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Environmental Assessment for Construction and Operation of a Human Genome Laboratory at Lawrence Berkeley Laboratory Berkeley, California

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1.0 INTRODUCTION

Lawrence Berkeley Laboratory (LBL) proposes to construct and operate a new laboratory for consolidation of current and future activities of the Human Genome Center (HGC). This document addresses the potential direct, indirect, and cumulative environmental and human-health effects from the proposed facility construction and operation. This document was prepared in accordance the *National Environmental Policy Act of 1969* (United States Codes 42 U.S.C. 4321-4347) (NEPA) and the U. S. Department of Energy's (DOE) *Final Rule for NEPA Implementing Procedures* [Code of Federal Regulations 10CFR 1021].

Five alternatives to the proposed action are considered and associated potential impacts are addressed in this EA (environmental assessment). The five alternatives to the proposed action include:

- No action (continue research under current management practices)
- Different building configuration (2-stories)
- Alternative onsite location (adjacent to Centennial Drive)
- Offsite location (Richmond Field Station)
- Location at another DOE facility (Lawrence Livermore National Laboratory)

2.0 PURPOSE AND NEED

DOE established the Human Genome Initiative (HGI), a national program with a long-term goal of helping determine the sequence and variation of the approximately three billion DNA bases comprising the genetic material of human cells (LBL, 1992a). LBL was designated by the Secretary of Energy as one of three DOE Human Genome Centers (HGCs) (LBL, 1992e). Each DOE Genome Center has developed specialized instruments and talents not available at other centers. The LBL HGC currently is an ongoing research effort that requires additional consolidated space at or near LBL. The purpose and need for the construction and operation of the proposed laboratory for the LBL HGC is to consolidate existing human genome research that is currently ongoing at various locations at the LBL site and at the University of California, Berkeley (UCB) campus, to foster scholarly interaction among related research programs, and to provide space for growth at a location that is easily accessible to LBL and UCB researchers. Research conducted at the proposed facility, development and implementation of directed methods for high throughput and cost effective human DNA sequencing, would provide a fundamental understanding of the structure and function of the human genome (the genetic basis of susceptibility to disease-causing agents) for use in defining risk and providing health protection.

The Center's current goals are the following: to provide very high resolution genetic maps of human chromosomes; to develop efficient methods of physical mapping and chromosome segment construction; to develop novel methods of sequencing DNA (e.g., using mass spectroscopy); to develop the technology to overcome problems in mapping chromosome regions; and to extend automation capabilities to achieve these goals in a reasonable length of time and at a reasonable cost.

2.1 RELATIONSHIP TO OTHER ACTIONS

Each DOE HGC has developed specialized instruments and talents not available at other centers (LBL, 1992e); therefore, collaboration among the centers is important. Two collaborations have been undertaken to maximize the benefits of the effort. A collaboration with Lawrence Livermore National Laboratory (LLNL) is focused on producing a physical map of human chromosome 19 using innovative techniques. LBL also is collaborating with Los Alamos National Laboratory (LANL) in an experiment involving cloned chromosomes that utilizes the specialized talents and experience of both institutions.

3.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

The proposed action is to construct and operate the proposed HGL in the Life Sciences Research Area at LBL. The no action alternative would continue human genome research and related activities at Buildings 50B, 70A, 74, and the Donner Laboratory under current management practices; no new facility would be constructed. Under the no action alternative, no future growth would occur. Two onsite alternatives are considered: 1) construction of the proposed HGL in the same location and square footage as the proposed action but with a different building configuration; and 2) construction of the proposed HGL in a different LBL location (south of Building 74). Two proposed offsite locations also are considered: the Richmond Field Station (RFS), located in Richmond, California, approximately eight miles east of LBL, and LLNL.

The above alternatives were selected based on criteria necessary to meet the purpose and need of the HGI and HGC at LBL. The key criteria for a site that would meet HGC project objectives and HGI goals include the following:

- The site must accommodate suitable space and facilities for consolidating and conducting human genome initiative experiments in one location and meeting other project objectives

- The site must be within 45 minutes driving time of LBL in order to allow for minimally acceptable personal communication between LBL and HGL researchers

- Infrastructure and services must be in place or have expansion potential to serve proposed building development. Infrastructure and services include water, sewer, security, fire, and recreational amenities

- The site must have no environmentally-sensitive resources, such as endangered species, rare plants, or animals

- Adequate access must be available to existing and future highways and public transportation systems

- Land must be easily assembled, preferably in single ownership

- A leased site must meet DOE terms and conditions for leased space

Except for the no action alternative, all alternatives selected for analysis meet these minimum criteria. However, none of the alternatives offer economic or programmatic advantages over the proposed action.

3.1 PROPOSED ACTION

The proposed action is to construct and operate a Human Genome Laboratory (HGL) at LBL on the present site of Building 74B. A proposed three-story laboratory and office building would be used for research in mapping the arrangement of deoxyribonucleic acid (DNA) on human chromosomes and identifying the variability of the DNA-encoded genetic information. Research on the human genome currently conducted at Buildings 50B, 70A, 74 at LBL and at the Donner Laboratory at the UCB campus would be relocated to the new proposed facility. The proposed HGL would include a core of laboratories where multidisciplinary teams of technical staff would use a common pool of instrumentation and cell culture facilities. The proposed HGL would be occupied by a staff of approximately 92 scientists, students, and support personnel. Approximately half the staff would be relocated from Buildings 50B, 70A, and 74 At LBL, and the Donner Laboratory at UCB, resulting in a net increase of 46 persons at LBL. The vacated facilities would be used to accommodate an existing need for additional office and laboratory space and to reduce the need for leasing offsite space.

Prior to construction of the proposed HGL, demolition of existing facilities would be required to create adequate space for the new building. The existing building, 74B, is too small to provide for HGL needs. Demolition and construction would be accomplished within 24 months.

The proposed HGL would be located in the Life Sciences Research Area near the LBL Strawberry Gate within the City of Oakland on land leased from the Regents of the University of California (UC) (Figure 3-1). The building would be located northeast of the existing Biomedical Laboratory (Building 74) and southeast of the existing Cell Culture Laboratory (Building 83) (Figure 3-2), on the present site of Building 74B (Figure 3-4). Access to the proposed site would be from Centennial Drive.

3.1.1 Construction

The proposed HGL would consist of a three-story building and a 20-space parking lot providing approximately 44,400 gross square feet (gsf). The building would contain approximately 15,000 assignable square feet (asf) of wet and dry laboratory space, 7,000 asf of office space, and 6,000 asf of miscellaneous support space (Figure 3-3). The West Module (B) of the proposed building would be constructed with two floors. The Center (A) and East (C) Modules would be constructed with three floors. Beneath a portion of the Center Module and extending the full length of the East Module would be a basement or Lower Level.

Surface grading would be required to provide a level pad foundation for the proposed building and for the alternate parking lot location, if developed, and approximately 15,000 cubic yards of soil would be removed from the adjacent hillside to make room for the HGL. This soil may be deposited on a hillside located adjacent to Building 54, across Cyclotron Road from Building 29B (Figure 3-3a) for construction of a parking lot. More details of the parking lot construction are contained in Sections 5.1.5 and 5.1.6. The grading plan for the proposed HGL is shown in Figure 3-5.

The HGL building would be connected to nearby existing site utility systems. The only addition to the utilities at this site would be a new non-PCB transformer to step down from the available 12 kilovolt (kV).

Pre-construction demolition would include removal of Building 74B (animal holding facilities) and fencing. Building 74B occupants would relocate to other existing LBL offices and to the Biomedical Isotope Facility. The animal holding facilities would be relocated adjacent to the southeast side of Building 74.

Figure 3-1 Location of Lawrence Berkeley Laboratory in Relation to the San Francisco Bay Region

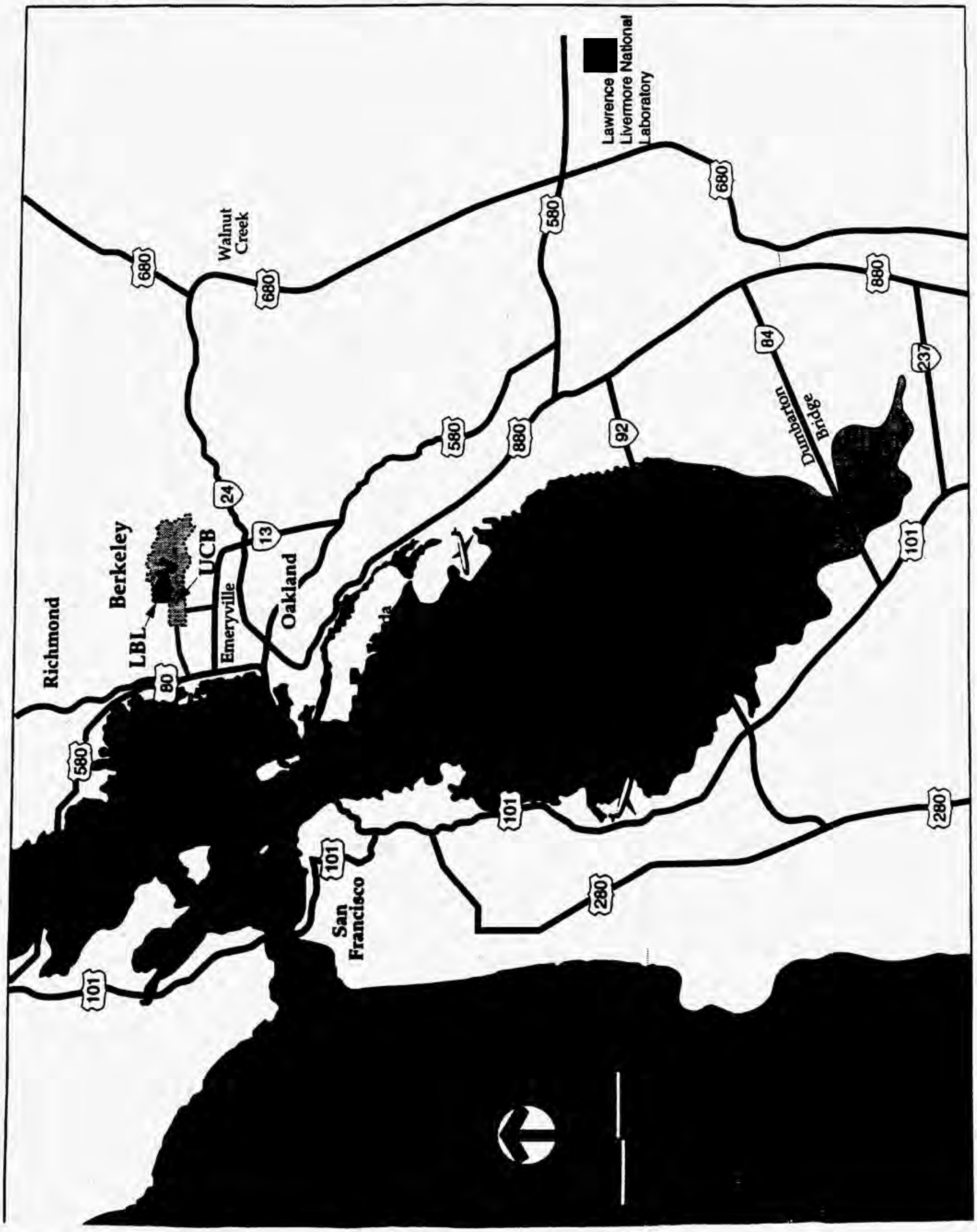


Figure 3-2 Location of the Proposed Human Genome Laboratory at Lawrence Berkeley Laboratory

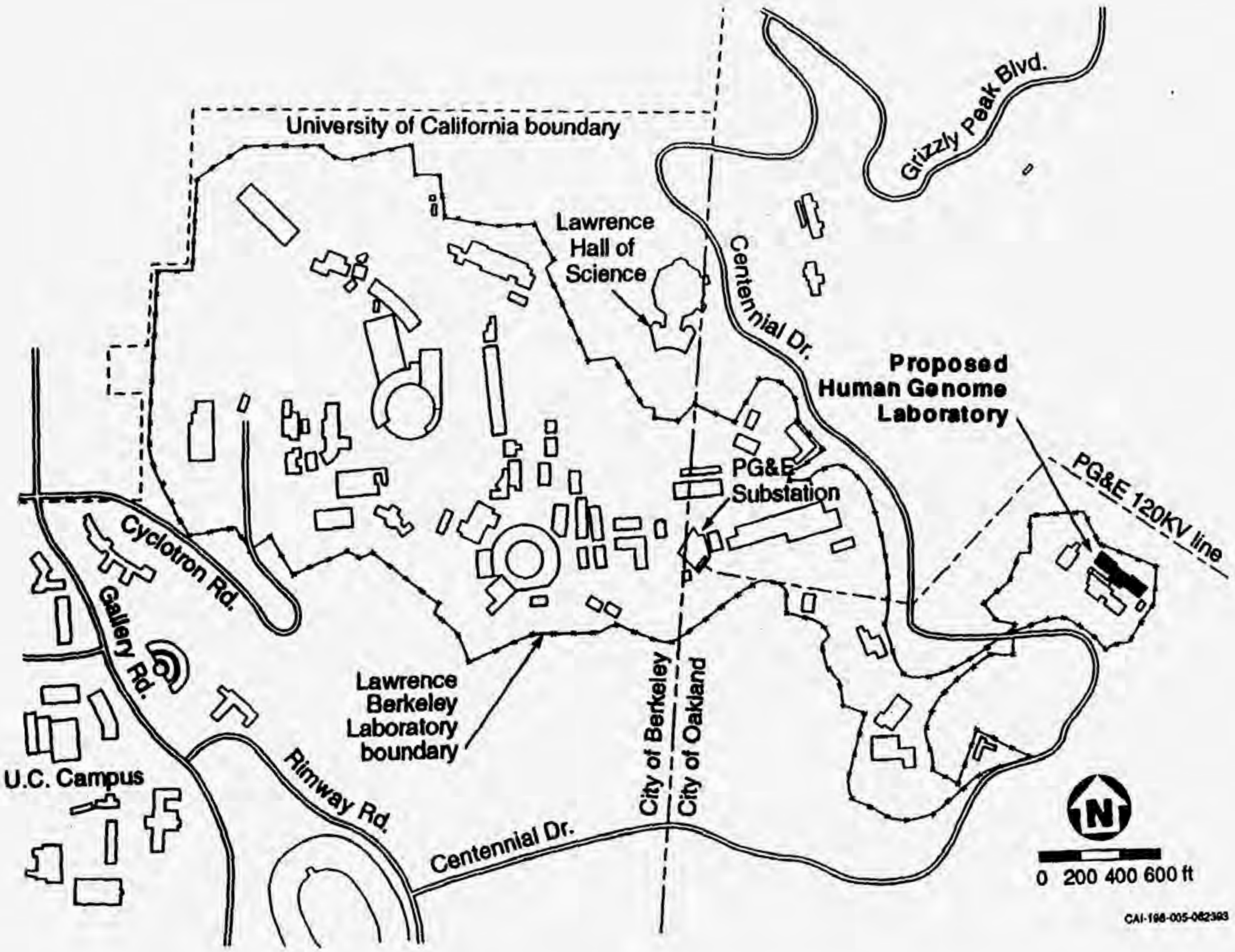
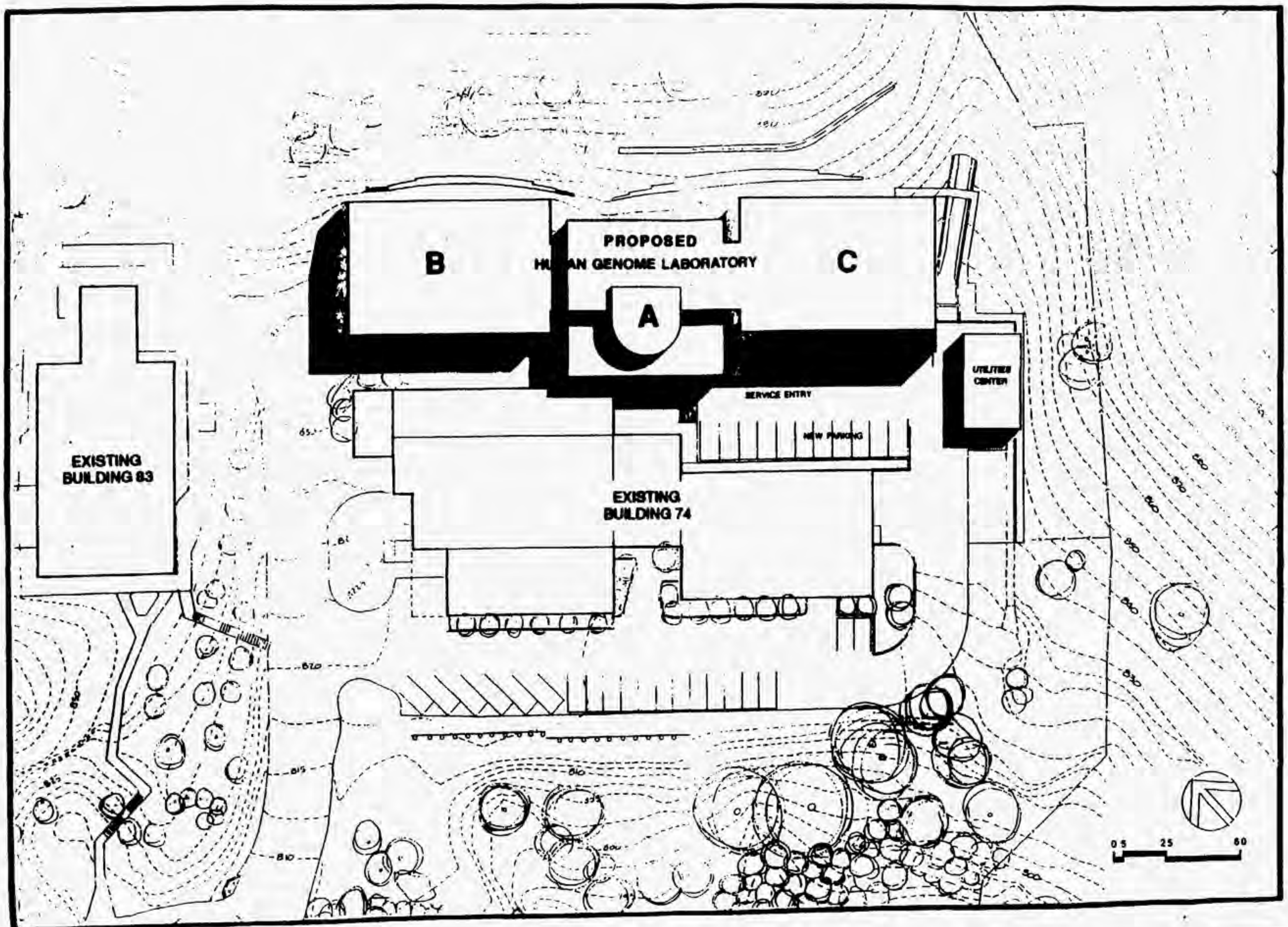


Figure 3-3 Layout of the Proposed Human Genome Laboratory in Relation to Existing Buildings



