NATIONAL BIO AND AGRO DEFENSE FACILITY (NBAF)

Site Characterization Study

Department of Homeland Security

DHS Project No.: LGL07C00004

July 25, 2008

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NBAF Design Partnership

The *Joint Venture* of

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Table of Contents

Section 1: Project Summary

1.1. Introduction

1.2. NBAF Basis of Design

1.1. INTRODUCTION

Site Selection & EIS Summary:

The Source Selection Authority for the NBAF site selection determined that six (6) sites, including Plum Island, would advance as reasonable alternatives in the Notice of Intent (NOI), published in the Federal Register on July 31, 2007 for the NBAF Environmental Impact Statement (EIS) Process. The six (6) sites listed in alphabetical order by city are as follows:

Alternative Sites	
Athens, Georgia	South Milledge Avenue Site
Manhattan, Kansas	Manhattan Campus Site
Flora, Mississippi	Flora Industrial Park Site
Plum Island, New York	Plum Island Site
Butner, North Carolina	Umstead Research Farm Site
San Antonio, Texas	Texas Research Park Site

The publishing of the NOI on July 31, 2007 began the National Environmental Policy Act (NEPA) process. The NEPA of 1969 requires the preparation of an Environmental Impact Statement (EIS) for major federal actions that may significantly affect the quality of the environment. Once the final EIS is published, a minimum 30-day waiting period is required by NEPA before a ROD can be issued in the *Federal Register*. The ROD notifies the public of decisions on the proposed action and the reasons for them. The ROD also notifies the public of the decision on the proposed action of whether to build the NBAF and, if so, where to build and operate it. The ROD documents the reasons for the decision and addresses the following items:

1. The decision whether or not to build the NBAF.
2. If the decision is made to build the NBAF, where it will be built.
3. Discussion of the alternative sites considered, specifying the alternative sites which are environmentally preferable.
4. Discussion of factors involved in the decision of if and where NBAF will be built, including any considerations of national policy, site specific costs, site characterizations, security, and other programmatic considerations.
5. Discussion as to whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted and, if not, why they weren't; any required mitigation, monitoring and enforcement programs that would be necessary to offset any unavoidable environmental impacts.

The engineering analysis, which contains a site characterization study and a site cost analysis, will provide this additional decision data that DHS may use to select the final site for the NBAF, which will be issued as a ROD in the *Federal Register*.

Site Characterization Study Summary:

This report represents the findings and evaluations based on a site specific analysis of each of the six sites based on the following criteria:

- Preliminary Subsurface Investigation
- Phase I Site Assessment
- Wetlands Delineation
- Seismic Analysis
- Foundation Analysis Based on Geotechnical Report
- Preliminary Site Concept Diagrams of NBAF Program to Test Fit Sites
- Evaluation of Anticipated Site Work
- Analysis of Utilities
- Analysis of Roadway Infrastructure
- Evaluation of any Special Permitting Requirements
- Evaluation of Labor Market
- Evaluation of Required Security and Set-Backs

Over a four week period members of the NBAF Design Partnership, NDP, accompanied members of the EIS and DHS teams to each site and met with the consortium representatives and walked the sites to begin documenting the items noted above. Each consortium also submitted various documents which were used to help fulfill the needs of completing the analysis of these sites. The site visit to the Plum Island added the additional requirement of analyzing three potential sites on the Island. The specific goals as set forth by DHS for both studies are as follows:

Goals:

Site Characterization Study - The Department of Homeland Security's (DHS) goal with the site characterization study is to provide detailed description and analysis to the NBAF steering committee to facilitate selection of a site with the least physical and geographical encumbrances so that the site may be developed without extremely complicated, costly, invasive, or lengthy mitigation techniques. This Report will indicate any factors relative to site selection and indicate any additional costs unique for each site. These cost factors are those which may require additional site work and/or specialized engineering in order to construct and or operate the NBAF program.

Site Costs Analysis - The goal of the report is to determine the economic factors of the alternative sites and to quantify these factors and express them in dollar amounts. DHS's goal is to minimize the construction, infrastructure and operating costs of the NBAF. The Site Cost Analysis will present the final evaluation of each alternative including all estimated costs. The goal is to minimize the cost while meeting the mission of the NBAF.

This report will not present any recommendations but rather provide any findings with anticipated cost implications.

Organization of Site Characterization Study:

This report is organized to present the findings and recommendations that have been determined to support the goals as noted above. The first section, "Project Summary",

provides the general basis of understanding for the purpose, need and process used to develop this report. The second section, "Site Alternative Descriptions", provides the actual findings and analyses for each site and is assembled so that each site description is all inclusive, contains the same evaluation criteria and can be separated from the rest of the report as a stand alone document if necessary. The third section, "Waste Stream Analysis", evaluates the anticipated waste treatment options as well as provides anticipated pollutant discharge ranges for the building support systems. The fourth section, "Site Concepts", includes the conceptual site diagrams. The fifth section, "Environmental Sustainability", provides the strategy to address sustainable design practices for a high containment facility. And the sixth section, "Code Summary", contains an summary of all known applicable codes for each site and also includes a preliminary code review of NBAF.

1.2. BASIS of DESIGN

Program Basis of Design:

The National Bio and Agro Defense Facility (NBAF) is envisioned to provide the nation with the first integrated agricultural and zoonotic disease, research, diagnostics, training and evaluation (RDT&E) facility with the capability to address threats from high-consequence zoonotic disease agents and foreign animal disease (FAD) agents. The facility would also provide the additional infrastructure required for threat and vulnerability assessments and for testing and evaluating promising FAD and zoonotic disease countermeasures. NBAF would support the complementary missions of the Department of Homeland Security (DHS) and the United States Department of Agriculture (USDA).

The NBAF project provides an opportunity for a new state-of-the art facility to replace the current Plum Island Animal Disease Center (PIADC) which currently supports:

- DHS Science & Technology (S&T) FAD Targeted Advanced Development (TAD) countermeasure program
- USDA, Animal and Plant Health Inspection Service (APHIS) Foreign Animal Disease Diagnostic Laboratory (FADDL) program
- USDA, Agricultural Research Service (ARS) Foreign Animal Diseases Research Unit (FADRU) program.

The conceptual design and feasibility study, completed in August 2007, reviewed two major areas:

- Existing Mission – The PIADC facility is now greater than 50 years old and due to obsolete design, systems, a deteriorating infrastructure, and expanded DHS and USDA programs it is becoming increasingly more difficult and expensive to maintain in support of the scientific research, development, and diagnostic programs. The feasibility study explored keeping the scope of the NBAF the same as the current PIADC mission while building the facilities required to meet the needs of the first half of the 21st century.
- Expanded Mission – Expand the scope to include additional agricultural biocontainment laboratories at BSL- 3 agriculture (BSL-3Ag), BSL-3E and BSL-4 for foreign animal and zoonotic diseases as called for in Homeland Security Presidential Directive (HSPD)-9.

Program Components:

The NBAF project scope would consist of two laboratory facilities and three outbuildings within the site itself. One of the two laboratory buildings would be the main research building containing the BSL-2, BSL-3E, BSL-3Ag, & BSL-4 laboratories with their associated support spaces as identified in the space summary list located in section 4 of this report. The other laboratory building is the cGMP laboratory located adjacent to the main research building. In addition to the two laboratory facilities, there are also three outbuildings which support the overall operation of NBAF:

- Main Research Building – 504,000 GSF
- cGMP Facility – 13,000 GSF
- Main Security Gatehouse – 1,000 GSF
- Central Receiving (Ground Keeping Equipment/Feed Storage, Transfer Station/ Visitors' Center/ Feed and Bedding Storage) – 22,000 GSF
- Central Utility Plant – 56,000 GSF

Architectural Basis of Design:

NBAF is a national asset which would become the international 'icon' for biocontainment around the world. All design decisions will be measured against the goals and vision as set forth in the Conceptual Design and Feasibility Study. The one overarching design goal will be to provide a facility which supports and enables the science while providing a safe, secure and enjoyable work environment.

One of the primary preliminary design goals was to provide an adequate level of redundant safety and containment which would be integrated into every component of the building. All lab areas, animal areas, support areas and engineering systems would have 100% back-up and redundancy. Each site was evaluated against the following design goals:

- [redacted]

[redacted] This level of safety, redundancy and security would help provide instant and automatic safeguards to the staff and community it serves to support the overarching design goal of providing a safe and enjoyable work environment. Each site will be evaluated to insure that these safeguards can be met.

Section 2: Site Alternative Descriptions

2A.1. SITE IMPACT ANALYSIS (Athens, Georgia)

2A.1.1. Preliminary Geotechnical Report Findings

Preliminary Geotechnical Engineering Report Provided by Terracon

Terracon Project 49079038 dated December 5th, 2007.

The following summary information is based on the above referenced preliminary report.

Site description:

The site location is on South Milledge Avenue. The 66 acre partially wooded site is the current location of a horse pasture. An intermittent stream runs through the property in a western direction in the middle of the western edge of the site.

Topography:

Site has significant grade change in the area anticipated for development. The site might be generically described as having rolling terrain.

Subsurface Stratigraphy:

Subsurface conditions were evaluated by 5 borings completed in this study. The findings would generally be described as follows:

- 0 to 1.5 feet — CULTIVATED-SILTY SAND
- 13.5 to 53.5 feet — SILTY SAND
- 1.5 to 60 feet — SANDY SILT (B-1 and B-3 only)
- 1.5 to 71 feet — PARTIALLY WEATHERED ROCK / SILTY SAND (All Except B-1)
- 17 to 27 feet — ROCK (B-5 only)

Please see boring logs in the referenced report for specific information.

The Geotech report contains a review of area geology as well.

Groundwater:

Subsurface water observed in three borings between 26 to 37.5 feet.

Groundwater was measured about one day after drilling @ a depth of 25' in boring B-3.

Note. Survey was performed during extreme draught conditions late 2007. Further consideration of groundwater fluctuations is warranted.

Soil preparation and Structural considerations:

Geotechnical considerations reviewed soil bearing capacity and anticipated soil movement.

The proposed building can likely be supported on conventional shallow foundations bearing on residual soil or engineered fill.

Some of the higher loaded interior column loads require ground modification, including undercutting and replacement with No. 57 stone or possibly stone columns for loads higher than anticipated by this report.

The PARTIALLY WEATHERED ROCK encountered typically requires ripping with heavy bulldozer for excavation. The material can be used as engineered fill, but requires large compaction equipment.

Depth to auger refusal materials varied across the site from 17 feet to 71 feet. Blasting is typically required for these conditions for excavation.

Soil bearing pressures anticipated in the range of 2,500 to 3,500 psf for conventional spread footings.

Perimeter footings and footings beneath unheated areas should bear 1.5 feet below lowest adjacent finished grade for frost protection.

The report does not address deep foundations.

Site improvement:

Adequate drainage behind site retaining walls or foundations walls would need to be addressed to reduce potential hydrostatic loading.

Seismic design criteria:

Site class D (Based on 2006 IBC)

Maximum Considered Earthquake 0.2 second Spectral Acceleration S_S = (not indicated)

Maximum Considered Earthquake 1.0 second Spectral Acceleration S_1 = (not indicated)

Paving subgrade preparation and system selection:

Pavement on site may be either flexible or rigid systems depending on traffic loading conditions.

Flexible paving:

Automobiles only: 12” treated subgrade, 6” aggregate base, 2” asphalt.

Medium duty: 12” treated subgrade, 8” aggregate base, 3” asphalt.

Rigid paving:

Light duty: 12” treated subgrade, 4” crush stone base, 5” concrete.

Medium duty: 12” treated subgrade, 4” crush stone base, 7” concrete.

Concrete pads for heavy loading and recommended areas 7” with 4” GAB.

2A.1.2. Phase I Findings

Phase I Environmental Site Assessment Provided by Terracon

Terracon Project 49079039 dated November 19th, 2007.

The following summary information is based on the above referenced report.

Summary of recognized environmental conditions (RECs):

There was no identification of RECs. on site

The existing conditions do not indicate any previous existence of RECs.

There are two sites within a search radius that do not warrant further study.

No further environmental testing or assessment is recommended at this time.

Zoning / land use:

The site is zoned G (Government)

2A.1.3. Wetlands Delineation Findings

A wetlands/waters of the United States (WoUS) review found that the site contains no wetland areas however some stream channels were observed on the western portion of the property.

Subsurface water observed in three borings between 26 to 37.5 feet.

Note. Survey was performed during extreme draught conditions late 2007. Further consideration of groundwater fluctuations is warranted.

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2A.2. RESOURCE RESTORATION (Athens, Georgia)

There is a potential for piping of a stream which would impact approximately 160 linear feet of bed and bank wetlands. Up to 300 linear feet is allowed under USACE nationwide permits; however, notification to the Corps and mitigation for the impacts would be required.

The majority of the site is pasture with a few trees existing in the stream area that would be disturbed. Per the local covenants the site is required to maintain 40% tree canopy cover, if there is no cover then the site is required to be planted to achieve the requirement.

2A.3. SITE WORK ANALYSIS

2A.3.1. Anticipated Earthwork Analysis:

It is anticipated that the earthwork can be balanced on-site with 292,000 cubic yards of cut. Fills range from 0-34 feet and cuts from 0-36 feet. Note that this earthwork would likely require rock removal.

2A.3.2. Anticipated Utility Routing:

Power, water and gas can be run directly from South Milledge Avenue along the proposed entrance drive directly into the CUP. It is anticipated that water and gas upgrades may be necessary along South Milledge by the utility companies to support the facility.

It is anticipated that sanitary sewer would be collected outside the basement level and be pumped a total of 9,500 feet from the facility to a gravity line at a soccer complex located northwest on South Milledge Avenue.

Site run off would be detained on the NBAF site per local and state regulations to meet the required 10, 25 & 100 year rain events.

2A.3.3. Transportation Infrastructure:

Approximately 1,200 feet of driveway would need to be constructed from South Milledge Avenue to the gate onsite. It is expected that South Milledge Avenue can support the facility with its current condition and no major road upgrades are necessary. There may be a need for deceleration and acceleration lanes and a left turn lane at the driveway entrance to facilitate traffic flow. An exit only road (which is intended for emergency evacuations) is proposed along the southeast side of the site and connects to Whitehall Road.

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2A.4. UTILITY ANALYSIS (Athens, Georgia)

2A.4.1. Existing Utility Infrastructure

The site Consortia have reviewed and verified that the estimated NBAF service loads and demands can be met by the local utility provider however some improvements would need to occur to their local infrastructure. The costs and details of these improvements are included in the Site Cost Analysis and In-Kind evaluation.

All utilities are available except for those listed below.

Chilled Water:

Existing chilled water utilities are not available to serve NBAF. Chilled water would be provided as part of the central utility plant constructed as part of the NBAF project.

Steam:

Existing steam utilities are not available to serve NBAF. Steam would be provided as part of the central utility plant constructed as part of the NBAF project.

2A.4.2. NBAF Program Loads & Capacity Requirements

Chilled Water:

Preliminary chilled water loads for the Athens, Georgia site are based on the current facility program using the 0.4% design dry-bulb (89°F) and 0.4% design wet-bulb (78°) temperatures as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak chilled water load of 5,200 tons including 750 tons for process cooling is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized chillers at 1,040 tons are required. This N+1 strategy would maintain the firm capacity of 5,200 tons and require a total installed capacity of 6,240 tons. This allows the peak capacity of the facility to be met in the event of the loss of one chiller.

Steam:

Preliminary steam loads for the Athens, Georgia site are based on the current facility program using the 99.6% design condition (20°F and 7.74 gr/lb moisture) as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak steam load of 133,500 lb/hr including 55,000 lb/hr for process loads is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized boilers at 26,700 lb/hr are required. This N+1 strategy would maintain the firm capacity of 133,500 lb/hr and require a total installed capacity of 160,200 lb/hr. This allows the peak capacity to be met in the event of the loss of one boiler.

Natural Gas:

The CUP should be provided with a 10 PSI natural gas supply to meet the installed natural gas burning equipment firm capacity of 133,500 CFH.

Fuel Oil:

Multiple fuel oil tanks serving the boilers and generators with a total capacity of 550,000 gallons are required to provide stand-by operation of the facility for thirty days in the event of either a loss of normal power or natural gas service to the site.

Water:

Dual water service is required to the site with a minimum delivery pressure of 35 psi. Water consumption ranges between 50,000 and 275,000 gallons per day with a peak flow rate of 657 GPM. The maximum value includes cooling tower make-up water for peak cooling days during the summer months and is less other times of the year. The estimated total annual water consumption is 43,000,000 gallons.

Sanitary:

Discharge to the sanitary system ranges between 50,000 and 150,000 gallons per day with an annual estimated discharge of 26,500,000 gallons. If a tissue digester is utilized for carcass disposal a small percentage of the effluent stream would have the following composition.

BOD (mg/L)	10,250
COD (mg/L)	19,600
Suspended Solids (mg/L)	1,400
pH	9.48

It is anticipated that a dilution level acceptable to the local sewer district would be achieved based on the total effluent discharge from the facility. This would be confirmed as part of the detailed design phase.

Electrical:

A minimum of two redundant medium voltage services with multiple feeders are required to serve the NBAF campus. The specific arrangement of electrical service is required to be coordinated with the utility provider.

A utility substation at 34.5 kV is required on site with two transformers feeding 15 kV Class switchgear in a main-tie-main arrangement. The secondary feeders would provide primary electric service at 13.8 kV to the Central Utility Plant (CUP) and to the building.

The total normal power load required to accommodate the specific site infrastructure loads as well as the typical building load for Athens, Georgia is approximated at 12.8 MW.

Stand-by / Emergency Power:

The critical nature of the building loads requires that nearly 90% of the normal power loads be on emergency/standby power and backup. In lieu of segregating the building distribution as normal and emergency, the entire load would be served by the emergency/standby power system.

To meet these requirements eight 2000eKW generators would be required. This N+1 strategy would allow normal maintenance to occur while still maintaining reliable capacity. Generation would be at 13.8kV and be connected to the 15kV switchgear through motorized breakers.

