# TABLE OF CONTENTS

## 4. Sustainable Design



## 5. Structural Engineering



## 6. Mechanical Engineering - HVAC Systems

# 1 CONVENTIONAL FACILITIES OVERVIEW

## 1.1 Introduction

The NSLS-II conventional facilities will provide the structures and systems necessary to enable installation and operation of the accelerator and experimental beamlines. The conventional facilities must be designed and constructed to enable the world-leading performance objectives of the project mission. Furthermore, the conventional facilities must be constructed on an aggressive schedule that enables installation of the accelerator systems and experimental beamlines in accordance with the project schedule goals. Lastly, the conventional facilities must meet the functional and aesthetic goals of creating an economically vibrant research facility that achieves technical excellence and is adaptable to the varied and changing requirements of the user community. This report describes the scope and design considerations for the NSLS-II conventional facilities.

## 1.2 Project Goals

The goals of the conventional facilities portion of the project support the overall goals of the NSLS-II project. These goals provide the guiding principals for preliminary design of the conventional facilities.

- World-class scientific capability
- Promote collaborative interaction
- Flexible building capability
- Economic construction and operation
- Sustainable design
- Phase construction to allow earliest start of accelerator installation

## 1.3 Project Description

The NSLS-II conventional facilities will be designed to provide the buildings, services and utility infrastructure needed to support the technical scope of the project and the mission of a high technology user facility. The selected site is at the southeast corner of the present intersection of Brookhaven Avenue and Groves Street. The facility will be proximate to the existing NSLS Building and the recently constructed Center for Functional Nanomaterials, (CFN) as indicated on the site plan, Figure 1.1.

The conventional facilities will consist of a Ring Building to house the accelerator and associated beamlines, an Injection Building for the compact booster, and linac, a two story Operations Center for the control room function, three Lab Office Buildings (LOB’s) for beamline staff and the beamline user community, an RF Building, and five two story Service Buildings containing mechanical and electrical equipment. Additionally, the overall building complex is being planned to include two additional future Lab Office Buildings, the Joint Photon Science Institute (JPSI) Building and possible locations for future scientific buildings. An alternate for a third floor to the Operations Center is also being considered to provide office space for NSLS-II management and accelerator scientists. These additional buildings are considered alternate or future construction and are not included in the Program or Cost of the NSLS-II project.

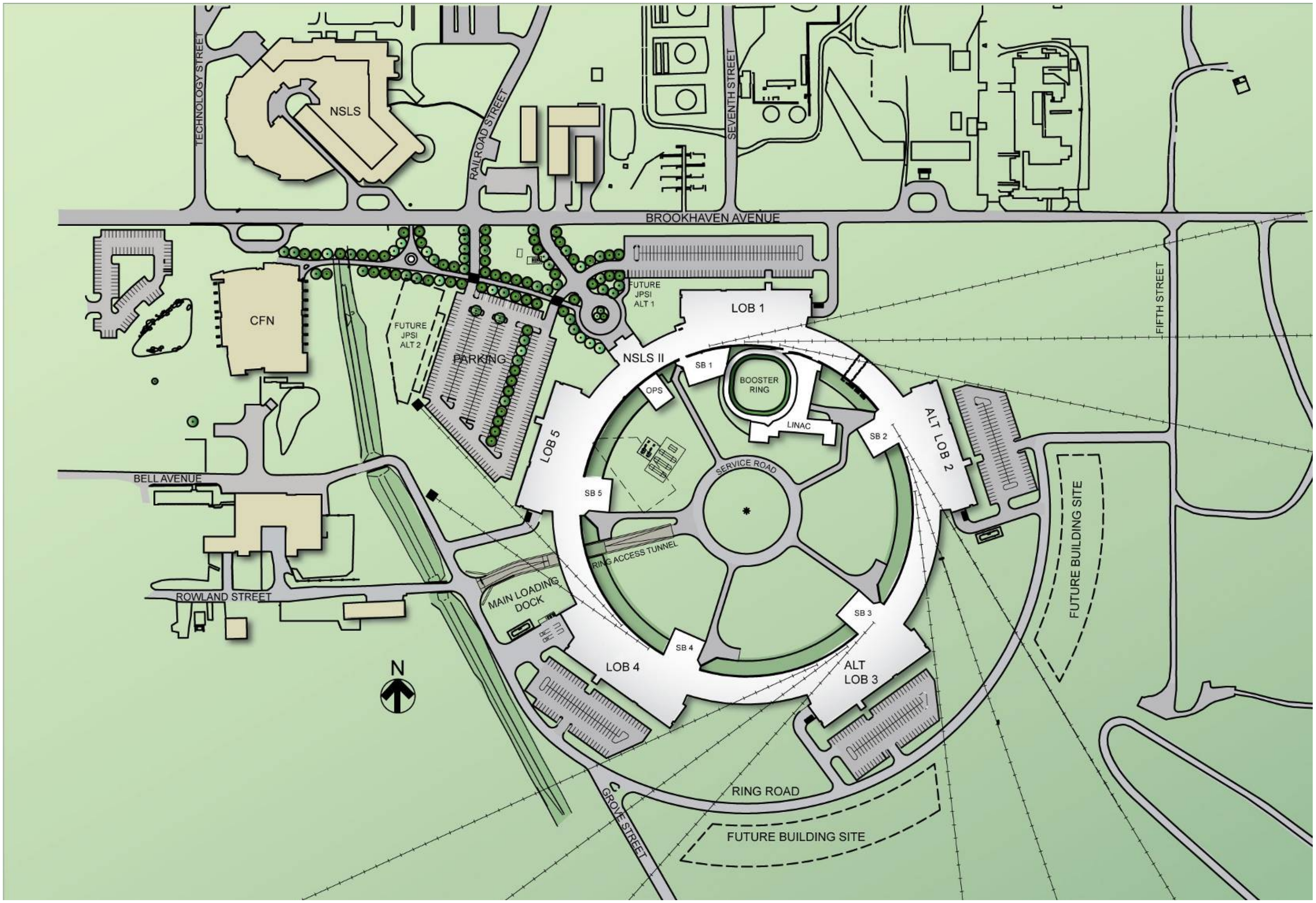


**Figure 1.1** NSLS-II Site Plan.

An architectural rendering of NSLS-II, shown in Figure 1.2, indicates the preliminary design architectural theme for the facility. Figure 1.3 indicates the floor plan and functional relationships of the built-out NSLS-II complex. The approximate gross area for each of these buildings is shown in Table 1.1. The building program is discussed more fully in the Architectural Section of this report.

**Table 1.1 NSLS-II Area.**

| Building Component | Net Area (ft$^2$) | Gross Area (ft$^2$) |
|---|---|---|
| Operations Center | 9,232 | 11,600 |
| Injection Building | 17,693 | 24,440 |
| RF Building | 10,182 | 10,630 |
| Ring Building | 219,888 | 240,075 |
| Service buildings (5) | 48,130 | 53,640 |
| Lab Office Buildings (3) | 50,358 | 71,536 |
| Total NSLS-II | 355,483 | 411,921 |

**Figure 1.2** Architectural rendering of NSLS-II.

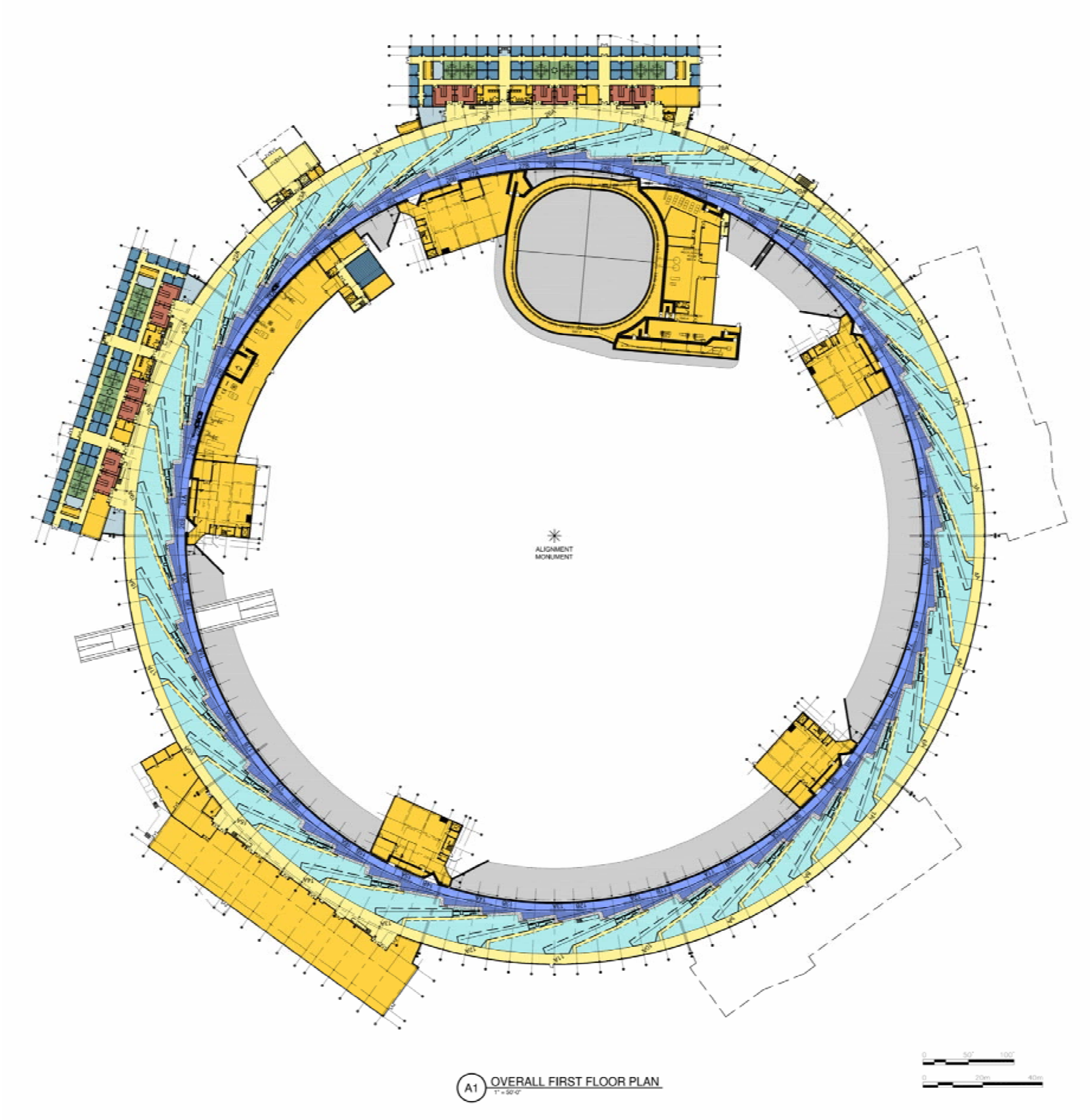


**Figure 1.3** NSLS-II Complex Layout – First Floor Plan.

## 1.4 The Design Process

The NSLS-II site, located at the present intersection of Brookhaven Avenue and Groves Street is at the eastern boundary of the Science and Technology zone in the BNL Master Plan. It is the last parcel in the Brookhaven Avenue corridor development plan. The site is well suited to construction of NSLS-II given its close proximity to the existing NSLS and CFN buildings and has many advantages in terms of constructability including a relatively level and mostly clear site, good geologic conditions, good access to utilities and low background vibration levels.. The NSLS-II site plan comprises the following: NSLS-II Ring Building Complex - the heart of the project where scientific experiments are conducted, the loop road circling around the building, allowing access to Lab Office Buildings and connected to a vehicle tunnel for emergency and maintenance vehicle access to the inner Ring road area, and the service drive inside the ring for vehicle access to the Operations Center, Injection Building, Service Buildings and storage ring tunnel. For planning purposes, additional elements which are not part of this project, are indicated on the site plan. These include the proposed Joint Photon Science Institute and possible future scientific buildings.

The current site design supports the need for reasonable proximity to the existing NSLS and the CFN. The existing NSLS will continue to provide office and technical support space for NSLS-II staff, thus the NSLS-II footprint has been moved as far West and North (close to NSLS) to minimize travel distance for these staff. This siting also supports anticipated collaborative interaction of the CFN with NSLS-II. The proposed landscaped walkways link all building main entrances and outdoor interaction spaces encouraging exchange of ideas among scientists. In addition Groves Street is discontinued from Bell Avenue to Brookhaven Avenue to discourage through traffic near the NSLS-II building. There will be a formal drop-off, circle drive in front of the NSLS-II main entrance lobby at the Operations Center Building which would be highly visible from the main entrances to the CFN and existing NSLS buildings.

Another important issue in development of the NSLS-II site plan was to maximize opportunities for installation of extra-long beamlines that would extend beyond the Ring Building walls and into the surrounding landscape. The NSLS-II orientation on the site, as well as the location of each LOB is influenced by the best possible location for these future extra long beamlines. Due to existing site topography and site access issues, the most preferable locations for the longest beamlines (up to several hundred meters) are in the easterly direction between LOBs 1 and 2, and southeast between LOBs 2 and 3. Opportunities for extra long beamlines of 100 – 200 meters are also available between LOBs 3 and 4 and between LOBs 4 and 5.

## 1.5 Work Breakdown Structure

The work breakdown structure for the NSLS-II conventional facilities is shown in Figure 1.4.


**Figure 1.4** NSLS-II Conventional Facilities Work Breakdown Structure.

## 1.6 Method of Accomplishment

### 1.6.1 Design

Title I and Title II design of the NSLS-II conventional facilities will be performed by an A/E firm under contract to BNL. HDR Architecture has been competitively selected to provide design services for the NSLS-II main buildings and facilities. Title I and II design of the expansion of the Central Chilled Water Facility will be performed by Giffels Engineers. Each firm will also optionally provide Title III support services for shop drawing review, field verification and engineering support during construction.

Additional engineering support will be provided by BNL Plant Engineering Division to assure that new utility services and systems provided by NSLS-II are compatible with existing BNL utility systems and are properly interconnected.

The conventional facilities design team led by HDR includes the following firms:

- HDR Architecture, Inc.
- GEI Consultants, Inc.
- Colin Gordon Associates, Inc.
- VitaTech Engineering, LLC
- VJ Associates
- EMO Energy Solutions, LLC
- Municipal Land Survey, P.C.

### 1.6.2 Construction Management

Construction management of NSLS-II conventional facilities will be performed by the NSLS-II conventional facilities team with staff augmentation support services from a competitively procured construction management firm. The joint venture of Liro/Gilbane has been selected to provide design phase construction management services. Procurement of construction phase construction management services will be via a competitive “best value” process awarded prior to award of the main construction contracts.

### 1.6.3 Procurement & Contracting Plan

Conventional construction will involve construction of the NSLS-II complex of buildings and improvements to land and utilities including expansion of the existing Central Chilled Water Facility. These will be procured generally as lump-sum competitively procured contracts to general contractors. It is anticipated that there will be one major contract for the complex of buildings to be constructed on the NSLS-II site and a series of smaller construction packages for specialized work scope that has clearly defined interface points with the main construction contract. The anticipated construction packages are:

1. Site Preparation - Certain aspects of the site preparation work will be contracted as an early package to clear and prepare the site, reduce risk of unforeseen underground conditions and reduce overall schedule duration of the main contract.
2. Ring Building Complex -The main Ring Building contract will encompass site development and construction of all the NSLS-II buildings and on-site utilities and systems.
3. Central Chilled Water - The Chilled water contract will expand the Central Chilled Water Facility to provide cooling capacity to NSLS-II. This will be jointly funded by BNL and NSLS-II

4. Electrical Substation – The electrical substation contract will expand the main site electrical substation to provide electrical power to NSLS-II

Additional smaller packages may be issued as advantageous to the project. The contractors will be selected based on a competitive evaluated bid whereby the award is given to the firm meeting all technical, management, financial, past performance record, and safety qualifications for the project at the best value.

### 1.6.4 Construction Schedule

The construction schedule for conventional facilities is fully integrated with the overall resource loaded schedule for the NSLS-II project. Design and construction of conventional facilities is essentially the critical path for the project until such time as beneficial occupancy of the buildings can be accepted and installation of the accelerator systems can begin. In order to enable earliest start of accelerator systems installation, the Ring building construction will be broken into phases enabling earliest completion of pentants (or 1/5 of the Ring Building circumference) and each pentant will be accepted as early as possible. Scheduling of installation of various utility systems has been coordinated to support this phasing.

### 1.6.5 Construction Safety

Maintaining a safe work environment and the prevention of worker injury is paramount to the success of conventional facility construction. Specific construction safety measures are detailed in the Final Hazards Analysis and the ESH section of the project Preliminary Design Report. Among the measures that will be taken to assure worker safety are:

1. Selection of contractors based on a proven record of safety performance
2. Designation of dedicated full time safety oversight staff as part of the NSLS-II team, the construction manager and each contractor
3. Development and implementation of a robust and effective construction safety plan governing all work on the project that utilizes integrated safety management principles
4. Line management responsibility for safety and active oversight and intervention as needed
5. Use of construction safety incentives to motivate outstanding safety performance

### 1.6.6 Quality Assurance

The project will be conducted in accordance with BNL’s site-wide Quality Assurance Program (QAP) that applies to all work conducted at BNL. The BNL QAP conforms to the requirements of Department of Energy (DOE) Order 414.1, Quality Assurance, and 10CFR 830 Subpart A, Quality Assurance Requirements. BNL’s QAP consists of the following ten criteria:

- Program
- Personnel Training and Qualification
- Quality Improvement
- Documents and Records
- Work Processes
- Design
- Procurement
- Inspection and Acceptance Testing
- Management Assessment
- Independent Assessment

BNL's approach to satisfying the requirements of these criteria are delineated in the BNL Quality Assurance Program Description within the BNL Standards-Based Management System (SBMS). The NSLS-II design, construction and operation are subject to the QAP. A key element of the QAP is the concept of "Graded Approach", that is, applying an appropriate level of analysis, controls, and documentation commensurate with the potential to have an environmental, safety, health, radiological, or quality impact.

The NSLS-II QAP has been developed and addresses both the conventional and technical aspects of the project. This plan addresses project activities from design through construction, as well as commissioning and startup. The sections of the NSLS-II QAP applicable to conventional facilities address the basic design and construction of the building and utilities systems executed by the NSLS-II Conventional Facilities Division. Requirements of the NSLS-II QAP will flow down to contractors performing design and construction of conventional facilities.

### 1.6.7 Value Management

Value Management (VM) will be performed for this project as required under DOE Order 413.3A, "Program and Project Management for the Acquisition of Capital Assets." An independent value management team will perform VM review during Title I design. A VM report will be provided to the NSLS-II Project Director for consideration and, where feasible, incorporation into project design documents.

The VM review will be a systematic review of the mature Title I design performed by an independent team of qualified consultants. The team will comprehensively review design elements and material selections with regard to their needed level of performance and quality. Alternate methods, elements and selections that meet the necessary performance and quality will be considered. The comparative first cost and life cycle cost of these alternatives will be determined and compared to the original design. A VM report will be prepared indicating alternatives considered, their respective costs and recommendations as to which alternatives should be implemented in the project design.

A Value Engineering Workshop was conducted with Liro/Gilbane and independent VE specialist hired by BNL on Wednesday and Thursday October 3rd and 4th, 2007. The results of this workshop are not finalized as of this writing but several VE items have been incorporated into the 100% Title 1 submission. They have been incorporated in one of two ways.

- The drawings and other documents were changed to incorporate the VE item.
- A note was added to the documents that addresses the VE item with the understanding that further design and/or investigation needs to be done to fully incorporate the VE item.

### 1.6.8 Commissioning

An important element in the ultimate success of the NSLS-II will be proper commissioning of the facilities systems and instruments. The sensitivity of the storage ring and research beamlines requires that all systems and instruments achieve their maximum performance capability to fulfill the research mission. Additionally, any systems or equipment that can create environmental disturbance must be properly calibrated, balanced, tuned, or shielded to prevent detrimental impact to the research. During the design phase, a preliminary facility commissioning plan will be prepared to assure that appropriate commissioning requirements have been included in the NSLS-II design. The commissioning plan will:

- Present a schedule and sequence for start-up of building systems and instruments, including dependencies linked to the conventional or technical construction schedule.
- Identify safety approvals required prior to start-up
- Identify systems and instruments at the equipment level that will require commissioning.
- Identify references and sources of start-up procedures and performance, test and acceptance criteria for the instruments and equipment.

- Identify whether the equipment will be commissioned by BNL staff, contractor staff, vendor staff, or if the services of a specialty commissioning contractor are warranted.
- Identify the point at which equipment has been accepted and can be turned over to operations staff.
- Be updated during the design and construction phases as appropriate to reflect changes in equipment selection and performance.

# 2 SITE / CIVIL

## 2.1 Design Criteria

### 2.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

### 2.1.2 DOE Orders

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities

### 2.1.3 Codes, Standards, and Guides

10CFR851 Worker Safety and Health Program
Building Code of New York State (NYSBC) – 2002 Edition
American Concrete Institute
Building Code Requirements for Structural Concrete (ACI 318-99)
BNL Standards Based Management System Subject Areas
New York State and Suffolk County Department of Health Codes
American National Standards Institute
ANSI 117.1 Accessible and Useable Buildings and Facilities
American Society for Testing Materials Standards
National Institute of Standards and Technology
Occupational Safety and Health Administration (OSHA)
New York State Fire Prevention Code - 2002 Edition
ACGIH Standards
Americans with Disabilities Act Accessibility Guideline (ADAAG)
Leadership in Energy and Environmental Design (LEED) 2.2
LEED for Labs

## 2.2 Site Description

The location for the proposed NSLS-II site is based upon several criteria and includes the ability to comply with environmental requirements; the ability to meet research mission objectives; the physical proximity to collaborative BNL research facilities in the new Center for Functional Nanomaterials (CFN) and the existing NSLS, constructability factors related to site conditions; economic factors affecting project cost; conformance with BNL strategic planning goals and the ability to support future expansion and long beam lines. The site selected for construction of the NSLS-II meets all of the criteria indicated above. The site design also responds to these criteria. The NSLS-II site plan is shown in Figure 2.1.

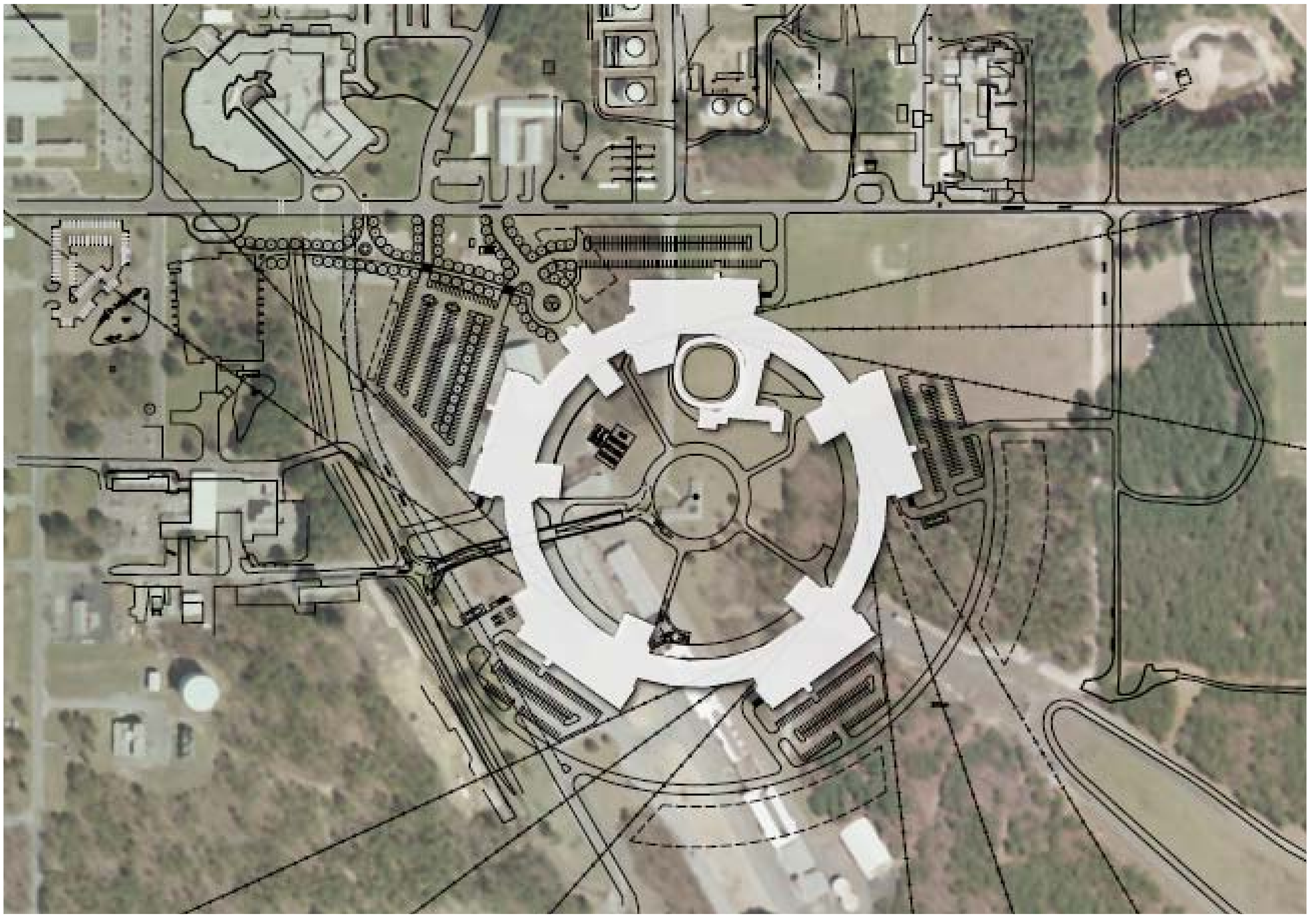

**Figure 2.1** NSLS-II Site Plan.

## 2.3 Campus Planning

The site is approximately 50 acres located at the southeast corner of the intersection of Brookhaven Avenue and Groves Street on the BNL campus. Master planning envisions Brookhaven Avenue becoming the primary east–west arterial street through the BNL campus. Land adjacent to Brookhaven Avenue is considered desirable for current and future building projects at BNL, including NSLS-II. The architectural vocabulary along this axis is transforming in character from traditional masonry aesthetics to the west to an advanced technology image to the east.

Located at this strategic location along Brookhaven Avenue and together with the CFN, NSLS-II will form a significant “sciences” focal point, and further emphasize BNL’s commitment to newer facilities that promote leading-edge discoveries.

Locating NSLS-II here allows for future extended beamlines of up to 1000 m in length. These may eventually project eastward along Brookhaven Avenue, or have a disposition that is to the southeast or the south. The site accommodates many future options for BNL.

The adjacencies that NSLS-II will leverage at this site are highly advantageous. The existing NSLS building located diagonally across Brookhaven Avenue to the northwest, will promote ease of interaction between that building and NSLS-II. This is particularly important since many of the NSLS-II staff will office in the existing NSLS building. This location will also simplify the relocation of equipment and staff between the two facilities. Additionally, the site is situated directly adjacent to the CFN (across Groves Street to the west). This adjacency will provide for unparalleled opportunities of collaborative research between two of the nation's premier science facilities.  Locations for the potential Joint Photon Source Institute (JPSI) building have also been proposed, one near the Operations Center another in the northwest corner of the site or possibly across Brookhaven Avenue just east of the existing NSLS. This building would be a separate structure, physically disconnected from NSLS-II, but with a public space landscaped with pedestrian walkways in between the two buildings.  Space for possible future scientific buildings are also shown on the site plan immediately outside of the Loop Road.

## 2.4 Access, Traffic, Parking

The site is bounded by Brookhaven Avenue on the north, Groves Street on the west and Fifth Street on the east. This configuration will provide easy access to all parts of the facility. The main entrance of the Operations Center Building will face the present intersection of Brookhaven Avenue and Groves Street. (Following construction of the NSLS-II Groves Street will no longer extend all the way to Brookhaven Avenue, but rather terminate at Bell Avenue.) This northwest orientation of the main entrance of the Operations Center Building achieves the objective of minimizing the walking distances to the existing NSLS. Traffic into the primary NSLS-II parking lot will be from Brookhaven Avenue, and a drop-off, circle drive will be provided at the main entrance of the Operations Center Building. Groves Street will be discontinued between Bell and Brookhaven Avenues, but will be connected to the NSLS-II Loop Road that will be constructed around most of the outer perimeter of the building site. NSLS-II will also have access points from Bell Avenue and Rowland Street. The Loop Road will serve most of the Lab Office Buildings and also provide for service road access around the site.

Parking immediately west of the Operations Center Building and LOB-5 will serve the NSLS-II, and possibly  the future JPSI building.  All parking will be situated an appropriate distance away from the new structures to accommodate potential security measures/guidelines.

Each of the Lab Office Buildings will have an entrance serving the occupants of that building. Approximately 100 parking spaces will be provided at each LOB within convenient walking distance. Bicycle racks will be provided near each building entrance.  Fire Department access will be provided to each LOB, but said access will remain a minimum of 40 feet away from the structure (establishing a "stay clear zone").

Service vehicles will access the "center" of NSLS-II via a tunnel under the Ring Building. The tunnel will allow emergency vehicles as well as delivery of large equipment to enter this "center". It will be required to comply with NYDOT requirements, and will be at least 19 ft wide (with a minimum 14'-2" clearance as it travels under the Ring Building). The ramps in and out will have a slope not to exceed 8 percent grade.

Pedestrian traffic will be accommodated by careful placement of sidewalks between the existing NSLS, the CFN, and NSLS-II.

## 2.5 Vibration Survey

Pre-design vibration surveys of the building site were conducted by Colin Gordon Associates and additional site baseline vibration measurements and analysis have been performed by BNL staff. The purpose of the surveys were to evaluate the ability of the proposed NSLS-II to meet stated vibration criteria. The data and analysis indicate the site existing background or cultural vibration levels are low and that there are  no particular vibration characteristics that would adversely affect the performance of the NSLS-II scientific equipment. Results indicate  the site is  quiet  "vibrationally" and capable of meeting the proposed vibration and stability criteria. A minimum 100 foot building setback along both Brookhaven Avenue and Groves Street will be maintained from the Experimental Floor to minimize the potential negative vibration impacts of passing traffic on these roads. Specific vibration criteria for NSLS-II are described elsewhere in this document (Section 3 – Architecture) . Additional analysis and independent technical review by the Stability Task Force have also been performed and are available for review.

### 2.5.1 Experimental Hall

Data were collected in mid-afternoon at six locations at the NSLS-II site and processed to obtain one-third octave band velocity spectra. Results indicate the site will easily meet all vibration criteria for VC-E, but will not meet NIST-A criteria below a frequency of 5 Hz. It is believed that the low-frequency component which exceeds NIST-A is due to nearby traffic, probably on the Long Island Expressway and the William Floyd Parkway.

It is anticipated that the heavy floor slab of NSLS-II will reduce the amplitude at most frequencies, yielding a more favorable comparison to the criteria. Additional data was therefore taken on the floor slab of the nearby CFN (partially complete at the time) in the late evening hours. The analysis indicated that the slabs of the CFN will meet NIST-A criteria during the nighttime hours. These data are thought to be representative of the eventual nighttime performance of the Experimental Hall in NSLS-II.

### 2.5.2 Accelerator Tunnel

To evaluate the Accelerator Tunnel, survey data were transformed to displacement Power Spectral Density (PSD) spectra. This is the desired format for storage ring vibration criteria. When calculated over the range of 4 to 50 Hz, the calculated R values do not meet the stated criteria of R less than 25 nm. However, it was noted that the data below 6 or 7 Hz was contaminated by system noise due to an instrument cable. If the criteria are modified slightly to calculate R from 6 to 50 Hz or from 8 to 50 Hz, thereby eliminating the questionable data, the R values will generally meet the stated criteria of less than 25 nm.

Supplemental data collected in the CFN microscopy lab again validates the hypothesis that the heavy building slab will make a significant difference in the vibration data. Measurements taken at 7:30 pm and at 11:40 pm both yielded results that met the RMS amplitude criteria for NSLS-II of 25 nm. Again, it is anticipated that the improvement in vibration results due to the floor slabs at CFN will translate to improvements in the NSLS-II data.

Overall, the vibration study indicates that following the installation of the floor slab for the Accelerator Tunnel and the Experimental Hall, which will significantly stiffen the site, the vibration environment will be comparable to that of other leading light source facilities around the world.

Numerical models were constructed which allow examination of such design issues as placement of the Support Building with respect to the Ring, and even the placement of equipment within the Support Building. These models were calibrated using known and measurable performance of source data at several other facilities, including APS, RHIC, CFN and SPring8.

One of the key studies involved a comparison of placing the Support Building inside the ring versus outside of it. The preliminary results at this time suggest that placement inside the ring would lead to lower vertical ring displacement, and that if the mechanical systems were placed on a structurally supported floor (rather than a slab on grade) there would be further benefit, providing placement within the building were considered. The differences are quite dramatic, as indicated below:

**Table 2.1 Service Building Vibration Comparison**

| Service Building Location | Floor Type | Equipment Location | Vertical Ring Displacement |
|---|---|---|---|
| Outside | Slab-on-grade | Middle | 16.0 nm |
| Inside | Structurally Supported | Inner area | 15.0 nm |
| | | Middle area | 2.6 nm |
| | | Outer area | 8.8 nm |

Modeling studies will continue, refining issues that have already been addressed in a preliminary way and examining additional variables.

On parameter which will be considered will be the use of polymer-modified concrete to mitigate cultural and mechanical vibrations that might be transmitted through the slab. This was employed in the CFN, and measurements there indicate that vibration attenuation with distance can be doubled by the use of a 6” topping poured over an 8” structural slab, where the topping is treated with a particular polymer admixture and fiber reinforcement.

## 2.6 EMI/RFI Survey

Pre-design electromagnetic interference surveys were conducted on June 14th and September 19th, 2006 by VitaTech Engineering, LLC. Several types of measurements were taken to characterize the site:

- AC Extremely Low Frequency Electromagnetic Interference (ELF EMI)
- DC Electromagnetic Interference
- Radiofrequency Interference (RFI)

The site demonstrated no ambient electromagnetic or radio frequency interference that would adversely affect the performance of NSLS-II scientific equipment. The nearby NWS Doppler radar facility does not appear to have a problematic effect with respect to RFI.

The site is generally undeveloped and therefore should be relatively free of large electromagnetic fields above the ambient background. Buried electrical power feeders running east-west along Brookhaven Avenue and north-south along Seventh Street are sources of EMI that need to be considered. A 100 foot building setback along Brookhaven Avenue will allow fields to largely decay without impacting the building’s performance. The feeder along Seventh Street will be relocated away from the NSLS-II building footprint and will not impact the facility.

### 2.6.1 AC ELF Electromagnetic Interference

AC ELF EMI fields are substantial along Brookhaven Avenue due to the existing underground electrical feeders, ranging up to 3.36 mG. These flux densities drop off rapidly to the south, reaching approximately 0.1 mG at the 100 foot building setback line, and dropping further to essentially zero beyond that point. Likewise, flux densities peak at approximately 0.4 mG above the buried electrical power lines at Seventh Street, but drop off very rapidly to the east. As a point of reference, flux densities of up to 0.3 mG are acceptable for high-accuracy instruments such as TEMs, SEMs, and E-beam writers, which will be used in the CFN. There are currently no instruments planned for NSLS-II that will have these sensitivities.

### 2.6.2 DC Electromagnetic Interference

DC Electromagnetic Interference is caused by ferromagnetic masses in motion, typically objects such as elevators, trains, cars, buses, etc. There is potential for DC EMI due to regular traffic along Brookhaven Avenue to the north, as well as along Fifth Avenue to the east. Analysis by VitaTech indicates that between 40 to 130 feet south of Brookhaven Avenue the DC fields will be such that instrumentation with dB/dt differential DC EMI and resultant RMS thresholds between 1 mG and 0.1 mG will meet the specifications. Between 130 to 200 feet, instruments with a threshold of 0.1 mG to 0.01 mG will meet the specifications (197 feet is the predicted 0.01 mG isoline). Similar separation distances will apply to north–south traffic along Fifth Street.

### 2.6.3 Radiofrequency Interference

The RFI site measurements indicated very low electric field strength across a range of frequencies from 100 kHz to 18 GHz. The NEXRAD Doppler weather radar that is located only 2,200 ft away operates at a frequency of 2877 MHz. The existing NSLS building has experienced RFI impacts from the NEXRAD radar, causing the need for RF shielding around select laboratory and research areas to reduce the problem. A similar remediation approach will be used at NSLS-II (if needed); shielding will be provided specifically at the hutches based on scientific requirements (rather than providing general shielding for the entire building).

Electric field strength RF levels were recorded on September 19, 2006 by VitaTech Engineering at a point approximately in the center of the NSLS-II site. Data over a broad spectrum of frequencies indicated elevated RF levels at a number of frequencies (from various sources, including the NEXRAD radar). In all cases, the electric field strength RF levels were below 1V/m, which is the typical threshold for scientific instrumentation.

## 2.7 Geotechnical Survey

A geotechnical survey of the preferred site was conducted in July of 2006 and additional subsurface explorations were performed in April 2007. The explorations included 15 cone penetrometer test (CPT) soundings and ten test borings. The results indicate that the site conditions are generally uniform with 2 to 12 inches of topsoil and 2 to 9 feet of existing fill lays over medium dense to very dense sands near the proposed buildings and roadways. The sand deposits will work well for spread footings and may be suitable for reuse as compacted structural fill. The existing fill material is generally suitable for use as common fill around the site outside the building footprint.

With regard to column and wall settlement it is estimated that total settlement of spread footings will be less than 1 inch, and differential settlements will be less than 0.75 inch. This settlement will occur as loads are applied and therefore these settlements will be essentially complete by the time construction is finished. This settlement is acceptable for column and wall footings and will not effect the technical systems.

The floor slab within the experimental hall will support highly sensitive scientific equipment, and settlement of the floor slab after the equipment has been installed and calibrated must be minimized. Soils beneath the floor slab will settle in response to dead and live loads. It is anticipated that settlement will be complete within about one to two weeks after load application. Settlement resulting from floor slab dead loads and fill required beneath the floor slab is expected to occur during construction, and therefore will not contribute to post-construction settlement. However, application of substantial localized live load could cause minor post-construction settlement. We calculate the total and differential post-construction settlement from the live load to be less than 0.25 inch. Differential settlement will be less than the total settlement. For sensitive equipment where heavy beamline equipment loads are applied, it may be desirable to allow a two to three week waiting period between installation and final calibration.

Soils at the site are classified as Site Class D, “Stiff Soil Profile” in accordance with the New York State Building Code. The soil is not susceptible to liquefaction. The geotechnical report is included in the Appendix for reference.

A final set of borings will be performed prior to detailed design to fully detail the geotechnical conditions of the full building footprint in its final location. These borings in concert with other engineering factors will form the basis of the final finished floor elevation which will be optimized for building stability, cut and fill quantities and existing utility elevations.

## 2.8 Topographic Survey

A preliminary topographic survey was conducted in June of 2006. That survey indicated the site to be relatively flat and well-suited for the NSLS-II.  A more detailed topographic survey specifically for the NSLS-II site was conducted in September 2007. Site elevations appear to vary from 10 feet above the proposed Experimental Floor elevation, to 6 feet below said elevation; however, most of the site appears to be near the proposed floor elevation. Level grades may minimize the requirement for substantial cut and fill operations, and may work to accommodate potential future long beamlines extending up to 1000 m onto adjacent ground.

## 2.9 Existing Site Utilities

Existing site utilities consist of electrical power, chilled water, steam, potable water, sanitary sewers, storm drainage, and dry compressed air lines. Electrical power is wheeled to the site at 69 kV by the local electrical utility company (LIPA). This tie line has sufficient capacity for NSLS-II loads. The other site utilities are generated at BNL's central utility plants and distributed underground for use throughout the BNL campus. The distribution systems for these site utilities are of sufficient capacity to serve the NSLS-II; however, additional generating capacity will be required for chilled water and cooling tower water. Additional chiller capacity and cooling tower capacity will be added at the existing central utility plant. A separate cooling tower system for process water cooling will be located near NSLS-II.

The most significant impact NSLS-II will have on the current BNL utility infrastructure is the central chilled water system which is currently at the maximum without spare capacity to meet additional loads for the NSLS-II. As part of this project, additional chilled water capacity will be added to the existing central chilled water plant. Expanding the central chilled water plant (in lieu of constructing dedicated local capacity) provides advantages in reliability and reduced costs to the project .

Existing sanitary sewers are located parallel to and south of Brookhaven Avenue (6 in. VTP) and parallel to and west of Seventh Street (10 in. VTP). The system along Brookhaven Avenue can generally remain as is and the northerly and easterly Lab Office Buildings will be connected to this sewer line. The system along Seventh Street, extending further south parallel to and east of Groves Street, must be relocated, as it conflicts with proposed NSLS-II construction.

All utilities except chilled water will be accessed from Brookhaven Avenue. These utilities have adequate capacities and connections, enabling the routing of new site utilities through a common utility vault (underneath the Ring Building floor) and into the "center" of NSLS-II. This approach provides good access for maintenance, while also minimizing the effects of noise and vibration, when compared to running utilities through the building.

The following site utilities are available at or near the site and will used for NSLS-II:

- Potable water
- Sanitary sewers
- Storm drainage
- Chilled water
- Steam and condensate
- Compressed air
- Electrical power
- Telephone/data
- Fire alarm

### 2.9.1 Potable Water

Existing potable water lines are located around the perimeter of the site as follows:

- Along the north side of Brookhaven Avenue (12 in. and 10 in.)
- Parallel to and west of Seventh Street (8 in.) and extending south beyond the NSLS-II site
- Parallel to and east of Groves Street (8 in.)

The 8 in. line west of Seventh Street will need to be relocated around the footprint of the building. Connection of fire protection water and domestic water for the NSLS-II loop system will be from the relocated 8 in. line west of Seventh Street and the 12 in. line at Brookhaven Avenue and North Sixth Street. Potable water for fire protection must be maintained to existing buildings 485,497 and the RADTEC area to the south of the NSLS-II site.

### 2.9.2 Sanitary Sewers

Existing sanitary sewer lines are adjacent to the site on two sides. A 6 in. VTP line parallels Brookhaven Avenue on the north of the site and a 10 in. VTP west of Seventh Street meets with the 6 in. line at MH-163. The sanitary line then crosses Brookhaven to a 20 in. VTP line. The NSLS-II will connect to the 6 in. line from the Operations Center and one LOB. The remaining services will be routed to a new underground pumping station and pumped into the 10 in. VTP line.

### 2.9.3 Storm Drainage

Storm drainage will be collected and directed on site through a combination of both underground piping and structures, as well as overland flows. Multiple retention basins will be utilized to encourage and accelerate percolation of rainfall into the ground as near as possible to the location where it falls (as encouraged by LEED). The storm drainage system will be designed to insure that historical runoffs are not exceeded in the post NSLS-II condition. Excess storm drainage runoff will collect in retention basins and/or other storm drainage structures. Calculations to determine the current capacity of the existing open drainage channel along the west side of Groves Street will be done.

### 2.9.4 Chilled Water

Chilled water is a BNL campus-wide distributed utility. A joint BNL and NSLS-II funded activity will expand the BNL Central Chilled Water facility (CCWF) to meet both growing BNL chilled water loads as well as the added load for NSLS-II. The plant expansion will be a four bay plant that will install two new chillers for NSLS-II loads. NSLS-II will tie into existing central chilled water lines at Rochester Street. A chilled water supply and return header will be routed underground to the Ring Building and pass under the Ring Building through the traffic access tunnel and then be routed to supply each of the service buildings and other building loads. Underground piping will be ductile iron.

### 2.9.5 Steam & Condensate

Steam & Condensate lines are a BNL campus-wide distributed utility. The existing BNL Central Steam Facility (CSF) has adequate capacity to support NSLS-II requirements. NSLS-II will tie into existing steam (10 in.) & condensate (4 in.) lines just north of Brookhaven Avenue. These lines will connect at MH-47. Underground piping will be insulated steel.

### 2.9.6 Compressed Air

Compressed air is a BNL campus-wide distributed utility that is provided with the central chilled water distribution. NSLS-II will tie into existing site compressed air at Rochester St. and will route this piping in concert with the chilled water piping.. A 3 in. compressed air line will be routed underground to the Ring Building and pass under the Ring Building through the traffic access tunnel. Compressed air piping will be PVC coated steel.

### 2.9.7 Electrical Power

For a description of electrical site utilities, see Section 10, Electrical Engineering.

### 2.9.8 Telephone / Data

For a description of telephone/data utilities, see Section 10.10.2, Telecommunications System.

### 2.9.9 Fire Alarm

For a description of fire alarms, see Section 10.10.1, Fire Alarm System.

## 2.10 Existing Facilities

BNL has an on-going program to remove older, inefficient, non-sustainable World War II erafacilities and consolidate operations into more permanent buildings. Consistent with this program, there is a project underway to relocate BNL warehousing, shipping, and receiving operations from the WW-II era buildings at the western edge of the proposed NSLS-II site. BNL will remove buildings and structures associated with these operations prior to construction of NSLS-II.

### 2.10.1 Existing Conditions

A preliminary topographic survey was conducted in June 2006. That survey drawing identified 1 foot contours and major surface features. It has been the basis for the site/civil design through Title 1. A more detailed topographic survey for the specific NSLS-II site was conducted in September 2007 and will be complete in October 2007. That survey will be the basis for the site/civil design through Title 2.

The proposed construction site is relatively level with mostly open fields, previously used for recreation. As previously stated there are warehouse buildings on the western edge of the NSLS-II site that are in the process of being removed under a separate BNL project. There are also some existing trees within the NSLS-II construction site that will require removal. Additionally, there is a railroad spur running parallel to Groves Street that enters the site from the south that will need to be cut back to a point outside the NSLS-II site. This railroad spur will be available for use during construction for delivery of bulk materials (if needed). The existing tree removal and cut back of the railroad spur are part of the NSLS-II site preparation work.

Existing storm drainage is accommodated along the western edge of the NSLS-II site in an open drainage channel. However, consistent with sustainable design principles, on-site recharge/infiltration of storm drainage will be maximized with only limited overflow going to the existing open drainage channel .

## 2.11 Preliminary Design

### 2.11.1 Improvements to Land

Improvements to the land include removal of existing structures, pavements, abandoned site utilities, a railroad spur, and some unsuitable fill. Once this has occurred, grading to new finished grades, installation of all new site utilities, storm drainage, site lighting and pavements (as well as final landscaping) can take place. This WBS element will consist of two work packages:

- Site Preparation which will encompass site clearing and grubbing, isolation of utilities, and rerouting of water and electric services.;
- Site Restoration and Landscaping, which will be included in the Ring Building contract, will include site grading and earthwork, the installation of all new storm drainage features, site lighting, pavements and final seeding.

#### 2.11.1.1 Existing Structures

Removal of the existing building structures will be performed under a separate contract prior to NSLS-II site work. Underground utilities serving these buildings will be removed back to the utility mains as part of the NSLS-II contract. An early site preparation package will be done to provide temporary services to any existing structures that are to remain.

#### 2.11.1.2 Existing Pavements

Removal of existing pavements will be required for all of Railroad Street and Seventh Street, and parts of Groves Street. These roadways will be removed to a point that enables tie-in to new roads and parking areas constructed as part of NSLS-II.

#### 2.11.1.3 Existing Abandoned Utilities

Existing site utility systems that are not being used or have been abandoned in place will be removed as part of the NSLS-II project. The site plan identifies several underground utility pipes that will be removed back to an approved location and terminated.

#### 2.11.1.4 Existing Railroad Spur

The existing railroad spur that runs parallel to Groves Street will be removed to a point south of the proposed NSLS-II site. Approximately 500 feet of existing track will be removed.

#### 2.11.1.5 Other Miscellaneous Site Work

Site clearing will be required to remove existing trees to the west of Seventh Street and in the east/southeast quadrant of the NSLS-II site. The geotechnical report indicates a one foot layer of topsoil above sand, gravel, and silt. The topsoil will be removed for construction and retained for finished grading and replacement topsoil near the end of construction. Any other unsuitable fill identified by the geotechnical report will also be removed and replaced by material from an on-site borrow pit. Final site grading will bring the site to finished grade elevations shown elsewhere in this document. The proposed finished floor elevation for NSLS-II at 70.0 feet above mean sea level (as shown/referenced in other areas of this report) was previously established following preliminary cut and fill quantity studies. These studies will be refined and recalculated during detailed designto confirm that this elevation remains the most optimum for NSLS-II.

Construction staging and access areas, as well as future lay-down yards and/or excess soil stockpile areas (out of the way of future building construction) will be designated. Construction trailers and associated contractor parking will be situated on the north side of Brookhaven Avenue. This location provides easy access to current and future construction areas, and capitalizes on existing facilities/utilities in this area previously used for this same purpose. Designated future lay-down yards and/or excess soil stockpile areas will be situated immediately south of Brookhaven Avenue (and west of Fifth Street). This location has already been mostly cleared of existing trees/vegetation (due to existing recreational ball fields here) and is relatively level. It is also adjacent to the current and future construction area, but out of the way of any actual new construction.

#### 2.11.1.6 New Paving

New paving for NSLS-II will include:

- Curbed drives and entrances from Brookhaven Avenue and Groves Street to NSLS-II facilities
- Curbed drop-off, circle drive (with enhanced concrete paving) for the Operations Center Building's main entrance
- Parking (predominantly uncurbed) for the Operations Center Building
- Loop Road (uncurbed) around the outer perimeter of the NSLS-II site
- Access to the Loop Road from Groves Street and Fifth Street
- Parking (mostly uncurbed) for LOBs 1,4and 5 only (parking for LOBs 2 and 3 are future)
- Truck access to the main loading dock at LOB 4 and loading platforms at LOBs 1 and 5. Fire truck access must be maintained at the locations of future LOBs 2 and 3.
- Traffic access tunnel under the Ring Building into the "center" of NSLS-II
- Service drives (uncurbed) around the infield within the "center" of NSLS-II, including individual access points to each service building
- Campus sidewalks and outdoor gathering spaces (with enhanced concrete paving) in the areas between the existing NSLS, CFN and NSLS-II

#### 2.11.1.7 New Storm Drainage

Storm water drainage from the roofs of buildings and drainage from the paved areas will be directed by either underground pipes and/or overland flow to small retention basins (as encouraged by the LEED guidelines) to achieve the maximum possible infiltration/percolation into the ground water system. For paved areas closest to the existing open drainage channel along the west side of Groves Street, some of the storm drainage will be piped directly into this feature. A retention basin will also be required within the "center" of NSLS-II, at the infield of the Ring Building. Special drainage accommodations will be required for the traffic access tunnel under the Ring Building. Both of these areas will be designed to adequately discharge all storm drainage effectively away from NSLS-II, requiring piping and/or a sump pump associated with the low point in the traffic access tunnel. The other retention basins will be situated outside the Ring Building, and generally out of the way of any future long beamlines. Collected storm water at the retention basins will be allowed to percolate into the ground following storm events as on-site soil conditions suggest percolation will be rapid. All storm water drainage systems will be designed (as required) to meet 100 year storm design criteria.

#### 2.11.1.8 New Landscaping

After construction, all disturbed areas will be re-vegetated with a combination of native or indigenous plant materials, seeding, sod and/or wildflowers/groundcovers to minimize the negative effects of soil erosion and allow for minimal maintenance by BNL.

#### 2.11.1.9 Erosion and Sedimentation Control

Erosion and sedimentation control systems will be installed and utilized for the duration of the construction phase of the project. Silt fencing and stabilized construction entrances will be installed prior to the commencement of construction activities. Disturbed areas within the construction site will be stabilized as soon as practical and subsequently maintained with appropriate methods to minimize erosion of exposed earth. Temporary seeding, mulching, or crushed stone will be used to achieve stabilization.

The proposed construction activities will result in the disturbance of one (1) or more acres of land. Therefore, BNL will be required to obtain coverage under a SPDES General Permit (GP-02-01) prior to the commencement of any soil disturbance. To obtain coverage under the general permit, BNL will file a completed Notice of Intent (NOI) with the New York State Department of Environmental Conservation (NYSDEC) affirming that a Stormwater Pollution Prevention Plan (SWPPP) has been prepared for the construction site (and will be fully implemented prior to the start of construction activities). Best Management Practices (BMP’s) from the New York State Standards and Specifications for Erosion and Sediment Control will be put into place to limit the negative impacts of soil erosion. BMP's include the following:

- Sediment Traps will be located as required to minimize the amount of soil loss, and to keep soil from entering existing storm drainage systems.
- Temporary Sediment Basins will be located in watershed basins and within future permanent extended detention/retention/recharge basins.
- Temporary swales (wet and dry) will be used to convey storm water during current and future construction to soil erosion and sediment control features.
- Check dams and rock dams will be located in drainage swales as required to help filter/settle out any sediment.
- Construction access points (stabilized construction entrances with wash racks) will be employed to prevent the tracking of mud from construction vehicles onto existing roadways.
- Temporary grassing will used to stabilize all areas of soil disturbance.
- Dust control will be utilized during dry conditions to minimize the nuisance of blowing of dust.

In addition to the above-mentioned BMP’s, the contractor will be required to stage the work consistent with NYSDEC requirements, and will need to stabilize all land disturbing activity within 14 days. In the event that temporary grassing can not be performed due to cold weather conditions, mulching will be required instead. Temporary grassing of the site will be required by completion of work once grasses can be planted. Erosion control devices will need to be inspected at least weekly (and after each rain), and repaired as necessary. Erosion control devices will be properly installed prior to site disturbance as logistically feasible and depending on the staging of work. These will be maintained in good working condition until completion of the early site preparation package construction (and/or replaced when effectiveness is reduced to 50%). Finally, additional erosion control measures will be installed to control sediment and silt from leaving the site as determined necessary by the ESHQ Directorate.

# 3 ARCHITECTURE

## 3.1 Design Criteria

### 3.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

### 3.1.2 DOE Orders

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities

### 3.1.3 Codes, Standards, and Guides

Building Code of New York State (NYSBC) – 2002 Edition
American Concrete Institute
Building Code Requirements for Structural Concrete (ACI 318-99)
BNL Standards Based Management System Subject Areas
New York State and Suffolk County Department of Health Codes
American National Standards Institute
ANSI 117.1 Accessible and Useable Buildings and Facilities
American Society for Testing Materials Standards
ASHRAE Standard 90.1-2001 Energy Standards for Buildings Except Low-Rise Residential Buildings
Factory Mutual
National Institute of Standards and Technology
National Fire Protection Association (NFPA) Standards
Occupational Safety and Health Administration (OSHA)
Underwriters Laboratory
New York State Fire Prevention Code - 2002 Edition
Energy Conservation Code of New York State - 2002 Edition
Americans with Disabilities Act Accessibility Guideline (ADAAG)
Leadership in Energy and Environmental Design (LEED) 2.2
LEED for Labs

## 3.2 Architecture

### 3.2.1 Building Envelope

The building envelope will be designed to meet at a minimum the prescriptive requirements of the Energy Conservation Code of New York (ECCNY). Brookhaven National Laboratory is located in Climate Zone 11B of the ECCNY. The thermal design parameters for envelope elements are dependent on the ratio of fenestration to overall wall area. The Ring Building has a window-wall ratio of less than 10 % and the LOBs and the Operations Center have window-wall ratios greater than 10%. This ratio affects the prescriptive requirements of the ECCNY, as shown in Tables 3.1 and 3.2. Window to wall ratios of 0 to 10% are considered low fenestration area buildings and ratios of 25 to 40% are high fenestration area buildings.

**Table 3.1 R-Values for High Fenestration Area Buildings – ECCNY**

| Building Component | Prescriptive R-Value |
|---|---|
| Exterior wall | R-11 |
| Exterior wall below grade | R-11 |
| Glazing | R-2 (U=0.5) |
| Roof (continuous insulation) | R-24 |
| Slab on grade edge | R-8 |

**Table 3.2 R-Values for Low Fenestration Area Buildings – ECCNY**

| Building Component | Prescriptive R-Value |
|---|---|
| Exterior wall | R-11 |
| Exterior wall below grade | R-11 |
| Glazing | No requirement |
| Roof (continuous insulation) | R-19 |
| Slab on grade edge | No requirement |

More stringent criteria will be used in most locations as required to meet the temperature stability performance of the building and to help achieve sustainability (LEED) goals. Targeted design R-values for wall and roofing systems will match or be slightly higher than the prescriptive values shown above:

- Target R-value for Exterior wall system R-20
- Target R-value for Roofing system R-24

### 3.2.2 Building Occupancy

NSLS-II will be in operation 24 hours a day, 7 days a week; however, occupied hours for most staff are 8:00 AM to 5:00 PM. The overall building will be classified, per the Building Code of New York State, as a Business (“B”) Occupancy. The anticipated populations of the various areas are shown in Table 3.3:

**Table 3.3 Building Office Capacity**

| Building | Population |
|---|---|
| Operations Center | 75 (Alt 3rd floor) |
| Ring Tunnel / Experimental Hall | 0 |
| Lab Office Building 1 | 72 |
| Lab Office Building 2 | 72 (future) |
| Lab Office Building 3 | 72 (future) |
| Lab Office Building 4 | 72 (future) |
| Lab Office Building 5 | 72 |
| Booster / Linac Building | TBD |
| RF Building | 0 |

### 3.2.3 Parking

Parking will be provided for the Operations Center, the future JPSI building and for each of the Lab Office Buildings. LOBs 1, 4, and 5 will have approximately 100 parking spaces provided for employees and visitors. The main parking area for the Operations Center and the future JPSI will provide approximately 200 parking spaces for employees and visitors. Parking at LOBs 2 and 3 will be future and added when LOB 2 and 3 are added. A drop-off loop will be provided to the entrance of the Operations Center. Each parking lot will be barrier free and provide the required number of ADA-compliant parking spaces to meet current LEED requirements. Requirements for parking spaces are as shown in Table 3.4.

**Table 3.4 Parking Requirements.**

| Building | Parking Spaces |
|---|---|
| Operations Center & future JPSI* | 210 |
| Lab Office Building 1 | 100 |
| Lab Office Building 2 | Future |
| Lab Office Building 3 | Future |
| Lab Office Building 4 | 100 |
| Lab Office Building 5 | 84 |
| Total | 494 |
| *Not part of NSLS-II Project | |

### 3.2.4 Vibration Criteria

The vibration limits of the Experimental Hall are those criteria associated with the user-supplied research instruments, which are not well defined at this time. Therefore, the vibration requirements of this space will be established to meet general vibration criteria for similar physical science research centers. The vibration requirements of the vast majority of research equipment available today would be satisfied by a floor meeting vibration criterion VC-E or the more stringent NIST-A. The NIST-A criterion is more stringent than VC-E at frequencies less than 20 Hz. A minimum target of VC-E will be established for the Experimental Hall.

The vibration requirements for the accelerator tunnel have been provided in a much different manner. The storage ring is most sensitive to frequencies in the range of 4 to 50 Hz. The criterion for the storage ring vibration is defined in terms of R, the area beneath the power spectral density (PSD) spectrum $\Delta(f)$, between cutoff frequencies $f_1$ and $f_2$. The RMS amplitude, R, is to be less than 25 nm. R is defined as

$$R = \sqrt{\sum_{f_1=4}^{f_2=50} \Delta(f) \times \delta f}$$

where $\Delta(f)$ is the displacement power spectral density spectrum (in units such as $m^2$/Hz, where the frequency term in the denominator is the measurement bandwidth) and $\delta f$ is the frequency resolution of the spectrum, 0.25 Hz. The lower and upper bounds of the summation are 4 and 50 Hz, respectively. Frequency components outside this range may be neglected.

### 3.2.5 Noise Criteria

One of the primary goals of the NSLS-II is to provide world-class research facilities. One aspect of this requirement is to provide a very quiet Experimental Hall. The facility will have two primary types of noise sources: 1) the facility's mechanical systems, such as air handlers, and 2) the user-provided research equipment. The noise control associated with the first group is within the purview of the NSLS-II design team, but the ability to mitigate noise associated with the second group is somewhat limited. It can be anticipated via passive room noise control measures incorporated into the design, but it cannot be controlled via mechanical constraints such as airflow velocities, fan selection, or silencers, concepts typically employed for the first group.

Studies carried out during the design of the Advanced Photon Source determined that final operational room noise in the Experimental Hall would be a mix of sound from both groups of sources, and that NC-60 to NC-65 would be achievable from a combination of mechanical system noise control measures on the proposed air handling system and room absorption incorporated into walls and ceiling. In the absence of absorptive material, the noise at APS was predicted to be on the order of NC-70. This assumed a degree of localized noise control (with regard to user equipment) similar to what was used in NSLS I. APS elected to require noise control to be provided by users as part of the instrumentation and/or hutches, and omitted plans for absorbent material.

In March 2007, a program of measurements was carried out at APS, determining that the mean+$\sigma$ noise in operational areas of the Experiment Hall was NC-61 (67 dBA), with a total range of only 4 NC points and a $\sigma$ of one point. In an undeveloped area (representing a noise contribution only from building facilities), the noise was found to be NC-56 (62 dBA).

NSLS-II will utilize absorptive material and appropriate mechanical system design to achieve NC 55 or better in the As-Built stage (prior to operation of user equipment), with a goal of providing a Mean+$\sigma$ noise environment of NC-58 or better. Noise Criteria (NC) level guidelines for other spaces in the facility will be as shown in Table 3.3.5.

**Table 3.5 Acoustic Noise Criteria.**

| Space Type | Noise Criteria (NC) Level |
|---|---|
| Office | 35–40 |
| Laboratory | 45–50 |
| Conference rooms | 30 |
| Interaction space | 40 |
| Common use areas | 40–45 |
| Accelerator tunnel | None |
| Experimental Hall | 55 or better |
| Mechanical / electrical rooms | Per ACGIH TLVs |

### 3.2.6 EMI / RFI Criteria

No universal EMI/RFI design criteria has been established for the NSLS-II facility, although individual beamlines or experiments may have specific requirements. Shielding, if required will be the responsibility of the researcher at the individual beamline or laboratory.

## 3.3 Functional Program

Adjacencies of the various functional areas within the NSLS-II complex have been established through detailed discussions with the Accelerator Systems Division, the Experimental Facilities Division, the Conventional Facilities Division, Plant Engineering, Environmental Safety & Health, Maintenance, and Management.

Relationships between the areas will meet the requirements outlined in the following sections.

### 3.3.1 Ring Tunnel

- Requires access from the Ring Building infield for tunnel equipment installation.
- Shielding is required on the inboard, outboard, and top of the ring tunnel. This can be achieved with high-density concrete, normal weight concrete, or soil. This can also be achieved with a combination of these materials. The primary shielding material will be standard weight concrete.
- Access to the tunnel from the Experimental Hall is required at each beamline. This access will be included on the initial 15 beamlines (IDs 14-29) and be through sliding shielded doors. On the remaining 15 beamlines (IDs 1-13 and 30) will be blocked up with shield block and installed when a beamline is added at them.
- Storage ring power supplies will be located on the tunnel mezzanine directly above the ring tunnel.
- Easy access from the Operations Center control room to the ring tunnel is desirable.
- Access from the Experimental Floor to the ring mezzanine will be from stairs or ships ladders running parallel to the interior ring tunnel ratchet wall at locations where there is no active beam line.
- Walls of the ring tunnel must provide radiation shielding from the rest of the facility.

### 3.3.2 Experimental Hall and Access Corridor

- The Experimental Hall will have 30 sectors (a sector includes a straight section and the adjacent bending magnet) and must accommodate 25 to 30 60 m insertion device beamlines and hutches and another 25 to 30 bending magnet beamlines. The Experimental Hall must be able to accommodate future beamlines that will extend outside the building.
- Floor height with respect to the tunnel must allow beamlines to be 1.4 meters above the finished floor in the Experimental Hall. The floor must be constructed to limit differential settlement, as the beamlines must be maintained at 1.4 meters along their entire length.
- The Experimental Hall must have line-of-sight access into the tunnel for beamline set-up and alignment.
- A perimeter access corridor for equipment and personnel access to the beamlines is required. Beamlines must have easy access to nearby LOBs and Operations Center.
- The access corridor should provide space for informal interaction between researchers.
- An outdoor public space with seating will be provided near LOB 1 for lunch, coffee breaks, etc. A sandwich grille with a service window to the outdoor space and into the Experimental Hall will be provided to serve light meals.

### 3.3.3 Operations Center

- The Operations Center should provide visitors a viewing gallery overlooking the Experimental Floor.
- The control room and small conference room, should be grouped together on the second floor with easy access to the Booster / Linac and Ring Tunnel areas.
- The computer room should be below the control room.
- Provision for future covered access to the Joint Photon Sciences Institute building should be considered.
- The Operations Center should have an entry lobby for displays and a reception area for new users and guests.

- A third floor including offices and meeting spaces will be designed as a bid alternate. The decision to accept the alternate will be made prior to construction.

### 3.3.4 Lab Office Buildings

- Laboratory space and offices should be near to their respective beamlines.
- LOBs needs an entrance and parking lot.
- Individual laboratories in the LOBs should have access to the Experimental Hall through double doors.
- Informal interaction space should be provided in each LOB, as well as conference rooms.
- Laboratory space within a LOB will be shared by all six sectors using the LOB.
- Laboratories will require chemicals and gases to be delivered to them. Provision for delivery and storage of these materials is required. A high hazard storage area is provided adjacent to LOB-4 adjacent to the main loading dock.
- LOBs must be configured to allow for future expansion requiring additional labs and offices.
- LOBs 1 and 5 as well as future LOBs will have an at-grade loading platform.
- The main loading dock replaces the at-grade loading platform for LOB 4.
- Each LOB will have a gas bottle storage area.
- HVAC for the LOBs will be air handling units in each LOB mechanical mezzanine.
- Each LOB will have two fume hoods. One HEPA-filtered laboratory fume hood for working with nanomaterials and the second capable of being retrofitted with HEPA filtration.

### 3.3.5 Service Buildings

- Service buildings will house mechanical and electrical equipment supporting the Ring Building and must therefore be equally spaced around the interior side of Ring Building.
- Service buildings require access for large equipment moves.
- Access to the ring tunnel for both equipment and personnel will be provided through the service buildings from both the tunnel mezzanine and the Ring Building infield.
- Service buildings must be located so utilities can be easily and efficiently routed to them.
- Service Buildings will have a hoist/crane located on the second floor and accessible to the outside through double doors for hoisting materials for the Tunnel Mezzanine up onto the second floor.
- The ductwork leading from the Service Building into the Accelerator Tunnel must run through a labyrinth for radiation shielding.
- Pedestrian access from the Service Building into the Accelerator Tunnel must run through a labyrinth for radiation shielding.

### 3.3.6 Injection and RF Buildings

- The Injection and RF Buildings must be adjacent to the storage ring tunnel.
- The Injection Building must be shielded due to radiation during linac and booster operation.
- The RF Building must have a shielded test area
- The RF Building must have a small cryo equipment enclosure nearby (but separate for vibration isolation) and concrete pad for associated Helium storage tanks.
- HVAC for the RF Building and Booster Service Building will be by roof mounted AHU’s.
- HVAC for the Injection Building will be by AHUs located in rooms within the buildings. The ductwork leading into these buildings must run through a labyrinth for radiation shielding.

## 3.4 Space Program

### 3.4.1 Building Program

NSLS-II will have distinct components that make up the final building plan. They are the Ring Building, the Operations Center, the Lab Office Buildings, the Service Buildings, the Injection Building and the RF Building. Each of these buildings has separate space and utility requirements. It is also important to note that the existing NSLS will continue to be utilized to provide administrative and engineering office, workshop and technical space that will support the needs of NSLS-II. The net additional building program requirements for NSLS-II include the User and Facility beamline office and lab space, NSLS-II operations space and the physical support space to house the operating machinery, accelerator and beamlines.

#### 3.4.1.1 Definitions

Net Square Feet (NSF): The sum of all areas that are required to meet general or specific functional needs. NSF is calculated based on the interior dimensions of the rooms and spaces.

Gross Square Feet (GSF): The total area of all spaces in the building including wall thicknesses. GSF is calculated based on the exterior face of the building spaces and includes non-assignable spaces such as building circulation, mechanical/electrical rooms, restrooms, janitor closets, and the area of interior and exterior walls.

Building Efficiency: Building efficiency is calculated as the ratio of NSF/GSF.

**Table 3.6 Summary Program of Spaces.**

| Space Description | NSF | GSF |
|---|---|---|
| Operations Center | 9,232 | 11,600 |
| Injection Building | 17,693 | 22,440 |
| RF Building | 10,182 | 10,630 |
| Ring Building (incl. Service Buildings) | 268,018 | 293,715 |
| Lab Office Buildings* ( 3 ) | 50,358 | 71,536 |
| Total Square Feet | 355,483 | 411,921 |
| Building Efficiency: 86% | | |

* 2 additional LOBs are future

### 3.4.2 Operations Center

The Operations Center will be a two-story structure, with an alternate third story, that serves as the focal point of the facility. It includes a two story high entry lobby space for reception and displays. The Operations Center will contain the accelerator control room with associated conference room, lunch room, and computer room, support space and a visitor’s viewing gallery located on the second level overlooking the Experimental Floor. Figure 3.1 illustrates the layout of the Operations Center first floor and Figure 3.2 shows the second floor layout.

An optional third floor will accommodate offices for administration and accelerator physicists associated with storage ring operations. This will include the area over the entrance lobby that could be used for a Director’s suite or a large Conference Room.

**Table 3.7 Operations Center Program of Spaces.**

| Room Name | Size NSF | No. of Spaces | Total NSF | GSF | Notes |
|---|---|---|---|---|---|
| First Floor | | | | | |
| Lobby | 2,415 | 1 | 2,415 | | |
| Computer room | 976 | 1 | 976 | | |
| Telecom | 409 | 1 | 409 | | |
| Switchgear | 655 | 1 | 655 | | |
| Break room / Kitchenette | 512 | 1 | 512 | | |
| Unisex Toilet | 78 | 1 | 78 | | |
| | | | | | |
| Second Floor | | | | | |
| Control conference room | 676 | 1 | 676 | | |
| Control room | 1,547 | 1 | 1,547 | | |
| Toilets & Showers | 76 | 2 | 152 | | |
| Men's Locker Room | 128 | 1 | 128 | | |
| Women's Locker Room | 126 | 1 | 126 | | |
| Storage | 108 | 1 | 108 | | |
| Bridge & Viewing Gallery | 1,450 | 1 | 1,450 | | |
| Operations Center | | 15 | 9,232 | 11,600 | |
| Efficiency – Operations Center: 79% | | | | | |
| | | | | | |
| Alternate Third Floor | | | 132 | | |
| Private office | | | 2,561 | | |
| Open office | | | 2,469 | | |
| Toilets | | | 284 | | |
| Kitchenette | 126 | 1 | 126 | | |
| Directors Office | 301 | 1 | 301 | | |
| Conference Rooms | | | 943 | | |
| Director's Assistant | 221 | 1 | 221 | | |
| Alternates | | 55 | 6,753 | 10,310 | |

### 3.4.3 Injection Building

The Injection Building (Booster / Linac) consists of spaces for the compact booster, the linac, klystron gallery and support for these in a single story building. Two Service Buildings are adjacent to the Booster ring and will provide services for it and the linac. The Booster ring and linac require shielding. This is accomplished by a combination of concrete walls and earthen berms. The layout of the Injection Building is shown in Figure 3.4.

**Table 3.8 Injection Building Program of Spaces.**

| Room Name | Size NSF | No. of Spaces | Total NSF | GSF | Notes |
|---|---|---|---|---|---|
| Linac Room | 1,715 | 1 | 1,715 | | |
| Klystron Gallery | 1,620 | 1 | 1,620 | | |
| Booster Service Building - East | 6,102 | 1 | 6,102 | | |
| Booster Service Building – West | 1,568 | 1 | 1,568 | | |
| Booster Ring Tunnel | 6,688 | 1 | 6,688 | | |
| Injection Building | | 5 | 17,693 | 24,440 | |
| Efficiency: 72% | | | | | |

### 3.4.4 RF Building

The RF Building is located inside the ring on the west side of the Operations Center and connected to the Operations Center by a double door. This building houses the RF cavities which are located on ID 22A and 24A. The space requires at least 6 meter height clearance and a crane or temporary gantry for installing equipment. There is also a concrete shielded room for doing RF testing located in this building. The RF Building layout is illustrated in Figure 3.3.

Located adjacent to this building on the inner part of the ring is the Helium tank yard that services the RF cavities and a pre-engineered pump building to serve the Helium Tank Yard.

**Table 3.9 RF Building Program of Spaces.**

| Room Name | Size NSF | No. of Spaces | Total NSF | GSF | Notes |
|---|---|---|---|---|---|
| RF Cavity Room | 9,756 | 1 | 9,756 | | |
| RF Test | 426 | 1 | 426 | | |
| RF Building | | 2 | 10,182 | 10,630 | |
| Efficiency: 96% | | | | | |

### 3.4.5 Ring Building

The Ring Building, shown in Table 3.7, will consist of four main space components, the Ring Tunnel, the Tunnel Mezzanine, the Experimental Hall, and the Access Corridor. Additionally, the main loading dock, stock room and hazardous materials storage are also included in the Ring Building and located adjacent to LOB 4.

The ring tunnel, housing the booster ring and the storage ring, occupies the inner most area of the Ring Building. The beamlines used by the experimental stations extend tangentially from the ring at select locations. The Experimental Hall is designed to accommodate beamlines that are approximately 60 m long from the center of the straight section to the intersection at the access corridor. Outboard of the Experimental Hall will be the access corridor. Above the ring tunnel is the tunnel mezzanine. Power supplies for the accelerator will be located on the tunnel mezzanine with electrical power feeds dropping through the floor into the tunnel.

Beyond the ring tunnel is the experimental floor where the beamlines and hutches for the experiments are located. The floor in this area will be designed to reduce transmission of vibration and prevent differential settlement of the floor which can be detrimental to the performance of the beamlines.

Along the periphery of the experimental floor is the access corridor which is approximately 10 ft wide and designed for fork truck and pedestrian traffic. This will be a continuous aisle that runs the circumference of the Ring Building. It is from this aisle that the experimental floor and LOBs will be accessed. The access corridor between LOB 1 and 2 will accommodate future long beam lines that will interrupt the corridor where they penetrate it. Access over the long beamlines will be accomplished by a raised steel bridge over the beamline sized for forklift traffic. The bridge will include an equipment lift on one end closest to the LOB, access lifts to each of the beam lines, and a ramp on the other end. The access corridor between the other LOBs will have a thickened slab design that will allow for installation of the raised platform in the future.

An outdoor public space with seating will be provided for lunch, coffee breaks, etc. A sandwich grille will be provided to serve light meals. It will be located on the Ring Building between LOB One and the Operations Center.

A typical Ring Building Pentant is illustrated in Figure 3.5.

**Table 3.10 Ring Building Program of Spaces.**

| Room Name | Size NSF | No. of Spaces | Total NSF | GSF | Notes |
|---|---|---|---|---|---|
| Ring tunnel | 37,300 | 1 | 37,300 | | |
| Experimental Hall | 94,235 | 1 | 94,235 | | |
| Access Corridor | 33,018 | 1 | 33,018 | | |
| Tunnel mezzanine | 50,950 | 1 | 50,950 | | |
| Grille | 257 | 1 | 257 | | Located near LOB 1 |
| Loading dock | 2,060 | 1 | 2,060 | | Located near LOB 4 |
| Stock Room | 1,618 | 1 | 1,618 | | Located near LOB 4 |
| Hazardous materials storage | 450 | 1 | 450 | | Located near LOB 4 |
| Ring Building | | 8 | 219,888 | 240,075 | |
| Efficiency: 92% | | | | | |

### 3.4.5.1 Service Buildings

There will be five two-story service buildings located inboard of the ring. These buildings will house the mechanical and electrical equipment to service the experimental floor, the ring tunnel, and the tunnel mezzanine. The Service Building first floor will provide personnel access to the ring tunnel through a labyrinth, and equipment access to the ring tunnel at two of these service buildings through a shielded door. The other three Service Buildings will each have an opening filled with removable, pre-engineered concrete shield block to accommodate a future shielded door. The inner road access will connect to the service buildings through the first floor.

The Service Building second floor will house air handlers for the experimental floor area. The second floor will be serviced by a equipment hoist and double exterior doors located on the second floor and fire stairs from the first floor. It will provide equipment access to the tunnel mezzanine via an a double six foot wide hollow metal door. Mechanical equipment rooms for the Lab Office Buildings, Booster, and Operations center are included with their respective buildings.

The layout of a typical Service Building is shown in Figure 3.6.

**Table 3.11 Service Buildings Program of Spaces.**

| Room Name | Size NSF | No. of Spaces | Total NSF | GSF | Notes |
|---|---|---|---|---|---|
| Service Building # 1 | 9,626 | 1 | 9,626 | | |
| Service Building # 2 | 9,626 | 1 | 9,626 | | |
| Service Building # 3 | 9,626 | 1 | 9,626 | | |
| Service Building # 4 | 9,626 | 1 | 9,626 | | |
| Service Building # 5 | 9,626 | 1 | 9,626 | | |
| | | 5 | 48,130 | 53,640 | |
| Efficiency: 90% | | | | | |

## 3.4.6 Lab Office Buildings

There will be three single-story Lab Office Buildings (LOB), two fully built out (LOBs 1 and 5) and one shelled (LOB 4). There will be two future LOBs that can be constructed when the beamlines are built in their area of the building. LOBs include open-plan offices for the scientists and technicians, (a VE items that eliminates all enclosed offices in LOBs 1 and 5 has been incorporated here and on the drawings by note only) twelve laboratory modules (two modules per typical laboratory) plus interaction areas, conference rooms, machine shop, and shipping/receiving and storage. The shipping/receiving area will be eliminated in LOB 4 and a stock room and main loading dock added that will service LOB 4 as well as the rest of the facility. The layout typical to LOB 1 and 5 is shown in Figure 3.7.

LOB 4 will be a shelled space in the base building work with just the exterior envelope constructed. This includes exterior walls, roofs, doors and windows. Minimum mechanical, electrical lighting and power rough-in and plumbing rough-in that provides minimum life safety for exiting and to prevent freezing of sprinkler piping in the winter.

### 3.4.6.1 Laboratory Design

Each built-out LOB will have six laboratories, which will be shared with all the beamlines associated with that particular LOB. These labs are based on a 12 ft wide and 20 ft long lab planning module with each lab being two modules wide. These labs will have access to the Experimental Hall through recessed double doors 6 ft wide (two 3 ft wide leaves). The labs will be accessed from the LOB by a single recessed 3 ft wide door.

At least two labs in each LOB will be wet labs, either chemistry or biology, which will require a fume hood. At least one of these hoods will be HEPA filtered in each LOB, and one more will be upgradeable with HEPA filtration. Additionally, each LOB will have the capability to provide at least one HEPA filtered fume hood designated for nanomaterials work. The other labs will be dry labs with cabinetry and equipment but a fume hood is planned for only one of the four dry labs. These labs may be equipped with elephant trunk exhausts or glove boxes as needed by the laboratory type.

Chemistry wet labs will include ventilated chemical storage cabinets incorporated into the fume hood base. Each wet laboratory will also be furnished with a safety shower/eyewash station. Floor drains will not be provided in laboratory spaces.

Since the LOB labs are going to be shared labs, it is necessary to make the labs as generic as possible while still serving the requirements of the research being performed.

**Table 3.12 Lab Office Buildings Program of Spaces.**

| Room Name | Size NSF | No. of Spaces | Total NSF | GSF | Notes |
|---|---|---|---|---|---|
| Lab Office Building | | | | | |
| Private office | 110 | 48 | 5,280 | | |
| Open office space | 90 | 24 | 2,160 | | |
| Laboratory – Wet | 480 | 2 | 960 | | |
| Laboratory – Dry | 480 | 4 | 1,920 | | |
| Storage | 110 | 1 | 110 | | . |
| Conference room | 560 | 2 | 1,120 | | |
| Conference room | 220 | 2 | 440 | | |
| Lobby & interaction spaces | 600 | 1 | 600 | | |
| Break rooms / kitchenettes | 240 | 2 | 480 | | |
| Shipping Receiving & Storage | 960 | 1 | 960 | | |
| Toilet/shower | 250 | 2 | 500 | | |
| Electrical / Data | 153 | 1 | 153 | | |
| Janitor Closet | 63 | 1 | 63 | | |
| Access Corridor Interface | 2,090 | 1 | 2,090 | | |
| Machine Shop | 270 | 1 | 270 | | |
| | | 93 | 17,106 | | |
| Lab Office Buildings 1 & 5 | | 186 | 34,212 | | |
| Lab Office Building 4 (Shelled) | | 1 | 16,146 | | |
| | | | 50,358 | 71,536 | |
| Efficiency: 70% | | | | | |

### 3.4.7 Construction Alternates

Some components of the NSLS-II will be bid as Alternates to the Base Building. These will be designed as part of the Title II Design and constructed as budget allows. Other components are identified as Future construction and will not be designed at this time.

- Operations Center Floors 1 and 2 Base
- Operation Center Floor 3 Alternate
- Injection Building Base
- RF Building Base
- Ring Building Pentants 1-5 Base
- Lab Office Building #1 Base
- Lab Office Building #2 Future
- Lab Office Building #3 Future
- Lab Office Building #4 Shell Base
- Lab Office Building #4 Fit-out Future
- Lab Office Building #5 Base

### 3.4.8 Circulation

Entry points into the Ring Building are provided around the circumference of the building both from the outside and the inside of the ring. The main entrance to the Ring Building will be from the Operations Center lobby. Other entrances to the complex are available from the LOBs and from the service buildings. Within the two-story Operations Center, two elevators will provide vertical transportation – a passenger elevator in the lobby and a service elevator inside the ring.

When the accelerator is operating, access to the ring tunnel is not allowed, for safety reasons. Doors into the ring tunnel will be interlocked with the accelerator to prevent entry into the tunnel when the beam is operating.

Primary circulation within the Ring Building will be provided by the access corridor that circumscribes the outside of the building. It will provide for both pedestrian and vehicular (bicycle, forklift, etc.) traffic. The access corridor will have points of entry from each LOB and from each laboratory within the LOBs. Emergency exit doors are located on the perimeter of the ring (both inside and outside walls) that meet the current NYS Building Code. A elevated bridge with ramps and equipment platform lift is located between LOB 1 and future LOB 2 to accommodate long beamlines being installed in this area. Provisions for elevated bridges in other area where long beamlines are anticipated in the future are included the design and sized for all anticipated traffic in these areas.

Access to the Tunnel mezzanine from the Experimental Hall will be via steel stairs located at the ratchet for the bending magnets. There will be one per pendant (approx. every 600' to meet NYSBC for travel) except that the bridge at the Operations Center will take the place of one of these stairs.

Control room personnel require ready access to the tunnel mezzanine and the ring tunnel itself. The tunnel mezzanine will provide the means of circulation around the ring from the control room. A pedestrian bridge will be provided from the Operations Center second floor across the Experimental Hall to the tunnel mezzanine. Entrance to the accelerator tunnel will be via the service buildings. Stairs in the service buildings will provide circulation between the mezzanine level and the tunnel level. Personnel will access the accelerator tunnel through a personnel labyrinth on the first level.

### 3.4.9 Building Floor Elevations

The floor elevation for the Ring Building (experimental floor) is the functional baseline for the elevations of the adjoining buildings and spaces. This elevation is set to minimize the need for engineered fill while also considering the balance of cut and fill on the site. The floor elevations for the components are given in Table 3.13.

**Table 3.13 Building Floor Elevations.**

| Building Component | Floor Elevation |
|---|---|
| Experimental floor and access corridor | + 70 ft |
| Ring tunnel | + 71 ft 4 in. |
| Tunnel mezzanine | + 83 ft 7 in. |
| Lab Office Building | + 70 ft |
| Operations Center | -- |
| First floor | +70 ft |
| Second floor | + 83 ft 7 in. |
| Third floor | +98 ft |
| Service buildings | -- |
| Lower level / Ring tunnel access | + 71 ft 4 in. |
| Upper level | + 83 ft 7 in. |
| Booster / Linac Building | + 71 ft 4 in. |
| RF Building | + 71 ft 4 in. |

# 3.5 Preliminary Design

## 3.5.1 Operations Center

### 3.5.1.1 Architectural Concepts

The Operations Center lobby will serve as the front door to the NSLS-II complex. It is envisioned to be two stories in height and will provide a welcoming environment for guests.

### 3.5.1.2 Future Expansion

The Operations Center will be designed for an optional third floor, that will house a combination of open plan and private offices along with a large conference room and director's suite above the lobby area. The design does not provide for future expansion horizontally or vertically, however, connectivity to future adjacent buildings is possible.

### 3.5.1.3 Space Program

The first floor will consist of the lobby with space for displays, elevator and restroom on the front side of the ring. An outdoor seating area with coffee bar and sandwich grille will be adjacent to the Lobby. The computer room, break room switchgear and telecom rooms are on the first floor on the inside of the ring. The second floor includes the control room, a conference room, toilets and the viewing gallery overlooking the Experimental Hall, a bridge across the Experimental Hall. The alternate third floor will house a combination of open plan and private offices.

### 3.5.1.4 Circulation

The primary point of entry will be the main entrance and lobby that will draw in pedestrian traffic from the parking lot and drop-off loop. Sidewalks are envisioned for pedestrian traffic to and from the adjacent future JPSI and to the CFN across Groves Street and the NSLS across Brookhaven Avenue. Interaction areas will be incorporated adjacent to key circulation areas of the building. The building also provides the primary entrance into the Experimental Hall. A bridge accessed from the second floor will span across the Experimental Hall and provide access to the control room as well as the accelerator tunnel, tunnel mezzanine, Linac and RF Building. Two elevators will provide vertical circulation within the building.

### 3.5.1.5 Quality of Life

Building orientation, sustainable materials, and the use of natural light will be integrated into the design to promote a comfortable and productive environment. Unlike the Ring Building, the Operation Center's envelope will consist of large areas of glass, allowing for visual transparency and to provide an inviting front door to the NSLS-II complex. The lobby will be a space for informal interaction and social events. An outdoor seating area can be provided between the Operations Center and the future JPSI building as a comfortable place to enjoy coffee or lunch.

### 3.5.1.6 Building Construction

The exterior of the Operations Center will be constructed of an insulated metal wall panel and stud system. The wall system on the entrance lobby will be comprised of the exterior panel system to match Type A without the liner panel, exterior sheathing, air barrier, 6 in. metal studs, fiberglass batt insulation, and interior gypsum board. The minimum thermal resistance of the system will be R-20.

The wall system on the inner ring portion of the Operations Center will be comprised of the exterior panel system to match Type A without the liner panel, exterior sheathing, air barrier, 6 in. metal studs, fiberglass batt insulation, and interior gypsum board. The minimum thermal resistance of the system will be R-20.

The roof of the Operations Center will be a flat TPO membrane roofing system that meets current LEED requirements and the energy code minimum R-value. A built-up roofing system is an option in place of the TPO system but not meet LEED requirements for Heat Island, Energy Star Roofing.

The curtain wall windows at the Operations Center will consist of 1 in. clear tempered insulated glass with a low-E coating in a thermally broken aluminum frame. The thermal transmission value for the glazing will be a U value of 0.30 in the summer and 0.30 in the winter. The visible light transmission will be 69% and the shading coefficient will be a maximum of 0.44.

The exterior doors will be curtain wall aluminum insulated doors to match the windows at the entrance, and insulated hollow metal doors and frames on the inner ring portion of the Operations Center.

#### 3.5.1.7 Interior Finishes

The Operations Center will have gypsum board walls with wood doors and hollow metal frames. The offices will have a side light or interior window to allow natural light into the interior spaces. The interior finishes are as follows:

- Floor finishes office area and conference rooms – carpet tile
- Floor finishes control room and computer room – raised floor
- Floor finishes lobby – porcelain ceramic tile
- Floor finishes toilet rooms – porcelain ceramic tile
- Exterior walls - painted
- Interior walls typical – painted
- Interior walls conference rooms – paint or wall coverings
- Interior walls of toilet rooms – ceramic tile
- Ceiling system – suspended acoustical tiles and grid
- Doors – wood, stained
- Door frames – painted
- Floor surfaces shall have a wet slip coefficient of 0.5 or greater.

### 3.5.2 Ring Building

#### 3.5.2.1 Architectural Concepts

The Ring Building is the scientific and visual focal point for the NSLS-II facility. The halo-shaped building will dominate the site by its sheer breadth, although its height is not proportionally commanding.

#### 3.5.2.2 Future Expansion

The Ring Building is designed for future expansion by the addition of LOBs or support buildings to its outer or inner periphery. It is also possible that future beamlines will be added with a length of up to 1000 m, which will extend substantially beyond the limits of the building. The facility is being designed to allow these long beamlines to be installed in the future with minimal impact on the current building. Accommodation for the long beamlines will include an elevated access corridor between LOB 1 and 2 which will enable pedestrian and forklift traffic to transit the area with the use of ramps and lifts.

### 3.5.2.2 Space Program

Within the Ring Building are the Injection Building, the RF Building, the Ring Tunnel, the Tunnel Mezzanine, and the Experimental Hall. Service buildings connected to the inboard side of the Ring Building will provide HVAC, mechanical, and electrical services to some building components. The Injection and RF Buildings will have their own HVAC systems.

On the exterior of the ring there will be the Loading Dock, Stock Room and Hazardous Material Storage, located adjacent to LOB four. There is also a Grill area for food vending and lunch services, this Grill will be located adjacent to LOB one between LOB one and the main entrance.

### 3.5.2.3 Circulation

The access corridor around the outside perimeter of the Ring Building provides the primary circulation route for the building. It will be designed to handle both pedestrian and forklift traffic. The corridor will provide access to the Operations Center, all of the LOBs, individual laboratories within the LOBs, and the adjacent Experimental Hall. Stairs from the Experimental Hall will provide access to the tunnel mezzanine and the service buildings. The pedestrian bridge spanning the Experimental Hall will allow operators to conveniently walk between the control room and the lobby. Stairs within the service building will provide a means of accessing the ring tunnel from the tunnel mezzanine level.

Egress from the Experimental Hall will be through the four LOBs, the Operations Center, across the tunnel mezzanine and through the service buildings, or through intermediate emergency exit doors spaced around the exterior perimeter of the Ring Building.

The access corridor will incorporate provisions for the long beam lines between the LOBs. This will be a raised steel ramp and corridor that will allow the beam line to run underneath it. There will be a ramp on one end and an access platform lift on the other. Running between the beamlines from this raised corridor will be platform lifts and stairs for access to the beamlines.

### 3.5.2.4 Quality of Life

Although the focus of the Ring Building is the enhancement of scientific inquiry, it is desirable to make the space an environment that researchers will enjoy occupying. Comfort facilities for the Ring Building are provided in the Operations Center and in the five LOBs (two in the base build) within a reasonable distance from all beamlines. An alternate for perimeter windows will bring natural lighting into the space . Exterior shading will prevent direct sunlight from impacting experimental performance.

### 3.5.2.5 Building Construction

#### 3.5.2.5.1 Experimental Hall

The Ring Building exterior walls will be comprised of a built-up sandwiched pre-formed metal wall panel system with rigid insulation and interior metal liner panel. The minimum thermal resistance of the system will be R-20. The panels profiles will be Type A on the exterior side of the Ring and Type B on the inner side of the Ring Building (Tunnel mezzanine).

The roof of the Ring Building will be a curved standing seamed metal roof system. The system will be comprised of the standing seamed roof over R24 rigid insulation, gypsum board sheathing, and structural metal roof deck.

The optional clerestory windows at the Ring Building will consist of 1 in. clear tempered insulated glass with a low-E coating in a thermally broken aluminum frame. The thermal transmission value for the glazing will be a U value of 0.30 in the summer and 0.30 in the winter. The visible light transmission will be 69% and the shading coefficient will be a maximum of 0.44. These clerestories will be included in the design and a bid alternate.

The exterior doors of the Ring Building will be insulated hollow metal doors and hollow metal frames.

Acoustical treatments will line the ceiling and walls to maintain an acceptable noise level in the Experimental Hall.

The Grill area will be of similar construction to the ring building.

The Loading Dock and Stock rooms will be of similar construction to the adjacent LOB. See the building construction for the LOBs in section 3.5.3.

The Hazardous Storage will be made of concrete or concrete block with the appropriate fire rating. The roof will be a poured concrete flat roof with TPO roofing above the concrete. A built-up roofing system is an option in place of the TPO system but not meet LEED requirements for Heat Island or Energy Star Roofing.

#### 3.5.2.5.2 Ring Tunnel

The ring tunnel will be constructed of poured in place standard weight concrete as described in the Building Superstructure section. Additional shielding will be provided in specifically identified areas as required. A shielded door (boronated polyethylene and lead filled steel) will be provided at each beamline allowing access to the Ring Tunnel from the Experimental Hall. Where no door is provided the opening will be blocked up with radiation shield block.

The roof of the Ring Tunnel will have embedded uni-strut at four feet on center for hanging ductwork, cable tray, piping, etc.

#### 3.5.2.5.3 Service Buildings

The service buildings' lower level will be constructed of poured in place concrete walls with a soil berm to the height of the second level. The second level exterior walls will be a built-up metal wall panel system Type B with rigid insulation and interior metal liner panel. The minimum thermal resistance of the system will be R-20.

The roof of the service buildings will be a sloped standing seam metal roofing system. It will consist of a standing seamed roof over R24 rigid insulation, gypsum board sheathing, and structural metal roof deck.

The exterior doors of the service buildings will be insulated hollow metal doors and hollow metal frames.

Each service building will be provided with an opening into the Ring Tunnel that may be filled with concrete block as portable shielding, or be used for a superdoor (radiation shield door made of boronated polyethylene and lead-filled steel door) installation. Initially two doors will be installed.,

A one ton hoist or lift will be provided at each service building for lifting power supplies and other electric gear to the mezzanine level.

#### 3.5.2.5.4 Injection and RF Buildings

The Booster tunnel will be constructed of poured in place standard weight concrete, which will be covered with earth as additional shielding.

The Linac Building will be constructed of a combination of poured in place standard weight concrete and a built-up metal wall panel system Type B with rigid insulation and interior metal liner panel. The minimum thermal resistance of the system will be R-20.

The exterior walls of the Booster Service building and the RF Building will be a built-up metal wall panel system Type B with rigid insulation and interior metal liner panel. The minimum thermal resistance of the system will be R-20.

Interior walls shared with the ring tunnel will be concrete of sufficient thickness to provide adequate radiation shielding.

The roof of these buildings will be a TPO membrane roofing system. It will consist of a mechanically adhered TPO roof over R24 rigid insulation, gypsum board sheathing, and structural metal roof deck. Earth covered structures will include a fluid applied water proofing system.

The exterior doors of the Booster Service building, the Klystron Galley and the RF Building will be insulated hollow metal doors and hollow metal frames.

### 3.5.2.6 Interior Finishes

#### 3.5.2.6.1 Experimental Hall

The Experimental Hall will have the following interior finishes:

- Floor finishes – sealed concrete with a wet slip coefficient of 0.5 or greater.
- Exterior walls – factory-finished wall panels
- Interior walls – factory finished steel or concrete or gypsum board walls – painted.
- Steel – painted
- Roof Structure – painted
- Doors and frames– painted
- Shield doors – factory finish

#### 3.5.2.6.2 Ring Tunnel

The ring tunnel will have the following finishes:

- Floor finishes – sealed concrete with a wet slip coefficient of 0.5 or greater.
- Interior and exterior concrete walls – painted or sealed
- Concrete roof structure – painted or sealed

#### 3.5.2.6.3 Service Buildings

The service buildings will have the following finishes:

- Floor finishes – Sealed concrete with a wet slip coefficient of 0.5 or greater.
- Exterior and interior metal wall – Factory-finished wall panels
- Interior and exterior concrete walls – painted
- Steel – painted
- Doors and frames– painted or factory finished.
- Shield doors – factory finish

#### 3.5.2.6.4 Injection and RF Buildings

The Injection and RF Buildings will have the following finishes:

- Floor finishes – Sealed concrete with a wet slip coefficient of 0.5 or greater.
- Exterior wall – Factory-finished wall panels
- Interior walls – factory-finished steel or concrete or gypsum board walls – painted
- Steel – painted
- Roof Structure – painted
- Doors and frames– painted
- Shield doors – factory finish

#### 3.5.2.6.5 Loading Dock, Hazardous Storage and Stock Room

These buildings will have the following finishes:

- Floor finishes – Sealed concrete
- Exterior wall Loading Dock/Stock Room– Factory-finished wall panels
- Exterior wall Hazardous Storage – Concrete or Concrete Block
- Interior and exterior concrete walls – painted
- Steel – painted
- Doors and frames– painted or factory finished.
- Overhead Doors – Factory Finished.

#### 3.5.2.6.6 Grille

The Grille will have the following finishes:

- Floor finishes – Sealed concrete
- Exterior– Factory-finished wall panels
- Interior walls – painted, see section 3.3.5 for acoustical requirements
- Steel – painted
- Doors and frames– painted or factory finished.

## 3.5.3 Lab Office Buildings

### 3.5.3.1 Architectural Concepts

Five LOBs ( three base build and two future) will be spaced around the exterior of the Ring Building. The LOBs will be the primary entrance for many researchers and beamline staff. A focus on interactive spaces will provide an environment where collaboration is encouraged.

### 3.5.3.2 Future Expansion

The five Lab Office Buildings are being designed with the intent of future expansion. Each LOB is being initially programmed to support six sectors, with one insertion device and one bending magnet beamline per sector. If additional beamlines are added by canting insertion device beamlines, the LOBs will need to expand to support these. The LOBs are designed to expand horizontally along the outside of the Ring Building as future need demands. Services to any expansion, including HVAC, plumbing, power, etc. will be added at the time of the expansion. They are not included in the initial scope of the project.

### 3.5.3.3 Space Program

LOBs 1 and 5 will contain 72 offices, 12 laboratory modules (2 modules per lab for six total labs per LOB), conference rooms, storage, a kitchenette, a machine shop and a delivery / staging space adjacent to the loading berth. The Experimental Hall will have direct access to the staging space via a six foot wide double door. The intent of the Lab Office Buildings is to provide support space for experimentation that is close to the beamlines. Each LOB will support six sectors in the Experimental Hall. The LOB will provide offices for each supported sector. The six laboratories will be shared by all six sectors to minimize duplication of space requirements and lab equipment. Each laboratory will have direct access to the Experimental Hall access corridor via double doors for moving equipment between them. There will be two wet labs per LOB which will have fume hoods. One of these fume hoods will be HEPA filtered.

LOB four will be a shelled space in the base building work with just the exterior envelope included, this includes exterior walls, roofs, doors and windows. Minimum mechanical, electrical lighting and power rough-in and plumbing rough-in that provides minimum life safety for exiting and to prevent freezing of sprinkler piping in the winter.

Each of the three LOBs as well as the two future will be designed to be a separate control area from the Ring Building with a one hour fire separation wall between the LOB and the Ring Building. It will then be up to the NSLS-II administration to determine which of the LOBs is designated one of the three remaining Control Areas. See section 12.4.5 for the code requirements for Control Areas.

#### 3.5.3.4 Circulation

Each Lab Office Building will be primarily one story high with an exception for an upper level mechanical attic (accesses by stairs on the access corridor side of the LOB) and have a parking lot adjacent to the building and an exterior entrance that will be the primary entrance for most researchers and visitors. Direct access to the Experimental Hall will be provided from the lobby/interaction area and will be a controlled access point. Equipment and materials will be brought into the building from a loading area that will also allow equipment to be conveniently moved into the Experimental Hall. Pedestrian traffic to other LOBs or to the Operations Center will be via the access corridor around the perimeter of the Ring Building.

#### 3.5.3.5 Quality of Life

The Lab Office Buildings will be home to staff and visitors who frequently work long and irregular hours. The glass storefront exterior walls will bring natural light into the office space. The glass façade and the relatively small size of the LOBs will create a contrast to the massive form of the Ring Building and will break down the scale. Open space with comfortable seating will encourage cooperative interactions between research teams. A kitchenette will include a sink, refrigerator, and microwave for preparing simple meals. Comfort facilities will include toilets and a shower in each LOB. The building materials and use of natural lighting will provide the Lab Office Buildings with a pleasant work environment.

#### 3.5.3.6 Building Construction

The exterior walls of the LOBs will be comprised of the exterior panel system to match Type A without the liner panel, exterior sheathing, air barrier, 6 in. metal studs, fiberglass batt insulation, and interior gypsum board. The minimum thermal resistance of the system will be R-20. Portions of the LOB exterior will be an aluminum and glass curtain wall.

The roof of the LOBs will be a standing seamed metal roof system. The system will be comprised of the standing seamed roof over R24 rigid insulation, vapor barrier, and structural metal roof deck. There will be an AHU mezzanine within the roof space for air-handling equipment serving the LOB.

The curtain wall windows at the LOBs will consist of 1 in. clear tempered insulated glass with a low-E coating in a thermally broken aluminum frame. The thermal transmission value for the glazing will be a U value of 0.30 in the summer and 0.30 in the winter. The visible light transmission will be 69% and the shading coefficient will be a maximum of 0.44.

The exterior doors will be curtain wall aluminum insulated doors to match the windows or insulated hollow metal doors and frames.

The laboratory walls and doors leading from the LOB to the Ring access corridor will be one-hour rated construction. Walls will be metal stud and gypsum board and the doors will be hollow metal doors and frames.

### 3.5.3.7 Interior Finishes

The LOBs will have gypsum board walls with wood doors and hollow metal frames. The offices will have a side light or interior window to allow natural light into the interior spaces. The interior finishes of the LOBs are as follows:

- Floor finishes, office area and conference rooms – carpet tile
- Floor finishes, laboratories – sheet linoleum
- Floor finishes, lobby – porcelain ceramic tile
- Floor finishes, toilet rooms – porcelain ceramic tile
- Exterior walls - painted
- Interior walls, offices and labs – painted
- Interior walls, conference rooms – paint or wall coverings
- Interior walls, toilet rooms – ceramic tile
- Ceiling system – suspended acoustical tiles and grid or gypsum board at high ceilings
- Acoustical treatments – see section 3.2.5 for acoustical requirements
- Doors – stained wood
- Door frames – painted
- All floor surfaces shall have a wet slip coefficient of 0.5 or greater.

# 4 SUSTAINABLE DESIGN

## 4.1 Design Criteria

### 4.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

### 4.1.2 DOE and Other Governmental Orders

Executive Order 13423 – Strengthening Federal Environmental, Energy, and Transportation Management

Energy Policy Act of 2005

10 CFR Part 433

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities

### 4.1.3 Codes, Standards, and Guides

Building Code of New York State (NYSBC) – 2002 Edition
ASHRAE Standard 90.1-2001 Energy Standards for Buildings Except Low-Rise Residential Buildings
Energy Conservation Code of New York State - 2002 Edition
Leadership in Energy and Environmental Design (LEED) 2.2
LEED for Labs

## 4.2 Sustainable Design Overview and Approach

Sustainable design is an approach that addresses how design decisions will impact the natural environment, building occupants, and the bottom line. Making sustainable design a priority does not mean losing sight of other program requirements such as schedule and budget. Instead, sustainable design is as an additional set of criteria on which to base design decisions.

### 4.2.1 Project Goals

The National Synchrotron Light Source II (NSLS-II) Facility will strive to incorporate a wide range of sustainable strategies and objectives throughout the design and construction process, while meeting the functional requirements of advanced technology and creating a workplace that is environmentally friendly, energy-efficient, and both healthy and pleasant to be in. The team was challenged to design the NSLS-II Facility not only to meet the LEED® (The Leadership in Energy and Environmental Design) requirements but also to address the new Executive Order (EO) 13423 and the clarifying guidance dated March 29, 2007. The EO 13423 titled "Strengthening Federal Environmental, Energy, and Transportation Management" was issued on January 24, 2007 and requires all Federal agencies to lead by example in advancing the nation's energy security and environmental performance by achieving the following goals:

- VEHICLES: Increase purchase of alternative fuel, hybrid, and plug-in hybrid electric vehicles when commercially available.
- PETROLEUM CONSERVATION: Reduce petroleum consumption in fleet vehicles by 2% annually through 2015.
- ALTERNATIVE FUEL USE: Increase alternative fuel consumption at least 10% annually.
- ENERGY EFFICIENCY: Reduce energy intensity by 3 % annually through 2015 or by 30% by 2015.
- GREENHOUSE GASES: By reducing energy intensity by 3% annually or 30% by 2015, reduce greenhouse gas emissions.
- RENEWABLE POWER: At least 50% of current renewable energy purchases must come from new renewable sources (in service after January 1, 1999).
- BUILDING PERFORMANCE: Construct or renovate buildings in accordance with sustainability strategies, including resource conservation, reduction, and use; siting; and indoor environmental quality.
- WATER CONSERVATION: Reduce water consumption intensity by 2% annually through 2015.
- PROCUREMENT: Expand purchases of environmentally-sound goods and services, including biobased products.
- POLLUTION PREVENTION: Reduce use of chemicals and toxic materials and purchase lower risk chemicals and toxic materials from top priority list.
- ELECTRONICS MANAGEMENT: Annually, 95% of electronic products purchased must meet Electronic Product Environmental Assessment Tool standards where applicable; enable Energy Star® features on 100% of computers and monitors; and reuse, donate, sell, or recycle 100% of electronic products using environmentally sound management practices.
- ENVIRONMENTAL MANAGEMENT SYSTEMS: Implement EMS at all appropriate organizational levels to ensure use of EMS as the primary management approach for addressing environmental aspects of internal agency operations and activities.

Our team will evaluate five of the goals listed in the Executive Order that apply directly to new building construction:

- Energy Efficiency
- Greenhouse Gases
- Renewable Power
- Building Performance
- Water Conservation

### 4.2.2 LEED Point System

The LEED Rating System is a voluntary, consensus-based, national rating system developed by the U.S. Green Building Council. LEED provides a complete framework for assessing building performance and meeting sustainability goals. Its current version: LEED Version 2.2 for New Construction and Major Renovations (NC) is being proposed for this project. With this version, USGBC has launched a series of enhancements including LEED on-line which will aid in the documentation and certification process for this project. LEED projects can now submit 100% of their documentation on-line, track Credit Interpretation Requests (CIRs), manage key project details, etc.

Consistent with the USGBC LEED program and the Executive Order the team identified five key principles that define and guide our sustainable approach. These principles will continue to be monitored throughout the design and construction and include the following:

- Site: Sustainable Site Design
- Water: Protecting and Conserving Water
- Energy: Designing for Energy Efficiency and Considering Alternative Energy Sources
- Materials: Optimizing the Environmental Life Cycle of Materials
- IEQ: Enhance Indoor Environmental Quality

The project is evaluated per each LEED criteria which is either a 'Prerequisite' or 'Credit' which results in a point score for certification:

Prerequisites: This category is based on minimum requirements and must be met. No further points will be awarded unless the minimum is achieved. There are a total of seven Prerequisites.

Credits: Credits are evaluated and result in a point score. Under LEED-NC v.2.2 there are 69 total points available.

The certifications levels are available as follows:

| | |
|---|---|
| LEED Certified | 26-32 Points |
| LEED Silver | 33-38 Points |
| LEED Gold | 39-51 Points |
| LEED Platinum | 52-69 Points |

## 4.3 Sustainable Site

- Maximizing the benefit of the existing site can be accomplished though a number of sustainable measures, one of which is stormwater management. The volume of stormwater generated on the site depends on the area of impervious surfaces and it could potentially have a negative Impact on the New York Sound Water Quality.
- To control the quantity of stormwater run-off detention ponds have been designed to capture excess and reduce the impact on the municipal system.
- The possibility of utilizing bio-retention ponds or pervious pavement to treat stormwater runoffs is proposed, in addition to controlling quantity. These strategies help to promote infiltration, and capture and treat the stormwater runoff.
- Our team identified other life Cycle Cost Savings Strategies that can reduce stormwater runoffs and provide significant savings in potable water use for the building. Rainwater Collection System if implemented could in fact contribute to achieving eight LEED Credits and reduce annual potable water usage for the building by up to 7.5 million gallons. Annual Rainwater Collection for the NSLS-II calculated based on 48" annual average rainfall (see Table 4.1 below) from 310,000 sf roof area equals 7,827,000 gal per year. The LEED Credits affected by this approach are as follows: Potable Water Usage Reduction: For 500 Occupants = 778,800 gal/yr (64,900 gal/month) = 3 Credits
- Potable Water Usage Reduction for Process Cooling = 7,050,000 gal/yr (587,500 gal/month) = 1 Innovation Credit

- Stormwater Runoffs Reduction = 2 Credits
- Irrigation = 2 Credits

**Table 4.1 - BNL Monthly Average Rainwater Collection**

| Month | Ave. rainfall inches | Collection area sq. ft. | gal per in. sf | Recovered water % | Collected gallons |
|---|---|---|---|---|---|
| Jan | 3.75 | 310,000 | 0.62 | 85 | 612,600 |
| Feb | 3.42 | 310,000 | 0.62 | 85 | 558,700 |
| Mar | 4.17 | 310,000 | 0.62 | 85 | 681,300 |
| Apr | 4.01 | 310,000 | 0.62 | 85 | 655,100 |
| May | 3.93 | 310,000 | 0.62 | 85 | 642,000 |
| Jun | 3.93 | 310,000 | 0.62 | 85 | 642,000 |
| Jul | 4.44 | 310,000 | 0.62 | 85 | 725,400 |
| Aug | 4.49 | 310,000 | 0.62 | 85 | 733,500 |
| Sep | 4.14 | 310,000 | 0.62 | 85 | 676,400 |
| Oct | 3.83 | 310,000 | 0.62 | 85 | 625,700 |
| Nov | 3.95 | 310,000 | 0.62 | 85 | 645,300 |
| Dec | 3.85 | 3100,000 | 0.62 | 85 | 629,000 |
| Totals | 48 | | | | 7,827,000 |

**Table 4.2 - Rainwater Harvesting System Design Based On One Storage Tank Per Each LOB Building.**

| Quantity | Description | Unit cost | Total cost |
|---|---|---|---|
| 5 | Storage tanks, above ground, 40,000 gal each (200,000 gal total storage) | $1.00 per gal | 200,000 |
| 2500 lf | Aluminum or galvalume gutters and downspouts | $6.00 per lf | 15,000 |
| 5 | "First wash" equipment (piping, strainers, valves, tanks) | $800 each | 4,000 |
| 5 | Distribution equipment (piping, pumps, pressure tanks) | $1200 each | 6,000 |
| 5 | Misc. piping, valves, etc. per tank | $1000 each | 5,000 |
| 1 | Contingency | 10% | 13,000 |
| 1 | Design and engineering fees | 15% | 21,000 |
| TOTAL | | | $264,000 |

(Cost based on other projects. )

## 4.4 Water: Protecting and Conserving Water

Implementing water efficiency measures can reduce potable water withdraws, and often save building owners money. In addition, sustainable water use protects natural water bodies from contamination. To reduce potable water consumption, no permanent irrigation will be provided for the site, the plantings will be native to the region and will require little or no additional water after new growth has been established.

In addition to rain water usage, we will specify water conserving fixtures to provide savings of 20-30 percent less water than the water usage requirements under the Energy Policy Act 1992. Appropriate water treatment will be required prior to water re-use.

## 4.5 Energy: Designing for Energy Efficiency and Considering Alternative Sources of Energy

The impact that energy use has on the environment is broad and long-lived. Almost every aspect of conventional energy use poses some threat to the natural environment. To create energy requires fuel. Harvesting these fuel resources from the Earth, whether they are coal, natural gas, oil or wood, is destructive to natural habitats. Federal Energy Management Program (FEMP) at the US Department of Energy (DOE) released an interim final rule for new federal building energy efficiency standard that requires new buildings to achieve an energy consumption level that is at least 30% below the level achieved under the standard (ASHRAE 90.1-2004).

Implementing energy efficient strategies will include daylighting, high energy efficiency equipment, EMS optimization, ENERGY STAR roof, and commissioning. These will all contribute to a reduction off the baseline- creating a building which will perform at a higher level, ultimately reducing overall energy consumption and reducing operating and maintenance costs.

Some of the Life Cycle Cost Saving Strategy proposed to reach highest possible Energy Efficiency for this project follows:

- Solar shading
- Energy Efficient Building Envelope and Roofing System
- Daylight Harvesting and Occupancy Sensors
- Energy Efficient Lighting System
- Designed to economically turn waste heat into useful heat for loads such as space heating and domestic hot water
- Process load recovery
- Exhaust air heat recovery to be used on 100% outside air handling units.
- On-Site renewable energy sources

Design and construction project’s costs associated with the above energy efficiency strategies can be defined further as the project’s design progresses and LEED Certification Level is approved by the Client.

## 4.6 Materials: Optimizing the Environmental Life Cycle of Materials

Almost 70 percent of all energy invested in a building’s construction is embodied in the materials themselves. Embodied energy is the energy required to extract, transport, process, install, recycle or dispose of these materials. Our team will evaluate the environmental impact, resource efficiency and performance of the proposed building materials. We will consider non-toxic materials from local and renewable sources.

The material selection process will focus on life-cycle issues rather than solely on aesthetic or first cost. The team is committed to maximize use of recycled content materials and those that are manufactured regionally.

Material recycling will be facilitated to reduce waste and conserve resources. The design team will provide for an area dedicated to the separation, collection, and storage of materials for recycling by the building occupants.

Construction Waste Management Plan will be required for this project. A minimum of 75% of construction, demolition and land clearing waste will be recycled and/or salvaged to meet LEED requirements.

The team is committed to specifying locally manufactured materials and recycled content materials that are durable and esthetically pleasing.

## 4.7 IEQ: Enhance Indoor Environmental Quality

The quality of the indoor environment has a significant impact on human health, productivity and quality of life. Sustainable indoor environments promote daylighting, natural ventilation, and interiors that are free of toxins. The result is an interior environment that safeguards occupant health, and reduces operating costs. These can include strategies such as CO2 monitoring System, low VOC and non-toxic materials, air monitoring systems.

A large contributor to the quality of the indoor environment is the indoor air quality; the development and implementation of an Indoor Air Quality (IAQ) Management Plan during construction and pre-occupancy can positively impact both the occupant and the maintenance budget.

In addition to industry standard sustainable initiatives, NSLS-II team will propose specific innovations in sustainability pertaining to IEQ and human comfort. These innovations include using furniture systems which use post-consumer recycled content and reduce harmful VOCs into the working environment. This in conjuncture with the development and utilization of simulated daylight will add to the quality of the indoor working environment providing signification benefits to human health, productivity and quality of life.

## 4.8 LEED Status

In order to keep track of LEED prerequisite and credit point status of the project a tracking spreadsheet has been developed and attached to this report.

A description of the columns included in the spreadsheets is as follows:

- LEED Prerequisite/ Credit. Title and Intent of each prerequisite/credit taken directly from LEED. What the credit/prerequisite is meant to achieve.
- LEED Points Available. Notes the number of points available for each LEED credit if an REQ’D appears in the column, this indicates a prerequisite for which there are no associated points).
- “Yes” / “Maybe” / “No” Status
  - “Yes” The credit can be achieved
  - “Maybe” The credit will be pursued although there is not enough information at this time to assume it will be earned
  - “No” The credit is not achievable.

To meet LEED Certified Level it is required to have a minimum of 26 points. Current design shows that we can achieve 28 Yes and 18 Maybe points. The feasibility of achieving LEED Certified is shown in the LEED Point Summary below and it is also in line with the new Federal mandates. There are minimal cost implications associated with this strategy. These costs can be defined further as the project's design progresses.

**Table 4.3 - LEED NC 2.2 TOTAL POINT SUMMARY**

| **Certified Level** | |
|---|---|
| Yes | 28 points |
| Maybe | 18 points |
| No | 23 points |
| Total Possible | 69 points |
| | |
| SUSTAINABLE SITES | |
| Yes | 5 points |
| Maybe | 7 points |
| No | 2 points |
| Total Possible | 14 points |
| | |
| WATER EFFICIENCY | |
| Yes | 3 points |
| Maybe | 2 points |
| No | 0 points |
| Total Possible | 5 points |
| | |
| ENERGY & ATMOSPHERE | |
| Yes | 3 points |
| Maybe | 1 points |
| No | 13 points |
| Total Possible | 17 points |
| | |
| MATERIALS & RESOURCES | |
| Yes | 7 points |
| Maybe | 0 points |
| No | 6 points |
| Total Possible | 13 points |
| | |
| INDOOR ENVIRONMENTAL QUALITY | |
| Yes | 6 points |
| Maybe | 7 points |
| No | 2 points |
| Total Possible | 15 points |
| | |
| LEED AP AND INNOVATION CREDITS | |
| Yes | 4 points |
| Maybe | 1 points |
| No | 0 points |
| Total Possible | 5 points |

## 4.9 LEED Project Checklist

LEED-NC Version 2.2 Registered Project Checklist is included below for Certified Level.

# 5 STRUCTURAL ENGINEERING

## 5.1 Design Criteria

### 5.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

### 5.1.2 DOE Orders

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities

### 5.1.3 Codes, Standards, and Guides

Building Code of New York State (NYSBC) – 2002 Edition
American Concrete Institute
Building Code Requirements for Structural Concrete (ACI 318-99)
BNL Standards Based Management System Subject Areas
New York State and Suffolk County Department of Health Codes
American National Standards Institute
ANSI 117.1 Accessible and Useable Buildings and Facilities
AISC Specification for Structural Steel Buildings
SJI Standard Specifications for Long Span Steel Joists (LH Series) and Deep Long Span Steel Joists (DLH Series)
American Society for Testing Materials Standards
Factory Mutual
National Institute of Standards and Technology
Occupational Safety and Health Administration (OSHA)
Underwriters Laboratory
New York State Fire Prevention Code - 2002 Edition
Americans with Disabilities Act Accessibility Guideline (ADAAG)
Leadership in Energy and Environmental Design (LEED) 2.2
LEED for Labs

## 5.2 Soil Conditions

### 5.2.1 Subsurface Conditions

The subsurface explorations encountered topsoil lying above a layer of fill overlying a stratified sand deposit that extends to more than 100 ft deep. Topsoil ranging in thickness from 2 to 12 in. was encountered in borings drilled in landscaped areas. Topsoil was not encountered in borings drilled in paved/developed areas. Each of the borings encountered fill ranging in thickness from 2 to 9 ft. This fill is characterized as silty sand or widely-graded sand. Fill was also detected within the upper 1 to 10 feet in CPT soundings made near existing roadways. Several explorations experienced refusals, indicating buried objects within the fill.

A layer of stratified sand, sand with silt, and sand with gravel was encountered below the fill in all of the borings and CPT soundings. The sand is light brown to brown, with density ranging from medium dense to very dense.

Subsurface explorations were terminated within the sand at maximum depths of about 100 ft. A 1999 report on the stratigraphy and hydrogeologic conditions at the lab prepared by the United States Geologic Survey refers to the sand as the “Upper Glacial Aquifer,” and states that the thickness at BNL is about 185 ft. Confining clay units and additional sand and gravel aquifers overlie bedrock, which reportedly occurs at a depth of about 1,500 ft.

The depth to groundwater appears to range from about 21.5 to 36.5 ft below ground surface, depending on the location at the site. This is based on the boring and CPT observations, as well as data collected in 2003 for CFN.

The soil beneath the NSLS-II has an average shear velocity that classifies it as a stiff profile for earthquake design purposes as defined by the New York State Building Code. The corresponding site class is D. The soil is not considered to be susceptible to liquefaction.

It is recommended that foundations be designed as spread footing foundations with slab-on-grade floors. Fill should be removed below footings so they bear directly on the sand deposits, or on a layer of compacted structural fill placed after removal of fill. Maximum allowable bearing pressure is 2.5 tons per square foot on footings at least 3 ft wide.

The site contours indicate that the Experimental Hall floor will range from 9 ft below grade to 4 ft above grade. Floors are well above groundwater levels encountered in the explorations. It is recommended that the slab-on-grade floors bear on a minimum of 6 in. of compacted structural fill placed over the natural sand deposit. The existing fill should be removed below floor slabs due to the tight settlement tolerance. Adequate densification should be accomplished using a heavy roller for both the native sand as well as the structural fill. This will provide a base for the Experimental Hall floor and should yield a low differential settlement when combined with the floor slab design.

Soils beneath the floor slab will settle in response to dead and live loads. It is anticipated that settlement will be complete within about one to two weeks after load application. Settlement resulting from floor slab dead loads and fill required beneath the floor slab is expected to occur during construction, and therefore will not contribute to post-construction settlement. However, the 250 psf live load could cause minor post-construction settlement. GEI calculated that the total and post-construction settlement from the live load to be less than 0.25 inches. Differential settlement will be less than the total settlement.

### 5.2.2 Laboratory Testing

Geotechnical studies of the proposed NSLS-II building site have been performed which included 21 grain size distribution analyses on soil samples recovered from the test borings.

## 5.3 Design Loads

### 5.3.1 Live Loads:

- Laboratories: 125 psf
- Experimental Hall: 250 psf (2000 psf capacity of 15 inch SOG)

- Ring Tunnel: 250 psf (3000 psf capacity of 33 inch SOG)
- Booster Ring 250 psf (2000 psf capacity of 18 inch SOG)
- Tunnel Mezzanine: 250 psf
- Ring Building Access Corridor: 125 psf or wheel loads from fork lift trucks
- Corridors: 100 psf
- Stairs, Lobbies & Viewing Gallery: 100 psf
- Offices: 100 psf (incl. 20 psf for partitions)
- Light Storage Areas: 125 psf
- Mechanical Rooms: 150 psf or actual weight of equipment

### 5.3.2 Snow Loads:

- Ground snow load Pg: 45 psf
- Snow importance factor $I_s$: 1.0 (Category I)
- Snow exposure factor Ce: 0.9
- Thermal Factor Ct: 1.0
- Design snow load: 30 psf + drift where applicable

### 5.3.3 Wind Loads:

- Basic wind speed (3-second gust): 120 mph
- Wind load importance factor $I_w$: 1.00 (Category I)
- Wind exposure: B

### 5.3.4 Earthquake Loads:

- Short period acceleration Ss: 0.25g
- 1 second period acceleration S1: 0.08g
- Site Class: D
- Seismic Use Group: I
- Seismic Design Category: B
- Seismic Importance Factor $I_E$: 1.0 (Category I)

## 5.4 Structural System

### 5.4.1 Foundation:

Geotechnical investigation reports on the project done during the Conceptual Design Phase (August 30, 2006) and Advanced Conceptual Phase (May 25, 2007) by GEI Consultants recommend the foundation system to be spread footings bearing directly on sand deposits or compacted structural fill after removal of existing fill. The recommended maximum allowable bearing pressure is 2.5 tons per square foot.

### 5.4.2 Building Super-Structure:

a) Ring Building:

The overall structure for this building will be in structural steel with curved roof supported by 67'-0" span open web steel joists on columns radially spaced on inner and outer rings @ approximately 21'-0" and 25'-0" spacing respectively. For lateral force resistance, radial steel joists shall be connected to end columns by moment connections and braced frames shall be used circumferentially. The roof deck shall typically be 20 GA – 1 ½" thick steel deck.

