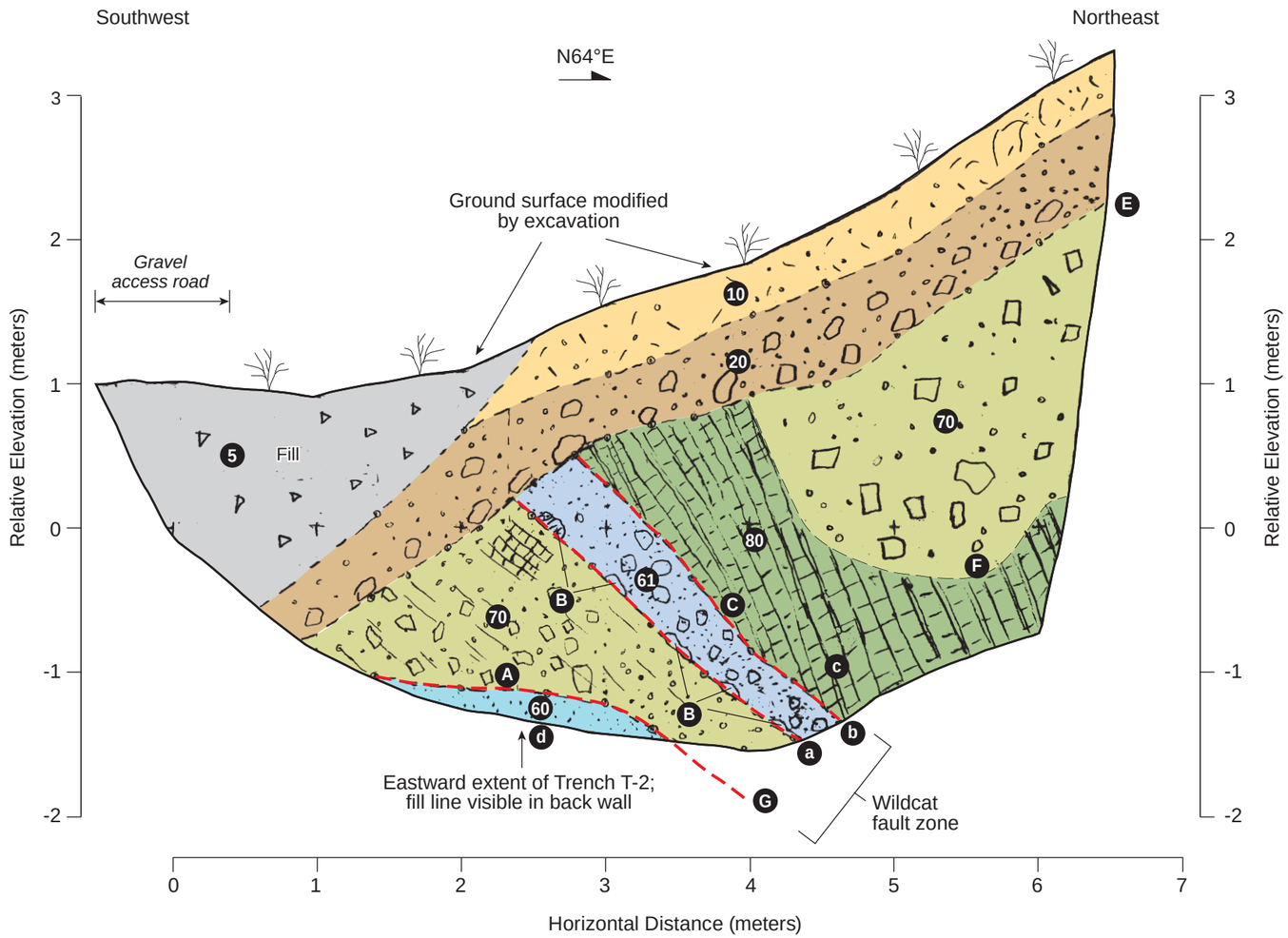
*Orientations are relative to true north and not corrected for the LBNL grid system.

WILDCAT FAULT STUDY

Trench T-2

WLA William Lettis & Associates, Inc. | Plate 3

Modified 11.18.08 | 2023.001 Wildcat Fault



Explanation

Symbols

Fault, dashed where approximate

Contact, dashed where approximate

Unit Descriptions

5 SAND with silt and gravel, dark brown (10 YR 3/3); dry, loose; poorly sorted; fine grained sand with silty matrix; 10% gravels mostly <5 to 10 cm wide, subangular chert, large pieces of wood <30 cm wide at base of unit, many pores and rootlets, result of sidewall collapse during backfilling of Trench T-2, lower boundary is clear. [FILL]

10 SILT with fine sand and gravel; dark grayish brown (10 YR 4/2), dry, soft to medium stiff; slightly weathered; 20% angular gravels <5 cm, mostly 1 cm wide of chert with white carbonate(?) rinds; many small to large pores from rootlets and roots, fairly massive and homogeneous throughout, lower boundary clear. [HOLOCENE COLLUVIUM]

20 GRAVEL with silt and fine sand; dark yellowish brown (10 YR 4/4); dry, moderately weathered; moderately dense; ~40% angular chert gravels <20 cm wide, nearly clast supported, generally fining upward sequence; poorly sorted, some rootlets, lower boundary clear to abrupt marked by white bleaching. [HOLOCENE COLLUVIUM]

61 SANDSTONE with clay; yellowish brown; damp, slightly weathered; dense, massive fine-grained sandstone containing block of intact sandstone supported by a matrix of less indurated sandstone of similar composition, western boundary marked by clay seam with large clayey blebs in places, does not contain clasts of chert, same contact on south wall contains fat clay, western boundary is clear and wavy. [SAN PABLO GROUP?]

60 SANDSTONE with silt and clay; grayish green (GLEY 1 5/2) to dark reddish brown (2.5 YR 3/4); dry, slightly weathered; dense; fairly massive fine-grained sand with bands of silt and clay, shears and clay seams absent, lower boundary not visible. [SAN PABLO GROUP/ORINDA FORMATION]

70 Weathered CHERT, gravel with sand and silt; dark yellowish brown (10 YR 4/6), dry to slightly damp, moderately weathered; dense; ~40% angular to subangular chert clasts <30 cm wide; silty matrix; random to broken bedded orientation of blocky chert clasts, very few rootlets, slight oxidation staining on clast surfaces, decent cohesion, lower boundary clear/wavy and in fault contact with Unit 65 in Trench T-2 [In-situ DECOMPOSED TERTIARY CLAREMONT CHERT]

80 CHERT, dry to slightly damp, weak, well-bedded chert beds are 5 to 20 cm thick with 1 to 2 cm thick beds of silty chert and minor sand, bedding preservation varies and become indistinct in eastern portion of trench, in places massive with only subtle indications of bedding, lower boundary is not visible, except in fault contact with Unit 65. [TERTIARY CLAREMONT CHERT]

Notes

- **A** Weak bedding; lower boundary clayey (fault zone?)
- **B** Clayey boundary, no shearing visible
- **C** Chert bedding truncated against Unit 61; no visible shearing
- **D** Shores no shown
- **E** Colluvium not offset by faulting
- **F** Claremont bedding on east side of trench becomes indistinct and massive. Contact approximately located.
- **G** Pothole to 3.6 meter deep revealed Unit 60 at 4 meters.

*Structural Measurements**

- **a** 343°, 40° E – fault F4
- **b** 330°, 42° E – fault F5
- **c** 340°, 70° E – bedding
- **d** 230°, 20° E – fault F3 (from WLA Trench T-2)

*Orientations are relative to true north and not corrected for the LBNL grid system.

WILDCAT FAULT STUDY

Trench T-3 (sketch log)

WLA William Lettis & Associates, Inc.

Plate 4

APPENDIX B

Soil Profile Data Sheets and Soil Profile Photographs

Profile: SP-1 LBL

Site: Trench T-1 LBL

Elevation: _____ Slope: ~30°

Job #: 2023 Wildcat Fault Investigation

Site description: Grassy hillslope with scattered oak & eucalyptus
Trench oriented downslope, crossing Wildcat Fault

Date: 9-26-08
Time: 2:00pm
By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
10	A1	a s c w g i d b	10YR 4/2 (d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si clay ~15%	v1 f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	Gray, granular loam with abundant very fine roots.
40	A2	a s g w g i d b	10YR 4/2 (d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	Gray, granular structure with many very fine roots
72	A3	a s c w g i d b	10YR 5/2 (d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c abk 3 vc sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si clay ~30%	v1 f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	Gray clay loam, granular structure
99	AB	a s c w g i d b	YR 6/2 (d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c abk 3 vc sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	Coarse colluvium: matrix has granular to sbk structure. Transition horizon
129	Bt	a s c w g i d b	7.5YR 6/3 (d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c abk 3 vc sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	co. sand C SC SiC SCL CL SiCL LS SL L SiL S Si clay ~45%	v1 f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	Weathered colluvium with sandy clay matrix, similar to below, but with fine sbk structure
184	Bt	a s c w g i d b	7.5YR 5/3 (d) (m)	7.5YR 4/3 clay films (d) (m)	m vf gr sg f pl 1 m p r 2 c abk 3 vc sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	co. sand C SC SiC SCL CL SiCL LS SL L SiL S Si clay ~40%	v1 f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	Weathered colluvium with sandy clay matrix. Clay occurs as clay films and as primary clay in matrix. Few thin fine root marks

Notes:

Profile: SP-1 Site: Trench T-1 LBL

Elevation: Slope: Job #: 2023

Site description:

Date: 9-26-08

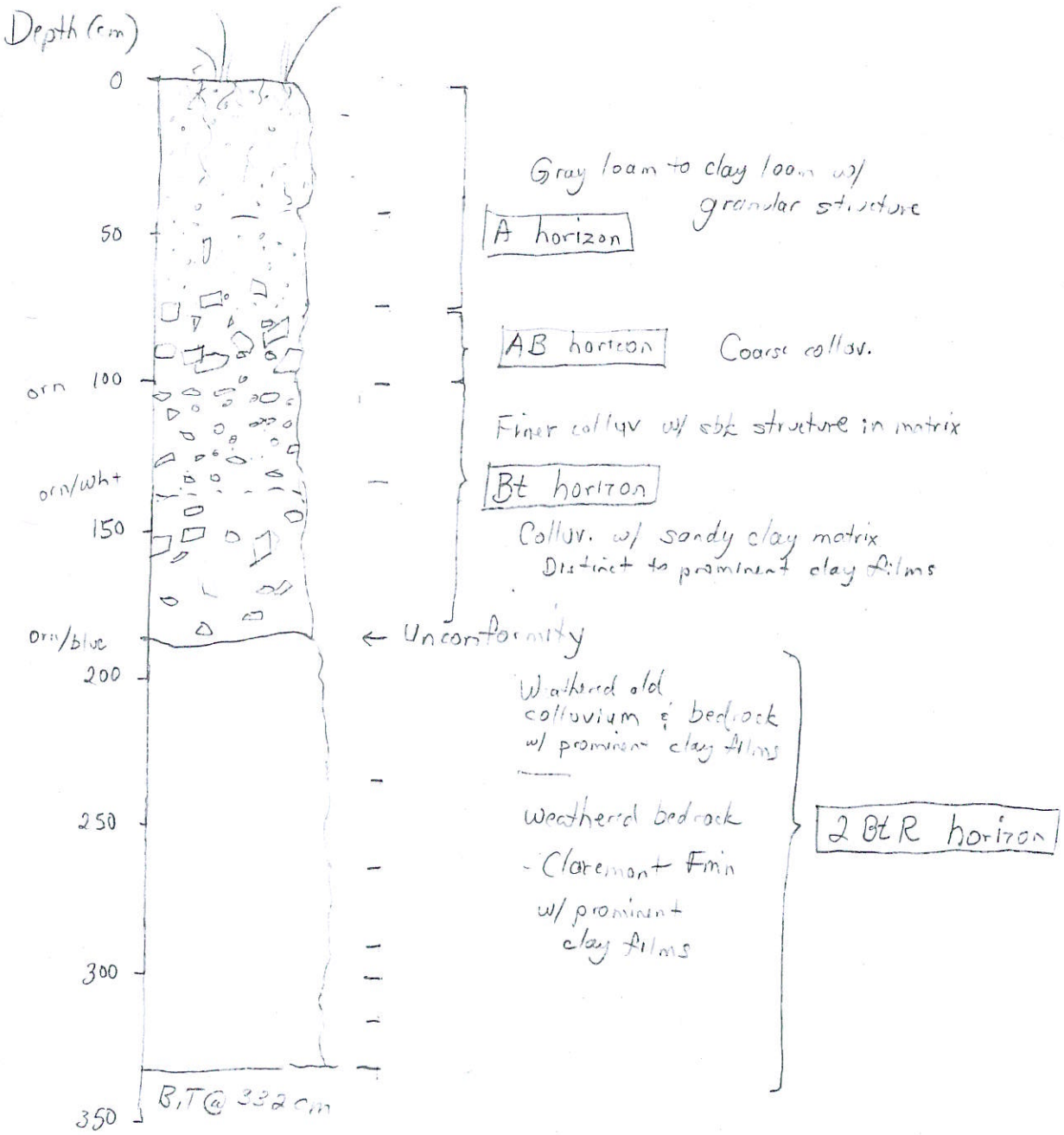
Time:

By: JM Powers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
184 234	2 Bt1	a s c w g i d b	10YR 6/4 (d) (m)	10YR 6/6 patches (d) 10YR 4/4 to 7.5YR 4/4 clay films (m)	m vf gr sg f pl 1 m pr 2 c abk 3 vc sbk	f r 0 m sr 10 c sa 25 a 50 75 100	so po / lo lo ss ps / vfr so s p / fr sh vs vp / fi h vfi vh efi eh	C SC SiC SCL CL SiCL SL L SiL LS S Si clay ~20%	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Older rollover above fold. Weathering similar to lower horizons
262	2 Bt2 R	a s c w g i d b	10YR 6/4 (d) (m)	10YR 6/6 patches & stringers (d) dark clays (m)	m vf gr sg f pl 1 m pr 2 c abk 3 vc sbk	f r 0 m sr 10 c sa 25 a 50 75 100	so po / lo lo ss ps / vfr so s p / fr sh vs vp / fi h vfi vh efi eh	v. co. sandy loam C SC SiC SCL CL SiCL SL L SiL LS S Si clay ~10%	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Tip of fold, Weathered bedrock chert frag's have dismant. prominent clay films. Some clay laminae 2mm thk
288	2Bt3 R	a s c w g i d b	10YR 6/4 (d) (m)	10YR 4/4 clay films (d) (m)	m vf gr sg f pl 1 m pr 2 c abk 3 vc sbk	f r 0 m sr 10 c sa 25 a 50 75 100	so po / lo lo ss ps / vfr so s p / fr sh vs vp / fi h vfi vh efi eh	C SC SiC SCL CL SiCL SL L SiL LS S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	red stripe Weathered bedrock (Claremont) Chert & shale Bedding disrupted Prominent red-brn clay films
300	2Bt3 R	a s c w g i d b	10YR 6/4 (d) (m)	(d) (m)	m vf gr sg f pl 1 m pr 2 c abk 3 vc sbk	f r 0 m sr 10 c sa 25 a 50 75 100	so po / lo lo ss ps / vfr so s p / fr sh vs vp / fi h vfi vh efi eh	co. sandy C SC SiC SCL CL SiCL SL L SiL LS S Si clay ~20%	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	red stripe Weathered bedrock (Claremont) Siliceous shale
315	2Bt4 R	a s c w g i d b	10YR 6/4 (d) (m)	10YR 6/6 patches & stringers (d) 10YR 4/4 clay films (m)	m vf gr sg f pl 1 m pr 2 c abk 3 vc sbk	f r 0 m sr 10 c sa 25 a 50 75 100	so po / lo lo ss ps / vfr so s p / fr sh vs vp / fi h vfi vh efi eh	C SC SiC SCL CL SiCL SL L SiL LS S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV mn V V+	pink Weathered bedrock (Claremont) Thicker (2-3cm) chert beds int'b. with weathered shale some clay films rounded
332	2Bt5 R	a s c w g i d b	10YR 6/4 (d) (m)	10YR 4/4 clay films (d) (m)	m vf gr sg f pl 1 m pr 2 c abk 3 vc sbk	f r 0 m sr 10 c sa 25 a 50 75 100	so po / lo lo ss ps / vfr so s p / fr sh vs vp / fi h vfi vh efi eh	C SC SiC SCL CL SiCL SL L SiL LS S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV mn V V+	Weathered bedrock (Claremont) retains some bedding strat'n Prominent clay films in matrix and coating clasts

Notes:

SP-1, Trench T1 Wildcat Fault Investigation



Discussion

SP-1, Trench T-1 Wildcat Fault trench

- Two soil profiles, one in weathered bedrock, the other in colluvium
- Age of colluvial profile?
  1. Based on colluvial deposition rate from lit. (Look this up)
  2. No good upslope source for colluv. Not located in hollow
  3. Well developed profile with thick A and B horizons, prominent clay films
  - Probably Pre-Holocene

William Lettis & Associates, Inc.

Profile: SP-2, Trench Site: Wildcat Fault Evaluation

Elevation: _____ Slope: _____ Job #: 2023

Site description: _____

Date: 9-29-08
Time: _____
By: JMSowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
40	Fill	a (s) c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Fill
84	Fill	(a) (s) c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Fill Coarse roots at base
118	A1	a (s) c w (g) i d b	10YR 5/2 (d) (m)	(d) (m)	m vf (gr) sg f pl 1 (m) pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo (so) sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Colluvium w/ angular chert gravel, common fin-med roots
165	A2	a (s) (c) w g i d b	10YR 5/2 (d) (m)	(d) (m)	m vf (gr) sg f pl 1 (m) pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps (s) (p) vs vp / lo vfr fr fi vfi efi / lo (so) sh h vh eh	med-co sand C SC SiC SCL (CL) SiCL LS SL L SiL S Si clay ~35%	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Colluvium with angular chert gravel, fine-med. common fin-v.fi. roots
220	AC	(a) (s) c w g i d b	10YR 6/3 (d) (m)	(d) (m)	m vf (gr) sg f pl (1) (m) pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa (50) c a 75 100	so po ss ps (s) (p) vs vp / lo vfr fr fi vfi efi / lo (so) sh h vh eh	med-co sand C SC SiC (SCL) CL SiCL LS SL L SiL S Si clay ~30%	v1 f pf (1) po 2 (d) br 3 p (co) cobr	k I y II z III q IV V V+	Colluvium with angular chert gravel, co-fine common fin-v.fi roots clay films on clast surfaces look degraded.
238	2 Bt	a (s) c w (g) i d b	10YR 4/2 (d) 10YR 6/3 (d) 10YR 4/3 (m)	(prism faces) (prism tops) (d) (prism interiors) (m)	m vf gr sg (f) pl 1 (m) (pr) 2 c cpr 3 vc abk sbk	f r (0) 10 m sr 25 sa 50 c a 75 100	so po ss ps s p (vs) (vp) / lo vfr fr fi vfi efi / lo so sh h vh eh	fine sand C (SC) SiC SCL CL SiCL LS SL L SiL S Si clay ~60%	v1 f (pf) 1 po (2) (d) br 3 p co cobr	k I y II z III q IV V V+	Weathered San Pablo/Orinda Formation Prismatic structure w/ clay films on faces - eroded Bt ? Tops of prisms leached (~2cm)

upper 10cm (220-230cm)

Notes:

Profile: SP-2 Site: LBL Wildcat Fault excavation

Elevation: Slope: Job #: 2023

Site description:

Date: 9-29-08

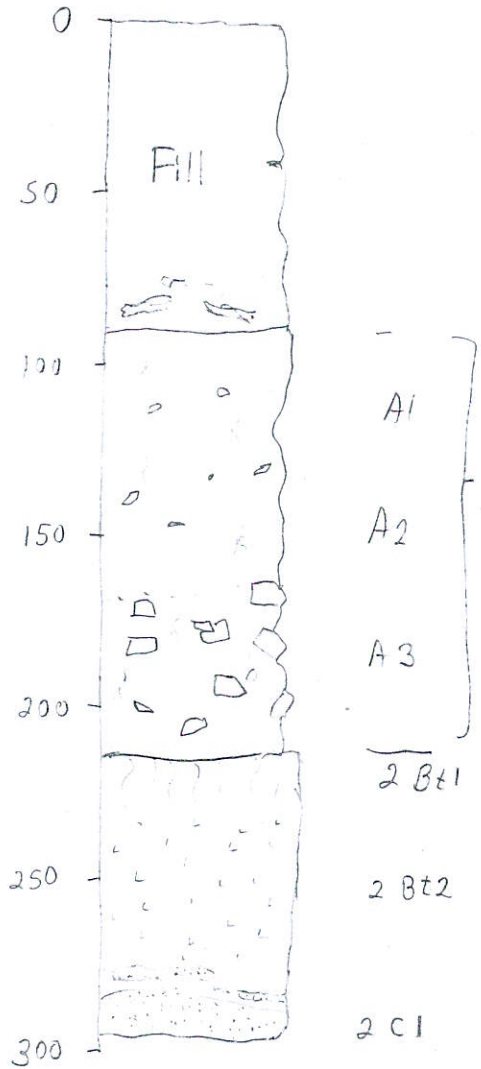
Time:

By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
280	2Bt2	a s c w g i d b	5Y 5/2 7.5YR 4/3 (d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp lo vfr fr fi vfi efi lo so sh h vh eh	C SC SiC SCL CL SiCL SL L LS SiL S Si	vf f pf 1 d po 2 br 3 p co cobr	k 1 y II z III q IV V V+	Brown & olive gray clays with $CaCO_3$-lined fractures. Wild Orinda? 280-288 = Transition zone
293	2R	a s c w g i d b	2.5Y 5/4 (d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp lo vfr fr fi vfi efi lo so sh h vh eh	C SC SiC SCL CL SiCL SL L LS SiL S Si	vf f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	Fine sand, massive weathered Orinda?
B.T.		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp lo vfr fr fi vfi efi lo so sh h vh eh	C SC SiC SCL CL SiCL SL L LS SiL S Si	vf f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	
		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp lo vfr fr fi vfi efi lo so sh h vh eh	C SC SiC SCL CL SiCL SL L LS SiL S Si	vf f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	
		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp lo vfr fr fi vfi efi lo so sh h vh eh	C SC SiC SCL CL SiCL SL L LS SiL S Si	vf f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	
		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp lo vfr fr fi vfi efi lo so sh h vh eh	C SC SiC SCL CL SiCL SL L LS SiL S Si	vf f pf 1 d po 2 br 3 p co cobr	k I y II z III q IV V V+	

Notes:

SP-2 Trench Wildcat Fault investigation



Chert-derived colluvium
- granular structure
- roots
- degraded clay films on clasts
- loose-soft

Brown clay w/ prismatic structure, bleached tops of prisms

Brown & olive gray clay, abk structure

Light olive brown fine sand massive

Weathered Orinda or San Pablo Formation

The colluvium is significantly younger than the colluvium at SP-1. It may be derived from it, based on the degraded clay films on the chert clasts. No Bt horizon in this colluvium.

APPENDIX C.2

GEOTECHNICAL REPORT: BUILDING 25

Appendix C2.A

Lettis & Associates, 2009

Paleolandslide Investigation, Building 25, Lawrence Berkeley National Laboratory, Berkeley, California

Paleolandslide Investigation
Building 25
Lawrence Berkeley National Laboratory
Berkeley, California

Submitted to:

Mr. Jerome Ohearn
Project Manager, Facilities Division
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720
JOhearn@lbl.gov

Prepared by:

William Lettis & Associates, Inc.
1777 Botelho Drive, Suite 262
Walnut Creek, CA 94596

August 31, 2009

SIGNATURE PAGE

Paleolandslide Investigation, Building 25, Lawrence Berkeley National Laboratory, Berkeley, California

William Lettis & Associates, Inc. Project No. 2072.001

This investigation and report were prepared by the following qualified William Lettis & Associates, Inc. personnel:

_____ ___August 31, 2009___

John N. Baldwin, C.E.G. 2167 Date
Principal Geologist
Project Manager

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1.0 INTRODUCTION

William Lettis & Associates, Inc. (WLA), under subcontract to Alan Kropp and Associates, Inc. (AKA), presents the results of a paleolandslide investigation for a proposed redevelopment of the Building 25 area of Lawrence Berkeley National Laboratory (LBNL). The approximate site location is shown on Figure 1 and the site geologic map (Plate 1).

1.1 Project Description

The Building 25 site is located in the "Old Town" area of the LBNL facility in an area of moderately steep slopes. The proposed re-development would include: (1) the demolition of LBNL Buildings 25 and 25A; (2) the construction a General Purpose Laboratory (GPL) building; and (3) a building or building(s) unrelated to the GPL project. The exact location of the proposed building footprints and site improvements are unknown at the time of this report but are assumed to be near Building 25 and its adjacent parking lots.

The "Old Town" area of LBNL includes some of the earliest buildings constructed at the LBNL campus. The natural topography of the area has been extensively modified by grading; however, it is apparent that Building 25 is situated atop a north-south trending ridgeline that extends down into Strawberry Canyon (Figure 1). Old topographic maps of this area generally show the ridgeline and adjacent swales sloping down toward the south at declinations between 2:1 (horizontal to vertical) and 4:1. The general area of Building 25 has been graded to an approximately level pad near Elevation +940 feet (LBNL datum); the nose of the ridgeline intersects the floor of Strawberry Canyon at about 500 feet below the level of the building pad.

Regional geologic mapping and recent subsurface investigations and mapping performed in the general area of Building 25 have encountered volcanic rocks of the Moraga Formation overlying sedimentary rocks of the Orinda Formation (Figure 2; and Plate 1). Previous geotechnical and geologic studies by LBNL consultants have interpreted the contact between these rocks to be depositional. However, the September 2000 (Parsons, 2000) RCRA Facility Investigation (RFI) Report prepared by LBNL's EH&S group presents an alternative interpretation; specifically, that the Moraga Formation rocks have moved downslope as landslide blocks and were deposited on a paleosurface eroded on the Orinda Formation (Figure 3).

The interpreted "paleolandslide" underlying Building 25 (shown as $QTls_{(m)}$ on Plate 1) is a maximum of 80 to 90 feet deep, as depicted in Figure B2.3-9 of the RFI Report (Parsons, 2000) and Figure 2 of AKA (2009a). A "mixed unit" comprised of both types of rocks has been interpreted at the base of the paleolandslide and has shears and slickensided surfaces. The geologic interpretations presented in the RFI Report (Parsons, 2000) were developed as part of a comprehensive environmental study by LBNL's EH&S group that addresses chemically-impacted soils and groundwater on the LBNL

campus.

1.2 Purpose

The purpose of the investigation is to compile existing data on the origin of the volcanic block beneath Building 25, and to assess the presence or absence of paleolandslide features in the subsurface, and if present, assess the activity of the features. The scope of the investigation includes exploratory trenching along the western and eastern margins of the paleolandslide to: (1) establish the presence or absence of the inferred paleolandslide; (2) evaluate the activity and age of the paleolandslide deposits; and (3) compare the rate of activity (i.e., frequency of movement) with the preliminary Newmark analyses derived from an AKA (2009a) initial study of the Building 25 site. The initial findings of the Newmark analysis predicted translation coincident with frequent large magnitude earthquakes on the Hayward fault (AKA, 2009a).

The techniques employed during this study follow the standard procedures used to assess active faulting (i.e., the State's Alquist-Priolo Act). Although, the Building 25 site does not overlie a State-recognized active fault, the techniques used to assess the presence or absence of active faulting are readily applicable to assessing the presence or absence of active landslide-related deformation. For instance, if bedrock shearing is present in the trenches, the recency of landslide deformation can be evaluated by characterizing the upward termination of deformation with respect to the age of the overlying undeformed deposits. The A-P Act defines an active fault as one that has ruptured the ground surface within the past approximately 11,000 years (the Holocene Epoch). Note that no similar age delineation for active landsliding is mandated by State regulation(s).

1.3 Previous AKA/WLA Investigations

The geologic interpretations presented in this study build upon previous investigations conducted by AKA and WLA at other nearby areas within the LBNL facility, such as the Helios site (AKA, 2009b) in Chicken Creek Canyon, and our on-going study at Building 71. Selected AKA/WLA reports used or referred to during this study are listed in Section 9.0 (References). An initial investigation of the Building 25 site performed by WLA and AKA (AKA, 2009a) included a review of existing site data and drilling of several deep boreholes. The preliminary findings from AKA (2009a) suggested that the site geologic conditions encountered below Building 25 were consistent with a paleolandslide hypothesis. Furthermore, simple computer modeling (Newmark analysis) developed from assumptions regarding slide plane geometry and strength parameters indicated the inferred paleolandslide is stable under static conditions, but unstable under dynamic loading resulting from a large earthquake on the active Hayward fault. It was recommended that additional geologic investigation (i.e., trenching) be performed to further evaluate the recency of landslide movement.

1.4 Limitations

This report has been prepared specifically for LBNL and its design consultants for the proposed redevelopment of Building 25, and is to be used solely for its planning purposes. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has not been prepared for use by other parties, and may not contain sufficient information for the purpose of other parties or other uses. Note that this study does not constitute a geotechnical investigation for foundation design nor an evaluation of other potential geologic hazards (e.g., strong ground motion, liquefaction, landsliding, surface-faulting,) potentially impacting the subject site. These issues should be evaluated in a separate geologic and geotechnical investigation for the site.

2.0 SCOPE OF WORK

Based on a letter of authorization dated July 10, 2009, WLA and AKA were retained by LBNL to evaluate the recency of movement associated with a hypothetical paleolandslide mapped previously beneath the Building 25 site. The investigation focused on new exploratory trenching to complement our previous borehole exploration, as well as a data compilation of nearby previous consultant studies. The scope of work is designed to (1) establish the presence or absence of the inferred paleolandslide; (2) evaluate the activity and age of the paleolandslide deposits; and (3) compare the rate of activity (i.e., frequency of movement). Our scope of work included the following tasks:

- Compilation and review of existing published and unpublished geologic information, including consultants reports, stereo-pair aerial photographs, and oblique historical topographic maps and photographs;
- Site reconnaissance and geologic mapping;
- Excavation and documentation of trenches and a test pit totaling about 170 lineal feet;
- Perform relative age dating of trench deposits using soil profile development;
- Data analysis to assess the location and activity of the inferred paleolandslide;
- Technical peer review of the trenches by LBNL geologist Mr. Preston Jordan, GPL and LBNL stakeholders, Mr. Wayne Magnusen and Ms. Dona Mann of AKA; and Mr. Jeffery Bachhuber (Senior Principal Engineering Geologist) of WLA; and
- Report preparation and submittal.

2.1 Data Review, Site Reconnaissance, and Geologic Mapping

WLA geologists conducted an initial review of pre-construction aerial photographs (Table 1), historical photographs (Figures 4 and 5), topographic maps, geologic and engineering reports, and logs from existing site borings and trenches (Plate 1), field reconnaissance between Building 25 and the Lawrence Hall of Science (LHS) to evaluate local bedrock exposures, surficial deposits, and fault contacts mapped previously (e.g., Clements, 1963; HLA, 1982; Parsons, 2000; Graymer, 2000).

Table 1. Aerial Photography Reviewed

Type	Date	Scale	Photo No.	Source
Black and White, Stereo Pair	08/02/1939	1:20,000	BUT-BUU-289-67,68	United States Soil Conservation Service

Pre-development historic oblique and vertical aerial photographs were examined to check

for geomorphic indicators of landsliding within the area of Building 25. The oldest photograph reviewed was an oblique aerial photograph of the site area from circa 1935, which was obtained from AKA's historical reference library. Representative photographs of the site from 1935 are presented in Figures 4 and 5. The figures are annotated to show the approximate location of the existing Building 25 and key geologic features. The earliest stereo-pair vertical aerial photographs of the site are from 1939 and show the building site consisting of grassy rolling hills in the western and southern part and a eucalyptus grove in the northeastern part of the site vicinity.

We also reviewed published geologic maps and literature pertaining to geologic conditions in the project vicinity. The earliest topographic map reviewed included one with mapped geology in Lawson and Palache (1901). A substantial amount of information exists regarding geotechnical and geologic conditions within the Building 25 area from consulting reports and LBNL environmental documents (i.e. Parsons, 2000). Some of the data contained in the referenced reports was used and relied upon during our initial engineering geologic evaluation of conditions affecting the Building 25 site (AKA, 2009a). The locations of nearby borings, test pits, and trenches used in this report are shown on Plate 1.

2.2 Personal Communications

WLA's engineering geologists contacted Dr. Russell Graymer of the U.S. Geological Survey, on May 29, 2009, through email regarding his geologic mapping of the Berkeley Hills and LBNL area (Graymer et al. 1996; Graymer, 2000). Dr. Graymer is a research geologist and an expert on the local and regional geology and provides an 'independent' perspective on the geologic conditions within the LBNL vicinity. Dr. Graymer stated that he was unaware of any large paleolandslide features in the area, but also acknowledged that he did not necessarily consider this deformation mode during his mapping. Dr. Graymer's maps are small-scale representations of regional-scale stratigraphic and structural bedrock relations in the East Bay Hills (Figure 2).