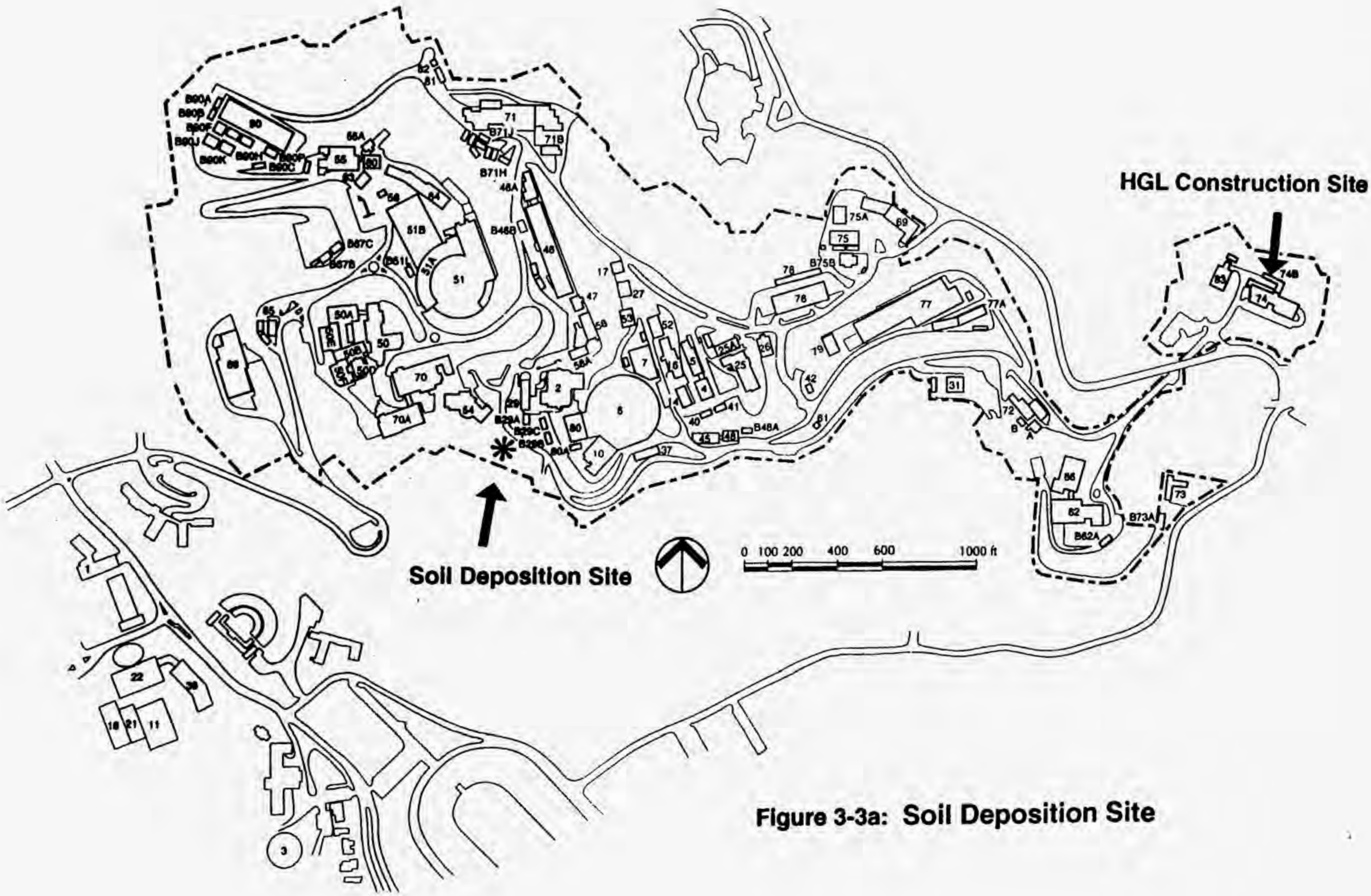
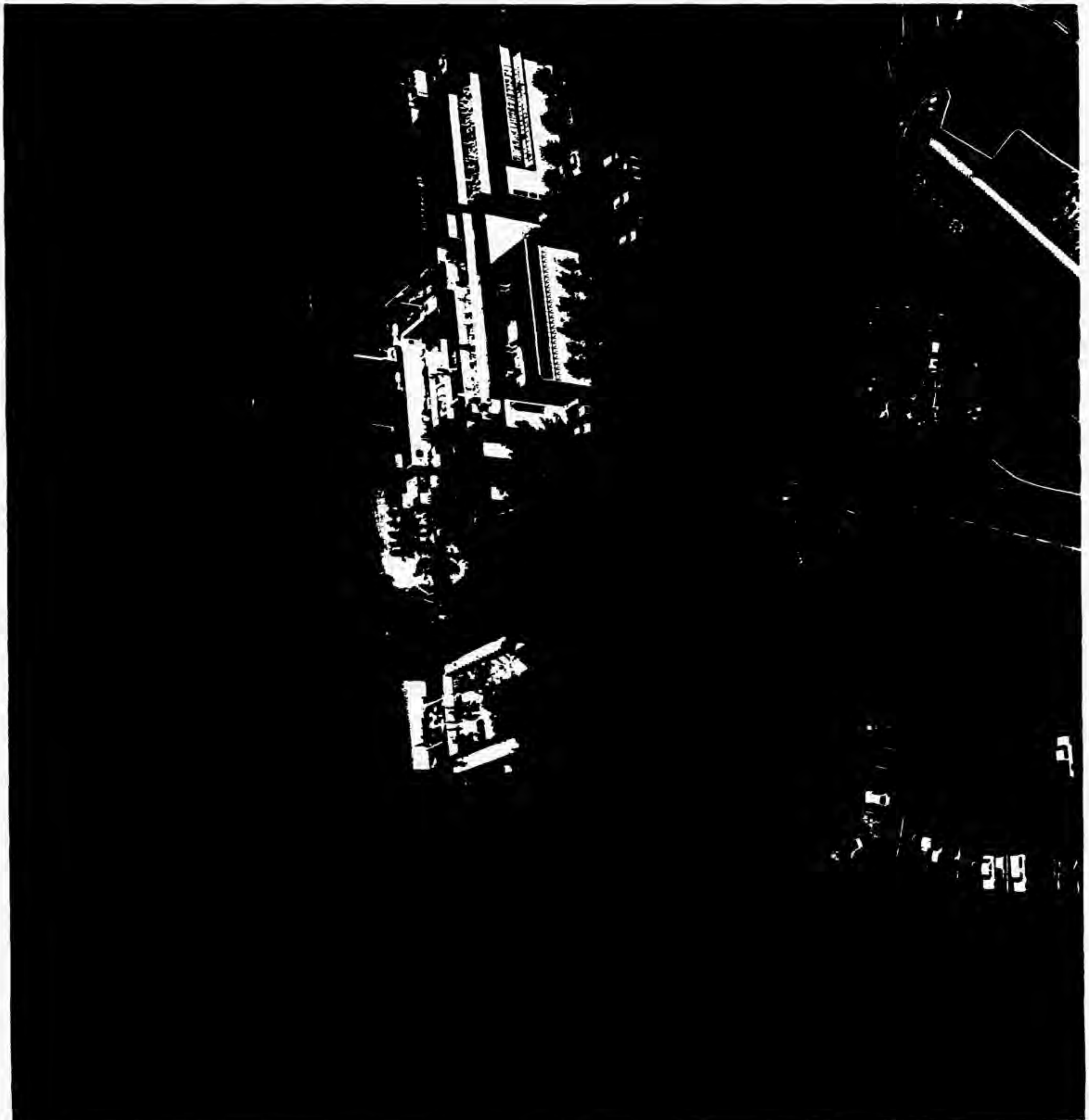


Figure 3-3a: Soil Deposition Site

Figure 3-4 Aerial Photograph Showing Location of Building 74B



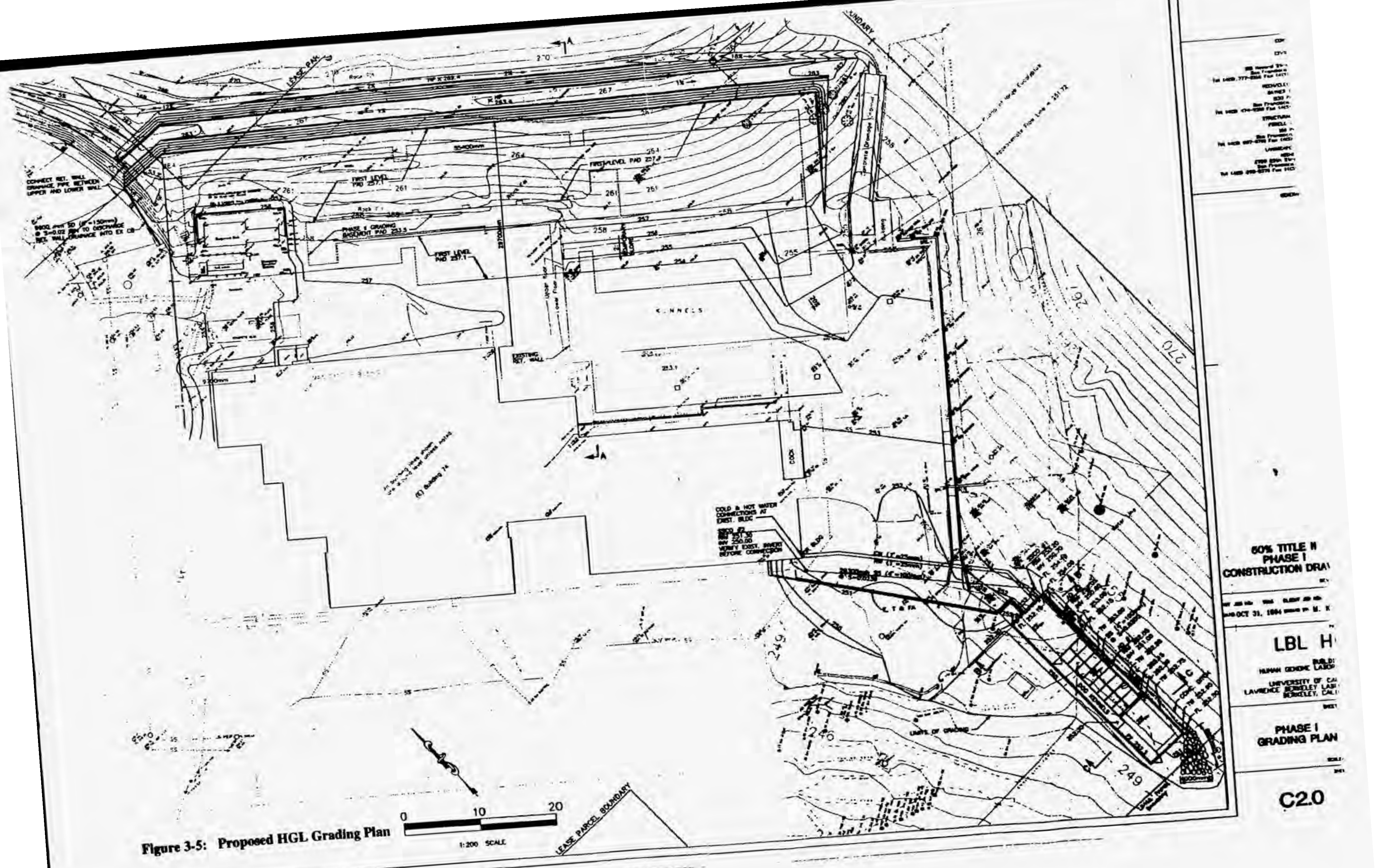


Figure 3-5: Proposed HGL Grading Plan

Building 74B was constructed in 1969 for chemical and biological research. The laboratories within the building contain filtered gloveboxes that may be contaminated with low levels of isotopes previously used in the development of radioisotope production methods for nuclear medicine studies [strontium-82 (^{82}Sr), strontium-85 (^{85}Sr), gallium-68 (^{68}Ga) and fluorine-18 (^{18}Fl)]. These are short-lived radioisotopes and it is unlikely that any residual radioactivity would be present at decommissioning. The strontium isotopes have half-lives of less than 70 days and have not been used for 15 months. Fluorine-18 and ^{68}Ga have half-lives of two hours and one hour, respectively.

The main isotope currently used in the building is ^{18}Fl. Sufficient time for decay of this isotope will have passed once decommissioning begins. The other isotope in current use in the glove boxes is a germanium-68/ gallium-68 generator. Germanium-68 has a 270-day half-life. The germanium isotope will be contained in the generator or in the glove box containment system (HEPA filter). Fume hoods in the building were also previously used for preparing very low level (sub-microcurie) solutions containing the longer-lived isotopes of copper-244 (^{244}Cu), americium-241 (^{241}Am), plutonium-238 (^{238}Pl), carbon-14 (^{14}C), and tritium (^{3}H). No spills of these materials are known to have occurred. In all cases the glove box inserts and containment and ventilation systems will be tested for contamination and disposed as radioactive waste, if contamination cannot be removed. It is anticipated that a maximum of 40 cubic feet of solid radioactive waste containing at most millicuries of radiation would be generated during demolition activities.

Stock solutions, materials, and equipment would be moved out of Building 74B to other authorized locations at LBL. A plan would be prepared by LBL in accordance with DOE Orders that specify methods to be used to ensure that no residual contamination remains in the building (e.g., meter and smear monitoring would be used to evaluate residual radioactivity in remaining fixtures, such as ventilation ducting, waste lines, wall, floors).

Allowable levels of residual radioactivity are specified in DOE Order 5400.5 (DOE, 1990). Items exceeding these levels would be removed, processed, and shipped for disposal as radioactive waste to the DOE Hanford Site in compliance with procedures approved by DOE.

Although no releases of radioactive materials to the air are expected during decommissioning, precautions to protect workers (such as use of respirators and protective clothing) and air sampling would be employed when evaluating residual contamination. Negative pressure ventilation and air filtration would remain in place in the building during the evaluation and cleanup to ensure minimal releases of radioactive materials to workers or the environment (LBL, 1992a).

Existing retaining walls, stairs, walkways, and underground utilities associated with Building 74B would be cut or removed as required to construct the proposed building. Earthwork would include grading for pads and walls; onsite road preparation; backfilling of trenches, foundations, and retaining walls; and placement of base materials for slabs on grade.

The proposed HGL building structure would be steel framed with concrete floors; the roof would be supported on a metal deck; and the exterior would be glass-reinforced, concrete panel walls. A heating, ventilating, and air conditioning system with 100 percent outside air supply to laboratories would be installed. The building would be protected by a fire sprinkler system connected to the LBL alarm system. Fire alarm stations would be provided on each floor with smoke detectors in all corridors and other areas where required. Lighting in laboratories would be provided by fluorescent fixtures with electronic ballasts. Access to the site would be from Centennial Drive. Twenty new parking spaces would be provided adjacent to Building 74 (LBL, 1992a). The parking would be arranged on one of three possible configurations: (1) all 20 spaces would be located between the HGL and Building 74; (2) all 20 spaces would be located just south of Building 74; or (3) both locations would be used to accommodate a minimum total of 20 parking spaces. The exact location of the parking spaces will be determined during later design stages of the project.

All surfaces in the laboratories would be impermeable to liquids and chemicals used in the area to provide containment and permit routine cleaning. Small quantities of hazardous materials would be stored in designated areas. Fume hoods would be provided for storage and use of volatile chemicals such as phenols and thiols. Safety lockers would be provided in storage areas for flammable and volatile chemicals. A mass spectrometer would be installed.

The lower level of Module C would house electrical and mechanical equipment and the utilities center situated in an extension of that wing. Parking may be located outside this level of Module C. An electrical substation, the elevators, and an access for receiving would be situated in Module A of this level.

The main entry and lobby of the proposed HGL would be located on the first floor in Module A. Access to other floors would be gained by elevators and stairways. Facilities designated for the first floor of Module B would be the glassware washing room, the spectroscopy and microscopy equipment areas, the stock room, two shop areas, two media preparation rooms, a men's restroom, additional mechanical and electrical facilities, and a stairway to the exterior.

Facilities in the first floor of Module C would be designated for optics, robotics, a large centralized laboratory with multiple workbenches, a dark room, an equipment room, two offices, a meeting room, a storage room, a women's restroom, and a freezer room.

Facilities planned for the second floor of Module A would consist of a large centralized laboratory area, a DNA sequencing room, a dark room, and equipment and freezer rooms. On the second floor, Module B would contain a large centralized laboratory area, a tissue culture room, equipment and freezer rooms, seven offices, eight work-station areas, a conference room, a smaller meeting room, and a women's restroom. Facilities on the second floor of Module C would be assigned to robotics, a large laboratory area, a sample preparation room, equipment and freezer rooms, two offices, a service lobby, storage and janitorial facilities, a meeting room, and a men's restroom.

Modules A and C would be three-story structures. The third floor of Module A would be dedicated to offices. A large conference room, a janitorial room, and a men's and women's restrooms are planned for this floor. The large conference room on this floor would be designed for an occupancy of 50. The third floor of Module C would contain a large centralized laboratory area, robotics and imaging areas, equipment and freezer rooms, a dark room, a cold room, five offices, one support staff room, and a meeting room. To facilitate the interaction between researchers, a small meeting area would be provided on each floor.

The proposed HGL facilities would be designed to comply with the hazardous materials safety requirements as defined by the Uniform Building Code and California Building Code (LBL, 1993).

3.1.2 Operations

Information in this section is a summary of the description in the *Preliminary Safety Analysis Document (PSAD) for the HGL at LBL* (LBL, 1993). Proposed operations within the proposed HGL would be identical or similar to bench-top experiments, laboratory activities, and computer programming efforts currently conducted at LBL and UCB. The proposed HGL is designed to be the prime component of the HGC. The activities within the proposed HGL can be divided into the following three components: 1) biology component; 2) instrumentation program; and 3) informatics (Figure 3-6).

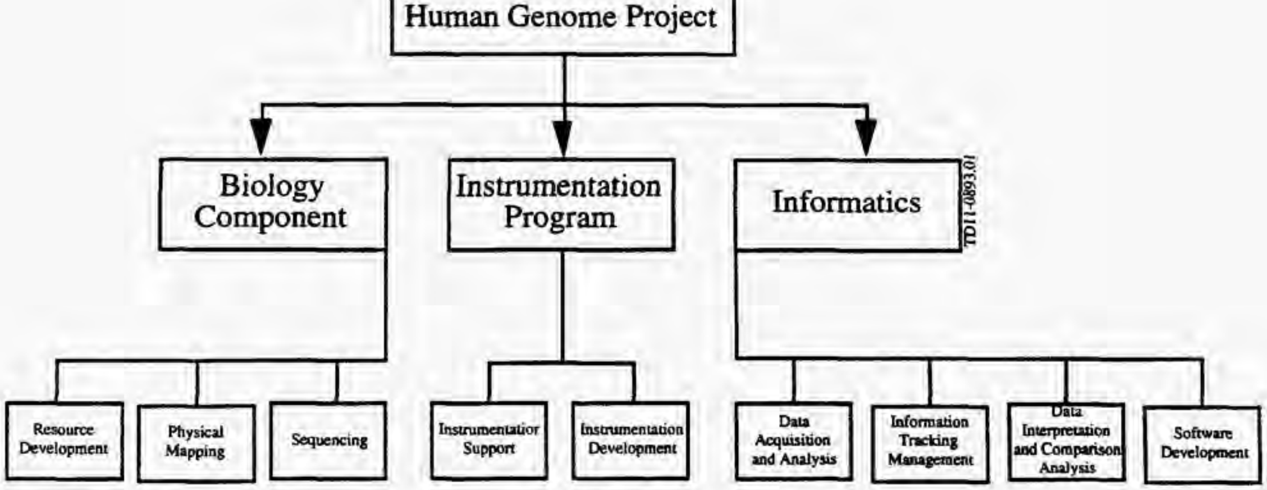


Figure 3-6. Components of the HGL Project.