Within the Ring Building, there will be the ring tunnel, walls and roof of which shall be constructed in cast-in place concrete. The thickness for walls adjacent to earth berming shall be 20" and the thickness for walls without earth berming shall be 32". The tunnel roof slab shall be 34" thick, designed to provide shielding and support the electrical gear. The tunnel floor slab shall be 33" thick reinforced concrete slab on grade poured in place over compacted sub-grade.

The Experimental Floor shall have 15" thick reinforced concrete slab, poured in place over compacted sub-grade. This slab shall be poured against and tied to the tunnel floor slab with rebar dowels to minimize differential settlement. Isolated from this slab, will be the 8" reinforced concrete access corridor slab, poured over compacted sub-grade near the outer ring and designed for fork lift truck wheel loads.

b) Service Buildings:

These buildings along the inner perimeter of the Ring Building shall be two story structures with concrete exterior walls at the Lower Level supporting the braced steel frames for the Second Floor above. The concrete side walls shall be designed for lateral earth pressure from the berms.

The Second Floor construction shall typically consist of 20 GA – 2" thick composite steel deck with 3" lightweight concrete topping (total slab thickness = 5") supported on framework of steel beams and girders.

The Roof will comprise of structural steel framing supporting 20 GA – 1 ½ " thick steel roof deck.

The First Floor construction shall consist of 6" thick slab on grade reinforced with 6x6 – W2.9 x W2.9 WWF over 6" compacted granular fill and vapor retarder. Vibrating equipment areas will have a structural slab with an air gap between the compacted fill below.

c) Operations Center Building:

This two story building (with alternate third floor) shall have construction similar to the Service Buildings except that the lowest story shall be framed and braced in structural steel too.

d) Lab Office Buildings

These are generally single story structures with Penthouse above the laboratories. The Penthouse floor construction shall comprise of 20 GA – 2" thick composite steel deck with lightweight concrete topping (total slab thickness = 5") supported on framework of steel beams and girders. The roof shall consist of 20 GA - 1 ½ " thick steel roof deck supported on structural steel beams and girders instead of open web steel joists (See sketch SK-6 for typical framing) The use of steel beams/girders will provide better support for the mechanical equipment and systems.

The First Floor construction shall be similar to the Service Buildings.

e) Linac and RF Buildings:

These structures are mainly single story structures with partial mezzanine/ second level floor in the RF Building. Construction of these structures in structural steel is similar to Service Buildings.

f) Access Tunnel:

There will be an Access Tunnel 20' wide and 14' high (clear height) that will go through under the Ring Building for service vehicles .The tunnel retaining walls shall be about18" thick reinforced concrete walls, also supporting the tunnel roof/experimental floor. This may consist of eight span continuous one way reinforced concrete slabs supported on concrete beams spanning between the tunnel walls.

g) Special Considerations:

The floor slab for the Storage Ring Tunnel, the Experimental Hall and the Booster Tunnel shall be designed to allow minimal differential settlement. Thickness of floor slabs, walls, and tunnel roof are driven by radiation shielding requirements and not gravity loads.

The floor slabs of the Storage Ring Tunnel, Booster and Linac tunnel, and the Experimental Hall shall be structurally continuous with no isolation joints or contraction joints.

### 5.4.3 Lateral Load Resisting System:

Lateral loads shall be mainly resisted by braced frames wherever possible, otherwise by moment frames where bracing location would become architecturally prohibitive.

### 5.4.4 Materials

- Concrete (normal weight, unless noted otherwise):

  Foundation and slab on grade: f'c = 4000 psi.

  Piers, walls, grade beams, slabs and stairs on grade: f'c = 4000 psi.

  Light weight concrete for Second Level/Mezzanine Floors: f'c = 4000 psi.

- Reinforcing steel:

  Deformed: ASTM 615, Grade 60.

  Welded wire fabric: ASTM A185.

- Structural steel:

  Wide flanges and tees: ASTM A992, Fy = 50 ksi.

  Channels, angles and plates: ASTM A36, Fy = 36 ksi.

  Steel pipes: ASTM A53, Type E or S, Grade B, Fy = 35 ksi.

  Structural tubes: ASTM A500, Grade B, Fy = 46 ksi.

  Anchor bolts: ASTM F1554, 3/4" dia. min.

  Bolts: ASTM A325, 7/8" dia. min.

- Steel Joists:

  Chord and web sections: ASTM A36, Fy = 36 ksi ; or ASTM A588 Fy = 50 ksi

# 6 MECHANICAL – HVAC SYSTEMS

## 6.1 Design Criteria

### 6.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

### 6.1.2 DOE Orders

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities

### 6.1.3 Codes, Standards, and Guides

Building Code of New York State (NYSBC) – 2002 Edition
American National Standards Institute
ANSI 117.1 Accessible and Useable Buildings and Facilities
American Society of Mechanical Engineers
American Society for Testing Materials Standards
American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Design Guidelines
ASHRAE Standard 90.1-2001 Energy Standards for Buildings Except Low-Rise Residential Buildings
American Water Works Association
ANSI/ASHRAE Standard 62-2001 Ventilation for Acceptable Indoor Air Quality
ANSI/AIHA Z9.5-2003 Standards for Laboratory Ventilation
ANSI/ASHRAE 110-1985 Method of Testing Performance of Laboratory Fume Hoods
Factory Mutual
Mechanical Code of New York State
National Institute of Standards and Technology
National Fire Protection Association (NFPA) Standards
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) Standards for Ductwork Design
Occupational Safety and Health Administration (OSHA)
Underwriters Laboratory
New York State Plumbing Code - 2002 Edition
New York State Fire Prevention Code - 2002 Edition
Energy Conservation Code of New York State - 2002 Edition
Americans with Disabilities Act Accessibility Guideline (ADAAG)
Leadership in Energy and Environmental Design (LEED) 2.2
LEED for Labs

## 6.2 Design Conditions

### 6.2.1 Outdoor:

Summer - 95 °F dry bulb,
76 °F wet bulb

Winter - 0 °F, 15 mph wind

### 6.2.2 Indoor:

**Table 6.1 Indoor Design.**

| Area Designation | Design Temperature ºF | | Accuracy ±ºF | Relative Humidity % | | Accuracy ±%RH |
|---|---|---|---|---|---|---|
| | Winter | Summer | | Winter | Summer | |
| Ring Tunnel | 78 | 78 | 0.18 | 30 | 50 | 10% |
| Experimental Hall | 75 | 75 | 1.0 | 30 | 50 | 10% |
| Booster Ring Tunnel | 78 | 78 | 1.8 | 30 | 50 | 10% |
| Linac | 72 | 75 | 1.8 | 30 | 50 | 10% |
| Klystron Gallery | 72 | 75 | 1.8 | 30 | 50 | 10% |
| RF Building | 72 | 75 | 1 | 30 | 50 | 10% |
| Offices | 72 | 75 | 5 | 30 | 50 | 10% |
| Laboratories | 72 | 75 | 5 | 30 | 50 | 10% |
| Conference Rooms | 72 | 75 | 5 | 30 | 50 | 10% |
| Support Spaces | 72 | 75 | 5 | 30 | 50 | 10% |

### 6.2.3 Air Filtration:

**Table 6.2 Air Filtration.**

| Area | Pre-filters | Final Filters |
|---|---|---|
| Tunnel | 30% | 95% |
| Laboratories / shops | 30% | 95% |
| Experimental Hall | 30% | 95% |
| Linac & RF | 30% | 95% |
| Offices, lobby, support | 30% | 90% |

## 6.3 Utility Systems

### 6.3.1 Chilled water

1. Twenty inch supply and return chilled water pipes will be connected from the existing underground site chilled water system to the building. The chilled water temperature supplied by the Central Plant is 46°F. The flow and supply/return water temperature difference will be measured for cooling energy calculations. Estimated cooling load of the building is 2400 tons. The total chilled water flow is 4100 GPM using 14 °F temperature rise. Chilled water will serve air handling units, electrical power supply units, and miscellaneous cooling equipment. Since the chilled water pumps at the central plant have adequate capacity and head, no chilled water pumps

will be provided in the building. Chilled water will also be used for temperature control trim and redundancy for process cooling water systems located in the service buildings.

### 6.3.2 Steam

Steam is available at the site from the Central Utility Plant at 125 psig.

The estimated peak steam load of the new building is 17,000 lbs/hr, and the estimated size required for the underground steam supply pipe is 8 inch. The condensate will be collected at a duplex condensate receiver and returned to the central plant in a separate conduit using a 3 inch Schedule 80 carrier pipe. Condensate pumps will be sized for 2.5 times the maximum condensate flow and for 40 psig head. Steam flow will be measured for energy calculations.

### 6.3.3 Process Cooling Tower Water

Cooling towers located at the building and operating year around will provide cooling for the process system. The estimated cooling load of 2700 tons will be handled by three cooling towers of 1350 ton each, one of which will operate as stand-by. The system will be sized for 11°F temperature difference and 84°F tower leaving water temperature.

## 6.4 HVAC Systems

### 6.4.1 General Laboratories

In laboratories, a minimum of 12 air changes per hour will be used, providing 2 cfm/sq. ft based on 10 ft ceiling height. Assuming no external heat gain, 1.5 W/sq. ft for lighting, and 165 sq. ft /person for people load, this design will allow 9.5 W/sq. ft miscellaneous heat gain from equipment. After the equipment heat gain and the number of fume hoods are further defined, the supply and exhaust air requirement of the laboratories will be finalized. In order to minimize the systems energy usage, coil loop heat recovery will be provided as an alternate. It consists of glycol heat recovery coils in the air handling units and in the exhaust system. Duplex pumps, each sized for 100% of the maximum capacity will circulate glycol between the coils to transfer heat from the exhaust air into the outside air in the winter. Depending upon outdoor conditions, the system can also be used in the summer to pre-cool the outside air. The Fire Department will have the ability to control the ventilation system to exhaust smoke. The control will be at the fire alarm system panel in the main lobby of the Operational Center and each of the LOB buildings.

### 6.4.2 Accelerator Tunnel

The Accelerator Tunnel HVAC systems consist of five constant volume custom packaged air handling units located along the tunnel in five service buildings. The AHU's will have 2inch double wall construction, galvanized steel inner lining, and stainless steel condensate drain pan. Each unit will include prefilter, silencers, steam preheat coil, cooling coil, dual supply and return fans, 95% final filter, steam humidifier, hot water reheat coil, and a duct mounted low heat density electric reheat coil for final accurate temperature control with SCR controller. The supply and return fans will have Adjustable Frequency Drives (AFD) to compensate for filter loading, allow future flexibility, and provide ease of adjustment during balancing. Supply air will be cooled to 50°F for dehumidification and reheated by the fan heat and hot water reheat coil to 0.9°F (0.5°C) below the required discharge temperature. The final discharge temperature to the tunnel will be controlled by the electric reheat coil to ±0.18°F (0.1°C) accuracy. Four high precision temperature sensors per air handling unit will be located in the tunnel. Their accuracy will be ±0.018°F (0.01°C). Temperature will be controlled by any individual sensor or by the average of the four. Cooling coil discharge temperature will be reset based upon the tunnel relative humidity to maintain RH set point with minimum energy consumption.

### 6.4.3 Experimental Hall

The Experimental Hall HVAC systems consist of ten variable air volume packaged air handling units located in the service buildings, two units per pentant. They will be variable volume terminal reheat type utilizing hot water for reheat. The units will have 2 inch double wall construction with stainless steel condensate drain pans and galvanized steel interior liner. Unit components include return fan, relief and outside air sections, 30% prefilters, silencers, steam preheat coil, cooling coil, supply fan, and humidifier. The supply and return fans will have adjustable frequency drives. Cooling coils will be sized to cool the air to 50°F for dehumidification. Return air will be partially ducted. Return registers will be located above the accelerator tunnel in order to remove the heat generated by the equipment. Hutches will be served by constant volume air terminal units with hot water re-heat coil and two exhaust registers to remove the contaminants. The hutch exhaust systems will be sized for future exhaust requirements and will have 100% redundant fans. One general exhaust system, serving toilets, janitor closets, and other areas requiring exhaust, will be provided for each sector. The Fire Department will have the ability to control the ventilation system to exhaust smoke. The control will be at the fire alarm system panel in the main lobby of the Operational Center and each of the LOB buildings.

### 6.4.4 RF Service Building

The Service building will be served by a rooftop mounted HVAC unit sized for the total sensible equipment load. Depending on the final load, one or two CRAC units will be installed for stand by. Ventilation and humidity control will be provided by a 2inch double wall air handling unit sized for 6 AC/HR but normally delivering 2 AC/HR 100% outside air. The added capacity will also allow the unit to be used for smoke evacuation.

### 6.4.5 Booster Ring Tunnel

The tunnel will be served by a constant volume custom packaged air handling unit, located in the service building. The AHU’s will have 2inch double wall construction, galvanized steel inner lining, and stainless steel condensate drain pan. Each unit will include pre-filter, silencers, steam preheat coil, cooling coil, supply and return fans, 95% final filter, steam humidifier, and hot water reheat coil. The supply and return fans will have Adjustable Frequency Drives (AFD) to compensate for filter loading, allow future flexibility, and provide ease of adjustment during balancing. Supply air will be cooled to 50°F for dehumidification. The Fire Department will have the ability to control the ventilation system to exhaust smoke. The control will be at the fire alarm system panel in the service building.

### 6.4.6 Booster RF Service Room

The Service Room will be served by a variable volume packaged air handling unit located on the roof. The AHU will have 2 inch double wall construction, galvanized steel inner lining, and stainless steel condensate drain pan. The unit will include pre-filter, silencers, steam preheat coil, cooling coil, supply and return fans, 95% final filter, steam humidifier, and hot water reheat coil. The supply and return fans will have Adjustable Frequency Drives (AFD) to compensate for filter loading, allow future flexibility, and provide ease of adjustment during balancing. Supply air will be cooled to 50°F for dehumidification.

### 6.4.7 Linac and Linac Klystron Gallery

The Linac and Gallery will be served by a constant volume packaged air handling unit located in Booster RF Service Room. The AHU will be a constant volume re-heat type with 2 inch double wall construction, galvanized steel inner lining, and stainless steel condensate drain pan. Unit will include pre-filter, steam preheat coil, cooling coil, supply and return fans, 95% final filter, steam humidifier, and hot water reheat coil. The supply and return fans will have Adjustable Frequency Drives (AFD) to compensate for filter loading, allow future flexibility, and provide ease of adjustment during balancing. Supply air will be cooled to 50°F for dehumidification. Constant volume air terminal units will be utilized for individual space temperature control.

### 6.4.8 Operations Center

The Operations Center will be served by a variable volume packaged air handling unit located on the roof of the building. The AHU will have 2inch double wall construction, galvanized steel inner lining, and stainless steel condensate drain pan. Unit will include pre-filter, silencers, steam preheat coil, cooling coil, supply and return fans, 90% final filter, steam humidifier, and hot water reheat coil. The supply and return fans will have Adjustable Frequency Drives (AFD) to compensate for filter loading, allow future flexibility, and provide ease of adjustment during balancing. Variable air volume air terminal units with hot water re-heat coil will be utilized for space temperature zone control.

The computer room and control room will be served by chilled water computer room air conditioning (CRAC) units complete with 90% efficiency filter, humidifier and hot water heating coil.\

The lobby entrance will be served by a constant volume packaged air handling unit located in the mechanical room, complete with 90% efficient filter, cooling coil and hot water heating coil.

### 6.4.9 Lab Office Building

The building will be served by two air handling units located in the penthouse, one to serve the office area and the other to serve the laboratory area. The office area AHU will be a variable volume unit and the laboratory area AHU will be a constant volume unit. Both AHU’s will have 2inch double wall construction, galvanized steel inner lining, and stainless steel condensate drain pan. The office air handling unit will include pre-filter, silencers, steam preheat coil, cooling coil, supply and return fans, 90% final filter, and steam humidifier The laboratory air handling unit will include pre-filter, steam heating coil, heat recovery coil, cooling coil, supply fan, 95% final filter, and steam humidifier. Both AHU’s will utilize Adjustable Frequency Drives (AFD) to compensate for filter loading, allow future flexibility, and provide ease of adjustment during balancing. Variable volume air terminal units with hot water re-heat coil will be used for office area temperature zone control and constant volume air terminal units with hot water re-heat coil will be used for laboratory area temperature zone control.

## 6.5 Air Handling Units - General

All air-handling units will have access sections between the various components to allow efficient airflow through the units and adequate space to perform inspection and maintenance. All units will be installed in draw through configuration providing good dehumidification and even air flow through the cooling coils.

Supply and return fans will be housed centrifugal, belt-driven and will have high efficiency airfoil blades and AMCA label. In order to minimize their vibration, all fans will be dynamically balanced after installation on the job site. Air pre-filters and final filters will be replaceable cartridge type with filter efficiencies based on NBS Atmospheric Dust Spot Method. Their sizes will be standardized 24 x 24 and 12 x 24 inch where possible.

Energy efficient electric motors will be compatible with AFD’s.

## 6.6 Air Distribution

### 6.6.1 Ductwork

All ductwork will be constructed in accordance with SMACNA standards. Supply air ducts will be galvanized steel, and be insulated on the exterior. High-pressure duct upstream of the terminal units will be built to 6 inch WG pressure standards and will be sized for medium velocity. Low-pressure ducts constructed to 2 inch WG will be used from terminal units to diffusers. Flexible run outs to diffusers will allow ease of installation and provide final sound attenuation of terminal unit and duct-generated noise. Exhaust and return ductwork will be low and medium pressure construction sized for 0.075 inch WG/ 100 ft friction loss and/or 1800 FPM velocity maximum. It will be un-insulated except in areas where condensation on duct surfaces may occur. In supply ducts, no internal lining will be used. Galvanized steel will be used for all lab main exhaust ductwork and stainless steel for all exposed branch ductwork.

### 6.6.2 Air Terminal Units

Temperature control of individual spaces will be by constant and variable volume terminal units with reheat coils. Heating coils will have copper tubes with bonded aluminum fins. Separate terminal units will be provided for areas requiring individual temperature control. Offices with similar thermal load, maximum four, may be served by one terminal unit.

### 6.6.3 Diffusers, Registers and Grilles

Four-way, louvered faced supply diffusers and perforated face return and exhaust registers will be used in laboratories and administrative offices.

In noise and vibration sensitive areas, high volume diffusers will be considered. Air devices in large open areas will be sized to provide good air distribution and maximum noise criteria of NC 35.

### 6.6.4 Pressurization

A negative pressurization of 100 cfm per door will be maintained in the laboratories by exhausting more air from the rooms than is supplied.

In toilets, janitor closets, and other less critical areas, negative pressurization will be maintained at 50 cfm per door. The entire building will be kept at positive pressure.

### 6.6.5 Ventilation

Ventilation will be provided as follows:

- Offices, conference rooms and other occupied areas will be provided a minimum of 20 cfm per person.
- The Experimental Hall will be provided 20 cfm per person.
- Laboratories will be provided 6 air changes per hour minimum.
- The Ring Tunnel will be provided 6 air changes per hour.
- The Booster Tunnel and Linac will be provided 6 air changes per hour.
- Service Buildings will be provided 6 air changes per hour.
- The RF Building will be provided 6 air changes per hour

## 6.7 Exhaust Systems

### 6.7.1 Exhaust fans will be provided for the following:

- Fume hoods
- General laboratory exhaust
- Toilet rooms
- Mechanical and electrical rooms
- Process equipment
- Hazardous storage
- Beamline hutches via a common exhaust system
- Other areas requiring exhaust

### 6.7.2 Chemical Fume Hoods

Chemical fume hoods will be designed for a maximum airflow based upon a 100 fpm air velocity with the sash open to 18 in. height. All hoods shall have flow alarms. The Laboratory HVAC system will be a constant volume design utilizing air valves. Fume hoods identified for nanomaterials research will be provided with bag-in bag-out HEPA filtration rated at 99.97% efficiency, with gel seal type filter housing. At least one such hood will be furnished for each LOB. Wet laboratories will also be provided with ventilated chemical storage cabinets integral to the fume hood. All fume hoods shall be configured to be retrofitted with HEPA filtration in the future. Hoods shall be tested in the “As-Installed” condition.

### 6.7.3 Bio-Safety Cabinets

The need for these is yet to be determined.

## 6.8 Distribution Systems

### 6.8.1 Steam Distribution

The building will be served with 125 psig high pressure steam from the central plant which will be reduced in the main utility vault to 15 psig. Two pressure reducing valves, one used as standby, will be provided. The 15 psig steam will be routed underground inside the ring and distributed to the individual service buildings. Steam will be used in preheat coils, heat exchangers, domestic water heaters, humidifiers, and other miscellaneous heating devices. Condensate from the individual service buildings will be pumped to a main condensate receiver located in the central mechanical equipment room. From there, condensate will be returned to the Central Plant. Flash steam from high pressure condensate will be recovered in a flash tank and utilized in the low pressure system.

### 6.8.2 Heating Hot Water

In order to minimize the building’s energy consumption, the primary source of hot water for space heating will be heat pumps located in the individual service buildings. They will recover heat from the process cooling system, utilizing it as the energy source for space heating. Excess heat from the process system will be directed to cooling towers on the site. An alternate to this approach is to use the process cooling water directly as a heat exchange medium. As a back up to the heat recovery system and to provide supplementary heating if necessary, the hot water will be circulated through steam fired heat exchangers located in the individual service buildings. The hot water will be used for terminal reheat coils, reheat coils in air handling units, and in miscellaneous heating devices such as fan coil units, unit heaters, and finned tube radiation. Duplex heat exchangers will each be sized for 100% of the heating load, while redundant circulating pumps will each be sized for 66% of the full flow. Control valves will be two-way type, with three-way valves used at the end of long runs to assure adequate system circulation and minimum 25% flow through the circulating pumps. Isolation valves will be provided for future maintenance, and piping will be designed in a reverse return configuration to simplify balancing.

### 6.8.3 Chilled Water

The pumps at the central plant have adequate capacity to serve the building. Consequently, no local chilled water pumps will be provided. Chilled water will be supplied directly to cooling coils and miscellaneous cooling equipment such as fan coil units. Cooling coils will be selected for 12-14 °F waterside temperature difference. In general, two-way control valves will be used at the air handling unit chilled water coils to achieve flow reduction at low loads, while three-way valves will be provided at the end of long runs to maintain minimum flow. For the electrical power units' cooling, a secondary cooling system will be provided consisting of duplex plate heat exchangers and duplex circulating pumps each sized for 100% of the cooling load.

### 6.8.4 Process Cooling Water

The 18 inch main condenser water supply and return piping will be routed underground inside the ring. It will be distributed to each service building to serve process water for aluminum and non-aluminum system heat exchangers.

### 6.8.5 Humidification

For humidification, steam from the central plant will be utilized by humidifiers in the air handling units to maintain the required humidity levels. Multiple manifold stainless steel humidifiers will be located downstream of final filters and will be selected to minimize vapor trail. Humidity sensors will be located in the return air ducts.

### 6.8.6 Piping Systems

Water and steam piping will be schedule 40 black steel with screwed joints through 2inch and welded joints 2-½inch and up. Schedule 80 black steel will be utilized for condensate return pipe to provide a longer life. Steam and condensate piping shall be pre-insulated with galvanized or epoxy coated steel jacket. Pipe will be provided with fiberglass pipe insulation and all-service jacket with self-sealing lap. Hydronic piping systems will be sized for a maximum velocity of 8 feet per second, and a maximum pressure drop of 4 ft WG per 100 ft. In noise and vibration sensitive areas, velocity will be limited to 4 feet per second. Chilled water piping insulation will be provided with vapor barrier jacket to prevent condensation. In-line circulators will be used for pumps under 1/2 HP. Pumps 1/2 HP and larger will be base mounted end suction or vertical/horizontal split case type. Motors 3 HP and over will be premium efficiency. Strainers, check valves, and temperature and pressure gauges, water treatment system, air and pressure control will be provided. Clean steam supply and condensate return pipes will be stainless steel.

## 6.9 Miscellaneous Heating/Cooling Devices

Fan coil units will be provided in stairways and lobbies for heating, cooling, and humidity control. Unit heaters will be used in mechanical and electrical equipment rooms. Finned tube radiation will be used to offset the "cold wall" effect of exterior walls and windows in offices and other areas.

## 6.10 Energy Conservation

In order to minimize the building's energy consumption and comply with LEED certification criteria, various energy conservation techniques will be evaluated during the design and will be incorporated if analysis is favorable.

### 6.10.1 Energy Saving Measures

For air handling units with 100% outside air, coil loop heat recovery will be provided. The filters and heat recovery coil will be bypassed during non-recovery periods to minimize exhaust fan energy.

The building heating system will utilize heat pumps to recover heat from process cooling.

Discharge temperature of heating hot water will be reset during the summer to minimize heat loss.

Adjustable Frequency Drives (AFD's) will be used for all major air moving devices and pumps. This will provide considerable energy savings for the variable volume air and hydronic systems. For constant volume air handling units serving the laboratories, AFD's will simplify initial balancing, accommodate future changes, and save energy by allowing adjustment as filters become loaded.

High efficiency equipment and high efficiency motors will be selected for all applications.

Non-critical air handling units will utilize optimum start-stop energy management software.

Insulation of piping systems will exceed the applicable energy codes.

## 6.11 Automatic Temperature Control

Direct digital controls compatible with the existing Building Automation System will be utilized. Except for air terminal units, control valves and dampers will have pneumatic actuators. A duplex control air compressor, air dryer, and filter will be installed in the lower level mechanical room.

Air handling units with return fans will have airside economizer, allowing the utilization of 100% outside air for free cooling. A signal from the fire alarm system will shut down all air-handling units. The Fire Department may manually activate a smoke purge.

## 6.12 System Testing and Balancing

### 6.12.1 Waterside

System will be leak tested, and pumps and other equipment will be checked for alignment and proper operation. Flow through pumps will be measured and properly adjusted. Motor amperage will be read and recorded.

### 6.12.2 Air Side

High-pressure supply ducts and all hood exhaust duct systems will be tested for leaks. System fans will be checked for proper rotation and balance, and all drive sheaves will be adjusted for proper airflow. Motor amperage will be read and recorded. Airflow at all terminal units, diffusers, registers, and grilles will be adjusted to specifications and recorded.

## 6.13 Vibration

Minimization of vibration caused by rotating equipment is a primary concern for the NSLS-II facility. Several strategies will be used to accomplish this goal.

1. Rotating equipment will not be located adjacent to the Ring Tunnel or the Experimental Hall. Separation is a primary strategy for reducing the impact of vibration on the machine performance.
2. Mechanical equipment will be isolated from distribution systems using flexible connectors where possible.
3. Major equipment items will be specified at a higher quality level (not commercial standard).
4. Major rotational equipment will be factory balanced.
5. Rotating equipment will be mounted using vibration isolation supports and where applicable, inertia bases will be used.
6. Distribution systems such as piping and ductwork will be supported using vibration isolators.

## 6.14 Commissioning

Due to the size and complexity of the project and in compliance with LEED requirements, a commissioning contractor will supervise and document performance of all equipment startup, balancing, testing and verification.

**Table 6.3 NSLS-II Estimated Cooling Load.**

| | Chilled Water Loads | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Load | Linac | Linac / Klystron Galley | Booster RF | Booster Ring Tunnel | RF Service Building | Tunnel Mezzanine | Ring Tunnel | Experimental Hall | OPS Center | Lab Office Building | Process Chilled Water | Process Cooling Tower |
| EQUIPMENT (KW) | | | | | | | | | | | | |
| Transformers | | | | | | 59 | | | | | | |
| RF power usage | 40 | 40 | 16 | | 264 | | | | | | | 2734 |
| Booster controls | | | 1 | | | | | | | | | |
| Storage Ring controls | | | | | 4 | | | | | | 36 | |
| Cryogenic Plant | | | | | | | | | | | | 1000 |
| RF diagnostics | 1 | | | | 1 | | | | | | | |
| Controls & Instrumentation | 13 | | 64 | 12 | | | | 65 | | | 30 | |
| Vacuum | | | | | | | | 24 | | | 219 | |
| Interlock | | | | | | 32 | | | | | 32 | |
| Tunnel Magnets | | | | | | | 229 | | | | | |
| Tunnel Leads | | | | | | | 95 | 231 | | | | 1872 |
| Power Supply | | | | | | | | 34 | | | 651 | |
| Equipment Leads | | | | | | 189 | | | | | | |
| Sub-total (KW) | 54 | 40 | 81 | 12 | 269 | 280 | 324 | 354 | 0 | 0 | 968 | 5606 |
| Sub-total (MBH) | 183 | 137 | 277 | 40 | 918 | 957 | 1106 | 1208 | 0 | 0 | 3304 | 19132 |
| Walls & Roof (MBH) | 7 | 7 | 16 | - | 13 | 478 | - | 1910 | | | | |
| Lights (MBH) | 17 | 16 | 53 | 34 | 69 | 348 | 195 | 1349 | | | | |
| People Sensible (MBH) | 1 | 1 | 5 | 9 | 9 | 34 | 34 | 137 | | | | |
| OA Sensible (MBH) | 1 | 1 | 4 | 9 | 10 | 101 | 44 | 303 | | | | |
| People Latent (MBH) | 2 | 2 | 5 | 9 | 9 | 34 | 34 | 135 | | | | |
| OA Latent (MBH) | 2 | 2 | 5 | 10 | 10 | 213 | 149 | 446 | | | | |
| Fan Heat to SA(MBH) | 47 | 36 | 79 | 19 | 227 | 409 | 265 | 1036 | | | | |
| TOTAL LOAD (MBH) | 260 | 202 | 443 | 129 | 1265 | 2572 | 1825 | 6525 | | | | |
| TOTAL LOAD (TONS) | 22 | 17 | 37 | 11 | 105 | 214 | 152 | 544 | 48 | 577 | 275 | 1594 |

TOTAL CHILLER LOAD (TONS) 2002 TOTAL COOLING TOWER LOAD (TONS) 1,594

Assumptions:

Fan heat based on 4.5 deg. F rise.
Lab office bldg is based on Calculated Load
OPS Center is based on Calculated Load
Equipment load is based on BNL spread sheet and meeting comments.
Wall & roof load based on calculated skin load
Outside air at 20 cfm/person based on BNL estimated people occupancy.

# 7 MECHANICAL ENGINEERING - PLUMBING

## 7.1 Design Criteria

### 7.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

### 7.1.2 DOE Orders

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities

### 7.1.3 Codes, Standards, and Guides

Building Code of New York State (NYSBC) – 2002 Edition
American National Standards Institute
ANSI 117.1 Accessible and Useable Buildings and Facilities
American Society of Mechanical Engineers
American Society for Testing Materials Standards
American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Design Guidelines
ASHRAE Standard 90.1-2001 Energy Standards for Buildings Except Low-Rise Residential Buildings
American Water Works Association
ANSI/ASHRAE Standard 62-2001 Ventilation for Acceptable Indoor Air Quality
ANSI/AIHA Z9.5-2003 Standards for Laboratory Ventilation
ANSI/ASHRAE 110-1985 Method of Testing Performance of Laboratory Fume Hoods
Factory Mutual
Mechanical Code of New York State
National Institute of Standards and Technology
National Fire Protection Association (NFPA) Standards
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) Standards for Ductwork Design
Occupational Safety and Health Administration (OSHA)
Underwriters Laboratory
New York State Plumbing Code - 2002 Edition
New York State Fire Prevention Code - 2002 Edition
Energy Conservation Code of New York State - 2002 Edition
Americans with Disabilities Act Accessibility Guideline (ADAAG)
Leadership in Energy and Environmental Design (LEED) 2.2
LEED for Labs

## 7.2 Plumbing Systems

The NSLS-II facility will require the following plumbing systems:

- Domestic cold water
- Domestic hot water
- Sanitary sewer
- Tempered water (for emergency eye wash and shower)
- Storm (rain) water drainage

These services will be distributed within the Operations Center, the LOBs, the Experimental Hall, and the Booster / Linac and RF Buildings.

## 7.3 Preliminary Design

### 7.3.1 Plumbing Systems

#### 7.3.1.1 Potable Water

| | |
|---|---|
| Scope/Major elements | Water heaters |
| | Piping and accessories |
| | Safety showers/ eye washes |
| Redundancy | Two mains, with multiple connection points to the site system will connect to form a looped system feeding the building. |
| Cold water supply temperature | Ambient |
| Hot water supply temperature | See Narrative below |
| Coverage | Experimental Hall |
| | Operations Center |
| | LOB |
| Service buildings | |
| Materials of construction | |
| Piping | 3 in. and over: Ductile iron, cement lined (buried) |
| | 3 in. and under: Copper ( above ground) |
| Valves | Ball, globe or gate, bronze |
| Pumps | Stainless steel impeller, shaft |
| | Mechanical seals |
| | Ductile iron casing |
| Tanks | Galvanized steel (storage) |
| | Stainless steel or glass lined (water heaters) |
| Remarks | Disinfected to code requirements |

Single 3 inch domestic water services with valves will be extended from the site water main to the Service Buildings as described below. The available pressure has not been verified at this time. Flow data will be obtained during Title II. Installation of a booster pump is not anticipated.

Supply for the domestic water systems shall originate from the water main loop on the interior (courtyard) side of the Ring Building. This interior loop shall be fed from an exterior (road side) loop water main in two locations. In turn, the exterior loop is also fed from two locations from the water mains on the site. (See Civil discussion for additional information on the water distribution plan.)

A domestic service shall enter each of the Service Buildings and supply the water system for the Service Building, adjacent LOB, and approximately 20-percent of the Ring Building. The service will be provided with two (2) full size ASSE 1013 listed reduced pressure backflow prevention devices piped in parallel. Potable water serving the facility will be used for both the domestic and laboratory plumbing fixtures and equipment.

Laboratory faucets will incorporate integral vacuum breakers, and make-ups to mechanical and laboratory equipment will be provided with appropriate backflow prevention devices.

Domestic hot water will be provided at each laboratory building mechanical equipment room and include a circulated piping system. Hot water will be produced by a storage type electric water heater. The hot water will be stored at 140°F and distributed to lavatories and laboratory fixtures at 120°F through a thermostatic mixing valve.

A tempered (85°F) water distribution piping system will be provided through a thermostatic mixing valve and used as the source for the eyewash / safety showers located throughout each laboratory building. The system will be circulated.

Type "L" copper tubing with wrought copper or cast brass fittings and solder joints will be the pipe material. The pipe joints will be formed with 95-5 tin-antimony solder or code approved "lead free" solder and flux having a chemical composition equal to or less than 0.2-percent lead. Piping 2 in. and smaller may be joined with fittings utilizing a copper crimping system such as the Rigid/Viega ProPress System. 2½ in. piping and over may be schedule 40 galvanized steel with threaded or mechanical couplings (Victaulic style connections). The piping will be insulated with fiberglass pipe insulation having an all service jacket and self-sealing lap.

#### 7.3.1.2 Sanitary

At a minimum, each LOB and Service Building will have a sanitary sewer connection to the site sanitary sewer. Due to the anticipated elevations of the site sanitary sewers, several of the LOB’s will need to have sewage ejectors. The remainder will be gravity flow. (See Civil Discussion for additional description of the site sanitary sewers.)

The sanitary drainage system will provide drainage facilities for the toilet fixtures and mechanical room drains. The piping will typically be 4-inch where water closets are served, and 3-inch otherwise. The associated vent piping will be 2-inch and 1 1/2-inch respectively.

Horizontal collection into the building drain will occur below the slab of the First floor and generally exit by gravity to the site sanitary sewer.

To facilitate maintenance and reliability of service, cleanouts will be provided throughout the drainage system. Generally, these will be in accordance with Code requirements, however, consideration of placement will also address accessibility and disturbance to the ongoing functions of the facility. Cleanouts will be the same size as the pipe to which they are connected up to 4-inch, and for larger sizes the cleanout will not exceed 4-inch. Long sweep ells, or wye and 1/8th bends will be utilized to transition from the cleanout to the pipe to permit easy entry for maintenance.

Service weight cast iron soil pipe and fittings was selected as the piping material for this system. Cast iron piping has repeatedly proven its dependability of service. Two methods of joining the pipe and fittings are available. The gasketed bell and spigot joint using a neoprene gasket will be used for the portions of the system placed underground. The no-hub clamped joint using a one piece neoprene gasket, and stainless steel shield with retaining clamps will be used for the above ground portions where the possibility of modifications exist.

### 7.3.1.3 Storm (Rain) Water Drainage

Storm water will be collected utilizing commercially available drains of style, size, and quantity consistent with the area being drained. Sizing of the drains and collection piping will be based on using a rainfall rate of 3 inches per hour for a storm of 1 hour duration and 100 year return for the primary roof drainage system. Where required, emergency overflow drains and piping will be provided. The piping will generally be routed vertically from the drains to below the First floor slab where it will be collected horizontally and discharge by gravity to the site storm sewers.

Cleanouts will be provided and will follow the same parameters described for the sanitary drainage system.

The pipe materials will be the same as those selected for the sanitary drainage system.

# 8 FIRE PROTECTION

## 8.1 Design Criteria

### 8.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

### 8.1.2 DOE Orders

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities
10 CFR 851

### 8.1.3 Codes, Standards, and Guides

Building Code of New York State (NYSBC) – 2002 Edition
American National Standards Institute
ANSI 117.1 Accessible and Useable Buildings and Facilities
American Society for Testing Materials Standards
Factory Mutual
Mechanical Code of New York State
National Institute of Standards and Technology
National Fire Protection Association (NFPA) Standards
Occupational Safety and Health Administration (OSHA)
Underwriters Laboratory
New York State Fire Prevention Code - 2002 Edition
Americans with Disabilities Act Accessibility Guideline (ADAAG)

## 8.2 Preliminary Design

### 8.2.1 Fire Zones

The NSLS-II complex is divided into five fire zones, corresponding to the ring pentants.

### 8.2.2 Fire Protection System

| | |
|---|---|
| Scope/Major elements | Fire water main |
| | Hydrants |
| | Piping, sprinklers and accessories |
| Redundancy | System loop is fed from two connection points to the site system |
| Capacity | Per Code |
| Coverage | Entire NSLS-II complex |
| Hazard classifications | Ordinary Hazard Group 1 unless noted otherwise |
| Accelerator tunnel | See narrative |
| Experimental Hall | See narrative |
| Office / Public spaces | See narrative |
| Utility areas | See narrative |
| Gas cabinets | See narrative |
| Chemical storage areas | Extra Hazard Group 2 |
| Fire hose allowance | Per NFPA 13 |
| Fusible link rating | As required for application |
| Minimum supply pressure | TBD |
| Materials of construction | |
| Piping | Ductile iron, cement lined (buried) |
| | Schedule 40 black steel (above ground) |
| Valves | Butterfly or OS&Y – Supervised |
| Pumps | Not required. |

Within each fire zone a single fire service will be extended from the site water main to the Service Buildings as described below. The available pressure has not been verified at this time. Fire flow data will be obtained during Title II from the BNL Fire Protection Engineering Group. Installation of a fire pump is not anticipated.

Supply for the fire protection systems shall originate from the water main loop on the interior (courtyard) side of the Ring Building. This interior loop shall be fed from an exterior (road side) loop water main in two locations. In turn, the exterior loop is also fed from two locations from the water mains on the sight. (See Civil discussion for additional information on the water distribution plan.)

A fire service shall enter each of the Service Buildings and supply the four (4) combined sprinkler and standpipe systems for the Service Building, adjacent LOB, and approximately 20-percent of the Ring Building. The service will be provided with two (2) full size Underwriters Laboratory and Factory Mutual listed reduced pressure principle backflow prevention devices piped in parallel. Downstream of the service entry there will be a wet alarm valve assembly for the combined sprinkler and standpipe systems. The combined sprinkler and standpipe systems are: the Service Building with the area above the Mezzanine floor, the remained of the Experimental floor, the Tunnel, and the LOB. Each floor within a system shall be individually annunciated and provided with a supervised zone control valve. The header will have two (2) fire department Siamese connections. One connection shall be located on the front face of the building, and the other on the interior face (courtyard) of the building. Each shall be located near an entry point into the facility. A water motor gong connected to each wet alarm valve assembly will be provided. The water motor gong shall be located adjacent to the entrance on the exterior interior ring wall.

The multiple wet sprinkler systems will be designed to provide 100-percent protection of the facility. A 2 inch capped pipe fed from the Experimental floor sprinkler system shall be provided by each of the beamline entrances for protection of hutches. Where the piping installation will be subject to freezing temperatures, dry sprinklers will be employed.

Interior piping will be Schedule 40 steel pipe. No other piping material will be acceptable. The piping will be joined by welding, threaded fittings, or roll-groove fittings and couplings. Pipe and fittings used in dry pipe portions of the system will be galvanized inside and outside.

Unless otherwise indicated, the entire sprinkler system will be designed as an Ordinary Hazard Group 1 occupancy with 0.15 GPM/SF density. The remote hydraulic area for each system shall be calculated at 2500 square feet.

A fire standpipe system is not required for this facility based on the Building and Fire Codes of New York State. However, per BNL's requirements, a fire standpipe system will be provided that will serve 2-1/2 inch fire department valves. These valves will be located in the Ring Building approximately every 200 feet around the Experimental Hall. The 2-1/2 inch fire department valves will have 2-1/2 x 1-1/2 inch reducers. Additional fire department valves will be located in stairs and at all other entrance as required to achieve total coverage. Hose valves in stairs shall be located on the floor level and not the intermediate level stair landing.

Fire hydrants will be located along the Loop Road outside of the Ring Building and along the Service Road inboard of the Ring Building at distances meeting DOE and local code requirements, but not more than 300 ft from all building entrances. Hydrants will not be located less than 50 feet from the building.

# 9 PROCESS SYSTEMS

## 9.1 Design Criteria

### 9.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

### 9.1.2 DOE Orders

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities

### 9.1.3 Codes, Standards, and Guides

Building Code of New York State (NYSBC) – 2002 Edition
American National Standards Institute
ANSI 117.1 Accessible and Useable Buildings and Facilities
American Society of Mechanical Engineers
American Society for Testing Materials Standards
American Water Works Association
ANSI/AIHA Z9.5-2003 Standards for Laboratory Ventilation
Factory Mutual
Mechanical Code of New York State
National Institute of Standards and Technology
National Fire Protection Association (NFPA) Standards
Occupational Safety and Health Administration (OSHA)
Underwriters Laboratory
New York State Plumbing Code - 2002 Edition

## 9.2 Preliminary Design

Process systems will be provided to NSLS-II to meet the needs of the accelerator, beamlines, and laboratories. The following process systems are included:

- Nitrogen
- Liquid nitrogen
- Compressed air
- Deionized water
- Process Cooling Water (provided by Accelerator Systems)

### 9.2.1 Nitrogen

| | |
|---|---|
| Scope/Major elements | Site nitrogen skid, evaporator |
| | Piping and accessories |
| Redundancy | None* |
| Supply pressure | 100 psig |
| Coverage | Experimental Hall |
| | Lab Office Buildings |
| Materials of construction | |
| Piping | Type L hard-drawn copper, oxygen cleaned |
| Valves | Ball, full port, brass, 3-piece, oxygen cleaned |

*System redundancy is initially not provided, however the system will be configured to add an additional nitrogen tank and vaporizer in the future as beamlines are added and demand increases.

The source for gaseous nitrogen will be vaporizers installed at the liquid nitrogen tank. Primary distribution will occur in the Ring Building. Secondary mains serving the lab/office buildings will be valved to permit isolation for maintenance and modifications. Branches serving individual laboratory modules will be valved.

Piping material will be type L copper tubing with wrought copper fittings and solder joints utilizing 95-5 tin-antimony solder.

The gaseous nitrogen distribution system will be designed to maintain a maximum pressure drop of 10-percent from the point of discharge to the farthest outlet.

### 9.2.2 Liquid Nitrogen

| | |
|---|---|
| Scope/Major elements | Site nitrogen skid |
| | Piping and accessories |
| Redundancy | None* |
| Coverage | Experimental Hall |
| | RF Building |
| Materials of construction | |
| Piping | Vacuum jacketed |

*System redundancy is initially not provided, however the system will be configured to add an additional nitrogen tank and vaporizer in the future as beamlines are added and demand increases.

Liquid nitrogen will be stored in a centrally located tank between LOBs 4 and 5. Primary distribution will occur in the Ring Building with connection points available for beamline use and the RF cryo systems area. Filling stations will be provided at each lab/office building to permit dewars to be filled.

The piping distribution system will be through vacuum jacketed piping with either a dynamic or static vacuum. The piping shall contain an inner carrier tube and an exterior jacket. The annular space shall be under vacuum and have appropriate spacers. The system components (piping, fittings, valves, etc.) shall be products manufactured by, or provided by, a single manufacturer and not built up assemblies.

### 9.2.3 Clean Dry Compressed Air

| | |
|---|---|
| Scope/Major elements | Filter / dryer skids |
| | Piping and Accessories |
| Redundancy | Oil free back-up compressor / dryer skid |
| Capacity | TBD |
| Supply pressure | 100 psig from site system |
| | 95 psig after regulator |
| Quality | Clean (Oil free), dry air |
| Moisture | -20°F dew point |
| Particulate | 1 micron |
| Coverage | Experimental Hall |
| | Central Lab Office Building |
| | Lab Office Buildings |
| | Service buildings |
| Materials of construction | |
| Piping | Hard-drawn copper, brazed |
| Valves | Ball, full port, brass |

The source for the laboratory compressed air will be the site wide 100 psig system. The site system is oil free, filtered, clean, and dried to minus 20°F dew point.

To assure clean, dry compressed air delivery to the laboratories, the incoming service will be provided with a 1 micron coalescing filter to collect moisture and/or particulates originating in the site distribution piping. The filter will be designed to remove all particulates 1 micron and larger, and 100% of liquid water. A pressure regulator will be installed downstream of the filter and set for a discharge pressure of 95 psig. Individual connection points for personnel use will be provided with a regulator set limiting the pressure to 30 psig.

Piping for the system will be Type L copper tubing (ASTM B819) with wrought copper fittings and brazed joints. All components including valves will be cleaned for oxygen service and capped and/or bagged by the manufacturer for delivery to the site for installation. Assembly will be with brazing filler alloy without the use of flux.

Note: During the detailed design phase the need for both a GN2 system and compressed air system will be evaluated. It may be feasible to just utilize GN2 in lieu of compressed air service. The compressed air main will be run to the NSLS II site as part of the connection to the central chilled water system and will be available if deemed necessary.

### 9.2.4 Deionized Water

| | |
|---|---|
| Scope/Major elements | DI water |
| | Point-of-use systems |
| Redundancy | |
| Capacity | |
| Supply temperature | 78 F |
| Supply pressure | |
| Make-up water source | Potable water make-up system |
| Coverage | Lab Office Buildings Laboratories |
| Water quality | |
| Resistivity | 1 mega-ohm/cm (min) |
| Materials of construction | |
| Piping | Sch. 80 polypropylene |
| Tanks | GRP, stainless steel |
| Valves | Diaphragm or ball, polypropylene |
| Pumps | Stainless steel |

Each Lab Office Building that requires DI water as a consumable will be provided with a separate point-of-use water system. The system will include polishing, storage, and distribution components. Point-of-use polishing units will be installed in the laboratory designated for “wet use” in each LOB.

### 9.2.5 Process Cooling Water

The deionized process cooling water systems for the Booster, Linac, Storage Ring and beamlines are included in the Technical Construction portion of the NSLS-II project. These systems will be located in designated space in the Service Building and the equipment areas of the Injection and RF Buildings. Conventional Facilities will provide process cooling tower water and chilled water to these systems.

The process cooling tower water system will reject the majority of the process loads captured by the process water systems. Chilled water will be used to finely control the cooling water temperature. Plate and frame heat exchangers located in the mechanical equipment room spaces will reject heat to both the process cooling tower water system and the chilled water system. Process cooling water piping will be distributed around the perimeter of the Ring Building. Chilled water piping will be insulated to prevent condensation at low supply water temperatures. Cooling tower water and process cooling water systems will not require insulation.

# 10 ELECTRICAL ENGINEERING

## 10.1 Design Criteria

### 10.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

### 10.1.2 DOE Orders

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities

### 10.1.3 Codes, Standards, and Guides

Building Code of New York State (NYSBC) – 2002 Edition
National Electrical Code, NFPA 70, 2008.
Standard for Electrical Safety in the Workplace, NFPA 70E, 2004
National Fire Alarm Code, NFPA 72, 2002
Life Safety Code, NFPA 101, 2006
Emergency and Standby Power Systems, NFPA 110, 2005
29 CFR 1910, Occupational Safety and Health Standards
29 CFR 1926, Safety and Health Regulations for Construction
Energy Conservation Code of New York State - 2002 Edition
Americans with Disabilities Act Accessibility Guideline (ADAAG)
Leadership in Energy and Environmental Design (LEED) 2.2
LEED for Labs

## 10.2 SITE UTILITIES

### 10.2.1 Relocation and/or Demolition of Existing Utilities

The scope of relocation and/or demolition of existing electric and communication utilities will be based on a utility survey and the final building footprint. Existing utilities around the perimeter of the site that are active will remain, while utilities that cross the site and are abandoned will be removed where they cross under the footprint of the building.

### 10.2.2 Building 603 Substation Expansion:

The Building 603 campus substation will be expanded to include a fourth transformer (Transformer #0) to support the NSLS-II project. Plans and specifications associated with this work and modifications within

Building 603 will be provided in a separate package to allow early construction to begin in advance of the NSLS-II building package.

The existing 69 kV substation yard will be modified to allow the new equipment to be installed. The two existing 69 kV potential transformers will be relocated. A new 69 kV SF6 breaker and a new 20.0/26.7/29.9 MVA, 66.0-13.8 kV transformer will be provided. A new fire separation wall will be provided between the existing Transformer #3 and the new transformer. The exterior of Building 603 adjacent to the Transformer #0 will be sprayed with an exterior grade fire proofing material.

Within Building 603, the existing walls around the storage room will be removed and a new 275 ft2 addition with a roll-up door will be provided to house the relocated supplies. Existing utilities above the proposed location of the new switchgear line-up will be rerouted.

The new Bus #0, 15 kV, SF6 metal-clad switchgear will be located over the existing cable trench and adjacent to the existing Bus #2 switchgear.

The Bus #0 switchgear will include a 2000 A main breaker, three 2000 A tie breakers to Bus #1, Bus #2, and Bus #3, one 1200 A outgoing breaker to feed the NSLS-II project, and three cells for future 1200 A outgoing breakers.

A new 2000 A tie breaker will be provided in each of the existing Bus #1, Bus #2, and Bus #3 switchgear lineups.

A new 1200 A outgoing breaker will be provided in one of the empty cells in the Bus #2 switchgear to provide redundant service to the NSLS-II Project.

Modifications to existing switchgear will match their respective manufacturer’s standards.

2000 A, 15kV busway will be utilized between the new transformer and the new switchgear, and to interconnect the new switchgear to each of the existing lineups.

### 10.2.3 Campus Distribution:

Two 1000 A feeders will be provided to serve the NSLS-II Project. The primary feeder will originate at the Bus #0 switchgear in Building 603. An alternate for a back-up feeder will be included which will originate at the Bus #2 switchgear.

Each feeder will consisting of two sets of 3-1/C, 1000 kcmil, 15 kV, MV-105, 133% EPR copper conductors and will be routed through a new manhole and duct bank system from Building 603 south along North Sixth Street, and west along Brookhaven Avenue to the NSLS-II site. The duct bank will be a 6-way 6 in. concrete encased duct bank.

The manhole and duct bank portion of this work will be included in the Building 603 substation upgrade package. The feeder cables will be included in the NSLS-II building package.

### 10.2.4 NSLS-II Site Distribution:

The site distribution system will be configured in a primary selective scheme with all unit-substations connected to the primary feeder.

A 6-way 6 in. concrete-encased duct bank will be routed from a manhole at Brookhaven Avenue to a manhole in the infield of the Ring Building via the basement utility room. A 6-way 6 in. duct bank will then be routed around the infield interconnecting all the unit-substations. Each 1000 A feeder consisting of two sets of 3-1/c, 1000 kcmil, 15 kV, MV-105, 133% EPR copper conductors will be routed to the “A” and “B” switches receptively of each unit-substation.

One unit-substation will be located at each Service Building #1 through #5 and at the Linac / Booster Building. Two unit-substations will be located between the Cryo Plant and the RF Building..

Each unit-substation will consist of primary switchgear, a 13,800-480Y/277 V, oil-filled substation type transformer, and a secondary air terminal section. The primary switchgear will be 15 kV outdoor, non-walk-in metal-enclosed switchgear with a key-interlocked duplex switch in series with one set of fuses. Each 2000 or 2500 kVA transformer will be triple rated 55˚ OA, 65˚ OA, and 65˚ FA. A duct bank and secondary feeder will be extended from the secondary air terminal cabinet to the 480 V switchgear located in the main electrical room of each service building. In lieu of a secondary air terminal cabinet, the unit-substations serving the Cryo Plant and RF Building will include outdoor walk-in 480Y/277 volt switchgear for distribution of feeders to loads within the Cryo Plant and RF Building.

An outgoing 480 V feeder in two 4 in. ducts (minimum one spare) will be provided from switchgear #2 to the process cooling tower facility on the north side of Brookhaven Avenue.

### 10.2.5 Voice/Data:

A new four-way 4 in. concrete-encased ductbank will be provided from existing manhole MH-84 to the BDF room in the Operations Building. The ductbank will be used for both copper and fiber optic cables.

Copper cables will be routed from Building 537 to the BDF via manholes MH-85 and 84.

Fiber optic cable will be routed from Building 515 near the intersection of Brookhaven Avenue and Rochester Street through existing ductbanks and manholes MH-14B, 14H, 87, 86, 85 and 84 and through a new 4-way 4” duct bank from MH-84 to the BDF.

### 10.2.6 Street Lighting:

New street lighting, matching the Brookhaven standard, will be provided along Brookhaven Avenue between Groves Street and the last vehicle entry point into the site, and along Groves Street between Brookhaven Avenue and its last vehicle entry point into the site. Pole mounted full cut-off fixtures will be provided to comply with LEED and Dark-sky requirements. The street lights will be circuited to building lighting panels via the building low-voltage lighting control panels.

## 10.3 Interior Power Distribution

### 10.3.1 Service Building Power Distribution:

A 3000 or 4000 amp, 480Y/277 V, 3-phase, 4-wire switchgear will be located in each of the five service building main electrical rooms. Each switchgear will include a main breaker section, and two or more distribution sections. The main sections will contain a drawout power air circuit breaker, CTs, digital meter with communication, and surge suppression equipment. Feeder devices in the distribution sections will also be drawout power air circuit breakers.

480 Y/277 V distribution panels will be located in the mechanical rooms on both levels to serve lighting and mechanical equipment. Receptacle panels will be located adjacent to each mechanical panel to serve receptacles and other 120 V equipment.

Electrical power loads are shown in Table 10.1 at the end of this section.

### 10.3.2 Tunnel and Tunnel Mezzanine Power Distribution:

Most of the equipment that supports the storage ring is located on the mezzanine above the tunnel and operates at 120 or 208 V. Power to this equipment will be distributed on a per cell basis with 6 cells served by each of the five Service Building switchgear line-ups (each cell serves two beamlines). A separate 480Y277 V feeder will serve one distribution panel at each cell. This panel will in turn sub-feed five 208Y120 V panels via separate transformers. A separate transformer and double section panel will be provided for each of the three single magnet power supply racks. A fourth transformer and double section panel will be provided to serve the vacuum instrument racks. A fifth transformer will serve Experimental Hall equipment.

To reduce arc-flash hazard, transformer sizes will be limited and remote controlled electrically operated molded case circuit breakers will be provided in the 480Y/277 V panel.

Future branch circuits can be routed from the panels to the racks in conduit or cable tray supported by a support grid mounted above the Mezzanine.

Lights and miscellaneous receptacles will be circuited to panels located in the adjacent service building.

### 10.3.3 Experimental Hall Power Distribution:

A fifth transformer and single section panel will be provided at the tunnel mezzanine to serve Experimental Hall equipment. These panels will sub-feed two single section panels at the mezzanine level, one above each ratchet wall to serve equipment associated with that beamline.

Future branch circuits can drop out of these panels and be routed across the Experimental Hall on a support grid to equipment located along the beamline. Distribution panels for future beamlines between LOB2 thru LOB 4 will be provided with future beamlines.

Lights and miscellaneous receptacles in the Experimental Hall will be circuited to panels located in the adjacent service building.

### 10.3.4 Injection Building Power Distribution:

One 3000 A switchgear line-up will be located in the mechanical / service room. This switchgear will be dedicated to Linac and Booster equipment within the Injection Building.

### 10.3.5 RF Building/Cryo Plant Power Distribution:

Two 3000 A outdoor walk-in switchgear line-ups will be located at each unit-substation in the electric yard between the RF Building and the Cryo Plant. One line-up will serve loads within the RF Building. The second line-up will serve loads associated with the Cryo Plant.

### 10.3.6 Lab Office Building Power Distribution:

Each Lab Office Building will be provided with a 480Y/277 V panel fed directly from the switchgear in the associated service building. These panels will sub-feed two additional panels, one in each third of the building. These panels will serve lighting and mechanical equipment within the Lab Office Building, and sub-feed 208Y/120 V panels to serve receptacles in the labs and office areas.

Within each lab, two-compartment surface mounted raceway will be provided at bench tops and around the perimeter of the lab. Equipment in the center of the room will be served by surface-mounted raceways mounted on overhead ceiling-mounted service carriers.

### 10.3.7 Emergency Power:

Because of the building’s large size, two generators will be provided, one each at Service Building #2 and at the RF Building. The assumed size of each generator is 250 kW. A sub-base fuel tank in compliance with

Suffolk County Article 12 will be provided with a 12-hour full load operation capacity. To reduce noise and vibration, a weatherproof, sound attenuated reach-in enclosure will be provided.

Two automatic transfer switches will be provided; one to serve code required emergency loads, and one to serve optional standby loads. The emergency loads include egress and exit lighting, the fire alarm system, fire suppression system, smoke exhaust fans, selected lab exhaust and make-up systems, and select HVAC control systems. The emergency loads will be reenergized within 10 seconds of sensing a power outage.

The optional standby loads are not defined, but will likely include selected laboratory equipment, one switched light fixture in each lab, and the communication and security systems. Optional standby loads may be delayed to limit motor starting kVA.

### 10.3.8 Uninterruptible Power Supply (UPS):

A UPS will be provided to support the Control Room and Computer Room. The preliminary size is 30 kVA.

If uninterruptible power is required for a specific piece of lab or experimental equipment, point-of-use UPS units will be provided by the users.

### 10.3.9 Voltage Utilization:

- Site distribution – 13,800 V, 3-phase, grounded wye distribution system.
- Building lighting - 277 V
- Motors 1/2 horsepower and larger - 480 V, 3-phase
- Motors less than 1/2 horsepower - 120 V
- Equipment – As required by nameplate, except special voltages and frequencies including 220 V, 230 V, 240 V, 380 V, DC, 50 Hz, 400 Hz, 415 Hz, etc. will require user provided point-of-use transformers and/or frequency converters.

### 10.3.10 Voltage Drop:

Voltage drop will be limited to 2% in feeders and 3% in branch circuits.

### 10.3.11 Feeders and Branch Circuits:

All conductors will be copper installed in conduit. Conductors #3 and smaller will have THWN insulation. Conductors #2 and larger will have XHHW insulation.

Conductors #10 AWG and smaller will be solid. Conductors #8 AWG and larger will be stranded. Minimum size conductors will be #12 AWG for branch circuits, #14 AWG for control wiring and #18 for signal cables.

All feeder and branch circuit conductors will be provided with color coded insulation throughout their entire length.

Separate neutral conductors will be provided for each receptacle circuit. Insulation of neutrals will be provided with three colored strips matching their associate phase conductors. Insulation of neutrals serving two or three pole circuits will be solid.

All feeders and branch circuits will be provided with a green insulated equipment grounding conductor.

All branch circuits serving sensitive electronic laboratory receptacles and equipment will be provided with a green with three yellow strips isolated equipment grounding conductors.

Generally, conduit will be electrical metallic tubing with compression fittings. Conduit below grade will be concrete encased schedule 40 PVC. No conduit will be imbedded within slabs on or above grade.

### 10.3.12 Arc-Flash Hazard Analysis:

An arc-flash hazard analysis will be performed during design to compare different distribution system configurations and again during construction using installed component characteristics to determine actual incident energy levels and recommended boundary information and PPE category.

## 10.4 Grounding

### 10.4.1 Grounding Electrode System

The grounding electrode system will consist of underground metal piping, building steel, concrete encased 250 kcmil Ufer ground within all exterior wall foundations with direct buried cross connecting 250kcmil conductors 100 ft on center, and 10 ft ground rods spaced at approximately 100 ft on center around the perimeter.

A ground grid will be provided at the Building 603 substation expansion, and at each unit substation transformer at the project site to reduce earth resistance and to limit step and touch potential.

All underground connections will be exothermically welded.

The ground grid shall be designed to provide <5 ohms of resistance to earth.

A main ground bus will be located in the main electrical room at each service building. The grounding electrode conductors, interior metal pipe grounds, and the telecommunication ground will be connected to the main grounding bus.

### 10.4.2 Power System Grounding:

All power system grounding will be in accordance with the NEC.

The secondary of each 13,800-480Y/277 V substation transformer will be grounded at the substation. The grounded neutral will be re-bonded at each switchgear main breaker.

The generator neutral will be grounded at each generator. Four-pole automatic transfer switches will be provided.

The secondary of each 480-208Y/120 V transformer will be connected to the nearest building steel via a local power system ground bus.

Ground fault protection will be provided at the switchgear main and all feeder breakers.

A separate green insulated equipment grounding conductor will be provided in all feeders and branch circuits.

Branch circuits serving sensitive electronic equipment will be provided with a green with yellow strips isolated equipment grounding conductor in addition to the green equipment grounding conductor.

### 10.4.3 Instrument Reference Ground:

An instrument reference ground bus will be provided at each beamline to be used by users only for the purpose of grounding sensitive electronic communication circuits. The bus will be connected directly to the grounding electrode system and bonded to the local transformer(s) which provide power to that beamline equipment. The instrument reference ground bus will be considered the beamline's single point ground for all user equipment. Reference grounds within the hutches will be connected to the beamline's single point ground.

### 10.4.4 Telecommunication grounding:

Telecommunication grounding will be provided in accordance with EIA/TIA 607 including providing a ground conductor in all telecommunication cable trays.

### 10.4.5 Lightning protection:

A complete lightning protection system will be provided in accordance with NFPA 780 and UL 96A.

### 10.4.6 Cathodic protection:

Cathodic protection will not be provided.

## 10.5 RFI and ELF EMI Mitigation

No specific provisions are needed to mitigate radio frequency interference or extremely low frequency (60 Hz) electromagnetic fields.

## 10.6 Vibration Isolation

The generators will be provided with spring isolators as recommended by the vibration consultant. All transformers will be mounted on neoprene pads. No conduit will be installed under or within vibration isolation slabs.

## 10.7 Radiation Protection

Conduit penetrations in to the tunnel will be limited in quantity and located only through the tunnel roof or the service building labyrinth. All penetrations will include an off-set to eliminate line of sight through the roof concrete. Spare penetrations will be provided for future use

## 10.8 Exterior Lighting

Exterior illumination levels will be as indicated in DOE/IES standards, LEED 2.2 SS Credit 8 and Dark-sky requirements.

Parking lots, loop and interior roadways will be lit by 175 watt metal halide full cut-off fixtures mounted on 20 foot aluminum poles.

Walkways will be lit by 100 watt metal halide cut-off fixtures mounted on 12 foot aluminum poles and 50 watt metal halide bollards.

Building mounted exterior lighting will be provided at entrances and exits and at the loading dock. Equipment yards will be lighted with spill light from the adjacent access drive fixtures and by 100 watt metal halide full cut-off fixtures mounted on 12 foot aluminum poles.

No architectural/façade lighting will be provided.

Site lighting will be circuited to building panels and controlled by photocell to provide on/off operation.

## 10.9 Interior Lighting

Lighting design will be accomplished with energy efficient fluorescent lamps and electronic ballasts. Downlights and accent lights will be provided by compact fluorescent lamps.

Fluorescent lamps for troffers and pendant type fixtures will be a combination of T5 28 watt, T5HO 54 watt and T8, 32 watt lamps with a color temperature of 4100K with a CRI of at least 75. The T5 and T5HO lamps are provided to maximize energy conservation by using the highest efficiency lamps in the highest efficiency fixtures.

Fluorescent ballasts for T5, T5HO and T8 lamps and compact fluorescent lamps will be electronic type with a ballast factor of 0.85 minimum and total harmonic distortion of less than 10%.

Compact fluorescent lamps will be used in downlights and wall wash fixtures.

Exit lights will be LED type.

Fluorescent fixtures in labs will be controlled by a low-voltage control system with low-voltage switches at the entrances.

Occupancy sensors will be provided in enclosed offices and in open office areas, corridors, restrooms, and in support spaces.

Footcandle levels will be in accordance with DOE standards where applicable and with the IES Handbook for other spaces:

- Storage Ring Tunnel: 30 FC.
- Mezzanine: 30 FC.
- Experimental Hall: 30 FC.
- LINAC: 30 FC.
- Booster Ring Tunnel: 30 FC.
- Booster/LINAC Support Building: 30 FC.
- RF Building: 30 FC.
- Laboratories: 50-75 FC general with 75 FC on work surfaces.
- Offices: 30-50 FC general with 50 FC on work surfaces.
- Operations Center: 50 FC.
- Conference rooms: 30 FC.
- Attended support spaces: 30 FC.
- Unattended support spaces: 15 FC.
- Corridors, Stairs: 10-15 FC.
- Restrooms: 10-15 FC general with 30 FC at the mirror/sink area.
- Mechanical/electrical equipment rooms: 15 FC.
- Telephone/communication rooms: 50 FC.

Fixture types are tentatively defined as follows:

- Tunnel: Surface mounted enclosed and gasketed.
- Mezzanine: 2-lamp industrial fluorescent with 10% uplight.
- Experimental Hall: 250 watt metal halide with glass reflectors. Because of the restrike time of metal halide fixtures, wall mounted fluorescent fixtures will be provided on the outside wall for egress lighting.
- Laboratories: Pendant mounted direct/indirect fixtures with a single row of T5HO lamps.
- Enclosed offices: Recessed volumetric type fluorescent troffers with ribbed acrylic lens under each T5 lamp.
- Open office areas: Recessed volumetric type fluorescent troffers with ribbed acrylic lens under each T5 lamp.
- Conference rooms: Pendant mounted direct/indirect fixtures with a single row of T5HO lamps.
- Support spaces: Recessed volumetric type fluorescent troffers with ribbed acrylic lens under each T5 lamp.
- Corridors: Recessed volumetric type fluorescent troffers with ribbed acrylic lens under each T5 lamp.
- Stairs: Direct/indirect fluorescent wall brackets.
- Restrooms: Recessed linear fluorescent wall washers mounted along the back and front walls.
- Mechanical/electrical equipment rooms: 2-lamp industrial fluorescent with 10% uplight.
- Telephone/communication rooms: 2-lamp industrial fluorescent with 10% uplight.

Egress and exit lighting will be provided in accordance with NYSBC and NFPA 101.

## 10.10 Special Systems

### 10.10.1 Fire Alarm System:

A complete manual and automatic, supervised, fire detection and voice evacuation system will be provided. It will be a non-coded, addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices. Initiating and appliance circuits will be Class B. The fire alarm system will be in accordance with DOE requirements and NFPA 72.

There will be five (5) fire alarm control panels. The fire alarm control panels will be located adjacent to the exterior doors of the service buildings. The panels will be Grinnell/Simplex model 4100U fire alarm panels. The panels will be connected together by fiber cabling. Seven (7) remote fire alarm annunciation panels will be located. at the main entrance of the operations building, adjacent to the truck dock by each of the Laboratory Office Buildings, at the exterior door where future Laboratory Office Buildings will be connected, and at the Linac. The remote fire alarm annunciation panels will be connected to the fire alarm panel via fiber cable. A central fire alarm annunciation workstation will be located in the control room in the operations building.

Manual stations will be programmable and located at all building exits, at all exit stairs, and at 300 foot intervals in egress corridors.

Photoelectric area smoke detectors will be located in each lab and in elevator lobbies, shaft and machine room. Provisions will be made for smoke detectors to be located within the future hutches. Smoke detectors in elevator lobbies, shaft and machine room will initiate elevator recall. Duct smoke detectors will be provided in air handling systems as required by NYSBC and NFPA 90A.

An air sampling smoke detection system will be provided throughout the Tunnel and Experimental Hall including the Tunnel Mezzanine. Each air sampling system can cover up to 20,000 sf. Therefore each Pentant will be provided with one air sampling system in the Tunnel and three air sampling systems in the Experimental Hall. The air sampling system will be Fenwal Protection System model AnaLaser-II.

Heat detectors will be located adjacent to sprinkler heads in elevator shafts and machine room and will de-energize elevator power in accordance with ANSI 17.1, Elevator Code.

Wet sprinkler valves assemblies, sprinkler/standpipe water flow and tamper switches, and pre-action and dry-pipe systems will be monitored.

Combination audio/visual and/or visual only devices will be provided throughout the facility. A minimum of two indicating circuits will be provided in each area with devices connected alternately. A visual device will be located on the exterior of the building adjacent to each entrance where a fire alarm control panel is located to guide the Fire Department to the activated panel.

Notification appliance circuit power supplies will be distributed throughout the facility to provide power for the audible/visual appliances and to reduce voltage drop. The power supplies will be located in easily accessible locations.

Common alarm and trouble signals will be transmitted via fiber optic cable to the campus fire alarm system.

### 10.10.2 Telecommunication System (Voice, Data and Video):

A complete pathways, spaces, and structured cabling distribution system will be provided that consists of telecommunication rooms, plywood backboards, racks, cabinets, cable tray, conduit, back boxes, copper cable, fiber optic cable, connectors, cover plates, termination blocks, cross connect cables, patch panels, and all necessary accessories and will be provided in accordance with applicable EIA/TIA standards.

The Building Distribution Frame room will be located in the Operations Building. The BDF room will also serve as the Intermediate Distribution Frame room for the Operations Building.

One IDF will be located in each Service Building and in each Lab Office Building. The Service Building IDF will serve outlets in that Service Building and in the adjacent Experimental Hall. The Lab Office Building IDF will serve outlets in the associated lab office areas.

Cable tray will be provided above the Mezzanine to interconnect the BDF with all the IDF’s. This tray will carry backbone cables and station cables serving the Experimental Hall.

Cable tray will be provided at lab and office corridors to route station cables to outlets in the lab office areas.

Conduit will be provided between the cable tray and each outlet or raceway.

Each voice/data outlet will be provided with one Cat 6 voice jack and one Cat 6 data jack.

Each data outlet will be provided with one Cat 6 data jack.

Voice and data riser cabling will be provided from the BDF to each IDF. Voice riser cables will be multi unshielded twisted pairs, 24 gauge, solid copper and terminated on the terminal block in each closet. Data riser cabling will be 12 multi mode and 12 single mode fiber optic cables terminated at each end in a patch panel with a type SC connector. Voice will be terminated directly on rack-mounted termination panels. Patch panels will be mounted in 19 in. equipment racks.

Station cabling from each voice/data will consist of two four-pair Category 6 cables terminated at the devices and on the rack mounted telephone terminal blocks. Cables will be labeled at each device, terminal block, and patch panel.

### 10.10.3 Security System:

The security system will consist of a card reader access control system with limited security camera feed to the Security Center at Building 50.

Card readers will be located at each building entrance, and at each entrance to other selected spaces such as the control room, control computer room and electrical switchgear rooms.

CCTV systems will be provided for limited property protection areas such as the control room and control computer room. To match campus standards, security equipment components (card readers, controllers, locks, door contacts, etc.) will be owner furnished, contractor installed. Door exiting device, power transfer hinges, etc. will be coordinated with the door schedule. Security system cabling will be contractor installed and terminated by the owner.

Table 10.1 Electrical Loads.

| | Equip. kW | VA/SF | SF | kVA | df | kVA / Pentant | Total kVA |
|---|---|---|---|---|---|---|---|
| Storage Ring Equipment: (uniform load) | | | | | | | |
| Storage Ring | 3211.9 | | | | | | |
| Insertion Devices | 204.0 | | | | | | |
| Experimental Hall Equipment: | | | | | | | |
| Beam Lines | 401.8 | | | | 200% spare | | 805 |
| Lab Office Buildings: (5 LOBs) | | | | | | | |
| Lighting | | 2 | 20000 | 40 | 1.0 | 40 | 200 |
| Mechanical | | 5 | 20000 | 100 | 1.0 | 100 | 500 |
| Receptacles | | 3 | 12800 | 38 | 0.6 | 23 | 115 |
| Labs | | 25 | 2880 | 72 | 0.6 | 43 | 215 |
| 25% Spare | | | | | | 52 | 260 |
| | | | | | | 258 | 1290 |
| Experimental Hall and Service Buildings: | | | | | | | |
| Lighting | | 2 | 64000 | 128 | 1.0 | 128 | 640 |
| Mechanical | | 6 | 64000 | 384 | 1.0 | 384 | 1920 |
| Receptacles | | 1 | 64000 | 64 | 0.6 | 38 | 190 |
| 25% Spare | | | | | | 138 | 690 |
| Storage Ring Point loads: | | | | | | 688 | 3440 |
| Storage Ring Equipment (point load): | | | | | | | |
| SR Dipole (assumed at Sector #2) | 460.0 | | | | | | |
| RF, Cryo Plant, Injection Loads: | | | | | | | |
| Linac Equipment: | | | | | | | |
| Source | 11.6 | | | | | | |
| LINAC | 29.6 | | | | | | |
| LINAC RF | 200.0 | | | | | | |
| Booster Ring Equipment: | | | | | | | |
| Booster Ring LEBT | 51.8 | | | | | | |
| Booster Ring Booster | 1075.0 | | | | | | |
| Booster Ring HEBT | 70.8 | | | | | | |
| Booster RF | 170.0 | | | | | | |
| Linac, Booster Ring : | | | | | | | |
| Lighting | | 2 | 32000 | 64 | 1.0 | | 64 |
| Mechanical | | 6 | 32000 | 192 | 1.0 | | 192 |
| Receptacles | | 1 | 32000 | 32 | 0.6 | | 19.2 |
| 25% Spare | | | | | | | 69 |
| RF Building Equipment: | | | | | | | 344 |
| Main Ring RF | 2850.0 | | | | | | |
| Cryogenic Plant | 500.0 | | | | | | |
| RF Controls and Diagnostics | 40.0 | | | | | | |
| RF, Cryo Plant : | | | | | | | |
| Lighting | | 2 | 8000 | 16 | 1.0 | | 16 |
| Mechanical | | 6 | 8000 | 48 | 1.0 | | 48 |
| Receptacles | | 1 | 8000 | 8 | 0.6 | | 4.8 |
| 25% Spare | | | | | | | 17 |
| | | | | | | | 86 |
| | | Building Lighting, Misc Receptacle, Mechanical and Spare = | | | | | 5963 |
| Total Equipment Load | 9276.5 | | | | | | 9277 |
| Loads for 3 GeV Energy Level | | | | | | Total Building Load (kVA) = | 15,239 |

# 11 ENVIRONMENT, SAFETY AND HEALTH

## 11.1 Scope and Content

The scope and intent of this Environment, Safety and Health analysis is to:

1. Identify codes and standards applicable to conventional facility design.
2. Identify specific criteria for design of the conventional facility building and systems that meet the requirements of the applicable codes and standards, particularly those criteria that address the hazards identified by BNL in the Preliminary Hazards Analysis.
3. Define concepts for the conventional facility building and safety systems design to mitigate the identified hazards.

This ES&H analysis includes the following sections:

1. Building Code Analysis (BCNY)
2. Other Codes and Standards
3. Preliminary Hazards Analysis
4. Fire Protection
5. Pressure Safety
6. Industrial Hygiene
7. Other ES&H Issues

This document will be used as a reference by the design team and BNL throughout subsequent phases of the project.

## 11.2 Building Code Analysis

The preliminary building code analysis is attached to the end of this report.

## 11.3 Other Codes and Standards

The following DOE Orders and Guidelines will govern design and operation of the facility. Specific requirements in each order or guideline that are applicable to the facility design are summarized.

Where specific requirements conflict, or conflict with the Building Code of New York State, the more stringent requirement will govern.

### 11.3.1 DOE O 420.1B – Facility Safety

a) Fire protection system design

b) Natural phenomena hazards mitigation

### 11.3.2 DOE O 420.2B -Safety of Accelerator Facilities

a) Beamline safety systems (access control, beamline shutoffs/ interlocks, search confirmation system)

b) Electrical safety

c) Cryogenic and oxygen-deficiency hazards

d) Ionizing and non-ionizing radiation

e) Experimental activities

### 11.3.3 10 CFR 851 – Worker Safety and Health Program

a) Fire protection

b) Pressure safety

c) Industrial hygiene

d) Biological safety

e) Electrical safety

f) Nanotechnology safety

### 11.3.4 BNL Worker Safety and Health Program

a) To be confirmed during detailed design

## 11.4 Preliminary Hazards Analysis

BNL has developed a Preliminary Hazards Analysis (PHA) which identifies hazards related to facility construction and operation. This analysis will be updated to a Final Hazards Analysis for submission at Critical Decision 2 (CD-2).

The Hazards Analysis is used to identify design and operation strategies to mitigate potential hazards. Relevant findings and requirements from the Preliminary Hazards Analysis are incorporated into the following sections.

A summary of the risk assessment from the Preliminary Hazards Analysis, with pre-and post-mitigation risk categories, is presented in Table 11.1 for reference. A full description of the design and operation mitigation strategies is provided in the PHA.

**Table 11.1 Preliminary Hazards Analysis**

| PHA Hazard Identifier | Hazard | Pre-Mitigation Risk Category | Post Mitigation Risk Category |
|---|---|---|---|
| NSLS-II PHA - 1 | Construction | High | Moderate |
| NSLS-II PHA – 2 | Natural Phenomena | Low | Routine |
| NSLS-II PHA – 3 | Environmental | Moderate | Low |
| NSLS-II PHA – 4 | Waste | Moderate | Low |
| NSLS-II PHA – 5 | Fire | High | Low |
| NSLS-II PHA – 6 | Electrical | High | Moderate |
| NSLS-II PHA – 7 | Noise | Moderate | Low |
| NSLS-II PHA – 8 | Cryogenic | Moderate | Low |
| NSLS-II PHA – 9 | Confined space | Moderate | Low |
| NSLS-II PHA – 10 | Ozone | Low | Low |
| NSLS-II PHA – 11 | Chemical/hazmat | High | Moderate |
| NSLS-II PHA – 12 | Vacuum, cooling water, air | Moderate | Low |
| NSLS-II PHA – 13 | Ionizing Radiation | High | Moderate |
| NSLS-II PHA – 14 | Non-Ionizing Radiation | Moderate | Low |
| NSLS-II PHA – 15 | Material Handling | High | Moderate |
| NSLS-II PHA – 16 | Experimental Operations | High | Moderate |

This section of the Title I design narrative addresses, directly or indirectly, all of the hazards identified in the Preliminary Hazards Analysis except construction hazards and natural phenomena hazards. The latter are addressed in the civil, structural, and architectural chapters of this narrative. Construction hazards will be addressed separately.

## 11.5 Fire Protection

### 11.5.1 Requirements

For the purposes of this analysis, “Fire Protection” includes the following elements as defined in DOE Order 420.1B – Facility Safety:

a) Water supply

b) Fire-rated construction and barriers

c) Automatic extinguishing systems

d) Redundant fire protection systems for vulnerable safety class systems

e) Emergency egress and illumination

f) Fire department access and standpipe systems

g) Containment of fire fighting water

Requirements and criteria for fire protection are derived from the following codes and orders:

a) Building Code of New York State (2002)

b) Fire Code of New York State (2002)

c) DOE O 420.1B – Facility Safety

d) DOE O 420.2B – Safety of Accelerator Facilities

e) 10 CFR 851 – Worker Safety and Health Program

Design mitigation strategies are also identified in the PHA under PHA-5.

### 11.5.2 Codes and Standards

The following codes and standards will apply to design of fire protection systems.

a) DOE STD-1066-99 – Fire Protection System Design Criteria

b) NFPA 70 – National Electrical Code (2005)

c) NFPA 70E – Standard for Electrical Safety in the Workplace (2004)

d) NFPA 101 – Life Safety Code (2006)

e) NFPA 90A – Standard for Installation of Air-Conditioning and Ventilating Systems (2002)

f) NFPA 780 – Standard for Installation of Lightning Protection Systems (2004)

g) NFPA 72 – National Fire Alarm Code (2007)

h) NFPA 14 – Standard for the Installation of Standpipe and Hose Systems (2003)

i) NFPA 45 – Standard on Fire Protection for Laboratories Using Chemicals (2004)

j) NFPA 13 – Standard for the Installation of Sprinkler Systems (2002)

### 11.5.3 Compartmentation

The BCNY requires fire rated barriers at the following locations, as indicated in Section B - Building Code Analysis:

a) Occupancy separations

b) Control area separations

c) Vertical exit enclosures

d) Horizontal exit enclosures

DOE Order 420.1B also requires construction of fire rated barriers to limit maximum possible fire loss (MPFL) from a single fire event to $50 million, or installation of redundant fire protection systems where the MPFL exceeds this limit.

The MPFL is defined as the value of property (excluding land), within a fire area, including the replacement cost of equipment and property and any applicable decontamination and clean-up costs following a fire event. This loss assumes the failure of both automatic fire sprinkler systems and manual fire fighting efforts. A waiver from the DOE will be required to allow the experimental hall and tunnel to be constructed without intermediate fire barriers since the MPFL value of these spaces exceeds the established limit.

For the NSLS-II facility, fire rated barriers are proposed at the following locations:

a) 1-hour fire rated separation between the experimental hall and each LOB

b) 1-hour fire rated enclosure around stairwells in the service buildings and the operations center

c) 2-hour fire rated separation between the operation center (portion inside the ring) and the ring building

d) no fire barrier separation within the experimental hall or the tunnel

e) no fire barrier separation between the experimental hall and the service buildings, RF service building, or booster ring building

### 11.5.4 Fire Department Access

The Fire Code of New York State requires a Fire Department access to be a minimum of 14 feet high and 20 feet wide. This will accommodate the BNL Fire Department’s largest response vehicle (22 tons, 37 feet long, 13 feet high, and 11 feet wide). The Fire Department will be able to reach NSLS-II by road from the north, west or south.

Access to the NSLS-II building complex will be provided from Brookhaven Avenue to the main facility entrance, to the west end of the facility perimeter road (bypassing the main parking areas), and directly to the perimeter road east entrance. Additional points of access to the west side of the perimeter road will be from Bell Avenue and Rowland Street, and to the south from Princeton Street via Weaver Drive or Groves Street. Each LOB is accessed from the perimeter road. The main entrance is accessed directly off of Brookhaven. Access to the service buildings, RF Building, and Injection Buildings will be from the inside of the main ring building via a tunnel from the perimeter road. The tunnel will be sized to accommodate the largest BNL firefighting vehicle and will have a maximum 8 percent slope.

There is the potential for construction of long beamlines in the southeast quadrant of the building that could cross the perimeter road. Any changes in perimeter road grade will be limited to a maximum 8 percent slope.

There will be 10 primary entrances for emergency responders to the NSLS-II building, six from outside and 5 from inside the ring building. These primary entrances are:

a) Main entrance to the Operations Building

b) Main truck dock entrance to each LOB

c) Service building (access from inside the ring)

d) Exterior door where Alternate LOB will be located.

Because of the size of the facility, a means of easily identifying emergency responder access points during daytime and nighttime hours will be provided. This will be further developed during detailed design.

### 11.5.5 Fire Protection Water Supply

DOE Standard 1066-99 specifies requirements for fire protection water supply, including hydrant demand. This standard also requires that an additional, independent source of fire protection water be provided when the Maximum Possible Fire Loss (MPFL) is in excess of $100 million.

For the NSLS-II facility, fire protection water will be supplied by BNL’s potable water system, which is supplied by several deep wells and is stabilized by two elevated water storage tanks (one with a capacity of 1 million gallons and another of 350,000 gallons). The system can sustain three days of domestic supply and a maximum fire demand (4000 gpm for 4 hours) for BNL when two of the system's largest pumps are out of service and one storage tank is unavailable. The piping distribution network is well gridded to reduce the impact to any one building from a single water main break.

Five (5) potable water/fire water services will be extended from the site water mains to the service buildings. Each feed into the building will be hydraulically sized to handle the total combined requirements for water supply of the domestic and automatic sprinkler/standpipe systems.

Each service will be provided with two reduced pressure backflow prevention devices. The potable water supply will be protected against backflow from the automatic fire sprinkler and standpipe systems by an Underwriters Laboratory and Factory Mutual listed reduced pressure principle backflow preventor as required by Section 608.16.4.of the Plumbing Code of New York State (PCNY).

### 11.5.6 Fire Protection

BCNY Section 903 defines fire protection requirements applicable to the NSLS-II facility.

DOE Standard 1066-99 specifies that sprinkler systems must be designed in accordance with NFPA Standard 13.

DOE Standard 1066-99 also specifies the following fire protection system requirements to limit loss potential. Implementation or waiver of both of these requirements will need further review with the DOE.

a) A redundant fire protection system that, despite the failure of the primary fire protection system, will limit the loss to acceptable levels as determined by the AHJ (when the MPFL exceeds $50 million)

b) A redundant fire protection system and a 3-hour fire barrier when the MPFL exceeds $150 million

Neither the FCNY nor DOE Standard 1066-99 require standpipes for buildings less than 3 stories in height, unless deemed necessary for facilities with "extensive and complex interior layouts" by the DOE Fire Protection AHJ. Where standpipes are installed they shall be designed to NFPA Standard 14.

DOE Standard 1066-99 indicates that hydrants should be provided so that hose runs to all exterior portions of a protected building are no more than 300 feet, and that hydrants are located not closer than 40 feet to buildings. Hydrant water supply should be per the FCNY for the most severe facility fire risk, reduced as allowed for building automatic sprinkler protection.

For the NSLS-II facility, a combination sprinkler/standpipe system meeting the requirements of NFPA 13 "Standard for Installation of Sprinklers" and NFPA 14 "Standard for the Installation of Standpipe and Hosepipe Systems" will be designed to provide 100-percent protection of the facility. Where the piping installation will be subject to freezing temperatures, dry sprinklers will be employed; this will be further evaluated during detailed design. Means of adding water conditioning chemicals to the sprinkler system to combat corrosion will be provided.

Two Fire Department connections for each of the five fire (5) zones. One connection shall be located on the front face of the building, and the other on the interior face (courtyard) of the building. Each shall be located near an entry point into the facility. Each pair of FDC will serve a single fire zone and will be interconnected with the automatic sprinkler and standpipe systems.

Fire hydrants will be located along the Loop Road outside of the Ring Building and along the Service Road inboard of the Ring Building at distances meeting DOE and code requirements and not more than 300 feet from all building entrances.

### 11.5.7 Detection and Alarming

Specific requirements for fire detection and notification in the BCNY/FCNY will be detailed in the next phase of design.

DOE Standard 1066-99 requires that fire alarm systems comply with NFPA 72 - National Fire Alarm Code and have the following features:

a) Retransmission of signals to the site Fire Department alarm center

b) Local alarms for the building or zone(s) in alarm.

c) Visual alarms.

d) Location of a fire alarm control panel near the main entrance or other protected location as determined by the AHJ. For buildings with multiple zones, a zone alarm panel or graphic is required at the main entrance.

e) Supervisory devices except for locked valves.

f) Water flow alarm at each sprinkler riser.

g) Means of manual fire notification.

For NSLS-II, a complete manual and automatic, supervised, fire detection and voice evacuation system meeting the requirements of NFPA 72 will be provided. It will be a non-coded, addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices. Initiating and appliance circuits will be Class B. The fire alarm system will be in accordance with DOE and NY State Code requirements.

Smoke detection will be provided in laboratories in the LOBs, in the control room, in all electrical rooms (including switchgear rooms in the Service Buildings), in telephone and data communications rooms, and in elevator lobbies, shafts and machine rooms. Provisions will be provided for connecting future smoke detectors located within the future experimental hutches. Smoke detectors in elevator lobbies, shafts and machine rooms will initiate elevator recall. Duct smoke detectors will be provided in air handling systems as required by BCNY and NFPA 90A. Manual pull stations will be located at each building exit.

High sensitivity smoke detectors (HSSD systems) will be provided in four (4) areas: the Experiment Floor, the Tunnel Mezzanine area, the accelerator ring tunnel and the booster tunnel.

Heat detectors will de-energize elevator power in accordance with ANSI 17.1 Elevator Code.

Sprinkler system water flow will be monitored and the system will supervise the sprinkler valves and the installed detection systems.

Combination audible/visual alarm and/or visual only annunciation devices to alert the occupants will be provided throughout the ring, the corridor system, in each laboratory, in each hutch, and in most rooms, other than single person offices. Fire alarm and supervisory signals will be transmitted via dedicated fiber optic cable to the BNL Fire Rescue Group in Building 599 monitors and to a secondary monitoring station at Security (Bldg 50) via the Site Fire Alarm System. All fire alarm signals will also annunciate in the control room. The main fire alarm control panel will be located at the facility entrance, with repeater panels located at the entrance to each LOB and each Service Building.

Spot smoke detection will be arranged to have a “pre-alarm” signal (permissible by NFPA 72 with the approval of the Authority Having Jurisdiction). This “pre-alarm” signal from single smoke detector(s) will be displayed in the control room and transmitted to the BNL Fire Rescue Group without immediately activating the fire alarm audible/visual devices. Notification devices will be activated automatically within a fixed time period unless the facility operators in the main control room do not put the system on hold.

### 11.5.8 Smoke Control

No code requirements have been identified that would require installation of a means of smoke control for the tunnel, experimental hall, or lab office buildings. However, BNL has indicated a need for smoke control from the experimental hall, the accelerator ring tunnel, and the booster tunnel to further enhance the ability to quickly evacuate personnel from this space in a fire emergency and to limit the spread of fire/smoke beyond the point of origin. The Fire Department will have the ability to control the ventilation systems to divert recirculated air to the outdoors. Fresh air would not continue to be supplied from the activated GHVAC system. The control panel will be at the fire alarm system panels.

## 11.6 Pressure Safety

### 11.6.1 Requirements

Requirements and criteria for pressure safety are derived from the following:

a) 10 CFR 851 – Worker Safety and Health Program

### 11.6.2 Applicable Codes and Standards

The following codes and standards will apply to the design and fabrication of pressure systems.

a) ASME Boiler and Pressure Vessel Code (2007)

b) ANSI B31.3 – Process Piping (2002)

c) ANSI B31.9 – Building Services Piping (1996)

d) CGA S-1.3 – Pressure Relief Device Standards Part 3 – Stationary Storage Containers for Compressed Gases (2005)

### 11.6.3 Design Requirements

Specific requirements for implementation of pressure safety-related codes and standards will be defined in the next phase of design. These requirements may include, but not be limited to, the following.

a) Incorporation of applicable codes and standards into the relevant construction specifications.

b) Location of compressed gas cylinder racks in areas protected from potential damage or potential sources of energy that could cause an overpressure condition.

c) Specification and selection of appropriate relief valves and other protective devices on mechanical and process services under pressure.

d) Routing of relief valve and rupture disk discharges to safe locations, away from potential personnel travel pathways.

e) Routing of pressurized services away from exposure to damage from mobile equipment, hoists, etc.

## 11.7 Industrial Hygiene

### 11.7.1 Requirements

Requirements and criteria for industrial hygiene are derived from the following codes and orders:

a) Building Code of New York State (2002)

b) DOE O 420.2B –Safety of Accelerator Facilities

c) 10 CFR 851 – Worker Safety and Health Program

Design mitigation strategies are also identified in the PHA under the following:

a) Waste Hazards (PHA-4)

b) Noise and Vibration Hazards (PHA-7)

c) Cryogenic Hazards (PHA-8)

d) Confined Space Hazards (PHA-9)

e) Ozone Hazards (PHA-10)

f) Chemical and Hazardous Materials Hazards (PHA-11)

g) Accelerator/Beamline Hazards (PHA-12)

h) Ionizing Radiation Hazards (PHA-13)

i) Non-Ionizing Radiation Hazards (PHA-14)

j) Material Handling Hazards (PHA-15)

k) Experimental Hazards (PHA-16)

### 11.7.2 Codes and Standards

The following codes and standards will apply to design of facilities and systems related to the hazard areas identified above.

a) Building Code of New York State (2002)

b) NFPA 30 – Flammable and Combustible Liquids Code (2003)

c) NFPA 55 – Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks (2005)

d) OSHA 29 CFR 1910 – Standards for General Industry (2007)

e) ANSI Z136.1 – Safe Use of Lasers (2000)

f) ANSI Z9.5 – Standard for Laboratory Ventilation (2003)

g) CGA V-6 – Standard Cryogenic Liquid Transfer Connections (2000)

### 11.7.3 Hazardous Material Storage and Handling

a) Allowable Quantities

The maximum allowable quantities of hazardous chemicals and gases (unused chemicals and gases, materials in use, and waste) are dictated by the BCNY for any control area in a B-occupancy building. These are indicated in Tables 11.2 and 11.3.

**Table 11.2 – Allowable Quantities of Chemicals**

Maximum Allowable Quantities per Control Area

| Material | Allowed Storage(1) | Allowed Use (Open System)(2) |
|---|---|---|
| Flammable Class 1-A | 120 gal | 20 gal |
| Flammable Class I-B | 240 gal | 30 gal |
| Flammable Class I-C | 360 gal | 40 gal |
| Combined Flammables | 480 gal | 60 gal |
| | | |
| Water Reactive Class 1 | No limit | No limit |
| Water Reactive Class 2 | 200 lbs (3) | 20 lbs (3) |
| Water Reactive Class 3 | 20 lbs | 2 lbs |
| | | |
| Oxidizer Class 1 | 800 gal | 200 gal |
| Oxidizer Class 2 | 50 gal | 10 gal |
| Oxidizer Class 3 | 4 gal | 0.4 gal |
| Oxidizer Class 4 | 0.2 gal | 0.02 gal |
| | | |
| Unstable (Reactive) Class 1 | No limit | No limit |
| Unstable (Reactive) Class 2 | 200 lbs | 20 lbs |
| Unstable (Reactive) Class 3 | 20 lbs | 2 lbs |
| Unstable (Reactive) Class 4 | 2 lbs | 0.25 lbs |
| | | |
| Toxic | 500 lbs | 125 lbs |
| Highly Toxic | 40 lbs | 3 gal |
| Corrosive | 2,000 gal | 200 gal |

Notes:

1. Increased as allowed for automatically sprinklered spaces and use of approved storage cabinets.
2. Aggregate quantity of storage and in-use shall not exceed allowable quantity for storage.
3. Assumes sulfuric acid. Equivalent to 20 gallons in storage and 2 gallons in open use.

**Table 11.3 – Allowable Quantities of Hazardous Gases**

Maximum Allowable Quantities per Control Area

| Material | Allowed Storage(1) | Allowed Use (Closed System)(2) |
|---|---|---|
| Flammable | 2,000 cf | 2,000 cf |
| Pyrophoric | 100 cf | 20 cf |
| Highly Toxic | 40 cf (3) | 40 cf |
| Toxic | 1,620 cf | 1,620 cf |
| Oxidizing | 3,000 cf | 3,000 cf |

Notes:

1. Increased as allowed for sprinklered spaces.
2. Aggregate quantity of storage and in-use shall not exceed allowable quantity for storage.
3. In approved gas cabinets only.

Definitions of “highly toxic” and “toxic” gases, as defined in the Toxic Gas Ordinance (TGO), are as follows:

"Highly Toxic" (Class I): material that has a median lethal concentration in air of 200 ppm or less by volume, when administered by continuous inhalation of one hour to albino rats weighing between 200 and 300 grams each

"Toxic" (Class II): material that has a median lethal concentration in air of more than 200 ppm but less than 3,000 ppm by volume, under the same conditions

For mixtures, the classification as "highly toxic" or "toxic" depends on the mole fraction of the toxic material in the mixture. For purposes of this analysis, it is assumed that all gases will be pure.

If the volume of any hazardous chemical or gas in storage or use exceeds the amount listed in Tables 11.2 or 11.3, the area in which it is stored and/or used in excess of these amounts must be H-occupancy.

b) Hazardous Material Storage Areas

The design criteria for hazardous chemical and gases storage areas are prescribed by the BCNY. There are criteria applicable to storage within control areas in B occupancies (within the maximum allowable quantities) and additional criteria applicable to rooms or buildings for storage of quantities exceeding the maximum allowable quantities per control area (H-occupancy storage rooms or buildings).

For storage of materials in less than or equal to the maximum allowable quantities in control areas, code requirements include the following.

i) Separation of the control area by 1-hour fire barrier from adjacent control areas with minimum 2-hour rated floor construction for levels above ground

ii) Where storage cabinets are used to increase maximum allowable quantities of materials, which is reflected in the amounts listed in Table 11.2, cabinets shall be constructed per code and a liquid-tight floor to minimum of 2 inches

iii) Where gas cabinets are used to increase maximum allowable quantities of materials, which is reflected in the amounts listed in Table 11.3, cabinets shall be constructed per code and ventilated to maintain negative pressure with respect to the surroundings. No more than 3 cylinders may be housed in a single cabinet.

iv) For exhausted enclosures where necessary per code or where provided to increase maximum allowable quantities, enclosures shall be ventilated at negative pressure relative to surrounding areas, and provided with automatic fire extinguishing system if flammables are stored therein.

For H-occupancy rooms or buildings intended for storage of hazardous materials in quantities exceeding the amounts allowed per control area, the following additional code criteria apply:

i) Liquid storage cabinets may not exceed 120 gallons of total storage capacity, with no more than 60 gallons of Class I or Class II liquids.

ii) A minimum aisle width of 4 feet is required between adjacent liquid storage racks and a minimum 8-foot main aisle must be maintained.

iii) Rooms for storage of liquids shall be ventilated and maintained negative to surrounding spaces.

iv) An automatic sprinkler system is required.

v) Spill control and secondary containment is required to contain a spill from the largest vessel plus 20 minutes of fire protection water flow over the minimum system design area or room area (whichever is smaller).

vi) Non-compatible materials shall be stored in separate, approved enclosures.

A central chemical storage building will be provided adjacent to the LOB-1 loading dock. This building will be designed as an H-occupancy building and will be subdivided by partial non-combustible partitions to separate oxidizers, water reactives, acids, bases, and toxics. If any highly toxic liquids are intended to be used in the NSLS-II facility, a separate room with 1-hour fire barrier would have to be constructed. This will be evaluated further during detailed design.

The chemical storage building will be constructed of non-combustible materials. No explosion venting panels will be provided. Spill containment per BCNY and FCNY requirements for H-occupancy spaces will be provided for these rooms, with leak detection systems capable of alarming to the facility control room.

A separate building will be provided for 90-day storage of waste chemicals at the same location outside LOB-1. Waste chemicals will be stored in individual containers in chemical storage cabinets in the room. The waste room will be divided by non-combustible partitions as required to provide segregation by chemical type (oxidizers, water reactives, acids, bases, and toxics). The room will be designed the same as the chemical storerooms.

Each chemical storeroom will be provided with an exhaust ventilation system with a minimum of 1 cfm per square foot of floor area. The system will be designed to operate continuously and exhaust to the outside without recirculation. Each room will be conditioned to a temperature range of 55 to 85 F.

Each chemical storeroom will be provided with an automatic sprinkler system. A combination safety shower/eye wash station will be provided in each storeroom.

Chemicals and wastes used in laboratories or in beamline hutches will be stored in approved enclosures, ventilated where required by code. It is anticipated that only small volumes of chemicals for immediate use will be stored outside the central chemical storage room.

Treatment chemicals for closed-loop water systems (e.g., scale and corrosion inhibitors and biocides for use in the cooling towers) will be stored in drums or portable totes, depending on the anticipated rate of consumption. These chemicals will be stored in suitable enclosures at the point of use.

Gas cylinder storage areas will be provided near the loading dock in each LOB. Space will be provided for storage of gas cylinders in delivery to the final points of use, and for empty cylinders awaiting collection. No central storage of gas cylinders will be provided for NSLS-II; these will be delivered on a “just-in-time” basis.

Cylinder racks will be segregated by gas type, e.g., flammables and oxidizers. Appropriate cylinder restraints will be provided. The need for cages or other form of security for new or empty cylinders will be further evaluated during the next phase of design.

c) Hazardous Material Distribution

The design criteria for fixed distribution of hazardous chemicals and gases are prescribed by the BCNY. These criteria include:

i) Piping system construction

ii) Automatic shutoff valves

iii) Pressure relief

iv) Backflow prevention

v) Leak detection

Other than chemicals for closed loop system conditioning and liquid nitrogen (addressed in a separate part of this section), no piped distribution of chemicals is anticipated.

Piping systems for treatment chemicals will be compatible with the chemical and will be provided with containment and leak detection.

For chemicals used for experimental purposes, liquid transfer of materials having an NFPA 704 hazard ranking of 3 or 4 will be by safety cans complying with UL 30. Liquid containers exceeding 5 gallons will be transported on a cart or truck. In addition, containers with materials that have a hazard ranking of 3 or 4 per NFPA 704 will be transported on a cart or truck, unless no more than two containers are hand carried in safety containers. The cart or truck will be capable of containing a spill from the largest single container being transported.

It is anticipated that inert gases will be piped directly from cylinders to the equipment using the gas, with the cylinders located near to the point of use and manually changed when required. If demand dictates that multiple cylinders can be in use for a particular purpose, or if automatic change-over from empty to full cylinders is required for uninterrupted operation, fixed gas manifolds with distribution piping to the point of use will be provided. This will be further evaluated during detailed design.

Wherever hazardous gases are used, these will be housed in approved gas cabinets and piped via contained piping systems from the cylinder manifold to the point of use. Hazardous gas piping systems will be provided with leak detection, excess flow protection, and automatic shutoff as required by applicable codes. This will also be further evaluated during detailed design.

d) Safety Showers/Eyewash Stations

OSHA (29 CFR 1910.151(c)) requires "where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use." “Suitable facilities” is defined by OSHA as meeting current industry standards. ANSI Z358.1-2004 is the recognized industry standard. ANSI's definition of "hazardous material" includes caustics and additional substances and compounds that have the capability of producing adverse effects on the health and safety of humans. This standard requires the following:

i) Installation of eyewash and shower equipment in appropriate situations when employees are exposed to hazardous materials.

ii) Location of emergency showers and eyewashes within 10 seconds travel distance of and no greater than 55 feet from a hazard, located on same level as hazard, and with a travel path free of obstructions including doors.

iii) Shower valves of simple operation, turn off to on in one second or less, and providing hands-free operation once activated.

iv) Flushing fluids shall be tepid.

v) Showers can be either plumbed or self-contained.

vi) Flow alarms should be installed in shower supply piping to indicate when the unit is being used.

vii) Pressure and minimum flow requirements as provided in the standard.

For the NSLS-II facility, safety shower/eyewash stations will be located in the following areas:

i) Chemical and waste storage areas.

ii) Laboratories containing fume hoods.

iii) Experimental hutches where chemicals are used.

Water for safety showers and eyewashes will be either a central tepid water loop (potable water maintained at required temperature) or from local hot and cold potable water services with local mixing valve at each appliance. These alternates will be evaluated further during detailed design. Safety showers will not be fitted with flow switches. Safety showers in areas subject to freezing will be provided with suitable freeze protection.

Other Wastes

The types and volume of wastes that will be generated and transported by NSLS-II are not anticipated to differ markedly from those generated and transported by the existing NSLS. During a typical year of operation, NSLS-II will generate 3,000 to 5,000 pounds of wastes. The following are estimates of the types of wastes (in addition to waste chemicals):

i) Industrial Waste: oils and oily rags, cutting fluids, resin recharge rinse waters, and photographic wastes; oils and rinse water are the major components of industrial waste

ii) Radiological Waste: sources and other radioactive materials; eliminated by decay-in-storage when possible and disposed of as hazardous waste.

iii) Mixed Waste: eliminated by decay in-storage when possible and disposed of as hazardous waste

iv) Regulated Medical Waste: the Medical Department will dispose of syringes, needles, pipettes, vials, and razor blades

Storage areas meet appropriate code requirements will be provide at each LOB for non-chemical wastes. These areas will be B-occupancy.

### 11.7.4 Cryogenics Storage and Handling

Bulk storage of liquid nitrogen and liquid helium will be required at the new facility. These cryogenic fluids are used for cooling of magnets and other ring components, and for cooling of experimental apparatus.

Storage vessel and pressurized distribution piping system design and construction is governed by the ASME Boiler and Pressure Vessel Code (2007) and by ANSI/ASME B31.3 – Process Piping (2002). All piping systems and storage systems will be designed and installed to comply with applicable ASME and ANSI standards. Some specialized accelerator components that do not fall within code parameters will require engineering analysis to assure reliability.

The predominant hazard associated with distribution and use of cryogenic liquids is oxygen depletion in the event of a cryogen spill with subsequent flash to vapor (the expansion ratios for liquid nitrogen and liquid helium are 696 and 754 respectively, at 70° F). This hazard is present anywhere cryogenic liquids may be used in the facility, including the RF service building, tunnel, experimental hutches, and laboratories, and can result from a piping system failure, dewar leak, or similar occurrence. A lesser hazard is the potential for burns; this is typically mitigated by procedure and PPE.

The OSHA Respiratory Protection Standard 29 CFR 1910.134 defines an oxygen deficient atmosphere as an atmosphere containing less than 19.5% oxygen by volume. BNL has procedures in place to determine the Oxygen Deficiency Hazard (ODH) classification of any space where cryogenic liquids are used, and has established ODH control measures applicable to each hazard class. These control measures include ventilation (minimum one volume change per hour) for spaces with hazard class of 2 or greater, use of a personal monitor and availability of a self-rescue respirator for hazard class 1 or greater, and provisions for SCBA near the hazard area for spaces with hazard class of 4.

Determination of ODH hazard classes will be made during detailed design, when the scope of cryogen distribution and use is more firmly established. All spaces where cryogens may be used will be ventilated to at least one air volume change per hour. It is anticipated that the following additional control measures will be required:

a) Installation of local oxygen concentration monitors at locations where dewars may be used (e.g., in laboratories and experimental hutches). Monitors will be linked to local alarm lamps and sounders to provide warning alarms when the oxygen concentration falls to pre-determined levels. Warning lamps will be placed inside potential hazardous spaces and outside any entry to the space.

b) Dewar vessel filling stations will have interlocks to prevent flow of cryogenic fluid until the dewar is properly vented.

The need for emergency venting of enclosed spaces where cryogens are used will be evaluated during detailed design.

### 11.7.5 Material Handling

The new NSLS-II facility will be designed to accommodate delivery and movement of experimental equipment, facilities equipment components (e.g., pumps and motors) for service and maintenance, chemical containers, gas cylinders, dewars, water treatment ion exchange vessels for off-site regeneration, and other consumables for offices and laboratories from the loading docks to the points of use.

Accelerator and storage ring component installation will be addressed separately.

BNL has determined that there is no requirement for installation of a permanent bridge crane in the experimental hall. Provisions will be made for use of portable hoists. The requirement for permanent attachment points to structure will be determined during detailed design, along with method of personnel access to the attachment points for fixing hoists prior to use.

The need for permanent cranes or hoists in the service buildings will also be evaluated during detailed design.

Hoists will comply with applicable codes and standards, including the following:

a) ANSI/ASME B30.16-2003 - Standard for Overhead Hoists (Underhung)

b) ANSI/ASME B30.21-2005 - Standard for Manually Operated Lever Hoists

The following provisions will be made for material transport to and within the facility:

a) Roadway access to the inner ring with sufficient turning radii for an articulated tanker to make the initial helium delivery and for box van or flatbed truck for loading and unloading of equipment to the service buildings.

b) Roadway access with turning provisions for a box van or flatbed truck delivery to LOB loading docks for delivery of equipment, chemicals, gases, and other consumables. The main loading dock (at LOB-1) will be elevated and provided with dock levelers.

c) Roadway access suitable for an articulated tanker to make deliveries of liquid nitrogen to the storage tank between LOB-4 and LOB-5 and the future tank near LOB-2. The roadway layout will allow the tanker to unload without blocking other traffic to the LOB docks. Nitrogen storage tanks will be oriented away from personnel to reduce noise and fog exposure.

d) Bollards will be provided where necessary to protect equipment adjacent to roadways.

e) A nominal 10-foot wide circulation aisle will be maintained around the perimeter of the experimental hall to allow access to the beamlines from the LOB docks. The aisle will be suitable for forklift access for movement of heavy experimental equipment. Overhead services will be maintained at least 10 ft above the aisleway.

f) For beamlines which extend into the perimeter aisle and beyond, ramps will be provided with maximum slope to accommodate a forklift. Where the ramps are too steep for manual movement of liquid nitrogen dewars, automatic dewar fill stations will be provided at the LOBs on either side of the ramp(s).

g) An access aisle will be maintained at the perimeter of the mezzanine level.

### 11.7.6 Ionizing Radiation

Protection against ionizing radiation is addressed in DOE O 420.2B - Safety of Accelerator Facilities as well as in 10 CFR 830 Subpart B - Safety Basis Requirements of the Nuclear Safety Management Rule and 10 CFR 835 - Occupational Radiation Protection.

Shielding of the accelerator, storage ring, and beamline systems will be addressed elsewhere as part of the accelerator and storage ring systems design.

Beam interlocks, including exclusion zone search system interlocks, will also be addressed as part of the accelerator and storage ring systems design. These will be provided with the accelerator/storage ring installation.

### 11.7.7 Non-Ionizing Radiation

Regulatory requirements for control of exposure to non-ionizing radiation, including lasers and radiation in the radio frequency and microwave frequency regions, shall meet the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists. The requirements for shielding will be addressed along with ionizing radiation shielding as part of the accelerator and storage ring component design and installation.

There is the potential for use of Class 1, 2, 3a, 3b, or 4 lasers as part of the beamline or laboratory experiments. BNL regulations regarding installation and user lasers will be applied to this project, including the requirement for failsafe laser interlocks for Class 4 lasers. This will be further evaluated during detailed design.

### 11.7.8 Process Exhaust

ANSI/AIHA Z9.5-2003 - Standard for Laboratory Ventilation and ANSI/AIHA Z9.2-2001 - Standard for Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems are the governing standards for design of process exhaust systems for laboratory and experimental operations. These standards will define the criteria for process exhaust systems for NSLS-II. ANSI/AIHA Z9.2 is also referenced in OSHA 29 CFR 1910.94.

Laboratory fume hoods and corresponding process exhaust system(s) will be in accordance with Standard Z9.5. Evaluation of compatibility of exhaust streams to determine if multiple hoods can be manifolded will be made during detailed design. When chemical storage cabinets are integral with a fume hood, the chemical cabinet will be ventilated by the hood exhaust system.

An exhaust system will be required for experimental hutches that use hazardous chemicals or gases. The requirements for this system need further evaluation. Alternatives that will be evaluated during detailed design include:

a) Provision of a central exhaust system with capability to connect to any beamline hutch, installed as part of the conventional facility construction.

b) Provision for separate and dedicated exhaust systems for beamlines that require exhaust, installed with each beamline construction.

Chemical and gas storage cabinets in the central chemical store will be exhausted directly to atmosphere.

Process exhaust ductwork materials of construction will be selected to be compatible with the chemicals or gases being exhausted and compliant with applicable codes and standards with regard to smoke and flame spread rating.

### 11.7.9 Noise

29 CFR 1910.95 (OSHA) has established permissible noise exposures for the workplace. Additional requirements by the American Conference of Governmental Industrial Hygienists (ACGIH) are also established which are generally more stringent than OSHA. This project will limit noise to the ACGIH TLVs or even more strict requirements.

Appropriate equipment performance criteria and/or sound attenuation will be specified for plant equipment, particularly air handling units and pumps, to ensure that these noise levels are not exceeded in the service buildings and other plant spaces.

The required noise criteria for experimental areas, offices, and laboratories for the purpose of personnel comfort are significantly lower than the OSHA or ACGIH criteria. These criteria are listed in Table 3.5.

Design criteria to achieve these NC levels will be further developed during detailed design. These include ductwork sizing and routing restrictions as well as proper equipment selection and application of acoustic treatments.

### 11.7.10 Confined Spaces

Confined spaces will be identified and managed in accordance with the requirements in OSHA 29 CFR 1910.146 – Permit-Required Confined Spaces and with BNL's confined space access program. Wherever practical, the need for a confined space will be avoided during design.

## 11.8 Biological Safety

### 11.8.1

Requirements and criteria for biological safety systems are derived from the following codes and orders

a) 10 CFR 851 – Worker Safety and Health Program

### 11.8.2 BSL-2 Laboratories

It is anticipated that theNSLS-II program will require fit-out of at least one Biosafety Level 2 (BSL-2) laboratory for biological experimentation. Design of the laboratory and ventilation systems will be in accordance with ANSI/AIHA Z9.5-2003 - Standard for Laboratory Ventilation. Provisions will be made to restrict access to personnel with the appropriate training or other qualifications. There is no requirement for directional inward air flow in a BSL-2 laboratory, except as may be required for chemical odor control; although the BSL-2 laboratories at NSLS-II will be designed to be negative to the surrounding spaces.

A fume hood or Class II, Type A biological safety cabinet will be provided in each BSL-2 laboratory.

Additional requirements for BSL-2 laboratories will be established during detailed design.

## 11.9 Electrical Safety

### 11.9.1 Requirements

Requirements and criteria for electrical system design are derived from the following codes and orders:

a) Building Code of New York State (2002)

b) DOE O 420.2B –Safety of Accelerator Facilities

c) 10 CFR 851 – Worker Safety and Health Program

d) OSHA 29 CFR 1910.147 – Control of Hazardous Energy (Lockout/Tagout)

Design mitigation strategies are also identified in the PHA under PHA-6 (Electrical Hazards)

### 11.9.2 Codes and Standards

The following codes and standards will apply to design of facilities and systems related to the hazard areas identified above.

a) Building Code of New York State (2002)

b) NFPA 70 – National Electrical Code (2005)

c) NFPA 70E – Standard for Electrical Safety in the Workplace (2004)

d) NFPA 780 – Standard for Installation of Lightning Protection Systems (2004)

### 11.9.3 Design Requirements

Specific requirements for implementation of applicable electrical codes and standards will be defined in the next phase of design. These requirements may include, but not be limited to, the following.

a) Specification of NRTL-approved devices.

b) Review of cable segregation, cable tray loadings, and cable stirrups.

c) Completion of an arc flash analysis for all electrical panels and disconnects.

d) Location of disconnects and provisions for lockout/tagout.

e) Provisions for adequate power distribution for beamline and experimental equipment, including allowances for future beamline installation.

f) Maintenance of proper clearances around distribution panels and other electrical equipment.

## 11.10 Other Environment, Safety And Health Issues

### 11.10.1 Experimental Operations

Most of the experimental hazards identified in the PHA are addressed in other sections of this chapter (e.g., chemical handling, ODH hazards resulting from use of cryogenic liquids).

PHA-10 describes the hazards associated with the generation of ozone when the unattenuated synchrotron beam passes through air. This hazard is most likely to occur at the experimental end stations. Several mitigation strategies are identified in the PHA, most of which are related to end station set-up. The need for conventional facilities such as extract or local air filtration will be further evaluated during detailed design.

### 11.10.2 Emissions to Air and Releases to Groundwater

PHA-3 describes the anticipated environmental hazards resulting in operation from the NSLS-II facility. BNL has also prepared an Environmental Assessment (EA) for the facility which describes anticipated environmental impacts in more detail.

Potential environmental hazards from NSLS-II include the potential for releasing, in amounts beyond regulatory limits, oils, solvents, chemicals, and radioactive material to the soil, groundwater, air, or sanitary system as a result of the failure of equipment, impact from a natural phenomenon, fire, or a violation of established procedure.

Accelerator cooling water will be a closed-loop system with no anticipated discharges other than the potential rinsing of ion exchangers before they are brought on-line. While some accelerator components become locally activated as a result of operations, the levels are expected to be well below BNL's Accelerator Safety Subject Area guidelines for soil activation.. NSLS-II would not generate tritiated water above the BNL defined Action Level. Periodic sampling of the cooling water systems will assure that tritium levels remain below the Action Level.

Experiments using radioisotopes will be controlled by specific facility procedures, rendering remote the likelihood of these materials entering the sanitary or groundwater systems.

Roof and parking lot drains will empty into groundwater recharge basin 005 that lies southeast of the NSLS-II site. Cooling tower blowdown will be discharged to a separate stormwater collection basin. All other water discharges will be disposed of through the sanitary waste stream; there are no expected requirements to monitor this outflow's quantity or chemistry.

Exhaust emissions from laboratory fume hoods and experimental hutches are associated with research and development and, therefore, would be exempt from Federal and state permitting requirements. Fume hood exhaust systems will be designed to permit the installation of HEPA filters in the exhaust stream should experimental conditions warrant.

### 11.10.3 Equipment Protection

a) Leak detection will be provided where the potential for liquid leaks exist in areas that are not normally occupied (e.g., the tunnel), to provide remote indication of a potential piping or equipment system failure. An unobserved leak could result in equipment damage, injury to personnel, or both.

b) Access control requirements for protection of sensitive and/or hazardous spaces will be evaluated in the next phase of design.

# 12 CODE ANALYSIS

## 12.1 General

### 12.1.1 Introduction

This report serves as the Title One Phase Fire Protection Analysis Report for National Synchrotron Light Source II at Brookhaven National laboratories, Upton, New York. It is intended to identify minimum requirements for the building as mandated by the applicable codes and standards, user needs, or required operations as requested by BNL. This document will be used as a reference by the design team and BNL throughout subsequent phases of the project.

### 12.1.2 Purpose

The purpose of this report is to summarize the fire protection and life safety requirements contained in the codes and standards applicable to the project. This report identifies the minimum code requirements that will provide an acceptable level of fire/life safety. Measures, which result in an increased level of fire/life safety are not discussed. Requirements regarding accessibility for the disabled and other disciplines, except for fire alarm requirements, are outside the scope of this report and will be discussed elsewhere in future submissions.

This report is limited to the most restrictive requirements contained in the codes listed in this report. Throughout the report, code reference sections are provided in parenthesis following each requirement to facilitate review of the provisions in detail.

## 12.2 Applicable Codes and Standards

The facility design will be in accordance with the codes, standards and guidelines as listed the Architectural section. 3.1.3. Where there is a conflict between two or more codes, the most stringent requirement will be used.

## 12.3 Occupancy Classifications

### 12.3.1 Main Use

NYSBC section 304.1classifies the overall building occupancy as a Group B (Business) occupancy, this includes the Ring Building including the accelerator tunnel the experimental floor, the access corridor and the tunnel mezzanine, the Booster Ring/Linac and RF Buildings, the five Lab Office Buildings (LOB) three of which are in the base building scope and two are bid alternates, the five service buildings (SB) and the Operations Center Building. Other accessory use spaces within the NSLS-II will be classified as shown in Table 12.1 below.

**Table 12.1 Building Classification.**

| Space | Code Ref. | Occupancy Classification |
|---|---|---|
| Ring Building, Central Lab Office Building, Lab Office Buildings, Linac, RF Building | NYSBC 304.1 | Group B, Business |
| Breakout Rooms and Conference Rooms over 750sf | NYSBC 303.1 | A-3, Assembly without fixed seats |
| Chemical and Gas Storage over the amount allowed per control area. | NYSBC 307.4<br>NYSBC 307.5 | H2 or H-3 High Hazard Storage. |

Per NYSBC Sec. 302.2, Accessory Use Areas are not required to have fire barrier separation if the accessory use area is < 10% of the area of the story in which it is located except as shown below in 12.3.2. Per NYSBC Table 302.3.3 note d. accessory assembly use A-3 area is not considered a separate occupancy from the main occupancy if the floor area of the given assembly use is less than 750sf. Per Section 303.1 an assembly area with less than 50 occupants will not be considered a separate occupancy from the main occupancy.

### 12.3.2 Separations between Occupancies

In accordance with table 302.3.3 of the NYSBC separations between occupancies shall be as follows:

- Between “B” Occupancy and A-3 Occupancy: Two hour fire barrier wall separation and 1 1/2 hour door separation, unless it is less than 10% of floor area, or less than 750sf, than no separation is required.
- Between “B” Occupancy and H-2 Occupancy: two hour fire separation and 1 ½” hour door separation.
- Between “B” Occupancy and H-3 Occupancy: one hour fire separation and ¾ hour door separation.

NYSBC section 302.3.3 exception (1) allows one hour rated separation deduction for a fully sprinklered building.

## 12.4 Construction

### 12.4.1 Type of Construction

The NSLS-II will be a Type IIB construction per NYSBC section 602.2, unprotected non-combustible. Type II-B also requires fully non-combustible (and therefore inorganic), construction which is also beneficial to a laboratory-use based project.

### 12.4.2 Allowable Area

The main building will be classified as a two story building and will have an unlimited fire area per NYSBC section 507.3 because it has a automatic fire sprinkler system and will be surrounded on all sides with a 60ft wide yard or public way..

The Operations Center Building (OPS Center) will two stories, the inside portion separated from the Ring Building with a two hour fire wall. The Operations Center allowable area will be a minimum of 46,000sf (23,000sf per floor) before area modifications. The maximum allowable height will be four stories and 55 feet (the actual height will be two stories with an optional third story) above grade plane. The following illustrates the maximum allowable individual floor and overall building gross square footage possible under Type II-B construction, if all of the additional area modifications are used, Per NYSBC Chapter 5:

The governing NYSBCC Sec. 503 area increase formula is:

$$A_a = A_f + \frac{A_t I_f}{100} + \frac{A_t I_s}{100}$$

where:

$A_a$ = Allowable area/floor (sf)

$A_t$ = Tabular area/floor in accordance w/ Table 503 ( = 23,000 gsf for Type II-B)

$I_f$ = Area increase due to frontage (%) as calculated in accordance w/ Sec. 506.2 (see calculation below; 80%)

$I_s$ = Area increase due to sprinkler protection (%) as calculated in accord w/ Sec. 506.3 (200% for multi-story building)

The specific value for the frontage increase indicated by the "$I_f$" value in the area increase formula above is:

$I_f$ = 100((F/P)-0.25)(W/30) ;

$I_f$ = 100((50/100)-0.25)(30/30)

$I_f$ = 100(.25)(1)

$I_f$ = 25% Area increase due to frontage

F = Bldg perimeter which fronts on a public way or open space w/ > 20ft open width (expressed as 50%.