2.3 Subsurface Exploration

WLA geologists excavated and documented trenches T-1 and T-2, and test pit TP-1 between July 13 and August 2, 2009 (Plate 1). Goebel Paving, Grading, & Underground, Inc. (Goebel) excavated the trenches and test pit using either a track-mounted excavator or rubber tire backhoe equipped with a 36-inch-wide bucket. The south wall of the trenches and test pit were completely cleaned to expose fresh material. Structural and stratigraphic features were flagged and logged at 1 inch = 2 ft (1:24) scale. Attitudes and orientations of structural features and bedding were measured and logged on the south wall after correlating with similar features on the north wall. Detailed soil profiles (SP-1 to SP-4) were prepared by Dr. Janet Sowers of WLA of trenches T-1 and T-2 for age dating purposes (see Appendix A).

Trenches T-1 and T-2 extend generally perpendicular to the previously mapped eastern

and western margins of the inferred paleolandslide (Plate 1). Trench T-1, located between Buildings 4 and 25, crosses the previously mapped western margin of the paleolandslide (Parsons, 2000). The T-1 trench site is a sloping lawn area surrounded by trees, a parking lot, and an adjacent paved access road. Trench T-2, located along a moderately inclined slope (about 15 degrees inclination) on the southeast side and below the southern parking lot of Building 25, intersects the eastern margin of the paleolandslide. A test pit, TP-1, located west of trench T-2, was excavated to assist in properly locating trench T-2.

Prior to excavation, a site-safety meeting was held with WLA, LBNL, and Goebel employees to review the excavation plan and discuss safety elements of the trenching investigation. The trenches used aluminum hydraulic shoring in accordance with OSHA regulations. Daily site safety inspections were performed by the WLA competent person and LBNL safety personnel prior to entering the trenches. The trench locations were approximated in the field using a tape measure and Brunton compass, coupled with a hand-held GPS device. Upon completion of the investigation and a formal review of the findings, trenches were backfilled in 12-inch lifts using a backhoe and/or an excavator-mounted vibratory plate and the addition of water. The trench backfill was confirmed visually without laboratory testing and specified backfill conditions or limits. The site was restored to previous grade using the blade of the backhoe and excavator equipment. Because the trench backfilling was not controlled by a specification and testing, there is a potential for future settlement of backfill soil that needs to be considered with respect to future grading and foundations for the redevelopment of Building 25. The GPS data points of the trench locations have been intergrated into our GIS site map of the area and could help define the limits of the trench for future geotechnical/foundation assessment.

3.0 REGIONAL GEOLOGIC AND SEISMIC SETTING

In the following sections, we summarize the regional geologic and seismic information obtained from our review of published and unpublished geologic information. More detailed discussions of local geologic conditions are presented in Section 4.00, "Local Geologic Conditions."

3.1 Berkeley Hills Geology

The proposed re-development of the Building 25 site is situated at about 940 ft MSL along the west side of the northwest-trending Berkeley Hills, and is characterized by gentle to steep topography. Bedrock geology in the Berkeley Hills is complex and includes a variety of moderately to highly deformed (faulted and folded) sedimentary, volcanic and metamorphic rock units that have been subjected to a long history of regional uplift, folding, and landsliding. These rock units range in age from the Late Jurassic/Cretaceous (135 to 150 million years ago) to the Tertiary (66.5 to 1.6 million years ago).

The regional geology map presented on Figure 2 is based on a published geologic map of this area from the United States Geological Survey (Graymer, 2000). Bedrock units mapped in the site area include the Cretaceous Great Valley Group (Ku), Miocene Orinda Formation (Tor), Miocene Moraga Volcanics (Tmb) and Miocene Claremont Chert (Tcc). Regional geologic mapping shows the Tertiary sedimentary and volcanic rocks are folded into a syncline in the eastern part of LBNL that has been displaced by the inactive Wildcat fault in the East Canyon (Figure 2). The Hayward fault (considered a major active fault) also trends northwest and runs along the western side of the Berkeley Hills near its base (Figures 1 and 2).

3.2 Bay Area Active Faults

The San Francisco Bay Area lies within a broad region of deformation that defines the boundary between the North American and Pacific tectonic plates. This boundary includes a series of major active northwest-trending faults, which include the San Andreas, Hayward, Rodgers Creek, Calaveras, San Gregorio, Concord-Green Valley, West Napa, and Greenville faults. These major faults are near-vertical and generally exhibit right-lateral strike-slip movement (which means that the movement is predominantly horizontal and when viewed from one side of the fault, the opposite side of the fault is observed as being displaced to the right). There are numerous active and potentially active faults within the Bay Area that are secondary to the major strike-slip faults. Faults that are defined as active exhibit one or more of the following: (1) evidence of Holocene-age (within about the past 11,000 years) displacement, (2) measurable fault creep, (3) close proximity and alignment with linear concentrations or trends of earthquake epicenters, and (4) tectonic-related geomorphology. Potentially active faults are defined as those that have evidence of Quaternary-age displacement (within about the

past 2 million years), but have not been definitively shown to lack Holocene movement.

Various researchers and government agencies have mapped the locations of active and potentially active faults in California. The closest known active fault to the project site is the Hayward fault, which has been mapped by Lienkaemper (1992), Geomatrix (2006), and WLA (2007) approximately 1,800 feet southwest of the site on the UCB Campus. The State of California has designated official Special Studies Zones (later renamed Earthquake Fault Zones) around known active faults. These official State Earthquake Fault Zones were initially delineated by the State Geologist in conjunction with the California Division of Mines and Geology (CDMG, now the California Geological Survey) as part of the Alquist-Priolo Fault Evaluation Program, and are commonly referred to as A-P Zones. The CGS continues to revise and update the A-P Zone maps. The Building 25 site is not located within a State Earthquake Fault Zone (see Figure 1).

3.3 Bay Area Seismicity

The greater San Francisco Bay Area region is characterized by a high level of seismic activity. Historically, this region has experienced strong ground shaking from large earthquakes, and will continue to do so in the future. A map showing the locations and magnitudes of historical earthquakes in the San Francisco Bay Area is presented in Figure 6. Since 1800, five earthquakes of magnitude (M) 6.5 or greater have occurred in the Bay Area (Bakun, 1999). These include the: 1836 M6.5 event east of Monterey Bay; 1838 M6.8 event on the Peninsula section of the San Andreas fault; 1868 M6.8-7.0 Hayward event on the southern Hayward fault; 1906 M7.9 San Francisco earthquake on the San Andreas fault; and 1989 M6.9 Loma Prieta event in the Santa Cruz Mountains.

In 2003, The Working Group on California Earthquake Probabilities (WGCEP, 2003), in conjunction with the United States Geological Survey (USGS), published an updated report evaluating the probabilities of significant earthquakes occurring in the Bay Area over the next three decades, (2002-2031), which has since been updated on a state wide scale in 2008 for the time span of 2007-2036 (WGCEP, 2008). The WGCEP (2008) report indicates that there is a 0.63 (63 percent) probability that at least one magnitude 6.7 or greater earthquake will occur in the San Francisco Bay region before 2037, and a 0.31 probability (31 percent) that a M 6.7 or larger earthquake will occur on the Hayward fault in this same time period. A large earthquake on the Hayward fault was used in the preliminary Newmark analysis of the Building 25 site to evaluate the dynamic stability of the inferred paleolandslide shown in Plate 1 (AKA, 2009a).

The Hayward fault accommodates about 25% of the strain associated with the Pacific/North American plate boundary in the San Francisco Bay area. The Hayward fault lies along the southwestern margin of the East Bay Hills and extends from Warm Springs (Fremont) on the south to San Pablo Bay on the north for a distance of about 87 ± 10 km (Figure 1). The fault consists of two major sections: the 30 ±15 km long northern segment, and 55 ± 7.5 km long southern segment, respectively (WGCEP, 2003). The northern Hayward fault also represents the central segment of the 140-km-long Hayward-Rodgers Creek fault (HRCF) system, which according to the latest evaluation by the

Working Group on California Earthquake Probabilities has the highest probability (27%) of the "characterized" faults within the Bay Area capable of producing a **M**≥6.7 earthquake in the next 30 years (2002-2032). Recent paleoseismic data collected on the southern Hayward fault at Tyson's Lagoon indicate as many as 11 large surface-fault ruptures within the last approximately 1,800 years, and a mean recurrence interval of 170 ± 82 years (Lienkaemper and Williams, 2007). This short recurrence interval for large earthquakes on the nearby Hayward fault suggests that strong ground shaking-induced slope failures at the Building 25 site should be recorded in the geologic deposits overlying the hypothesized paleolandslide margins.

4.0 LOCAL GEOLOGIC CONDITIONS

In the following sections, we discuss the results of our geologic reconnaissance together with information obtained from our review of published and unpublished sources, including geologic, geotechnical and environmental consulting reports. The introductory discussions presented in this section refer extensively to the Geologic Map presented on Plate 1 and the oblique aerial photographs presented in Figures 4 and 5.

4.1 Local Geomorphology

The Building 25 site is located on the southwest facing slopes of the Berkeley Hills and specifically on a bedrock ridge that has been significantly altered from its original condition. Early maps (Lawson and Palache, 1901) and historical photographs (1935 and 1939) of the site area depict pre-development morphology, and show a gently sloping and rounded north-south trending bedrock ridge with southwest-trending and southeast-trending bedrock spurs. These early depictions show the ridge continuing northward and steepening toward present-day Lawrence Hall of Science (Figure 4). Highly resistant andesitic and basalt units of the Moraga Formation form the steep ridges and cliff faces directly upslope of Building 25 dip northerly into the hillslope, and locally define a north-plunging syncline (Figure 5).

The eastern part of the site is bordered by the headwater of Chicken Creek Canyon whereas the western margin is bounded by a broad west-sloping surface that drains toward Blackberry Creek. The southern part of the site, near Buildings 40 and 41, aligns with the headwaters of Ten-Inch Creek (Figure A2.2-4 of Parsons, 2000) that drains south to Strawberry Creek. An abrupt linear tree line (no longer present) captured in Figure 4 demarcates the Oakland-Berkeley City limits. A south to southeast alignment of vegetation also occupies the southeast spur of the Building 25 site close to the location of trench T-2 excavated during this investigation.

A review of 1939 stereo-paired photography identified a tear-dropped shaped feature suggestive of a shallow landslide located southwest of Building 25 near Buildings 45 and 48 (Plate 1). The approximate location of the shallow landslide is consistent with present-day morphology that depicts an arcuate shaped headwall, stressed and tilted foundations of Buildings 40 and 41, and unstable slopes currently being retained by walls constructed behind Buildings 45 and 48. Lastly, large curvilinear moist zones that coincide with a south-facing break in slope northeast of Building 25 are visible in the 1939 photos and appear to approximate the geologic contact between the Moraga and Orinda Formations. In general, the morphology depicted from the pre-development maps and photography is suggestive of a landscape that is relatively stable with most mass wasting processes confined to existing and pre-existing colluvial hollows and drainages and not ridge tops.

4.2 Bedrock Units

Bedrock within the project area consists of northeast-dipping Cretaceous Great Valley Group and Tertiary Orinda Formation overlain by Moraga Formation (Plate 1). Jordan and Javandel (2007) define the boundary between the Great Valley Group and Orinda Formation at the site as a fault contact. Southeast of the site, the contact is defined, in part, by folded Orinda Formation along a west to northwest-trending anticline (Plate 1). The southwestern limb is cut by an unnamed fault (previously named as the 'Chicken Creek fault' by AKA [2009b]) that juxtaposes Orinda Formation on the northeast against Great Valley Group on the southwest (Jordan and Javandel, 2007).

4.2.1 Cretaceous Great Valley Group

The Cretaceous sedimentary deposits are defined as part of Mesozoic rock complex that includes the Coast Range ophiolite and the Great Valley Group. Although the Great Valley Group is usually separated from the ophiolite, it is known from regional mapping that the Great Valley Group sedimentary rocks were originally deposited on the ophiolitic rocks (Graymer, 2000). This complex represents the accreted and deformed remnants of arc-related Jurassic oceanic crust covered by a thick sequence of turbidites (Graymer, 2000). The sedimentary rocks of this sequence are the oldest strata that crop out in the direct vicinity of the site and consist of sandstone and shale of the Great Valley Group. Based on borehole information acquired and interpreted as part of this study, the middle and lower portions of Chicken Creek Canyon consist of shale, claystone, and siltstone.

Within Chicken Creek Canyon the Great Valley Group strikes northwest and dips 25° to 45° northeast on the east side of the canyon, and increases in inclination to 60° near Centennial Drive and Strawberry Creek. South of the Building 25 site, the Great Valley Group material has been identified as in fault contact with the overlying Miocene Orinda Formation. Great Valley rocks near the fault zone are described as a dark gray to black, sheared and brecciated fine-grained shale and siltstone (Jordan & Javandel, 2007; Kleinfelder, 2004). Although not encountered in boreholes in the Building 25 area, the Great Valley Group would project beneath the site at considerable depth and would lie below the Orinda Formation.

4.2.2 Tertiary Orinda Formation

The Miocene Orinda Formation is a non-marine, well- to poorly-bedded siltstone, claystone, fine lithic sandstone, and pebble conglomerate up to 2400 ft in thickness. The conglomerate contains a high percentage of detritus derived from the Franciscan Assemblage (Graymer, et al., 1996). The coarse-grained conglomerate was deposited under alluvial fan conditions, while the sandstone, mudstone and finer-grained conglomerate were deposited as flood plain and channel material (Jones and Curtis, 1992). In the vicinity of the Building 25 site Lawson and Palache (1901) and Lawson (1900) interpret the sedimentary lacustrine deposits as interfingering with volcanic deposits of the Moraga Formation at or near the interplay between eruptive and fluvial

deposition.

The Miocene Orinda Formation underlies the upper portion of Chicken Creek Canyon and portions of Old Town west of Building 25 (Plate 1). Locally, it consists of well-bedded to massive siltstone and claystone and occasional lenses of coarse-grained sandstone and conglomerate. The top of bedrock consists of fluid-stained, yellowish/reddish brown weathered silty sandstone to siltstone. With increasing depth, the Orinda Formation gradually becomes less weathered and maintains coloration more indicative of the deposit, such as, greenish-gray, gray, olive gray, and grayish-blue colors with discontinuous lenses of sand and gravel lenses.

The coarse-grained assemblage of the Orinda Formation underlies the northern portion of upper Chicken Creek Canyon (i.e. near Buildings 72 and 78) and consists predominantly of fine- and medium-grained sandstone with occasional pebble conglomerates. The sandstone exposed along Cyclotron/Lawrence Road strikes northwest and dips approximately 30° northeast (Plate 1). Exposures in Chicken Creek, at or near the contact with the Great Valley Group, show the inclination within the Orinda Formation to be ~30° south to southwest. The southwest inclination is interpreted as the southwestern limb of a northwest-trending anticline confined to the hanging wall of the Chicken Creek fault (Parsons, 2000).

The Orinda Formation is in fault contact with the Great Valley Group. The fault contact is interpreted as a northwest-striking low to steep east-dipping discontinuity, and is expressed as a brecciated, slickensided sheared zone (Dames and Moore, 1962; Parsons, 2000; Kleinfelder, 2004; Jordan and Javandel, 2007). To the northeast of the site, the Orinda Formation is interpreted to be in a depositional contact with the overlying Moraga Formation (Plate 1 and Figure 2). Based on the geologic and geotechnical data compilation, the anticipated fault contact between the Orinda Formation and Great Valley Group is located southwest of Building 25 and Lawrence Road (Plate 1).

4.2.3 Tertiary Moraga Formation

The Miocene Moraga Formation consists of as many as five distinct flows typically defined by basaltic and andesitic composition (Wahrhaftig and Sloan, 1989). The thickness of the Moraga Formation in the vicinity of LBNL is estimated at about 800 to 1000 ft (Lawson and Palache, 1901). The source vent is believed to be the Round Top volcanic complex located several miles southeast of the site. Early studies by Lawson and Palache (1901) refer to the volcanic deposits in the vicinity of the Building 25 as the Campan series and are described as fresh-water deposits interbedded with lavas and tuffs. Others also describe similar clastic deposits at or near the base of eruptive sequences (Lawson, 1901; Wahrhaftig and Sloan, 1989; and Clements, 1963). The Moraga Formation is exposed in multiple cut slopes along Centennial Drive and Grizzly Peak Blvd north of the site and in several abandoned quarries at LBNL (i.e. northwest of Building 78). Moraga Formation also is exposed in the Lawrence Road cut directly east of Building 48 (south and downslope of Building 25).

In the site area, the Moraga Formation consists of andesitic and basaltic flows, tuff, and volcaniclastics (locally described as agglomerate or volcanic breccia). Potassium-argon ages of the volcanic flows vary from 10.2 million years (Ma) to 8.5 Ma (Curtis, 1989). The basal member of the volcanics, defined as an amygdaloidal andesite is interpreted to have been deposited over a broad alluvial flood plain with later flows and tuffs being confined to narrow channels, ravines and valleys (Lawson and Palache, 1901; Wahrhaftig and Sloan, 1989). Locally, the Moraga Formation rests depositionally on the Orinda Formation, or is present as intact translated slide bodies (Parsons, 2000). At the site, the Moraga Formation typically consists of highly fractured and weathered, subangular to subrounded cobble to large, boulder-size agglomerate to andesite with a predominantly silty to fine gravelly matrix. Minor amounts of weathered and altered ash and tuff also are present.

4.2.4 Unconsolidated Deposits

4.2.4.1 Undifferentiated Natural Surficial Deposits (Quaternary) – Symbol Qu

Quaternary colluvium, minor clay-rich alluvium, and debris-flow deposits have accumulated along the steep to moderate slopes bounding the bedrock ridge of Building 25 (Plate 1) Based on borehole and trench explorations for Building 25 site the unconsolidated colluvial materials are inferred to be as much as 5- to 15-feet-thick.

4.2.4.2 Quaternary Landslide Deposits

Landsliding in this part of Old Town and upslope of Building 25 has occurred at a variety of scales (deep-seated and shallow) and involves a variety of mass-wasting processes. Landslide deposits usually are constrained to the present-day topographic swales and areas of thick colluvium and poorly consolidated deposits of Orinda Formation where slopes have been oversteepened. The landslide deposits are derived from several types of materials: (1) Quaternary colluvium, (2) deposits containing mixed blocks of Orinda and Moraga Formation, and (3) homogeneous blocks of Moraga Formation or Orinda Formation. The mapped landslides depicted on Plate 1 are primarily derived from: (1) valley morphology, (2) landslide-related deposits encountered during grading activities, (3) geological and geophysical features encountered during site investigations, and (4) previously mapped boundaries of landslides.

4.2.4.3 Artificial Fill, Historic

Development within the Old Town area has included the grading of pre-existing topographic highs and filling of topographic lows by placement of artificial fill directly beneath and surrounding portions of Buildings 25 and 25A, including within the former swales and creeks associated with Blackberry Creek and Ten Inch Creek.

4.3 Building 25 Geologic Conditions

Tertiary bedrock units encountered in the Building 25 area include from oldest to youngest: Orinda Formation, Moraga Formation and an inferred Tertiary sedimentary deposit likely close in age to the Moraga Formation (Plate 1). The Geologic Map compiled for this study (Plate 1) shows bedrock units, bedrock faults, and probable deep-seated, bedrock-involved and shallow landslide deposits in the vicinity of Building 25.

In the site vicinity, the Tertiary sedimentary and volcanic rocks are folded along the western limb of a regional south-plunging syncline (Graymer, 2000; Lawson and Palache, 1901) (Figure 2). Local bedding data, compiled borehole information, and geologic reconnaissance also define a north-trending and north-plunging syncline directly upslope of Building 25 (Plate 1). Field reconnaissance of the graded cuts and quarry walls north of Building 25 mapped layered andesite, rhyolite and basalt flows that to the west become interbedded with a pebble conglomerate. Interestingly, trench and borehole data suggest the bedrock ridge occupied by Building 25 consists of an asymmetrical north-south trending synform partly aligned with the syncline north of Building 25 and also having a resistant core of volcanics (see Plate 1 and Figures 7 to 9).

Minor bedrock faults ranging from steep to shallow dipping have been exposed in cut slopes and an abandoned quarry north of Building 25 (Clements, 1963). For instance, Clements (1963) maps a thrust fault along the Orinda and Moraga contact north of LHS and directly west of Building 76 (Plate 1). The fault is mapped as a northwest-southeast striking thrust fault dipping easterly 55 to 65 degrees. To the southeast, Clements (1963) depicts the same contact as depositional and coinciding with the presence of a topographic break in slope (Plate 1). The thrust fault west of Building 76 is mapped as a shallow south dipping fault. A previous slope cut in this area apparently exposed a southeast 20° dipping fault coincident with a four-foot thick gouge zone that separates the Moraga and Orinda Formations (Clements, 1963). Lastly, Clements (1963) maps an east-west striking normal fault displacing Moraga volcanics in the quarry northwest of Building 76. All of these faults are considered inactive and do not fall within a State designated Earthquake Fault Zone (Figure 1).

5.0 ORIGIN OF MORAGA FORMATION IN OLD TOWN

As many as three viable models have been proposed to explain the juxtaposition of various discontinuous Moraga volcanic bodies in the region of Old Town and LHS: (1) paleolandsliding; (2) faulting; and (3) deposition on pre-existing topography and subsequent erosion.

5.1 Paleolandsliding

The Moraga-Orinda contact is defined as an undulatory surface across much of the Old Town area (Parsons, 2000). The Moraga Formation is interpreted as filling former depressions or topographic lows millions of years ago (Figure 3). Present-day morphology indicates many of these former topographic lows currently are expressed as topographic highs, or resistant bedrock ridges comprised of volcanic material, and forming inverted topography. The volcanics are up to 100 ft thick and form a northwest-trending volcanic mass of variable thickness across the Old Town area (Figure 3). Since this massive volcanic block appears to rest structurally below the inferred primary geologic contact between the Moraga and Orinda Formations to the north, previous researchers and consultants have interpreted this northwest-trending block of volcanic material to be displaced by ancient landsliding (HLA, 1983 [near Building 52]; HLA, 1988 [Building 58A]; Parsons, 2000).

The inferred HLA (1983) paleolandslide beneath Building 52 coincides with a thick accumulation of colluvium that buries the inferred headwall of the bedrock paleolandslide (e.g., material shown primarily as Qc in Plate 1). The paleolandslide model of Parsons (2000) infers the contact between the Moraga Formation and underlying Orinda Formation to be an ancient slip surface based on shear planes interpreted from regional boreholes and dissimilar bedding attitudes noted between the underlying Orinda Formation and the overlying "displaced" Moraga volcanic blocks (Parsons, 2000). The paleolandslides are interpreted to have originated after the time of deposition (8 to 10 Ma) or after the tectonic uplift of the Berkeley Hills (5 Ma) (Parsons, 2000).

Cross section B-B′ (Figure 8) intersects one of the hypothetical landslide blocks of Parsons (2000; Figure 3) and provides a schematic representation of the overall geologic conditions at the Building 25 site. This section shows that the Orinda Formation and Moraga Formation are in fault contact to the north along a steeply dipping structure, and that further south the Moraga Formation overlies Orinda Formation along a shallow dipping contact. It also shows the Building 25 site is underlain by a large, lobate mass of volcanic rock (Moraga Formation).

The north end of cross section B-B′ (Station 0 to 220 ft) traverses part of a 50-ft-thick landslide with basal clay gouge that has translated volcanic rock of the Moraga

Formation downslope onto Orinda Formation sandstone and siltstone. The displacement vector for this slide is roughly normal to the cross section alignment.

At Station 400 ft a steeply northeast-dipping (55 to 65 deg) fault intersects the ground surface and places Orinda Formation over and against Moraga Formation in an apparent thrust relationship. The steep dip of this fault was observed in a cut exposure by Clements (1963) during excavation for the Lawrence Hall of Science and is further constrained by documentation of Orinda Formation at the bottom of boring 484 at about 995 ft elevation (Evans, 1963). Multiple clay gouge intervals in boring 484 suggest hanging wall deformation within the Orinda Formation.

Borings 485, 490, 495, 498, 499, and 500 all encountered Moraga Formation volcanic bedrock across the Lawrence Hall spur ridge (Evans, 1963). Map relationships shown on Plate 1 indicate that the Moraga Formation here is roughly 200- to 250-ft-thick and that the basal Moraga Formation contact traverses northwest along the spur ridge at roughly the same elevations as McMillan Road. A roughly 40-ft-thick package of sedimentary rock bracketed above and below by Moraga Formation andesite was mapped along the south face of the Lawrence Hall spur ridge by Clements (1963) and encountered in Borings 498, 495, and 500 (Evans, 1963). Bedding attitudes demonstrated by these strata define a broad, north-plunging synform that projects toward the Building 25 site (Plate 1).

Subsurface data indicate that the Building 25 site is underlain by a lobe of Moraga Formation (volcanic and volcaniclastic rock) up to 70-ft-thick that overlies Orinda Formation siltstone along a concave, roughly south-dipping contact (Figure 8). Absence of Moraga Formation bedrock in borings 429 and 447 demonstrates that the Orinda Formation-Moraga Formation contact below the Building 25 site is not laterally continuous with the Orinda-Moraga contact exposed along McMillan Road. There is little evidence for a vertical structural separation between these two contacts (e.g., east-west oriented faulting or folding). A 4-ft-thick northeast-striking and 20-degree southeast-dipping gouge zone was observed along the Orinda Formation-Moraga Formation contact north of the site by Clements (1963), but the continuation of this feature toward cross section B-B′ is unclear. The feature was not observed in adjacent borings. It also is inconsistent with the north-dipping contact predicted by the north-plunging synform mapped to the northwest along McMillan Road.

Two borings at the Building 25 site (421 and 434) encountered fine-grained tuffaceous sedimentary rock bracketed above and below by volcanic rock. We infer that this package of sedimentary rock may be similar (or equivalent) to the interval mapped by Clements (1963) upslope of the site. In the paleolandslide model, the similarity of these deposits implies that the volcanic rock below the Building 25 site may be derived from upslope during a past sliding event, or is unrelated and represents the Orinda Formation, or separate intra-Moraga sedimentary deposit.

Lastly, our previous exploration of the Building 25 site included drilling three boreholes (429 to 431) along an approximately north-south transect (Plate 1) through the length of

the Parsons (2000) landslide (AKA, 2009a; Figures 10 to 12). Only boring 430 (AKA-2) encountered the Moraga-Orinda contact. The contact was encountered at approximately 91 feet and consisted of soft to medium hard reddish brown 3 to 6 in-thick clay inclined 10 to 15 degrees (Figure 10). Directly overlying the clay shear is fractured and brecciated andesite to tuff (Moraga Formation) and directly below the shear are subhorizontal laminations of clay and siltstone (Orinda Formation) mixed with Moraga volcanic clasts. Borehole 429 (AKA-1) located in the northern parking lot of Building 25 encountered primarily colluvium with weak zones at about 14.5 ft and 21 ft in depth; and Orinda-like deposits between 22 and 25 ft with a clay rich zone at 26 ft associated with slickensides and polished bedrock surfaces. Borehole 431 (AKA-3) is located south of Building 85 and east of Building 48 near the small parking lot north of Lawrence Road. The borehole is located directly south of a steep bedrock ridge of volcanics, however the borehole encountered Orinda Formation siltstone and conglomerate. Anomalous shear zones associated with clay seams (some soft and moist) were noted at various depths and inferred to be possible landslide slip surfaces (22 ft; 41 ft; and 48 ft) (Figure 12). These borings, coupled with the borehole compilation provide information on the depth and approximate geometry of the Moraga block located beneath Building 25. The lobate shape of the volcanic block defined by the borehole data, coupled with the presence of anomalous shears some which occur at the Moraga-Orinda Formational contact, led AKA (2009a) to agree with previous postulations that a large bedrock paleolandslide could potentially exist beneath Building 25.

5.2 Faulting

The tectonic fault model of Graymer (2000) interprets the structural discontinuity between the Moraga blocks southwest and northeast of McMillan Road to be the result of vertical displacement from faulting. The down-dip projection of the fault would presumably merge at depth with the east-dipping inactive Chicken Creek fault located west of the site. Although previous researchers associated with LBNL have interpreted nearly east-west trending faults across the campus, none show a fault located beneath McMillan Road.

5.3 Depositional

Early geologic mapping by Lawson and Palache (1901) of the Berkeley Hills, prior to significant anthropological development and hillside reforestation, does not show a fault (landslide or tectonic) displacing the isolated volcanic blocks of the Old Town area from those beneath the Lawrence Hall of Science. Based on the absence of a fault on the map, it is inferred that Lawson and Palache (1901) interpret the volcanic material as deposited within pre-existing depressions developed on a highly irregular alluvial landscape.

6.0 RESULTS OF SUBSURFACE INVESTIGATION

The results of the investigation consist of geologic description and interpretation of three excavations (T-1, T-2 and TP-1) intersecting the margin of the hypothesized paleolandslide, and mapping of nearby surface and road cut exposures of the Moraga-Orinda contact. Excavation descriptions include the geologic units and their stratigraphic relationships, soil profiles, and documentation of faults, shears, and discontinuities observed. We then interpret the geologic data in light of the paleolandslide hypothesis of Parsons (2000). Collectively, the geologic data provide direct evidence for the presence of undisplaced Quaternary colluvium and paleosol horizons overlying bedrock shears and the Moraga-Orinda formational contact.

The geologic materials encountered in the subsurface investigation are divided into five geologic units: (1) Orinda Formation (2) an unnamed Tertiary sedimentary unit possibly contemporaneous with the Moraga Formation, (3) Moraga Formation, (4) Late Pleistocene to Holocene colluvium, and (5) artificial fill. These units are further divided into numbered subunits (e.g. units 10, 11, 12 etc.; see Plates 2 to 4).

Graphic logs of trenches WLA T-1 to T-2 are provided in Plates 2 and 3, and the log of test-pit TP-1 is presented in Plate 4. Detailed descriptions of geologic materials and soil characteristics observed in trenches are provided on the trench logs, as well as the soil profile descriptions in Appendix A. Discussion of the age of these units is in Section 6.3.

6.1 Exploratory Trench WLA T-1

Trench T-1 was excavated on a gentle to moderately inclined, south sloping hillside southeast of Building 25 (Plate 1, Photographs 1 and 2). Trench T-1 exposed four primary units, which from oldest to youngest include the (1) Miocene Moraga Formation (Tm); (2) an inter-Moraga Formation deposit of sedimentary origin (Tms); Late Pleistocene to Holocene colluvium (Hc), and artificial fill (Fill).

6.1.1 Stratigraphic Relations in Trench T-1

In general, the trench encountered a massive fine-grained colluvium overlying a very dense, reddish brown to gray, coarse-to fine-grained Tertiary alluvium, and andesite of the Moraga Formation. All of these deposits are overlain by about three feet of artificial fill emplaced when the area was first developed in the 1940's to 1950's. The trench exposes bedrock faults displacing Tertiary fluvial sediments and volcanic rocks. A thick, well-developed soil with clay films and calcium carbonate nodules mantles the Tertiary bedrock units and is undeformed across the zones of bedrock shearing. The soil is well developed throughout the trench, and extends well into the weathered bedrock.

Andesite and andesitic agglomerate of the Moraga Formation are exposed in the western end of trench T-1 between stations 38 and 52 (Plate 2). The andesite consists of medium

to large angular blocks bounded by intersecting planar fractures. Strong iron oxide and manganese staining coats the fracture faces. The fractures are open to tight, randomly oriented and do not exhibit kinematic indicators.

Directly overlying the Moraga Formation along an undulatory to wavy abrupt contact is a reddish-orange brown sedimentary conglomerate with sand and clay matrix that is interbedded with siltstone to claystone (Photographs 3 and 4). The sedimentary deposits are weakly to moderately consolidated, highly oxidized and contain calcium carbonate filaments and nodules. The coarse-grained sediments are poorly to moderately bedded with crude cross-beds and fining upward sequences, and contain clasts of Orinda, Moraga and Franciscan origin. The siltstone is massive, highly fractured near its base with tight, closely spaced fractures with a trace of rounded pebbles.

Two massive colluvial units consisting of very dark gray clay overlie the Tertiary deposits. The lowermost colluvium (unit 60) contains a trace of Moraga-derived clasts randomly dispersed throughout the unit with a minor concentration in the eastern part of the trench. The colluvial contacts are wavy and gradational, and have been overprinted by pedogenesis. The upper clay-rich colluvial unit (unit 70) is massive, slightly mottled, and is characterized by vertical pedogenic fractures. Calcium carbonate nodules and fine filaments are present in the lower part of the colluvium. An approximately three foot thick layer of artificial fill overlies the colluvium.

A well-developed soil profile is developed in the colluvium and into the underlying siltstone bedrock (Photograph 5). The upper part of soil is a dark gray A-horizon formed from the decomposition and incorporation of organic material in colluvium derived from the Tertiary bedrock. The traces of gravel found in the soil, especially the A horizon, are assumed to be derived partly from the coarser interbeds within the silt, and partly from colluvium derived from basalt and andesite upslope. The A-horizon grades downward into a reddish brown Bt-horizon, the upper portion of which contains prominent whitish nodules of carbonate (Photograph 5, near the white flag). The Bt horizon is developed in the bedrock and its red color is inherited from the reddish siltstone.