The proposed operations that would be conducted by the biology component cover the whole spectrum of genomic research. These processes can be loosely grouped into three areas: resource development, physical mapping, and sequencing of chromosomal materials. Human biological samples for research would be obtained as cloned DNA contained primarily in bacteria and to a limited extent in yeast. The samples would be obtained from existing commercial libraries that use anonymous human donors.

The resource development group would concentrate on three areas. One area would emphasize the perpetuation of single human chromosomes in rodent-human hybridization lines. This process for generation of rodent-human hybridization lines involves the insertion of isolated single human chromosomes into rodent hosts. These lines are maintained as sources of single human chromosomes. These rodent-human hybridization lines are maintained and monitored at the HGC. Rodents, animal blood, and possibly human blood would be used in this research. If used, the human blood would be obtained from commercial sources utilizing anonymous donors. The second area is the development of yeast artificial chromosomes (YAC) specific for various human chromosomes. YACs are large, artificially constructed fragments of human DNA attached to sequences that can be grown in yeast. Each fragment is manufactured for mapping specific areas on designated chromosomes. Also, the HGC maintains cloned DNA lines. These lines are maintained as a source pool of genetic material that can be used to manufacture new probes and markers for mapping purposes.

Physical mapping operations would be conducted to identify and map different regions on chromosomes. This would entail either systematically breaking large DNA fragments into smaller pieces, which are then probed to determine mapping configurations, or using short pieces of pre-sequenced DNA as probes on larger DNA fragments.

The efforts of the instrumentation program at the HGC would support the electrical, mechanical, and chemical instrumentation currently being used onsite and would develop more efficient and higher resolution chromosomal separation or detection devices. The HGC experiments and instrumentation are focused on mapping and sequencing the human genome. DNA comes from colonies of cells that are imaged by charge-coupled device cameras for high sensitivity and isolated in culture dishes by high-speed colony pickers. DNA is sized and sequenced by gel electrophoresis (pulsed-field gradient gels and capillary gels). The gels are read by gel scanners that can detect very small amounts of material, usually through fluorescence. A major technology development is DNA synthesis using the polymerase chain reaction (PCR) in thermal cyclers that can raise and lower the temperature of samples very rapidly. In addition, short pieces of DNA can be directly constructed in an oligonucleotide synthesizer. The HGC hopes to utilize systems that will permit automation of almost every step of mapping and sequencing. In the near future, the new instrumentation will include automated handling of DNA on filters, preparation of reaction mixtures for PCR and sequencing, and even more sensitive gel readers. Because each component of DNA has an identifiable weight, LBL may be able to develop mass spectrometry to speed sequencing.

The informatics group would provide management of data acquisition, information tracking, and data interpretation and analysis systems. Efforts are underway to improve database designs to better manage the large libraries of DNA information and database access and manipulations. Sophisticated software is needed for new algorithms for sequence assembly and data analysis.

3.2 NO ACTION ALTERNATIVE

Currently, research on the human genome is being conducted at Buildings 50B, 70A, and 74 at LBL and Donner Laboratory at UCB. Under the no action alternative, this research would continue to be conducted in the present locations under current management practices. No new facility for relocation, consolidation, modernization and expansion of this research effort would be constructed.

3.3 DIFFERENT BUILDING CONFIGURATION

This alternative consists of constructing a two-story building with the same square footage in the same location as the proposed building. The design would disturb a larger area in order to accommodate the same space in two rather than three floors.

3.4 ALTERNATIVE ONSITE LOCATION (ADJACENT TO CENTENNIAL DRIVE)

This alternative consists of constructing the proposed HGL directly south of Building 74 adjacent to Centennial Drive, within the Life Sciences Research Area. The building footprint and size would be the same as under the proposed action.

3.5 OFFSITE LOCATION (RICHMOND FIELD STATION)

This alternative consists of constructing the proposed HGL at the Richmond Field Station (RFS), located approximately 7 miles (mi) northwest of the LBL site, and owned by UC. The building footprint and size would be the same as under the proposed action.

3.6 LOCATION AT ANOTHER DOE FACILITY (LAWRENCE LIVERMORE NATIONAL LABORATORY)

This alternative consists of constructing the new building at LLNL, located approximately 25 miles southeast of the LBL site. The building footprint and size would be the same as under the proposed action.

4.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

4.1 HUMAN HEALTH

4.1.1 Background Radiation and Doses

The public is continuously exposed to radiation from natural sources; primarily from cosmic radiation; external radiation from natural radioactive material in the earth; and internal radiation from natural radioactive materials taken into the body by air, water, and food. The public receives radiation from medical X-rays, nuclear medicine procedures, and consumer products. On average, a member of the public in the United States receives approximately 300 millirem per year (mrem/yr) ($1.5x10^6$ person-rem) from natural sources of radiation; approximately 50 mrem/yr from medical procedures; and approximately 10 mrem/yr from consumer products [National Council on Radiation Protection and Measurements (NCRP), 1987a; NCRP, 1987b], for a total of 360 mrem/yr. (A person-rem is the measure of the effective dose, in rem, to a person.)

The total quantity of radionuclides at LBL during the year 1992 was 10,000 curies (Ci, 99.99 percent tritium) plus 800 Ci of sealed sources. Regarding penetrating radiation (gamma and neutron), data from 1990 indicate that LBL operations contributed less than two percent of the DOE standard of 100 mrem annual effective dose equivalent (AEDE) to offsite individuals (LBL, 1993). The additional collective dose to all persons within 50 miles of LBL is less than or equal to 3.4 person-rem (LBL, 1992b).

4.1.2 Existing Human Genome Operations and Doses

Many of the proposed HGL operations are currently performed in LBL HGC and UCB buildings. These operations include routine biochemical reactions, such as labeling of DNA with radioactive tracers, analytical chemistry, and use of bench-scale instrumentation. Section 3.1.2 describes these operations in detail. The estimated quantity of radioactive material in use (in 1992) for human genome research at LBL was 80 mCi (millicuries) (phosphorus-32). The total average whole body exposure for LBL radiation workers was about 4.0 mrem in 1992. The average whole body exposure for HGC radiation workers was about 2.5 mrem between 1991 and 1994 and the maximum whole body exposure during that time period was about 54 mrem.

4.1.3 Hazardous Materials

Hazardous materials are stored and used for operations and research at LBL. Solid and liquid hazardous materials for human genome research represented 2.6 and 0.1 percent, respectively, of total quantities of solid and liquid hazardous materials at LBL in 1992 (Table 4-1). A complete list of the chemicals, including amounts, that would be used at the HGL is presented in Appendix A.

Use of hazardous materials at LBL requires special training to ensure protection of workers and the public. The Environment, Health and Safety (EH&S) Division coordinates health, safety, and compliance (e.g., waste-related) training of LBL employees and guest users of the LBL facilities. LBL ensures ongoing compliance with workplace safety standards. Within the EH&S Division, the Industrial Hygiene Department serves as a resource for information about hazardous agents, hazard assessment, and hazard mitigation. This Department conducts hazard analyses and develops policies regarding industrial hygiene and safety and provides training. The Industrial Hygiene Department's Bio-Hazard Program includes training for the proper handling of materials used in biomedical research, such as blood and blood products (LBL, 1992b).

Table 4-1. Estimated Quantities of Hazardous Materials in 1992.

Type	LBL Totals for 1992	Current Human Genome Research at LBL
Solid	73,200 lb	1900 lb
Liquid	174,000 gal[a]	230 gal
Gas	4,390,000 lb	NA[b]

[a] Gallon

[b] Not applicable

4.2 ENVIRONMENT

4.2.1 Air Quality

Regional Conditions

LBL is located within the San Francisco Bay Area Air Quality Basin (Bay Area). The Bay Area Air Quality Management District (BAAQMD) has the authority to develop and enforce regulations to control ambient air quality in the Bay Area. Under California regulations, the Bay Area is considered a nonattainment area for state ozone, carbon monoxide (CO), and particulate matter less than 10 microns in diameter (PM_{10}). Under Federal regulations, the Bay Area has been designated as a "moderate" nonattainment area for ozone. BAAQMD has adopted new source review rules (NSR) for nonattainment pollutants to conform with a goal of "no net increase" in emissions. New or modified sources of air emissions at LBL would be subject to lower applicable permitting thresholds under this more stringent rule.

LBL Air Emissions

Currently, LBL emits various criteria air pollutants, toxic air contaminants (TACs) including volatile organic and inorganic compounds, and radionuclides. BAAQMD's regulations currently provide that bench-scale laboratory equipment and equipment used exclusively for chemical or physical analyses are exempt from permit requirements unless single criteria pollutant emissions exceed 150 pounds per day or TAC emissions exceed the BAAQMD threshold levels. LBL maintains numerous types of source permits from the BAAQMD to operate 40 sources of criteria air pollutants. Based on the January 1991 inventory, BAAQMD classified LBL as a "medium priority" facility not required at present to prepare a facility-wide risk assessment.

There are a number of existing TAC sources and TAC emissions at LBL. Existing sources that may emit TACs at LBL include the following: boilers; cooling towers; cleaners and degreasers; chemical laboratories; fume hoods; and tanks. TAC emissions from LBL include benzene; 1,4-dioxane; freon; toluene; 1,1,1-trichloroethane; and xylenes (LBL, 1992b).

The primary source of radioactive emissions from LBL is the National Tritium Labeling Facility (NTLF) in Building 75. The major radionuclide emitted from LBL is tritium in the form of tritiated water vapor (HTO). Various other radioactive materials are released from laboratory stacks at locations throughout LBL, typically less than 1 Ci/yr total, including phosphorus-32, carbon-14, iodine-125, and sulfur-35 (LBL, 1992b).

In compliance with applicable regulations and orders, LBL routinely monitors radioactive air emissions. The average concentration of tritium sampled in 1990 at each monitoring site at LBL was less than one percent of the DOE standard, based on the Derived Concentration Guide (DCG) value for tritium (LBL, 1992b). (The DCG value for tritiated water is 1×10^{-7} microcuries/milliliter of air). The average alpha concentrations for 1990 were less than ten percent of the DOE DCG value for thorium-232 (which is used at LBL to represent all alpha-emitting materials) of 7×10^{-15}, with the exception of one perimeter station, where the average was approximately 18 percent of the DOE DCG value. Average beta concentrations for 1990 at each monitoring location were less than 0.2 percent of the DOE DCG value for strontium-90 (which is used to represent all beta-emitting materials at LBL) of 5×10^{-11}. The average concentrations of radionuclides and carbon-14 dioxide in 1990 were well below one percent of the DOE DCG value of 5×10^{-7}.

4.2.2 Utilities, Services, and Energy

LBL's onsite utility systems have sufficient capacity to meet present and future requirements for electrical power, natural gas, water, cooling, and waste (LBL, 1992c). However, many segments and load centers of existing utility systems, including water, electrical power, and sanitary sewers, are old and are undergoing rehabilitation to improve flexibility and reliability (LBL, 1992c).

Electrical Power

Electrical power is distributed at LBL through a 12 kV underground system connected to smaller substations and transformers (LBL, 1992b). In 1990, total electrical power consumption at LBL was 74,045 megawatt-hr (LBL, 1992b). Based on a 1991 population of 3,055 at the LBL site, per capita electrical power consumption is estimated at 24.24 megawatt-hr per year. Pacific Gas and Electric has the capacity to meet anticipated demand for the foreseeable future (LBL, 1992c).

Natural Gas

Natural gas, provided by Pacific Gas and Electric, is used primarily for space and water heating and for equipment and experimental use in shops and laboratories (LBL, 1992c). In 1990, natural gas usage at LBL, including offsite leased space, was 1,772,338 therms (LBL, 1992b). Per capita natural gas use was approximately 558 therms per year (LBL, 1992b). Capacity is ample to meet anticipated demand for the foreseeable future (LBL, 1992c).

Water

The onsite water distribution system is gravity-fed and supports all laboratory uses, including domestic, fire suppression, cooling, and low-conductivity. There is no restriction on the volume of water available from East Bay Municipal Utility District (EBMUD) (LBL, 1992b). In 1990, water usage at LBL was 105,103 CCF (hundred cubic feet) or 78,617,044 gal (LBL, 1992b). Per capita use was approximately 70.5 gal per calendar day (LBL, 1992b).

Sanitary Sewer

The sanitary sewer system at LBL is a gravity flow system that discharges through two monitoring stations, one located at Hearst Avenue and the other at Centennial Drive in Strawberry Canyon. Discharges are transported by the City of Berkeley sewer system to an East Bay Municipal Utility District (EBMUD) wastewater treatment plant. LBL has three wastewater discharge permits issued by EBMUD: one for each of the outfalls at Hearst and Strawberry, one for the Building 77 Fixed Treatment Unit (FTU), and one for the Building 25 FTU. The City of

Berkeley has instituted a 20-year program to upgrade their sanitary sewers (which receive wastewater from LBL). UC agreed to contribute $250,000 per year to the City of Berkeley for these sewer upgrades (LBL, 1992b).

The calculated volume of wastewater (both sanitary and industrial sanitary) discharged into LBL's sanitary sewer system in 1990 was 75,057 CCF or 56,142,636 gal (approximately 70 percent of water usage) (LBL, 1992b). Per capita wastewater generation was approximately 50.3 gal/day. Sewer and wastewater treatment capacity are anticipated to be sufficient to meet the foreseeable future demand.

Industrial Sanitary Sewage

Industrial sanitary sewage is combined with domestic wastewater and is discharged to East Bay Municipal Utility District through two monitoring stations. One is located at Hearst Avenue and the other is at Centennial Avenue in Strawberry Canyon. This wastewater effluent is sampled periodically and analyzed for radioactive materials, heavy metals, organics, and other contaminants to ensure compliance with discharge requirements imposed by DOE and the East Bay Municipal Utility District (LBL, 1992b). East Bay Municipal Utility District has ample capacity to meet anticipated demand for the foreseeable future.

4.2.3 Traffic, Circulation, Parking, and Noise

Traffic and Circulation

The primary access routes to LBL are Grizzly Peak Boulevard/Centennial Drive, University Avenue, Hearst Avenue, and Piedmont Avenue/Gayley Road. Access to the site is provided by three sentry-controlled gates: Blackberry Canyon (main gate); Strawberry Canyon; and Grizzly Peak. More than 5,400 vehicles arrived at or departed LBL on a typical work day in 1992.

Traffic flow conditions in an urbanized area are often described through peak-hour level of service (LOS) analysis. Many of the existing LBL access routes have traffic backups and delays (LOS of "E" or "F") during peak traffic periods. However, the LOS for intersections along Centennial Drive and Grizzly Peak are either "A" or "B" (little or no delay).

Parking

The supply of parking at LBL is limited and parking demand currently exceeds the number of available spaces. However, in 1991, the ratio of LBL employee population to parking spaces was 1.66, which is better than the ratio of 1.7 called for in LBL's Long Range Development Plan (LRDP) (LBL, 1987). With the additional parking included in the proposed action, LBL would continue to meet or exceed the 1.7 ratio with implementation of the HGL project.

Noise

Within the boundaries of LBL, the ambient noise environment is generated by vehicular traffic; jet aircraft; general aviation aircraft; and building heating, ventilating, and air-conditioning equipment (LBL, 1986). Traffic to and from LBL contributes to overall traffic noise in residential neighborhoods (LBL, 1992b).

Ambient noise levels measured during the period from 1979 to 1991 ranged from 41 dB (decibels) to 53 dB at distances of 100 to 2,400 feet (ft) from the site (LBL, 1992b). These noise levels are lower than in most of the City of Berkeley. According to information from the Master

Plan (City of Berkeley, 1977), in September 1974, 24-hr noise at 42 sites was equal to or greater than 58 dB.

4.2.4 Geology, Soils, and Seismicity

Geology

Most of LBL is underlain by a complex sequence of sedimentary and volcanic rocks, deformed by folding and faulting. The bedrock is generally weak and weathers deeply, producing a colluvial cover several feet thick (LBL, 1986). Much of the immediate area near the proposed HGL site is underlain by colluvium, which is a combination of slope wash and ravine deposits consisting of up to 35 ft of soil and rock fragments (Figure 4-1). There are three rock formations that crop out in the vicinity of the proposed HGL site: the Orinda Formation; the Claremont Chert; and the Moraga Formation. All of these rocks are weak and subject to landsliding on steep slopes.

Bedrock at the parking lot site southeast of Building 54 consists of sedimentary rock of the Orinda Formation overlain by andesite of the Moraga Formation. The siltstone, claystone, and sandstone members of the Orinda formation are typically closely fractured, friable to moderately hard, weak, and moderately to deeply weathered.

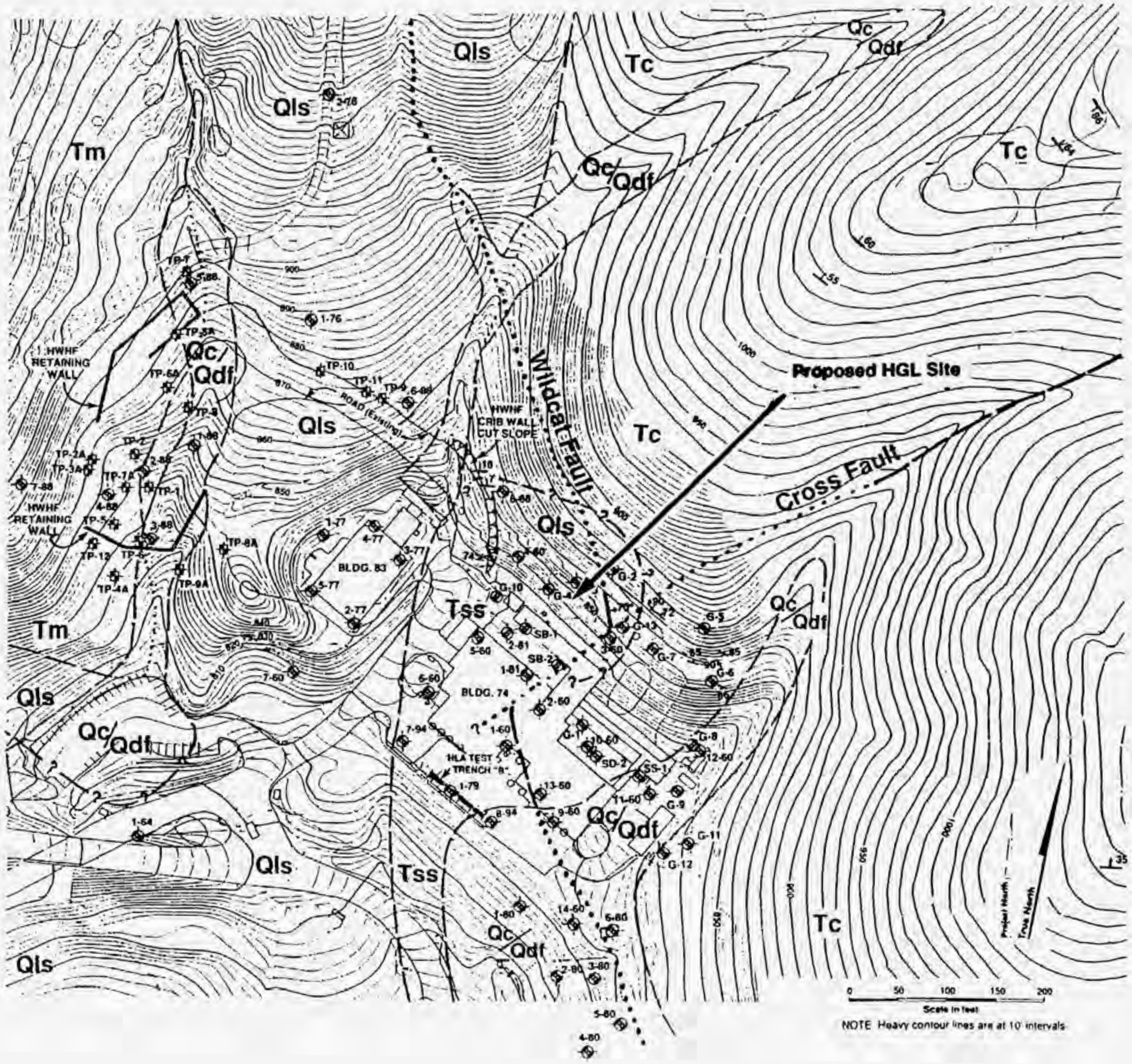
Instability of steep slopes is and has been a major problem in the LBL area. Two 500-ft long horizontal dewatering wells, called hydraugers, were installed in 1969 to dewater and stabilize the Centennial Drive Overpass, approximately 500 ft west of the proposed HGL site. These hydraugers appear to have contributed to near-surface slope stability, but have not eliminated slope stability problems in the area. The hydraugers are judged to be very responsive in draining near-surface groundwater flow, such as from perched aquifers, but are insufficient in number to prevent the numerous slope stability problems in the area (UC, 1984).