2A.4.3. Utility Outages

Due to the mission critical nature of the facility, availability and reliability of the primary utilities is critical. In the unlikely event that one of the utilities, natural gas, electric, water or sewer service, is lost to the building the following redundancies / provisions have been included.

Natural Gas

In the event of the loss of natural gas service to the facility, on site fuel storage to support the operation of the boilers is provided. This storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only natural gas to the facility is lost the fuel storage would support the boilers for up 120 days depending on the season.

Electrical

In the event of loss of the primary feeder to the site, power would automatically transfer to the redundant feeder without interruption of power to the building. In the event of the loss of both the primary and redundant feeders the generators would start and restore power to the building. As noted above the fuel storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only electrical service is lost the fuel storage would support the generators for up to 60 days depending on the season.

Water

In the event of loss of the primary water service to the site, water would be provided by the redundant dual water service. In the event of complete loss of utility provided, water provisions would be in place to allow temporary connection to a tanker truck. SOP's would be required to strictly limit water use to only critical facility functions.

Sanitary

In the event of loss of sanitary service to the facility, the effluent decontamination system (EDS) would allow for up to 48 hours of storage of effluent discharged from the BSL-3AG and BSL-4. SOP's should be in place to limit discharge to extend this holding time if possible. All areas of the building not discharging through the EDS would require SOP's to immediately suspend all sanitary discharge. If the outage is estimated to last beyond the 48 hour holding time, temporary provisions could be made to pump the waste from a local manhole into a tanker truck for proper disposal.

The waste would be decontaminated through normal protocols prior to discharge from the facility.

2A.4.4. Utility Costs

Utility costs for the site have been developed based on the current programming utilizing computer software that models the operation of the building throughout the year on an hourly basis. Utility rates were obtained from the Energy Information Administration website www.eia.doe.gov which is governed by the Department of Energy. Actual consortia provided rate structures may differ significantly. The energy model would be updated as new information becomes available. The current estimated utility consumptions and costs for Athens, Georgia are summarized below. Fuel oil values are based on weekly testing and 80 hours of back-up operation per year.

Utility	Estimated Annual Cost
Electrical	$3,500,000 to $4,500,000
Natural Gas	$1,000,000 to $1,500,000
Fuel Oil	$ 300,000 to $ 500,000

2A.4.5. Boiler Emissions

Boiler emissions have been calculated using the annual natural gas consumption determined in the energy model. Emission rates were then applied to the total consumption to obtain estimated boiler emission rates in pounds. The results of this for Athens, Georgia are summarized in the table below.

Estimated Boiler Emissions (Natural Gas)				
Athens, Georgia	Estimated Annual Consumption (MMBtu)	Boiler Emission Levels (lb/MMBtu)	Estimated Annual Emissions	Estimated Annual Emissions
Substance				
Nitrogen Oxide (NOX)	110,630	0.035	3,872 lbs	1.9 tons
Particulate Matter < 10 Micron Diameter (PM-10)	110,630	0.010	1,106 lbs	0.6 tons
Volatile Organic Compounds (VOC)	110,630	0.016	1,770 lbs	0.9 tons
Sulfur Oxide (SOX)	110,630	0.001	111 lbs	0.1 tons
Carbon Monoxide (CO)	110,630	0.040	4,425 lbs	2.2 tons

2A.4.6. Generator Emissions

Generator emissions have been calculated based on weekly testing of the generators and stand-by power operation at 75% capacity for both 80 hours (normal operation) and 30 days (catastrophic event) per year. The results are summarized below.

Substance	**Estimated Annual Emissions**	
Stand-by Duty→	**80 Hours**	**30 Days**
Nitrogen Oxide (NOX)	31,795 lbs	142,387lbs
Carbon Monoxide (CO)	3,238 lbs	14,502 lbs
Total Hydrocarbon (VOC)	1,914 lbs	8,570 lbs

DIESEL GENERATOR EMISSIONS VALUES -80 hours stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs Total per Generator Number of Units	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
	104	2246.4 lbs	228.8 lbs	135.2 lbs
	80	1728.0 lbs	176.0 lbs	104.0 lbs
	184	3974.4 lbs	404.8 lbs	239.2 lbs
	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		31795 lbs 15.9 Tons	3238 lbs 1.6 Tons	1914 lbs 1.0 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

DIESEL GENERATOR EMISSIONS VALUES -30 days stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs Total per Generator Number of Units	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
	104	2246.4 lbs	228.8 lbs	135.2 lbs
	720	15552.0 lbs	1584.0 lbs	936.0 lbs
	824	17798.4 lbs	1812.8 lbs	1071.2 lbs
	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		142387 lbs 71.2 Tons	14502 lbs 7.3 Tons	8570 lbs 4.3 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

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2A.5. STRUCTURAL BASIS FOR DESIGN (Athens, Georgia)

The parameters for the NBAF structural system were evaluated to support a structure that consists of a basement (fully or partially below grade), an occupied research floor, an interstitial service floor and a penthouse.

Structural Engineering Assumptions based on the Geotechnical Report: 3 story concrete structure plus penthouse, with concrete roof at penthouse.

2A.5.1. Design Criteria:

Live Loads

Laboratories	100 psf
Animal Research Facilities	100 psf
Animal Research Facilities with Primates	125 psf
Storage Rooms	150 psf
Mechanical Areas (or weight of equipment if greater)	150 psf
Conference Rooms	125 psf
Reception Lobby Areas	125 psf
Frozen Storage	210 psf
Loading Docks and Receiving Areas	250 psf
Loading Docks and Receiving Areas	250 psf
Stairs and Permanent Corridors	100 psf
Roofs	45 psf

Superimposed Dead Loads

Mechanical and Plumbing (or weight of supported systems, if greater)	10 psf
Ceilings	3 psf

Wind Loads

Basic Wind Speed	90 mph
Wind Directionality Factor (K_d)	0.85
Importance Factor (I)	1.15
Exposure Category	C
Velocity Pressure Coefficient (K_h)	1.13
Topographic Factor (K_{zt})	1.0
Gust Effect Factor (G)	0.85
Enclosure Classification	Enclosed
Internal Pressure Coefficient (GC_{pi})	±0.18
External Pressure Coefficients (C_p)	
Windward	+0.8
Leeward	-0.3
Sidewall	-0.7
Velocity Pressure ($_{qh}$)	22.9 psf
Components and Cladding	
Windward Walls	1.5 times windward MWFRS
Leeward Walls	3 times leeward MWFRS
Corners	5 times leeward MWFRS

Earthquake Loads

Mapped Spectral Accelerations for Short Periods (S_s)	0.262g
Mapped Spectral Accelerations for 1-Second Period (S1)	0.092g
Seismic Occupancy Category	IV
Seismic Occupancy Importance Factor (IE)	1.50
Site Classification	D
Site Coefficient F_a	1.6
Site Coefficient F_v	2.4
Response Modification Coefficient	5
Seismic Design Category	C
Seismic Response Coefficient (C_s)	7.4%

2A.5.2. Seismic or Wind Lateral Design

Based on the preliminary Geotechnical Report the anticipated structural foundation and lateral design system consists of the following components: (Seismic controls the lateral design)

- Shear Walls - Per 5000 sf of building footprint: 62.2 cu yd concrete, 4.4 tons reinforcement.
- Shear Wall Foundations - Spread footing per 5000 sf of building footprint: 204.0 cu yd concrete, 8.8 tons reinforcement.
- Columns - Spread footing per 700 sf of building footprint: 41.2 cu yd concrete, 1.1 tons reinforcement.

2A.6. SITE SECURITY (Athens, Georgia)

2A.6.1. [redacted]

[redacted]

[redacted]

2B.1. SITE IMPACT ANALYSIS (Manhattan, Kansas)

2B.1.1. Preliminary Geotechnical Report Findings

Preliminary Geotechnical Engineering Study Provided by Terracon

Terracon Project 14079038 dated December 5th, 2007.

The following summary information is based on the above referenced preliminary report.

Site description:

The site location is southeast of the intersection of Kimball avenue and Denison Avenue. The site is the current location of the Kansas State University Research site and has been utilized for animal research since the 1970's. The site is improved with several structures including five research buildings, a residential structure, and a storage building for recycling materials.

Topography:

The site drains toward west to southwest. The site flattens along higher elevations along the north and east property boundaries.

Subsurface Stratigraphy:

Subsurface conditions were evaluated by 5 borings completed in this study. The findings are generally described as follows:

- 0 to 5 feet FILL / POSSIBLE FILL: fat clays, rock fragments
- 5 to 12 feet NATIVE FAT CLAYS with rock
- 7 to 17 feet SANDY LEAN CLAY
- 5 to 26 feet ROCK: alternating limestone and shale

Please see boring logs in the referenced report for specific information.

The report contains a review of area geology.

Groundwater:

Subsurface water was observed in one boring at 25 feet. A free static water surface was not observed at completion of drilling.

Soil preparation and Structural considerations:

Geotechnical considerations review soil bearing capacity and anticipated soil movement. Existing fill is expected in all areas of the site. Expansive soils are present at the site.

Native soils or engineered fill may support 2,000 to 3,000 psf.

Un-weathered bedrock may range 5,000 to 10,000 psf.

Drilled piers through 5 feet of clay bearing on shale or limestone may support 15,000 to 20,000 psf, and may experience settlement of 1inch or less.

Spread footings with light loads may experience settlement of 1 inch or less.

Spread footings with heavy loads may experience settlement of 2 inchs or more.

Site improvement:

Adequate drainage behind site retaining walls or foundations walls is required to reduce potential hydrostatic loading.

Seismic design criteria:

Site class D (Based on 2006 IBC)

Maximum Considered Earthquake 0.2 second Spectral Acceleration S_S = 0.20g

Maximum Considered Earthquake 1.0 second Spectral Acceleration S_1 = 0.05g

Paving subgrade preparation and system selection:

Pavement on site may be either flexible or rigid systems depending on traffic loading conditions.

Flexible paving:

Light duty: subgrade treated with fly ash, 6" full depth asphalt.

Medium duty: subgrade treated with fly ash, 8" full depth asphalt.

Rigid paving:

Light duty: subgrade treated with fly ash, 4" crush stone base, 5" concrete.

Medium duty: subgrade treated with fly ash, 4" crush stone base, 7" concrete.

2B.1.2. Phase I Findings

Phase I Environmental Site Assessment Provided by Terracon

Terracon Project 14079039 dated November 29th, 2007.

The following summary information is based on the above referenced report.

Summary of recognized environmental conditions (RECs):

Identification of a leach field adjacent to the east of the site associated with a former serum plant as an REC warrants investigation of impact of site.

The existing septic tank onsite was in use 30 years ago, prior to availability of sewer service. The proper closing of the system was not documented and should be investigated for same with local and/or state regulations.

It is recommended that the US Army Corps of Engineers be consulted prior to site development for information regarding any required permits for the two storm water detention basin areas on site.

Zoning / land use:

The site is zoned University District (U). Because the State of Kansas owns the property, city zoning does not apply to the site.

2B.1.3. Wetlands Delineation Findings

No surface water is evident. Hydrophytic vegetation and/or hyrdic soils were not verified during this limited review. The site contains 2 storm water detention basins. These basins are isolated from other waters of the US.

The site is indicated as 'Zone X' which is defined as 'other areas determined to be outside the 0.2% annual chance floodplain.

Subsurface water observed in one boring at 25 feet. A free static water surface was not observed at completion of drilling.

Fluctuations of groundwater level and seasonal variances warrant consideration of further study in continuing planning and design.

2B.2. RESOURCE RESTORATION (Manhattan, Kansas)

There is no anticipated disturbance of wetlands or streams on the site.

The site falls within the zoning classification "U" of the City of Manhattan, Kansas Zoning Ordinance. The city zoning requires a landscape buffer from adjoining zoning districts and public streets.

2B.3. SITE WORK ANALYSIS

2B.3.1 Anticipated Earthwork Analysis:

It is anticipated that the earthwork can be balance on-site with 285,000 cubic yards of cut. The anticipated fill range is 0-24 feet and the cut range is 0-39 feet. Existing Small structures on the site need to be demolished and removed from site. Reference the site concept under section 4 of this report.

2B.3.2. Anticipated Utility Routing:

The proposed layout shows that existing gas, power, and a 24-inch water main running easterly through the site would be re-located just north of the building and taps for the water and gas shall be made off of these re-located lines into the CUP. There is an existing Westar Power Facility just west of the proposed CUP. Existing lines traversing the site would be relocated north of the CUP and a new power line can be installed from the existing power facility to the CUP.

The sanitary sewer would exit at the basement level of the facility and be routed along the southeastern portion of the site to an existing 8-inch gravity sewer line along Denison Avenue.

Site run off would be detained on the NBAF site per local and state regulations to meet the required 10, 25 & 100 year rain events.

2B.3.3. Transportation Infrastructure:

The proposed main entrance to the site from Denison Avenue is expected to be able to support the proposed use with no major upgrades. There is still the possibility despite being on a college campus, that a left turning lane and deceleration and acceleration lanes could be required by the city. An exit only road (which is intended for emergency evacuations) is located along the south side of the site. The proposed site diagram show Serum Plant Road being terminated at the north and south of the NBAF property due to the roads current location being in conflict with NBAF's recommended stand-off security setback of 181-feet. It was confirmed with the Kansas Consortium that removal of this road is acceptable.

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2B.4. UTILITY ANALYSIS (Manhattan, Kansas)

2B.4.1 Existing Utility Infrastructure

The site Consortia have reviewed and verified that the estimated NBAF service loads and demands can be met by the local utility provider with very minor improvements to their local infrastructure. The costs and details of these improvements are included in the Site Cost Analysis and In-Kind evaluation.

All utilities are available except for those listed below.

Chilled Water:

Existing chilled water utilities are not available to serve NBAF. Chilled water would be provided as part of the central utility plant constructed as part of the NBAF project.

Steam:

Existing steam utilities are not available to serve NBAF. Steam would be provided as part of the central utility plant constructed as part of the NBAF project.

2B.4.2 NBAF Program Loads & Capacity Requirements

Chilled Water:

Preliminary chilled water loads for the Manhattan, Kansas site are based on the current facility program using the 0.4% design dry-bulb (90°F) and 0.4% design wet-bulb (79°) temperatures as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak chilled water load of 5,400 tons including 750 tons for process cooling is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized chillers at 1,080 tons are required. This N+1 strategy would maintain the firm capacity of 5,400 tons and require a total installed capacity of 6,480 tons. This allows the peak capacity of the facility to be met in the event of the loss of one chiller.

Steam:

Preliminary steam loads for the Manhattan, Kansas site are based on the current facility program using the 99.6% design condition (-2.0°F and 2.56 gr/lb moisture) as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak steam load of 148,000 lb/hr including 55,000 lb/hr for process loads is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized boilers at 29,600 lb/hr are required. This N+1 strategy would maintain the firm capacity of 148,000 lb/hr and require a total installed capacity of 177,600 lb/hr. This allows the peak capacity to be met in the event of the loss of one boiler.

Natural Gas:

The CUP should be provided with a 10 PSI natural gas supply to meet the installed natural gas burning equipment firm capacity of 148,000 CFH.

Fuel Oil:

Multiple fuel oil tanks serving the boilers and generators with a total capacity of 650,000 gallons are required to provide stand-by operation of the facility for thirty days in the event of either a loss of normal power or natural gas service to the site.

Water:

Dual water service is required to the site with a minimum delivery pressure of 35 psi. Water consumption ranges between 50,000 and 250,000 gallons per day with a peak flow rate of 665 GPM. The maximum value includes cooling tower make-up water for peak cooling days during the summer months and would be less other times of the year. The estimated total annual water consumption is 37,750,000 gallons.

Sanitary:

Discharge to the sanitary system ranges between 50,000 and 140,000 gallons per day with an annual estimated discharge of 25,000,000 gallons. If a tissue digester is utilized for carcass disposal a small percentage of the effluent stream would have the following composition.

BOD (mg/L)	10,250
COD (mg/L)	19,600
Suspended Solids (mg/L)	1,400
pH	9.48

It is anticipated that a dilution level acceptable to the local sewer district would be achieved based on the total effluent discharge from the facility. This would be confirmed as part of the detailed design phase.

Electrical:

A minimum of two redundant medium voltage services with multiple feeders are required to serve the NBAF campus. The specific arrangement of electrical service would be coordinated with the utility provider.

A utility substation at 34.5 kV is required on site with two transformers feeding 15 kV Class switchgear in a main-tie-main arrangement. The secondary feeders would provide primary electric service at 13.8 kV to the Central Utility Plant (CUP) and to the building.

The total normal power load required to accommodate the specific site infrastructure loads as well as the typical building load for Manhattan, Kansas is approximated at 13.1 MW.

Stand-by / Emergency Power:

The critical nature of the building loads requires that nearly 90% of the normal power loads be on emergency/standby power and backup. In lieu of segregating the building distribution as normal and emergency, the entire load would be served by the emergency/standby power system.

To meet these requirements eight 2000eKW generators would be required. This N+1 strategy would allow normal maintenance to occur while still maintaining reliable capacity. Generation would be at 13.8kV and connected to the 15kV switchgear through motorized breakers.

2B.4.3 Utility Outages

Due to the mission critical nature of the facility, availability and reliability of the primary utilities is critical. In the unlikely event that one of the utilities, natural gas, electric, water or sewer service, is lost to the building the following redundancies / provisions have been included.

Natural Gas

In the event of the loss of natural gas service to the facility, on site fuel storage to support the operation of the boilers is provided. This storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only natural gas to the facility is lost the fuel storage would support the boilers for up 120 days depending on the season.

Electrical

In the event of loss of the primary feeder to the site, power would automatically transfer to the redundant feeder without interruption of power to the building. In the event of the loss of both the primary and redundant feeders the generators would start and restore power to the building. As noted above the fuel storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only electrical service is lost the fuel storage would support the generators for up to 60 days depending on the season.