The soil profile encountered in trench T-1 formed from long-term weathering and pedogenic processes acting on the weakly indurated siltstone as it underlay the hillside. Horizon boundaries are sub-parallel to the ground surface, dissimilar to the orientation of the fault plane or to the bedding in the coarser grained Tertiary alluvial units displaced by the fault. Thus, the soil has formed in association with the present hillside.

6.1.2 Structural Relations in Trench T-1

A prominent shear zone occurs at the boundary between the Moraga Formation and an overlying Tertiary sedimentary unit (Tms) in the western end of the trench (Photograph 6). This bedrock fault zone predominantly dips east, however, moving west along the trench wall, it becomes highly undulatory and less well organized as a subhorizontal clay seam (Photographs 7 and 8). The primary fault zone is three to four feet wide, composed

of completely altered andesite bedrock, anastomozing shear fabric, crushed and brecciated rock, and multiple subparallel east-dipping shears between stations 36 and 40 ft that strike northwest between 290°and 314° and dip 30° to 50° NE. The shears are less than 0.5 cm wide and are coated with calcium carbonate deposits and a light-gray to whitish clay-rich material. The thinning of the Tertiary sedimentary units and appearance of Moraga Formation volcanics suggests an apparent west-side-up vertical separation. West of station 40 ft. the shear zone thins dramatically to a grayish white several inch thick shear of calcium carbonate-lined stiff clay with highly variable dip directions of 33°, 21° NW, 321°, 8°N, and 267°, 30°N. Measurements of the fault orientations were made by either by cleaning a clay-rich surface, or projecting the fault zone across the trench. No kinematic indicators were observed.

The western fault zone of trench T-1 does not offset or deform the overlying colluvium or well-developed pedogenic horizons. A prominent soil horizon with pedogenic nodules of calcium carbonate (Btk on soil descriptions, unit 45 on Plate 2), projects nearly straight across the fault zone indicating the fault has not displaced this horizon and thus pre-dates its formation. The age of this horizon is at least late Pleistocene (≥ 10,000 yrs) to early Holocene (10,000 to 8,000 years), and thus demonstrates inactivity.

In the central part of trench T-1, at station 26 ft, a secondary west-dipping fault is located in the hanging wall of the primary western fault zone. The west-dipping fault appears to exhibit west-side down vertical separation as noted by the tilted and folded lower Tertiary sedimentary units and thinning of an overlying siltstone across the zone of faulting. The fault zone is composed of thin fractures and fine pulverized sedimentary laminations. The fault becomes highly weathered and obscured upsection but does not offset the overlying well-developed calcic soil horizons or Holocene colluvium, and thus is inactive.

6.2 Test Pit T-1

Test Pit TP-1 was excavated prior to the excavation of Trench T-2 for the primary purpose of assessing whether the Orinda-Moraga contact lay upslope or downslope. The test pit was 16 feet long and up to 13 ft deep, and located on the slope southeast of Building 25. The trench pit was backfilled up to about 6 ft bgs prior to entry because of the loose and weathered bedrock condition encountered.

Test Pit T-1 exposed Moraga volcanic rock beneath colluvium derived from volcanic rock, thus the contact with the Orinda Formation was determined to be in the downslope direction. Based on this information, trench T-2 was excavated beginning near the downslope end of the test pit. Colluvial and bedrock units in test pit TP-1 (Plate 4) are logged as extensions of the units in trench T-2 (Plate 3).

6.3 Exploratory Trench T-2

Trench T-2 was excavated on a moderate slope (about 15 degrees) on the southeast side of Building 25 approximately 15 ft west of Glaser Road (Plate 1, Photograph 9). The

slope is semi-natural with the upper part modified by fill placed during construction of Building 25. The slope is covered with dry grass and a cluster of large Monterey pines. Similar to trench T-1, trench T-2 exposes Tertiary fluvial and volcanic bedrock overlain by colluvium. The trench is oriented N76°E and intersects the previously mapped boundary between the Moraga and Orinda Formations, at the eastern margin of the hypothesized paleolandslide. The maximum depth of trench T-2 is approximately 10 ft and a length of about 65 feet. A small extension of the trench, offset to the north 3 feet, was excavated at the east end to avoid a large buried pine tree stump. Groundwater was not encountered in any excavation. No fill was present except at the far eastern end.

6.3.1 Stratigraphic Relations of Trench T-2

Trench T-2 exposes Tertiary Orinda Formation sedimentary deposits (Tor) and Moraga Formation volcanics (Tm) along a west-dipping geologic contact (Plate 3). Both Tertiary units are overlain by Holocene colluvium derived from Orinda and Moraga materials. The Orinda Formation consists of poorly bedded fluvial conglomerate (Unit 11) interfingering with massive siltstone (unit 10) and is exposed in the eastern and central part of the trench. At station 30 ft, near the western end of the trench, the Orinda Formation is in an abrupt contact with the overlying Moraga Formation (Photographs 10 to 12). Bedding in the Orinda Formation, as well as the overlying contact with the Moraga Formation, dip gently (up to 20°) to the west. The siltstone is massive, moderately weathered and very weak. Occasional lenses of fine gravel occur within the siltstone indicating a temporary shift in depositional environment or an increase in fluvial energy. The conglomerate beds are generally thin and interfinger with the more massive siltstone. The conglomerates have slightly more rock strength than the siltstone, but have similar moderate weathering. Clasts are subangular to subrounded, up to 2 inches in diameter.

The Moraga Formation volcanics exposed in the western portion of trench T-2 were deposited sequentially as layers of a volcanic eruption sequence (ashflows and lappilli tuff to andesite). The lapilli tuff unit (lower portion of unit 20) is a pyroclastic deposit of pea-sized ignimbrite fragments of ash and rock in a finer tuff matrix. As observed, the unit is moderately well consolidated and appears intact as deposited. Overlying the lapilli tuff is the upper portion of unit 20 containing subangular andesitic blocks intermixed within stiff ash matrix and lapilli grains. The contact between the two volcanic units is diffuse over 1 to 2 inches. Multiple units of blocky andesitic flows (unit 21) overlie the pyroclastic sequence. The blocky andesite contains clay films developed on the fracture surfaces indicating some in-situ weathering has occurred.

The basal contact of the Moraga Formation is sharp, wavy and undulatory with the overlying lapilli tuff filling lows within the Orinda Formation. There are no shears or fractures within the lapilli tuff or in the vicinity of the contact (Photographs 11 and 12). The basal contact of the Moraga Formation is marked by a very thin (0.8-1.3 cm) seam or lamination of moderately plastic clay that is continuous and present on both trench walls. This clay is interpreted to represent a thin volcanic ash that has been altered to clay after

interacting with groundwater. No straie, moullins, or brecciated zones occur along the contact. The minimal thickness of the clay and the lack of observed kinematic indicators and deformation, argue against this lamination being associated with landslide movement.

Two primary colluvial units mantle the Moraga and Orinda bedrock. Unit 30 is a colluvium derived primarily from the Moraga andesite/ignimbrite flows of unit 20 in the western portion of the trench. The clasts are highly weathered (smaller clasts can be cut with a knife) and all clasts are coated with distinct clay films. Because this degree of weathering is similar to the in-place exposure, it is likely that these features are for the most part inherited from the in-place weathering of the ignimbrite. The upper portion of this unit may still be in active transport.

A younger colluvial unit (units 31 and 32) extends the length of the trench mantling all lower units, and hosts a fairly thick organic-rich A-horizon. The colluvium is a silt with 10% to 50% gravel The presence of this moderately thick soil horizon indicates the hillslope is not eroding rapidly and instead is relatively stable.. Similar to the soils in trench T-1, the T-2 soils have been relatively stable throughout the Holocene with the slow rates of erosion keeping pace with the rates of weathering and pedogenesis.

6.3.2 Structural Relations of Trench T-2

The trench T-2 investigation encountered no positive evidence of a landslide margin at the Moraga-Orinda bedrock contact. The bedrock strata exposed in trench T-2 show a clear volcanic eruption sequence overlying Orinda Formation siltstone formed on Tertiary floodplains and alluvial fans. This unique time sequence of deposits is not deformed, mixed, or brecciated, suggesting an absence of landslide processes in the area of the trench exposure. Furthermore, any movement at this contact would have disrupted the fragile lapili tuff unit (lower part of unit 20) lying at the base of the Moraga Formation, or the overlying colluvial deposits. As mentioned above, a thin clay lamination was observed at this bedrock contact, but the minimal thickness and lack of observed kinematic indicators argue against this unit being associated with landslide movement.

Trench T-2 encountered a Tertiary-age bedrock fault that offsets Orinda Formation siltstone and conglomerate members, as well as an isolated Moraga volcanic block (Plate 3). The fault zone is very diffuse and poorly developed, and has been obscured by pedogenic and weathering processes-all of which suggest significant antiquity. Projected upsection, the fault zone does not offset older colluvium (unit 12) or the sequence of younger overlying Holocene colluvial units (units 30, 31, and 32). Exposure of the fault on both the north and south walls is very weak with no observed kinematic indicators. The bedrock fault trends N19°E, with a measured dip of 76°SE, based on exposures on both trench walls and across the trench floor. Apparent near-vertical displacement down-to-the-east is interpreted from the juxtaposition of various Tertiary siltstone and conglomerate units, as well as the Moraga Formation. The conglomerate beds west of the

fault zone exhibit substantial drag folding that are indicative of vertical displacement down-on-the-east. An apparent change in dip direction across the fault further supports this sense of displacement. It is unclear if the block of Moraga Formation (unit 22) is correlative with volcanic material to the west (units 20 and 21) because of several stratigraphic inconsistencies, however, if they are assumed to be correlative, the Moraga-Orinda bedrock contact is displaced about 7 to 9 feet in a dip-slip sense of displacement.

The age of faulting is considered to be pre-Holocene due to the highly weathered and diffuse nature of the zone, lack of distinct shear planes, and upward termination of the fault zone in deeply weathered colluvial deposits derived from the Orinda Formation (unit 12). This Orinda-derived colluvium (unit 12) contains no clasts of Moraga Formation that dominate the younger colluvium, and was probably emplaced shortly after cessation of faulting. The fault is likely a sympathetic structure related to the regional uplift of the Berkeley Hills during the late Tertiary.

6.4 Estimated Ages of Deposits

A key means of assessing fault activity is to estimate the ages of deposits that overlie a fault trace. Age estimates can be made by: (1) direct dating of materials sampled from within the deposit (e.g. radiocarbon dating of charcoal); (2) dating of deposits based on fossil assemblages; (3) correlating deposits with deposits of known age in the site vicinity based on lithologic characteristics and geomorphology; or (4) evaluating the degree of soil profile development in the deposits. We use detailed soil profiles and models of depositional processes and paleo-landscapes to evaluate the ages of colluvium and pedogenic soil horizons in trenches T-1 and T-2 because detrital charcoal and fossils were not found.

The trenches are excavated on hillslopes where slow weathering, soil profile development, and erosion are the dominant geomorphic processes. As the Tertiary bedrock is weathered, it is loosened by bioturbation, and transported downslope as colluvium. The colluvium forms a mantle over the weathered bedrock, and itself undergoes continued weathering and pedogenesis along with the underlying bedrock, even as it slowly creeps down the hillslope. Soil profiles, a vertical sequence of horizons that reflect soil processes such as addition of organic material from plants, translocation and accumulation of clay and other weathering products in the subsoil, are indicators of relative landscape stability. When little erosion or deposition is taking place, the soil horizons become more well-developed. The degree of maturity of the soil profile can be an indication of the degree of landscape stability.

Trench T-1 exposes a mature soil profile developed on weathered Tertiary bedrock overlain by somewhat less mature upper horizons developed in the colluvial mantle. The soil profile is parallel to the ground surface, thus its features are presumed to be associated with weathering of the present hillslope. The older soil includes a horizon with carbonate nodules that accumulated during a drier climate consistent with the late Pleistocene interglacial (e.g. 100,000 to about 10,000 years ago). The carbonate nodules are now degraded and coated with clay films and reside within the argillic horizon of the

soil. Based on geomorphology and soil characteristics in trench WLA T-1, the pedogenic carbonate horizons that are developed in the Tertiary siltstone are interpreted to be late Pleistocene in age. The moderately-thick hillside soil profile present in trench T-2 formed from long-term weathering and pedogenic processes acting on the weakly indurated Tertiary siltstone. The soil horizon boundaries noted in Plate 2 are sub-parallel to the ground surface, dissimilar to the orientation of the fault plane or to the bedding in the coarser grained Tertiary alluvial units displaced by the fault. Thus, the soil and associated horizons formed in association with the present hillside. The present-day geomorphic setting, coupled with the thick soil, clay and carbonate accumulation argues for some antiquity to the soil profile and colluvial deposits. The hillside is interpreted to have attained its present shape by late Pleistocene and to have been relatively stable throughout the Holocene, the rates of weathering and pedogenesis keeping pace with a slow rate of hillslope erosion.

Trench T-2 likewise exposes a mature soil profile developed on a combination of weathered Tertiary bedrock and colluvium derived from Tertiary bedrock units upslope. Tertiary sediments, volcaniclastics, and volcanic rocks are gradually being weathered and transported downslope as colluvium. The presence of clay films and highly weathered clasts in the colluvium of trench T-2 are not good indicators of age for these deposits because they are derived from weathering of the original bedrock. The weathering of the small clasts in the colluvium, however, may reflect weathering within the colluvium as they are too fragile to have survived transport in their present state. The presence of the A-horizon is moderately well developed and thick considering the hillslope environment. Similar to the soils in trench T-1, the trench T-2 soils have developed through the late Pleistocene and have been relatively stable throughout the Holocene with the slow rates of erosion keeping pace with the rates of weathering and pedogenesis. Therefore, the fault located in the eastern end of the trench is not Holocene active. In addition, the geologic contact between the Moraga and Orinda Formations also has not been the focus of differential displacement as noted by the undisplaced overlying colluvial units.

7.0 DISCUSSION

WLA excavated two trenches near and across the eastern and western margins of the hypothetical paleolandslide projected beneath Building 25. The trenches exposed sheared Tertiary sedimentary and volcanic material along northwest-striking and northeast-striking faults, as well as undeformed depositional bedrock contacts striking approximately N30W. All of these bedrock contacts are overlain by unfaulted colluvium ranging in age from late Pleistocene to Holocene indicating the features have not been active in thousands, and some likely in millions of years.

The data collected to date are insufficient to definitively determine the placement of the lobate-shaped Moraga Formation block beneath the Building 25 site. The origin of the block of Moraga Formation is equivocal. The data analyzed both support and contradict the presence of a large ancient landslide at the site. The trenches either intersect the previously mapped landslide margins or cross key bedrock contacts hypothesized by Parsons (2000), and also likely lie close to any previously unknown main margin(s). However, regardless of the origin and placement of the volcanics, information obtained from the shears encountered in the trenches provides direct evidence for the absence of deformation for thousands of years, as well as millions of years for some of the bedrock shears. Furthermore, one of the trenches demonstrates that the geologic contact between the Moraga and Orinda Formations is depositional and lacks bedrock shearing in contrast to that postulated by Parsons (2000). Whether any of the structures encountered in the trenches represent the main paleolandslide margin(s), the features likely are in close proximity to the margin. For instance, based on the dip directions being preferentially aligned, the shears should have undergone triggered slip during displacement of the hypothesized paleolandslide during one or more large events on the Hayward fault during the Holocene Epoch. As noted previously the shearing does not offset paleosol horizons or overlying colluvium. Collectively, this study indicates that the Moraga Formation block previously characterized as a paleolandslide has been stable for many thousands of years and has undergone tens of large magnitude earthquakes on the Hayward fault without notable displacement.

Although there remain other viable explanations for the origin of the Moraga Formation blocks in the Old Town area, such as ancient tectonic faulting and volcanic deposition on a highly undulatory paleotopography, these other models suffer from a paucity of data. The tectonic fault model of Graymer (2000) hypothesizes that the structural discontinuity is a result of a northwest-striking fault beneath McMillan Road. The geologic cross section B-B' prepared to evaluate the paleolandslide model partly supports a south-dipping fault; however, other than the observation that the Moraga Formation appears displaced across McMillan Road, no geologic evidence was discovered from a review of previous consultant reports to support this fault model. Furthermore, this model does not explain the Moraga/Orinda Formation undulations to the southwest of McMillan Road that have amplitudes on the order of 100 feet.

Under the depositional model, the highly undulatory boundary between the Moraga and Orinda Formations that has been previously delineated from borehole data would reflect paleotopography and not landsliding. This pre-eruptive landscape (many millions of years ago) would have had to consist of narrow and deep ravines and valleys that became subsequently buried by ten(s) to hundred(s) of feet of volcanic debris. Similar, to the faulting hypothesis there is no overwhelming geologic data to support this model. Proving this hypothesis would require a systematic evaluation of the Moraga-Orinda geologic contact across the Old Town area, such as (1) documenting the existence of coarse-grained fluvial deposits (i.e., buried channels) or buried paleosols directly beneath the formational contact to demonstrate the lavas were filling an irregular ground surface, and (2) the absence of shearing across the contact. It is interesting to note that trench T-2 identified a clear depositional contact between the Moraga and Orinda Formations, whereas boring 430 (AKA-2) encountered a strong reddish brown (baked zone?), clay rich feature at the contact that is consistent with shearing. It may be that none of the three models by themselves explains the structural anomaly of the Moraga volcanics, and it can best be reconciled as a combination of two or more processes.

7.1 Paleolandslide Model

The paleolandslide model of Parsons (2000) considers a large block of Moraga volcanics breaking free from the steep ridge north of the site and translating downslope to its current position. The vertical and lateral displacement is on the order of several hundred feet or greater. Interpretation of geologic cross-section B-B' indicates it is permissible to retrodeform the lobate volcanic mass and tuffaceous siltstone beneath Building 25 with the steep ridge of "intact" Moraga Formation north of the site (Figure 8). The geologic cross section supports the paleolandslide hypothesis. However, we note that there is no geomorphic expression of an east-or west-trending arcuate headscarp traversing the bedrock ridge. The absence of the headscarp either suggests the landslide does not exist or the previous topography associated with landsliding has been removed by erosion and weathering. Considering the absence of such features, coupled with the rounded and subdued ridge of Building 25, if a paleolandslide does exist, it is geologically stable.

Exposures in trenches T-1 and T-2 provide further support for the presence of a stable landscape over much of the Holocene. The stratigraphic and structural relations exposed in trench T-1 indicate that Holocene colluvial deposits and late Pleistocene pedogenic horizons overlying the bedrock shears provide evidence for long-term stability and the absence of recent deformation along the hypothesized western margin. We acknowledge that the margin could project between the west end of trench T-1 and borehole 476 and thus would be consistent with the paleolandslide model of Figure 3 (e.g., Moraga Formation overlying Orinda Formation along an east-dipping contact). However, even if the main landslide margin lies directly west of trench T-1, the prominent bedrock shearing and folding documented in trench T-1 would likely undergo sympathetic secondary displacement and/or rotation during large-scale translation. As noted previously, the colluvium and well developed soil profiles are undeformed across the shear zones. Lastly, a more westerly located shear plane invokes a very narrow and discontinuous Moraga block as the controlling landslide margin.

Trench T-2 located across the eastern margin of the hypothetical paleolandslide provides direct evidence for the absence of shearing along the inferred slide plane between the Moraga and Orinda Formations. The trench exposed a west-dipping geologic contact strongly suggestive of an eruptive sequence (air fall tuff followed by andesitic flows) deposited on the Orinda Formation. The geologic contact lacks the shearing and internal deformation expected along a landslide margin translated hundreds of feet from its origin. Lastly, the overlying Holocene colluvial deposits do not show evidence of repeated deformation across this contact.

Deciphering the structural geology in the Old Town area is very complicated due to a number of factors: (1) the absence of numerous bedrock exposures; (2) limited bedding information for the Orinda and Moraga Formations; (3) significant anthropogenic landscape alterations, and (4) interbedded fluvial deposits within the Moraga Formation closely resemble Orinda Formation deposits possibly leading to incorrect bedrock classifications by others. Individual borehole observations (some at five foot sampling intervals or greater) interpreted from pervious investigations provide only a limited perspective of the subsurface conditions. Trenches excavated for this study clearly demonstrate the complexity in the bedrock shears and stratigraphy across a short lateral distance. Despite the difficult geologic conditions and scarcity of high-quality data from Old Town, we believe the subsurface investigation and geomorphic evaluation of evidence supporting recent landslide movement, indicate that if a paleolandslide exists beneath the site it is geologically stable under present-day conditions.

8.0 CONCLUSIONS

Based on the findings of this study, we conclude that the Building 25 site is suitable for redevelopment assuming the recommendations provide below are considered. The paleolandslide investigation conducted for this study provides evidence that indicates if a paleolandslide exists beneath the site it is geologically stable as previously mapped. The initial engineering geologic characterization of the paleolandslide and assumed strength and geometrical boundary conditions that suggested frequent large translations from major earthquakes on the Hayward fault were based on geologic assumptions (e.g. overall paleolandslide geometry and residual shear strengths) that are no longer considered valid. The trench and geomorphic data provide evidence for long-term (thousands of years) stability of the bedrock ridge.

The following recommendations are based on this investigation:

- Prior to final design of new major structures, site-specific geotechnical and/or geologic investigations should be performed to assess the soil and bedrock conditions, minor slope instabilities, site grading and loading, strong ground shaking, and surface fault rupture potential.
- Avoid future development in the area of Buildings 40 and 41 (southwest of Building 25) without characterization of the upslope limits of historical landsliding.
- The trenches were not backfilled to engineering design specifications. Any proposed buildings or structures that intersect the trenches should include removal and re-compaction of the trench backfill.

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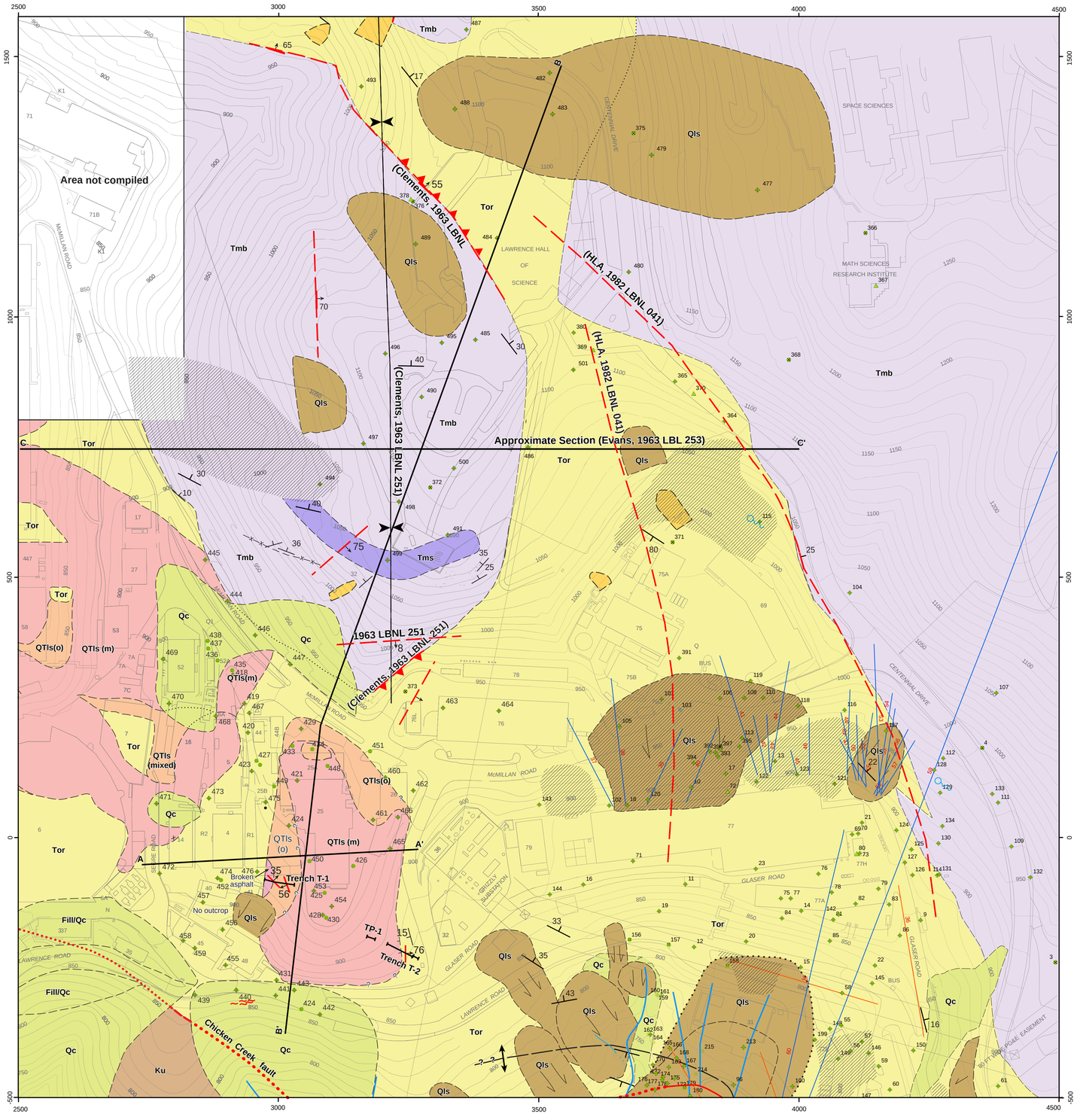
FIGURES

PLATES



Explanation

Map Symbols

- Contour, 10-foot interval (2003)
- Contact, dashed where approximate dotted where concealed
- Fault, dashed where approximate, dotted where concealed and uncertain
- 84 — Attitude bedding
- Overturned bedding
- Fault with dip angle and direction
- Syncline
- Anticline
- Buildings, roads, vegetation (2003)
- Spring (Parsons, 2000)
- Stream (LBNL, 2003)
- Road-parallel cracks
- Trench
- Active or former location of slide, which has been removed or mitigated
- Approximate extent of repaired slope/landslide
- Potentially active Quaternary landslide
- Qls — Quaternary landslide deposits with minimum (dashed) landslide extent (may or may not have been mitigated)

Geologic Units

Qc	Quaternary colluvium
QTls(m)	Hypothesized Moraga paleolandslide unit (see report)
QTls(o)	Hypothesized Orinda paleolandslide unit (see report)
Tmb	Miocene Moraga Formation (volcanics)
Tms	Miocene Moraga Formation (volcaniclastic siltstone/sandstone)
Tor	Miocene Orinda Formation (sandstone, siltstone, and conglomerate)
Ku	Cretaceous Great Valley Group (sandstone and shale)

Subsurface Data
(numbers refer to GIS database)

GIS Data Point ID	
24	Boring
294	Pier hole
72	Slope indicator boring
4	Piezometer
283	Monitoring well
164	Well boring
352	Test pit
103	Borehole-hydrograph
60	Hydroauger
34	Seismic line
22	Trench or test pit
72	Cut wall

True north
Grid north

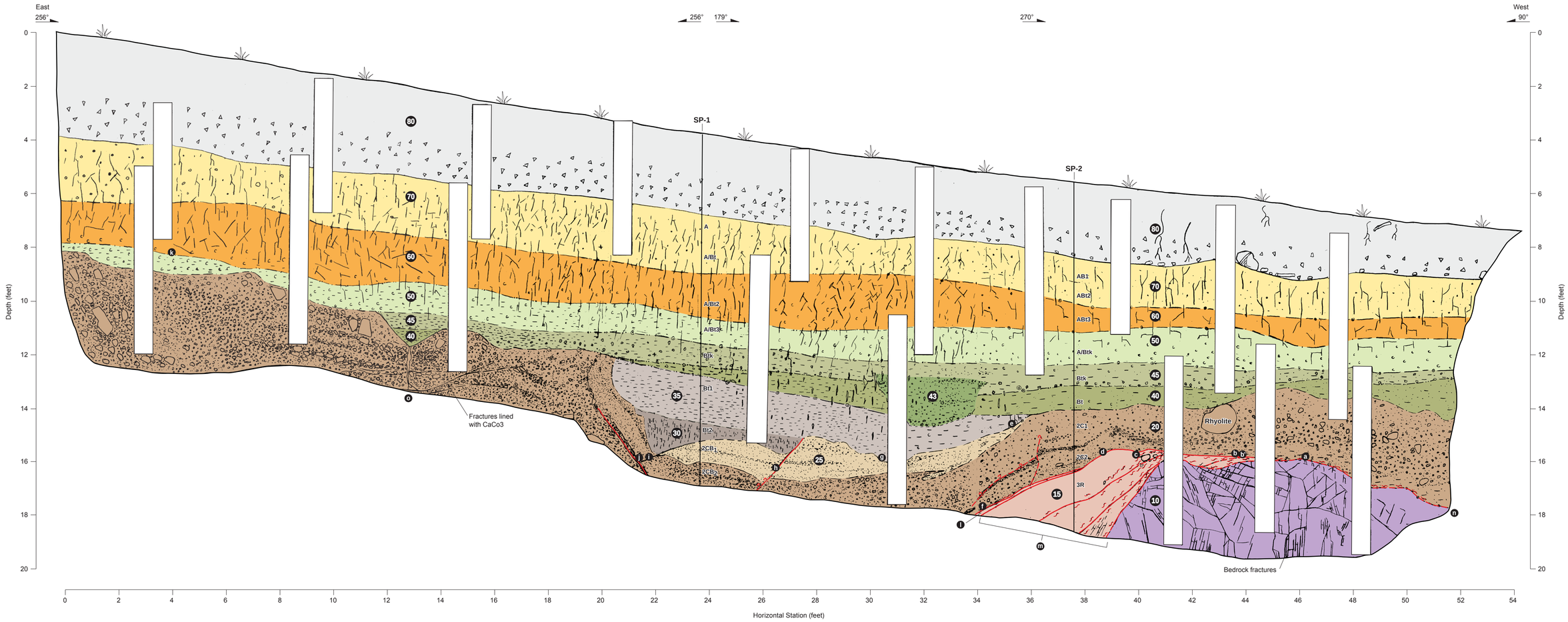
0 50 100 200 feet

Grid north is ~16° west of true north

Notes:
1. Coordinate system is the University of California Grid system.
2. Mapping is based on field reconnaissance and compilation of previous studies.
3. The location accuracy of all data is limited to resolution provided in source documents. Georeferencing error maybe up to 10 feet.

Graphics, Active Projects, 2072.001, Modified:08:31:09

GEOLOGIC MAP



Explanation

Symbols

- Soil pattern
- Pedogenic fractures
- Contact, solid where certain, dashed where approximate, dotted where inferred
- Fault, dashed where approximate, queried where uncertain
- Shear fabric
- SP-1 — Soil profile (see Appendix A)
  - A
  - A/Bt
  - A/Bt2

Unit Descriptions

80 — Upper fill: SILT (ML); Very dark gray (10YR 3/1); dry; stiff; 85% silt, 10% very fine sand, 5% clay; High dry strength; high toughness; no dilatancy; low plasticity; block massive structure, abundant roots (1" to 0.5" diameter) and rootlets, common large roots (>1" diameter), basal contact planar to slightly undulatory over 2-3".
Lower fill: Sand with silt and gravel (SW); Light yellowish brown (2.5Y 6/3); dry; dense; 90-95% matrix (matrix: 80% very fine sand, 20% silt), 5-10% gravel; low dry strength; slow to no dilatancy; low toughness; non-plastic; gravel is angular 1" to 3" clasts, gravel clasts are sandstone and are parent material for matrix, rare glass along basal contact, basal contact is planar and sharp [FILL].

70 — CLAY, silty with sand (CL); Very dark gray (10YR 3/1); dry to slightly damp; stiff; 70-80% clay, 20% silt, <10% fine sand, trace coarse sand; medium dry strength; slow dilatancy; medium to high toughness; medium to high plasticity; angular block to weak columnar pedogenic structure, strong brown (.5YR 4/6) mottles coating vertical columnar pedogenic surfaces, moderate to weak clay films coating some coarse sand clasts, common fine pores, common roots and rootlets; weak to no reaction to HCl; massive, angular coarse sand consists primarily of Moraga Formation fragments; slightly wavy diffuse basal contact over ~6" [COLLUVIUM, A and A/Bt pedogenic soil horizon].

60 — CLAY, silty (CL), trace coarse sand; Very dark gray (10YR 3/1); slightly damp; medium stiff; 70-80% clay, 20-30% silty, trace to ≤ 5% coarse sand; low to medium dry strength; no dilatancy; low toughness; medium to high plasticity; angular irregular to massive pedogenic structure; moderate to weak clay films on pedogenic faces and coating coarse sand clasts, weak carbonate (CaCO3) film coating clasts, clasts are weakly effervescent, matrix (clay) does not effervesce with HCl, common roots and rootlets, few fine pores; trace sands are angular and consist of Moraga Formation, coarse sand clasts seem to be associated with areas with higher abundance of roots, lining root casts, diffuse basal contact over ~6", wavy [COLLUVIUM and mixed siltstone bedrock with A/Bt2 soil overprint].