Soils

The natural soil covering the proposed project location is composed of Maymen loam, covering about one-third of the upland slopes. This is a shallow acidic soil, 10 to 20 inches deep over shale, with a high to very high risk of erosion. Engineered fill of varying thicknesses is present beneath Building 74 and other structures adjacent to the proposed HGL, and should be more stable for foundation purposes than the prevalent natural soils or colluvium.

The lower portion of the parking lot site is underlain by silty clays overlaying sedimentary rock. The native colluvial/residual soils consist primarily of stiff to hard silty clay with rock fragments, present in depths from 3 to 9 feet. The upper portion of the parking lot site consists of repair work performed on a landslide that occurred during the 1968-69 rainy season. The landslide debris were removed, keyways were excavated into the bedrock beneath the landslide area, subdrains were installed, and the hillside was reconstructed with compacted fill.

Soil and groundwater sampling undertaken under LBL's Resource Conservation and Recovery Act (RCRA) Facility Investigation program indicate hydrocarbon contamination of the soil and groundwater in the vicinity of the proposed HGL site. An additional potential source of contamination near the site are two abandoned radioactive waste storage tanks buried beneath Building 74 (LBL, 1992d). Additional background research and remedial field investigation work has been ongoing under the RCRA Facility Investigation program to further investigate and define the sources and extent of the contamination. Any remedial activities that may be required based upon the results of the investigation will be covered under separate NEPA documentation. All necessary soil remediation activities currently are anticipated to be completed in October or



LEGEND

Qc/Qdf	Colluvium and Debris Flow deposits
Qls	Landslide Deposit
Tm	Moraga Formation
Tss	Sandstone/Siltstone undifferentiated
Tc	Claremont Formation

KEY

- Geologic Contact - dotted where uncertain or covered, queried where unknown
- Fault - dotted where uncertain or covered, queried where unknown. Arrow indicates direction of dip of fault plane with magnitude shown
- Cut Slope
- Borehole from other investigators. See appendix for logs.
- TP-1 Test Pit - from other investigators. See appendix for logs.
- 65 Strike of Bedding - with direction and magnitude of dip

NOTES

1. Geology based on previous mapping by Marliave, 1965; Korbay & Lewis, 1980; P.J. Holland, personal communication, 1994; and limited field mapping.
2. Limit of landslide deposit based on subsurface conditions encountered during the construction of the Hazardous Waste Handling Facilities (HWHF) crib wall and retaining walls (P.J. Holland, personal communication, 1994). See Ng and others, 1989 for further details.
3. Location of Wildcat Fault based on limited subsurface exploration, by others as shown on map, inspection of slope repair at Bldg. 74 (S. Korbay, personal communication, 1994; see appendix) and a trench across the faults (Korbay & Lewis, 1980), approximately 600 feet north of north map boundary

Figure 4-1: Exploration and Geologic Map. Proposed HGL Site and Vicinit

November 1994, which is prior to any activities associated with construction of the proposed HGL.

Seismicity

The proposed HGL site lies within 4,700 ft of the active trace of the Hayward Fault, where the maximum credible earthquake (MCE) is of Richter magnitude 7.5. The parking lot site is about 800 feet northeast of the Hayward Fault. The San Andreas Fault Zone lies about 19 miles to the west of both sites, with a potential for a Richter magnitude 8.3 earthquake; while the Calaveras Fault zone, located about 10 miles east of LBL, has a potential for an MCE of about 7.5 Richter magnitude (LBL, 1986). An MCE on the Hayward Fault would generate more intense groundshaking at the site than MCEs on either the San Andreas or the Calaveras Faults, although a sizable earthquake on any of these faults could affect the HGL site (LBL, 1992b). However, it should be noted that the proposed HGL site is located on well consolidated bedrock. This hard substrate tends to transmit higher frequency vibrations than softer substrates, and the high frequency motions are generally less destructive to the type of building proposed for the HGL than medium to low frequency vibrations. Bedrock sites have little or no tendency for amplification of seismic energy or resonant motion, and are thus preferable to sites founded on alluvium. Figure 4-2 shows the location of the Hayward Fault in relation to LBL.

The Wildcat Fault, an apparent branch of the Hayward Fault system, runs beneath Building 74. To determine more about the Wildcat Fault, two trenches were dug across the suspected fault in November and December 1979. Based on an analysis of the materials found in the trenches, there is no evidence that the Wildcat Fault in this area is active (Harding-Lawson, 1980).

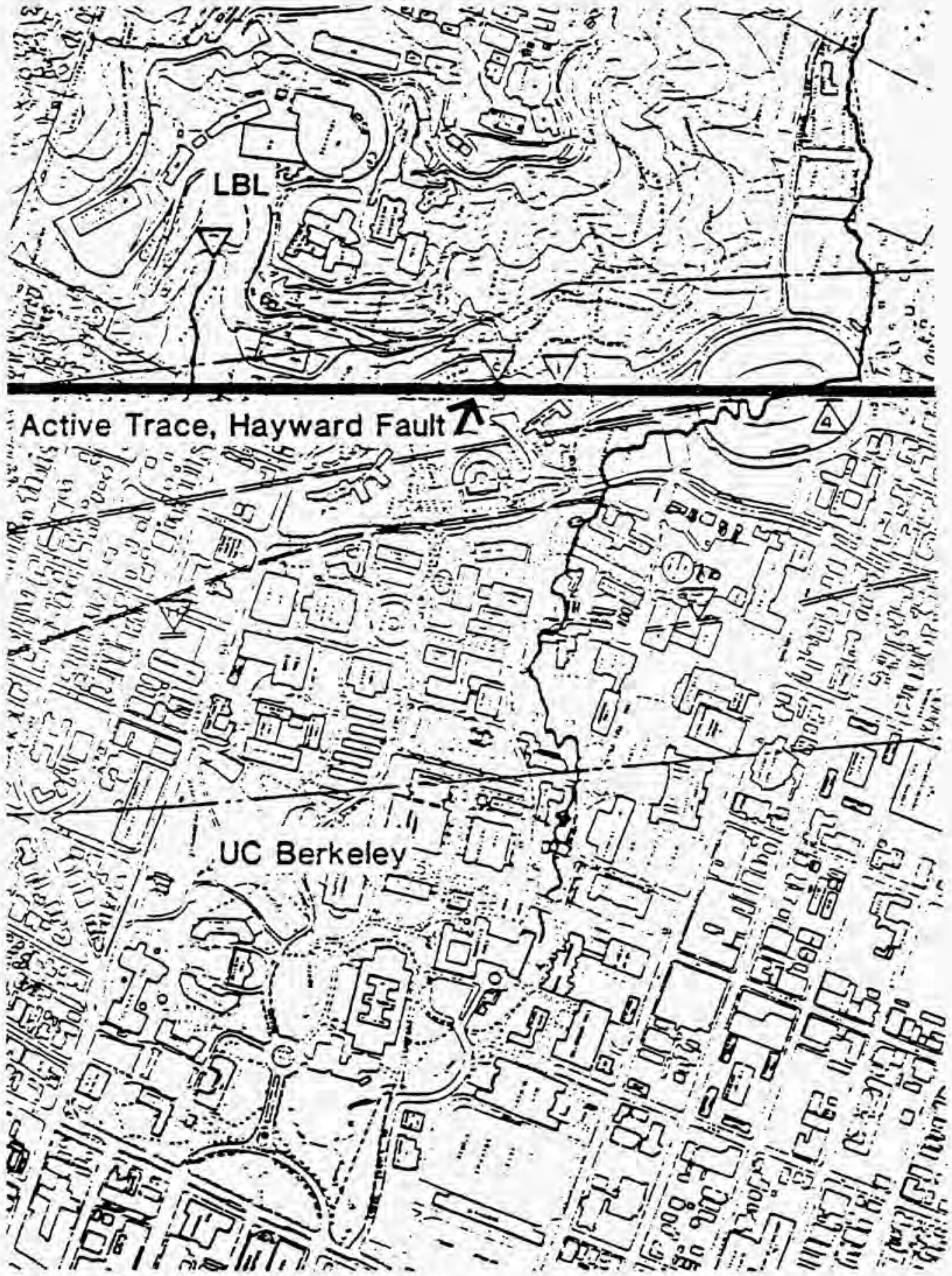
4.2.5 Hydrology, Surface Water, and Water Quality

The proposed HGL site is located within the 502-acre Upper Strawberry Canyon sub-watershed in the Berkeley Hills. Within this sub-watershed, LBL has developed approximately four acres. Other developments, consisting of approximately 10 acres, include UCB buildings, public roads, and private residences. The remainder of the Upper Strawberry Canyon sub-watershed consists of vegetated steep hillside canyons (LBL, 1986).

Annual precipitation at LBL averages 24.8 inches, with approximately 95 percent of the total rainfall occurring from October to April (LBL, 1992b). The existing drainage facilities at LBL are capable of handling surface water runoff generated by a 100-year storm of 2.0 inches/hr. (LBL, 1986). Surface water runoff near the proposed HGL site is diverted from the site by a series of corrugated metal and reinforced concrete pipes to a tributary of Strawberry Creek, which ultimately empties into the San Francisco Bay. Surface flow in Strawberry Creek varies from nearly dry in the summer to large flows during heavy winter storms (LBL, 1991). No portion of the LBL site is within the 100-year floodplain Federal Emergency Management Agency (FEMA, 1982).

Highly complex groundwater flow conditions are present at LBL. The complex geologic development and structure of the Berkeley Hills have produced an underground structure which is difficult to model. The sedimentary rocks that underlie LBL have been deformed and truncated by faults and volcanic vent structures (LBL, 1992e). The presence of year-round springs and variable water levels in observation wells indicate discontinuous and localized aquifers (LBL, 1991).

The depth to groundwater in the vicinity of the proposed HGL varies from 3.9 ft to more than 50 ft (LBL, 1992d). The local groundwater gradient is probably toward the south following the surface topography (LBL, 1992c). As mentioned in Section 4.2.4, property surrounding Building



Source: Ira Fink and Associates, Inc., based on "Fault Hazard Study", prepared by Ben J. Lenert, Civil Engineer and Garniss H. Curtis, Geologist, for the University of California, Berkeley, June 1980.

Figure 4-2: Hayward Fault in Vicinity of LBL

74, 74B, and 83 (including the proposed location of the HGL) is included in the LBL RCRA Facility Investigation Work Plan. Potential contaminants include lead, nickel, gasoline, diesel, and radionuclides (LBL, 1992d). Investigation and remediation of areas including the proposed HGL site would be completed prior to construction of the HGL in accordance with federal, state, and local regulatory requirements.

4.2.6 Waste Management

Estimated quantities of biomedical, hazardous, radioactive, and mixed waste streams at LBL in 1992 are provided in Table 4-2.

Solid and liquid hazardous wastes are accumulated in satellite accumulation areas. After accumulation, the wastes are either transferred to a 90-day waste storage area and then to LBL's Hazardous Waste Handling Facility (HWHF), or are transferred directly to the HWHF. LBL has retained a contractor to transfer wastes from the various points of generation and accumulation to the HWHF and to package wastes for shipment to offsite licensed commercial treatment and disposal facilities or recyclers. Activities occurring at the HWHF consist of waste receipt, treatment, storage, packaging, and shipment. LBL ships hazardous waste to approved Environmental Protection Agency (EPA) and DOE offsite disposal facilities.

Table 4-2. Estimated Quantities of Hazardous, Radioactive, Mixed, and Medical Waste Streams at LBL in 1992.

Waste Type	Quantity
Hazardous	Solid: 129,000 lb Liquid: 300,000 lb
Low-level Radioactive	10,000 curies
Low-level Mixed	140 ft^3
Medical	27,100 lb

Solid and liquid radioactive wastes are stored and treated at the HWHF. Liquid wastes are solidified and solid wastes are compacted whenever possible in accordance with regulations. Scintillation vials are crushed to separate the solids from the liquids. If these liquids are below 50 nCi/g (nanocuries per gram), they are collected in drums and shipped offsite for incineration; if not, they are solidified. Radioactive waste carcasses are kept in freezers until ready to be shipped. LBL ships low-level radioactive waste to DOE's Hanford site for disposal.

Solid and liquid mixed wastes are sent to LBL's Hazardous Waste Handling Facility for full characterization, packaging, and shipment to Hanford. Because of the lack of acceptable disposal sites, LBL currently ships drums of mixed waste to the Hanford site for storage. Medical wastes are disposed of at offsite licensed medical waste disposal facilities.

Non-hazardous Solid Waste

In 1990, LBL generated 1300 tons of solid waste, consisting of 550 tons of office-type waste and 750 tons of construction and grounds waste. Approximately 500 tons of office-type waste were recycled. Solid waste generated by LBL is taken to a private recycling service in Oakland. About 90 percent of the materials are reused; 10 percent (by volume) are baled and sent to Altamont Landfill in Livermore (LBL, 1992b). Construction and grounds waste are sent to the landfill.

Despite the implementation of aggressive solid waste recycling and reduction programs by many facilities (including LBL) and municipalities, there is a shortage in solid waste capacity for the Bay Area and many other regions in California. California has enacted recent legislation aimed at reducing solid waste by 50 percent over the next several years, coupled with a planning process designed to ensure adequate new solid waste disposal capacity. If the agencies charged with implementing the requirements of this solid waste planning system fail to do so, it is probable that shortfalls in solid waste capacity would become acute within the foreseeable future (LBL, 1992b).

4.2.7 Land Use, Sensitive Resources, and Aesthetics

Land Use

LBL is on 134 acres of land owned by the Regents of UC located in the cities of Oakland and Berkeley. LBL is exempt from local zoning and planning regulations because it is on land controlled by a state agency, UC, and operated under contract with DOE. It is the policy of UC and LBL to cooperate with local agencies in planning matters affecting local authorities (LBL, 1992b). The proposed HGL is consistent with LBL's Long Range Development Plan (UC, 1989).

The proposed HGL site is bounded by an undeveloped natural area to the north, an ecological study area to the east, Building 74 to the west, and a narrow bank of trees to the south. The UC Botanical Gardens are located 100 yd (yards) to the southeast. LBL is surrounded on all sides by a buffer zone of University land. The nearest residential neighborhood is more than 0.5 miles to the southwest. The proposed HGL would be located in the Life Sciences Research Area, which is near the LBL Strawberry Gate off Centennial Drive, within the city limits of Oakland.

The parking lot proposed to be constructed near Building 54 using soil excavated from the HGL is located in an area designated as open space in the *Lawrence Berkeley Laboratory Long Range Development Plan* (August, 1987). This open space lies within the West Strawberry Canyon Buffer Zone Landscape Area. The primary considerations for maintaining this area in open space are to protect Bay views and eucalyptus, dawn redwood, and cork oak trees growing in the area.

Biological Resources

The vegetation and habitat of the proposed HGL site is highly disturbed and dominated by non-native plant species, primarily annual grasses, annual broad-leaf plants, and eucalyptus trees. Information on existing conditions and effects was gathered from a literature review, conversations with natural resource specialists, and a January 30, 1993 site survey. Protected and sensitive species potentially present on the proposed HGL site were determined by the U.S. Fish and Wildlife Service (FWS) (FWS, 1993), previous surveys of nearby areas, the *Supplemental Environmental Impact Report for the Proposed Renewal of the Contract between the United States Department of Energy and The Regents of the University of California for Operation and Management of the Lawrence Berkeley Laboratory* (SEIR) (LBL, 1992b), and a January 30, 1993 survey of the proposed HGL site. FWS (1993) noted that no threatened or endangered species would likely be on or near the proposed HGL site. However, the FWS did identify one proposed plant and 14 candidate species as potentially being present in the area.

The SEIR (LBL, 1992b) and a previous nearby survey did not identify the presence of protected or sensitive species in the areas of the proposed HGL site or other sites on LBL. In addition, the area to the southeast of Building 74 that may be used for HGL parking was surveyed on July 15, 1994, and the site for the parking lot near Building 54 was surveyed on April 27, 1993. No habitat or signs of protected, proposed, or candidate species were observed on the proposed HGL site or parking lot site near Building 54 during the January 30, 1993, April 27, 1993, and July 15, 1994 surveys. No streams or wetlands are within any of these areas.

Historical and Cultural Resources

All undeveloped land and proposed building locations within the LBL site were examined for historical and cultural resources in support of the 1986 LBL Site Development Plan (SDP), (LBL, 1986). No indications of historic or prehistoric archaeological resources were identified within the LBL site. Recent verification of applicable Archaeological Resource Service data indicated that no new archaeological sites have been reported since 1982. No prehistoric cultural resources are reported to lie within LBL (LBL, 1992b). An historic evaluation of LBL's buildings and equipment is currently underway.

Aesthetics

The Berkeley/Oakland hills provide a semi-natural, vegetated open-space backdrop to the LBL site. Most of the western slopes of these hills are wooded either with native canyon stands of oak and California bay or with introduced plantations of eucalyptus or conifers. The proposed HGL site is located in a portion of the East Canyon which is visible only to persons driving through the Strawberry Gate entrance to LBL or along a short segment of Centennial Drive in the immediate vicinity of the site. The building site cannot be seen from most of Centennial Drive because of a dense eucalyptus stand to the west and an approximately 100-ft-wide vegetation buffer to the south. The proposed HGL site is not visible from any Berkeley scenic highway, pedestrian way, or bikeway (City of Berkeley, 1977), or any Oakland scenic route, bikeway, or pathway (City of Oakland, undated). The proposed parking lot adjacent to Building 54 would be screened from view by existing eucalyptus and conifers.