Water

In the event of loss of the primary water service to the site, water would be provided by the redundant dual water service. In the event of complete loss of utility provided, water provisions would be in place to allow temporary connection to a tanker truck. SOP's would be required to strictly limit water use to only critical facility functions.

Sanitary

In the event of loss of sanitary service to the facility, the effluent decontamination system (EDS) would allow for up to 48 hours of storage of effluent discharged from the BSL-3AG and BSL-4. SOP's should be in place to limit discharge to extend this holding time if possible. All areas of the building not discharging through the EDS would require SOP's to immediately suspend all sanitary discharge. If the outage is estimated to last beyond the 48 hour holding time, temporary provisions could be made to pump the waste from a local manhole into a tanker truck for proper disposal. The waste would be decontaminated through normal protocols prior to discharge from the facility.

2B.4.4 Utility Costs

Utility costs for the site have been developed based on the current programming utilizing computer software that models the operation of the building throughout the year on an hourly basis. Utility rates were obtained from the Energy Information Administration website www.eia.doe.gov which is governed by the Department of Energy. Actual consortia provided rate structures may differ significantly. The energy model will be updated as new information becomes available. The current estimated utility consumptions and costs for Manhattan, Kansas are summarized below. Fuel oil values are based on weekly testing and 80 hours of back-up operation per year.

Utility	Estimated Annual Cost
Electrical	$2,500,000 to $3,500,000
Natural Gas	$1,500,000 to $2,000,000
Fuel Oil	$ 300,000 to $ 500,000

2B.4.5 Boiler Emissions

Boiler emissions have been calculated using the annual natural gas consumption determined in the energy model. Emission rates were then applied to the total consumption to obtain estimated boiler emission rates in pounds. The results of this for Flora, Mississippi are summarized in the table below.

Estimated Boiler Emissions (Natural Gas)				
Manhattan, Kansas	Estimated Annual Consumption (MMBtu)	Boiler Emission Levels (lb/MMBtu)	Estimated Annual Emissions	Estimated Annual Emissions
Substance				
Nitrogen Oxide (NOX)	141,000	0.035	4,935 lbs	2.5 tons
Particulate Matter < 10 Micron Diameter (PM-10)	141,000	0.010	1,410 lbs	0.7 tons
Volatile Organic Compounds (VOC)	141,000	0.016	2,256 lbs	1.1 tons
Sulfur Oxide (SOX)	141,000	0.001	141 lbs	0.1 tons
Carbon Monoxide (CO)	141,000	0.040	5,640 lbs	2.8 tons

2B.4.6 Generator Emissions

Generator emissions have been calculated based on weekly testing of the generators and stand-by power operation at 75% capacity for both 80 hours (normal operation) and 30 days (catastrophic event) per year. The results are summarized below.

Substance	**Estimated Annual Emissions**	
Stand-by Duty→	**80 Hours**	**30 Days**
Nitrogen Oxide (NOX)	31,795 lbs	142,387lbs
Carbon Monoxide (CO)	3,238 lbs	14,502 lbs
Total Hydrocarbon (VOC)	1,914 lbs	8,570 lbs

DIESEL GENERATOR EMISSIONS VALUES -80 hours stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
	104	2246.4 lbs	228.8 lbs	135.2 lbs
Total per Generator	80	1728.0 lbs	176.0 lbs	104.0 lbs
	184	3974.4 lbs	404.8 lbs	239.2 lbs
Number of Units	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		31795 lbs 15.9 Tons	3238 lbs 1.6 Tons	1914 lbs 1.0 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

DIESEL GENERATOR EMISSIONS VALUES -30 days stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
	104	2246.4 lbs	228.8 lbs	135.2 lbs
Total per Generator	720	15552.0 lbs	1584.0 lbs	936.0 lbs
	824	17798.4 lbs	1812.8 lbs	1071.2 lbs
Number of Units	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		142387 lbs 71.2 Tons	14502 lbs 7.3 Tons	8570 lbs 4.3 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

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2B.5. STRUCTURAL BASIS FOR DESIGN (Manhattan, Kansas)

The parameters for the NBAF structural system were evaluated to support a structure that consists of a basement (fully or partially below grade), an occupied research floor, an interstitial service floor and a penthouse.

Structural Engineering Assumptions based on the Geotechnical Report: 3 story concrete structure plus penthouse, with concrete roof at penthouse.

2B.5.1. Design Criteria:

Live Loads

Laboratories	100 psf
Animal Research Facilities	100 psf
Animal Research Facilities with Primates	125 psf
Storage Rooms	150 psf
Mechanical Areas (or weight of equipment if greater)	150 psf
Conference Rooms	125 psf
Reception Lobby Areas	125 psf
Frozen Storage	210 psf
Loading Docks and Receiving Areas	250 psf
Loading Docks and Receiving Areas	250 psf
Stairs and Permanent Corridors	100 psf
Roofs	45 psf

Superimposed Dead Loads

Mechanical and Plumbing (or weight of supported systems, if greater)	10 psf
Ceilings	3 psf

Wind Load

Basic Wind Speed	90 mph
Wind Directionality Factor (K_d)	0.85
Importance Factor (I)	1.15
Exposure Category	C
Velocity Pressure Coefficient (K_h)	1.13
Topographic Factor (K_{zt})	1.0
Gust Effect Factor (G)	0.85
Enclosure Classification	Enclosed
Internal Pressure Coefficient (GC_{pi})	±0.18
External Pressure Coefficients (C_p)	
Windward	+0.8
Leeward	-0.3
Sidewall	-0.7
Velocity Pressure ($_{qh}$)	22.9 psf
Components and Cladding	
Windward Walls	1.5 times windward MWFRS
Leeward Walls	3 times leeward MWFRS
Corners	5 times leeward MWFRS

Earthquake Loads

Mapped Spectral Accelerations for Short Periods (S_s)	0.206g
Mapped Spectral Accelerations for 1-Second Period (S1)	0.053g
Seismic Occupancy Category	IV
Seismic Occupancy Importance Factor (IE)	1.50
Site Classification	D
Site Coefficient F_a	1.6
Site Coefficient F_v	2.4
Response Modification Coefficient	5
Seismic Design Category	C
Seismic Response Coefficient (C_s)	4.2%

2B.5.2. Seismic or Wind Lateral Design

Based on the preliminary Geotechnical Report the anticipated structural foundation and lateral design system consists of the following components: (Seismic controls the lateral design)

- Shear Walls - Per 5000 sf of building footprint: 52.0 cu yd concrete, 2.8 tons reinforcement.
- Shear Wall Foundations - Spread footing per 5000 sf of building footprint: 114.5 cu yd concrete, 5.4 tons reinforcement.
- Columns - Spread footing per 700 sf of building footprint: 41.2 cu yd concrete, 1.1 tons reinforcement.

2B.6. SITE SECURITY (Manhattan, Kansas)

2B.6.1. [redacted]

[redacted]

[redacted]

2C.1. SITE IMPACT ANALYSIS (Flora, Mississippi)

2C.1.1. Preliminary Geotechnical Report Findings

Preliminary Geotechnical Engineering Study Provided by Terracon

Terracon Project 18079038 dated December 13th, 2007.

The following summary information is based on the above referenced preliminary report.

Site description:

The site is a 150 acres located off Highway 49 near the intersection of North 1st St. The site is a pasture with one pond. A second depression is a possible detention pond. The site has a few scattered wooded areas. An overhead power transmission line is present through the south-central and west-central portions of the site. Existing Rail Road runs along the east boundary line.

Topography:

The site is gently sloping with about 30 feet of relief across the site. Detailed topographic mapping was not available at time of report.

Subsurface Stratigraphy:

Subsurface conditions were evaluated by 5 borings completed in this study. The findings are generally described as follows:

- 0 to 8 feet LEAN CLAY
- 3 to 22 feet LEAN CLAY
- 12 to 22 feet LEAN CLAY to FAT CLAY
- 12 to 50 feet FAT CLAY
- 43 to 100 feet FAT CLAY

Please see boring logs in the referenced report for specific information.

The report contains a review of area geology.

Groundwater:

Subsurface water observed in one boring at 20 feet below existing grade.

Note: Further consideration of groundwater fluctuations is warranted. (see "Preliminary Geotechnical Engineering Report").

Soil preparation and Structural considerations:

Geotechnical considerations review soil bearing capacity and anticipated soil movement.

Subgrade Stone columns with a performance specification could be used to support building foundations.

Native soils or engineered fill may support to 3,000 psf.

Drilled piers may support heavier loads, depending on design criteria.

Spread footings with light loads may experience settlement of 1 inch or less.

A combination of spread footings and subgrade stone columns are recommended.

Floating slab foundations are appropriate on prepared subgrade.

Site improvement:

Adequate drainage behind site retaining walls or foundations walls is required to reduce potential hydrostatic loading.

Seismic design criteria:

Site class D (Based on 2006 IBC).

Maximum Considered Earthquake 0.2 second Spectral Acceleration S_S = 0.21g

Maximum Considered Earthquake 1.0 second Spectral Acceleration S_1 = 0.10g

Paving subgrade preparation and system selection:

Pavement on site may be either flexible or full depth pavement.

Flexible paving:

Light duty include 8" aggregate base and 2" asphalt surface.

Heavy duty: 8" aggregate base, 2" asphalt base and 1 1/2" asphalt surface.

Full depth asphalt concrete:

Light duty: 3" asphalt base, 2" asphalt surface.

Heavy duty: 4.5" asphalt base, 2" asphalt surface.

Rigid concrete pavement for heavy loading and pads recommended:

Light: 4" aggregate base, 6" concrete.

Heavy: 4" aggregate base, 7" concrete.

2C.1.2. Phase I Findings

Phase I Environmental Site Assessment Provided by Terracon

Terracon Project A8075012 dated December 10th, 2007.

The following summary information is based on the above referenced report.

Summary of recognized environmental conditions (RECs):

The site contains remnants of tenant houses and hay barns. There is an overhead power transmission line.

There is no evidence of above ground storage tanks.

There are 3 abandoned cisterns. These may be tested for possible pesticides.

There is no evidence of hazardous waste storage or disposal. There is no evidence of (RECs). There are no RECs from activities on site or surrounding properties.

The site is vacant, undeveloped ranchland.

There are no RECs that warrant additional investigation at this time.

Zoning / land use:

The site is currently zoned Industrial and was zoned Agricultural prior to acquisition by the town of Flora in about 1995.

2C.1.3. Wetlands Delineation Findings

The site is not located in a floodplain.

There are two watercourses located near the south east corner of the site that meet the definition of jurisdictional streams.

Subsurface water observed in one boring at 20 feet below existing grade.

Fluctuations of groundwater level and seasonal variances warrant consideration of further study in continuing planning and design.

A pond is located on the site.

A possible detention pond is located on the site.

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2C.2. RESOURCE RESTORATION (Flora, Mississippi)

The property lies within the Flora Industrial Park and is governed by its own set of Protective Covenants, which in some areas refer back to local ordinances. Other than providing landscaping along the U.S. Highway 49 frontage, the Covenants and local ordinances do not appear to present any restoration requirements.

There are two ponds on the property. The larger pond would be immediately adjacent to the proposed facility. This feature appears primarily fed by surface runoff and releases via an intermittent channel that runs toward the northeast corner of the property. The other pond appears to have been created to serve as a stormwater management facility for the adjacent tenant (Primos). The USGS mapping shows the larger pond and discharge channel, as well as a separate channel that runs in the southern portion of the site that is not within the proposed limits of construction.

It should be noted however, that based on a preliminary determination (11-7-07) from the USACE, that both ponds were deemed non-jurisdictional impoundments, and that the only areas that might warrant mitigation are in the southern most portion of the site and should not be impacted by the proposed development.

2C.3. SITE WORK ANALYSIS

2C.3.1 Anticipated Earthwork Analysis:

It is anticipated that the earthwork can be balance on-site with 166,089 cubic yards of cut. The anticipated fill range is 0-14 feet and the cut range is 0-20 feet.

2C.3.2 Anticipated Utility Routing:

There is an existing water (10-inch line) running along U.S. Highway 49, from which a service line could be run up the proposed drive and into the CUP. Power is also available via an overhead line that runs in an easement along the front portion of the property. A connection could be made using an underground service into the CUP. An existing 6-inch gas line runs along the eastern (far) side of the railroad tracks the area adjacent to the rear of the property. A connection to this line would require the line to be bored under the tracks.

It is anticipated that sanitary sewer would be collected outside the basement level and be connected via a gravity line to the existing 10-inch gravity sewer that is stubbed into the southeastern corner of the site. This line then runs under the railroad tracks into a pump station that utilizes a 6-inch forcemain to send the effluent to the STP.

It should be noted that given the locations of the existing utilities, the service connections would not be ‘bundled”, but rather each in its own excavation.

Site run off would be detained on the NBAF site per local and state regulations to meet the required 10, 25 & 100 year rain events.

2C.3.3 Transportation Infrastructure:

The property fronts U.S. Highway 49, which is a 4 lane divided highway, and the proposed entrance aligns with an existing median break. It is anticipated that a left turn lane (south bound Highway 49) would be needed, as well as typical acceleration and deceleration lanes at the entrance drive. There appears to be sufficient room within the median and R.O.W. to construct these improvements.

2C.4. UTILITY ANALYSIS (Flora, Mississippi)

2C.4.1 Existing Utility Infrastructure

The site Consortia have reviewed and verified that the estimated NBAF service loads and demands can be met by the local utility provider however some improvements would need to occur to their local infrastructure. The costs and details of these improvements are included in the Site Cost Analysis and In-Kind evaluation.

All utilities are available except for those listed below.

Chilled Water:

Existing chilled water utilities are not available to serve NBAF. Chilled water would be provided as part of the central utility plant constructed as part of the NBAF project.

Steam:

Existing steam utilities are not available to serve NBAF. Steam would be provided as part of the central utility plant constructed as part of the NBAF project.

2C.4.2 NBAF Program Loads & Capacity Requirements

Chilled Water:

Preliminary chilled water loads for the Flora, Mississippi site are based on the current facility program using the 0.4% design dry-bulb (90°F) and 0.4% design wet-bulb (80°) temperatures as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak chilled water load of 5,500 tons including 750 tons for process cooling is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized chillers at 1,100 tons are required. This N+1 strategy would maintain the firm capacity of 5493 tons and require a total installed capacity of 6,600 tons. This allows the peak capacity of the facility to be met in the event of the loss of one chiller.

Steam:

Preliminary steam loads for the Flora, Mississippi site are based on the current facility program using the 99.6% design condition (21°F and 8.00 gr/lb moisture) as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak steam load of 133,000 lb/hr including 55,000 lb/hr for process loads is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized boilers at 26,600 lb/hr are required. This N+1 strategy would maintain the firm capacity of 132883 lb/hr and require a total installed capacity of 159,600 lb/hr. This allows the peak capacity to be met in the event of the loss of one boiler.

Natural Gas:

The CUP should be provided with a 10 PSI natural gas supply to meet the installed natural gas burning equipment firm capacity of 133,000 CFH.

Fuel Oil:

Multiple fuel oil tanks serving the boilers and generators with a total capacity of 550,000 gallons are required to provide stand-by operation of the facility for thirty days in the event of either a loss of normal power or natural gas service to the site.

Water:

Dual water service is required to the site with a minimum delivery pressure of 35 psi. Water consumption ranges between 50,000 and 290,000 gallons per day with a peak flow rate of 669 GPM. The maximum value includes cooling tower make-up water for peak cooling days during the summer months and would be less other times of the year. The estimated total annual water consumption is 48,150,000 gallons.

Sanitary:

Discharge to the sanitary system ranges between 50,000 and 150,000 gallons per day with an annual estimated discharge of 28,250,000 gallons. If a tissue digester is utilized for carcass disposal a small percentage of the effluent stream would have the following composition.

BOD (mg/L)	10,250
COD (mg/L)	19,600
Suspended Solids (mg/L)	1,400
pH	9.48

It is anticipated that a dilution level acceptable to the local sewer district would be achieved based on the total effluent discharge from the facility. This would be confirmed as part of the detailed design phase.

Electrical:

A minimum of two redundant medium voltage services with multiple feeders are required to serve the NBAF campus. The specific arrangement of electrical service is required to be coordinated with the utility provider during the design phase.

A utility substation at 34.5 kV is required on site with two transformers feeding 15 kV Class switchgear in a main-tie-main arrangement. The secondary feeders would provide primary electric service at 13.8 kV to the Central Utility Plant (CUP) and to the building.

The total normal power load required to accommodate the specific site infrastructure loads as well as the typical building load for Flora, Mississippi is approximated at 13.1 MW.

Stand-by / Emergency Power:

The critical nature of the building loads requires that nearly 90% of the normal power loads be on emergency/standby power and backup. In lieu of segregating the building distribution as normal and emergency, the entire load would be served by the emergency/standby power system.

To meet these requirements eight 2000eKW generators would be required. This N+1 strategy would allow normal maintenance to occur while still maintaining reliable capacity. Generation would be at 13.8kV and be connected to the 15kV switchgear through motorized breakers.

2C.4.3 Utility Outages

Due to the mission critical nature of the facility, availability and reliability of the primary utilities is critical. In the unlikely event that one of the utilities, natural gas, electric, water or sewer service, is lost to the building the following redundancies / provisions have been included.

Natural Gas

In the event of the loss of natural gas service to the facility, on site fuel storage to support the operation of the boilers is provided. This storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only natural gas to the facility is lost the fuel storage would support the boilers for up 120 days depending on the season.

Electrical

In the event of loss of the primary feeder to the site, power would automatically transfer to the redundant feeder without interruption of power to the building. In the event of the loss of both the primary and redundant feeders the generators would start and restore power to the building. As noted above the fuel storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only electrical service is lost the fuel storage would support the generators for up to 60 days depending on the season.