P = Perimeter of entire bldg. (expressed as 100%)

W = Minimum width of public way or open space (based on the approximately 30ft of open space on two sides and 100' minimum of one side, but shall not exceed 1)

THEREFORE, the increased maximum allowed area per floor is :

$$A_a = (23{,}000) + \frac{(23{,}000)(25)}{100} + \frac{(23{,}000)(200)}{100}$$

(Type II-B construction):

$A_a$ = 23,000 + 5750 + 46,000

$A_a$ = 74,750 gsf/flr

Per NYSBC Sec. 506.4, the total building allowed area is (3x) the total single floor allowed area, therefore the total allowable building area based on Type II-B construction would be:

TOTAL ALLOWED BLDG.AREA = 74,750 gsf/flr x 2= 149,500 gsf.

If the alternate third floor is accepted the allowable square footage will increase to 224,250 gsf.

(Type II-B, "B" occupancy)

### 12.4.3 Allowable Height

Based on NYSBC section 504 The allowable height for the Operation Center Building can increase by one story and 20 feet because it is equipped throughout with an automatic sprinkler system. The height of the Operations Center can now be 5 stories and 75feet height.

### 12.4.4 Mezzanines – (NYSBC section 505)

Section 505.1: A mezzanine(s) in compliance with this section shall be considered a part of the floor below. Such mezzanines shall not contribute to the building area or number of stories regulated by Section 503.1. The area of the mezzanine shall be included in determining the fire area defined in Section 702. The clear height above and below the mezzanine floor shall be 7'-0" clear minimum.

Section 505.2 Area Limitations: The aggregate area of a mezzanine or mezzanines with in a room shall not exceed one–third of the area of the room in which it is located.

Section 505.3 Egress: There shall be two independent means of egress where the common path of travel does not exceed the limitations of 100 feet set forth in section 1004.2.5. exception 1. There will be exits from the mezzanines based on exiting distance, there should be on exit every 600 feet minimum. The actual distance on the Tunnel Mezzanine will average 85 feet maximum.

Section 505.4 Openness: A mezzanine shall be open and unobstructed to the room within which it is located, except for walls not more than 42” high, columns and posts.

### 12.4.5 Control Areas – (NYSBC section 414.2)

Control Areas shall be areas within the building where quantities of hazardous materials not exceeding the maximum quantities allowed by this code are stored, dispensed, used or handled. See tables 12.3 and 12.4 for allowable chemical amounts per control area.

Wall Construction – NYSBC 414.2.1: The control areas need to be separated from each other with a 1 hour Fire barrier Wall (per section 706) or as called for in Table 414.2.2.

Floor construction – NYSBC 414.2.3: The floor construction and the construction supporting the floor shall have a 2 hour fire resistance rating.

Number of Control Areas per floor is governed by NYSBC Table 414.2.2 and is summarized below in Table 12.2.

**Table 12.2 Control Areas per Floor.**

| Floor Level | Number of Control Areas |
|---|---|
| Below Grade | 3 |
| Above Grade First floor | 4 |
| Above Grade Second Floor | 3 |
| Third Floor | 2 |

The Ring Building, the Booster Ring/Linac Building, the part of the OPS Center third floor above the Ring Building and The RF Building and the five service buildings (SB) will all be considered as part of one control area.

Each of the five LOBs will be designed to be a separate control area from the Ring Building with a one hour fire separation wall between the LOB and the Ring Building. It will then be up to the NSLS 2 administration to determine which of the three LOBs is designated a Control Area.

Since the Inner Ring Portion of the Operations Center is separated by a two hour fire wall then each floor can have control areas as shown in Table 12.2.

The current intent is to include the entire facility as a single control area at this time. With the construction separations described above, additional control areas can be administratively identified at a later time.

**Table 12.3 Allowed Quantities of Hazardous Chemicals.**

Maximum Allowable Quantities per Control Area

| Material | Allowed Storage(1) | Allowed Use (Open System)(2) |
|---|---|---|
| Flammable Class 1-A | 120 gal | 20 gal |
| Flammable Class I-B | 240 gal | 30 gal |
| Flammable Class I-C | 360 gal | 40 gal |
| Combined Flammables | 480 gal | 60 gal |
| | | |
| Water Reactive Class 1 | No limit | No limit |
| Water Reactive Class 2 | 200 lbs (3) | 20 lbs (3) |
| Water Reactive Class 3 | 20 lbs | 2 lbs |
| | | |
| Oxidizer Class 1 | 800 gal | 200 gal |
| Oxidizer Class 2 | 50 gal | 10 gal |
| Oxidizer Class 3 | 4 gal | 0.4 gal |
| Oxidizer Class 4 | 0.2 gal | 0.02 gal |
| | | |
| Unstable (Reactive) Class 1 | No limit | No limit |
| Unstable (Reactive) Class 2 | 200 lbs | 20 lbs |
| Unstable (Reactive) Class 3 | 20 lbs | 2 lbs |
| Unstable (Reactive) Class 4 | 2 lbs | 0.25 lbs |
| | | |
| Toxic | 500 lbs | 125 lbs |
| Highly Toxic | 40 lbs | 3 gal |
| Corrosive | 2,000 gal | 200 gal |

Notes:

1. Increased as allowed for automatically sprinklered spaces and use of approved storage cabinets.
2. Aggregate quantity of storage and in-use shall not exceed allowable quantity for storage.
3. Assumes sulfuric acid. Equivalent to 20 gallons in storage and 2 gallons in open use.

**Table 12.4 Allowable Quantities of Hazardous Gases**

Note: Quantities include all allowed increases for building automatic sprinkler system.

Maximum Allowable Quantities per Control Area

| Material | Allowed Storage(1) | Allowed Use (Closed System)(2) |
|---|---|---|
| Flammable | 2,000 cf | 2,000 cf |
| Pyrophoric | 100 cf | 20 cf |
| Highly Toxic | 40 cf (3) | 40 cf |
| Toxic | 1,620 cf | 1,620 cf |
| Oxidizing | 3,000 cf | 3,000 cf |

Notes:

1. Increased as allowed for sprinklered spaces.
2. Aggregate quantity of storage and in-use shall not exceed allowable quantity for storage.
3. In approved gas cabinets only.

### 12.4.6 Minimum Fire Resistance Ratings for TYPE II-B

The minimum fire resistance ratings for Type II-B construction is given in NYSBC Tables 601 & 602. the applicable data is shown in Tables 12.8.5 and 12.8.6 below.

**Table 12.5 (NYSBC 601 and 602) Fire Resistive Rating Requirements for Building Elements.**

| Building Element | (Hours) |
|---|---|
| Structural Frame<br>(Including columns, girders, trusses) | 0 |
| Bearing Walls: | |
| Exterior | 0 |
| Interior | 0 |
| Nonbearing walls and partitions: | |
| Exterior | (SEE TABLE 12.4) |
| Nonbearing walls and partitions: | |
| Interior | 0 |
| Floor Construction<br>(Including supporting beams and joists) | 0 |
| Roof Construction<br>(Including supporting beams and joists) | 0 |
| Per NYSBC Section 707:<br>Exit Enclosures – 707.4 (connecting less than 4 stories) | 1 |
| Shafts – at floor Penetrations | |
| • connecting no more than two floors | 0 |
| • Connecting less than four stories | 1 |
| • Connecting four stories or more | 2 |
| • The shaft enclosure shall not be less than the floor structure it penetrates but will not exceed 2-hours. | |
| • Shafts are not required from a mezzanine to the floor below | |
| Corridors – NYSBC Table 1004.3.2.1, greater than 30 Occupant Load With sprinklers | 0 |
| Control Areas – NYSBC 414.2, from each other | 1 |

**Table 12.6 (NYSBC Table 715.3) Fire-Resistive Rating Requirements for Exterior Walls based On Fire Separation Distance for unprotected openings.**

| Fire Separation Distance | Type of Construction | Rating (hours) |
|---|---|---|
| < 5ft | II-B | 1 |
| ≥ 5ft < 10ft | II-B | 1 |
| ≥ 10ft < 30ft | II-B | 0 |
| ≥ 30ft | II-B | 0 |

### 12.4.6 Protection of Openings

General opening protective ratings in accordance with NYSBC Table 715.3 are as follows:

**Table 12.7 (NYSBC Table 715.3) Protective Ratings of Openings.**

| Wall Type | Protective Rating |
|---|---|
| 2-hour fire walls and fire barriers: | |
| Chemical storage rooms (NFPA 30-4-4.1.2) | 1-1/2 hrs |
| 1-hour fire barriers: | |
| Shaft exit enclosure and exit passageway walls | 1 |
| Other fire separation wall assemblies | 3/4 |
| Chemical storage rooms (NFPA 30-4-4.1.2) | 3/4 |
| Fire partitions: | |
| Corridor walls | 1/3 |
| Other fire partitions | 3/4 |
| Exterior Wall Openings: (NYSBC Table 704.8) | See Table 12.6 |

The maximum area of unprotected openings permitted in an exterior wall in any story may not exceed the following values. Note that per NYSBC Sec. 704.8.1, buildings that are fully sprinkled in accordance with Sec. 903.3.1.1, the "Unprotected" values are used in lieu of the "Protected" values. Fire separation distance is defined as the distance measured from the building face to the closest interior lot line, to the centerline of the street or public way of to an imaginary line between two buildings on the same property

**Table 12.8 (NYSBC table 704.8) Unprotected Opening in Exterior Walls**

| Fire Separation Distance ft | Percentage of Exterior Wall Area (unprotected Values) | Percentage of Exterior Wall Area (Protected Values) |
|---|---|---|
| 0 to 3 | Not permitted | Not permitted |
| Greater than 3 to 5 | Not permitted – unlimited in exterior walls not required to be fire rated. | 15 % |
| Greater than 5 to 10 | 10 %– unlimited in exterior walls not required to be fire rated. | 25 % |
| Greater than 10 to 15 | 15%– unlimited in exterior walls not required to be fire rated. | 45% |
| Greater than 15 to 20 | 25 %– unlimited in exterior walls not required to be fire rated. | 75 % |
| Greater than 20 to 25 | 45 %– unlimited in exterior walls not required to be fire rated. | Not limited |
| Greater than 25 to 30 | 70 %– unlimited in exterior walls not required to be fire rated. | Not limited |
| Greater than 30 | Not limited | Not limited |

NYSBC Section 714.3.2 Wired glass and NYSBC table 714.3.2 designate the amount of wired glass allowed in protected openings. The use of wired glass while still allowed for this occupancy and code is being disallowed in most construction codes and occupancies. The desired glass for protected openings is a fire protection (ceramic) glass complying with NFPA 80 for size limitations.

**Table 12.9 (NYSBC table 714.3.2) Limited Size of Wired Glass Panels**

| Fire Protection Rating | Maximum Area (square inches) | Maximum Height (Inches) | Maximum Width (Inches) |
|---|---|---|---|
| 3-hours | 0 | 0 | 0 |
| 1 1/2 hour in exterior doors | 0 | 0 | 0 |
| 1 and 1 ½ hours | 100 | 33 | 10 |
| 3/4 hour | 1296 | 54 | 54 |
| 20 minutes | Not limited | Not limited | Not limited |
| Fire window assemblies | 1296 | 54 | 54 |

Ducts and Air Transfer Openings will be protected in accordance with NYSBC section 715. Fire Dampers will be installed in accordance with NYSBC table 715.3.1

**Table 12.10 (NYSBC table 715.3.1) Fire Damper Rating**

| Type of Penetration | Minimum Damper Rating (Hour) |
|---|---|
| Less than 3-hours fire resistive-rated assemblies | 1.5 hours |
| 3-hour or greater fire resistive-rated assemblies | 3 hours |

## 12.5 Interior Finishes

### 12.5.1 Interior Finish Flame Spread Ratings

Interior flame spread rating shall be established in accordance with NYSBC Sec. 803 & Table 803.4 - “Sprinkled” values

**For “B” Occupancy**

- Vertical exits and exit passageways: Use Group B Class B
- Exit access corridors and other exitways: Use Group B Class C
- Rooms and enclosed spaces: Use Group B Class C

**For “A-3” Occupancy**

- Vertical exits and exit passageways: Use Group B Class B
- Exit access corridors and other exitways: Use Group B Class B
- Rooms and enclosed spaces: Use Group B Class C

**Other Requirements**

- Plastics: Foam plastics installed as interior trim or finish shall comply with NYSBC Sec 2604.

- Acoustical Ceilings: Acoustical ceiling materials exposed within a plenum space shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84.
- Plenum Wire: All wiring within plenum spaces shall conform to Article 300.22 of NFPA 70, National Electrical Code.

### 12.5.2 Interior Floor Finish/Covering Classifications

Finished floors or floor covering materials of a traditional type, such as wood, vinyl, linoleum, terrazzo and other resilient floor covering materials are acceptable, and shall comply with NYSBC Sec. 804.5.

Carpeting and similar materials should comply with the DOC FF-1 "pill test" (CPSC 16 CFR, Part 1630).

Where building is equipped throughout with an automatic sprinkler system, class II are permitted where Class I materials are required.

### 12.6 Automatic Sprinkler System

A wet automatic sprinkler system will be install in accordance with NYSBC section 903 and NFPA 13.

## 12.6 Means of Egress

### 12.6.1 Exits

The minimum number of exits is based on occupancy in accordance with NYSBC Sec. 1005.2.1. All rooms and spaces within each story shall be provided with and have access to the minimum number of approved independent exits as required by Table 12.11.

**Table 12.11 (NYSBC table 1005.2.1) Minimum Number of Exits for Occupant Load.**

| Occupancy | Minimum # of Exits |
|---|---|
| 1 - 500 | 2 |
| 500 – 1,000 | 3 |
| Over 1000 | 4 |

Buildings allowed to have one exit are as follows:

**Table 12.12 (NYSBC table 1005.2.2) Building with one Exit**

| Occupancy | Maximum Height of Building above grade | Maximum Occupants per floor and travel distance |
|---|---|---|
| A-3 | 1 story | 50 occupants and 75 feet travel distance |
| B | 1 story | 50 occupants and 75 feet travel distance |
| H-2, H-3 | 1 story | 3 occupants and 25 feet travel distance |

Exit Access is established by NYSBC Section 1004. Maximum Travel Distance shall be in accordance with NYSBC Sec. 1004.2.4 & Table 1004.2.4. The maximum length of exit access travel, measured from the most remote point in an area to an exit, should not exceed the values in Table 12.13.

**Table 12.13 (NYSBC table 1005.2.1) Exit Access Travel Distance.**

| Occupancy | w/ Sprinkler System (feet) |
|---|---|
| Assembly (A), Storage (S-1) | 250 |
| Business (B) | 300 |
| High Hazard Storage (H2) | 100 |
| High Hazard Storage (H3) | 150 |

Based on the above information and the circumference of approx. 2965 feet the number of exit access points into the Ring Building is 5 doors at a maximum of 600feet apart. However because of the maximum allowable common path of travel of 80 feet between the beamlines, from the ratchet wall door to the end of the hutch) an exit door has been provided at approx. 156 feet apart with a total number (including those into the LOBs) of 19 doors at 36” each. The two doors at each LOB (five total) are 72” doors.

Dead Ends are limited by NYSBC Sec 1008.8.5. The maximum dead-end distance shall not exceed 20 feet, except for “B” and “F” occupancies where the limit is 50 feet in a fully sprinkled building.

Common Path of Travel is limited by NYSBC Sec. 1004.2.5. The maximum common path of travel should not exceed the limits of Table 12.14.

**Table 12.14 Maximum Common Path of Travel.**

| Occupancy | Common Path of Travel Allowed | Common Path of Travel Actual |
|---|---|---|
| Assembly (A) | 75 ft | 75 ft |
| Business (B), including Labs and Mechanical spaces | 100 ft | 80 ft |
| High Hazard H-2 or H-3 | 25 ft | 25 ft |

### 12.6.2 Egress Width

Egress Width is established by NYSBC Table 1003.2.3. Using the sprinkled building values, the required egress widths are as follows:

- Stairways: 0.2 inches/person
- Other Egress Components: 0.15 inches/person
- Exit Access Corridor Width Minimum: 44 inches (NYSBC Sec. 10043.2.2; 24 inches for access to electrical, mechanical or plumbing systems, 36 inches with a required occupant capacity of <50.)
- Doors shall not reduce the required width to less than one-half during the swing, and no more than 7 inches when fully open.

Exit or Exit Access Doorway Arrangement is governed by NYSBC Sec. 1014.2.1, Exception 2. Where a building is equipped throughout with an automatic sprinkler system in accordance with Sec. 903.3.1.1 or 903.3.1.2, the separation distance of the exit doors or exit access doorways shall not be less than one-third of the length of the maximum overall diagonal dimension of the area served.

Vertical Exit Enclosures must have fire ratings in accordance with NYSBC 707.4. Interior exit stairways and interior exit ramps shall be enclosed with fire barriers. Exit enclosures shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more and not less than 1 hour where connecting less than four stories.

Horizontal Exits are governed by NYSBC Sec. 1005.3.5. A horizontal exit shall not serve as the only exit from a portion of the building, and not more than one-half of the total number of required exits from a portion of the building. The horizontal exit shall be separated by a fire wall complying with Sec 705 or a fire barrier

Exit Discharge requirements are established by NYSBC Sec. 1006. All exits should discharge directly to the exterior of the building. The exit discharge shall be at grade or shall provide direct access to grade. The exit discharge shall not re-enter a building. Exception #1 states that a maximum of 50 percent of the number and capacity of the exit enclosures is permitted to egress through areas on the level of exit discharge provided all of the following area met:

- Exits discharge to a free and unobstructed way to the exterior of the building, which is readily visible and identifiable from the point of termination of the exit enclosure.
- The entire area of the level of discharge is separated from areas below by construction conforming to the fire-resistance rating for the exit enclosure.

### 12.6.3 Egress Capacity and Width

The occupant load of a room, space or floor shall be determined using the occupant load factors from NYSBC Sec 1003.2.2 as shown in Table 12.15.

**Table 12.15 (NYSBC table 1003.2.2.2) Maximum Floor Area Allowances per Occupant**

| Use | $ft^2$/person |
|---|---|
| Offices, Industrial (Labs) | 100 gross |
| Conference Rooms (Tables & Chairs) | 15 net |
| Loading Docks, Storage, Mechanical/Electrical Rm. | 300 gross |

### 12.8.6.4 Doors

Doors shall meet the requirements of NYSBC 1003.3.1 and 1005.3.1. Two exits or exit access doorways from any space shall be provided where one of the following conditions exists:

- The occupant load of the space exceeds the values in Table 12.16
- The common path of egress travel exceeds the limitations of Section 1004.2.5 shown in Table 12.14.
- Where required by NYSBC Table 1003.2.1

**Table 12.16 Spaces with One Means of Egress**

| Occupancy | Maximum Occupant Load |
|---|---|
| Assembly (A) , Business (B) | 50 |
| High Hazard Storage (H2 and 3) | 3 |

The minimum clear door width is 32 inches as established by NYSBC 1003.3.1.1 and 1005.3.1. Where a pair of doors are provided, at least one of the doors should provide a minimum clear width opening. The maximum width of a door leaf 48 inches.

Floor elevations at door openings are set by NYSBC Sec. 1003.1.4. The floor shall be the same elevation on both sides of the door, and level except for exterior landings, which are permitted a slope of 2%. Thresholds at doorways shall not exceed 1/2 inches. (NYSBC 1003.3.1.6)

Door Swing is specified by NYSBC section 1003.3.1.2. All means of egress doors regardless of occupancy shall swing in the direction of egress where serving a room with an occupant load of 50 or more persons, and for all H occupancy rooms. All egress doors shall be readily open-able from the side from which egress is made without the use of a key or special knowledge or effort (NYSBC Sec. 1003.3.1.8).

Latches and Panic Hardware are specified by NYSBC Sec 1003.3.1.8.3. A latch or other fastening device on a door should be provided with a knob, handle, exit device or other simple releasing device having an obvious method of operation under all lighting conditions. Doors shall be open-able with no more than one releasing operation. The releasing mechanism for any latch shall be installed between 34 inches and 48 inches above the finished floor.

### 12.6.4 Stairways

Stairways shall comply with NYSBC sections 1003.3.3.1 through 1003.3.3.12.1.

The minimum clear width of stairways is to be determined by Table NYSBC 1003.2.3 – Stairways, but not less than 44inches per 1003.3.3.1. Protruding Objects are limited by NYSBC sections 1003.2.5.1, 1003.5.4 and 1104.

Stair construction (NYSBC 1003.3.3.5) shall be of materials consistent with the construction type.

The minimum dimension of landings measured in the direction of travel shall be equal to the required width of the stairway. (NYSBC Sec 1003.3.3.4)

Minimum Headroom (NYSBC Sec. 1003.3.3.2): 80 inches.

Maximum Height between landings (NYSBC Sec. 1003.3.6): 12 feet.

Treads and Risers (NYSBC Sec. 1003.3.3.3):

- Maximum riser height - 7 in
- Minimum riser height - 4 in
- Minimum tread depth - 11 in

Stair Dimensions (NYSBC Sec. 1003.3.3.3.1): Stair dimensions should be uniform. Variation between treads or risers should not exceed 3/8 in.

## 12.7 Elevators

Elevators shall be designed in accordance with NYSBC section 1003.2.13.3. All passenger elevators shall be accessible in accordance with ADAAG, and ANSI A117.1.

## 12.8 Ramps

Ramps shall be designed in accordance with NYSBC section 1003.3.4.

# 13. ROOM DATA SHEETS

# Program of Spaces - Net Area

| Room # | Room Name | Room NSF | Qty | Total NSF |
|---|---|---|---|---|

## Injection

| Room # | Room Name | Room NSF | Qty | Total NSF |
|---|---|---|---|---|
| BR-101 | Booster Ring Tunnel | 6,688 | 1 | 6,688 |
| BR-102 | Linac Room | 1,715 | 1 | 1,715 |
| BR-103 | Booster Service Building - East | 6,102 | 1 | 6,102 |
| BR-104 | Klystron Gallery | 1,620 | 1 | 1,620 |
| BR-105 | Booster Service Building - Wes | 1,568 | 1 | 1,568 |
| | | Injection Total Net Square Feet: | | 17,693 |

## Lab Office Buildings

| Room # | Room Name | Room NSF | Qty | Total NSF |
|---|---|---|---|---|
| LOB1-101 | Private Office | 110 | 48 | 5,280 |
| LOB1-102 | Open Office Space | 90 | 24 | 2,160 |
| LOB1-103 | Laboratory - Wet | 480 | 2 | 960 |
| LOB1-103A | Laboratory - Dry | 480 | 4 | 1,920 |
| LOB1-104 | Storage | 110 | 1 | 110 |
| LOB1-105 | Conference Room | 560 | 2 | 1,120 |
| LOB1-105A | Conference Room | 220 | 2 | 440 |
| LOB1-106 | Lobby & Interaction Space | 150 | 4 | 600 |
| LOB1-107 | Break Room / Kitchen | 240 | 2 | 480 |
| LOB1-108 | Ship-Receive & Storage | 960 | 1 | 960 |
| LOB1-109 | Toilet / Shower | 250 | 2 | 500 |
| LOB1-110 | Electrical / Data | 153 | 1 | 153 |
| LOB1-111 | Janitor Closet | 63 | 1 | 63 |
| LOB1-112 | Access Corridor Interface | 2,090 | 1 | 2,090 |
| LOB1-113 | Machine Shop | 270 | 1 | 270 |
| LOB4-101 | LOB #4 Shell | 16,146 | 1 | 16,146 |
| LOB5-101 | Private Office | 110 | 48 | 5,280 |
| LOB5-102 | Flexible Office Space | 90 | 24 | 2,160 |
| LOB5-103 | Laboratory - Wet | 480 | 2 | 960 |
| LOB5-103A | Laboratory - Dry | 480 | 4 | 1,920 |
| LOB5-104 | Storage | 110 | 1 | 110 |
| LOB5-105 | Conference Room | 560 | 2 | 1,120 |

| Room # | Room Name | Room NSF | Qty | Total NSF |
|---|---|---|---|---|
| LOB5-105A | Conference Room | 220 | 2 | 440 |
| LOB5-106 | Lobby & Interaction Space | 150 | 4 | 600 |
| LOB5-107 | Break Room / Kitchen | 240 | 2 | 480 |
| LOB5-108 | Ship-Receive & Storage | 960 | 1 | 960 |
| LOB5-109 | Toilet / Shower | 250 | 2 | 500 |
| LOB5-110 | Electrical / Data | 153 | 1 | 153 |
| LOB5-111 | Janitor Closet | 63 | 1 | 63 |
| LOB5-112 | Access Corridor Interface | 2,090 | 1 | 2,090 |
| LOB5-113 | Machine Shop | 270 | 1 | 270 |

**Lab Office Buildings Total Net Square Feet: 50,358**

## Operations Center

| Room # | Room Name | Room NSF | Qty | Total NSF |
|---|---|---|---|---|
| OPS-103 | Control Conference Room | 676 | 1 | 676 |
| OPS-104 | Control Room | 1,547 | 1 | 1,547 |
| OPS-105 | Computer Room | 976 | 1 | 976 |
| OPS-106 | 2nd Floor Toilet & Shower | 76 | 2 | 152 |
| OPS-107 | Entrance Lobby & Vestibule | 2,415 | 1 | 2,415 |
| OPS-108 | Bridge & Viewing Gallery | 1,450 | 1 | 1,450 |
| OPS-109 | Unisex Toilet | 78 | 1 | 78 |
| OPS-110 | Break Room / Kitchenette | 512 | 1 | 512 |
| OPS-111 | Telecom Room | 409 | 1 | 409 |
| OPS-118 | Switchgear Room | 655 | 1 | 655 |
| OPS-120 | Men's Locker Room | 128 | 1 | 128 |
| OPS-121 | Women's Locker Room | 126 | 1 | 126 |
| OPS-122 | Storage | 108 | 1 | 108 |

**Operations Center Total Net Square Feet: 9,232**

## RF Building

| Room # | Room Name | Room NSF | Qty | Total NSF |
|---|---|---|---|---|
| RF-101 | RF Cavity Room | 9,756 | 1 | 9,756 |
| RF-102 | RF Test | 426 | 1 | 426 |

**RF Building Total Net Square Feet: 10,182**

## Ring Building

| Room # | Room Name | Room NSF | Qty | Total NSF |
|---|---|---|---|---|
| RB-101 | Accelerator Tunnel | 37,300 | 1 | 37,300 |

| Room # | Room Name | Room NSF | Qty | Total NSF |
|---|---|---|---|---|
| RB-102A | Experimental Hall | 94,235 | 1 | 94,235 |
| RB-102B | Access Corridor | 33,018 | 1 | 33,018 |
| RB-103 | Tunnel Mezzanine | 50,950 | 1 | 50,950 |
| RB-104 | Loading Dock | 2,060 | 1 | 2,060 |
| RB-105 | Hazardous Materials Storage | 450 | 1 | 450 |
| RB-106 | Stock Room | 1,618 | 1 | 1,618 |
| RB-107 | Grille | 257 | 1 | 257 |
| | | **Ring Building Total Net Square Feet:** | | **219,888** |

## Service Buildings

| Room # | Room Name | Room NSF | Qty | Total NSF |
|---|---|---|---|---|
| SB-101 | Service Building #1 | 9,626 | 1 | 9,626 |
| SB-102 | Service Building #2 | 9,626 | 1 | 9,626 |
| SB-103 | Service Building #3 | 9,626 | 1 | 9,626 |
| SB-104 | Service Building #4 | 9,626 | 1 | 9,626 |
| SB-105 | Service Building #5 | 9,626 | 1 | 9,626 |
| | | **Service Buildings Total Net Square Feet:** | | **48,130** |
| | | **NSLS-II Net Square Feet:** | | **355,483** |

# ROOM DATA SHEET

**Room Name:** Booster Ring Tunnel **Room Number:** BR-101

**Functional Area:** Injection Ground Level **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 6,688 NSF x 1 Rooms Reqd. = **6,688** Total Net Square Feet

Function: House the Booster ring

Occupancy Class: B

General Notes: Radiation shielding required for tunnel walls and roof. Shielded doors or labyrinths required for entry.

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load ______ psf Vibration Requirements: None

Structural Notes: Minimize differential settlement

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Concrete Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 78 F +/- 1.8 F Cooling 78 F +/- 1.8 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Neutral Vibration Criteria None

Acoustic Noise Level NC None EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes: Labyrinth entry required

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☑ Floor / Trench Drain Trench drain around perimeter

☐ Eyewash / Safety Shower

Plumbing Notes: Trench to have holding sump to allow testing prior to discharge to Sanitary Sewer.

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☑ Nitrogen Possible replacement for compresse ☑ Process Cooling Water - Cu Cu / Al by ASD

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Surface Mount

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Low Voltage Switch

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 20 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power: Lighting, life safety

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☑ Fire Detection Type: HSSD

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Linac Room **Room Number:** BR-102

**Functional Area:** Injection Ground Level **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 1,715 NSF x 1 Rooms Reqd. = **1,715** Total Net Square Feet

Function: House the Linac

Occupancy Class: B

General Notes: Radiation shielding required for tunnel walls and roof. Shielded doors or labyrinths required for entry.

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes: Minimize differential settlement

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Concrete Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria None

Acoustic Noise Level NC None EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes: Labyrinth entry required

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☑ Process Cooling Water - Cu Cu / Al by ASD

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Low Voltage Switch

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 0 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Booster Service Building - East **Room Number:** BR-103

**Functional Area:** Injection Ground Level **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 6,102 NSF x 1 Rooms Reqd. = **6,102** Total Net Square Feet

Function: House support functions for the Booster Ring

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 1 F Cooling 72 F +/- 1 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Neutral Vibration Criteria None

Acoustic Noise Level NC Per ACGIH TLVs EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☑ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☑ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 0 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Klystron Gallery **Room Number:** BR-104

**Functional Area:** Injection Ground Level **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 1,620 NSF x 1 Rooms Reqd. = **1,620** Total Net Square Feet

Function: House klystrons and support equipment for the Linac

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht. 17'-0" clear

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 1 | F | Cooling | 72 F +/- | 1 F | Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 RH +/- | 10 RH | Heating |

Room Pressure: Positive Vibration Criteria: None

Acoustic Noise Level NC: Per ACGIH TLVs EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☑ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☑ Process Cooling Water - Cu: Cu / Al by ASD

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Low Voltage Switch

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 0 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Booster Service Building - West **Room Number:** BR-105

**Functional Area:** Injection Ground Level **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 1,568 NSF x 1 Rooms Reqd. = **1,568** Total Net Square Feet

Function: Support functions and HVAC for the Booster Ring

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 72 | F +/- | 5 | F Heating |
| Humidity | 0 | RH +/- | 0 | RH | Cooling | 0 | RH +/- | 0 | RH Heating |

Room Pressure Vibration Criteria

Acoustic Noise Level NC Per ACGIH TLVs EMI Criteria None

## SPECIAL REQUIREMENTS:

- [ ] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [ ] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group

- [x] Wet System:
- [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr

Recirc / Single Pass Airflow: Recirculated

- [ ] General Exhaust:
- [ ] Heat Exhaust:
- [ ] Chemical Exhaust:
- [x] Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- [x] Domestic Water H/C
- [ ] Eyewash / Safety Shower
- [x] Floor / Trench Drain: Provide floor drains to sanitary waste.

Plumbing Notes:

## PROCESS PIPING:

- [ ] Compressed Air
- [ ] Nitrogen
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 0 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [ ] Phone / Voice
- [ ] PA System
- [ ] Gas Leak Detection
- [ ] Liquid Leak Detection
- [ ] Data Connections:
- [x] Access Control:
- [ ] CCTV:
- [ ] Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Private Office **Room Number:** LOB1-101

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Office

## SPACE REQUIREMENT:

Allocated Space : 110 NSF x 48 Rooms Reqd. = 5,280 Total Net Square Feet

Function: Enclosed private office space

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Painted Gypsum Board Floors: Carpet Tile

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 72 | F +/- | 5 | F Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 | RH Heating |

Room Pressure: Positive Vibration Criteria: None

Acoustic Noise Level NC: 35-40 EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30-50 (50 at work surface)

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 3 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Open Office Space **Room Number:** LOB1-102

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Office

## SPACE REQUIREMENT:

Allocated Space : 90 NSF x 24 Rooms Reqd. = 2,160 Total Net Square Feet

Function: Cubicle space

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Movable Partition Floors: Carpet Tile

Ceilings: No Ceiling Clg. Ht. 10'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria None

Acoustic Noise Level NC 35-40 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30-50 (50 at work surface)

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 3 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Laboratory - Wet | **Room Number:** LOB1-103

**Functional Area:** Lab Office Buildings | Ground Level | **Space Type:** Laboratory

## SPACE REQUIREMENT:

Allocated Space : 480 NSF x 2 Rooms Reqd. = **960** Total Net Square Feet

Function: General Purpose Wet Laboratory

Occupancy Class: B

General Notes: Laboratory equals two laboratory modules, each 240 SF.

## STRUCTURAL DATA:

Floor Live Load: 350 psf | Floor Capacity Load ____ psf | Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Epoxy Painted | Floors: Linoleum Sheet

Ceilings: Acoustic Ceiling Tile | Clg. Ht. 12'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 F +/- | 5 F | Cooling | | 72 F +/- | 5 F | Heating |
| Humidity | 50 RH +/- | 10 RH | Cooling | | 30 RH +/- | 10 RH | Heating |
| Room Pressure | Negative | | Vibration Criteria | | None | | |
| Acoustic Noise Level NC | 45-50 | | EMI Criteria | | None | | |

## SPECIAL REQUIREMENTS:

- ☑ Storage Cabinet
- ☑ Casework
- ☑ Fume Hood — chemical storage cabinet below.
- ☑ Toxic / Hazardous Materials — Fume Hood cabinet

Special Requirements Notes: Two labs per LOB require Fume Hoods. One Hood per LOB to have HEPA filtration

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group | ☑ Wet System: | ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 100 % | ☑ General Exhaust: Room Exhaust | ☑ Chemical Exhaust: Fume Hood

Recirc / Single Pass Airflow: Single Pass | ☐ Heat Exhaust: | ☑ Smoke Exhaust: by AHU

HVAC Notes: One fume hood with HEPA filtration on exhaust. Second to have capability to add HEPA filtration in the future.

## PLUMBING:

- ☑ Domestic Water H/C
- ☑ Eyewash / Safety Shower
- ☐ Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- ☑ Compressed Air — Lab Bench
- ☑ Nitrogen — Lab Bench
- ☐ Liquid Nitrogen
- ☐ Other
- ☑ DI Water
- ☐ Process Cooling Water - Cu
- ☐ Process Cooling Water - Al
- ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct/Indirect

Light Switching: Low Voltage Switch

Lighting Level (FC): 50-75 (75 at work surface)

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 2 | 120 v | 1 ph | Normal | Wall |
| 0 | 120 v | 1 ph | Normal | Raceway |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- ☑ Phone / Voice
- ☐ PA System
- ☐ Gas Leak Detection
- ☐ Liquid Leak Detection
- ☑ Data Connections:
- ☑ Access Control:
- ☐ CCTV:
- ☑ Fire Detection Type: Photoelectric Smoke Detectors

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Laboratory - Dry **Room Number:** LOB1-103A

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Laboratory

## SPACE REQUIREMENT:

Allocated Space : 480 NSF x 4 Rooms Reqd. = 1,920 Total Net Square Feet

Function: General Purpose Dry laboratory

Occupancy Class: B

General Notes: Laboratory equals two laboratory modules, each 240 SF.

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Linoleum Sheet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 12'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 72 F +/- | 5 F | Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 RH +/- | 10 RH | Heating |
| Room Pressure | Negative | | | | Vibration Criteria | None | | |
| Acoustic Noise Level NC | 45-50 | | | | EMI Criteria | None | | |

## SPECIAL REQUIREMENTS:

☑ Storage Cabinet ☑ Fume Hood

☑ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 100 % ☑ General Exhaust: Room Exhaust ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☑ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air: Lab Bench ☐ DI Water

☑ Nitrogen: Lab Bench ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct/Indirect

Light Switching: Low Voltage Switch

Lighting Level (FC): 50-75 (75 at work surface)

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 2 | 120 v | 1 ph | Normal | Wall |
| 0 | 120 v | 1 ph | Normal | Raceway |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☑ Fire Detection Type: Photoelectric Smoke Detectors

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Storage **Room Number:** LOB1-104

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Lab Support

## SPACE REQUIREMENT:

Allocated Space : 110 NSF x 1 Rooms Reqd. = **110** Total Net Square Feet

Function: Storage for Laboratory Equipment

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Vinyl Tile

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 72 | F +/- | 5 | F Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 | RH Heating |

Room Pressure: Negative Vibration Criteria: None

Acoustic Noise Level NC: 40-45 EMI Criteria: None

## SPECIAL REQUIREMENTS:

- [ ] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [ ] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group

- [x] Wet System:
- [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr

Recirc / Single Pass Airflow: Recirculated

- [ ] General Exhaust:
- [ ] Heat Exhaust:
- [ ] Chemical Exhaust:
- [x] Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- [ ] Domestic Water H/C
- [ ] Eyewash / Safety Shower
- [ ] Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- [ ] Compressed Air
- [ ] Nitrogen
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [ ] Phone / Voice
- [ ] PA System
- [ ] Gas Leak Detection
- [ ] Liquid Leak Detection
- [ ] Data Connections:
- [ ] Access Control:
- [ ] CCTV:
- [ ] Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Conference Room **Room Number:** LOB1-105

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Interaction Area

## SPACE REQUIREMENT:

Allocated Space : 560 NSF x 2 Rooms Reqd. = **1,120** Total Net Square Feet

Function: Conference Room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Wall Coverings Floors: Carpet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 10'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Neutral Vibration Criteria None

Acoustic Noise Level NC 30 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct/Indirect

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Conference Room **Room Number:** LOB1-105A

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Interaction Area

## SPACE REQUIREMENT:

Allocated Space : 220 NSF x 2 Rooms Reqd. = 440 Total Net Square Feet

Function: Conference / Meeting Room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Wall Coverings Floors: Carpet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 10'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 72 | F +/- | 5 F Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 RH Heating |

Room Pressure: Neutral Vibration Criteria: None

Acoustic Noise Level NC: 30 EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct/Indirect

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Lobby & Interaction Space **Room Number:** LOB1-106

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Interaction Area

## SPACE REQUIREMENT:

Allocated Space : 150 NSF x 4 Rooms Reqd. = **600** Total Net Square Feet

Function: LOB Entrance

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Carpet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 12'-0"

Finishes Notes: Lobby floors to be ceramic tile.

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria None

Acoustic Noise Level NC 40-45 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C Drinking Fountain ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Break Room / Kitchen **Room Number:** LOB1-107

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Interaction Area

## SPACE REQUIREMENT:

Allocated Space : 240 NSF x 2 Rooms Reqd. = **480** Total Net Square Feet

Function: Seating and space for refrigerator, microwave, sink

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Linoleum Sheet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 10'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 F +/- | 5 F | Cooling | | 72 F +/- | 5 F | Heating | |
| Humidity | 50 RH +/- | 10 RH | Cooling | | 30 RH +/- | 10 RH | Heating | |
| Room Pressure | Negative | | | Vibration Criteria | None | | | |
| Acoustic Noise Level NC | 40 | | | EMI Criteria | None | | | |

## SPECIAL REQUIREMENTS:

- ☐ Storage Cabinet
- ☐ Casework
- ☐ Fume Hood
- ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- ☑ Domestic Water H/C: to sink
- ☑ Floor / Trench Drain: Provide floor drains to sanitary waste.
- ☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

- ☐ Compressed Air
- ☐ Nitrogen
- ☐ Liquid Nitrogen
- ☐ Other
- ☐ DI Water
- ☐ Process Cooling Water - Cu
- ☐ Process Cooling Water - Al
- ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 7 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- ☑ Phone / Voice
- ☑ PA System
- ☐ Gas Leak Detection
- ☐ Liquid Leak Detection
- ☑ Data Connections:
- ☐ Access Control:
- ☐ CCTV:
- ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Ship-Receive & Storage **Room Number:** LOB1-108

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 960 NSF x 1 Rooms Reqd. = **960** Total Net Square Feet

Function: Shipping / Receiving loading platform and storage.

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 75 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria None

Acoustic Noise Level NC 45-50 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes: Overhead door

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculation ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes: Air curtain at overhead door.

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☑ Liquid Nitrogen to Dewar fill station. ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 11 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Toilet / Shower **Room Number:** LOB1-109

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 250 NSF x 2 Rooms Reqd. = **500** Total Net Square Feet

Function: Restroom & shower

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Vinyl Tile

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature F +/- F Cooling F +/- F Heating

Humidity RH +/- RH Cooling RH +/- RH Heating

Room Pressure Negative Vibration Criteria None

Acoustic Noise Level NC 40 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Surface Mount

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 1 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Electrical / Data **Room Number:** LOB1-110

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 153 NSF x 1 Rooms Reqd. = **153** Total Net Square Feet

Function:

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Movable Partition Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Neutral Vibration Criteria None

Acoustic Noise Level NC Per ACGIH TLVs EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Janitor Closet **Room Number:** LOB1-111

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 63 NSF x 1 Rooms Reqd. = 63 Total Net Square Feet

Function: Maintenance space

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Acoustic Ceiling Tile Clg. Ht. 8'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 0 F +/- 0 F Cooling 0 F +/- 0 F Heating

Humidity 0 RH +/- 0 RH Cooling 0 RH +/- 0 RH Heating

Room Pressure Negative Vibration Criteria None

Acoustic Noise Level NC None EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 1 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☐ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Access Corridor Interface — **Room Number:** LOB1-112

**Functional Area:** Lab Office Buildings — Ground Level — **Space Type:** Circulation

## SPACE REQUIREMENT:

Allocated Space : 2,090 NSF x 1 Rooms Reqd. = **2,090** Total Net Square Feet

Function: Extension of the Access Corridor into LOB

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf — Floor Capacity Load ____ psf — Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint — Floors: Sealed Concrete

Ceilings: No Ceiling — Clg. Ht.:

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 F +/- | 1 F | Cooling | 75 F +/- | 1 F | Heating | | |
| Humidity | 50 RH +/- | 10 RH | Cooling | 30 RH +/- | 10 RH | Heating | | |

Room Pressure: Positive — Vibration Criteria: None

Acoustic Noise Level NC: 55 or Better — EMI Criteria: None

## SPECIAL REQUIREMENTS:

- [ ] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [ ] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group — [x] Wet System: — [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr — [ ] General Exhaust: — [ ] Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated — [ ] Heat Exhaust: — [x] Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- [ ] Domestic Water H/C
- [ ] Eyewash / Safety Shower
- [ ] Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- [ ] Compressed Air
- [ ] Nitrogen
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Low Voltage Switch

Lighting Level (FC): 50

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [x] Phone / Voice
- [x] PA System
- [ ] Gas Leak Detection
- [ ] Liquid Leak Detection
- [x] Data Connections:
- [ ] Access Control:
- [ ] CCTV:
- [ ] Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Machine Shop **Room Number:** LOB1-113

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Lab Support

## SPACE REQUIREMENT:

Allocated Space : 270 NSF x 1 Rooms Reqd. = 270 Total Net Square Feet

Function: Machine shop

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Acoustic Ceiling Tile Clg. Ht. 12'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Negative Vibration Criteria None

Acoustic Noise Level NC Per ACGIH TLVs EMI Criteria None

## SPECIAL REQUIREMENTS:

- [ ] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [ ] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group

- [x] Wet System:
- [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 20 CFM/Person

Recirc / Single Pass Airflow: Recirculated

- [x] General Exhaust:
- [ ] Heat Exhaust:
- [ ] Chemical Exhaust:
- [x] Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- [ ] Domestic Water H/C
- [x] Eyewash / Safety Shower
- [ ] Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- [x] Compressed Air
- [ ] Nitrogen
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 50-75

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 2 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [x] Phone / Voice
- [ ] PA System
- [ ] Gas Leak Detection
- [ ] Liquid Leak Detection
- [x] Data Connections:
- [ ] Access Control:
- [ ] CCTV:
- [ ] Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** LOB #4 Shell **Room Number:** LOB4-101

**Functional Area:** Lab Office Buildings Ground Level **Space Type:**

## SPACE REQUIREMENT:

Allocated Space : 16,146 NSF x 1 Rooms Reqd. = **16,146** Total Net Square Feet

Function: Shelled space for future build-out of Lab Office Building

Occupancy Class:

General Notes:

## STRUCTURAL DATA:

Floor Live Load: psf Floor Capacity Load psf Vibration Requirements:

Structural Notes:

## FINISHES:

Walls: Floors: Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes: Unfinished space

## ROOM ENVIRONMENT:

Temperature 0 F +/- 0 F Cooling 0 F +/- 0 F Heating

Humidity 0 RH +/- 0 RH Cooling 0 RH +/- 0 RH Heating

Room Pressure Vibration Criteria

Acoustic Noise Level NC EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes: Sprinklers to be installed.

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow ☐ Heat Exhaust: ☐ Smoke Exhaust:

HVAC Notes: Freeze protection only.

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes: Stub up for future plumbing in labs and toilets.

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes: Process piping to be added when space fit-up

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): <10

Ground:

Electrical Notes: Exit lights and minimal lighting in space.

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 0 | | | | |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☑ PA System Temporary speakers ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Private Office **Room Number:** LOB5-101

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Office

## SPACE REQUIREMENT:

Allocated Space : 110 NSF x 48 Rooms Reqd. = 5,280 Total Net Square Feet

Function: Enclosed private office space

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Painted Gypsum Board Floors: Carpet Tile

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | |
|---|---|---|---|---|
| Temperature | 75 F +/- 5 F | Cooling | 72 F +/- 5 F | Heating |
| Humidity | 50 RH +/- 10 RH | Cooling | 30 RH +/- 10 RH | Heating |
| Room Pressure | Positive | Vibration Criteria | | |
| Acoustic Noise Level NC | 35-40 | EMI Criteria | | |

## SPECIAL REQUIREMENTS:

- ☐ Storage Cabinet
- ☐ Casework
- ☐ Fume Hood
- ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- ☐ Domestic Water H/C
- ☐ Eyewash / Safety Shower
- ☐ Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- ☐ Compressed Air
- ☐ Nitrogen
- ☐ Liquid Nitrogen
- ☐ Other
- ☐ DI Water
- ☐ Process Cooling Water - Cu
- ☐ Process Cooling Water - Al
- ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30-50 (50 at work surface)

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 3 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- ☑ Phone / Voice
- ☐ PA System
- ☐ Gas Leak Detection
- ☐ Liquid Leak Detection
- ☑ Data Connections:
- ☐ Access Control:
- ☐ CCTV:
- ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Flexible Office Space **Room Number:** LOB5-102

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Office

## SPACE REQUIREMENT:

Allocated Space : 90 NSF x 24 Rooms Reqd. = 2,160 Total Net Square Feet

Function: Cubicle space

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Movable Partition Floors: Carpet Tile

Ceilings: No Ceiling Clg. Ht. 10'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria

Acoustic Noise Level NC 35-40 EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30-50 (50 at work surface)

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 3 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☑ Fire Detection Type: Photoelectric Smoke Detectors

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Laboratory - Wet **Room Number:** LOB5-103

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Laboratory

## SPACE REQUIREMENT:

Allocated Space : 480 NSF x 2 Rooms Reqd. = **960** Total Net Square Feet

Function: General Purpose Wet Laboratory

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Epoxy Painted Floors: Linoleum Sheet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 12'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Negative Vibration Criteria

Acoustic Noise Level NC 45-50 EMI Criteria

## SPECIAL REQUIREMENTS:

☑ Storage Cabinet ☐ Fume Hood Chemical storage cabinet below

☐ Casework ☑ Toxic / Hazardous Materials Fume Hood cabinet

Special Requirements Notes: Two labs per LOB require Fume Hoods. One Hood per LOB to have HEPA filtration

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 100% ☑ General Exhaust: Room Exhaust ☑ Chemical Exhaust: Fume Hood

Recirc / Single Pass Airflow Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes: One fume hood with HEPA filtration on exhaust. Second to have capability to add HEPA filtration in the future.

## PLUMBING:

☑ Domestic Water H/C ☐ Floor / Trench Drain

☑ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air Lab Bench ☐ DI Water

☑ Nitrogen Lab Bench ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct/Indirect

Light Switching: Low Voltage Switch

Lighting Level (FC): 50-75 (75 at work surface)

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 2 | 120 v | 1 ph | Normal | Wall |
| 0 | 120 v | 1 ph | Normal | Raceway |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☑ Fire Detection Type: Photoelectric Smoke Detectors

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Laboratory - Dry **Room Number:** LOB5-103A

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Laboratory

## SPACE REQUIREMENT:

Allocated Space : 480 NSF x 4 Rooms Reqd. = **1,920** Total Net Square Feet
Function: General Purpose Dry laboratory
Occupancy Class: B
General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None
Structural Notes:

## FINISHES:

Walls: Paint Floors: Linoleum Sheet
Ceilings: Acoustic Ceiling Tile Clg. Ht. 12'-0"
Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 F +/- | 5 F | Cooling | 72 F +/- | 5 F | Heating |
| Humidity | 50 RH +/- | 10 RH | Cooling | 30 RH +/- | 10 RH | Heating |

Room Pressure: Negative Vibration Criteria
Acoustic Noise Level NC: 45-50 EMI Criteria

## SPECIAL REQUIREMENTS:

- [x] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [ ] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group
- [x] Wet System:
- [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 100%
Recirc / Single Pass Airflow: Single Pass
- [x] General Exhaust: Room Exhaust
- [ ] Heat Exhaust:
- [ ] Chemical Exhaust:
- [x] Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- [ ] Domestic Water H/C
- [x] Eyewash / Safety Shower
- [ ] Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- [x] Compressed Air: Lab Bench
- [x] Nitrogen: Lab Bench
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant
Lighting Lamp Type: Fluorescent
Lighting Direction: Direct/Indirect
Light Switching: Low Voltage Switch
Lighting Level (FC): 50-75 (75 at work surface)
Ground:
Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 2 | 120 v | 1 ph | Normal | Wall |
| 0 | 120 v | 1 ph | Normal | Raceway |

Clean Power:
UPS:
Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [x] Phone / Voice
- [ ] PA System
- [ ] Gas Leak Detection
- [ ] Liquid Leak Detection
- [x] Data Connections:
- [ ] Access Control:
- [ ] CCTV:
- [ ] Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Storage **Room Number:** LOB5-104

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Lab Support

## SPACE REQUIREMENT:

Allocated Space : 110 NSF x 1 Rooms Reqd. = **110** Total Net Square Feet

Function: Storage for Laboratory Equipment

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Painted Gypsum Board Floors: Vinyl Tile

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | |
|---|---|---|---|---|
| Temperature | 75 F +/- 5 F | Cooling | 72 F +/- 5 F | Heating |
| Humidity | 50 RH +/- 10 RH | Cooling | 30 RH +/- 10 RH | Heating |
| Room Pressure | Negative | Vibration Criteria | | |
| Acoustic Noise Level NC | 40-45 | EMI Criteria | | |

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Conference Room **Room Number:** LOB5-105

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Interaction Area

## SPACE REQUIREMENT:

Allocated Space : 560 NSF x 2 Rooms Reqd. = **1,120** Total Net Square Feet

Function: Conference Room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Wall Coverings Floors: Carpet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 10-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Neutral Vibration Criteria

Acoustic Noise Level NC 30 EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct/Indirect

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Conference Room **Room Number:** LOB5-105A

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Interaction Area

## SPACE REQUIREMENT:

Allocated Space : 220 NSF x 2 Rooms Reqd. = **440** Total Net Square Feet

Function: Conference / Meeting Room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Wall Coverings Floors: Carpet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 10'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Neutral Vibration Criteria

Acoustic Noise Level NC 30 EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct/Indirect

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Lobby & Interaction Space **Room Number:** LOB5-106

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Interaction Area

## SPACE REQUIREMENT:

Allocated Space : 150 NSF x 4 Rooms Reqd. = **600** Total Net Square Feet

Function: LOB Entrance

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Carpet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 12'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria

Acoustic Noise Level NC 40-45 EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Break Room / Kitchen **Room Number:** LOB5-107

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Interaction Area

## SPACE REQUIREMENT:

Allocated Space : 240 NSF x 2 Rooms Reqd. = **480** Total Net Square Feet

Function: Seating and space for refrigerator, microwave, sink

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Linoleum Sheet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 10'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 72 | F +/- | 5 | F Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 | RH Heating |

Room Pressure: Negative Vibration Criteria

Acoustic Noise Level NC 40 EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes: Overhead door

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain: Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 7 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Ship-Receive & Storage **Room Number:** LOB5-108

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 960 NSF x 1 Rooms Reqd. = **960** Total Net Square Feet

Function: Shipping / Receiving loading platform and storage.

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | Cooling | | | Heating | | |
|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- 5 F | Cooling | 72 | F +/- 5 F | Heating |
| Humidity | 50 | RH +/- 10 RH | Cooling | 30 | RH +/- 10 RH | Heating |

Room Pressure: Positive Vibration Criteria

Acoustic Noise Level NC: 45-50 EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☑ Liquid Nitrogen to Dewar fill station. ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 11 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Toilet / Shower **Room Number:** LOB5-109

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 250 NSF x 2 Rooms Reqd. = **500** Total Net Square Feet

Function: Restroom & shower

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Vinyl Tile

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 0 | F +/- | 0 | F | Cooling | 0 | F +/- | 0 F Heating |
| Humidity | 0 | RH +/- | 0 | RH | Cooling | 0 | RH +/- | 0 RH Heating |

Room Pressure: Negative Vibration Criteria

Acoustic Noise Level NC: 40 EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Surface Mount

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 1 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Electrical / Data **Room Number:** LOB5-110

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 153 NSF x 1 Rooms Reqd. = **153** Total Net Square Feet

Function:

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Neutral Vibration Criteria

Acoustic Noise Level NC Per ACGIH TLVs EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Janitor Closet **Room Number:** LOB5-111

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 63 NSF x 1 Rooms Reqd. = **63** Total Net Square Feet

Function: Maintenance space

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Acoustic Ceiling Tile Clg. Ht. 8'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature F +/- F Cooling F +/- F Heating

Humidity 0 RH +/- 0 RH Cooling 0 RH +/- 0 RH Heating

Room Pressure Negative Vibration Criteria

Acoustic Noise Level NC None EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 1 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Access Corridor Interface **Room Number:** LOB5-112

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Circulation

## SPACE REQUIREMENT:

Allocated Space : 2,090 NSF x 1 Rooms Reqd. = **2,090** Total Net Square Feet

Function: Extension of the Access Corridor into LOB

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Floors:

Ceilings: Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | |
|---|---|---|---|---|
| Temperature | 75 F +/- 1 F | Cooling | 72 F +/- 1 F | Heating |
| Humidity | 50 RH +/- 10 RH | Cooling | 30 RH +/- 10 RH | Heating |
| Room Pressure | Positive | Vibration Criteria | | |
| Acoustic Noise Level NC | 55 or Better | EMI Criteria | | |

## SPECIAL REQUIREMENTS:

- ☐ Storage Cabinet
- ☐ Casework
- ☐ Fume Hood
- ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- ☐ Domestic Water H/C
- ☐ Eyewash / Safety Shower
- ☐ Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- ☐ Compressed Air
- ☐ Nitrogen
- ☐ Liquid Nitrogen
- ☐ Other
- ☐ DI Water
- ☐ Process Cooling Water - Cu
- ☐ Process Cooling Water - Al
- ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Low Voltage Switch

Lighting Level (FC): 50

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- ☐ Phone / Voice
- ☑ PA System
- ☐ Gas Leak Detection
- ☐ Liquid Leak Detection
- ☐ Data Connections:
- ☐ Access Control:
- ☐ CCTV:
- ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Machine Shop **Room Number:** LOB5-113

**Functional Area:** Lab Office Buildings Ground Level **Space Type:** Lab Support

## SPACE REQUIREMENT:

Allocated Space : 270 NSF x 1 Rooms Reqd. = **270** Total Net Square Feet

Function: Machine shop

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Acoustic Ceiling Tile Clg. Ht. 12'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Negative Vibration Criteria

Acoustic Noise Level NC Per ACGIH TLVs EMI Criteria

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 20 CFM/Person ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☑ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 50-75

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 2 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Control Conference Room **Room Number:** OPS-103

**Functional Area:** Operations Center Level 2 **Space Type:** Laboratory

## SPACE REQUIREMENT:

Allocated Space : 676 NSF x 1 Rooms Reqd. = **676** Total Net Square Feet

Function: Meeting space for control room operators

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Wall Coverings Floors: Carpet Tile

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 72 | F +/- | 5 F Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 RH Heating |

Room Pressure: Positive Vibration Criteria: None

Acoustic Noise Level NC: 30 EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct/Indirect

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Control Room **Room Number:** OPS-104

**Functional Area:** Operations Center Level 2 **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 1,547 NSF x 1 Rooms Reqd. = **1,547** Total Net Square Feet

Function: House control panels for storage ring.

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Raised Floor

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | |
|---|---|---|---|---|---|---|
| Temperature | 75 F +/- | 5 F | Cooling | 72 F +/- | 5 F | Heating |
| Humidity | 50 RH +/- | 10 RH | Cooling | 30 RH +/- | 10 RH | Heating |
| Room Pressure | Positive | | Vibration Criteria | None | | |
| Acoustic Noise Level NC | 35-40 | | EMI Criteria | None | | |

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Indirect

Light Switching: Low Voltage Switch

Lighting Level (FC): 30-50

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 8 | 120 v | 1 | Normal | Wall |
| 16 | 120 v | 1 ph | Emergency | Floor |

Clean Power:

UPS: 30 kVA for Control & Computer Rooms

Emergency Power: Floor receptacles for control stations

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☑ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Computer Room **Room Number:** OPS-105

**Functional Area:** Operations Center Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 976 NSF x 1 Rooms Reqd. = **976** Total Net Square Feet

Function: House computers for storage ring control and monitoring

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Raised Floor

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 72 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria None

Acoustic Noise Level NC 45-50 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 20 CFM/Person ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct/Indirect

Light Switching: Occupancy Sensor

Lighting Level (FC): 50

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS: 30 kVA for Control & Computer Rooms

Emergency Power: for computers

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☑ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** 2nd Floor Toilet & Shower **Room Number:** OPS-106

**Functional Area:** Operations Center Level 2 **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 76 NSF x 2 Rooms Reqd. = **152** Total Net Square Feet

Function:

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Vinyl Tile

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature F +/- F Cooling F +/- F Heating

Humidity RH +/- RH Cooling RH +/- RH Heating

Room Pressure Negative Vibration Criteria None

Acoustic Noise Level NC None EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 10-15 (30 at sink)

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 1 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☑ Fire Detection Type: Photoelectric Smoke Detectors

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Entrance Lobby & Vestibule **Room Number:** OPS-107

**Functional Area:** Operations Center Ground Level **Space Type:** Circulation

## SPACE REQUIREMENT:

Allocated Space : 2,415 NSF x 1 Rooms Reqd. = **2,415** Total Net Square Feet

Function: Main entrance to NSLS-II and area for social gatherings

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Ceramic Tile

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | |
|---|---|---|---|---|
| Temperature | 75 F +/- 5 F | Cooling | 72 F +/- 5 F | Heating |
| Humidity | 50 RH +/- 10 RH | Cooling | 30 RH +/- 10 RH | Heating |
| Room Pressure | Positive | Vibration Criteria | None | |
| Acoustic Noise Level NC | 40-45 | EMI Criteria | None | |

## SPECIAL REQUIREMENTS:

- [ ] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [ ] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group [x] Wet System: [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 20 CFM/Person [ ] General Exhaust: [ ] Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated [ ] Heat Exhaust: [x] Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- [x] Domestic Water H/C: Drinking Fountain
- [ ] Floor / Trench Drain
- [ ] Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

- [ ] Compressed Air
- [ ] Nitrogen
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 2 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [x] Phone / Voice
- [x] PA System
- [ ] Gas Leak Detection
- [ ] Liquid Leak Detection
- [x] Data Connections:
- [x] Access Control:
- [ ] CCTV:
- [ ] Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Bridge & Viewing Gallery **Room Number:** OPS-108

**Functional Area:** Operations Center Level 2 **Space Type:** Circulation

## SPACE REQUIREMENT:

Allocated Space : 1,450 NSF x 1 Rooms Reqd. = **1,450** Total Net Square Feet

Function: Viewing area of Experimental Hall for tours.
Access to the Tunnel Mezzanine and Control Room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Vinyl Tile

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Neutral Vibration Criteria None

Acoustic Noise Level NC 40-45 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 0 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Unisex Toilet **Room Number:** OPS-109

**Functional Area:** Operations Center Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 78 NSF x 1 Rooms Reqd. = 78 Total Net Square Feet

Function: Restroom

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Vinyl Tile

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature F +/- F Cooling F +/- F Heating

Humidity RH +/- 0 RH Cooling RH +/- RH Heating

Room Pressure Negative Vibration Criteria None

Acoustic Noise Level NC None EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes: Toilet and sink in each room

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Surface Mount

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 10-15 (30 at sink)

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 1 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Break Room / Kitchenette **Room Number:** OPS-110

**Functional Area:** Operations Center Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 512 NSF x 1 Rooms Reqd. = **512** Total Net Square Feet

Function: Space to store and prepare personal meals

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Linoleum Sheet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Negative Vibration Criteria None

Acoustic Noise Level NC 40-45 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☑ Casework Counter & cabinets ☐ Toxic / Hazardous Materials

Special Requirements Notes: Provide sink; space for refrigerator, microwave, vending machines.

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes: Kitchen sink

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 7 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Telecom Room  **Room Number:** OPS-111

**Functional Area:** Operations Center  Ground Level  **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 409 NSF x 1 Rooms Reqd. = **409** Total Net Square Feet

Function: Electrical equipment room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf  Floor Capacity Load psf  Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint  Floors: Sealed Concrete

Ceilings: Acoustic Ceiling Tile  Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 78 | F +/- | 5 | F | Cooling | 72 | F +/- | 5 F | Heating |
| Humidity | 0 | RH +/- | 0 | RH | Cooling | 0 | RH +/- | 0 RH | Heating |

Room Pressure: Neutral  Vibration Criteria: None

Acoustic Noise Level NC: 45-50  EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet  ☐ Fume Hood

☐ Casework  ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group  ☑ Wet System:  ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr  ☐ General Exhaust:  ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated  ☐ Heat Exhaust:  ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C  ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air  ☐ DI Water

☐ Nitrogen  ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen  ☐ Process Cooling Water - Al

☐ Other  ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 8 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice  ☑ Data Connections:

☑ PA System  ☑ Access Control:

☐ Gas Leak Detection  ☐ CCTV:

☐ Liquid Leak Detection  ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Switchgear Room **Room Number:** OPS-118

**Functional Area:** Operations Center Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 655 NSF x 1 Rooms Reqd. = **655** Total Net Square Feet

Function:

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 72 | F +/- | 5 F Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 RH Heating |

Room Pressure Neutral Vibration Criteria None

Acoustic Noise Level NC 45-50 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Men's Locker Room **Room Number:** OPS-120

**Functional Area:** Operations Center Level 2 **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 128 NSF x 1 Rooms Reqd. = **128** Total Net Square Feet

Function:

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Vinyl Tile

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature F +/- F Cooling F +/- F Heating

Humidity RH +/- RH Cooling RH +/- RH Heating

Room Pressure Negative Vibration Criteria None

Acoustic Noise Level NC 40-45 EMI Criteria None

## SPECIAL REQUIREMENTS:

- [ ] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [ ] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group [x] Wet System: [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr [x] General Exhaust: [ ] Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass [ ] Heat Exhaust: [x] Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- [x] Domestic Water H/C
- [x] Floor / Trench Drain Provide floor drains to sanitary waste.
- [ ] Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

- [ ] Compressed Air
- [ ] Nitrogen
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Surface Mount

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 10-15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 1 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [ ] Phone / Voice
- [ ] PA System
- [ ] Gas Leak Detection
- [ ] Liquid Leak Detection
- [ ] Data Connections:
- [ ] Access Control:
- [ ] CCTV:
- [ ] Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Women's Locker Room **Room Number:** OPS-121

**Functional Area:** Operations Center Level 2 **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 126 NSF x 1 Rooms Reqd. = **126** Total Net Square Feet

Function:

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Vinyl Tile

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature F +/- F Cooling F +/- F Heating

Humidity RH +/- RH Cooling RH +/- RH Heating

Room Pressure Negative Vibration Criteria None

Acoustic Noise Level NC 40-45 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Surface Mount

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 10-15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 1 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Storage **Room Number:** OPS-122

**Functional Area:** Operations Center Level 2 **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 108 NSF x 1 Rooms Reqd. = **108** Total Net Square Feet

Function:

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 72 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Neutral Vibration Criteria None

Acoustic Noise Level NC 40-45 EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☐ Phone / Voice ☐ Data Connections:

☐ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Accelerator Tunnel **Room Number:** RB-101

**Functional Area:** Ring Building Ground Level **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 37,300 NSF x 1 Rooms Reqd. = **37,300** Total Net Square Feet

Function: Houses the Storage Ring

Occupancy Class: B

General Notes: Radiation shielding required for tunnel walls and roof. Shielded doors required for entry. Equipment entry from infield

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load 3000 psf Vibration Requirements: R = 25nm Power Spectral Density

Structural Notes: Minimize differential settlement

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: Concrete Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 78 F +/- 0.18 F Cooling 78 F +/- 0.18 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria R<25 nm PSD

Acoustic Noise Level NC None EMI Criteria No specific criteria established

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes: Shield doors required at ratchet wall for each beamline. Labyrinth entry require elsewhere.

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☑ Floor / Trench Drain Trench drain around perimeter

☐ Eyewash / Safety Shower

Plumbing Notes: Trench drain to have holding sump to allow testing

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☑ Nitrogen Possible replacement for compresse ☑ Process Cooling Water - Cu Cu / Al by ASD

☑ Liquid Nitrogen TBD ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes: Process Cooling Water and Process Chilled Water provided by ASD and coordinated by CFD.

## ELECTRICAL:

Lighting Fixture Type: Surface Mount

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes: Accelerator power fed from tunnel mezzanine thru tunnel roof.

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 0 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power: Lighting, life safety

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☐ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☑ Liquid Leak Detection In Trench Drain ☑ Fire Detection Type: HSSD

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Experimental Hall **Room Number:** RB-102A

**Functional Area:** Ring Building Ground Level **Space Type:** Laboratory

## SPACE REQUIREMENT:

Allocated Space : 94,235 NSF x 1 Rooms Reqd. = **94,235** Total Net Square Feet

Function: House Beamlines and experimental hutches

Occupancy Class: B

General Notes: Occupants will be stationed in the LOBs although they will spend substantial time in the Experimental Hall. The Hall

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load 2000 psf Vibration Requirements: VC-E

Structural Notes: Minimize differential settlement

## FINISHES:

Walls: Pre-insulated Building Wall Panel Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.:

Finishes Notes: Painted steel roof joists. Under side of roof to have acoustical treatment.

## ROOM ENVIRONMENT:

Temperature 75 F +/- 1 F Cooling 75 F +/- 1 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria VC-E

Acoustic Noise Level NC 55 or lower EMI Criteria No specific criteria established

## SPECIAL REQUIREMENTS:

- ☐ Storage Cabinet
- ☐ Casework
- ☐ Fume Hood
- ☑ Toxic / Hazardous Materials: unknown type

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr

Recirc / Single Pass Airflow: Recirculated

HVAC Notes:

- ☐ General Exhaust:
- ☐ Heat Exhaust:
- ☑ Chemical Exhaust: Hutch Exhaust
- ☑ Smoke Exhaust: by AHU

## PLUMBING:

- ☐ Domestic Water H/C
- ☑ Eyewash / Safety Shower: Distributed
- ☐ Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- ☑ Compressed Air: At tunnel mezzanine
- ☑ Nitrogen: At tunnel mezzanine
- ☑ Liquid Nitrogen: At tunnel mezzanine
- ☐ Other
- ☐ DI Water
- ☑ Process Cooling Water - Cu: Cu only/ by EF
- ☐ Process Cooling Water - Al
- ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Metal Halide

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground: Instrument Reference Ground

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 60 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

Electrical Notes: Each panelboard for beamlines is served by a 75kVA transformer. Panelboards mounted on tunnel mezzanine.

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- ☑ Phone / Voice
- ☑ PA System
- ☐ Gas Leak Detection
- ☐ Liquid Leak Detection
- ☑ Data Connections:
- ☑ Access Control:
- ☐ CCTV:
- ☑ Fire Detection Type: HSSD

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Access Corridor **Room Number:** RB-102B

**Functional Area:** Ring Building Ground Level **Space Type:** Circulation

## SPACE REQUIREMENT:

Allocated Space : 33,018 NSF x 1 Rooms Reqd. = 33,018 Total Net Square Feet

Function: Corridor around the outside of the Experimental Hall

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Pre-insulated Building Wall Panel Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 F +/- | 1 F | Cooling | 75 F +/- | 1 F | Heating | | |
| Humidity | 50 RH +/- | 10 RH | Cooling | 30 RH +/- | 10 RH | Heating | | |
| Room Pressure | Positive | | Vibration Criteria | VC-E | | | | |
| Acoustic Noise Level NC | 55 or lower | | EMI Criteria | None | | | | |

## SPECIAL REQUIREMENTS:

- [ ] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [ ] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group [x] Wet System: [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr

Recirc / Single Pass Airflow: Recirculated

HVAC Notes:

- [ ] General Exhaust:
- [ ] Heat Exhaust:
- [ ] Chemical Exhaust:
- [x] Smoke Exhaust: by AHU

## PLUMBING:

- [ ] Domestic Water H/C
- [ ] Eyewash / Safety Shower
- [x] Floor / Trench Drain: Trench drain around perimiter

Plumbing Notes:

## PROCESS PIPING:

- [x] Compressed Air
- [ ] Nitrogen
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Low Voltage Switch

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 60 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [x] Phone / Voice
- [x] PA System
- [ ] Gas Leak Detection
- [ ] Liquid Leak Detection
- [ ] Data Connections:
- [x] Access Control:
- [ ] CCTV:
- [x] Fire Detection Type: HSSD

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Tunnel Mezzanine **Room Number:** RB-103

**Functional Area:** Ring Building Mezzanine **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 50,950 NSF x 1 Rooms Reqd. = **50,950** Total Net Square Feet

Function: Space for Electrical Gear supporting storage ring.

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Pre-insulated Building Wall Panel Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 75 F +/- 5 F Heating

Humidity 50 RH +/- 10 RH Cooling 30 RH +/- 10 RH Heating

Room Pressure Positive Vibration Criteria None

Acoustic Noise Level NC 55 or lower EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☑ Floor / Trench Drain Floor drains

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☐ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☑ Process Cooling Water - Al by ASD

☐ Other ☐ Chemical Drain

Piping Notes: Chilled Water supply and return for power supply cooling is required.

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Low Voltage Switch

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 60 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☑ Fire Detection Type: HSSD

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Loading Dock **Room Number:** RB-104

**Functional Area:** Ring Building Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 2,060 NSF x 1 Rooms Reqd. = 2,060 Total Net Square Feet

Function: Loading Dock for NSLS-II facility

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Pre-insulated Building Wall Panel Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 75 F +/- 5 F Cooling 75 F +/- 5 F Heating

Humidity 0 RH +/- 0 RH Cooling 0 RH +/- 0 RH Heating

Room Pressure Positive Vibration Criteria None

Acoustic Noise Level NC None EMI Criteria None

## SPECIAL REQUIREMENTS:

- ☐ Storage Cabinet
- ☐ Casework
- ☐ Fume Hood
- ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Recirculated ☐ Heat Exhaust: ☐ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- ☐ Domestic Water H/C
- ☐ Eyewash / Safety Shower
- ☐ Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- ☑ Compressed Air
- ☐ Nitrogen
- ☐ Liquid Nitrogen
- ☐ Other
- ☐ DI Water
- ☐ Process Cooling Water - Cu
- ☐ Process Cooling Water - Al
- ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 8 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- ☑ Phone / Voice
- ☑ PA System
- ☐ Gas Leak Detection
- ☐ Liquid Leak Detection
- ☑ Data Connections:
- ☑ Access Control:
- ☐ CCTV:
- ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Hazardous Materials Storage **Room Number:** RB-105

**Functional Area:** Ring Building Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 450 NSF x 1 Rooms Reqd. = **450** Total Net Square Feet

Function: Receipt and storage of hazardous materials

Occupancy Class: H-6

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Pre-insulated Building Wall Panel Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 75 | F +/- | 5 F Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 RH Heating |

Room Pressure: Negative Vibration Criteria: None

Acoustic Noise Level NC: 45-50 EMI Criteria: None

## SPECIAL REQUIREMENTS:

- [ ] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [x] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group

- [x] Wet System:
- [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr

Recirc / Single Pass Airflow: Single Pass

- [ ] General Exhaust:
- [ ] Heat Exhaust:
- [x] Chemical Exhaust:
- [x] Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- [ ] Domestic Water H/C
- [x] Eyewash / Safety Shower
- [ ] Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- [ ] Compressed Air
- [ ] Nitrogen
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 0 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

Electrical Notes: Wall outlets for standard power to be suitable for flammable / hazardous environment.

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [x] Phone / Voice
- [x] PA System
- [x] Gas Leak Detection
- [ ] Liquid Leak Detection
- [ ] Data Connections:
- [x] Access Control:
- [ ] CCTV:
- [ ] Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Stock Room **Room Number:** RB-106

**Functional Area:** Ring Building Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 1,618 NSF x 1 Rooms Reqd. = **1,618** Total Net Square Feet

Function: Receiving and storage for non-hazardous materials.

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 125 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Pre-insulated Building Wall Panel Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | |
|---|---|---|---|---|---|---|
| Temperature | 75 F +/- | 5 F | Cooling | 75 F +/- | 5 F | Heating |
| Humidity | 50 RH +/- | 10 RH | Cooling | 30 RH +/- | 10 RH | Heating |

Room Pressure: Positive Vibration Criteria: None

Acoustic Noise Level NC: 40-45 EMI Criteria: None

## SPECIAL REQUIREMENTS:

- [ ] Storage Cabinet
- [ ] Casework
- [ ] Fume Hood
- [ ] Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group

- [x] Wet System:
- [ ] Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr

Recirc / Single Pass Airflow: Recirculated

- [ ] General Exhaust:
- [ ] Chemical Exhaust:
- [ ] Heat Exhaust:
- [x] Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- [ ] Domestic Water H/C
- [ ] Eyewash / Safety Shower
- [ ] Floor / Trench Drain

Plumbing Notes:

## PROCESS PIPING:

- [ ] Compressed Air
- [ ] Nitrogen
- [ ] Liquid Nitrogen
- [ ] Other
- [ ] DI Water
- [ ] Process Cooling Water - Cu
- [ ] Process Cooling Water - Al
- [ ] Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- [x] Phone / Voice
- [x] PA System
- [ ] Gas Leak Detection
- [ ] Liquid Leak Detection
- [x] Data Connections:
- [x] Access Control:
- [ ] CCTV:
- [ ] Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Grille **Room Number:** RB-107

**Functional Area:** Ring Building Ground Level **Space Type:** Interaction Area

## SPACE REQUIREMENT:

Allocated Space : 257 NSF x 1 Rooms Reqd. = **257** Total Net Square Feet

Function:

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 100 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Pre-insulated Building Wall Panel Floors: Linoleum Sheet

Ceilings: Acoustic Ceiling Tile Clg. Ht. 9'-0"

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 5 | F | Cooling | 75 | F +/- | 5 | F Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 | RH Heating |

Room Pressure: Negative Vibration Criteria: None

Acoustic Noise Level NC: 40-45 EMI Criteria: None

## SPECIAL REQUIREMENTS:

- ☐ Storage Cabinet
- ☐ Casework
- ☐ Fume Hood
- ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☑ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

- ☑ Domestic Water H/C
- ☑ Floor / Trench Drain: Provide floor drains to sanitary waste.
- ☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

- ☐ Compressed Air
- ☐ Nitrogen
- ☐ Liquid Nitrogen
- ☐ Other
- ☐ DI Water
- ☐ Process Cooling Water - Cu
- ☐ Process Cooling Water - Al
- ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Recessed Troffer

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 8 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

- ☐ Phone / Voice
- ☐ PA System
- ☐ Gas Leak Detection
- ☐ Liquid Leak Detection
- ☐ Data Connections:
- ☐ Access Control:
- ☐ CCTV:
- ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** RF Cavity Room **Room Number:** RF-101

**Functional Area:** RF Building Ground Level **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 9,756 NSF x 1 Rooms Reqd. = 9,756 Total Net Square Feet

Function: Location of RF cavities and support

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht. 20'-0" clear

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 1 | F | Cooling | 72 | F +/- | 1 | F | Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 | RH | Heating |

Room Pressure: Neutral Vibration Criteria: None

Acoustic Noise Level NC: None EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☑ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 12 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** RF Test **Room Number:** RF-102

**Functional Area:** RF Building Ground Level **Space Type:** Accelerator

## SPACE REQUIREMENT:

Allocated Space : 426 NSF x 1 Rooms Reqd. = **426** Total Net Square Feet

Function: RF Test

Occupancy Class: B

General Notes: Radiation shielding required for walls and roof. Labyrinth for entrance to be provided.

## STRUCTURAL DATA:

Floor Live Load: 350 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes:

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht. 20'-0" clear

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temperature | 75 | F +/- | 1 | F | Cooling | 75 | F +/- | 1 | F Heating |
| Humidity | 50 | RH +/- | 10 | RH | Cooling | 30 | RH +/- | 10 | RH Heating |

Room Pressure: Positive Vibration Criteria: None

Acoustic Noise Level NC: None EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes: Labyrinth entry required

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Recirculated ☐ Heat Exhaust: ☑ Smoke Exhaust: by AHU

HVAC Notes:

## PLUMBING:

☐ Domestic Water H/C ☐ Floor / Trench Drain

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☑ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Dimmer

Lighting Level (FC): 30

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 4 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☐ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Service Building #1 **Room Number:** SB-101

**Functional Area:** Service Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 9,626 NSF x 1 Rooms Reqd. = **9,626** Total Net Square Feet

Function: Mechanical and Electrical room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350/150 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes: 350 psf ground floor ; 150 psf second floor

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 78 F +/- 5 F Cooling 78 F +/- 5 F Heating

Humidity RH +/- 0 RH Cooling 0 RH +/- 0 RH Heating

Room Pressure Neutral Vibration Criteria None

Acoustic Noise Level NC Per ACGIH TLVs EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 6-10 AC/Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass ☑ Heat Exhaust: Summer Ventilatio ☑ Smoke Exhaust: Yes

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☑ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 24 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Service Building #2 **Room Number:** SB-102

**Functional Area:** Service Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 9,626 NSF x 1 Rooms Reqd. = **9,626** Total Net Square Feet

Function: Mechanical and Electrical room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350/150 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes: 350 psf ground floor ; 150 psf second floor

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Temperature | 78 F +/- | 5 F | Cooling | 78 F +/- | 5 F | Heating |
| Humidity | 0 RH +/- | 0 RH | Cooling | 0 RH +/- | 0 RH | Heating |

Room Pressure: Neutral Vibration Criteria: None

Acoustic Noise Level NC: Per ACGIH TLVs EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 6-10 AC/Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Single Pass ☑ Heat Exhaust: Summer Ventilatio ☑ Smoke Exhaust: Yes

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain: Provide floor drains to sanitary waste.

☑ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 24 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Service Building #3 **Room Number:** SB-103

**Functional Area:** Service Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 9,626 NSF x 1 Rooms Reqd. = **9,626** Total Net Square Feet

Function: Mechanical and Electrical room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350/150 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes: 350 psf ground floor ; 150 psf second floor

## FINISHES:

Walls: Paint Floors: Sealed Concrete

Ceilings: No Ceiling Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

Temperature 78 F +/- 5 F Cooling 78 F +/- 5 F Heating

Humidity 0 RH +/- 0 RH Cooling 0 RH +/- 0 RH Heating

Room Pressure Neutral Vibration Criteria None

Acoustic Noise Level NC Per ACGIH TLVs EMI Criteria None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: Ordinary Hazard Group ☑ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr 6-10 AC/Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow Single Pass ☑ Heat Exhaust: Summer Ventilatio ☑ Smoke Exhaust: Yes

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain Provide floor drains to sanitary waste.

☑ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 24 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Service Building #4 **Room Number:** SB-104

**Functional Area:** Service Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 9,626 NSF x 1 Rooms Reqd. = **9,626** Total Net Square Feet

Function: Mechanical and Electrical Room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350/150 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes: 350 psf ground floor ; 150 psf second floor

## FINISHES:

Walls: Floors:

Ceilings: Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Temperature | 78 F +/- | 5 F | Cooling | 78 F +/- | 5 F | Heating |
| Humidity | 0 RH +/- | 0 RH | Cooling | 0 RH +/- | 0 RH | Heating |

Room Pressure: Neutral Vibration Criteria: None

Acoustic Noise Level NC: Per ACGIH TLVs EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: ☐ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 6-10 AC/Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Single Pass ☑ Heat Exhaust: Summer Ventilatio ☑ Smoke Exhaust: Yes

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain: Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 24 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

# ROOM DATA SHEET

**Room Name:** Service Building #5 **Room Number:** SB-105

**Functional Area:** Service Buildings Ground Level **Space Type:** Building Support

## SPACE REQUIREMENT:

Allocated Space : 9,626 NSF x 1 Rooms Reqd. = **9,626** Total Net Square Feet

Function: Mechanical and Electrical Room

Occupancy Class: B

General Notes:

## STRUCTURAL DATA:

Floor Live Load: 350/150 psf Floor Capacity Load psf Vibration Requirements: None

Structural Notes: 350 psf ground floor ; 150 psf second floor

## FINISHES:

Walls: Floors:

Ceilings: Clg. Ht.

Finishes Notes:

## ROOM ENVIRONMENT:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temperature | 78 | F +/- | 5 | F Cooling | 78 | F +/- | 5 | F | Heating |
| Humidity | 0 | RH +/- | 0 | RH Cooling | 0 | RH +/- | 0 | RH | Heating |

Room Pressure: Neutral Vibration Criteria: None

Acoustic Noise Level NC: Per ACGIH TLVs EMI Criteria: None

## SPECIAL REQUIREMENTS:

☐ Storage Cabinet ☐ Fume Hood

☐ Casework ☐ Toxic / Hazardous Materials

Special Requirements Notes:

## FIRE PROTECTION:

Hazard Classification: ☐ Wet System: ☐ Preaction System

Fire Protection Notes:

## HVAC:

Air Changes / Hr: 6-10 AC/Hr ☐ General Exhaust: ☐ Chemical Exhaust:

Recirc / Single Pass Airflow: Single Pass ☑ Heat Exhaust: Summer Ventilatio ☑ Smoke Exhaust: Yes

HVAC Notes:

## PLUMBING:

☑ Domestic Water H/C ☑ Floor / Trench Drain: Provide floor drains to sanitary waste.

☐ Eyewash / Safety Shower

Plumbing Notes:

## PROCESS PIPING:

☑ Compressed Air ☐ DI Water

☐ Nitrogen ☐ Process Cooling Water - Cu

☐ Liquid Nitrogen ☐ Process Cooling Water - Al

☐ Other ☐ Chemical Drain

Piping Notes:

## ELECTRICAL:

Lighting Fixture Type: Pendant

Lighting Lamp Type: Fluorescent

Lighting Direction: Direct

Light Switching: Occupancy Sensor

Lighting Level (FC): 15

Ground:

Electrical Notes:

Power Outlets:

| No. | Voltage | Phase | Type | Location |
|---|---|---|---|---|
| 24 | 120 v | 1 ph | Normal | Wall |
| 0 | | | | |

Clean Power:

UPS:

Emergency Power:

## TELECOMMUNICATION AND SPECIAL SYSTEMS:

☑ Phone / Voice ☑ Data Connections:

☑ PA System ☑ Access Control:

☐ Gas Leak Detection ☐ CCTV:

☐ Liquid Leak Detection ☐ Fire Detection Type:

Telecom Notes:

LEED-NC

# LEED-NC Version 2.2 Registered Project Checklist

BNL NSLS II Design Case

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 5 | 7 | 2 | **Sustainable Sites** | | **14** Points |
| Y | | | Prereq 1 | **Construction Activity Pollution Prevention** | Required |
| Y | | | Credit 1 | **Site Selection** | 1 |
| | | N | Credit 2 | **Development Density & Community Connectivity** | 1 |
| | | N | Credit 3 | **Brownfield Redevelopment** | 1 |
| Y | | | Credit 4.1 | **Alternative Transportation**, Public Transportation Access | 1 |
| Y | | | Credit 4.2 | **Alternative Transportation**, Bicycle Storage & Changing Rooms | 1 |
| Y | | | Credit 4.3 | **Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles | 1 |
| | ? | | Credit 4.4 | **Alternative Transportation**, Parking Capacity | 1 |
| | ? | | Credit 5.1 | **Site Development,** Protect of Restore Habitat | 1 |
| Y | | | Credit 5.2 | **Site Development,** Maximize Open Space | 1 |
| | ? | | Credit 6.1 | **Stormwater Design,** Quantity Control | 1 |
| | ? | | Credit 6.2 | **Stormwater Design,** Quality Control | 1 |
| | ? | | Credit 7.1 | **Heat Island Effect,** Non-Roof | 1 |
| | ? | | Credit 7.2 | **Heat Island Effect,** Roof | 1 |
| | ? | | Credit 8 | **Light Pollution Reduction** | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 3 | 2 | | **Water Efficiency** | | **5** Points |
| Y | | | Credit 1.1 | **Water Efficient Landscaping**, Reduce by 50% | 1 |
| Y | | | Credit 1.2 | **Water Efficient Landscaping**, No Potable Use or No Irrigation | 1 |
| | ? | | Credit 2 | **Innovative Wastewater Technologies** | 1 |
| Y | | | Credit 3.1 | **Water Use Reduction**, 20% Reduction | 1 |
| | ? | | Credit 3.2 | **Water Use Reduction**, 30% Reduction | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 3 | 1 | 13 | **Energy & Atmosphere** | | **17** Points |
| Y | | | Prereq 1 | **Fundamental Commissioning of the Building Energy Systems** | Required |
| Y | | | Prereq 2 | **Minimum Energy Performance** | Required |
| Y | | | Prereq 3 | **Fundamental Refrigerant Management** | Required |
| 1 | 1 | 8 | Credit 1 | **Optimize Energy Performance** New (see below) | 1 to 10 |
| | | 3 | Credit 2 | **On-Site Renewable Energy** (see below) | 1 to 3 |
| Y | | | Credit 3 | **Enhanced Commissioning** | 1 |
| Y | | | Credit 4 | **Enhanced Refrigerant Management** | 1 |
| | | N | Credit 5 | **Measurement & Verification** | 1 |
| | | N | Credit 6 | **Green Power** Provide at least 35% of the building's electricity from renewable sources by engaging in at least a two-year renewable energy contract | 1 |

**Optimize Energy Performance** (Credit 1)

| New Buildings | Existing Building Renovations | Points |
|---|---|---|
| 10.5% | 3.5% | 1 |
| 14% | 7% | 2 |
| 17.5% | 10.5% | 3 |
| 21% | 14% | 4 |
| 24.5% | 17.5% | 5 |
| 28% | 21% | 6 |
| 31.5% | 24.5% | 7 |
| 35% | 28% | 8 |
| 38.5% | 31.5% | 9 |
| 42% | 35% | 10 |

**On-Site Renewable Energy** (Credit 2)

| % Renewable Energy | Points |
|---|---|
| 2.5% | 1 |
| 7.5% | 2 |
| 12.5% | 3 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 7 | | 6 | **Materials & Resources** | | **13** Points |
| Y | | | Prereq 1 | **Storage & Collection of Recyclables** | Required |
| | | N | Credit 1.1 | **Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof | 1 |
| | | N | Credit 1.2 | **Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof | 1 |
| | | N | Credit 1.3 | **Building Reuse**, Maintain 50% of Interior Non-Structural Elements | 1 |
| Y | | | Credit 2.1 | **Construction Waste Management**, Divert 50% from Disposal | 1 |
| Y | | | Credit 2.2 | **Construction Waste Management**, Divert 75% from Disposal | 1 |
| | | N | Credit 3.1 | **Materials Reuse**, 5% | 1 |
| | | N | Credit 3.2 | **Materials Reuse**,10% | 1 |
| Y | | | Credit 4.1 | **Recycled Content**, 10% (post-consumer + ½ pre-consumer) | 1 |
| Y | | | Credit 4.2 | **Recycled Content**, 20% (post-consumer + ½ pre-consumer) | 1 |
| Y | | | Credit 5.1 | **Regional Materials**, 10% Extracted, Processed & Manufactured Regic | 1 |
| Y | | | Credit 5.2 | **Regional Materials**, 20% Extracted, Processed & Manufactured Regic | 1 |
| | | N | Credit 6 | **Rapidly Renewable Materials** | 1 |
| Y | | | Credit 7 | **Certified Wood** | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 6 | 7 | 2 | **Indoor Environmental Quality** | | **15** Points |
| Y | | | Prereq 1 | **Minimum IAQ Performance** | Required |
| Y | | | Prereq 2 | **Environmental Tobacco Smoke** (ETS) **Control** | Required |
| Y | | | Credit 1 | **Outdoor Air Delivery Monitoring** | 1 |
| | | N | Credit 2 | **Increased Ventilation** | 1 |
| Y | | | Credit 3.1 | **Construction IAQ Management Plan**, During Construction | 1 |
| Y | | | Credit 3.2 | **Construction IAQ Management Plan**, Before Occupancy | 1 |
| Y | | | Credit 4.1 | **Low-Emitting Materials**, Adhesives & Sealants | 1 |
| Y | | | Credit 4.2 | **Low-Emitting Materials**, Paints & Coatings | 1 |
| Y | | | Credit 4.3 | **Low-Emitting Materials**, Carpet Systems | 1 |
| | | N | Credit 4.4 | **Low-Emitting Materials**, Composite Wood & Agrifiber Products | 1 |
| | ? | | Credit 5 | **Indoor Chemical & Pollutant Source Control** | 1 |
| | ? | | Credit 6.1 | **Controllability of Systems**, Lighting | 1 |
| | ? | | Credit 6.2 | **Controllability of Systems**, Thermal Comfort | 1 |
| | ? | | Credit 7.1 | **Thermal Comfort**, Design | 1 |
| | ? | | Credit 7.2 | **Thermal Comfort**, Verification | 1 |
| | ? | | Credit 8.1 | **Daylight & Views**, Daylight 75% of Spaces | 1 |
| | ? | | Credit 8.2 | **Daylight & Views**, Views for 90% of Spaces | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 4 | 1 | | **Innovation & Design Process** | | **5** Points |
| Y | | | Credit 1.1 | **Innovation in Design**: Recycled Content 30% | 1 |
| Y | | | Credit 1.2 | **Innovation in Design**: Green Cleaning | 1 |
| Y | | | Credit 1.3 | **Innovation in Design**: Sustainable Site Maintenance | 1 |
| | ? | | Credit 1.4 | **Innovation in Design**: Provide Specific Title | 1 |
| Y | | | Credit 2 | **LEED® Accredited Professional** | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 28 | 18 | 23 | **Project Totals** **(pre-certification estimates)** | | **69** Points |

**Certified** 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

# APPENDICES

**Appendix A1**

Preliminary Geotechnical Report
May 25, 2007
GEI Consultants

**Appendix A2**

Preliminary Vibration and Acoustic Report
September 15, 2006
Colin Gordon & Associates, Inc.

**Appendix A3**

Preliminary EMI/RFI Site Assessment Study Report
September 1, 2006
VitaTech Engineering, LLC

**Appendix A4**

HVAC Calculations
Accelerator Ring Tunnel – one pentant
Experimental Hall – one pentant

**Appendix A5**

Hourly Whole Building Energy Analysis
September 10, 2007
EMO Energy Solutions

**Appendix A1**

Preliminary Geotechnical Report
May 25, 2007

GEI Consultants

GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

**Geotechnical Report**

# National Synchrotron Light Source II

Advanced Concept Design Phase
Brookhaven National Laboratory
Upton, New York

**Submitted to:**
HDR Architecture, Inc.
1101 King Street, Suite 400
Alexandria, VA 22314


**Submitted by:**
GEI Consultants, Inc.
455 Winding Brook Drive
Suite 201
Glastonbury, CT 06033
860-368-5300


May 25, 2007
Project 062152-*-1000




Nathan L. Whetten, P.E., C.G.
Senior Project Manager

# Table of Contents

# Table of Contents (cont.)

## Figures



## Appendices



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# 1. Introduction

## 1.1 Introduction

Previously, we conducted subsurface explorations and geotechnical engineering evaluations for Conceptual Design, and prepared a summary report dated November 9, 2006. The proposed building location was subsequently shifted about 500 feet to the west. In April and May 2007, we conducted supplemental explorations and engineering evaluations within the western portion of the site, to update our conceptual design recommendations for the current building configuration.

This report summarizes the results of previous (conceptual design) and recent (advanced conceptual design) subsurface explorations, and our geotechnical design and construction recommendations for conceptual design of the proposed National Synchrotron Light Source II (NSLS II). This report supersedes our conceptual design phase geotechnical report dated November 9, 2006.

## 1.2 Summary

The subsurface explorations encountered up to about 9 feet of fill overlying a sand deposit that extends to more than 100 feet below ground surface (bgs). We recommend that foundations be designed as spread footing foundations with slab-on-grade floors. The existing fill should be removed within the building limits and replaced with compacted Structural Fill.

## 1.3 Scope of Work

GEI performed the following conceptual design tasks in 2006:

1. Engaged subsurface exploration contractors to conduct test borings and cone penetrometer tests.
2. Provided a full-time field representative to observe the explorations, and classify the soil samples in the borings.
3. Engaged a materials testing laboratory to perform mechanical gradation analyses on representatives soil samples from the borings.
4. Evaluated the subsurface conditions encountered in the conceptual design explorations and prepared a summary report dated November 9, 2006.

GEI performed the following advanced conceptual design tasks in 2007:

1. Engaged subsurface exploration contractors to conduct supplemental test borings and cone penetrometer tests.
2. Provided a full-time field representative to observe the explorations, and classify the soil samples in the borings.
3. Engaged a materials testing laboratory to perform mechanical gradation analyses on representatives soil samples from the borings.
4. Evaluated the subsurface conditions encountered in the conceptual design and advanced conceptual design explorations and prepared this summary report.

## 1.4 Project Personnel

The following personnel performed services for this project:

| | |
|---|---|
| Steven Hawkins | Field Engineer |
| Nathan Whetten, P.E. | Senior Project Manger |
| Michael Paster, P.E. | Technical Review |

## 1.5 Authorization

The 2006 work was completed in accordance with our agreement dated June 26, 2006. The 2007 Advanced Concept Design phase work was completed in accordance with our agreement dated April 6, 2007.

## 1.6 Project Vertical Datum

Elevations in this report are in feet. The vertical coordinate system is Brookhaven National Laboratory (BNL) ’94. We understand that BNL ’94 is substantially equivalent to National Geodetic Vertical Datum of 1929 (NGVD-29).

# 2. Site and Project Description

## 2.1 Site Description

The approximately 50-acre site is bounded by Brookhaven Avenue to the north, Grove Street to the west, Fifth Street to the east, and a former landfill to the southeast. Seventh Street runs through the middle of the site in a north-south direction, and divides the site roughly in half.

The eastern portion of the site is generally a lawn area or is wooded. The western portion is occupied by several buildings, adjacent parking areas, access roads with asphalt, concrete, or gravel pavement, concrete loading docks, at-grade concrete pads, two railroad tracks, and chain link fences. Existing site features are shown on Figure 2.

The ground surface slopes gently downward from east to west. Ground surface elevations range from about El. 83 along Fifth Street to about El. 63 along Grove Street.

## 2.2 Project Description

Brookhaven Science Associates is planning to replace the existing National Synchrotron Light Source with a new facility, referred to as NSLS II. The new facility will be located within the BNL, south and east of the existing NSLS building (Figure 1). NSLS II will be located south of Brookhaven Avenue and east of Grove Street. The proposed facility layout is shown in plan on Figure 2.

NSLS II will be a state-of-the-art research facility. The facility will include a Ring Building, Operations Center Building, lab/office buildings, and service buildings, totaling about 382,000 square feet. The facility will also include an approximately 50,000 square foot Joint Photon Science Institute (JPSI) building.

We understand that the lowest level floors will generally be at existing site grades, and no basement levels are planned. Proposed floor elevations for the various facility components, provided by HDR Architecture, Inc. (HDR), are indicated in the table below.

| Structure | Proposed Floor El. | Ground Surface Elevation |
|---|---|---|
| Experimental Floor<br>Storage Ring Floor<br>Booster Ring | El. 70<br>El. 71.33<br>El. 71.33 | El. 68 (SW) to El. 77 (E)<br>El. 68 (SW) to El. 77 (E)<br>El. 73 |
| Lab/Office Buildings (LOB) | El. 70 | El. 73 to 74 (N LOB)<br>El. 73 to 77 (NE LOB)<br>El. 70 to 77 (SE LOB)<br>El. 66 to 68 (SW LOB)<br>El. 68 to 73 (W LOB) |
| Operations Center Lower Floor | El. 71.33 | El. 73 |
| Service Buildings Lower Floor | El. 70 | El. 73 (N Svc Bldg)<br>El. 74 to 75 (NE Svc Bldg)<br>El. 72 to 75 (SE Svc Bldg)<br>El. 70 to 71 (SW Svc Bldg) |
| Joint Photon Science Institute | El. 70 | El. 73 to 75 |

Comparing the proposed floor grades with the existing site grades, up to about 9 feet of excavation and up to 4 feet of fill will be required below floors.

We understand that the floor slab for the experimental hall will be 18 inches thick, and the adjacent tunnel ring slab will be 36 inches thick. These elements will be constructed as a monolithic slab. The design live load for the floor in these areas is 250 pounds per square foot (psf).

# 3. Subsurface Conditions

## 3.1 Previous Subsurface Explorations

**1977 Explorations –** In 1977, Stone & Webster conducted subsurface explorations for the existing NSLS facility. The explorations included six soil borings and four test pits. The borings were drilled to depths of 100 to 102 feet and the test pits were excavated to a depth of about 12 feet. Approximate exploration locations are shown on Figure 2, and logs of the test pits and borings are presented in Appendix A.

**2003 Explorations –** In 2003, we conducted eleven test borings for the nearby Center for Functional Nanomaterials (CFN) building. The test borings were advanced to depths of 7 to 62 feet bgs. Drilling activities were monitored by a GEI field technician. Test boring locations are shown on Figure 2, and boring logs prepared by the driller are provided in Appendix B.

## 3.2 Recent Subsurface Explorations

During the periods July 19 to 21, August 16, 2006, and April 23 to 26, 2007, we conducted ten test borings, (B101-B104 and B201-B206) and fifteen cone penetrometer soundings (CPT-1 to CPT-6, CPT-8, CPT-10 to CPT-14, and CPT-201 to CPT-203). Shear wave velocity measurements were made in CPT-3, -5A, -6, -12, -202, and -203 at 10-foot intervals within the sand. Explorations were monitored by a GEI engineer.

Test borings B101, B102, and B201-B204 were drilled to depths of 47 to 62 bgs. These borings were drilled using 3-inch-diameter driven casing, and Standard Penetration Tests were conducted at 5-foot intervals. Borings B101A and B102A were drilled a few feet away from borings B101 and B102, respectively, with continuous samples taken to a depth of 10 feet. Borings B103 and B104B were drilled to a depth of 32 feet using hollow-stem augers. B104 and B104A were terminated after encountering shallow refusals. Most of the borings included continuous or semi-continuous sampling within the upper 12 to 14 feet. Logs are presented in Appendix C.

The CPT soundings penetrated to depths typically ranging from 53 to 100 feet, and were terminated at refusal or at a maximum depth of 100 feet. Shallow refusals at depths less than 10 feet were encountered in CPT-5, -7, -13, and -13A. A second sounding (CPT-5A) was completed near CPT-5 to a depth of 83 feet; a second sounding (CPT-13A) near CPT-13 encountered shallow refusal and was terminated. CPT-9 was deleted from the exploration program. Logs of CPT soundings are presented in Appendix D.

## 3.3 Laboratory Testing

GeoTesting Express, of Boxborough, Massachusetts, performed 21 mechanical gradation analyses on soil samples recovered from the test borings. Sixteen gradation analyses were conducted on samples from borings B101 and B102, and five were conducted on samples from borings B202, B203, B204 and B206. Results are presented in Appendix E.

## 3.4 Subsurface Soil Conditions

**Fill**

Topsoil ranging in thickness from 2 to 12 inches was encountered in test borings that were drilled in landscaped areas. Topsoil was not encountered in B103, B104, B202, and B206, which were drilled in developed areas. Bituminous concrete approximately 4 inches thick was encountered in B202, which was drilled in an existing parking lot.

Each of the borings encountered fill typically described as silty sand (SM) or widely-graded sand (SW), and the thickness ranged from 2 to 9 feet. SPT N-Values ranged from 4 to 21 blows per foot (bpf), indicating the fill is loose to medium dense. Fill was also detected within the upper 1 to 10 feet in CPT soundings made near existing buildings and roadways. Explorations B104, B104A, CPT-13, and CPT-13A, located within the southern portion of the ring building, encountered refusals believed to represent buried objects, cobbles, or boulders within the fill.

**Sand**

A thick layer of stratified sand, sand with silt, and sand with gravel was encountered below the fill in all of the explorations. Subsurface explorations were terminated within the sand at maximum depths of about 100 feet. The sand is light brown to brown. SPT N-values ranged from about 15 bpf (medium dense) to greater than 50 bpf (very dense). The average corrected SPT N-value calculated from the CPTs within the upper 50 feet was about 30 bpf, The CPTs detected some localized zones with equivalent N-values between 10 and 20, 40 and 50, and over 50 bpf.

Shear wave velocity measurements made in CPT-3, -5A, -6, -12, -202, -203 indicate a uniform to slightly increasing shear wave velocity with depth. Velocities varied from 660 feet per second (fps) to 1,180 fps and typically ranged from 850 fps to 1,100 fps. The average of 54 shear wave velocity tests in these six CPTs was 946 fps.

A 1999 report on the stratigraphy and hydrogeologic conditions at the lab prepared by the United States Geologic Survey[1] refers to the sand as the "Upper Glacial Aquifer," and the thickness at BNL appears to be about 185 feet. Confining clay units and additional sand and gravel aquifers overlie bedrock, which reportedly occurs at a depth of about 1,500 feet.

## 3.5 Groundwater Conditions

Depths to groundwater range from about 21.5 (CPT-203) to 36.5 feet (B102) bgs, and vary with location at the site. Depths were measured in temporary wells and boreholes, and using a pore pressure transducer mounted on the cone probe. At the end of the cone probes, the excess pore water pressure was allowed to dissipate to measure the static water pressure. Groundwater level measurements represent conditions at the times and locations the measurements were made. Significantly different groundwater levels may occur at other times and locations.

1 "Stratigraphy and Hydrogeologic Conditions at the Brookhaven National Laboratory and Vicinity, Suffolk County, New York 1994-1997," prepared by the United States Geologic Survey, dated 1999.

# 4. Preliminary Foundation Recommendations

## 4.1 Foundation Design

We recommend that the proposed buildings be supported on spread footings bearing directly on the sand deposit, or on compacted structural fill placed after removal of existing fill. We recommend that footings be designed for a maximum allowable bearing pressure of 2.5 tons psf, and that footings be at least 3-feet wide.

Exterior footings should bear at least 4 feet below the adjacent finished grade for frost protection. Interior footings should be founded at least 18 inches below the bottom of the floor slab. The top of all footings should be at least 6 inches below the bottom of the overlying floor slab.

## 4.2 Floor Slab Design

Based on a comparison of proposed floor levels with existing site grades, the lowest level floors will range from 9 feet below to 4 feet above existing site grades. The lowest level floor may be designed as a slab-on-grade.

The existing fill is not considered suitable for support of floor slabs due to the low tolerance for settlement. Therefore, we recommend that all existing fill be removed from within the building limits, and replaced with compacted structural fill. A minimum of 6 inches of compacted structural fill should be placed below all floors.

Floors are above groundwater levels encountered in the explorations. Underslab drainage will not be required.

## 4.3 Settlement

**Column and Wall Settlement**

We estimate that total settlement of spread footings will be less than 1 inch, and differential settlements will be less than 0.75 inch. Settlement will occur as loads are applied. We understand that this settlement is acceptable for column and wall footings.

**Floor Settlement**

We understand that the floor slab within the experimental hall will support highly sensitive scientific equipment, and that settlement of the floor slab after the equipment has been installed and calibrated must be small. Based on discussions with HDR, we understand that post-construction total and differential settlement may need to be less than about 0.25 inch.

Soils beneath the floor slab will settle in response to dead and live loads. We anticipate that settlement will be complete within about one to two weeks after load application.

Settlement resulting from floor slab dead loads and fill required beneath the floor slab is expected to occur during construction, and therefore will not contribute to post-construction settlement. However, the 250 psf live load could cause minor post-construction settlement. We calculate the total and differential post-construction settlement from the live load to be less than 0.25 inch. Differential settlement will be less than the total settlement. For sensitive equipment, it may be desirable to allow a two to three week waiting period between installation and final calibration.

## 4.4 Seismic Design

The soil beneath the proposed buildings has an average shear wave velocity of 946 feet per second and is classified as a stiff soil profile for earthquake design purposes as defined by the New York State Building Code. The corresponding site class is D. The soil is not considered to be susceptible to liquefaction.

## 4.5 Reuse of Existing Fill

Based on the results of sieve analyses conducted on soil samples recovered from borings B101 and B102, we anticipate that the natural sand deposit will be suitable for reuse as compacted structural fill below building foundations. The existing fill has a relatively high percentage of fines (silt and clay size particles) and is not suitable for reuse as structural fill. The existing fill is suitable for reuse as common fill outside the building limits.

## 4.6 Subsurface Explorations for Final Design

Subsurface explorations conducted for the 2006 conceptual design and 2007 advanced concept design studies included a relatively small number of widely-spaced explorations. Most of these explorations penetrated to depths of 50 to 100 feet, to evaluate general subsurface conditions in the area of the facility.

We recommend that subsurface explorations for final design include additional test borings with continuous SPT sampling, to further evaluate the nature and thickness of fill materials.

Shallow refusals were encountered in B104, B104A, CPT-13 and -13A, and may indicate buried foundations or other objects within the fill. We recommend that test pits be excavated at locations where shallow refusal was encountered within the fill.

# 5. Final Design Services and Limitations

## 5.1 Final Design Engineering Services

We recommend that GEI be engaged during final design to:

- Conduct subsurface explorations, prepare a final geotechnical engineering report, and provide geotechnical consultation to the design team.
- Review plans and specifications to confirm that our recommendations have been interpreted and implemented as intended.

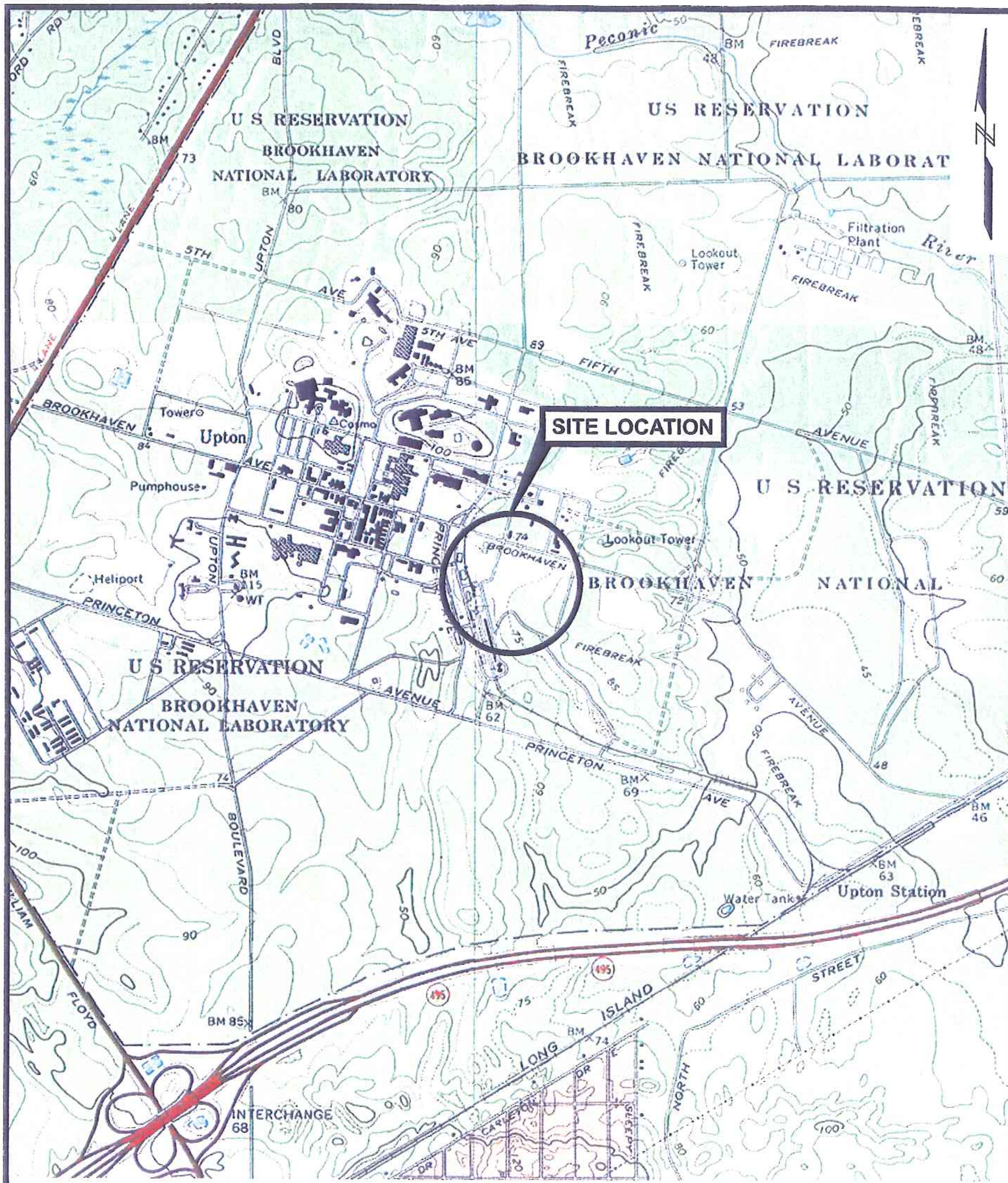
## 5.2 Limitations

This report was prepared for the exclusive use of HDR Architecture, Brookhaven Science Associates, and the NSLS II design team. Our recommendations are based on the project information provided to us at the time of this report and may require modification if there are any changes in the nature, design, or location of the proposed structure. We cannot accept responsibility for designs based on our recommendations unless we are engaged to review the final plans and specifications to determine whether any changes in the project affect the validity of our recommendations and whether our recommendations have been properly implemented in the design.

The recommendations in this report are based in part on the data obtained from the subsurface explorations. The nature and extent of variations between explorations may not become evident until construction. If variations from the anticipated conditions are encountered, it may be necessary to revise the recommendations in this report.

Our professional services for this project have been performed in accordance with generally accepted engineering practices. No warranty, express or implied, is made.