5.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND ALTERNATIVES

5.1 PROPOSED ACTION

5.1.1 Human Health

Construction and Demolition

Construction activities are expected to generate vehicle exhaust and airborne particulates. These air contaminants are not expected to pose a threat to human health because of the low levels that would be generated and the short duration of construction. The ground surface would be sprayed with water, as needed, to ensure that the generation of dust is below the state regulatory standard of 50 $\mu g/m^3$ for PM_{10}. Hearing protection may be required by persons operating heavy machinery and those within the construction zone.

To ensure that the HGL construction site is safe for both non-LBL employees and LBL employees alike, it would be inspected regularly for environmental, health, and safety compliance. HGL construction and maintenance contracts would be reviewed by the LBL EH&S Division to ensure that they have the proper safety program requirements (LBL, 1992b).

As discussed in Section 3.1.1, Building 74B would be demolished and removed to construct the proposed facility. It is anticipated that no more than millicuries of residual radioactivity would remain at the time of Building 74B demolition. Demolition workers would use additional precautions to ensure safety. Air sampling would be used to determine if residual radioactivity is present. Workers would use respirators and protective clothing as needed. Also, negative building ventilation and air filtration would be used during evaluation and cleanup to ensure that no radioactive material would be released (LBL, 1992a).

If residual radioactivity is encountered in the demolition debris of Building 74B, it would be treated as radioactive waste and shipped to the DOE Hanford facility in Washington State in accordance with procedures approved by DOE. At most, the six decommissioned gloveboxes and three ovens would be disposed of radioactive waste; this equipment would constitute approximately 40 cubic feet of waste. If the air ducts are determined to have residual radioactivity, they would be washed to remove the radioactivity and the wash water would be disposed of as radioactive waste. Handling, packaging, and shipping of this amount would not result in measurable effects to workers or the general public. As discussed in Section 3.1.1, procedures approved by DOE would be followed to ensure correct handling and shipping of waste (also see Section 5.1.7).

Operations

Radiation

Operations at the HGL would use phosphorus-32 in solution under laboratory fume hoods, which would emit prompt radiation. The solutions would be very dilute and almost all of the radiation would be attenuated in the glassware used to hold the solutions. The total unsealed sources in the proposed HGL are estimated to be 100 mCi annually (2 mCi/week). No sealed sources are expected to be used. The PSAD (LBL, 1993) concluded that maximum extremity doses would be "negligible" and whole body doses would be even less than extremity doses.

LBL has an active worker radiation monitoring program which ensures worker doses are as low as reasonably achievable (ALARA) and do not approach the DOE-established limit of 5,000 mrem per yr for radiation workers (see Section 4.1.2). Radiation workplaces are audited to assure compliance with procedures. All LBL radiation workers wear dosimeters that are returned periodically and analyzed. A noticeably increased dose results in an investigation to determine the cause.

Solutions containing radionuclides would be stored and transported in lead containers. The PSAD (LBL, 1993) concluded that "there is no concern with regards to radiation exposure under normal conditions due to transport of solutions containing phosphorus-32 to and from, or within, the HGL."

Some of the radionuclides in solution would be volatilized, resulting in radionuclide emissions. Radionuclide emissions from HGL operations are estimated to be 1.04 mCi per year. Potential exposed populations include LBL onsite workers and offsite members of the public.

The potentially exposed LBL onsite worker population consists of 3,500 persons located within 1,400 m of the proposed HGL. The collective dose to LBL onsite workers is estimated to be 2.17×10^{-2} person-rem. Based on the DOE dose to risk conversion factor of 4×10^{-4} (4 in 10,000) latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 8.7×10^{-6} (8.7 in 1 million) excess fatal cancers.

The annual radiation dose to a maximally exposed worker under routine operations would be 1.3 x 10^{-5} millirem (mrem)/year. Because the lifetime of the facility is estimated to be 30 years, the estimated lifetime dose would be 3.9 x 10^{-4} mrem. Based on the DOE dose-to-risk conversion factor of 4 x 10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a lifetime probability of fatal cancer risk of 1.56 x 10^{-4} (1.56 in 10,000). The annual radiation dose to a maximally exposed offsite individual under routine operations is estimated to be 5.0 x 10^{-6} mrem/year, which would be 1.5 x 10^{-4} mrem over the 30-year life of the facility. Using the DOE dose-to-risk conversion factor of 5 x 10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 7.5 x 10^{-5} (7.5 in 100,000).

The collective dose to the members of the public is estimated to be 3.39 x 10^{-4} person-rem. Based on the DOE dose to risk conversion factor of 5 x 10^{-4} (5 in 10,000) latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 1.7 x 10^{-7} in (1.7 in 10 million) excess fatal cancers.

The quantity of radiological waste to be generated annually during routine operations and shipped to Hanford is 0.1 curies (about 0.001 percent of LBL annual radiological waste shipped to Hanford). This amount would not result in measurable effects to workers or the general public during packing, handling, or shipping between LBL and Hanford (see also Section 5.1.7).

Hazardous Materials

The hazardous materials expected to be used within the proposed HGL cover a wide range of chemicals common to biological research laboratories. They would be stored and used in small quantities (e.g., 5-liter containers or smaller) and would include corrosive liquids; organic solvents; toxic compounds; flammable solids and liquids; carcinogenic solids and liquids; and solid and liquid irritants. Table 5-1 provides a comparison of the 1992 quantities of hazardous materials at LBL and estimates for the proposed HGL.

Table 5-1. Comparison of Hazardous Material Quantities at LBL in 1992 and Estimated Future Annual Quantities at the Proposed HGL.

Type	LBL Totals for 1992	Future Annual HGL Estimates
Solid	73,300 lb	2500 lb
Liquid	174,000 lb	300 gal
Gas	4,390,000 lb	none

Hazardous materials would be stored in appropriate cabinets within the proposed building. All sink drains where hazardous materials may be handled would be valved closed and would be opened only when all hazardous chemicals were removed from the sink and adjacent countertops. Personnel would wear appropriate protective clothing and equipment.

The chemical laboratory operations would be bench-scale and have hoods where volatile chemicals would be used. Emissions of 13 chemicals under normal operating conditions were modeled for the PSAD (LBL, 1993). These indicator chemicals for the expected chemical inventory of the facility included acrylamide, diethanolamine, formaldehyde (50 percent), hydrogen peroxide (30 percent), phenol, and sulfuric acid. It was determined that ground-level concentrations would be at least 3000 times lower than the Threshold Limit Values (TLV) for occupational exposures [American Conference of Government Industrial Hygienists (ACGIH), 1992] for these indicator substances. The TLV is the maximum limit suggested by the ACGIH where workers do not suffer any adverse health effects if exposed 8 hours per day and 40 hours per week. Non-occupational exposure limits are not available for these compounds. Based on emission calculations, it is anticipated that the BAAQMD would exempt the proposed facility from permitting requirements. At completion of the design of this proposed project, the operations would be reviewed and any required permit applications would be submitted to the BAAQMD.

About 5,000 pounds (about 1 percent of total annual hazardous waste generated at LBL) of hazardous waste would be generated annually during routine operations and shipped offsite. Exposure to workers and the public would be minimized through the continuing use of DOE-approved operational procedures to ensure safe and correct handling, packaging, and shipping of waste. Also, licensed transporters would be used to ship wastes (see also sections 4.2.6 and 5.1.7). Therefore, potential effects to workers and the public from transportation of this waste would not increase measurably above existing conditions.

Biological Materials

Entities such as bacterial phages or plasmids would be used as vectors to transfer DNA fragments into bacteria, yeast, or other hosts. Bacterial phages, or bacteriophages, are viruses that only infect bacteria. Three bacteriophages will be used at the HGL: lambda virus, M13, and P1 phages; these viruses cannot infect humans or animals, and thus represent no threat to human health and safety. One human virus would be used at the HGL: the Adeno virus, which is a natural human cold virus. It is not a dangerous virus, and cannot be accidentally transmitted to humans in the liquid form in which it would be used at the HGL (injection would be required). Personnel at the HGL would practice standard laboratory safety procedures and adhere to safety standards pertaining to Biohazard Level 2, as defined in the *Biosafety in Microbiological and Biomedical Laboratories* guide prepared by the U.S. Department of Health and Human Services, U.S. Centers for Disease Control and Prevention, and the National Institutes of Health. Safe laboratory procedures for Biosafety Level 2 are presented in Appendix B.

Escherichia coli (E. coli) would be the sole bacteria used as a viral host at the HGL; this would be a continuation of current Human Genome research at LBL and would merely represent a change in building location at which the activities occur. While a wild strain of E. coli could infect particularly susceptible individuals (e.g., in a hospital setting), potentially resulting in serious illness or death, the laboratory strains of E. coli such as would be used at the HGL are quite different and are not dangerous to humans because they cannot survive in the human body. As stated above, lab personnel would follow standard laboratory safety procedures in the use of E. coli.

5.1.2 Air Quality

Construction and Demolition

Construction-related emissions at the proposed HGL site would be relatively short-term (24 months) and would include suspended particulates (PM_{10}), volatile organic compounds (VOCs), and exhaust emissions (e.g., carbon monoxide and nitrogen oxides). Particulates would be generated from earth moving, excavation, and grading; facility construction; and landscaping. VOC emissions would result from painting and asphalting. Exhaust emissions would be generated from construction equipment and motor vehicles traveling to and from the site. In the vicinity of the construction activity, the ground surface would be sprayed with water, as needed, to ensure that the generation of dust would be below the state regulatory standard of 50 μg/m³ for PM_{10}.

Operations

The proposed project would conform to applicable BAAQMD regulations, including those specific to emissions of ozone precursors (e.g., VOCs), carbon monoxide, and PM_{10} and its precursors. (See Section 5.1.10, Cumulative Effects, regarding effects to regional air quality and the status as a non-attainment area.) In reviewing proposed projects, the BAAQMD typically considers a net increase of one percent over the county-wide emissions, or a net increase of 150 lb/day as the thresholds of significance for carbon monoxide, VOCs, nitrogen oxides, sulfur oxides, and PM_{10}. Because of the small quantities of chemicals to be used, the proposed HGL operations are expected to result in a slight increase in LBL emissions that would not approach the BAAQMD thresholds.

Potential air emissions from proposed HGL operations have been conservatively projected to increase in an amount proportionate to the increase in square footage of laboratory space. LBL laboratory space is projected to increase about 186,000 gsf between 1993 and 1997, with the HGL comprising about 44,400 gsf. The estimated annual emissions from the HGL would be 2.8 percent of current emissions from existing LBL sources (Table 5-2).

Table 5-2. Existing LBL and Estimated HGL Emissions of Criteria Pollutants Compared to Alameda County Emissions.

Source	Criteria Pollutant Emissions (tons/day)				
	Carbon Monoxide	Ozone Precursor Organic Compounds	Nitrogen Oxides	Sulfur Dioxide	PM_{10}
LBL-existing (1991)	0.002	0.021	0.024	0	0.006
HGL - estimated (1993-1997)	0.00003	0.0003	0.0004	0	0.0001
Alameda County-wide (1991)	538	140	113	19	109
HGL to Alameda County ratio (percent)	0.0006	0.0003	0.0004	0	0.00004

It is anticipated that the BAAQMD would exempt the proposed HGL operations from permitting requirements because small quantities of chemicals (including a short-lived radionuclide) would be used under fume hoods. At completion of the design of this project, the operations would be reviewed and any required permit applications would be submitted to the BAAQMD.

Radionuclide emissions would be approximately 1.04 mCi per year from proposed HGL operations (LBL, 1993). This is 0.1 percent of total annual radionuclide emissions (not including tritium) from existing LBL operations.

5.1.3 Utilities, Services, and Energy

Construction and Demolition

During the construction phase, electrical power and water would be provided to the construction site through temporary connections to existing onsite distribution systems. Existing provisions of utilities, services, and energy at LBL are expected to be adequate for construction activities. As discussed in Section 3.1.1, communications and utility tie-ins would be installed during facility construction. New utility equipment would consist of a new 1000 kilovolt-amperes (kVA) electrical substation on the first floor of the proposed facility and an emergency power diesel-generator in another fire-rated room.

Operation

Proposed HGL operations are expected to result in incremental increase of less than 3 percent over current LBL usage for water, sanitary sewer, natural gas, and electrical power (Table 5-3). Available levels of service are expected to be more than adequate for the proposed HGL.

Table 5-3. Estimated Incremental Change (from Current LBL Use) in Utility Use and Wastewater Generated from Operation of the Proposed HGL Facility.

Utility	Incremental Change[a]	Percent of LBL Total[b]
Domestic Water	6,486 gal/day	3.0
Natural Gas	51,336 therms/yr	2.9
Electrical Power	2,230 MWH[c]/yr	3.0
Industrial Wastewater	1,689,074 gal/yr	3.0

Notes:

[a] Does not take credit for reduced utility use as a result of demolition of Building 74B

[b] Based on 1992 use

[c] Megawatt-hour

Wastewater effluent would be sampled periodically. Samples would be tested for radioactive materials, heavy metals, and other constituents as required to ensure compliance with the discharge requirements of East Bay Municipal Utility District and DOE (LBL, 1992a). This would decrease the likelihood of unauthorized releases of biomedical, hazardous, radioactive, and mixed materials and wastes and thus would reduce the potential for exposure to the environment and the public.

Existing services, including communications, emergency notification, fire, and police are expected to be adequate to support proposed HGL operations. Existing emergency preparedness and response programs would be continued. Such programs would minimize impacts that may result from a release of biomedical, hazardous, radioactive, or mixed materials or wastes to the environment. LBL complies with the pertinent requirements of the *Federal Emergency Planning and Community-Right-to-Know Act (EPCRA), Federal Occupational Safety and Health Act, California Hazardous Materials Release Response Plans and Inventory Law of 1985 (Business Plan Act), California Emergency Services Act,* National Fire Protection Standards, and applicable

DOE Orders (LBL, 1992b). The LBL emergency preparedness and response program would be updated to include the operations of the proposed HGL (LBL, 1992b).

5.1.4 Traffic, Circulation, Parking, and Noise

Construction and Demolition

During construction, short-term transportation effects would include vehicle trips by workers to and from the site, and truck travel related to construction. Traffic, circulation, and parking effects are expected to be minor because of the small additional number of persons to be working at the proposed site. The effects of construction on traffic, circulation, and parking would be localized to a small portion of LBL, and would be minor and of short duration.

The construction of the proposed HGL would generate noise at the site over a period of about 24 months, from the summer of 1995 through the summer of 1997 (LBL, 1992b). During construction, the noise levels in Buildings 74 and 83 may reach 70 dB but are not expected to exceed 81 dB. Noise levels at the UC Botanical Gardens would approach 70 dB. The daytime noise level at the nearest Berkeley residence (approximately 2,000 ft to the southwest) may reach 53 dB, which is below ambient levels. Noise levels in the City of Berkeley are not expected to exceed the City's noise ordinance limits (ambient noise limit of 55 dB daytime) or the ACGIH TLV (85 dB(A) over an 8-hr day). The City of Oakland does not have a quantitative noise ordinance.

Noise would be minimized by locating noise-generating equipment as far as possible from existing buildings. Construction would be limited to daytime, and construction equipment would be fitted with acoustical enclosures, high performance mufflers, or both to reduce noise emissions.

Operations

The 46 additional personnel who would be accessing the Life Sciences Area of LBL would increase daily traffic to and from LBL by 10 peak-hr vehicle trips and 100 average daily trips (ADTs), based on the current trip generation rate of 2.18 daily trips per employee (LBL, 1992b). This represents less than 10 percent of the 113 peak-hr vehicle trips and 1,166 ADTs, projected site-wide at LBL through 1997 (LBL, 1992b).

Traffic in and out of LBL during operation of the proposed HGL would remain below the goals set forth in the agreement with the City of Berkeley. Centennial Drive is expected to be a primary travel route for HGL employees. Peak-hour traffic volumes would increase, particularly at the Grizzly Peak and Strawberry Canyon Gates, but the level of service at all of the Centennial Drive locations would remain "B" or better (no delays), resulting in minimal adverse traffic/circulation effects.

Based on a ratio of 1.7 employees per parking space established in the LBL Long Range Development Plan (LBL, 1987), the 46 new HGL employees would require approximately 30 parking spaces. The current parking space inventory in the Life Sciences Research Area and the proposed HGL parking area would provide adequate parking to maintain this ratio.

The regular operation of the proposed HGL would produce little noise, the major sources of which would be heating/cooling equipment and emergency generators. Noise levels at a typical LBL laboratory are 55 dB L_{10} and 49 dB L_{50} (LBL, 1992a). Assuming similar noise levels at the proposed HGL, the attenuated noise from the HGL at the nearest Berkeley residential area would be no higher than 23.5 dB L_{10} and 17.5 dB L_{50} (minimum attenuation is 31.5 dB). This translates to a negligible (< 0.1 dB) increase in the ambient noise level at the nearest Berkeley residential neighborhood. Attenuation at 800 ft (a minimum of 24 dB) would result in 31 dB L_{10} and 25 dB L_{50}, respectively. This translates to a negligible (< 0.1 dB) increase in noise level at the UC Botanical Gardens, assuming an ambient noise level of 50 dB L_{50}. Traffic noise, the primary source of noise measured at the UC Botanical Gardens, would not increase above current levels because of the small increase in vehicle trips per day.

5.1.5 Geology, Soils, and Seismicity

Construction and Demolition

Construction of the proposed HGL (and demolition of Building 74B) would involve excavation into the steep hillside east of Building 74. To prevent this excavation from being a source of increased erosion and potential landsliding, preventive measures would be employed, including construction of retaining walls upslope of the proposed HGL (Figure 5-1), installation of piers into the bedrock as support for the building, and revegetation of disturbed areas. Construction and demolition are expected to have minor, localized effects on surface geology and soils, and no effect on seismicity.

Erosion, sedimentation, and landsliding could also occur near Building 54, where 15,000 cubic yards of soil excavated from the HGL site would be deposited for a 54-space parking lot. Implementation of the appropriate slope stability measures would prevent these impacts at this location. These measures would include, among others, cutting a keyway into the bottom of the slope so that the fill could be tied into the slope; cutting horizontal benches into the slope and compacting deposited fill in horizontal benches; installing subdrains within rock drain layers; and placing horizontal layers of high-strength geogrid within the benched fill, extending from the slope face to the back of the reinforced zone. Additional erosion control measures are addressed below in Section 5.1.6.

Operations

Proposed HGL operations are expected to have no effects on geology, soils, or seismicity. Accident scenarios, including a seismic event, are discussed in Section 5.1.9.

5.1.6 Hydrology, Surface Water, and Water Quality

Construction and Demolition

Dewatering of boreholes prior to construction of the proposed HGL foundation piers may be required. This water would be discharged into the existing storm drainage system or into a collection and treatment system (if groundwater contamination is present), but would not be expected to be of sufficient quantity to affect the groundwater system or the storm water collection system. As discussed in Section 5.1.5, erosion (and therefore effects to water quality) would be minimized by constructing retaining walls upslope of the proposed facility, revegetating disturbed areas, and minimizing the duration and size of disturbances. In addition, storm water runoff would be diverted from the construction and demolition area using drainages and culverts that would flow into the existing storm water collection system. This system has sufficient capacity for peak flows from rain fall events.