Water

In the event of loss of the primary water service to the site, water would be provided by the redundant dual water service. In the event of complete loss of utility provided, water provisions would be in place to allow temporary connection to a tanker truck. SOP's would be required to strictly limit water use to only critical facility functions.

Sanitary

In the event of loss of sanitary service to the facility, the effluent decontamination system (EDS) would allow for up to 48 hours of storage of effluent discharged from the BSL-3AG and BSL-4. SOP's should be in place to limit discharge to extend this holding time if possible. All areas of the building not discharging through the EDS would require SOP's to immediately suspend all sanitary discharge. If the outage is estimated to last beyond the 48 hour holding time, temporary provisions could be made to pump the waste from a local manhole

into a tanker truck for proper disposal. The waste would be decontaminated through normal protocols prior to discharge from the facility.

2C.4.4 Utility Costs

Utility costs for the site have been developed based on the current programming utilizing computer software that models the operation of the building throughout the year on an hourly basis. Utility rates were obtained from the Energy Information Administration website www.eia.doe.gov which is governed by the Department of Energy. Actual consortia provided rate structures may differ significantly. The energy model would be updated as new information becomes available. The current estimated utility consumptions and costs for Flora, Mississippi are summarized below. Fuel oil values are based on weekly testing and 80 hours of back-up operation per year.

Utility	Estimated Annual Cost
Electrical	$4,000,000 to $5,000,000
Natural Gas	$1,000,000 to $1,500,000
Fuel Oil	$ 300,000 to $ 500,000

2C.4.5 Boiler Emissions

Boiler emissions have been calculated using the annual natural gas consumption determined in the energy model. Emission rates were then applied to the total consumption to obtain estimated boiler emission rates in pounds. The results of this for Flora, Mississippi are summarized in the table below.

Estimated Boiler Emissions (Natural Gas)				
Flora, Mississippi	Estimated Annual Consumption (MMBtu)	Boiler Emission Levels (lb/MMBtu)	Estimated Annual Emissions	Estimated Annual Emissions
Substance				
Nitrogen Oxide (NOX)	107,240	0.035	3,753 lbs	1.9 tons
Particulate Matter < 10 Micron Diameter (PM-10)	107,240	0.010	1,072 lbs	0.5 tons
Volatile Organic Compounds (VOC)	107,240	0.016	1,716 lbs	0.9 tons
Sulfur Oxide (SOX)	107,240	0.001	107 lbs	0.1 tons
Carbon Monoxide (CO)	107,240	0.040	4,290 lbs	2.1 tons

2C.4.6 Generator Emissions

Generator emissions have been calculated based on weekly testing of the generators and stand-by power operation at 75% capacity for both 80 hours (normal operation) and 30 days (catastrophic event) per year. The results are summarized below.

Substance	**Estimated Annual Emissions**	
Stand-by Duty→	**80 Hours**	**30 Days**
Nitrogen Oxide (NOX)	31,795 lbs	142,387lbs
Carbon Monoxide (CO)	3,238 lbs	14,502 lbs
Total Hydrocarbon (VOC)	1,914 lbs	8,570 lbs

DIESEL GENERATOR EMISSIONS VALUES -80 hours stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
Total per Generator	104	2246.4 lbs	228.8 lbs	135.2 lbs
Number of Units	80	1728.0 lbs	176.0 lbs	104.0 lbs
	184	3974.4 lbs	404.8 lbs	239.2 lbs
	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		31795 lbs 15.9 Tons	3238 lbs 1.6 Tons	1914 lbs 1.0 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

DIESEL GENERATOR EMISSIONS VALUES -30 days stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
Total per Generator	104	2246.4 lbs	228.8 lbs	135.2 lbs
Number of Units	720	15552.0 lbs	1584.0 lbs	936.0 lbs
	824	17798.4 lbs	1812.8 lbs	1071.2 lbs
	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		142387 lbs 71.2 Tons	14502 lbs 7.3 Tons	8570 lbs 4.3 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

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2C.5. STRUCTURAL BASIS FOR DESIGN (Flora, Mississippi)

The parameters for the NBAF structural system were evaluated to support a structure that consists of a basement (fully or partially below grade), an occupied research floor, an interstitial service floor and a penthouse.

Structural Engineering Assumptions based on the Geotechnical Report: 3 story concrete structure plus penthouse, with concrete roof at penthouse.

2C.5.1. Design Criteria:

Live Loads

Laboratories	100 psf
Animal Research Facilities	100 psf
Animal Research Facilities with Primates	125 psf
Storage Rooms	150 psf
Mechanical Areas (or weight of equipment if greater)	150 psf
Conference Rooms	125 psf
Reception Lobby Areas	125 psf
Frozen Storage	210 psf
Loading Docks and Receiving Areas	250 psf
Loading Docks and Receiving Areas	250 psf
Stairs and Permanent Corridors	100 psf
Roofs	45 psf

Superimposed Dead Loads

Mechanical and Plumbing (or weight of supported systems, if greater)	10 psf
Ceilings	3 psf

Wind Load

Basic Wind Speed	90 mph
Wind Directionality Factor (K_d)	0.85
Importance Factor (I)	1.15
Exposure Category	C
Velocity Pressure Coefficient (K_h)	1.13
Topographic Factor (K_{zt})	1.0
Gust Effect Factor (G)	0.85
Enclosure Classification	Enclosed
Internal Pressure Coefficient (GC_{pi})	±0.18
External Pressure Coefficients (C_p)	
Windward	+0.8
Leeward	-0.3
Sidewall	-0.7
Velocity Pressure ($_{qh}$)	22.9 psf
Components and Cladding	
Windward Walls	1.5 times windward MWFRS
Leeward Walls	3 times leeward MWFRS
Corners	5 times leeward MWFRS

Earthquake Loads

Mapped Spectral Accelerations for Short Periods (S_s)	0.213g
Mapped Spectral Accelerations for 1-Second Period (S1)	0.092g
Seismic Occupancy Category	IV
Seismic Occupancy Importance Factor (IE)	1.50
Site Classification	D
Site Coefficient F_a	1.6
Site Coefficient F_v	2.4
Response Modification Coefficient	5
Seismic Design Category	C
Seismic Response Coefficient (C_s)	6.8%

2C.5.2. Seismic or Wind Lateral Design

Based on the preliminary Geotechnical Report the anticipated structural foundation and lateral design system consists of the following components: (Seismic controls the lateral design)

- Shear Walls - Per 5000 sf of building footprint: 62.2 cu yd concrete, 3.8 tons reinforcement.
- Shear Wall Foundations - Spread footing per 5000 sf of building footprint: 204.0 cu yd concrete, 8.8 tons reinforcement.
- Columns - Spread footing per 700 sf of building footprint: 41.2 cu yd concrete, 1.1 tons reinforcement.

2C.6. SITE SECURITY (Flora, Mississippi)

[redacted]

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2D.1. SITE IMPACT ANALYSIS (Butner, North Carolina)

2D.1.1. Preliminary Geotechnical Report Findings

Preliminary Geotechnical Engineering Study Provided by Terracon

Terracon Project 70079038 dated December 14th, 2007.

The following summary information is based on the above referenced preliminary report.

Site description:

The general site location is off Old NC 75 and Range Road (NCSR 1121) northwest of Butner, NC. Two sites were considered within a portion of the 4,035 acre NC Department of Agricultural Umstead Research Farm.

North Portion - Site A (Preferred Site): Adjoining the western site boundaries.

North Portion - Site B (Alternate Site): Adjoining the northeast perimeter.

The site is wooded, with logged sections overgrown with brush and new timber. One gravel road and a former logging road cross the site.

Topography:

The site ranges from 490 feet at the north to 350 feet in the south. It has 2 to 3 crowned areas, dissected by drainage features.

Subsurface Stratigraphy:

Subsurface conditions were evaluated by 5 borings completed in this study. The findings might be generally described as follows:

- 0 to 5-13 feet CLAYEY SILT, primarily at site A
- 5 to 13-30 feet SANDY SILT / SILTY SAND with trace rock fragments, Site A
- 14 to 26.5 feet PARTIALLY WEATHERED ROCK, Site A, B-2
- 0 to 30 feet SANDY SILT / SILTY SAND with trace rock fragments, Site B
- 14 to 28.5 feet PARTIALLY WEATHERED ROCK, Site B, B-4

Please see boring logs in the referenced report for specific information.

The report contains a review of area geology.

Groundwater:

No subsurface water observed. However, draught conditions prevent an accurate assessment of groundwater levels during normal precipitation levels.

Soil preparation and Structural considerations:

Geotechnical considerations review soil bearing capacity and anticipated soil movement. Potential Vertical Rise (PVR) of 1" or less is usually acceptable.

Soils exhibiting higher plasticity are treated by over excavation and replacement by engineered fills. Differential settlement of engineered fills and native soils may require the use of deep foundations or ground improvement.

For trenching, partially weathered rock and auger refusal materials should be treated as trench rock excavation.

Shallow foundations for ancillary structures can use a soil bearing pressure of 2,500 to 3,000 PSF.

The primary facility bearing on stiffer / denser soils are suitable for bearing pressures in the 5,000 to 6,000 psf range.

Piers bearing on partially weathered rock / fractured rock can be sized for 40 kips per sq foot end bearing. Friction bearing designs are not recommended.

Building floor slabs below exterior grades should be waterproofed using waterproofing materials instead of water resistant materials. The report provides recommendations for reduction of soil movements depending on structural options chosen.

Perimeter footings and footings beneath unheated areas should bear below frost line for frost protection.

Seismic design criteria:

Site class C (Based on 2006 IBC).

Maximum Considered Earthquake 0.2 second Spectral Acceleration S_{MS} = 0.23g

Maximum Considered Earthquake 1.0 second Spectral Acceleration S_{M1} = 0.13g

Paving subgrade preparation and system selection:

Pavement on site may be either flexible or rigid systems depending on subgrade modification and traffic loading conditions.

Flexible paving:

Light duty: 6” aggregate base and 2.5” asphalt surface.

Heavy duty: 8” aggregate base, 2-3” asphalt binder and 1.5” asphalt surface.

Rigid paving:

Light duty: 4” crush stone base, 5” concrete.

Heavy duty: 4” crush stone base, 7” concrete.

2D.1.2. Phase I Findings

Phase I Environmental Site Assessment Provided by Terracon

Terracon Project 70079038 dated December 21, 2007.

The following summary information is based on the above referenced report.

Summary of recognized environmental conditions (RECs):

There is a cemetery adjacent to the site. It is assumed that development would not impact this area.

There is no evidence of RECs on site. There are no RECs from activities on site or surrounding properties.

There are no RECs that warrant additional investigation at this time.

Zoning / land use:

The site is zoned Institutional according to the local town.

2D.1.3. Wetlands Delineation Findings

No subsurface water observed. However, draught conditions prevent an accurate assessment of groundwater levels during normal precipitation levels.

Areas that met the criteria to be considered a wetland or jurisdictional water were flagged.

On site wetlands consist of head water forest wetlands, wetland seeps, and wet herbaceous assemblage.

No known population of endangered species occurs within a one-mile radius.

Note: Further investigation may be required.

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2D.2. RESOURCE RESTORATION (Butner, North Carolina)

There is no anticipated disturbance of wetlands or streams for this site. The site is partially wooded and overrun with brush. Tree cover requirements are not known at this time; however, only 25-30% of the overall site area is disturbed which leaves a significant area for tree preservation

2D.3. SITE WORK ANALYSIS

2D.3.1 Anticipated Earthwork Analysis:

It is anticipated that the earthwork can balance onsite with 244,000 cubic yards of cut. The anticipated fill range is 0-37 feet and the cut range is 0-33 feet.

2D.3.2. Anticipated Utility Routing:

Power, water and gas can be run along a the existing channel to the southwest of the site for approximately 2,500 feet to tap into existing utilities along Hwy. 75.

It is anticipated that sanitary sewer would be collected outside the basement level and would be required to be routed approximately 2,500 feet from the facility to an existing gravity line south of the property running along Hwy. 75.

Site run off would be detained on the NBAF site per local and state regulations to meet the required 10, 25 & 100 year rain events.

2D.3.3 Transportation Infrastructure:

It is anticipated that approximately 1,100 feet of entrance paving to the immediate property line is required and an additional 4,100 of road improvements, of what appears to be a dirt road, is necessary to connect the site to Range Road. The driveway would need to be constructed with a gate onsite. It is expected that Range Road can support the facility with its current condition and no major road upgrades would be necessary. There may be a need for deceleration and acceleration lanes and a left turn lane at the driveway entrance to facilitate traffic flow.

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2D.4. UTILITY ANALYSIS (Butner, North Carolina)

2D.4.1 Existing Utility Infrastructure

The site Consortia have reviewed and verified that the estimated NBAF service loads and demands can be met by the local utility provider however some improvements would need to occur to their local infrastructure. The costs and details of these improvements are included in the Site Cost Analysis and In-Kind evaluation.

All utilities are available except for those listed below.

Chilled Water:

Existing chilled water utilities are not available to serve NBAF. Chilled water would be provided as part of the central utility plant constructed as part of the NBAF project.

Steam:

Existing steam utilities are not available to serve NBAF. Steam would be provided as part of the central utility plant constructed as part of the NBAF project.

2D.4.2 NBAF Program Loads & Capacity Requirements

Chilled Water:

Preliminary chilled water loads for the Butner, North Carolina site are based on the current facility program using the 0.4% design dry-bulb (88°F) and 0.4% design wet-bulb (78°) temperatures as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak chilled water load of 5,125 tons including 750 tons for process cooling is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized chillers at 1,025 tons are required. This N+1 strategy would maintain the firm capacity of 5125 tons and require a total installed capacity of 6,150 tons. This allows the peak capacity of the facility to be met in the event of the loss of one chiller.

Steam:

Preliminary steam loads for the Butner, North Carolina site are based on the current facility program using the 99.6% design condition (16°F and 6.30 gr/lb moisture) as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak steam load of 136,500 lb/hr including 55,000 lb/hr for process loads is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized boilers at 27,300 lb/hr are required. This N+1 strategy would maintain the firm capacity of 136232 lb/hr and require a total installed capacity of 163,800 lb/hr. This allows the peak capacity to be met in the event of the loss of one boiler.

Natural Gas:

The CUP should be provided with a 10 PSI natural gas supply to meet the installed natural gas burning equipment firm capacity of 136,500 CFH.

Fuel Oil:

Multiple fuel oil tanks serving the boilers and generators with a total capacity of 600,000 gallons are required to provide stand-by operation of the facility for thirty days in the event of either a loss of normal power or natural gas service to the site.

Water:

Dual water service is required to the site with a minimum delivery pressure of 35 psi. Water consumption ranges between 50,000 and 275,000 gallons per day with a peak flow rate of 665 GPM. The maximum value includes cooling tower make-up water for peak cooling days during the summer months and would be less other times of the year. The estimated total annual water consumption is 39,500,000 gallons.

Sanitary:

Discharge to the sanitary system ranges between 50,000 and 150,000 gallons per day with an annual estimated discharge of 25,500,000 gallons. If a tissue digester is utilized for carcass disposal a small percentage of the effluent stream would have the following composition.

BOD (mg/L)	10,250
COD (mg/L)	19,600
Suspended Solids (mg/L)	1,400
pH	9.48

It is anticipated that a dilution level acceptable to the local sewer district would be achieved based on the total effluent discharge from the facility. This would be confirmed as part of the detailed design phase.

Electrical:

A minimum of two redundant medium voltage services with multiple feeders are required to serve the NBAF campus. The specific arrangement of electrical service would be coordinated with the utility provider.

A utility substation at 34.5 kV is required on site with two transformers feeding 15 kV Class switchgear in a main-tie-main arrangement. The secondary feeders would provide primary electric service at 13.8 kV to the Central Utility Plant (CUP) and to the building.

The total normal power load required to accommodate the specific site infrastructure loads as well as the typical building load for Butner, North Carolina is approximated at 12.8 MW.

Stand-by / Emergency Power:

The critical nature of the building loads requires that nearly 90% of the normal power loads be on emergency/standby power and backup. In lieu of segregating the building distribution as normal and emergency, the entire load would be served by the emergency/standby power system.

To meet these requirements eight 2000eKW generators would be required. This N+1 strategy would allow normal maintenance to occur while still maintaining reliable capacity. Generation would be at 13.8kV and be connected to the 15kV switchgear through motorized breakers.

2D.4.3 Utility Outages

Due to the mission critical nature of the facility, availability and reliability of the primary utilities is critical. In the unlikely event that one of the utilities, natural gas, electric, water or sewer service, is lost to the building the following redundancies / provisions have been included.

Natural Gas

In the event of the loss of natural gas service to the facility, on site fuel storage to support the operation of the boilers is provided. This storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only natural gas to the facility is lost the fuel storage would support the boilers for up 120 days depending on the season.

Electrical

In the event of loss of the primary feeder to the site, power would automatically transfer to the redundant feeder without interruption of power to the building. In the event of the loss of both the primary and redundant feeders the generators would start and restore power to the building. As noted above the fuel storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only electrical service is lost the fuel storage would support the generators for up to 60 days depending on the season.

Water

In the event of loss of the primary water service to the site, water would be provided by the redundant dual water service. In the event of complete loss of utility provided, water provisions would be in place to allow temporary connection to a tanker truck. SOP's would be required to strictly limit water use to only critical facility functions.

Sanitary

In the event of loss of sanitary service to the facility, the effluent decontamination system (EDS) would allow for up to 48 hours of storage of effluent discharged from the BSL-3AG and BSL-4. SOP's should be in place to limit discharge to extend this holding time if possible. All areas of the building not discharging through the EDS would require SOP's to immediately suspend all sanitary discharge. If the outage is estimated to last beyond the 48 hour holding time, temporary provisions could be made to pump the waste from a local manhole into a tanker truck for proper disposal.

The waste would be decontaminated through normal protocols prior to discharge from the facility.