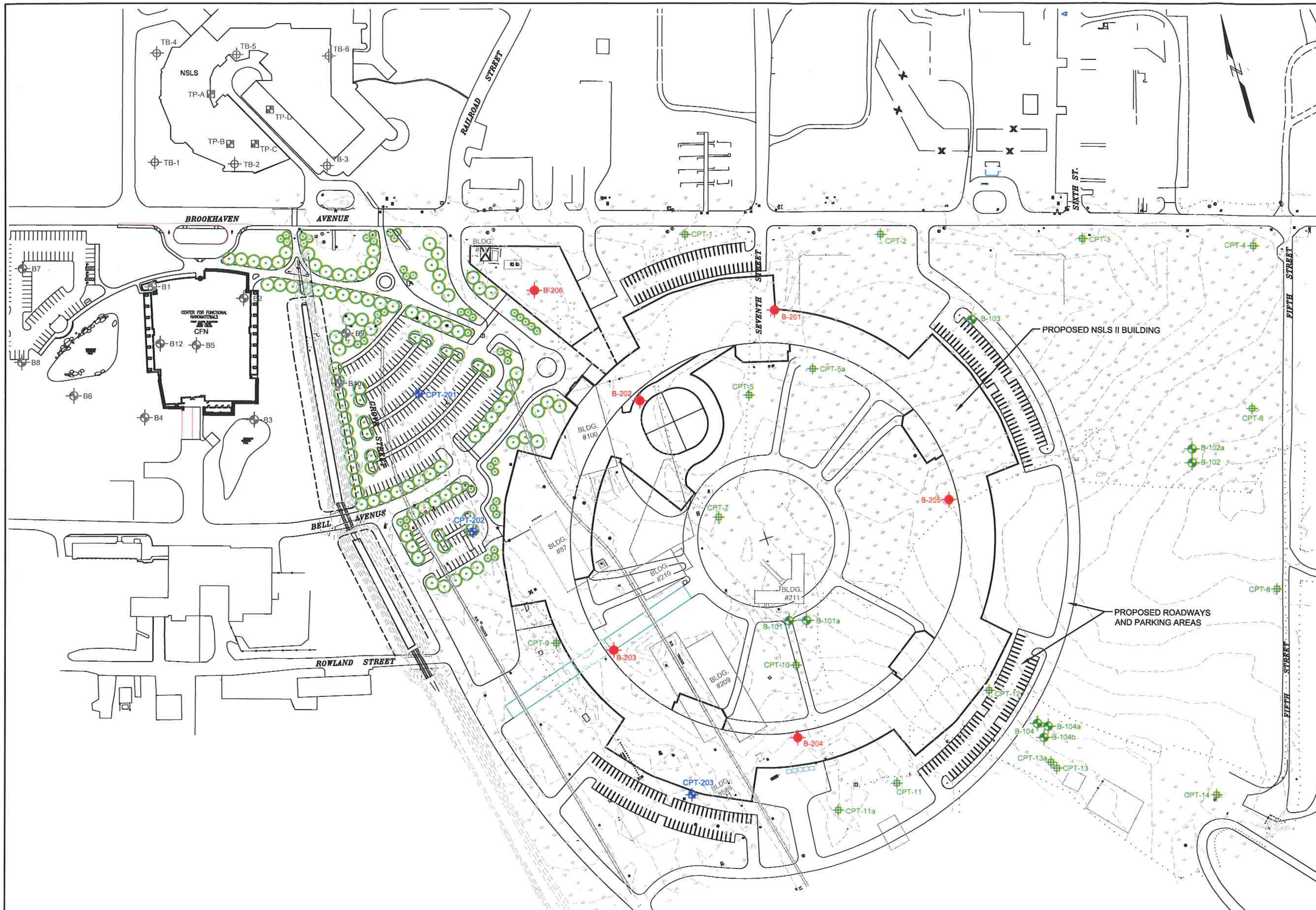
# Figures




SOURCE: Map created with TOPO! ® ©2003 National Geographic (www.nationalgeographic.com/topo)

| | | |
|---|---|---|
| PROPOSED NSLS II<br>BROOKHAVEN NATIONAL LABORATORY<br>UPTON, NEW YORK | GEI Consultants | SITE LOCATION MAP |
| HDR ARCHITECTURE, INC. | PROJECT 062150 | August 2006 Figure 1 |

BROOKHAVEN NL\062150\BROOKHAVEN LOCATION MAP.CDR




## LEGEND:

### ADC EXPLORATIONS:

CPT-201 — APPROXIMATE LOCATION OF CONE PENETROMETER TEST MADE IN APRIL 2007

B-201 — APPROXIMATE LOCATION OF TEST BORING DRILLED IN APRIL 2007

### 2006 EXPLORATIONS:

B-101 — APPROXIMATE LOCATION OF TEST BORING DRILLED IN JULY AND AUGUST 2006

CPT-1 — APPROXIMATE LOCATION OF CONE PENETROMETER TEST MADE IN JULY 2006

### PREVIOUS EXPLORATIONS:

TB-1 — APPROXIMATE LOCATION OF TEST BORING INSTALLED IN 1977

TP-A — APPROXIMATE LOCATION OF TEST PIT INSTALLED IN 1977

B1 — APPROXIMATE LOCATION OF TEST BORING INSTALLED IN 2003

## NOTES:

1. PLAN BASED ON MAP TITLED ***TOPOGRAPHIC SURVEY, PROPOSED NSLS II SITE, SITUATED AT BNL,*** UPTON, NEW YORK, PREPARED BY MUNICIPAL LAND SURVEY P.C., 10 SYLVIA LANE, MIDDLE ISLAND, NEW YORK, 11953.
2. APPROXIMATE LOCATIONS OF 2006 AND 2007 EXPLORATIONS WERE PROVIDED BY BNL, AND WERE DETERMINED BY PACING FROM SITE FEATURES. LOCATIONS OF PREVIOUS EXPLORATIONS WERE ESTIMATED BASED ON RECORD DRAWINGS.
3. THE HORIZONTAL COORDINATE SYSTEM IS IN THE STATE PLANE COORDINATE SYSTEM, NEW YORK LONG ISLAND ZONE 3104, NAD '83, EXPRESSED IN US SURVEY FEET AS DEFINED BY BNL POINT COSMO RM3.
4. THE VERTICAL COORDINATE SYSTEM IS BNL '94 WHICH IS SUBSTANTIALLY EQUIVALENT TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 1929), EXPRESSED IN US SURVEY FEET AS DEFINED BY BNL POINT COSMO RM3.
5. PROPOSED BUILDING LAYOUT REVISED BASED ON MAP PROVIDED BY HDR ARCHITECTURE, INC.

| | | |
|---|---|---|
| PROPOSED NSLS II<br>BROOKHAVEN NATIONAL LABORATORY<br>UPTON, NEW YORK | GEI Consultants | ADC EXPLORATION LOCATIONS |
| HDR ARCHITECTURE, INC. | 455 WINDING BROOK DRIVE<br>SUITE 201<br>GLASTONBURY, CONNECTICUT 06033 | |
| PROJECT 062152-1000 | | May 2007 — Figure 2 |

I:\GEI\Brookhaven National Laboratory\614687\ BROOKHAVEN ADC EXPLORATION 5-07.dwg \May 23, 2007

# Appendix A

## 1977 Test Boring and Test Pit Logs

SH. 1 OF 2

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE — J.O. No. 13011.01 — BORING No. 1

TYPE OF BORING: SS — LOCATION: BROOKHAVEN NATIONAL LABORATORY — GROUND ELEV. 73.4

DATE DRILLED: August 23, 1977 — DRILLED BY: V. AIMAN — LOGGED BY: SMT

SUMMARY OF BORING:

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS OR RECOV. | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION |
|---|---|---|---|---|---|---|
| | 0 | | 28 | | SM | TOP SOIL, SILTY SAND, WIDELY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 15-20% NONPLASTIC FINES, LIGHT BROWN. |
| | 5 | | 36 | SS 2 | SP-SM | SAND, UNIFORM, MEDIUM TO FINE, MOSTLY MEDIUM, 8-10% NONPLASTIC FINES, LIGHT YELLOWISH BROWN. |
| | 10 | | 18 | SS 3 | SM | SILTY SAND, WIDELY GRADED, FINE TO VERY FINE, 20-25% NONPLASTIC FINES, GRAYISH BROWN. |
| | 15 | | 43 | SS 4 | SP | GRAVELLY SAND, POORLY GRADED, 10-15% ROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND MEDIUM 3-5% NONPLASTIC FINES, GRAYISH BROWN. |
| | 20 | | 16 | SS 5 | SP-SM | GRAVELLY SAND, 10-15% ROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND MEDIUM, 8-10% NONPLASTIC FINES, BROWNISH GRAY. |
| | 25 | | 39 | [illegible] | SP | SAND, SIMILAR TO SS #4, EXCEPT GRAVEL TO 0.5 INCH MAXIMUM |
| | 30 | | 77 | SS 7 | SP | GRAVELLY SAND, POORLY GRADED, 18-20% ROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM, 3-5% NONPLASTIC FINES, BROWNISH GRAY. |
| | 35 | | 65 | SS 8 | SP | SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM, 3-5% NONPLASTIC FINES, BROWNISH GRAY. |
| | 40 | | 35 | SS 9 | SP | SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 2-3% NONPLASTIC FINES, BROWNISH GRAY. |
| | 45 | | 58 | SS 10 | SP | GRAVELLY SAND, POORLY GRADED, 20-25% GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND MEDIUM 0-3% NONPLASTIC FINES, BROWNISH GRAY. |
| | 50 | | 63 | SS 11 | SP | SAND, SAME AS SS #10. |
| | 55 | | 51 | SS 12 | SP | [illegible] UNIFORM MEDIUM TO FINE, SOME COARSE PIECES, LESS THAN 3% [illegible]PLASTIC FINES, GRAY. |
| | 60 | | 51 | SS 13 | SP | GRAVELLY SAND, POORLY GRADED, 12-15% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY COARSE AND MEDIUM, LESS THAN 3% FINES, GRAY. |
| | 65 | | 37 | SS 14 | SP | GRAVELLY SAND, SIMILAR TO SS #13, EXCEPT ROUNDED GRAVEL TO 0.3 INCH MAXIMUM. |
| | [illegible] | | ? | [illegible] | SP | SAND, POORLY GRADED, 3-5% GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM 3-5% NONPLASTIC FINES, BROWNISH GRAY. |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ■2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▼6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. □▽ INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊥ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH. 2 OF 2

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE — J.O. No. 13011.10 — BORING No. 1

TYPE OF BORING: SS — LOCATION: BROOKHAVEN NATIONAL LABORATORY — GROUND ELEV. 73.4

DATE DRILLED: August 23, 1977 — DRILLED BY: V. AIMAN — LOGGED BY: SMT

SUMMARY OF BORING:

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS OR RECOV. | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION |
|---|---|---|---|---|---|---|
| | 75 | | 56* | SS 16 | SP | SAND, SAME AS SS #15. |
| | 80 | | 140 | SS 17 | SP | SAND, UNIFORM FINE, SOME COARSE PIECES, LESS THAN 3% NONPLASTIC FINES, LIGHT BROWNISH GRAY. |
| | 85 | | 58 | SS 18 | SP | GRAVELLY SAND, POORLY GRADED, 10-12% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM 3-4% NONPLASTIC FINES, BROWNISH GRAY. |
| | 90 | | 58 | SS 19 | SP | SAND, UNIFORM MEDIUM, SOME COARSE PIECES, LESS THAN 5% NONPLASTIC FINES, LIGHT BROWNISH GRAY. |
| | 95 | | 58 | SS 20 | SP | SAND, SAME AS SS #19. |
| | 100 | ? TERMINATED | 59 | SS 21 | SP | SAND, SAME AS SS #19, [illegible]CK OF ROUNDED GRAVEL TO 0.3 INCH MAXIMUM. END OF BORING AT 101.5 FT. |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ■2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▼6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. □▽ INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊥ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 1 OF 2

SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. NO. 13011.10 BORING NO. 2
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 71.4
DATE DRILLED AUGUST 27, 1977 DRILLED BY Y. AIMAR LOGGED BY RBT
SUMMARY OF BORING

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS RECOV | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS / SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | 0 | | 13 | SS 1 | SM | SILTY SAND, WIDELY GRADED, COARSE TO FINE, MOSTLY FINE, 30-40% NONPLASTIC FINES, MOTTLED GRAY AND BROWN. |
| | 5 | | 15 | SS 2 | SP | SAND, UNIFORM; FINE, LESS THAN 5% NONPLASTIC FINES, LIGHT YELLOWISH GRAY. |
| | 10 | | 25 | SS 3 | SP | SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE; LESS THAN 5% NONPLASTIC FINES, LIGHT YELLOWISH GRAY. |
| | 15 | | 23 | SS 4 | SP-SM | SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, 5-8% NONPLASTIC FINES, BROWNISH ORANGE. |
| | 20 | | 30 | SS 5 | SP | SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, LESS THAN 5% NONPLASTIC FINES, LIGHT YELLOWISH GRAY, SMALL BROWNISH ORANGE POCKETS OF SILTY SAND. |
| | 25 | | 39 | SS 6 | SP | GRAVELLY SAND, POORLY GRADED, 12-15% SUBROUNDED GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 3-5% NONPLASTIC FINES, YELLOWISH GRAY, SMALL LAYER OF BROWNISH GRAY VERY FINE SILTY SAND. |
| | 30 | | 38 | SS 7 | SP | GRAVELLY SAND, POORLY GRADED, 20-25% SUBROUNDED TO ROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 35 | | 104 | SS 8 | SM | SILTY SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, 35-40% NONPLASTIC FINES, BROWN. |
| | 40 | | 52 | SS 9 | SP-SM | SAND, POORLY GRADED, 1 PIECE OF SUBROUNDED GRAVEL 1.0 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 5-8% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 45 | | 57 | SS 10 | SP | GRAVELLY SAND, POORLY GRADED, 10-15% ROUNDED GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 50 | | 33 | SS 11 | SP | SAND, POORLY GRADED, LESS THAN 5% SUBROUNDED GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 55 | | 64 | SS 12 | SP | SAND, POORLY GRADED, 3-5% SUBANGULAR GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 60 | | 44 | SS 13 | SP | SAND, SIMILAR TO SS #12 EXCEPT MOSTLY MEDIUM AND FINE SAND. |
| | 65 | | 50 | SS 14 | SP | SAND, POORLY GRADED, LESS THAN 3% SUBANGULAR GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM, LESS THAN 3% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 70 | | 114 | SS 15 | SP | GRAVELLY SAND, POORLY GRADED, 12-15% SUBROUNDED TO ROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▇2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▞6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ☐7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊻ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

| | |
|---|---|
| 4 | |
| 3 | |
| 2 | |
| 1 | |

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 2 OF 2

SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. NO. 13011.10 BORING NO. 2
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 71.4
DATE DRILLED AUGUST 27, 1977 DRILLED BY Y. AIMAR LOGGED BY RBT
SUMMARY OF BORING

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS RECOV | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS / SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | | | | | | LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 75 | | 65 | SS 16 | SP-SM | SAND, POORLY GRADED, LESS THAN 5% ROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM, 5-8% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 80 | | 52 | SS 17 | SP | SAND, POORLY GRADED, LESS THAN 3% SUBANGULAR GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM TO FINE; LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 85 | | 54 | SS 18 | SP | GRAVELLY SAND, POORLY GRADED, 15-20% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 90 | | 70 | SS 19 | SP-SM | SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 5-8% NONPLASTIC FINES, YELLOWISH GRAY, SOME REDDISH BROWN STAINING AND A FEW PIECES OF GRAVEL TO 0.25 INCH MAXIMUM. |
| | 95 | | 80 | SS 20 | SP | SAND, POORLY GRADED, LESS THAN 5% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 100 | TERMINATED | 160 | SS 21 | SP-SM | SAND, POORLY GRADED, 5-8% SUBROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY FINE, 5-8% NONPLASTIC FINES, LIGHT GRAY. |
| | | | | | | END OF BORING AT 101.5 FT. |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▇2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▞6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ☐7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊻ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

| | |
|---|---|
| 4 | |
| 3 | |
| 2 | |
| 1 | |

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 1 OF 2

SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. NO. 13011.10 BORING NO. 3
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 72.1
DATE DRILLED AUGUST 24, 1977 DRILLED BY Y. AIHAR LOGGED BY [illegible]
SUMMARY OF BORING

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS OR RECOV. | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS / SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | 0 | | 18 | SS 1 | SM | TOP SOIL: SILTY SAND, WIDELY GRADED, 15-20% ANGULAR GRAVEL TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 15-20% SLIGHTLY PLASTIC FINES, DARK BROWN MOTTLED WITH LIGHT BROWN, SOME ORGANIC MATERIAL |
| | 5 | | 36 | SS 2 | SP | SAND, POORLY GRADED, TRACE OF 0.4 INCH GRAVEL, COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, LIGHT BROWN |
| | 10 | | 50 | SS 3 | SP | GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR TO SUBROUNDED GRAVEL TO 0.8 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, LIGHT BROWN |
| | 15 | | 24 | SS 4 | SP-SM | SAND, POORLY GRADED, 3-8% GRAVEL TO 0.5 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN |
| | 20 | | 39 | SS 5 | SP-SM | GRAVELLY SAND, POORLY GRADED, 35-40% SUBROUNDED TO SUBANGULAR GRAVEL TO 0.7 [illegible] MAXIMUM COARSE TO FINE, MOSTLY MEDIUM SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN |
| | 25 | | 61 | SS 6 | SP-SM | GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR GRAVEL TO 0.9 INCH MAX. COARSE TO FINE, MOSTLY FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN |
| | 30 | | 73 | SS 7 | SP | GRAVELLY SAND, POORLY GRADED, 15-20% SUBANGULAR GRAVEL TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES GRAYISH BROWN |
| | 35 | | 74 | SS 8 | SP | GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 30-35% GRAVEL |
| | 40 | | 96 | SS 9 | SP | SAND, POORLY GRADED, 3-5% GRAVEL TO 0.4 INCH MAX., COARSE TO FINE, MOSTLY FINE (VERY LITTLE COARSE) SAND, <5% FINES, GRAYISH BROWN |
| | 45 | | 29 | SS 10 | SP | GRAVELLY SAND, POORLY GRADED, 30-35% SUBROUNDED GRAVEL TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN |
| | 50 | | 43 | SS 11 | SP | GRAVELLY SAND, SIMILAR TO ABOVE |
| | 55 | | 46 | SS 12 | SP | GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 25-30% GRAVEL |
| | 60 | | [illegible] | SS 13 | SP | GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR TO SUBROUNDED GRAVEL TO 0.8 INCH MAX. COARSE TO FINE MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN |
| | 65 | | 69 | SS 14 | SP | GRAVELLY SAND, POORLY GRADED, 25-30% SUBANGULAR TO SUBROUNDED TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN |
| | 70 | | 65 | SS 15 | SP-SM | |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▩2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▨6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊻ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 2 OF 2

SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. NO. 13011.10 BORING NO. 3
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 72.1
DATE DRILLED AUGUST 24, 1977 DRILLED BY Y. AIHAR LOGGED BY [illegible]
SUMMARY OF BORING

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS OR RECOV. | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS / SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | | | | | | SAND, POORLY GRADED, 3-5% GRAVEL, [illegible] 0.5 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN |
| | 75 | | 53 | SS 16 | SP-SM | SAND, SIMILAR TO ABOVE |
| | 80 | | 63 | SS 17 | SP | GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR TO SUBROUNDED GRAVEL TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN |
| | 85 | | 62 | SS 18 | SP | GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 30-35% GRAVEL |
| | 90 | | 65 | SS 19 | SP | GRAVELLY SAND, SIMILAR TO #18 |
| | 95 | | 73 | SS 20 | SP | GRAVELLY SAND, POORLY GRADED, 10-15% SUBROUNDED GRAVEL TO 0.4 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN |
| | 100 | TERMINATED | 76 | SS 21 | SP | SAND, UNIFORM, MEDIUM TO FINE, TRACE OF COARSE SAND, <5% FINES, MEDIUM BROWN |
| | | | | | | END OF BORING AT 101.5 FT |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▩2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▨6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊻ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 1 OF 2

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE — J.O. NO. [illegible] — BORING NO. 1
TYPE OF BORING: SS — LOCATION: BROOKHAVEN NATIONAL LABORATORY — GROUND ELEV. 73.1
DATE DRILLED: AUGUST 25, 1977 — DRILLED BY: V. AIMAR — LOGGED BY: [illegible]
SUMMARY OF BORING:

## SOIL OR ROCK DESCRIPTION

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS OR RECOV | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS, OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS; SOIL STRATA DESCRIPTION, LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | 0 | | 11 | SS 1 | SM | TOP SOIL, SILTY SAND, WIDELY GRADED, 10-12% SUBANGULAR GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY FINE, 25-30% NONPLASTIC FINES, BROWN, SOME BRICK FRAGMENTS, FEW ROOTS, BRICK FRAGMENTS FILL |
| | 5 | | 24 | SS 2 | SP | SAND, UNIFORM FINE, LESS THAN 5% NONPLASTIC FINES, LIGHT GRAYISH [illegible]. |
| | 10 | | 14 | SS 3 | SP | SAND, UNIFORM MEDIUM TO FINE, MOSTLY FINE, 3-5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 15 | | 56 | SS 4 | SP-SM | GRAVELLY SAND, POORLY GRADED 14-18% ROUNDED GRAVEL TO 0.4 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND MEDIUM, 5-8% NONPLASTIC FINES, YELLOWISH GRAY, SOME POCKETS OF YELLOWISH GRAY SILTY SAND. |
| | 20 | | 37 | SS 5 | SP-SM | GRAVELLY SAND, POORLY GRADED, 12-14% SUBROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, 10-12% NONPLASTIC FINES, BROWNISH GRAY. |
| | 25 | | 32 | SS 6 | SP | GRAVELLY SAND, POORLY GRADED, 12-15% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, GRAY. |
| | 30 | | 49 | SS 7 | SP | SAND, UNIFORM MEDIUM TO FINE (TRACE OF COARSE), LESS THAN 5% NONPLASTIC FINES, GRAY, 2 PIECES OF GRAVEL TO 0.35 INCH MAXIMUM. |
| | 35 | | 75 | SS 8 | SP-SM | GRAVELLY SAND, POORLY GRADED, 14-18% SUBROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE, MOSTLY COARSE AND MEDIUM, 10-12% NONPLASTIC FINES, YELLOWISH GRAY MOTTLED WITH DARK GRAY. |
| | 40 | | 77 | SS 9 | SP | GRAVELLY SAND, POORLY GRADED, 12-15% SUBROUNDED TO ROUNDED GRAVEL, TO [illegible] INCH, COARSE TO FINE MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 45 | | 54 | SS 10 | SP | GRAVELLY SAND, POORLY GRADED, 20-25% SUBANGULAR TO SUBROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE LESS THAN 5% NONPLASTIC FINES. YELLOWISH GRAY. |
| | 50 | | 83 | SS 11 | SP | GRAVELLY SAND, POORLY GRADED, 15-20% SUBROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE (VERY LITTLE COARSE). LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 55 | | 93 | SS 12 | SP | GRAVELLY SAND, POORLY GRADED, 15-20% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, (VERY LITTLE COARSE) LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 60 | | 12[illegible] | SS [illegible] | SP | GRAVELLY SAND, POORLY GRADED, 10-12% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES. |
| | 65 | | [illegible] | | SP-SM | GRAVELLY SAND, POORLY GRADED, 20-30% SUBROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 5-8% NONPLASTIC FINES, YELLOWISH GRAY, WITH SOME BROWN STAINING. |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ■2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▼6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊥ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 2 OF 2

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE — J.O. NO. [illegible] — BORING NO. [illegible]
TYPE OF BORING: SS — LOCATION: BROOKHAVEN NATIONAL LABORATORY — GROUND ELEV. 73.1
DATE DRILLED: AUGUST 25, 1977 — DRILLED BY: V. AIMAR — LOGGED BY: [illegible]
SUMMARY OF BORING:

## SOIL OR ROCK DESCRIPTION

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS OR RECOV | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS, OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS; SOIL STRATA DESCRIPTION, LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | | | | | | SAND, UNIFORM MEDIUM AND FINE, [illegible] PIECES OF ROUNDED GRAVEL TO 0.5 INCH MAXIMUM. (A TRACE OF COARSE SAND) LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 75 | | 86 | SS 16 | SP | GRAVELLY SAND, POORLY GRADED, [illegible] SUBANGULAR TO SUBROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 80 | | 86 | SS 17 | SP | GRAVELLY SAND, POORLY GRADED, 10-15% GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, (TRACE OF COARSE) LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 85 | | [illegible] | SS 18 | SP | SAND, UNIFORM MEDIUM AND FINE, (TRACE OF GRAVEL TO 0.25 INCH) MOSTLY FINE, LESS THAN 5% NONPLASTIC FINES, GRAY. |
| | 90 | | 62 | SS [illegible] | SP | GRAVELLY SAND, POORLY GRADED 15-20% SUBROUNDED TO ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, GRAY. |
| | 95 | | 34 | SS 20 | SP | GRAVELLY SAND, POORLY GRADED, 15-20% SUBROUNDED GRAVEL, COARSE TO FINE, MOSTLY MEDIUM, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 100 | TERMINATED | 137 | SS 21 | SP | SAND, UNIFORM MEDIUM AND FINE, (TRACE OF GRAVEL TO 0.25 INCH), LESS THAN 5% NONPLASTIC FINES, GRAY. |

END OF BORING AT 101.5 FT

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ■2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▼6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊥ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE
JO NO. [illegible]   BORING NO. 1
TYPE OF BORING: SS   LOCATION: BROOKHAVEN NATIONAL LABORATORY
DATE DRILLED: AUGUST 24, 1977   GROUND ELEV. 72.6
DRILLED BY: TOMPKINS   LOGGED BY: [illegible]
SUMMARY OF BORING

## SOIL OR ROCK DESCRIPTION

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD (0 25 50 75 100) | SAMPLE BLOWS OR RECOV | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS, ROCK JOINTING, BEDDING AND FAULTING DESCRIPTIONS; SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | 0 | | | | | |
| | 5 | | | SS 1 | SP | SAND, UNIFORM, FINE TO VERY FINE, MOSTLY FINE, < 5% NONPLASTIC FINES, GRAYISH YELLOW. |
| | 10 | | 22 | SS 2 | SP | SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, < 5% NONPLASTIC FINES, GRAYISH YELLOW. |
| | 15 | | 26 | SS 3 | SP | SAND, SIMILAR TO SS #2, [illegible] GRAY. |
| | 20 | | 42 | SS 4 | SP | SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, < 5% NONPLASTIC FINES, [illegible] GRAY. |
| | 25 | | 61 | SS 5 | SP | GRAVELLY SAND, POORLY GRADED, 15-20% SUBROUNDED TO ROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 30 | | 35 | SS 6 | SP-SM | GRAVELLY SAND, POORLY GRADED, [illegible] SUBROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, 5-8% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 35 | | | SS [illegible] | SP-SM | SAND, SAME AS SS #6. |
| | 40 | | [illegible] | SS [illegible] | SP-SM | GRAVELLY SAND, POORLY GRADED, [illegible] ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY [illegible], 5-8% NONPLASTIC FINES, MOTTLED YELLOWISH GRAY AND LIGHT YELLOWISH BROWN. |
| | 45 | | 79 | SS [illegible] | [illegible] | SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 50 | | 64 | SS 10 | [illegible] | SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE (ONE PIECE OF GRAVEL TO 0.5 INCH) < 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 55 | | [illegible] | SS 11 | SP | SAND, SAME AS SS #1[illegible] (NO GRAVEL). |
| | 60 | | [illegible] | SS 12 | SP | SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE (TRACE OF COARSE AND ONE PIECE OF GRAVEL TO 0.25 INCH) < 5% NONPLASTIC FINES. |
| | 65 | | [illegible] | SS 13 | SP | GRAVELLY SAND, GAP GRADED, 20-25% SUBROUNDED GRAVEL TO 1.0 INCH MAXIMUM, MOSTLY MEDIUM AND FINE, < 5% NONPLASTIC FINES, GRAYISH YELLOW. |
| | 70 | | 35 | SS 14 | SP | SAND, UNIFORM, FINE TO MEDIUM (ONE PIECE OF GRAVEL TO 0.3 INCH) TRACE OF COARSE SAND, < 5% NONPLASTIC FINES, YELLOWISH GRAY. |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ■2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▮6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⯆ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

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| 4 | |
| 3 | |
| 2 | |
| 1 | |

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION



SITE: NATIONAL SYNCHROTRON LIGHT SOURCE
JO NO. 13011.01   BORING NO. 1
TYPE OF BORING: SS   LOCATION: BROOKHAVEN NATIONAL LABORATORY
DATE DRILLED: AUGUST 24, 1977   GROUND ELEV. 72.6
DRILLED BY: TOMPKINS   LOGGED BY: [illegible]
SUMMARY OF BORING

## SOIL OR ROCK DESCRIPTION

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD (0 25 50 75 100) | SAMPLE BLOWS OR RECOV | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS, ROCK JOINTING, BEDDING AND FAULTING DESCRIPTIONS; SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | 75 | | | SS 15 | SP | GRAVELLY SAND, POORLY GRADED, 12-15% SUBROUNDED GRAVEL TO 1.0 INCH MAXIMUM, MEDIUM TO FINE, MOSTLY FINE, < 5% NONPLASTIC FINES, GRAYISH YELLOW - BROKEN JAR. |
| | 80 | | 109 | SS 16 | SP | SAND, POORLY GRADED, 5-8% SUBANGULAR GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM TO FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 85 | | 121 | SS 17 | SP | GRAVELLY SAND, POORLY GRADED, 15-20% GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY, LAYER OF GRAY FINE TO VERY FINE SAND. |
| | 90 | | 151? | SS 18 | SP | SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE (TRACE OF COARSE) 5% NONPLASTIC FINES, GRAYISH YELLOW. |
| | 95 | | 196 | SS 19 | SP | SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY WITH SOME REDDISH BROWN STAINING. |
| | 100 | Terminated | 213 | SS 20 | SP | SAND, UNIFORM, FINE TO VERY FINE (TRACE OF COARSE) < 5% NONPLASTIC FINES, YELLOWISH GRAY. |
| | 105 | | | | | END OF BORING AT 102.0 FT |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ■2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▮6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⯆ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

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| 4 | |
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| 2 | |
| 1 | |

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 1 OF 2

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE — J.O. NO. 13011.01 — BORING NO. 6
TYPE OF BORING: SS — LOCATION: BROOKHAVEN NATIONAL LABORATORY — GROUND ELEV. 74.4
DATE DRILLED: AUGUST 25, 1977 — DRILLED BY: TOMKINS — LOGGED BY: DRM
SUMMARY OF BORING:

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS OR RECOV. | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | 5 | | [illegible] | SS 1 | [illegible] | SILTY SAND, UNIFORM MEDIUM TO FINE, MOSTLY FINE, 12-15% NONPLASTIC FINES, YELLOWISH BROWN. |
| | 10 | | 98 | SS 2 | SM | SILTY SAND, WIDELY GRADED, 18-23% SUBANGULAR GRAVEL TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 18-23% NONPLASTIC FINES, BROWN |
| | 15 | | 50 | SS 3 | SP | SAND, POORLY GRADED, 10-15% SUBANGULAR GRAVEL TO 0.6 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, BROWN |
| | 20 | | 147 | SS 4 | GP | SANDY GRAVEL, POORLY GRADED, SUBANGULAR TO 0.8 INCH MAX. 43-47% COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 3-5% FINES, GRAYISH BROWN |
| | 25 | | 126 | SS 5 | SP | GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR TO SUBROUNDED TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN |
| | 30 | | 149 | SS 6 | SP | GRAVELLY SAND, POORLY GRADED, 20-25% SUBANGULAR GRAVEL TO 0.8 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN |
| | 35 | | 123 | SS 7 | SP | GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR GRAVEL TO 0.7 INCH MAX [illegible] MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN |
| | 40 | | 83 | SS 8 | SP | GRAVELLY SAND, POORLY GRADED, 12-18% SUBROUNDED GRAVEL TO 0.5 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN |
| | 45 | | 99 | SS 9 | SP | GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 10-15% GRAVEL |
| | 50 | | 128 | SS 10 | SP | GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 15-25% GRAVEL TO 0.6 INCH MAX. |
| | 55 | | 112 | SS 11 | SP-SM | SAND, POORLY GRADED, 5-8% GRAVEL TO 0.4 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN |
| | 60 | | 40 | SS 12 | SP-SM | SAND, SIMILAR TO ABOVE |
| | 65 | | 72 | SS 13 | SP-SM | SAND, SIMILAR TO ABOVE |
| | 70 | | 57 | SS 14 | SP-SM | SAND, UNIFORM, MEDIUM TO FINE, TRACE OF 0.4 INCH GRAVEL, 5-8% NONPLASTIC FINES, GRAY |

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▮2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▯6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⯆ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 2 OF 2

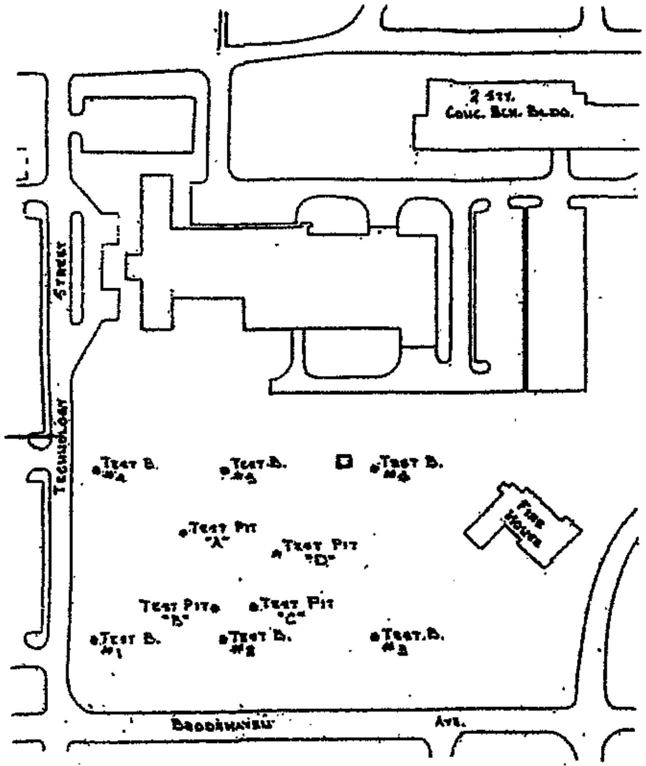
SITE: NATIONAL SYNCHROTRON LIGHT SOURCE — J.O. NO. 13011.01 — BORING NO. 6
TYPE OF BORING: SS — LOCATION: BROOKHAVEN NATIONAL LABORATORY — GROUND ELEV. 7
DATE DRILLED: AUGUST 25, 1977 — DRILLED BY: TOMKINS — LOGGED BY: DSR
SUMMARY OF BORING:

| ELEV. FEET | DEPTH FEET | OVERALL WEATHERING AND RQD | SAMPLE BLOWS OR RECOV. | SAMPLE TYPE | GRAPHIC LOG | SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE) |
|---|---|---|---|---|---|---|
| | 75 | | 132 | SS 15 | SP-SM | SAND, POORLY GRADED, 8-12% GRAVEL TO 0.5 INCH MAX., COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN |
| | 80 | | 190/9" | SS 16 | SP-SM | SAND, SIMILAR TO ABOVE |
| | 85 | | 206 | SS 17 | SP-SM | GRAVELLY SAND, POORLY GRADED, 10-15% SUBANGULAR GRAVEL TO 0.5 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN |
| | 90 | | 90 | SS 18 | SP-SM | SAND, UNIFORM, MEDIUM TO FINE, TRACE OF 0.4 INCH GRAVEL, 5-8% NONPLASTIC FINES, GRAYISH BROWN |
| | 95 | | 116 | SS 19 | SP | GRAVELLY SAND, POORLY GRADED, 15-20% SUBANGULAR GRAVEL TO 0.6 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN |
| | 100 | TERMINATED | 137 | SS 20 | SP | SAND, POORLY GRADED, 8-12% GRAVEL TO 0.5 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN<br>END OF BORING AT 102 FT |


1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▮2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▯6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⯆ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION




## LOG OF TEST PITS

**Test Pit "A"**

East Wall

| | |
|---|---|
| 0 - 2'-6" | Fill, Topsoil At Top |
| 2'-6" - 4'-0" | Sand, Silty, Fine Uniform, Compact, Medium Brown Weathered And Stained |
| 4'-0" - 12'-0" | Sand, Clean, Medium Fine, Uniform, Firm Well Rounded; Light Yellow Gray Shows Fore-Set Bedding Dipping South |

West Wall

| | |
|---|---|
| 0 - 1'-0" | Fill, Sandy Topsoil |
| 1'-0" - 3'-3" | Fill, Sandy |
| 3'-3" - 5'-6" | Sand, Silty, Fine, Uniform, Compact, Medium Brown, Weathered And Stained |
| 5'-6" - 12'-0" | Sand, Clean, Medium Fine, Uniform, Firm Well Rounded, Light Yellow-Gray Shows Fore-Set Bedding Dipping SW 20° |

**Test Pit "B"**

| | |
|---|---|
| 0 - 3'-5" | Topsoil (Fill?) |
| 3'-5" - 8'-0" | Sand, Silty, Fine, Uniform, Compact Medium Brown, Weathered And Stained |
| 8'-0" - 12'-0" | Sand, Clean, Medium Fine, Uniform Firm, Rounded, Light Yellow Gray Shows Fore-Set Bedding Dipping SW At 15°-20° |

Note: Backfilled Trench Crosses Test Pit In East-West Direction - Bottom Depth Of 6.8 Ft. From Surface

**Test Pit "C"**

| | |
|---|---|
| 0 - 1'-5" | Fill - Topsoil |
| 1'-5" - 2'-4" | Topsoil |
| 2'-4" - 5'-7" | Sand, Silty, Fine, Uniform, Compact Medium Brown, Weathered And Stained |
| 5'-7" - 12'-0" | Sand, Clean, Medium Fine, Uniform, Firm Rounded, Light Yellow Gray Shows Fore-Set Bedding Dipping WSW |

Note: Backfilled Trench Crosses Test Pit In East-West Direction, Bottom Depth 6'-8"

**Test Pit "D"**

| | |
|---|---|
| 0 - 1'-0" | Topsoil |
| 1'-0" - 4'-10" | Sand, Silty, Fine, Uniform, Compact Medium Brown, Weathered And Stained |
| 4'-10" - 11'-0" | Sand, Clean, Medium Fine, Uniform Firm, Rounded, Light Yellow-Gray Shows Fore-Set Bedding Dipping WSW At 20° |

| Location | Ground Elev. | Coordinates North | Coordinates East |
|---|---|---|---|
| Test Boring #1 | 72.8 | [illegible] | 100,350 |
| " " #2 | 71.4 | 100,100 | 100,510 |
| " " #3 | 72.3 | 100,100 | 100,700 |
| " " #4 | 73.1 | 100,320 | 100,350 |
| " " #5 | 72.6 | 100,320 | 100,510 |
| " " #6 | 74.4 | 100,320 | 100,700 |
| Test Pit A | 71.7 | 100,240 | 100,460 |
| " " B | 71.5 | 100,140 | 100,500 |
| " " C | 71.7 | 100,140 | 100,550 |
| " " D | 71.7 | 100,210 | 100,580 |

7 6 5 4 3 2 1

FOUNDATION INVESTIGATIONS
NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

Fig. 1

# Appendix B

## 2003 Test Boring Logs

| CLIENT: GEI | NEW ENGLAND BORING CONTRACTORS OF CT., INC. | BORING No. B-1 |
|---|---|---|
| PROJECT NAME: Brookhaven National Labs | 129 KRIEGER LANE, GLASTONBURY, CT 06033 | SHEET 1 OF 1 |
| LOCATION: Long Island, NY | (860) 633-4649 – (413) 733-1232 | ARCHITECT/ ENGINEER |
| DRILLER: T. Roe | FAX (860) 657-8046 | FILE NO. GEI-LongIsland, NY |
| INSPECTOR: A. Smart | | SURFACE ELEV. |
| DATE START: 10/28/03 | | LINE & STATION |
| DATE FINISH: 10/28/03 | | OFFSET |

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-1/4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 1 | 1 | 2 | 1 | 8" | | 8" Dark Brown Topsoil (.6) | | |
| | | | | | | | | Gray Brown Fine Sand, Some Silt, Trace of Roots - Fill (2.5) | | |
| S2 | 5'-7' | 5 | 6 | 8 | 9 | 14" | | Light Brown Fine Sand, Stratified | | |
| S3 | 10'-12' | 7 | 7 | 9 | 12 | 24" | | Light Brown Fine Sand, Some Silt, Stratified | | |
| S4 | 15'-17' | 5 | 12 | 14 | 13 | 20" | | Light Brown Fine Sand, Little Gravel, Stratified | | |
| | | | | | | | | Cobble @ 19'-19'6" | | |
| S5 | 20'-22' | 5 | 7 | 7 | 9 | 24" | | Brown Fine-Med. Sand, Trace of Gravel, Stratified | | |
| S6 | 25'-27' | 5 | 6 | 10 | 11 | 24" | | | | |
| S7 | 30'-32' | 9 | 11 | 13 | 17 | 20" | | Brown Med.-Crs. Sand, Little Fine Sand (32.0) | | |
| | | | | | | | | End of Boring @ 32' | | |
| | | | | | | | | Water @ 31' | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of ground-water may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/28/03

DATE FINISH: 10/28/03


**NEW ENGLAND BORING CONTRACTORS OF CT., INC.**

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046


| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-1/4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

**BORING No. B-2**

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 2 | 2 | 2 | 2 | 20" | | 5" Dark brown Sandy Topsoil (.4); Brown Fine Sand, Little Silt, Trace of Roots - Fill (3.0) | | |
| S2 | 5'-7' | 4 | 7 | 10 | 13 | 18" | | Light Brown Fine Sand; Trace of Silt @ S6, Stratified; Little Silt @ S7 | | |
| S3 | 10'-12' | 3 | 5 | 5 | 7 | 18" | | | | |
| S4 | 15'-17' | 3 | 4 | 5 | 5 | 16" | | | | |
| S5 | 20'-22' | 5 | 5 | 6 | 8 | 18" | | | | |
| S6 | 25'-27' | 6 | 8 | 10 | 10 | 20" | | | | |
| S7 | 30'-32' | 7 | 9 | 10 | 9 | 18" | | (32.0) End of Boring @ 32'; Water @ 29'; Water @ 28' Overnight | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS: *Note: Moved Hole 10' West Due to Overhead Branches*

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/28/03

DATE FINISH: 10/28/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.
129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-1/4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

## BORING No. B-3

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 3 | 3 | 1 | 1 | 14" | | 1" Asphalt - 2" Dark Brown Topsoil. (2) Brown Fine Sand, Trace of Silt, Possible Fill (2.5) Light Brown Fine Sand, Stratified | | |
| S2 | 5'-7' | 3 | 6 | 8 | 10 | 20" | | | | |
| S3 | 10'-12' | 3 | 5 | 5 | 5 | 16" | | | | |
| S4 | 15'-17' | 3 | 2 | 3 | 4 | 24" | | | | |
| S5 | 20'-22' | 3 | 4 | 5 | 8 | 20" | | | | |
| S6 | 25'-27' | 4 | 6 | 6 | 9 | 24" | | | | |
| S7 | 30'-32' | 2 | 5 | 6 | 10 | 24" | | (32.0) End of Boring @ 32' Water @ 31' Water @ 28' Overnight | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/27/03

DATE FINISH: 10/27/03

**NEW ENGLAND BORING CONTRACTORS OF CT., INC.**

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | NW | SS | |
| SIZE I.D. | 3" | 1-3/8" | |
| HAMMER WT. | 300 | 140 | |
| HAMMER FALL | 24" | 30" | |

## BORING No. B-4



ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 1 | 2 | 2 | 3 | 20" | | Dark Brown Sandy Topsoil (1.0); Gray Fine Sand, Little Silt, Trace of Roots - Fill (3.0); Light Brown Fine-Med. Sand, Stratified | | |
| S2 | 5'-7' | 8 | 11 | 13 | 14 | 20" | | | | |
| S3 | 10'-12' | 9 | 10 | 9 | 8 | 18" | | | | |
| S4 | 15'-17' | 11 | 14 | 17 | 19 | 16" | | Light Brown Fine-Crs. Sand, Trace of Fine Gravel, Stratified | | |
| S5 | 20'-22' | 3 | 4 | 6 | 9 | 12" | | Light Brown Fine Sand, Some Med.-Crs. Sand, Trace of Fine-Crs. Gravel | | |
| S6 | 25'-27' | 14 | 16 | 26 | 28 | 12" | | | | |
| S7 | 30'-32' | 15 | 25 | 25 | 28 | 12" | | | | |
| S8 | 35'-37' | 9 | 12 | 15 | 22 | 14" | | | | |
| S9 | 40'-42' | 13 | 25 | 34 | 36 | 12" | | | | |
| S10 | 45'-47' | 9 | 22 | 22 | 25 | 14" | | | | |
| S11 | 50'-52' | 9 | 15 | 16 | 14 | 12" | | | | |
| S12 | 55'-57' | 10 | 14 | 10 | 9 | 12" | | | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/27/03

DATE FINISH: 10/27/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.
129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | NW | SS | |
| SIZE I.D. | 3" | 1-3/8" | |
| HAMMER WT. | 300 | 140 | |
| HAMMER FALL | 24" | 30" | |

BORING No. B-4

SHEET 2 OF 2

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S13 | 60'-62' | 8 | 13 | 17 | 18 | 12" | | 62.0<br>End of Boring @ 62'<br>Water @ 18' Overnight<br>Water @ 23' After 60 Hours +/- | | |

| | | |
|---|---|---|
| CLIENT: GEI<br>PROJECT NAME: Brookhaven National Labs<br>LOCATION: Long Island, NY<br>DRILLER: T. Roe<br>INSPECTOR: A. Smart<br>DATE START: 10/30/03<br>DATE FINISH: 10/30/03 | **NEW ENGLAND BORING CONTRACTORS OF CT., INC.**<br>129 KRIEGER LANE<br>GLASTONBURY, CT 06033<br>(860) 633-4649 – (413) 733-1232<br>FAX (860) 657-8046 | **BORING No. B-5**<br>SHEET 1 OF 1<br>ARCHITECT/ ENGINEER<br>FILE NO. GEI-LongIsland, NY<br>SURFACE ELEV.<br>LINE & STATION<br>OFFSET |

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-1/4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

| SAMPLE | | | | | | | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER | | | | REC. | | | | |
| | | 0-6 | 6-12 | 12-18 | 18-24 | | | | | |
| S1 | 0'-2' | 2 | 2 | 2 | 1 | 18" | | 6" Dark Brown Topsoil (.5)<br>Brown Fine Sand, Little Silt - Fill (3.0)<br>Light Brown Fine Sand, Stratified | | |
| S2 | 5'-7' | 5 | 8 | 9 | 13 | 20" | | | | |
| S3 | 10'-12' | 4 | 5 | 6 | 7 | 24" | | | | |
| S4 | 15'-17' | 4 | 4 | 4 | 6 | 20" | | | | |
| S5 | 20'-22' | 4 | 7 | 9 | 11 | 24" | | Brown Fine Sand, Little Silt, Stratified | | |
| S6 | 25'-27' | 6 | 10 | 12 | 16 | 18" | | Light Brown Fine Sand, Little Fine Gravel, Stratified | | |
| S7 | 30'-32' | 5 | 4 | 9 | 8 | 15" | | Light Brown Fine-Med. Sand, Some Gravel, Stratified (32.0)<br>End of Boring @ 32'<br>Water @ 28' Overnight | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.
2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/29/03

DATE FINISH: 10/29/03


NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 -- (413) 733-1232
FAX (860) 657-8046


| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-1/4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

# BORING No. B-6

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 2 | 7 | 4 | 2 | 24" | | 4" Dark Brown Topsoil - Fine Sand, Some Silt, Little Roots (.3) | | |
| | | | | | | | | Brown Fine Sand, Some Silt, Stratified - Fill (5.5) | | |
| S2 | 5'-7' | 9 | 11 | 12 | 19 | 20" | | Light Brown Fine Sand, Stratified | | |
| S3 | 10'-12' | 9 | 10 | 12 | 15 | 24" | | Trace of Gravel @ S3 | | |
| S4 | 15'-17' | 4 | 9 | 6 | 7 | 24" | | | | |
| S5 | 20'-22' | 8 | 18 | 18 | 21 | 24" | | Light Brown Fine Sand, Trace of Med.-Crs. Sand, Stratified | | |
| S6 | 25'-27' | 10 | 21 | 25 | 30 | 24" | | | | |
| S7 | 30'-32' | 16 | 27 | 25 | 22 | 24" | | (32.0) | | |
| | | | | | | | | End of Boring @ 32'<br>Water @ 30' +/- | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/29/03

DATE FINISH: 10/29/03


NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046


| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | SA | SS | |
| SIZE I.D. | 4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

**BORING No. B-7**

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 1 | 2 | 1 | 1 | 24" | | Dark Brown Topsoil | | |
| | | | | | | | | 1.0 | | |
| | | | | | | | | Brown Fine Sand, Some Silt - Fill | | |
| | | | | | | | | 3.0 | | |
| S2 | 5'-7' | 5 | 8 | 10 | 12 | 24" | | Light Brown Fine Sand, Stratified | | |
| | | | | | | | | 7.0 | | |
| | | | | | | | | End of Boring @ 7'<br>No Water | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/29/03

DATE FINISH: 10/29/03


NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 -- (413) 733-1232
FAX (860) 657-8046


| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | SA | SS | |
| SIZE I.D. | 4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

**BORING No. B-8**

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 3 | 2 | 3 | 2 | 18" | | Brown Fine Sand, Little Silt - Fill | | |
| | | | | | | | | 4.0 | | |
| S2 | 5'-7' | 3 | 3 | 4 | 4 | 24" | | Light Brown Fine Sand, Trace of Gravel, Stratified | | |
| | | | | | | | | 7.0 | | |
| | | | | | | | | End of Boring @ 7'<br>No Water | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/29/03

DATE FINISH: 10/29/03


NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 -- (413) 733-1232
FAX (860) 657-8046


| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | SA | SS | |
| SIZE I.D. | 4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

# BORING No. B-9

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 1 | 6 | 6 | 5 | 20" | | 8" Dark Brown Topsoil (.6) | | |
| | | | | | | | | Black Fine Sand, Trace of Roots, Ash, Brick | | |
| S2 | 5'-7' | 1 | 2 | 1 | 1 | 24" | | Brown Fine Sand, Some Silt - Fill (7.0) | | |
| | | | | | | | | Light Brown Fine Sand | | |
| S3 | 10'-12' | 5 | 5 | 4 | 7 | 18" | | (12.0) | | |
| | | | | | | | | End of Boring @ 12'<br>No Water | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/29/03

DATE FINISH: 10/29/03

**NEW ENGLAND BORING CONTRACTORS OF CT., INC.**

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

# BORING No. B-10

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | SA | SS | |
| SIZE I.D. | 4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 1 | 4 | 3 | 3 | 24" | | Dark Brown Topsoil (1.0) | | |
| | | | | | | | | Brown Fine Sand, Some Silt - Fill (5.0) | | |
| S2 | 5'-7' | 2 | 4 | 6 | 5 | 24" | | Light Brown Fine Sand, Trace of Gravel, Stratified (7.0) | | |
| | | | | | | | | End of Boring @ 7' No Water | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of ground-water may occur due to factors other than those present at the time measurements were made.

REMARKS:

| | | |
|---|---|---|
| CLIENT: GEI<br>PROJECT NAME: Brookhaven National Labs<br>LOCATION: Long Island, NY<br>DRILLER: T. Roe<br>INSPECTOR: A. Smart<br>DATE START: 10/29/03<br>DATE FINISH: 10/29/03 | NEW ENGLAND BORING CONTRACTORS OF CT., INC.<br>129 KRIEGER LANE<br>GLASTONBURY, CT 06033<br>(860) 633-4649 – (413) 733-1232<br>FAX (860) 657-8046 | **BORING No. B-12**<br>SHEET 1 OF 1<br>ARCHITECT/ ENGINEER<br>FILE NO. GEI-LongIsland, NY<br>SURFACE ELEV.<br>LINE & STATION<br>OFFSET |

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-1/4" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

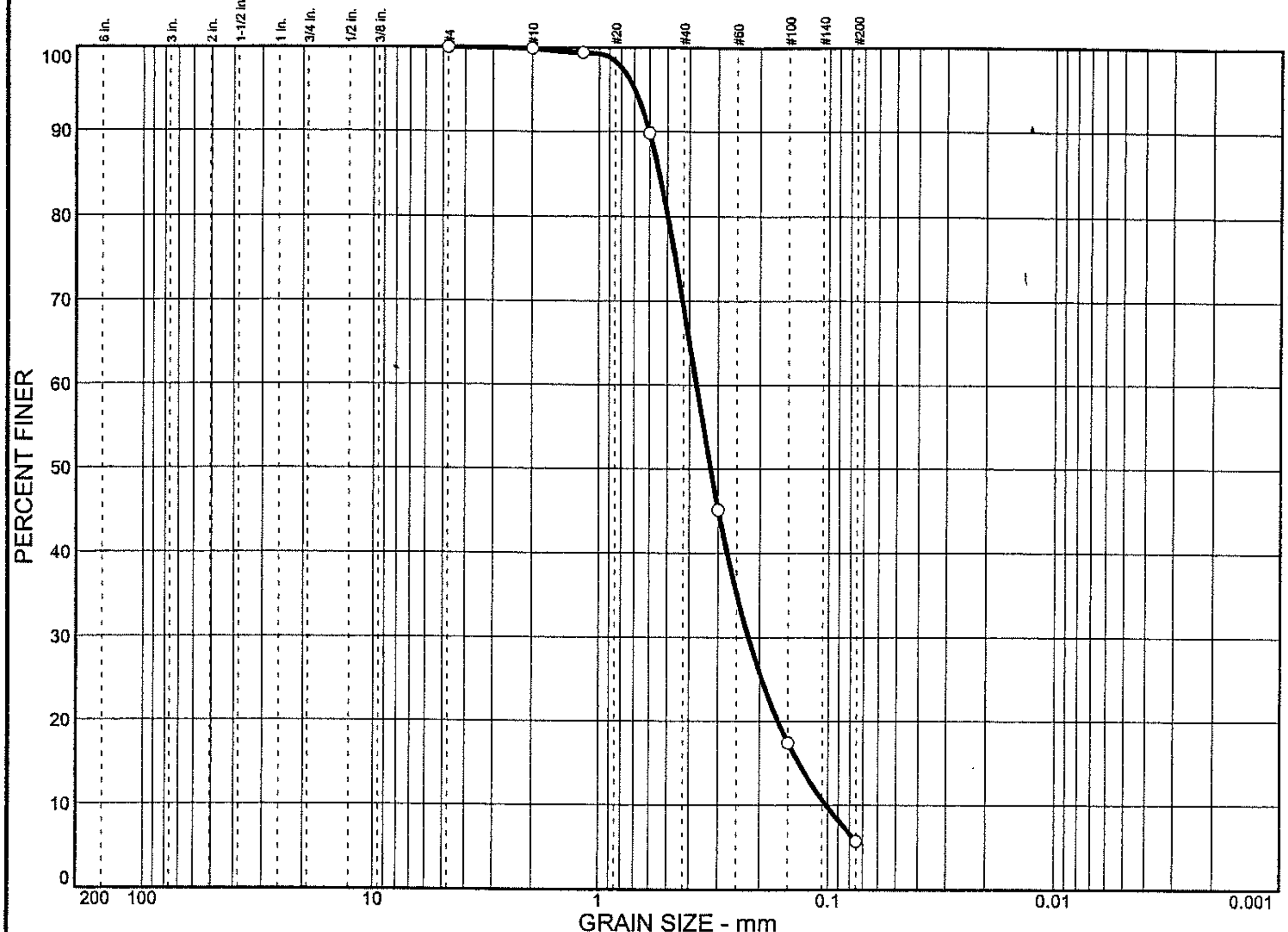
| SAMPLE No. | DEPTH RANGE IN FEET | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | 18-24 | REC. | CASING BLOWS/ CORING TIMES PER FT. | FIELD CLASSIFICATION AND REMARKS | Well Cons. | Installation Details |
|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0'-2' | 1 | 2 | 3 | 2 | 24" | | 8" Dark Brown Topsoil (.6)<br>Brown Fine Sand, Little Silt - Fill (4.0) | | |
| S2 | 5'-7' | 2 | 5 | 8 | 8 | 24" | | Brown Fine Sand, Stratified | | |
| S3 | 10'-12' | 5 | 9 | 9 | 11 | 24" | | | | |
| S4 | 15'-17' | 4 | 5 | 5 | 5 | 24" | | Alternating 4"-10" Layers of Brown Fine Sand and Brown Fine Sand, Little Silt | | |
| S5 | 20'-22' | 7 | 11 | 18 | 19 | 24" | | Light Brown Fine-Med. Sand, Trace of Gravel, Stratified | | |
| S6 | 25'-27' | 4 | 5 | 8 | 8 | 16" | | Cobbles @ 22' to 24' Depth<br>Light Brown Med. Sand, Little Gravel, Stratified | | |
| S7 | 30'-32' | 9 | 12 | 14 | 18 | 20" | | (32.0)<br>End of Boring @ 32'<br>Water @ 30' +/- | | |

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS: *Note: B-11 was Omitted*

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ○ | 0.0 | 0.0 | 94.3 | 5.7 | |
| | | | | | |
| | | | | | |

| ☒ | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 0.544 | 0.374 | 0.324 | 0.223 | 0.135 | 0.102 | 1.31 | 3.67 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ○ Narrowly graded SAND with Silt | SP-SM | |

**Project No.** 03420 **Client:** HDR Architecture, Inc.

**Project:** Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B1 **Sample No.:** S2 **Elev./Depth:** 5 to 7 ft

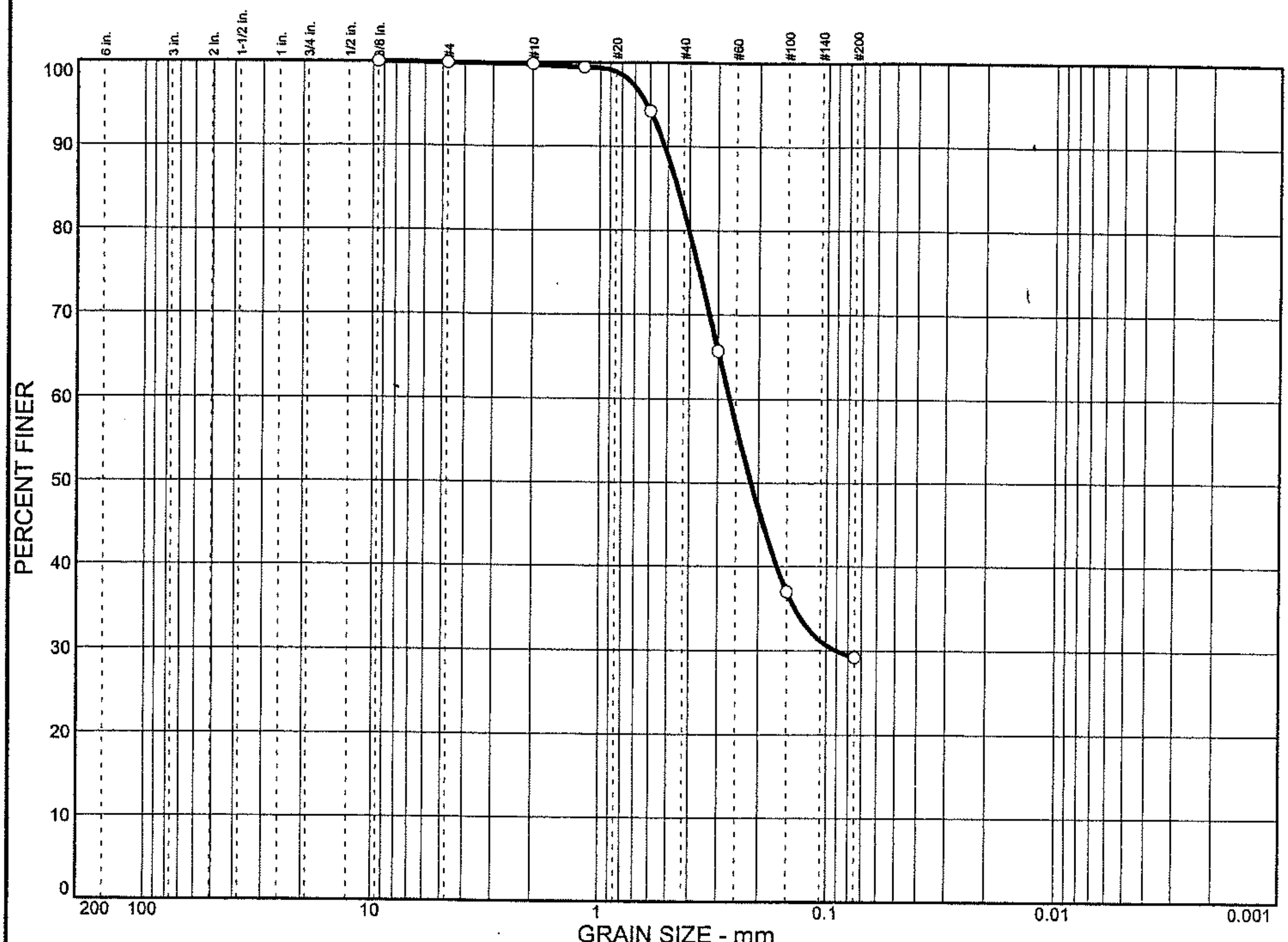
GEI Consultants, Inc.

**Remarks:**

○

**Fig.**

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ○ | 0.0 | 0.1 | 70.7 | 29.2 | |
| | | | | | |
| | | | | | |

| ☒ | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 0.454 | 0.267 | 0.215 | 0.0903 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ○ Silty SAND | SM | |

**Project No.** 03420 **Client:** HDR Architecture, Inc.

**Project:** Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B2 **Sample No.:** S1 **Elev./Depth:** 5 to 7 ft

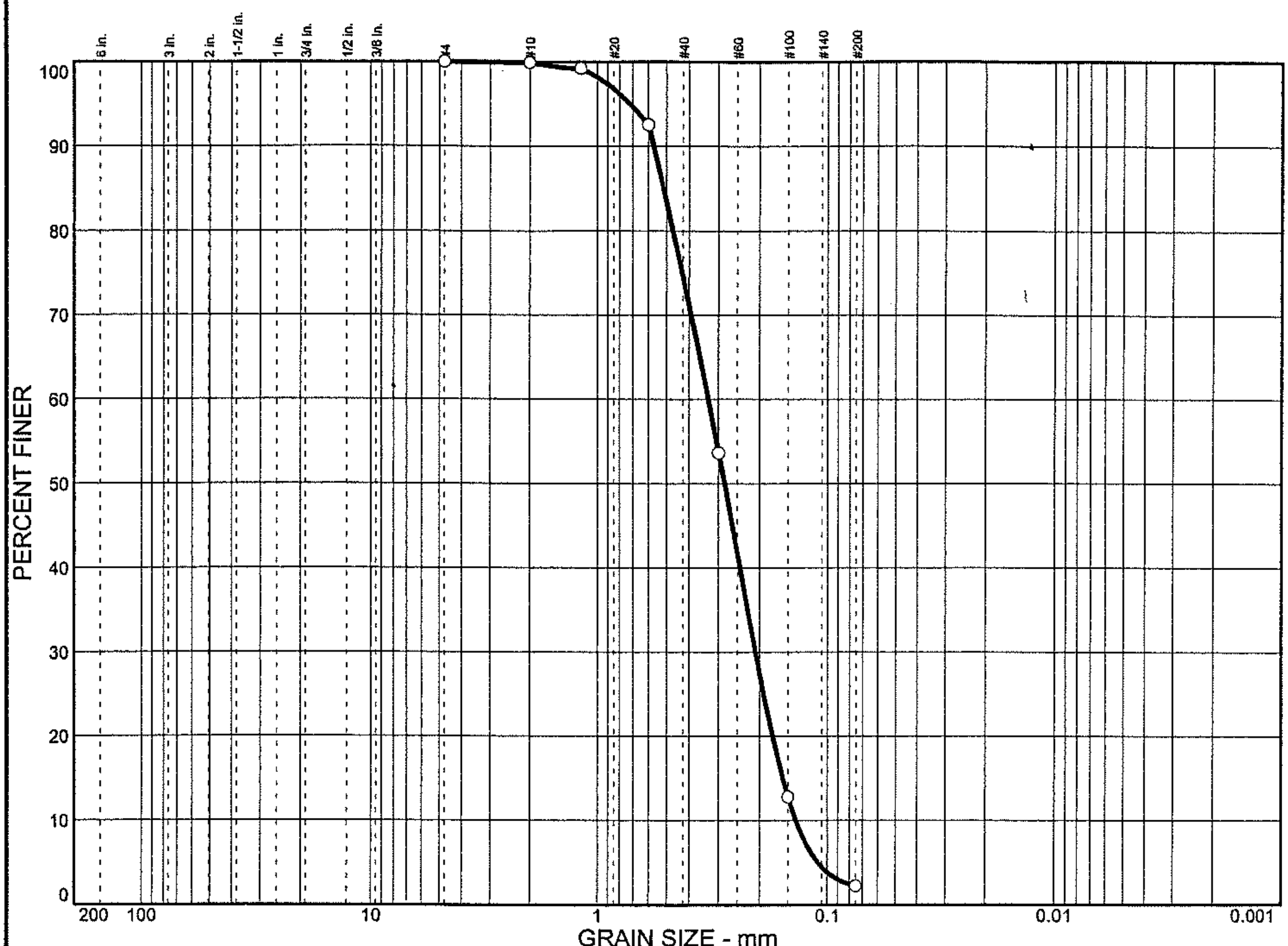
**Remarks:**

○

GEI Consultants, Inc.

**Fig.**

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ○ | 0.0 | 0.0 | 97.8 | 2.2 | |
| | | | | | |
| | | | | | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 0.518 | 0.332 | 0.284 | 0.209 | 0.158 | 0.138 | 0.95 | 2.40 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ○ Narrowly graded SAND | SP | |

**Project No.** 03420 **Client:** HDR Architecture, Inc.

**Project:** Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B3 **Sample No.:** S2 **Elev./Depth:** 5 to 7 ft

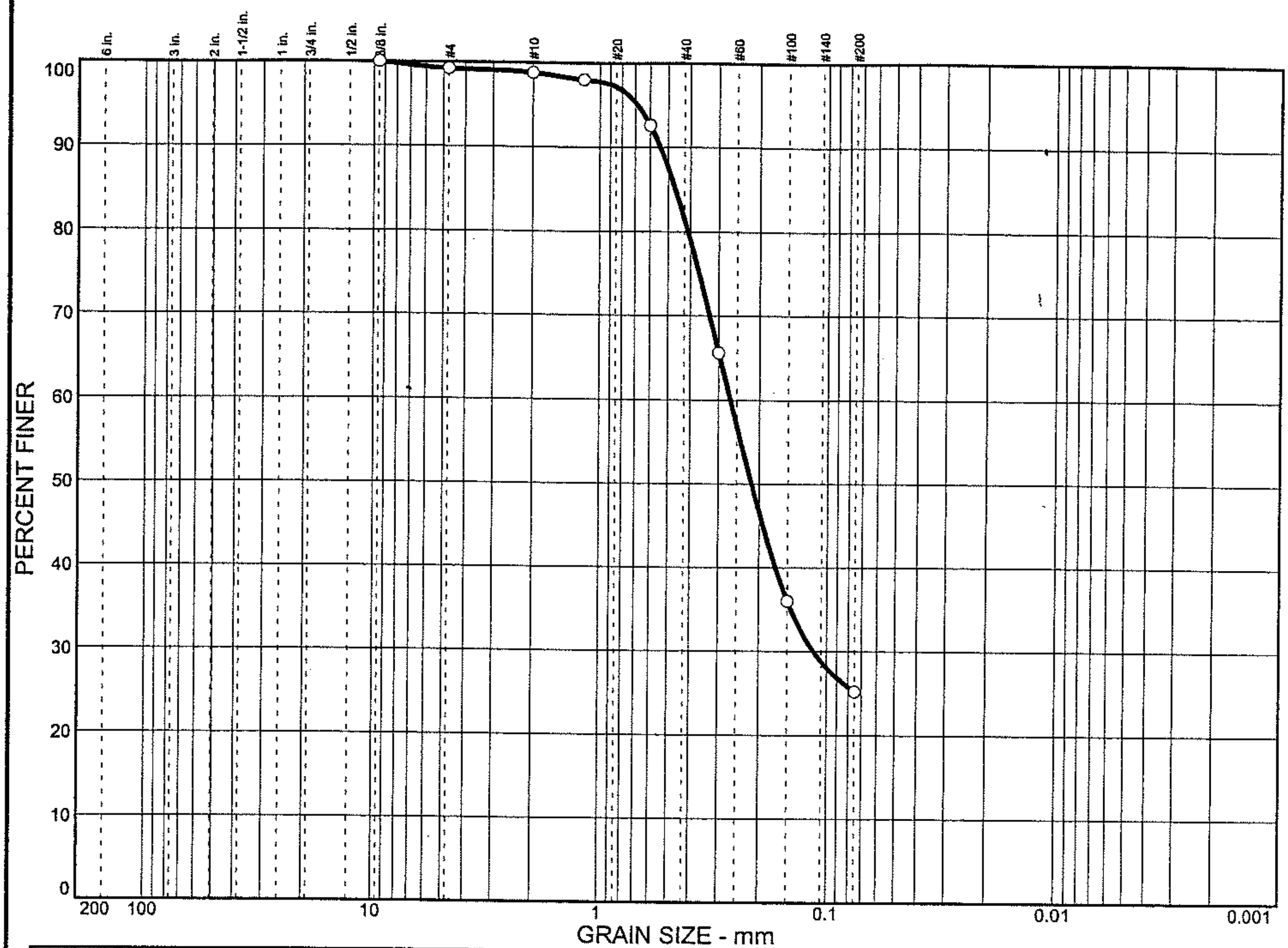
**Remarks:**

○

Φ GEI Consultants, Inc.

**Fig.**

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ○ | 0.0 | 0.8 | 74.0 | 25.2 | |
| | | | | | |
| | | | | | |

| ☒ | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 0.467 | 0.267 | 0.216 | 0.115 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ○ Silty SAND | SM | |

**Project No.** 03420 **Client:** HDR Architecture, Inc.

**Project:** Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B5 **Sample No.:** S1 **Elev./Depth:** 0 to 2 ft

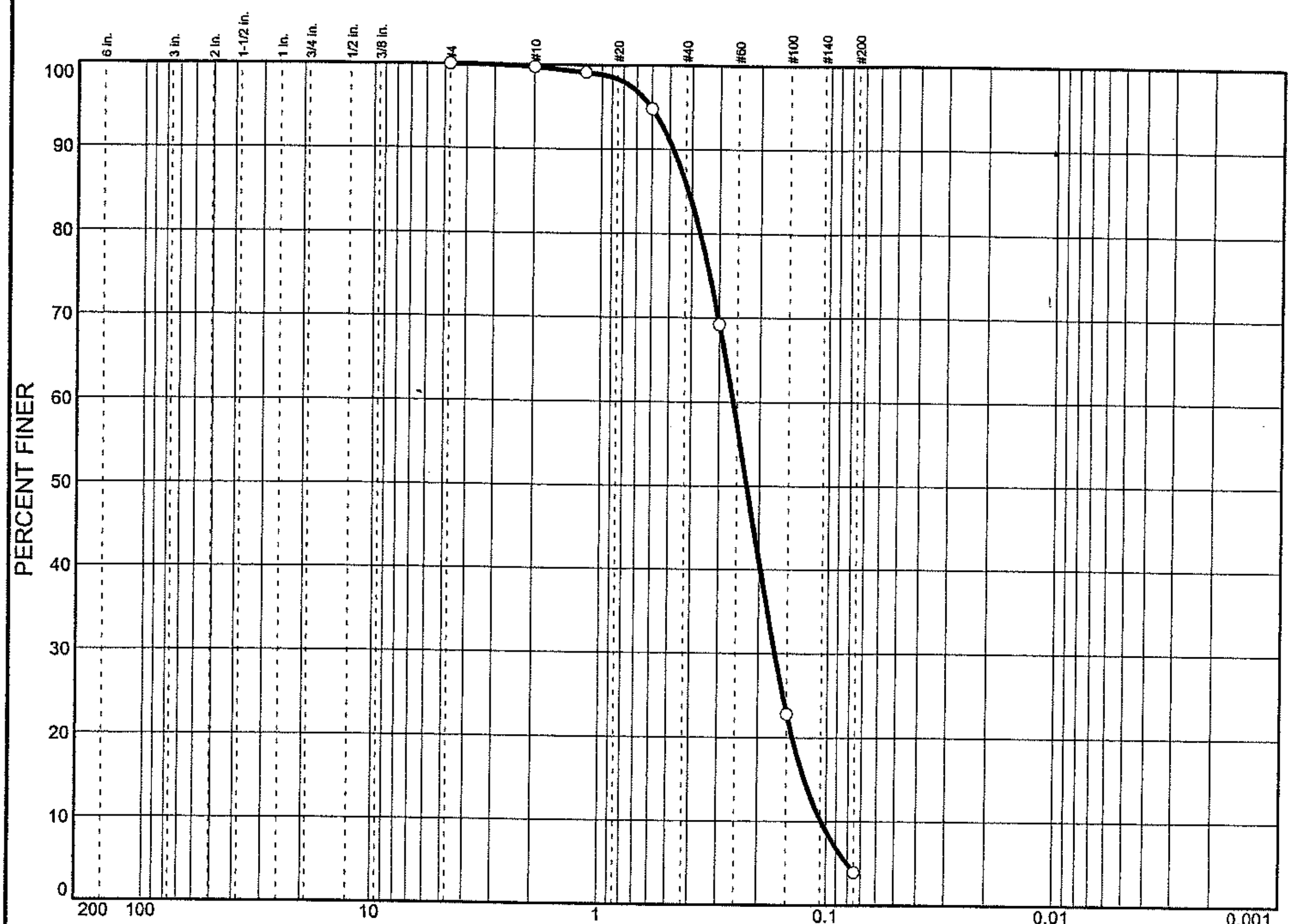
**Remarks:**

○

Φ GEI Consultants, Inc.

Fig.

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ○ | 0.0 | 0.0 | 96.1 | 3.9 | |
| | | | | | |
| | | | | | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 0.415 | 0.261 | 0.227 | 0.170 | 0.125 | 0.105 | 1.05 | 2.48 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| ○ Narrowly graded SAND | SP | |

**Project No.** 03420 **Client:** HDR Architecture, Inc.

**Project:** Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B5 **Sample No.:** S2 **Elev./Depth:** 5 to 7 ft

Φ GEI Consultants, Inc.

**Remarks:**

○

**Fig.**

# Appendix C

## 2006-2007 Test Boring Logs

**Boring Location**

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______

HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 74.0

LOCATION: See Figure 2

BORING

# B-101



**Drilling Information**

DATE START / END: 7/20/2006 - 7/20/2006 TOTAL DEPTH (FT): 52.0

CONTRACTOR: New England Boring DRILLER: Jeff Leavitt LOGGED BY: Steve Hawkins

EQUIPMENT: Mobile Drill B-53 Truck mounted Drill Rig BORING METHOD: Drive and Wash

AUGER ID/OD: N/A / N/A CASING ID/OD: N/A / 3 in CORE INFO:

HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30

WATER LEVEL DEPTHS (ft):

GENERAL NOTES: Samples collected using a 2-in diameter split spoon

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, $Q_v$ = Pocket Penetrometer Strength, $S_v$ = Pocket Torvane Shear Strength, $F_v$ = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | S | 0 to 2 | 24/18 | 4-6-9-9 | | | SILTY SAND (SM); fine to coarse sand, 32% silty fines, 6% fine gravel, moist, dark brown, roots (TOPSOIL). Probable Fill, Silty Sand on auger cuttings. | | |
| 70 | | | | | | | | | | | | Strata change estimated at 3.5 feet |
| | 5 | | 2 | S | 5 to 7 | 24/12 | 21-25-27-30 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 12% silty fines, 3% fine gravel, moist, light brown. | | |
| 65 | | | | | | | | | | | | |
| | 10 | | 3 | S | 10 to 12 | 24/10 | 4-8-8-9 | | | WIDELY GRADED SAND (SW); fine to coarse sand, 8% fine gravel, 1% silty fines, wet, light brown. | | |
| 60 | | | | | | | | | | | | |
| | 15 | | 4 | S | 15 to 17 | 24/10 | 13-15-17-17 | | | WIDELY GRADED SAND (SW); fine to coarse sand, 6% fine gravel, 3% silty fines, wet, light brown. | | |
| 55 | | | | | | | | | | | | |
| | 20 | | 5 | S | 20 to 22 | 24/12 | 20-25-32-41 | | | WIDELY GRADED SAND (SW); fine to coarse sand, 5% fine gravel, 4% silty fines, wet, light brown. | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.

PROJECT NAME: NSLS II Geotechnical Investigation

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

**Boring Location**
NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 74.0
LOCATION: See Figure 2

BORING
**B-101**


| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | 6 | | 25 to 27 | 24/12 | 25-27-29-31 | | | WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, 25% fine gravel, 5% silty fines, wet, light brown. | | |
| 45 | | | | | | | | | | | | |
| | 30 | | 7 | | 30 to 32 | 24/10 | 18-22-24-29 | | | WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~30% fine gravel, <5% silty fines, wet, light brown. | | |
| 40 | | | | | | | | | | | | |
| | 35 | | 8 | | 35 to 37 | 24/6 | 14-16-20-22 | | | WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, 27% fine to coarse gravel, 5% silty fines, wet, light brown. | | |
| 35 | | | | | | | | | | | | |
| | 40 | | 9 | | 40 to 42 | 24/8 | 15-16-20-22 | | | WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~30% fine gravel, <5% silty fines, wet, light brown. | | |
| 30 | | | | | | | | | | | | |
| | 45 | | 10 | | 45 to 47 | 24/8 | 20-26-35-47 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 8% silty fines, 1% fine gravel, wet, light brown. | | |
| 25 | | | | | | | | | | | | |
| | 50 | | 11 | | 50 to 52 | 24/12 | 29-30-31-28 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~10% fine gravel, wet, brown. | | |
| | | | | | | | | | | End of Boring at 52 feet | | |
| 20 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants
**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

**Boring Location**

NORTHING: ____ EASTING: ____ STATION: ____ OFFSET: ____
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ____
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 74.0
LOCATION: See Figure 2

BORING **B-101a**
PAGE 1 of 1

**Drilling Information**

DATE START / END: 8/16/2006 - 8/16/2006 TOTAL DEPTH (FT): 10.0
CONTRACTOR: New England Borings DRILLER: Jeff Leavitt LOGGED BY: Steven Hawkins
EQUIPMENT: Mobile Drill B-53 truck mounted drill rig. BORING METHOD: Hollow Stem Auger
AUGER ID/OD: 4.25 in / N/A CASING ID/OD: N/A / N/A CORE INFO:
HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft):
GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength; $S_v$ = Pocket Torvane Shear Strength; $F_v$ = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | Sample Description & Classification | $H_20$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S-1 | | 0 to 2 | 24/14 | 3-3-4-4 | | SILTY SAND (SM); fine to coarse sand, ~25% silty fines, ~5% fine gravel, dry, brown, ~10% organics, 4 inches of topsoil. | | |
| | | | S-2 | | 2 to 4 | 24/20 | 4-9-9-10 | | SILTY SAND (SM); fine to coarse sand, ~25% silty fines, ~5% fine gravel, dry, brown, Bottom 5 inches consists of fine to coarse sand. FILL. | | Strata change estimated at 3.3 feet |
| 70 | 5 | | S-3 | | 4 to 6 | 24/12 | 9-10-10-12 | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, brown. | | |
| | | | S-4 | | 6 to 8 | 24/12 | 13-16-16-15 | | WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine to coarse gravel, dry, brown. | | |
| 65 | | | S-5 | | 8 to 10 | 24/18 | 12-13-13-15 | | WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine gravel, dry, brown. | | |
| | 10 | | | | | | | | End of Boring at 10 feet<br>Fill with cuttings upon completion | | |
| 60 | 15 | | | | | | | | | | |
| 55 | 20 | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

**Boring Location**

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 81.0
LOCATION: See Figure 2

**Drilling Information**

DATE START / END: 7/19/2006 - 7/20/2006 TOTAL DEPTH (FT): 62.0
CONTRACTOR: New England Boring DRILLER: Jeff Leavitt LOGGED BY: Steve Hawkins
EQUIPMENT: Mobile Drill B-53 Truck mounted Drill Rig BORING METHOD: Drive and Wash
AUGER ID/OD: N/A / N/A CASING ID/OD: N/A / 3 in CORE INFO:
HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): ▼ 36.50 7/20/2006 9:20 am ▼ 36.50 7/20/2006 1:55 pm
GENERAL NOTES: Samples collected using a 2-in diameter split spoon

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength; $S_v$ = Pocket Torvane Shear Strength; $F_v$ = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | | | 1 | | 0 to 2 | 24/8 | 3-13-5-4 | | | SILTY SAND (SM); fine to coarse sand, 27% silty fines, 11% fine gravel, dry, brown, Contains roots, TOPSOIL.. Probable Fill, Silty Sand on auger cuttings. | | |
| 75 | 5 | | 2 | | 5 to 7 | 24/12 | 8-14-15-16 | | | WIDELY GRADED SAND (SW); fine to coarse sand, 13% fine gravel, 5% silty fines, moist, light brown. | | Strata change estimated at 5.0 feet |
| 70 | 10 | | 3 | | 10 to 12 | 24/10 | 8-10-13-13 | | | WIDELY GRADED SAND (SW); fine to coarse sand, 9% fine gravel, 3% silty fines, moist, light brown. | | |
| 65 | 15 | | 4 | | 15 to 17 | 24/12 | 4-9-18-18 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 7% fine gravel, 7% silty fines, moist, light brown. | | |
| 60 | 20 | | 5 | | 20 to 22 | 24/12 | 12-18-24-22 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to medium sand, 6% silty fines, 1% fine gravel, moist, light brown. | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

**Boring Location**
NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 81.0
LOCATION: See Figure 2

BORING
**B-102**


| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55 | 25 | | 6 | | 25 to 27 | 24/12 | 27-36-46-45 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to medium sand, 10% silty fines, 3% fine gravel, moist, light brown. | | Begins washing out ahead of casing advancement. Material too dense to drive casing. |
| 50 | 30 | | 7 | | 30 to 32 | 24/10 | 37-45-47-61 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine gravel, ~5% silty fines, wet, light brown. | | |
| 45 | 35 | | 8 | | 35 to 37 | 24/10 | 31-47-61-73 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 7% silty fines, 5% fine gravel, wet, light brown. | ▼ | |
| 40 | 40 | | 9 | | 40 to 41.5 | 18/10 | 39-62-100 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~5% fine gravel, ~5% silty fines, wet, brown. | | |
| 35 | 45 | | 10 | | 45 to 47 | 24/12 | 31-42-49-55 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 9% fine gravel, 8% silty fines, wet, brown. | | |
| 30 | 50 | | 11 | | 50 to 52 | 24/14 | 29-37-40-46 | | | WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~20% fine gravel, ~5% silty fines, wet, light brown. | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

**Boring Location**

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______

HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 81.0

LOCATION: See Figure 2

BORING

**B-102**



| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | | | 12 | | 55 to 57 | 24/14 | 27-32-39-48 | | | WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~20% fine gravel, ~5% silty fines, wet, light brown. | | |
| 20 | 60 | | 13 | | 60 to 62 | 24/10 | 30-36-39-45 | | | WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~20% fine gravel, ~5% silty fines, wet, light brown. | | |
| | | | | | | | | | | End of Boring at 62 feet | | |
| 15 | 65 | | | | | | | | | | | |
| 10 | 70 | | | | | | | | | | | |
| 5 | 75 | | | | | | | | | | | |
| 0 | 80 | | | | | | | | | | | |
| | 85 | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.

PROJECT NAME: NSLS II Geotechnical Investigation

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

## Boring Location

NORTHING: ____ EASTING: ____ STATION: ____ OFFSET: ____
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ____
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 81.0
LOCATION: See Figure 2

BORING **B-102a**



## Drilling Information

DATE START / END: 8/16/2006 - 8/16/2006 TOTAL DEPTH (FT): 10.0
CONTRACTOR: New England Borings DRILLER: Jeff Leavitt LOGGED BY: Steven Hawkins
EQUIPMENT: Mobile Drill B-53 truck mounted drill rig. BORING METHOD: Hollow Stem Auger
AUGER ID/OD: 4.25 in / N/A CASING ID/OD: N/A / N/A CORE INFO:
HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft):
GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, $Q_v$ = Pocket Penetrometer Strength, $S_v$ = Pocket Torvane Shear Strength, $F_v$ = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | | | S-1 | | 0 to 2 | 24/24 | 4-3-2-2 | | | SILTY SAND (SM); fine to coarse sand, ~20% silty fines, ~10% fine to coarse gravel, dry, brown, Organics, 4 inches of Topsoil. | | |
| | | | S-2 | | 2 to 4 | 24/12 | 3-3-3-4 | | | SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine to coarse gravel, dry, brown, FILL. | | |
| | 5 | | S-3 | | 4 to 6 | 24/12 | 4-5-6-6 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, light brown. | | Strata change estimated at 4 feet |
| 75 | | | S-4 | | 6 to 8 | 24/13 | 8-10-11-6 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, light brown. | | |
| | | | S-5 | | 8 to 10 | 24/17 | 8-12-12-14 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, light brown. | | |
| 70 | 10 | | | | | | | | | End of Boring at 10 feet<br>Fill with cuttings upon completion | | |
| 65 | 15 | | | | | | | | | | | |
| 60 | 20 | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

## Boring Location

NORTHING: ____ EASTING: ____ STATION: ____ OFFSET: ____
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ____
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 73.0
LOCATION: See Figure 2

**BORING**

# B-103



## Drilling Information

DATE START / END: 8/16/2006 - 8/16/2006 TOTAL DEPTH (FT): 32.0
CONTRACTOR: New England Borings DRILLER: Jeff Leavitt LOGGED BY: Steven Hawkins
EQUIPMENT: Mobile Drill B-53 truck mounted drill rig. BORING METHOD: Hollow Stem Auger
AUGER ID/OD: 4.25 in / N/A CASING ID/OD: N/A / N/A CORE INFO:
HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): ⊻ 28.00 8/16/2006 10:19 am
GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength; $S_v$ = Pocket Torvane Shear Strength; $F_v$ = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | Graphic Log | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S-1 | | 0 to 2 | 24/12 | 4-7-8-8 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, light brown, roots, topsoil, FILL. | | |
| 70 | | | S-2 | | 2 to 4 | 24/12 | 7-4-5-9 | | | SILTY SAND (SM); fine to coarse sand, ~20% silty fines, ~5% fine gravel, moist, brown, FILL. | | |
| | | | | | | | | | | 4-5 ft: Soil cuttings similar to material observed in S-2, FILL. | | |
| | 5 | | S-3 | | 5 to 7 | 24/24 | 5-9-25-46 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~10% fine gravel, moist, brown. | | Strata change estimated at 5 feet |
| 65 | | | S-4 | | 7 to 9 | 24/18 | 16-29-30-35 | | | SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine gravel, moist, reddish brown. | | |
| | | | | | | | | | | 9-10 ft: Soil cuttings similar to material observed in S-4. | | |
| | 10 | | S-5 | | 10 to 12 | 24/20 | 13-16-16-17 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, brown. | | |
| 60 | | | S-6 | | 12 to 14 | 24/14 | 17-19-19-20 | | | WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~15% fine to coarse gravel, ~10% silty fines, dry, brown. | | |
| | 15 | | S-7 | | 15 to 17 | 24/15 | 4-5-6-9 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine gravel, dry, tan. | | |
| 55 | | | | | | | | | | | | |
| | 20 | | S-8 | | 20 to 22 | 24/15 | 7-9-13-13 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine to coarse gravel, ~5% silty fines, moist, tan. | | |
| 50 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

**Boring Location**
NORTHING: ____ EASTING: ____ STATION: ____ OFFSET: ____
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ____
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 73.0
LOCATION: See Figure 2

BORING
**B-103**


| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | S-9 | | 25 to 27 | 24/15 | 9-12-16-17 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine gravel, moist, tan. | | |
| 45 | | | | | | | | | | | ∇ | |
| | 30 | | S-10 | | 30 to 32 | 24/18 | 13-16-19-39 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, wet, brown. | | |
| | | | | | | | | | | End of Boring at 32 feet<br>Fill with cuttings upon completion | | |
| 40 | 35 | | | | | | | | | | | |
| 35 | 40 | | | | | | | | | | | |
| 30 | 45 | | | | | | | | | | | |
| 25 | 50 | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants

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Glastonbury, CT 06033
860.368.5408

## Boring Location

**NORTHING:** ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______
**HORIZONTAL DATUM:** NAD 83 **STATION CENTERLINE:** ______
**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 76.0
**LOCATION:** See Figure 2

**BORING**

# B-104



## Drilling Information

**DATE START / END:** 8/16/2006 - 8/16/2006 **TOTAL DEPTH (FT):** 7.0
**CONTRACTOR:** New England Boring **DRILLER:** Jeff Leavitt **LOGGED BY:** Steve Hawkins
**EQUIPMENT:** Mobile Drill B-53 truck mounted drill rig. **BORING METHOD:** Hollow Stem Auger
**AUGER ID/OD:** 4.25 in / N/A **CASING ID/OD:** N/A / N/A **CORE INFO:**
**HAMMER TYPE:** Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30
**WATER LEVEL DEPTHS (ft):**
**GENERAL NOTES:** Samples collected using a 2-inch diameter split spoon.

**ABBREVIATIONS:** ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength; $S_v$ = Pocket Torvane Shear Strength; $F_v$ = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 | | | S-1 | X | 0 to 2 | 24/12 | 3-4-4-3 | | | SILTY SAND (SM); fine to coarse sand, ~25% silty fines, slight petroleum-like odor, moist, dark brown, organics, FILL. | | |
| | | | S-2 | X | 2 to 4 | 24/15 | 3-4-6-16 | | | SILTY SAND (SM); fine to coarse sand, ~30% silty fines, ~10% fine gravel, moist, brown, FILL. | | |
| | | | | | | | | | | 4-5 ft: Soil cuttings similar to material observed in S-2, FILL. | | |
| 70 | 5 | | S-3 | X | 5 to 7 | 24/10 | 16-19-30-30 | | | SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine gravel, dry, brown, Probable FILL. | | |
| | | | | | | | | | | Auger refusal encountered ~7-feet bgs. Fill with cuttings upon completion | | |
| 65 | 10 | | | | | | | | | | | |
| 60 | 15 | | | | | | | | | | | |
| 55 | 20 | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II Geotechnical Investigation
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062150-*-1000

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455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

## Boring Location

**BORING B-104a**
PAGE 1 of 1

**NORTHING:** ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______
**HORIZONTAL DATUM:** NAD 83 **STATION CENTERLINE:** ______
**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 76.0
**LOCATION:** ~5 feet North of B-104; See Figure 2

## Drilling Information

**DATE START / END:** 8/16/2006 - 8/16/2006 **TOTAL DEPTH (FT):** 3.0
**CONTRACTOR:** New England Boring **DRILLER:** Jeff Leavitt **LOGGED BY:** Steve Hawkins
**EQUIPMENT:** Mobile Drill B-53 truck mounted drill rig. **BORING METHOD:** Hollow Stem Auger
**AUGER ID/OD:** 4.25 in / N/A **CASING ID/OD:** N/A / N/A **CORE INFO:**
**HAMMER TYPE:** Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30
**WATER LEVEL DEPTHS (ft):**
**GENERAL NOTES:** Samples collected using a 2-inch diameter split spoon.

**ABBREVIATIONS:** ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength; $S_v$ = Pocket Torvane Shear Strength; $F_v$ = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 | 0–3 | | | | | | | | | Soil cuttings similar to B-104a S-1, FILL. | | |
| | 3 | | | | | | | | | Electrical wire encountered ~3-feet bgs. Auger refusal at ~3 feet bgs.<br>Fill with cuttings upon completion | | |
| 70 | 5 | | | | | | | | | | | |
| 65 | 10 | | | | | | | | | | | |
| 60 | 15 | | | | | | | | | | | |
| 55 | 20 | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II Geotechnical Investigation
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062150-*-1000

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

## Boring Location

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 76.0
LOCATION: ~5 feet West of B-104a; See Figure 2

**BORING**

# B-104b



## Drilling Information

DATE START / END: 8/16/2006 - 8/16/2006
TOTAL DEPTH (FT): 32.0
CONTRACTOR: New England Borings
DRILLER: Jeff Leavitt
LOGGED BY: Steven Hawkins
EQUIPMENT: Mobile Drill B-53 truck mounted drill rig.
BORING METHOD: Hollow Stem Auger
AUGER ID/OD: 4.25 in / N/A
CASING ID/OD: N/A / N/A
CORE INFO:
HAMMER TYPE: Safety Hammer
HAMMER WEIGHT (lbs): 140
HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): ⊻ 31.00 8/16/2006 12:57 pm
GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength; $S_v$ = Pocket Torvane Shear Strength; $F_v$ = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | Graphic Log | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 | | | | | | | | | | See boring log B-104a for sample information and description of material from 0 to 7-feet bgs. | | |
| | 5 | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |
| | | | S-1 | | 7 to 9 | 24/6 | 15-22-27-39 | | | SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine gravel, dry, brown. | | |
| | | | | | | | | | | 9-10: Soil cuttings similar to material observed in S-4. | | |
| | 10 | | S-2 | | 10 to 12 | 24/19 | 9-17-19-15 | | | SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine gravel, moist, brown. | | |
| 65 | | | | | | | | | | | | |
| | | | S-3 | | 12 to 14 | 24/20 | 13-14-16-16 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine gravel, moist, brown. | | |
| | 15 | | S-4 | | 15 to 17 | 24/12 | 3-4-8-7 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine to coarse gravel, ~5% silty fines, dry, tan. | | |
| 60 | | | | | | | | | | | | |
| | 20 | | S-5 | | 20 to 22 | 24/18 | 6-9-12-10 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine to coarse gravel, ~5% silty fines, dry, tan. | | |
| 55 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

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**Boring Location**
NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 76.0
LOCATION: ~5 feet West of B-104a; See Figure 2

BORING
**B-104b**


| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | S-6 | | 25 to 27 | 24/12 | 10-15-19-17 | | | WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~15% fine to coarse gravel, ~5% silty fines, dry, tan. | | |
| 50 | | | | | | | | | | | | |
| | 30 | | S-7 | | 30 to 32 | 24/16 | 7-11-11-10 | | | WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine to coarse gravel, ~5% silty fines, moist, tan. | ∇ | |
| 45 | | | | | | | | | | | | |
| | | | | | | | | | | End of Boring at 32 feet<br>Fill with cuttings upon completion | | |
| | 35 | | | | | | | | | | | |
| 40 | | | | | | | | | | | | |
| | 40 | | | | | | | | | | | |
| 35 | | | | | | | | | | | | |
| | 45 | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| | 50 | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants
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Glastonbury, CT 06033
860.368.5408

## Boring Location

NORTHING: ____ EASTING: ____ STATION: ____ OFFSET: ____

HORIZONTAL DATUM: NAD83 CT STATION CENTERLINE: ____

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 73.0

LOCATION: See Plan

**BORING**

**B-201**



## Drilling Information

DATE START / END: 4/23/2007 - 4/23/2007 TOTAL DEPTH (FT): 47.0

CONTRACTOR: New England Borings DRILLER: Jeff Leavitt LOGGED BY: Steven Hawkins

EQUIPMENT: Truck BORING METHOD: Drive and Wash

AUGER ID/OD: N/A / N/A CASING ID/OD: 3 in / 3.25 in CORE INFO:

HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30

WATER LEVEL DEPTHS (ft): ⊻ 27.30 4/24/2007 7:26 am

GENERAL NOTES:

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, $Q_v$ = Pocket Penetrometer Strength, $S_v$ = Pocket Torvane Shear Strength, $F_v$ = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S-1 | | 0 to 2 | 24/15 | 6-4-4-4 | | | SILTY SAND (SM); ~75% sand, ~20% fines, ~5% gravel; moist, brown, F-M sand, roots, F gravel, 4" topsoil, FILL. | | |
| 70 | | | S-2 | | 2 to 4 | 24/16 | 11-13-27-30 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, dry, yellowish brown, F-C gravel max. 1in. | | |
| | 5 | | S-3 | | 4 to 6 | 24/19 | 21-21-31-36 | | | WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to medium, dry, light brown, F-C gravel max. 1in. | | |
| | | | S-4 | | 6 to 8 | 24/17 | 41-57-65-70 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, dry, light brown, F-C gravel max. 1in. | | |
| 65 | | | S-5 | | 8 to 10 | 24/19 | 22-27-31-37 | | | WIDELY GRADED SAND WITH SILT (SW-SM); ~85% sand, ~10% fines, ~5% gravel; fine to medium, moist, brown, F-C gravel max. 1in. | | |
| | 10 | | S-6 | | 10 to 12 | 24/14 | 40-41-42-40 | | | WIDELY GRADED SAND WITH SILT (SW-SM); ~85% sand, ~10% fines, ~5% gravel; fine to medium, moist, brown, F-C gravel max. 3/4 in. | | |
| 60 | | | | | | | | | | | | |
| | 15 | | S-7 | | 15 to 17 | 24/9 | 14-10-10-11 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, wet, light brown. | | |
| 55 | | | | | | | | | | | | |
| | 20 | | S-8 | | 20 to 22 | 24/10 | 19-17-22-34 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, wet, light brown. | | |
| 50 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.

PROJECT NAME: NSLS II - ACD

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062152

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

**Boring Location**

**NORTHING:** ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______

**HORIZONTAL DATUM:** NAD83 CT **STATION CENTERLINE:** ______

**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 73.0

**LOCATION:** See Plan

**BORING**

## B-201



| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | S-9 | | 25 to 27 | 24/11 | 20-21-37-29 | | WIDELY GRADED GRAVEL WITH SAND (GW); ~60% gravel, ~35% sand, ~5% fines; fine to coarse, rounded, wet, light brown. | ▽ | |
| 45 | | | | | | | | | | | |
| | 30 | | S-10 | | 30 to 32 | 24/10 | 20-25-30-35 | | WIDELY GRADED SAND (SW); ~95% sand, ~5% fines, ~0% gravel; fine to medium, wet, light brown. | | |
| 40 | | | | | | | | | | | |
| | 35 | | S-11 | | 35 to 37 | 24/8 | 21-22-22-23 | | WIDELY GRADED SAND (SW); ~95% sand, ~5% fines, ~0% gravel; fine to medium, wet, light brown. | | |
| 35 | | | | | | | | | | | |
| | 40 | | S-12 | | 40 to 42 | 24/8 | 17-21-25-39 | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, coarse gravel, wet, light brown. | | |
| 30 | | | | | | | | | | | Drill Chatter |
| | 45 | | S-13 | | 45 to 47 | 24/2 | 11-12-13-17 | | WIDELY GRADED SAND (SW); ~70% sand, ~25% gravel, ~5% fines; fine to coarse, fine to coarse gravel, wet, brown. | | Running sands, rewash out casing. |
| | | | | | | | | | End of Boring at 47 feet | | |
| 25 | | | | | | | | | | | |
| | 50 | | | | | | | | | | |
| 20 | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II - ACD
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062152

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

## Boring Location

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD83 CT STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 73.5
LOCATION: See Plan

**BORING**

# B-202



## Drilling Information

DATE START / END: 4/25/2007 - 4/25/2007
TOTAL DEPTH (FT): 47.0
CONTRACTOR: New England Borings
DRILLER: Jeff Leavitt
LOGGED BY: Steven Hawkins
EQUIPMENT: Truck
BORING METHOD: Drive and Wash
AUGER ID/OD: N/A / N/A
CASING ID/OD: 3 in / 3.25 in
CORE INFO:
HAMMER TYPE: Safety Hammer
HAMMER WEIGHT (lbs): 140
HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): ▼ 31.30 4/25/2007 10:14 am
GENERAL NOTES:

**ABBREVIATIONS:** ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength; $S_v$ = Pocket Torvane Shear Strength; $F_v$ = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | ASPHALT; 4" asphalt, 8" subbase. | | |
| | | | S-1 | | 1 to 3 | 24/14 | 3-2-2-2 | | | SILTY SAND (SM); ~57% sand, ~35% fines, ~8% gravel; rounded, fine to coarse gravel, moist, dark brown to brown, FILL. | | |
| 70 | | | S-2 | | 3 to 4.5 | 18/11 | 3-3-3 | | | SILTY SAND (SM); ~65% sand, ~30% fines, ~5% gravel; rounded, fine to coarse gravel, moist, brown, FILL. | | |
| | 5 | | S-3 | | 5 to 7 | 24/21 | 8-13-21-28 | | | SILTY SAND (SM); ~55% sand, ~40% fines, ~5% gravel; rounded, fine to coarse gravel, moist, brown, FILL. | | Drilled through cobble. Move rig north ~2ft. in order to get casing past. |
| | | | | | | | | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, fine gravel, moist, light brown. | | |
| | | | S-4 | | 7 to 9 | 24/13 | 27-28-30-33 | | | WIDELY GRADED SAND WITH SILT (SW-SM); ~85% sand, ~10% fines, ~5% gravel; fine to medium, fine gravel, moist, light brown. | | |
| 65 | | | S-5 | | 9 to 11 | 24/16 | 25-30-31-23 | | | WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, dry, light brown. | | |
| | 10 | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| | 15 | | S-6 | | 15 to 17 | 24/11 | 17-20-20-21 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, dry, light brown. | | |
| 55 | | | | | | | | | | | | |
| | 20 | | S-7 | | 20 to 22 | 24/12 | 14-12-12-16 | | | WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown. | | |
| 50 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II - ACD
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062152

GEI Consultants

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

**Boring Location**
**NORTHING:** ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______
**HORIZONTAL DATUM:** NAD83 CT **STATION CENTERLINE:**
**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 73.5
**LOCATION:** See Plan

**BORING**

**B-202**



| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | H$_2$0 Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | S-8 | | 25 to 27 | 24/10 | 20-21-17-17 | | | WIDELY GRADED SAND (SW); ~80% sand, ~15% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown. | | |
| 45 | | | | | | | | | | | | |
| | 30 | | S-9 | | 30 to 32 | 24/14 | 17-16-12-16 | | | WIDELY GRADED SAND (SW); ~75% sand, ~20% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, dry, light brown. | ▼ | |
| 40 | | | | | | | | | | | | |
| | 35 | | S-10 | | 35 to 37 | 24/10 | 20-20-21-23 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown. | | |
| 35 | | | | | | | | | | | | |
| | 40 | | S-11 | | 40 to 42 | 24/9 | 17-14-19-25 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown. | | |
| 30 | | | | | | | | | | | | |
| | 45 | | S-12 | | 45 to 47 | 24/0 | 17-20-21-26 | | | No recovery. | | |
| | | | | | | | | | | End of Boring at 47 feet | | |
| 25 | | | | | | | | | | | | |
| | 50 | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II - ACD
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062152

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

## Boring Location

**BORING B-203**



**NORTHING:** ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______
**HORIZONTAL DATUM:** NAD83 CT **STATION CENTERLINE:** ______
**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 71.0
**LOCATION:** See Plan

## Drilling Information

**DATE START / END:** 4/25/2007 - 4/25/2007 **TOTAL DEPTH (FT):** 47.0
**CONTRACTOR:** New England Borings **DRILLER:** Jeff Leavitt **LOGGED BY:** Steven Hawkins
**EQUIPMENT:** Truck **BORING METHOD:** Drive and Wash
**AUGER ID/OD:** N/A / N/A **CASING ID/OD:** 3 in / 3.25 in **CORE INFO:**
**HAMMER TYPE:** Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30
**WATER LEVEL DEPTHS (ft):** ▼ 28.00 4/25/2007 2:07 pm
**GENERAL NOTES:**

**ABBREVIATIONS:** ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength; $S_v$ = Pocket Torvane Shear Strength; $F_v$ = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | | | S-1 | | 0 to 2 | 24/14 | 7-8-15-11 | | WIDELY GRADED SAND (SW); ~70% sand, ~20% gravel, ~10% fines; fine to coarse, coarse gravel, roots, moist, dark brown to gray, Top 8" topsoil, FILL. | | |
| | | | S-2 | | 2 to 2.5 | 6/0 | 6 | | No recovery. | | Grind through cobble/debris |
| 65 | 5 | | S-3 | | 4 to 6 | 24/12 | 8-12-14-16 | | WIDELY GRADED SAND WITH SILT (SW-SM); ~78% sand, ~13% fines, ~9% gravel; fine to coarse, rounded, fine to coarse gravel, dry, light brown. | | |
| | | | S-4 | | 6 to 8 | 24/16 | 12-16-21-28 | | SILTY SAND (SM); ~80% sand, ~15% fines, ~5% gravel; fine to coarse, rounded, fine gravel, dry, light brown. | | |
| | | | S-5 | | 8 to 10 | 24/12 | 8-9-10-10 | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, dry, light brown. | | |
| 60 | 10 | | S-6 | | 10 to 12 | 24/17 | 10-8-8-11 | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown. | | |
| 55 | 15 | | S-7 | | 15 to 17 | 24/10 | 11-12-13-14 | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown. | | |
| 50 | 20 | | S-8 | | 20 to 22 | 24/10 | 23-25-26-31 | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown. | | Drill chatter |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II - ACD
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062152

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

**Boring Location**
**NORTHING:** ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______
**HORIZONTAL DATUM:** NAD83 CT **STATION CENTERLINE:** ______
**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 71.0
**LOCATION:** See Plan

**BORING**

# B-203



| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | 25 | | S-9 | | 25 to 27 | 24/8 | 24-36-37-43 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown. | ▼ | |
| 40 | 30 | | S-10 | | 30 to 32 | 24/11 | 16-14-12-10 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown. | | |
| 35 | 35 | | S-11 | | 35 to 37 | 24/8 | 16-16-16-20 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown. | | Rig chatter |
| 30 | 40 | | S-12 | | 40 to 42 | 24/7 | 11-10-9-9 | | | WIDELY GRADED SAND (SW); ~75% sand, ~20% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, moist, light brown. | | |
| 25 | 45 | | S-13 | | 45 to 47 | 24/0 | 11-15-12-14 | | | No recovery. | | |
| | | | | | | | | | | End of Boring at 47 feet | | |
| 20 | 50 | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II - ACD
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062152

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

**Boring Location**

**NORTHING:** ____ **EASTING:** ____ **STATION:** ____ **OFFSET:** ____

**HORIZONTAL DATUM:** NAD83 CT **STATION CENTERLINE:** ____

**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 68.0

**LOCATION:** See Plan

**BORING**

# B-204



**Drilling Information**

**DATE START / END:** 4/25/2007 - 4/26/2007 **TOTAL DEPTH (FT):** 47.0

**CONTRACTOR:** New England Borings **DRILLER:** Jeff Leavitt **LOGGED BY:** Steven Hawkins

**EQUIPMENT:** Truck **BORING METHOD:** Drive and Wash

**AUGER ID/OD:** N/A / N/A **CASING ID/OD:** 3 in / 3.25 in **CORE INFO:**

**HAMMER TYPE:** Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30

**WATER LEVEL DEPTHS (ft):** ▼ 26.00 4/26/2007 8:31 am

**GENERAL NOTES:**

**ABBREVIATIONS:** ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength; $S_v$ = Pocket Torvane Shear Strength; $F_v$ = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S-1 | | 0 to 2 | 24/19 | 2-3-5-7 | | | WIDELY GRADED SAND WITH SILT (SM); ~83% sand, ~13% fines, ~4% gravel; fine to coarse, fine gravel, moist, dark brown to brown, Top 8" topsoil, FILL. | | |
| 65 | | | S-2 | | 2 to 4 | 24/16 | 7-5-2-4 | | | SILTY SAND (SM); ~70% sand, ~25% fines, ~5% gravel; fine to coarse, fine gravel, dry, brown, FILL. | | |
| | 5 | | S-3 | | 4 to 6 | 24/20 | 7-9-11-12 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, dry, grayish brown, FILL. | | |
| | | | S-4 | | 6 to 8 | 24/18 | 15-25-37-41 | | | WIDELY GRADED SAND WITH SILT (SW-SM); ~80% sand, ~10% gravel, ~10% fines; fine to coarse, fine to coarse gravel, moist, grayish brown. | | |
| 60 | | | S-5 | | 8 to 10 | 24/20 | 37-39-49-50 | | | WIDELY GRADED SAND WITH SILT (SW-SM); ~71% sand, ~15% gravel, ~14% fines; fine to medium, fine gravel, moist, grayish brown. | | |
| | 10 | | S-6 | | 10 to 12 | 24/20 | 17-21-28-27 | | | WIDELY GRADED SAND WITH SILT (SW-SM); ~85% sand, ~10% fines, ~5% gravel; fine to medium, fine gravel, moist, grayish brown. | | |
| | | | | | | | | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, dry, light brown. | | |
| 55 | | | | | | | | | | | | |
| | 15 | | S-7 | | 15 to 17 | 24/14 | 27-35-34-27 | | | WIDELY GRADED SAND (SW); ~80% sand, ~15% gravel, ~5% fines; fine to coarse, subrounded, fine to coarse gravel, dry, light brown. | | |
| 50 | | | | | | | | | | | | |
| | 20 | | S-8 | | 20 to 22 | 24/13 | 20-22-24-20 | | | WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, subrounded, fine gravel, dry, light brown. | | |
| 45 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.

**PROJECT NAME:** NSLS II - ACD

**CITY/STATE:** Upton, New York

**GEI PROJECT NUMBER:** 062152

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

**Boring Location**

NORTHING: ____ EASTING: ____ STATION: ____ OFFSET: ____

HORIZONTAL DATUM: NAD83 CT STATION CENTERLINE: ____

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 68.0

LOCATION: See Plan

BORING **B-204**



| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | S-9 | | 25 to 26.5 | 18/10 | 19-29-40 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, subrounded, fine gravel, dry, light brown. | ▼ | Running sands |
| 40 | | | | | | | | | | | | |
| | 30 | | S-10 | | 30 to 32 | 24/12 | 14-14-14-11 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, subrounded, fine gravel, dry, light brown. | | |
| 35 | | | | | | | | | | | | |
| | 35 | | S-11 | | 35 to 37 | 24/7 | 9-9-7-13 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, subrounded, fine to coarse gravel, dry, light brown. | | |
| 30 | | | | | | | | | | | | |
| | 40 | | S-12 | | 40 to 42 | 24/7 | 14-18-18-26 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, subrounded, coarse gravel, dry, light brown. | | |
| 25 | | | | | | | | | | | | |
| | 45 | | S-13 | | 45 to 47 | 24/12 | 20-29-35-37 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, subrounded, fine gravel, dry, light brown. | | |
| | | | | | | | | | | End of Boring at 47 feet | | |
| 20 | | | | | | | | | | | | |
| | 50 | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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860.368.5300

**Boring Location**

**NORTHING:** ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______

**HORIZONTAL DATUM:** NAD83 CT **STATION CENTERLINE:**

**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 77.0

**LOCATION:** See Plan

**BORING**

# B-205



**Drilling Information**

**DATE START / END:** 4/24/2007 - 4/24/2007
**TOTAL DEPTH (FT):** 47.0

**CONTRACTOR:** New England Borings **DRILLER:** Jeff Leavitt **LOGGED BY:** Steven Hawkins

**EQUIPMENT:** Truck **BORING METHOD:** Drive and Wash

**AUGER ID/OD:** N/A / N/A **CASING ID/OD:** 3 in / 3.25 in **CORE INFO:**

**HAMMER TYPE:** Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30

**WATER LEVEL DEPTHS (ft):** ▼ 32.00 4/24/2007 11:36 am

**GENERAL NOTES:**

**ABBREVIATIONS:** ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length; bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample; U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core; WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter; $Q_v$ = Pocket Penetrometer Strength, $S_v$ = Pocket Torvane Shear Strength, $F_v$ = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S-1 | | 0 to 2 | 24/19 | 3-3-4-4 | | | SILTY SAND (SM); ~75% sand, ~20% fines, ~5% gravel; roots, moist, dark brown, Top 8" topsoil, FILL. | | |
| 75 | | | S-2 | | 2 to 4 | 24/17 | 9-11-15-26 | | | SILTY SAND (SM); ~80% sand, ~15% fines, ~5% gravel; fine to coarse gravel, dry, grayish brown. | | |
| | 5 | | S-3 | | 4 to 6 | 24/20 | 21-41-40-29 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, fine to coarse gravel, dry, brown. | | |
| 70 | | | S-4 | | 6 to 8 | 24/15 | 21-22-25-21 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, fine to coarse gravel, dry, brown. | | |
| | | | S-5 | | 8 to 10 | 24/16 | 6-7-10-10 | | | WIDELY GRADED SAND (SW); ~90% sand, ~10% gravel, ~0% fines; fine to medium, rounded, fine to coarse gravel, dry, light brown. | | |
| | 10 | | S-6 | | 10 to 12 | 24/14 | 12-10-11-10 | | | WIDELY GRADED SAND (SW); ~90% sand, ~10% gravel, ~0% fines; medium to coarse, rounded, fine to coarse gravel, dry, light brown. | | |
| 65 | | | | | | | | | | | | |
| | 15 | | S-7 | | 15 to 17 | 24/8 | 12-15-17-21 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, wet, light brown. | | |
| 60 | | | | | | | | | | | | |
| | 20 | | S-8 | | 20 to 22 | 24/10 | 15-17-24-21 | | | WIDELY GRADED SAND WITH GRAVEL (SW); ~70% sand, ~25% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, wet, light brown. | | |
| 55 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II - ACD
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062152

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

**Boring Location**
**NORTHING:** ____ **EASTING:** ____ **STATION:** ____ **OFFSET:** ____
**HORIZONTAL DATUM:** NAD83 CT **STATION CENTERLINE:** ____
**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 77.0
**LOCATION:** See Plan



| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | S-9 | | 25 to 27 | 24/9 | 36-25-22-34 | | | WIDELY GRADED SAND WITH GRAVEL (SW); ~65% sand, ~30% gravel, ~5% fines; fine to coarse, rounded, fine gravel, wet, light brown. | | |
| 50 | | | | | | | | | | | | |
| | 30 | | S-10 | | 30 to 32 | 24/6 | 15-12-8-10 | | | WIDELY GRADED SAND WITH GRAVEL (SW); ~65% sand, ~30% gravel, ~5% fines; fine to coarse, rounded, fine gravel, wet, light brown. | ▼ | |
| 45 | | | | | | | | | | | | |
| | 35 | | S-11 | | 35 to 37 | 24/9 | 16-20-21-25 | | | WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, rounded, fine gravel, wet, light brown. | | |
| 40 | | | | | | | | | | | | |
| | 40 | | S-12 | | 40 to 42 | 24/9 | 20-21-20-30 | | | WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, rounded, fine gravel, wet, light brown. | | |
| 35 | | | | | | | | | | | | |
| | 45 | | S-13 | | 45 to 47 | 24/10 | 17-20-24-30 | | | WIDELY GRADED SAND (SW); ~95% sand, ~5% fines, ~0% gravel; fine to coarse, wet, brown. | | |
| 30 | | | | | | | | | | End of Boring at 47 feet | | |
| | 50 | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II - ACD
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062152


GEI Consultants

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

**Boring Location**

**NORTHING:** ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______
**HORIZONTAL DATUM:** NAD83 CT **STATION CENTERLINE:** ______
**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 73.5
**LOCATION:** See Plan



**Drilling Information**

**DATE START / END:** 4/24/2007 - 4/24/2007 **TOTAL DEPTH (FT):** 47.0
**CONTRACTOR:** New England Borings **DRILLER:** Jeff Leavitt **LOGGED BY:** Steven Hawkins
**EQUIPMENT:** Truck **BORING METHOD:** Drive and Wash
**AUGER ID/OD:** N/A / N/A **CASING ID/OD:** 3 in / 3.25 in **CORE INFO:**
**HAMMER TYPE:** Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30
**WATER LEVEL DEPTHS (ft):** ▼ 35.00 4/24/2007 4:06 pm
**GENERAL NOTES:**

**ABBREVIATIONS:** ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, $Q_v$ = Pocket Penetrometer Strength, $S_v$ = Pocket Torvane Shear Strength, $F_v$ = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S-1 | | 0 to 2 | 24/20 | 6-5-5-5 | | | SILTY SAND (SM); ~65% sand, ~30% fines, ~5% gravel; coal, dry, dark brown, FILL. | | |
| | | | S-2 | | 2 to 4 | 24/3 | 7-11-21-26 | | | SILTY SAND (SM); ~80% sand, ~15% fines, ~5% gravel; roots, dry, dark brown, FILL. | | |
| 70 | | | | | | | | | | | | |
| | 5 | | S-3 | | 4 to 6 | 24/18 | 15-21-28-39 | | | WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to medium, rounded, fine gravel, dry, light brown, FILL. | | |
| | | | S-4 | | 6 to 8 | 24/14 | 26-29-31-33 | | | SILTY SAND (SM); ~64% sand, ~26% fines, ~10% gravel; fine to coarse, rounded, dry, brown, FILL. | | |
| 65 | | | S-5 | | 8 to 10 | 24/23 | 12-13-13-16 | | | SILTY SAND (SM); ~75% sand, ~20% fines, ~5% gravel; fine to coarse, rounded, dry, brown, FILL. | | |
| | 10 | | S-6 | | 10 to 12 | 24/14 | 15-12-12-15 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; medium to coarse, fine gravel, moist, light brown. WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, fine gravel, dry, white. | | |
| 60 | | | | | | | | | | | | |
| | 15 | | S-7 | | 15 to 17 | 24/9 | 9-10-11-15 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, dry, light brown. | | |
| 55 | | | | | | | | | | | | |
| | 20 | | S-8 | | 20 to 22 | 24/14 | 14-18-20-25 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, dry, light brown. | | |
| 50 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II - ACD
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062152

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

**Boring Location**
**NORTHING:** ____ **EASTING:** ____ **STATION:** ____ **OFFSET:** ____
**HORIZONTAL DATUM:** NAD83 CT **STATION CENTERLINE:** ____
**VERTICAL DATUM:** BNL 94 **GROUND SURFACE ELEVATION (FT):** 73.5
**LOCATION:** See Plan



| Elev. (ft) | Depth (ft) | Casing Pen. (bpf) or Core Rate (mpf) | Sample No. | Type | Depth (ft) | Pen./ Rec. (in) | Blows Count or RQD | Field Test Data | GRAPHIC LOG | Sample Description & Classification | $H_2O$ Depth | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | S-9 | | 25 to 27 | 24/12 | 26-25-25-25 | | | WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, coarse gravel, dry, light brown, Max. gravel size 1.5". | | |
| 45 | | | | | | | | | | | | Rig chatter |
| | 30 | | S-10 | | 30 to 32 | 24/11 | 16-11-10-10 | | | WIDELY GRADED SAND WITH GRAVEL (SW); ~80% sand, ~15% gravel, ~5% fines; fine to coarse, fine gravel, dry, light brown, Max. gravel size 1.5". | | |
| 40 | | | | | | | | | | | | |
| | 35 | | S-11 | | 35 to 37 | 24/8 | 17-23-23-26 | | | WIDELY GRADED SAND WITH SILT (SW-SM); ~80% sand, ~10% gravel, ~10% fines; fine to coarse, fine gravel, dry, light brown, Max. gravel size 1.5". | ▼ | |
| 35 | | | | | | | | | | | | |
| | 40 | | S-12 | | 40 to 42 | 24/6 | 15-16-20-23 | | | WIDELY GRADED SAND WITH SILT (SW-SM); ~80% sand, ~10% gravel, ~10% fines; fine to coarse, fine gravel, dry, light brown, Max. gravel size 1.5". | | |
| 30 | | | | | | | | | | | | |
| | 45 | | S-13 | | 45 to 47 | 24/4 | 26-29-37-39 | | | WIDELY GRADED SAND WITH SILT (SW-SM); ~80% sand, ~10% gravel, ~10% fines; fine to medium, fine gravel, dry, brown, Max. gravel size 1.5". | | |
| | | | | | | | | | | End of Boring at 47 feet | | |
| 25 | | | | | | | | | | | | |
| | 50 | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

**CLIENT:** HDR Architechture, Inc.
**PROJECT NAME:** NSLS II - ACD
**CITY/STATE:** Upton, New York
**GEI PROJECT NUMBER:** 062152

**GEI Consultants, Inc.**
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

# Appendix D

## 2006-2007 Cone Penetrometer Test (CPT) Logs

CONETEC

# TABLE 1 - SUMMARY OF CPTU SOUNDINGS

**Job No.:** 06-773
**Location:** Brookhaven National Labs
**Client:** GEI Consultants
**Date:** July 19, 20, 21, 2006

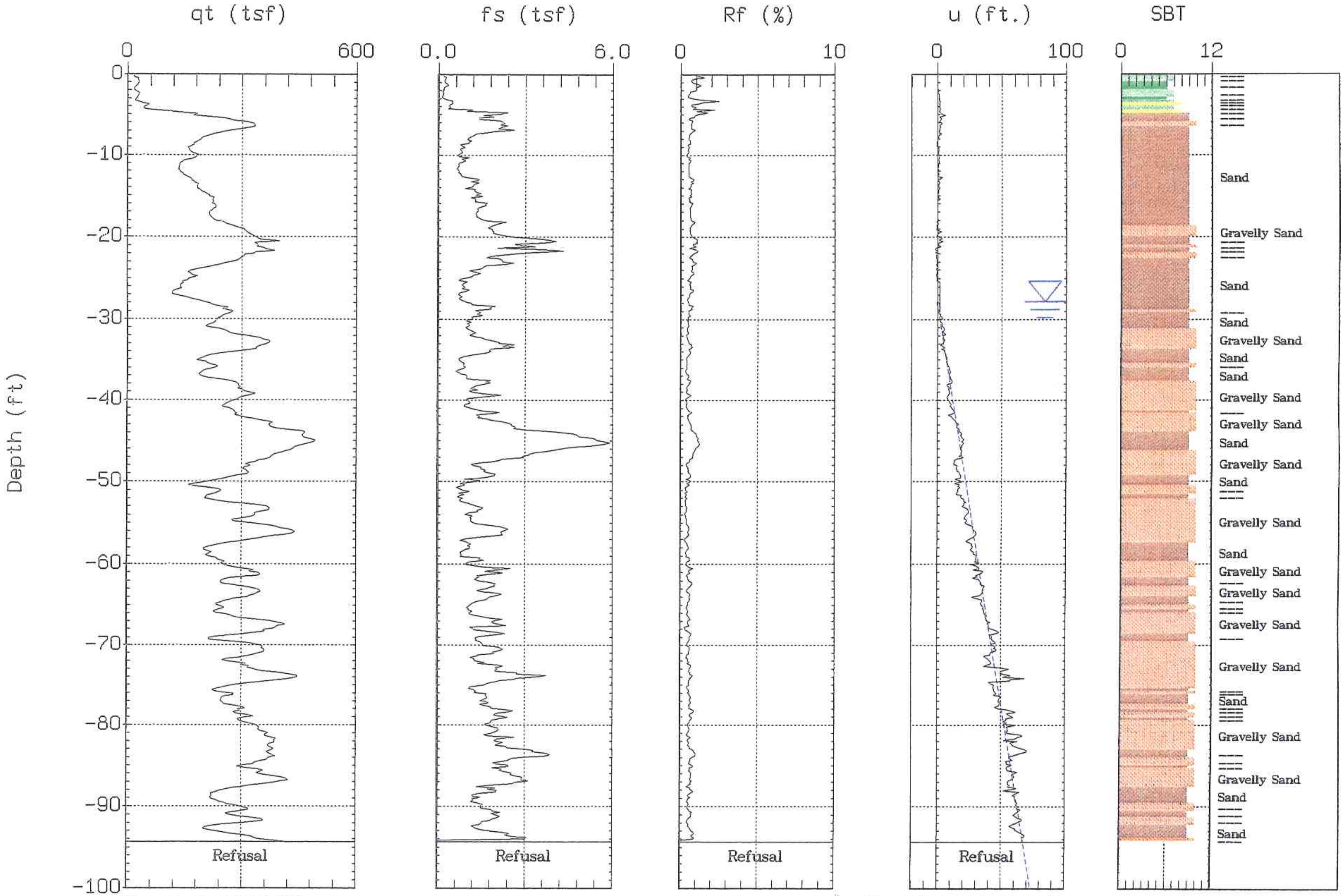
| Date | CPTU Sounding | File Name | CPT Total Depth (ft) | Shear wave Velocity Tests | Comments |
|---|---|---|---|---|---|
| 19-Jul-06 | CPT-1 | 773cp01.cor | 94.32 | | refusal |
| 19-Jul-06 | CPT-2 | 773cp02.cor | 100.06 | | |
| 20-Jul-06 | CPT-3 | 773cp03.cor | 86.12 | 9 | refusal |
| 19-Jul-06 | CPT-4 | 773cp04.cor | 95.14 | | refusal |
| 20-Jul-06 | CPT-5 | 773cp05.cor | 7.87 | | refusal |
| 20-Jul-06 | CPT-5A | 773cp05a.cor | 82.68 | 9 | refusal |
| 20-Jul-06 | CPT-6 | 773cp06.cor | 100.06 | 10 | |
| 21-Jul-06 | CPT-7 | 773cp07.cor | 6.40 | | refusal |
| 20-Jul-06 | CPT-8 | 773cp08.cor | 52.98 | | refusal |
| 21-Jul-06 | CPT-10 | 773cp10.cor | 61.02 | | |
| 21-Jul-06 | CPT-11 | 773cp11.cor | 73.49 | | |
| 20-Jul-06 | CPT-12 | 773cp12.cor | 100.06 | 10 | |
| 20-Jul-06 | CPT-13 | 773cp13.cor | 6.73 | | refusal |
| 20-Jul-06 | CPT-13A | 773cp13a.cor | 5.58 | | refusal |
| 21-Jul-06 | CPT-14 | 773cp14.cor | 95.80 | | refusal |
| Job Totals: | | 15 | 968.31 | 38 | |

CONETEC

*GEI Consultants*

Sounding:CPT-1
Site:National Labs

Piezocone:20 Ton AD164
Date:07:19:06 16:08




Max. Depth: 94.32 (ft)
Depth Inc.: 0.164 (ft)

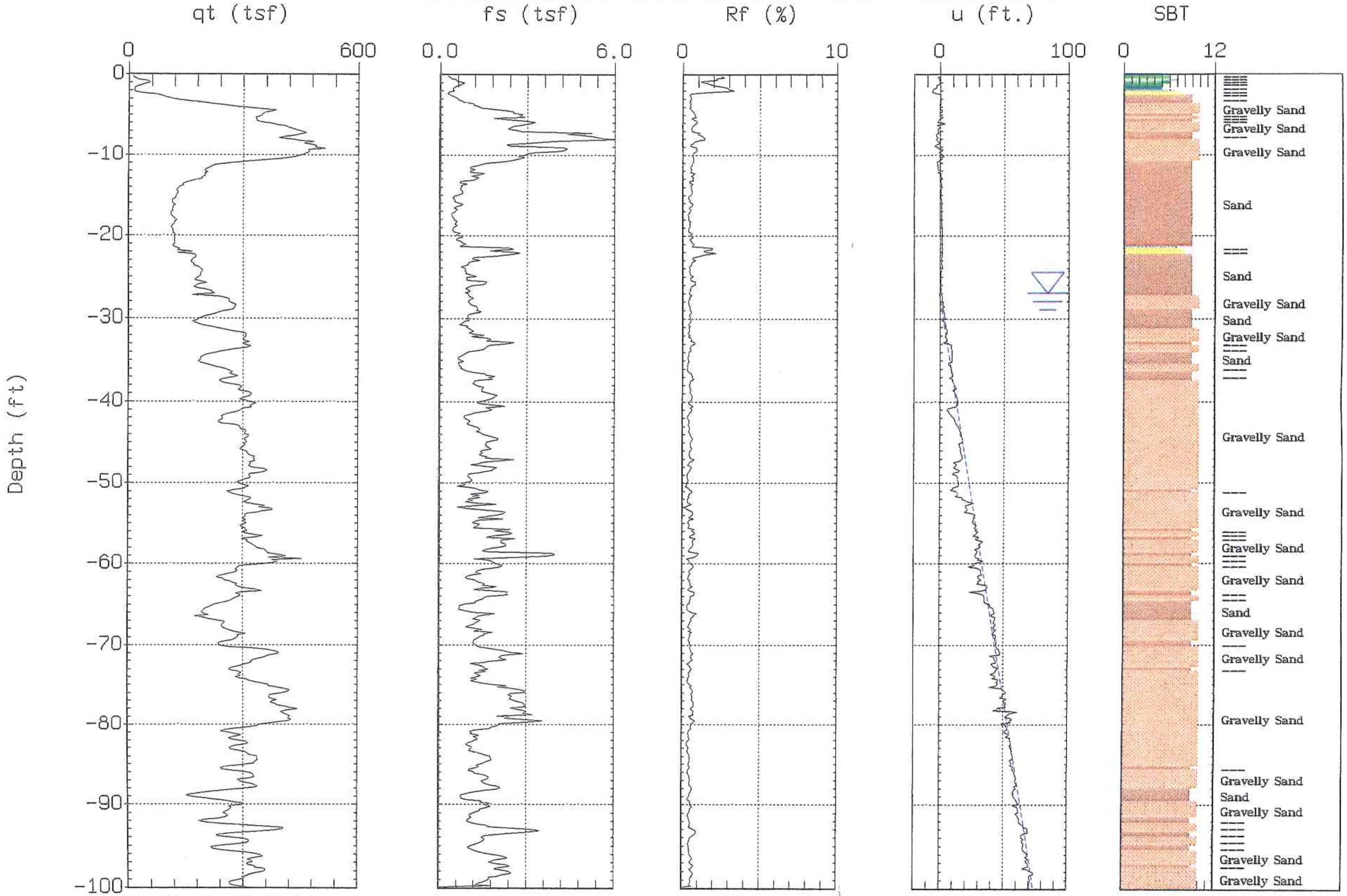
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

*GEI Consultants*

Sounding:CPT-2
Site:National Labs

Piezocone:20 Ton AD164
Date:07:19:06 14:30



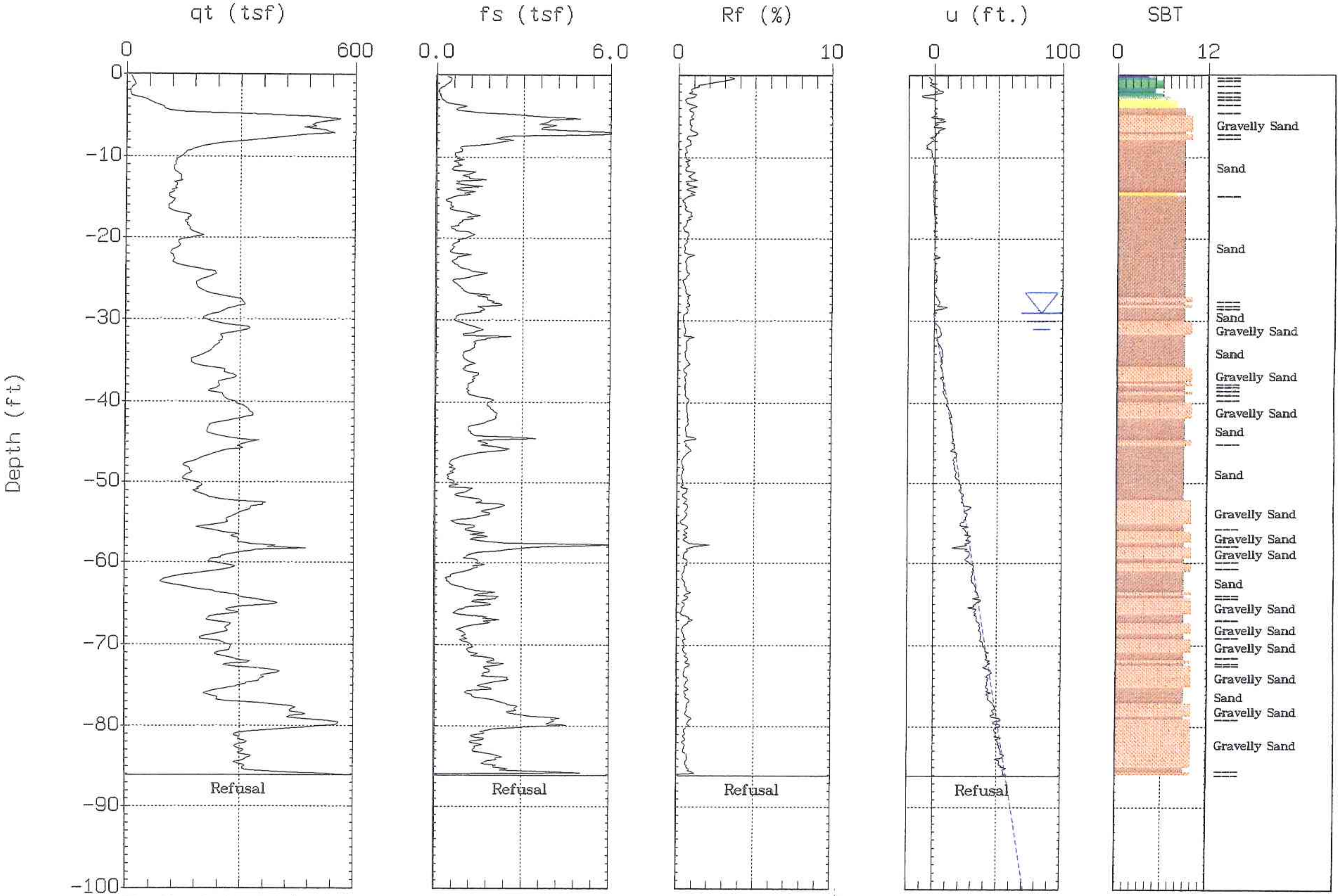

Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-3
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 07:32




Max. Depth: 86.12 (ft)
Depth Inc.: 0.164 (ft)