Unit Descriptions (continued)

50 — CLAY, silty with sand (CL-ML), Dark reddish brown (5YR 3/3); dry to slightly damp; medium stiff; 60% clay, 25% silt, 15% fine- to coarse-grained sand; sand is 10% coarse, 5% fine-grained, subrounded to subangular sand of Moraga Formation (Rhyolite and Andesite) and clasts of mixed alluvial bedrock deposited at post/coincident Moraga time (siltstone clasts); medium dry strength; no dilatancy; medium toughness; medium plasticity; irregular angular to very weak blocky pedogenic structure; weak clay films coating clasts; CaCO3 coating clasts, abundant small ~ 1-2 mm rounded carbonate nodules throughout; basal contact is gradational over <4 inches, [BEDROCK, siltstone member of the mixed alluvial bedrock deposited at post/coincident Moraga time, A/Bt3 with minor Btk soil overprint].

45 — CLAY, silty (CL-ML), Dark reddish brown (5YR 3/3); dry; medium stiff; 50-60% clay, 30-40% silt, <10% sand; medium dry strength; no to slow dilatancy; medium toughness; medium plasticity; irregular angular pedogenic structure; clay films on pedogenic surfaces, abundant CaCO3 nodules 1-2.5 cm diameter along the base of the unit, some sub-vertical carbonate stringers, nodules and matrix strongly effervesce; massive; basal contact is gradational over 1-3" [BEDROCK, siltstone member of the mixed alluvial bedrock deposited at post/coincident Moraga time, Btk soil overprint].

43 — CLAY, silty, with gravel clay, Dark reddish brown (5YR 3/3); dry; medium stiff; 30-40% clay, ~20% coarse sand, ~20% fine gravel, 10-20% silt; weakly interbedded channel within Units 40 and 45, poorly defined coarse-grained channel, granular nature of deposit, interbeds within Units 40 and 45, loose CaCO3 precipitations [BEDROCK, interbedded coarse-grained facies of siltstone member of the mixed alluvial bedrock deposited at post/coincident Moraga time, Btk soil overprint].

40 — CLAY, silty (CL-ML), Reddish brown (5YR 4/4); dry to damp; medium stiff; 45-55% clay, 45-55% silt, <10% sand; medium dry strength; no to slow dilatancy; medium toughness; medium plasticity; weak irregular angular pedogenic structure; clay films on pedogenic surfaces and clasts, few 0.5 cm wide CaCO3 nodules, common vertical CaCO3 filaments; few angular coarse sand clasts, nodules effervesce strongly with HCl, matrix has weak to no reaction to HCl; basal contact is diffuse over <6 inches and planar [BEDROCK, siltstone member of the mixed alluvial bedrock deposited at post/coincident Moraga time, Btk soil overprint, pedogenic subunit of Unit 45].

Unit Descriptions (continued)

35 — SILT with sand (ML); Reddish brown (2.5YR 4/4); dry to slightly damp; soft; ~60% silt, ~40% sand, trace clay; no dry strength; slow dilatancy; low toughness; low plasticity; very weak angular blocky pedogenic structure, weak clay films on pedogenic fracture surfaces and clasts; sand is fine to coarse grained, subangular; CaCO3 filaments coating/infilling some pedogenic fractures, filaments have strong reaction to HCl, matrix has weak to no reaction to HCl; Unit 35 has no residual bedrock fabric, Unit 30 has blocky siltstone fabric, siltstone is well cemented and crumbles in angular irregular <1 inch siltstone clasts [BEDROCK, siltstone member of the mixed alluvial bedrock deposited at post/coincident Moraga time, Bt soil overprint].

30

25 — SAND, silty, clayey (SC-SM); Dark reddish gray (5YR 4/2); damp soft to medium stiff; ~80% very fine sand, ~10% silt, ~10% clay, trace gravel; massive with occasional gravel interbeds; well sorted; slight to strong reaction to HCl; basal contact is gradational over 1" [BEDROCK, fine-grained facies of conglomerate member of the mixed alluvial bedrock deposited at post/coincident Moraga time; Bt overprint].

20 — GRAVEL with silt and sand (GW-GM); Reddish brown (2.5YR 4/4); dry; loose; ~55% gravel, ~35% sand, ~10% silt; conglomerate with subrounded Orinda and Moraga gravels; poorly sorted; highly friable; many CaCO3 nodules and filaments (stringers) up to 3" long; indistinguishable pedogenic structure, upper 2 feet of conglomerate is highly weathered, clasts of Orinda Formation are weathering in place; conglomerate is well cemented in places and weakly weathered where more than 2 feet of the conglomerate profile is exposed [BEDROCK, conglomerate member of the mixed alluvial bedrock deposited at post/coincident Moraga time; Bt overprint].

15 — BRECCIATED ANDESITE; crushed and breciated andesite with anastomosing calcium carbonate seams and coated blocks. Fault zone material.

10 — ANDESITE; gray agglomerate volcanic rock, angular blocks of weathered andesite

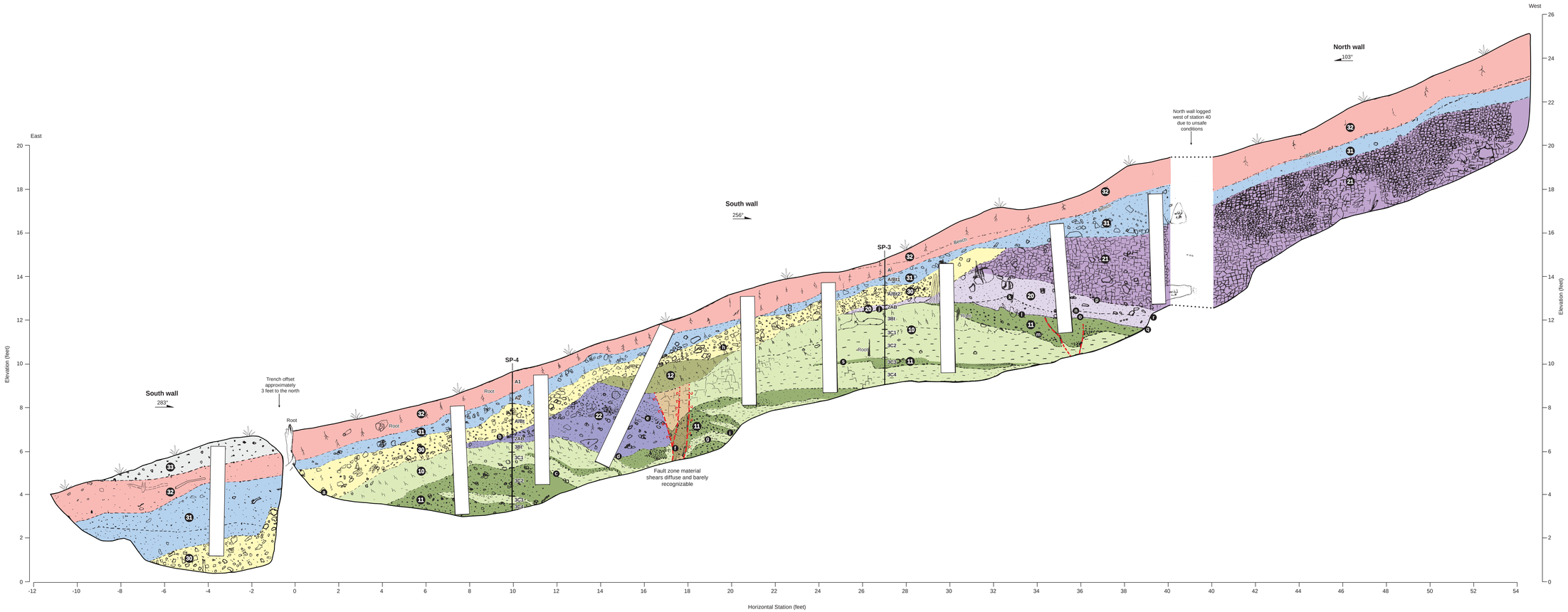
Notes

- **a** Fault orientation, 33°, 21°NW
- **b** Fault orientation, 321°, 8°NE
- **b'** Fault plane, opposite (north) wall, 267°, 30°N
- **c** Fault orientation, 314°, 30°N. Locally, between Stations 38 and 41 the fault plane is wavy and undulates with 3-6 inches relief. A 1-2 mm thick rind of CaCO3 coats the fault plane, the CaCO3 is moderately hard, and picks clean as resistant shelf, no striations or movement indicators.
- **d** Fault orientation, 302°, 28°NE. A 1-2 mm thick rind of CaCO3 coats the fault plane, the CaCO3 is moderately hard, and picks clean as resistant shelf, no striations or movement indicators.
- **e** Bedding orientation, 283°, 25°N
- **f** Fault orientation, 290°, 35°NE
- **g** Bedding orientation, 354°, 19°E
- **h** East-dipping shear places coarse sand in fault contact with siltstone
- **i** East-dipping shear not present on North wall, east-dipping shear is discontinuous near the base of the trench where it is truncated by a west-dipping shear. West-dipping shear is the dominant feature.
- **j** Fault orientation, 326°, 56°SW. Across trench strike and dip measured from the base of fine sand overlying gravel.
- **k** Soil bedding orientation, 324°, ≤10°SW (Soil ABt3)
- **l** Clay gouge ~1.5" thick at bottom of trench thins to single strand of clay, ≤1 inch thick, where it crosses Station 38.
- **m** Primary fault zone highly sheared, completely altered bedrock, very weak, no remaining bedrock fabric.
- **n** Shear zone several inches wide defined by thin seams of clay gouge CaCO3-lined shears, fractures and aligned and stretched weathered Tm pebbles.
- **o** CaCO3-lined fractures predominantly subhorizontal through gravel to sub vertical, thick vertically orientated CaCO3-lined fracture near Station 13.

PALEOLANDSLIDE INVESTIGATION
LOG OF TRENCH T-1

PLATE 2

Graphics, Active Projects, 2072.001, Modified:08.31.09



Explanation

Symbols

- Soil pattern
- Pedogenic fractures
- Contact, solid where certain, dashed where approximate, dotted where inferred
- Fault, dashed where approximate, queried where uncertain, dotted where concealed
- **SP-4** — A1, A2, A/Bt: Soil profile (see Appendix A)

Unit Descriptions

33 — SILT with sand and gravel (ML); very dark grayish brown (10YR 3/2); dry; medium stiff to soft; ~55% silt, ~25% sand, ~20% gravel; poorly sorted subangular to subrounded gravels up to 0.8' diameter or andesite and siltstone; medium dry strength, slow dilatancy, low toughness, no plasticity; many grass roots, organics, and foreign material (nails and glass); no reaction to HCl; lower contact diffuse over 0.2' (FILL)

32 — SILT with sand (ML); very dark gray (10YR 3/1); dry; medium stiff; ~60% silt, ~35% sand, ~5% gravel, trace clay; moderately sorted; massive; sand is fine to coarse grained andesite and tuff; gravel increasing in abundancy near lower contact; medium to low dry strength, slow to no dilatancy, low toughness, no plasticity; several large roots, many rootlets; no reaction to HCl; lower contact diffuse over 0.2' (A Horizon in Colluvium)

31 — SILT with gravel (ML); black (5Y 2.5/1); dry; medium stiff to soft; ~50% silt, ~30% gravel, ~20% sand; low dry strength, slow dilatancy, low toughness, no plasticity; poorly sorted; gravels are andesite and welded tuff clasts, subangular, 0.05' to 0.4' diameter; many roots and rootlets; no reaction to HCl; lower contact gradational over 0.3' (A/Bt horizon in Colluvium)

30 — COLLUVIUM (gravel/silt/clay conglomerate); light brownish gray (10YR 6/2) clasts with very dark gray (10YR 3/1) matrix; dry; medium dense; poorly sorted; clayey matrix towards the east; clasts are subangular weathered andesite and some welded tuff ignimbrite 0.05' to 0.5' diameter; ~60% gravels, ~40% matrix, matrix grading to more silty and sandy upslope to the west; few roots and rootlets; no reaction to HCl (Colluvium derived from Moraga Fm.)

22 — ANDESITE siltstone with sand and gravel; dark grayish brown (10YR 4/2) to very dark grayish brown (10YR 3/2); moderately sorted; sand is fine to coarse grained; gravel is subangular andesite, <0.4' diameter, random orientation with no fabric; few roots and krotovina; no reaction to HCl, well defined lower contact (Moraga Fm.)

Unit Descriptions (continued)

21 — ANDESITE; dark brown (10YR 3/5) with fresh, gray (10YR 5/1) exposed; moderately to slightly weathered; very weak to hard; ~80% gravel to boulders, ~20% sandy matrix between fractured clasts; boulders <2' diameter; andesite vesicles are filled with a black secondary mineral; blocky planar fractures with random orientation; weathering rinds on all surfaces; no reaction to HCl (Moraga Fm.)

20 — SILT (lapilli TUFF) with sand and clay (ML); very dark grayish brown (10YR 3/2); dry; medium stiff; ~55% silt, ~30% sand, ~15% clay, several subangular andesite gravels intermixed; medium dry strength, slow to no dilatancy, medium toughness, low plasticity; sand grains are subrounded volcanic lapilli; no reaction to HCl; no pedogenic structure; lower contact diffuse over 0.1'; less silt and clay with ~25% gravel towards the west (Moraga Fm.)

12 — SILTSTONE; brown (10YR 4/3) with some dark reddish brown (2.5YR 3/3); moderately weathered; very weak; moderately sorted; slightly mottled; siltstone is ~60% silt, ~25% sand, ~15% clay; coarse sand and trace gravel is subrounded to subangular sandstone; few roots; no reaction to HCl; faint angular blocky pedogenic structure; lower contact diffuse over 0.3' (Orinda Fm. or very old Orinda-derived colluvium)

11 — CONGLOMERATE; dark yellowish brown (10YR 3/4); moderately weathered; very to extremely weak; clast supported; fine gravel to coarse sand clasts; subrounded to subangular <0.1' diameter clasts of sandstone with siltstone, tuff, andesite and trace shale, quartzite, and serpentinite; iron oxide and manganese weathering rind on surfaces of clasts; interfingering layers of siltstone 0.3' to 1.0' thick; siltstone equally intermixed towards west; few roots and rootlets; no reaction to HCl; lower contact diffuse over 0.5' (Orinda Fm.)

10 — SILTSTONE; dark gray (5YR 4/1), dark reddish brown (2.5YR 3/4), and dark grayish brown (10YR 4/2); very to extremely weak; moderately to slightly weathered; massive with some mottling, medium plasticity; well sorted grading up to poorly sorted; slightly sandy with trace to 15% subrounded to subangular sandstone and siltstone gravels; interfingers with conglomerate unit; some volcanics intermixed towards upper and lower contacts; angular blocky pedogenic structure; contacts diffuse over 0.3'; no reaction to HCl; (Orinda Fm.)

Bedding and Orientations

- **a** — Ignimbrite tuff dips steeply north to paleoswale on north wall. Top of rock is under hole. Total thickness of ignimbrite is unknown.
- **b** — 330, 40NE
- **c** — 022, 27NW
- **d** — 040, 25NW
- **e** — 050, 27NW
- **f** — 019, 76SE
- **g** — Sharp 65°-70° contact 020, 15NW
- **h** — 257, 26E
- **i** — Mixed zone of units to east; 025, 15NW
- **j** — 005, 20E
- **k** — 015, 16SE
- **l** — 330, 10SW
- **m** — 335, 19SW
- **n** — 325, 13SW
- **o** — 330, 8-12SW
- **p** — 357 - 350, 11SW
- **q** — Thin (0.8-1.3 cm.) clay lens at lapilli tuff (Tm) (above unit) and competent gray siltstone (Tsr) (below unit). Low to moderate plasticity, no kinematic indicators observed. 337 along seam in floor.
- **r** — Unit contains welded tuff volcanic bombs.
- **s** — 302, <10°SW

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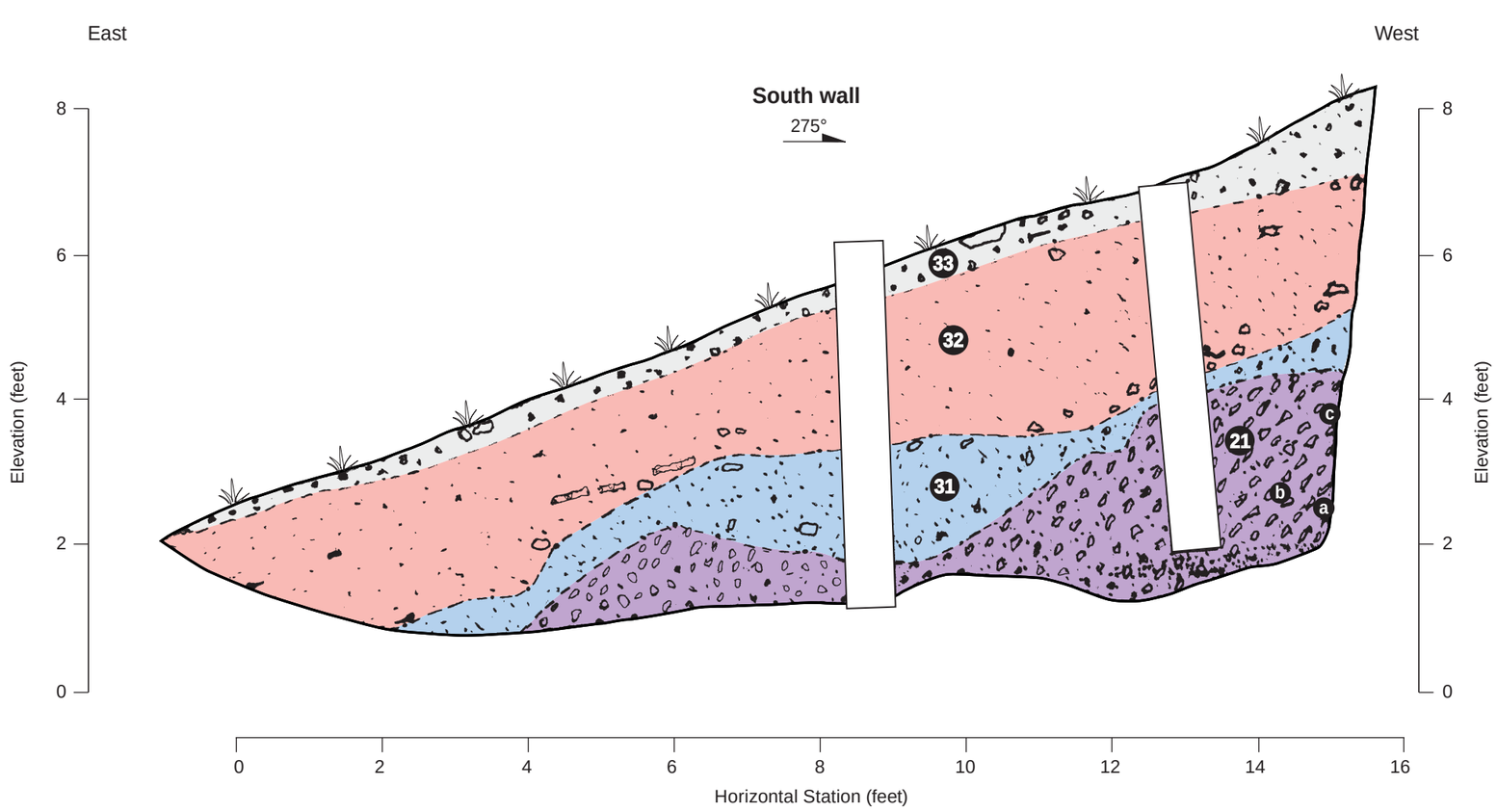
PALEOLANDSLIDE INVESTIGATION
LOG OF TRENCH T-2



Explanation

Unit Descriptions

33 — SILT with sand and gravel (ML); very dark grayish brown (10YR 3/2); dry; medium stiff to soft; ~55% silt, ~25% sand, ~20% gravel; poorly sorted subangular to subrounded gravels up to 0.8' diameter or andesite and siltstone; medium dry strength, slow dilatancy, low toughness, no plasticity; many grass roots, organics, and foreign material (nails and glass); no reaction to HCl; lower contact diffuse over 0.2' (FILL)

32 — SILT with sand (ML); very dark gray (10YR 3/1); dry; medium stiff; ~60% silt, ~35% sand, ~5% gravel, trace clay; moderately sorted; massive; sand is fine to coarse grained; gravel increasing in abundancy near lower contact; medium to low dry strength, slow to no dilatancy, low toughness, no plasticity; several large roots, many rootlets; no reaction to HCl; lower contact diffuse over 0.2' (A Horizon developed with colluvium))

31 — SILT with gravel (ML); black (5Y 2.5/1); dry; medium stiff to soft; ~50% silt, ~30% gravel, ~20% sand; low dry strength, slow dilatancy, low toughness, no plasticity; poorly sorted; gravels are andesite and welded tuff clasts, subangular, 0.05' to 0.4' wide; many roots and rootlets; no reaction to HCl; no pedogenic development; lower contact gradational over 0.3' (Colluvium)

21 — ANDESITE; dark brown (10YR 3/5) with fresh, gray (10YR 5/1) exposed; moderately to slightly weathered; very weak to hard; ~80% gravel to boulders, ~20% sandy matrix between fractured clasts; boulders <2' wide; andesite vesicles are filled with a black secondary mineral; blocky planar fractures with random orientation; weathering rinds on all surfaces; no reaction to HCl (Moraga Fm.)

Bedding and Orientations

a — Fracture; 350, 27°W; wavy to planar; several similar fractures subparallel spaced 0.5 to 1 inch apart.

b — Joint; 006, 40°SE; wavy to planar; tight; no infill but weathered surface; many similar subparallel joints spaced 0.02 to 0.1 inch apart

c — Joint; 045, 47°S; wavy to planar; no infill but weathered surface; many similar subparallel joints spaced 0.02 to 0.1 inch apart

Graphics, Active Projects, 2072.001, Modified 08.31.09

PALEOLANDSLIDE STUDY
TEST PIT TP-1

PHOTOGRAPHS

Photograph 1. View to the northwest showing the trench T-1 location in a narrow lawn area sloping southwest toward Building 42 (not shown).

Photograph 2. View to the east showing the location of trench T-1.

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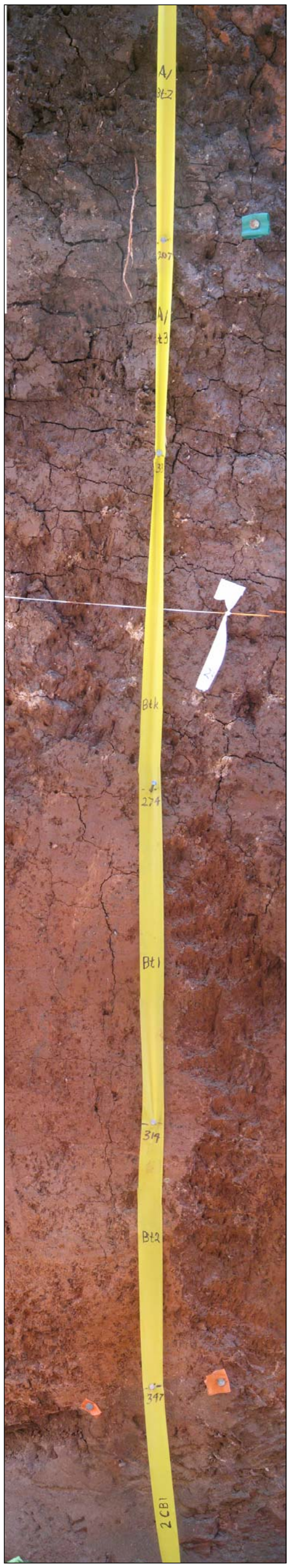
Photograph 3. View of the southwall of trench T-1 near Station 16 feet. Photograph shows the coarse-grained and partially bedded and fractured character of the Tertiary sediments. Overlying the coarse-grained deposit is a reddish brown fine-grained silt also part of the Tertiary sediments.

Photograph 4. View of the zone of folding and faulting in Tertiary sediments near Station 22 feet.

Graphics, Active Projects, 2072.001, Modified 08.31.09



Photograph 5. Photomosaic of a portion of soil profile SP-1 evaluated at Station 24 feet. See Appendix A for the description of the profile and explanation of the soil horizon abbreviations.

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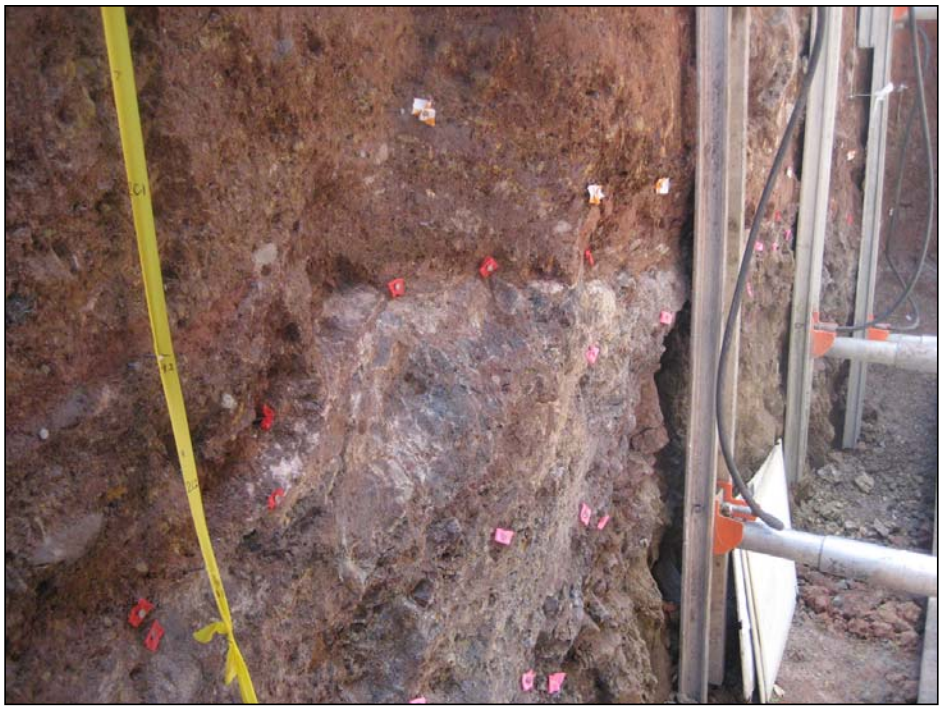
Photograph 6. View of the geologic contact between the Tertiary sediments (reddish brown in color) and sheared Moraga Formation (grayish in color) near Station 38 feet in trench T-1. Yellow tape is the location of soil profile SP-2 (see Appendix A).

Graphics, Active Projects, 2072.001, Modified 08.31.09



Photograph 7. View looking west of the abrupt and sheared contact (red flags) between the Tertiary sediments (reddish brown in color) and the Moraga Formation (grayish in color) near Station 38 feet in trench T-1.

Photograph 8. A close-up of calcium carbonate lining the shear zone between the Tertiary sediments and Moraga Formation at Station 42 feet near note b (see log of trench T-1).

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Photograph 9. View looking west and upslope toward the southern Building 25 parking lot showing the location of trench T-2. The geologist standing in the trench is within the Moraga Formation located at the west end of trench T-2.

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Photograph 10. View of the geologic contact between Moraga-derived colluvium (orange/white stripe flags) and Moraga Formation (Lapilli tuff) (yellow flags) and the underlying Orinda Formation (from yellow flags to bottom of trench) near Station 38 feet. Yellow tape is the location of soil profile SP-3 (see Appendix A).

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Photograph 11. View of the south wall of trench T-2 showing the geologic contact (yellow flags) between the Moraga Formation (brownish blocky material) and the Orinda Formation (gray and red siltstone) near Station 34 feet.

Photograph 12. Close-up of the geologic contact (yellow flags) between the Moraga and Orinda Formations at Station 34 feet showing the absence of shearing.

Graphics, Active Projects, 2072.001, Modified 08.31.09

APPENDIX A

Soil Profile Data Sheets

SOIL PROFILE DESCRIPTION

William Lettis & Associates, Inc.

Profile: SP-1 Site: LBL Building 25, T-1

Elevation: Slope: Job #: 2072

Site description: Sloping lawn area surrounded by trees, in between buildings 25 and 4
Trees = dawn redwood, sequoia, live oak

Date: 7-16-09
Time: 11:00 am
By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
85	Fill	a s; c w; g i; d b	(d) / (m)	(d) / (m)	m vf gr; sg f pl; 1 m p r; 2 c cpr; 3 vc abk; sbk	f r 0; m sr 10; sa 25; c a 50; 75; 100	so po lo; ss ps vfr lo; s p fr so; vs vp fi sh; vfi h; efi vh; eh	C; SC SiC; SCL CL SiCL; LS SL L SiL; S Si	v1 f pf; 1 d po; 2 br; 3 p co; cobr	k I; y II; z III; q IV; V; V+	Fill Abundant fin-co roots Ang. ss gravel in sandy matrix
115	A	a s; c w; g i; d b	(d) / 7.5YR 3/2 (m)	(d) / 7.5YR 4/4-5/6 (<5%) (m)	m vf gr; sg f pl; 1 m p r; 2 c cpr; 3 vc abk; sbk	f r 0; m sr 10; sa 25; c a 50; 75; 100	so po lo; ss ps vfr lo; s p fr so; vs vp fi sh; vfi h; efi vh; eh	C; SC SiC; SCL CL SiCL; LS SL L SiL; S Si; clay ~ 60%	v1 f pf; 1 d po; 2 br; 3 p co; cobr	k I; y II; z III; q IV; V; V+	Dark brown silty clay w/ strong brown lining pores and coating ped faces v. few clay films coat clasts
179	A/Bt1	a s; c w; g i; d b	(d) / 7.5YR 3/2 (m)	(d) / 2.5YR 4/4 5YR 5/6 (m)	m vf gr; sg f pl; 1 m p r; 2 c cpr; 3 vc abk; sbk	f r 0; m sr 10; sa 25; c a 50; 75; 100	so po lo; ss ps vfr lo; s p fr so; vs vp fi sh; vfi h; efi vh; eh	Tri co. ang sand; C; SC SiC; SCL CL SiCL; LS SL L SiL; S Si	v1 f pf; 1 d po; 2 br; 3 p co; cobr	k I; y II; z III; q IV; V; V+	Dark brown clay with distinct reddish (dusky red, yellowish red) stains on prominent vertical fractures and lining pores. Coarse roots.
207	A/Bt2	a s; c w; g i; d b	(d) / 7.5YR 3/2 (m)	(d) / (m)	m vf gr; sg f pl; 1 m p r; 2 c cpr; 3 vc abk; sbk	f r 0; m sr 10; sa 25; c a 50; 75; 100	so po lo; ss ps vfr lo; s p fr so; vs vp fi sh; vfi h; efi vh; eh	C; SC SiC; SCL CL SiCL; LS SL L SiL; S Si; clay ~ 70%	v1 f pf; 1 d po; 2 br; 3 p co; cobr	k I; y II; z III; q IV; V; V+	Dark brown clay
233	A/Bt3	a s; c w; g i; d b	(d) / 7.5YR 3/3 to 2.5Y 4/3 (m)	(d) / (m)	m vf gr; sg f pl; 1 m p r; 2 c cpr; 3 vc abk; sbk	f r 0; m sr 10; sa 25; c a 50; 75; 100	so po lo; ss ps vfr lo; s p fr so; vs vp fi sh; vfi h; efi vh; eh	C; SC SiC; SCL CL SiCL; LS SL L SiL; S Si; clay ~ 50%	v1 f pf; 1 d po; 2 br; 3 p co; cobr	mn <I; k II; y III; z IV; q V; V+	Dark reddish-brown clay w/ rectangular blocky structure Color reddens with depth Tri mn coatings Scattered $CaCO_3$ nodules ≤ 0.5 cm
274	Btk	a s; c w; g i; d b	(d) / 2.5YR 3/4 (m)	(d) / 7.5YR 8/3 ($CaCO_3$) (m)	m vf gr; sg f pl; 1 m p r; 2 c cpr; 3 vc abk; sbk	rectangular; f r 0; m sr 10; sa 25; c a 50; 75; 100	so po lo; ss ps vfr lo; s p fr so; vs vp fi sh; vfi h; efi vh; eh	C; SC SiC; SCL CL SiCL; LS SL L SiL; S Si; clay ~ 50%	v1 f pf; 1 d po; 2 br; 3 p co; cobr	k I; y II; z III; q IV; V; V+	Red-brown clay $CaCO_3$ nodules, up to 1.5 cm - soft, punky exterior ~10-20 cm apart. Most have hard interiors May be degraded

Notes:

SOIL PROFILE DESCRIPTION

William Lettis & Associates, Inc.