2D.4.4 Utility Costs

Utility costs for the site have been developed based on the current programming utilizing computer software that models the operation of the building throughout the year on an hourly basis. Utility rates were obtained from the Energy Information Administration website www.eia.doe.gov which is governed by the Department of Energy. Actual consortia provided rate structures may differ significantly. The energy model would be updated as new information becomes available. The current estimated utility consumptions and costs for Butner, North Carolina are summarized below. Fuel oil values are based on weekly testing and 80 hours of back-up operation per year.

Utility	Estimated Annual Cost
Electrical	$3,500,000 to $4,500,000
Natural Gas	$1,250,000 to $1,750,000
Fuel Oil	$ 300,000 to $ 500,000

2D.4.5 Boiler Emissions

Boiler emissions have been calculated using the annual natural gas consumption determined in the energy model. Emission rates were then applied to the total consumption to obtain estimated boiler emission rates in pounds. The results of this for Butner, North Carolina are summarized in the table below.

Estimated Boiler Emissions (Natural Gas)				
Butner, North Carolina	Estimated Annual Consumption (MMBtu)	Boiler Emission Levels (lb/MMBtu)	Estimated Annual Emissions	Estimated Annual Emissions
Substance				
Nitrogen Oxide (NOX)	102,190	0.035	3,577 lbs	1.8 tons
Particulate Matter < 10 Micron Diameter (PM-10)	102,190	0.010	1,022 lbs	0.5 tons
Volatile Organic Compounds (VOC)	102,190	0.016	1,635 lbs	0.8 tons
Sulfur Oxide (SOX)	102,190	0.001	102 lbs	0.1 tons
Carbon Monoxide (CO)	102,190	0.040	4,088 lbs	2.0 tons

2D.4.6 Generator Emissions

Generator emissions have been calculated based on weekly testing of the generators and stand-by power operation at 75% capacity for both 80 hours (normal operation) and 30 days (catastrophic event) per year. The results are summarized below.

Substance	**Estimated Annual Emissions**	
Stand-by Duty→	**80 Hours**	**30 Days**
Nitrogen Oxide (NOX)	31,795 lbs	142,387lbs
Carbon Monoxide (CO)	3,238 lbs	14,502 lbs
Total Hydrocarbon (VOC)	1,914 lbs	8,570 lbs

DIESEL GENERATOR EMISSIONS VALUES -80 hours stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs Total per Generator Number of Units	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
	104	2246.4 lbs	228.8 lbs	135.2 lbs
	80	1728.0 lbs	176.0 lbs	104.0 lbs
	184	3974.4 lbs	404.8 lbs	239.2 lbs
	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		31795 lbs 15.9 Tons	3238 lbs 1.6 Tons	1914 lbs 1.0 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

DIESEL GENERATOR EMISSIONS VALUES -30 days stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs Total per Generator Number of Units	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
	104	2246.4 lbs	228.8 lbs	135.2 lbs
	720	15552.0 lbs	1584.0 lbs	936.0 lbs
	824	17798.4 lbs	1812.8 lbs	1071.2 lbs
	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		142387 lbs 71.2 Tons	14502 lbs 7.3 Tons	8570 lbs 4.3 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

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2D.5. STRUCTURAL BASIS FOR DESIGN (Butner, North Carolina)

The parameters for the NBAF structural system were evaluated to support a structure that consists of a basement (fully or partially below grade), an occupied research floor, an interstitial service floor and a penthouse.

Structural Engineering Assumptions based on the Geotechnical Report: 3 story concrete structure plus penthouse, with concrete roof at penthouse.

2D.5.1. Design Criteria:

Live Loads

Laboratories	100 psf
Animal Research Facilities	100 psf
Animal Research Facilities with Primates	125 psf
Storage Rooms	150 psf
Mechanical Areas (or weight of equipment if greater)	150 psf
Conference Rooms	125 psf
Reception Lobby Areas	125 psf
Frozen Storage	210 psf
Loading Docks and Receiving Areas	250 psf
Loading Docks and Receiving Areas	250 psf
Stairs and Permanent Corridors	100 psf
Roofs	45 psf

Superimposed Dead Loads

Mechanical and Plumbing (or weight of supported systems, if greater)	10 psf
Ceilings	3 psf

Wind Load

Basic Wind Speed	90 mph
Wind Directionality Factor (K_d)	0.85
Importance Factor (I)	1.15
Exposure Category	C
Velocity Pressure Coefficient (K_h)	1.13
Topographic Factor (K_{zt})	1.0
Gust Effect Factor (G)	0.85
Enclosure Classification	Enclosed
Internal Pressure Coefficient (GC_{pi})	±0.18
External Pressure Coefficients (C_p)	
Windward	+0.8
Leeward	-0.3
Sidewall	-0.7
Velocity Pressure ($_{qh}$)	22.9 psf
Components and Cladding	
Windward Walls	1.5 times windward MWFRS
Leeward Walls	3 times leeward MWFRS
Corners	5 times leeward MWFRS

Earthquake Loads

Mapped Spectral Accelerations for Short Periods (S_s)	0.19g
Mapped Spectral Accelerations for 1-Second Period (S1)	0.074g
Seismic Occupancy Category	IV
Seismic Occupancy Importance Factor (IE)	1.50
Site Classification	C
Site Coefficient F_a	1.2
Site Coefficient F_v	1.7
Response Modification Coefficient	5
Seismic Design Category	A
Equivalent Seismic Response Coefficient (C_s)	1.0%A

2D.5.2. Seismic or Wind Lateral Design

Based on the preliminary Geotechnical Report the anticipated structural foundation and lateral design system consists of the following components: (Wind controls the lateral design)

- Shear Walls - Per 5000 sf of building footprint: 31.1 cu yd concrete, 1.2 tons reinforcement.
- Shear Wall Foundations - Spread footing per 5000 sf of building footprint: 27.8 cu yd concrete, 1.5 tons reinforcement.
- Columns - Spread footing per 700 sf of building footprint: 25.4 cu yd concrete, 0.7 tons reinforcement.

2D.6. SITE SECURITY (Butner, North Carolina)

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2E.1. SITE IMPACT ANALYSIS (Plum Island, New York)

As part of the site evaluation of Plum Island DHS requested that the visiting NDP team analyze three different sites on the island and provide a preliminary recommendation as to which site would be further evaluated as part of the site characterization study. The following represents the findings and recommendation of that site visit.

Site 1

Site 1 was the original site that NDP evaluated during the NBAF Feasibility Study Report.

Initial analysis:

1. There might be potential views to the water once the site is cleared.
2. There appears to be the availability of adequate land to construct the complete program.
3. The general topography is relatively level with the exception of a bluff which may be used to bury a portion of the buildings basement so that the main animal floor can be accessed from grade. If this elevation change cannot be used then access into the main animal floor would need to be provided by the use of ramps. There is the possibility to completely or partially bury the basement floor in order to minimize the use of external ramps. Careful consideration to the ground water table needs to be taken.
4. A portion of this site was previously used to bury debris which has been reported to have been screened and cleaned. Further evaluation and analysis of this site has been provided under the supplemental Phase I report dated March 25, 2008 and no additional remediation is required.
5. Proximity to the exiting facility and central utility plant makes this site less costly to connect utilities.

Site 2

Site 2 is located adjacent to Ft. Terry.

Initial analysis:

1. There are direct views to the water.
2. The elevation of the site is fairly close to the water level so there is a concern of flooding during storm surges.
3. There appears to be the availability of adequate land to construct the complete program.
4. The general topography is relatively level thus access into the main animal floor would need to be provided by the use of ramps.
5. The site formally contained Army barracks therefore a Geotech analysis of this site would need to be done to confirm that no debris remains.
6. Proximity to the exiting facility and central utility plant makes this site more costly to connect utilities. We estimate approximately 1 mile to these services. Also, the connection of the sanitary system would most likely need to be pumped due to the lower site elevation and distance from the sewage treatment plant.

Site 3

Site 3 is also located adjacent to Ft. Terry just northeast of site 2.

Initial analysis:

1. There might be views to the water once the site is cleared however these views would be limited.
2. The elevation of the site is much higher than either of the first two sites and should be well above any storm surges and ground water table.
3. There appears to be the availability of adequate land to construct the complete program.
4. The site has much more topography than the other two and there would be more grading required. Access into the main animal floor might be able to be provided on grade due to the amount of topography.
5. A portion of this site was previously used to bury debris which has been reported to have been screened and cleaned.
6. Proximity to the exiting facility and central utility plant makes this site more costly to connect utilities. We estimate approximately 1 mile to these services.

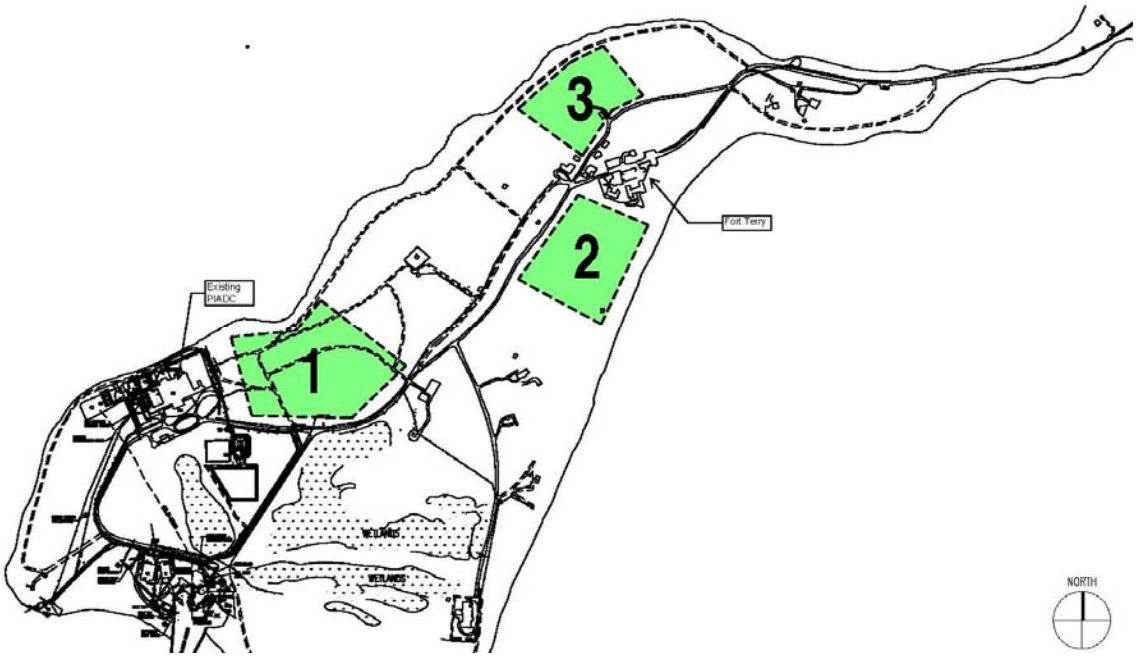


Diagram 1: (3) Initial Proposed Sites

Recommendation:

Based on this initial site analysis, NDP recommended considering site 1 as the primary site to complete the Site Characterization Study, Site Cost Analysis and EIS studies on. As all three sites could be engineered to construct this program, site 1 represents the fewest challenges and risks to the government for the successful completion and operation of this facility. The following site descriptions relate to analysis of site 1.

2E.1.1. Preliminary Geotechnical Report Findings

Preliminary Geotechnical Engineering Study Provided by Terracon

Terracon Project J2075404 dated November 30th, 2007.

The following summary information is based on the above referenced preliminary report.

Site description:

Plum Island is located about 12 miles southwest of New London, Connecticut and a mile and a half from the northeast tip of Long Island, NY. Access to the Island is provided by government ferries, but only government employees, contractors and approved visitors are allowed. The 24 acre proposed site has no structures. Dense underbrush with gravel roads are found generally within the southwestern and northeastern portions. The southeastern portion, which had previously been used for sand mining, is generally void of vegetation. The northwestern portion has minor vegetation. A potable water line bisects the site from east to west. An underground electric service borders the site on the north side. An abandoned cistern was noted in the general vicinity of JB-2. A large surface boulder with a maximum dimension of about 15' was noted in the general vicinity of JB-1.

Topography:

The site topography is slightly hilly, generally sloping to the south-southwest.

Subsurface Stratigraphy:

Subsurface conditions were evaluated by 5 borings completed in the Geotech study. The findings would generally described as follows:

- 0 to .3 feet TOPSOIL (JB-5 only)
- 0 to 3 feet FILL (JB-1, JB-4 only)
- 1.5 to 3.5 feet FORMER TOPSOIL (JB-1, JB-4 only)
- 2 to 4.5 feet FORMER SUBSOIL (JB-1, JB-4 only)
- 0 to 52 feet GLACIAL OUTWASH (Observed in all borings)

Please see boring logs in the referenced report for specific information.

The Geotech report contains a review of area geology.

Groundwater:

Subsurface water observed in all test borings at about 14 feet, except one (JB-3) boring where water was encountered at 18 feet.

Soil preparation and Structural considerations:

Geotechnical considerations review soil bearing capacity and anticipated soil movement.

The underside of soil-supported footings should be at least three (3) feet below the lowest exterior grade that is exposed to freezing.

The proposed facility may be supported on shallow spread footings deriving support from the undisturbed native glacial outwash, or from structural fill placed and compacted on the glacial outwash. A maximum net allowable bearing pressure of around 4,000 to 6,000 psf would likely be appropriate for shallow spread footings at the site.

Concrete floor slabs may be designed to be soil-supported, provided they are underlain by at least a 12-inch thickness of structural fill.

The Geotech report does not contain information on deep foundation options.

Site improvement:

Adequate drainage behind site retaining walls or foundations walls is required to reduce potential hydrostatic loading.

Seismic design criteria:

Site class D (Based on 2006 IBC)

Maximum Considered Earthquake 0.2 second Spectral Acceleration S_S = 0.23g

Maximum Considered Earthquake 1.0 second Spectral Acceleration S_1 = 0.07g

Paving subgrade preparation and system selection:

Pavement on site may be either flexible or rigid systems depending on traffic loading conditions.

Flexible paving:

Standard duty: 12” Granular Sub base, 1.5” asphalt binder, 1.5” asphalt wearing.

Heavy duty: 12” Granular Sub base, 2” asphalt binder, 1.5” asphalt wearing.

Rigid paving:

Standard duty: 12” Granular Sub base, 5” reinforced concrete.

Heavy duty: 12” Granular Sub base, 6” reinforced concrete.

2E.1.2. Phase I Findings

Phase I Environmental Site Assessment Provided by Terracon

Terracon Project J2077369 dated December 20th, 2007.

Terracon Project J2077369 dated March 25th, 2008.

The following summary information is based on the above referenced reports.

Summary of recognized environmental conditions (RECs):

The site of the proposed National Bio and Agro-Defense Facility (NBAF) is undeveloped and moderately vegetated.

The site is located adjacent to the existing Plum Island Animal Disease Center (PIADC). The MOSF Aboveground Storage Tank (MOSF AST) and MOSF databases and notes 19 USTs with a total capacity of 646,380 gallons. The tanks are used for the containment of various petroleum products. All ASTs have secondary containment.

PIADC is also listed in the NY Spills, NY Hist Spills, Resource Conservation and Recovery Act Small Quantity Generator (RCRA-SQG), Comprehensive Environmental Response, Compensation, and Liability Information System No Further Remedial Action Planned (CERC-NFRAP), NY MANIFEST, NJ MANIFEST, and CT MANIFEST. Spills appear to have been addressed as required by the New York State Department of Environmental Conservation (NYSDEC) and are considered historic RECs. However, based on the regulatory status, these spills are not expected to pose a threat to the environmental integrity of the site.

Based on a review of the historical information, the site for the proposed NBAF was formerly utilized as a dumping area for miscellaneous wastes associated with PIADC. From the inception of PIADC until the middle 1990's, there was a "nothing leaves the island" policy to prevent biological agents, studied at the facility, from escaping the island and infecting the country's food supply.

Two of the identified waste management areas (WMAs) and two areas of potential concern (AOPC) are partially within the footprint of the proposed building and identified as containing large amounts of laboratory wastes. The laboratory wastes are considered treated regulated medical waste (TRMW).

The former WMAs and AOPCs at the site are considered RECs.

WMA 7 and 8 have not been completely remediated. These areas are located approximately 1,000 feet to the northeast of the proposed NBAF site and cross-gradient. WMA 7 and 8 are not expected to pose a reasonable threat to the environmental integrity to the site and are not considered a REC.

Recommendations:

The site of the proposed NBAF has been remediated to remove TRMW. Closure sampling indicated concentrations of PAHs metals and PCRs above applicable regulations however concentrations of PAHs (benzo(a)pyrene) is likely attributed to past disposal of ash and is a common contaminant throughout the island. Based on the BMY Entech, Inc report the concentrations of benzo(a)pyrene were nor significant enough to warrant removal. Concentration of metals were attributed to metallic materials encountered and removed from the site.

Slight exeeedances of PAHs metals and PCRs exist within the proposed development area. Should construction of the proposed NBAF be selected for the Plam Island site, a detailed Health and Safety Plan and Soil Management Plan should be completed prior to construction activities. The Health and Safety Plan should identify the risks associated with working at the site and would establish proper procedures and protocols for workers at the site during construction. In addition, because of the potential to generate contaminated soil during excavation, a Soil Management Plan would be required to properly identify and dispose of contaminated material.

Zoning / land use:

The site is not zoned by Suffolk County and is owned and operated by the Department of Homeland Security.

2E.1.3. Wetlands Delineation Findings

Long Island Sound is located adjacent to the site to the north. Unnamed wetlands are located approximately 500 feet to the south. No evidence of chemical sheens or noxious odors was observed.

Both tidal and freshwater wetlands are present on the Island.

Wetlands do not occur on the proposed expansion site.

A freshwater wetland is located several hundred feet south of the proposed expansion site. No tidal wetlands permit would be needed.

A sand and gravel pit is indicated on the Surficial Geology Map of Plum Island on the east side of the NBAF site.