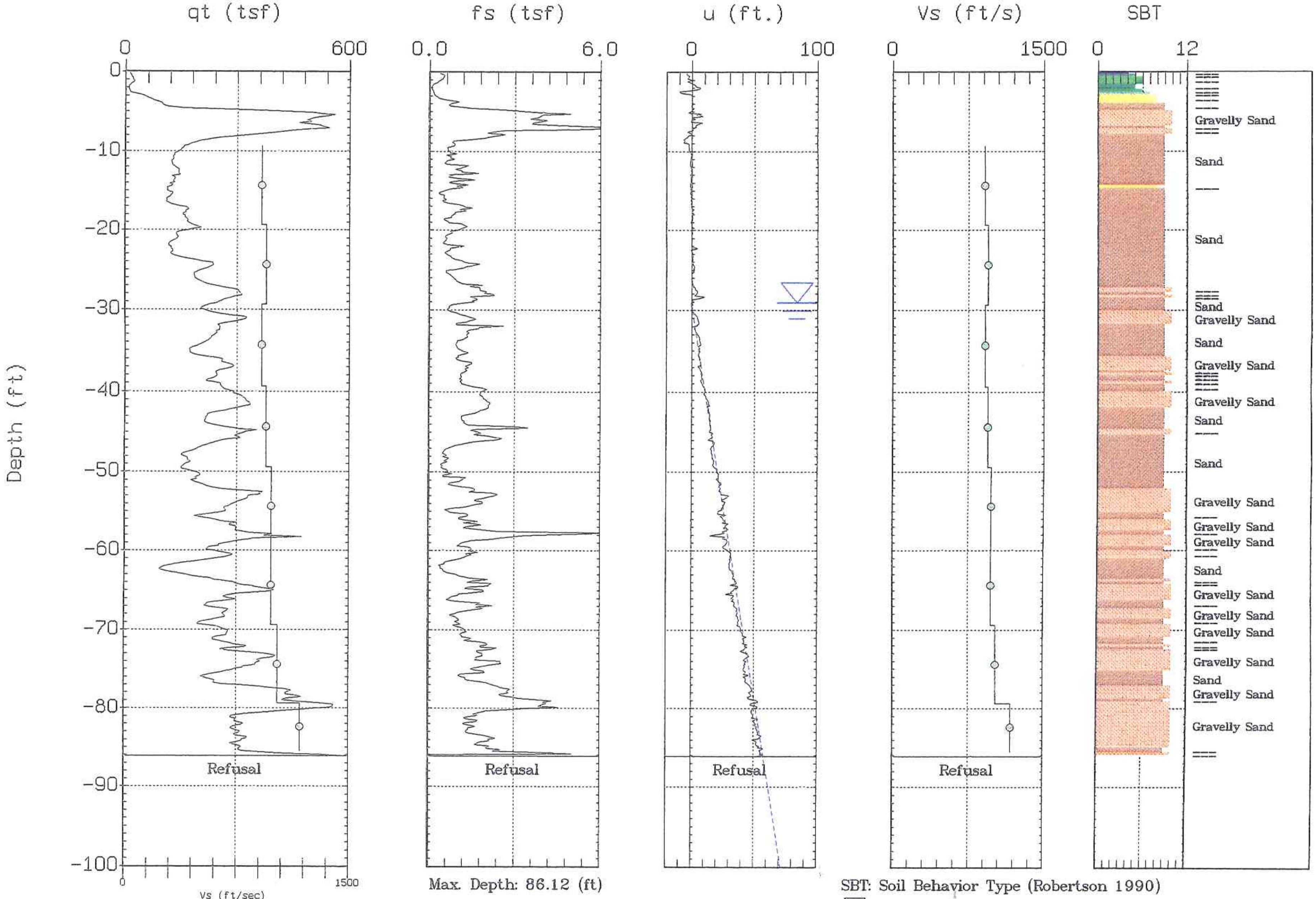
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

*GEI Consultants*

Sounding:CPT-3
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 07:32




Max. Depth: 86.12 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

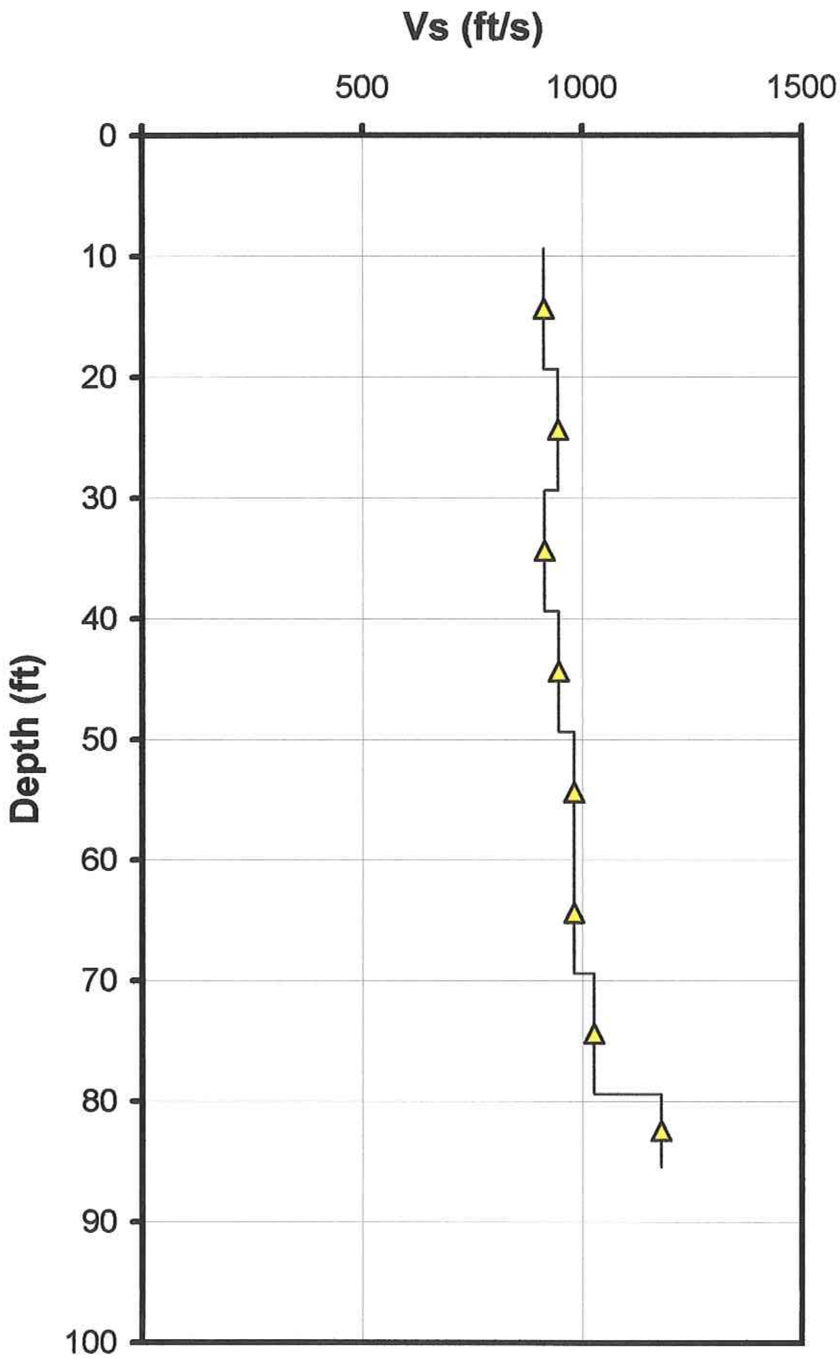
| | |
|---|---|
| Job No | 06-773 |
| Client | GEI Consultants |
| Project Title | National Labs |
| Hole | CPT-3 |
| Site | Brookhaven, New York |
| Date | 7/20/2006 |

| | | |
|---|---|---|
| Seismic Source: | Beam | |
| Source Offset: | 1.97 | (ft) |
| Source Depth: | 0.00 | (ft) |
| Geophone Offset: | 0.66 | (ft) |

SEISMIC TEST RESULTS - Vs

| Tip Depth (ft) | Geophone Depth (ft) | Ray Path (ft) | Depth Interval (ft) | Time Interval (ms) | Mid-layer Depth (ft) | Vs Interval Velocity (ft/s) |
|---|---|---|---|---|---|---|
| 10.01 | 9.35 | 9.56 | | | | |
| 20.01 | 19.35 | 19.45 | 9.89 | 10.84 | 14.35 | 913 |
| 30.02 | 29.36 | 29.43 | 9.98 | 10.57 | 24.36 | 944 |
| 40.03 | 39.37 | 39.42 | 9.99 | 10.93 | 34.37 | 914 |
| 50.03 | 49.37 | 49.41 | 9.99 | 10.57 | 44.37 | 945 |
| 60.04 | 59.38 | 59.42 | 10.00 | 10.20 | 54.38 | 981 |
| 70.05 | 69.39 | 69.42 | 10.01 | 10.20 | 64.39 | 981 |
| 80.05 | 79.39 | 79.42 | 10.00 | 9.75 | 74.39 | 1025 |
| 86.12 | 85.46 | 85.49 | 6.07 | 5.15 | 82.43 | 1178 |

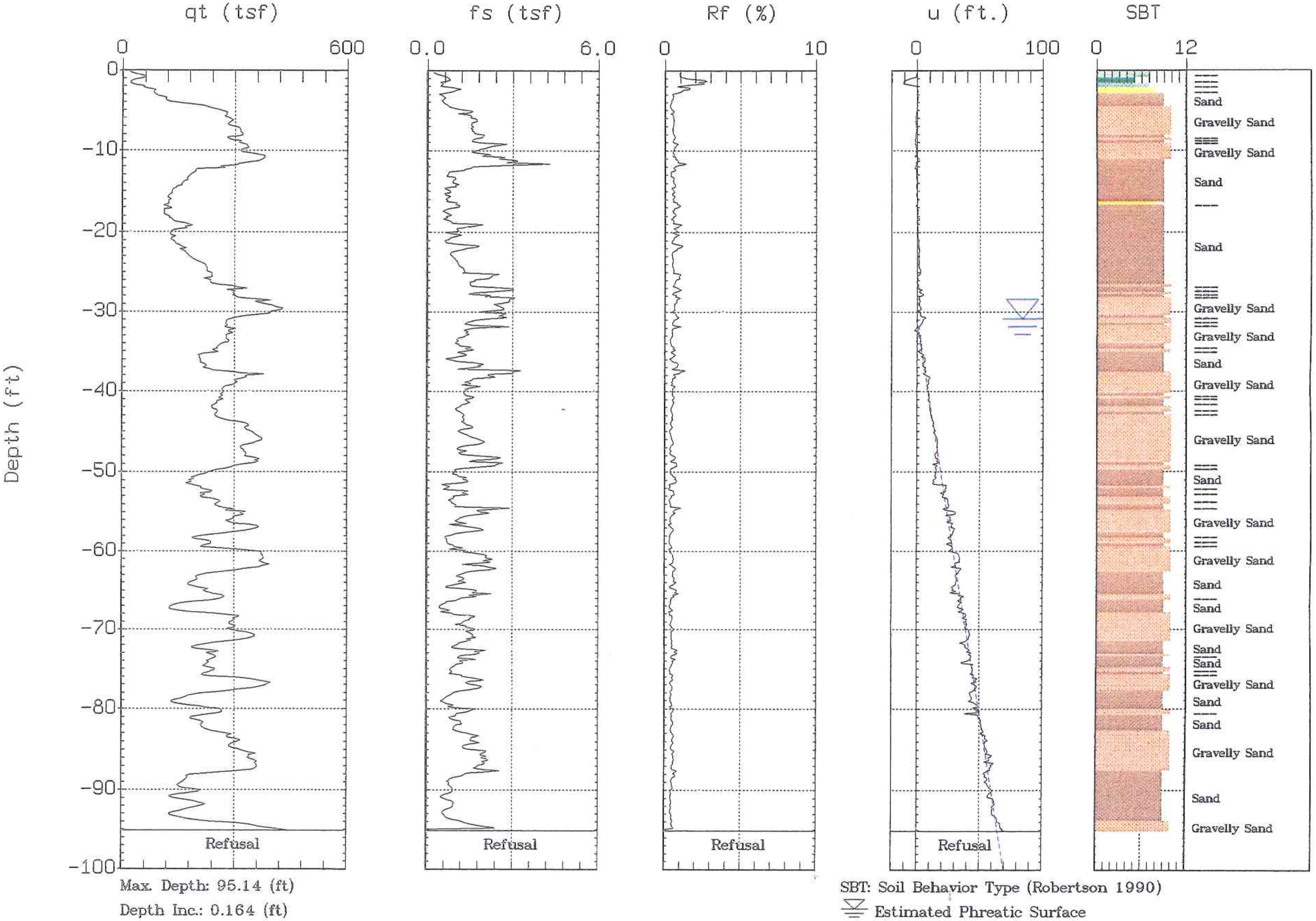
Job No: 06-773
Client: GEI Consultants
Project: National Labs
Sounding: CPT-3
Date: July 20, 2006



GEI Consultants

Sounding:CPT-4
Site:National Labs

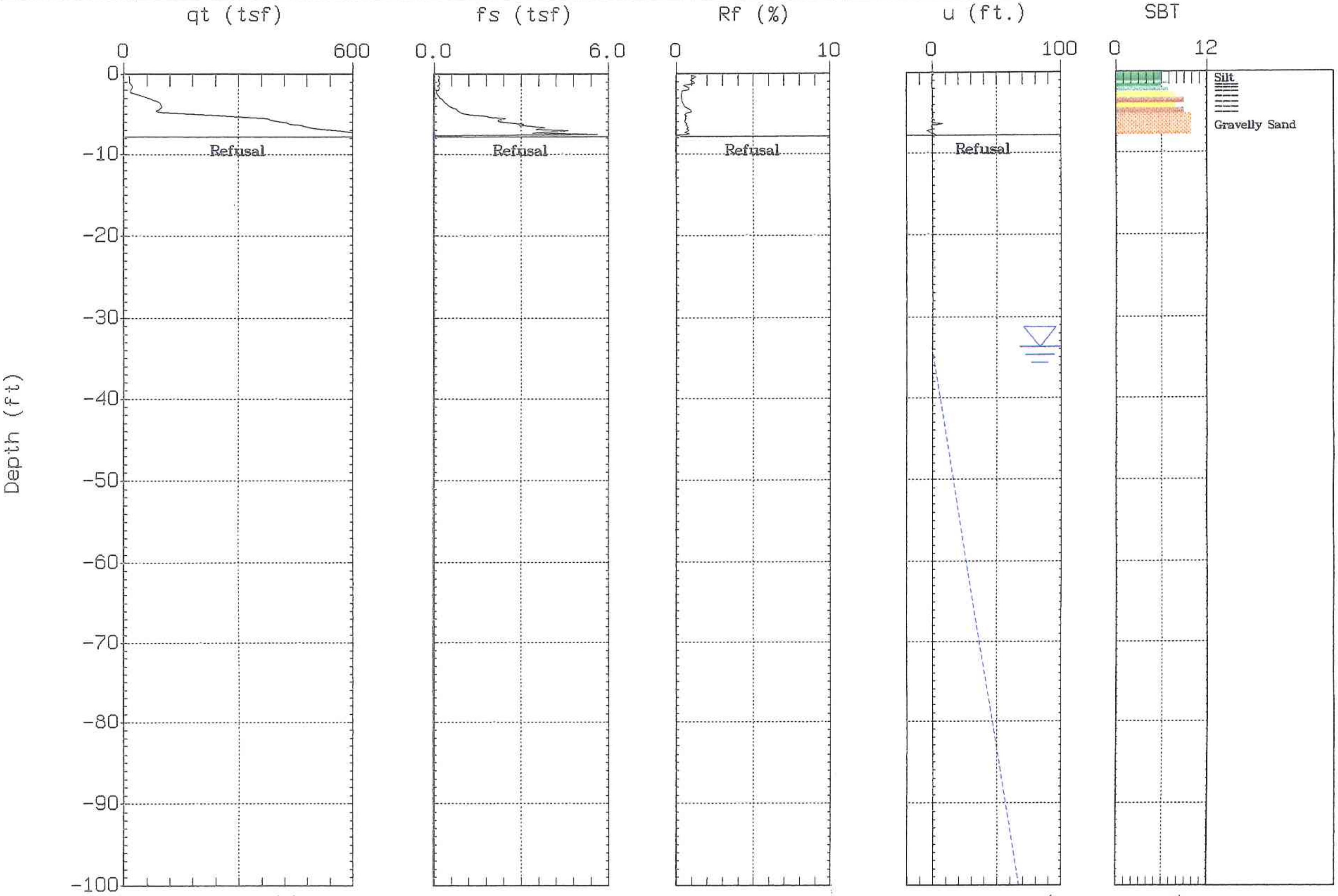
Piezocone:20 Ton AD164
Date:07:19:06 13:13



GEI Consultants

Sounding:CPT-5
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 08:58



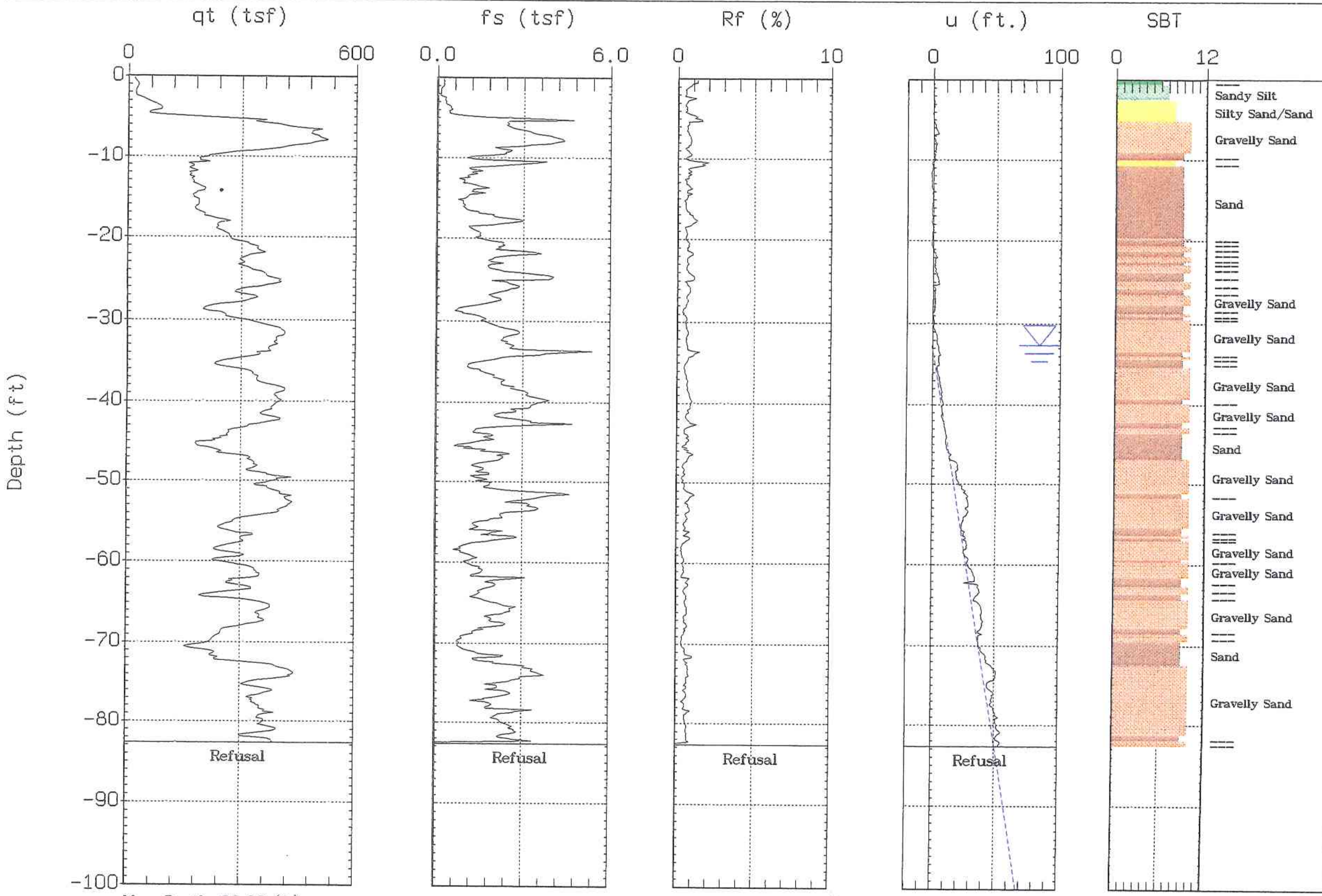

Max. Depth: 7.87 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC **GEI Consultants**

Sounding:CPT-5A
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 09:27




Max. Depth: 82.68 (ft)
Depth Inc.: 0.164 (ft)

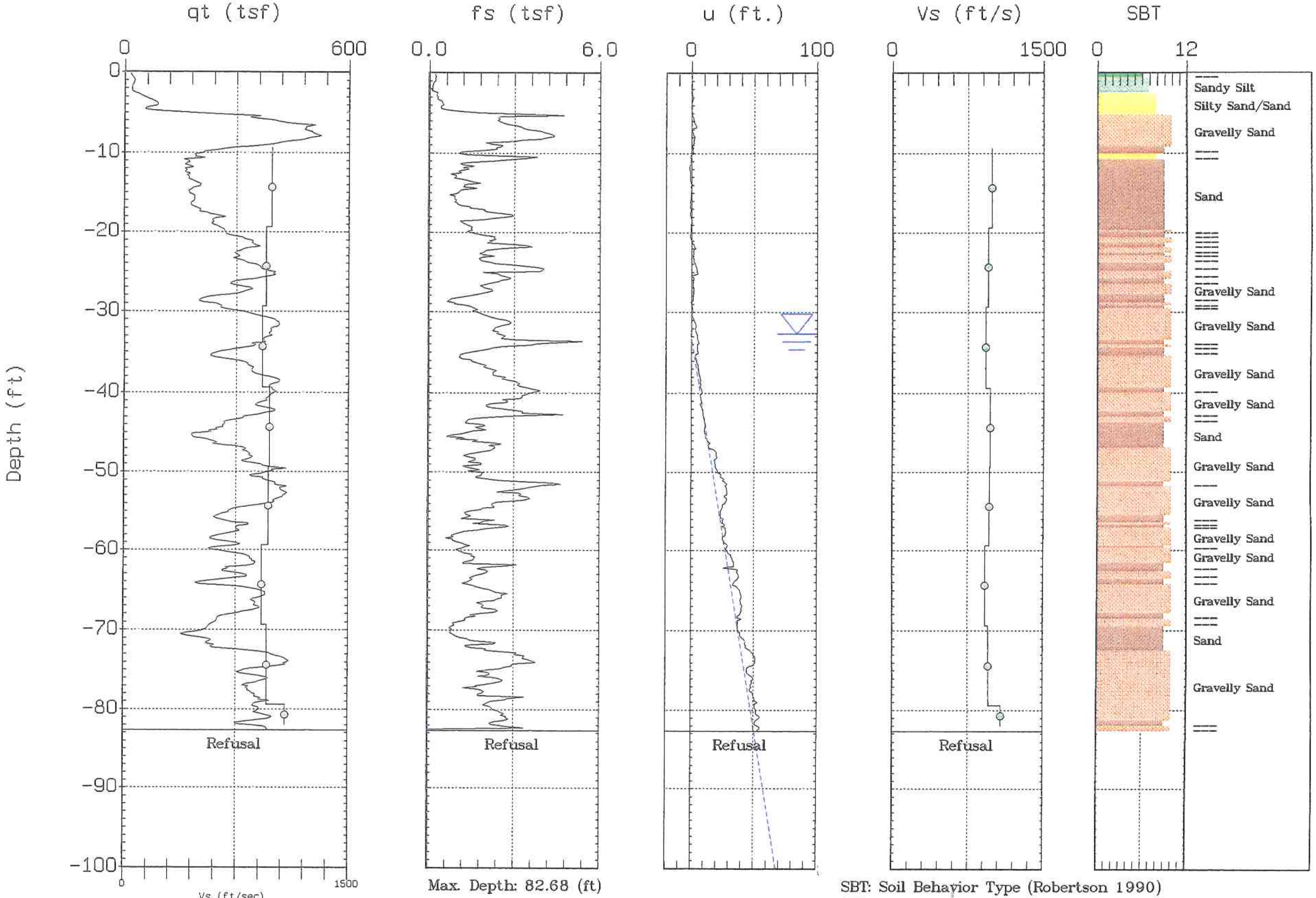
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

GEI Consultants

Sounding:CPT-5A
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 09:27




Max. Depth: 82.68 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

| | |
|---|---|
| Job No | 06-773 |
| Client | GEI Consultants |
| Project Title | National Labs |
| Hole | CPT-5A |
| Site | Brookhaven, New York |
| Date | 7/20/2006 |

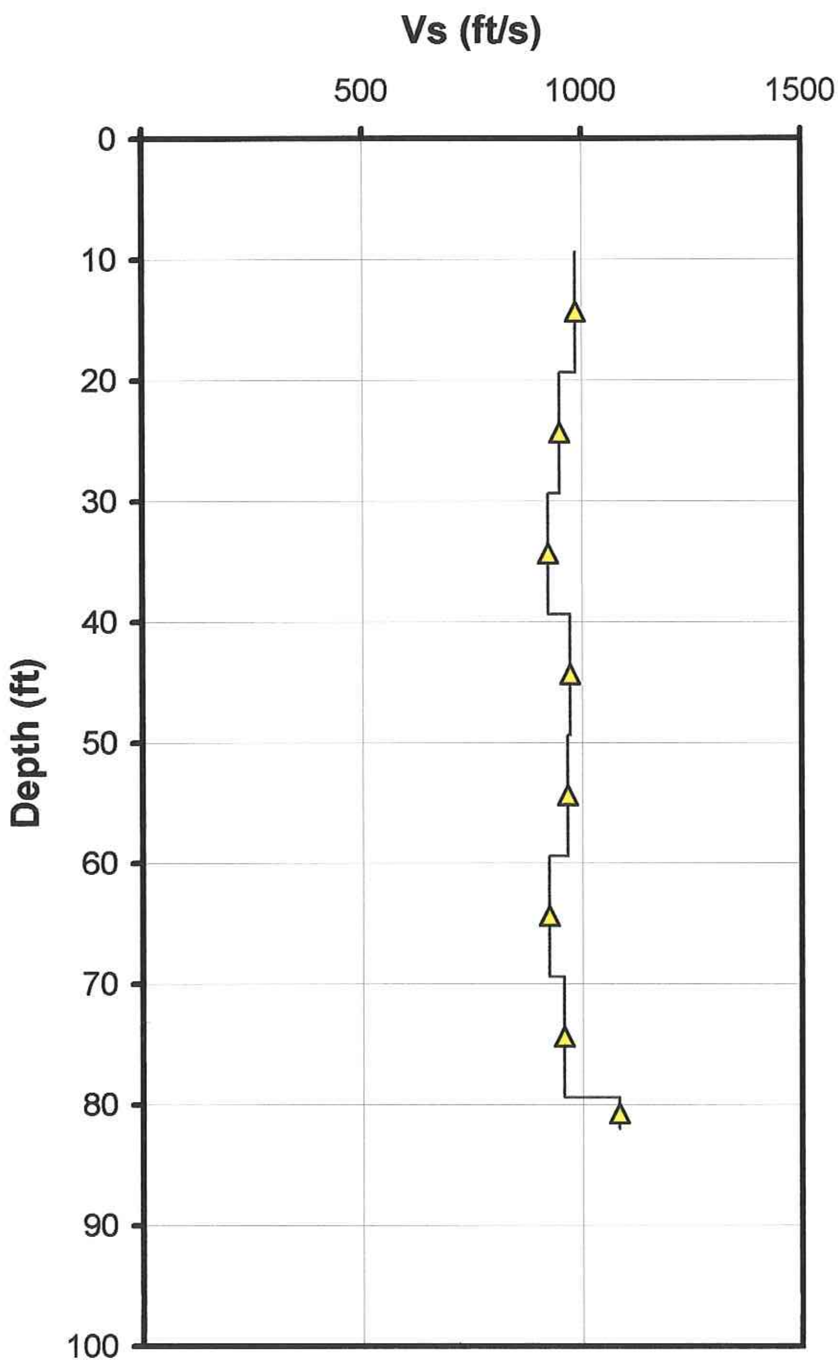
| | | |
|---|---|---|
| Seismic Source: | Beam | |
| Source Offset: | 1.97 | (ft) |
| Source Depth: | 0.00 | (ft) |
| Geophone Offset: | 0.66 | (ft) |

SEISMIC TEST RESULTS - Vs

| Tip Depth (ft) | Geophone Depth (ft) | Ray Path (ft) | Depth Interval (ft) | Time Interval (ms) | Mid-layer Depth (ft) | Vs Interval Velocity (ft/s) |
|---|---|---|---|---|---|---|
| 10.01 | 9.35 | 9.56 | | | | |
| 20.01 | 19.35 | 19.45 | 9.89 | 10.05 | 14.35 | 985 |
| 30.02 | 29.36 | 29.43 | 9.98 | 10.52 | 24.36 | 948 |
| 40.03 | 39.37 | 39.42 | 9.99 | 10.83 | 34.37 | 923 |
| 50.03 | 49.37 | 49.41 | 9.99 | 10.28 | 44.37 | 972 |
| 60.04 | 59.38 | 59.42 | 10.00 | 10.36 | 54.38 | 966 |
| 70.05 | 69.39 | 69.42 | 10.01 | 10.83 | 64.39 | 924 |
| 80.05 | 79.39 | 79.42 | 10.00 | 10.44 | 74.39 | 958 |
| 82.68 | 82.02 | 82.05 | 2.63 | 2.43 | 80.71 | 1082 |

8

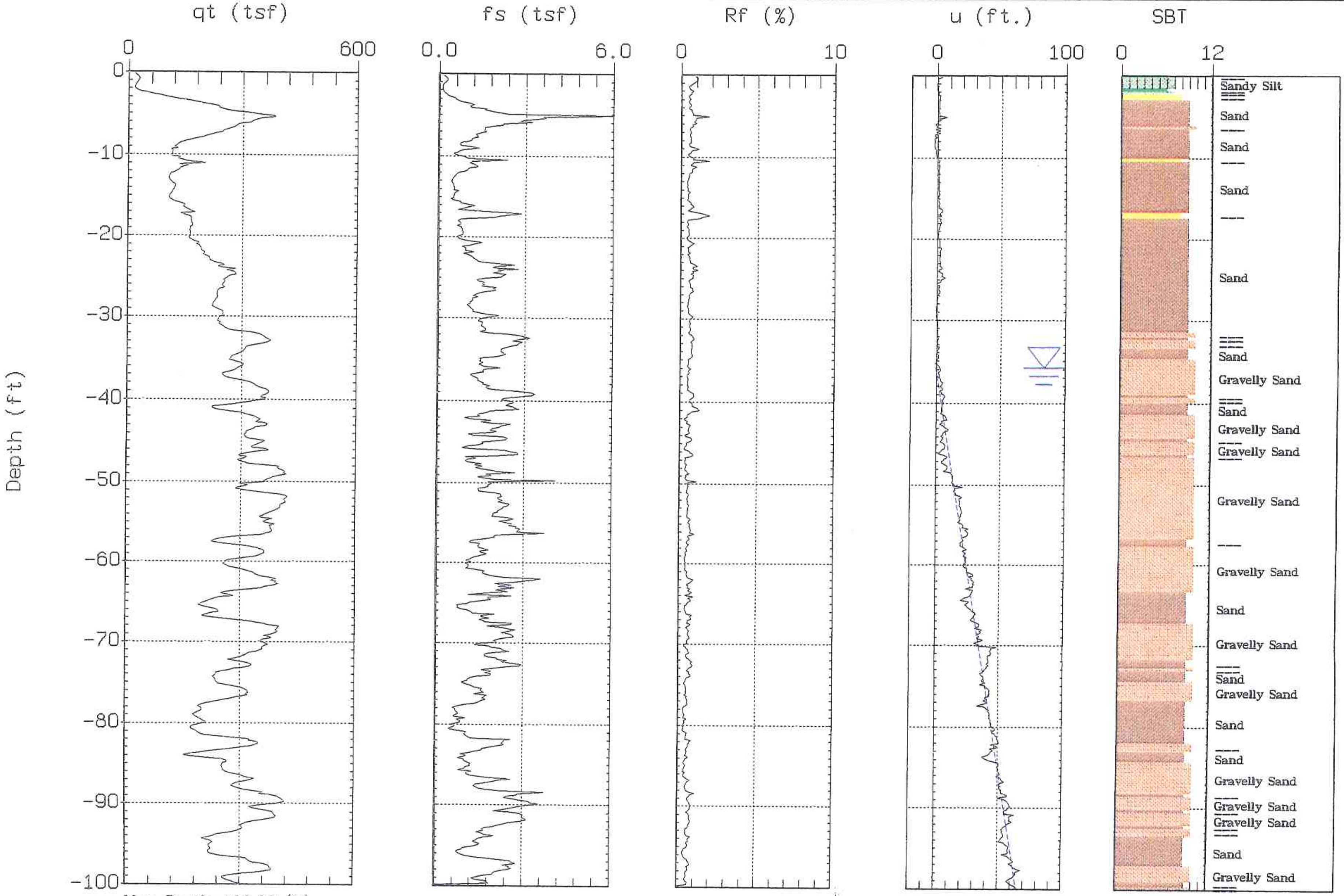
Job No: 06-773
Client: GEI Consultants
Project: National Labs
Sounding: CPT-5A
Date: July 20, 2006



GEI Consultants

Sounding:CPT-6
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 10:46




Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

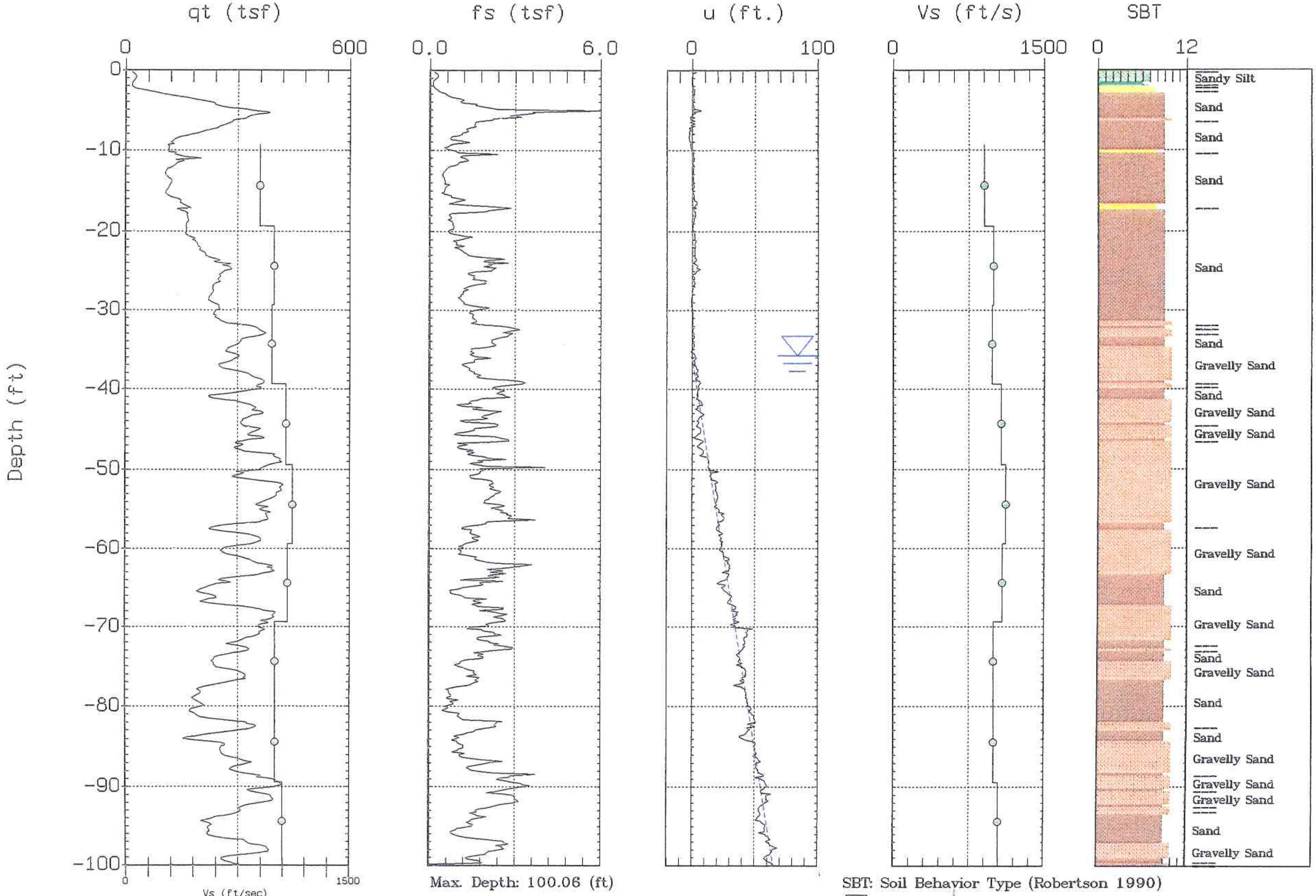
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

*GEI Consultants*

Sounding:CPT-6
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 10:46




Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

| | |
|---|---|
| Job No | 06-773 |
| Client | GEI Consultants |
| Project Title | National Labs |
| Hole | CPT-6 |
| Site | Brookhaven, New York |
| Date | 7/20/2006 |

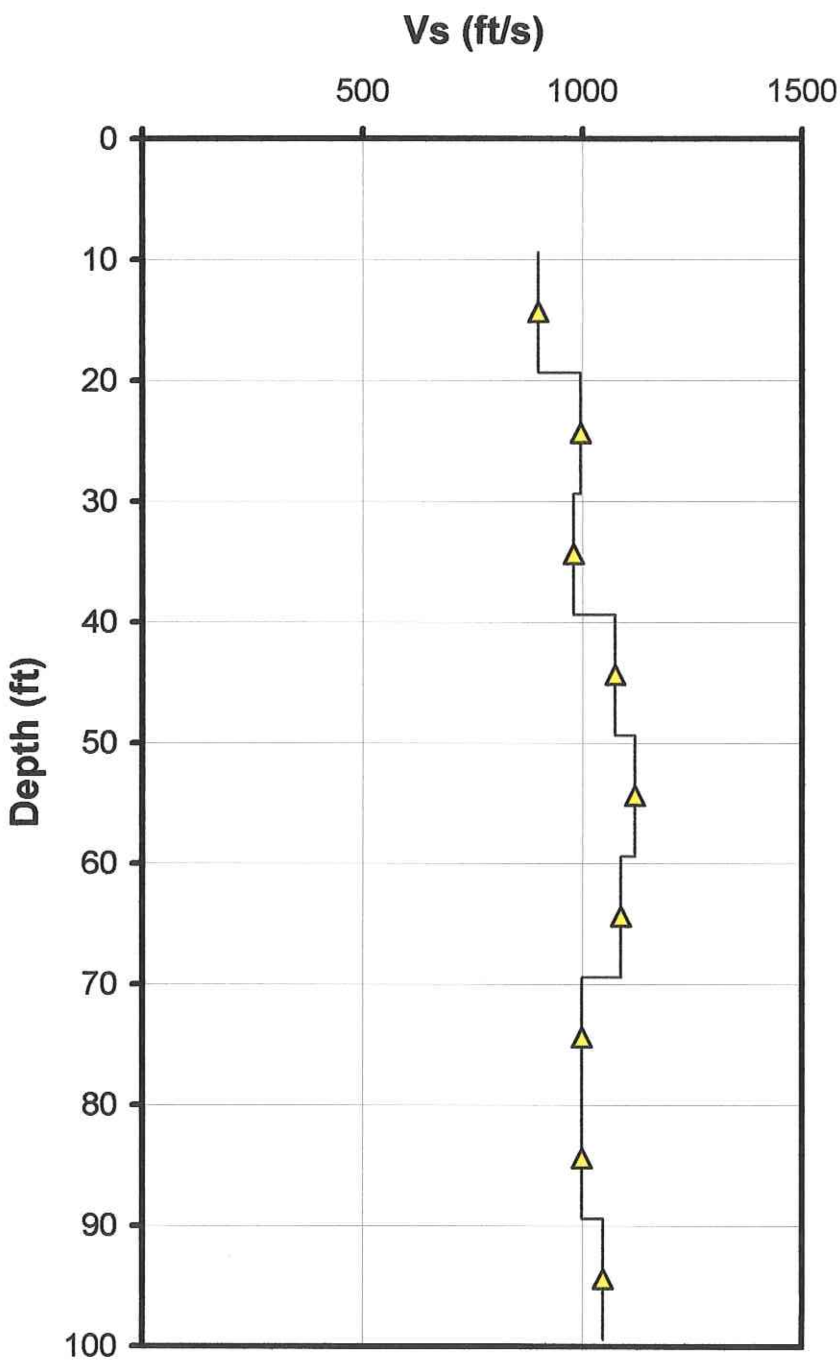
| | | |
|---|---|---|
| Seismic Source: | Beam | |
| Source Offset: | 1.97 | (ft) |
| Source Depth: | 0.00 | (ft) |
| Geophone Offset: | 0.66 | (ft) |

SEISMIC TEST RESULTS - Vs

| Tip Depth (ft) | Geophone Depth (ft) | Ray Path (ft) | Depth Interval (ft) | Time Interval (ms) | Mid-layer Depth (ft) | Vs Interval Velocity (ft/s) |
|---|---|---|---|---|---|---|
| 10.01 | 9.35 | 9.56 | | | | |
| 20.01 | 19.35 | 19.45 | 9.89 | 11.00 | 14.35 | 900 |
| 30.02 | 29.36 | 29.43 | 9.98 | 10.02 | 24.36 | 996 |
| 40.03 | 39.37 | 39.42 | 9.99 | 10.20 | 34.37 | 980 |
| 50.03 | 49.37 | 49.41 | 9.99 | 9.30 | 44.37 | 1074 |
| 60.04 | 59.38 | 59.42 | 10.00 | 8.94 | 54.38 | 1119 |
| 70.05 | 69.39 | 69.42 | 10.01 | 9.21 | 64.39 | 1086 |
| 80.05 | 79.39 | 79.42 | 10.00 | 10.02 | 74.39 | 998 |
| 90.06 | 89.40 | 89.43 | 10.01 | 10.02 | 84.40 | 999 |
| 100.07 | 99.41 | 99.43 | 10.01 | 9.57 | 94.41 | 1046 |

9

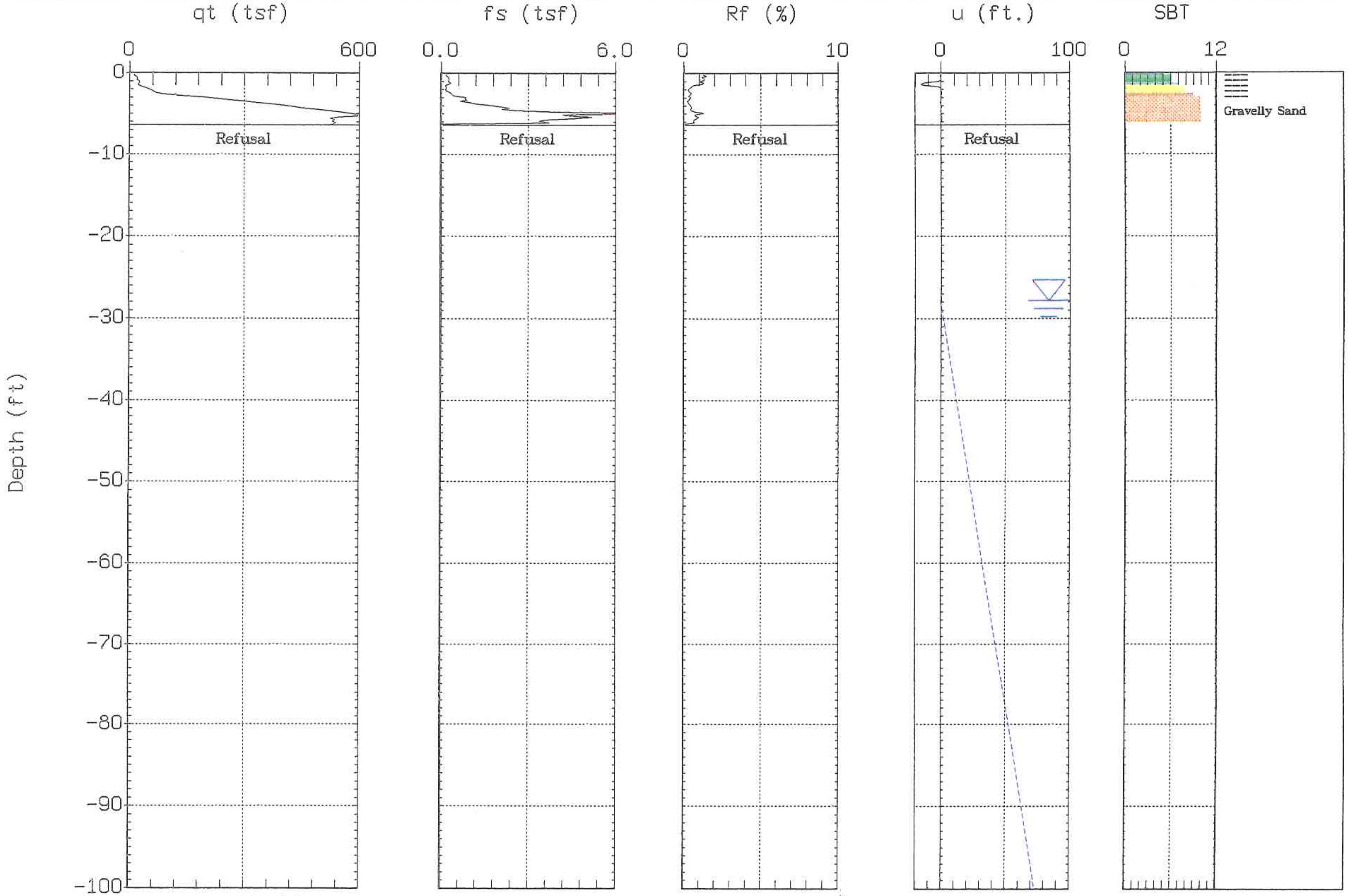
Job No: 06-773
Client: GEI Consultants
Project: National Labs
Sounding: CPT-6
Date: July 20, 2006



GEI Consultants

Sounding:CPT-7
Site:National Labs

Piezocone:20 Ton AD179
Date:07:21:06 12:03



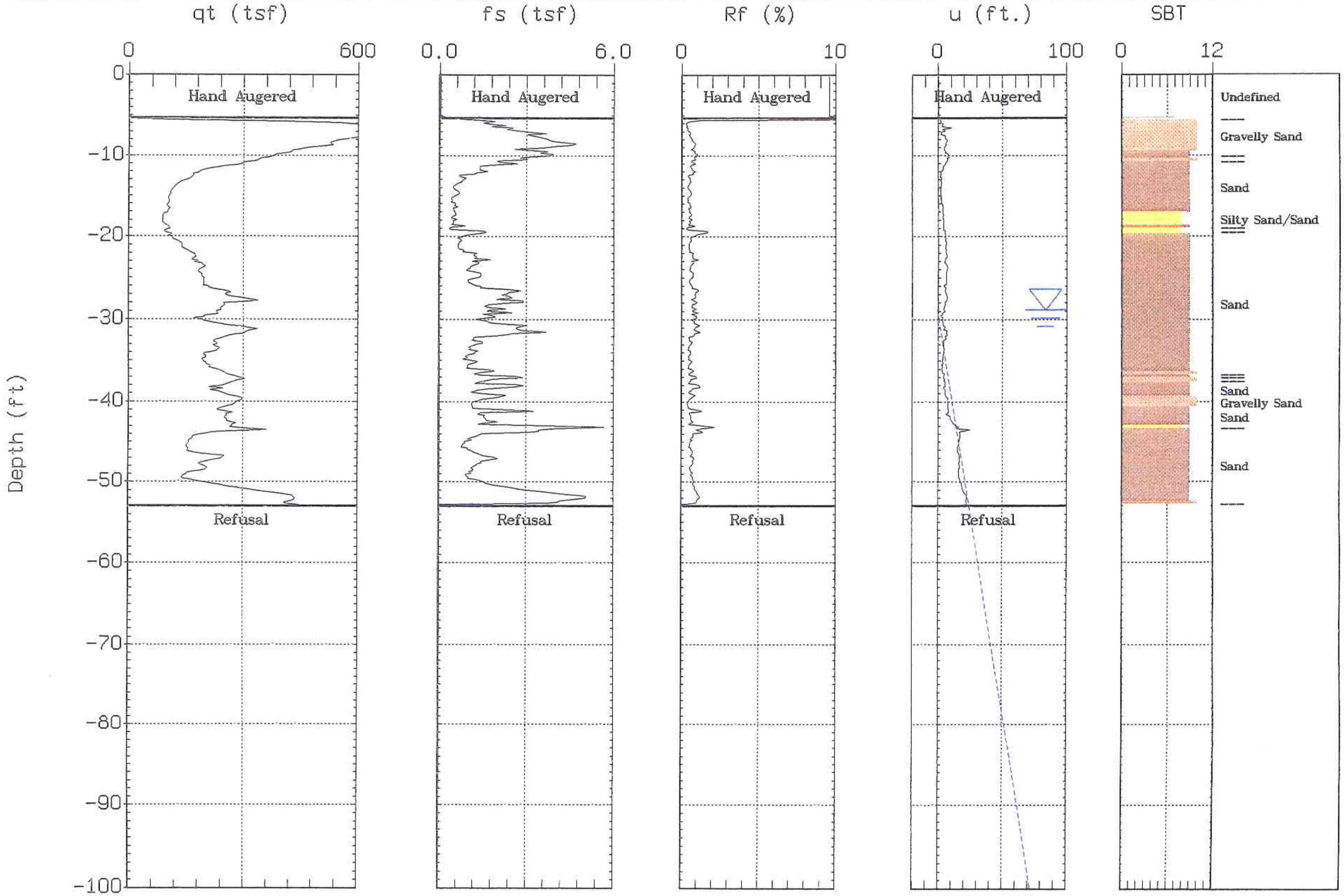

Max. Depth: 6.40 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-8
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 15:23



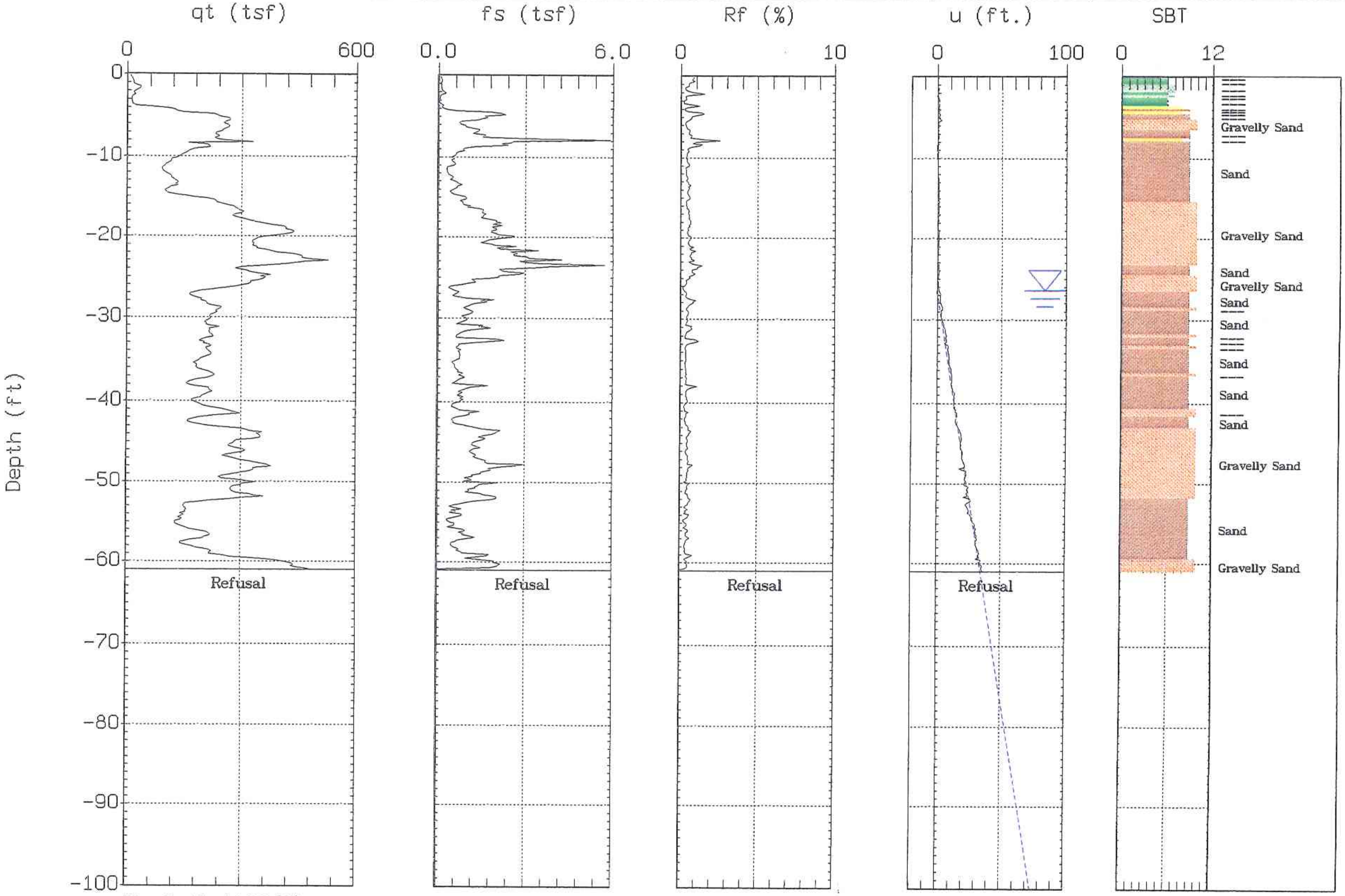

Max. Depth: 52.98 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-10
Site:National Labs

Piezocone:20 Ton AD179
Date:07:21:06 09:56




Max. Depth: 61.02 (ft)
Depth Inc.: 0.164 (ft)

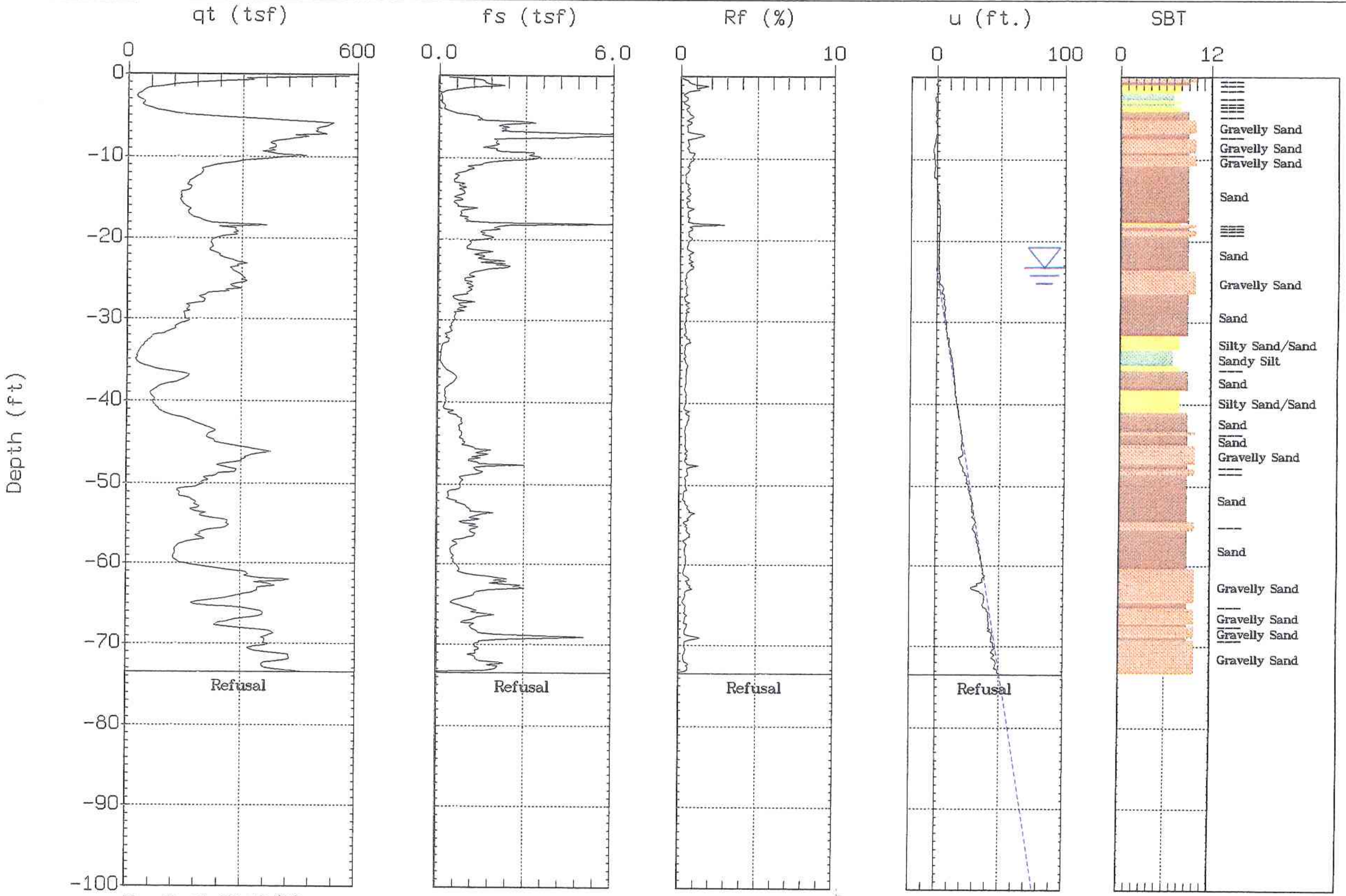
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

*GEI Consultants*

Sounding:CPT-11
Site:National Labs

Piezocone:20 Ton AD179
Date:07:21:06 08:42



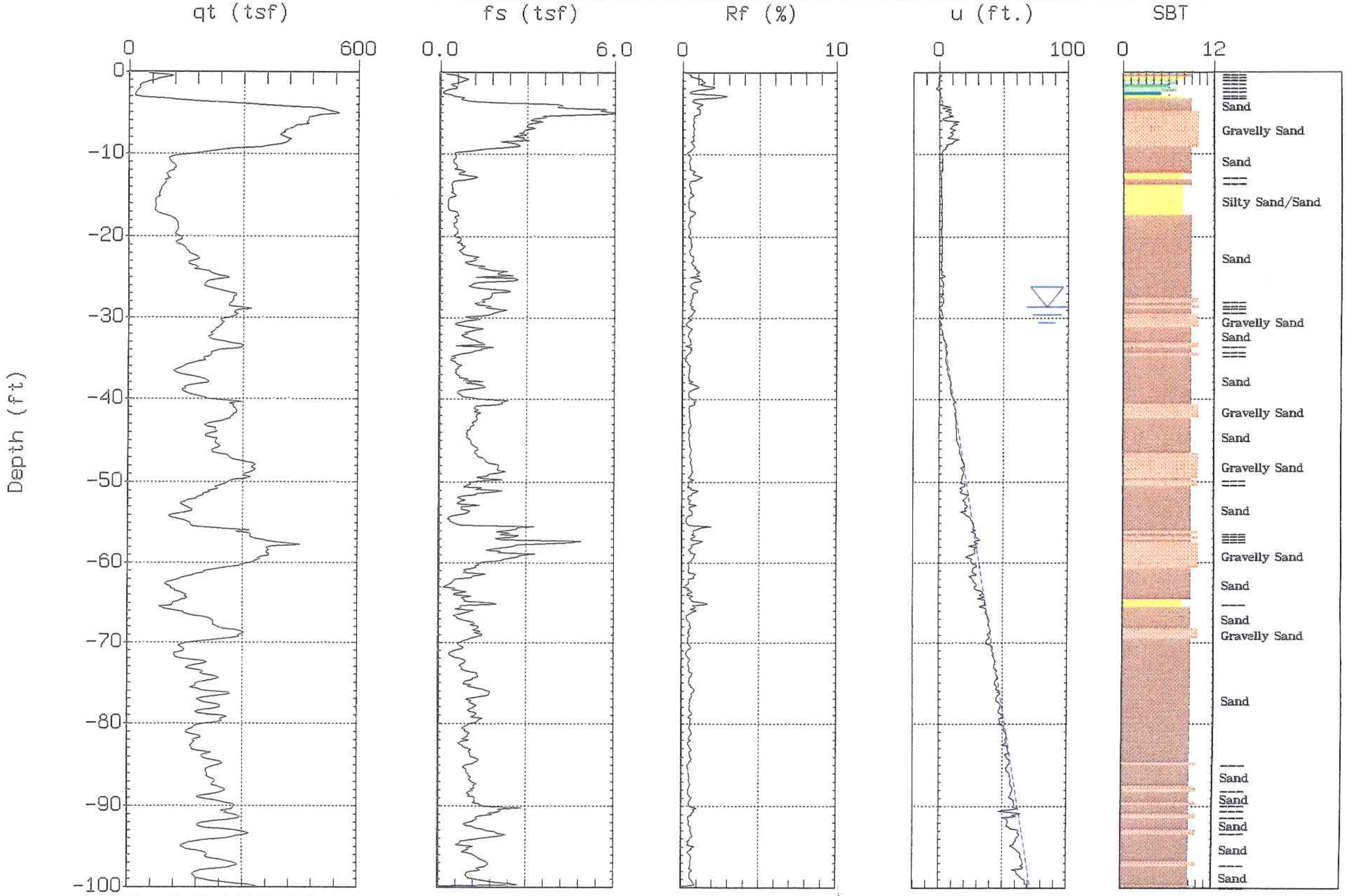

Max. Depth: 73.49 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-12
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 13:19




Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

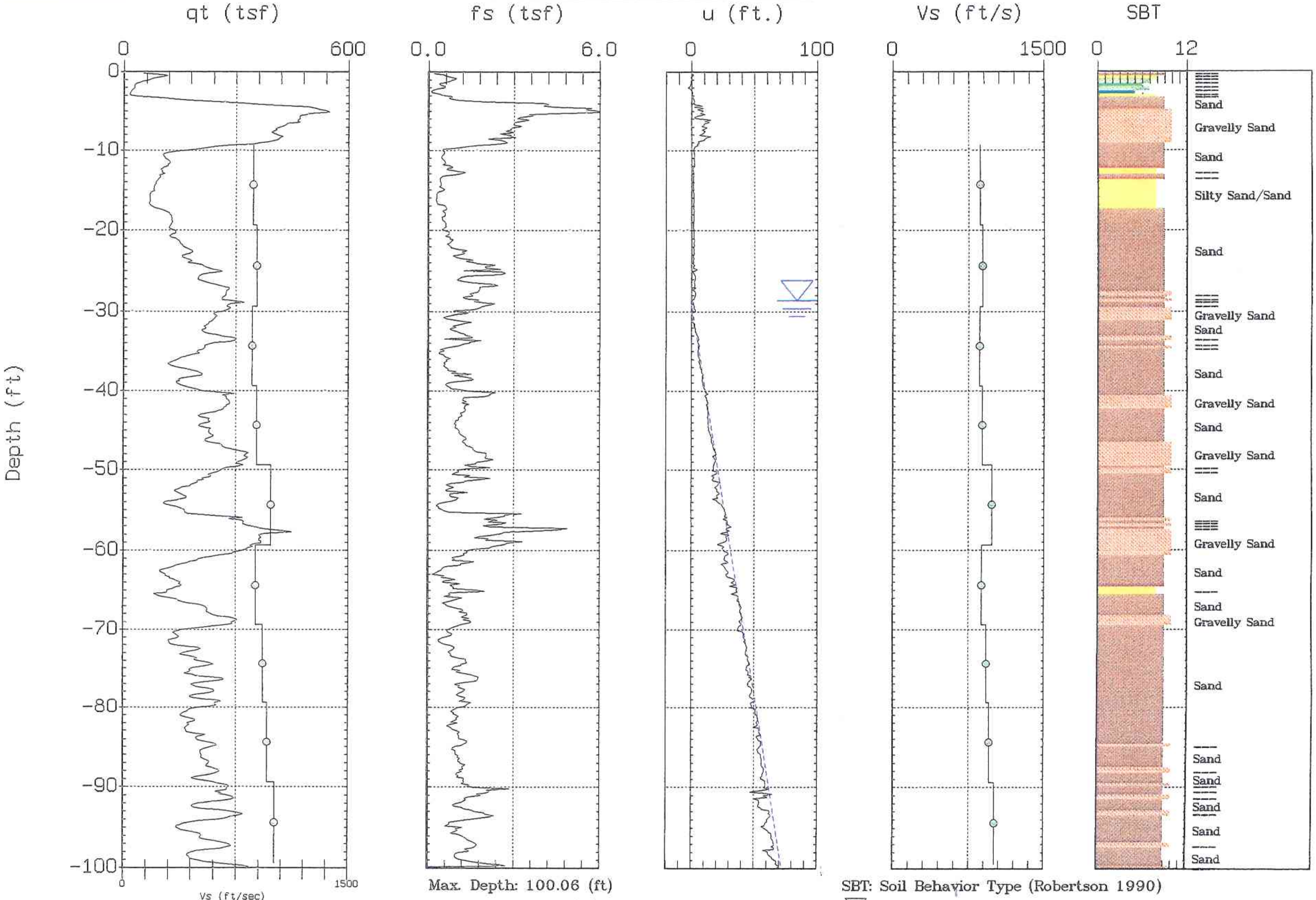
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

GEI Consultants

Sounding:CPT-12
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 13:19




Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

ConeTec

| | |
|---|---|
| Job No | 06-773 |
| Client | GEI Consultants |
| Project Title | National Labs |
| Hole | CPT-12 |
| Site | Brookhaven, New York |
| Date | 7/20/2006 |

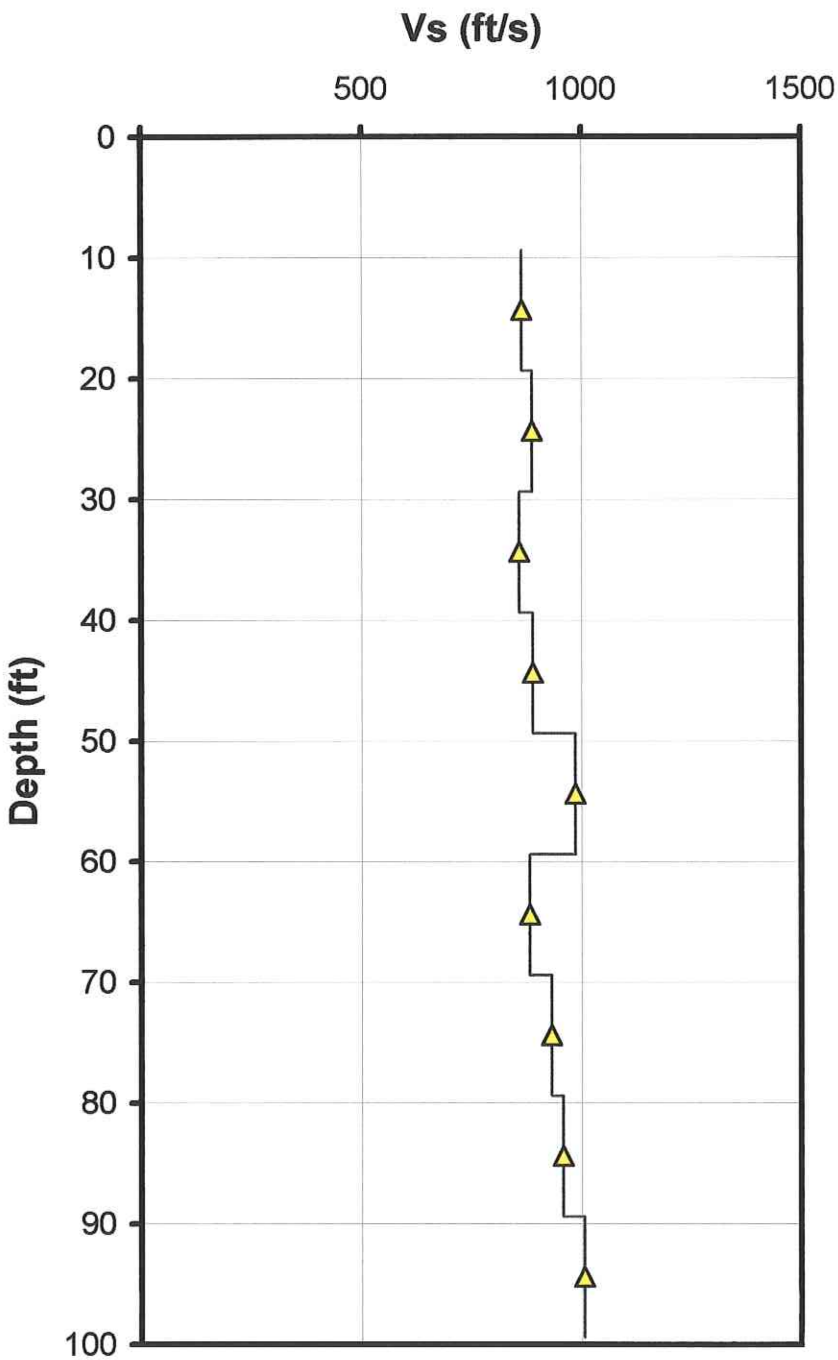
| | | |
|---|---|---|
| Seismic Source: | Beam | |
| Source Offset: | 1.97 | (ft) |
| Source Depth: | 0.00 | (ft) |
| Geophone Offset: | 0.66 | (ft) |

## SEISMIC TEST RESULTS - Vs

| Tip Depth (ft) | Geophone Depth (ft) | Ray Path (ft) | Depth Interval (ft) | Time Interval (ms) | Mid-layer Depth (ft) | Vs Interval Velocity (ft/s) |
|---|---|---|---|---|---|---|
| 10.01 | 9.35 | 9.56 | | | | |
| 20.01 | 19.35 | 19.45 | 9.89 | 11.44 | 14.35 | 865 |
| 30.02 | 29.36 | 29.43 | 9.98 | 11.24 | 24.36 | 888 |
| 40.03 | 39.37 | 39.42 | 9.99 | 11.64 | 34.37 | 859 |
| 50.03 | 49.37 | 49.41 | 9.99 | 11.24 | 44.37 | 889 |
| 60.04 | 59.38 | 59.42 | 10.00 | 10.15 | 54.38 | 986 |
| 70.05 | 69.39 | 69.42 | 10.01 | 11.34 | 64.39 | 882 |
| 80.05 | 79.39 | 79.42 | 10.00 | 10.74 | 74.39 | 931 |
| 90.06 | 89.40 | 89.43 | 10.01 | 10.45 | 84.40 | 958 |
| 100.07 | 99.41 | 99.43 | 10.01 | 9.95 | 94.41 | 1006 |

9

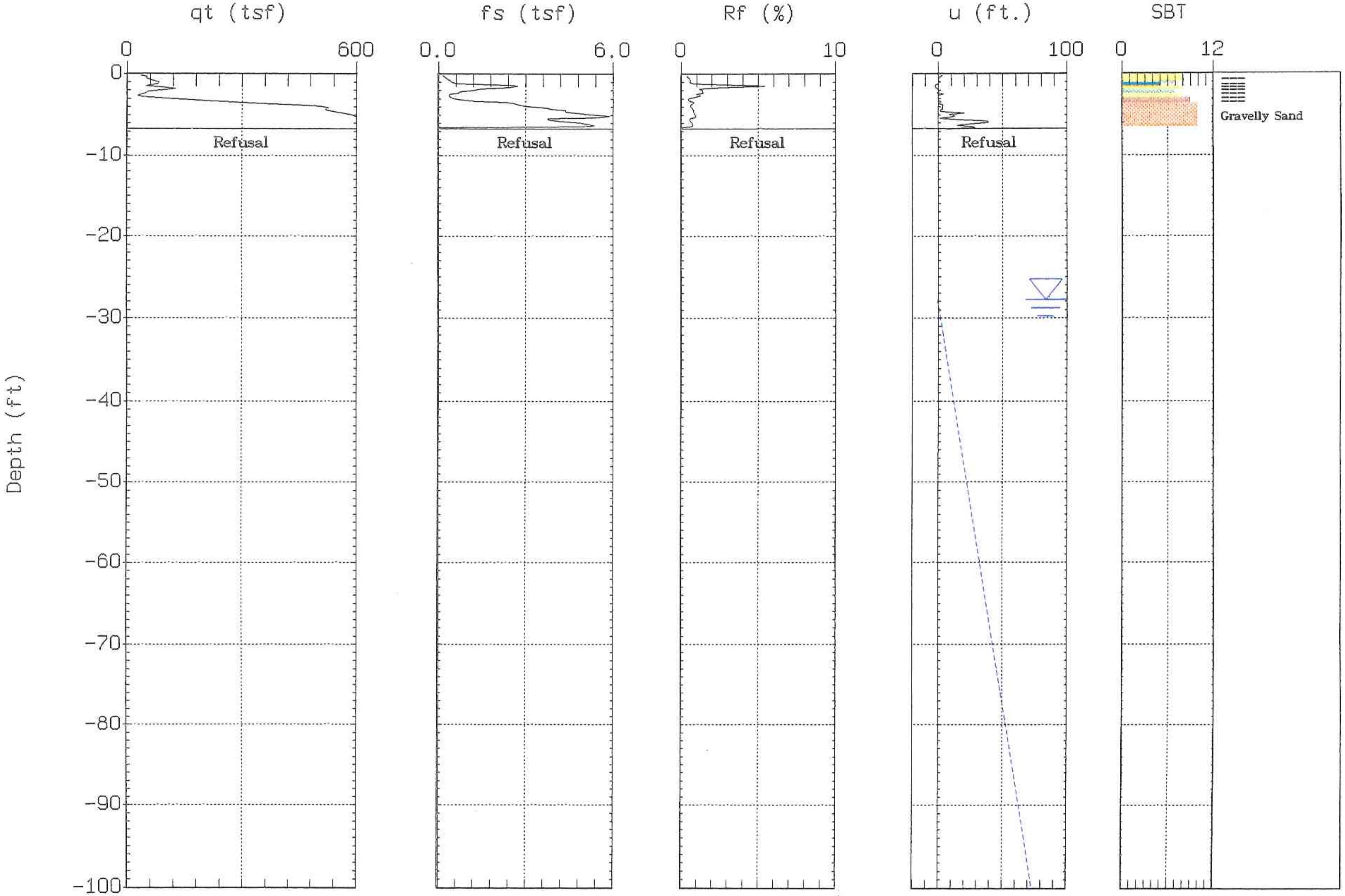
Job No: 06-773
Client: GEI Consultants
Project: National Labs
Sounding: CPT-12
Date: July 20, 2006



GEI Consultants

Sounding:CPT-13
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 12:23



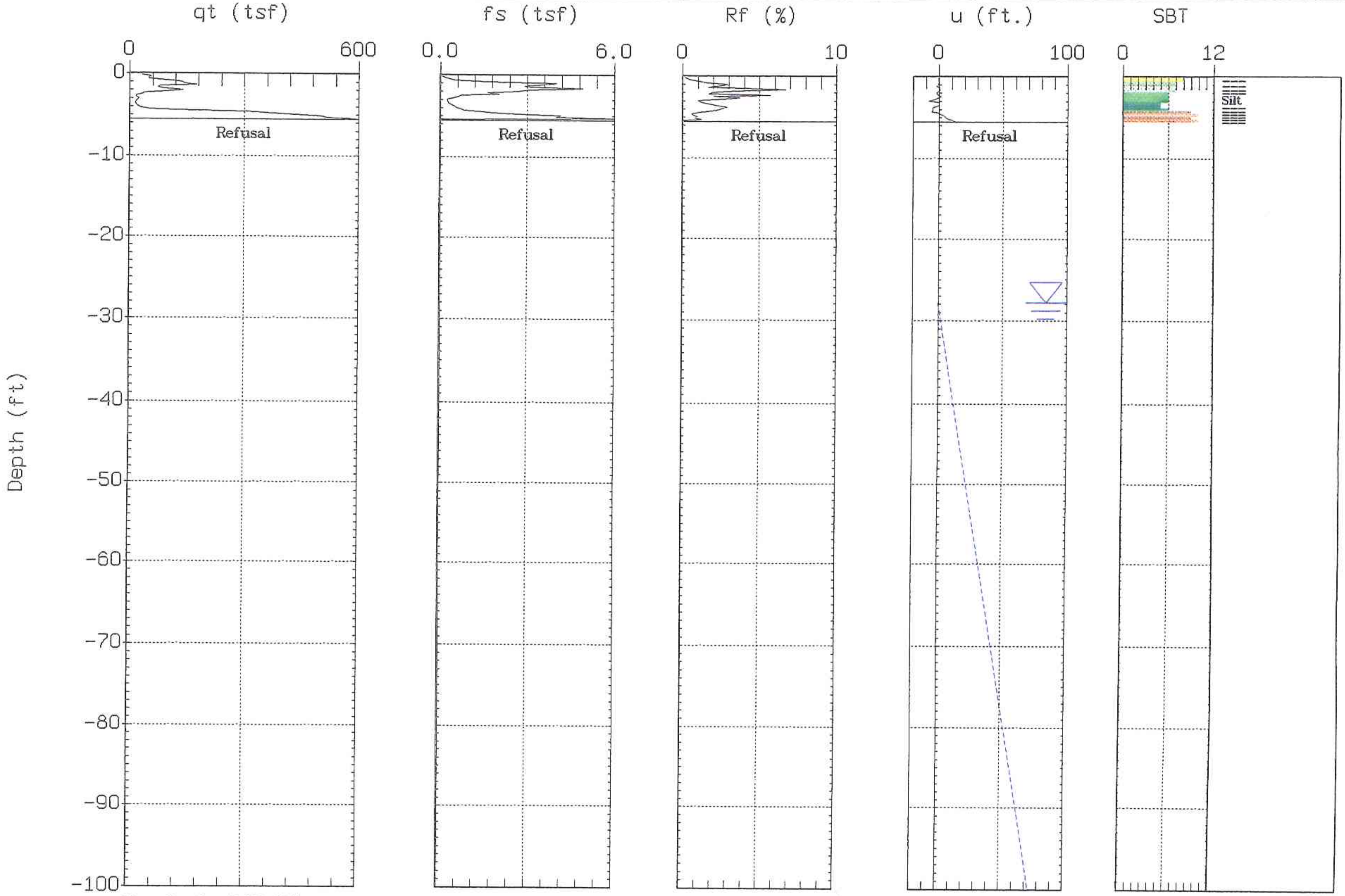

Max. Depth: 6.73 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-13A
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 12:50



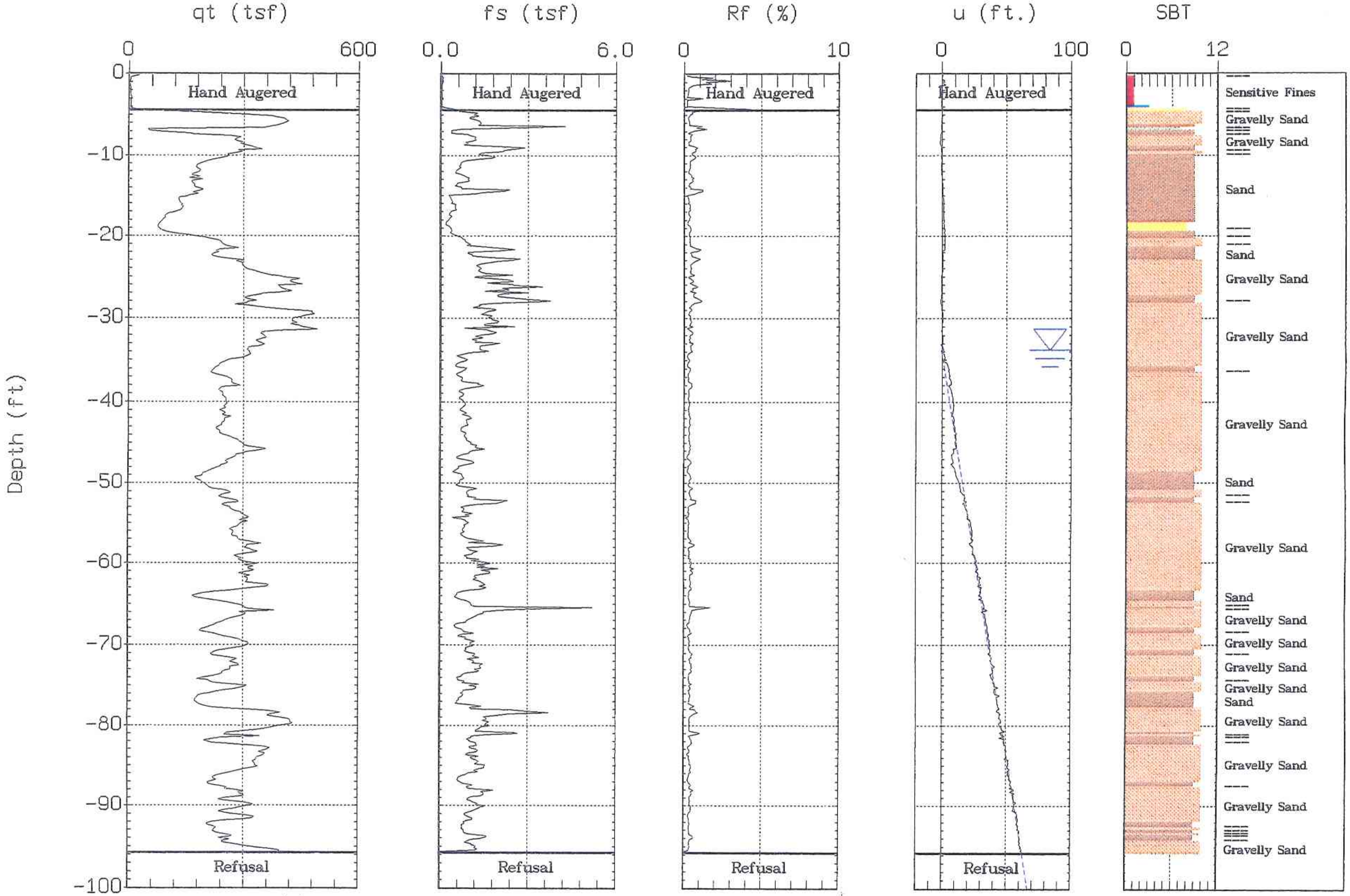

Max. Depth: 5.58 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-14
Site:National Labs

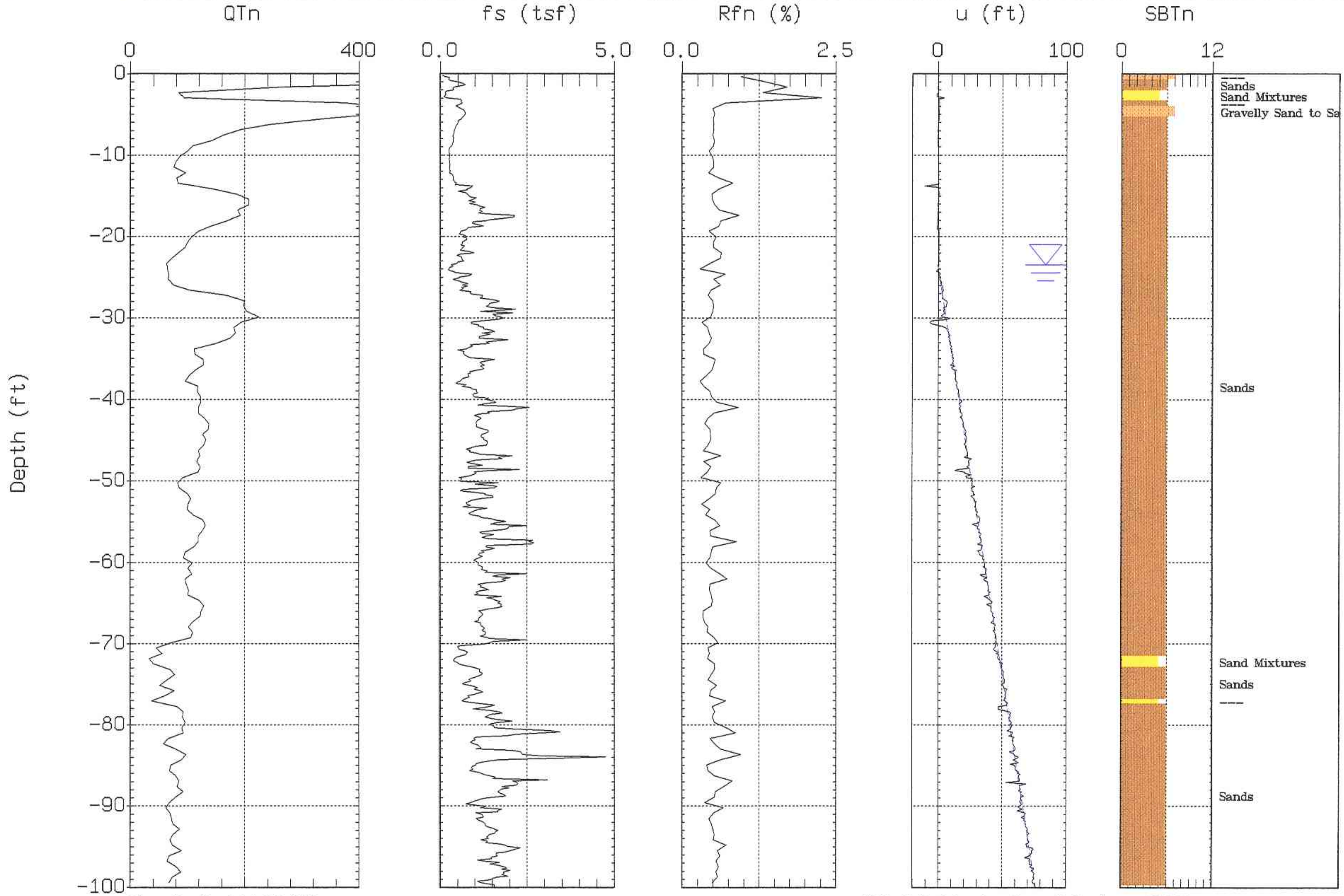
Piezocone:20 Ton AD179
Date:07:21:06 07:28




Max. Depth: 95.80 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

ConeTec | GEI Consultants | Site: CPT-201
Location: Upton, NY | Cone: STD 20T AD179
Date: 04:23:07 12:01



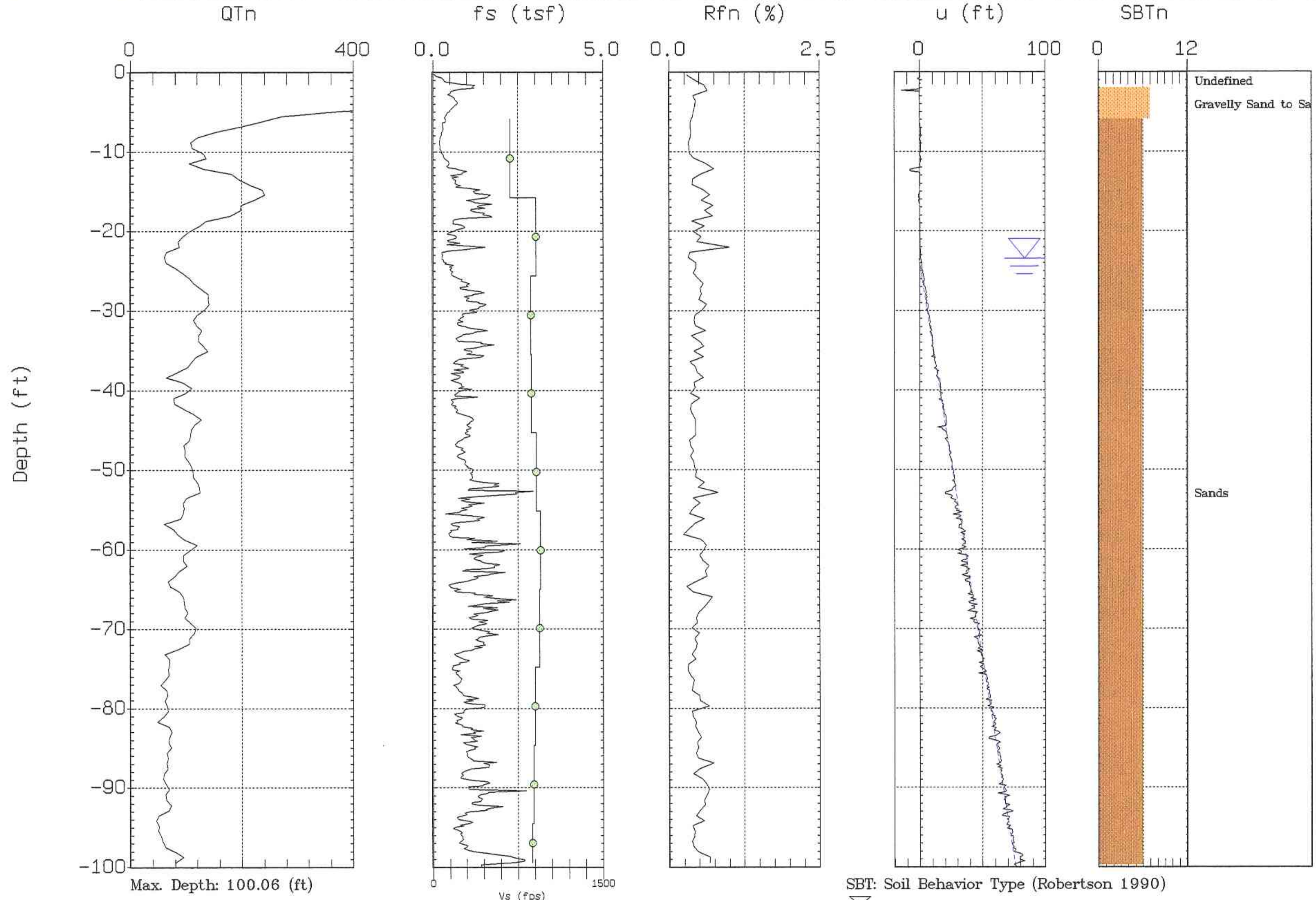

Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Site: CPT-202
Location: Upton, NY

Cone: STD 20T AD179
Date: 04:23:07 13:32




Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

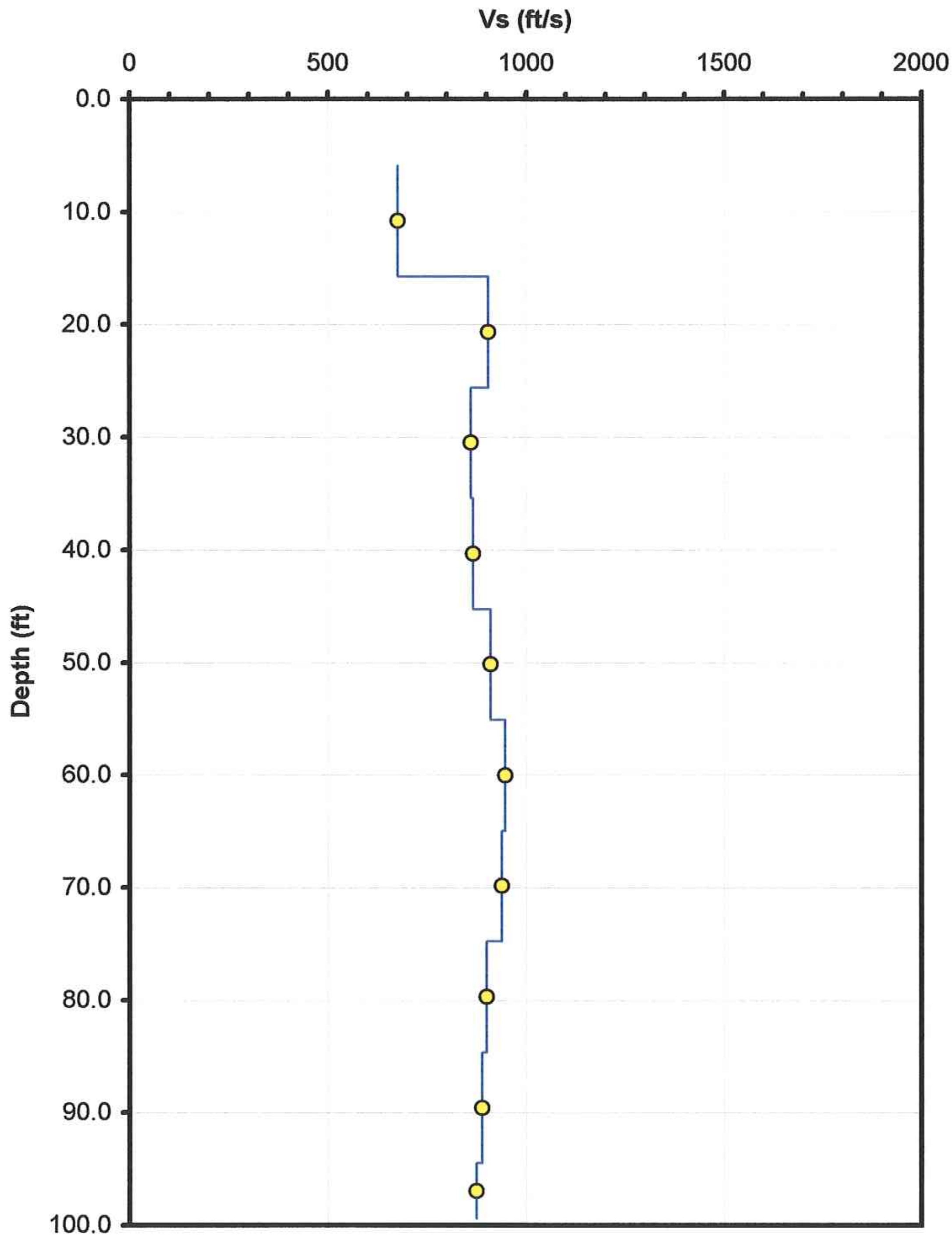
Client: GEI Consultants
Project: Brookhaven National Laboratory, Upton, NY
Sounding: CPT-202
Date: April 23, 2007

Seismic Source: Beam
Source Offset (ft): 2.00
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

## SEISMIC - Vs

| Tip Depth (ft) | Geophone Depth (ft) | Ray Path (ft) | Depth Interval (ft) | Time Interval (ms) | Vs (ft/s) | Mid Layer (ft) |
|---|---|---|---|---|---|---|
| 6.56 | 5.90 | 6.23 | | | | |
| 16.40 | 15.74 | 15.87 | 9.64 | 14.24 | 677 | 10.82 |
| 26.25 | 25.59 | 25.66 | 9.79 | 10.82 | 905 | 20.67 |
| 36.09 | 35.43 | 35.49 | 9.82 | 11.41 | 861 | 30.51 |
| 45.93 | 45.27 | 45.32 | 9.83 | 11.35 | 866 | 40.35 |
| 55.77 | 55.11 | 55.15 | 9.83 | 10.80 | 911 | 50.19 |
| 65.62 | 64.96 | 64.99 | 9.84 | 10.39 | 947 | 60.04 |
| 75.46 | 74.80 | 74.83 | 9.84 | 10.49 | 938 | 69.88 |
| 85.30 | 84.64 | 84.67 | 9.84 | 10.93 | 900 | 79.72 |
| 95.14 | 94.48 | 94.51 | 9.84 | 11.08 | 888 | 89.56 |
| 100.07 | 99.41 | 99.43 | 4.92 | 5.63 | 874 | 96.94 |

Client: GEI Consultants
Location: Brookhaven National Laboratory, Upton, NY
CPT Sounding: CPT-202
Date: April 23, 2007

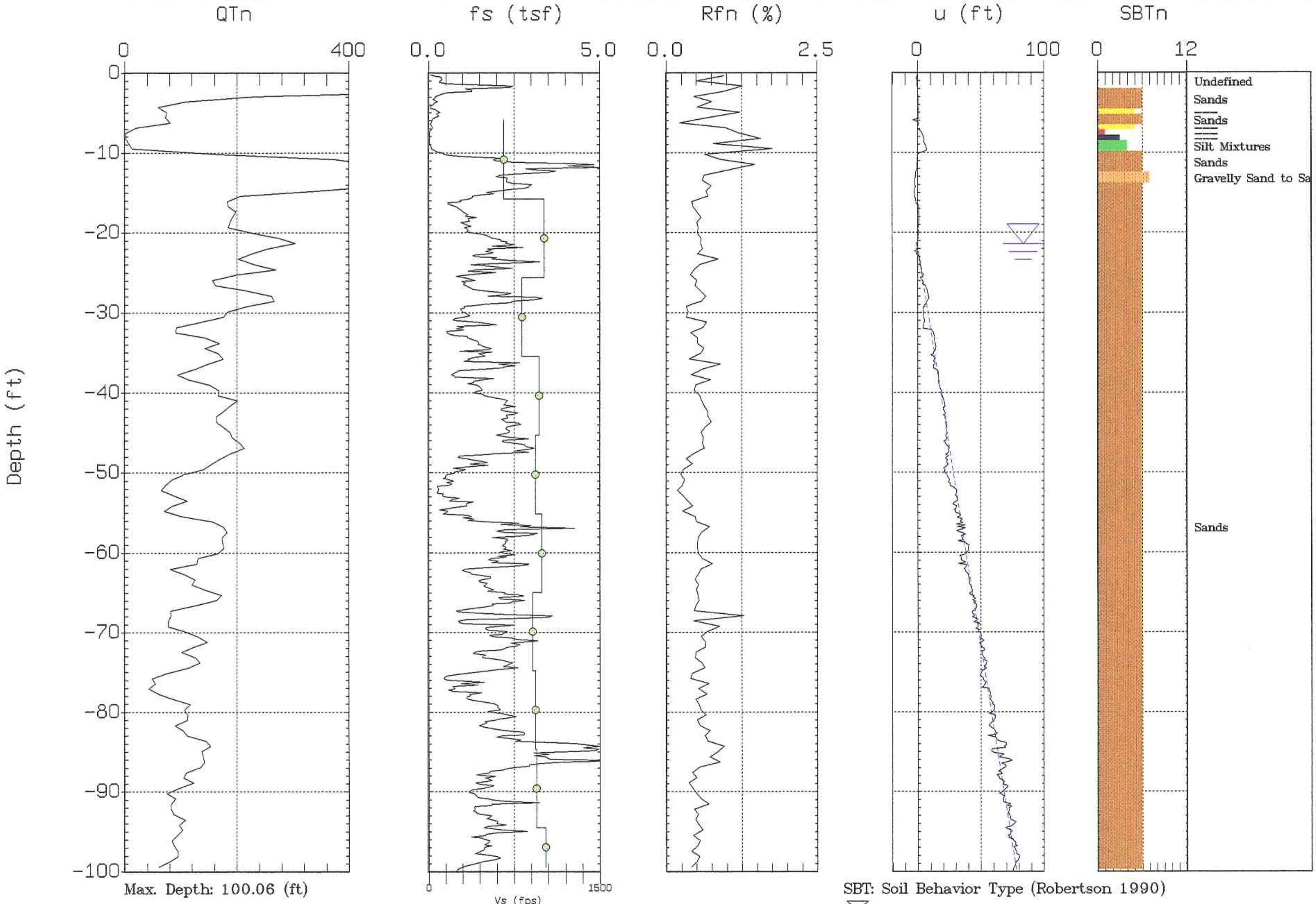


ConeTec

GEI Consultants

Site: CPT-203
Location: Upton, NY

Cone:STD 20T AD179
Date:04:23:07 15:16




Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

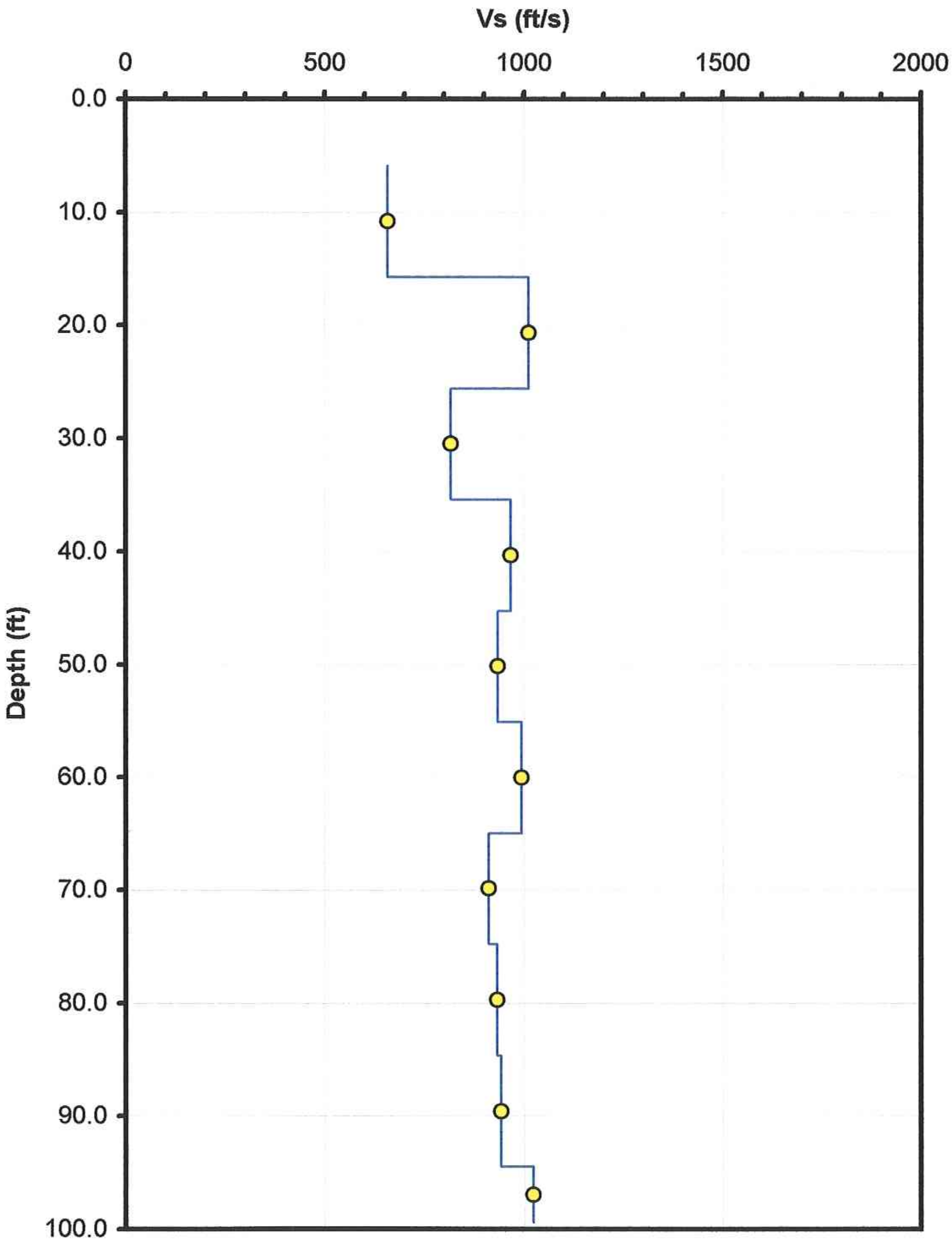
Client: GEI Consultants
Project: Brookhaven National Laboratory, Upton, NY
Sounding: CPT-203
Date: April 23, 2007

Seismic Source: Beam
Source Offset (ft): 2.00
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

## SEISMIC - Vs

| Tip Depth (ft) | Geophone Depth (ft) | Ray Path (ft) | Depth Interval (ft) | Time Interval (ms) | Vs (ft/s) | Mid Layer (ft) |
|---|---|---|---|---|---|---|
| 6.56 | 5.90 | 6.23 | | | | |
| 16.40 | 15.74 | 15.87 | 9.64 | 14.63 | 659 | 10.82 |
| 26.25 | 25.59 | 25.66 | 9.79 | 9.68 | 1011 | 20.67 |
| 36.09 | 35.43 | 35.49 | 9.82 | 12.03 | 816 | 30.51 |
| 45.93 | 45.27 | 45.32 | 9.83 | 10.17 | 967 | 40.35 |
| 55.77 | 55.11 | 55.15 | 9.83 | 10.53 | 934 | 50.19 |
| 65.62 | 64.96 | 64.99 | 9.84 | 9.91 | 993 | 60.04 |
| 75.46 | 74.80 | 74.83 | 9.84 | 10.79 | 912 | 69.88 |
| 85.30 | 84.64 | 84.67 | 9.84 | 10.55 | 933 | 79.72 |
| 95.14 | 94.48 | 94.51 | 9.84 | 10.44 | 943 | 89.56 |
| 100.07 | 99.41 | 99.43 | 4.92 | 4.81 | 1024 | 96.94 |

Client: GEI Consultants
Location: Brookhaven National Laboratory, Upton, NY
CPT Sounding: CPT-203
Date: April 23, 2007



# Appendix E

## Laboratory Test Results

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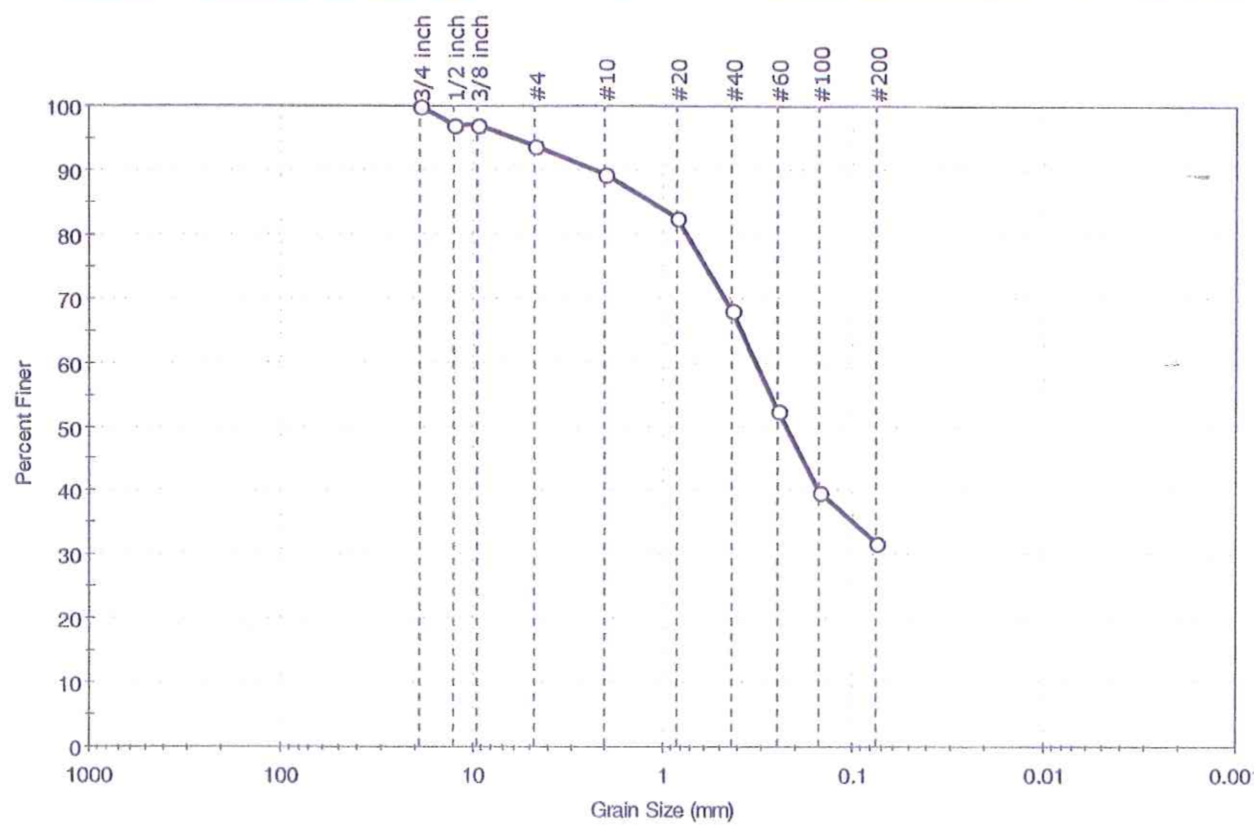
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-101 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-1 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 0-2 ft | Test Id: | 94474 | | |
| Test Comment: | sieve stack 6 | | | | |
| Sample Description: | Moist, yellowish brown silty sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 6.2 | 61.9 | 31.9 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/4 inch | 19.00 | 100 | | |
| 1/2 inch | 12.70 | 97 | | |
| 3/8 inch | 9.51 | 97 | | |
| #4 | 4.75 | 94 | | |
| #10 | 2.00 | 89 | | |
| #20 | 0.84 | 83 | | |
| #40 | 0.42 | 68 | | |
| #60 | 0.25 | 52 | | |
| #100 | 0.15 | 40 | | |
| #200 | 0.075 | 32 | | |

**Coefficients**

$D_{85}$ = 1.1382 mm    $D_{30}$ = N/A
$D_{60}$ = 0.3233 mm    $D_{15}$ = N/A
$D_{50}$ = 0.2260 mm    $D_{10}$ = N/A
$C_u$ = N/A    $C_c$ = N/A

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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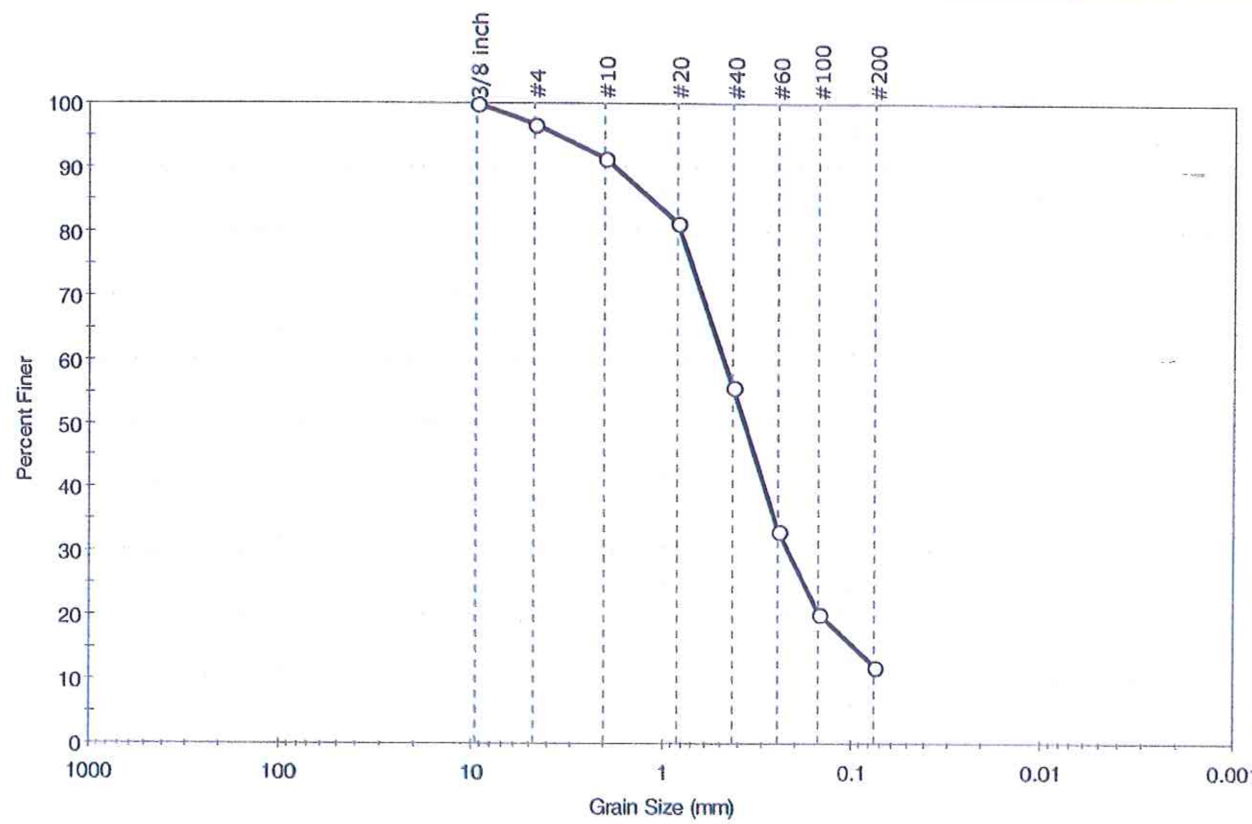
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-101 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-2 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 5-7 ft | Test Id: | 94475 | | |
| Test Comment: | sieve stack 6 | | | | |
| Sample Description: | Moist, light gray silty sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 3.2 | 84.6 | 12.2 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 inch | 9.51 | 100 | | |
| #4 | 4.75 | 97 | | |
| #10 | 2.00 | 91 | | |
| #20 | 0.84 | 81 | | |
| #40 | 0.42 | 56 | | |
| #60 | 0.25 | 33 | | |
| #100 | 0.15 | 20 | | |
| #200 | 0.075 | 12 | | |

**Coefficients**

| | |
|---|---|
| $D_{85}$ =1.1429 mm | $D_{30}$ =0.2189 mm |
| $D_{60}$ =0.4753 mm | $D_{15}$ =0.0949 mm |
| $D_{50}$ =0.3706 mm | $D_{10}$ =0.0622 mm |
| $C_u$ =7.641 | $C_c$ =1.621 |

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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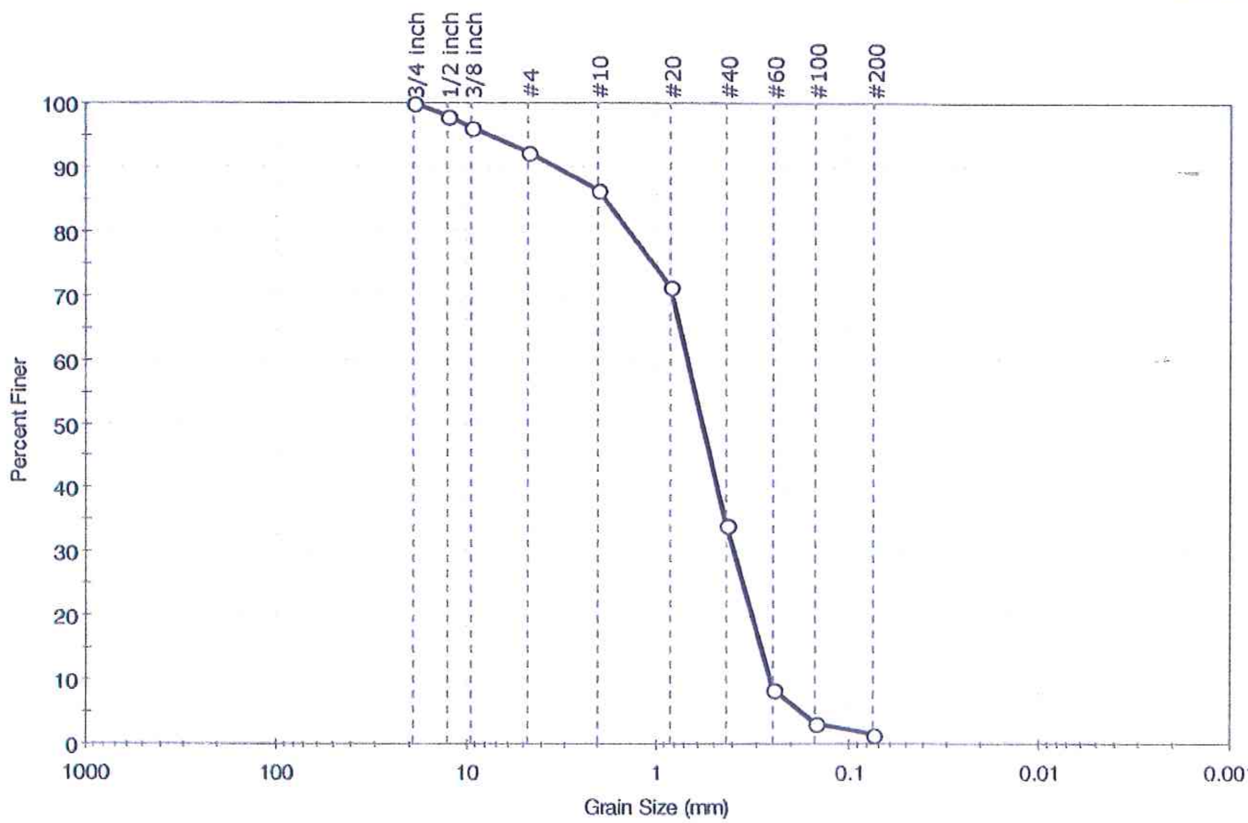
GeoTesting express
a subsidiary of Geocomp Corporation

| Client: | GEI Consultants | | | | |
|---|---|---|---|---|---|
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-101 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-3 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 10-12 ft | Test Id: | 94476 | | |
| Test Comment: | sieve stack 6 | | | | |
| Sample Description: | Moist, light gray sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 7.8 | 90.8 | 1.4 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/4 inch | 19.00 | 100 | | |
| 1/2 inch | 12.70 | 98 | | |
| 3/8 inch | 9.51 | 96 | | |
| #4 | 4.75 | 92 | | |
| #10 | 2.00 | 86 | | |
| #20 | 0.84 | 71 | | |
| #40 | 0.42 | 34 | | |
| #60 | 0.25 | 9 | | |
| #100 | 0.15 | 3 | | |
| #200 | 0.075 | 1 | | |

**Coefficients**

$D_{85}$ = 1.8530 mm　　$D_{30}$ = 0.3886 mm

$D_{60}$ = 0.6828 mm　　$D_{15}$ = 0.2854 mm

$D_{50}$ = 0.5676 mm　　$D_{10}$ = 0.2575 mm

$C_u$ = 2.652　　$C_c$ = 0.859

**Classification**

ASTM　Poorly graded sand (SP)

AASHTO　Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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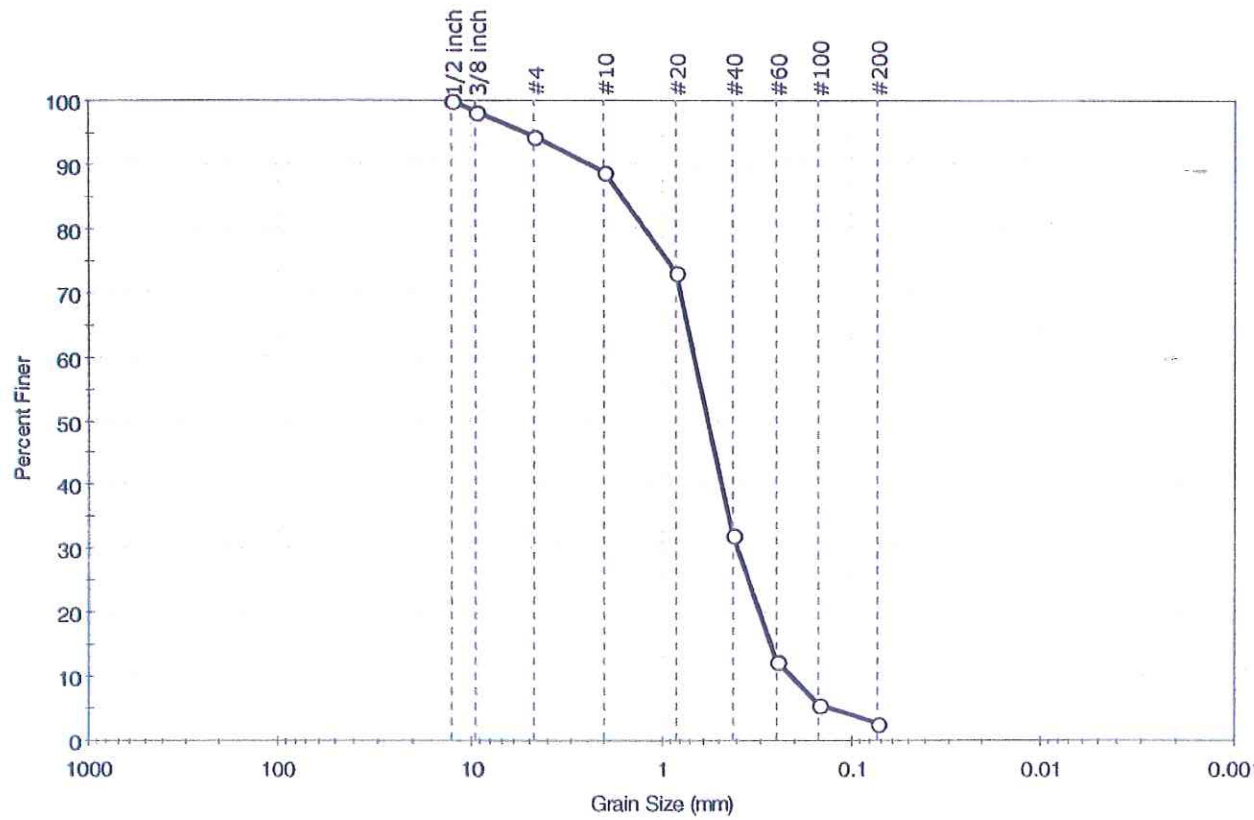
GeoTesting express
a subsidiary of Geocomp Corporation

| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-101 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-4 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 15-17 ft | Test Id: | 94477 | | |
| Test Comment: | sieve stack 1 | | | | |
| Sample Description: | Moist, light gray sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 5.5 | 91.8 | 2.7 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1/2 inch | 12.70 | 100 | | |
| 3/8 inch | 9.51 | 98 | | |
| #4 | 4.75 | 95 | | |
| #10 | 2.00 | 89 | | |
| #20 | 0.84 | 73 | | |
| #40 | 0.42 | 32 | | |
| #60 | 0.25 | 12 | | |
| #100 | 0.15 | 6 | | |
| #200 | 0.074 | 3 | | |

**Coefficients**

$D_{85}$ = 1.6294 mm　　$D_{30}$ = 0.3979 mm

$D_{60}$ = 0.6737 mm　　$D_{15}$ = 0.2672 mm

$D_{50}$ = 0.5689 mm　　$D_{10}$ = 0.2070 mm

$C_u$ = 3.255　　$C_c$ = 1.135

**Classification**

ASTM　Poorly graded sand (SP)