Similar erosion control measures would be undertaken for the parking lot that would be constructed adjacent to Building 54. Drains would be installed under the parking lot within a 4-inch gravel bed. These drains would be diverted to a subdrain that would be installed along the base of the existing hillside. This system would divert surface runoff from the parking lot to an

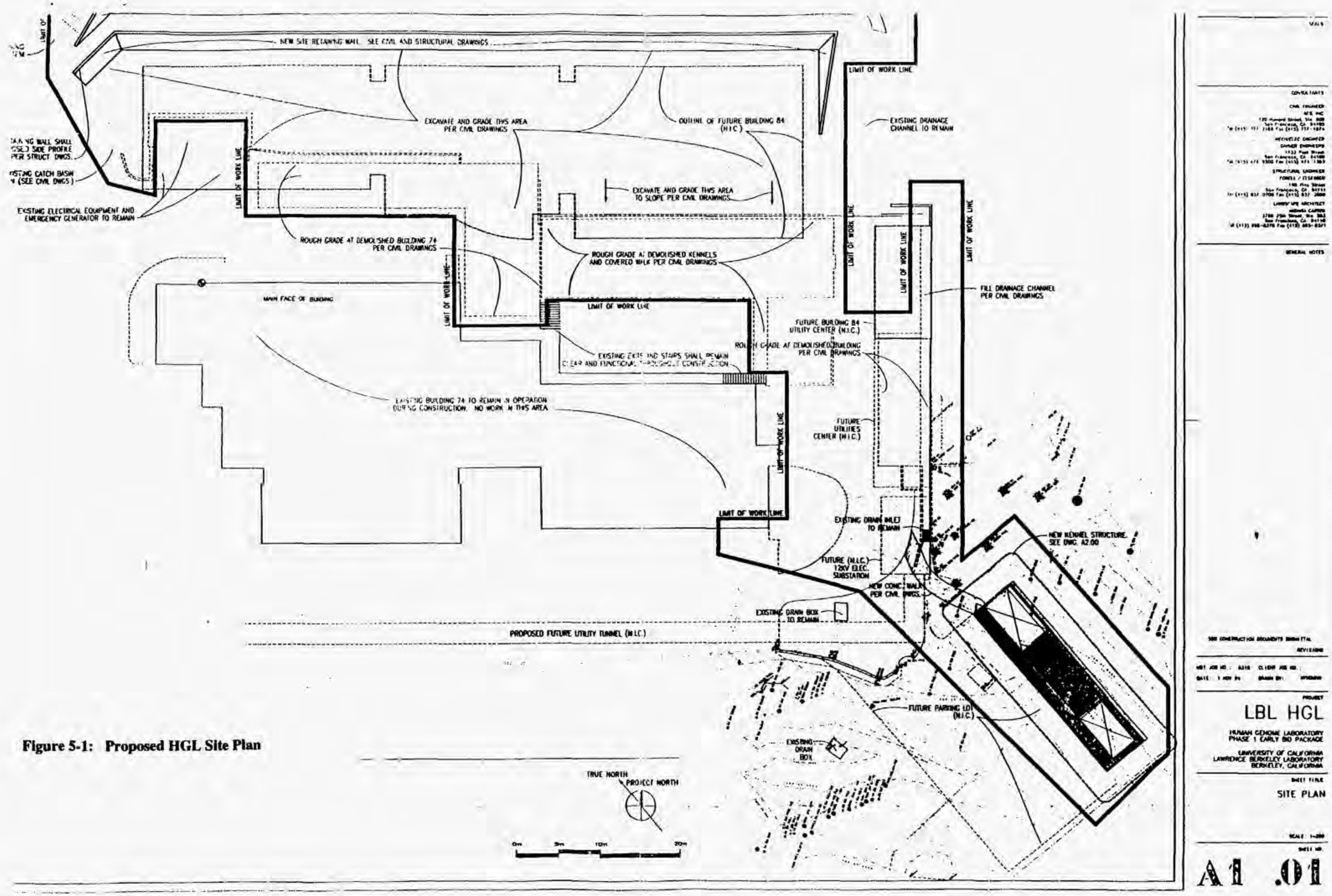


Figure 5-1: Proposed HGL Site Plan

existing storm drain. A perimeter berm of asphalt or soil with an impermeable seal coat would be constructed to further reduce surface runoff. The unpaved slopes surrounding the parking lot would be hydroseeded and, if civil engineering design determines that it is necessary, covered with jute mesh.

Operation

Minor diversion of subsurface groundwater flow in the hillside east of the proposed HGL by the retaining walls may be required. This water would be diverted along the retention walls by weep holes or perforated pipe to either the storm drain system or an appropriate collection facility (LBL, 1992a). The diversions would not affect the hydrology, surface water, or water quality of the area because of the minor quantities of water involved and the short distance of diversion.

The proposed HGL would cover an additional 0.65 acres of soil with impervious material, which represents about 0.07 percent of the Strawberry Canyon Watershed. Minimal effects on groundwater recharge are expected (LBL, 1992b).

5.1.7 Waste Management

Construction and Demolition

Preconstruction demolition at the proposed HGL site would include saw-cutting and removing existing retaining walls, stairs, and walkways, and removing the one-story wing of Building 74 (Building 74B), animal holding facilities, and fencing. These materials would be recycled, if possible, or landfilled at the Altamont Landfill near Livermore, California. About 2,500 cubic (cu) yd of construction waste would be generated. It is estimated that removal of this material would result in about 10 truck trips per day leaving the LBL site over a period of about a month and a half. This is not expected to adversely affect traffic on local roads or freeways or to result in a significant increase in traffic accidents.

Demolition of Building 74B would require sampling of suspected asbestos-containing materials. Sampling and removal of building materials would be conducted according to methods established in U.S. Environmental Protection Agency's (EPA) Asbestos Hazards Emergency Response Act by qualified personnel and would also comply with Occupational, Safety, and Health Administration and BAAQMD requirements.

The laboratories within Building 74B contain filtered glove boxes that may be contaminated with low levels of isotopes, as discussed in Section 3.1.1. The isotopes that were used are short-lived and it is unlikely that any residual activity would be present when decommissioning begins. A plan would be prepared by LBL in accordance with DOE Orders that would specify methods to be used to ensure that no residual contamination remains in the building. Waste equipment that exceeds allowable levels of residual activity would be removed, processed, and shipped for disposal as radioactive waste to the DOE Hanford site. As stated in Section 5.1.1, DOE-approved operational procedures to ensure safe and correct handling, packaging, and shipping of waste would be followed and licensed transporters would be used to ship radioactive wastes.

Site grading and excavation for this project is expected to result in approximately 15,000 cubic yards of excess soil. As stated in Section 3.1.1, this soil may be deposited on a hillside near Building 54 and used for the construction of a parking lot at that location. In the event excess cut material is generated beyond that which can be used for the hillside parking lot, it would be disposed of offsite at the Altamont Landfill.

Construction of the proposed HGL would require the use of hazardous materials such as paints, thinners, and cleaning solvents. The small quantities of hazardous waste (such as paint waste and solvents) generated would be recycled or disposed of as described in Section 4.2.6, Waste Management.

Operation

Biomedical, Hazardous, Radioactive, and Mixed Wastes

Operations at the proposed HGL would generate biomedical, hazardous, radioactive, mixed (radioactive and hazardous), and non-hazardous waste streams (LBL, 1992f). Research activities that would be relocated to the proposed HGL are currently being conducted in LBL and UCB buildings. The waste streams would be similar to ongoing activities, but quantities may increase over current levels at full building occupancy.

The increase in waste generation is anticipated to be less than one percent of the current LBL total and would not require additional waste storage space at LBL, nor would it substantially affect current levels of waste transport or disposal (Table 5-4). As the LBL-wide Waste Minimization and Pollution Prevent Plan is fully implemented, hazardous materials use and wastes generated are anticipated to decrease. That plan contains goals and policies pertaining to the reduction of hazardous, radioactive, mixed, medical/biohazardous, and solid wastes generated at LBL. The overall goal is to reduce the monetary costs and release of pollutants into the environment resulting from the storage, handling, and disposal of hazardous, radioactive, and other substances that generate those wastes. In addition to establishing specific waste reduction targets, with internal and external mechanisms for tracking and reporting on progress achieved, the plan also includes both site-wide and generator-specific strategies for achieving the reduction targets. It establishes training programs, technical assistance development, source reduction programs, and recycling programs. Implementation of the plan is expected to reduce total waste generation at LBL by 10 percent per year until a 50 percent target established by DOE is achieved. The potential effects on workers and the public of handling and transporting, hazardous and radioactive wastes are addressed in Section 5.1.1.

Table 5-4. Comparison of Quantities of Hazardous, Radioactive, Mixed, and Biomedical Waste Streams at LBL in 1992 and Quantity Estimates of Future Annual Waste Streams for the Proposed HGL.

Waste Stream Type	LBL Totals for 1992	Proposed HGL Annual Estimates
Hazardous	Solid: 129,000 lb Liquid: 300,000 lb	Solid: 2000 lb Liquid: 3000 lb
Low-level Radioactive Waste	10,000 curies	0.1 curies
Low-level Mixed Waste	140 cu ft	3 cu ft
Biomedical Waste	27,100 lb	8000 lb

Wastes would be collected at their point of generation, transported to and stored in compatible groups at LBL's HWHF, placed into approved shipping containers, and transported off site for treatment or disposal. These wastes would be handled in compliance with applicable laws, regulations, and DOE orders. LBL routinely includes provisions in contract specifications

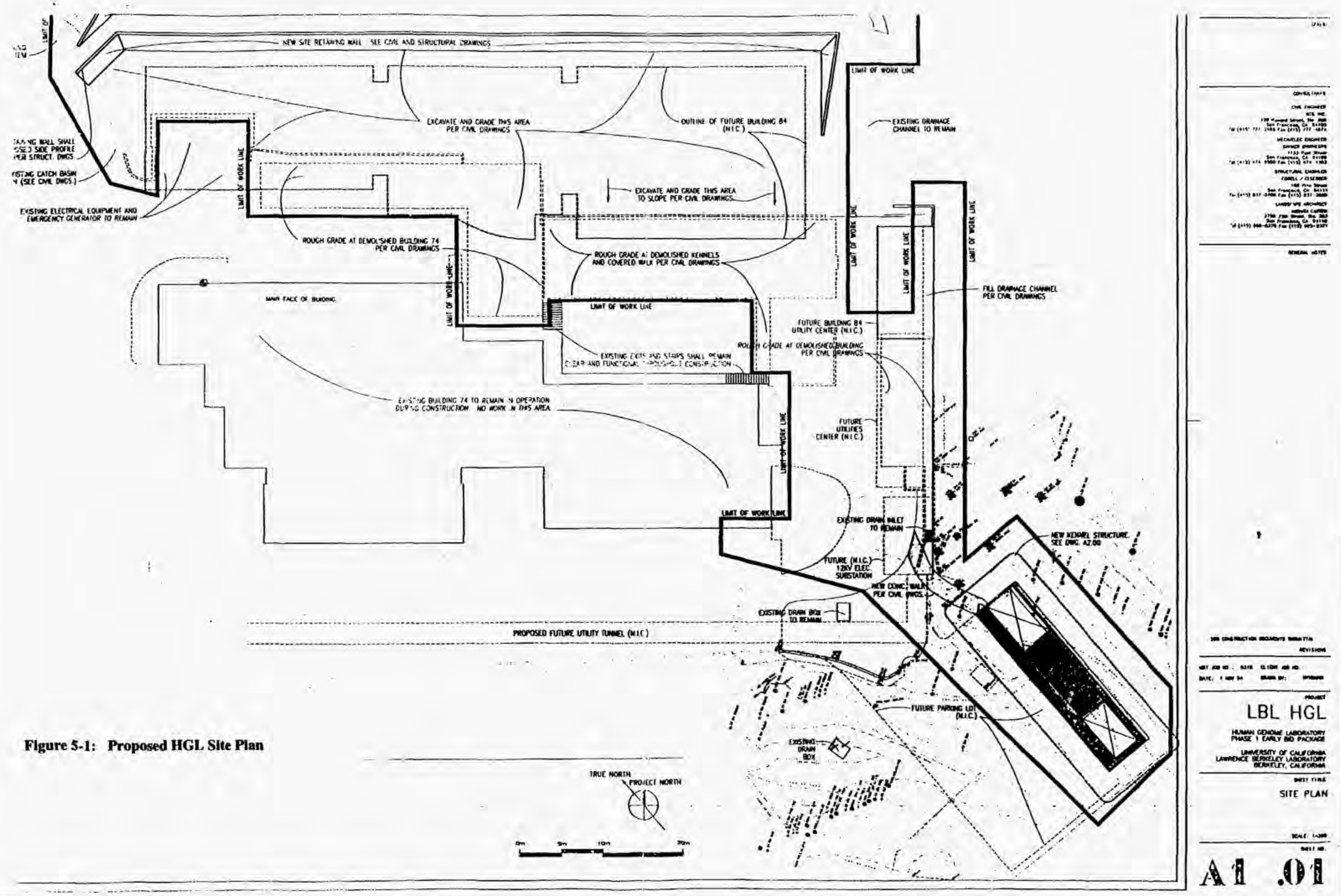


Figure 5-1: Proposed HGL Site Plan

requiring vendors to comply with pertinent regulatory requirements pertaining to biomedical, hazardous, radioactive, and mixed waste. To help reduce the potential for accidents and other problems associated with offsite transportation of these materials and wastes, LBL contracts licensed transporters to transport particular types of waste off site. Prior to transporting waste, LBL must confirm that the receiving facility is licensed to receive the waste type (LBL, 1992b).

An Environmental Assessment was prepared for the proposed Construction of the Replacement Hazardous Waste Handling Facility at Lawrence Berkeley Laboratory Project (April 1992). A Finding of no Significant Impact (FONSI) was issued on October 20, 1992. The EA addressed activities that are ongoing at the existing HWHF and that would be transferred to the replacement HWHF when the building is completed. All hazardous waste generated during HGL operations would be transferred to the onsite HWHF for consolidation and shipment offsite to an approved treatment, storage, and disposal facility. The EA on the HWHF addressed potential impacts from the transportation of hazardous and radioactive wastes from the HWHF to approved offsite disposal facilities. It is estimated in that document that there would be ten trips per year by tractor trailer of LBL-generated hazardous waste.

Non-hazardous Solid Waste

Proposed HGL operations are expected to generate non-hazardous solid waste, which would be recycled, if possible, or disposed of in a landfill as described in Section 4.2.6. HGL operations would be expected to contribute less than an additional 3 percent to current LBL office-type waste, 90 percent (volume) of which is recycled. No additional grounds waste is expected from proposed HGL operations.

5.1.8 Land Use, Sensitive Resources, and Aesthetics

Land Use

The proposed HGL is consistent with existing and proposed surrounding land uses and local land use plans, including the City of Oakland land use designations (LBL, 1986). The LBL site is surrounded on all sides by a buffer of LBL property which is intended to ensure compatibility with land uses outside of LBL boundaries (LBL, 1992g). The proposed HGL is consistent with local land uses.

The proposed parking lot near Building 54 would be constructed in an area designated open space in the LRDP, with the purpose of preserving the following qualities: Bay views; eucalyptus, dawn redwood, and cork oak trees. Construction of the parking lot would not compromise those qualities; Bay views, dawn redwoods, and nearby oak trees would be preserved.

Biological Resources

The proposed construction and operation of the HGL is not expected to affect endangered, threatened, proposed, or candidate species or critical habitat. Similarly, the action is not expected to affect fish or wildlife populations, riparian habitat, or wetlands.

Direct and indirect effects to flora and fauna would be minimal. The proposed site is already highly modified and developed, with no protected species, wetlands, or riparian areas. Approximately 1.07 acres of shrub and herbaceous cover and 7 immature and approximately 20 mature Monterey pines, as well as 5 or 6 immature oak trees, would be removed during the construction of the proposed HGL and the parking lot near Building 54. Human activity in the immediate area during construction may displace some diurnal animals or alter their behavior. Mortality of burrowing animals may occur during construction; however, this should be limited, as few burrows were observed on the proposed site during the 1993 survey. Increased traffic may result in a limited increase in animal mortality from vehicular collisions.

As described in Section 5.1.1, safety protocols would be followed so that a release into the environment of recombinant organisms (bacteria and viruses) would be very unlikely. The recombinant organisms that would be used at the HGL have been used in research laboratories for a long time and are relatively benign to both humans and ecosystems. If a release did occur, only small quantities would be released. These are naturally-occurring organisms that have been altered in a way that does not fundamentally change the organism. Therefore, releasing them into the environment would not be releasing a significantly foreign organism, and no adverse effects on the neighboring ecosystem would be anticipated.

Historical and Cultural Resources

Surface examinations in 1986 and literature reviews of the LBL site indicate that the proposed HGL building site does not contain historical and cultural resources; therefore, no adverse effects are expected.

Aesthetics

The proposed HGL would be visible from very few locations offsite and from adjacent laboratories onsite. It is shielded from off-site view by vegetation and adjacent buildings. On-site visual quality would not change substantially because a new, architecturally congruent structure would be added to an existing developed area.

5.1.9 Accident Scenarios

The accident scenarios that could potentially produce the most severe onsite and offsite consequences were analyzed in the PSAD prepared for the HGL (LBL, 1993). The information presented in this section was taken from that analysis. The PSAD hazard evaluation identified two categories of potential major accidents: operational accidents (facility fire and bounding spill) and natural phenomena (earthquake and external fire). A summary of the risks associated with these scenarios is provided below and shown in Table 5-5. The potential effects of an accidental release of recombinant organisms are discussed in Section 5.1.1 and 5.1.8.

5.1.9.1 Operational Accidents

Operational accidents for this facility were identified to be a facility fire and a bounding spill. A facility fire would be an effective mechanism for releasing radioactivity or other hazardous materials into the atmosphere.

Facility Fire

For this scenario, the accident is postulated to occur inside the proposed HGL by a nonspecified fire initiator. The entire proposed HGL building would be protected by fire suppression equipment such as sprinklers and fire extinguishers. The laboratories and rooms would be isolated by fire walls. Therefore, a postulated bounding fire would be confined to a single laboratory or room.

Table 5-5. Summary of Potential Excess Fatal Cancer Risks from Accident Scenarios (person/rem).

Scenario	HGL Worker	LBL Onsite Worker	Offsite Member of Public
Facility Fire	N/A[a]	8.7×10^{-6}	1.7×10^{-7}
Bounding Spill: Inside HGL	4.4×10^{-7}	8.4×10^{-6}	1.6×10^{-7}
Bounding Spill Outside HGL	8.4×10^{-5}	8.4×10^{-5}	2.4×10^{-7}
Earthquake	4.4×10^{-7}	8.4×10^{-6}	1.6×10^{-7}
External Fire	N/A[a]	7.2×10^{-8}	1.9×10^{-7}

Notes:

[a] No risks specific to HGL workers because workers are assumed to evacuate the facility.