Profile: SP-1 Site: LB2 Building 25 T-1

Elevation: Slope: Job #: 2072

Site description:

Date: 7-16-09
Time:
By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
274 314	Bt1	a s c w g i d b	(d) 2.5YR 4/6 (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr abk 3 vc sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo vfr lo ss ps vfr so s p fr sh vs vp fi h fi vh efi eh	C SC SiC SCL CL SiCL LS SL L SiL S Si clay ~30%	v1 f pf 1 po 2 d br 3 p co cobr	k < I y II z III q IV V V+	Dark red clayey silt v. few stringers & pore fillings of $CaCO_3$ silt grains = red 6
347	Bt2	a s c w g i d b	(d) 2.5YR 4/4-4/6 (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo vfr lo ss ps fr so s p fi sh vs vp vfi h efi vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k < I y II z III q IV V V+	Dark red as above, with stronger structure v. few stringers & pore fillings of $CaCO_3$ 7
375	2CBt1	a s c w g i d b	(d) 2.5YR 3/3-4/2 (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr abk 3 vc sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo vfr lo ss ps fr so s p fi sh vs vp vfi h efi vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si clay <5%	v1 f pf 1 po 2 d br 3 p co cobr	k < I y II z III q IV V V+	Sand with primary bedding Clay films on bedding partings $CaCO_3$ filaments, v. few Sand incl. volcanic grains 8
396	2CBt2	a s c w g i d b	(d) 2.5YR 3/3 (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr abk 3 vc sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo vfr lo ss ps fr so s p fi sh vs vp vfi h efi vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	mn < I k II y III z IV q V V+	Sandy gravel, w/ primary bedding. Rounded ss and volcanic clasts, many can be cut w/ knife. Coated w/ clay films 9
B.T		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr abk 3 vc sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo vfr lo ss ps fr so s p fi sh vs vp vfi h efi vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	
		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr abk 3 vc sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo vfr lo ss ps fr so s p fi sh vs vp vfi h efi vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	

Notes:

FIELD SKETCH

Soil SP-1

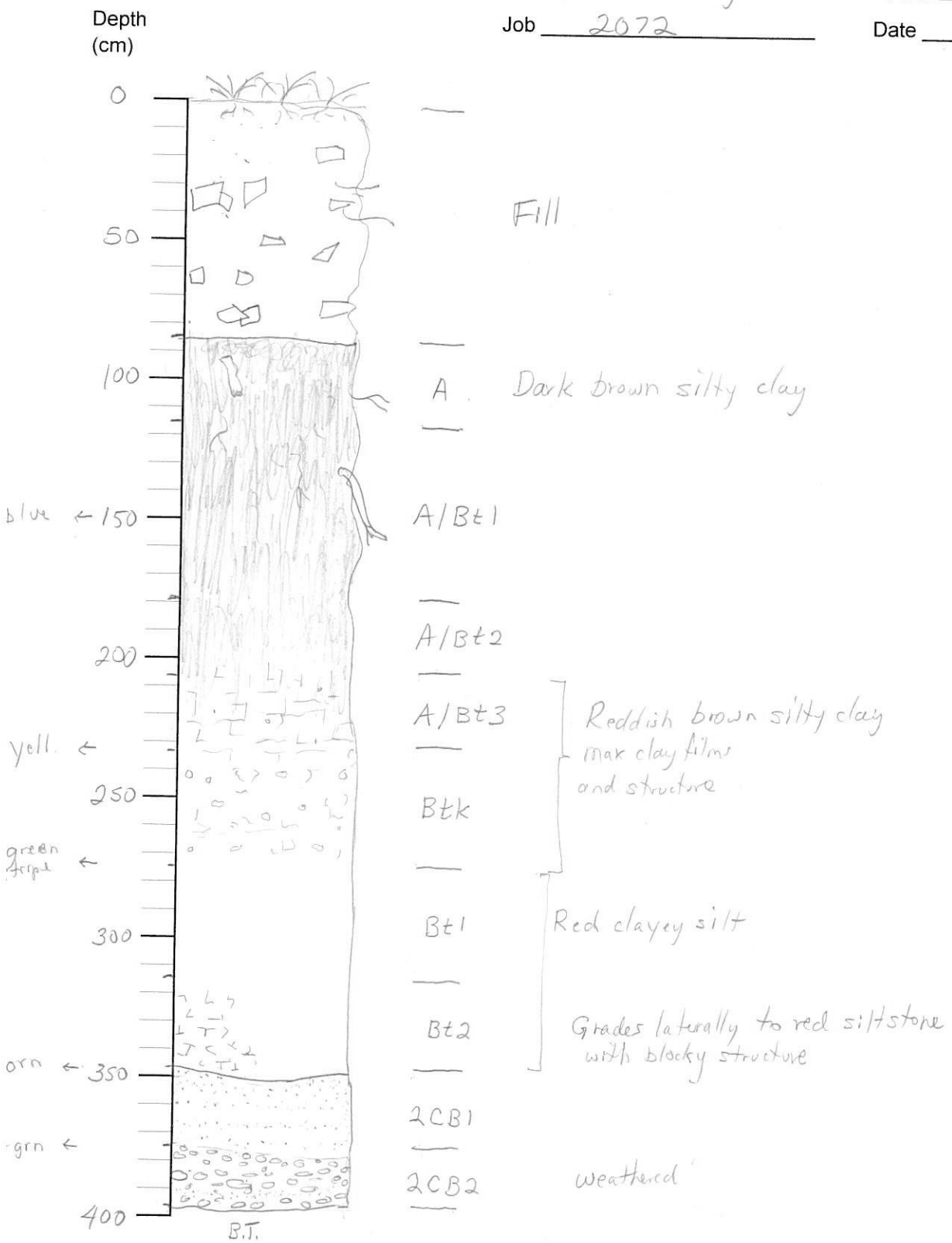
Site LBL Building 25

Job 2072

Page 3 of 3

By JM Sowers

Date



SOIL PROFILE DESCRIPTION

William Lettis & Associates, Inc.

Profile: SP-2 Site: LBL Building 25 T-1

Elevation: Slope: Job #: 2072

Site description:

Date: 7-17-09
Time:
By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
76		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo lo ss ps vfr so s p fr sh vs vp fi h vfi vh efi eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	FILL
99		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo lo ss ps vfr so s p fr sh vs vp fi h vfi vh efi eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	1
129		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo lo ss ps vfr so s p fr sh vs vp fi h vfi vh efi eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	2
160		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo lo ss ps vfr so s p fr sh vs vp fi h vfi vh efi eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	~blue 3
197		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo lo ss ps vfr so s p fr sh vs vp fi h vfi vh efi eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Dark brown w/ $CaCO_3$ nodules, 2-10mm, scattered — green 4
219		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po lo lo ss ps vfr so s p fr sh vs vp fi h vfi vh efi eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Red brown clayey silt with rectangular blocky structure. Lower 10 cm has $CaCO_3$ nodules 10-20 mm. — yell 5 green

Notes:

SOIL PROFILE DESCRIPTION

William Lettis & Associates, Inc.

Profile: SP-2 Site: LBL Building 25, T-1

Elevation: Slope: Job #: 2072

Site description:

Date: 7-17-09

Time:

By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
244		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Red clayey silt. Grades into unit below. 6
292		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Sandy gravel w/ red silt at base. Drn weathered. 80 % of clasts can be cut w/ knife. 7
319		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Sandy gravel, also w/ red silt at base. 60-70% of clasts can be cut w/ knife. Abrupt, sloping lower contact 8
390		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	Sheared, weathered volcanic 9
	B.T	a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	
		a s c w g i d b	(d) (m)	(d) (m)	m vf gr sg f pl 1 m pr 2 c cpr 3 vc abk sbk	f r 0 10 m sr 25 sa 50 c a 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 f pf 1 po 2 d br 3 p co cobr	k I y II z III q IV V V+	

Notes:

FIELD SKETCH

Soil SP-2

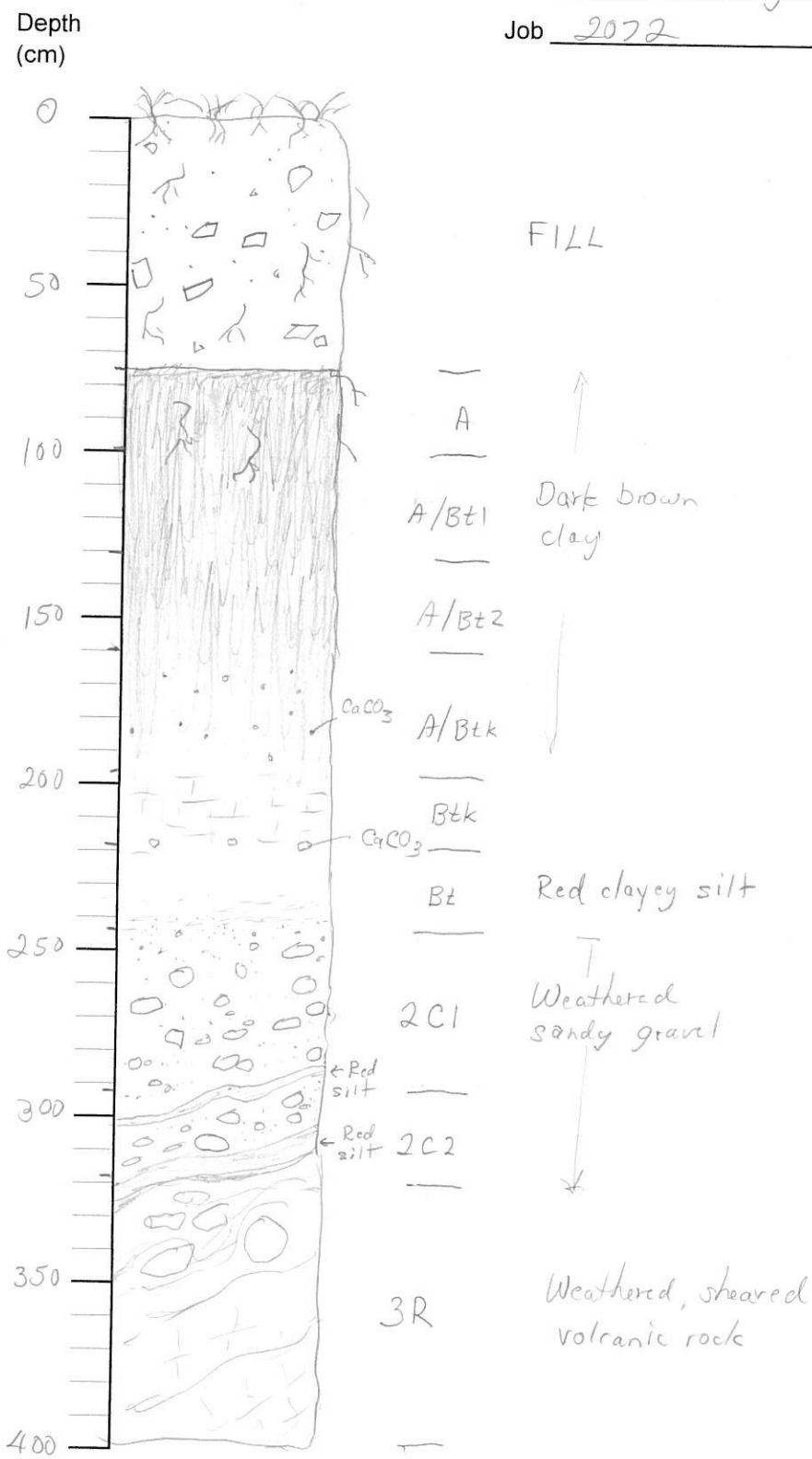
Site LBL Building 25, T-1

Job 2072

Page 3 of 3

By JMSowers

Date 7-17-09



SOIL PROFILE DESCRIPTION

William Lettis & Associates, Inc.

Profile: SP-3 Site: LBL Building 25, T-2

Elevation: Slope: Job #: 2072

Site description: East-facing grassy slope below Building 25
In trench T-2, North wall at 29 ft. Large pines 20-50 ft to north

Date: July 29, '09
Time: 9:30 am
By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)	
23	A1	a s / c w / g i / d b	10YR 2/2 (d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m pr / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp / lo vfr / fr / fi / vfi / efi / lo so / sh / h / vh / eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si; clay 30%	v1 f pf / 1 d po / 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	Colluvium Common fine to co. roots Rodent burrows	1
36	A/Bt	a s / c w / g i / d b	10YR 2/2 (d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m pr / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp / lo vfr / fr / fi / vfi / efi / lo so / sh / h / vh / eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si; clay ~20%	v1 f pf / 1 d po / 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	Colluvium Common fine to co. roots Clay films coat clasts, and some ped faces, incr. w/ depth. Stained 10YR 2/2	2
63	A/Bt 2	a s / c w / g i / d b	matrix 7.5YR 3/3 (d) / (m)	clast surfaces 7.5YR 4/4 to 5/4 (d) / (m)	m vf gr / sg f pl / 1 m pr / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp / lo vfr / fr / fi / vfi / efi / lo so / sh / h / vh / eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si; clay ~30%	v1 f pf / 1 d po / 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	Colluvium, gravelly. Common fine to co roots Clay films coat clasts and some ped faces. Color lighter than above. Bioturbation	3
68	2A/Bt	a s / c w / g i / d b	10YR 6/4, 6/6 (50%) 7.5YR 3/2 (d) / (m)	7.33 (50%) (d) / (m)	m vf gr / sg f pl / 1 m pr / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp / lo vfr / fr / fi / vfi / efi / lo so / sh / h / vh / eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si; clay 5-10%	v1 f pf / 1 d po / 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	Yellowish ash? Stained from above Few med roots	4
96	3Bt	a s / c w / g i / d b	10YR 5/1 (70%) 2.5YR 4/6, 3/3 (d) / (m)	(30%) (d) / (m) Colors grade into each other	m vf gr / sg f pl / 1 m pr / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp / lo vfr / fr / fi / vfi / efi / lo so / sh / h / vh / eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si; clay 5-10%	v1 f pf / 1 d po / 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	Gray siltstone mottled with red, vertical fractures. Few med roots along vertical ped faces.	5
106		a s / c w / g i / d b	2.5YR 4/3 (d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m pr / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp / lo vfr / fr / fi / vfi / efi / lo so / sh / h / vh / eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si; clay 5-10%	v1 f pf / 1 d po / 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	Red siltstone v. few med roots	6

Notes:

SOIL PROFILE DESCRIPTION

William Lettis & Associates, Inc.

Profile: SP-3 Site: LBL Building 25, T-2

Elevation: Slope: Job #: 2072

Site description:

Date: July 29, 09
Time:
By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
135		a s c w g i d b	2.5YR 4/3 10YR 5/1 (d) 2.5Y 5/2 (m)	6/1 (d) Color boundary sharp. (m)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r sr m sa c a 0 2.5% 10 25 50 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 1 2 3 f d p / pf po br co cobr	~0~ I k II y III z IV q V V+	Red siltstone, mottled with gray. Few fi-med roots along ped faces 7
158		a s c w g i d b	7.5YR 6/2, 6/1, 2.5Y 6/2 (70%) 2.5YR 3/3, 4/4 (30%) (d)	(d)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r sr m sa c a 0 10 25 50 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si clay 5-10%	v1 1 2 3 f d p / pf po br co cobr	~0~ I k II y III z IV q V V+	Gray sand with stringers of red siltstone and line of gravel clasts at top. [rounded] mixed lithology 8 line
171		a s c w g i d b	2.5YR 4/4 (d)	(d)	m vf gr sg f pl 1 m p r 2 c cpr 3 vc abk sbk	f r sr m sa c a 0 10 25 50 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si clay <5%	v1 1 2 3 f d p / pf po br co cobr	~0~ I k II y III z IV q V V+	Red siltstone 9 v. few fi-med roots
B.T.	—	a s c w g i d b	(d)	(d)	m vf gr sg f pl 1 m p r 2 c abk 3 vc sbk	f r sr m sa c a 0 10 25 50 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 1 2 3 f d p / pf po br co cobr	I k II y III z IV q V V+	
		a s c w g i d b	(d)	(d)	m vf gr sg f pl 1 m p r 2 c abk 3 vc sbk	f r sr m sa c a 0 10 25 50 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 1 2 3 f d p / pf po br co cobr	I k II y III z IV q V V+	weathered ignimbrite breccia @ ~40' in T-2
		a s c w g i d b	(d)	(d)	m vf gr sg f pl 1 m p r 2 c abk 3 vc sbk	f r sr m sa c a 0 10 25 50 75 100	so po ss ps s p vs vp / lo vfr fr fi vfi efi / lo so sh h vh eh	C SC SiC SCL CL SiCL LS SL L SiL S Si	v1 1 2 3 f d p / pf po br co cobr	I k II y III z IV q V V+	

Notes:

SOIL FIELD SKETCH

Soil SP-3

Site LBL Bldg 25 T-2

Job 2072

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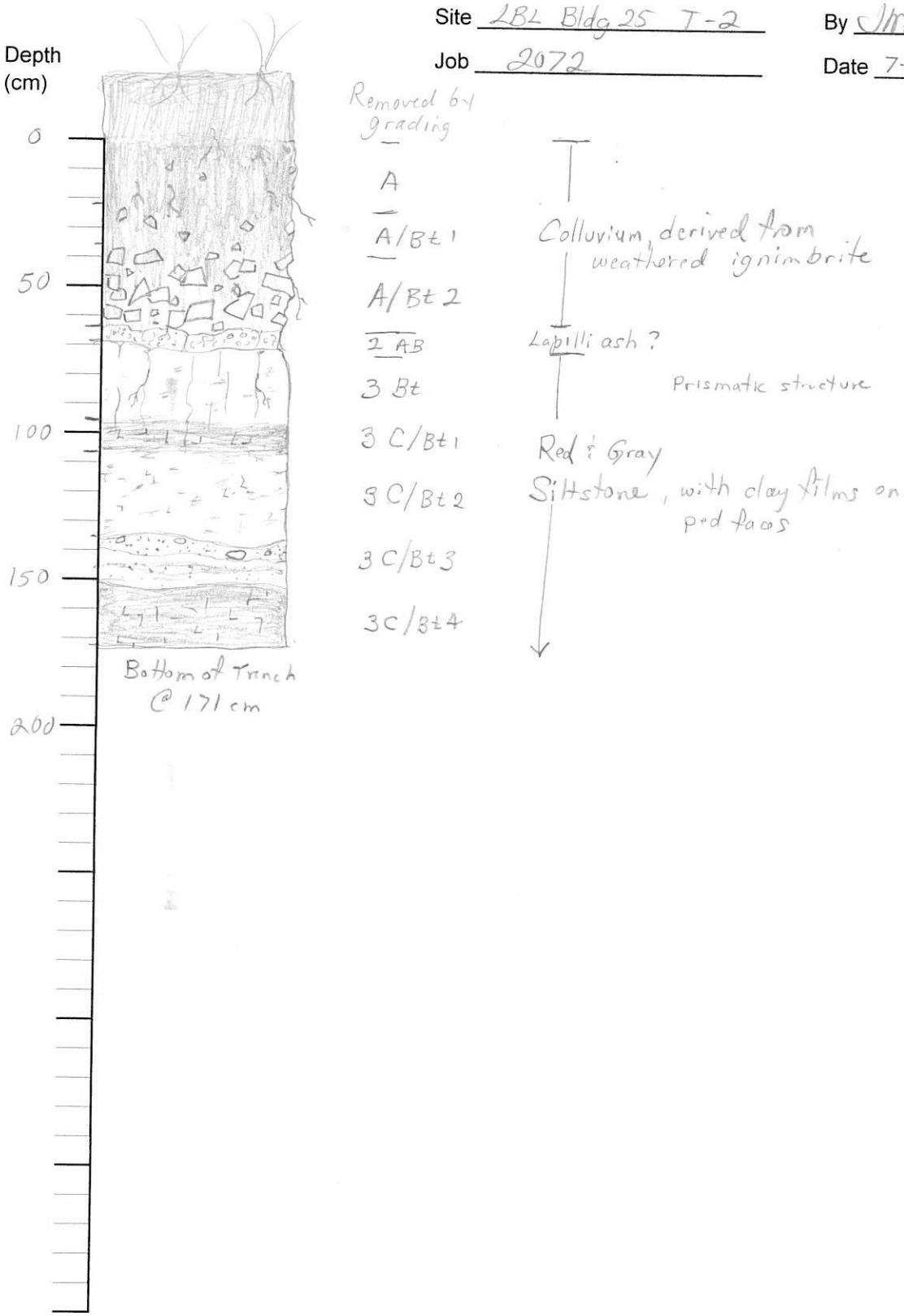
By JMSowers

Date 7-29-09



SOIL PROFILE DESCRIPTION

William Lettis & Associates, Inc.

Profile: SP-4 Site: LBL Building 25 T-2

Elevation: Slope: Job #: 2072

Site description: Trench T-2 @ 10 ft

Date: July 29, 09
Time:
By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
25	A	a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp; lo vfr fr fi vfi efi / lo so sh h vh eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 1 2 3 / f d p / pf po br co cobr	k y z q / I II III IV V V+	Colluvium
43	A/Bt1	a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp; lo vfr fr fi vfi efi / lo so sh h vh eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 1 2 3 / f d p / pf po br co cobr	k y z q / I II III IV V V+	Colluvium w/ ang. yell-gray ignimbrite clasts
84	ABt2	a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp; lo vfr fr fi vfi efi / lo so sh h vh eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 1 2 3 / f d p / pf po br co cobr	k y z q / I II III IV V V+	Colluvium w/ ang. yell-gray ignimbrite clasts
96	2	a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp; lo vfr fr fi vfi efi / lo so sh h vh eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 1 2 3 / f d p / pf po br co cobr	k y z q / I II III IV V V+	? Lapilli Tuff ?
109	3Bt1	a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp; lo vfr fr fi vfi efi / lo so sh h vh eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 1 2 3 / f d p / pf po br co cobr	k y z q / I II III IV V V+	Red siltstone
130	3Bt2/C	a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / sa 25 / c a 50 / 75 / 100	so po / ss ps / s p / vs vp; lo vfr fr fi vfi efi / lo so sh h vh eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 1 2 3 / f d p / pf po br co cobr	k y z q / I II III IV V V+	Reddish gray w/ ltgy. rounded mottles siltstone Few floating clasts of rounded gravel, wt'd.

Notes:

SOIL PROFILE DESCRIPTION

William Lettis & Associates, Inc.

Profile: SP-4 Site: LBL Building 25 T-2

Elevation: Slope: Job #: 2072

Site description:

Date: 7-29-09
Time:
By: JM Sowers

Depth (cm)	Horizon	Boundary	Color dominant	Color mottles	Structure	Gravel size rnd %	Consistence wet moist dry	Texture	Clay films	Salts & silica	Notes: (pores, roots, HCl test samples, pH, etc.)
169	3C2	a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / c sa 25 / a 50 / 75 / 100	so po lo / ss ps vfr so / s p fr sh / vs vp fi h / vfi vh / efi eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 f pf / 1 po / d 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	Weathered conglomerate, mixed lithology. most clasts can be cut w/ knife
181	3C3	a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / c sa 25 / a 50 / 75 / 100	so po lo / ss ps vfr so / s p fr sh / vs vp fi h / vfi vh / efi eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 f pf / 1 po / d 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	Gray siltstone
191	3C4	a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / c sa 25 / a 50 / 75 / 100	so po lo / ss ps vfr so / s p fr sh / vs vp fi h / vfi vh / efi eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 f pf / 1 po / d 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	Weathered sandy conglomerate
		a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / c sa 25 / a 50 / 75 / 100	so po lo / ss ps vfr so / s p fr sh / vs vp fi h / vfi vh / efi eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 f pf / 1 po / d 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	
		a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / c sa 25 / a 50 / 75 / 100	so po lo / ss ps vfr so / s p fr sh / vs vp fi h / vfi vh / efi eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 f pf / 1 po / d 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	
		a s / c w / g i / d b	(d) / (m)	(d) / (m)	m vf gr / sg f pl / 1 m p r / 2 c cpr / 3 vc abk / sbk	f r 0 / m sr 10 / c sa 25 / a 50 / 75 / 100	so po lo / ss ps vfr so / s p fr sh / vs vp fi h / vfi vh / efi eh	C / SC SiC / SCL CL SiCL / LS SL L SiL / S Si	v1 f pf / 1 po / d 2 br / 3 p co / cobr	k I / y II / z III / q IV / V / V+	

Notes:

SOIL FIELD SKETCH

Soil SP-4

Site LBL Building 25

Job 2072

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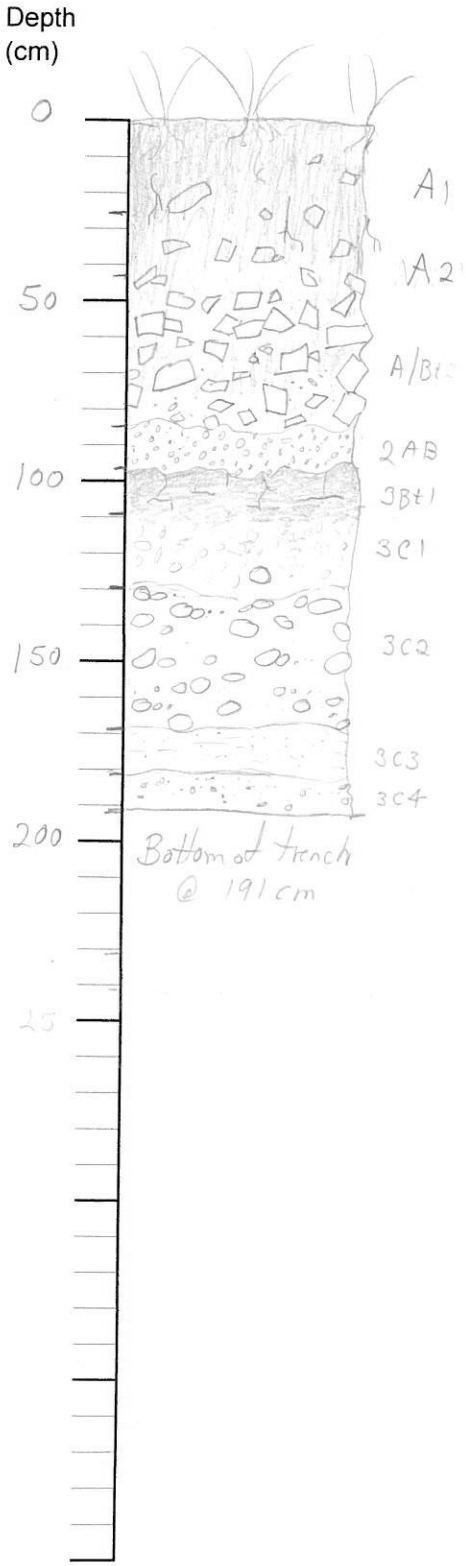
By JMSawyers

Date 7-30-09



Appendix D

Transportation and Traffic

FEHR & PEERS
TRANSPORTATION CONSULTANTS

MEMORANDUM

Date: May 22, 2009

To: Shabnam Barati, Impact Sciences
Jeff Philliber, LBNL
Sheree Swanson, LBNL
Nancy Ware, LBNL

From: Sam Tabibnia and Ryan McClain

Subject: ***LBNL Construction Projects – Cumulative Truck Impact Analysis***

WC08-2614

Fehr & Peers has been tasked with determining the maximum average daily truck trips that can be generated by various construction projects at Lawrence Berkeley National Laboratory (LBNL) without causing a significant impact on the designated truck route through the City of Berkeley. Additionally, an alternative truck route to State Route 24 was analyzed. This memorandum summarizes the results of the analysis which included impacts to intersection operations, roadway segment operations and pavement conditions.

Based on our analysis, LBNL can generate the following truck traffic without causing a significant impact:

- An average of 98 one-way truck trips[1] per day through the Hearst Avenue, Oxford Street and University Avenue intersections.
- An average of 50 one-way truck trips per day through the Stadium Rim Way/Gayley Road intersection.
- An average of 60 one-way truck trips per day but not more than 2,190 one-way truck trips per year on the alternative truck route along Centennial Drive, Grizzly Peak Boulevard and Fish Ranch Road

The study assumptions and analysis results are summarized below.

STUDY PARAMETERS

Figure 1 shows the designated truck route that trucks would use to access the various construction sites at LBNL. As shown in the figure, all trucks would use Interstate 80 (I-80). They would use University Avenue, Oxford Street, and Hearst Avenue to travel between the freeway and LBNL. Trucks would use either Cyclotron Road or Centennial Drive to access the project sites.

[1] For the purposes of this memo, all references to truck trips are to one-way truck trips. Each truck makes two one way trips; one to the site and one from the site.

The analysis was completed for the following scenarios:

- ***Existing Conditions*** – represents current conditions based on recently collected traffic counts.
- ***Background Conditions*** – represents existing conditions plus additional traffic generated by other projects over the next few years.
- ***Background Plus Project Conditions*** – represents Background conditions plus truck traffic generated by the construction of LBNL projects.

The intersection operations analysis focuses on the following intersections along the designated truck route that have been identified in recent studies as operating at or near failing conditions:

1. Stadium Rim Way/Gayley Road (All-Way Stop)
2. Hearst Avenue/Gayley Road/La Loma Road (Signal)
3. University Avenue/San Pablo Avenue (Signal)
4. University Avenue/6th Street (Signal)

Construction projects would generate truck traffic throughout the day during normal business hours. Since the AM and PM peak hours represent the peak traffic conditions when congestion is worst throughout the day, this analysis was conducted for the AM and PM peak hours to represent the worst case conditions. Thus, it is expected that if construction trucks would not cause a significant impact during the peak hours, then they would not cause a significant impact during other hours of the day.

The pavement analysis focuses on the following roadway segments along the designated truck route:

1. Hearst Avenue between Gayley Road and Oxford Street
2. Oxford Street between Hearst Avenue and University Avenue
3. University Avenue between Oxford Street and Sacramento Street
4. University Avenue between Sacramento Street and I-80

24-hour pneumatic tube counts were collected on each of the segments to determine current levels of truck activity along the designated truck route.

LEVEL OF SERVICE ANALYSIS

Transportation engineers and planners use the term “level of service” (LOS) to qualitatively describe the operational status of intersections. LOS ranges from LOS A (indicating free-flow traffic conditions with little or no delay) to LOS F (representing oversaturated conditions in which traffic flows exceed design capacity, resulting in long queues and delays). The Synchro Software, using the methods presented in the Transportation Research Board’s 2000 *Highway Capacity Manual* (2000 HCM), was used to calculate delay and LOS for signalized and unsignalized intersections.

Signalized Intersections

Signalized intersection operations were calculated using the method described in Chapter 16 of the 2000 HCM (Transportation Research Board, 2000). This method correlates the level of service to the average control delay experienced at the intersection. Control delay is defined as the delay directly associated with the traffic control device (e.g., a traffic signal or a stop sign) and

specifically includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Control delay is calculated and correlated to a level of service as summarized in Table 1.

Unsignalized Intersections

For side-street stop-controlled intersections, the method described in Chapter 17 of the 2000 HCM was used. LOS is based on control delay. Control delay estimates are considered meaningful indicators of driver discomfort and frustration, fuel consumption, and lost travel time. For all-way stop-controlled intersections, average delay and corresponding LOS for the entire intersection is calculated and reported; while for side-street stop-controlled intersections, delay and corresponding LOS for the worst movement are calculated and reported. The specific LOS definitions for unsignalized intersections are presented in Table 2.

TABLE 1
SIGNALIZED INTERSECTION
LEVEL OF SERVICE CRITERIA

Level of Service	Description of Traffic Conditions	Average Control Delay (seconds/vehicle)
A	Operations with very low delay occurring with favorable progression and/or short cycle lengths.	≤ 10.0
B	Operations with low delay occurring with good progression and/or short cycle lengths.	10.1 – 20.0
C	Operations with average delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures begin to appear.	20.1 – 35.0
D	Operations with longer delays due to a combination of unfavorable progression, long cycle lengths, and high volume/ capacity ratios. Many vehicles stop and individual cycle failures are noticeable.	35.1 – 55.0
E	Operations with high delay values indicating poor progression, long cycle lengths, and high volume/capacity ratios. Individual cycle failures are frequent occurrences.	55.1 – 80.0
F	Operations with delays unacceptable to most drivers occurring due to oversaturation, poor progression, or very long cycle lengths.	> 80.0

Source: *Highway Capacity Manual* (Transportation Research Board, 2000), Chapter 16 – Signalized Intersections.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

TABLE 2
UNSIGNALIZED INTERSECTION
LEVEL OF SERVICE CRITERIA

Level of Service	Description of Traffic Conditions	Average Control Delay (seconds/vehicle)
A	Little or no conflicting traffic for minor street approach.	≤ 10
B	Minor street approach begins to notice absence of available gaps.	10 – 15
C	Minor street approach begins experiencing delay for available gaps.	15 – 25
D	Minor street approach experiences queuing due to a reduction in available gaps.	25 – 35
E	Extensive minor street queuing due to insufficient gaps.	35 – 50
F	Insufficient gaps of suitable size to allow minor street traffic demand to cross safely through a major traffic stream.	> 50

Source: *Highway Capacity Manual* (Transportation Research Board, 2000), Chapter 17 – Unsignalized Intersections.

Significance Criteria

The City of Berkeley's applicable significance criteria for traffic operations, based on the City's *Guidelines for Development of Transportation Impact Reports,* are listed below. These criteria were used to determine if traffic generated by the proposed project would result in a significant impact on the surrounding roadway network.

According to the City of Berkeley, a significant traffic-related impact would occur at signalized and all-way-stop controlled intersections if the addition of project traffic results in:

- Intersection operations degrade from LOS D to LOS E or worse and there is a two-second or greater increase in delay; or
- A three-second or greater increase in delay at intersections operating at LOS E without and with the project; or
- Intersection operations degrade from LOS E to LOS F and there is a three-second or greater increase in delay; or
- At intersections operating at LOS F without the project, a change in the volume-to-capacity (V/C) ratio of 0.01 or greater.