AASHTO　Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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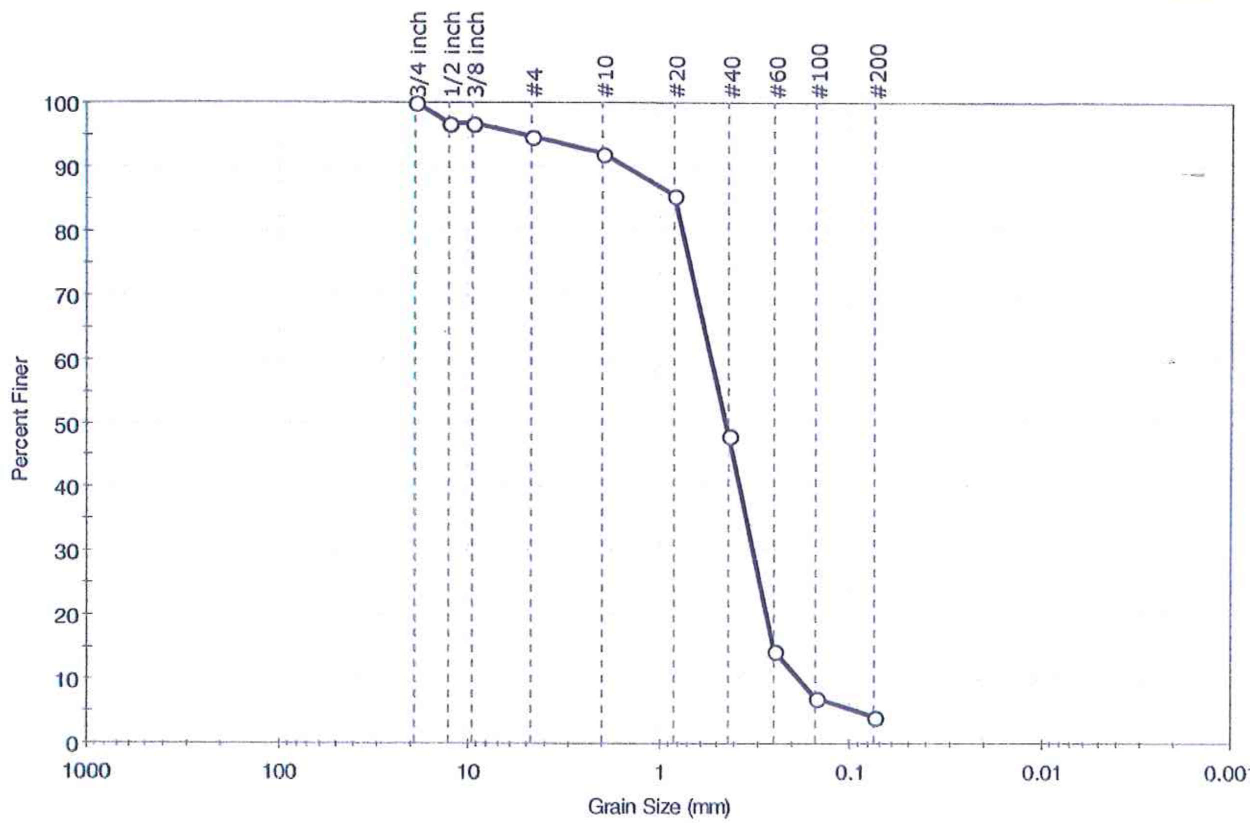
GeoTesting express
a subsidiary of Geocomp Corporation

| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-101 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-5 | Test Date: | 08/02/06 | Checked By: | jdt |
| Depth : | 20-22 ft | Test Id: | 94478 | | |
| Test Comment: | sieve stack 6 | | | | |
| Sample Description: | Moist, white sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 5.4 | 90.5 | 4.1 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/4 inch | 19.00 | 100 | | |
| 1/2 inch | 12.70 | 97 | | |
| 3/8 inch | 9.51 | 97 | | |
| #4 | 4.75 | 95 | | |
| #10 | 2.00 | 92 | | |
| #20 | 0.84 | 86 | | |
| #40 | 0.42 | 48 | | |
| #60 | 0.25 | 15 | | |
| #100 | 0.15 | 7 | | |
| #200 | 0.075 | 4 | | |

**Coefficients**

| | |
|---|---|
| $D_{85}$ = 0.8317 mm | $D_{30}$ = 0.3192 mm |
| $D_{60}$ = 0.5280 mm | $D_{15}$ = 0.2516 mm |
| $D_{50}$ = 0.4402 mm | $D_{10}$ = 0.1818 mm |
| $C_u$ = 2.904 | $C_c$ = 1.061 |

**Classification**

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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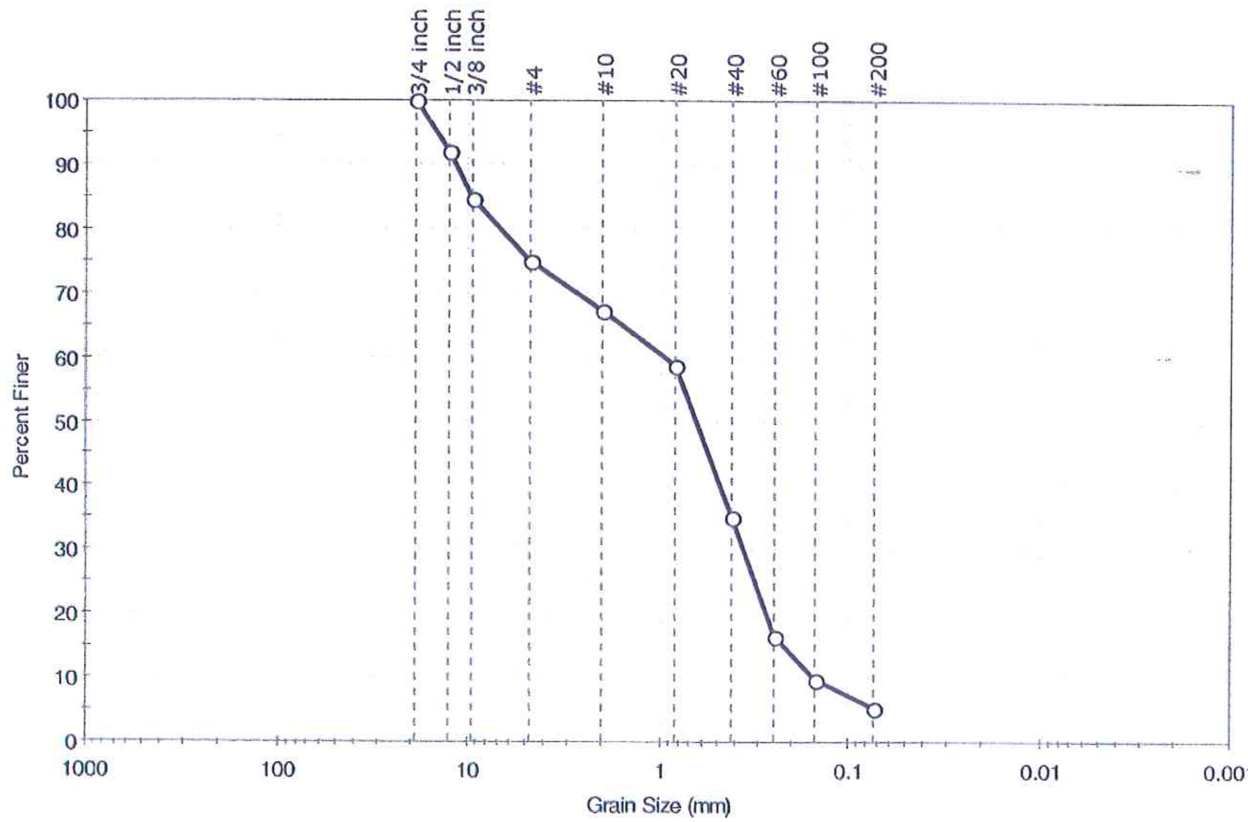
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-101 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-6 | Test Date: | 08/02/06 | Checked By: | jdt |
| Depth : | 25-27 ft | Test Id: | 94479 | | |
| Test Comment: | sieve stack 1 | | | | |
| Sample Description: | Moist, very pale brown sand with silt and gravel | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 25.2 | 69.5 | 5.3 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/4 inch | 19.00 | 100 | | |
| 1/2 inch | 12.70 | 92 | | |
| 3/8 inch | 9.51 | 85 | | |
| #4 | 4.75 | 75 | | |
| #10 | 2.00 | 67 | | |
| #20 | 0.84 | 59 | | |
| #40 | 0.42 | 35 | | |
| #60 | 0.25 | 17 | | |
| #100 | 0.15 | 10 | | |
| #200 | 0.074 | 5 | | |

**Coefficients**

$D_{85}$ =9.6327 mm | $D_{30}$ =0.3633 mm
$D_{60}$ =0.9539 mm | $D_{15}$ =0.2209 mm
$D_{50}$ =0.6500 mm | $D_{10}$ =0.1520 mm
$C_u$ =6.276 | $C_c$ =0.910

**Classification**

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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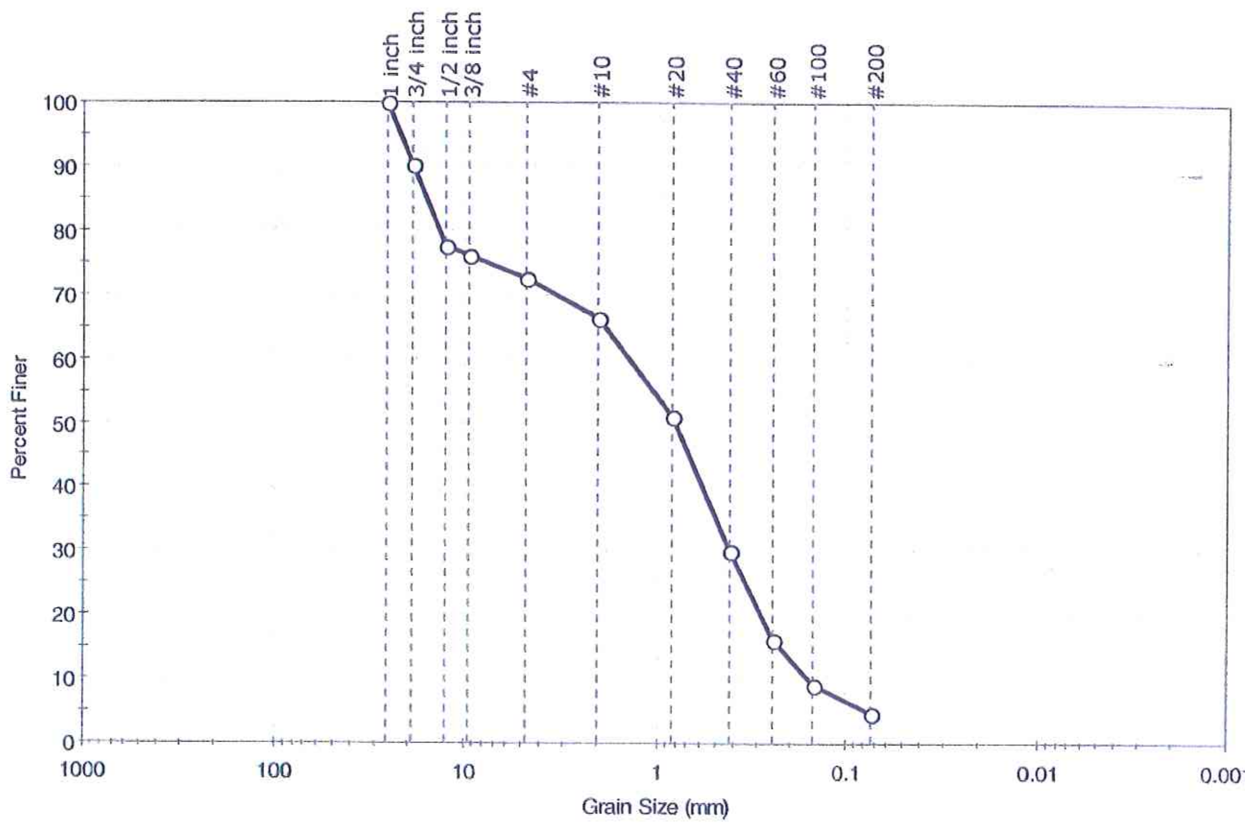
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-101 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-8 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 35-37 ft | Test Id: | 94480 | | |
| Test Comment: | sieve stack 1 | | | | |
| Sample Description: | Moist, pale brown sand with gravel | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 27.3 | 68.1 | 4.6 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1 inch | 25.70 | 100 | | |
| 3/4 inch | 19.00 | 90 | | |
| 1/2 inch | 12.70 | 78 | | |
| 3/8 inch | 9.51 | 76 | | |
| #4 | 4.75 | 73 | | |
| #10 | 2.00 | 66 | | |
| #20 | 0.84 | 51 | | |
| #40 | 0.42 | 30 | | |
| #60 | 0.25 | 16 | | |
| #100 | 0.15 | 9 | | |
| #200 | 0.074 | 5 | | |

**Coefficients**

| | |
|---|---|
| $D_{85}$ = 16.0845 mm | $D_{30}$ = 0.4168 mm |
| $D_{60}$ = 1.3899 mm | $D_{15}$ = 0.2294 mm |
| $D_{50}$ = 0.8125 mm | $D_{10}$ = 0.1594 mm |
| $C_u$ = 8.720 | $C_c$ = 0.784 |

**Classification**

ASTM Poorly graded sand with gravel (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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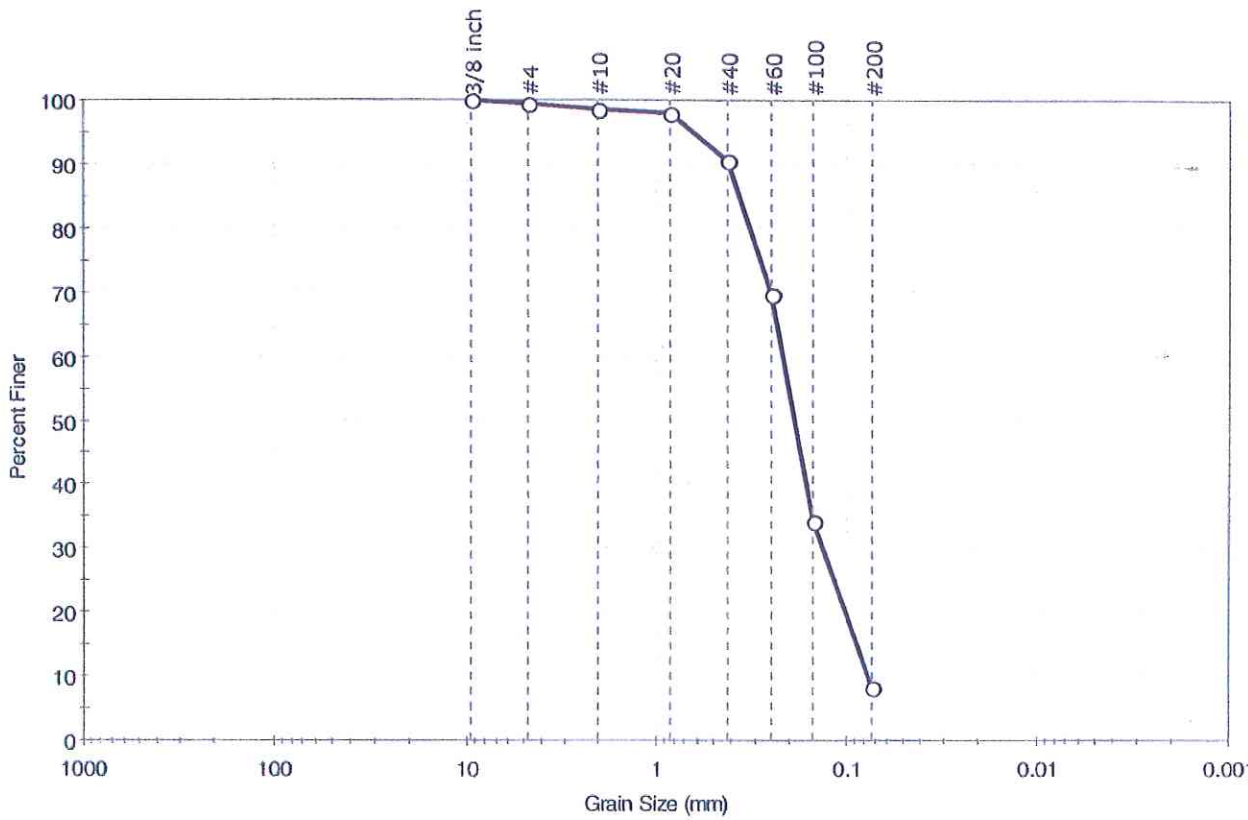
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-101 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-10 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 45-47 ft | Test Id: | 94481 | | |
| Test Comment: | sieve stack 1 | | | | |
| Sample Description: | Moist, light yellowish brown sand with silt | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 0.5 | 91.2 | 8.3 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 inch | 9.51 | 100 | | |
| #4 | 4.75 | 99 | | |
| #10 | 2.00 | 99 | | |
| #20 | 0.84 | 98 | | |
| #40 | 0.42 | 90 | | |
| #60 | 0.25 | 70 | | |
| #100 | 0.15 | 34 | | |
| #200 | 0.074 | 8 | | |

**Coefficients**

$D_{85}$ =0.3666 mm    $D_{30}$ =0.1332 mm
$D_{60}$ =0.2172 mm    $D_{15}$ =0.0888 mm
$D_{50}$ =0.1877 mm    $D_{10}$ =0.0775 mm
$C_u$ =2.803    $C_c$ =1.054

**Classification**

ASTM N/A

AASHTO Fine Sand (A-3 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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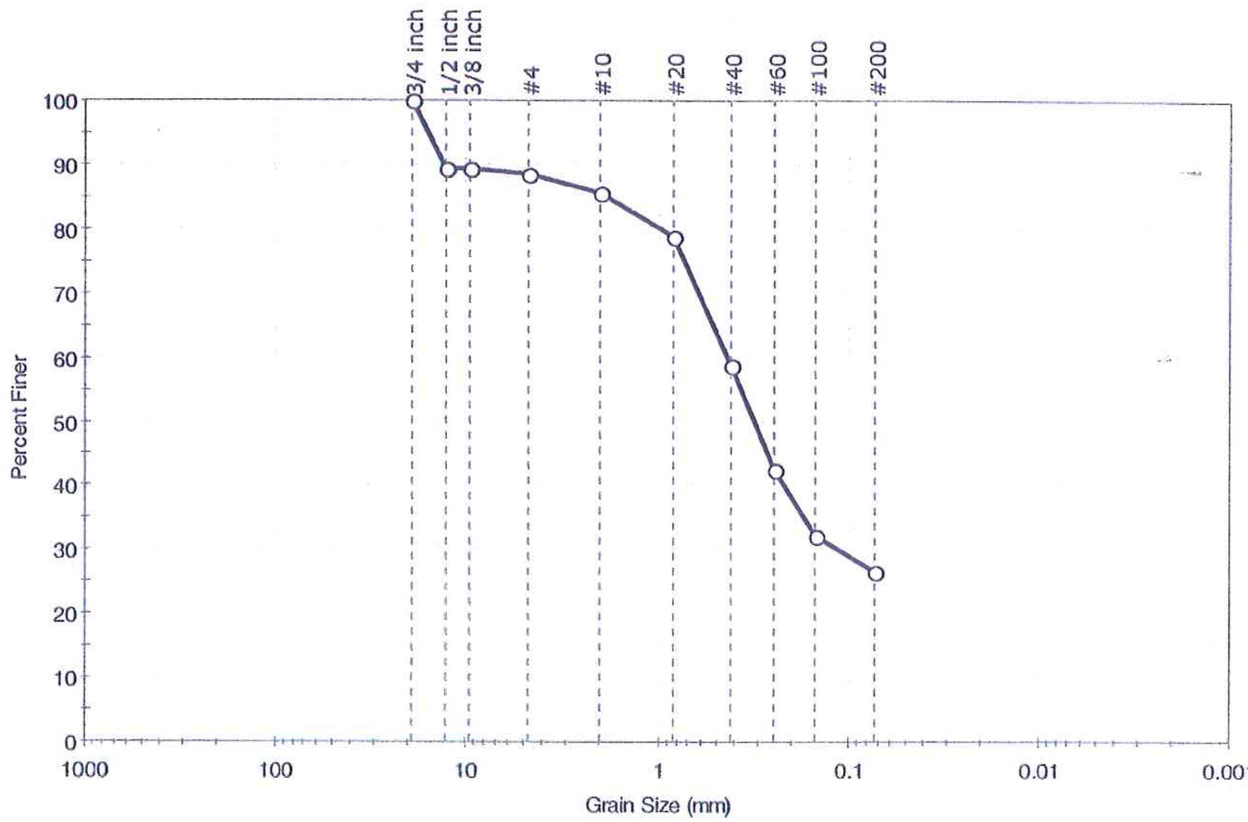
| Client: | GEI Consultants | | | | |
|---|---|---|---|---|---|
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-102 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-1 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 0-2 ft | Test Id: | 94482 | | |
| Test Comment: | sieve stack 1 | | | | |
| Sample Description: | Moist, Dark yellowish brown silty sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 11.4 | 61.9 | 26.7 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/4 inch | 19.00 | 100 | | |
| 1/2 inch | 12.70 | 89 | | |
| 3/8 inch | 9.51 | 89 | | |
| #4 | 4.75 | 89 | | |
| #10 | 2.00 | 86 | | |
| #20 | 0.84 | 79 | | |
| #40 | 0.42 | 59 | | |
| #60 | 0.25 | 42 | | |
| #100 | 0.15 | 32 | | |
| #200 | 0.074 | 27 | | |

**Coefficients**

$D_{85}$ = 1.8592 mm — $D_{30}$ = 0.1121 mm

$D_{60}$ = 0.4377 mm — $D_{15}$ = N/A

$D_{50}$ = 0.3177 mm — $D_{10}$ = N/A

$C_u$ = N/A — $C_c$ = N/A

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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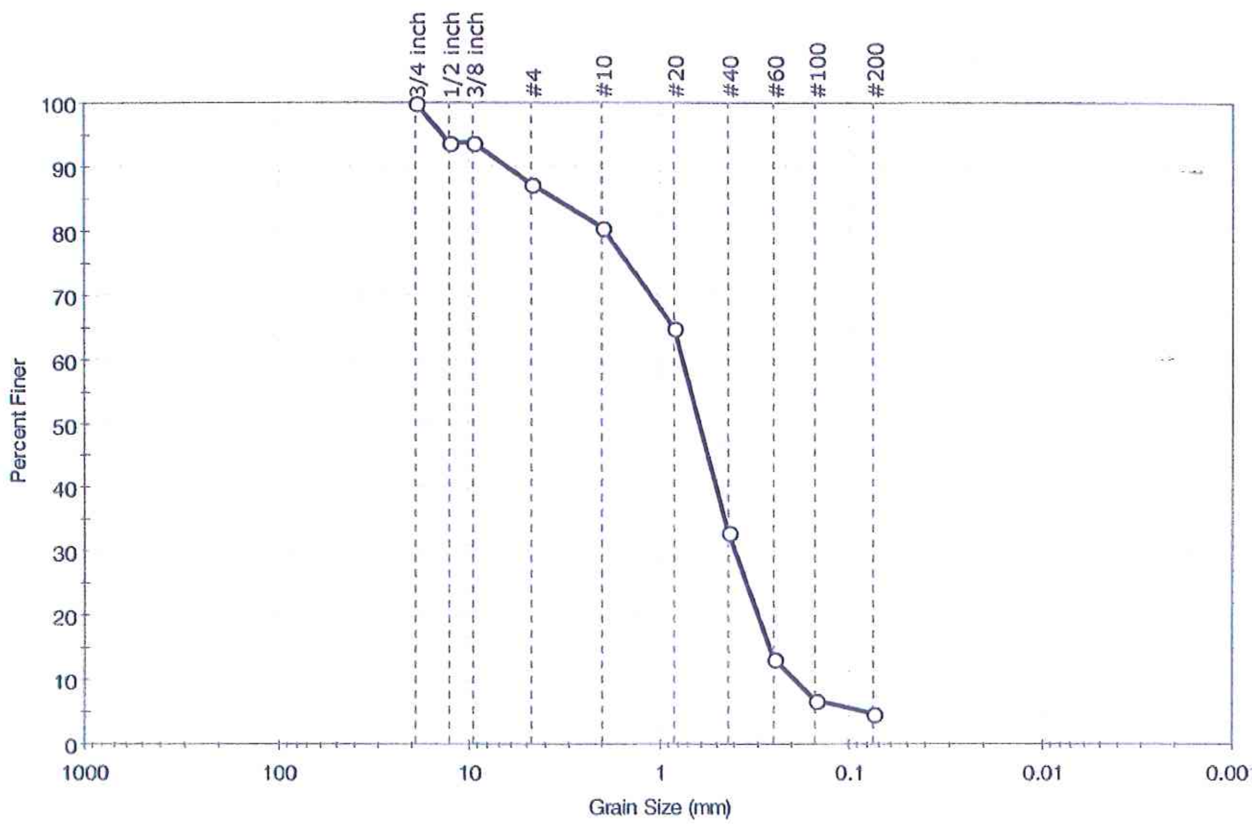
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: B-102 | | Sample Type: | jar | Tested By: | pcs |
| Sample ID:S-2 | | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : 5-7 ft | | Test Id: | 94483 | | |
| Test Comment: | sieve stack 6 | | | | |
| Sample Description: | Moist, light olive brown sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 12.7 | 82.7 | 4.6 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/4 inch | 19.00 | 100 | | |
| 1/2 inch | 12.70 | 94 | | |
| 3/8 inch | 9.51 | 94 | | |
| #4 | 4.75 | 87 | | |
| #10 | 2.00 | 81 | | |
| #20 | 0.84 | 65 | | |
| #40 | 0.42 | 33 | | |
| #60 | 0.25 | 13 | | |
| #100 | 0.15 | 7 | | |
| #200 | 0.075 | 5 | | |

**Coefficients**

$D_{85}$ =3.5367 mm | $D_{30}$ =0.3920 mm
$D_{60}$ =0.7575 mm | $D_{15}$ =0.2627 mm
$D_{50}$ =0.6114 mm | $D_{10}$ =0.1938 mm
$C_u$ =3.909 | $C_c$ =1.047

**Classification**

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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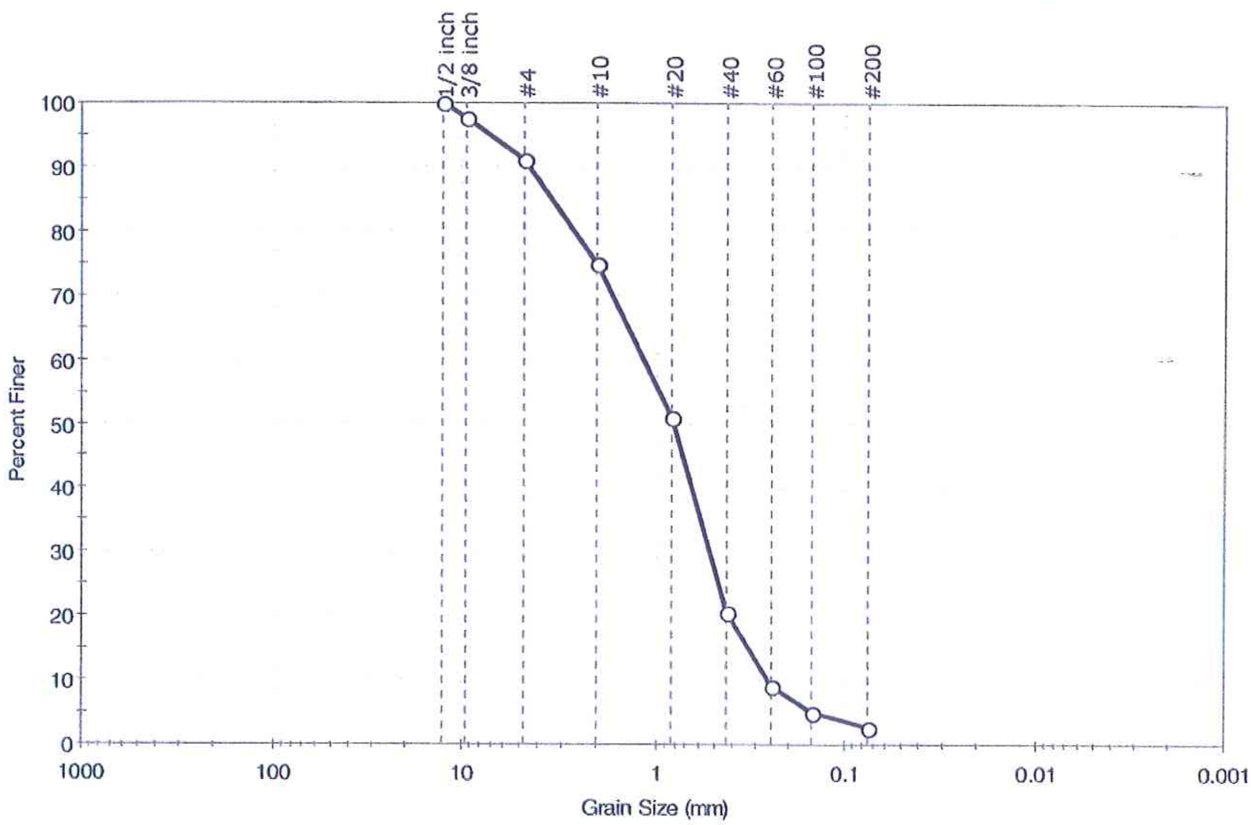
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-102 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-3 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 10-12 ft | Test Id: | 94484 | | |
| Test Comment: | sieve stack 6 | | | | |
| Sample Description: | Moist, light yellowish brown sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 9.0 | 88.2 | 2.8 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1/2 inch | 12.70 | 100 | | |
| 3/8 inch | 9.51 | 98 | | |
| #4 | 4.75 | 91 | | |
| #10 | 2.00 | 75 | | |
| #20 | 0.84 | 51 | | |
| #40 | 0.42 | 21 | | |
| #60 | 0.25 | 9 | | |
| #100 | 0.15 | 5 | | |
| #200 | 0.075 | 3 | | |

**Coefficients**

$D_{85}$ =3.4384 mm — $D_{30}$ =0.5240 mm

$D_{60}$ =1.1657 mm — $D_{15}$ =0.3278 mm

$D_{50}$ =0.8227 mm — $D_{10}$ =0.2611 mm

$C_u$ =4.465 — $C_c$ =0.902

**Classification**

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape :

Sand/Gravel Hardness :

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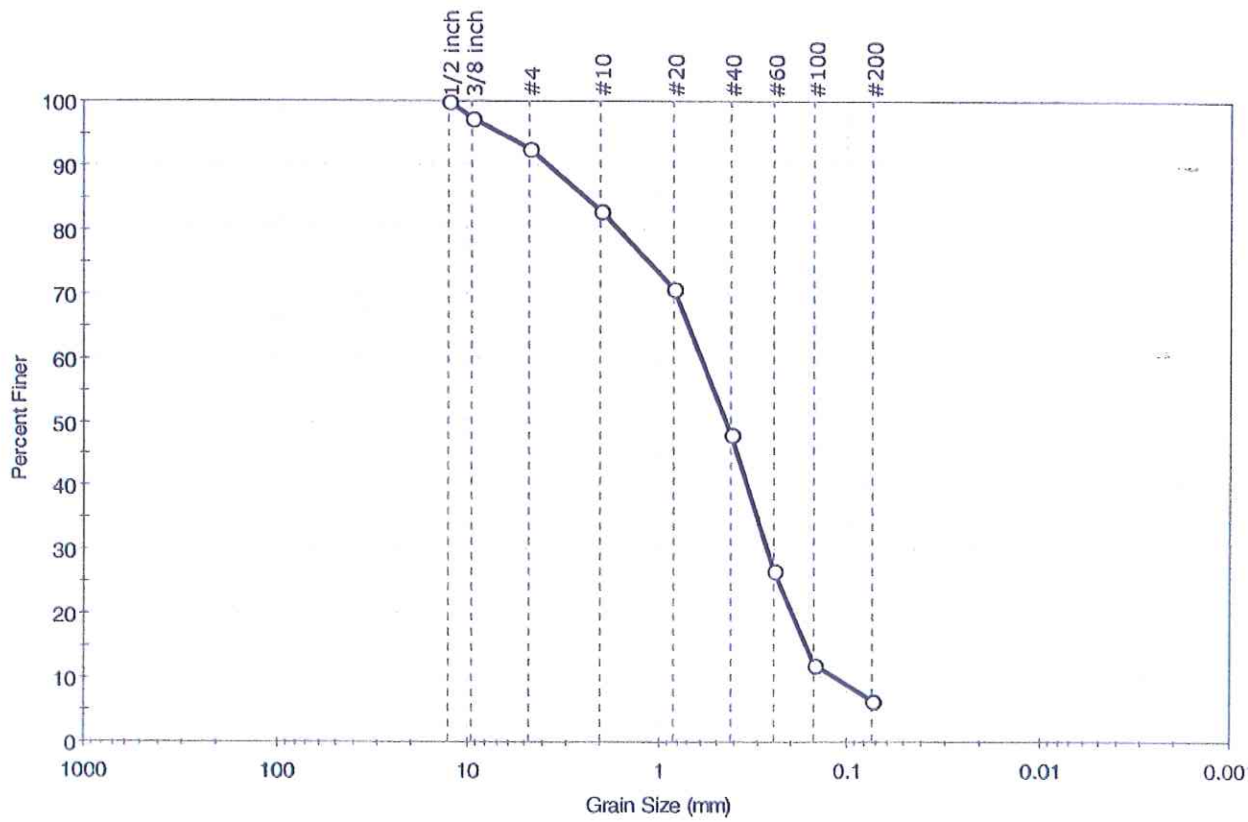
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-102 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-4 | Test Date: | 08/02/06 | Checked By: | jdt |
| Depth : | 15-17 ft | Test Id: | 94485 | | |
| Test Comment: | sieve stack 1 | | | | |
| Sample Description: | Moist, brown sand with silt | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 7.4 | 86.1 | 6.5 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1/2 inch | 12.70 | 100 | | |
| 3/8 inch | 9.51 | 97 | | |
| #4 | 4.75 | 93 | | |
| #10 | 2.00 | 83 | | |
| #20 | 0.84 | 71 | | |
| #40 | 0.42 | 48 | | |
| #60 | 0.25 | 27 | | |
| #100 | 0.15 | 12 | | |
| #200 | 0.074 | 7 | | |

**Coefficients**

$D_{85}$ =2.4268 mm    $D_{30}$ =0.2707 mm
$D_{60}$ =0.6058 mm    $D_{15}$ =0.1657 mm
$D_{50}$ =0.4464 mm    $D_{10}$ =0.1157 mm
$C_u$ =5.236    $C_c$ =1.045

**Classification**

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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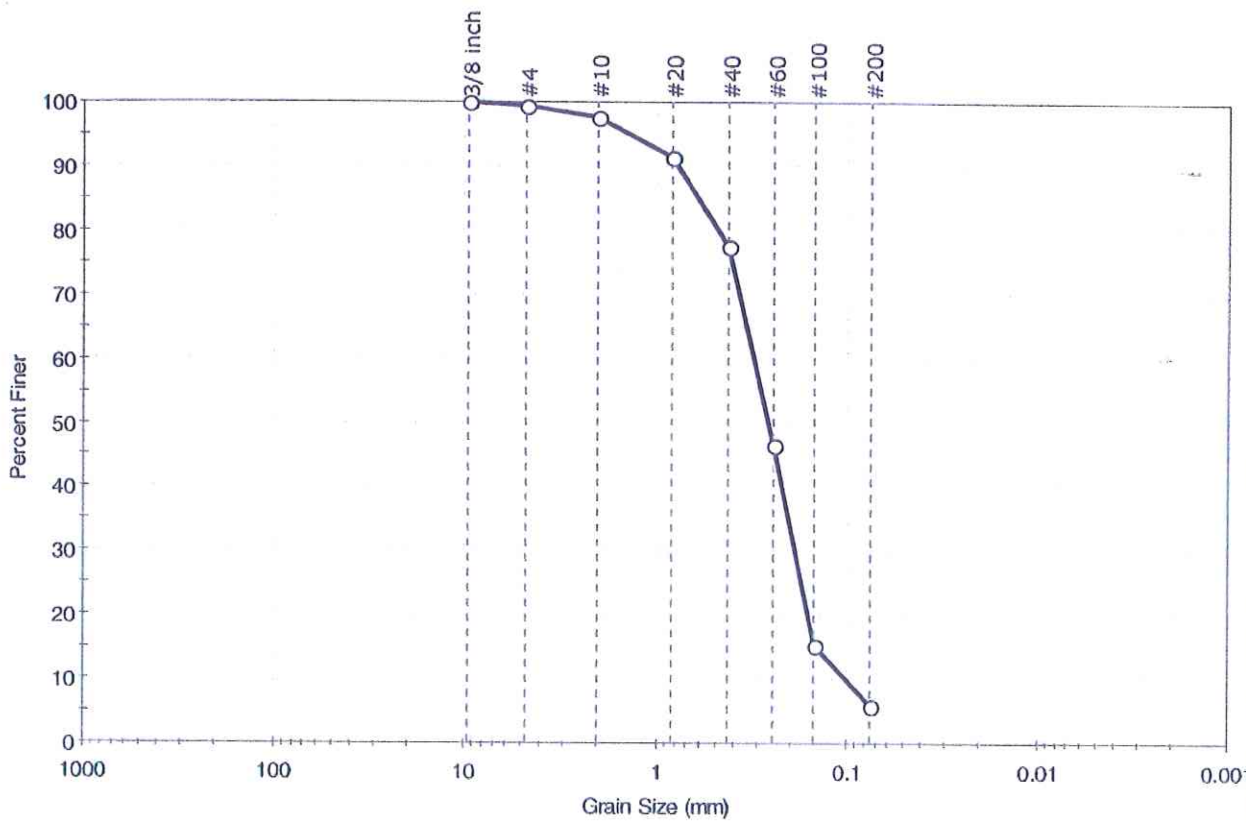
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-102 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-5 | Test Date: | 08/02/06 | Checked By: | jdt |
| Depth : | 20-22 ft | Test Id: | 94486 | | |
| Test Comment: | sieve stack 6 | | | | |
| Sample Description: | Moist, light brown sand with silt | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 0.8 | 93.2 | 6.0 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 inch | 9.51 | 100 | | |
| #4 | 4.75 | 99 | | |
| #10 | 2.00 | 98 | | |
| #20 | 0.84 | 92 | | |
| #40 | 0.42 | 78 | | |
| #60 | 0.25 | 47 | | |
| #100 | 0.15 | 15 | | |
| #200 | 0.075 | 6 | | |

**Coefficients**

$D_{85}$ =0.6113 mm | $D_{30}$ =0.1901 mm
$D_{60}$ =0.3148 mm | $D_{15}$ =0.1455 mm
$D_{50}$ =0.2653 mm | $D_{10}$ =0.1005 mm
$C_u$ =3.132 | $C_c$ =1.142

**Classification**

ASTM N/A

AASHTO Fine Sand (A-3 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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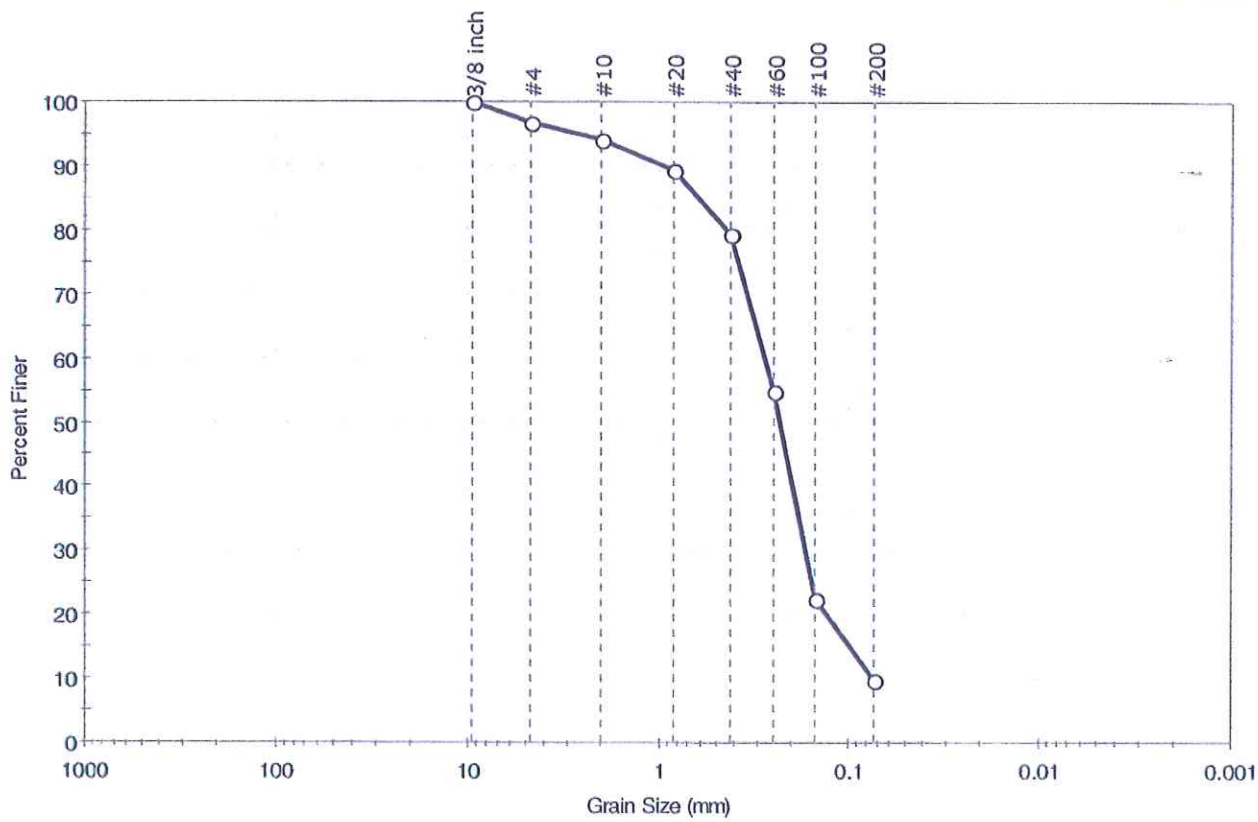
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-102 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-6 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 25-27 ft | Test Id: | 94487 | | |
| Test Comment: | sieve stack 1 | | | | |
| Sample Description: | Moist, light yellowish brown sand with silt | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 3.4 | 87.0 | 9.6 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 inch | 9.51 | 100 | | |
| #4 | 4.75 | 97 | | |
| #10 | 2.00 | 94 | | |
| #20 | 0.84 | 89 | | |
| #40 | 0.42 | 79 | | |
| #60 | 0.25 | 55 | | |
| #100 | 0.15 | 22 | | |
| #200 | 0.074 | 10 | | |

**Coefficients**

| | |
|---|---|
| $D_{85}$ =0.6207 mm | $D_{30}$ =0.1681 mm |
| $D_{60}$ =0.2791 mm | $D_{15}$ =0.0992 mm |
| $D_{50}$ =0.2315 mm | $D_{10}$ =0.0756 mm |
| $C_u$ =3.692 | $C_c$ =1.339 |

**Classification**

ASTM N/A

AASHTO Fine Sand (A-3 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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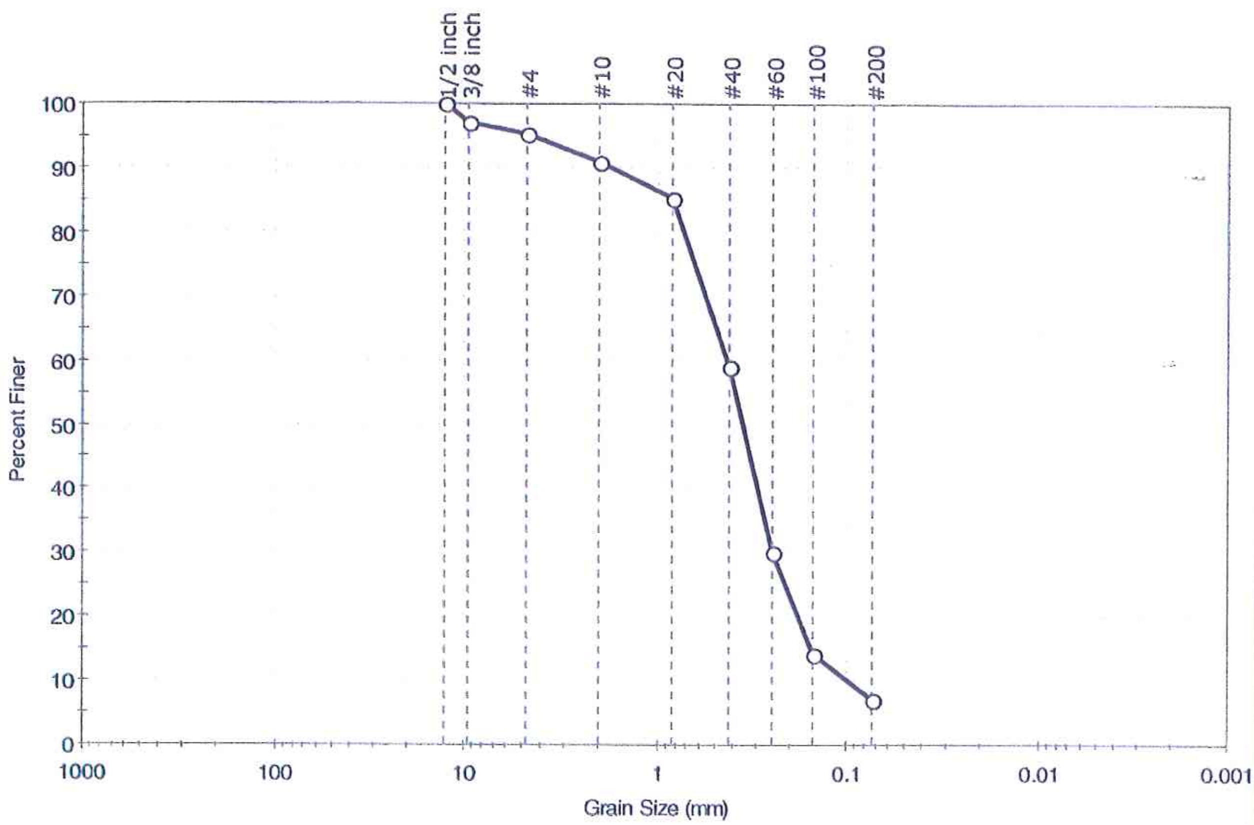
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-102 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-8 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 35-37 ft | Test Id: | 94488 | | |
| Test Comment: | sieve stack 1 | | | | |
| Sample Description: | Moist, pale brown sand with silt | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 4.7 | 88.2 | 7.1 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1/2 inch | 12.70 | 100 | | |
| 3/8 inch | 9.51 | 97 | | |
| #4 | 4.75 | 95 | | |
| #10 | 2.00 | 91 | | |
| #20 | 0.84 | 85 | | |
| #40 | 0.42 | 59 | | |
| #60 | 0.25 | 30 | | |
| #100 | 0.15 | 14 | | |
| #200 | 0.074 | 7 | | |

**Coefficients**

$D_{85}$ =0.8377 mm | $D_{30}$ =0.2499 mm

$D_{60}$ =0.4304 mm | $D_{15}$ =0.1533 mm

$D_{50}$ =0.3572 mm | $D_{10}$ =0.0988 mm

$C_u$ =4.356 | $C_c$ =1.469

**Classification**

ASTM N/A

AASHTO Fine Sand (A-3 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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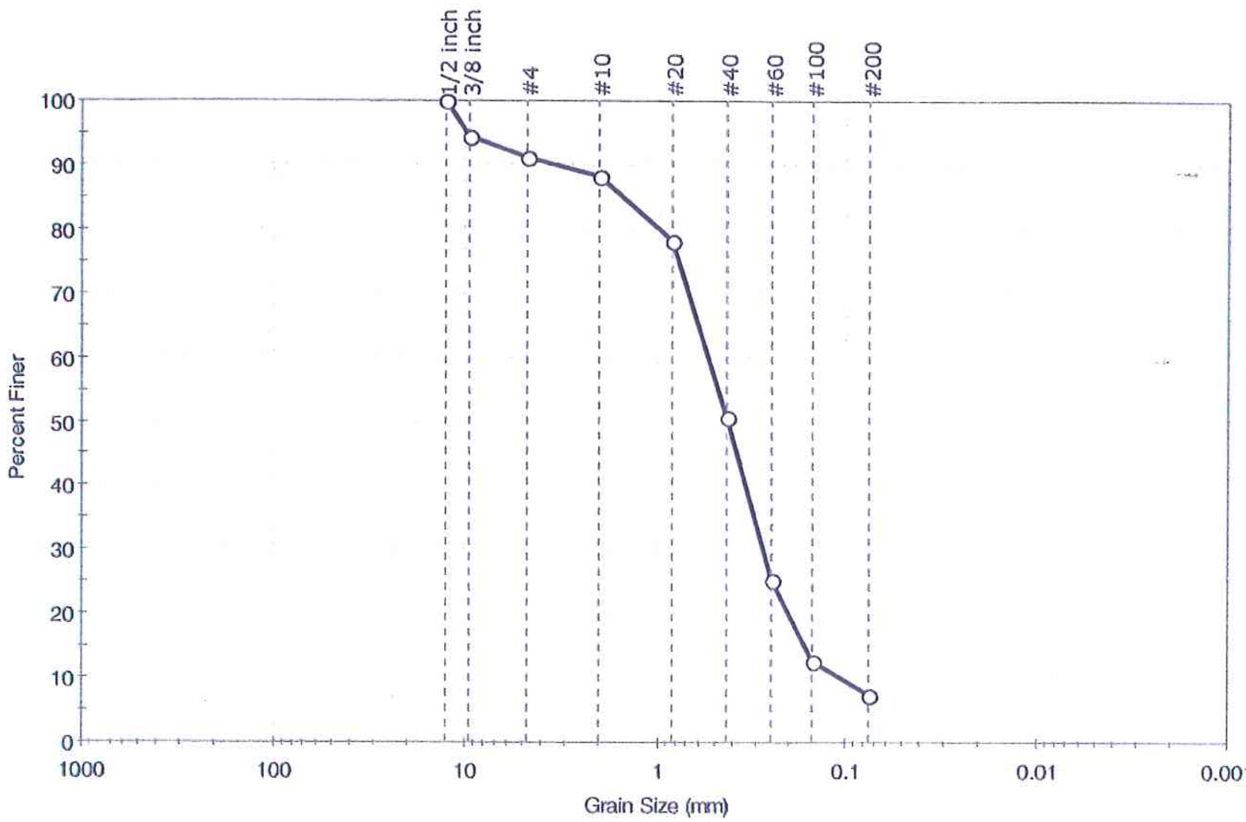
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-102 | Sample Type: | jar | Tested By: | pcs |
| Sample ID: | S-10 | Test Date: | 08/04/06 | Checked By: | jdt |
| Depth : | 45-47 ft | Test Id: | 94489 | | |
| Test Comment: | sieve stack 6 | | | | |
| Sample Description: | Moist, light olive brown sand with silt | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 9.0 | 83.5 | 7.5 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1/2 inch | 12.70 | 100 | | |
| 3/8 inch | 9.51 | 94 | | |
| #4 | 4.75 | 91 | | |
| #10 | 2.00 | 88 | | |
| #20 | 0.84 | 78 | | |
| #40 | 0.42 | 51 | | |
| #60 | 0.25 | 25 | | |
| #100 | 0.15 | 13 | | |
| #200 | 0.075 | 7 | | |

**Coefficients**

| | |
|---|---|
| $D_{85}$ = 1.5029 mm | $D_{30}$ = 0.2758 mm |
| $D_{60}$ = 0.5361 mm | $D_{15}$ = 0.1639 mm |
| $D_{50}$ = 0.4196 mm | $D_{10}$ = 0.1047 mm |
| $C_u$ = 5.120 | $C_c$ = 1.355 |

**Classification**

ASTM N/A

AASHTO Fine Sand (A-3 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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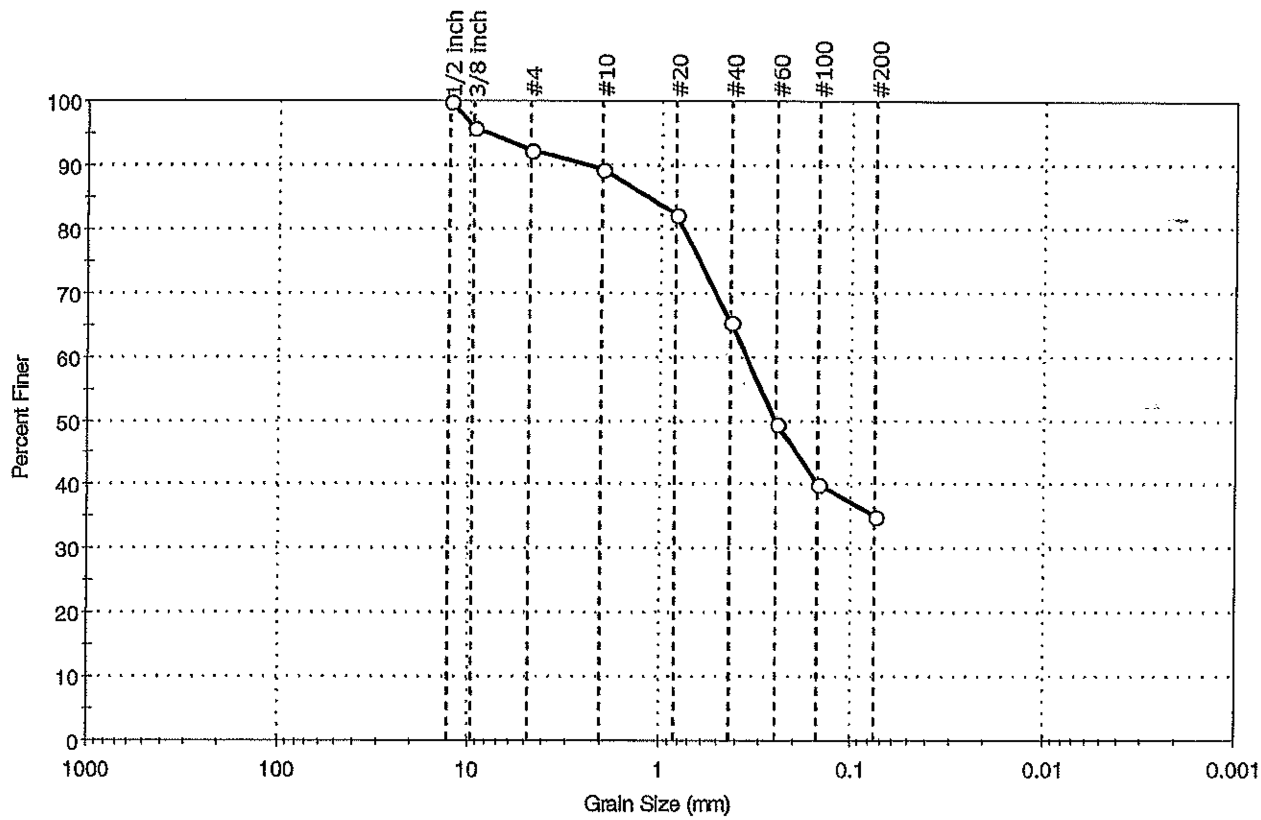
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-202 | Sample Type: | bag | Tested By: | mll |
| Sample ID: | S-1 | Test Date: | 05/14/07 | Checked By: | jdt |
| Depth : | 1-3 ft | Test Id: | 111381 | | |
| Test Comment: | --- | | | | |
| Sample Description: | Moist, light olive brown clayey sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422-63 (reapproved 2002)




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 7.7 | 57.2 | 35.1 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1/2 inch | 12.70 | 100 | | |
| 3/8 inch | 9.51 | 96 | | |
| #4 | 4.75 | 92 | | |
| #10 | 2.00 | 89 | | |
| #20 | 0.84 | 82 | | |
| #40 | 0.42 | 65 | | |
| #60 | 0.25 | 49 | | |
| #100 | 0.15 | 40 | | |
| #200 | 0.075 | 35 | | |

**Coefficients**

$D_{85}$ =1.1764 mm  $D_{30}$ =N/A

$D_{60}$ =0.3555 mm  $D_{15}$ =N/A

$D_{50}$ =0.2544 mm  $D_{10}$ =N/A

$C_u$ =N/A  $C_c$ =N/A

**Classification**

ASTM N/A

AASHTO Silty Soils (A-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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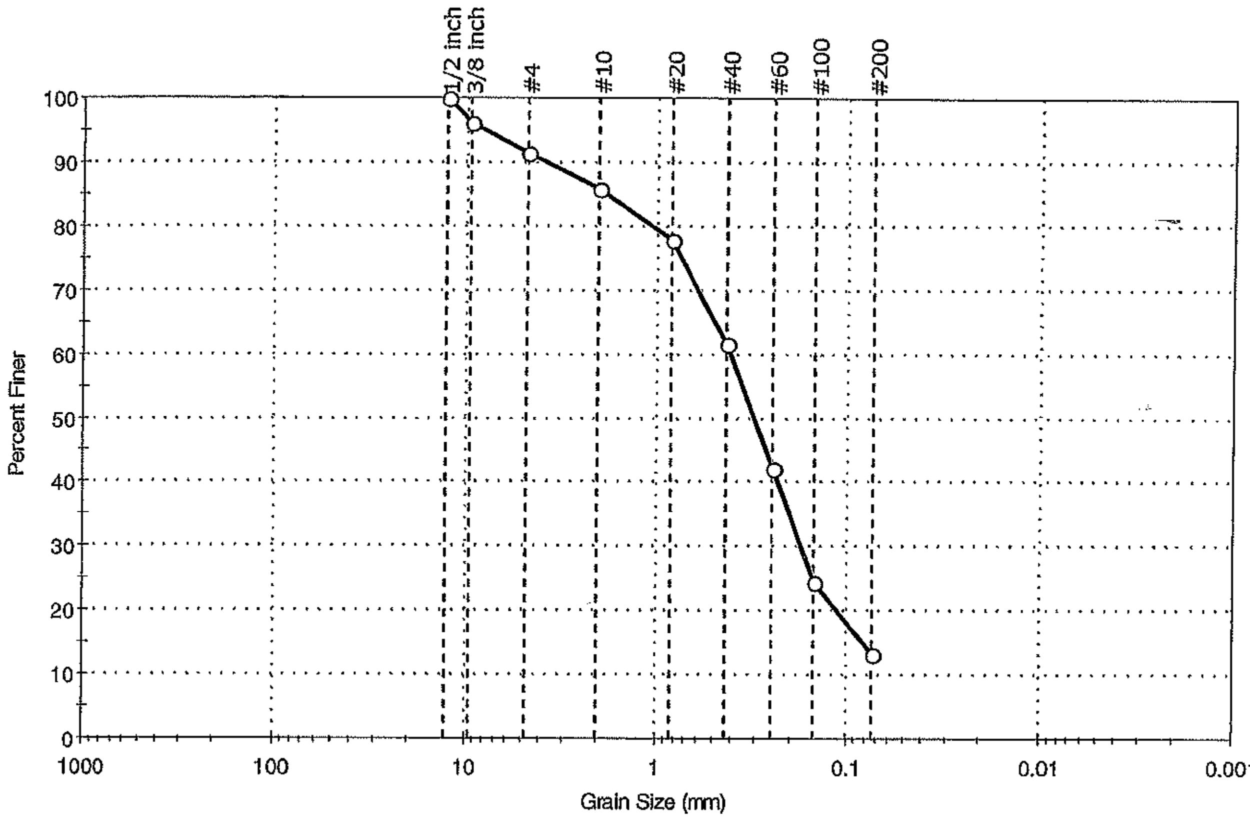
| | | | |
|---|---|---|---|
| Client: GEI Consultants | | | |
| Project: Brookhaven National Laboratory | | | |
| Location: Upton, NY | | Project No: | GTX-6864 |
| Boring ID: B-203 | Sample Type: bag | Tested By: | mll |
| Sample ID:S-3 | Test Date: 05/14/07 | Checked By: | jdt |
| Depth : 4-6 ft | Test Id: 111382 | | |
| Test Comment: --- | | | |
| Sample Description: Moist, light yellowish brown silty sand | | | |
| Sample Comment: --- | | | |

# Particle Size Analysis - ASTM D 422-63 (reapproved 2002)




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 8.6 | 78.1 | 13.3 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1/2 inch | 12.70 | 100 | | |
| 3/8 inch | 9.51 | 96 | | |
| #4 | 4.75 | 91 | | |
| #10 | 2.00 | 86 | | |
| #20 | 0.84 | 78 | | |
| #40 | 0.42 | 62 | | |
| #60 | 0.25 | 42 | | |
| #100 | 0.15 | 25 | | |
| #200 | 0.074 | 13 | | |

**Coefficients**

$D_{85}$ =1.8062 mm $D_{30}$ =0.1753 mm
$D_{60}$ =0.4064 mm $D_{15}$ =0.0822 mm
$D_{50}$ =0.3087 mm $D_{10}$ =0.0601 mm
$C_u$ =N/A $C_c$ =N/A

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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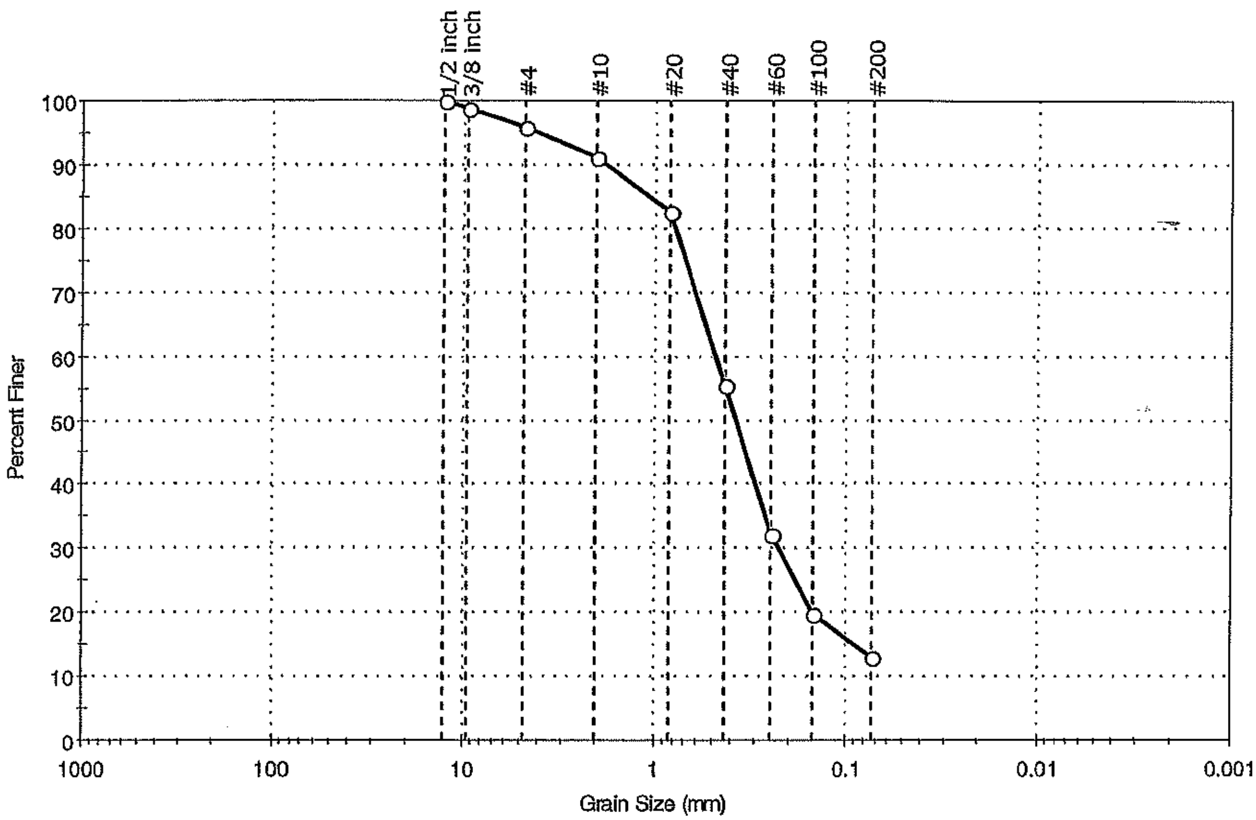
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-204 | Sample Type: | bag | Tested By: | mll |
| Sample ID: | S-1 | Test Date: | 05/14/07 | Checked By: | jdt |
| Depth : | 0-2 ft | Test Id: | 111383 | | |
| Test Comment: | --- | | | | |
| Sample Description: | Moist, olive brown silty sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422-63 (reapproved 2002)




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 4.1 | 82.9 | 13.0 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1/2 inch | 12.70 | 100 | | |
| 3/8 inch | 9.51 | 99 | | |
| #4 | 4.75 | 96 | | |
| #10 | 2.00 | 91 | | |
| #20 | 0.84 | 83 | | |
| #40 | 0.42 | 55 | | |
| #60 | 0.25 | 32 | | |
| #100 | 0.15 | 20 | | |
| #200 | 0.074 | 13 | | |

**Coefficients**

$D_{85}$ =1.0741 mm
$D_{30}$ =0.2279 mm
$D_{60}$ =0.4772 mm
$D_{15}$ =0.0912 mm
$D_{50}$ =0.3755 mm
$D_{10}$ =0.0544 mm
$C_u$ =N/A
$C_c$ =N/A

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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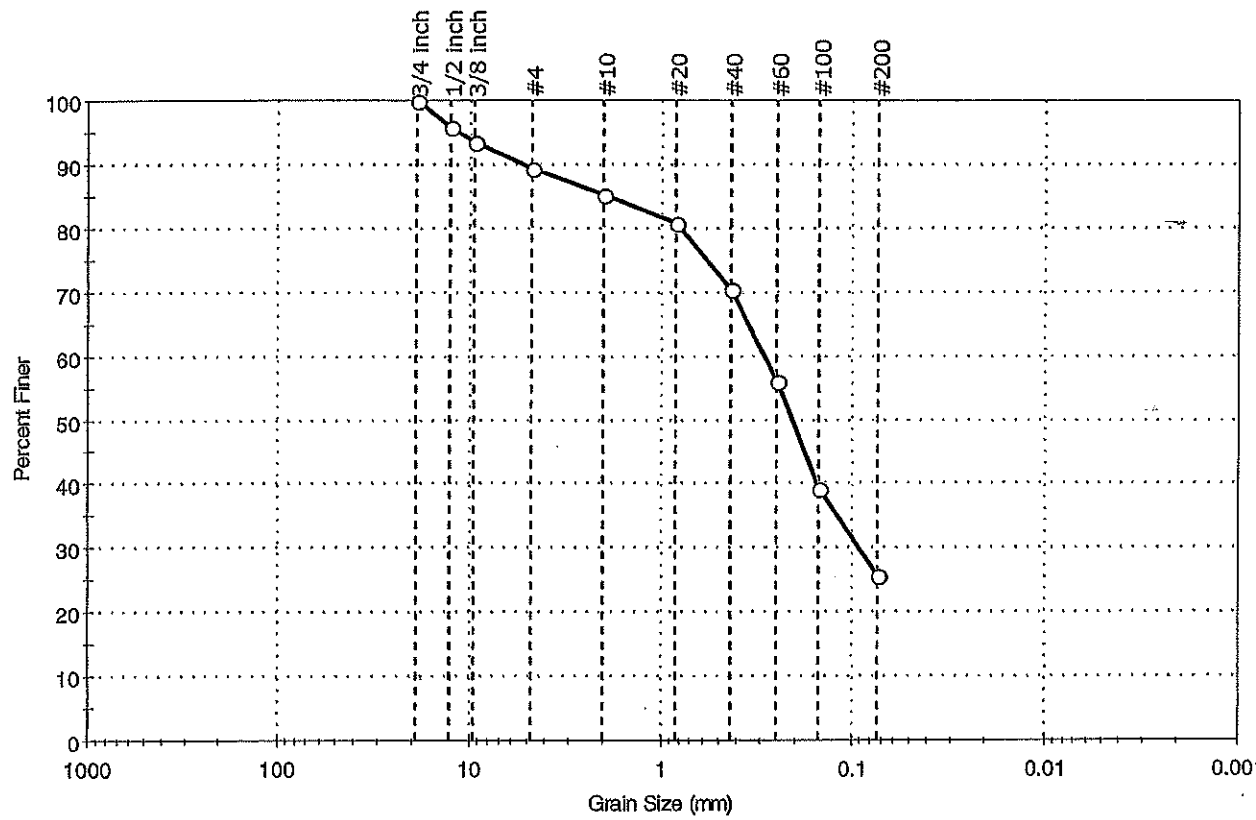
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-206 | Sample Type: | bag | Tested By: | mll |
| Sample ID: | S-4 | Test Date: | 05/15/07 | Checked By: | jdt |
| Depth : | 6-8 ft | Test Id: | 111385 | | |

Test Comment: ---
Sample Description: Moist, reddish brown silty sand
Sample Comment: ---

# Particle Size Analysis - ASTM D 422-63 (reapproved 2002)




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 10.6 | 63.8 | 25.6 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/4 inch | 19.00 | 100 | | |
| 1/2 inch | 12.70 | 96 | | |
| 3/8 inch | 9.51 | 93 | | |
| #4 | 4.75 | 89 | | |
| #10 | 2.00 | 85 | | |
| #20 | 0.84 | 81 | | |
| #40 | 0.42 | 70 | | |
| #60 | 0.25 | 56 | | |
| #100 | 0.15 | 39 | | |
| #200 | 0.074 | 26 | | |

**Coefficients**

$D_{85}$ =1.8829 mm $D_{30}$ =0.0928 mm
$D_{60}$ =0.2898 mm $D_{15}$ =N/A
$D_{50}$ =0.2083 mm $D_{10}$ =N/A
$C_u$ =N/A $C_c$ =N/A

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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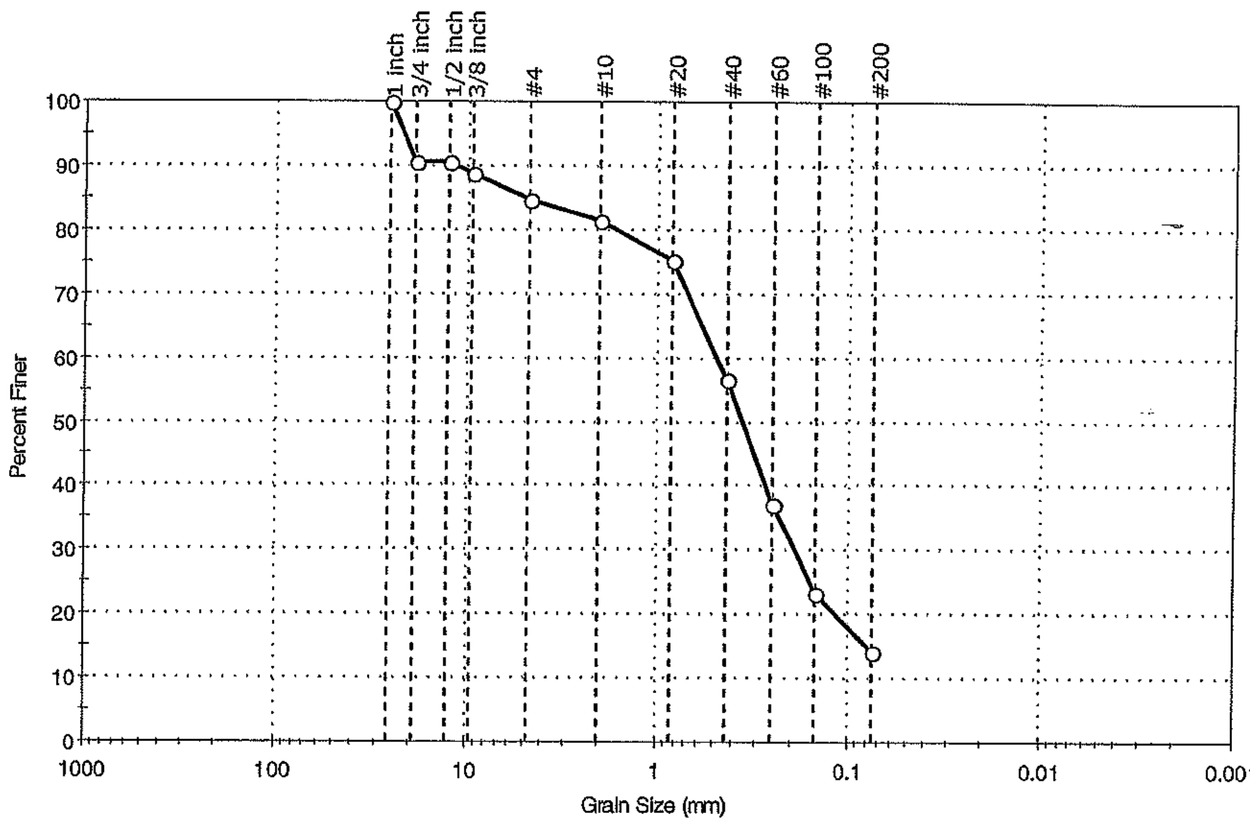
| | | | | | |
|---|---|---|---|---|---|
| Client: | GEI Consultants | | | | |
| Project: | Brookhaven National Laboratory | | | | |
| Location: | Upton, NY | | | Project No: | GTX-6864 |
| Boring ID: | B-204 | Sample Type: | bag | Tested By: | mll |
| Sample ID: | S-5 | Test Date: | 05/14/07 | Checked By: | jdt |
| Depth : | 8-10 ft | Test Id: | 111384 | | |
| Test Comment: | --- | | | | |
| Sample Description: | Moist, light olive brown silty sand with gravel | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D 422-63 (reapproved 2002)




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 15.4 | 70.5 | 14.1 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1 inch | 25.70 | 100 | | |
| 3/4 inch | 19.00 | 91 | | |
| 1/2 inch | 12.70 | 91 | | |
| 3/8 inch | 9.51 | 89 | | |
| #4 | 4.75 | 85 | | |
| #10 | 2.00 | 81 | | |
| #20 | 0.84 | 75 | | |
| #40 | 0.42 | 57 | | |
| #60 | 0.25 | 37 | | |
| #100 | 0.15 | 23 | | |
| #200 | 0.075 | 14 | | |

**Coefficients**

$D_{85}$ =5.0799 mm | $D_{30}$ =0.1913 mm
$D_{60}$ =0.4813 mm | $D_{15}$ =0.0804 mm
$D_{50}$ =0.3543 mm | $D_{10}$ =0.0552 mm
$C_u$ =N/A | $C_c$ =N/A

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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**Appendix A2**

Preliminary Vibration and Acoustic Report
September 15, 2006

Colin Gordon & Associates, Inc.

## NSLS II Vibration and Acoustic Criteria

*Vibration – Experiment Hall*

The vibration limits of the experiment hall are those associated with the user-supplied research instruments, which are not well defined at this time. It may only be possible to represent the vibration requirements of this space using generic vibration criteria. The vibration needs of the vast majority of research equipment available today would be satisfied by a floor meeting vibration criterion VC-E or NIST-A.[1] At frequencies less than 20 Hz, the NIST-A criterion is more stringent than VC-E.

*Vibration – Storage Ring*

The vibration requirements for the storage ring have been provided in a much different manner. The RMS amplitude[2], *R*, is to be less than 20 to 30 nm, where *R* is defined as

$$R = \sqrt{\sum_{f=50}^{f=4} \Delta(f) \times \delta f}$$

where $\Delta(f)$ is the displacement power spectral density spectrum (in units such as $m^2$/Hz, where the frequency term in the denominator is the measurement bandwidth) and $\delta f$ is the frequency resolution of the spectrum. The lower and upper bounds of the summation are 4 and 50 Hz, respectively. Frequency components outside this range may be neglected. The vibrations associated with fluid flow should meet the condition $R < 20$.

*Acoustic Noise*

The facility will have two primary groups of noise sources: (1) the facility's mechanical systems, such as air handlers, and (2) the user-provided research equipment. The noise control associated with the first group is within the purview of the NSLS II design team, but the ability to mitigate noise associated with the second group is somewhat limited. It can be anticipated via passive room noise control measures incorporated into the design, but it cannot be controlled via mechanical constraints such as airflow velocities, fan selection, or silencers, concepts typically employed for the first group.

Studies carried out during the design of the Advanced Photon Source determined that final operational room noise in the Experiment Hall would be a mix of sound from both groups of sources, and that NC-60 to NC-65 would be achievable from a combination of

---

[1] Vibration criteria VC-E and NIST-A are defined in **H. Amick**, M. Gendreau, T. Busch, and C. Gordon, "Evolving criteria for research facilities: vibration," *Proceedings of SPIE Conference 5933: Buildings for Nanoscale Research and Beyond*, San Diego, CA. Criterion VC-E has a one-third octave band rms velocity amplitude of 125 microinches/sec at frequencies between 1 and 100 Hz. Criterion NIST-A has a one-third octave band rms displacement amplitude of 1 microinch at frequencies between 1 and 20 Hz and a one-third octave band rms velocity amplitude of 125 microinches/sec at frequencies between 20 and 100 Hz.

[2] Simply stated, *R* is the area under the displacement PSD spectrum ($m^2$/Hz) between a lower and upper bound frequency.

mechanical system noise control measures on the proposed air handling system and room absorption made part of walls and ceiling.[3] This is the noise range found in many industrial cleanrooms. In the absence of absorptive material, the noise at APS was predicted to be on the order of NC-70. In order to achieve this, the recommended noise goal of the mechanical systems alone is NC-50 to NC-55.

[3] The results of the study were reported in "Acoustical Evaluation of Experiment Hall: Argonne National Laboratory", A. M. Yazdanniyaz & S. K. Bui, Acentech Report No. 56, January 1991. The noise from the experimental equipment was included in the model via sound power estimates based on measurements made at NSLS in 1989 by Acentech Incorporated as part of the APS design effort, reported in "Measurement of Noise and Vibration: National Synchrotron Light Source, Brookhaven National Laboratory", Hal Amick & Colin G. Gordon, Acentech Report No. 11, June 1989.

**Site Vibration Study**

Figure 1 shows an aerial photograph of the portion of the BNL complex containing the NSLS II site. Nearby are the site of the Center for Functional Nanomaterials (CFN), now under construction, and the existing NSLS. Vibrations were measured at all of these locations, as well as at Location 'A' and at a remote location to the north east of the indicated portion of the BNL campus.

Figure 2 shows a plan view of the proposed NSLS II, indicating Locations 1-6 at which ambient vibration measurements were made on the afternoon of 14 June 2006.[1] Vibrations were measured at each of these locations in each of three principal directions (vertical, north-south, and east-west). Each measurement lasted approximately two minutes, and produced an energy-averaged constant-bandwidth (FFT) rms velocity spectrum with 400 data points, 0-100 Hz frequency range, Hanning windowing, and 90% overlapping. The sensor, a seismic accelerometer, was supported on a 12" steel stake with a flat top, driven into the ground such that the flat top was flush with the ground.

The data were analyzed "live" and saved as spectra to the internal memory of the portable analyzer. The spectra were downloaded to a laptop computer and subsequently post-processed to obtain one-third octave band velocity spectra and 400-line displacement power spectral density (PSD) spectra. The PSD spectra, in turn, were processed to calculate RMS displacement amplitudes using numerical summing between a lower-frequency cutoff (CO) and 50 Hz. Nominally, the lower cutoff was 4 Hz for consistency with the particle ring criterion.

As noted previously, the nominal lower cutoff was 4 Hz for consistency with the particle ring criterion. However, in some cases the spectra below 6-7 Hz was contaminated by instrumentation noise floor. As a result, all of the RMS amplitudes are reported with low-frequency cutoff of 4, 6 and 8 Hz.

Figure 2(a) and (b) show a statistical representation of the vertical and horizontal vibrations, respectively, at the NSLS II site, in terms of one-third octave band rms velocity. These measurements were made during the mid-afternoon. Shown for reference are the VC-E and NIST-A criteria.

It should be noted in Figure 2 that the vibrations easily meet VC-E, but do not meet the NIST-A requirement. A similar observation was made at the time of the CFN vibration survey, and an additional study (using measurements at Location 'A') demonstrated that the low-frequency component which exceeds NIST-A disappears at night, and is thought to be due to traffic, probably on the Long Island Expressway.

The daytime and nighttime measurements at Location 'A' are represented in Figure 4 by open and closed triangles, respectively. At frequencies of 20 Hz and greater, the

[1] At the suggestion of BNL personnel, vibrations were not measured in the wooded areas, in order to avoid ticks.

difference is visible though not as significant as that observed at frequencies near 4 Hz. The log mean of the vertical vibrations at the NSLS II site, represented in Figure 4 using diamond symbols, lies between the two Location 'A' spectra at frequencies of 10 Hz and less.

The data from the NSLS II measurement locations, as well as from Location 'A', were taken with the sensor supported on a steel stake. It is known that a "free-field" measurement made in this manner produces a spectrum with a higher amplitude at most frequencies than one made on a slab of significant size or inside a building.[2] Discussions of this effect in the context of the NSLS II measurements suggested the desirability of carrying out vibrations inside a building with a similar thick slab, at night when the vibrations were at their least. The vertical spectrum obtained in this manner in the partially-completed microscopy suite in CFN is shown with circle symbols, and is thought to be representative of the performance of the eventual nighttime performance of the Experiment Hall slab in NSLS II.

The constant-bandwidth FFT velocity spectra saved to the portable analyzer and downloaded to a spreadsheet on a laptop were transformed to rms displacement spectra by dividing each point in a spectrum by 2π times the frequency of that point. The rms displacement spectra were then transformed to displacement PSD spectra by squaring the amplitude and dividing each squared amplitude by the measurement bandwidth (0.375 Hz). The statistical displacement PSD spectra are shown in Figure 5(a) and (b), for vertical and horizontal vibration, respectively. The log mean (the heavier red line) will be used for comparative purposes in a discussion that will follow.

As noted previously, the vibration criterion for the ring is defined in terms of *R*, the area beneath the PSD spectrum $\Delta(f)$ between cutoff frequencies $f_1$ and $f_2$, defined as 4 and 50 Hz, respectively. For the discrete spectra being used in this study, this may be defined as

$$R = \sqrt{\sum_{f_2=50}^{f_1=4} \Delta(f) \times \delta f}$$

where $\delta f$ is the frequency resolution of 0.25 Hz. However, it was observed during post-processing that some of the spectra were contaminated by system noise at low frequencies (found after the fact to be due to connection noise in a cable), so values of *R* were calculated using additional $f_1$ frequencies of 6 and 8 Hz. The *R* values are summarized for the NSLS II site in Table 1. When the lower cutoff frequency $f_1$ is set to 4 Hz, the RMS quantities do not meet the criterion of 30 nm specified by BNL, but when $f_1$ is increased to 6 Hz, the quantity is within the prescribed limits. As noted previously, the PSD content at frequencies below 6 or 7 Hz is thought to be due to system noise, not actual vibration.

---

[2] H. Amick, T. Xu, and M. Gendreau, "The Role of Buildings and Slabs-on-Grade in the Suppression of Low-Amplitude Ambient Ground Vibrations," *Proc. 11th Intl. Conf. on Soil Dyn. & Earthquake Engng. (11th ICSDEE) & the 3rd Intl. Conf. on Earthquake Geotech. Engng. (3rd ICEGE)*, 7-9 January, 2004, Berkeley, CA.

Supplemental measurements were carried out on 31 Aug 2006 and 1 Sept 2006. The results of those measurements, along with some taken at Location 'A' for the CFN site study, are summarized in Table 2. The most important data are likely those taken in the microscopy lab at CFN, where the RMS amplitudes at both measurement times are 20 nm or less, in any direction. (The amplitudes calculated using 6 Hz and 8 Hz cutoff frequencies are shown for interest, but the CFN space meets the most stringent interpretation of the NSLS II criterion. This demonstrates that the building effect impacts the RMS amplitude, as well as the one-third octave band spectrum (shown in Figure 4).

Vibrations were measured on the floor at Beam Line X1 in NSLS, around midnight, to provide a comparison with the vibrations measured in CFN. These results are also shown in Table 2, as Location 9. The difference between the two is quite dramatic, 71 nm for NSLS compared to 20 nm in CFN. (The same low-noise setup was used in both cases.)

BNL provided collected PSD spectra measured at several other light source facilities. The log mean PSD for the NSLS II site are shown superimposed on these data in Figure 6. The arrow indicates the NSLS II spectrum. It should be noted that the data from other facilities represent several different quantities of data points (the present data containing 200 points between 0 and 50 Hz) and quantity of averages. Either a smaller number of data points or a greater number of averages (or both) will produce a smoother spectrum. (For example, the vertical PSD spectrum from ESRF (shown in red) contains a very large number of data points, but most likely resulted from less than five spectra being averaged.) However, it is the fundamental nature of PSD spectra that spectral amplitude of stationary random vibration is roughly independent of bandwidth.

The data in Figure 6 initially suggest a rather unfavorable comparison between the NSLS II site and the other light sources. This was one of the reasons that nighttime data were subsequently measured in NSLS and CFN, such that the presence of a building could be taken into consideration, and at a remote location on the BNL property, so that proximity to the campus energy sources could be removed from consideration.

Data measured at the following locations were used for comparison:

- Microscopy suite of CFN, under construction
- Foundation of a light standard near CFN, prior to installation of the pole; this may be considered a "free-field" location, unstiffened by the presence of the building
- The floor of NSLS, directly beneath Beam Line X1 in the Experiment Hall
- A remote location near the northeast corner of BNL campus, on a hard surface at the center of a fire access road

Figure 7 shows the vertical Log Mean of site vibrations at NSLS II site (red curve marked by red arrow), expressed as PSD, compared with similar data from ALS, ESRF and SPRING-8 (using data provided by BNL). Shown also are PSD spectra measured at NSLS Beam Line X1 just after midnight, the "free-field" location near CFN, and the microscopy suite at CFN (identified by the black arrow). The vertical red dashed line indicates 4 Hz. The legend indicates the RMS amplitude using summation between 4 and 50 Hz, except for the NSLS II log mean, which is summed with a 6 Hz lower cutoff.

The vibrations near Beam Line X1 lie well above all the others, particularly at frequencies associated with rotating mechanical equipment, such as 18 Hz and 30 Hz. The data from the CFN microscopy suite lies below all the other BNL locations and ties with ALS for the -lowest RMS amplitude, at 20 nm.

Figure 8 compares the "best" BNL location—the CFN microscopy suite—with Location 'A' measured night using a stake and with the remote location simply measured on a road surface at noon. In this comparison, the remote location lies somewhat higher than the CFN spectrum at frequencies less than 8 Hz, but lies well below it at frequencies between 10 and 25 Hz. Recall from Figure 4 that there was a reduction factor of 3 to 5 times (in terms of amplitude) at frequencies below 8 Hz. In terms of power (i.e., PSD) this reduction factor becomes 9 to 25 times, which would suggest that the *surface* nighttime vibration at the remote location is less than that inside CFN, and would be lower yet inside a building at that location. Even though vibrations were not measured at night at the remote location, it is suggested that there is a cultural effect in the diurnal vibrations on the BNL campus, and that a remote site farther from the utility plant and the expressway might be worthy of consideration as design progresses.

The vibration study indicates that following the installation of the ring structure and experiment hall, which will significantly stiffen the site, the vibration environment will be comparable to that of other light source facilities. Additional modeling studies are recommended as the design progresses to examine the building and slab effect in greater detail, as much of the published experience deals with rectangular buildings, rather than toroidal. The dynamics are likely to differ to some extent.

Greater insight would be gained from carrying out a continuous vibration survey of 24 hours or more, in order to better document the diurnal variation of vibration at the site. This could be done at the ring site, using simultaneous multiple recording locations distributed around the ring. With data taken simultaneously, it may be possible to glean additional insight into the mechanism(s) and source(s) involved in the vibrations between 1 and 10 Hz.

The researchers may also benefit from a statistical representation of the temporal variation of vibration.[3]

---

[3] This is discussed at length in H. Amick, M. Gendreau, & N. Wongprasert, "Centile spectra, measurement times, and statistics of ground vibration," *Proceedings of the Second International Symposium on Environmental Vibrations: Prediction, Monitoring, Mitigation and Evaluation (ISEV2005)*, Okayama University, Okayama, Japan (20 to 22 September 2005)

**Table 1. Summary of RMS amplitudes at NSLS II site, mid-afternoon**

| Location | Position | | Vertical | | | North-South | | | East-West | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $f_1$: | 4 Hz | 6 Hz | 8 Hz | 4 Hz | 6 Hz | 8 Hz | 4 Hz | 6 Hz | 8 Hz |
| 1 | 8 o'clock | | 69 | 29 | 23 | 45 | 23 | 19 | 35 | 24 | 21 |
| 2 | 10 o'clock | | 52 | 29 | 24 | 37 | 25 | 22 | 42 | 28 | 25 |
| 3 | 11 o'clock | | 43 | 26 | 20 | 30 | 20 | 17 | 29 | 19 | 16 |
| 4 | 1 o'clock | | 44 | 30 | 26 | 34 | 25 | 21 | 33 | 25 | 21 |
| 5 | 2 o'clock | | 36 | 26 | 22 | 30 | 23 | 21 | 46 | 36 | 33 |
| 6 | 7 o'clock | | 30 | 21 | 18 | 26 | 16 | 12 | 26 | 13 | 10 |

**Table 2. Summary of RMS amplitudes at supplemental locations, various times**

| Location | Description | Time | | Vertical | | | North-South | | | East-West | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f_1$: | 4 Hz | 6 Hz | 8 Hz | 4 Hz | 6 Hz | 8 Hz | 4 Hz | 6 Hz | 8 Hz |
| 7 | Microscopy Lab in CFN | 730pm | | 20 | 15 | 14 | 12 | 8 | 7 | 19 | 9 | 7 |
| | | 1120pm | | 20 | 14 | 13 | 11 | 6 | 5 | 13 | 7 | 6 |
| 8 | Free-Field, Foundation of Light Standard at CFN | 1140pm | | 24 | 19 | 17 | 41 | 37 | 35 | 38 | 35 | 34 |
| 9 | Beam Line X1 at NSLS | Midnight | | 71 | 48 | 42 | 12 | 9 | 8 | 13 | 9 | 7 |
| 10 | Remote Site, on Wellhead | Noon | | 24 | 12 | 8 | 27 | 16 | 15 | 33 | 15 | 10 |
| 11 | Remote Site, on Road | Noon | | 21 | 9 | 6 | 25 | 14 | 12 | 26 | 12 | 9 |
| 12 | Location "A" | 315pm | | 80 | 53 | 46 | | | | | | |
| | | 1030pm | | 35 | 29 | 27 | | | | | | |

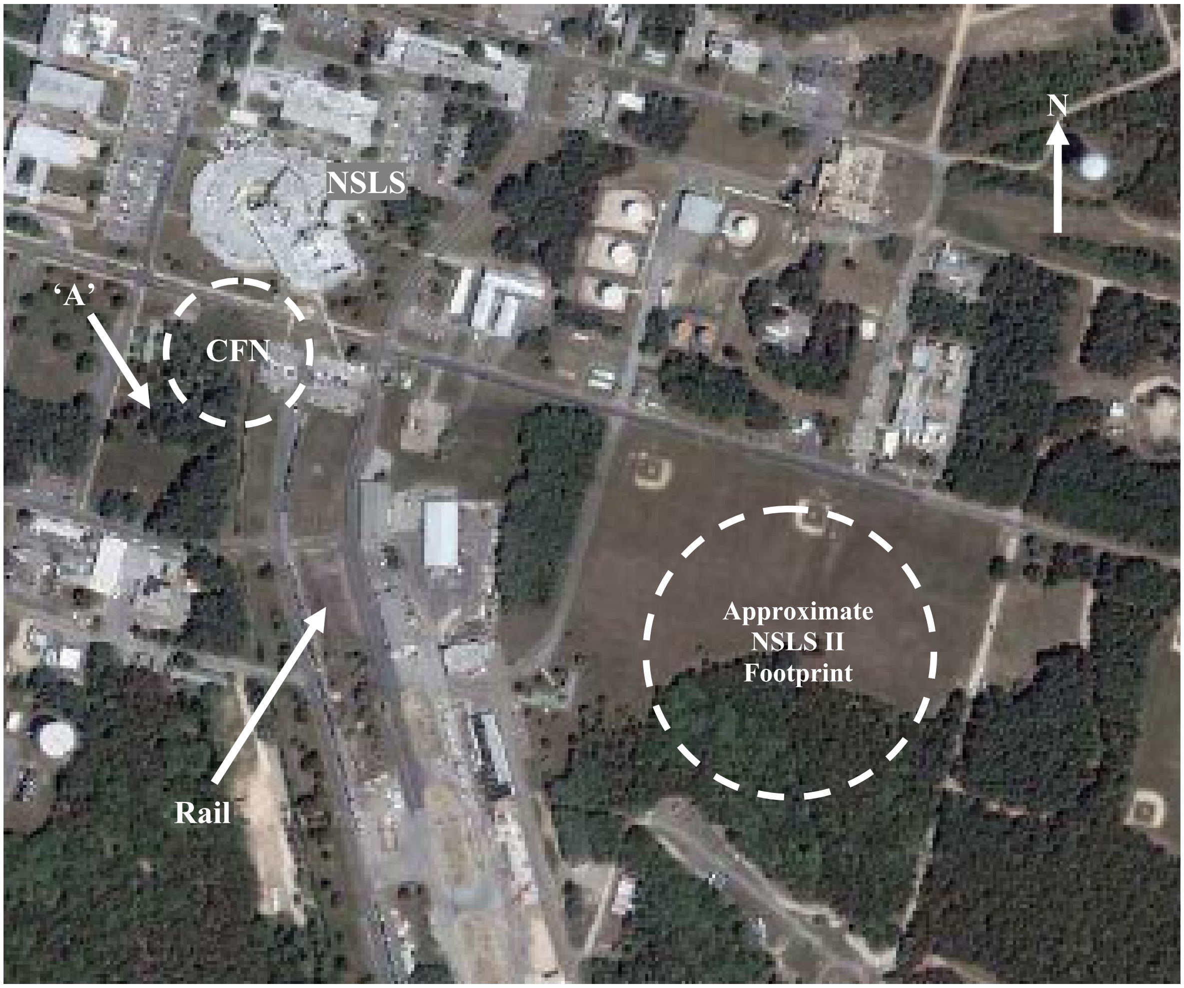


**Figure 1. Aerial photograph of a portion of BNL showing approximate location for NSLS II and other relevant locations**

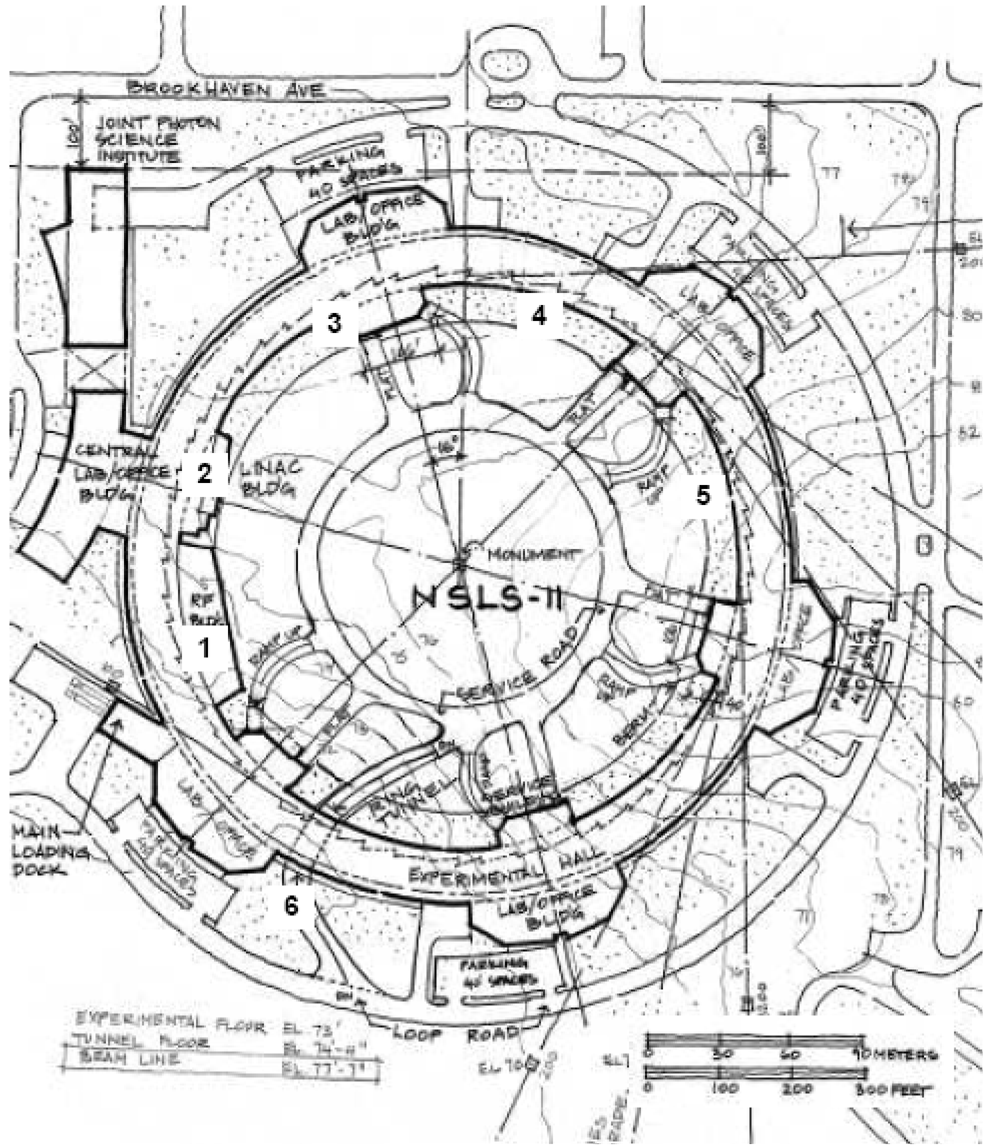


**Figure 2. Site plan showing approximate location of NSLS II and the measurement locations used in this study**

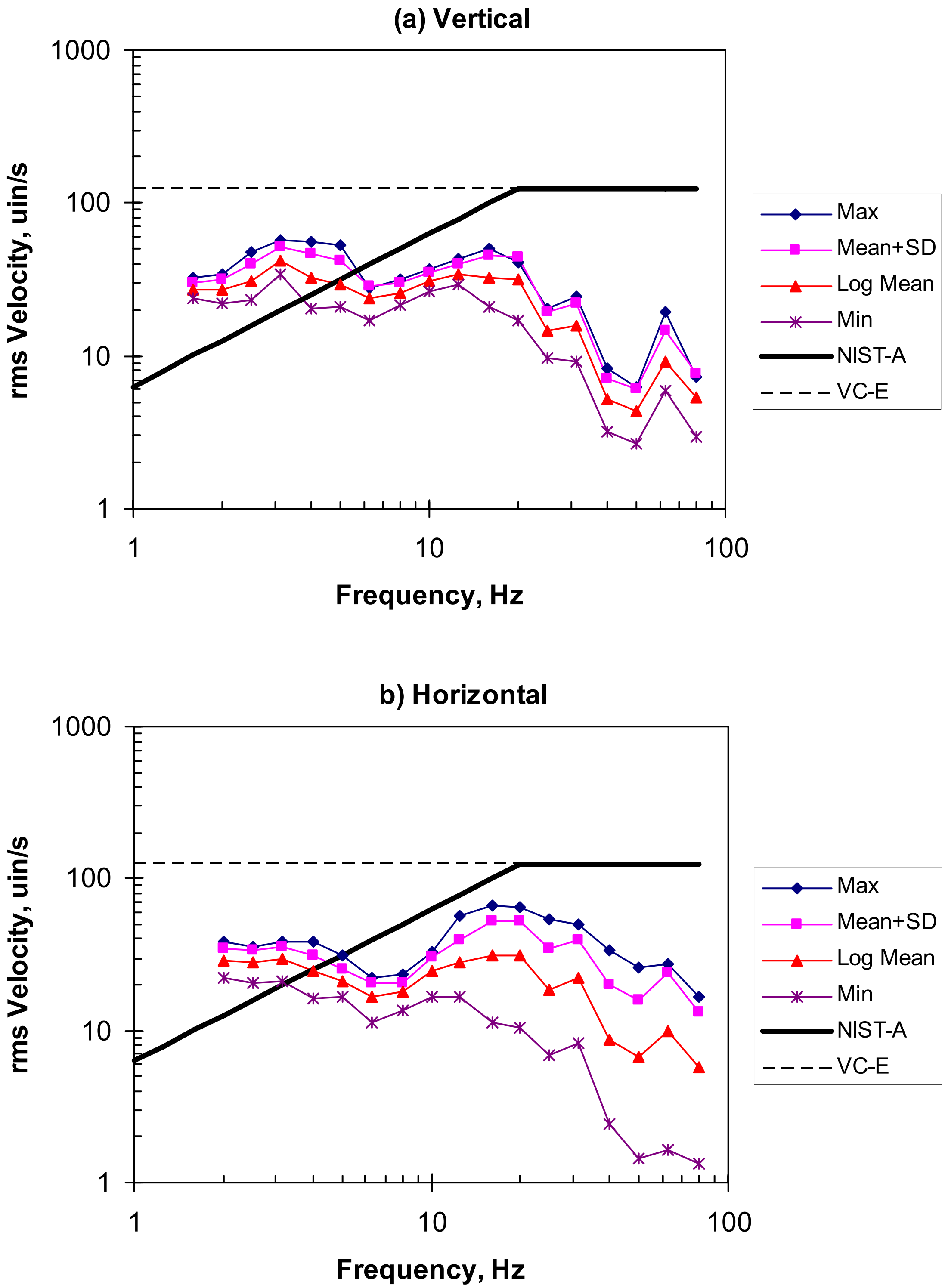


**Figure 3. Statistical representation of daytime ambient site vibrations at Locations 1-6, NSLS II site**

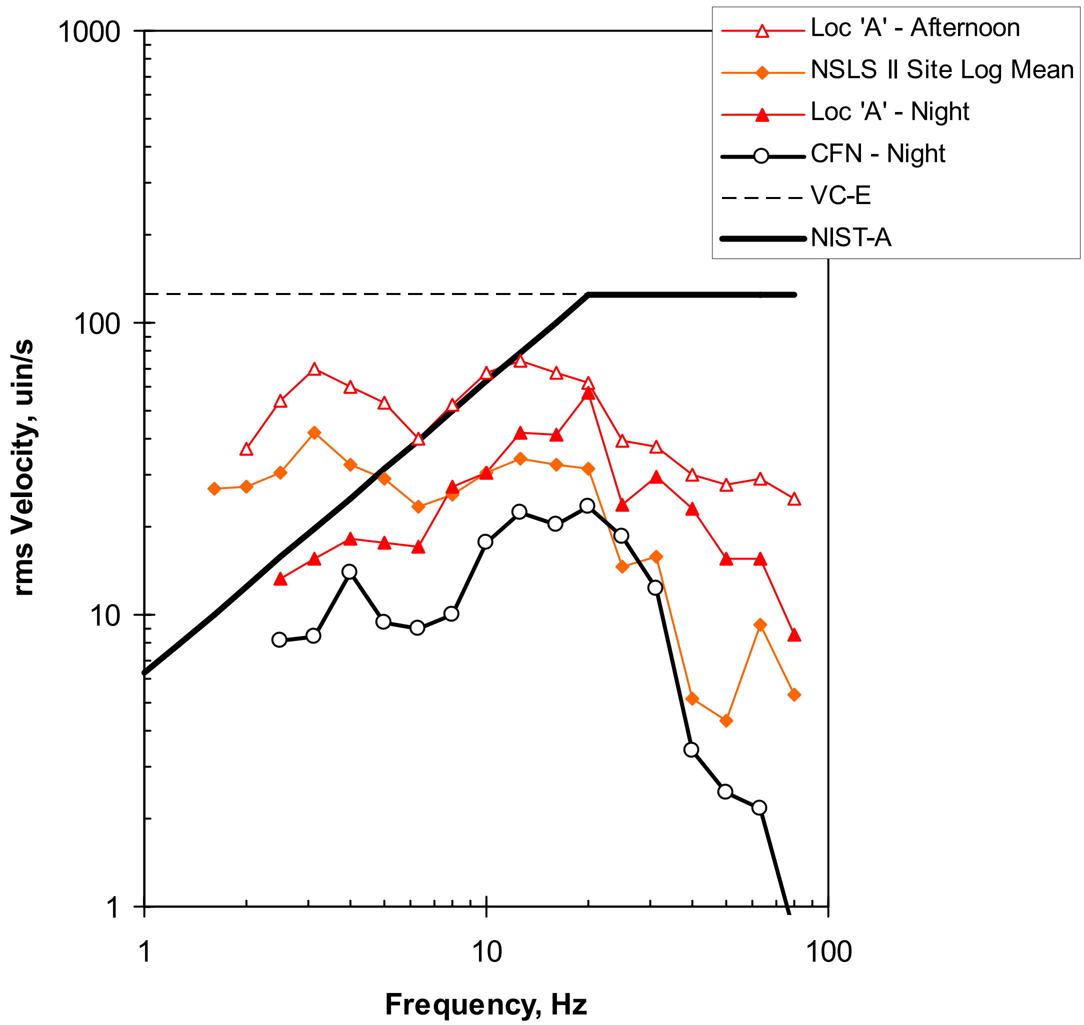


**Figure 4. Comparison of one-third octave band vibrations at the NSLS II site, Location 'A', and at night in the CFN microscopy suite.**

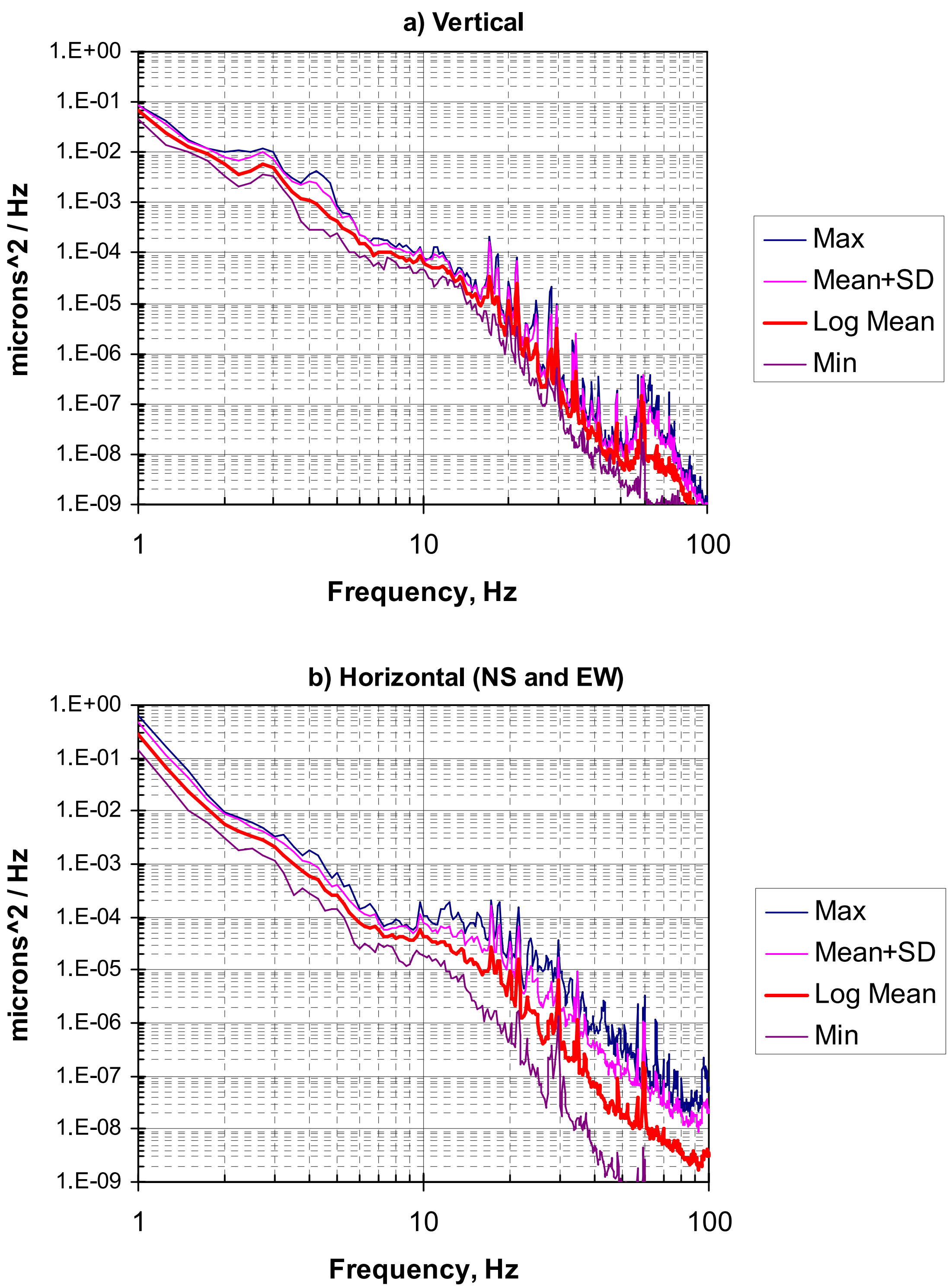


**Figure 5. Statistical representation of daytime ambient site vibrations at Locations 1-6, NSLS II site, in terms of displacement power spectral density (PSD), 1-100 Hz**

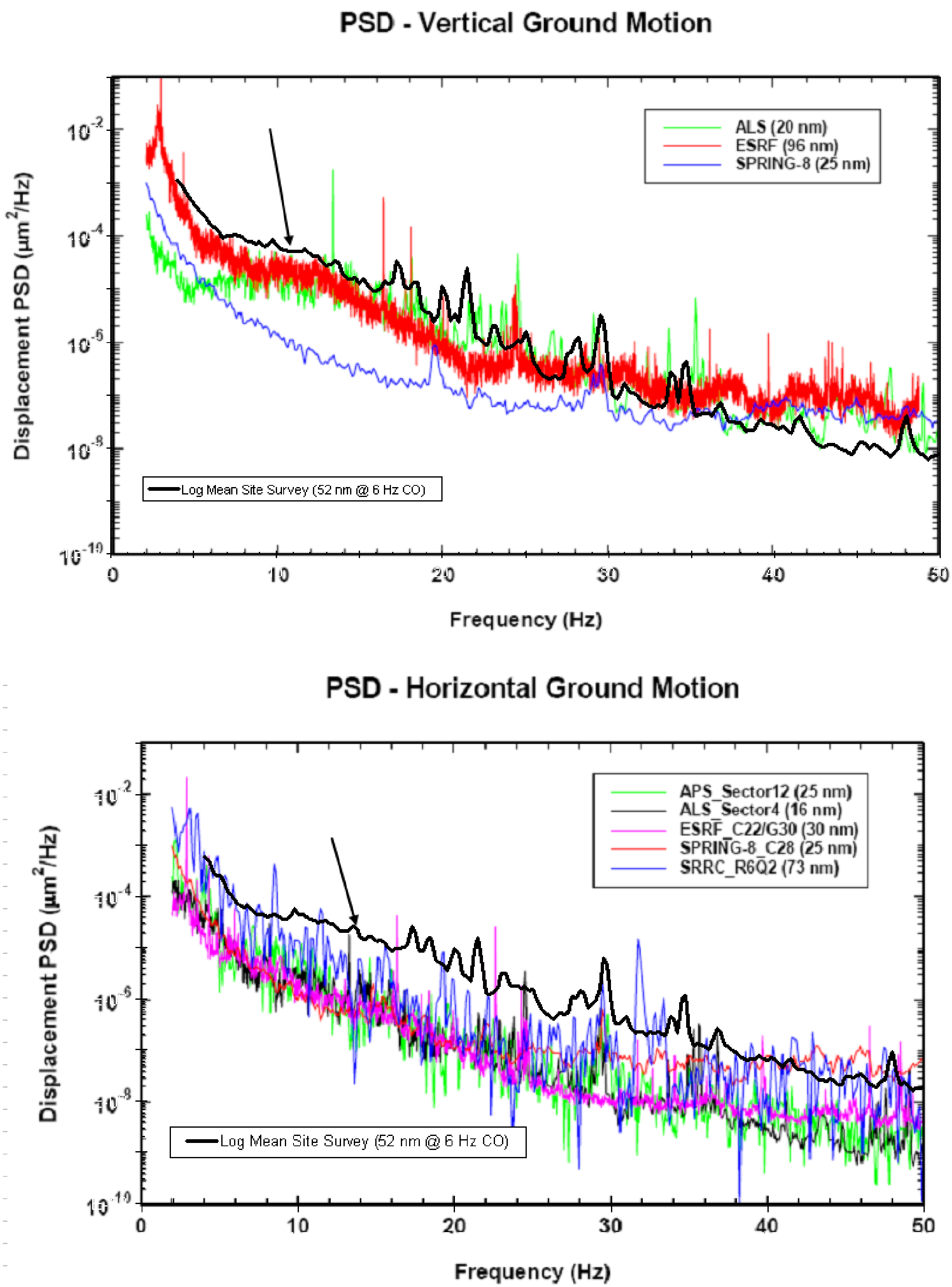


**Figure 6. Log Mean of site vibrations at NSLS II site, expressed as PSD, compared with other sites (data for other sites provided by BNL)**

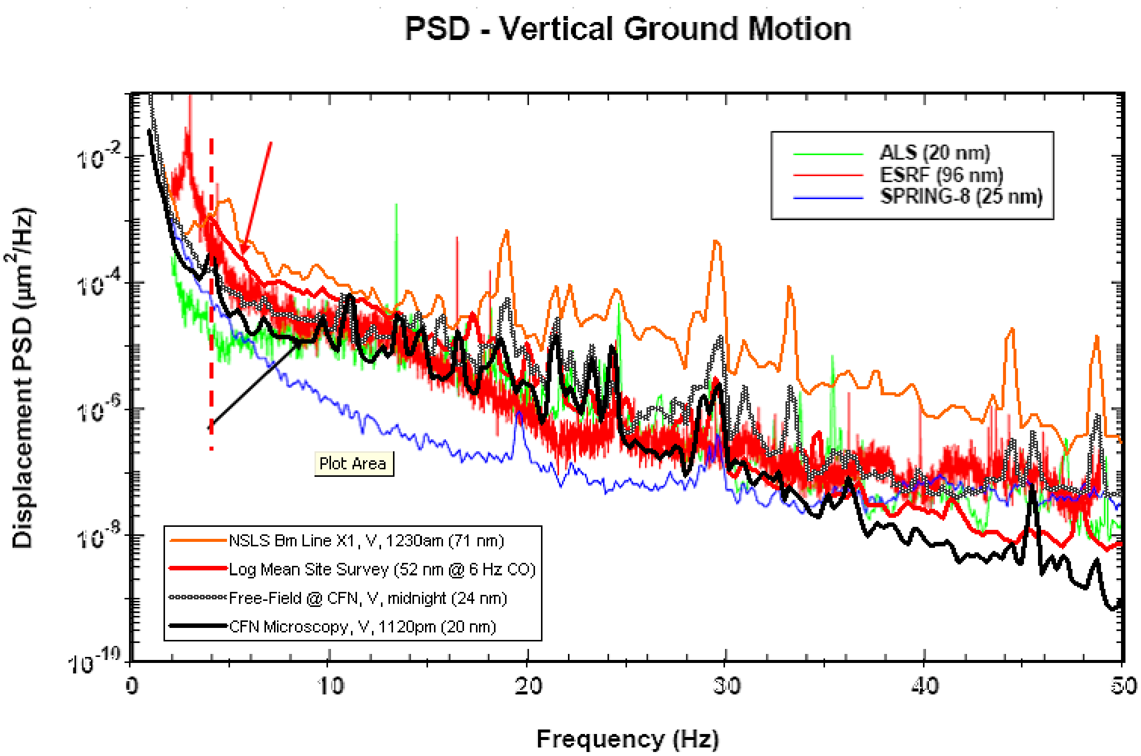


**Figure 7. Log Mean of site vibrations at NSLS II site, expressed as PSD, compared with other sites (data for other sites provided by BNL) and with NSLS Beam Line X1, Free-Field at CFN, and the microscopy suite at CFN.**

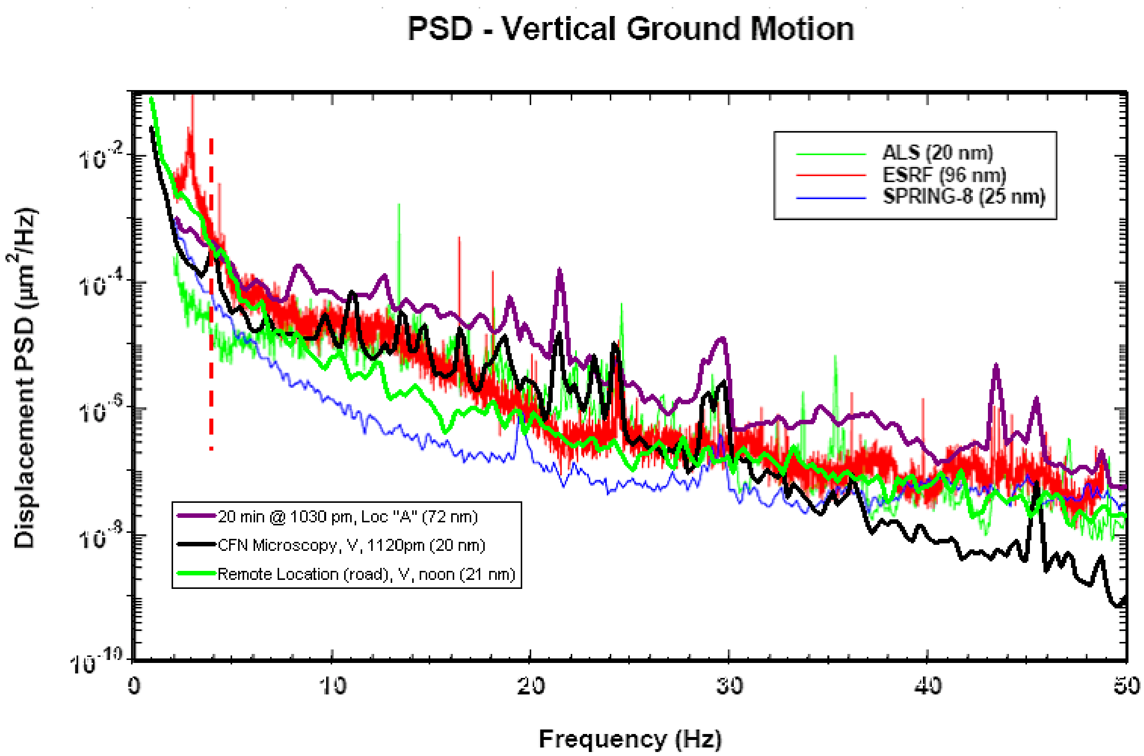


**Figure 8. Comparison of PSD vibrations at three alternate reference locations, including Location 'A' and CFN Microscopy, both at night, and the remote location at noon.**

**Vibration and Acoustic Design Issues**

*Utility Distribution*

Two utility concepts were examined during the course of this review. One was a distributed system along the lines of that used for APS, where the air handlers are placed at locations around the ring, perhaps along the outside of the experiment hall as at APS. The other concept was a centralized system, where the air handlers are placed at a central location and air distribution is via ducting. Each approach offers arguments pro and con, but examination of the issues specific to BNL philosophy and the proposed NSLS II layout led toward the centralized system.

From a vibration perspective, the difference between the two concepts lies in the amount of energy present in a concentrated area. (The distributed system works with a larger quantity of smaller air handlers, thus the maximum horsepower at any location near the ring is less, so there is a lower risk in placing the units closer to the ring.) However, a centralized system offers maintenance benefits, and the primary vibration control design issues become those of distance and conservative vibration isolation. It is important to maximize the distance between the air handlers themselves and the ring, though this will affect energy efficiency. A careful study of tradeoff between these two variables is recommended as design progresses.

A preference has been expressed to avoid vibration isolation on piping and ducting as much as possible. An important reason for this is that isolation works on the concept of exploiting a low resonance frequency of a sprung mass (the duct or pipe on a spring) and the random vibration energy in the duct or pipe is shifted to very low frequencies. Because the ring is sensitive to displacement, particularly at low frequencies, this is not a desirable feature. The alternatives for vibration control include low duct and pipe velocities (i.e., larger diameters) and long straight runs of mains. Both of these concepts can easily be incorporated as the design progresses.

*Isolation of the Experiment Hall floor from the Ring tunnel floor*

The outer corridor of the Experiment Hall will be separated from the floor slab of the Experiment Hall by means of a joint in the slab, following the APS model. This decouples the public corridor, which has pedestrian activities and deliveries, from the more vibration-sensitive Experiment Hall area.

Concerns have been expressed regarding the connectivity of the Tunnel and the floor of the Experiment Hall. This is not as simple a decision as that to decouple the outer corridor. The argument in favor of a joint is similar: it is desirable to mitigate “humming” and other vibration that might be generated by the equipment associated with the ring. The argument against a joint is that it introduces the risk of differential settlement between the Tunnel and Experiment Hall, which could cause a small, though quasi-static, beam misalignment.

The thick concrete slab of the Experiment Hall and Tunnel together will offer some improvement of the ground surface that might not be as dramatic if it is actually two ring slabs, one inside the other. This is an issue that can be addressed analytically as the design progresses.

An option worthy of consideration is the use of a damping admixture in the concrete beneath the ring. It would help to dissipate the high-frequency “humming” vibration. It could be placed as a topping on the concrete, as done in mechanical corridors at CFN. An unknown that would require evaluation is the severity of the radiation and how the polymer would respond to that radiation.

*Acoustics of Experiment Hall*

The Experiment Hall is a large open area which will have a vast quantity of user-supplied noise sources. A noise study was carried out in 1989 as part of the APS design effort, in part to develop a “typical” source sound power spectrum for design of the APS Experiment Hall.[1] At that time, the average noise level was found to be 69 dBA, though noise levels as high as 80 dBA were measured. It was assumed that the experiments themselves were not adversely affected (as noise protection could be built into the hutches), but the noise environment in the hall was a detriment to speech communication and contributed to researcher fatigue.

It might be worthwhile for BNL to consider imposing a limit on the allowable sound power associated with user-supplied equipment. However, the most proactive move is probably to use acoustically absorbent materials on walls and ceiling. The latter is relatively straightforward, by means of an acoustically absorbent roof deck. There are number of manufacturers of the product. Essentially it is a corrugated decking in which the grooves (as seen from above) are perforated and filled with acoustical material. The high spots are surfaces for supporting roofing or sheeting that supports concrete roof system. You can get very good performance from these systems. A facility with this kind of decking is the Experiment Hall at the Center for Advanced Microstructures and Devices (CAMD) at Louisiana State University. Some of the vendors of this product are Versa-Dek, United Steel Deck, and Vulcraft. A noise study should be carried out as the design progresses to the point that the mechanical system noise can be combined with the sound power for the research equipment.[2] That study can develop specific recommendations regarding the NRC of the decking and wall coverings and the optimal percentage of wall covering.

---

[1] Amick, H., and C. G. Gordon, "Measurement of Noise and Vibration, National Synchrotron Light Source, Brookhaven National Laboratory", Acentech Report 11 (June 1989).

[2] Sound power data for typical NSLS equipment were reported in “Acoustical Evaluation of Experiment Hall: Argonne National Laboratory”, A. M. Yazdanniyaz & S. K. Bui, Acentech Report No. 56, January 1991. The noise from the experimental equipment was included in their noise model via sound power estimates based on measurements made at NSLS in 1989, see Acentech Report 11.