2E.2. RESOURCE RESTORATION ANALYSIS (Plum Island, New York)

There did not appear to be any natural resources, in the project area, that would require any specific protection. There is a wetland mitigation area, near the existing sewage treatment plant (STP), that was required as part of an earlier disturbance activity.

The majority of the site area is an open area that had previous earthwork activity that is not evident from the 1974 topography. There are small areas of brush and non-specimen trees scattered throughout the proposed site. As part of its environmental stewardship the PI staff erected several osprey nesting sites, some of which may be in the project area, however there should be no issue with relocating these to other locations.

2E.3. SITE WORK ANALYSIS

2E.3.1 Anticipated Earthwork Analysis:

It is anticipated that the earthwork would generate approximately 215,000 cubic yards of excess material. This roughly translates to 5 feet of fill over a 25 acre area. Fortunately there appears to be sufficient area on the island to "lose" the excess material. Fills range from 0-16 feet and cuts from 0-30 feet.

2E.3.2 Anticipated Utility Routing:

It is presumed that power, and water can be run directly from the existing CUP to the proposed facility. Water is provided via 14 on-site wells that receive chlorine treatment and Ph balancing. A 2003 study indicated an available yield of 150,000 gal., and there is an existing 200,000 gal water tank. Reference section 2.4 for further evaluation of the availability of on-site water to meet NBAF's demands. The existing facility uses sea water for cooling.

The Long Island Power Association (LIPA) supplies island power. Two high voltage electrical lines supply the island, but only one electrical line is used at any given time. These lines are the primary source of power for Plum Island and operate primarily on electricity from Suffolk County, NY.

One high voltage line was installed in 1999, while the second line is much older and possibly less reliable.

It should be noted that there was conflicting information pertaining to the serviceability of these lines. PIADC is currently using both and has not indicated that the older line is not adequate.

There is also 900,000 gal of on-site fuel oil storage for back up generators.

It is anticipated that sanitary sewer would be collected outside the basement level and would be required to be pumped 1000 feet from a new pump station to a new sewage treatment plant, STP. The existing STP plant is permitted to 80,000 GPD and utilizes mechanical tertiary treatment.

Site run off would be detained on the NBAF site per local and state regulations to meet the required 10, 25 & 100 year rain events.

2E.3.1. Transportation Infrastructure:

It is assumed that the existing warehouse and loading facilities at Orient Point are sufficient to handle the increased bulk deliveries. Depending on staffing levels, residency (NY or CT) and shift schedules, additional and /or larger passenger ferries may be needed. Off island parking at the two ferry stations would also need to be evaluated against the proposed increase in staff to determine if it provides adequate capacity.

2E.4. UTILITY ANALYSIS (Plum Island, New York)

2E.4.1 Existing Utility Infrastructure

Chilled Water:

The existing chilled water plant has a total installed capacity of 1,700 tons. While the plant is currently meeting the needs of the island, it is not capable of serving NBAF based on the required loads of the new facility and the age of the existing equipment.

Steam:

The existing boiler plant came on line in 2005 and has three equally sized boilers with a total installed capacity of 1,500 boiler horse power (51,750 lb/hr). Currently the assumption is that this equipment may be used to provide redundancy to the new boiler plant, but does not meet the base program loads of NBAF.

Fuel Oil:

The existing fuel oil tank farm has three equally sized tanks with a total installed capacity of 630,000 gallons.

Natural Gas:

Natural gas service is not available to the island.

Water:

The site is currently served by 14 supply wells with a maximum daily draw rate of 170,000 to 200,000 gallons. The existing water tower has a usable volume of 200,000 gallons.

Electrical:

Normal power is supplied to the island from Orient Point on Long island. A single 13.2 KV aerial line serves two underwater feeders and represents a single point of failure for power to the island. The historical peak demand on the electrical service is 2.3MW. The current distribution isolation switches are positioned to operate the bulk of the existing facilities on one underwater service cable with the second underwater service cable serving the remainder of the facility. Isolation switches can be opened and closed to redistribute sections of the existing facility distribution from one underwater service cable to the other underwater service cable. The two underwater feeders to the island can each supply the 2.3MW load at a voltage drop of the approximately 2% for the estimated 2.5 Mile conductor length. A previous facility assessment report indicated that the older of the cables had been damaged and its condition and useful life is questionable while the other cable was installed in 1999 and is fully operational. The PIADC facility staff does not concur with the previous facility assessment report and notes that either underwater cable will carry the total Island load. Both cables are currently in operation and the loop is currently split between the two sources at pad mounted switch (SW-B2 Way-1). The winter load is currently predominantly on one cable. During the summer, the chiller load is picked

up by the other cable essentially splitting the Island load between the two cables. Once the new power plant is on line, the two cables are scheduled to each feed half the PIADC lab with tie breakers open, and the loop re segmented at a point that permits the best load balance on the two cables.

Stand-by Power:

The existing generator plant has three equally sized generators with a total installed capacity of 5.475 MW. This plant is not yet operational and is not included in any load analysis for the new proposed facility.

Sanitary:

The existing waste treatment plant was built in 1995 with a major upgrade completed in 2004. Per the PIADC Research Needs and Corrective Action Project Prioritization Study dated January 27, 2006, this facility is currently capable of treating up to 80,000 gallons per day (GPD). Per the on-site system operator, the plant is currently permitted to 80,000 GPD and treats to a tertiary level using a mechanical treatment system with discharge to the harbor area. Confirmation that their permit has been updated from 60,000 GPD to 80,000 GPD should be obtained. Pre-treatment of animal feed solids removal carryover is currently provided for in building 102.

2E.4.2 NBAF Program Loads & Capacity Requirements

Chilled Water:

Preliminary chilled water loads for the Plum Island, New York site are based on the current facility program using the 0.4% design dry-bulb (83°F) and 0.4% design wet-bulb (76°) temperatures as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak chilled water load of 4,700 tons including 750 tons for process cooling is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized chillers at 940 tons are required. This N+1 strategy would maintain the firm capacity of 4683 tons and require a total installed capacity of 5,640 tons. This allows the peak capacity of the facility to be met in the event of the loss of one chiller.

Steam:

Preliminary steam loads for the Plum Island, New York site are based on the current facility program using the 99.6% design condition (8°F and 4.20 gr/lb moisture) as published in the 2005 ASHRAE Fundamentals Handbook.

An estimated peak steam load of 142,000 lb/hr including 55,000 lb/hr for process loads is required to serve NBAF based on this analysis. To meet the firm capacity of this mission critical facility five equally sized boilers at 28,400 lb/hr are required. A cross connect with the existing boiler plant would provide the required boiler redundancy.

Fuel Oil:

It is estimated that the new facility would consume 1.6 million gallons of fuel oil per year including normal boiler operation, weekly testing and 30 days of operation in the stand-by mode for the generators. The 660,000 gallon fuel storage capacity represents a 30 day supply during the month of January in the event the facility needed to operate solely on stand-by power.

Depending on the available frequency of refueling of the tanks during the winter months the fuel tank farm may be deemed sufficient or need to be expanded as required to meet the needs of NBAF.

Water:

Water consumption ranges between 50,000 and 200,000 gallons per day with a peak flow rate of 636 GPM. The maximum value includes cooling tower make-up water for peak cooling days during the summer months and would be less other times of the year. The estimated total annual water consumption is 36,500,000 gallons.

To meet these requirements a new well(s) should be added to ensure a minimum daily draw of 200,000 gallons. An additional 200,000 gallon water tower should also be added to allow storage of two days of water consumption during peak periods.

Sanitary:

Discharge to the sanitary system ranges between **50,000 and 125,000** gallons per day with an annual estimated discharge of 23,000,000 gallons. Currently, a tissue digester is not being considered for Plum Island. Given that the existing system has a capacity of only 80,000 GPD, it does not meet some of the peak demand days. Possible options to address this issue are:

1. A new waste treatment plant would need to be constructed as the existing plant is not capable to accommodate the anticipated loads from NBAF. This new plant would also be required to be permitted for an annual treatment capacity with SPDES. Pre-treatment of animal feed solids removal carryover would be required.

2. Expansion of the existing facilities to handle the additional NBAF loads. This would also require a revision to the permit and pre-treatment of animal feed solids removal carryover.

3. Add pre-treatment holding tanks so that the peaks are averaged to fall within the existing permit levels. For example the projected 23,00,000 gallon annual discharge equates to approximately 70,000 GPD if averaged over 330 days. This also requires a revision to the permit and pre-treatment of animal feed solids removal carryover.

Of these options, #1 would allow for the existing facilities to operate uninterrupted, and if interconnected (manual switchover) and sized correctly can allow for needed redundancy. This would also however be the most costly option.

Option #2, should be able to be accomplished with minimal interruption to existing operations, and again if designed properly can provide required redundancy. It should be noted however that a thorough analysis of the existing facilities would need to be completed in order to determine any unforeseen issues.

Option #3, may be the fastest and cheapest way to handle projected increases. This is especially true if it is anticipated that the new facility would not be operating at full capacity for some period of time. The tanks can be sized to provide excess storage, but there would not be any redundancy of the mechanical treatment as would be achieved with the first 2 options.

Regardless of the option selected, a new pump station would be required to move the effluent from the new facility to the area of the treatment facility.

Electrical:

The total normal power load required to accommodate the specific site infrastructure loads as well as the typical building load is approximated at 12.8 MW. A minimum of two redundant medium voltage services with multiple feeders are required to serve the facilities and Plum Island infrastructure. The specific arrangement of electrical service is required to be coordinated with the utility provider during the design phase.

Service from utility substations on the Long island or Connecticut mainland at 13.2 kV or 34.5 kV is required with two submarine cables from the mainland to supply feeding 15 kV Class switchgear in a main-tie-main arrangement. The submarine cables would each be supplied from separate utility transformer buses at the utility substation. The secondary feeders would provide primary electric service to distribution substations with main-tie-main switchgear for 480 volt service to support the buildings and the island infrastructure equipment. Distribution substations with 5kV main-tie-main switchgear for 4160 volt service to support the Central Utility Plant (CUP) chillers and 480 volt transformers to motor control centers.

The addition of the NBAF Facility electrical loads would require the installation of (2) new undersea cables from Long Island Power Authority (LIPA) at Point Orient or from Connecticut Lighting & Power (CL&P) to support new service switchgear and medium voltage distribution to the new facilities. It is anticipated that the new medium voltage service switchgear would include feeders to re-supply the existing facilities which are to remain in operation after the interim transition period. The existing service would serve the existing facilities during construction of the new service infrastructure. At the current LIPA service voltage of 13.2kV, the available capacity limit for the existing two 2/0 AWG submarine cables is estimated at 3.3MW each (Currently, the existing cables each have capacity to meet the current site requirements in the event of damage to one of the two cables. The site has experienced a prior event in which an anchor from a ferry damaged a submarine cable.) . The addition of two 240 mm^2 13.2 kV submarine cables from LIPA at Point Orient would provide the submarine cable capacity to meet the requirements for the new facility, but would not provide the capacity in the submarine cables for each cable to meet the facility capacity requirements in the event of damage to one of the cables. The upgrade of the service to 34.5 kV service with two 2/0 AWG or two 95mm^2 34.5 kV submarine cables from LIPA at Point Orient would provide the submarine cable capacity for each cable to meet the facility capacity requirements in the event of damage to one of the cables.

An Assumption regarding LIPA's ability to provide the additional service (Plum Island is at the end of a 70-80 mile transmission line from the generation point.) has been made pending confirmation from LIPA of the available capacities from LIPA distribution grid to support upgrades to the Point Orient supply service and redundancy provisions available in the LIPA distribution grid. The submarine cables noted above are for three-core submarine XLPE cable systems with copper conductors, lead sheath and steel wire armour. Submarine cables are also available with fiber-optics integrated into the cable system for communications if required for upgrade to the island communication infrastructure provisions.

As an alternate source for improved reliability of commercial power service, submarine service from CL&P would require two 500mm^2 34.5 kV submarine cables due to the increased distance from the island to CL&P in comparison to the distance to LIPA at Point Orient. The 500mm^2 34.5 kV submarine cables would provide the submarine cable capacity for each cable to meet the facility capacity requirements in the event of damage to one of the cables. Confirmation of capacities and redundancy provisions available in the CL&P grid to support the facility service requirements are required to evaluate the option for an CL&P commercial power service to the island.

Installation of new submarine cables anticipated to be installed to support the "NBAF on Plum Island" EIS alternative, would require additional coordination and planning with NY State on this issue since Plum Gut (the waters between Long Island and Plum Island) is considered a Significant Habitat for Fish and Wildlife. Installation of new submarine cables to support the "NBAF on Plum Island" EIS alternative between Plum Island and Connecticut would require additional coordination and planning with NY State and Connecticut State on this issue. Precedents for prior approvals of submarine cables across the Long Island Sound include the Cross Sound Cable Project completed in 2005 with 24 miles of submarine cable interconnecting New Haven, Connecticut and Shoreham, Long Island to interconnect electricity grids in the two areas and the Northport to Norwalk Cable Replacement projects to replace submarine cables interconnecting Long Island and Connecticut.

Stand-by / Emergency Power:

The critical nature of the building loads requires that nearly 90% of the normal power loads be on emergency/standby power and backup. In lieu of segregating the building distribution as normal and emergency, the entire load would be served by the emergency/standby power system.

To meet these requirements eight 2000eKW generators would be required. This N+1 strategy would allow normal maintenance to occur while still maintaining reliable capacity. Generation would be at 13.8kV and be connected to the 15kV switchgear through motorized breakers.

A back-up power plant was recently constructed and will soon be operational (total distance between the main power plant and the central utility plant is about 80 miles). Generators in these plants will operate only when the primary (LIPA) power source is not functioning. No additional upgrades or improvements in the new generators are expected to meet known future needs.

2E.4.3 Utility Outages

Due to the mission critical nature of the facility, availability and reliability of the primary utilities is critical. In the unlikely event that one of the utilities, natural gas, electric, water or sewer service, is lost to the building the following redundancies / provisions have been included. Due to the remote nature of the island SOP's would be an integral part of handling outages. Unlike the other sites it is not feasible to bring tanker trucks or portable equipment to the facility in a timely manner.

Natural Gas: – not applicable to Plum Island

Electrical:

In the event of loss of one of the submarine utility service feeders to the site, power would automatically be transferred to the redundant feeder with momentary interruption of power to the loads normally supplied from the corresponding utility service feeder. In the event of the loss of both the primary and redundant feeders the generators would start and restore power to the building.

Water:

The water system is served by multiple wells which offer some redundancy as only a portion of the feed water to the towers would be lost with a single failure. Multiple water towers allow for two days of facility operation assuming all feed water to the water towers is lost. SOP's should be in place to limit water consumption if water supply to the facility is compromised in any way.

Sanitary:

In the event of loss of sanitary service to the facility the effluent decontamination system (EDS) would allow for up to 48 hours of storage of effluent discharged from the BSL-3AG and BSL-4. SOP's should be in place to limit discharge to extend this holding time. All areas of the building not discharging through the EDS would require SOP's to immediately suspend all sanitary discharge.

2E.4.4 Utility Costs

Utility costs for the site have been developed based on the current programming utilizing computer software that models the operation of the building throughout the year on an hourly basis. Utility rates were obtained from the Energy Information Administration website www.eia.doe.gov which is governed by the Department of Energy. Actual consortia provided rate structures may differ significantly. The energy model would be updated as new information becomes available. The current estimated utility consumptions and costs for Plum Island, New York are summarized below.

Utility	Estimated Annual Cost
Electrical	$3,500,000 to $4,500,000
Fuel Oil	$2,750,000 to $3,500,000

2E.4.5 Boiler Emissions

Boiler emissions have been calculated using the annual natural gas consumption determined in the energy model. Emission rates were then applied to the total consumption to obtain estimated boiler emission rates in pounds. The results of this for Plum, Island, New York are summarized in the table below.

Estimated Boiler Emissions (No. 2 Fuel Oil)				
Plum Island, New York	Estimated Annual Consumption (MMBtu)	Boiler Emission Levels (lb/MMBtu)	Estimated Annual Emissions	Estimated Annual Emissions
Substance				
Nitrogen Oxide (NOX)	143,700	0.187	26,872 lbs	13.4 tons
Particulate Matter < 10 Micron Diameter (PM-10)	143,700	0.025	3,593 lbs	1.8 tons
Volatile Organic Compounds (VOC)	143,700	0.030	4,311 lbs	2.2 tons
Sulfur Oxide (SOX)	143,700	0.520	74,724 lbs	37.4 tons
Carbon Monoxide (CO)	143,700	0.070	10,059 lbs	5.0 tons

2E.4.6 Generator Emissions

Generator emissions have been calculated based on weekly testing of the generators and stand-by power operation at 75% capacity for both 80 hours (normal operation) and 30 days (catastrophic event) per year. The results are summarized below.

Substance	**Estimated Annual**	**Emissions**
Stand-by Duty→	**80 Hours**	**30 Days**
Nitrogen Oxide (NOX)	31,795 lbs	142,387lbs
Carbon Monoxide (CO)	3,238 lbs	14,502 lbs
Total Hydrocarbon (VOC)	1,914 lbs	8,570 lbs

DIESEL GENERATOR EMISSIONS VALUES -80 hours stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
Back-up hrs	104	2246.4 lbs	228.8 lbs	135.2 lbs
Total per Generator	80	1728.0 lbs	176.0 lbs	104.0 lbs
	184	3974.4 lbs	404.8 lbs	239.2 lbs
Number of Units	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		31795 lbs	3238 lbs	1914 lbs
		15.9 Tons	1.6 Tons	1.0 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

DIESEL GENERATOR EMISSIONS VALUES -30 days stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
Back-up hrs	104	2246.4 lbs	228.8 lbs	135.2 lbs
Total per Generator	720	15552.0 lbs	1584.0 lbs	936.0 lbs
Number of Units	824	17798.4 lbs	1812.8 lbs	1071.2 lbs
	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		142387 lbs	14502 lbs	8570 lbs
		71.2 Tons	7.3 Tons	4.3 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

2E.5. STRUCTURAL BASIS FOR DESIGN (Plum Island, New York)

The parameters for the NBAF structural system were evaluated to support a structure that consists of a basement (fully or partially below grade), an occupied research floor, an interstitial service floor and a penthouse.