Existing Conditions

The Existing conditions LOS analysis was completed based on intersection turning movement counts collected in September and October 2007 (University Avenue/Sixth Street and University Avenue/San Pablo Avenue intersections), and November 2002[2] (Hearst Avenue/Gayley Road/La Loma Road and Stadium Rim Way/Gayley Road intersections). The existing AM and PM peak

[2] More recent traffic volume data was collected at these intersections in 2006. Since the newer data was lower than traffic counts collected in 2002, the older traffic volumes are used to present a conservative analysis.

hour intersection volumes and intersection configuration and controls are shown on Figure 2. Table 3 summarizes the existing levels of service at the study intersections. The detailed levels of service calculations are included in Appendix A. As shown in Table 3, the four study intersections operate at acceptable LOS D or better during the AM peak hour. During the PM peak hour, the Stadium Rim Way/Gayley Road and University Avenue/6th Street intersections operate at unacceptable LOS E and the University Avenue/San Pablo Avenue intersection operates at unacceptable LOS F.

TABLE 3
EXISTING CONDITIONS
LEVEL OF SERVICE SUMMARY

Intersection	Intersection Control	Peak Hour	Delay (Seconds)	LOS[1]
Stadium Rim Way/ Gayley Road	All-Way Stop-Controlled	AM	29.6	D
		PM	**41.1**	**E**
Hearst Avenue/Gayley Road/La Loma Avenue	Signalized	AM	22.7	C
		PM	24.1	C
University Avenue/ San Pablo Avenue	Signalized	AM	43.7	D
		PM	**91.3 (v/c=1.00)**	**F**
University Avenue/ 6th Street	Signalized	AM	40.0	D
		PM	**68.3**	**E**

Note: Results in **bold** represent unacceptable levels of service.

1. Signalized and all-way stop-controlled intersection level of service determined using the HCM 2000 methods.

Source: Fehr & Peers, 2009.

Background Conditions

Background conditions represent traffic conditions over the next several years while various projects are under construction at LBNL. It includes traffic expected to be generated by the following:

- ***City of Berkeley Projects to be Completed Before LBNL Construction*** – Several projects are currently under construction throughout the City of Berkeley and are expected to be completed while construction is taking place at LBNL. However, most of these projects are small and are not expected to generate much vehicle traffic at these study intersections. Thus, these trips were not included in this analysis.
- ***City of Berkeley Construction Projects to Coincide with LBNL Construction*** – Several other projects throughout the City of Berkeley would be under construction during construction of LBNL projects. Construction truck traffic generated by these projects is expected to be comparable to current construction truck traffic generated by projects currently under construction throughout the City and accounted for in the existing traffic volumes. Thus, additional truck trips were not added in this analysis.

- ***UC Berkeley Construction Projects*** – The analysis completed for the UC Berkeley Long Range Development Plan (LRDP) EIR states that a maximum of one million gross square feet would be under construction at any one time (LRDP EIR, page 4.12-46) and that would result in maximum of 525 daily truck trips. The following projects are expected to be under construction on the UC Berkeley Campus through 2012:
    - Warren Hall Replacement – 97,200 gross square feet
    - Naval Architecture Building – 12,200 gross square feet
    - Student Athlete High Performance Center – 135,000 gross square feet
    - Law Infill – 52,100 gross square feet

  Assuming that all these projects would be under construction simultaneously, the UC Berkeley projects combined are estimated to generate 70 one-way truck trips on an average day. This average represents conservative conditions because it is unlikely that all of these projects would experience peak construction activity at the same time and simultaneously generate the highest daily average truck trips. Depending on the schedule and the construction stage of each specific project, the actual number of truck trips may be lower or higher than the average. All these truck trips are assumed to travel through the University Avenue intersections, however, only truck trips from the Student Athlete High Performance Center are assumed to travel through the Gayley Road intersections based on location of the projects.

- ***East Bay Municipal Utility District (EBMUD) Projects*** – EBMUD is currently in the planning process for new storage and/or pipeline improvements in the vicinity of LBNL. EBMUD expects this project to begin construction as early as summer 2012 or as late as summer 2015; therefore these truck trips were not included in this analysis.

Based on these assumptions, Background conditions is represented by an average of 70 additional one-way truck trips. This study assumes that truck traffic would be generated over a 10-hour day. The peak hour truck traffic was converted to passenger car traffic using a passenger car equivalent (PCE)[3] of 2.5, which represents the largest trucks that would serve these project sites. The PCE's were assigned to the designated truck routes, and added to the existing intersection volumes to estimate the Background conditions intersection volumes.

Table 4 summarizes the levels of service at the study intersections under Background conditions. The detailed levels of service calculations are included in Appendix A. As shown in Table 4, all study intersections would operate at the same level of service as existing conditions with slightly more delay.

Background Plus Project Conditions

The Background Plus Project conditions includes the number of daily one-way truck trips generated by LBNL construction projects without causing a significant impact at the study intersections. Construction truck trips were converted to peak hour PCEs, assigned to designated truck routes, and added to the background conditions intersection volumes to estimate the Background Plus Project conditions intersection volumes.

This maximum average was determined to be 98 one-way truck trips per day at the University Avenue/6th Street, University Avenue/San Pablo Avenue and Hearst Avenue/Gayley Road

[3] Truck traffic is converted to PCEs to account for trucks generally traveling at lower speeds than passenger cars and requiring more time to accelerate and decelerate. A PCE of 2.5 means that each truck will have the same effect as 2.5 passenger cars on traffic flow and intersection operations.

intersections. An average of 50 one-way truck trips per day was estimated to be the maximum at the Stadium Rim Way/Gayley Road intersection. These averages were used for the Background Plus Project conditions. Table 4 compares intersection operations at the four study intersections under Background conditions and Background Plus Project conditions. The detailed levels of service calculations are included in Appendix A.

TABLE 4
BACKGROUND CONDITIONS
LEVEL OF SERVICE SUMMARY

Intersection	Intersection Control	Peak Hour	Background Conditions[1]		Background Plus Project Conditions[2]	
			Delay (Seconds)	LOS[3]	Delay (Seconds)	LOS[3]
Stadium Rim Way/ Gayley Road	All-Way Stop-Controlled	AM	30.5	D	32.3	D
		PM	**42.4**	**E**	**44.8**	**E**
Hearst Avenue/Gayley Road/La Loma Avenue	Signalized	AM	25.8	C	27.1	C
		PM	24.8	C	25.7	C
University Avenue/ San Pablo Avenue	Signalized	AM	43.8	D	44.0	D
		PM	**93.1 (v/c=1.00)**	**F**	**95.3 (v/c=1.00)**	**F**
University Avenue/ 6th Street	Signalized	AM	40.3	D	40.8	D
		PM	**69.5**	**E**	**71.1**	**E**

Note: Results in **bold** represent unacceptable levels of service.

1. Background conditions represents an additional 70 one-way truck trips per day through the two University Avenue intersections and an additional 32 one-way truck trips per day through the two Gayley Road intersections generated by UC Berkeley construction projects.
2. Background Plus Project conditions represents an average of 50 additional one-way truck trips per day through the Stadium Rim Way/Gayley Road intersection and 98 additional one-way truck trips per day through all other intersections generated by LBNL.
3. Signalized and all-way stop-controlled intersection level of service determined using the HCM 2000 methods.

Source: Fehr & Peers, 2009.

PAVEMENT ANALYSIS

The potential effect of truck traffic on a roadway can be evaluated by calculating the roadway's traffic index (TI). The TI value is based on the number of heavy vehicles such as trucks and buses expected to use the roadway over its design lifetime, and is used to determine the thickness of various paving materials sufficient to support this amount of heavy vehicle traffic. Effects on pavement life from passenger vehicles and trailers are considered negligible.

Unlike the Level of Service analysis above, which required analysis of daily average truck trips during peak construction periods to determine the worst-case peak hour impact on the roadway network, pavement analysis requires the average daily truck trips over the entire project life to determine the cumulative impact on the pavement.

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The 2008 Caltrans *Highway Design Manual* (HDM) Topic 613 provides the methodology for determining TI values. For the purposes of this study, a pavement design life of 20 years was selected for all calculations, which is typical for these types of roadways. According to the HDM, the TI is determined to the nearest 0.5.

Significance Criteria

For the purposes of this study, a change in the calculated TI value of less than 0.5 is a less than significant impact, since TI values are rounded to the nearest 0.5[4].

Existing Conditions

The existing pavement analysis was based on 24-hour heavy vehicle counts along the designated truck route collected on January 27, 2009. The TI value was calculated based on a 20-year pavement design life and assuming a constant level of heavy vehicles consistent with the current level through the entire 20-year life of the pavement. Table 5 provides the TI values for each segment under Existing conditions.

TABLE 5
EXISTING TI VALUES

Segment	Average Daily Traffic	Autos, Vans & Pickups	2 Axle Trucks & Buses	3 & 4 Axle Trucks	5 or More Axle Trucks	20-Year TI Value[1]
Hearst Avenue between Gayley Road and Oxford Street	10,400	93%	5%	<1%	1%	9.9
Oxford Street between Hearst Avenue and University Avenue	12,700	94%	2%	3%	1%	9.1
University Avenue between Oxford Street and Sacramento Street	25,600	94%	3%	2%	1%	10.3
University Avenue between Sacramento Street and I-80	25,700	92%	3%	3%	2%	10.4

Notes:
1. Values not rounded to nearest 0.5 for comparison purposes

Source: Fehr & Peers, 2009.

Background Conditions

For the Background conditions pavement analysis, average daily truck trips over the next 20 years is required. Truck traffic generated for the following was accounted for:

- ***City of Berkeley Construction Projects to Coincide with LBNL Construction*** – Several other projects throughout the City of Berkeley would be under construction during construction at LBNL. Construction truck traffic generated by these projects is expected to be comparable to current construction truck traffic generated by projects currently

[4] Consistent with criterion from the 2007 LBNL Long Range Development Plan EIR, page IV.L-41.

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under construction throughout the City and accounted for in the existing traffic volumes. Thus, these trips were not included in this analysis.

- ***UC Berkeley Construction Projects*** – For UC Berkeley, it was assumed that the level of construction estimated to coincide with construction at LBNL would continue over the next 20 years. As shown in the Level of Service section of this memorandum, the daily average truck trips for UC Berkeley construction projects is estimated to be 70.
- ***East Bay Municipal Utility District (EBMUD)*** – EBMUD is currently in the planning process for new storage and/or pipeline improvements in the vicinity of LBNL. EBMUD provided an estimate of up to 6,900 total truck trips for this project. Because these trips will only occur once over the 20-year pavement design life, they must be normalized over 20 years resulting in an average of 1 daily trip.

It is estimated that the UC and EBMUD projects combined would generate about 71 truck trips per day. As a conservative estimate, it was assumed that every truck would be a 5-axle truck. TI values for Background conditions are provided in Table 6.

Background Plus Project Conditions

For pavement analysis of Background Plus Project conditions, the 98 average one-way truck trips determined in the Level of Service analysis was used. Similar to the Background conditions pavement analysis, it was assumed that every truck would be a 5-axle truck.

As shown in Table 6, the TI values do not change by more than 0.5 between Background and Background Plus Project conditions, therefore the estimated amount of truck traffic would not cause a significant impact to the pavement along the designated truck route.

TABLE 6
BACKGROUND TI VALUES

Segment	Background 20-Year TI Value[1]	Background plus Project 20-Year TI Value[1]
Hearst Avenue between Gayley Road and Oxford Street	10.2	10.4
Oxford Street between Hearst Avenue and University Avenue	9.4	9.6
University Avenue between Oxford Street and Sacramento Street	10.4	10.5
University Avenue between Sacramento Street and I-80	10.5	10.6

Notes:
1. Values not rounded to nearest 0.5 for comparison purposes

Source: Fehr & Peers, 2009.

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ALTERNATIVE TRUCK ROUTE

An alternative truck route was proposed by LBNL that may be used to reduce the number of trucks using the designated truck route. Trucks using the alternative route would use either the Grizzly Gate or Strawberry Gate to enter and exit LBNL then use Centennial Drive, Grizzly Peak Boulevard and Fish Ranch Road to access State Route 24 as shown on Figure 3.

The analysis was completed for the following scenarios:

- ***Existing Conditions*** – represents current conditions based on recently collected traffic counts.
- ***Existing Plus Project Conditions*** – represents Background conditions plus truck traffic generated by the construction of LBNL projects.

This assumes that there would be no other construction projects that generate a large number of truck trips above existing levels of trucks along this route; therefore, Existing conditions is considered equal to Background conditions for analysis of the alternative truck route.

The operations and pavement analyses focus on the following roadway segments along the alternative truck route:

1. Grizzly Peak Boulevard between Centennial Drive and Fish Ranch Road
2. Fish Ranch Road between Grizzly Peak Boulevard and State Route 24

Construction projects would generate truck traffic throughout the day during normal business hours. Since the AM and PM peak hours represent the peak traffic conditions when congestion is worst throughout the day, this analysis was conducted for the AM and PM peak hours to represent the worst case conditions. Thus, it is expected that if construction trucks would not cause a significant impact during the peak hours, then they would not cause a significant impact during other hours of the day.

LEVEL OF SERVICE ANALYSIS

This alternative truck route consists of two-lane roads. Since these two-lane roads limit the amount of vehicle passing, they would control overall LOS of the route, and not the intersections; thus, roadway segments were analyzed based on 2000 HCM methodologies for two-lane class II highways. LOS for two-lane highways is based on the calculated percent time-spent-following, or the amount of time a motorist can be expected to be delayed by a platoon of vehicles. The HCS+ software was used to estimate the roadway segment LOS.

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TABLE 7
TWO-LANE HIGHWAYS IN CLASS II
LEVEL OF SERVICE CRITERIA

Level of Service	Description of Traffic Conditions	Percent Time-Spent-Following
A	Motorists are able to travel at their desired speed and platoons of three or more vehicles are rare.	≤ 40%
B	Speeds begin to fall but motorists will not be delayed in platoons for more than 55 percent of the time.	>40% – 55%
C	There are noticeable increases in platoon formation, platoon size, and frequency of passing impediments.	>55% – 70%
D	Traffic flow is unstable and platoons sizes of 5 to 10 vehicles are common. Turning vehicles and roadside distractions cause major shock waves in the traffic stream.	>70% – 85%
E	Passing is virtually impossible and platooning becomes intense as slower vehicles or other interruptions are encountered.	>85%
F	Traffic demand exceeds capacity and speeds are highly variable.	*

Note:
* LOS F applies whenever the flow rate exceeds the segment capacity.
Source: *Highway Capacity Manual* (Transportation Research Board, 2000), Chapter 20 – Two-Lane Highways.

Significance Criteria

For the purposes of this study, a significant traffic-related impact would occur on two-lane roadway segments if the addition of project traffic results in:

- Operations degrade from LOS D to LOS E or worse
- An increase in the volume to capacity ratio by more than 0.01 on roadway segments operating at LOS E or F under existing conditions.

Existing Conditions

The Existing conditions LOS analysis was completed based traffic volume counts on Grizzly Peak Boulevard and Fish Ranch Road in February 2009. Table 8 summarizes the existing conditions at the study segments. The detailed LOS calculations are included in Appendix B. As shown in Table 3, the roadway segments operate at acceptable LOS C or better with the exception of southbound Fish Ranch Road in the PM peak hour which operates at LOS E.

Existing Plus Project Conditions

Based on our analysis, an average of 60 daily one-way truck trips can use the alternative route and not cause a significant impact to LOS on the study segments. Peak hour LOS and V/C Ratios with the additional truck trips are summarized in Table 9.

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TABLE 8
ROADWAY SEGMENT EXISTING CONDITIONS SUMMARY

Street	Direction	Peak Hour	Traffic Volume	Truck Percentage	Percent Time-Spent-Following[1]	LOS[1]
Grizzly Peak Boulevard	Northbound	AM	219	5%	57%	C
		PM	127	2%	41%	B
	Southbound	AM	186	5%	61%	C
		PM	374	2%	74%	D
Fish Ranch Road	Northbound	AM	338	5%	68%	C
		PM	158	1%	41%	B
	Southbound	AM	346	3%	64%	C
		PM	861	1%	**93% (v/c = 0.56)**	**E**

Notes:
1. Percent time-spent-following and LOS determined using HCM 2000 two-lane highway segment analysis methodologies

Source: Fehr & Peers, 2009.

TABLE 9
ROADWAY SEGMENT LEVEL OF SERVICE SUMMARY

Street	Direction	Peak Hour	Existing Conditions		Existing plus Project Conditions	
			Percent Time-Spent-Following[1]	LOS[1]	Percent Time-Spent-Following[1]	LOS[1]
Grizzly Peak Boulevard	Northbound	AM	57%	C	58%	C
		PM	41%	B	41%	B
	Southbound	AM	61%	C	62%	C
		PM	73%	D	73%	D
Fish Ranch Road	Northbound	AM	68%	C	68%	C
		PM	41%	B	43%	B
	Southbound	AM	64%	C	64%	C
		PM	**93% (v/c = 0.56)**	**E**	**94% (v/c = 0.57)**	**E**

Notes:
1. V/C Ratio and LOS determined using HCM 2000 two-lane highway segment analysis methodologies

Source: Fehr & Peers, 2009.

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PAVEMENT ANALYSIS

Pavement analysis was performed using the same methodologies described above for the designated truck route.

Existing Conditions

The existing pavement analysis was based on 24-hour heavy vehicle counts along the designated truck route collected in February 2009. The TI value was calculated based on a 20-year pavement design life and assuming a constant level of heavy vehicles consistent with the current level through the entire 20-year life of the pavement. Table 10 provides the TI values for each segment under Existing conditions.

TABLE 10
EXISTING TI VALUES

Segment	Average Daily Traffic	Autos, Vans & Pickups	2 Axle Trucks & Buses	3 Axle Trucks	5 or More Axle Trucks	20-Year TI Value[1]
Grizzly Peak Boulevard between Centennial Drive and Fish Ranch Road	4,400	97%	2%	<1%	<1%	7.6
Fish Ranch Road between Grizzly Peak Boulevard and State Route 24	7,000	97%	2%	<1%	<1%	7.7

Notes:
1. Values not rounded to nearest 0.5 for comparison purposes

Source: Fehr & Peers, 2009.

Existing Plus Project Conditions

Similar to the LOS analysis, it was assumed that there would not be any significant construction projects that would generate a large number of truck trips above existing levels of trucks along this route, therefore, Existing conditions is considered equal to Background conditions for analysis of the alternative truck route.

Based on our analysis, an annual average of 2,190 one-way truck trips would not cause a significant impact to the Traffic Index on the study segments. The Traffic Index under Existing and Existing Plus Project conditions are compared in Table 11.

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TABLE 11
TRAFFIC INDEX SUMMARY

Street	Existing 20-Year TI[1]	Existing plus Project 20-Year TI[1]
Grizzly Peak Boulevard between Centennial Drive and Fish Ranch Road	7.6	7.8
Grizzly Peak Boulevard between Centennial Drive and Fish Ranch Road	7.7	7.9

Notes:
1. Traffic Index determined using Caltrans Highway Design Manual methodology

Source: Fehr & Peers, 2009.

Please contact us with questions or comments.

Attachments:

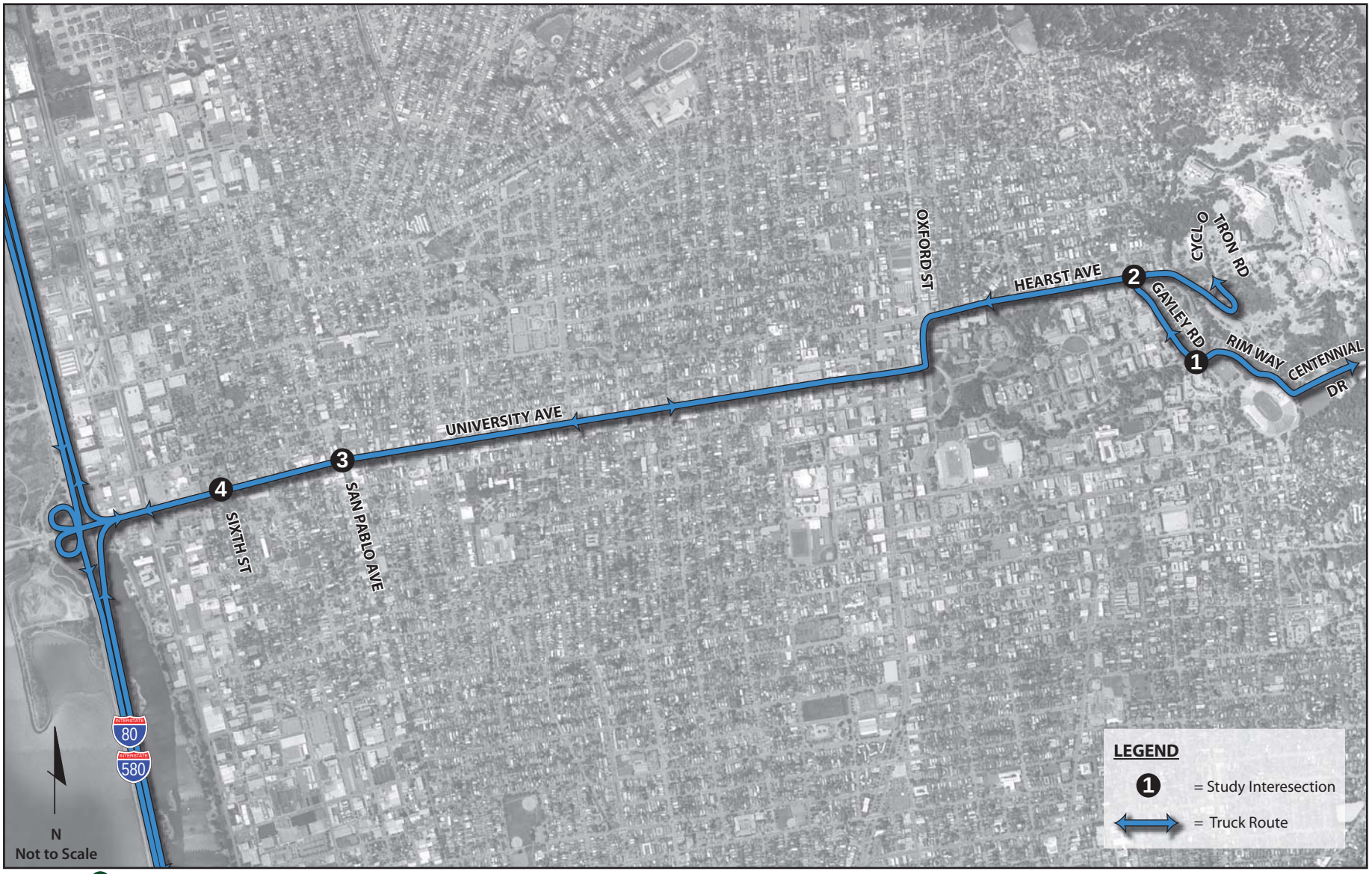
Figure 1 – Designated Truck Routes

Figure 2 – Existing Peak Hour Traffic Volumes, Lane Configurations, and Controls

Figure 3 – Alternative Truck Route

Appendix A – Detailed LOS Calculation Sheets

Appendix B – Detailed LOS Calculation Sheets for Alternative Route



LBNL Cumulative Truck Analysis

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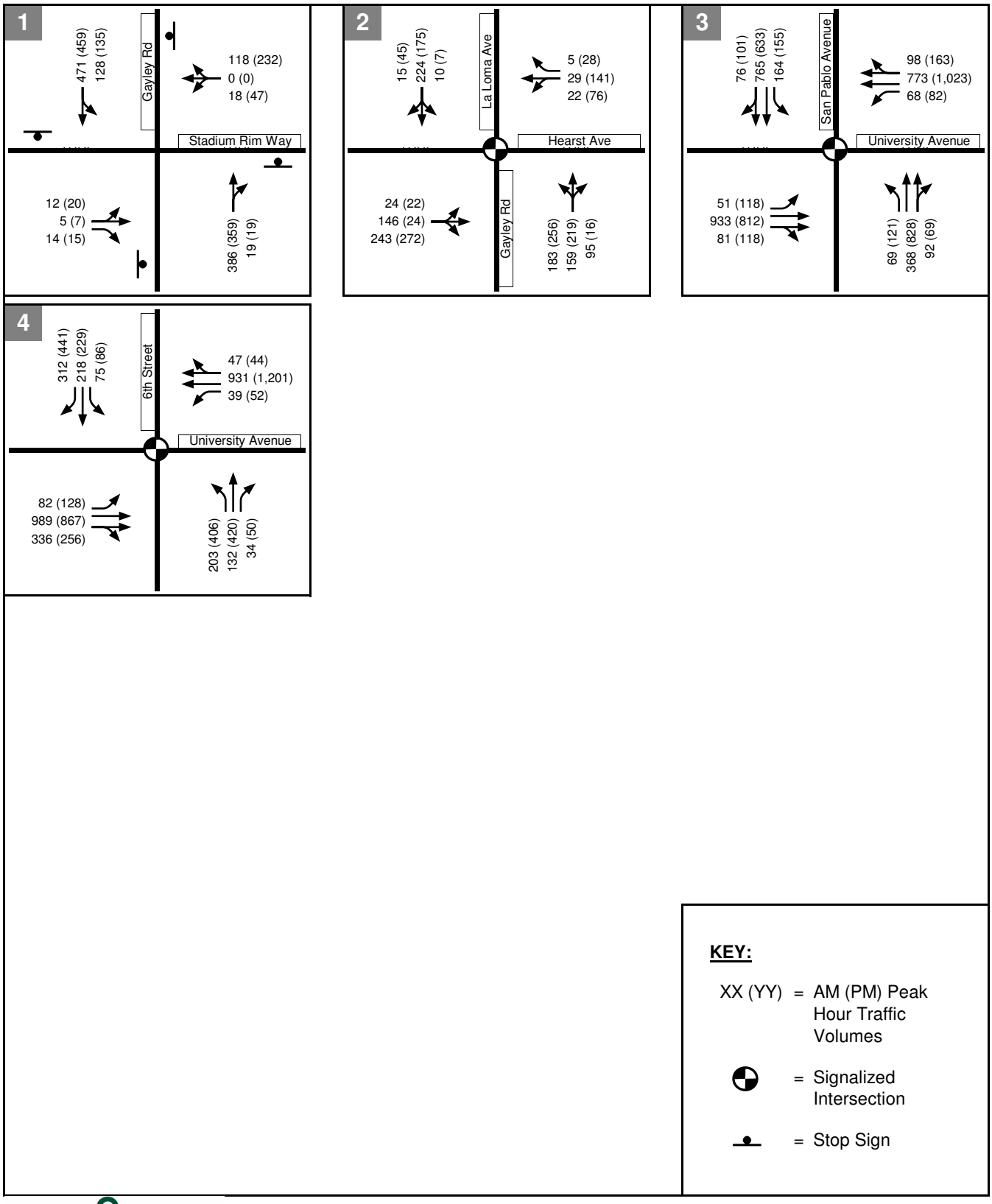
February 2009
WC08-2614_1

DESIGNATED TRUCK ROUTES

Figure 1



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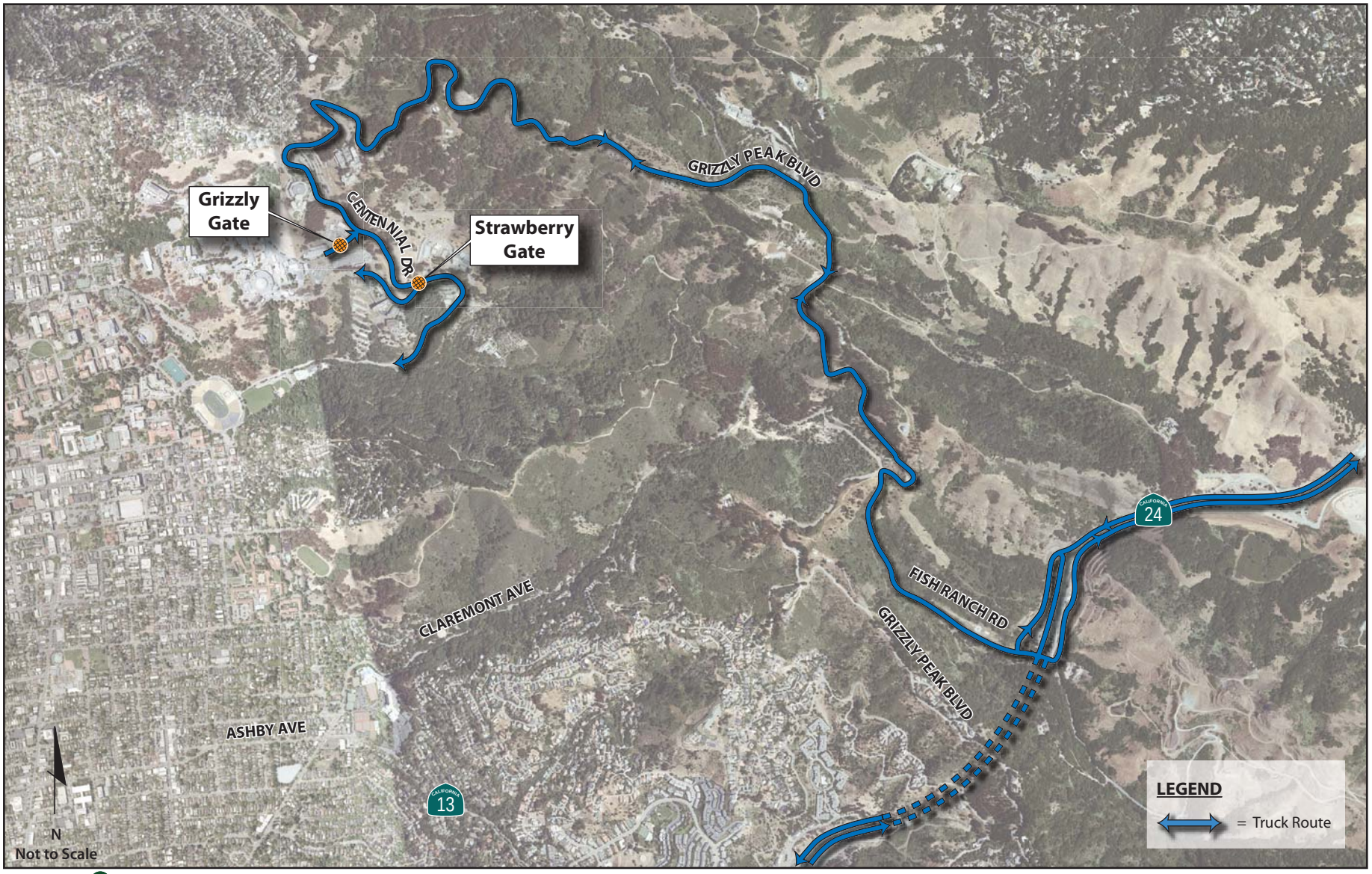
January 2009
WC08-2614_Figure2

Helios Cumulative Truck Impact Analysis

EXISTING PEAK HOUR TRAFFIC VOLUMES, LANE CONFIGURATIONS AND CONTROLS

FIGURE 2



LBNL Cumulative Truck Analysis

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April 2009
WC08-2614_3 Alt Truck Route

ALTERNATIVE TRUCK ROUTE

Figure 3

APPENDIX A:
DETAILED LOS CALCULATION SHEETS

EXISTING LOS CALCULATIONS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00			1.00	1.00		1.00			1.00	
Frpb, ped/bikes		0.98			1.00	0.89		0.99			1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00			1.00	
Frt		0.92			1.00	0.85		0.98			0.99	
Flt Protected		1.00			0.98	1.00		0.98			1.00	
Satd. Flow (prot)		1665			1828	1416		1755			1841	
Flt Permitted		0.98			0.83	1.00		0.70			0.98	
Satd. Flow (perm)		1643			1542	1416		1259			1803	
Volume (vph)	28	161	304	21	33	5	274	212	95	12	274	15
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	29	164	310	21	34	5	280	216	97	12	280	15
RTOR Reduction (vph)	0	89	0	0	0	3	0	11	0	0	3	0
Lane Group Flow (vph)	0	414	0	0	55	2	0	582	0	0	304	0
Confl. Peds. (#/hr)			11			59			71			44
Turn Type	Perm			Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)		21.5			21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0			22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34			0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5			4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		556			522	479		678			971	
v/s Ratio Prot												
v/s Ratio Perm		c0.25			0.04	0.00		c0.46			0.17	
v/c Ratio		0.75			0.11	0.00		0.86			0.31	
Uniform Delay, d1		19.0			14.7	14.2		12.9			8.3	
Progression Factor		1.00			1.00	1.00		1.00			1.00	
Incremental Delay, d2		8.8			0.4	0.0		13.4			0.8	
Delay (s)		27.8			15.2	14.3		26.2			9.2	
Level of Service		C			B	B		C			A	
Approach Delay (s)		27.8			15.1			26.2			9.2	
Approach LOS		C			B			C			A	

Intersection Summary			
HCM Average Control Delay	22.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	95.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	12	5	14	18	0	118	0	386	19	128	471	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	13	5	15	19	0	127	0	415	20	138	506	0