Radioactive Material

A fire in a laboratory in the proposed HGL could result in the total release of a solution containing phosphorus-32 into the atmosphere. This represents the bounding scenario. The peak inventory of radioactive material handled in any laboratory at a given time is estimated to be approximately 1 mCi of phosphorus-32 bound in adenosine triphosphate (ATP) in an alcohol solution. The fire suppression system, sprinklers, and the LBL fire department may not be sufficient to prevent an atmospheric release from the laboratory. In order to calculate the radiological consequences from such an event, 1 mCi of phosphorus-32 is assumed to be released over a period of 15 minutes (i.e., one complete air change). Personnel are assumed to be located around the facility as a result of evacuation, so there would be no potential for exposures inside the building. The radioactivity released is assumed to be mixed in the HGL building wake. A conservative wind speed of 1 m/s was used to calculate the dose due to inhalation based on a conservative building area of 323 square yards (yd^{2}). The resultant total dose from all exposure pathways would be 0.026 mrem. Offsite doses are conservatively assumed to equal the onsite, co-located worker doses of 0.026 mrem. The resultant dose of 0.026 mrem is well below the air pathway limit of 10 mrem/y established by the EPA for normal releases (EPA, 1992) and the DOE limit of 5 rem/y for workers (DOE, 1989b).

The collective lifetime dose to LBL onsite workers is estimated to be 2.17×10^{-2} person-rem. Based on the DOE dose to risk conversion factor of 4×10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 8.7×10^{-6} (8.7 in 1 million) excess fatal cancers.

The collective lifetime dose to the members of the public is estimated to be 3.4×10^{-4} person-rem. Based on the DOE dose to risk conversion factor of 5×10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 1.7×10^{-7} (1.7 in 1 million) excess fatal cancers.

Hazardous Materials

A facility fire could result in release of stored toxic chemicals. The likelihood of this occurring would be minimized by the following: installation of fire suppression equipment such as sprinklers, separate storage of incompatible chemicals, and storage of chemicals in glass or metal containers. In addition, most chemicals are in solid form and therefore not readily dispersible.

Bounding assumptions are that all liquid materials released from cracked containers would be completely vaporized. In the event of such a facility fire, the proposed HGL would be evacuated so there would be no potential for exposures inside the facility. Thirteen bounding indicator chemicals were chosen based on toxicity and estimated inventory (Table 5-6). Where guidelines for public exposure were not available [i.e., Emergency Response Planning Guidelines, Level 2 (ERPG-2s)], TLVs were used for exposure criteria (ACGIH, 1992). TLVs were devised to provide guidance for acceptable concentrations in the working environment and were not intended to be applied to the general public. In lieu of any guideline limits for allowable levels of public exposure of the chemicals, TLVs will be used for comparison purposes. All of the concentration levels are well below the comparison criteria, indicating that no health effects are expected from these bounding releases.

Table 5-6. Indicator Chemical Concentrations used in the External Fire Accident Scenario Compared to the Selected Exposure Criteria.

Indicator Chemical	Maximum Ground-level Concentration (mg/m^3)	Selected Exposure Criterion (mg/m^3)	Ratio of Ground-level Concentration to TLV
Acetic acid	1.33	37[a]	0.036
Acetonitrile	0.77	101[a]	0.0076
Acrylamide	0.78	110[b]	0.0071
Butanol	1.6	152[c]	0.010
Carbon tetrachloride	0.21	190[b]	0.0011
Chloroform	1.04	500[b]	0.0021
Diethanolamine	0.13	39[d]	0.0034
Dimethylformamide	0.076	1050[b]	0.000071
Formaldehyde (50 %)	0.0085	12[e]	0.00071
Formamide	0.37	54[d]	0.0069
Hydrogen peroxide (30 %)	0.16	10[b]	0.016
Phenol	0.66	190[e]	0.0035
Sulfuric acid	0.23	10[e]	0.23

Notes:

[a] Threshold limit value, short-term exposure limit.

[b] Level of concern.

[c] Threshold limit value, ceiling.

[d] Threshold limit value, excursion level.

[e] Emergency Response Planning Guidelines, Level 2.

Bounding Spill

Inside the HGL

Accidental spills could occur during transfer of containers to laboratory hoods or in the hoods themselves. Radioactive solutions containing up to 1 mCi of phosphorus-32 would be transported within the proposed HGL encased in lead containers. During transfer, the container could be dropped releasing the liquid and resulting in a potential source of exposure. For conservatism, it is assumed that the solution is immediately released into the laboratory volume, and the concentration in the laboratory would decrease with time because of the building ventilation. The resultant calculated total dose is 7 mrem.

The collective lifetime dose to HGL workers is estimated to be 1.1×10^{-3} person-rem. Based on the DOE dose to risk conversion factor of 4.0×10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 4.4×10^{-7} (4.4 in 10 million) excess fatal cancers. The collective lifetime dose to LBL onsite workers is estimated to be 2.1×10^{-2} person-rem. Based on the DOE dose to risk conversion factor of 4×10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 8.4×10^{-6} (8.4 in 1 million) excess fatal cancers.

The collective lifetime dose to the members of the public is estimated to be 3.3×10^{-4} person-rem. Based on the DOE dose to risk conversion factor of 5×10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 1.6×10^{-7} (1.6 in 10 million) excess fatal cancers.

A spill involving breakage of a glass hazardous materials container would result in release of the contents. One gallon would be the maximum container size at the proposed HGL; therefore one gallon is assumed to be spilled for chemicals with estimated inventories greater than one liter. For chemicals with a total facility inventory of approximately 0.25 gallon, 0.25 gallon is assumed to be spilled. Using evaporation rates of the chemicals, ventilation flow rate in the room, and the volume of a room, concentrations in the laboratory air were calculated for spills during transport within the building. These values were compared to short-term TLVs. The resulting ratios ranged from 0.45 for chloroform to 0.00000015 for sulfuric acid. Because none of the calculated maximum concentrations exceeded the TLVs, no health effects to workers would be expected.

Similar calculations were performed for hazardous materials spills in a ventilation hood. Hoods are designed to protect workers in such situations, so no effects to workers would be expected. Maximum ground-level concentrations were calculated. Ratios of the ground-level concentrations to selected exposure criteria (listed in Table 5-6) were calculated. Results ranged from 0.0047 for carbon tetrachloride to 0.0000000032 for sulfuric acid, indicating that no health effects would occur. Since the operating procedure would require the floor drains to be capped, a spill would be prevented from entering the sanitary sewer system.

Outside the HGL

Potential spills during transport of radioactive materials to the proposed HGL were postulated. A spill involving radioactive material was assumed to result in immediate release of phosphorus-32, resulting in a dose rate of 61 mrem/h at a distance of 3 feet. Assuming a puff release of 1 mCi of phosphorus-32 mixed in the building wake, the resultant total dose to a person outside the facility was calculated to be 0.028 mrem.

The collective lifetime dose to LBL onsite workers was estimated to be 2.1×10^{-1} person-rem. Based on the DOE dose to risk conversion factor of 4×10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 8.4 x 10^{-5} (8.4 in 100,000) excess fatal cancers. The collective lifetime dose to the members of the public was estimated to be 4.8 x 10^{-4} person-rem. Based on the DOE dose to risk conversion factor of 5x10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 2.4 x 10^{-7} (2.4 in 10 million) excess fatal cancers.

A potential hazardous materials spill during transport to the proposed HGL was postulated based on maximum container volumes. A wind speed of 1m/s was used to model an outside spill near the building. Concentrations at the facility boundary were calculated and compared to selected exposure criteria. The resulting ratios ranged from 0.068 for acetonitrile to 0.0000000039 for sulfuric acid. No health effects are expected under such a scenario.

5.1.9.2 Natural Phenomena

Earthquake

According to the U.S. Geologic Survey (USGS), there is a 28 percent change of a magnitude 7.0 earthquake on this segment of the Hayward fault in the next 30 years and a 67 percent change of an earthquake greater than magnitude 7.0 somewhere in the Bay Area in the next 30 years. The proposed HGL will be designed to accommodate the postulated forces and displacement for such an earthquake. The following damages are postulated to occur for a 7.0 earthquake: nonstructural damage and some structural damage and minor damage to the underground, but no structural failure or collapse.

The radioactive material release mechanism and quantity released for this event are similar to the accidents involving breach of a container within a laboratory or a laboratory fire. All releases that could occur during an earthquake have been bounded by the accidents scenarios previously discussed.

The release of hazardous materials from an earthquake would be bounded by the laboratory fire that assumed release of the facility inventory of the 13 indicator chemicals. In the event of an earthquake, seismic constraints on the storage cabinets along with the closed cabinet doors would confine any releases to within the cabinets. While the individual TLVs would not be exceeded, even a release of all the inventory of the 13 worst chemicals analyzed (Table 5-6) would not exceed the overall release criteria.

External Fire

If a fire similar to that which occurred in the Oakland-Berkeley area in October 1991 were to occur, it is possible that the entire proposed facility could be engulfed in flames. The probability that a fire would engulf the entire proposed HGL is considered extremely unlikely because the HGL would be a metal and concrete structure. In the event of such a fire, the entire contents of the HGL are conservatively assumed to be released. The releases would be carried aloft due to the buoyancy created by the heat of the fire. For conservatism, the maximum height of release is assumed to be 325 yd, which should be treated as an elevated release. The maximum dose would occur around 1.25 miles from the fire, and would be 2500 times less than the value calculated for a facility fire, 0.026 mrem.

The collective lifetime dose to HGL/LBL workers is estimated to be 1.8 x 10^{-4} person-rem. Based on the DOE dose to risk conversion factor of 4 x 10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 7.2 x 10^{-8} (7.2 in 100 million) excess fatal cancers. The collective lifetime dose to the members of the public is estimated to be 3.8 x 10^{-4}

person-rem. Based on the DOE dose to risk conversion factor of 5×10^{-4} latent cancer fatalities per person-rem (DOE, 1993), this is equivalent to a risk of 1.9×10^{-7} (1.9 in 10 million) excess fatal cancers.

In the case of total release of hazardous materials, a release due to fire of all the inventory for the 13 indicator chemicals as presented in Table 5-6 would result in a total concentration less than 0.32 times the overall criteria. The atmospheric dispersion factor under this scenario is 15,000 times less than that assumed in Table 5-6. As a result, a total release under this scenario of all (approximately 200) chemicals would result in a total concentration/criteria ratio of 0.0003.

5.1.10 Cumulative Effects

This section discusses potential cumulative effects for the three following areas: 1) regional air quality; 2) traffic; and 3) waste generation. Potential cumulative effects are not expected for:

- Human health-- modeled operations show air concentrations thousands of times below levels of concern
- Utilities, services, or energy-- existing capacities are adequate to meet planned growth, described in the LBL Long Range Development Plan
- Parking-- plans exist to alleviate the current parking problem (the LBL Site Development Plan)
- Noise-- HGL construction would add no more than 3 dB to nearest residence ambient noise levels; operations would add less than 0.1 dB to ambient offsite noise levels (LBL, 1992b)
- Geology, soils, seismicity, hydrology, surface water, or water quality-- due to the local or very minor nature of potential effects to these areas of the environment
- Land use-- the proposed HGL is compatible with planned and surrounding land uses
- Sensitive resources-- none have been identified near the proposed HGL
- Aesthetics-- the proposed HGL would not be highly visible from off site.

Regional Air Quality

Because the Bay Area does not meet emissions standards for carbon monoxide, ozone, and PM_{10}, any new project that creates mobile and stationary emission sources would contribute to this nonattainment status. Operation and construction of the proposed HGL in compliance with emission control measures would provide a minor contribution to the already poor regional air quality.

Traffic

Increases in traffic as a result of planned development by both LBL and UCB over the next 5 years, including the proposed HGL, would result in cumulative traffic impacts along Centennial Drive. The potential cumulative effects from the proposed HGL would be reduced by implementation measures that have already been committed to by the City of Berkeley, UCB, and LBL. LBL has implemented a trip management program to encourage the use of bicycles, public transportation, free shuttle buses, carpools, and other measures designed to reduce employee-related vehicle trips (LBL, 1992b). These measures ensure that potential cumulative effects attributable to the proposed project would be minimized.

Waste

The proposed HGL is expected to increase the quantity of various types of hazardous wastes that are being generated at LBL. California lacks adequate disposal capacity to handle current or projected quantities of hazardous wastes generated within the state, and has embarked on a hazardous waste facility siting and development process to provide the needed disposal capacity. Until these facilities are developed, LBL and other California generators continue to rely on licensed hazardous waste treatment and disposal facilities located outside of California. The increase in hazardous waste generated from the proposed HGL would represent approximately one percent of total LBL hazardous waste.

Currently, about 90 percent of the office-type solid waste generated at LBL is reused, and only 10 percent (by volume) is baled and sent to a landfill. Despite the implementation of aggressive solid waste recycling and reduction programs, there exists a shortage in the Bay Area and in many other regions in California. California has enacted recent legislation aimed at reducing solid waste by 50 percent over the next several years, coupled with a planning process designed to ensure adequate new solid waste disposal capacity. If the agencies charged with implementing the requirements of this solid waste planning system fail to do so, it is probable that shortfalls in solid waste capacity will become acute within the foreseeable future (LBL, 1992b).

5.2 NO ACTION

The no-action alternative would have no effect on the environment above existing conditions. However, this alternative would adversely affect DOE's ability to fulfill the Human Genome Project mission. Without the proposed facility, DOE would be unable to provide the consolidated and centralized space and equipment needed to obtain the overall goals of the HGC discussed in Section 2.0. Research on the genetic basis of disease and other human-health-related issues would continue at its current level with no programmatic growth.

5.3 DIFFERENT BUILDING CONFIGURATION

The primary difference between this alternative and the proposed action is that the building would be two stories high instead of three and the building would have a larger footprint. Cutting further into the adjacent hillside would be required for this alternative.

Increased excavation may increase in the likelihood for soil erosion, landsliding, and sedimentation, and the potential for diversion of a greater amount of groundwater around the building foundation. This alternative would disturb a larger area of vegetation and may result in the loss of mature, introduced eucalyptus trees. (However, eucalyptus is considered a fire hazard and the removal of mature trees could result in a net improvement in the area.) A larger amount of soil would be excavated and removed. The potential environmental effects associated with facility operations would be identical to the proposed action.

5.4 ALTERNATIVE ONSITE LOCATION (ADJACENT TO CENTENNIAL DRIVE)

Under this alternative, the proposed HGL would be constructed approximately 75 ft to the west of Building 74, instead of 75 ft to the east. Implementation of this alternative would result in loss of more native habitat and mature trees. Vegetation buffering the site from views from Centennial Drive would be removed. The new laboratory would be highly visible from Centennial Drive and detract from the natural character of the surroundings. Construction activities would be located adjacent to Centennial Drive and noise levels at the UC Botanical Gardens would be slightly higher than with the proposed action.

Under this alternative, the hill slope behind Building 74 would not require excavation, and consequently, a much smaller amount of soil would be excavated and removed from the site. The potential for soil erosion, sedimentation, and landsliding would be less during construction compared with the proposed action. Depth to groundwater at this alternative location would probably be greater, reducing the likelihood of dewatering activities.

The site is located on the same well-consolidated bedrock as the proposed project site, and because of its close proximity to the proposed project site, would experience the same level of seismic shaking in the event of an earthquake.

The environmental effects associated with facility operations would be similar to the proposed action.

5.5 OFFSITE LOCATION (RICHMOND FIELD STATION)

This alternative would construct the proposed HGL at the RFS, and would have greater environmental effects than the proposed action. The RFS is located within or nearby sensitive zones for potential historical and cultural resources, within the 100-year coastal flood zone, and near wetlands. Two federal endangered and one state-listed threatened species associated with wetland habitats may be present at the RFS. Implementation of this alternative might result in negative effects to these resources.

The RFS site is approximately 2 miles west/southwest of the Hayward fault. The RFS is underlain by poorly consolidated alluvium transitional to "bay mud" and fill towards the bay. These substrates tend to transmit and amplify medium- to low-frequency vibrations more effectively than shorter frequencies. Additionally, the RFS resides on thick unconsolidated sediments and is thus subject to magnification of seismic shaking due to basin effects. As the RFS is located near sea level next to San Francisco Bay, the unconsolidated sediments underlying the station are saturated at a very shallow depth. These factors mean the site is subject to liquefaction and possibly lateral spreading as well as magnified medium- to low-frequency strong shaking.

Implementation of this alternative could add a minimum of 200 daily commute trips to the local street system resulting in additional air emissions, and may slightly decrease the LOS around UCB and LBL. Utility/energy consumption at the RFS would be greater than that of the proposed action because the net increase in new employees would be 92 at the RFS, compared to 46 at the proposed location.

Currently, hazardous materials are used at the RFS; radioactive materials are not used and biomedical wastes are not generated. Under this alternative, the relative increase in materials used and wastes generated would be greater than under the proposed action.

5.6 LOCATION AT ANOTHER DOE FACILITY (LLNL)

This alternative would have less potential for impacts to hydrology, water quality, geology, soils, and seismicity than the proposed action, but would have greater potential for impacts to traffic, air quality, utilities, and energy.

LLNL is on relatively level ground with good drainage. Because of this, the potential for soil erosion and sedimentation of local streams is less than for the proposed project. Also the potential negative impact to people and property during a seismic event at LLNL is considered less because the Hayward Fault near LBL has a greater MCE than do the faults nearer to LLNL (i.e., Greenville Fault and Las Positas Fault). The LLNL site is approximately 16 miles east/northeast of the Hayward fault and is about 10 1/2 miles east/northeast of the Calaveras fault, which is generally believed to be capable of a magnitude 6 to 6.5 event. An event of estimated magnitude 5.6 occurred near Dublin in 1861 with fault rupture most likely on the Calaveras fault.[1] The Greenville fault is approximately 2 miles northeast of the site. A magnitude 5.6 event occurred on this fault 4 miles north of LLNL in 1980.[2] There are several more poorly understood faults within a few miles of LLNL, including the Carnegie, Tesla, Las Positas, Mocho, and Livermore faults. LLNL resides on a deep basin fill of unconsolidated alluvium. As such, this site will be preferentially subjected to medium- to low-frequency shaking possibly magnified by basin effects during an event on any of the named faults.

The project would add a minimum of 200 daily trips to the local street system serving LLNL, based upon current trip generation at LBL (92 employees x 2.18 trips per employee). Many of these trips would be made by motor vehicles because of the lack of developed public transportation in the area and the need to commute between LBL, UCB and the proposed HGL. This would increase local traffic and add to air quality impacts from motor vehicle emissions because of the increased distance researchers would have to travel.

Utility/energy consumption at LLNL would be greater than that of the proposed action under this alternative because the net increase in new employees would be 92 at LLNL compared to 46 at the proposed location.

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[2] Bolt, B.A., T.V. McEvilly, and R.A. Uhrhammer, 1981. The Livermore Valley, California, Sequence of January 1980, Bulletin of the Seismological Society of America, Vol. 71, No. 2, pp. 451-463.