**Appendix A3**

Preliminary EMI/RFI Site Assessment Study Report
September 1, 2006

VitaTech Engineering, LLC

**VitaTech Engineering, LLC**

EMF Measurements, Surveys & Risk Assessment
EMF Mitigation - Shielding & Cancellation
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Fredericksburg, VA 22406
(540) 286-1984
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September 1, 2006

Mark Jamison, P.E. Tel: (402) 399-4908
HDR One Company
8404 Indian Hills Drive
Omaha, NE 68114

Subject: Future NSLS-II Brookhaven Labs EMI/RFI Site Assessment Study

Dear Mr. Jamison:

VitaTech Engineering was engaged by HDR to perform an EMI/RFI Site Assessment Study for the future NLSL-II building site located at Brookhaven Labs in Long Island, New York. The EMI/RFI data contained in this report was recorded on 14 June 2006 by the author of this report and Mr. Eric Friedlein of VitaTech Engineering. The proposed NSLS-II site has underground distribution circuits traveling east-west along Brookhaven Avenue and other electrical feeders west of Seventh Avenue running north-south. *VitaTech must return in late September to record additional RF data from the NEXRAD Dopper Radar 2200 ft. from the site.*

**AC ELF Electromagnetic Interference (EMI)**

Electron microscopes (SEMs, TEMs, STEMs), Focus Ion Beam (FIB) writers and E-Beam Writers are very susceptible to AC ELF (extremely low frequency) 3 Hz to 3000 Hz magnetic fields emanating from various electrical power sources outside of the NLSL-II building and within. VitaTech recommends a maximum of 1 mG Br (resultant) RMS AC ELF magnetic flux density emissions for NMRs and MRIs, 0.3 mG Br (resultant) RMS AC ELF magnetic flux density emissions for Cleanrooms and 0.1 mG Br (resultant) RMS AC ELF magnetic flux density emissions for SEMs, TEMs, STEMs, FIBs and E-Beam Writers as shown in the Chart #1 below:

***EMI AC & DC Magnetic Field Performance Specs***
***NMR Maximum Requirement:***
***1 mG Br RMS (2.83 mG p-p)***

***Instrument & Quite Labs Maximum Requirement:***
***0.1 mG Br RMS (0.3 mG p-p)***

***Cleanrooms Maximum Requirement:***
***0.3 mG Br RMS (0.1 mG p-p)***

Chart #1, Recommended EMI AC & DC Magnetic Performance Specs

Electromagnetic induction occurs when time-varying AC magnetic fields couple with any conductive object including wires, electronic equipment and people, thereby inducing circulating currents and voltages. In unshielded (susceptible) electronic equipment (computers monitors, video projectors, computers, televisions, LANs, diagnostic instruments, magnetic media, etc.) and signal cables (audio, video, telephone & data), electromagnetic induction generates electromagnetic interference (EMI), which is manifested as visible screen jitter in displays, hum in analog telephone/audio equipment, lost sync in video equipment and data errors in magnetic media or digital signal cables.

Placement of each scientific tool and instrument depends on the actual EMI susceptibility under defined thresholds, which are often not easy to ascertain from the manufacturer's performance criteria. Magnetic flux density susceptibility can be specified in magnetic field strength (A/m) or in milligauss (mG) using one of three magnetic flux density terms: Brms, Bpeak-to-peak(Bp-p) and Bpeak (Bp) according to the following conversion formula below.

$$B_{rms} = \frac{Bp-p}{2\sqrt{2}} = \frac{Bp}{\sqrt{2}}$$

To convert magnetic field strength to units of milligauss (mG), simply multiple the magnetic field strength by 4π. For example, 3 A/m is equal to 37.7 mG (3 x 12.57 = 37.7 mG). Using simulated emission profiles and the correct conversion formula, it is possible to identify the appropriate levels acceptable for each tool *if the correct EMI susceptibility figure can be ascertained from the manufacturer's specifications. Therein, lies the real EMI challenge.*

Generally, for AC ELF sources the minimum EMI threshold is 10 mG in unshielded electronic equipment, especially 14" to 17" CRT color computer monitors and analog signal cables; however, the AC ELF EMI threshold for high-resolution 17" to 21" CRT color monitors is only 5 mG. *Analog audio/video equipment and cables are susceptible to EMI noise less than 5 mG including diagnostic medical instruments such as EEGs, EKGs, EMGs, ECGs, and other electrode contract devices.*

The semiconductor industry has specified AC EMI threshold performance requirements in SEMI E33-94, Specification For Semiconductor Manufacturing Facility Electromagnetic Compatibility, as shown below in Chart #2 - The AC ELF EMI Threshold Charts:

Chart #2 – AC ELF EMI Threshold Chart

**AC ELF EMI Thresholds (screen jitter & noise)**

**10 mG for 12-15 inch computer monitors & audio/video equipment**

**5 mG for 17-21 inch CRT monitors & medical (i.e., EEGs, ECGs, EMGs,. etc.).**

**1.0 mG for standard scientific tools (STEMs, TEMs, FIB, I-Beam, etc.)**

**0.1- 0.3 mG high resolution Nanotech scientific tools**

**0.01 mG for optimum superhigh resolution STEM tools.**

**SEMI E33-94 AC ELF EMC Standards**

Level A - less than 0.25 mG
Level B - less than 0.50 mG
Level C - less than 1.00 mG
Level D - less than 2.00 mG
Level E - 2.0 mG and greater

AC ELF EMI Recorded Data & Assessment

On 14 June 2006 VitaTech recorded lateral AC extremely low frequency (ELF) magnetic flux density levels at 1-meter above grade with a survey wheel and the FieldStar 1000 gaussmeter (see Test Instruments for details) within the proposed NLSL-II building site. The following is an AC ELF magnetic flux density assessment of the RMS recorded data:

Figure #1 shows five lateral Hatch Plots recorded across the proposed NLSL-II building site. Each lateral data path has four color hatch marks (0.1 mG, 0.25 mG, 1.0 mG and 5.0 mG) representing the threshold level recorded at each one-foot interval (no hatch marks indicate levels less the 0.1 mG). Figure #2 presents five Profile Plots of the Figure #1 Hatch Plots with resultant Br (black) levels and three Bx (red), By (green) and Bz (blue) components shown as a function of distance.

The three north-south laterals (records #1 - #3) in Figures #1 and #2 shows the recorded magnetic fields emanating from the east-west underground distribution lines on Brookhaven Avenue (peaks 1.5 to 3.4 mG). The three north-south laterals rapidly decay to less than 0.1 mG 75 to 100 feet from the Brookhaven Avenue south curb. The levels were also very low along the east-west lateral in the center of the field rapidly decaying to 0.00 mG between Seventh and Fifth Streets except within 75 feet south of Brookhaven Avenue. The proposed NLSL-II site has very low AC ELF magnetic flux density levels 75 feet south of Brookhaven Avenue, ranging from 0.1 mG to 0.00 mG as shown in the five Figure #2 Lateral Profile Plots.

Figure #3 shows the timed wideband 3 Hz to 3,000 Hz AC ELF magnetic flux density field levels at the proposed NLSL-II site recorded with the MultiWave System II three axis fluxgate magnetometer sampled at 15 second intervals for 42 minutes. The timed Br resultant peak was 0.192 mG with an average 0.18 mG over the 42 minute period: this is the noise floor of the MultiWave System II where the actual levels are below the recording range. Therefore, the actual timed levels are 0.0 mG at this distance (200 – 250 ft) south of Brookhaven Ave.

***Conclusions: The recorded AC ELF magnetic flux density emissions were very low ranging from 0.1 mG at 75 to 100 feet south of Brookhaven Avenue rapidly decay to 0.00 mG at 100 feet all the way to the other side of the site including the wooded areas. The NSLS-II site complies with all four of the following AC ELF magnetic flux density performance requirements 100 feet south of Brookhaven Avenue between Seventh and Fifths Streets:***

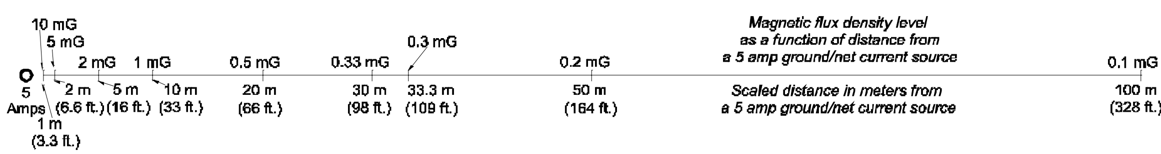
- ***0.01 to 0.1 mG EMI threshold for ultrahigh resolution STEMs;***
- ***0.1 to 0.3 mG EMI threshold for scientific tools (i.e., SEMs, TEMs, FIB, E-Beam Writers, etc.);***
- ***0.25 mG Level A SEMI E33-94 AC ELF EMF Standard; and,***
- ***10 mG long-term human exposures threshold recommended by the Swiss Bunderstat and NCRP Draft Report (see AC ELF Magnetic Field Health Issues, Standards & Guidelines)***

Ground/Net Current Issues

Ground and net currents are due to N.E.C. violations (i.e., grounded neutrals, wiring errors, etc.) in the electrical service, distribution and grounding systems of a building and N.E.S.C. violations (i.e., grounding problems, etc.) on distribution and transmission lines. Unbalanced phases on medium voltage distribution lines and 480V/208V low-voltage feeders generate zero-sequence currents, which return on the neutrals and grounding conductors. Most utilities maintain 5% and less unbalanced phases on high voltage transmission lines and 10-15% unbalanced phases on distribution lines (power quality issues) except in local neighborhoods where unbalanced phases may exceed 20%. A percentage of the zero-sequence neutral currents on distribution lines travel along other electrically conductive paths (i.e., underground water pipes, earth channels, grounded guy wires, building neutrals/grounding systems, etc.) back to the substation. If all the zero-sequence currents were to return via the multi-ground neutral system (MGN) wire mounted on the pole under the three phase conductors (sum of all phase and neutral currents are zero), then the magnetic fields would decay at the normal inverse square rate ($1/r^2$ in meters) from the single-circuit distribution line (same for transmission lines and low-voltage feeders). However, if only a fraction of the zero-sequence current returns on the MGN system or low-voltage neutral conductor, then there is a net current missing (amount of current returning via other paths) – this net current emanates a magnetic field similar to a ground current (electrical current of low voltage returning on a ground wire, water pipe or other conductive path) that decays at a linear 1/r (in meters) rate based upon the following formula:

$$\mathbf{B_{mG} = 2(I)/r} \quad \text{where I is amps and r meters}$$

Magnetic fields from ground and net (zero-sequence) currents decay at a slow, linear rate illustrated below, using a 5 amp ground/net current source: 10 mG is 1 m away, 1 mG is 10 m away, 0.5 mG is 20 m away and 0.1 m is 100 m away:




Since there is a proportional relationship between current load and magnetic flux density levels, the above chart can be used to predict the emission levels based upon ground/net current loads. Using 2.5 amps of ground/net current, the levels above the selected decay distance are calculated by dividing by 2, which is 50% of 5 amps. The ground/net current decay chart is indispensable in ascertaining the acceptable operating distance from ground and net (zero sequence) currents based upon a specified instrument performance criteria (i.e., 1 mG, 0.1 mG or 0.01 mG).

Ground and net current magnetic field emissions are difficult to shield using flat or L-shaped ferromagnetic and conductive shields -- the most effective shielding method for AC ELF ground/net current emissions requires a six-sided, seam welded aluminum plate shielding system with a waveguide entrance. *Finally, low ambient magnetic field levels can be achieved inside a research laboratory and imaging suite* *by adhering to the N.E.C. and good wiring practices. However, these low levels can only be achieved under the most pristine conditions and without any circulating ground/net currents present on the primary electrical distribution system outside of the building, low-voltage 480/208V distribution feeders and branch circuits inside the building systems and the grounding system.*

**DC Electromagnetic Interference (EMI)**

Large and small ferromagnetic masses in motion such as elevators, cars, trucks, trains, subways and metal doors produce geomagnetic field perturbations in the sub-extremely low frequency (SELF) 0 - 3 Hz band that radiate (similar to throwing a pebble in a pond) from the source generating DC electromagnetic interference (EMI) in sensitive scientific tools and instruments. The magnitude of the geomagnetic field perturbation and radiated distance from the source depends on the size, mass and speed of the moving ferromagnetic object. Theoretically, DC magnetic emission sources (i.e., ferromagnetic objects, magnets, etc.) decay according to the inverse cube law, in practice the decay rates are not ideal. Other problematic DC EMI sources include traction currents from underground/surface electric DC trolleys/subways, electromagnetic pulse (EMP) devices with high-voltage discharge, and finally unshielded NMRs and MRIs.

Electron microscopes (SEMs, TEMs, STEMs), Focus Ion Beam (FIB) writers and E-Beam Writers are very susceptible to DC EMI emissions and require clean DC environments. VitaTech recommends a maximum of 1 mG dB/dt Br (resultant) RMS DC EMI for NMRs and MRIs, 0.3 mG dB/dt Br (resultant) RMS DC EMI for Cleanrooms and 0.1 mG dB/dt Br (resultant) RMS DC EMI for SEMs, TEMs, STEMs, FIBs and E-Beam Writers as shown in the Chart #1 below:

***EMI AC & DC Magnetic Field Performance Specs***
***NMR Maximum Requirement:***
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***0.1 mG Br RMS (0.3 mG p-p)***

***Cleanrooms Maximum Requirement:***
***0.3 mG Br RMS (0.1 mG p-p)***

Chart #1, Recommended EMI AC & DC Magnetic Performance Specs

Placement of scientific tools depends on the actual DC EMI susceptibility under defined thresholds, which are often not easy to ascertain from the manufacturer's performance criteria. Electron microscopes are sensitive at 1 mG Brms from DC disturbances while SEMs and TEMs such as the TEM JOEL 2010 have 0.4 mG horizontal and 0.2 mG vertical performance requirements while next generation EM tools are less than 0.1 mG Brms and Super STEMs (also known as ultra-high resolution STEMs) have a 0.01 mG DC EMI threshold. DC susceptibility in typical 1.5 to 4 Tesla MRIs can range from 1 mG to over 0.5 Gauss depending on the magnetic field strength, resolution and type (open vs. closed, active shielding, etc.). ***Furthermore, to ensure a safe working environment around MRIs and NMRs, adequate signage must be posted at 5 and 10 Gauss lines to warn staff and visitors with implantable devices and to minimize inadvertent data corruption (coercivity) of credit cards and other valuable magnetic media.*** Below is a list of DC EMI Thresholds in Gauss that will impact CRT displays, electronic instruments and magnetic media:

Chart #3 – DC EMI Threshold Chart

| DC EMI Thresholds - CRT screen shift, noise & coercivity (data errors) |
|---|
| 0.001 Gauss & Less SEMs, TEMs E-Beam/FIB Writers |
| 0.75 Gauss CRT Monitors & Electronic Instruments |
| 5 Gauss Cardiac Pacemakers & Implantable Devices Warning Sign |
| 10 Gauss Credit Cards & Magnetic Media Warning Sign |
| 300 Gauss Low Coercivity Mag-Stripe Cards |
| 700 Gauss High Coercivity Mag-Sripe Cards & Video Tapes |
| ***1000 milligauss (mG) = 1 Gauss (G) & 1 mG = 0.001 G = 0.1 uT (microtesla)*** |

According to the **National Geophysical Data Center (NGDC),** the average Br resultant DC magnetic flux density level at Brookhaven National Labs is 528.5 mG at 0 ft. elevation. Depending on the location and distance from ferromagnetic materials (pipes, steel beams, rebar, cars, etc.), the recorded average time DC Br resultant RMS levels at the site was 536.9 mG (see Figure #3), which is only a 8.4 mG differential.

<u>Moving Vehicle DC EMI Emission Profiles & Impact</u>
As discussed the DC EMI emissions from moving vehicles (cars, SUVs, VANs, trucks and busses), and trains can compromise sensitive research tools. Normally, VitaTech recommends adequate spacing between the proposed building site, roads with heavy traffic, parking garages, trains, subways and other DC EMI emission sources to minimize potential EMI problems with sensitive instruments and tools.

Figure #4 shows the timed (15 second interval) resultant (Br) and component (Bx, By and Bz) RMS DC data recorded with the MultiWave System II three-axis fluxgate magnetometer more than 200 feet from Brookhaven Avenue. The only noticeable DC dB/dt EMI data was generated from an SUV that drove up to our location (200 – 250 feet south of Brookhaven Avenue) within 10 feet of the fluxgate probe. The Br resultant chart shows a 4 mG dB/dt square pulse from the SUV vehicle as it approached the fluxgate probe.

VitaTech recorded timed DC EMI data from moving vehicles at the University of Florida several years ago as shown in Figure #5. Calculated car and bus vehicle profiles were generated by applying the decay data to Curve Fitting software – this data was overlaid on the NSLS-II site plan. Similarly, the vehicle decay chart should be used to evaluate the DC EMI impact from cars driving on Brookhaven Avenue and Seventh/Fifth Streets adjacent to the proposed site. It should be noted that in practice the magnetic fields decay more rapidly after 30 meters than the calculated levels indicate (see recorded data). Nevertheless, the calculated DC differential dB/dt emissions from a moving bus at 40 meters would be 0.2 mG while in practice the actual bus levels will be less than 0.1 mG.

***Conclusions: Standard resolution imaging tools with dB/dt differential DC EMI resultant RMS thresholds of 1 mG to 0.1 mG can be located between 12 meters (40 ft) to 40 m (131.2 ft) south of Brookhaven Avenue assuming cars and busses are moving east and west. High resolution imaging tools with differential dB/dt DC EMI resultant RMS thresholds of 0.1 to 0.01 mG can be located from 40 m (131.2 ft) to 60 m (197 ft.), which is the predicted 0.01 mG isoline) south of Brookhaven Avenue. Similar separation distances are required from the north-south Seventh and Fifth streets to ensure adequate DC EMI immunity for moving vehicles of similar mass.***

**Radiofrequency Interference (RFI)**

The Federal Communications Commission (FCC), not the local municipal zoning authorities or law enforcement, has legal jurisdiction over radiofrequency interference (RFI). Simply stated RF devices (intentional and unintentional emitters) are not permitted to cause RFI with other radio services, electronic equipment and systems. At present, there are no mandated radiofrequency interference (RFI) susceptibility government standards in the United States. The only equipment susceptibility standards that exist are unique to equipment (quality control) internal standards written by equipment manufacturers based on radiated emission standards for intentional radiators set forth by the FCC. In other words, an equipment manufacturer in United States must design the equipment to function properly within a radiated emission field level from intentional radiators set forth by the FCC, Part 15. Like any other communications facility, wireless broadband facilities must comply with these FCC limits. The following FCC parts apply to electromagnetic interference (EMI) and radio frequency interference (RFI) conducted and radiated emissions (see below):

Radio Frequency Devices - Part 15
Multipoint Distribution Service - Part 21, subpart K
Paging and Radiotelephone Service - Part 22, subpart E
Cellular Radiotelephone Service - Part 22, subpart H
Personal Communications Services - Part 24
Satellite Communications - Part 25
General Wireless Communications Service - Part 26
Wireless Communications Service - Part 27
Radio Broadcast Services - Part 73
Experimental, auxiliary, and special broadcast and other program distributional services - Part 74
Experimental Radio Service - Part 5
Stations in the Maritime Service - Part 80
Private Land Mobile, Paging Operations - Part 90
Private Land Mobile, "Covered" Specialized Mobile Radio - Part 90
Amateur Radio Service - Part 97
Local Multipoint Distribution Service - Part 101, subpart L

Mobile and portable devices used as follows:

- Cellular Radio Service
- Personal Communications Service
- Satellite Communications Branch
- General Wireless Communications Service
- Wireless Communications Service
- Maritime Service
- "Covered" Specialized Mobile Radio Service

In Europe, there are susceptibility (radiated immunity) standards, such as the EN 61000-6-1, that states 3 V/m level for residential electronic equipment, while 10 V/m is standard for industrial electronic equipment in the EN 61000-6-2. Engineers in the United States utilize the European susceptibility standards as a guideline. The SEMI E33-94 EMC Standard is 10 V/m and 3 V/m depending on frequency (see below):

Chart #4 – RFI Threshold Chart

Electric field strength RF levels were recorded in volts-per-meter (V/m) for 10 minutes sampled at 0.04-second intervals with a Narda ERM-300 electric field meter using a Probe 18 from 100 kHz to 3 Ghz (range of 0.2 to 320 V/m) and Probe 9C from 3 MHz to 18 GHz (range of 0.5 to 1000 V/m). The objective is to investigate sources of radio-frequency interference (RFI) over a wide bandwidth. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.

<u>SEMI E33-94 RF Immunity Standards</u>
<u>Enclosure Ports</u>
Radiated AM Immunity: 10 V/m 450-520 MHz and 800-950 MHz @ 80% AM
Radiated Pulse Modulated: 3 V/m 1.89 GHz 50% Duty cycle
<u>Signal Line Ports & Ports for Process, Measurement & Control</u>
RF Common Mode: 3 V/m 0.15 - 100 MHz @ 80% AM
<u>Input/Output DC/AC Power Ports</u>
RF Common Mode: 3 V/m 0.15 - 100 MHz @ 80% AM

## RFI Electric Field Strength Site Assessments & Conclusions

<u>Timed Wideband 100 kHz – 18 GHz RF Electric Field Strength Data</u>

VitaTech recorded timed RF electric field strength data in volts-per-meter (V/m) was recorded at 1-meter above grade from 100 kHz to 3 GHz and 3 MHz to 18 GHz at 0.4 second intervals for two 10 minute periods on 14 June 2006 as shown in Figures #6 and #7. A summary of the 14 June 2006 recorded RF electric field strength levels are presented in Tables #1 and #2 below:

**Table #1: 100KHz - 3GHz RF Data 14 June 2006**

| Site | Max (V/m) | Min (V/m) | Average (V/m) |
|---|---|---|---|
| NSLS-II | 0.31 | 0.00 | 0.12 |

**Table #2: 3MHz - 18GHz RF Data 14 June 2006**

| Site | Max (V/m) | Min (V/m) | Average (V/m) |
|---|---|---|---|
| NSLS-II | 0.25 | 0.0 | 0.12 |

Tables #1 and #2 present 20 minutes of recorded RF electric field strength at the NSLS-II site as shown in Figure #6. These are very low RF electric field strength levels considering the NEXRAD Doppler Weather Radar is only 2200 ft. away from the site, therefore the radar was not operational or under low power during data collection. Figure #7 shows the maximum electric field strength thresholds recorded during two ten minute sampling periods. Again, very low maximum peak threshold levels were recorded from 100 kHz to 3 GHz and from 3 MHz to 18 GHz indicating the radar was not operational or under low power during the testing.

The NEXRAD Doppler Radar transmitter frequency range is 2.7 to 3.0 GHz with a peak output power of 750 kW (pulse width - short at 1.57 microsecond and 4.5 microsecond wide) from an S-Band center-feed parabolic dish (28 ft. outside-diameter) with a 0.95 degree pencil beam, 6 RPM azimuth rate and -1 to +20 degree elevation. VitaTech will return in late September 2006 with our new spectrum analyzer, the Narda SRM-3000 Selective Radiation Meter, to record the electric field strength and FCC Bulletin 65 (MPE) maximum permissible exposure levels at the proposed NSLS-II site with the NEXRAD Doppler Radar at maximum power (must be scheduled with the NEXRAD engineers and operators).

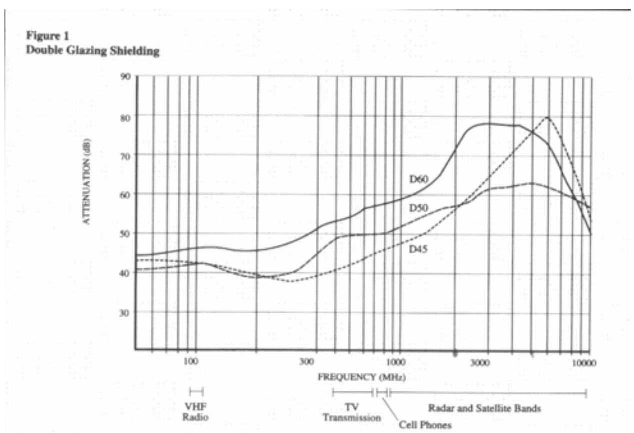
VitaTech previously recorded electric field strength levels for the Center for Functional Nanomaterials on the roof of the existing LightSpeed building. The RF emission levels around scientific tools such as the E-Beam Writers, NMRs, and Mass Spectrometers should be 20 mV/m or less. *Based upon the previously recorded RF emission levels at that site, RF shielding was recommended on the façade of the Center for Functional Nanomaterials, but budgetary issues deleted the RF shielding. Nevertheless, the existing LightSource building had RFI problems from the NEXRAD Dopper Radar, and RF shielding was installed around selected laboratory and research areas to reduce the RFI problems.*

<u>Center for Functional Nanomaterials RF Shielding Assessment/Mitigation Options</u>
The following section was extracted from the Center For Functional Nanomaterials report on RFI shielding options. It should be noted that the estimated prices are not accurate and should be increased by 30% for budgetary reasons:

> The nearby NEXTRAD Doppler Radar operates between the 2.7 to 3 GHz frequency range with up to 750 kW of effective radiated power (ERP) depending resolution and weather conditions. Building materials will provide natural shielding attenuation based upon frequency and distance from the façade facing the RF emission source. At 3 GHz the aluminum metal building façade (0.04 inches thick) would provide 50 dB to 60 dB of attenuation due to the high reflection and absorption characteristics of the exterior interlocking aluminum siding/roofing. The second floor heavy gage steel floor pans (0.034 inches thick) would add another 50 dB to 60 dB of attenuation (i.e., reflection and absorption) to the roof figures for a total of 100 to 120 dB attenuation in the vertical plane. If the east façade windows and walls were not shielded the natural horizontal attenuation factor would be 25 dB at 5 meters inside the exterior wall, over 35 dB at 10 meters, and over 60 dB at 20 meters deep inside the building. Although the east façade exterior wall is covered with aluminum panels providing at least 50 to 60 dB of attenuation, the large unshielded windows provide an open portal allowing the Doppler RF energy to penetrate deep into the building. ***Therefore, RF shielding the windows is necessary to minimize potential RFI problems in the adjacent ground floor laboratories.***

VitaTech presents two RF window shielding options: transparent conductive RF film that can be applied to the windows when needed and conductive RF shielded glass with conductive gaskets and aluminum window frames. The best conductive RF film available is from 3M and sold under the Scotchtint trademark providing from 26 to 36 dB of attenuation depending on the type of film purchased (i.e., tint, conductivity, UV block and other parameters). When installed by professionals, the 3M Scotchtint has a 10 year warranty. It is supplied in 100 ft. by 5 ft. wide rolls costing from $1,200 to $1,500 per roll (not including installation) depending on the tint, shielding performance and energy rating. VitaTech provided samples of the P-18AR High Performance Silver (26 dB at 2.5 GHz) and RE35AMARL (36 dB at 2.5 GHz) to HDR several week ago. *It would cost $40,000 - $60,000 to install 3M RF film on 2,380 sq. ft. of windows including labor, expenses and profit.*

The other option is to use recently developed RF shielded glass "DATASTOP" sold by Pilkington and Tempest Security Systems, Inc. of Troy, OH. Shielding performance of the sealed double glazed DATASTOP windows ranged from 62 dB for the D50 with neutral tint up to 78 dB for the D60 with gold tint as shown below:




The DATASTOP double glazed windows are typically two layers of ¼-inch thick glass separated by a ½-inch air gap mounted with conductive gaskets in an aluminum window frame shown below:

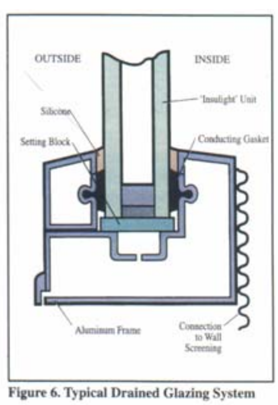


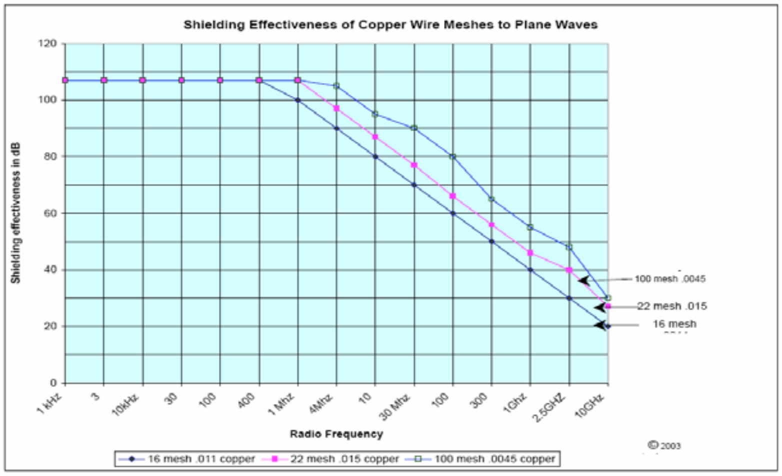

**Figure 6. Typical Drained Glazing System**

The basic no tint double glazed DATASTOP window costs $60 per square foot (not including installation). It has a 10 year warranty and would provide an average of 60 dB of attenuation, which is similar in attenuation to the exterior aluminum façade and aluminum roof. RF energy may penetrate into the building interior through various holes, openings, and mechanical seams in the aluminum exterior east façade wall: any space more than a 1/2λ of 3 GHz, which is 1.95 inches in diameter (see mesh section for formula). Since the DATASTOP aluminum window frames will not be conductively bonded and/or RF sealed to the exterior east aluminum wall panels, RF penetration through any 2 inch and large space will occur around the windows, doors and other separation joints between the conductive and metallic surfaces. *It would cost $290,000 - $325,000 to install 2,380 sq. ft. of DATASTOP D50 double glazed windows with no tint, fames and conductive gaskets including labor, expenses and profit.*

Shielding the east building façade with wire mesh behind the aluminum exterior panels would significantly attenuate any RF energy leakage into thorough holes and penetrations the research laboratories while providing an extra layer of RF protection. First, the wavelength of 3 GHz must be calculated using C = λf where C is the speed of light ($2.997 \times 10^8$ m/s) and f is frequency of attenuation ($3.0 \times 10^9$ in cycles per second). The wavelength λ of 3 GHz is 0.0999 meters (99.9 mm or 3.9 inches) while any wavelength greater than 1/2 λ (1.95 inches) is attenuated (i.e., lower the frequency the longer the wavelength).

Next, the ideal shielding effectiveness (SE) in decibels for wire mesh is calculated where λ (lamda) is the wavelength of the incident Doppler microwave in meters and g is the airgap in meters: $(SE)_{dB} = 20 \log_{10} (0.5\ \lambda/g)$

Assuming 60 dB of attenuation is the objective, than the calculated wire mesh spacing (airgap g) is 0.04995 mm (0.002 inches), which is equivalent to a 270 mesh. Only stainless steel fine mesh wire cloth is available in a 270 mesh size and is not used in RF shielding because of the difficulty in seam bonding and grounding. There are two other reasonable alternatives: 100 Mesh copper or aluminum screening. The calculated SE for 100 Mesh (0.0045 copper) with a 0.14 mm airgap is 51 dB while the measured SE is 47 dB as shown in the diagram below:




The 100 Mesh copper comes in 100 ft. rolls, 48 inches wide, and costs $1.30 to $1.50 per square foot (F.O.B). Aluminum 100 Mesh of the same length and width is a custom weave (must be an alloy with lower conductivity because of the needed tensile strength during the weaving process) costs $1.50 to $1.75 per square foot (F.O.B). The 100 Mesh copper and aluminum screens are easy to apply (staples, screws and adhesives) to the outside wall, can be mechanically bonded to the aluminum window frames using screws, and seam bonded (overlap edges and soldered) and grounded. Therefore, 47 dB of attenuation is available using the 100 Mesh copper and 40 dB using 100 Mesh aluminum alloy RF screening. *It would cost $55,000 - $80,000 to install 5,660 sq. ft. of aluminum 100 Mesh on the exterior walls beneath the aluminum panels and mechanically bonded to the aluminum window frames including labor, expenses and profit.*

VitaTech does not recommend applying copper and aluminum tapes with conductive adhesive backings over wire mesh seams, on window frames or other conductive structures because overall shielding performance will seriously degrade over time due to weathering and temperature variations. If wire mesh RF shielding is used on the east façade wall behind the exterior aluminum panels, it must be mechanically bonded to the window frames and all other metallic surfaces to ensure long-term performance with minimal failure (warning to avoid galvanic reactions only aluminum can be mechanically bonded to aluminum window/door frames).

<u>RF Shielding Options & Estimated Costs</u>
VitaTech presents the following RF shielding options with costs to minimize RFI interference from the nearby Doppler radar inside the new Center for Functional Nanomaterials building laboratories and offices:

**Option 1:** Additional RF shielding is not installed because the aluminum exterior east wall and roof building surfaces will provide at least 50 to 60 dB of attenuation coupled with the interior attenuation characteristics of the building. It should be noted that the east side 1$^{st}$ floor windows will provide open portals to the Doppler RF energy with only the office doors and walls to absorb and reflect the microwave energy. If RFI problems are identified and measured in specific laboratories, localized RF shielding should be applied to the area of concern to mitigate the problem, where practical. However, two alternative RF solutions are offered below with Option 1 where improved RF shielding is required:

**Alternative #1:** apply 3M conductive film to 1st floor windows for additional 36 dB of attenuation for an estimated cost of $40,000 - $60,000 including labor, expenses and profit. Shielding performance will be marginal because the edge between the conductive window film and window frame is difficult to bond (ground). Therefore, RF leakage around the inside glass window frames will present a serious problem.

**Alternative #2:** to reduce RF leakage through holes and seams along windows, doors and other openings apply 5,600 sq. ft. of aluminum 100 Mesh for an estimated costs of $55,000 - $80,000 including labor, expenses and profit. Special Note: aluminum 100 Mesh can not be applied after exterior aluminum wall panels are installed.

**Option 2:** Install DATASTOP RF shielded windows, conductive gaskets and frames in ground and 2nd floor east wall façade (2,380 sq. ft. area) as shown in Figure #11. Assume conductivity with aluminum exterior wall and roof to provide a reasonable RF shielding system of 60 dB and higher. Estimated cost: $290,000 - $325,000 for windows, frames, gaskets including labor, expenses and profit. Additional RF shielding is required to minimize RF leakage and improve overall shielding performance:

**Alternative #3:** seams with minimal electrical conductivity between DATASTOP aluminum window frames and exterior east aluminum walls will cause RF leakage penetrating into the interior building laboratories – install 100 Mesh aluminum screen to ground and 2nd floor walls behind aluminum panels and mechanically couple to the DATASTOP window frames RF sealing the east side of the building. Estimated cost: $55,000 - $80,000 for *5,660 sq. ft. of aluminum 100 Mesh includes labor, expense and profit.*

VitaTech recommends shielding the east exterior wall with the DATASTOP windows and 100 Mesh aluminum screen presented in Option 2 and Alternative #3 to provide the maximum RF shielding attenuation especially with close proximity to the ground floor research labs just several feet from the east side offices. Unfortunately, the Option 1 RF shielding solutions with Alternatives #1 and #2 will be marginally effective.

***Conclusions: The four ambient timed recorded 100 kHz to 18 GHz electric field strength average and maximum peak data does not reflect the actual conditions since the Doppler Radar was probably not operational or at very low power. VitaTech will return in late September 2006 to record additional RF data with a spectrum analyzer (coordinate with engineers).***

**AC ELF, DC & RF Test Instruments**

FieldStar 1000 Gaussmeter - AC ELF Magnetic Flux Density

VitaTech recorded the AC ELF magnetic flux density data using a FieldStar 1000 gaussmeter with a NIST traceable calibration certificate manufactured by Dexsil Corporation. The FieldStar 1000 has a resolution of 0.04 mG in the 0 - 10 mG range, 1% full-scale accuracy to 1000 mG and a frequency response of 60 Hz (55 - 65 Hz @ 3dB). Three orthogonal powdered-iron core coils are oriented to reduce interference to less than 0.25% over the full dynamic range. The three coils are arranged inside the unit holding horizontal with the display forward: Bx horizontal coil points forward, By horizontal coil points to the right side, and Bz vertical coil points upward. The microprocessor instantly converts the magnetic field to true RMS magnetic flux density (milligauss) readings of each axis (Bx, By, Bz) and simultaneously calculates the resultant $R_{rms}$ (root-means-square) vector according to the following formula:

$$R_{rms} = \sqrt{Bx^2 + By^2 + Bz^2}$$

When collecting contour path data, a nonmetallic survey wheel is attached to the FieldStar 1000 gaussmeter and the unit is programmed to record mapped magnetic flux density data at selected (1-ft., 5-ft., 10-ft. etc.) intervals. The FieldStar 1000 is exactly 39.37 inches (1 meter) above the ground with the survey wheel attached. Along each path the distance is logged by the survey wheel and the relative direction (turns) entered on the keyboard. Up to 22,000 spot, mapped and timed data points can be stored, each containing three components (Bx, By & Bz), event markers and turn information. After completing the path surveys, magnetic flux density data is uploaded and processed. All plots display a title, time/date stamp, ID path number, and the following statistical data (in milligauss) defined below:

**Peak** - maximum magnetic field (flux) value measured in group.
**Mean** - arithmetic average of all magnetic field (flux) values collected.

The following is a quick description of the Hatch, Profile and 3-D Contour plots presented in the figures of this report:

**Hatch Plot** - data is represented by four difference hatch marks (0.1 mG, 0.25 mG, 0.5 mG and 1.0 mG thresholds) based on width and color as a function of distance along the survey path that shows 90 and 45 degree turns. Note: the site drawing and all Hatch Plots were scaled in feet to verify actual recorded distances and correct survey locations.

**Profile Plot** - data shows each recorded component (Bx, By, Bz) axis and the resultant (Br) levels as a function of distance: Bx (red) is the horizontal component parallel to the survey path, By (green) is the horizontal component normal (perpendicular) to the survey path, and Bz (blue) is the vertical component with the computed Br resultant RMS (root-means-square) summation of the three components.

EMR-300 RF Meter - Electric Field Strength Data 100 kHz - 18 GHz

The EMR-300 is an radiofrequency (RF) electric field strength meter for broadband measuring and monitoring from 100 kHz to 18 GHz. The isotropic non-directional field probe with high sensitivity records average, maximum, peak and timed data in electric fields strength volts-per-meter (V/m), magnetic field strength amps-per-meter (A/m) and power levels. Ten minute timed data was sampled at 0.4 seconds intervals from 100 kHz – 3 GHz with a Probe 18 (range 0.2 V/m to 320 V/m) and from 3 MHz to 18 GHz with Probe 9C (range 0.5 V/m to 1000 V/m) at each location.

MultiWave System II – Magnetic Flux Density 0 Hz – 3000 Hz

Geomagnetic and static DC magnetic emission measurements were recorded with a fluxgate triple-axis MultiWave System II magnetometer (serial #1045). The MultiWave System II consists of a hand-held LCD display and keyboard controller unit, wideband 10 Gauss (G) peak (DC – 3 kHz) tri-axial fluxgate magnetometer, data acquisition and processing unit with 3.5" floppy disk drive unit and 0 to 10 Gauss range, 1% accuracy, 0.1 mG resolution.

**AC ELF Magnetic Field Health Issues, Standards & Guidelines**

*Currently, there are no Federal standards for AC ELF electric and magnetic field levels.* The National Energy Policy Act of 1992 authorized the Secretary of the Department of Energy (DOE) to establish a five-year, $65 million EMF Research and Public Information Dissemination (RAPID) Program to ascertain the affects of ELF EMF on human health, develop magnetic field mitigation technologies, and provide information to the public. In May 1999, the NIEHS Director Kenneth Olden, Ph.D. delivered his final report, *Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields*, to Congress that stated the following in the Cover Letter and Executive Summary below:

> *The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and* ***chronic lymphocytic leukemia in occupationally exposed adults... The NIEHS concludes that ELF-EMI exposure cannot be recognized at this time as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard.***

U.S. & International Organizational AC ELF EMF Standards

The International Commission on Non-Ionizing Radiation Protection (IRPA/INIRC) have established 833 mG maximum human exposure limit over 24 hours for the general public and 4,167 mG for occupational workers. Whereas The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a 10,000 mG (10 Gauss) exposure limit over 24 hours for occupational workers, but specifies only 1,000 mG (1 Gauss) as a maximum exposure for workers with cardiac pacemakers.

New York State Public Service Commission AC ELF EMF Standards

Effective September 1990, the State of New York Public Service Commission (PSC) "began a process looking toward the adoption of an interim magnetic field standard for future major electric transmission facilities". The Commission concludes that a prudent approach should be taken that will avoid unnecessary increases in existing levels of magnetic field exposure. Therefore, future transmission circuits shall be designed, constructed and operated such that magnetic fields at the edges of their rights-of-way will not exceed 200 mG when the circuit phase currents are equal to the winter-normal conductor rating. They also established an electric field strength interim standard of 1.6 kV/m electric transmission facilities.

IARC June 2002 Report

In June 2002, the International Agency for Research on Cancer (IARC) issued a 400+ page report formally classifying extremely low frequency magnetic fields as ***possibly carcinogenic to humans*** based on studies of EMF and childhood leukemia. **This is the first time that a recognized public health organization has formally classified EMF as a possible cause of human cancer**. IARC found that, while selection bias in the childhood leukemia studies could not be ruled out, pooled analyses of data from a number of well-conducted studies show a fairly consistent statistical association between childhood leukemia and power-frequency residential magnetic fields above 4 milliGauss (mG), with an approximately two-fold increase in risk that is unlikely to be due to chance.

IARC is a branch of the World Health Organization. The IARC classification of EMF was made by a panel of scientists from the U.S. National Institute of Environmental Health Sciences, the U.S. Environmental Protection Agency, the U.K. National Radiological Protection Board, the California Department of Health Services, EPRI, and other institutions around the world.

Switzerland's February 2000 AC ELF Standard

The Swiss Bundersrat in February 2000 set by law an emission control limit of 10 mG from overhead and underground transmission lines, substations, transformer vaults and all electrical power sources.

VitaTech's & NCRP Draft Recommended 10 mG Standard

Section 8.4.1.3 option 3 in the National Council of Radiation Protection and Measurements (NCRP) draft report published in the July/August 1995 issue of *Microwave News* (visit the Microwave News Homepage <www.microwavenews.com> for the entire draft report) recommended the following:

> ***8.4.1.3 Option 3:*** *An exposure guideline of 1 μT (10 mG) and 100 V/m: A considerable body of observations has documented bioeffects of fields at these strengths across the gamut from isolated cells to animals, and in man. Although the majority of these reported effects do not fall directly in the category of hazards, many may be regarded as potentially hazardous. Since epidemiological studies point to increased cancer risks at even lower levels, a case can be made for recommending 1 μT (10 mG) and 100 V/m as levels not*

*to be exceeded in prolonged human exposures. Most homes and occupational environments are within these values, but it would be prudent to assume that higher levels may constitute a health risk. In the short term, a safety guideline set at this level would have significant consequences, particularly in occupational settings and close to high voltage transmission and distribution systems, but it is unlikely to disrupt the present pattern of electricity usage. These levels may be exceeded in homes close to transmission lines, distribution lines and transformer substations, in some occupational environments, and for users of devices that operate close to the body, such as hair dryers and electric blankets. From a different perspective, adoption of such a guideline would serve a dual purpose: first, as a vehicle for public instruction on potential health hazards of existing systems that generate fields above these levels, as a basis for "prudent avoidance"; and second, as a point of departure in planning for acceptable field levels in future developments in housing, schooling, and the workplace, and in transportation systems, both public and private, that will be increasingly dependent on electric propulsion.*

**RF Human Exposure Standards**

Presently, four major RF standards are used in the United States: IEEE, ACGIH (American Conference of Governmental Industrial Hygienists), NCRP (National Council on Radiation Protection and Measurements) and the ICNIRP (International Commissions of Non-Ionizing Radiation Protection). In 1991, the IEEE released a revised RF human exposure standard IEEE C95.1-1991, *Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHZ*. However, in August 1997 the Federal Communications Commission (FCC) Office of Engineering & Technology (OTE) released Bulletin 65 *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, which became the defacto RF exposure standard in the United States. Both standards are very similar for Occupational/Controlled and General Population/Uncontrolled maximum permissible exposure (MPE), except for some minor differences -- the FCC standard is more restrictive and used in RF Safety & Exposure Testing.

The FCC's Bulletin 65 specifies separate maximum permissible exposure (MPE) limits for Occupational/Controlled and General Population/Uncontrolled exposure over a 0.3 MHz to 100 GHz bandwidth as shown below:

**LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)**

**(A) Limits for Occupational/Controlled Exposure**

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) ($mW/cm^2$) | Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes) |
|---|---|---|---|---|
| 0.3-3.0 | 614 | 1.63 | (100)* | 6 |

| | | | | |
|---|---|---|---|---|
| 3.0-30 | 1842/f | 4.89/f | $(900/f^2)$* | 6 |
| 30-300 | 61.4 | 0.163 | 1.0 | 6 |
| 300-1500 | -- | -- | f/300 | 6 |
| 1500-100,000 | -- | -- | 5 | 6 |

***Occupational/controlled*** limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

**(B) Limits for General Population/Uncontrolled Exposure**

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) ($mW/cm^2$) | Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes) |
|---|---|---|---|---|
| 0.3-1.34 | 614 | 1.63 | (100)* | 30 |
| 1.34-30 | 824/f | 2.19/f | $(180/f^2)$* | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | -- | -- | f/1500 | 30 |
| 1500-100,000 | -- | -- | 1.0 | 30 |

f = frequency in MHz *Plane-wave equivalent power density

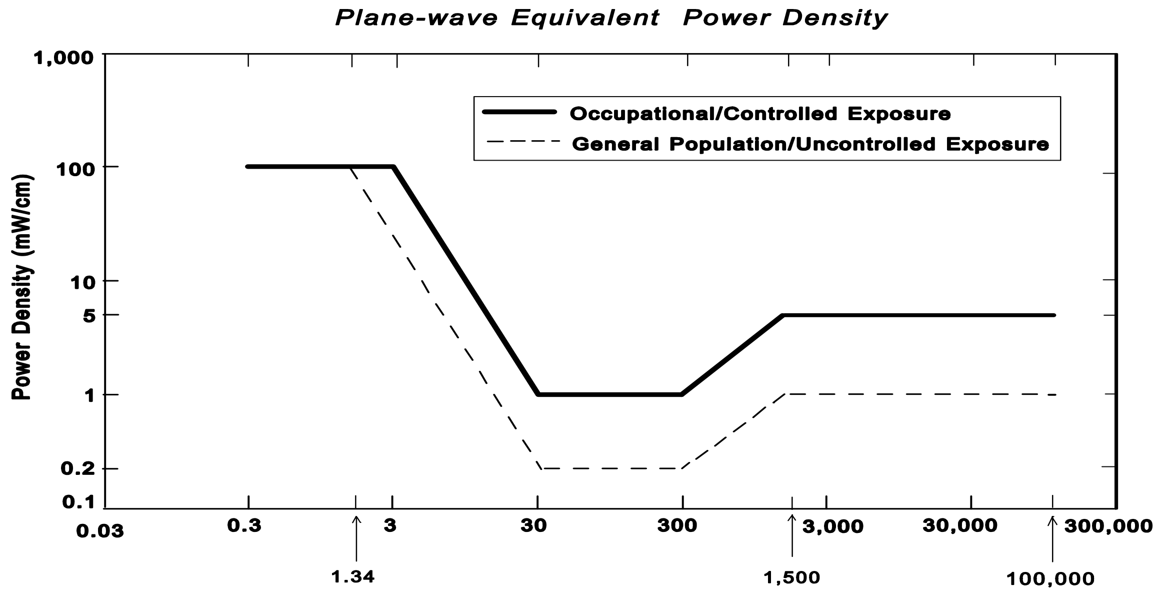
***General population/uncontrolled*** exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

Specific Absorption Rate (SAR) is the basis of most safety standards, when applied in the far-field, plane-wave conditions. It is the rate of energy absorption per unit of body mass. When the human body is exposed to the RF field, the SAR experienced is proportional to the squared value of the electric field strength induced in the body. At an absorption level of 4 W/kg, reversible behavioral disruption is noted. Levels above 5 W/kg can result in permanent adverse affects. Therefore, most standards have been based on SAR's of 0.4 W/kg to conservatively limit exposures to 1/10th of the levels to account for biological uncertainty and to add an additional safety factor.

Unfortunately, the Occupational Safety & Health Administration (OSHA) has not revised the standard since 1978 (see OSHA Regulations Standards - 29 CFR, Non-ionizing Radiation - 1910.97), but has already cited and fined organizations for exceeding the new standards. OSHA has the right to enforce based on consensus of scientifically-based standards under its general duty clause. **Nevertheless, OSHA uses 10 $mW/cm^2$ as the maximum SAR exposure over an averaged period of 6 minutes from continuous or intermittent RF sources between 10 MHz and 100 GHz.**

Figure 1, below presents the FCC Limits for Maximum Permissible Exposure (MPE) in units of Power Density (mW/cm²):

**Figure 1.** **FCC Limits for Maximum Permissible Exposure (MPE)**




**This completes the *Future NSLS-II Brookhaven Labs EMI/RFI Site Assessment Study.***

Best regards,

Louis S. Vitale, Jr.
President & Chief Engineer

Attachments: Figures #1 - #7.

**Figure #1, NSLS-II Brookhaven National Labs Proposed Site Hatch Plots AC ELF Magnetic Flux Density Levels @ 1-meter - Upton, Long Island, New York**

***Refer To Figure #2 for Profile Plots of Hatch Data***

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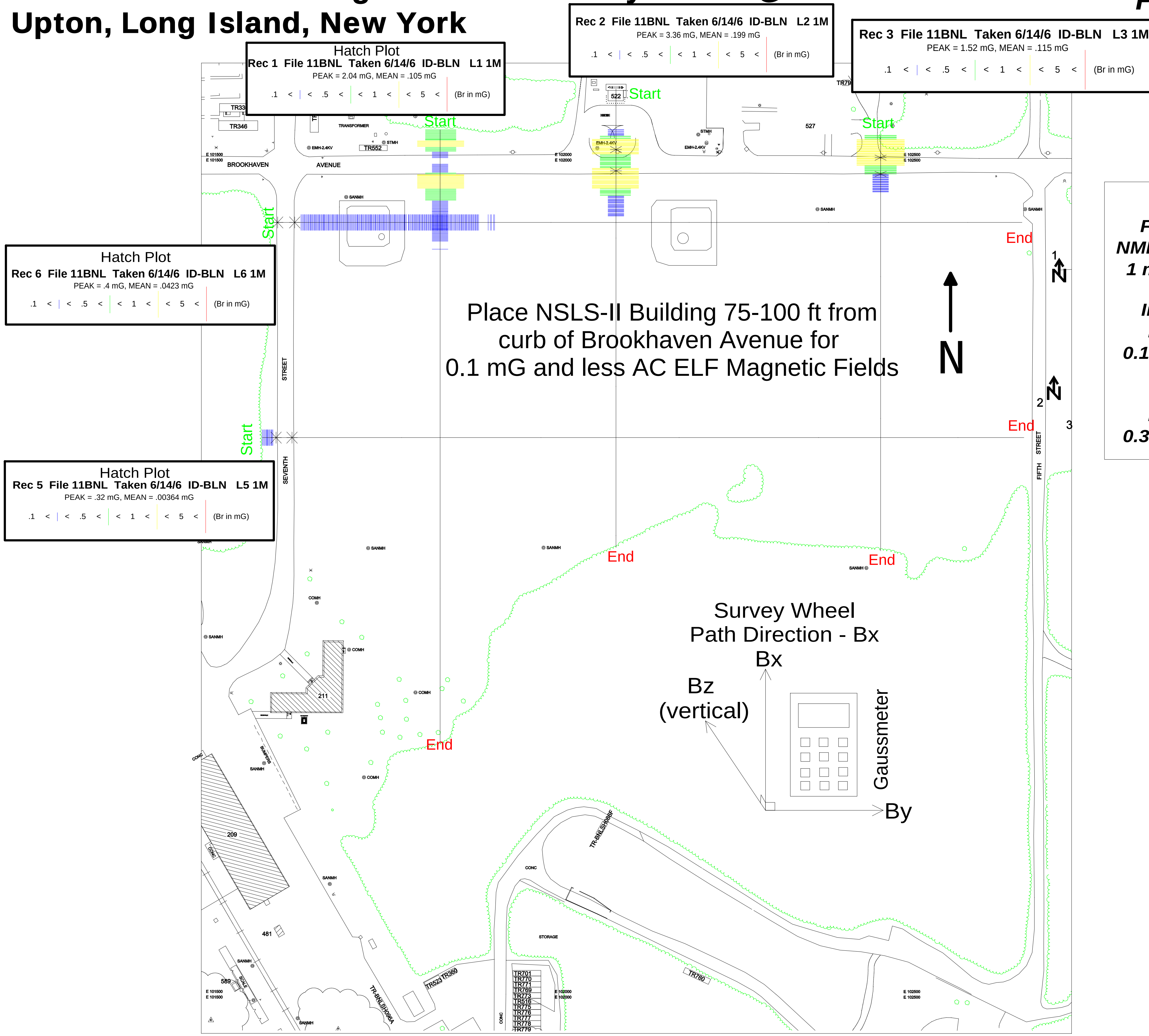


***EMI AC & DC Magnetic Field Performance Specs***
***NMR Maximum Requirement:***
***1 mG Br RMS (2.83 mG p-p)***

***Instrument & Quite Labs Maximum Requirement:***
***0.1 mG Br RMS (0.3 mG p-p)***

***Cleanrooms Maximum Requirement:***
***0.3 mG Br RMS (0.1 mG p-p)***

## AC ELF Magnetic Field Human Exposure Standards

NYS Public Service Commission
200 mG @ 1-meter on Edge -ROW
or 50 ft. from 69 kV poles

IRPA/INIRC
833 mG over 24 hours
General Public Exposure

ACGIH
1000 mG general public
& workers with cardia pacemakers

Swiss Bunderstat
NCRP Draft Report
10 mG from overhead/underground
transmission/distribution lines,
substations, etc.

*All magnetic flux density data recorded with a FieldStar 1000 gaussmeter and survey wheel.*

## AC ELF EMI Thresholds (screen jitter & noise)

**10 mG for 12-15 inch CRT computer monitors & audio/video equipment**
**5 mG for 17-21 inch CRT monitors & medical (i.e., EEGs, ECGs, EMGs,. etc.).**
**1.0 mG for standard scientific tools (STEMs, TEMs, FIB, I-Beam, etc.)**
**0.1- 0.3 mG for high resolution Nanotech scientific tools**
**0.01 mG for optimum superhigh resolution STEM tools**

SEMI E33-94 AC ELF EMC Standards
Level A - less than 0.25 mG
Level B - less than 0.50 mG
Level C - less than 1.00 mG
Level D - less than 2.00 mG
Level E - 2.0 mG and greater

# Figure #2, NSLS-II Brookhaven National Labs Proposed Site
# Profile Plots of Hatch Data AC ELF Magnetic Flux Density Levels @ 1-meter - Upton, Long Island, New York

***Refer To Figure #1 for Hatch Plots of Profile Data***

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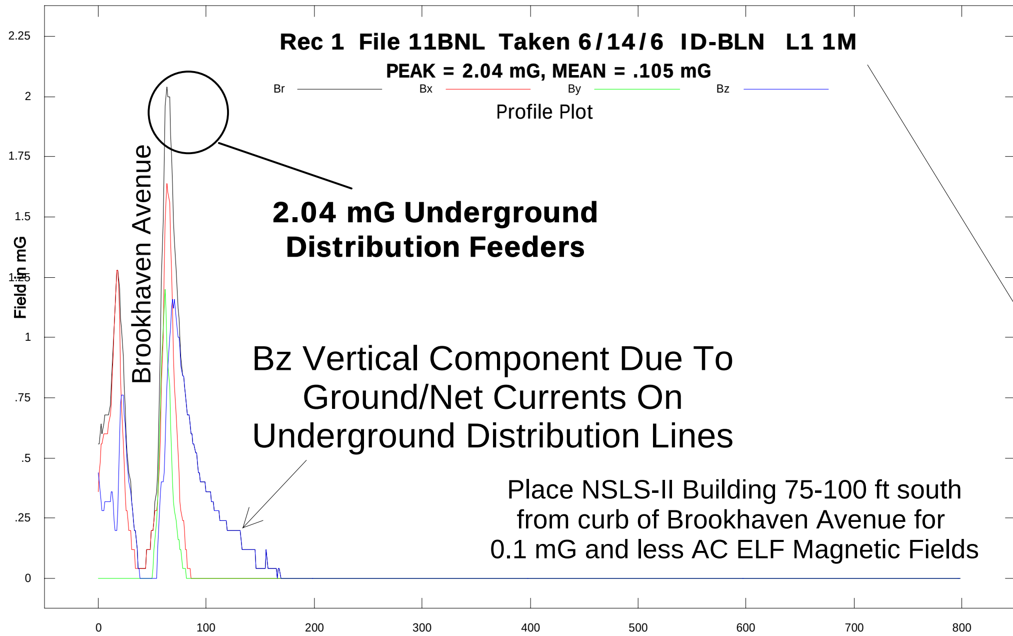
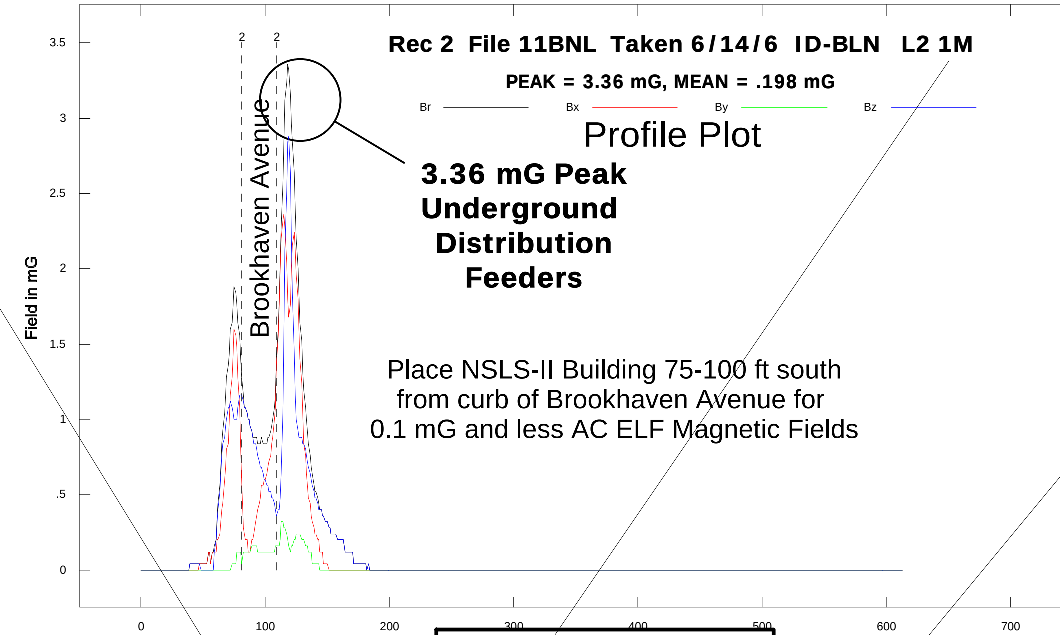
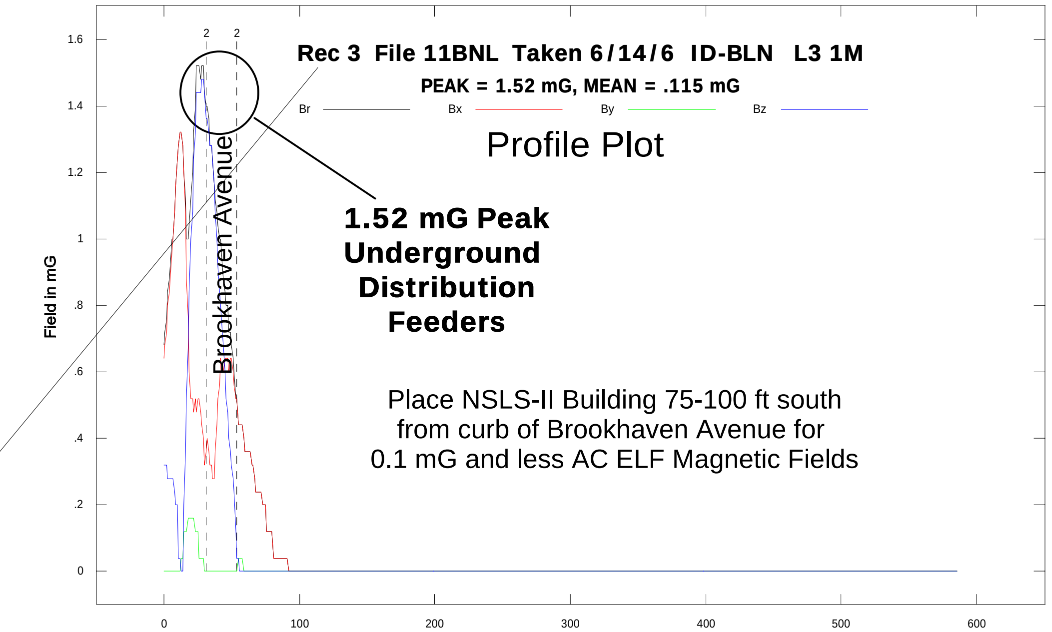
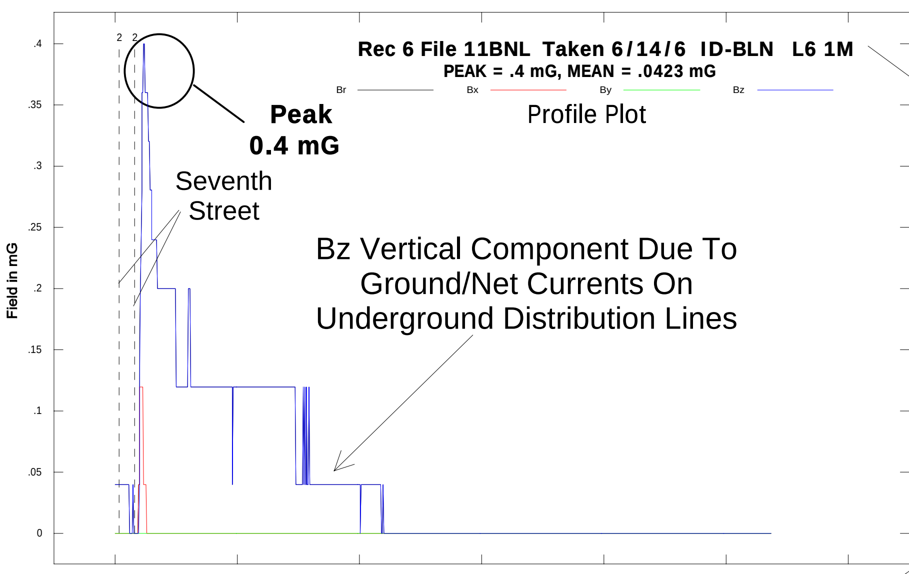
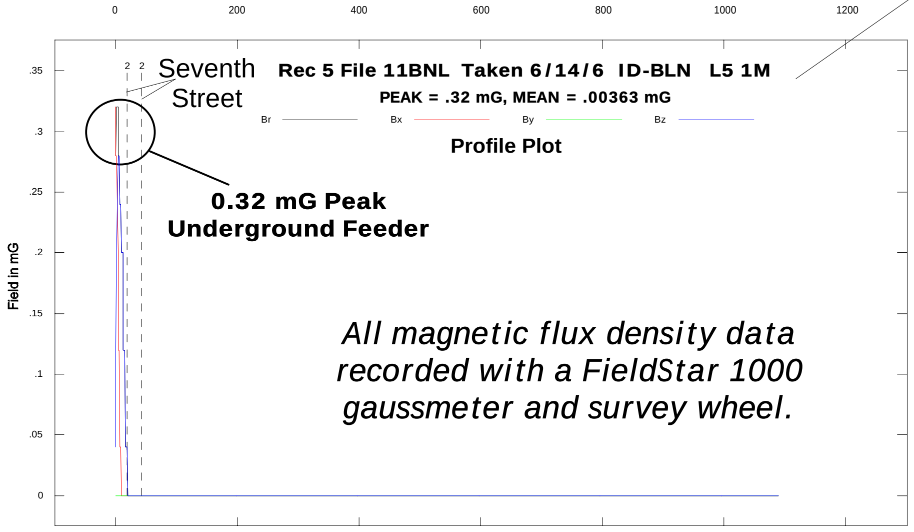
Fredericksburg, Va

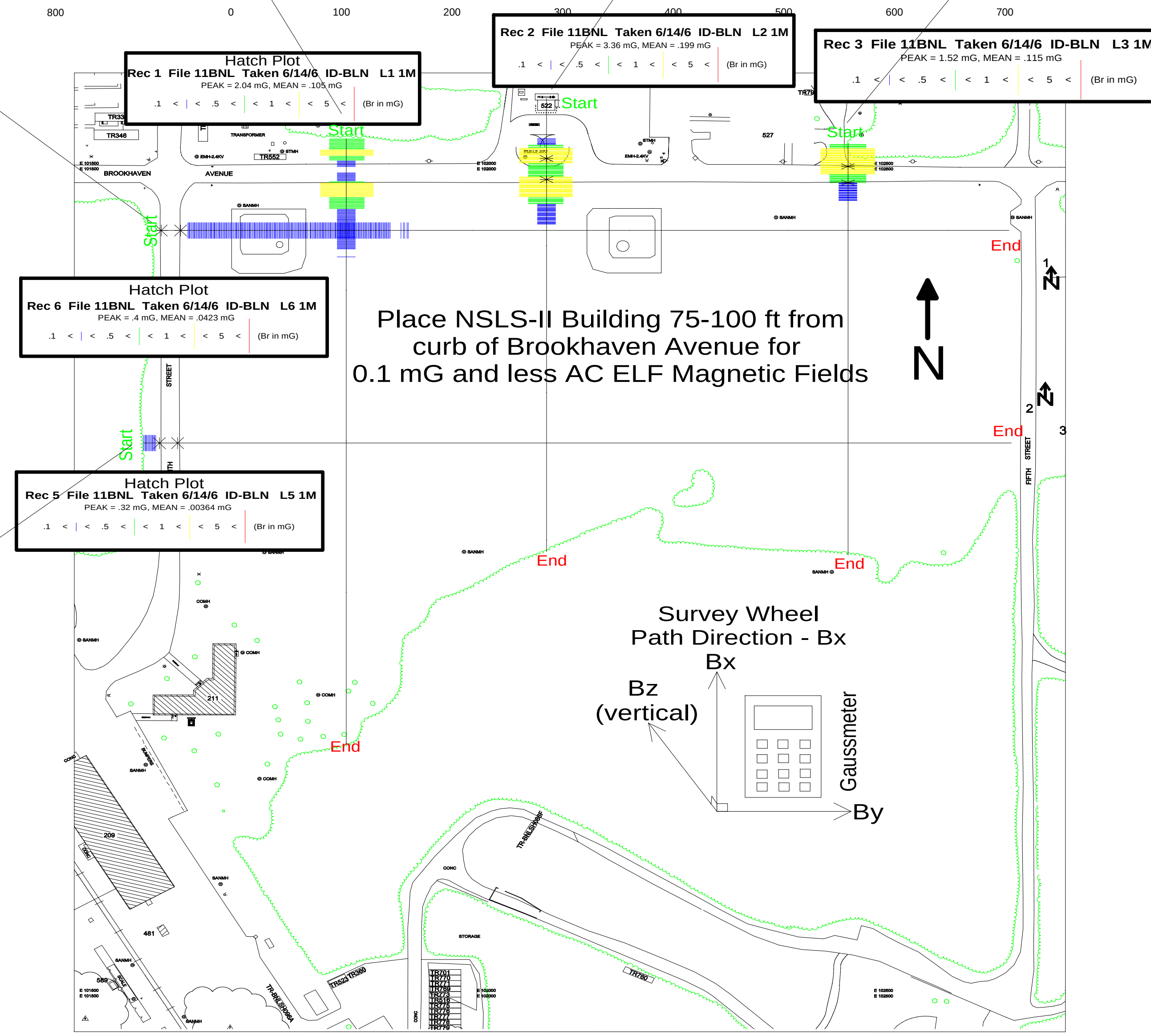



***EMI AC & DC Magnetic Field Performance Specs***

***NMR Maximum Requirement: 1 mG Br RMS (2.83 mG p-p)***

***Instrument & Quite Labs Maximum Requirement: 0.1 mG Br RMS (0.3 mG p-p)***

***Cleanrooms Maximum Requirement: 0.3 mG Br RMS (0.1 mG p-p)***

## AC ELF Magnetic Field Human Exposure Standards

NYS Public Service Commission
200 mG @ 1-meter on Edge -ROW or 50 ft. from 69 kV poles

IRPA/INIRC
833 mG over 24 hours
General Public Exposure

ACGIH
1000 mG general public & workers with cardia pacemakers

Swiss Bunderstat
NCRP Draft Report
10 mG from overhead/underground transmission/distribution lines, substations, etc.

## AC ELF EMI Thresholds (screen jitter & noise)

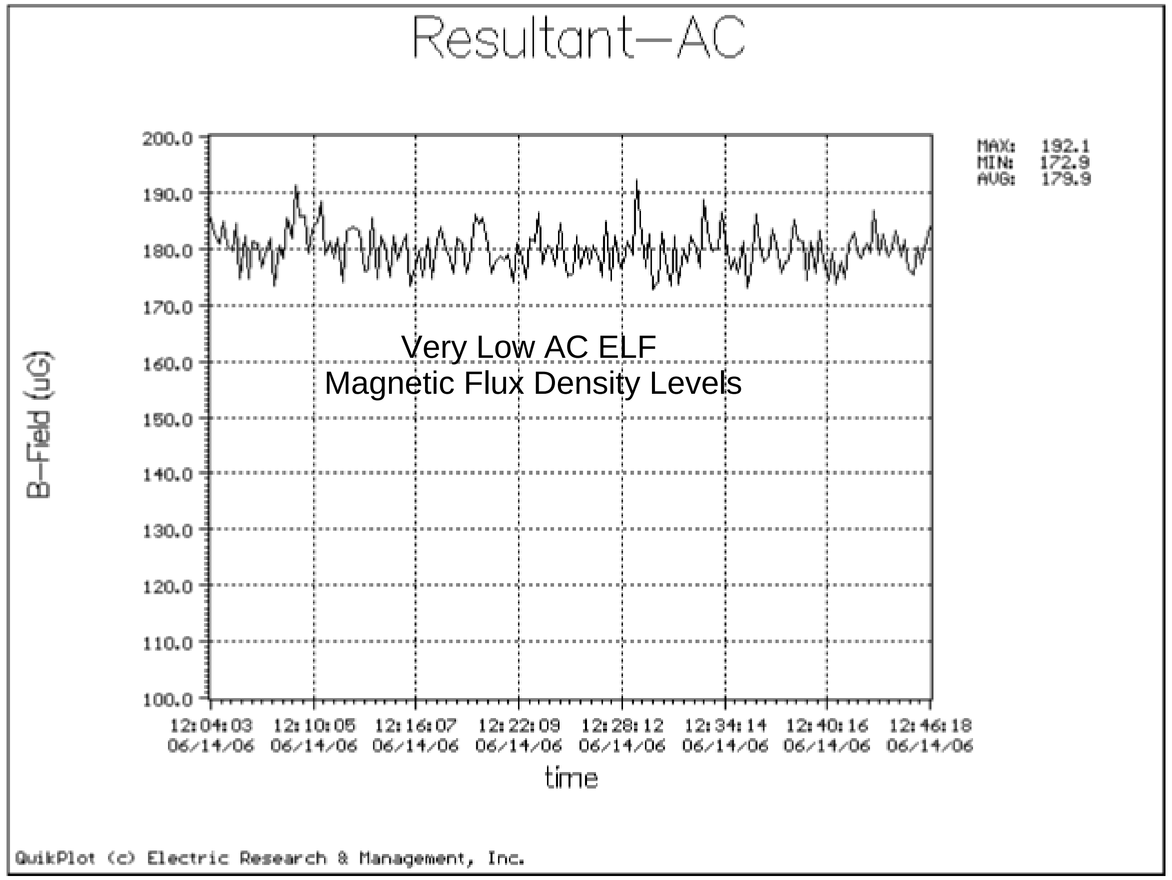
**10 mG for 12-15 inch CRT computer monitors & audio/video equipment**
**5 mG for 17-21 inch CRT monitors & medical (i.e., EEGs, ECGs, EMGs,. etc.).**
**1.0 mG for standard scientific tools (STEMs, TEMs, FIB, I-Beam, etc.)**
**0.1- 0.3 mG for high resolution Nanotech scientific tools**
**0.01 mG for optimum superhigh resolution STEM tools**

<u>SEMI E33-94 AC ELF EMC Standards</u>

Level A - less than 0.25 mG
Level B - less than 0.50 mG
Level C - less than 1.00 mG
Level D - less than 2.00 mG
Level E - 2.0 mG and greater

# Figure #3, NSLS-II Brookhaven National Labs Proposed Site
# Timed AC ELF (0.3 Hz - 3,000 Hz) Magnetic Flux Density Levels @ 1-meter
# Upton, Long Island, New York

VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va




**AC ELF Magnetic Field Human Exposure Standards**

NYS Public Service Commission
200 mG @ 1-meter on Edge -ROW
or 50 ft. from 69 kV poles

IRPA/INIRC
833 mG over 24 hours
General Public Exposure

ACGIH
1000 mG general public
& workers with cardia pacemakers

Swiss Bunderstat
NCRP Draft Report
10 mG from overhead/underground
transmission/distribution lines,
substations, etc.

***EMI AC & DC Magnetic Field Performance Specs***

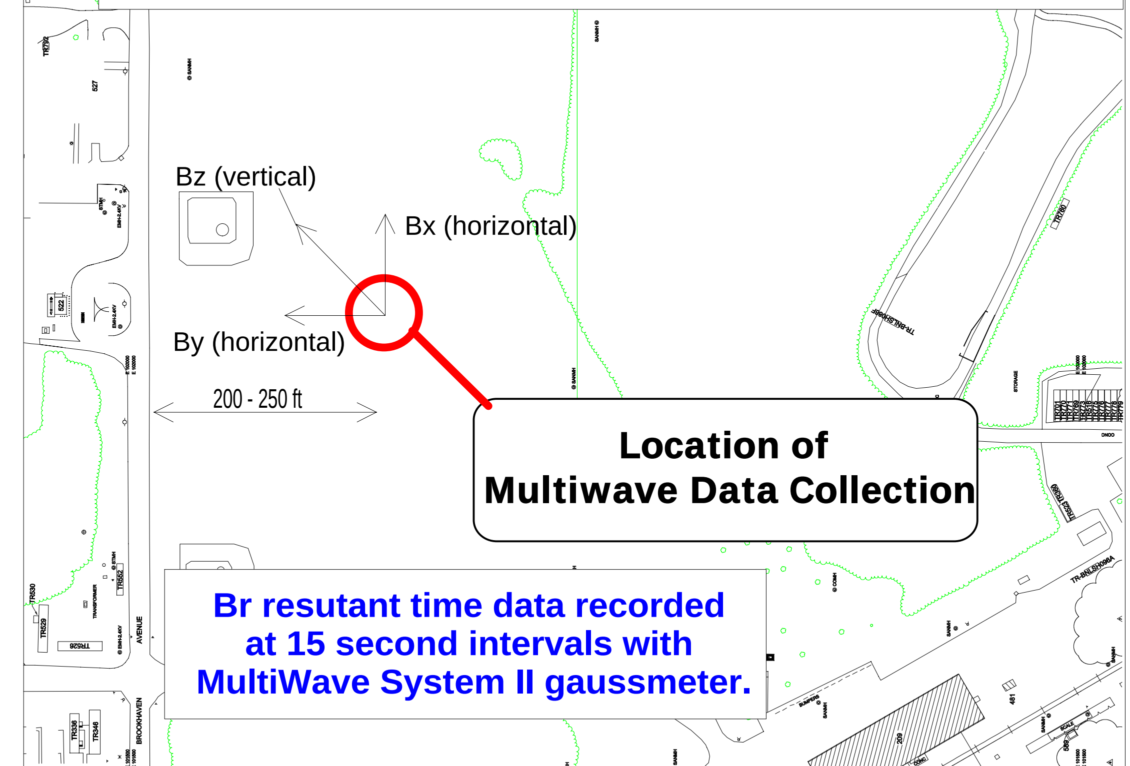
***NMR Maximum Requirement:***
***1 mG Br RMS (2.83 mG p-p)***

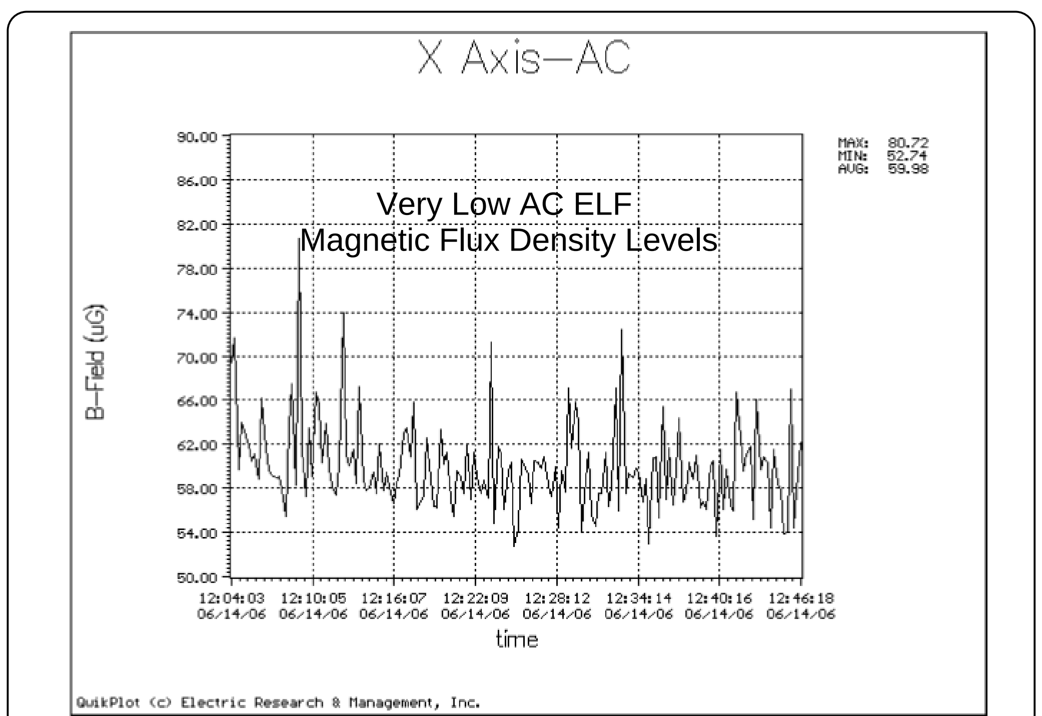
***Instrument & Quite Labs Maximum Requirement:***
***0.1 mG Br RMS (0.3 mG p-p)***

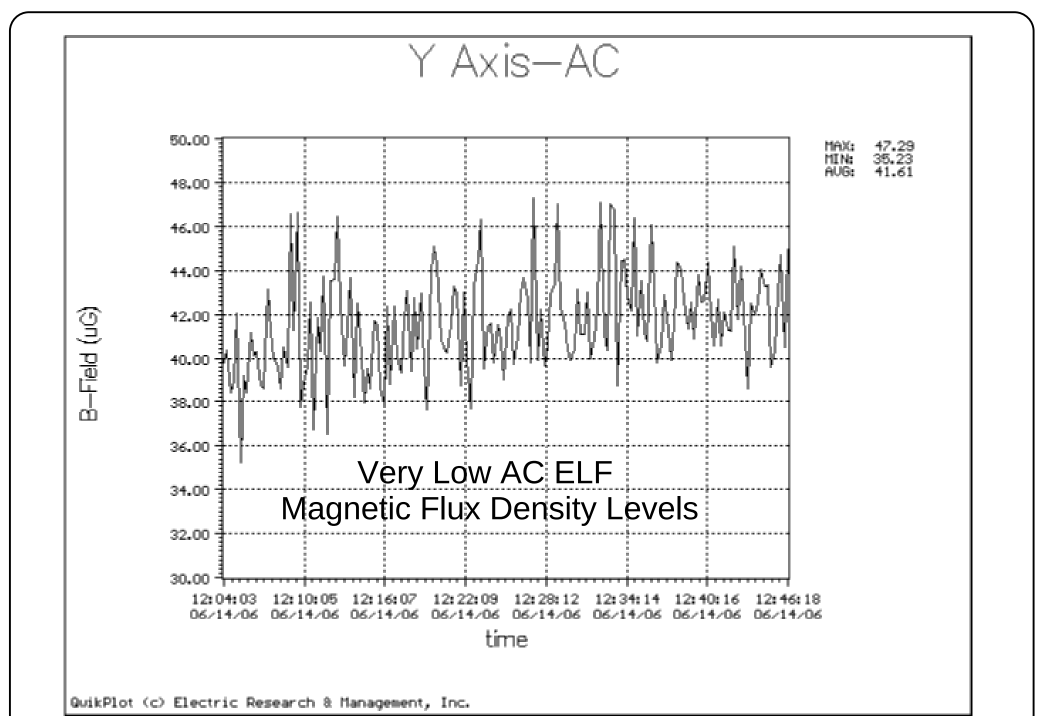
***Cleanrooms Maximum Requirement:***
***0.3 mG Br RMS (0.1 mG p-p)***

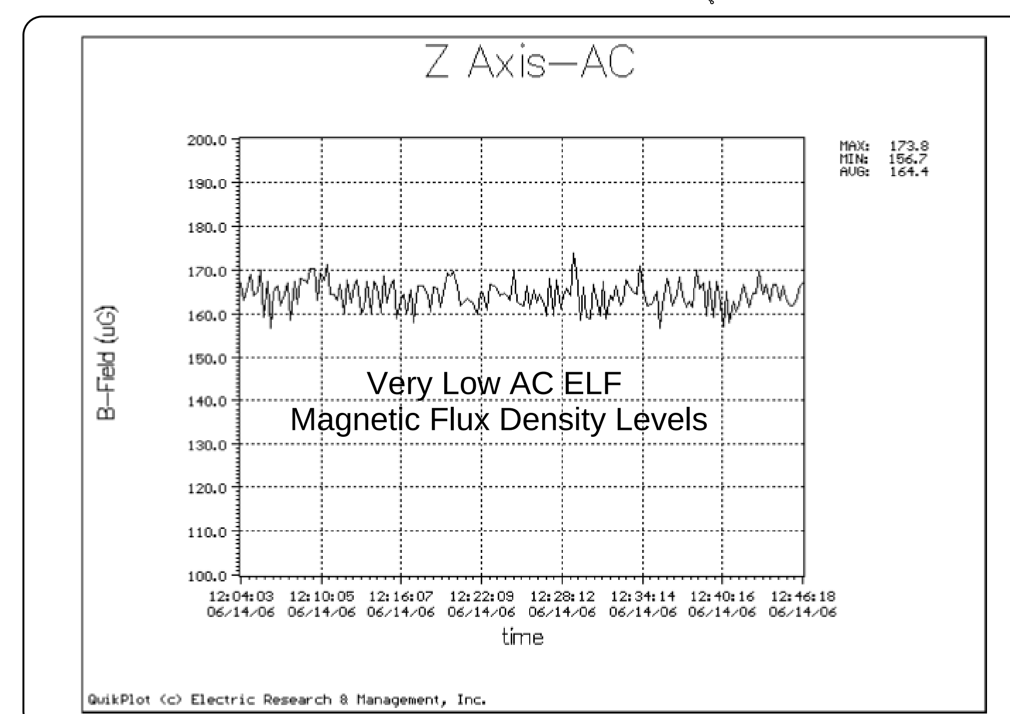
## AC ELF EMI Thresholds (screen jitter & noise)

**10 mG for 12-15 inch CRT computer monitors & audio/video equipment**
**5 mG for 17-21 inch CRT monitors & medical (i.e., EEGs, ECGs, EMGs,. etc.).**
**1.0 mG for standard scientific tools (STEMs, TEMs, FIB, I-Beam, etc.)**
**0.1- 0.3 mG for high resolution Nanotech scientific tools**
**0.01 mG for optimum superhigh resolution STEM tools**



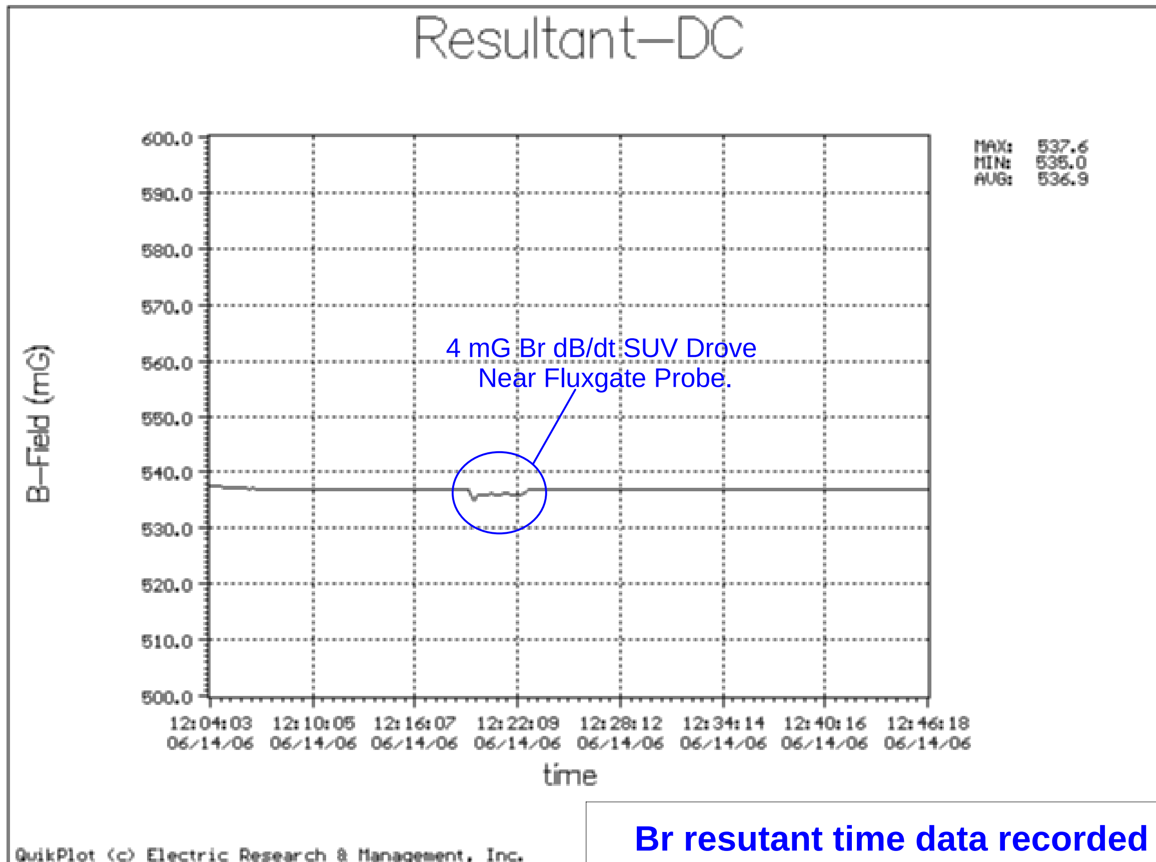
# Figure #4, NSLS-II Brookhaven National Labs Proposed Site
# Timed DC (0 Hz - 0.3 Hz) Magnetic Flux Density Levels @ 1-meter
# Upton, Long Island, New York


VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va


**DC EMI Thresholds - CRT screen shift, noise & coercivity (data errors)**

0.001 Gauss & Less SEMs, TEMs E-Beam/FIB Writers
0.75 Gauss CRT Monitors & Electronic Instruments
5 Gauss Cardiac Pacemakers & Implantable Devices Warning Sign
10 Gauss Credit Cards & Magnetic Media Warning Sign
300 Gauss Low Coercivity Mag-Stripe Cards
700 Gauss High Coercivity Mag-Sripe Cards & Video Tapes

***1000 milligauss (mG) = 1 Gauss (G) & 1 mG = 0.001 G = 0.1 uT (microtesla)***

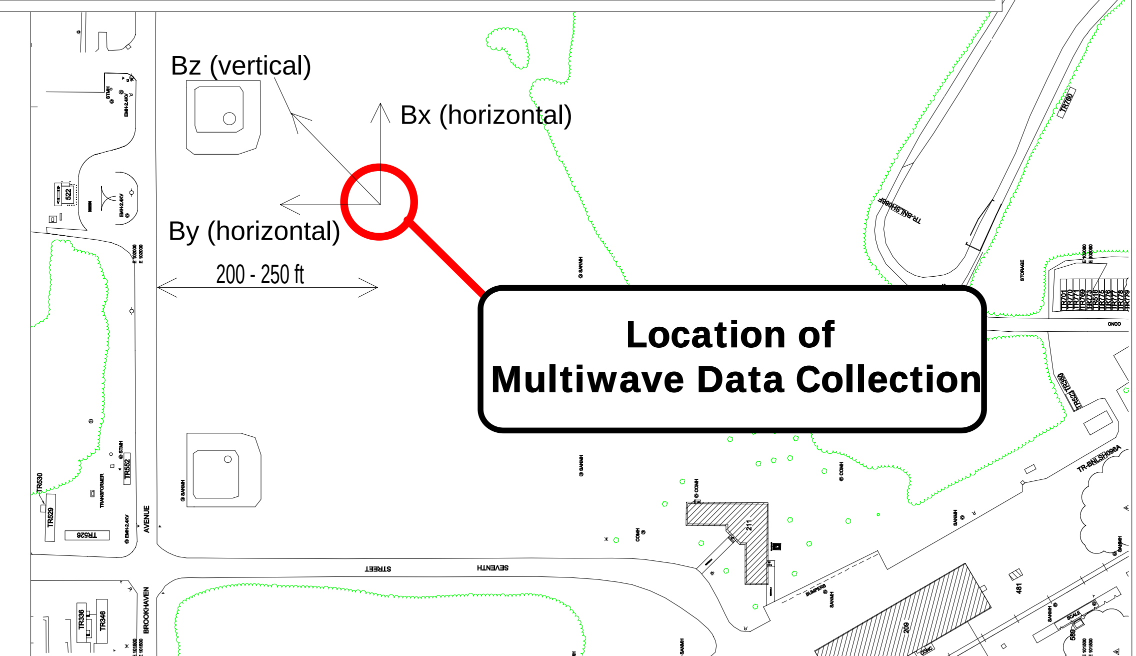


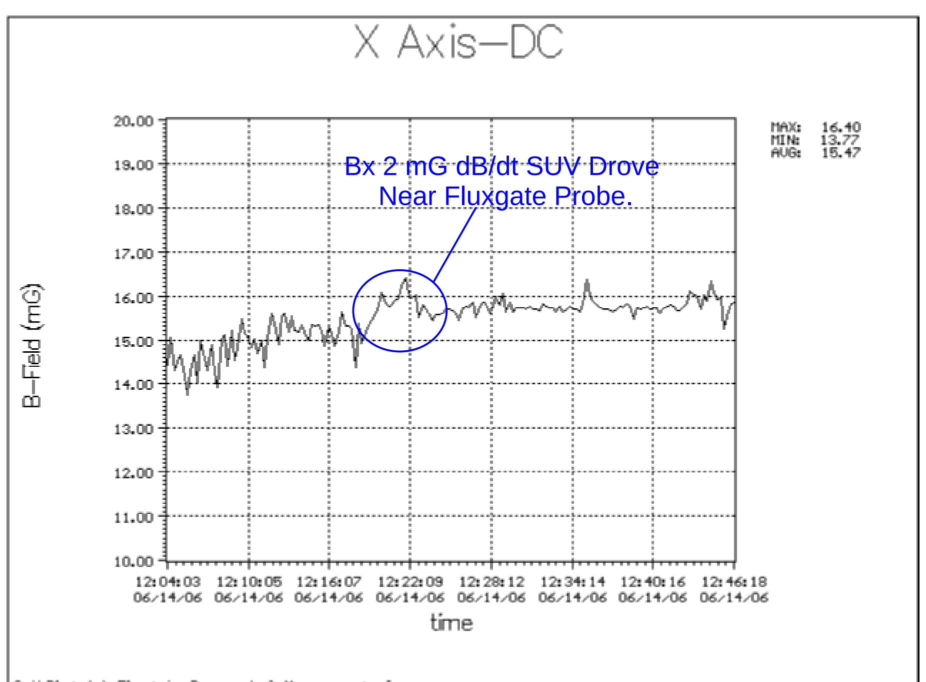

**Br resutant time data recorded at 15 second intervals with MultiWave System II gaussmeter.**

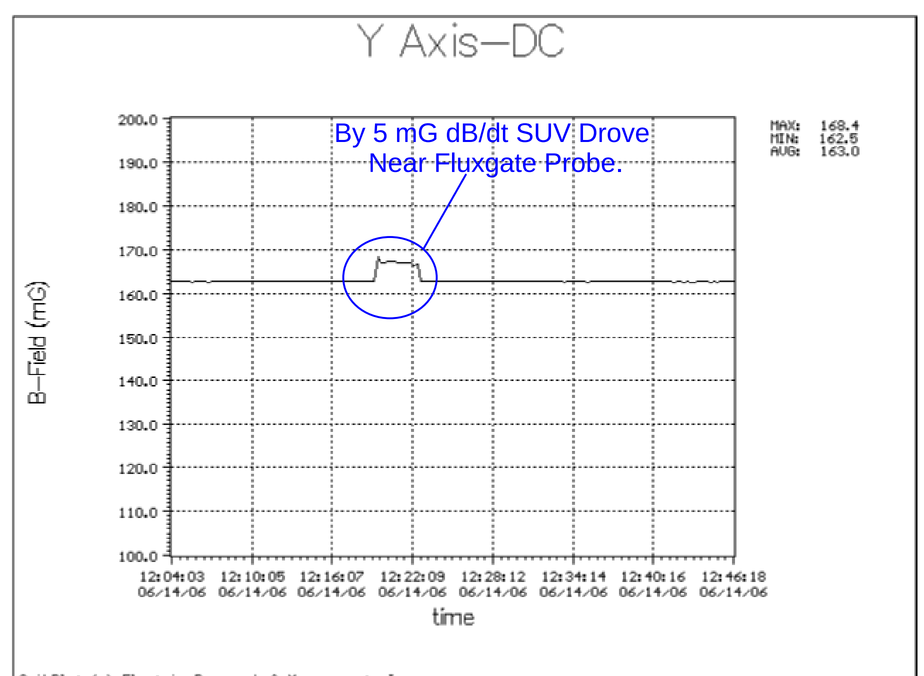
***EMI AC & DC Magnetic Field Performance Specs***
***NMR Maximum Requirement: 1 mG Br RMS (2.83 mG p-p)***

***Instrument & Quite Labs Maximum Requirement: 0.1 mG Br RMS (0.3 mG p-p)***

***Cleanrooms Maximum Requirement: 0.3 mG Br RMS (0.1 mG p-p)***



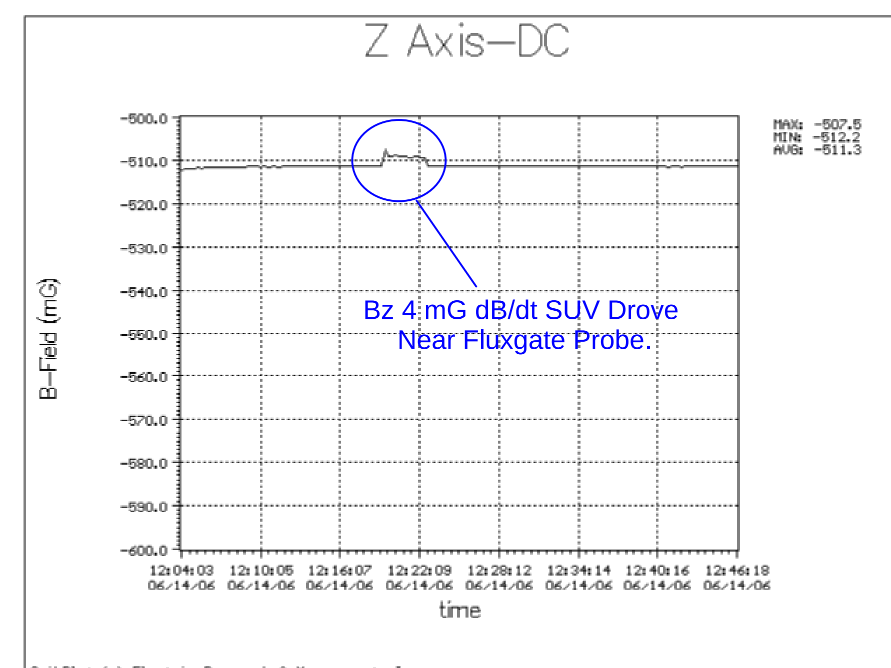
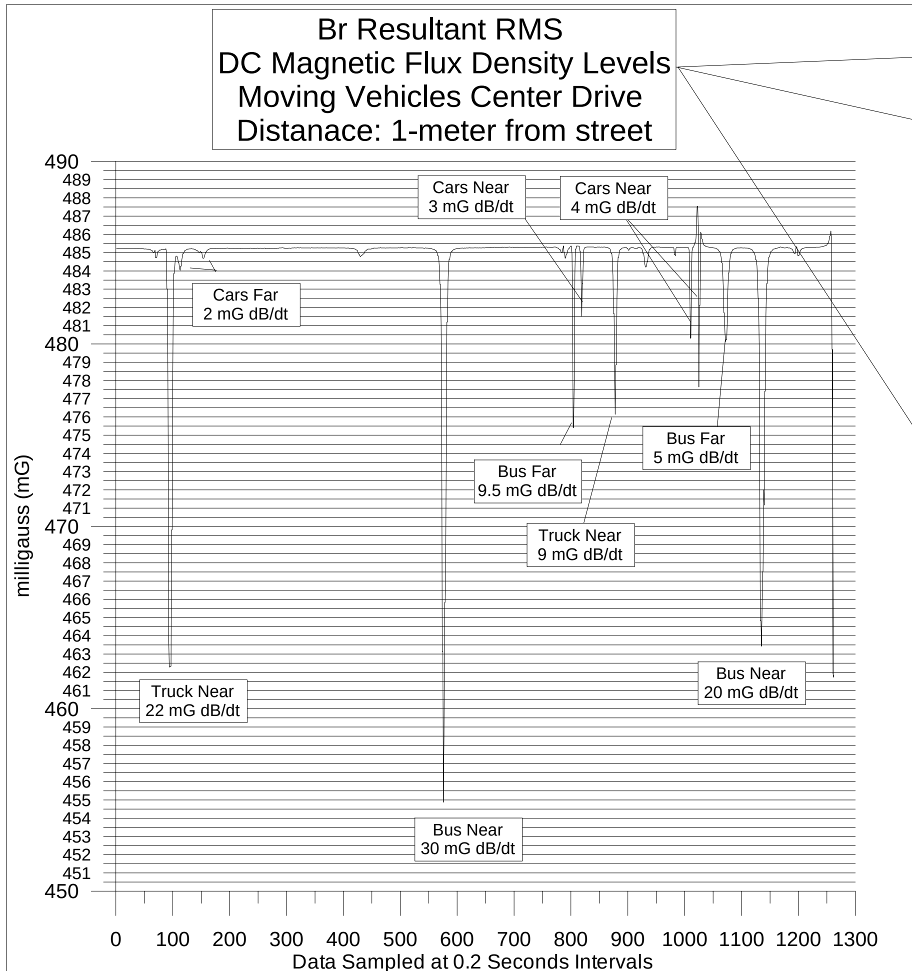
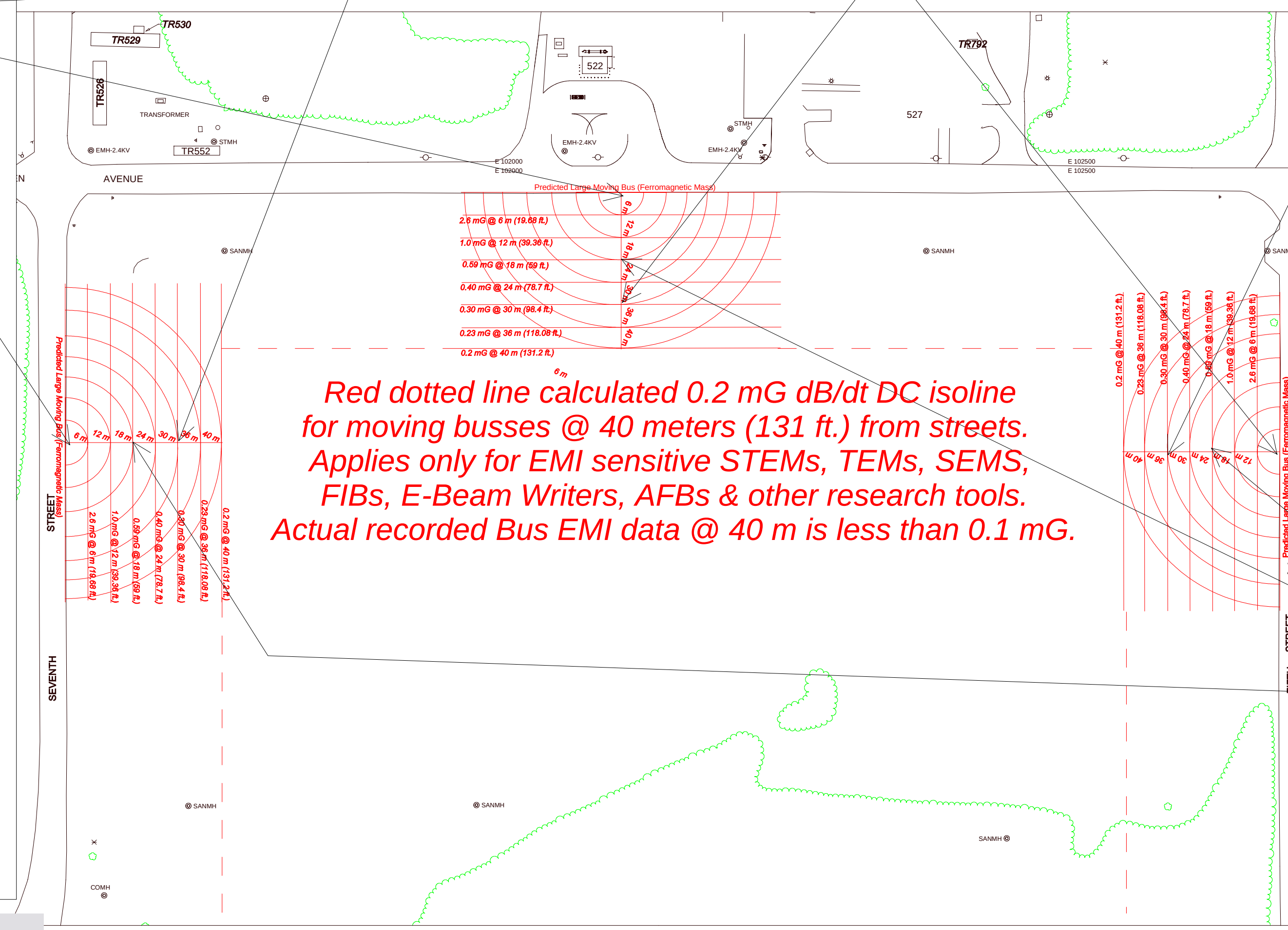
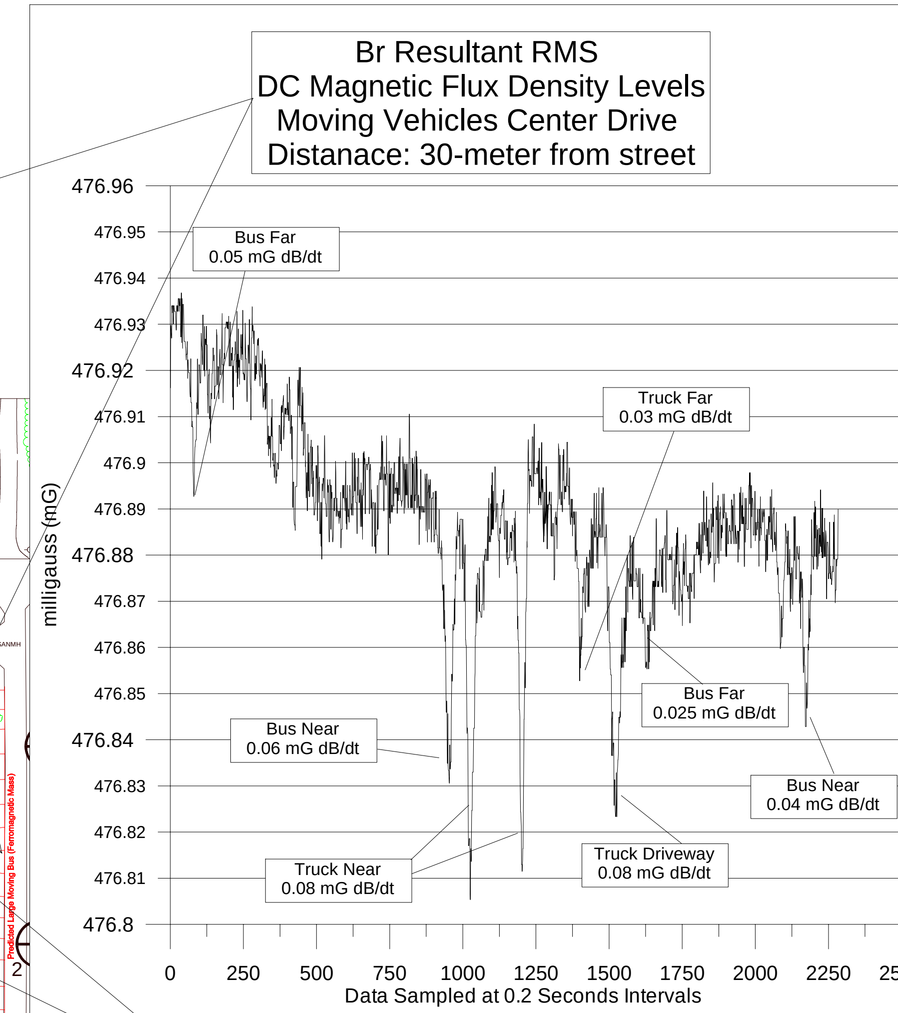



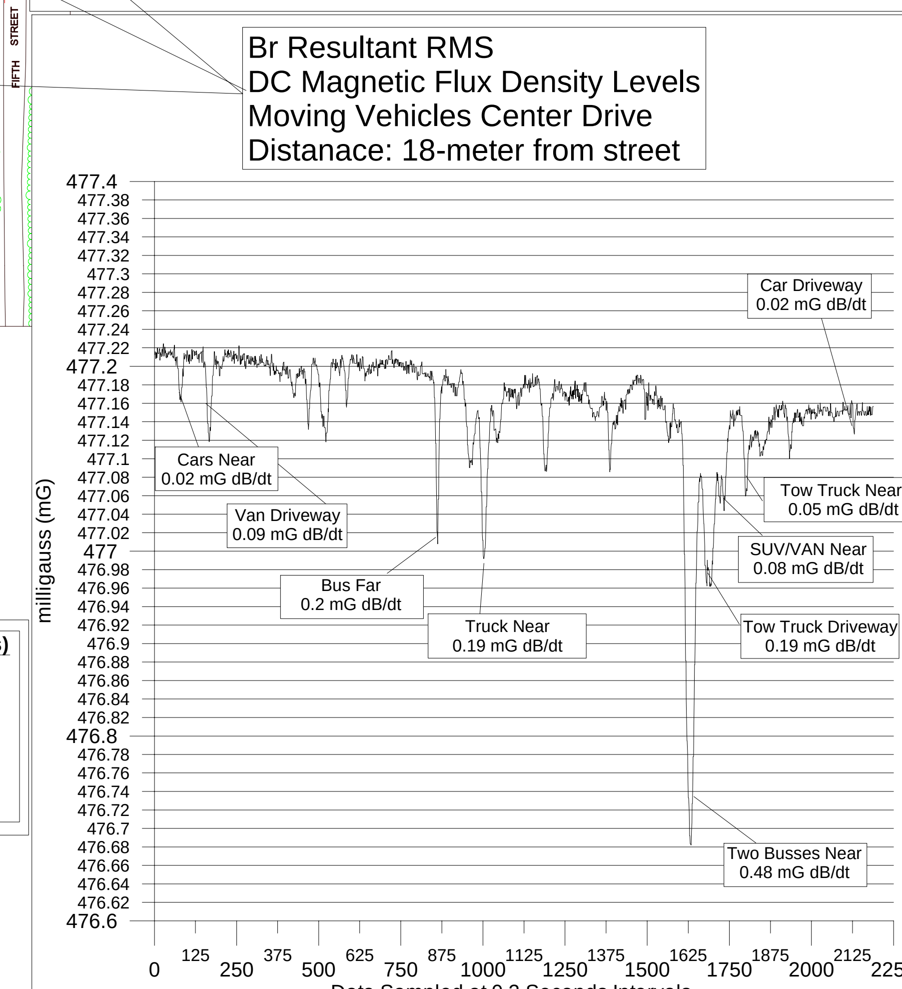
Figure #5, Comparison Recorded & Predicted Moving Vehicle DC Magnetic Emissions
DC magnetic flux density data recorded at 0.2 second intervals
University of Florida DC EMI Data
Nanoscience Institute for Medical & Engineering Technology (NIMET)
Nanoscale Research Facility (NRF), University of Florida
Overlayed on NSLS-II Brookhaven National Labs Proposed Site

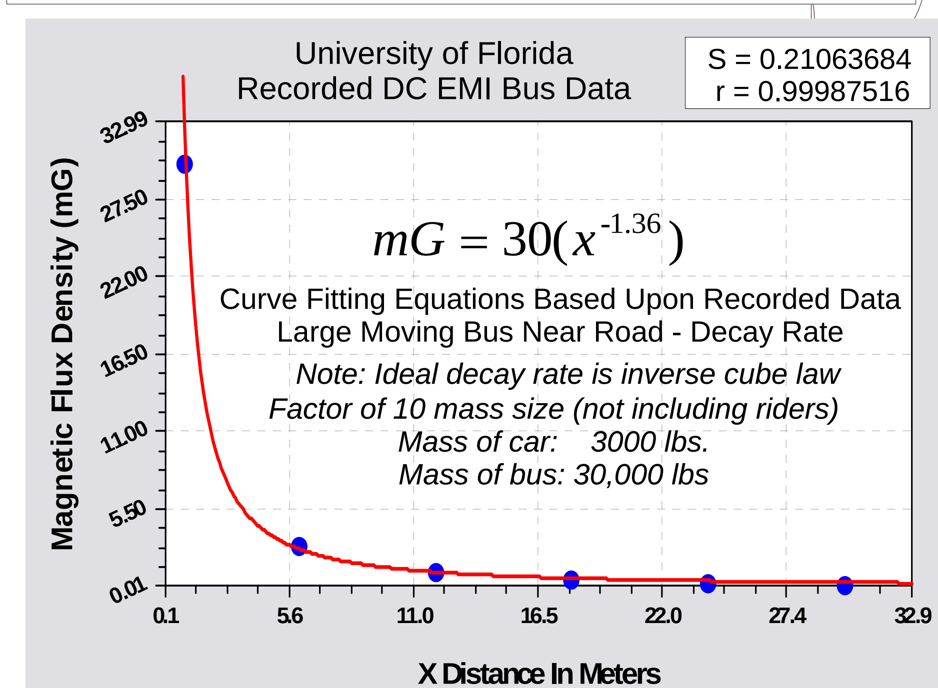
*Timed DC magnetic flux density levels recorded with MEDA FVM-400 three-axis fluxgate magnetometer (bandwidth DC - 5 Hz and 0.01 mG resolution, 1200 mG maximum) Data recorded on October 6, 2004*




## Calculated Vehicle Profiles

| Distance | Car | Bus |
|---|---|---|
| 1 m | 3.50 mG | 30.0 mG |
| 6 m | 0.48 mG | 2.6 mG |
| 12 m | 0.22 mG | 1.0 mG |
| 18 m | 0.15 mG | 0.59 mG |
| 24 m | 0.11 mG | 0.40 mG |
| 30 m | 0.08 mG | 0.30 mG |
| 36 m | 0.07 mG | 0.23 mG |
| 40 m | 0.06 mG | 0.20 mG |

*Special Note: magnetic fields decay more rapidly after 30 meters than the calculated levels indicate.*

**DC EMI Thresholds - CRT screen shift, noise & coercivity (data errors)**

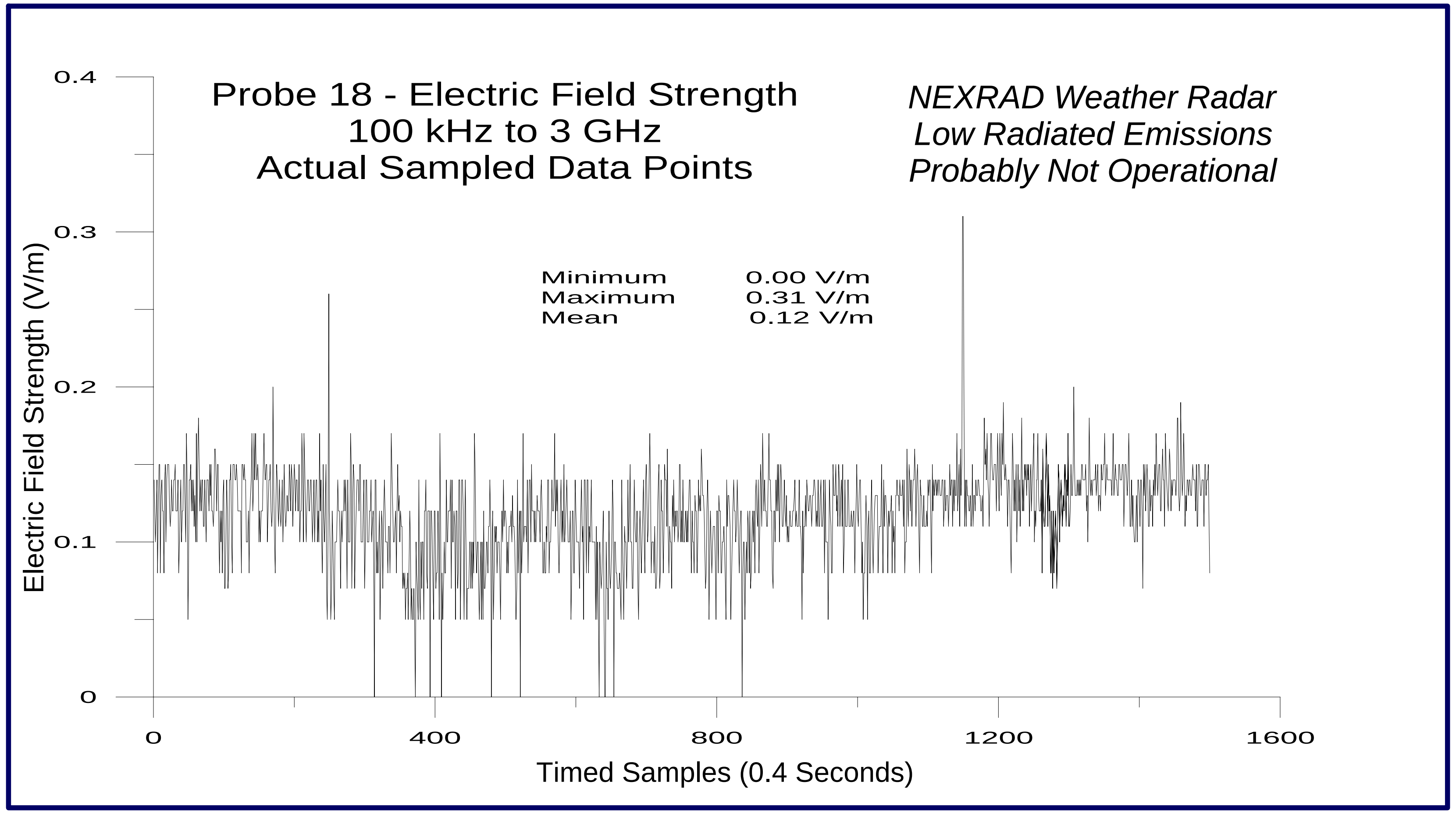
0.001 Gauss & Less SEMs, TEMs E-Beam/FIB Writers
0.75 Gauss CRT Monitors & Electronic Instruments
5 Gauss Cardiac Pacemakers & Implantable Devices Warning Sign
10 Gauss Credit Cards & Magnetic Media Warning Sign
300 Gauss Low Coercivity Mag-Stripe Cards
700 Gauss High Coercivity Mag-Sripe Cards & Video Tapes

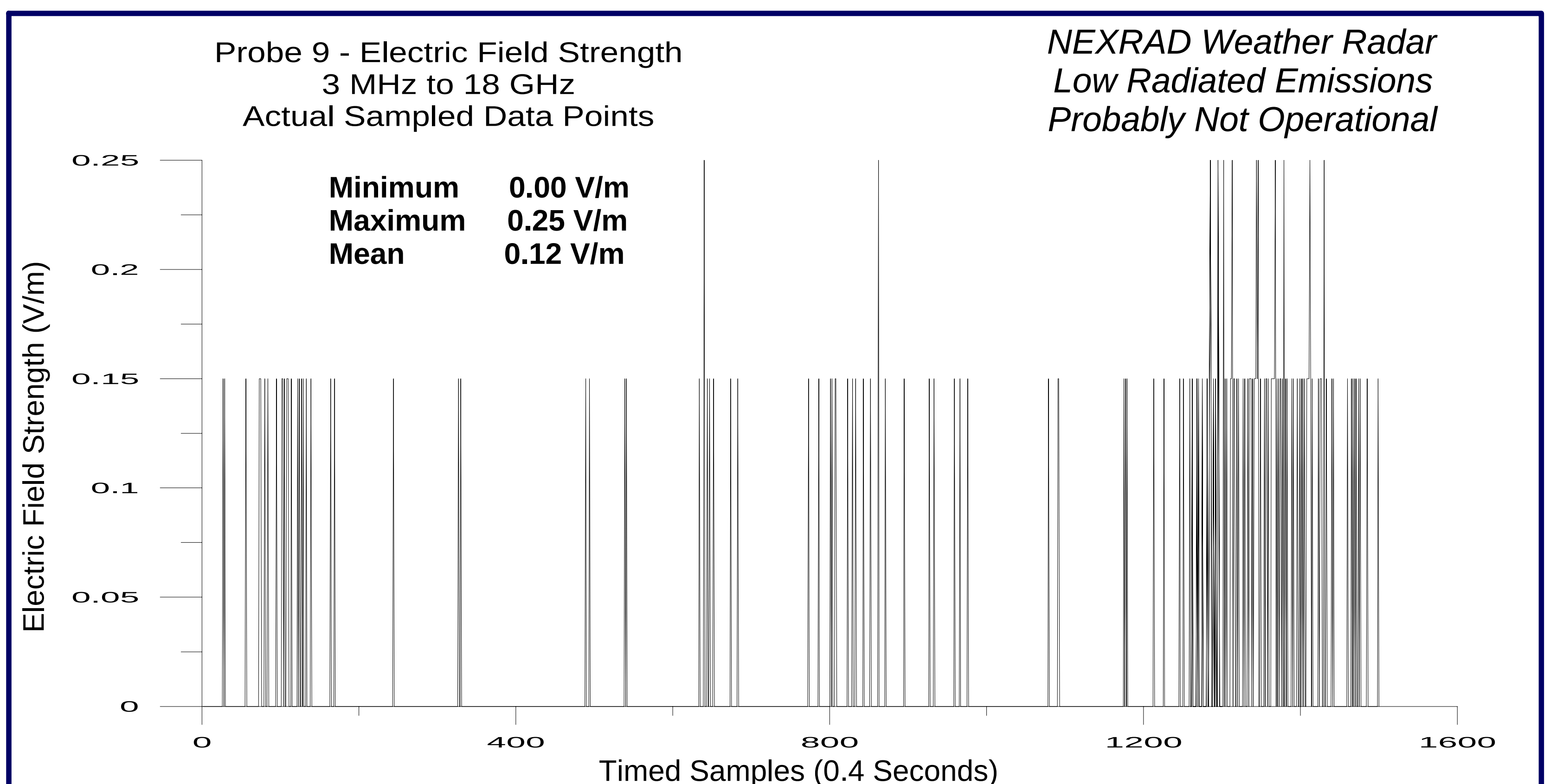
***1000 milligauss (mG) = 1 Gauss (G) & 1 mG = 0.001 G = 0.1 uT (microtesla)***

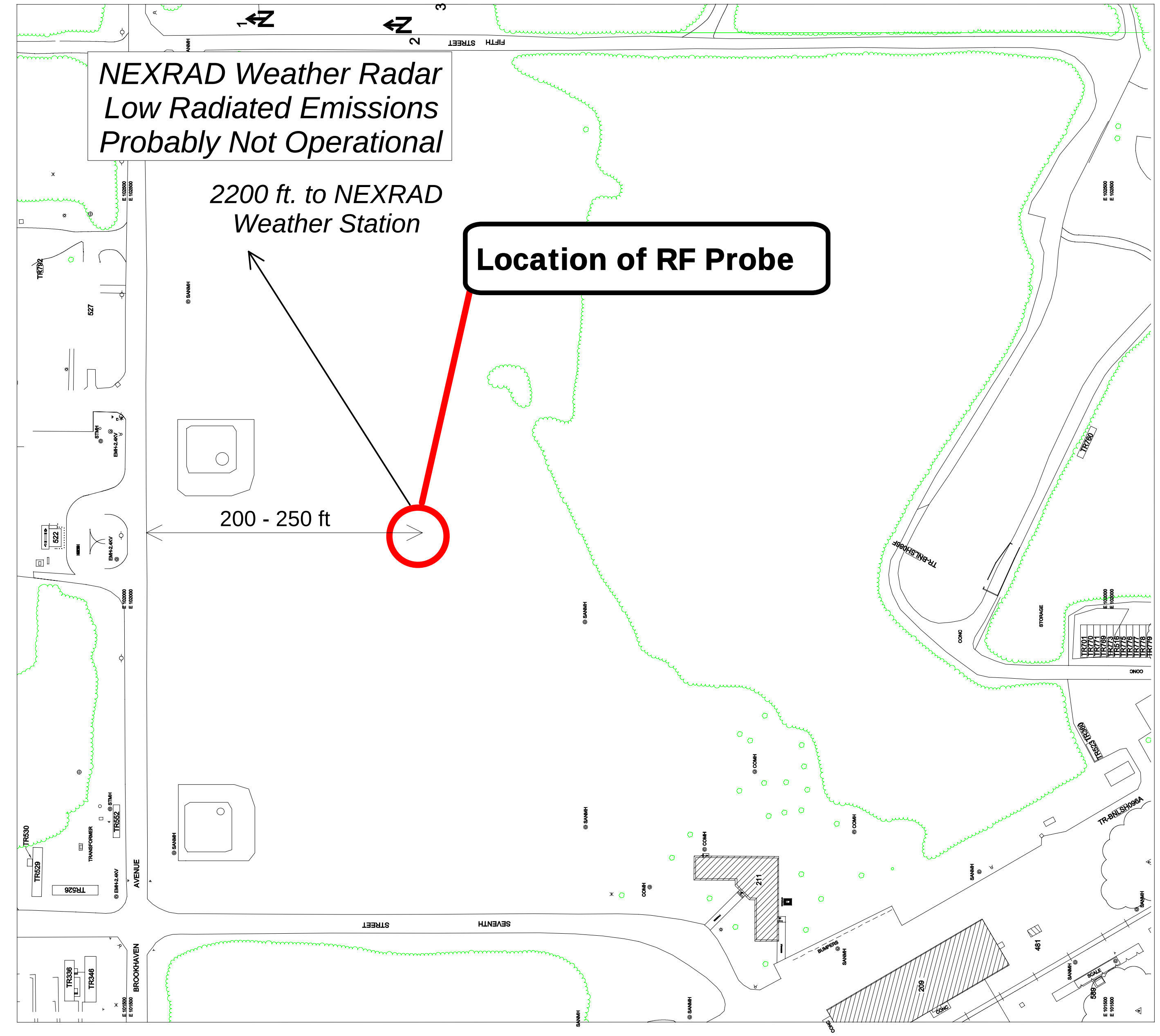
VitaTech Engineering, LLC
Fredericksburg, VA
July 20, 2006

VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va

# Figure #6, NSLS-II Brookhaven National Labs Proposed Site 100 kHz to 18 GHz Timed RF Electric Field Strength Data Upton, Long Island, New York



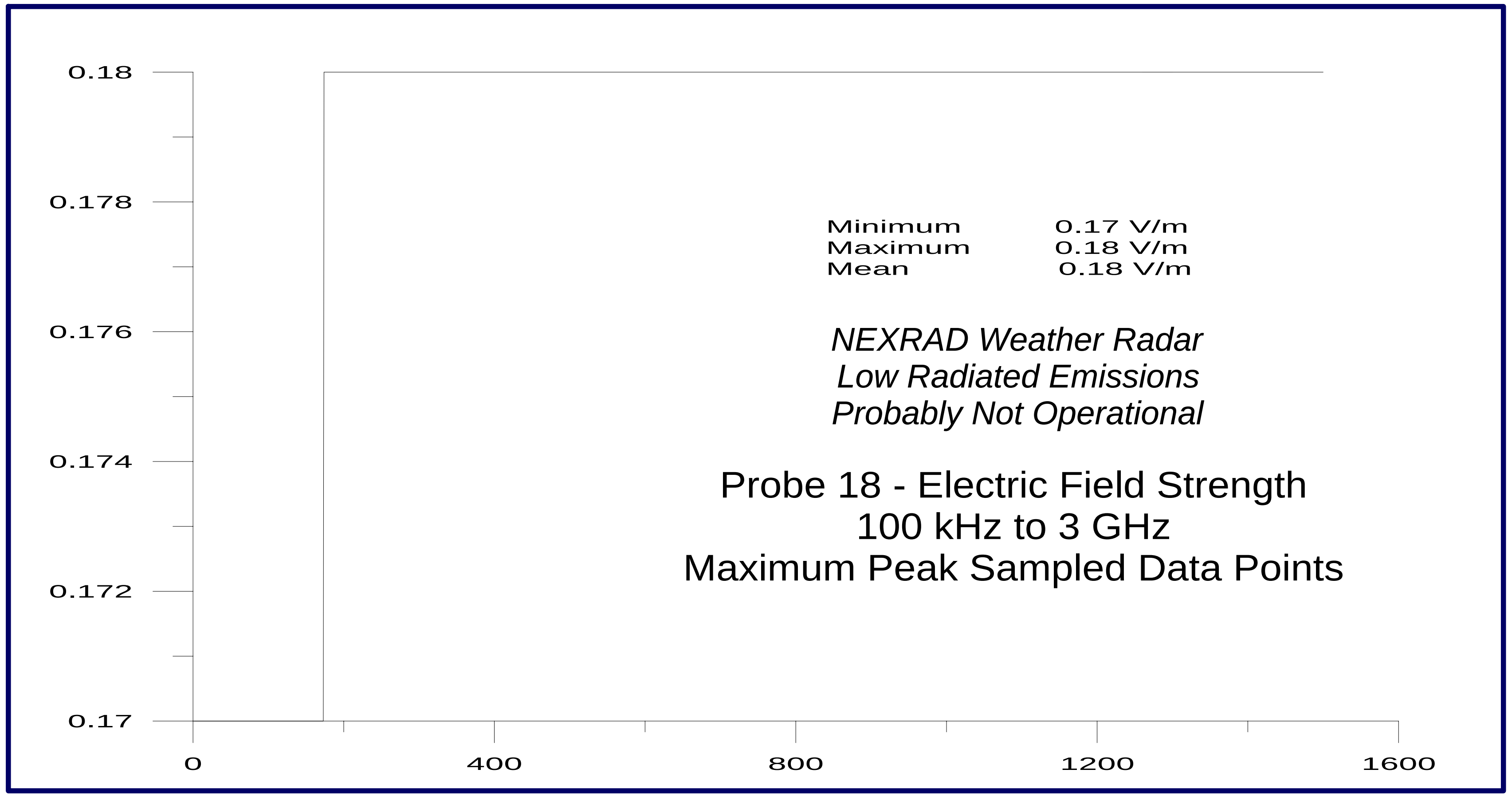



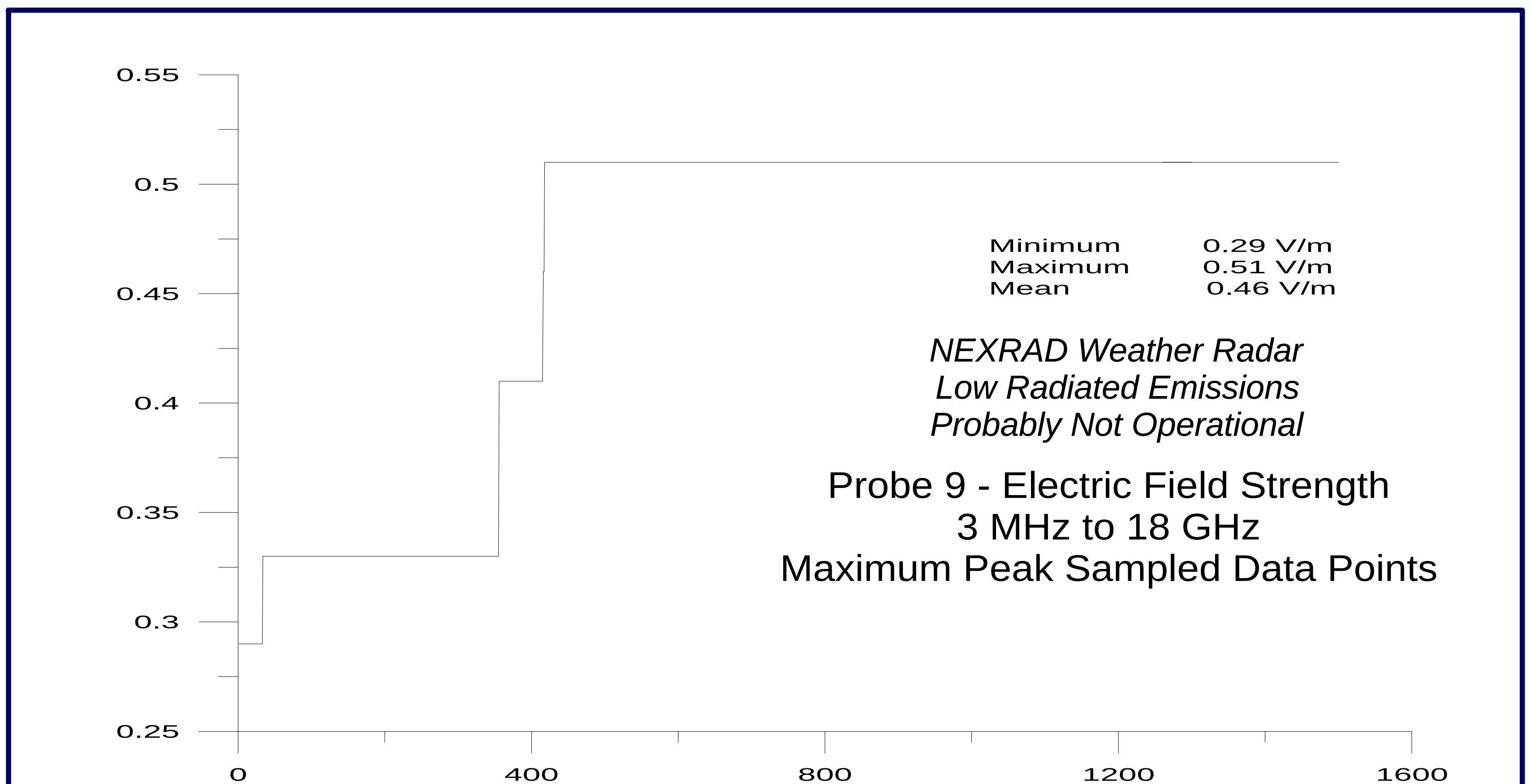



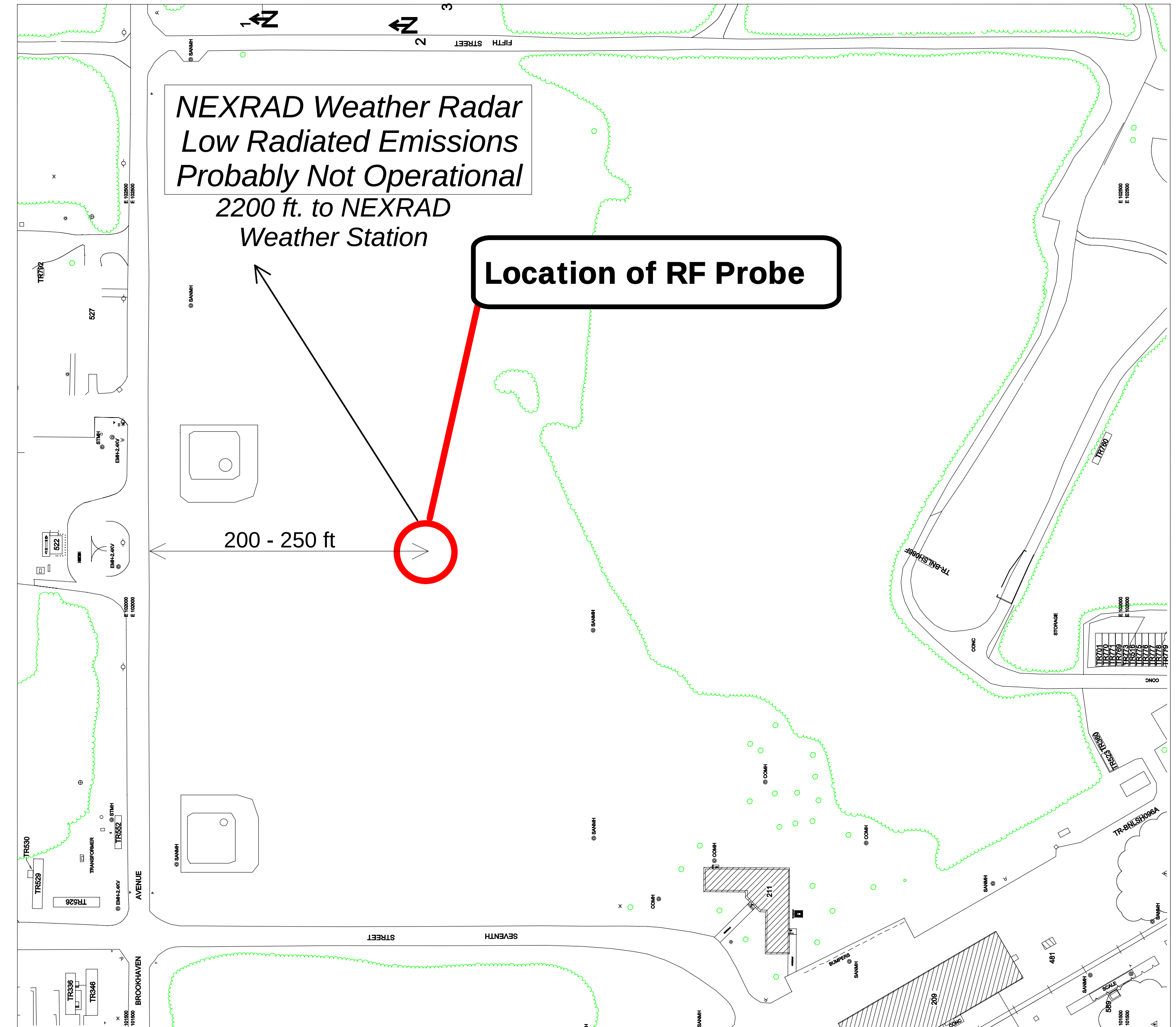

Electric field strength RF levels were recorded in volts-per-meter (V/m) for 10 minutes sampled at 0.04-second intervals with a Narda ERM-300 electric field meter using a Probe 18 from 100 kHz to 3 Ghz (range of 0.2 to 320 V/m) and Probe 9C from 3 MHz to 18 GHz (range of 0.5 to 1000 V/m). The objective is to investigate sources of radio-frequency interference (RFI) over a wide bandwidth. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.