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total (vph)	18	15	146	435	644
Volume Left (vph)	13	0	19	0	138
Volume Right (vph)	0	15	127	20	0
Hadj (s)	0.39	-0.67	-0.46	0.01	0.08
Departure Headway (s)	8.0	7.0	6.3	5.4	5.2
Degree Utilization, x	0.04	0.03	0.26	0.66	0.93
Capacity (veh/h)	413	470	535	651	644
Control Delay (s)	10.2	9.0	11.5	18.1	42.4
Approach Delay (s)	9.6		11.5	18.1	42.4
Approach LOS	A		B	C	E

Intersection Summary			
Delay	29.6		
HCM Level of Service	D		
Intersection Capacity Utilization	78.3%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.96		1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3307		1719	3414		1719	1810	1538	1719	1810	1538
Flt Permitted	0.95	1.00		0.95	1.00		0.25	1.00	1.00	0.67	1.00	1.00
Satd. Flow (perm)	1719	3307		1719	3414		448	1810	1538	1209	1810	1538
Volume (vph)	82	989	336	39	931	47	203	132	34	75	218	312
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	86	1041	354	41	980	49	214	139	36	79	229	328
RTOR Reduction (vph)	0	21	0	0	2	0	0	0	24	0	0	122
Lane Group Flow (vph)	86	1374	0	41	1027	0	214	139	12	79	229	206
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Turn Type	Prot			Prot			pm+pt		Perm	Perm		pm+ov
Protected Phases	5	2		1	6		3	8			4	5
Permitted Phases							8		8	4		4
Actuated Green, G (s)	11.3	59.9		7.2	55.8		38.9	38.9	38.9	19.3	19.3	30.6
Effective Green, g (s)	11.3	60.9		7.2	56.8		39.9	39.9	39.9	20.3	20.3	31.6
Actuated g/C Ratio	0.09	0.51		0.06	0.47		0.33	0.33	0.33	0.17	0.17	0.26
Clearance Time (s)	4.0	5.0		4.0	5.0		4.0	5.0	5.0	5.0	5.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	162	1678		103	1616		314	602	511	205	306	456
v/s Ratio Prot	c0.05	c0.42		0.02	0.30		c0.09	0.08			0.13	c0.04
v/s Ratio Perm							c0.14		0.01	0.07		0.09
v/c Ratio	0.53	0.82		0.40	0.64		0.68	0.23	0.02	0.39	0.75	0.45
Uniform Delay, d1	51.8	24.9		54.3	23.8		31.6	29.0	26.9	44.3	47.4	37.0
Progression Factor	1.00	1.00		0.83	1.52		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.3	4.6		2.1	1.6		6.0	0.2	0.0	1.2	9.6	0.7
Delay (s)	55.1	29.5		47.1	37.8		37.6	29.2	27.0	45.5	57.0	37.7
Level of Service	E	C		D	D		D	C	C	D	E	D
Approach Delay (s)		31.0			38.2			33.6			45.6	
Approach LOS		C			D			C			D	

Intersection Summary			
HCM Average Control Delay	36.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	77.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frt	1.00	0.99		1.00	0.98		1.00	0.97		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1719	3397		1719	3380		1719	3335		1719	3391	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1719	3397		1719	3380		1719	3335		1719	3391	
Volume (vph)	51	933	81	68	773	98	69	368	92	164	765	76
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	54	982	85	72	814	103	73	387	97	173	805	80
RTOR Reduction (vph)	0	4	0	0	6	0	0	24	0	0	7	0
Lane Group Flow (vph)	54	1063	0	72	911	0	73	460	0	173	878	0
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases												
Actuated Green, G (s)	8.1	49.6		9.1	50.6		9.0	30.4		14.9	36.3	
Effective Green, g (s)	8.1	49.6		9.1	50.6		9.0	30.4		14.9	36.3	
Actuated g/C Ratio	0.07	0.41		0.08	0.42		0.08	0.25		0.12	0.30	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	116	1404		130	1425		129	845		213	1026	
v/s Ratio Prot	0.03	c0.31		c0.04	0.27		0.04	0.14		c0.10	c0.26	
v/s Ratio Perm												
v/c Ratio	0.47	0.76		0.55	0.64		0.57	0.54		0.81	0.86	
Uniform Delay, d1	53.9	30.1		53.5	27.5		53.6	38.8		51.2	39.4	
Progression Factor	1.05	1.24		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.9	2.5		5.0	2.2		5.6	0.7		20.5	7.1	
Delay (s)	58.3	39.8		58.5	29.7		59.2	39.5		71.7	46.5	
Level of Service	E	D		E	C		E	D		E	D	
Approach Delay (s)		40.7			31.8			42.1			50.6	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM Average Control Delay	41.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00			1.00	1.00		1.00			1.00	
Frpb, ped/bikes		0.97			1.00	0.90		1.00			0.99	
Flpb, ped/bikes		1.00			1.00	1.00		1.00			1.00	
Frt		0.89			1.00	0.85		1.00			0.97	
Flt Protected		1.00			0.99	1.00		0.98			1.00	
Satd. Flow (prot)		1453			1655	1281		1805			1613	
Flt Permitted		0.96			0.81	1.00		0.71			0.99	
Satd. Flow (perm)		1404			1361	1281		1311			1603	
Volume (vph)	28	52	288	69	197	40	318	288	19	4	203	49
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	29	53	294	70	201	41	324	294	19	4	207	50
RTOR Reduction (vph)	0	185	0	0	0	20	0	1	0	0	12	0
Lane Group Flow (vph)	0	192	0	0	271	21	0	636	0	0	249	0
Confl. Peds. (#/hr)			11			59			71			44
Parking (#/hr)		0	0		0	0					0	0
Turn Type	Perm			Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)		24.5			24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0			25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36			0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5			4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		501			486	458		693			847	
v/s Ratio Prot												
v/s Ratio Perm		0.14			c0.20	0.02		c0.48			0.16	
v/c Ratio		0.38			0.56	0.05		0.92			0.29	
Uniform Delay, d1		16.8			18.1	14.7		15.1			9.2	
Progression Factor		1.00			1.00	1.00		1.00			1.00	
Incremental Delay, d2		2.2			4.6	0.2		19.0			0.9	
Delay (s)		19.0			22.6	14.9		34.1			10.1	
Level of Service		B			C	B		C			B	
Approach Delay (s)		19.0			21.6			34.1			10.1	
Approach LOS		B			C			C			B	

Intersection Summary			
HCM Average Control Delay	24.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	99.1%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	7	15	47	0	232	0	359	19	135	459	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	7	16	49	0	244	0	378	20	142	483	0

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total (vph)	28	16	294	398	625
Volume Left (vph)	21	0	49	0	142
Volume Right (vph)	0	16	244	20	0
Hadj (s)	0.40	-0.67	-0.43	0.00	0.08
Departure Headway (s)	8.5	7.5	6.4	6.1	5.9
Degree Utilization, x	0.07	0.03	0.53	0.68	1.03
Capacity (veh/h)	370	426	536	570	602
Control Delay (s)	11.0	9.5	16.4	21.0	67.7
Approach Delay (s)	10.5		16.4	21.0	67.7
Approach LOS	B		C	C	F

Intersection Summary			
Delay	41.1		
HCM Level of Service	E		
Intersection Capacity Utilization	88.8%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.98		1.00	1.00		1.00	1.00	0.96	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	0.98	1.00	1.00
Frt	1.00	0.97		1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3078		1719	3236		1765	1863	1518	1741	1863	1547
Flt Permitted	0.95	1.00		0.95	1.00		0.21	1.00	1.00	0.50	1.00	1.00
Satd. Flow (perm)	1719	3078		1719	3236		392	1863	1518	916	1863	1547
Volume (vph)	128	867	256	52	1201	44	406	420	50	86	229	441
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	139	942	278	57	1305	48	441	457	54	93	249	479
RTOR Reduction (vph)	0	17	0	0	2	0	0	0	12	0	0	28
Lane Group Flow (vph)	139	1203	0	57	1351	0	441	457	42	93	249	451
Confl. Peds. (#/hr)	30		30	30		30	20		20	20		20
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Parking (#/hr)		0	0		0	0						
Turn Type	Prot			Prot			pm+pt		Perm	Perm		pm+ov
Protected Phases	5	2		1	6		3	8			4	5
Permitted Phases							8		8	4		4
Actuated Green, G (s)	17.9	59.1		8.4	49.6		48.5	48.5	48.5	21.5	21.5	39.4
Effective Green, g (s)	17.9	60.1		8.4	50.6		49.5	49.5	49.5	22.5	22.5	40.4
Actuated g/C Ratio	0.14	0.46		0.06	0.39		0.38	0.38	0.38	0.17	0.17	0.31
Clearance Time (s)	4.0	5.0		4.0	5.0		4.0	5.0	5.0	5.0	5.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	237	1423		111	1260		392	709	578	159	322	528
v/s Ratio Prot	0.08	0.39		0.03	c0.42		c0.20	0.25			0.13	c0.12
v/s Ratio Perm							c0.23		0.03	0.10		0.17
v/c Ratio	0.59	0.85		0.51	1.07		1.12	0.64	0.07	0.58	0.77	0.85
Uniform Delay, d1	52.6	30.8		58.8	39.7		33.8	33.0	25.6	49.5	51.3	42.1
Progression Factor	1.00	1.00		0.78	1.71		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.7	6.3		0.4	34.4		83.9	2.0	0.1	5.4	11.0	12.8
Delay (s)	56.3	37.2		46.5	102.3		117.8	35.0	25.7	54.8	62.3	54.8
Level of Service	E	D		D	F		F	D	C	D	E	D
Approach Delay (s)		39.1			100.0			72.8			57.1	
Approach LOS		D			F			E			E	

Intersection Summary			
HCM Average Control Delay	68.3	HCM Level of Service	E
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.98		1.00	0.99		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1719	3181		1719	3175		1719	3215		1719	3175	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1719	3181		1719	3175		1719	3215		1719	3175	
Volume (vph)	118	812	118	82	1023	163	121	828	69	155	633	101
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	128	883	128	89	1112	177	132	900	75	168	688	110
RTOR Reduction (vph)	0	7	0	0	9	0	0	5	0	0	10	0
Lane Group Flow (vph)	128	1004	0	89	1280	0	132	970	0	168	788	0
Confl. Peds. (#/hr)	30		30	30		30	30		30	30		30
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Parking (#/hr)		0	0		0	0		0	0		0	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases												
Actuated Green, G (s)	13.2	42.1		11.8	40.7		15.0	43.1		17.0	45.1	
Effective Green, g (s)	13.2	42.1		11.8	40.7		15.0	43.1		17.0	45.1	
Actuated g/C Ratio	0.10	0.32		0.09	0.31		0.12	0.33		0.13	0.35	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	175	1030		156	994		198	1066		225	1101	
v/s Ratio Prot	c0.07	0.32		0.05	c0.40		0.08	c0.30		c0.10	0.25	
v/s Ratio Perm												
v/c Ratio	0.73	0.97		0.57	1.29		0.67	0.91		0.75	0.72	
Uniform Delay, d1	56.7	43.4		56.7	44.6		55.1	41.6		54.4	36.9	
Progression Factor	1.16	1.13		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	9.9	17.4		5.0	137.2		8.2	11.4		12.6	2.2	
Delay (s)	75.7	66.3		61.6	181.8		63.3	53.0		67.1	39.1	
Level of Service	E	E		E	F		E	D		E	D	
Approach Delay (s)		67.3			174.0			54.3			44.0	
Approach LOS		E			F			D			D	

Intersection Summary			
HCM Average Control Delay	91.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	87.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BACKGROUND LOS CALCULATIONS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00			1.00	1.00		1.00			1.00	
Frpb, ped/bikes		0.98			1.00	0.89		0.99			1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00			1.00	
Frt		0.92			1.00	0.85		0.98			0.99	
Flt Protected		1.00			0.98	1.00		0.98			1.00	
Satd. Flow (prot)		1498			1645	1275		1755			1651	
Flt Permitted		0.98			0.83	1.00		0.70			0.98	
Satd. Flow (perm)		1478			1384	1275		1250			1618	
Volume (vph)	28	161	308	21	33	5	278	212	95	12	274	21
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	29	164	314	21	34	5	284	216	97	12	280	21
RTOR Reduction (vph)	0	90	0	0	0	3	0	11	0	0	4	0
Lane Group Flow (vph)	0	417	0	0	55	2	0	586	0	0	309	0
Confl. Peds. (#/hr)			11			59			71			44
Parking (#/hr)		0	0		0	0					0	0
Turn Type	Perm			Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)		21.5			21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0			22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34			0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5			4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		500			468	432		673			871	
v/s Ratio Prot												
v/s Ratio Perm		c0.28			0.04	0.00		c0.47			0.19	
v/c Ratio		0.83			0.12	0.00		0.87			0.35	
Uniform Delay, d1		19.8			14.8	14.2		13.0			8.6	
Progression Factor		1.00			1.00	1.00		1.00			1.00	
Incremental Delay, d2		15.1			0.5	0.0		14.5			1.1	
Delay (s)		34.9			15.3	14.3		27.5			9.7	
Level of Service		C			B	B		C			A	
Approach Delay (s)		34.9			15.2			27.5			9.7	
Approach LOS		C			B			C			A	

Intersection Summary			
HCM Average Control Delay	25.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	12	5	14	18	0	118	0	390	19	128	475	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	13	5	15	19	0	127	0	419	20	138	511	0

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total (vph)	18	15	146	440	648
Volume Left (vph)	13	0	19	0	138
Volume Right (vph)	0	15	127	20	0
Hadj (s)	0.39	-0.67	-0.46	0.01	0.08
Departure Headway (s)	8.1	7.0	6.4	5.4	5.2
Degree Utilization, x	0.04	0.03	0.26	0.66	0.94
Capacity (veh/h)	412	469	534	651	648
Control Delay (s)	10.2	9.0	11.6	18.5	44.0
Approach Delay (s)	9.7		11.6	18.5	44.0
Approach LOS	A		B	C	E

Intersection Summary			
Delay	30.5		
HCM Level of Service	D		
Intersection Capacity Utilization	78.7%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.98		1.00	1.00		1.00	1.00	0.97	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	0.99	1.00	1.00
Frt	1.00	0.96		1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3095		1719	3234		1767	1863	1543	1750	1863	1557
Flt Permitted	0.95	1.00		0.95	1.00		0.23	1.00	1.00	0.67	1.00	1.00
Satd. Flow (perm)	1719	3095		1719	3234		433	1863	1543	1226	1863	1557
Volume (vph)	82	998	336	39	940	47	203	132	34	75	218	312
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	89	1085	365	42	1022	51	221	143	37	82	237	339
RTOR Reduction (vph)	0	20	0	0	2	0	0	0	25	0	0	115
Lane Group Flow (vph)	89	1430	0	42	1071	0	221	143	12	82	237	224
Confl. Peds. (#/hr)	15		15	15		15	10		10	10		10
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Parking (#/hr)		0	0		0	0						
Turn Type	Prot			Prot			pm+pt		Perm	Perm		pm+ov
Protected Phases	5	2		1	6		3	8			4	5
Permitted Phases							8		8	4		4
Actuated Green, G (s)	11.5	59.7		7.3	55.5		39.0	39.0	39.0	19.4	19.4	30.9
Effective Green, g (s)	11.5	60.7		7.3	56.5		40.0	40.0	40.0	20.4	20.4	31.9
Actuated g/C Ratio	0.10	0.51		0.06	0.47		0.33	0.33	0.33	0.17	0.17	0.27
Clearance Time (s)	4.0	5.0		4.0	5.0		4.0	5.0	5.0	5.0	5.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	165	1566		105	1523		318	621	514	208	317	466
v/s Ratio Prot	0.05	c0.46		0.02	0.33		c0.09	0.08			0.13	c0.05
v/s Ratio Perm							c0.14		0.01	0.07		0.10
v/c Ratio	0.54	0.91		0.40	0.70		0.69	0.23	0.02	0.39	0.75	0.48
Uniform Delay, d1	51.7	27.2		54.2	25.1		31.7	28.9	26.9	44.3	47.4	37.1
Progression Factor	1.00	1.00		0.78	1.62		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.4	9.7		1.9	2.1		6.5	0.2	0.0	1.2	9.3	0.8
Delay (s)	55.1	36.9		44.2	42.8		38.1	29.1	26.9	45.5	56.6	37.9
Level of Service	E	D		D	D		D	C	C	D	E	D
Approach Delay (s)		37.9			42.8			33.9			45.6	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM Average Control Delay	40.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.98		1.00	0.97		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1719	3388		1719	3200		1719	3148		1719	3213	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1719	3388		1719	3200		1719	3148		1719	3213	
Volume (vph)	51	942	81	68	782	98	69	368	92	164	765	76
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	55	1024	88	74	850	107	75	400	100	178	832	83
RTOR Reduction (vph)	0	4	0	0	6	0	0	23	0	0	7	0
Lane Group Flow (vph)	55	1108	0	74	951	0	75	477	0	178	908	0
Confl. Peds. (#/hr)	15		15	15		15	15		15	15		15
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Parking (#/hr)			0		0	0		0	0		0	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases												
Actuated Green, G (s)	8.1	46.3		9.2	47.4		9.1	33.4		15.1	39.4	
Effective Green, g (s)	8.1	46.3		9.2	47.4		9.1	33.4		15.1	39.4	
Actuated g/C Ratio	0.07	0.39		0.08	0.39		0.08	0.28		0.13	0.33	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	116	1307		132	1264		130	876		216	1055	
v/s Ratio Prot	0.03	c0.33		c0.04	0.30		0.04	0.15		c0.10	c0.28	
v/s Ratio Perm												
v/c Ratio	0.47	0.85		0.56	0.75		0.58	0.54		0.82	0.86	
Uniform Delay, d1	53.9	33.6		53.4	31.2		53.6	36.8		51.2	37.7	
Progression Factor	1.08	1.24		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.6	3.8		5.4	4.2		6.1	0.7		21.8	7.3	
Delay (s)	59.9	45.4		58.8	35.4		59.7	37.5		72.9	45.1	
Level of Service	E	D		E	D		E	D		E	D	
Approach Delay (s)		46.1			37.1			40.4			49.6	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	43.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	73.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00			1.00	1.00		1.00			1.00	
Frpb, ped/bikes		0.97			1.00	0.90		1.00			0.99	
Flpb, ped/bikes		1.00			1.00	1.00		1.00			1.00	
Frt		0.89			1.00	0.85		1.00			0.97	
Flt Protected		1.00			0.99	1.00		0.98			1.00	
Satd. Flow (prot)		1452			1655	1281		1804			1613	
Flt Permitted		0.96			0.81	1.00		0.71			0.99	
Satd. Flow (perm)		1404			1357	1281		1308			1603	
Volume (vph)	28	52	292	69	197	40	322	288	19	4	203	49
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	29	53	298	70	201	41	329	294	19	4	207	50
RTOR Reduction (vph)	0	187	0	0	0	20	0	1	0	0	12	0
Lane Group Flow (vph)	0	193	0	0	271	21	0	641	0	0	249	0
Confl. Peds. (#/hr)			11			59			71			44
Parking (#/hr)		0	0		0	0					0	0
Turn Type	Perm			Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)		24.5			24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0			25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36			0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5			4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		501			485	458		691			847	
v/s Ratio Prot												
v/s Ratio Perm		0.14			c0.20	0.02		c0.49			0.16	
v/c Ratio		0.39			0.56	0.05		0.93			0.29	
Uniform Delay, d1		16.8			18.1	14.7		15.3			9.2	
Progression Factor		1.00			1.00	1.00		1.00			1.00	
Incremental Delay, d2		2.2			4.6	0.2		20.4			0.9	
Delay (s)		19.0			22.7	14.9		35.7			10.1	
Level of Service		B			C	B		D			B	
Approach Delay (s)		19.0			21.6			35.7			10.1	
Approach LOS		B			C			D			B	

Intersection Summary			
HCM Average Control Delay	24.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	99.5%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	7	15	47	0	232	0	363	19	135	463	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	7	16	49	0	244	0	382	20	142	487	0

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total (vph)	28	16	294	402	629
Volume Left (vph)	21	0	49	0	142
Volume Right (vph)	0	16	244	20	0
Hadj (s)	0.40	-0.67	-0.43	0.00	0.08
Departure Headway (s)	8.6	7.5	6.5	6.1	5.9
Degree Utilization, x	0.07	0.03	0.53	0.68	1.04
Capacity (veh/h)	369	424	535	570	601
Control Delay (s)	11.0	9.5	16.4	21.4	70.2
Approach Delay (s)	10.5		16.4	21.4	70.2
Approach LOS	B		C	C	F

Intersection Summary			
Delay	42.4		
HCM Level of Service	E		
Intersection Capacity Utilization	89.2%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.98		1.00	1.00		1.00	1.00	0.96	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	0.98	1.00	1.00
Frt	1.00	0.97		1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3079		1719	3237		1765	1863	1518	1741	1863	1547
Flt Permitted	0.95	1.00		0.95	1.00		0.21	1.00	1.00	0.50	1.00	1.00
Satd. Flow (perm)	1719	3079		1719	3237		392	1863	1518	916	1863	1547
Volume (vph)	128	876	256	52	1210	44	406	420	50	86	229	441
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	139	952	278	57	1315	48	441	457	54	93	249	479
RTOR Reduction (vph)	0	17	0	0	2	0	0	0	12	0	0	28
Lane Group Flow (vph)	139	1213	0	57	1361	0	441	457	42	93	249	451
Confl. Peds. (#/hr)	30		30	30		30	20		20	20		20
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Parking (#/hr)		0	0		0	0						
Turn Type	Prot			Prot			pm+pt		Perm	Perm		pm+ov
Protected Phases	5	2		1	6		3	8			4	5
Permitted Phases							8		8	4		4
Actuated Green, G (s)	17.9	59.1		8.4	49.6		48.5	48.5	48.5	21.5	21.5	39.4
Effective Green, g (s)	17.9	60.1		8.4	50.6		49.5	49.5	49.5	22.5	22.5	40.4
Actuated g/C Ratio	0.14	0.46		0.06	0.39		0.38	0.38	0.38	0.17	0.17	0.31
Clearance Time (s)	4.0	5.0		4.0	5.0		4.0	5.0	5.0	5.0	5.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	237	1423		111	1260		392	709	578	159	322	528
v/s Ratio Prot	0.08	0.39		0.03	c0.42		c0.20	0.25			0.13	c0.12
v/s Ratio Perm							c0.23		0.03	0.10		0.17
v/c Ratio	0.59	0.85		0.51	1.08		1.12	0.64	0.07	0.58	0.77	0.85
Uniform Delay, d1	52.6	31.0		58.8	39.7		33.8	33.0	25.6	49.5	51.3	42.1
Progression Factor	1.00	1.00		0.79	1.71		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.7	6.7		0.4	37.8		83.9	2.0	0.1	5.4	11.0	12.8
Delay (s)	56.3	37.7		46.6	105.8		117.8	35.0	25.7	54.8	62.3	54.8
Level of Service	E	D		D	F		F	D	C	D	E	D
Approach Delay (s)		39.6			103.4			72.8			57.1	
Approach LOS		D			F			E			E	

Intersection Summary			
HCM Average Control Delay	69.5	HCM Level of Service	E
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.7%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.98		1.00	0.99		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1719	3181		1719	3176		1719	3215		1719	3175	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1719	3181		1719	3176		1719	3215		1719	3175	
Volume (vph)	118	821	118	82	1032	163	121	828	69	155	633	101
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	128	892	128	89	1122	177	132	900	75	168	688	110
RTOR Reduction (vph)	0	7	0	0	9	0	0	5	0	0	10	0
Lane Group Flow (vph)	128	1013	0	89	1290	0	132	970	0	168	788	0
Confl. Peds. (#/hr)	30		30	30		30	30		30	30		30
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Parking (#/hr)		0	0		0	0		0	0		0	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases												
Actuated Green, G (s)	13.2	42.1		11.8	40.7		15.0	43.1		17.0	45.1	
Effective Green, g (s)	13.2	42.1		11.8	40.7		15.0	43.1		17.0	45.1	
Actuated g/C Ratio	0.10	0.32		0.09	0.31		0.12	0.33		0.13	0.35	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	175	1030		156	994		198	1066		225	1101	
v/s Ratio Prot	c0.07	0.32		0.05	c0.41		0.08	c0.30		c0.10	0.25	
v/s Ratio Perm												
v/c Ratio	0.73	0.98		0.57	1.30		0.67	0.91		0.75	0.72	
Uniform Delay, d1	56.7	43.6		56.7	44.6		55.1	41.6		54.4	36.9	
Progression Factor	1.16	1.13		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	9.8	18.9		5.0	141.5		8.2	11.4		12.6	2.2	
Delay (s)	75.6	68.0		61.6	186.2		63.3	53.0		67.1	39.1	
Level of Service	E	E		E	F		E	D		E	D	
Approach Delay (s)		68.9			178.2			54.3			44.0	
Approach LOS		E			F			D			D	

Intersection Summary			
HCM Average Control Delay	93.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

BACKGROUND PLUS PROJECT
LOS CALCULATIONS

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00			1.00	1.00		1.00			1.00	
Frpb, ped/bikes		0.98			1.00	0.89		0.99			1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00			1.00	
Frt		0.92			1.00	0.85		0.98			0.99	
Flt Protected		1.00			0.98	1.00		0.98			1.00	
Satd. Flow (prot)		1499			1648	1275		1755			1651	
Flt Permitted		0.98			0.83	1.00		0.69			0.98	
Satd. Flow (perm)		1479			1395	1275		1246			1617	
Volume (vph)	28	167	314	21	39	5	284	212	95	12	274	21
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	29	170	320	21	40	5	290	216	97	12	280	21
RTOR Reduction (vph)	0	89	0	0	0	3	0	11	0	0	4	0
Lane Group Flow (vph)	0	430	0	0	61	2	0	592	0	0	309	0
Confl. Peds. (#/hr)			11			59			71			44
Parking (#/hr)		0	0		0	0					0	0
Turn Type	Perm			Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)		21.5			21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0			22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34			0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5			4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		501			472	432		671			871	
v/s Ratio Prot												
v/s Ratio Perm		c0.29			0.04	0.00		c0.48			0.19	
v/c Ratio		0.86			0.13	0.00		0.88			0.35	
Uniform Delay, d1		20.0			14.9	14.2		13.2			8.6	
Progression Factor		1.00			1.00	1.00		1.00			1.00	
Incremental Delay, d2		17.1			0.6	0.0		15.6			1.1	
Delay (s)		37.1			15.4	14.3		28.8			9.7	
Level of Service		D			B	B		C			A	
Approach Delay (s)		37.1			15.3			28.8			9.7	
Approach LOS		D			B			C			A	

Intersection Summary			
HCM Average Control Delay	27.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	97.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	12	5	14	18	0	124	0	390	19	134	475	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	13	5	15	19	0	133	0	419	20	144	511	0

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total (vph)	18	15	153	440	655
Volume Left (vph)	13	0	19	0	144
Volume Right (vph)	0	15	133	20	0
Hadj (s)	0.39	-0.67	-0.46	0.01	0.08
Departure Headway (s)	8.1	7.0	6.4	5.5	5.3
Degree Utilization, x	0.04	0.03	0.27	0.67	0.96
Capacity (veh/h)	410	466	534	640	674
Control Delay (s)	10.3	9.0	11.8	18.8	47.2
Approach Delay (s)	9.7		11.8	18.8	47.2
Approach LOS	A		B	C	E

Intersection Summary			
Delay	32.3		
HCM Level of Service	D		
Intersection Capacity Utilization	79.4%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	1.00		1.00	1.00	0.97	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	0.99	1.00	1.00
Frt	1.00	0.96		1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3097		1719	3234		1767	1863	1543	1750	1863	1557
Flt Permitted	0.95	1.00		0.95	1.00		0.23	1.00	1.00	0.67	1.00	1.00
Satd. Flow (perm)	1719	3097		1719	3234		433	1863	1543	1226	1863	1557
Volume (vph)	82	1010	336	39	952	47	203	132	34	75	218	312
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	89	1098	365	42	1035	51	221	143	37	82	237	339
RTOR Reduction (vph)	0	20	0	0	2	0	0	0	25	0	0	115
Lane Group Flow (vph)	89	1443	0	42	1084	0	221	143	12	82	237	224
Confl. Peds. (#/hr)	15		15	15		15	10		10	10		10
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Parking (#/hr)		0	0		0	0						
Turn Type	Prot			Prot			pm+pt		Perm	Perm		pm+ov
Protected Phases	5	2		1	6		3	8			4	5
Permitted Phases							8		8	4		4
Actuated Green, G (s)	11.5	59.7		7.3	55.5		39.0	39.0	39.0	19.4	19.4	30.9
Effective Green, g (s)	11.5	60.7		7.3	56.5		40.0	40.0	40.0	20.4	20.4	31.9
Actuated g/C Ratio	0.10	0.51		0.06	0.47		0.33	0.33	0.33	0.17	0.17	0.27
Clearance Time (s)	4.0	5.0		4.0	5.0		4.0	5.0	5.0	5.0	5.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	165	1567		105	1523		318	621	514	208	317	466
v/s Ratio Prot	0.05	c0.47		0.02	0.34		c0.09	0.08			0.13	c0.05
v/s Ratio Perm							c0.14		0.01	0.07		0.10
v/c Ratio	0.54	0.92		0.40	0.71		0.69	0.23	0.02	0.39	0.75	0.48
Uniform Delay, d1	51.7	27.4		54.2	25.3		31.7	28.9	26.9	44.3	47.4	37.1
Progression Factor	1.00	1.00		0.78	1.62		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.4	10.3		1.9	2.2		6.5	0.2	0.0	1.2	9.3	0.8
Delay (s)	55.1	37.8		44.1	43.1		38.1	29.1	26.9	45.5	56.6	37.9
Level of Service	E	D		D	D		D	C	C	D	E	D
Approach Delay (s)		38.8			43.2			33.9			45.6	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM Average Control Delay	40.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.98		1.00	0.97		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1719	3389		1719	3201		1719	3148		1719	3213	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1719	3389		1719	3201		1719	3148		1719	3213	
Volume (vph)	51	954	81	68	794	98	69	368	92	164	765	76
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	55	1037	88	74	863	107	75	400	100	178	832	83
RTOR Reduction (vph)	0	4	0	0	6	0	0	23	0	0	7	0
Lane Group Flow (vph)	55	1121	0	74	964	0	75	477	0	178	908	0
Confl. Peds. (#/hr)	15		15	15		15	15		15	15		15
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Parking (#/hr)			0		0	0		0	0		0	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases												
Actuated Green, G (s)	8.1	46.3		9.2	47.4		9.1	33.4		15.1	39.4	
Effective Green, g (s)	8.1	46.3		9.2	47.4		9.1	33.4		15.1	39.4	
Actuated g/C Ratio	0.07	0.39		0.08	0.39		0.08	0.28		0.13	0.33	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	116	1308		132	1264		130	876		216	1055	
v/s Ratio Prot	0.03	c0.33		c0.04	0.30		0.04	0.15		c0.10	c0.28	
v/s Ratio Perm												
v/c Ratio	0.47	0.86		0.56	0.76		0.58	0.54		0.82	0.86	
Uniform Delay, d1	53.9	33.8		53.4	31.4		53.6	36.8		51.2	37.7	
Progression Factor	1.08	1.24		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.6	4.0		5.4	4.4		6.1	0.7		21.8	7.3	
Delay (s)	59.8	45.9		58.8	35.8		59.7	37.5		72.9	45.1	
Level of Service	E	D		E	D		E	D		E	D	
Approach Delay (s)		46.5			37.5			40.4			49.6	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	44.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	73.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00			1.00	1.00		1.00			1.00	
Frpb, ped/bikes		0.97			1.00	0.90		1.00			0.99	
Flpb, ped/bikes		1.00			1.00	1.00		1.00			1.00	
Frt		0.90			1.00	0.85		1.00			0.97	
Flt Protected		1.00			0.99	1.00		0.97			1.00	
Satd. Flow (prot)		1455			1656	1281		1804			1613	
Flt Permitted		0.96			0.80	1.00		0.70			0.99	
Satd. Flow (perm)		1407			1349	1281		1305			1603	
Volume (vph)	28	58	298	69	203	40	328	288	19	4	203	49
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	29	59	304	70	207	41	335	294	19	4	207	50
RTOR Reduction (vph)	0	177	0	0	0	20	0	1	0	0	12	0
Lane Group Flow (vph)	0	215	0	0	277	21	0	647	0	0	249	0
Confl. Peds. (#/hr)			11			59			71			44
Parking (#/hr)		0	0		0	0					0	0
Turn Type	Perm			Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)		24.5			24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0			25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36			0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5			4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		503			482	458		690			847	
v/s Ratio Prot												
v/s Ratio Perm		0.15			c0.21	0.02		c0.50			0.16	
v/c Ratio		0.43			0.57	0.05		0.94			0.29	
Uniform Delay, d1		17.1			18.2	14.7		15.4			9.2	
Progression Factor		1.00			1.00	1.00		1.00			1.00	
Incremental Delay, d2		2.6			4.9	0.2		21.9			0.9	
Delay (s)		19.7			23.1	14.9		37.3			10.1	
Level of Service		B			C	B		D			B	
Approach Delay (s)		19.7			22.1			37.3			10.1	
Approach LOS		B			C			D			B	

Intersection Summary			
HCM Average Control Delay	25.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	100.9%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	7	15	47	0	238	0	363	19	141	463	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	7	16	49	0	251	0	382	20	148	487	0