Structural Engineering Assumptions based on the Geotechnical Report: 3 story concrete structure plus penthouse, with concrete roof at penthouse.

2E.5.1. Design Criteria:

Live Loads

Laboratories	100 psf
Animal Research Facilities	100 psf
Animal Research Facilities with Primates	125 psf
Storage Rooms	150 psf
Mechanical Areas (or weight of equipment if greater)	150 psf
Conference Rooms	125 psf
Reception Lobby Areas	125 psf
Frozen Storage	210 psf
Loading Docks and Receiving Areas	250 psf
Loading Docks and Receiving Areas	250 psf
Stairs and Permanent Corridors	100 psf
Roofs	45 psf

Superimposed Dead Loads

Mechanical and Plumbing (or weight of supported systems, if greater)	10 psf
Ceilings	3 psf

Wind Load

Basic Wind Speed	150 mph
Wind Directionality Factor (K_d)	0.85
Importance Factor (I)	1.15
Exposure Category	C
Velocity Pressure Coefficient (K_h)	1.13
Topographic Factor (K_{zt})	1.0
Gust Effect Factor (G)	0.85
Enclosure Classification	Enclosed
Internal Pressure Coefficient (GC_{pi})	±0.18
External Pressure Coefficients (C_p)	
Windward	+0.8
Leeward	-0.3
Sidewall	-0.7
Velocity Pressure ($_{qh}$)	40.7 psf
Components and Cladding	
Windward Walls	1.5 times windward MWFRS
Leeward Walls	3 times leeward MWFRS
Corners	5 times leeward MWFRS

Earthquake Loads

Mapped Spectral Accelerations for Short Periods (S_s)	0.196g
Mapped Spectral Accelerations for 1-Second Period (S1)	0.055g
Seismic Occupancy Factor	IV
Seismic Occupancy Importance Factor (IE)	1.50
Site Classification	D
Site Coefficient F_a	1.6
Site Coefficient F_v	2.4
Response Modification Coefficient	5
Seismic Design Category	C
Seismic Response Coefficient (C_s)	4.4%

2E.5.2. Seismic or Wind Lateral Design

Based on the preliminary Geotechnical Report the anticipated structural foundation and lateral design system consists of the following components: (Wind controls the lateral design)

- Shear Walls - Per 5000 sf of building footprint: 52.0 cu yd concrete, 2.9 tons reinforcement.
- Shear Wall Foundations - Spread footing per 5000 sf of building footprint: 88.9 cu yd concrete, 4.3 tons reinforcement.
- Columns - Spread footing per 700 sf of building footprint: 26.0 cu yd concrete, 0.7 tons reinforcement.

2E.6. SITE SECURITY (Plum Island, New York)

[redacted]

2E.7. ANALYSIS OF AVAILABLE ASSETS (Plum Island, New York)

2E.7.1. Plum Island Existing Infrastructure

1. **New Power Plant**: Proceed with the assumption that this facility and its associated steam and emergency power generation equipment would be fully commissioned and operable prior to NBAF construction.

    a. Emergency Back-up Power Generation – Incorporate the use of the three Caterpillar Generator units (1825KW ea) as a direct offset for back-up power generation requirements for NBAF. If NBAF requires greater than 5.475 MW of back-up power generation to provide N+1 capacity, new generators shall be installed as part of the NBAF CUP only as necessary to supplement this existing power generating capacity.

    b. Steam Generation – Utilize the 3 -500HP Cleaver Brooks boilers to provide all steam capacity for surge or redundant NBAF requirements and for all non-research focused operations needs that may exist (including the operation of outbuildings) in order to minimize the NBAF CUP steam production construction costs.

2. **Administration Building**: Assume that the current 1994 Administration Building (Building 101) would be utilized to the greatest extent feasible to offset NBAF administration construction needs. This facility includes 55,000 SF of mixed-use space that currently fulfills the following functions:

    a. BSL 2 Laboratory
    b. BSL 3 Change Rooms
    c. Audio/Visual Offices
    d. Administrative & Scientific Offices for DHS, ARS and APHIS
    e. Facility Engineering, Safety, Environmental Office
    f. O&M Contractor Offices
    g. Learning Center, Library, Conference Rooms
    h. Receiving Warehouse
    i. Security Command Center
    j. Telephone Switch Room
    k. Network Room & HSDN Room
    l. Cafeteria (Contained and Non-contained with common kitchen)
    m. Machine Spaces
    n. IT infrastructure upgrades

    It should be assumed that no research functions are performed in this facility. However, it is anticipated that this space could be utilized as a direct offset to current proposed NBAF space to support the following functions as identified in Section 4.11 of the Conceptual Design Feasibility Study:

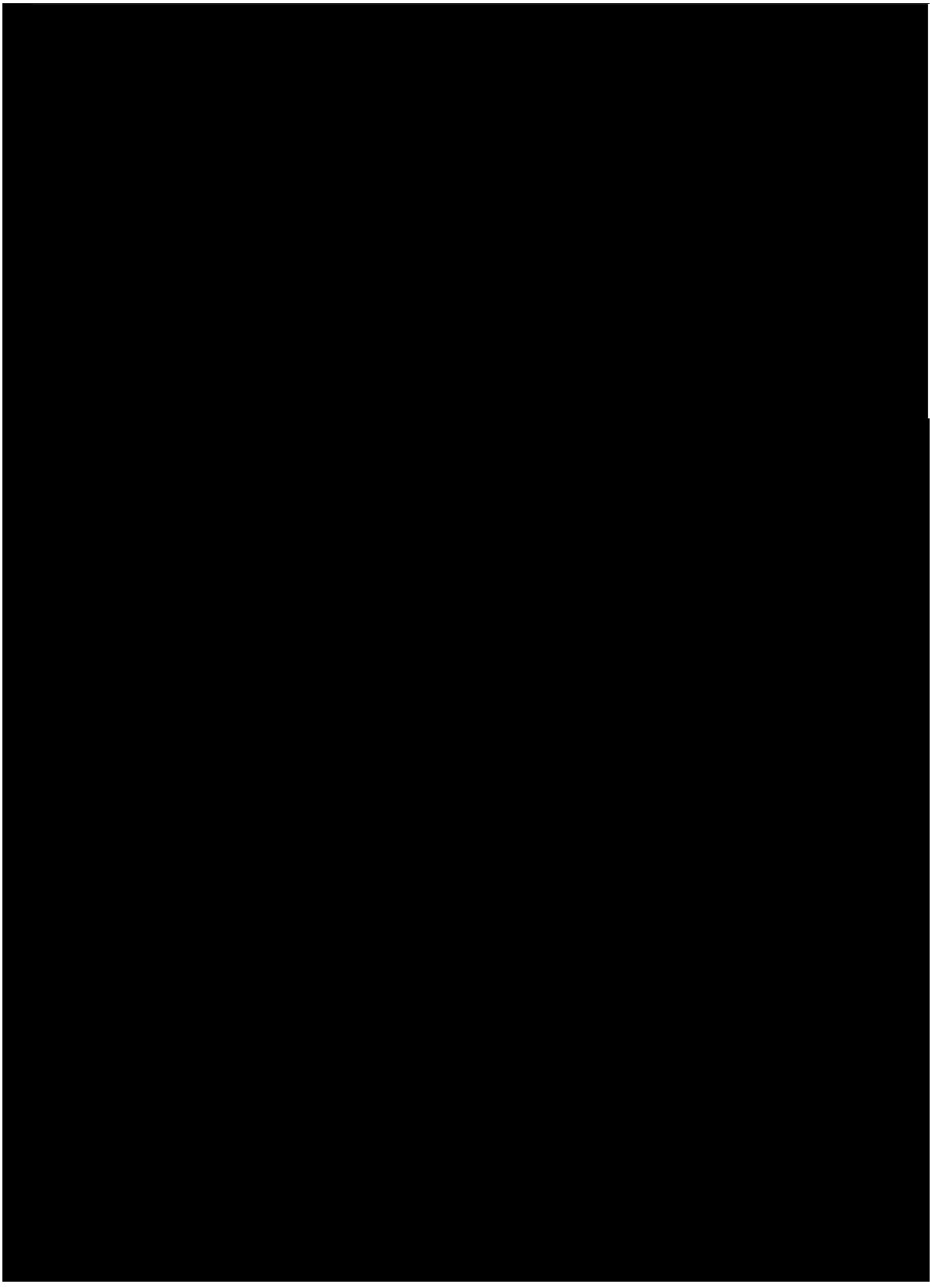
    a. Training Module Classroom Support (**3,600SF** for auditorium, pre-function, security, storage, and rest rooms)
    b. Office and Auxiliary Space
        i. 25% of all research program office space (ARS, APHIS and DHS) **3,660SF** of 14,640SF programmed
        ii. 33% of conference room requirements [~**260SF**]

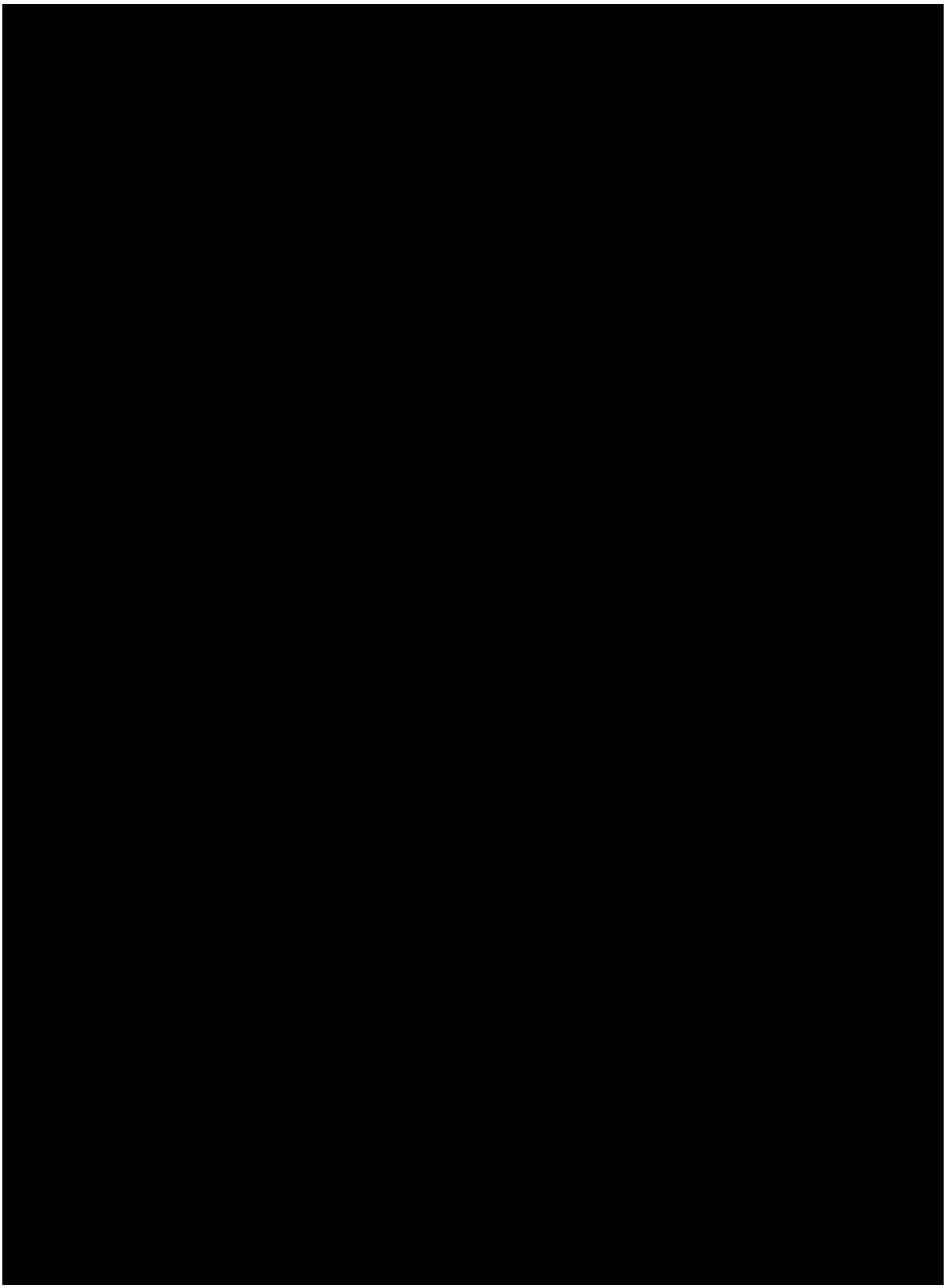
iii. 100% of library requirements
iv. 50% of kitchen/cafeteria requirements

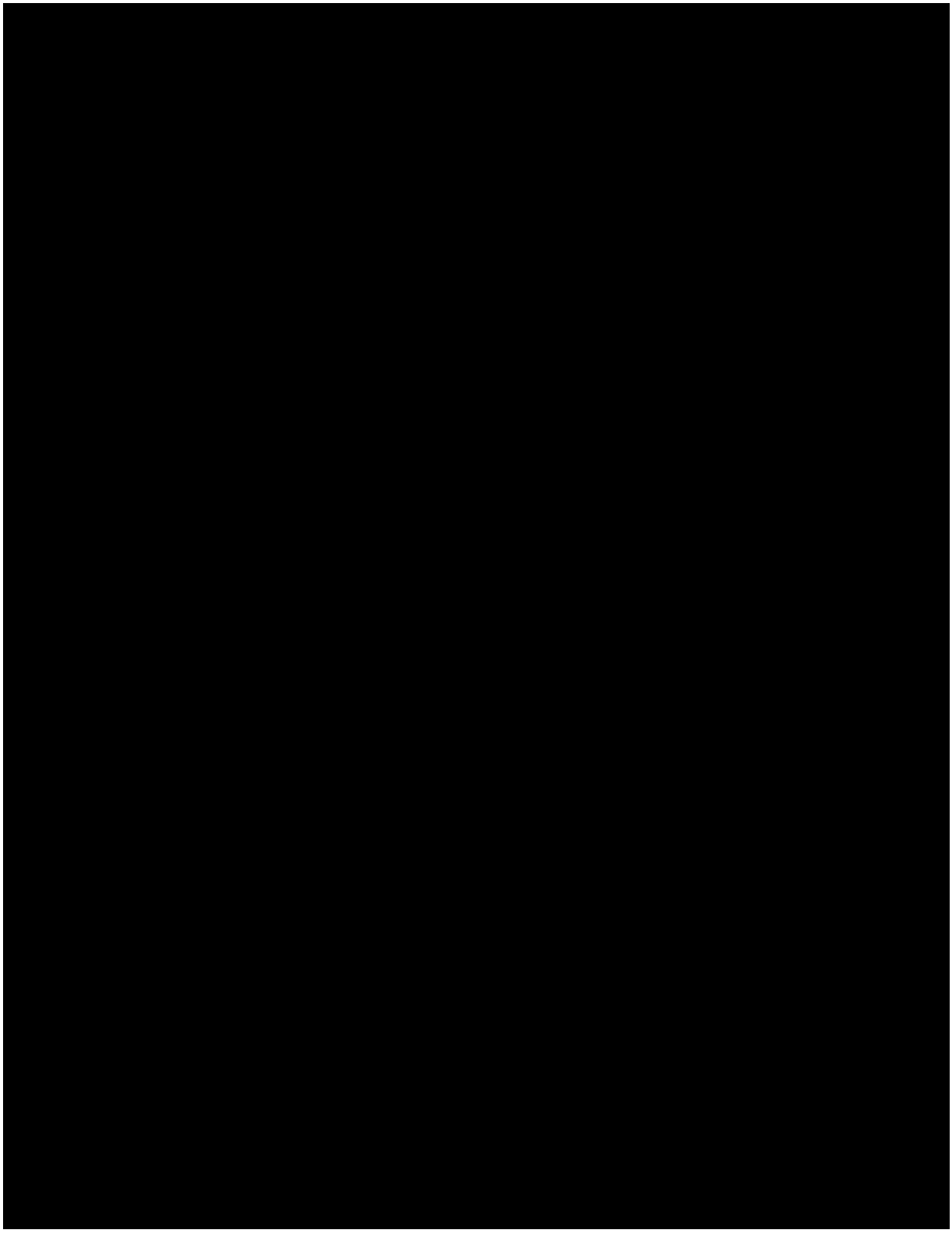
c. General Building Support Space
   i. 50% of engineering shops
   ii. 100% of mail room

d. Out Building Support Space
   i. 100% of visitor center
   ii. Assume that this facility includes a guardhouse and can meet any human occupancy requirements for security functions exterior to the bio-containment (perimeter guards, housing quarters, etc), CUP engineering staff offices, and feed and beading storage needs.
   iii. Existing locker rooms can be utilized for engineering and support staff change rooms.

SEE EXISTING FACILITY DIAGRAMS ON THE FOLLOWING PAGES.







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2F.1. SITE IMPACT ANALYSIS (San Antonio, Texas)

2F.1.1. Preliminary Geotechnical Report Findings

Preliminary Geotechnical Engineering Study Provided by Terracon

Terracon Project 90079038 dated December 7th, 2007.

The following summary information is based on the above referenced preliminary report.

Site description:

The site is located southwest of the intersection of Lambda and Omicron Drives in San Antonio, Texas and extends over the Bexar County line into a portion of Medina County, Texas. The site is a vacant and undeveloped 100 acre tract of ranchland, heavily wooded with native grasses and bushes.

Topography:

There is 80 feet of elevation change from northwest to southeast.

Subsurface Stratigraphy:

Subsurface conditions were evaluated by 5 borings completed in this study and 3 borings completed in 1987. The findings might be generally described as follows:

- 0 to 3 feet CLAY
- 3 to 18 feet SILTY CLAY
- 6 ½ to 64 feet MARLY CLAY
- 51 to 80+ feet MARLY CHALK
- 70 to 100 feet CHALKY MARL

Please see boring logs in the referenced report for specific information.