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7.0 PERSONS AND AGENCIES CONSULTED

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8.0 GLOSSARY

ACGIH	American Conference of Governmental Industrial Hygienists
ADT	Average Daily Trip
AEDE	Annual Effective Dose Equivalent
ALARA	As Low As Reasonably Achievable is a phrase used to describe an approach to radiation protection to control or manage exposures and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit, but rather it is a process that has as its objective the attainment of dose levels as far below the applicable limits practicable
^{241}Am	Americium-241
BAAQMD	Bay Area Air Quality Management District
^{14}C	Carbon-14
CCF	Hundred Cubic Feet
CFR	Code of Federal Regulations
CO	Carbon Monoxide
Colluvium	Weathered material deposited by gravity
Contig	Long segments of cloned chromosomes that have known overlapping regions
^{244}Cu	Copper-244
cu ft	Cubic Feet
Curie (Ci)	The curie is the activity of that quantity of radioactive material in which the number of disintegrations per second is 3.7×10^{10}
dB	Decibels
DCG	Derived Concentration Guide
DNA	Deoxyribonucleic Acid
DOE	U.S. Department of Energy

Dose	A generic term used to refer to a quantity of ionizing radiation received by members of the public from exposure to radiation and to radioactive material released by a DOE facility or operation, whether the exposure is within a DOE site boundary or offsite. The absorbed dose (in rads) is the energy imparted to matter by ionizing radiation per unit mass of irradiated material. One rad is equal to 100 ergs/g. The dose equivalent is a measure of biological damage expressed in units of rem. The dose equivalent is the product of absorbed dose (in rads) in tissue and a quality factor
Dosimeters	Devices used to measure radiation doses received by workers
EA	Environmental Assessment
EBMUD	East Bay Municipal Utility District
EH&S	Environmental Health & Safety
EPA	Environmental Protection Agency
EPCRA	Federal Emergency Planning and Community-Right-to-Know Act
FISH	Fluorescence in-situ hybridization
^{18}F	Fluorine-18
Fume Hood	A ventilated, enclosed work space intended to capture, contain and exhaust fumes, vapors and particulate matter generated inside the enclosure. It consists basically of side, back and top enclosure panels, a work surface or counter top, an access opening called the "face," a sash, and an exhaust plenum equipped with a baffle system for the regulation of airflow distribution
ft	Feet
^{68}Ga	Gallium
gal	Gallon
Gravity-Fed	System which is fed by gravity flow.
Gravity Flow	Fluid flow caused by the elevation difference between two points
gsf	Gross Square Feet
^{3}H	Tritium
HGC	Human Genome Center
HGL	Human Genome Laboratory
HTO	Tritiated water vapor
HWHF	Hazardous Waste Handling Facility

Informatics	The study of the application of computer and statistical techniques to the management of information. In genome projects, informatics includes the development of methods to search databases quickly, to analyze DNA sequencing information, and to predict protein sequence and structure from DNA sequence data.
kV	Kilovolts or 1000 volts.
L_{10}	Noise level that exceeds ambient levels 10 percent of the time
L_{50}	Noise level that exceeds ambient levels 50 percent of the time
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LLNL	Lawrence Livermore National Laboratory
LOS	Level Of Service
Low-Conductivity	Water that has passed through ion-exchange resins to reduce the number of water ions in solution
LRDP	Long Range Development Plan
Mass Spectroscopy	Method used to identify specific molecules by fragmenting the molecules into ions and sorting them by mass/charge ratio
MCE	Maximum Credible Earthquake
mCi	Millicuries
mi	Miles
mrem	Millirem (see Rem)
MWH	Megawatt-hours
nCi	Nanocuries
NCRP	National Council on Radiation Protection and Measurements
NSR	New Source Review Rules
NTLF	National Tritium Labeling Facility
PM_{10}	Particulate matter less than 10 microns
PCR	Polymerase Chain Reaction
PSAD	Preliminary Safety Analysis Document
^{238}Pu	Plutonium-238

Radioactivity	The spontaneous emission of radiation from the nucleus of an unstable isotope
Radioisotope	An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation
Radionuclide	A radioisotope
Rem	Measure of biological damage to living tissue from radiation exposure
RFS	Richmond Field Station
SDP	Site Development Plan
SEIR	Supplemental Environmental Impact Report
^{82}Sr	Strontium-82
^{85}Sr	Strontium-85
TAC	Toxic Air Contaminants
Therms	Unit of measure for consumption of electricity
TLV	Threshold Limit Value. An exposure level under which most people can work consistently for eight hours a day with no harmful effects. A Table of these values is published annually by the American Conference of Governmental Industrial Hygienists ACGIH).
Tritiated Water Vapor	Water vapor containing tritium ions
UC	University of California
U.S.C.	United States Codes
VOC	Volatile Organic Compound
YAC	Yeast Artificial Chromosome
y	Year
yd	Yards

APPENDIX A
CHEMICAL INVENTORY FOR THE HGL

Appendix A
CHEMICAL INVENTORY FOR THE HGL

Reagent	Amount
1- Butanol	1 L
4-Chloro-1-Naphthol	5 g
5-Fluorouracil	1 g
8-Hydroxyquinoline	50 g
Acetic Acid	10 L
Acetic Anhydride/Lutidine/THF	600 mL
Acetone	4 L
Acetonitrile	12.1 L
Acrylamide	2 L
Acrylamide	550 g
Acrylamide 40%	3.5 L
Adenine	100 g
Adenine-HCl	5 g
Agar	5 lb
Agarose	2 kg
Amberlite	500 g
Amberlite MB-1	25 g
Ammonium Acetate	2 kg
Ammonium Bicarbonate	500 g
Ammonium Hydroxide	7.5 L
Ammonium persulfate	100 g
Ammonium Sulfate	5.5 kg
Ampicillin Na salt	100 g
Anhydrous Acetronitrile	3.1 L
Aquacide I-A	1 kg
Aquacide II-A	1 kg
BenzolKonium Chloride	1 kg
Bind Silane Silane A-174	100 mL
BIS-N,N Methylene-bis-acrylamide	730 g
Boric Acid	6.0 kg
Brilliant Blue A	25 g
Bromophenol Blue	15 g
Cacodylic Acid	500 g
Calcium Chloride	1 kg
Cap B Soln THF N-methyl IMI	18 mL
Carbon Tetrachloride	500 mL
Casamino Acids	5 lb
Casein Hydrolysate Acid	1 lb
Cesium Chloride	2 kg
Chelating Resin Na form (Chelex 100)	200 g
Chloramphenicol	30 g
Chloroform	3 L
Dimethylformamide	0.6 L

Appendix A (con't.)
CHEMICAL INVENTORY FOR THE HGL

Reagent	Amount
Citric Acid monohydrate	1 kg
Cilric Acid tri Na Dihydride	500 g
Copper Destain	125 mL
Copper Stain (Cu Chloride)	125 mL
Cyanethylphosphoramide	1 g
D-Galactose	100 g
D-Sorbitol	5 kg
Dextran Sulfate	5.1 kg
Diethanolamine	3 L
Diethyl Ether	2 L
Diisopropylfluorophosphate	1 g
Dimethyl Sulfoxide	3 L
Dithiothreitol	5 g
DL-Dithiothreitol	5 g
Dodecyltrimethylammonium bromide	25 g
Drierite	10 lb
EDTA	1 kg
EDTA diNa dihydro	3.5 kg
Ethidium Bromide	10 g
Ethyl Alcohol	15 L
Ethylene Glycol	500 mL
Ethylene Glycol-bis	100 mL
Fe	10 g
Ferrous Ammonium Sulfate	500 g
Ficoll	525 g
Formaldehyde 37%	500 mL
Formamide	4 L
Gelatin	110 g
Giemsa (Azure Blue)	16 oz
Glucose (Dextrose)	5.5 kg
Glycerol	8.5 L
Glycine (free base)	2 kg
Glycine (Na salt)	500 g
Guanidine Thiocyanate	700 g
Hamposyl-Sodium Lauroyl Sarcosinate	100 mL
Hepes	600 mL
Hexadecyltrimethylammonium Bromide	100 g
Hexamine HCl	25 g
Histone II-A	100 mg
HTP-hydroxyapatite	10 g
Hydrochloric Acid 1N	500 mL
Hydrochloric Acid 38%	2.5 L
Hydrogen Peroxide	15.1 L

Appendix A (con't.)
CHEMICAL INVENTORY FOR THE HGL

Reagent	Amount
Iodine in THF/Water/Pyridine	380 mL
Isopropanol	5.5 L
Isopropyl b-D-thiogalactopyranoside	1 g
Kanamycin	5 g
L-Arginine HCL	100 g
L-Aspartic Acid	1.1 kg
L-Glutamic Acid	1.1 kg
L-Histidine	100 g
L-Isoleucine	25 g
L-Leucine	100 g
L-Lysine	100 g
L-Methionine	100 g
L-Phenylalanin	25 g
L- Threonine	100 g
L-Tryptophan	25 g
L-Tyrosine	100 g
L-Valine	100 g
Lithium Chloride	500 g
Magnesium Acetate	1 kg
Magnesium Chloride	2.5 kg
Magnesium Sulfate	1.5 kg
Magnesium Sulfate	1 kg
Maleic Acid	1 kg
Maltose	600 g
Manganous Chloride	500 g
Methanol	8 L
Mixed Alkyltrimethylammonium bromide	100 g
Mixed Red Resin	500 g
N-Lauroyilsarcosine (Na salt)	700 g
N-Methylimiddazole in THF	
N3 N Dimethylformamide	600 mL
NCS Tissue Solubilizer	500 mL
Nonidet P-40	2.1 L
Oxidizing Solution	200 mL
p-Toluene Sulfonic Acid	600 g
Peptone	6 lb
Percoll	100 mL
Phenol	4.5 kg
Phenol Red Na Salt	5 g
Phosphoric Acid	500 mL
Pipes	1 kg
Polyethylene Glycol	1.5 kg

Appendix A (con't.)
CHEMICAL INVENTORY FOR THE HGL

Reagent	Amount
Polyethylene Glycol 3500	500 g
Polyethylene Glyycol 8000	3 kg
Polyvinylpyrrolidone	700 g
Potassium Acetate	500 g
Potassium Chloride	2 kg
Potassium Hydroxide	3.5 kg
Potassium Permanganate	100 g
Potassium Phosphate, monobasic	2 kg
Potassium Phosphate, dibasic	500 g
Propidiumiodide	25 mg
Protol (White Mineral Oil)	500 mL
Resin, mixed bed	50 g
Resin, mixed bed BioRex MSZ-501	1 lb
Resin, mixed bed BioRad AG-501-X8	500 g
SDS, Sodium Dodecyl Sulfate	1.7 kg
Sephadex	50 g
Sephadex G-50	100 g
Sigma Kote SL-2	100 mL
Sigmacote	400 mL
Sodium Acetate, Anhydrous & Trihydrate	7 kg
Sodium Borate 10 hydrate	1 kg
Sodium Carbonate	2.5 kg
Sodium Chloride	23 kg
Sodium Citrate	250 g
Sodium Hydroxide	1 L
Sodium Hydroxide	3 kg
Sodium Hydroxide 1N	1 L
Sodium Lauryl Sulfate	2.5 kg
Sodium Perchlorate	250 g
Sodium Phosphate tribasic	500 g
Sodium Phosphate dibasic	4.5 kg
Sodium Phosphate monbasic	500 g
Sodium Pyrophosphate Decahydrate	25 g
Sodium Sulfate	500 g
Sodium Sulfide	500 g
Sodium Sulfite	1 kg
Sodium Thiosulfate 5-hydrate	500 g
Streptomycin Sulfate	100 g
Sucrose	6 kg
Sulfuric Acid	1 L
Synthetic Resin	500 mL
TEMED	15 mL

Appendix A (con't.)
CHEMICAL INVENTORY FOR THE HGL

Reagent	Amount
Tetramethylammonium Chloride	1 kg
Tetrazole/Acetonitrile	600 mL
Thiamine Hydrochloride	50 g
Thymine	10 g
Trichloroacetic Acid/Dichloromethane	1.5 kg
Trichloroacetic Acid/Dichloromethane	500 mL
Triethanolamine	500 g
Triethanolamine	500 mL
Triethylamine Acetate	300 mL
Trifluoroacetic Acid	450 mL
Trimethylamine	25 g
Tris Base	4 kg
Tris HCl	500 g
Triton X-100	2.8 L
Trizma Base	2 kg
Trypticase Agar Ba	500 g
Tryptone	5 lb
Tween 20	250 g
Uracil	100 g
Urea	7.25 kg
Uridine	25 g
Xylene Cyanole	115 g
Yeast Extract	5 lb
Yeast Nitrogen Base w/o Amino Acids	500 g
Yeast Nitrogen Base w/o AA & NH SO_4	500 g
Zinc Chloride	1.1 kg
ATP ^{32}P	4mCi
CTP ^{32}P	2 mCi

APPENDIX B
BIOSAFETY LEVEL 2 LABORATORY PROCEDURES

APPENDIX B

BIOSAFETY LEVEL 2
LABORATORY PROCEDURES

Biosafety Level 2 is similar to Level 1 and is suitable for work involving agents of moderate potential hazard to personnel and the environment. It differs in that (1) laboratory personnel have specific training in handling pathogenic agents and are directed by competent scientists, (2) access to the laboratory is limited when work is being conducted, (3) extreme precautions are taken with contaminated sharp items, and (4) certain procedures in which infectious aerosols or splashes may be created are conducted in biological safety cabinets or other physical containment equipment.

The following standard and special practices, safety equipment, and facilities apply to agents assigned to Biosafety Level 2:

A. Standard Microbiological Practices

1. Access to the laboratory is limited or restricted at the discretion of the laboratory director when experiments are in progress.

2. Persons wash their hands after they handle viable materials and animals, after removing gloves, and before leaving the laboratory.

3. Eating, drinking, smoking, handling contact lenses, and applying cosmetics are not permitted in the work areas. Persons who wear contact lenses in laboratories should also wear goggles or a face shield. Food is stored outside the work area in cabinets or refrigerators designated for this purpose only.

4. Mouth pipetting is prohibited; mechanical pipetting devices are used.

5. All procedures are performed carefully to minimize the creation of splashes or aerosols.

6. Work surfaces are decontaminated at least once a day and after any spill of viable material.

7. All cultures, stocks, and other regulated wastes are decontaminated before disposal by an approved decontamination method, such as autoclaving. Materials to be decontaminated outside of the immediate laboratory are to be placed in a durable, leakproof container and closed for transport from the laboratory. Materials to be decontaminated off-site from the laboratory are packaged in accordance with applicable local, state, and federal regulations, before removal from the facility.

8. An insect and rodent control program is in effect.

B. Special Practices

1. Access to the laboratory is limited or restricted by the laboratory director when work with infectious agents is in progress. In general, persons who are at increased risk of acquiring infection or for whom infection may be unusually hazardous are not allowed in the laboratory or animal rooms. For example, persons who are immunocompromised or immunosuppressed may be at risk of acquiring infections. The laboratory director has the final responsibility for assessing each circumstance and determining who may enter or work in the laboratory.

2. The laboratory director establishes policies and procedures whereby only persons who have been advised of the potential hazard and meet specific entry requirements (e.g., immunization) enter the laboratory or animal rooms.

3. When the infectious agent(s) in use in the laboratory require special provisions for entry (e.g., immunization), a hazard warning sign incorporating the universal biohazards symbol is posted on the access door to the laboratory work area. The hazard warning sign identifies the infectious agent, lists the name and telephone number of the laboratory director or other responsible person(s), and indicates the special requirement(s) for entering the laboratory.

4. Laboratory personnel receive appropriate immunizations or tests for the agents handled or potentially present in the laboratory (e.g., hepatitis B vaccine or TB skin testing).

5. When appropriate, considering the agent(s) handled, baseline serum samples for laboratory and other at-risk personnel are collected and stored. Additional serum specimens may be collected periodically, depending on the agents handled or the function of the facility.

6. A biosafety manual is prepared or adopted. Personnel are advised of special hazards and are required to read and to follow instructions on practices and procedures.

7. Laboratory personnel receive appropriate training on the potential hazards associated with the work involved, the necessary precautions to prevent exposures, and the exposure evaluation procedures. Personnel receive annual updates, or additional training as necessary for procedural or policy changes.

8. A high degree of precaution must always be taken with any contaminated sharp items, including needles and syringes, slides, pipettes, capillary tubes, and scalpels. Needles and syringes or other sharp instruments should be restricted in the laboratory for use only when there is no alternative, such as parenteral injection, phlebotomy, or aspiration of fluids from laboratory animals and diaphragm bottles. Plasticware should be substituted for glassware whenever possible.

   a. Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) are used for injection or aspiration of infectious materials. Used disposable needles must not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal; rather, they must be carefully placed in conveniently located puncture-resistant containers used for sharps disposal. Non-disposable sharps must be placed in hard-walled container for transport to a processing area for decontamination, preferably by autoclaving.

b. Syringes which re-sheathe the needle, needle-less systems, and other safe devices should be used when appropriate.

c. Broken glassware must not be handled directly by hand, but must be removed be mechanical means such as a brush and dustpan, tongs, or forceps. Containers of contaminated needles, sharp equipment, and broken glass are decontaminated before disposal, according to any local, state, or federal regulations.

9. Cultures, tissues, or specimens of body fluids are placed in a container that prevents leakage during collection, handling, processing, storage, transport, or shipping.

10. Laboratory equipment and work surfaces should be decontaminated with an appropriate disinfectant on a routine basis, after work with infectious materials is finished, and especially after overt spills, splashes, or other contamination by infectious materials. Contaminated equipment must be decontaminated according to any local, state, or federal regulations before it is sent for repair or maintenance or packaged for transport in accordance with applicable local, state, or federal regulations, before removal from the facility.

11. Spills and accidents which result in overt exposures to infectious materials are immediately reported to the laboratory director. Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained.

12. Animals not involved in the work being performed are not permitted in the lab.

C. Safety Equipment (Primary Barriers)

1. Properly maintained biological safety cabinets, preferable Class II, or other appropriate personal protective equipment or physical containment devices are used whenever:

a. Procedures with a potential for creating infectious aerosols or splashes are conducted. These may include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of infectious materials whose internal pressures may be different from ambient pressures, inoculating animals intranasally, and harvesting infected tissues from animals or eggs.

b. High concentrations or large volumes of infectious agents are used. Such materials may be centrifuged in the open laboratory if sealed rotor heads or centrifuge safety cups are used, and if these rotors or safety cups are opened only in a biological safety cabinet (BSC).

2. Face protection (goggles, mask, faceshield or other splatter guards) is used for anticipated splashes or sprays of infectious or other hazardous materials to the face, when the microorganisms must be manipulated outside the BSC.

3. Protective laboratory coats, gowns, smocks, or uniforms designated for lab use are worn while in the laboratory. This protective clothing is removed and left in the laboratory before leaving for non-laboratory areas (e.g., cafeteria, library, administrative offices). All protective clothing is either disposed of in the laboratory or laundered by the institution; it should never be taken home by personnel.

4. Gloves are worn when handling infected animals and when hands may contact infectious materials, contaminated surfaces, or equipment. Wearing two pairs of gloves may be appropriate; if a spill or splatter occurs, the hand will be protected after the contaminated glove is removed. Gloves are disposed of when contaminated, removed when work with infectious materials is completed, and are not worn outside the laboratory. Disposable gloves are not washed or reused.

D. Laboratory Facilities (Secondary Barriers)

1. Each laboratory contains a sink for hand washing.

2. The laboratory is designed so that it can be easily cleaned. Rugs in laboratories are not appropriate, and should not be used because proper decontamination following a spill is extremely difficult to achieve.

3. Bench tops are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.

4. Laboratory furniture is sturdy, and spaces between benches, cabinets, and equipment are accessible for cleaning.

5. If the laboratory has windows that open, they are fitted with fly screens.

6. A method for decontamination of infectious or regulated laboratory wastes is available (e.g., autoclave, chemical disinfection, incinerator, or other approved decontamination system).

7. An eyewash facility is readily available.