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total (vph)	28	16	300	402	636
Volume Left (vph)	21	0	49	0	148
Volume Right (vph)	0	16	251	20	0
Hadj (s)	0.40	-0.67	-0.43	0.00	0.08
Departure Headway (s)	8.6	7.5	6.5	6.2	6.0
Degree Utilization, x	0.07	0.03	0.54	0.69	1.05
Capacity (veh/h)	367	421	535	568	598
Control Delay (s)	11.0	9.6	16.7	21.6	75.1
Approach Delay (s)	10.5		16.7	21.6	75.1
Approach LOS	B		C	C	F

Intersection Summary			
Delay	44.8		
HCM Level of Service	E		
Intersection Capacity Utilization	89.9%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.98		1.00	1.00		1.00	1.00	0.96	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	0.98	1.00	1.00
Frt	1.00	0.97		1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	3081		1719	3237		1765	1863	1518	1741	1863	1547
Flt Permitted	0.95	1.00		0.95	1.00		0.21	1.00	1.00	0.50	1.00	1.00
Satd. Flow (perm)	1719	3081		1719	3237		392	1863	1518	916	1863	1547
Volume (vph)	128	888	256	52	1222	44	406	420	50	86	229	441
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	139	965	278	57	1328	48	441	457	54	93	249	479
RTOR Reduction (vph)	0	17	0	0	2	0	0	0	12	0	0	28
Lane Group Flow (vph)	139	1226	0	57	1374	0	441	457	42	93	249	451
Confl. Peds. (#/hr)	30		30	30		30	20		20	20		20
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Parking (#/hr)		0	0		0	0						
Turn Type	Prot			Prot			pm+pt		Perm	Perm		pm+ov
Protected Phases	5	2		1	6		3	8			4	5
Permitted Phases							8		8	4		4
Actuated Green, G (s)	17.9	59.1		8.4	49.6		48.5	48.5	48.5	21.5	21.5	39.4
Effective Green, g (s)	17.9	60.1		8.4	50.6		49.5	49.5	49.5	22.5	22.5	40.4
Actuated g/C Ratio	0.14	0.46		0.06	0.39		0.38	0.38	0.38	0.17	0.17	0.31
Clearance Time (s)	4.0	5.0		4.0	5.0		4.0	5.0	5.0	5.0	5.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	237	1424		111	1260		392	709	578	159	322	528
v/s Ratio Prot	0.08	0.40		0.03	c0.42		c0.20	0.25			0.13	c0.12
v/s Ratio Perm							c0.23		0.03	0.10		0.17
v/c Ratio	0.59	0.86		0.51	1.09		1.12	0.64	0.07	0.58	0.77	0.85
Uniform Delay, d1	52.6	31.2		58.8	39.7		33.8	33.0	25.6	49.5	51.3	42.1
Progression Factor	1.00	1.00		0.78	1.71		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.7	7.0		0.4	42.3		83.9	2.0	0.1	5.4	11.0	12.8
Delay (s)	56.3	38.3		46.4	110.3		117.8	35.0	25.7	54.8	62.3	54.8
Level of Service	E	D		D	F		F	D	C	D	E	D
Approach Delay (s)		40.1			107.7			72.8			57.1	
Approach LOS		D			F			E			E	

Intersection Summary			
HCM Average Control Delay	71.1	HCM Level of Service	E
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	97.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.98		1.00	0.99		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1719	3182		1719	3177		1719	3215		1719	3175	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1719	3182		1719	3177		1719	3215		1719	3175	
Volume (vph)	118	833	118	82	1044	163	121	828	69	155	633	101
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	128	905	128	89	1135	177	132	900	75	168	688	110
RTOR Reduction (vph)	0	7	0	0	9	0	0	5	0	0	10	0
Lane Group Flow (vph)	128	1026	0	89	1303	0	132	970	0	168	788	0
Confl. Peds. (#/hr)	30		30	30		30	30		30	30		30
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Parking (#/hr)		0	0		0	0		0	0		0	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases												
Actuated Green, G (s)	13.2	42.1		11.8	40.7		15.0	43.1		17.0	45.1	
Effective Green, g (s)	13.2	42.1		11.8	40.7		15.0	43.1		17.0	45.1	
Actuated g/C Ratio	0.10	0.32		0.09	0.31		0.12	0.33		0.13	0.35	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	175	1030		156	995		198	1066		225	1101	
v/s Ratio Prot	c0.07	0.32		0.05	c0.41		0.08	c0.30		c0.10	0.25	
v/s Ratio Perm												
v/c Ratio	0.73	1.00		0.57	1.31		0.67	0.91		0.75	0.72	
Uniform Delay, d1	56.7	43.9		56.7	44.6		55.1	41.6		54.4	36.9	
Progression Factor	1.16	1.13		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	9.6	21.4		5.0	146.6		8.2	11.4		12.6	2.2	
Delay (s)	75.4	70.9		61.6	191.3		63.3	53.0		67.1	39.1	
Level of Service	E	E		E	F		E	D		E	D	
Approach Delay (s)		71.4			183.0			54.3			44.0	
Approach LOS		E			F			D			D	

Intersection Summary			
HCM Average Control Delay	95.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

APPENDIX A:
DETAILED LOS CALCULATION SHEETS FOR ALTERNATIVE ROUTE

EXISTING LOS CALCULATIONS

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	PM Peak Hour
Highway	Southbound Grizzly Peak Blvd
From/To	Centenial Drive to Fish Ranch
Jurisdiction	
Analysis Year	2009
Description Existing	

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	2.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	3	/mi

Analysis direction volume, Vd 374 veh/h
Opposing direction volume, Vo 127 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.971		0.971	
Grade adj. factor,(note-1) fG	0.93		0.71	
Directional flow rate,(note-2) vi	450	pc/h	200	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	374	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	38.0	mi/h
Adjustment for no-passing zones, fnp	4.0	mi/h
Average travel speed, ATSd	28.9	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	2.5*	2.5*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.971	0.971
Grade adjustment factor,(note-1) fG	0.94	0.77
Directional flow rate,(note-2) vi	445 pc/h	185 pc/h

Base percent time-spent-following,(note-4) BPTSFd	41.0	%
Adjustment for no-passing zones, fnp	45.3	
Percent time-spent-following, PTSFd	73.0	%

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.26	
Peak 15-min vehicle-miles of travel, VMT15	305	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1122	veh-mi
Peak 15-min total travel time, TT15	10.5	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	3.0	mi
Length of two-lane highway upstream of the passing lane, Lu	3.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	28.9	mi/h
Percent time-spent-following, PTSFd (from above)	73.0	
Level of service,(note-1) LOSd (from above)	D	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-1.70	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane,(note-2) ATSpl		

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	7.74	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-7.74	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.61	
Percent time-spent-following including passing lane,(note-3) PTSFpl	73.0	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl
Peak 15-min total travel time, TT15 veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	AM Peak Hour
Highway	Southbound Grizzly Peak Blvd
From/To	Centenial Drive to Fish Ranch
Jurisdiction	
Analysis Year	2009
Description Existing	

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	2.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	3	/mi

Analysis direction volume, Vd 186 veh/h
Opposing direction volume, Vo 219 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.930		0.930	
Grade adj. factor,(note-1) fG	0.93		0.93	
Directional flow rate,(note-2) vi	234	pc/h	275	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	186	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	36.6	mi/h
Adjustment for no-passing zones, fnp	3.5	mi/h
Average travel speed, ATSd	29.1	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	2.5*	2.5*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.930	0.930
Grade adjustment factor,(note-1) fG	0.77	0.94
Directional flow rate,(note-2) vi	282 pc/h	272 pc/h

Base percent time-spent-following,(note-4) BPTSFd	30.9	%
Adjustment for no-passing zones, fnp	58.9	
Percent time-spent-following, PTSFd	60.8	%

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.14	
Peak 15-min vehicle-miles of travel, VMT15	152	veh-mi
Peak-hour vehicle-miles of travel, VMT60	558	veh-mi
Peak 15-min total travel time, TT15	5.2	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	3.0	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	29.1	mi/h
Percent time-spent-following, PTSFd (from above)	60.8	
Level of service,(note-1) LOSd (from above)	C	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	1.30	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.08	
Average travel speed including passing lane,(note-2) ATSpl	29.7	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	10.99	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-7.99	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.58	
Percent time-spent-following including passing lane,(note-3) PTSFpl	38.8	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	A	
Peak 15-min total travel time, TT15	5.1	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	PM Peak Hour
Highway	Southbound Fish Ranch Road
From/To	SR24 to Grizzly Peak Blvd
Jurisdiction	
Analysis Year	2009
Description Existing	

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	13.0	ft	% Trucks crawling	0.0	%
Segment length	0.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	1	/mi

Analysis direction volume, Vd 861 veh/h
Opposing direction volume, Vo 168 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.0*		3.0*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.990		0.980	
Grade adj. factor,(note-1) fG	0.99		0.71	
Directional flow rate,(note-2) vi	955	pc/h	262	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	861	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	41.7	mi/h
Adjustment for no-passing zones, fnp	3.6	mi/h
Average travel speed, ATSd	28.7	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.0*		3.0*	
PCE for RVs, ER	1.0*		1.0	
Heavy-vehicle adjustment factor, fHV	0.990		0.980	
Grade adjustment factor,(note-1) fG	1.00		0.77	
Directional flow rate,(note-2) vi	945	pc/h	242	pc/h
Base percent time-spent-following,(note-4) BPTSFd	68.2	%		
Adjustment for no-passing zones, fnp	30.9			
Percent time-spent-following, PTSFd	92.8	%		

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.56	
Peak 15-min vehicle-miles of travel, VMT15	187	veh-mi
Peak-hour vehicle-miles of travel, VMT60	689	veh-mi
Peak 15-min total travel time, TT15	6.5	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	0.8	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	28.7	mi/h
Percent time-spent-following, PTSFd (from above)	92.8	
Level of service,(note-1) LOSd (from above)	E	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.90	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.11	
Average travel speed including passing lane,(note-2) ATSpl	31.1	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	3.98	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-3.18	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.62	
Percent time-spent-following including passing lane,(note-3) PTSFpl	61.1	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	C	
Peak 15-min total travel time, TT15	6.0	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	AM Peak Hour
Highway	Southbound Fish Ranch Road
From/To	SR24 to Grizzly Peak Blvd
Jurisdiction	
Analysis Year	2009
Description Existing	

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	1.0	ft	% Trucks and buses	3	%
Lane width	13.0	ft	% Trucks crawling	0.0	%
Segment length	0.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	1	/mi

Analysis direction volume, Vd 346 veh/h
Opposing direction volume, Vo 338 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.0*		3.0*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.971		0.943	
Grade adj. factor,(note-1) fG	0.93		0.93	
Directional flow rate,(note-2) vi	417	pc/h	419	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	40	mi/h
Observed volume,(note-3) Vf	346	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	42.8	mi/h
Adjustment for no-passing zones, fnp	2.6	mi/h
Average travel speed, ATSd	33.7	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	2.0*	3.0*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.971	0.943
Grade adjustment factor,(note-1) fG	0.94	0.94
Directional flow rate,(note-2) vi	412 pc/h	414 pc/h

Base percent time-spent-following,(note-4) BPTSFd	43.8	%
Adjustment for no-passing zones, fnp	40.7	
Percent time-spent-following, PTSFd	64.1	%

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.25	
Peak 15-min vehicle-miles of travel, VMT15	75	veh-mi
Peak-hour vehicle-miles of travel, VMT60	277	veh-mi
Peak 15-min total travel time, TT15	2.2	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	0.8	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	33.7	mi/h
Percent time-spent-following, PTSFd (from above)	64.1	
Level of service,(note-1) LOSd (from above)	C	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.90	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane,(note-2) ATSpl	36.2	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	8.00	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-7.20	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.61	
Percent time-spent-following including passing lane,(note-3) PTSFpl	40.4	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	B	
Peak 15-min total travel time, TT15	2.1	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	PM Peak Hour
Highway	Northbound Grizzly Peak Blvd
From/To	Centenial Drive to Fish Ranch
Jurisdiction	
Analysis Year	2009
Description Existing	

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	2.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	3	/mi

Analysis direction volume, Vd 127 veh/h
Opposing direction volume, Vo 341 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.971		0.971	
Grade adj. factor,(note-1) fG	0.71		0.93	
Directional flow rate,(note-2) vi	200	pc/h	411	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	127	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	36.0	mi/h
Adjustment for no-passing zones, fnp	2.7	mi/h
Average travel speed, ATSd	28.6	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	2.5*	2.5*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.971	0.971
Grade adjustment factor,(note-1) fG	0.77	0.94
Directional flow rate,(note-2) vi	185 pc/h	406 pc/h

Base percent time-spent-following,(note-4) BPTSFd	24.0	%
Adjustment for no-passing zones, fnp	54.7	
Percent time-spent-following, PTSFd	41.1	%

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.12	
Peak 15-min vehicle-miles of travel, VMT15	104	veh-mi
Peak-hour vehicle-miles of travel, VMT60	381	veh-mi
Peak 15-min total travel time, TT15	3.6	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	3.0	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	28.6	mi/h
Percent time-spent-following, PTSFd (from above)	41.1	
Level of service,(note-1) LOSd (from above)	B	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	1.30	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.08	
Average travel speed including passing lane,(note-2) ATSpl	29.3	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	13.00	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-10.00	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.58	
Percent time-spent-following including passing lane,(note-3) PTSFpl	25.8	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	A	
Peak 15-min total travel time, TT15	3.6	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	AM Peak Hour
Highway	Northbound Grizzly Peak Blvd
From/To	Centenial Drive to Fish Ranch
Jurisdiction	
Analysis Year	2009
Description Existing	

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	2.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	3	/mi

Analysis direction volume, Vd 219 veh/h
Opposing direction volume, Vo 186 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.930		0.930	
Grade adj. factor,(note-1) fG	0.93		0.93	
Directional flow rate,(note-2) vi	275	pc/h	234	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	219	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	36.8	mi/h
Adjustment for no-passing zones, fnp	3.8	mi/h
Average travel speed, ATSd	29.1	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.0*		1.0	
Heavy-vehicle adjustment factor, fHV	0.930		0.930	
Grade adjustment factor,(note-1) fG	0.94		0.77	
Directional flow rate,(note-2) vi	272	pc/h	282	pc/h
Base percent time-spent-following,(note-4) BPTSFd	30.2	%		
Adjustment for no-passing zones, fnp	55.0			
Percent time-spent-following, PTSFd	57.2	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.16	
Peak 15-min vehicle-miles of travel, VMT15	179	veh-mi
Peak-hour vehicle-miles of travel, VMT60	657	veh-mi
Peak 15-min total travel time, TT15	6.2	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	3.0	mi
Length of two-lane highway upstream of the passing lane, Lu	3.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	29.1	mi/h
Percent time-spent-following, PTSFd (from above)	57.2	
Level of service,(note-1) LOSd (from above)	C	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-1.70	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.08	
Average travel speed including passing lane,(note-2) ATSpl		

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	11.24	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-11.24	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.58	
Percent time-spent-following including passing lane,(note-3) PTSFpl	57.2	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl
Peak 15-min total travel time, TT15 veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	PM Peak Hour
Highway	Northbound Fish Ranch Road
From/To	SR24 to Grizzly Peak Blvd
Jurisdiction	
Analysis Year	2009
Description Existing	

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	1.0	ft	% Trucks and buses	1	%
Lane width	13.0	ft	% Trucks crawling	0.0	%
Segment length	0.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	1	/mi

Analysis direction volume, Vd 158 veh/h
Opposing direction volume, Vo 861 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	3.0*		2.0*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.980		0.990	
Grade adj. factor,(note-1) fG	0.71		0.99	
Directional flow rate,(note-2) vi	247	pc/h	955	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	158	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	36.3	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h
Average travel speed, ATSd	25.8	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	3.0*	2.0*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.980	0.990
Grade adjustment factor,(note-1) fG	0.77	1.00
Directional flow rate,(note-2) vi	227 pc/h	945 pc/h
Base percent time-spent-following,(note-4) BPTSFd	35.1 %	
Adjustment for no-passing zones, fnp	32.6	
Percent time-spent-following, PTSFd	41.4 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.15	
Peak 15-min vehicle-miles of travel, VMT15	34	veh-mi
Peak-hour vehicle-miles of travel, VMT60	126	veh-mi
Peak 15-min total travel time, TT15	1.3	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	0.8	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	25.8	mi/h
Percent time-spent-following, PTSFd (from above)	41.4	
Level of service,(note-1) LOSd (from above)	B	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.90	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.08	
Average travel speed including passing lane,(note-2) ATSpl	27.4	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	12.34	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-11.54	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.58	
Percent time-spent-following including passing lane,(note-3) PTSFpl	24.6	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	A	
Peak 15-min total travel time, TT15	1.2	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	AM Peak Hour
Highway	Northbound Fish Ranch Road
From/To	SR24 to Grizzly Peak Blvd
Jurisdiction	
Analysis Year	2009
Description Existing	

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	1.0	ft	% Trucks and buses	5	%
Lane width	13.0	ft	% Trucks crawling	0.0	%
Segment length	0.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	1	/mi

Analysis direction volume, Vd 338 veh/h
Opposing direction volume, Vo 346 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	3.0*		2.0*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.909		0.952	
Grade adj. factor,(note-1) fG	0.93		0.93	
Directional flow rate,(note-2) vi	435	pc/h	425	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	40	mi/h
Observed volume,(note-3) Vf	338	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	42.9	mi/h
Adjustment for no-passing zones, fnp	2.6	mi/h
Average travel speed, ATSd	33.6	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	3.0*	2.0*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.909	0.952
Grade adjustment factor,(note-1) fG	0.94	0.94
Directional flow rate,(note-2) vi	430 pc/h	420 pc/h

Base percent time-spent-following,(note-4) BPTSFd	45.3	%
Adjustment for no-passing zones, fnp	45.1	
Percent time-spent-following, PTSFd	68.1	%

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.26	
Peak 15-min vehicle-miles of travel, VMT15	73	veh-mi
Peak-hour vehicle-miles of travel, VMT60	270	veh-mi
Peak 15-min total travel time, TT15	2.2	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	0.8	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	33.6	mi/h
Percent time-spent-following, PTSFd (from above)	68.1	
Level of service,(note-1) LOSd (from above)	C	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.90	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane,(note-2) ATSpl	36.2	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	7.86	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-7.06	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.61	
Percent time-spent-following including passing lane,(note-3) PTSFpl	42.9	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	B	
Peak 15-min total travel time, TT15	2.0	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

EXISTING PLUS PROJECT
LOS CALCULATIONS

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	PM Peak Hour
Highway	Southbound Grizzly Peak Blvd
From/To	Centenial Drive to Fish Ranch
Jurisdiction	
Analysis Year	2009
Description	Existing plus Project

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	2.0	ft	% Trucks and buses	2	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	3	/mi

Analysis direction volume, Vd 377 veh/h
Opposing direction volume, Vo 130 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.971		0.971	
Grade adj. factor,(note-1) fG	0.93		0.71	
Directional flow rate,(note-2) vi	454	pc/h	205	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	377	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	38.0	mi/h
Adjustment for no-passing zones, fnp	4.0	mi/h
Average travel speed, ATSd	28.9	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	2.5*	2.5*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.971	0.971
Grade adjustment factor,(note-1) fG	0.94	0.77
Directional flow rate,(note-2) vi	449 pc/h	189 pc/h

Base percent time-spent-following,(note-4) BPTSFd	41.3	%
Adjustment for no-passing zones, fnp	44.8	
Percent time-spent-following, PTSFd	72.9	%

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.27	
Peak 15-min vehicle-miles of travel, VMT15	307	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1131	veh-mi
Peak 15-min total travel time, TT15	10.6	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	3.0	mi
Length of two-lane highway upstream of the passing lane, Lu	3.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	28.9	mi/h
Percent time-spent-following, PTSFd (from above)	72.9	
Level of service,(note-1) LOSd (from above)	D	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-1.70	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane,(note-2) ATSpl		

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	7.71	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-7.71	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.61	
Percent time-spent-following including passing lane,(note-3) PTSFpl	72.9	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl
Peak 15-min total travel time, TT15 veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	AM Peak Hour
Highway	Southbound Grizzly Peak Blvd
From/To	Centenial Drive to Fish Ranch
Jurisdiction	
Analysis Year	2009
Description	Existing plus Project

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	2.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	3	/mi

Analysis direction volume, Vd 189 veh/h
Opposing direction volume, Vo 222 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.917		0.917	
Grade adj. factor,(note-1) fG	0.93		0.93	
Directional flow rate,(note-2) vi	241	pc/h	283	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	189	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	36.6	mi/h
Adjustment for no-passing zones, fnp	3.5	mi/h
Average travel speed, ATSd	29.1	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.0*		1.0	
Heavy-vehicle adjustment factor, fHV	0.917		0.917	
Grade adjustment factor,(note-1) fG	0.77		0.94	
Directional flow rate,(note-2) vi	291	pc/h	280	pc/h
Base percent time-spent-following,(note-4) BPTSFd	31.8	%		
Adjustment for no-passing zones, fnp	58.1			
Percent time-spent-following, PTSFd	61.5	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.14	
Peak 15-min vehicle-miles of travel, VMT15	154	veh-mi
Peak-hour vehicle-miles of travel, VMT60	567	veh-mi
Peak 15-min total travel time, TT15	5.3	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	3.0	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	29.1	mi/h
Percent time-spent-following, PTSFd (from above)	61.5	
Level of service,(note-1) LOSd (from above)	C	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	1.30	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.08	
Average travel speed including passing lane,(note-2) ATSpl	29.7	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	10.77	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-7.77	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.58	
Percent time-spent-following including passing lane,(note-3) PTSFpl	39.2	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	A	
Peak 15-min total travel time, TT15	5.2	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	PM Peak Hour
Highway	Southbound Fish Ranch Road
From/To	SR24 to Grizzly Peak Blvd
Jurisdiction	
Analysis Year	2009
Description	Existing plus Project

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	1.0	ft	% Trucks and buses	2	%
Lane width	13.0	ft	% Trucks crawling	0.0	%
Segment length	0.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	1	/mi

Analysis direction volume, Vd 864 veh/h
Opposing direction volume, Vo 161 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.0*		3.0*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.980		0.962	
Grade adj. factor,(note-1) fG	0.99		0.71	
Directional flow rate,(note-2) vi	968	pc/h	256	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	871	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	41.9	mi/h
Adjustment for no-passing zones, fnp	3.6	mi/h
Average travel speed, ATSd	28.8	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	2.0*	3.0*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.980	0.962
Grade adjustment factor,(note-1) fG	1.00	0.77
Directional flow rate,(note-2) vi	958 pc/h	236 pc/h

Base percent time-spent-following,(note-4) BPTSFd	68.5	%
Adjustment for no-passing zones, fnp	31.4	
Percent time-spent-following, PTSFd	93.7	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.57	
Peak 15-min vehicle-miles of travel, VMT15	188	veh-mi
Peak-hour vehicle-miles of travel, VMT60	691	veh-mi
Peak 15-min total travel time, TT15	6.5	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	0.8	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	28.8	mi/h
Percent time-spent-following, PTSFd (from above)	93.7	
Level of service,(note-1) LOSd (from above)	E	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.90	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.11	
Average travel speed including passing lane,(note-2) ATSpl	31.2	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	3.89	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-3.09	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.62	
Percent time-spent-following including passing lane,(note-3) PTSFpl	61.7	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	C	
Peak 15-min total travel time, TT15	6.0	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	AM Peak Hour
Highway	Southbound Fish Ranch Road
From/To	SR24 to Grizzly Peak Blvd
Jurisdiction	
Analysis Year	2009
Description	Existing plus Project

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	1.0	ft	% Trucks and buses	3	%
Lane width	13.0	ft	% Trucks crawling	0.0	%
Segment length	0.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	1	/mi

Analysis direction volume, Vd 349 veh/h
Opposing direction volume, Vo 341 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.0*		3.0*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.971		0.943	
Grade adj. factor,(note-1) fG	0.93		0.93	
Directional flow rate,(note-2) vi	420	pc/h	422	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	40	mi/h
Observed volume,(note-3) Vf	349	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	42.8	mi/h
Adjustment for no-passing zones, fnp	2.6	mi/h
Average travel speed, ATSd	33.7	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	2.0*	3.0*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.971	0.943
Grade adjustment factor,(note-1) fG	0.94	0.94
Directional flow rate,(note-2) vi	416 pc/h	418 pc/h

Base percent time-spent-following,(note-4) BPTSFd	44.2	%
Adjustment for no-passing zones, fnp	40.5	
Percent time-spent-following, PTSFd	64.4	%

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.25	
Peak 15-min vehicle-miles of travel, VMT15	76	veh-mi
Peak-hour vehicle-miles of travel, VMT60	279	veh-mi
Peak 15-min total travel time, TT15	2.3	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	0.8	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	33.7	mi/h
Percent time-spent-following, PTSFd (from above)	64.4	
Level of service,(note-1) LOSd (from above)	C	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.90	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane,(note-2) ATSpl	36.2	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	7.97	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-7.17	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.61	
Percent time-spent-following including passing lane,(note-3) PTSFpl	40.6	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	B	
Peak 15-min total travel time, TT15	2.1	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	PM Peak Hour
Highway	Northbound Grizzly Peak Blvd
From/To	Centenial Drive to Fish Ranch
Jurisdiction	
Analysis Year	2009
Description	Existing plus Project

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	2.0	ft	% Trucks and buses	4	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	3	/mi

Analysis direction volume, Vd 130 veh/h
Opposing direction volume, Vo 377 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.943		0.943	
Grade adj. factor,(note-1) fG	0.71		0.93	
Directional flow rate,(note-2) vi	211	pc/h	467	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	130	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	36.1	mi/h
Adjustment for no-passing zones, fnp	2.4	mi/h
Average travel speed, ATSd	28.4	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.0*		1.0	
Heavy-vehicle adjustment factor, fHV	0.943		0.943	
Grade adjustment factor,(note-1) fG	0.77		0.94	
Directional flow rate,(note-2) vi	195	pc/h	462	pc/h
Base percent time-spent-following,(note-4) BPTSFd	26.1	%		
Adjustment for no-passing zones, fnp	50.8			
Percent time-spent-following, PTSFd	41.2	%		

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.12	
Peak 15-min vehicle-miles of travel, VMT15	106	veh-mi
Peak-hour vehicle-miles of travel, VMT60	390	veh-mi
Peak 15-min total travel time, TT15	3.7	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	3.0	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	28.4	mi/h
Percent time-spent-following, PTSFd (from above)	41.2	
Level of service,(note-1) LOSd (from above)	B	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	1.30	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.08	
Average travel speed including passing lane,(note-2) ATSpl	29.0	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	13.00	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-10.00	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.58	
Percent time-spent-following including passing lane,(note-3) PTSFpl	25.9	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	A	
Peak 15-min total travel time, TT15	3.6	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	AM Peak Hour
Highway	Northbound Grizzly Peak Blvd
From/To	Centenial Drive to Fish Ranch
Jurisdiction	
Analysis Year	2009
Description	Existing plus Project

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	2.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	3.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	3	/mi

Analysis direction volume, Vd 222 veh/h
Opposing direction volume, Vo 189 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.917		0.917	
Grade adj. factor,(note-1) fG	0.93		0.93	
Directional flow rate,(note-2) vi	283	pc/h	241	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	222	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	36.9	mi/h
Adjustment for no-passing zones, fnp	3.7	mi/h
Average travel speed, ATSd	29.1	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5*		2.5*	
PCE for RVs, ER	1.0*		1.0	
Heavy-vehicle adjustment factor, fHV	0.917		0.917	
Grade adjustment factor,(note-1) fG	0.94		0.77	
Directional flow rate,(note-2) vi	280	pc/h	291	pc/h
Base percent time-spent-following,(note-4) BPTSFd	31.1	%		
Adjustment for no-passing zones, fnp	54.8			
Percent time-spent-following, PTSFd	58.0	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.17	
Peak 15-min vehicle-miles of travel, VMT15	181	veh-mi
Peak-hour vehicle-miles of travel, VMT60	666	veh-mi
Peak 15-min total travel time, TT15	6.2	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	3.0	mi
Length of two-lane highway upstream of the passing lane, Lu	3.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	29.1	mi/h
Percent time-spent-following, PTSFd (from above)	58.0	
Level of service,(note-1) LOSd (from above)	C	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-1.70	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.08	
Average travel speed including passing lane,(note-2) ATSpl		

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	11.04	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-11.04	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.58	
Percent time-spent-following including passing lane,(note-3) PTSFpl	58.0	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl
Peak 15-min total travel time, TT15 veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	PM Peak Hour
Highway	Northbound Fish Ranch Road
From/To	SR24 to Grizzly Peak Blvd
Jurisdiction	
Analysis Year	2009
Description	Existing plus Project

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	1.0	ft	% Trucks and buses	3	%
Lane width	13.0	ft	% Trucks crawling	0.0	%
Segment length	0.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	1	/mi

Analysis direction volume, Vd 161 veh/h
Opposing direction volume, Vo 864 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	3.0*		2.0*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.943		0.971	
Grade adj. factor,(note-1) fG	0.71		0.99	
Directional flow rate,(note-2) vi	261	pc/h	977	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed,(note-3) S FM	35	mi/h
Observed volume,(note-3) Vf	161	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	36.3	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h
Average travel speed, ATSd	25.6	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	3.0*	2.0*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.943	0.971
Grade adjustment factor,(note-1) fG	0.77	1.00
Directional flow rate,(note-2) vi	241 pc/h	967 pc/h
Base percent time-spent-following,(note-4) BPTSFd	36.7 %	
Adjustment for no-passing zones, fnp	31.8	
Percent time-spent-following, PTSFd	43.1 %	

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.15	
Peak 15-min vehicle-miles of travel, VMT15	35	veh-mi
Peak-hour vehicle-miles of travel, VMT60	129	veh-mi
Peak 15-min total travel time, TT15	1.4	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	0.8	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	25.6	mi/h
Percent time-spent-following, PTSFd (from above)	43.1	
Level of service,(note-1) LOSd (from above)	B	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.90	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.08	
Average travel speed including passing lane,(note-2) ATSpl	27.2	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	12.00	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-11.20	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.58	
Percent time-spent-following including passing lane,(note-3) PTSFpl	25.6	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	A	
Peak 15-min total travel time, TT15	1.3	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Ryan McClain
Agency/Co.	
Date Performed	3/4/2009
Analysis Time Period	AM Peak Hour
Highway	Northbound Fish Ranch Road
From/To	SR24 to Grizzly Peak Blvd
Jurisdiction	
Analysis Year	2009
Description	Existing plus Project

Input Data

Highway class	Class 2		Peak-hour factor, PHF	0.92	
Shoulder width	1.0	ft	% Trucks and buses	5	%
Lane width	13.0	ft	% Trucks crawling	0.0	%
Segment length	0.8	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length		mi	% No-passing zones	100	%
Up/down		%	Access points/mi	1	/mi

Analysis direction volume, Vd 341 veh/h
Opposing direction volume, Vo 349 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	3.0*		2.0*	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.909		0.952	
Grade adj. factor,(note-1) fG	0.93		0.93	
Directional flow rate,(note-2) vi	438	pc/h	428	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed,(note-3) S FM	40	mi/h
Observed volume,(note-3) Vf	341	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	-	mi/h
Adj. for lane and shoulder width,(note-3) fLS	-	mi/h
Adj. for access points,(note-3) fA	-	mi/h
Free-flow speed, FFSd	42.9	mi/h
Adjustment for no-passing zones, fnp	2.6	mi/h
Average travel speed, ATSd	33.6	mi/h

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	3.0*	2.0*
PCE for RVs, ER	1.0*	1.0
Heavy-vehicle adjustment factor, fHV	0.909	0.952
Grade adjustment factor,(note-1) fG	0.94	0.94
Directional flow rate,(note-2) vi	434 pc/h	424 pc/h

Base percent time-spent-following,(note-4) BPTSFd	45.7	%
Adjustment for no-passing zones, fnp	44.9	
Percent time-spent-following, PTSFd	68.4	%

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.26	
Peak 15-min vehicle-miles of travel, VMT15	74	veh-mi
Peak-hour vehicle-miles of travel, VMT60	273	veh-mi
Peak 15-min total travel time, TT15	2.2	veh-h

Notes:
1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt	0.8	mi
Length of two-lane highway upstream of the passing lane, Lu	0.0	mi
Length of passing lane including tapers, Lpl	0.0	mi
Average travel speed, ATSd (from above)	33.6	mi/h
Percent time-spent-following, PTSFd (from above)	68.4	
Level of service,(note-1) LOSd (from above)	C	

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	1.70	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-0.90	mi
Adj. factor for the effect of passing lane on average speed, fpl	1.10	
Average travel speed including passing lane,(note-2) ATSpl	36.2	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	7.83	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-7.03	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	0.61	
Percent time-spent-following including passing lane,(note-3) PTSFpl	43.1	%

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl	B	
Peak 15-min total travel time, TT15	2.0	veh-h

Notes:
1. If LOSd = F, passing lane analysis cannot be performed.
2. If Ld < 0, use alternative Equation 20-22.
3. If Ld < 0, use alternative Equation 20-20.
4. v/c, VMT15 , and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.

* These items have been entered or edited to override calculated value