**Figure #7, NSLS-II Brookhaven National Labs Proposed Site**
**100 kHz to 18 GHz Timed RF Maximum Electric Field Strength Data**
**Upton, Long Island, New York**

VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va

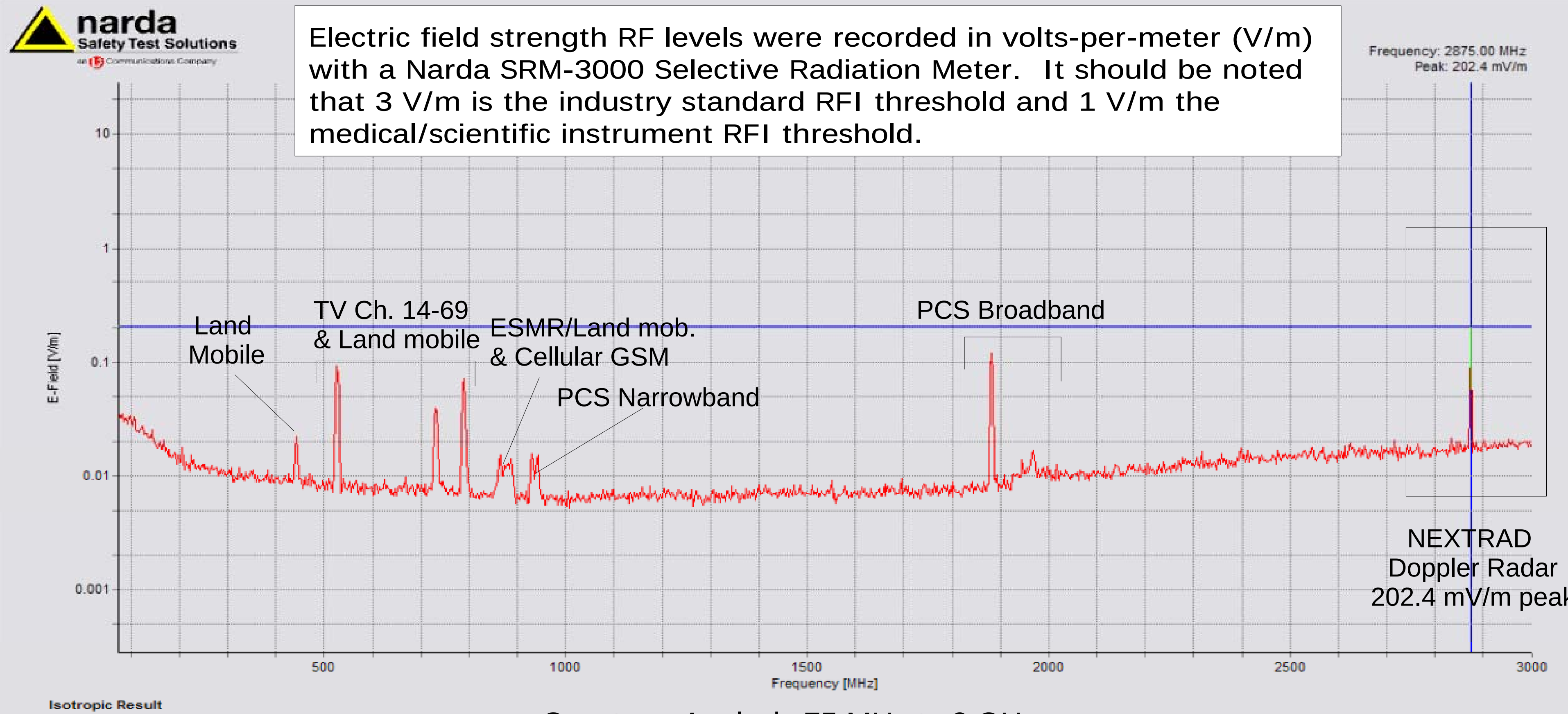



Electric field strength RF levels were recorded in volts-per-meter (V/m) for 10 minutes sampled at 0.04-second intervals with a Narda ERM-300 electric field meter using a Probe 18 from 100 kHz to 3 Ghz (range of 0.2 to 320 V/m) and Probe 9C from 3 MHz to 18 GHz (range of 0.5 to 1000 V/m). The objective is to investigate sources of radio-frequency interference (RFI) over a wide bandwidth. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.

Electric field strength RF levels were recorded in volts-per-meter (V/m) with a Narda SRM-3000 Selective Radiation Meter. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.




Spectrum Analysis 75 MHz to 3 GHz

## Peak Chart By Frequency & Level

| Index | Frequency | Level |
|---|---|---|
| 1 | 2875.00 MHz | 202.4 mV/m |
| 2 | 1882.32 MHz | 120.5 mV/m |
| 3 | 525.70 MHz | 97.07 mV/m |
| 4 | 789.27 MHz | 73.45 mV/m |
| 5 | 730.69 MHz | 39.49 mV/m |
| 6 | 82.26 MHz | 35.32 mV/m |
| 7 | 97.02 MHz | 33.77 mV/m |
| 8 | 105.52 MHz | 33.09 mV/m |
| 9 | 88.52 MHz | 32.23 mV/m |
| 10 | 123.96 MHz | 27.72 mV/m |
| 11 | 142.63 MHz | 25.48 mV/m |
| 12 | 114.28 MHz | 24.84 mV/m |
| 13 | 130.42 MHz | 23.77 mV/m |
| 14 | 137.95 MHz | 21.93 mV/m |
| 15 | 442.51 MHz | 21.88 mV/m |
| 16 | 2835.09 MHz | 21.26 mV/m |
| 17 | 2952.94 MHz | 20.85 mV/m |
| 18 | 2715.16 MHz | 20.76 mV/m |
| 19 | 2902.43 MHz | 20.65 mV/m |
| 20 | 2960.11 MHz | 20.62 mV/m |

| | |
|---|---|
| Dataset Type | SPEC |
| Store Mode | MAN |
| Date | 09/19/2006 |
| Time | 10:02:18 |
| Minimum Frequency [Hz] | 75 MHz |
| Maximum Frequency [Hz] | 3 GHz |
| Resolution Bandwidth [Hz] | 5 MHz |
| Measurement Range [V/m] | 2.5 V/m |
| Unit | V/m |
| Result Type | MAX |
| Number of Averages | 64 |
| Average Flag | OK |
| Overdrive Flag | OK |
| Threshold [V/m] | 25 µV/m |
| Y-Scale Reference [V/m] | 28 V/m |
| Y-Scale Range [dB] | 100 |
| Axis | RSS |
| Standard Name | ICNIRP GP |
| Comment | G4 |
| Device Serial No. | J-0016 |
| Device Calibration Date | 05/15/2006 |
| Device Firmware Version | V1.4.10 |
| Cable Name | |
| Cable Serial No. | |
| Cable Calibration Date | |
| Antenna Name | 3AX 75M-3G |
| Antenna Serial No. | G-0147 |
| Antenna Calibration Date | 05/18/2006 |

VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va

**RF Data Recorded**
**9/19/2006**

**Figure #2 - RF Spectrum 75 MHz - 3 GHz @ 1-meter**
**NSLS-II Brookhaven National Labs Proposed Site**

**RF Data Recorded**
**9/19/2006**

## Power Spectrum Chart By Service, Level & Frequency Band

| Service | Value | Lower Frequency | Upper Frequency |
|---|---|---|---|
| FM Radio | 375.5 pW/cm$^2$ | 88.000 MHz | 108.000 MHz |
| Paging | 56.83 pW/cm$^2$ | 152.000 MHz | 159.000 MHz |
| TV Ch. 7-13 | 166.3 pW/cm$^2$ | 174.000 MHz | 216.000 MHz |
| TV Ch. 14-69 | 2.169 nW/cm$^2$ | 470.000 MHz | 806.000 MHz |
| SMR Tx | 14.06 pW/cm$^2$ | 806.000 MHz | 821.000 MHz |
| Privat lnd mob | 3.397 pW/cm$^2$ | 821.000 MHz | 824.000 MHz |
| Cellular AMPS | 21.99 pW/cm$^2$ | 824.000 MHz | 849.000 MHz |
| ESMR/Land mob. | 48.83 pW/cm$^2$ | 849.000 MHz | 869.000 MHz |
| Cellular AMPS | 82.96 pW/cm$^2$ | 869.000 MHz | 894.000 MHz |
| aerontical mobl | 2.285 pW/cm$^2$ | 894.000 MHz | 896.000 MHz |
| private lnd mob | 4.556 pW/cm$^2$ | 896.000 MHz | 901.000 MHz |
| pcs narrowband | 1.013 pW/cm$^2$ | 901.000 MHz | 902.000 MHz |
| land mobile&Ham | 57.99 pW/cm$^2$ | 902.000 MHz | 930.000 MHz |
| pcs narrowband | 2.817 pW/cm$^2$ | 930.000 MHz | 931.000 MHz |
| Paging | 26.71 pW/cm$^2$ | 931.000 MHz | 932.000 MHz |
| pcs narrowband | 21.94 pW/cm$^2$ | 940.000 MHz | 941.000 MHz |
| public land mob | 14.88 pW/cm$^2$ | 941.000 MHz | 960.000 MHz |
| PCS Broadband | 283.3 pW/cm$^2$ | 1850.000 MHz | 1990.000 MHz |
| NEXTRAD Dopple | 972.4 pW/cm$^2$ | 2700.000 MHz | 2900.000 MHz |
| Others | 3.874 nW/cm$^2$ | | |
| Total | 8.201 nW/cm$^2$ | 88.000 MHz | 2900.000 MHz |

Electric field strength RF levels were recorded in volts-per-meter (V/m) with a Narda SRM-3000 Selective Radiation Meter. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.

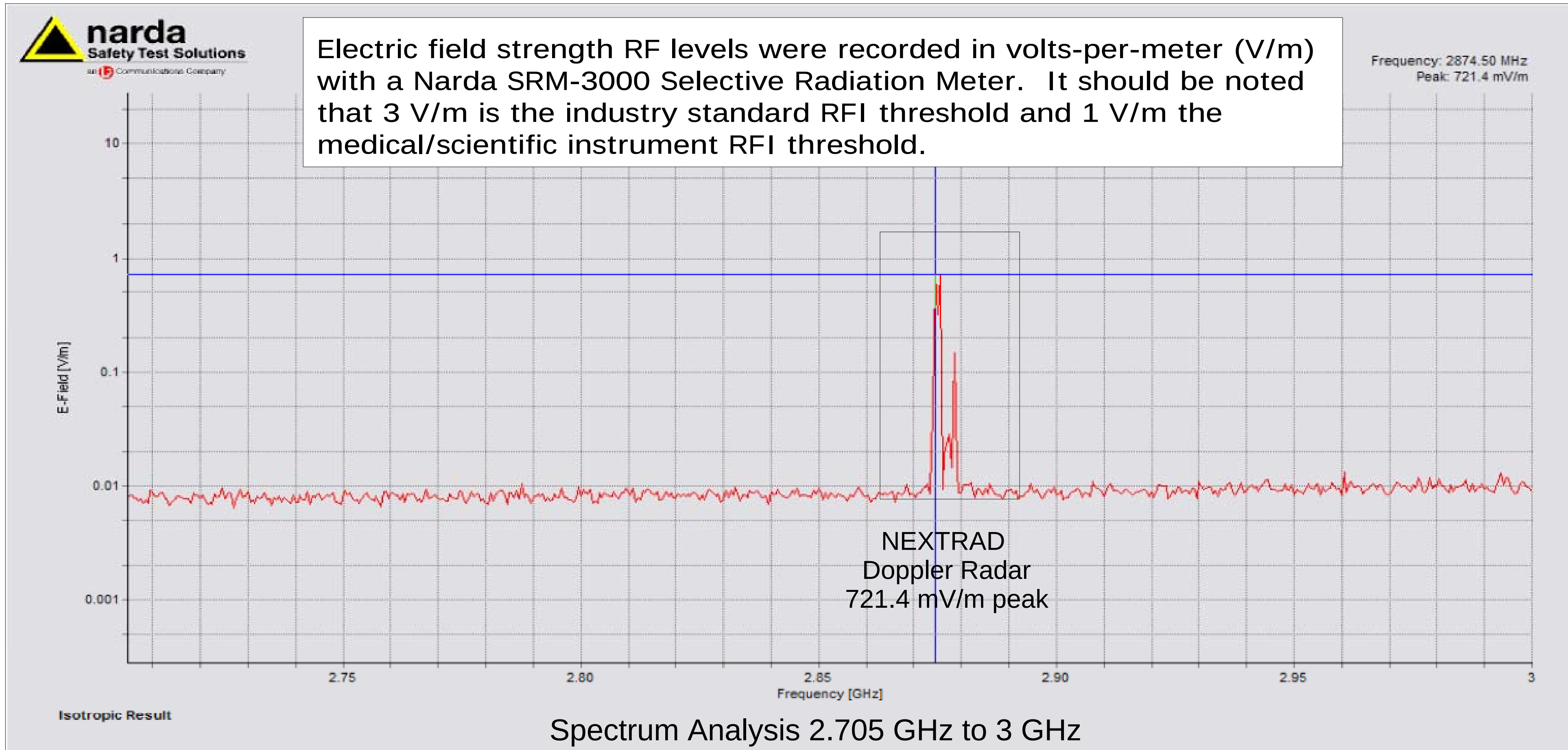
## Service Chart By Level & Frequency Band

| Service | Value | Lower Frequency | Upper Frequency |
|---|---|---|---|
| FM Radio | 37.63 mV/m | 88.000 MHz | 108.000 MHz |
| Paging | 14.64 mV/m | 152.000 MHz | 159.000 MHz |
| TV Ch. 7-13 | 25.04 mV/m | 174.000 MHz | 216.000 MHz |
| TV Ch. 14-69 | 90.43 mV/m | 470.000 MHz | 806.000 MHz |
| SMR Tx | 7.281 mV/m | 806.000 MHz | 821.000 MHz |
| Privat lnd mob | 3.579 mV/m | 821.000 MHz | 824.000 MHz |
| Cellular AMPS | 9.105 mV/m | 824.000 MHz | 849.000 MHz |
| ESMR/Land mob. | 13.57 mV/m | 849.000 MHz | 869.000 MHz |
| Cellular AMPS | 17.68 mV/m | 869.000 MHz | 894.000 MHz |
| aerontical mobl | 2.935 mV/m | 894.000 MHz | 896.000 MHz |
| private lnd mob | 4.144 mV/m | 896.000 MHz | 901.000 MHz |
| pcs narrowband | 1.954 mV/m | 901.000 MHz | 902.000 MHz |
| land mobile&Ham | 14.79 mV/m | 902.000 MHz | 930.000 MHz |
| pcs narrowband | 3.259 mV/m | 930.000 MHz | 931.000 MHz |
| Paging | 10.03 mV/m | 931.000 MHz | 932.000 MHz |
| pcs narrowband | 9.094 mV/m | 940.000 MHz | 941.000 MHz |
| public land mob | 7.489 mV/m | 941.000 MHz | 960.000 MHz |
| PCS Broadband | 32.68 mV/m | 1850.000 MHz | 1990.000 MHz |
| NEXTRAD Dopple | 60.55 mV/m | 2700.000 MHz | 2900.000 MHz |
| Others | 120.8 mV/m | | |
| Total | 175.8 mV/m | 88.000 MHz | 2900.000 MHz |

| | |
|---|---|
| Dataset Type | TAB |
| Store Mode | MAN |
| Date | 09/19/2006 |
| Time | 10:06:25 |
| Minimum Frequency [Hz] | 88 MHz |
| Maximum Frequency [Hz] | 2.9 GHz |
| Measurement Range [V/m] | 2.5 V/m |
| Unit | V/m |
| Result Type | MAX |
| Number of Averages | 4 |
| Average Flag | OK |
| Overdrive Flag | OK |
| Threshold [V/m] | 25 µV/m |
| Display | DETAIL |
| Axis | RSS |
| Standard Name | ICNIRP GP |
| Service Table Name | FCC STD |
| Comment | G5 |
| Device Serial No. | J-0016 |
| Device Calibration Date | 05/15/2006 |
| Device Firmware Version | V1.4.10 |
| Cable Name | |
| Cable Serial No. | |
| Cable Calibration Date | |
| Antenna Name | 3AX 75M-3G |
| Antenna Serial No. | G-0147 |
| Antenna Calibration Date | 05/18/2006 |

**Figure #2A - FCC Spectrum 75 MHz - 3 GHz @ 1-meter**
**NSLS-II Brookhaven National Labs Proposed Site**


VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va




## Peak Chart By Frequency & Level

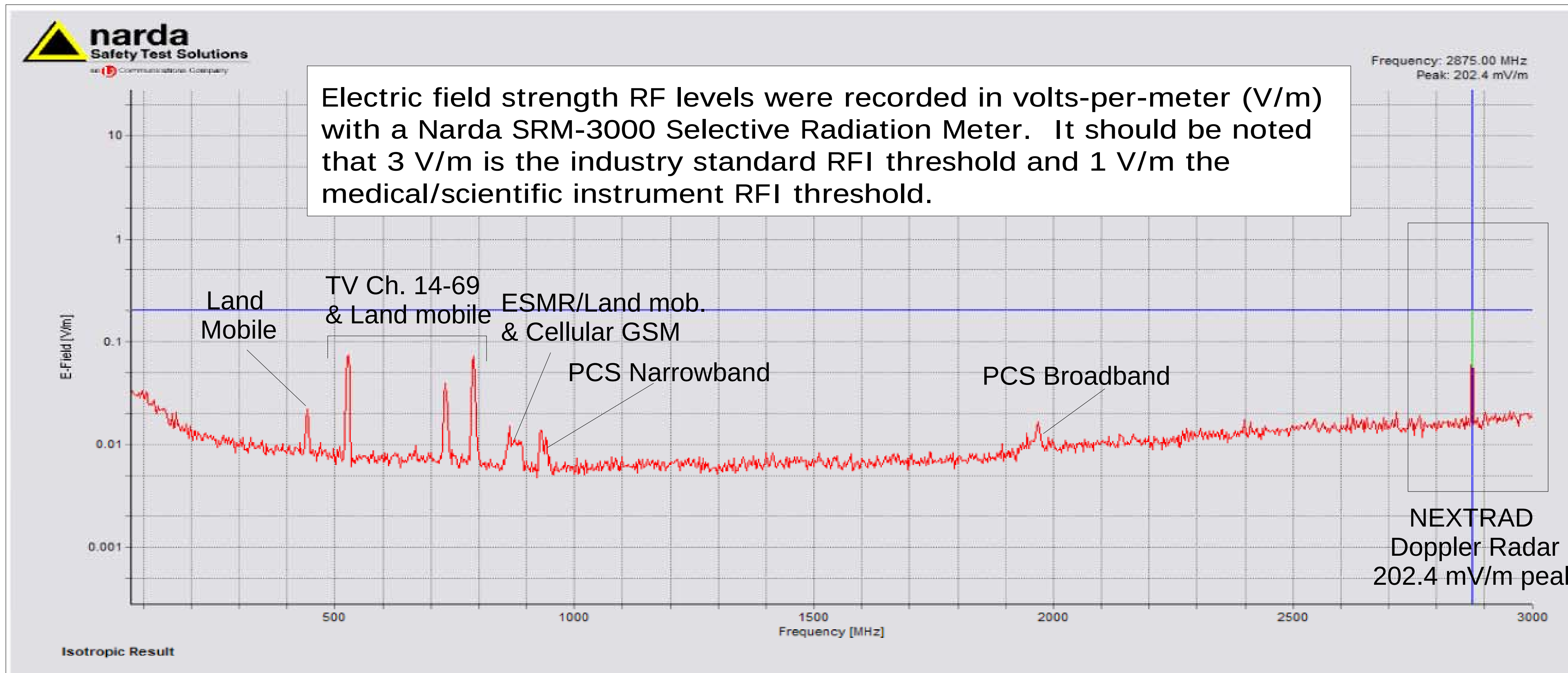
| Index | Frequency | Level |
|---|---|---|
| 1 | 2874.50 MHz | 721.4 mV/m |
| 2 | 2875.50 MHz | 698.0 mV/m |
| 3 | 2878.50 MHz | 146.6 mV/m |
| 4 | 2877.37 MHz | 29.03 mV/m |
| 5 | 2960.51 MHz | 13.30 mV/m |
| 6 | 2993.46 MHz | 12.80 mV/m |
| 7 | 2994.64 MHz | 11.95 mV/m |
| 8 | 2976.09 MHz | 11.78 mV/m |
| 9 | 2978.51 MHz | 11.62 mV/m |
| 10 | 2980.52 MHz | 11.37 mV/m |
| 11 | 2944.16 MHz | 11.36 mV/m |
| 12 | 2985.95 MHz | 11.29 mV/m |
| 13 | 2930.14 MHz | 11.14 mV/m |
| 14 | 2997.95 MHz | 11.05 mV/m |
| 15 | 2907.64 MHz | 11.03 mV/m |
| 16 | 2961.96 MHz | 10.96 mV/m |
| 17 | 2936.35 MHz | 10.72 mV/m |
| 18 | 2938.88 MHz | 10.69 mV/m |
| 19 | 2881.86 MHz | 10.68 mV/m |
| 20 | 2971.65 MHz | 10.66 mV/m |

| | |
|---|---|
| Dataset Type | SPEC |
| Store Mode | MAN |
| Date | 09/19/2006 |
| Time | 09:52:16 |
| Minimum Frequency [Hz] | 2.705 GHz |
| Maximum Frequency [Hz] | 3 GHz |
| Resolution Bandwidth [Hz] | 1 MHz |
| Measurement Range [V/m] | 2.5 V/m |
| Unit | V/m |
| Result Type | MAX |
| Number of Averages | 64 |
| Average Flag | OK |
| Overdrive Flag | OK |
| Threshold [V/m] | 25 µV/m |
| Y-Scale Reference [V/m] | 28 V/m |
| Y-Scale Range [dB] | 100 |
| Axis | RSS |
| Standard Name | ICNIRP GP |
| Comment | G1 |
| Device Serial No. | J-0016 |
| Device Calibration Date | 05/15/2006 |
| Device Firmware Version | V1.4.10 |
| Cable Name | |
| Cable Serial No. | |
| Cable Calibration Date | |
| Antenna Name | 3AX 75M-3G |
| Antenna Serial No. | G-0147 |
| Antenna Calibration Date | 05/18/2006 |

**Figure #1 - RF Spectrum 2.7 - 3 GHz NEXTRAD Doppler Radar @ 1-meter**
**NSLS-II Brookhaven National Labs Proposed Site**

**RF Data Recorded**
**9/19/2006**

VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va




## Peak Chart By Frequency & Level

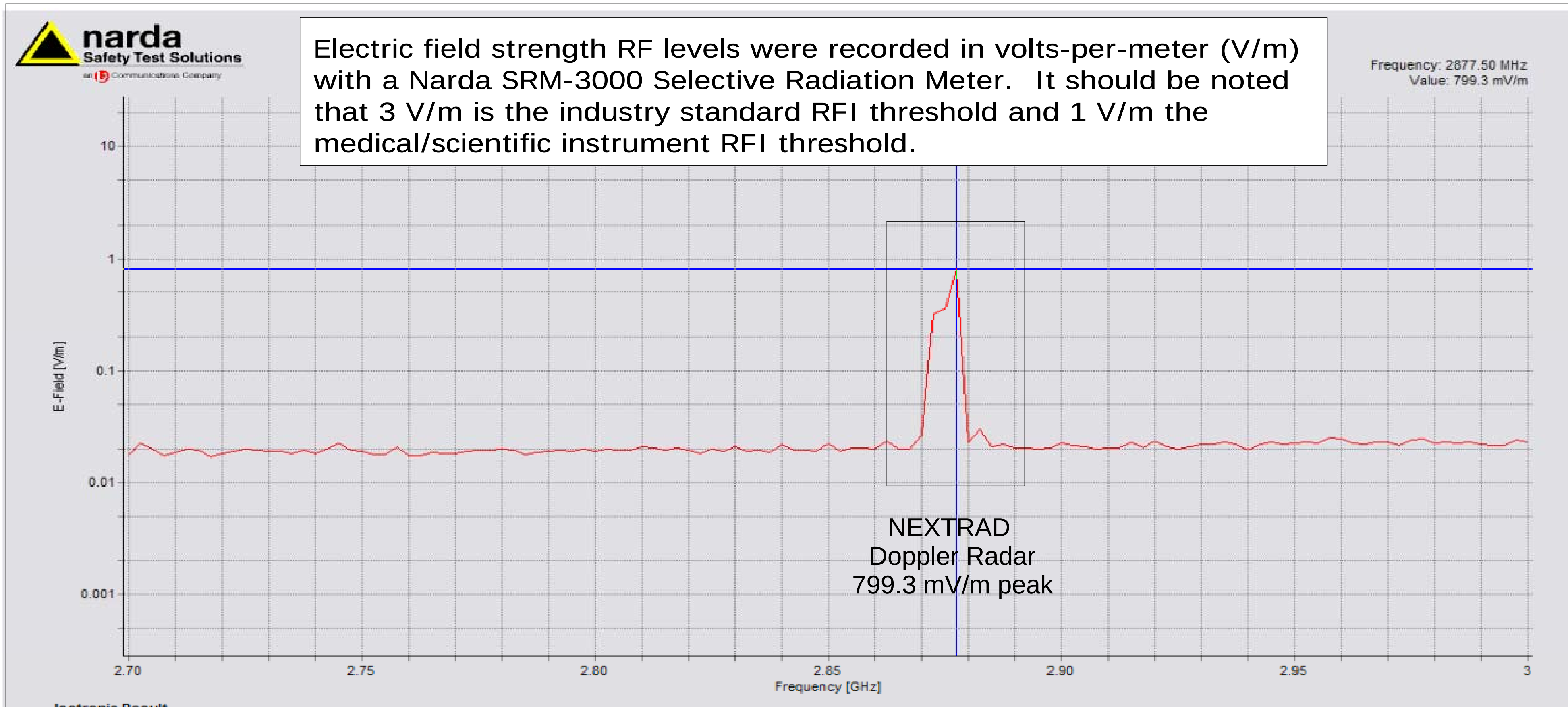
| Index | Frequency | Level |
|---|---|---|
| 1 | 2875.00 MHz | 202.4 mV/m |
| 2 | 526.38 MHz | 76.24 mV/m |
| 3 | 789.27 MHz | 73.45 mV/m |
| 4 | 730.05 MHz | 39.06 mV/m |
| 5 | 77.28 MHz | 33.71 mV/m |
| 6 | 96.96 MHz | 33.43 mV/m |
| 7 | 105.52 MHz | 33.09 mV/m |
| 8 | 89.69 MHz | 31.85 mV/m |
| 9 | 121.75 MHz | 27.17 mV/m |
| 10 | 114.79 MHz | 24.80 mV/m |
| 11 | 130.33 MHz | 23.81 mV/m |
| 12 | 143.68 MHz | 22.49 mV/m |
| 13 | 138.11 MHz | 21.94 mV/m |
| 14 | 442.51 MHz | 21.88 mV/m |
| 15 | 2952.42 MHz | 20.77 mV/m |
| 16 | 2715.16 MHz | 20.76 mV/m |
| 17 | 2902.43 MHz | 20.65 mV/m |
| 18 | 2960.28 MHz | 20.65 mV/m |
| 19 | 167.63 MHz | 20.56 mV/m |
| 20 | 2988.98 MHz | 20.52 mV/m |

| | |
|---|---|
| Dataset Type | SPEC |
| Store Mode | MAN |
| Date | 09/19/2006 |
| Time | 10:00:21 |
| Minimum Frequency [Hz] | 75 MHz |
| Maximum Frequency [Hz] | 3 GHz |
| Resolution Bandwidth [Hz] | 5 MHz |
| Measurement Range [V/m] | 2.5 V/m |
| Unit | V/m |
| Result Type | MAX |
| Number of Averages | 64 |
| Average Flag | OK |
| Overdrive Flag | OK |
| Threshold [V/m] | 25 µV/m |
| Y-Scale Reference [V/m] | 28 V/m |
| Y-Scale Range [dB] | 100 |
| Axis | RSS |
| Standard Name | |
| Comment | |
| Device Serial No. | J-0016 |
| Device Calibration Date | 05/15/2006 |
| Device Firmware Version | V1.4.10 |
| Cable Name | |
| Cable Serial No. | |
| Cable Calibration Date | |
| Antenna Name | 3AX 75M-3G |
| Antenna Serial No. | G-0147 |
| Antenna Calibration Date | 05/18/2006 |

**Figure #1A - RF Spectrum 75 Mz - 3 GHz @ 1-meter**
**NSLS-II Brookhaven National Labs Proposed Site**

**RF Data Recorded**
**9/19/2006**

VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va




Spectrum Analysis 2.7 GHz to 3 GHz

**Peak Chart By Frequency & Level**

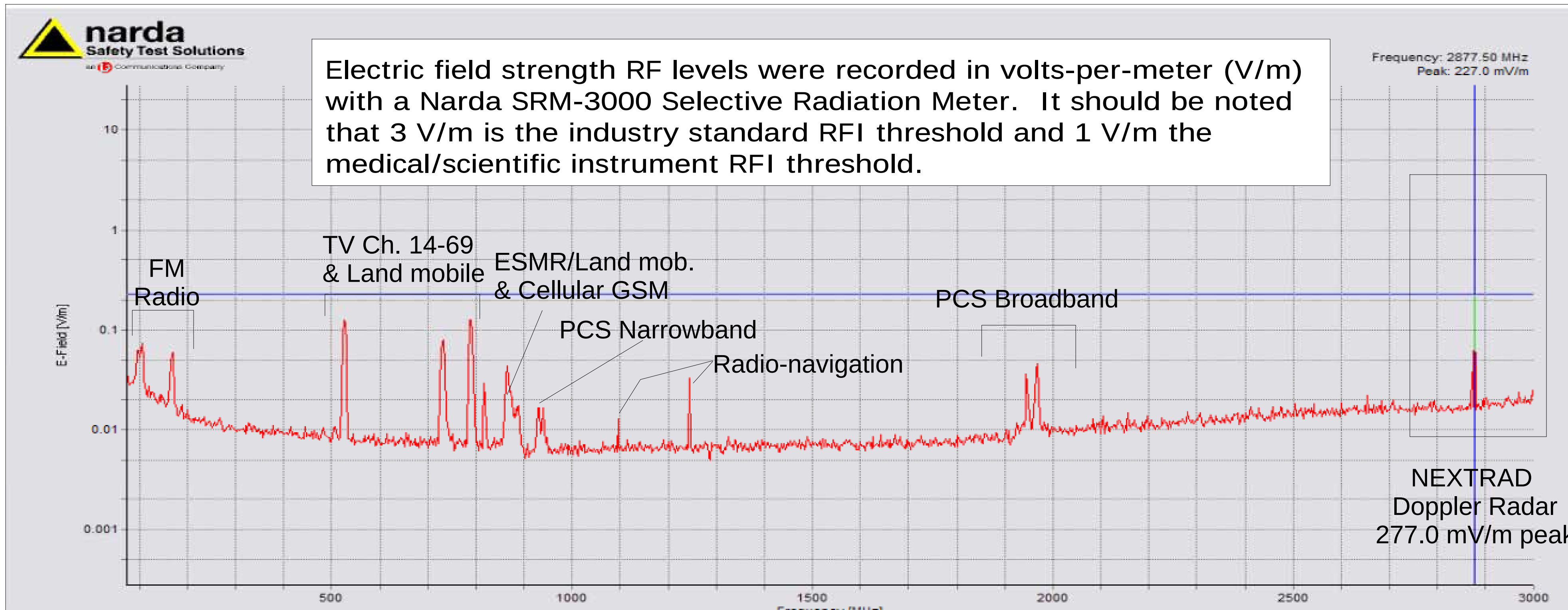
| Index | Frequency | Level |
|---|---|---|
| 1 | 2877.50 MHz | 799.3 mV/m |
| 2 | 2882.33 MHz | 29.75 mV/m |
| 3 | 2958.57 MHz | 25.45 mV/m |
| 4 | 2976.75 MHz | 24.74 mV/m |
| 5 | 2998.20 MHz | 24.10 mV/m |
| 6 | 2920.20 MHz | 23.58 mV/m |
| 7 | 2969.14 MHz | 23.33 mV/m |
| 8 | 2862.48 MHz | 23.32 mV/m |
| 9 | 2987.01 MHz | 23.30 mV/m |
| 10 | 2982.76 MHz | 23.07 mV/m |
| 11 | 2944.80 MHz | 22.96 mV/m |
| 12 | 2952.63 MHz | 22.96 mV/m |
| 13 | 2702.93 MHz | 22.82 mV/m |
| 14 | 2935.21 MHz | 22.82 mV/m |
| 15 | 2914.99 MHz | 22.79 mV/m |
| 16 | 2744.92 MHz | 22.69 mV/m |
| 17 | 2900.43 MHz | 22.65 mV/m |
| 18 | 2849.97 MHz | 22.51 mV/m |
| 19 | 2887.17 MHz | 21.96 mV/m |
| 20 | 2840.23 MHz | 21.96 mV/m |

| | |
|---|---|
| Dataset Type | SPEC |
| Store Mode | MAN |
| Date | 09/19/2006 |
| Time | 10:41:34 |
| Minimum Frequency [Hz] | 2.7 GHz |
| Maximum Frequency [Hz] | 3 GHz |
| Resolution Bandwidth [Hz] | 5 MHz |
| Measurement Range [V/m] | 2.5 V/m |
| Unit | V/m |
| Result Type | MAX |
| Number of Averages | 64 |
| Average Flag | OK |
| Overdrive Flag | OK |
| Threshold [V/m] | 25 µV/m |
| Y-Scale Reference [V/m] | 28 V/m |
| Y-Scale Range [dB] | 100 |
| Axis | RSS |
| Standard Name | |
| Comment | |
| Device Serial No. | J-0016 |
| Device Calibration Date | 05/15/2006 |
| Device Firmware Version | V1.4.10 |
| Cable Name | |
| Cable Serial No. | |
| Cable Calibration Date | |
| Antenna Name | 3AX 75M-3G |
| Antenna Serial No. | G-0147 |
| Antenna Calibration Date | 05/18/2006 |

**RF Data Recorded From Cherry-Picker 9/19/2006**

VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va

**Figure #3 - RF Spectrum 75 MHz - 3 GHz @ 15.2 m (50 ft)**
**NSLS-II Brookhaven National Labs Proposed Site**




Spectrum Analysis 75 MHz to 3 GHz

**Peak Chart By Frequency & Level**

| Index | Frequency | Level |
|---|---|---|
| 1 | 2877.50 MHz | 227.0 mV/m |
| 2 | 788.89 MHz | 130.6 mV/m |
| 3 | 526.03 MHz | 129.3 mV/m |
| 4 | 731.52 MHz | 83.46 mV/m |
| 5 | 104.60 MHz | 73.53 mV/m |
| 6 | 168.81 MHz | 67.70 mV/m |
| 7 | 96.37 MHz | 64.39 mV/m |
| 8 | 1966.71 MHz | 47.85 mV/m |
| 9 | 865.03 MHz | 42.70 mV/m |
| 10 | 2872.50 MHz | 37.88 mV/m |
| 11 | 1945.85 MHz | 37.86 mV/m |
| 12 | 1245.00 MHz | 32.78 mV/m |
| 13 | 84.61 MHz | 29.72 mV/m |
| 14 | 817.50 MHz | 29.29 mV/m |
| 15 | 119.93 MHz | 26.91 mV/m |
| 16 | 2997.38 MHz | 24.93 mV/m |
| 17 | 871.60 MHz | 24.34 mV/m |
| 18 | 126.17 MHz | 23.81 mV/m |
| 19 | 2970.19 MHz | 23.73 mV/m |
| 20 | 142.21 MHz | 22.54 mV/m |

| | |
|---|---|
| Dataset Type | SPEC |
| Store Mode | MAN |
| Date | 09/19/2006 |
| Time | 10:46:07 |
| Minimum Frequency [Hz] | 75 MHz |
| Maximum Frequency [Hz] | 3 GHz |
| Resolution Bandwidth [Hz] | 5 MHz |
| Measurement Range [V/m] | 2.5 V/m |
| Unit | V/m |
| Result Type | MAX |
| Number of Averages | 64 |
| Average Flag | OK |
| Overdrive Flag | OK |
| Threshold [V/m] | 25 µV/m |
| Y-Scale Reference [V/m] | 28 V/m |
| Y-Scale Range [dB] | 100 |
| Axis | RSS |
| Standard Name | |
| Comment | |
| Device Serial No. | J-0016 |
| Device Calibration Date | 05/15/2006 |
| Device Firmware Version | V1.4.10 |
| Cable Name | |
| Cable Serial No. | |
| Cable Calibration Date | |
| Antenna Name | 3AX 75M-3G |
| Antenna Serial No. | G-0147 |
| Antenna Calibration Date | 05/18/2006 |

**RF Data Recorded From Cherry-Picker 9/19/2006**

VitaTech Engineering, LLC
(540) 286-1984
Fredericksburg, Va

**Figure #3A - RF Spectrum 75 Mz - 3 GHz @ 15.2 m (50 ft.)**
**NSLS-II Brookhaven National Labs Proposed Site**

**Appendix A4**

HVAC Calculations
Accelerator Ring Tunnel – one pentant
Experimental Hall – one pentant

# HVAC

# CALCULATIONS

HVAC Load Calculations for:

- One Accelerator Ring Tunnel Pentant AHU-101
- One Experimental Hall Pentant AHU – 201A and AHU-201B

HDR MECHANICAL SECTION — HEATING/COOLING LOAD CALCULATIONS

1.000 ROOM TYPES

ROOM DATA — 0 CFM

PROJECT: BNL — UNIT: AHU-101

DATE: 05-Sep-07 — ENGINEER: ATIENZA

| | | | | |
|---|---|---|---|---|
| ROOM NO: | T1 | | PEOPLE (NO EA): | 15 |
| ROOM NAME: | TUNNEL 1 | | LIGHTS (WATTS): | 1.5 |
| AREA (SQFT): | 6393 | | MISC SENS (BTUH): | 216000 |
| HEIGHT (FT): | 9 | | MISC LAT (BTUH): | |
| DESIGN AC: | 6 | | RA=0/EA=1 | 0 |
| RM TEMP (DEG F): | 78 | 78 | CFM/SQFT: | |
| PEOPLE SENS (BTUH): | 450 | | PRESS (CFM): | 0 |
| PEOPLE LAT (BTUH): | 450 | | NO OF RMS: | 1 |

| | WALL AREA (SQFT) | WINDOW AREA (SQFT) |
|---|---|---|
| N: | 0 | 0 |
| E: | 0 | 0 |
| S: | 0 | 0 |
| W: | 0 | 0 |

| | |
|---|---|
| ROOF AREA (SQFT): | |
| WALL BELOW GRADE (SQFT): | 6841 |
| SLAB ON GRADE (SQFT): | 6393 |

========== =========== ======== ======== ======== ========= ======== ==========

HDR MECHANICAL SECTION

HEATING/COOLING LOAD CALCULATIONS

1.000 ROOM TYPES
0 CFM

ROOM DATA

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-A
ENGINEER: ATIENZA

| | | | | |
|---|---|---|---|---|
| ROOM NO: | P1A | | PEOPLE (NO EA): | 38 |
| ROOM NAME: | PENTANT 1A | | LIGHTS (WATTS): | 2.0 |
| AREA (SQFT): | 19762 | | MISC SENS (BTUH): | 118000 |
| HEIGHT (FT): | 12 | | MISC LAT (BTUH): | |
| DESIGN AC: | 6 | | RA=0/EA=1 | 0 |
| RM TEMP (DEG F): | 75 | 75 | CFM/SQFT: | |
| PEOPLE SENS (BTUH): | 450 | | PRESS (CFM): | 0 |
| PEOPLE LAT (BTUH): | 450 | | NO OF RMS: | 1 |

| | WALL AREA (SQFT) | WINDOW AREA (SQFT) |
|---|---|---|
| N: | 6411 | 1188 |
| E: | 0 | 0 |
| S: | 6295 | 0 |
| W: | 0 | 0 |

| | |
|---|---|
| ROOF AREA (SQFT): | 19762 |
| WALL BELOW GRADE (SQFT): | |
| SLAB ON GRADE (SQFT): | 19762 |

========== =========== ======== ======== ======== ========= ======== ==========

1.000 ROOM TYPES

ROOM DATA

0 CFM

PROJECT: BNL

DATE: 05-Sep-07

UNIT: AHU-201-B

ENGINEER: ATIENZA

| | | | | |
|---|---|---|---|---|
| ROOM NO: | P1B | | PEOPLE (NO EA): | 38 |
| ROOM NAME: | PENTANT 1B | | LIGHTS (WATTS): | 2.8 |
| AREA (SQFT): | 19762 | | MISC SENS (BTUH): | 118000 |
| HEIGHT (FT): | 12 | | MISC LAT (BTUH): | |
| DESIGN AC: | 6 | | RA=0/EA=1 | 0 |
| RM TEMP (DEG F): | 75 | 75 | CFM/SQFT: | |
| PEOPLE SENS (BTUH): | 450 | | PRESS (CFM): | 0 |
| PEOPLE LAT (BTUH): | 450 | | NO OF RMS: | 1 |

| | WALL AREA (SQFT) | WINDOW AREA (SQFT) |
|---|---|---|
| N: | 6411 | 1188 |
| E: | 0 | 0 |
| S: | 6295 | 0 |
| W: | 0 | 0 |

| | |
|---|---|
| ROOF AREA (SQFT): | 19762 |
| WALL BELOW GRADE (SQFT): | |
| SLAB ON GRADE (SQFT): | 19762 |

========== =========== ======== ======== ======== ========= ======== ==========

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-101
PAGE: 1

| ROOM NO | ROOM NAME | SA (CFM) | RA (CFM) | EA (CFM) | SQFT | )ES/SQFT AC | COOL AC | DT HTG |
|---|---|---|---|---|---|---|---|---|
| T1 | TUNNEL 1 | 10280 | 10280 | 0 | 6393 | 6 | 11 | 4 |
| | | 10280 | 10280 | 0 | 6393 | | | |

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-101
PAGE: 2

COOLING (BTUH)

| ROOM NO | ROOM | TOTAL SENS | EXT SENS | INTERNAL SENSIBLE LIGHTS | PEOPLE | MISC | TOTAL LATENT | HTG (BTUH) | HTG (BTUH/FT) |
|---|---|---|---|---|---|---|---|---|---|
| T1 | TUNNEL 1 | 255354 | 0 | 32604 | 6750 | 216000 | 6750 | 39702 | |
| | | 255354 | 0 | 32604 | 6750 | 216000 | 6750 | 39702 | |

HEATING/COOLING LOAD CALCULATIONS

AHU DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-101
PAGE: 3

| BTUH | 8 | 10 | 12 | 2 | 4 | 6 | HTG (BTUH) | | |
|---|---|---|---|---|---|---|---|---|---|
| | COOLING LOAD SENSIBLE (BTUH) | | | | | | | | |
| TOTAL SENSIBLE | 255354 | 255354 | 255354 | 255354 | 255354 | 255354 | 39702 | | |
| TOTAL LATENT | 6750 | 6750 | 6750 | 6750 | 6750 | 6750 | 0 | | |
| GRAND TOTAL | 262104 | 262104 | 262104 | 262104 | 262104 | 262104 | | | |
| | | | | | | | AC CFM | SQFT CFM | HTG CFM |
| AVG DT | 23 | 23 | 23 | 23 | 23 | | | | |
| SA (CFM) | 10280 | 10280 | 10280 | 10280 | 10280 | 10280 | 5754 | 0 | 106387 |
| RA (CFM) | 10280 | 10280 | 10280 | 10280 | 10280 | 10280 | | | |
| EA (CFM) | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| TOTAL SA (CFM) | 10280 | | | | | | | | |
| TOTAL RA (CFM) | 10280 | | | | | | | | |
| TOTAL EA (CFM) | 0 | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| SENSIBLE COOLING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 255354 | 255354 | 255354 | 255354 | 255354 | 255354 | 39702 | | |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 255354 | 255354 | 255354 | 255354 | 255354 | 255354 | 39702 | 0 | 0 |
| LATENT COOLING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 6750 | 6750 | 6750 | 6750 | 6750 | 6750 | 0 | | |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 6750 | 6750 | 6750 | 6750 | 6750 | 6750 | 0 | 0 | 0 |
| SUPPLY AIR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 10280 | 10280 | 10280 | 10280 | 10280 | 10280 | 5754 | 0 | 106387 |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 10280 | 10280 | 10280 | 10280 | 10280 | 10280 | 5754 | 0 | 106387 |
| RETURN AIR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 10280 | 10280 | 10280 | 10280 | 10280 | 10280 | 5754 | 0 | 60193 |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 10280 | 10280 | 10280 | 10280 | 10280 | 10280 | 5754 | 0 | 60193 |
| EXHAUST AIR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51610 |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51610 |

9 10 9 9 9 9 9 9 9 9 9 100

# HEATING/COOLING LOAD CALCULATIONS

## GLOBAL DATA

PROJECT: BNL
DATE: 05-Sep-07
ENGINEER: ATIENZA

AHU-101
PAGE: 4.00 4.00

| | | | | |
|---|---|---|---|---|
| Uwall: | 0.05 | 20.00 | PEOPLE SENS (BTUH | 250.00 |
| Uwindow s: | 0.30 | | PEOPLE LAT (BTUH): | 200.00 |
| Uwindow w: | 0.29 | | OAT WINT (DEG F): | 0.00 |
| Uroof: | 0.04 | | SA TEMP (DEG F): | 55.00 |
| SHADE FC: | 0.44 | | DT HTG (DEG F): | 40.00 |
| WALL CONST: | 3.00 | (BELOW GRADE) | | |
| FLOOR CONST: | 3.00 | (BELOW GRADE) | | |

Factors Corrected for Latitude-Month

| Time of Day | 08:00 AM | 10:00 AM | 12:00 PM | 02:00 PM | 04:00 PM | 06:00 PM |
|---|---|---|---|---|---|---|
| CLTDroof: | 22 | 23 | 26.00 | 31.00 | 36.00 | 39.00 |
| CLTDwall: TYPE B | | | | | | |
| N: | 9 | 8 | 7.64 | 8.47 | 9.30 | 23.00 |
| E: | 13 | 13 | 16.77 | 19.26 | 21.75 | 32.00 |
| S: | 12 | 10 | 10.13 | 10.96 | 13.45 | 43.00 |
| W: | 17 | 15 | 13.45 | 12.62 | 13.45 | 43.00 |
| CLTDwindow: | 3 | 7 | 12.00 | 16.00 | 17.00 | 12.00 |
| SHGF: | | | | | | |
| N: | 130 | 130 | 130 | 130 | 130 | 130 |
| E: | 216 | 216 | 216 | 216 | 216 | 216 |
| S: | 205 | 205 | 205 | 205 | 205 | 205 |
| W: | 216 | 216 | 216 | 216 | 216 | 216 |
| CLFwindow: | | | | | | |
| N: | 0.65 | 0.80 | 0.89 | 0.86 | 0.75 | 0.70 |
| E: | 0.80 | 0.62 | 0.27 | 0.22 | 0.17 | 0.16 |
| S: | 0.23 | 0.58 | 0.83 | 0.68 | 0.35 | 0.33 |
| W: | 0.11 | 0.15 | 0.17 | 0.53 | 0.82 | 0.67 |

============= ==========: ========: ========: ========: =========: ==========:

| Time of Day | 08:00 AM | 10:00 AM | 12:00 PM | 02:00 PM | 04:00 PM | 06:00 PM |
|---|---|---|---|---|---|---|

Raw Factors

| | | | | | | |
|---|---|---|---|---|---|---|
| CLTDroof | 20 | 21.00 | 24.00 | 29.00 | 34.00 | 38.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLTDwall | TYPE E | | | | | | |
| N: | | 4 | 6 | 9.00 | 13.00 | 17.00 | 20.00 |
| E: | | 11 | 26 | 36.00 | 37.00 | 34.00 | 32.00 |
| S: | | 3 | 5.00 | 13.00 | 24.00 | 32.00 | 33.00 |
| W: | | 6 | 6.00 | 9.00 | 14.00 | 27.00 | 43.00 |

| | |
|---|---|
| CLTD Correction Factor (LM) | |
| Roof: | 1 |
| Walls: | |
| N | 3 |
| E | 0 |
| S | 10 |
| W | 0 |

# HEATING/COOLING LOAD CALCULATIONS

## ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-A
PAGE: 1

| ROOM NO | ROOM NAME | SA (CFM) | RA (CFM) | EA (CFM) | SQFT | )ES/SQFT AC | COOL AC | DT HTG |
|---|---|---|---|---|---|---|---|---|
| P1A | PENTANT 1A | 23710 | 23710 | 0 | 19762 | 6 | 4 | 8 |
| | | 23710 | 23710 | 0 | 19762 | | | |

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-A
PAGE: 2

COOLING (BTUH)

| ROOM NO | ROOM | TOTAL SENS | EXT SENS | INTERNAL SENSIBLE LIGHTS | PEOPLE | MISC | TOTAL LATENT | HTG (BTUH) | HTG (BTUH/FT) |
|---|---|---|---|---|---|---|---|---|---|
| P1A | PENTANT 1A | 378408 | 108926 | 134382 | 17100 | 118000 | 17100 | 192059 | |
| | | 378408 | 108926 | 134382 | 17100 | 118000 | 17100 | 192059 | |

HEATING/COOLING LOAD CALCULATIONS

AHU DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-A
PAGE: 3

| | COOLING LOAD SENSIBLE (BTUH) | | | | | | HTG (BTUH) | | |
|---|---|---|---|---|---|---|---|---|---|
| BTUH | 8 | 10 | 12 | 2 | 4 | 6 | | | |
| TOTAL SENSIBLE | 344150 | 355770 | 365774 | 369640 | 367524 | 378408 | 192059 | | |
| TOTAL LATENT | 17100 | 17100 | 17100 | 17100 | 17100 | 17100 | 0 | | |
| GRAND TOTAL | 361250 | 372870 | 382874 | 386740 | 384624 | 395508 | | | |
| | | | | | | | AC CFM | SQFT CFM | HTG CFM |
| AVG DT | 20 | 20 | 20 | 20 | 20 | | | | |
| SA (CFM) | 15933 | 16471 | 16934 | 17113 | 17015 | 17519 | 23714 | 0 | 149622 |
| RA (CFM) | 15933 | 16471 | 16934 | 17113 | 17015 | 17519 | | | |
| EA (CFM) | 0 | 0 | 0 | 0 | 0 | 0 | | | |

| | |
|---|---|
| TOTAL SA (CFM) | 23710 |
| TOTAL RA (CFM) | 23710 |
| TOTAL EA (CFM) | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| SENSIBLE COOLING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 344150 | 355770 | 365774 | 369640 | 367524 | 378408 | 192059 | | |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 344150 | 355770 | 365774 | 369640 | 367524 | 378408 | 192059 | 0 | 0 |
| LATENT COOLING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 17100 | 17100 | 17100 | 17100 | 17100 | 17100 | 0 | | |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 17100 | 17100 | 17100 | 17100 | 17100 | 17100 | 0 | 0 | 0 |
| SUPPLY AIR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15933 | 16471 | 16934 | 17113 | 17015 | 17519 | 23714 | 0 | 149622 |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 15933 | 16471 | 16934 | 17113 | 17015 | 17519 | 23714 | 0 | 149622 |
| RETURN AIR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15933 | 16471 | 16934 | 17113 | 17015 | 17519 | 23714 | 0 | 103427 |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 15933 | 16471 | 16934 | 17113 | 17015 | 17519 | 23714 | 0 | 103427 |
| EXHAUST AIR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51610 |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51610 |

9 10 9 9 9 9 9 9 9 9 9 100

HEATING/COOLING LOAD CALCULATIONS

GLOBAL DATA

PROJECT: BNL
DATE: 05-Sep-07
ENGINEER: ATIENZA

AHU-201-A
PAGE: 4.00 4.00

| | | | | |
|---|---|---|---|---|
| Uwall: | 0.05 | 20.00 | PEOPLE SENS (BTUH | 250.00 |
| Uwindow s: | 0.30 | | PEOPLE LAT (BTUH): | 200.00 |
| Uwindow w: | 0.29 | | OAT WINT (DEG F): | 0.00 |
| Uroof: | 0.04 | | SA TEMP (DEG F): | 55.00 |
| SHADE FC: | 0.44 | | DT HTG (DEG F): | 40.00 |
| WALL CONST: | 3.00 | (BELOW GRADE) | | |
| FLOOR CONST: | 3.00 | (BELOW GRADE) | | |

Factors Corrected for Latitude-Month

| Time of Day | 08:00 AM | 10:00 AM | 12:00 PM | 02:00 PM | 04:00 PM | 06:00 PM |
|---|---|---|---|---|---|---|
| CLTDroof: | 22 | 23 | 26.00 | 31.00 | 36.00 | 39.00 |
| CLTDwall: TYPE B | | | | | | |
| N: | 9 | 8 | 7.64 | 8.47 | 9.30 | 23.00 |
| E: | 13 | 13 | 16.77 | 19.26 | 21.75 | 32.00 |
| S: | 12 | 10 | 10.13 | 10.96 | 13.45 | 43.00 |
| W: | 17 | 15 | 13.45 | 12.62 | 13.45 | 43.00 |
| CLTDwindow: | 3 | 7 | 12.00 | 16.00 | 17.00 | 12.00 |
| SHGF: | | | | | | |
| N: | 130 | 130 | 130 | 130 | 130 | 130 |
| E: | 216 | 216 | 216 | 216 | 216 | 216 |
| S: | 205 | 205 | 205 | 205 | 205 | 205 |
| W: | 216 | 216 | 216 | 216 | 216 | 216 |
| CLFwindow: | | | | | | |
| N: | 0.65 | 0.80 | 0.89 | 0.86 | 0.75 | 0.70 |
| E: | 0.80 | 0.62 | 0.27 | 0.22 | 0.17 | 0.16 |
| S: | 0.23 | 0.58 | 0.83 | 0.68 | 0.35 | 0.33 |
| W: | 0.11 | 0.15 | 0.17 | 0.53 | 0.82 | 0.67 |

============ =========: =======: =======: =======: ========: =========:

| Time of Day | 08:00 AM | 10:00 AM | 12:00 PM | 02:00 PM | 04:00 PM | 06:00 PM |
|---|---|---|---|---|---|---|

Raw Factors

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLTDroof | | 20 | 21.00 | 24.00 | 29.00 | 34.00 | 38.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLTDwall | TYPE E | | | | | | |
| N: | | 4 | 6 | 9.00 | 13.00 | 17.00 | 20.00 |
| E: | | 11 | 26 | 36.00 | 37.00 | 34.00 | 32.00 |
| S: | | 3 | 5.00 | 13.00 | 24.00 | 32.00 | 33.00 |
| W: | | 6 | 6.00 | 9.00 | 14.00 | 27.00 | 43.00 |

| | |
|---|---|
| CLTD Correction Factor (LM) | |
| Roof: | 1 |
| Walls: | |
| N | 3 |
| E | 0 |
| S | 10 |
| W | 0 |

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-B
PAGE: 1

| ROOM NO | ROOM NAME | SA (CFM) | RA (CFM) | EA (CFM) | SQFT | )ES/SQFT AC | COOL AC | DT HTG |
|---|---|---|---|---|---|---|---|---|
| P1B | PENTANT 1B | 23710 | 23710 | 0 | 19762 | 6 | 5 | 8 |
| | | 23710 | 23710 | 0 | 19762 | | | |

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-B
PAGE: 2

COOLING (BTUH)

| ROOM NO | ROOM | TOTAL SENS | EXT SENS | INTERNAL SENSIBLE LIGHTS | PEOPLE | MISC | TOTAL LATENT | HTG (BTUH) | HTG (BTUH/FT) |
|---|---|---|---|---|---|---|---|---|---|
| P1B | PENTANT 1B | 432161 | 108926 | 188134 | 17100 | 118000 | 17100 | 192059 | |
| | | 432161 | 108926 | 188134 | 17100 | 118000 | 17100 | 192059 | |

# HEATING/COOLING LOAD CALCULATIONS

## AHU DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-B
PAGE: 3

COOLING LOAD SENSIBLE (BTUH)

| BTUH | 8 | 10 | 12 | 2 | 4 | 6 | HTG (BTUH) | | |
|---|---|---|---|---|---|---|---|---|---|
| TOTAL SENSIBLE | 397902 | 409523 | 419526 | 423393 | 421277 | 432161 | 192059 | | |
| TOTAL LATENT | 17100 | 17100 | 17100 | 17100 | 17100 | 17100 | 0 | | |
| GRAND TOTAL | 415002 | 426623 | 436626 | 440493 | 438377 | 449261 | | | |
| | | | | | | | AC CFM | SQFT CFM | HTG CFM |
| AVG DT | 20 | 20 | 20 | 20 | 20 | | | | |
| SA (CFM) | 18421 | 18959 | 19423 | 19602 | 19504 | 20007 | 23714 | 0 | 113799 |
| RA (CFM) | 18421 | 18959 | 19423 | 19602 | 19504 | 20007 | | | |
| EA (CFM) | 0 | 0 | 0 | 0 | 0 | 0 | | | |

| | |
|---|---|
| TOTAL SA (CFM) | 23710 |
| TOTAL RA (CFM) | 23710 |
| TOTAL EA (CFM) | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| SENSIBLE COOLING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 397902 | 409523 | 419526 | 423393 | 421277 | 432161 | 192059 | | |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 397902 | 409523 | 419526 | 423393 | 421277 | 432161 | 192059 | 0 | 0 |
| LATENT COOLING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 17100 | 17100 | 17100 | 17100 | 17100 | 17100 | 0 | | |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 17100 | 17100 | 17100 | 17100 | 17100 | 17100 | 0 | 0 | 0 |
| SUPPLY AIR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 18421 | 18959 | 19423 | 19602 | 19504 | 20007 | 23714 | 0 | 113799 |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 18421 | 18959 | 19423 | 19602 | 19504 | 20007 | 23714 | 0 | 113799 |
| RETURN AIR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 18421 | 18959 | 19423 | 19602 | 19504 | 20007 | 23714 | 0 | 67604 |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 18421 | 18959 | 19423 | 19602 | 19504 | 20007 | 23714 | 0 | 67604 |
| EXHAUST AIR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51610 |
| | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= | ========= |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51610 |

9 10 9 9 9 9 9 9 9 9 9 100

HEATING/COOLING LOAD CALCULATIONS

GLOBAL DATA

PROJECT: BNL
DATE: 05-Sep-07
ENGINEER: ATIENZA

AHU-201-B
PAGE: 4.00 4.00

| | | | | |
|---|---|---|---|---|
| Uwall: | 0.05 | 20.00 | PEOPLE SENS (BTUH | 250.00 |
| Uwindow s: | 0.30 | | PEOPLE LAT (BTUH): | 200.00 |
| Uwindow w: | 0.29 | | OAT WINT (DEG F): | 0.00 |
| Uroof: | 0.04 | | SA TEMP (DEG F): | 55.00 |
| SHADE FC: | 0.44 | | DT HTG (DEG F): | 40.00 |
| WALL CONST: | 3.00 | (BELOW GRADE) | | |
| FLOOR CONST: | 3.00 | (BELOW GRADE) | | |

Factors Corrected for Latitude-Month

| Time of Day | | 08:00 AM | 10:00 AM | 12:00 PM | 02:00 PM | 04:00 PM | 06:00 PM |
|---|---|---|---|---|---|---|---|
| CLTDroof: | | 22 | 23 | 26.00 | 31.00 | 36.00 | 39.00 |
| CLTDwall: | TYPE B | | | | | | |
| N: | | 9 | 8 | 7.64 | 8.47 | 9.30 | 23.00 |
| E: | | 13 | 13 | 16.77 | 19.26 | 21.75 | 32.00 |
| S: | | 12 | 10 | 10.13 | 10.96 | 13.45 | 43.00 |
| W: | | 17 | 15 | 13.45 | 12.62 | 13.45 | 43.00 |
| CLTDwindow: | | 3 | 7 | 12.00 | 16.00 | 17.00 | 12.00 |
| SHGF: | | | | | | | |
| N: | | 130 | 130 | 130 | 130 | 130 | 130 |
| E: | | 216 | 216 | 216 | 216 | 216 | 216 |
| S: | | 205 | 205 | 205 | 205 | 205 | 205 |
| W: | | 216 | 216 | 216 | 216 | 216 | 216 |
| CLFwindow: | | | | | | | |
| N: | | 0.65 | 0.80 | 0.89 | 0.86 | 0.75 | 0.70 |
| E: | | 0.80 | 0.62 | 0.27 | 0.22 | 0.17 | 0.16 |
| S: | | 0.23 | 0.58 | 0.83 | 0.68 | 0.35 | 0.33 |
| W: | | 0.11 | 0.15 | 0.17 | 0.53 | 0.82 | 0.67 |

============= ========== ========: ========: ========: =========: ==========

| Time of Day | 08:00 AM | 10:00 AM | 12:00 PM | 02:00 PM | 04:00 PM | 06:00 PM |
|---|---|---|---|---|---|---|

Raw Factors

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLTDroof | | 20 | 21.00 | 24.00 | 29.00 | 34.00 | 38.00 |
| CLTDwall | TYPE E | | | | | | |
| N: | | 4 | 6 | 9.00 | 13.00 | 17.00 | 20.00 |
| E: | | 11 | 26 | 36.00 | 37.00 | 34.00 | 32.00 |
| S: | | 3 | 5.00 | 13.00 | 24.00 | 32.00 | 33.00 |
| W: | | 6 | 6.00 | 9.00 | 14.00 | 27.00 | 43.00 |

| | |
|---|---|
| CLTD Correction Factor (LM) | |
| Roof: | 1 |
| Walls: | |
| N | 3 |
| E | 0 |
| S | 10 |
| W | 0 |

# HEATING/COOLING LOAD CALCULATIONS

## ROOM DATA SUMMARY

PROJECT: BNL
DATE: 08-AUG-07

UNIT: AHU-101
PAGE: 1

| ROOM NO | ROOM NAME | SA (CFM) | RA (CFM) | EA (CFM) | SQFT | DES/SQFT AC | COOL AC | DT HTG | OA | %OA |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | TUNNEL 1 | 10280 | 10280 | | 6393 | 6 | 11 | 4 | 540 | 5.25% |
| | | 10280 | 10280 | | 6393 | | | | 540 | 5.25% |

| | | | |
|---|---|---|---|
| AIR FLOW W/DIVERSITY | 10280 | CFM | |
| SF AIR FLOW | 11822 | CFM | |
| RF AIR FLOW | 11822 | CFM | |
| EA=SF-RF | | CFM | |
| OA | 540 | CFM | 5% |
| OA CHECK | | CFM | |
| RELIEF | 540 | CFM | |

| | | |
|---|---|---|
| OA MAX | 540 CFM | |
| OA BY % | 540 CFM | |
| Y | 5.25% | <<<<<<<<<< |
| X | 5.25% | |
| Z | 5.25% | |

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 08-AUG-07

UNIT: \HU-201-A
PAGE: 1

| ROOM NO | ROOM NAME | SA (CFM) | RA (CFM) | EA (CFM) | SQFT | DES/SQFT AC | COOL AC | DT HTG | OA | %OA |
|---|---|---|---|---|---|---|---|---|---|---|
| P1A | PENTANT 1A | 23710 | 23710 | | 19762 | 6 | 4 | 8 | 1368 | 5.77% |
| | | 23710 | 23710 | | 19762 | | | | 1368 | 5.77% |

| | | |
|---|---|---|
| AIR FLOW W/DIVERSITY | 23714 CFM | |
| SF AIR FLOW | 27272 CFM | |
| RF AIR FLOW | 27272 CFM | |
| EA=SF-RF | CFM | |
| OA | 1368 CFM | 6% |
| OA CHECK | CFM | |
| RELIEF | 1368 CFM | |

| | | |
|---|---|---|
| OA MAX | 1368 CFM | |
| OA BY % | 1368 CFM | |
| Y | 5.77% | <<<<<<<<<< |
| X | 5.77% | |
| Z | 5.77% | |

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 08-AUG-07

UNIT: \HU-201-B
PAGE: 1

| ROOM NO | ROOM NAME | SA (CFM) | RA (CFM) | EA (CFM) | SQFT | DES/SQFT AC | COOL AC | DT HTG | OA | %OA |
|---|---|---|---|---|---|---|---|---|---|---|
| P1B | PENTANT 1B | 23710 | 23710 | | 19762 | 6 | 5 | 8 | 1368 | 5.77% |
| | | 23710 | 23710 | | 19762 | | | | 1368 | 5.77% |

| | | |
|---|---|---|
| AIR FLOW W/DIVERSITY | 20007 CFM | |
| SF AIR FLOW | 23009 CFM | |
| RF AIR FLOW | 23009 CFM | |
| EA=SF-RF | CFM | |
| OA | 1368 CFM | 7% |
| OA CHECK | CFM | |
| RELIEF | 1368 CFM | |

| | | |
|---|---|---|
| OA MAX | 1368 CFM | |
| OA BY % | 1368 CFM | |
| Y | 5.77% | <<<<<<<<<< |
| X | 5.77% | |
| Z | 5.77% | |

BNL NSLS II | AIR HANDLING UNIT PSYCHROMETRICS
05-Sep-07 | CV

AHU-101 <<<<<<<<< | ENGINEER: ATIENZA <<<<<<<<<

OUTSIDE DESIGN CONDITIONS

| SUMMER | | | | WINTER |
|---|---|---|---|---|
| OA DB | 95 | DEG F | <<<<<<<<< | 0 DEG F<<<<< |
| OA WB | 76 | DEG F | <<<<<<<<< | |
| OA ENT | 39.3 | BTU/LB OF DRY AIR | | |

| AIR FLOW | | | HEAT GAIN | | | HEAT LOSS | |
|---|---|---|---|---|---|---|---|
| SA | 11822 | CFM<<<<< | SENSIBLE | 255354 | BTUH<<<<< | 63839 BTUH<<<<< | 18776 W |
| RA | 11282 | CFM | PLENUM | 0 | BTUH<<<<<<< | | |
| OA | 540 | CFM<<<<< | LATENT | 1000 | BTUH<<<<< | | |

| FAN TOTAL PRESSURE | | | FAN TEMP RISE | | FAN ENT RISE | |
|---|---|---|---|---|---|---|
| SUPPLY | 4 | IN WG <<< | 3.1 | DEG F | 0.74 | BTU/LB OF DRY AIR |
| RETURN | 1.5 | IN WG <<< | 1.4 | DEG F | 0.35 | BTU/LB OF DRY AIR |
| LIGHTS TO PLENUM | | | 0.0 | DEG F | 0.00 | BTU/LB OF DRY AIR |

AHU LAT

| | | | |
|---|---|---|---|
| LAT DB | 56 | DEG F | <<<<<<<<< |
| LAT WB | 53.0 | DEG F | |
| LAT ENT | 22.61 | BTU/LB OF DRY AIR | |

ROOM CONDITIONS

| | | | | |
|---|---|---|---|---|
| SRMTEMP DB | 78.0 | DEG F<<<<<<< | WRMTEMP DB | 68 DEG F<<<<<<< |
| SRMTEMP WB | 60.0 | DEG F | | |
| RMENT | 27.91 | BTU/LB OF DRY AIR | | |

RETURN AIR

| | | |
|---|---|---|
| RA DB | 79.4 | DEG F |
| RA WB | 60.4 | DEG F |
| RA ENT | 28.26 | BTU/LB OF DRY AIR |

COOLING COIL

| | | |
|---|---|---|
| EAT DB | 80.2 | DEG F |
| EAT WB | 61.2 | DEG F |
| EA ENT | 28.76 | BTU/LB OF DRY AIR |
| LAT DB | 52.9 | DEG F |
| LAT WB | 52.8 | DEG F |
| LA ENT | 21.88 | BTU/LB OF DRY AIR |
| CAPACITY | 31 | TONS |

| PREHEAT COIL AT NORMAL OPERATION | | | | REHEAT COILS | HEAT LOSS | TOTAL HEATING |
|---|---|---|---|---|---|---|
| SA WINTER | 11822 | CFM | <<<<<<<<< | | | |
| EAT DB | 64.9 | DEG F | | 65 DEG F EAT | | |
| LAT DB | 52.9 | DEG F | | | | |
| HTG CAP | 0 | BTUH | | 39658 BTUH | 63839 BTUH | 103496 BTUH |
| HTG CAP | 0 | KW | | 12 KW | | |
| HTG CAP | 0 | LBS/HR STEAM | | 42 LBS/HR STEAM | | |

HUMIDIFIER

| | | | | | |
|---|---|---|---|---|---|
| WRMTEMP DB | 68.0 | DEG F | 0 | | |
| REL HUM | 30 | % | <<<<<<<<< | | |
| HUM RAT | 30 | GR/LB OF DRY AIR | | | |
| CAPACITY | 72 | LBS/HR STEAM | | ECON OA | 4244 CFM |
| | | | | MIN OA | 540 CFM |

PREHEAT COIL AT 100% OA

| | | |
|---|---|---|
| EAT DB | 0 | DEG F |
| LAT DB | 52.9 | DEG F |
| HTG CAP | 675757 | BTUH |
| HTG CAP | 199 | KW |
| HTG CAP | 711 | LBS/HR STEAM |

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BNL NSLS II — AIR HANDLING UNIT PSYCHROMETRICS

05-Sep-07 — VVR

AHU-201-A <<<<<<<<< ENGINEER: ATIENZA <<<<<<<<<

OUTSIDE DESIGN CONDITIONS

| | SUMMER | | WINTER |
|---|---|---|---|
| OA DB | 95 DEG F | <<<<<<<<< | 0 DEG F<<<<< |
| OA WB | 76 DEG F | <<<<<<<<< | |
| OA ENT | 39.3 BTU/LB OF DRY AIR | | |

| AIR FLOW | | HEAT GAIN | | HEAT LOSS | |
|---|---|---|---|---|---|
| SA | 27272 CFM<<<<< | SENSIBLE | 589066 BTUH<<<<< | 147266 BTUH<<<< | 43314 W |
| RA | 25904 CFM | PLENUM | 0 BTUH<<<<<<< | | |
| OA | 1368 CFM<<<<< | LATENT | 1000 BTUH<<<<< | | |

| FAN TOTAL PRESSURE | | FAN TEMP RISE | FAN ENT RISE |
|---|---|---|---|
| SUPPLY | 6 IN WG <<< | 4.6 DEG F | 1.11 BTU/LB OF DRY AIR |
| RETURN | 1.5 IN WG <<< | 1.4 DEG F | 0.35 BTU/LB OF DRY AIR |
| LIGHTS TO PLENUM | | 0.0 DEG F | 0.00 BTU/LB OF DRY AIR |

AHU LAT

| | | |
|---|---|---|
| LAT DB | 56 DEG F | <<<<<<<<< |
| LAT WB | 53.0 DEG F | |
| LAT ENT | 22.09 BTU/LB OF DRY AIR | |

ROOM CONDITIONS

| | | | |
|---|---|---|---|
| SRMTEMP DB | 75.0 DEG F<<<<<<< | WRMTEMP DB | 68 DEG F<<<<<<< |
| SRMTEMP WB | 60.0 DEG F | | |
| RMENT | 26.66 BTU/LB OF DRY AIR | | |

RETURN AIR

| | |
|---|---|
| RA DB | 76.4 DEG F |
| RA WB | 60.4 DEG F |
| RA ENT | 27.01 BTU/LB OF DRY AIR |

COOLING COIL

| | |
|---|---|
| EAT DB | 77.4 DEG F |
| EAT WB | 61.2 DEG F |
| EA ENT | 27.62 BTU/LB OF DRY AIR |
| LAT DB | 51.4 DEG F |
| LAT WB | 51.3 DEG F |
| LA ENT | 20.99 BTU/LB OF DRY AIR |
| CAPACITY | 68 TONS |

| PREHEAT COIL AT NORMAL OPERATION | | | REHEAT COILS | HEAT LOSS | TOTAL HEATING |
|---|---|---|---|---|---|
| SA WINTER | 27272 CFM | <<<<<<<<< | | | |
| EAT DB | 64.6 DEG F | | 65 DEG F EAT | | |
| LAT DB | 51.4 DEG F | | | | |
| HTG CAP | 0 BTUH | | 100466 BTUH | 147266 BTUH | 247732 BTUH |
| HTG CAP | 0 KW | | 30 KW | | |
| HTG CAP | 0 LBS/HR STEAM | | 106 LBS/HR STEAM | | |

HUMIDIFIER

| | | | | |
|---|---|---|---|---|
| WRMTEMP DB | 68.0 DEG F | | 0 | |
| REL HUM | 30 % | <<<<<<<<< | | |
| HUM RAT | 30 GR/LB OF DRY AIR | | | |
| CAPACITY | 154 LBS/HR STEAM | | ECON OA | 9091 CFM |
| | | | MIN OA | 1368 CFM |

PREHEAT COIL AT 100% OA

| | |
|---|---|
| EAT DB | 0 DEG F |
| LAT DB | 51.4 DEG F |
| HTG CAP | 1513618 BTUH |
| HTG CAP | 445 KW |
| HTG CAP | 1593 LBS/HR STEAM |

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BNL NSLS II
05-Sep-07

AIR HANDLING UNIT PSYCHROMETRICS
VVR

AHU-201-B <<<<<<<<< ENGINEER: ATIENZA <<<<<<<<<

OUTSIDE DESIGN CONDITIONS

| | SUMMER | | WINTER |
|---|---|---|---|
| OA DB | 95 DEG F | <<<<<<<<< | 0 DEG F<<<<< |
| OA WB | 76 DEG F | <<<<<<<<< | |
| OA ENT | 39.3 BTU/LB OF DRY AIR | | |

| AIR FLOW | | HEAT GAIN | | HEAT LOSS | |
|---|---|---|---|---|---|
| SA | 23009 CFM<<<<< | SENSIBLE | 496985 BTUH<<<<< | 124246 BTUH<<<< | 36543 W |
| RA | 21641 CFM | PLENUM | 0 BTUH<<<<<<< | | |
| OA | 1368 CFM<<<<< | LATENT | 1000 BTUH<<<<< | | |

| FAN TOTAL PRESSURE | | FAN TEMP RISE | FAN ENT RISE |
|---|---|---|---|
| SUPPLY | 6 IN WG <<< | 4.6 DEG F | 1.11 BTU/LB OF DRY AIR |
| RETURN | 1.5 IN WG <<< | 1.4 DEG F | 0.35 BTU/LB OF DRY AIR |
| LIGHTS TO PLENUM | | 0.0 DEG F | 0.00 BTU/LB OF DRY AIR |

AHU LAT

| | | |
|---|---|---|
| LAT DB | 56 DEG F | <<<<<<<<< |
| LAT WB | 53.0 DEG F | |
| LAT ENT | 22.09 BTU/LB OF DRY AIR | |

ROOM CONDITIONS

| | | | |
|---|---|---|---|
| SRMTEMP DB | 75.0 DEG F<<<<<<< | WRMTEMP DB | 68 DEG F<<<<<<< |
| SRMTEMP WB | 60.0 DEG F | | |
| RMENT | 26.66 BTU/LB OF DRY AIR | | |

RETURN AIR

| | |
|---|---|
| RA DB | 76.4 DEG F |
| RA WB | 60.4 DEG F |
| RA ENT | 27.01 BTU/LB OF DRY AIR |

COOLING COIL

| | |
|---|---|
| EAT DB | 77.5 DEG F |
| EAT WB | 61.4 DEG F |
| EA ENT | 27.74 BTU/LB OF DRY AIR |
| LAT DB | 51.4 DEG F |
| LAT WB | 51.3 DEG F |
| LA ENT | 20.99 BTU/LB OF DRY AIR |
| CAPACITY | 58 TONS |

| PREHEAT COIL AT NORMAL OPERATION | | | REHEAT COILS | HEAT LOSS | TOTAL HEATING |
|---|---|---|---|---|---|
| SA WINTER | 23009 CFM | <<<<<<<<< | | | |
| EAT DB | 64.0 DEG F | | 64 DEG F EAT | | |
| LAT DB | 51.4 DEG F | | | | |
| HTG CAP | 0 BTUH | | 100466 BTUH | 124246 BTUH | 224712 BTUH |
| HTG CAP | 0 KW | | 30 KW | | |
| HTG CAP | 0 LBS/HR STEAM | | 106 LBS/HR STEAM | | |

HUMIDIFIER

| | | | | |
|---|---|---|---|---|
| WRMTEMP DB | 68.0 DEG F | | 0 | |
| REL HUM | 30 % | <<<<<<<<< | | |
| HUM RAT | 30 GR/LB OF DRY AIR | | | |
| CAPACITY | 130 LBS/HR STEAM | | ECON OA | 7670 CFM |
| | | | MIN OA | 1368 CFM |

PREHEAT COIL AT 100% OA

| | |
|---|---|
| EAT DB | 0 DEG F |
| LAT DB | 51.4 DEG F |
| HTG CAP | 1277014 BTUH |
| HTG CAP | 376 KW |
| HTG CAP | 1344 LBS/HR STEAM |

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**Appendix A5**

Hourly Whole Building Energy Analysis
September 10, 2007

EMO Energy Solutions

EMO Energy Solutions
Energy Efficiency & Sustainable Design Consulting

**September 10th, 2007**

**BROOKHAVEN NSLS II – UPTON, NEW YORK: SCHEMATIC DESIGN ENERGY ANALYSIS**
**HOURLY WHOLE BUILDING ENERGY ANALYSIS AND LEED®-NC V2.2 EA CR.1 OPTIMIZATION**

## Purpose & Scope:

The United States Department of Energy (DOE) has contracted HDR Architecture, Inc. (HDR) and for the design and implementation of sustainable design strategies and features for the new Brookhaven National Laboratory – National Synchrotron Light Source II (NSLS II) in Upton, New York. This project is intended to incorporate environmentally sensitive materials and technologies along with the principals of sustainable design and the integrated whole building design approach. To this end, HDR has contracted EMO Energy Solutions, LLC (EMO) to perform a comprehensive whole building energy simulation, energy analysis, and general sustainable design and green engineering assistance.

This project will be applying for Leadership in Energy and Environmental Design, New Construction (LEED®-NC) version 2.2 with the goal of a "Gold" level of certification. As part of this certification process, EMO will simulate the annual energy use of the building as-designed / Design Energy Cost (DEC) model and the building as if it were designed to meet ASHRAE 90.1-2004 minimum specifications / Performance Rating Method (PRM) model. The difference in consumption between the two models is used to determine the final point total for Credit-1 of the LEED®-NC Energy and Atmosphere category.

Given this stage (Schematic) in design, this energy analysis report is intended to cover the following for the design team:

- Preliminary hourly building energy analysis
- Energy performance as compared to ASHRAE 90.1-2004 baseline (*initial – performance expected to change with more refined building*)
- Provide the design team feedback with regards to energy cost savings expectations going forward into the Design Development phase
- Itemize some of the energy cost savings for different energy efficiency opportunities
- Highlight some key ASHRAE 90.1-2004 Appendix G requirements
- Provide the design team information regarding energy utilization in the proposed facility and how to improve LEED®-NC EA Cr.1 performance

For this "SD Level" energy analysis, EMO has incorporated the <u>estimated</u> envelope, building design, and HVAC system options for the SD phase as well as all other parameters and components as represented in the documents (dated 27 January 2007), the "Title I Preliminary Design Report – 50% Review Submittal" and conversations with HDR.

## Methodology:

The standard sustainable design approach employed by EMO is based upon and optimized by the interactive design approach. Sustainable improvements are defined as modifications that will reduce the negative environmental impact of the building for future generations by minimizing the energy and water consumption, minimizing pollution emissions, and increasing the useful life of the building by improving the quality of the occupied spaces. This process incorporates four distinct, but fluid processes that work with the design team through the course of the design:

- **Generate the Baseline** - Generate a DOE-2.2 energy model of the current design of the facility, of which include all proposed building systems including the ASHRAE 90.1 guidelines for new construction where applicable.
- **Evaluate the Baseline** - Compare to ASHRAE or existing building code and PRM for LEED® ; determine energy goals and targets
- **Generate and Evaluate ECMs** - Generate parametric runs for any and all applicable ECMs to account for any associated savings that would add any LEED® credits in the Energy & Atmosphere category of the LEED® Rating System
- **Final Design** - Present the packaged ECMs, highlighting the energy savings, the overall Energy Usage Intensity (EUI-kBtu/sf) reduction, and the potential LEED® credits awarded.

The process of identifying energy efficiency and conservation measures relies on the following three step strategy. This strategy is applied to optimize and fully capitalize on the associated savings and emphasis on reduction of waste:

- **Minimize Building Loads** - Improve the building envelope, reduce lighting power densities and usage, incorporate suitable day lighting techniques, reduce equipment power densities and usage, and reduce water consumption flow rates.
- **Improve System Effectiveness** – Improve HVAC system design, increase motor efficiencies, utilize solar heating technologies, incorporate energy recovery technologies, and utilize applicable controls strategies.
- **Optimize Resource Delivery** – Provide renewable energy generation, incorporate energy storage techniques, increase the efficiency of the plant, review utility rate options, and investigate district heating and cooling options.

The method of evaluation closely followed the guidelines stipulated by the US Green Building Council's LEED® design approach and the ASHRAE/IESNA 90.1-2004 interactive calculation method.

All project energy modeling used eQUEST 3.61e, a program that utilizes DOE-2.2 to simulate the hourly energy consumption and demand load shapes for a given facility. To develop a model, the user creates a graphic representation of the building, using floor plans, floor heights, and window configurations. Specifics of the central plant, air-handling units, and building envelope are included along with the operating parameters such as lighting power density, occupancy, building schedules, and airflow rates. The simulation uses 30-year average hourly weather data to accurately estimate the energy consumption of the building for each hour of the year.

## Results Summary:

With the assumptions and strategies represented in the design drawings and implementation of all listed measures this project is expected to save ~**$492,908/yr (~21.8%)** in total energy costs when compared to the ASHRAE baseline **meeting EA Prerequisite 2** and equating to **(3-4) LEED®-NC v2.2 E&A Credit 1 (New Construction) points.**

It is important to note that the quoted performance will change once the design is developed further. However, it gives the project team an idea of the expectation following an aggressive design. [Review section "Energy Performance Issues"]

## Brief Modeling Description:

The following is a list, in no particular order, of some of the major modeling parameters accounted for at this stage. A more detailed line-by-line description of the differences between the "As-designed (DEC)" and "Initial Baseline (PRM)" energy simulations is shown in Figure 1.

- DOE Energy Information Administration published blended utility rates for New York State ($0.1543/kWh)
- Assumed a district steam rate of $25.00/MMBtu-delivered
- Utilizing typical meteorological year TMY2 hourly weather file for New York City, NY
- Utilized Title 24 approved diversity schedules for lighting, occupancy, plugs, process, etc.
- All envelop parameters (layer-by-layer assemblies, vertical glazings, programming, etc.)
- All internal loads (lighting, equipment "plugs", domestic hot water, occupancy, etc.)
- All external loads (climate zone, infiltration, solar transmitted, ground conductance, etc.)
- Photocells, occupancy sensors, $CO_2$, etc. / where anticipated
- All HVAC components (Chillers – ASHRAE 90.1, district steam, air-side equipment, controls, circulation loop infrastructure, settings, thermal zones, etc)
- Assumed on-site ASHRAE 90.1-2004 compliant chillers (per requirement for district system)
- All unknown parameters assumed to be ASHRAE 90.1-2004 Appendix G minimally compliant
- Water-cooled Synchrotron cooling neglected (i.e. ~2400 tons cooling, etc.); only energy uses of which can be controlled are included in addition to the LEED®-NC requirement for process energy
- Others…

**DEC – "As-Designed"**

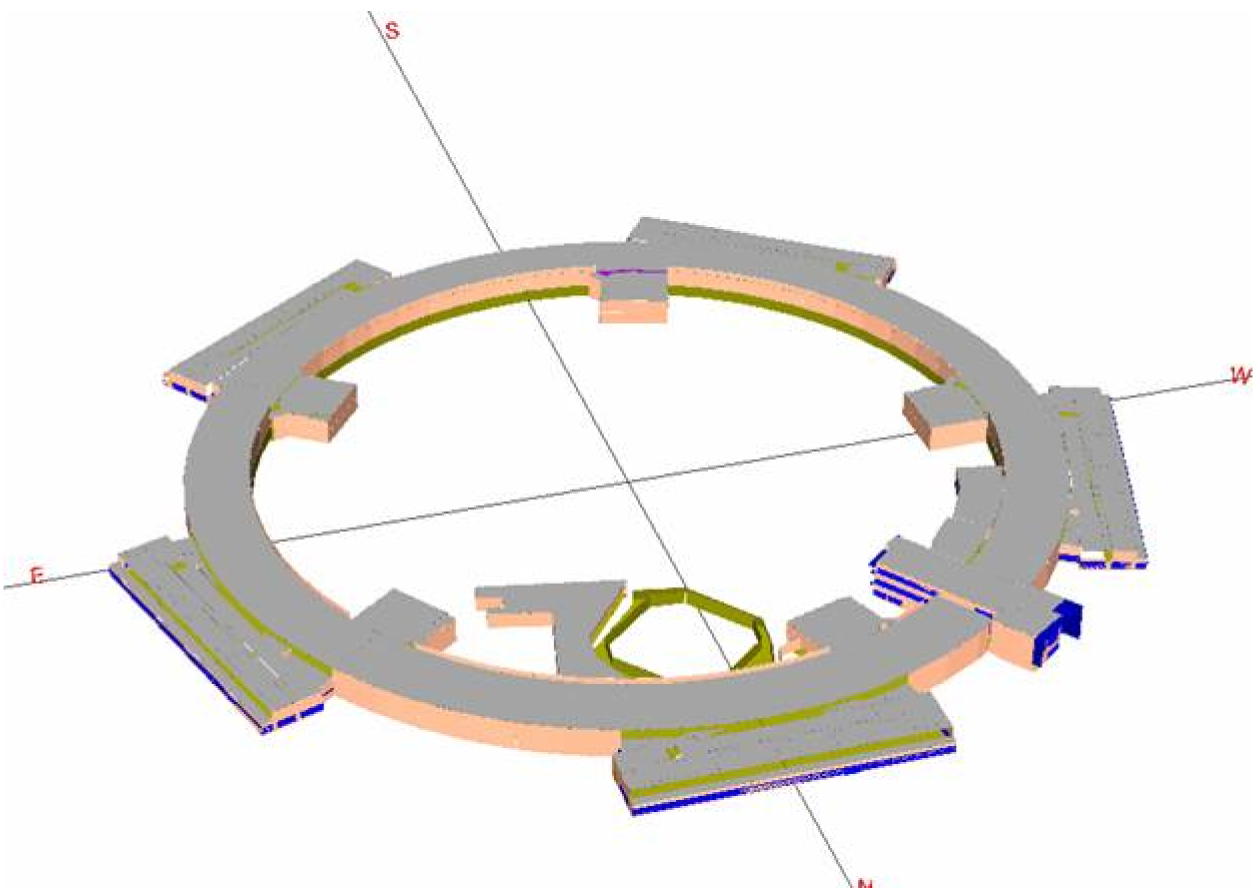



**Figure 1: 3-D Energy Model Renderings of the Design Energy Cost**

## Energy Performance Issues:

This section of the memo is intended to highlight some of the energy performance "highlights" and energy "hogs" of which will work either for or against optimizing total energy cost savings for LEED®-NC v2.2 Energy & Atmosphere Credit 1. The following, in no particular order, is a list of key parameters that are both improving and reducing our energy performance related to the ASHRAE 90.1-2004 Appendix G Performance Rating Method:

Improved Energy Cost Performance

- Having high process energy and tight indoor thermal requirements (i.e. 1°F) enables the project to do rather well when compared to ASHRAE 90.1-2004 compliance
- Long Island is one of the only areas in New York that doesn't require air-side economizers. **Including economizers at a facility with high internal heat gains will pay huge dividends.** If the site was located elsewhere the annual energy cost savings would be significantly less (see "Energy Efficiency Opportunities")
- Outside air economizers (N.R. per ASHRAE climate zone 4a)
- Having tight thermal requirements for the Experimental Hall provides significant opportunity (more so than most projects) for energy cost savings with a significantly improved envelope

  Centria® Formawall®: **U-value = 0.045**
  (see "Appendix A")

  Metal Deck Roof: **U-value = 0.054**
  (High Albedo white roof w/ low absorptance)

  High Performance Glazing:
  **U-value = 0.311 | SHGC =**
  (BOD: Viracon VE 1-2M)

- High efficiency lighting for Experimental Hall (**0.8 W/sf**), Offices (**0.9 W/sf**), and Laboratories (**1.0 W/sf**)
- Daylighting and photocell control for perimeter LOB offices (N.R. per ASHRAE 90.1)

Reduced Energy Cost Performance

- Stringent requirement for Total Fan Power. **Assumed ASHRAE 90.1-2004 Appendix G fan power** (very important to confirm) – Designers should review the following:

  Appendix G Table G3.1.2.9
  Section G31.2.9
  Appendix G User's Manual (Pgs G-28, G-29)

- District steam does not provide the opportunity to generate plant level heating savings given no site level heating source (Appendix G3.1.1.1)
- District chilled water does not provide the opportunity to generate plant level heating savings given no site level heating source (Appendix G3.1.3.7)
- **Constant volume** AHUs for Laboratory spaces
- Other parameters are unknown and a judgment cannot be made either way as to their impact at this time

## Energy Efficiency Opportunities:

***Variable Air Volume AHUs for Laboratories:*** Currently, the proposed facility is utilizing constant volume AHUs for the laboratories. If this is the case then the project cannot claim the energy cost savings associated with the sensible heat recovery since it will be required per ASHRAE 90.1-2004 G3.1.2.10. If VAV AHUs are utilized then the savings for ventilation energy or heat recovery can be claimed. Table 1 illustrates the savings associated with VAV AHUs equipped with variable speed drives.

**Table 1. Savings Summary for EEO-1**

| EEO No. | Description | Electricity Savings (kWh) | Annual Steam Savings (MMBtu) | Annual Energy Cost Savings | Total % Cost Savings |
|---|---|---|---|---|---|
| 1 | VAV for Laboratories | 129,777 | -1 | $19,977 | 1.1% |

***High Performance Glazings:*** As mentioned earlier, having tight thermal conditions in a large space volume opens up the opportunity for significant energy cost savings with improvements in the building envelope. The Experimental Hall is required to be maintained at 75°F year round with a 1.0°F tolerance. Therefore, there will be a significant amount of off-peak heating required and as such improving the glazing will generate energy cost savings. The basis-of-design for the "As-Designed" glazing is Viracon VE 1-2M or equivalent with improved conduction and reduced solar heat gain coefficient compared to that required by ASHRAE 90.1-2004 Climate Zone 4a. Table 2 illustrates the savings associated with VAV AHUs equipped with variable speed drives.

**Table 2. Savings Summary for EEO-2**

| EEO No. | Description | Electricity Savings (kWh) | Annual Steam Savings (MMBtu) | Annual Energy Cost Savings | Total % Cost Savings |
|---|---|---|---|---|---|
| 2 | High Performance Glazings | 45,439 | 764 | $26,089 | 1.5% |

***Daylighting Control:*** Currently, the proposed design shows several photocells in the commons areas, laboratories, classrooms, and main stairwell. EMO has elected to itemize the energy cost savings associated with turning off electrical lighting for the perimeter LOB office space only where adequate natural light is sufficient in supporting the specific space's primary function. Table 3 illustrates the savings associated with a typical LOB perimeter office employing photocell control based on natural light.

**Table 3. Brief Daylighting Statistics**

| Space | Percentage Lighting controlled | Foot Candle photocell setpoint | Peak Energy Reduction (Daylit hours) | Percentage Runtime Reduction (All hours) |
|---|---|---|---|---|
| LOB Perimeter Office | 100% | 50 | 79.0% | 46.0% |

Table 4 of this report illustrates the energy cost savings associated with this measure.

**Table 4. Savings Summary for EEO-3**

| EEO No. | Description | Electricity Savings (kWh) | Annual Steam Savings (MMBtu) | Annual Energy Cost Savings | Total % Cost Savings |
|---|---|---|---|---|---|
| 3 | Daylighting (Perimeter Offices Only) | 39,953 | -37 | $5,232 | 0.3% |

***Improved Building Envelope:*** Similar to that of EEO-2 an improved envelope will generate substantial savings at this site. EMO has itemized the savings with the improved wall assembly, roof assembly, and roof absorptance proposed for this project to illustrate the importance of the measure. Table 5 of this report illustrates the energy cost savings associated with this measure.

**Table 5. Savings Summary for EEO-4**

| EEO No. | Description | Electricity Savings (kWh) | Annual Steam Savings (MMBtu) | Annual Energy Cost Savings | Total % Cost Savings |
|---|---|---|---|---|---|
| 4 | Improved Building Envelope | 99,318 | 1,757 | $59,231 | 3.2% |

***Air-side Economizers:*** Upton, New York is one of the only regions in New York State of which air-side economizers are not required (Climate Zone 4a). The savings for this measure are much higher than in a typical building given the high internal heat gains, substantial exterior surface area, and only 75°F cooling requirement. Table 6 of this report illustrates the energy cost savings associated with this measure.

**Table 6. Savings Summary for EEO-5**

| EEO No. | Description | Electricity Savings (kWh) | Annual Steam Savings (MMBtu) | Annual Energy Cost Savings | Total % Cost Savings |
|---|---|---|---|---|---|
| 5 | Air-side Economizer | 1,826,471 | -354 | $272,952 | 13.4% |

***Improved Lighting Efficiency:*** HDR is expecting to have low peak power densities for a significant portion of the building. The majority of the electrical lighting in this facility is that of the Experimental Hall. The ASHRAE Table 9.6.1 requirement for this Laboratory type space is a lighting power density (LPD-W/sf) of 1.40 W/sf. HDR has indicated that the Experimental Hall will be designed to an LPD of 0.80 W/sf (43% improvement). This will require an aggressive lighting design most likely including 5-lamp T5HO technology in lieu of HID or T8 lighting technologies. Furthermore, HDR is designing to 0.90 W/sf in the Offices and 1.00 W/sf in the LOB laboratories. Table 7 of this report illustrates the energy cost savings associated with improving the lighting as indicated.

**Table 7. Savings Summary for EEO-6**

| EEO No. | Description | Electricity Savings (kWh) | Annual Steam Savings (MMBtu) | Annual Energy Cost Savings | Total % Cost Savings |
|---|---|---|---|---|---|
| 6 | Improved Lighting Efficiency | 632,559 | -871 | $75,810 | 4.1% |

Figure 2 and Figure 3 provide energy and cost by building end-use for the “Initial PRM” and “All EEOs” simulations.

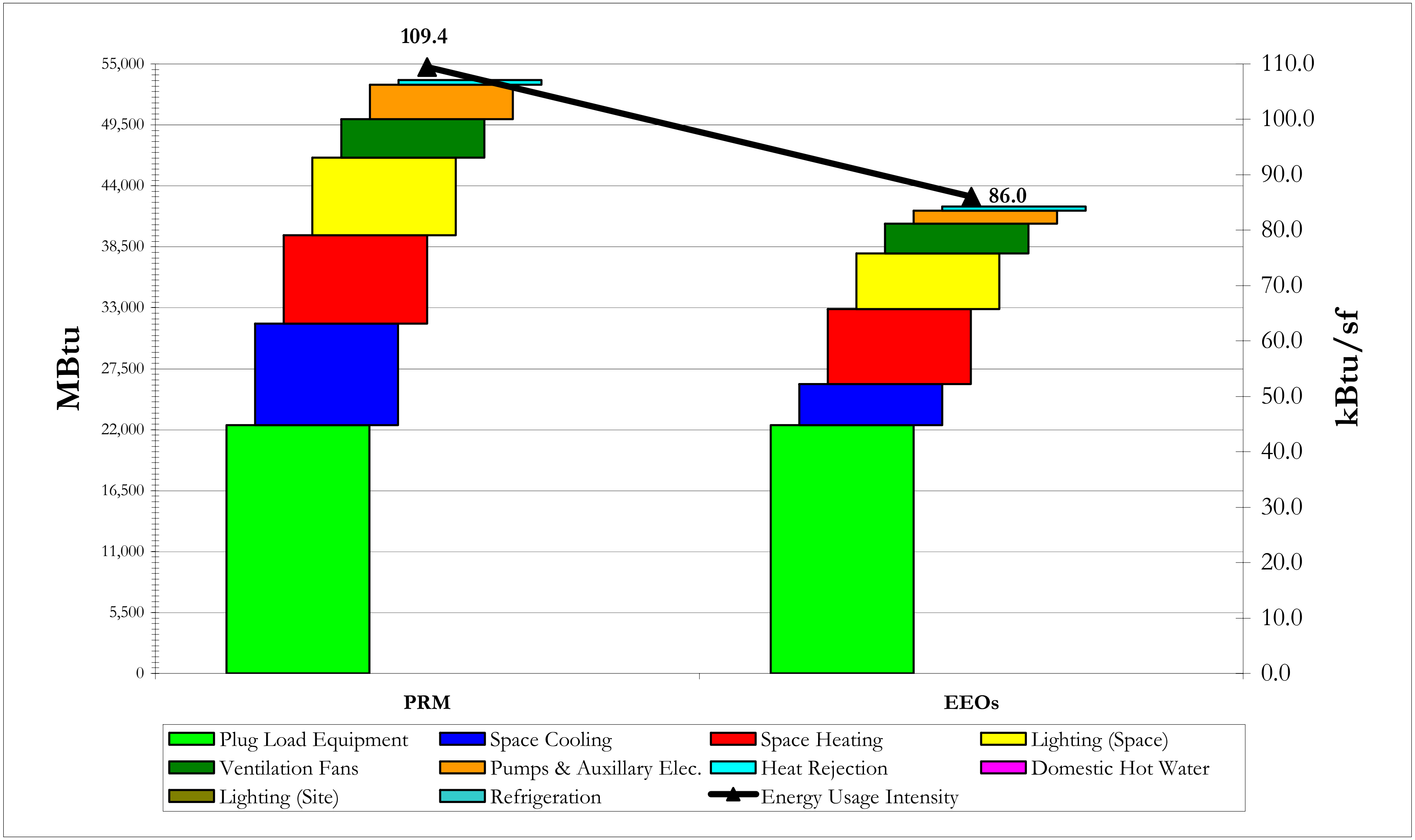
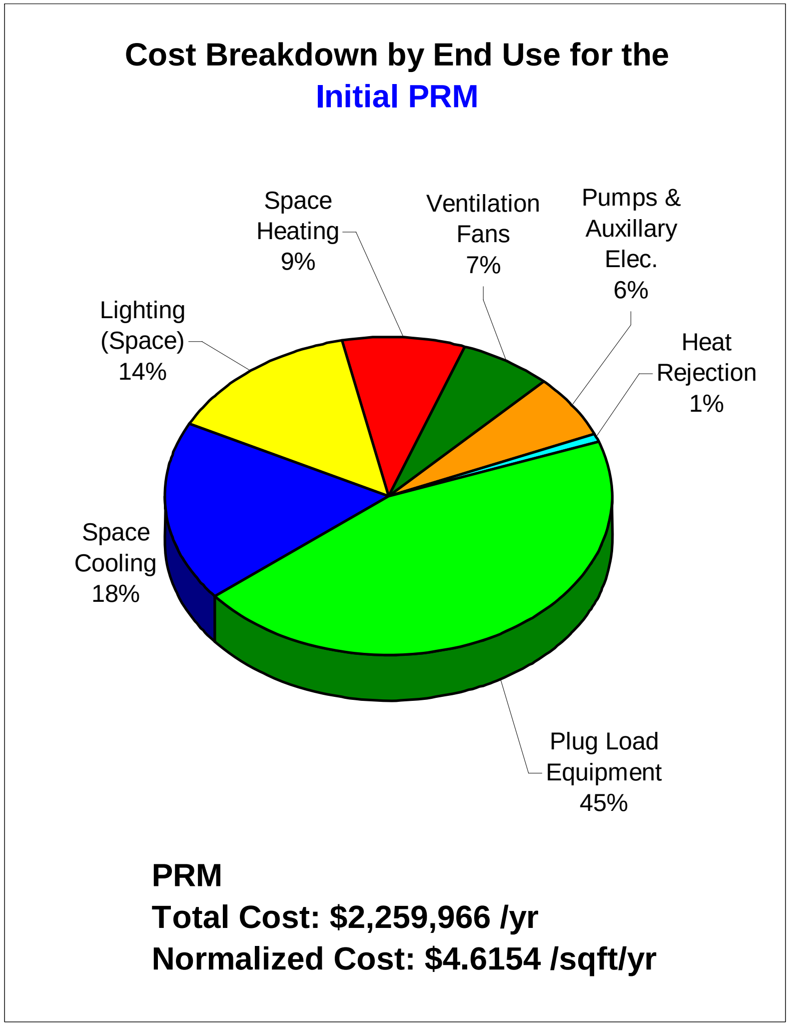



**Figure 2: Energy End-Use Breakdown and Energy Usage Intensity**



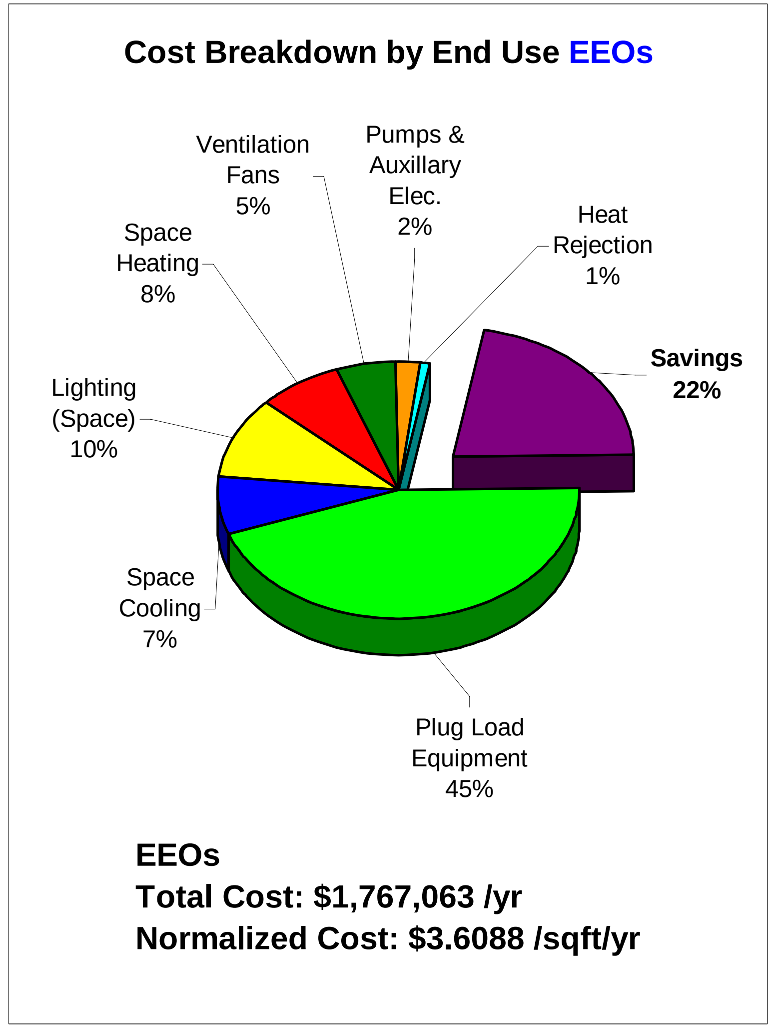




**Figure 3: Energy Cost Breakdown by End-Use and Annual Utility Budgets**

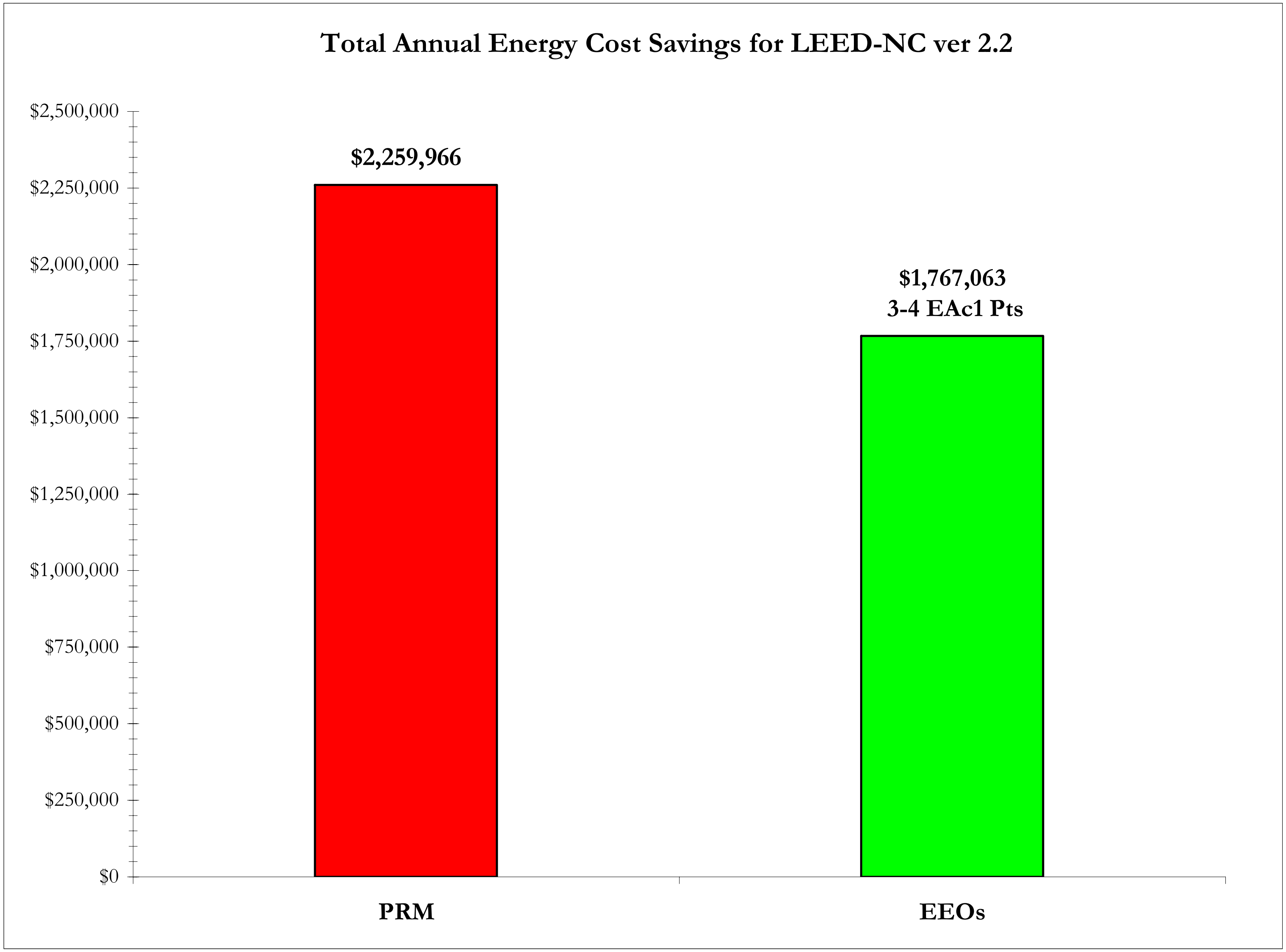
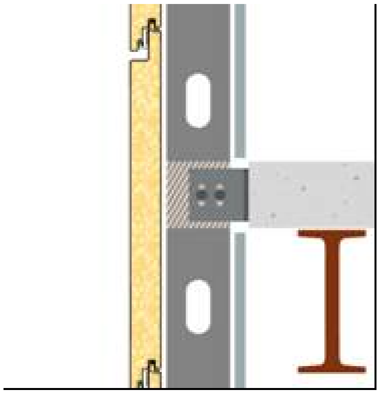
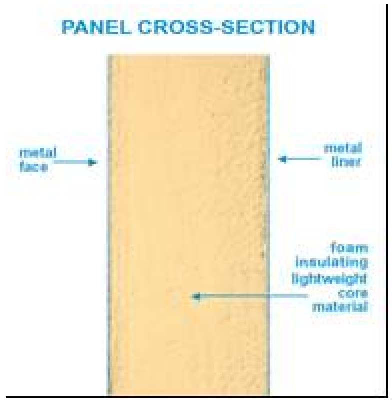



**Figure 4: Annual Energy Cost and LEED-NC ver 2.2 Points**

## Appendix A: Centria® Formawall™






**ASHRAE 90.1 R-Value Reductions Per ASTM C236 System Tests for Fiberglass Stud Insulation**

| Nominal Framing Depth | Nominal Insulation R-Value | x | Correction Factor | = | Effective R-Value |
|---|---|---|---|---|---|
| 4" @ 16" o.c. | R-15 | | 0.43 | | R-6.4 |
| 4" @ 24" o.c. | R-15 | | 0.52 | | R-7.8 |
| 6" @ 16" o.c. | R-21 | | 0.35 | | R-7.4 |
| 6" @ 24" o.c. | R-21 | | 0.43 | | R-9.0 |

SUBSTANTIAL REDUCTIONS

LEED® Quick Hits

- Significantly reduces thermal bridging from outside-to-inside and conduction for drastically improved envelope assembly (**Total wall = R-22.2 | AHSRAE 90.1-2004 = R-8.1**). [LEED®-NC EA Cr.1]
- Opportunity for earning **LEED® Innovation Credit for utilizing a "Cradle-to-Cradle" certified building material**
- Formawall™ panels contain an average of at least **16% post-consumer and 6% post-industrial recycled content**. [LEED®-NC MR Cr 4.1 & 4.2]
- **Panels have a VOC content of 180 grams/liter**, which is less than the maximum limit of 250 grams/liter established by this regulation for architectural sealants. [LEED®-NC EQ Cr. 4.1]
- **No VOC's are generated at the jobsite** from field-painting operations. [LEED®-NC EQ Cr 4.2]