The report contains a review of area geology.

Groundwater:

No subsurface water observed excepting wet cuttings on one boring at 40-45 feet in boring B-2.

Subsurface water levels are influenced by seasonal and climatic conditions which can and will change. Therefore, the foundation contractor should check the subsurface water conditions just prior to foundation excavation activities.

Soil preparation and Structural considerations:

Geotechnical considerations review soil bearing capacity and anticipated soil movement. Potential Vertical Rise (PVR) of 1" or less is usually acceptable.

For flat floor slab with shallow foundations, 2-3 feet of clay is to be replaced with non-expansive select fill. The report includes a section on select fill considerations.

For suspended floor slab with grade beams supported on drilled piers may be utilized if no subgrade movements can be tolerated.

For cutting into hillsides and construction with a walk-out lower level, shallow foundations may be more economical, including design for unbalanced lateral earth pressures for retaining walls and excavation of rock-like materials.

Building floor slabs below exterior grades should be waterproofed using waterproofing materials instead of water resistant materials.

The report provides recommendations for reduction of soil movements depending on structural options chosen.

Site improvement:

The site has 80 feet of elevation change and it is anticipated that earth retaining walls would be required to develop the site. Adequate drainage behind site retaining walls is required.

Seismic design criteria:

Site class D (Based on 2006 IBC)

Maximum Considered Earthquake 0.2 second Spectral Acceleration S_S = 0.11g

Maximum Considered Earthquake 1.0 second Spectral Acceleration S_1 = 0.04g

Paving subgrade preparation and system selection:

Pavement on site may be either flexible or rigid systems depending on subgrade modification and traffic loading conditions.

Flexible paving w/o modified subgrade:

Light duty: 6" moisture conditioned subgrade, 10" aggregate base and 2" asphalt surface.

Medium-Heavy duty: 6" moisture conditioned subgrade, 12" aggregate base, 2.5" asphalt surface.

Flexible paving with modified subgrade:

Light duty: 6" modified subgrade, 6" aggregate base and 2" asphalt surface.

Medium-Heavy duty: 6" modified subgrade, 10" aggregate base, 2" asphalt surface.

Rigid paving w/o modified subgrade:

Light duty: 6" moisture conditioned subgrade, 5.5" concrete.

Medium-Heavy duty: 6" modified conditioned subgrade, 6.5" concrete.

Rigid paving with modified subgrade:

Light duty: 6" moisture conditioned subgrade, 5" concrete.

Medium-Heavy duty: 6" modified conditioned subgrade, 6" concrete.

2F.1.2. Phase I Findings

Phase I Environmental Site Assessment Provided by Terracon

Terracon Project 90079039 dated December 12th, 2007.

The following summary information is based on the above referenced report.

Summary of recognized environmental conditions (RECs):

There is no evidence of underground or above ground storage tanks. There is no evidence of hazardous waste storage or disposal. There is no evidence of (RECs). There are no RECs from activities on site or surrounding properties.

The site is vacant, undeveloped ranchland.

The site is un-zoned.

There are no RECs that warrant additional investigation at this time.

Zoning / land use:

The site is not currently zoned because it is outside of the city limits.

2F.1.3. Wetlands Delineation Findings

No surface water or wetland features are evident. The site is not located in a floodplain.

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2F.2. RESOURCE RESTORATION (San Antonio, Texas)

According to the Expression of Interest, the site has no environmentally sensitive areas or historical / cultural sites. The property lies within the Texas Research & Technology Foundation, and although outside the city limits is a Designated Industrial District of the City of San Antonio which is governed by its own set of Protective Covenants. Based on the above, no restoration is anticipated.

2F.3. SITE WORK ANALYSIS

2F.3.1 Anticipated Earthwork Analysis:

It is anticipated that the earthwork can balance onsite with 324,900 cubic yards of cut. The anticipated fill range is 0-26 feet and the cut range is 0-31 feet. It should be noted that the final site design would most likely be able to reduce the overall earthwork quantities by as much as 20% by rotating the program approximately 180-degress.

2F.3.2 Anticipated Utility Routing:

There are existing power and water lines (16-inch lines) running along Lambda Drive, which runs along the easterly side of the site. An existing high pressure gas line runs along the northern side of the site, in the R.O.W. of the proposed Omnicron Drive extension. The gas service to the CUP would run along Lambda Drive, parallel to the power and water services.

It is anticipated that sanitary sewer would be collected outside the basement level and would be connected via a gravity line to the existing 8-inch gravity sewer that runs along the northern side of the site, in the R.O.W. of the proposed Omnicron Drive extension, parallel with the existing gas line.

Site run off would be detained on the NBAF site per local and state regulations to meet the required 10, 25 & 100 year rain events.

2F.3.3 Transportation Infrastructure:

Other than the new facility entrance and emergency exit off of Lambda Drive, no other improvements are anticipated to the existing Research Park road network, or to the main roadways leading to the Park.

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2F.4. UTILITY ANALYSIS (San Antonio, Texas)

2F.4.1 Existing Utility Infrastructure

The site Consortia have reviewed and verified that the estimated NBAF service loads and demands can be met by the local utility provider however some improvements would need to occur to their local infrastructure. The costs and details of these improvements are included in the Site Cost Analysis and In-Kind evaluation.

All utilities are available except for those listed below.

Chilled Water:

Existing chilled water utilities are not available to serve NBAF. Chilled water would be provided as part of the central utility plant constructed as part of the NBAF project.

Steam:

Existing steam utilities are not available to serve NBAF. Steam would be provided as part of the central utility plant constructed as part of the NBAF project.

2F.4.2 NBAF Program Loads & Capacity Requirements

Chilled Water:

Preliminary chilled water loads for the San Antonio, Texas site are based on the current facility program using the 0.4% design dry-bulb (87°F) and 0.4% design wet-bulb (78°) temperatures as published in the 2005 ASHRAE Fundamentals Handbook.

A peak chilled water load of 5,200 tons including 750 tons for process cooling is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized chillers at 1,040 tons are required. This N+1 strategy would maintain the firm capacity of 5,200 tons and require a total installed capacity of 6,240 tons. This allows the peak capacity of the facility to be met in the event of the loss of one chiller.

Steam:

Preliminary steam loads for the San Antonio, Texas site are based on the current facility program using the 99.6% design condition (26°F and 10.30 gr/lb moisture) as published in the 2005 ASHRAE Fundamentals Handbook.

A peak steam load of 130,000 lb/hr including 55,000 lb/hr for process loads is required to serve NBAF based on this analysis. To achieve appropriate levels of redundancy to serve this mission critical facility six equally sized boilers at 26,000 lb/hr are required. This N+1 strategy would maintain the firm capacity of 129373 lb/hr and require a total installed capacity of 156,000 lb/hr. This allows the peak capacity to be met in the event of the loss of one boiler.

Natural Gas:

The CUP should be provided with a 10 PSI natural gas supply to meet the installed natural gas burning equipment firm capacity of 130,000 CFH.

Fuel Oil:

Multiple fuel oil tanks serving the boilers and generators with a total capacity of 550,000 gallons are required to provide stand-by operation of the facility for thirty days in the event of either a loss of normal power or natural gas service to the site.

Water:

Dual water service is required to the site with a minimum delivery pressure of 35 psi. Water consumption ranges between 50,000 and 275,000 gallons per day with a peak flow rate of 656 GPM. The maximum value includes cooling tower make-up water for peak cooling days during the summer months and would be less other times of the year. The estimated total annual water consumption is 51,750,000 gallons.

Sanitary:

Discharge to the sanitary system ranges between 50,000 and 150,000 gallons per day with an annual estimated discharge of 29,250,000 gallons. If a tissue digester is utilized for carcass disposal a small percentage of the effluent stream would have the following composition.

BOD (mg/L)	10,250
COD (mg/L)	19,600
Suspended Solids (mg/L)	1,400
pH	9.48

It is anticipated that a dilution level acceptable to the local sewer district would be achieved based on the total effluent discharge from the facility. This would be confirmed as part of the detailed design phase.

Electrical:

A minimum of two redundant medium voltage services with multiple feeders are required to serve the NBAF campus. The specific arrangement of electrical service is required to be coordinated with the utility provider during the design phase.

A utility substation at 34.5 kV is required on site with two transformers feeding 15 kV Class switchgear in a main-tie-main arrangement. The secondary feeders would provide primary electric service at 13.8 kV to the Central Utility Plant (CUP) and to the building.

The total normal power load required to accommodate the specific site infrastructure loads as well as the typical building load for San Antonio, Texas is approximated at 12.8 MW.

Stand-by / Emergency Power:

The critical nature of the building loads requires that nearly 90% of the normal power loads be on emergency/standby power and backup. In lieu of segregating the building distribution as normal and emergency, the entire load would be served by the emergency/standby power system.

To meet these requirements eight 2000eKW generators would be required. This N+1 strategy would allow normal maintenance to occur while still maintaining reliable capacity. Generation would be at 13.8kV and be connected to the 15kV switchgear through motorized breakers.

2F.4.3 Utility Outages

Due to the mission critical nature of the facility, availability and reliability of the primary utilities is critical. In the unlikely event that one of the utilities, natural gas, electric, water or sewer service, is lost to the building the following redundancies / provisions have been included.

Natural Gas

In the event of the loss of natural gas service to the facility, on site fuel storage to support the operation of the boilers is provided. This storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only natural gas to the facility is lost the fuel storage would support the boilers for up 120 days depending on the season.

Electrical

In the event of loss of the primary feeder to the site, power would automatically transfer to the redundant feeder without interruption of power to the building. In the event of the loss of both the primary and redundant feeders the generators would start and restore power to the building. As noted above the fuel storage has been sized to allow normal operation of the facility for a 30 day period in the unlikely event of the loss of natural gas and both the primary and redundant power feeders. In the event that only electrical service is lost the fuel storage would support the generators for up to 60 days depending on the season.

Water

In the event of loss of the primary water service to the site, water would be provided by the redundant dual water service. In the event of complete loss of utility provided, water provisions would be in place to allow temporary connection to a tanker truck. SOP's would be required to strictly limit water use to only critical facility functions.

Sanitary

In the event of loss of sanitary service to the facility, the effluent decontamination system (EDS) would allow for up to 48 hours of storage of effluent discharged from the BSL-3AG and BSL-4. SOP's should be in place to limit discharge to extend this holding time if possible. All areas of the building not discharging through the EDS would require SOP's to immediately suspend all sanitary discharge. If the outage is estimated to last beyond the 48 hour holding time, temporary provisions could be made to pump the waste from a local manhole into a tanker truck for proper disposal.

The waste would be decontaminated through normal protocols prior to discharge from the facility.

2F.4.4 Utility Costs

Utility costs for the site have been developed based on the current programming utilizing computer software that models the operation of the building throughout the year on an hourly basis. Utility rates were obtained from the Energy Information Administration website www.eia.doe.gov which is governed by the Department of Energy. Actual consortia provided rate structures may differ significantly. The energy model would be updated as new information becomes available. The current estimated utility consumptions and costs for San Antonio, Texas are summarized below. Fuel oil values are based on weekly testing and 80 hours of back-up operation per year.

Utility	Estimated Annual Cost
Electrical	$4,000,000 to $5,000,000
Natural Gas	$1,000,000 to $1,500,000
Fuel Oil	$ 300,000 to $ 500,000

2F.4.5 Boiler Emissions

Boiler emissions have been calculated using the annual natural gas consumption determined in the energy model. Emission rates were then applied to the total consumption to obtain estimated boiler emission rates in pounds. The results of this for San Antonio, Texas are summarized below.

Estimated Boiler Emissions (Natural Gas)				
San Antonio, Texas	Estimated Annual Consumption (MMBtu)	Boiler Emission Levels (lb/MMBtu)	Estimated Annual Emissions	Estimated Annual Emissions
Substance				
Nitrogen Oxide (NOX)	100,230	0.035	3,508 lbs	21.8 tons
Particulate Matter < 10 Micron Diameter (PM-10)	100,230	0.010	1,002 lbs	0.5 tons
Volatile Organic Compounds (VOC)	100,230	0.016	1,604 lbs	0.8 tons
Sulfur Oxide (SOX)	100,230	0.001	100 lbs	0.1 tons
Carbon Monoxide (CO)	100,230	0.040	4,009 lbs	2.0 tons

2F.4.6 Generator Emissions

Generator emissions have been calculated based on weekly testing of the generators and stand-by power operation at 75% capacity for both 80 hours (normal operation) and 30 days (catastrophic event) per year. The results are summarized below.

Substance	Estimated Annual Emissions	
Stand-by Duty→	**80 Hours**	**30 Days**
Nitrogen Oxide (NOX)	31,795 lbs	142,387lbs
Carbon Monoxide (CO)	3,238 lbs	14,502 lbs
Total Hydrocarbon (VOC)	1,914 lbs	8,570 lbs

DIESEL GENERATOR EMISSIONS VALUES -80 hours stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
Total per Generator	104	2246.4 lbs	228.8 lbs	135.2 lbs
Number of Units	80	1728.0 lbs	176.0 lbs	104.0 lbs
	184	3974.4 lbs	404.8 lbs	239.2 lbs
	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		31795 lbs 15.9 Tons	3238 lbs 1.6 Tons	1914 lbs 1.0 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

DIESEL GENERATOR EMISSIONS VALUES -30 days stand-by operation

		Emissions Constituent -Load Level (% of unit rated ekW)		
		NOX -75%	CO -75%	VOC -75%
Testing (2 hrs / week) Annual Back-up hrs	hours	21.6 lbs / hour	2.2 lbs / hour	1.3 lbs / hour
Total per Generator	104	2246.4 lbs	228.8 lbs	135.2 lbs
Number of Units	720	15552.0 lbs	1584.0 lbs	936.0 lbs
	824	17798.4 lbs	1812.8 lbs	1071.2 lbs
	8	8 units	8 units	8 units
TOTAL ESTIMATED ANNUAL EMISSIONS		142387 lbs 71.2 Tons	14502 lbs 7.3 Tons	8570 lbs 4.3 Tons

NOX -Nitrogen Oxides CO -Carbon Monoxide
VOC -Volatile Organic Compounds

The generators are sized to run at 80% of rated capacity based on the connected load.

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2F.5. STRUCTURAL BASIS FOR DESIGN (San Antonio, Texas)

The parameters for the NBAF structural system were evaluated to support a structure that consists of a basement (fully or partially below grade), an occupied research floor, an interstitial service floor and a penthouse.

Structural Engineering Assumptions based on the Geotechnical Report: 1 story concrete structural slab.

2F.5.1. Design Criteria:

Live Loads

Laboratories	100 psf
Animal Research Facilities	100 psf
Animal Research Facilities with Primates	125 psf
Storage Rooms	150 psf
Mechanical Areas (or weight of equipment if greater)	150 psf
Conference Rooms	125 psf
Reception Lobby Areas	125 psf
Frozen Storage	210 psf
Loading Docks and Receiving Areas	250 psf
Loading Docks and Receiving Areas	250 psf
Stairs and Permanent Corridors	100 psf
Roofs	45 psf

Superimposed Dead Loads

Mechanical and Plumbing (or weight of supported systems, if greater)	10 psf
Ceilings	3 psf

Wind Load

Basic Wind Speed	100 mph
Wind Directionality Factor (K_d)	0.85
Importance Factor (I)	1.15
Exposure Category	C
Velocity Pressure Coefficient (K_h)	1.13
Topographic Factor (K_{zt})	1.0
Gust Effect Factor (G)	0.85
Enclosure Classification	Enclosed
Internal Pressure Coefficient (GC_{pi})	±0.18
External Pressure Coefficients (C_p)	
Windward	+0.8
Leeward	-0.3
Sidewall	-0.7
Velocity Pressure ($_{qh}$)	28.3 psf
Components and Cladding	
Windward Walls	1.5 times windward MWFRS
Leeward Walls	3 times leeward MWFRS
Corners	5 times leeward MWFRSCorners
	5 times leeward MWFRS

Earthquake Loads

Mapped Spectral Accelerations for Short Periods (S_s)	0.11g
Mapped Spectral Accelerations for 1-Second Period (S1)	0.03g
Seismic Occupancy Category	IV
Seismic Occupancy Importance Factor (IE)	1.50
Site Classification	D
Site Coefficient F_a	1.6
Site Coefficient F_v	2.4
Response Modification Coefficient	5
Seismic Design Category	A
Equivalent Seismic Response Coefficient (C_s)	1.0%

2F.5.2. Seismic or Wind Lateral Design

Based on the preliminary Geotechnical Report the anticipated structural foundation and lateral design system consists of the following components: (Wind controls the lateral design)

- Shear walls - Per 5000 sf of building footprint: 31.1 cu yd concrete, 1.2 tons reinforcement.
- Shear Wall Foundations - Pile foundation per 5000 sf of building footprint: 8-18” diameter piles, 48.0 cu yd concrete (pile cap), 2.7 tons reinforcement (pile cap).
- Columns - Pile foundation per 700 sf of building footprint: 6-18” diameter piles, 20.3 cu ft concrete (pile cap), 0.6 tons reinforcement (pile cap). Each 18”diameter pile will be 30 feet long with 2.0 cu yd concrete and 0.2 tons reinforcement.

2F.6. SITE SECURITY (San Antonio, Texas)

[redacted]

2.8. LOCAL CONSTRUCTION LABOR & MATERIAL COSTS

The varying regional cost factors that are found throughout the country can be attributed to labor markets, taxing authorities, delivery locations for material supplies, construction and facility types.

Labor – The Davis Bacon Rates have been used in determining the appropriate labor costs associated with each site. In the Northeast labor unions have controlled the labor market for numerous years, starting shortly after the turn of the last century. In the southeast this is partly true as well, but it has never been with as much intensity as the northeast. In the south central US, many of the states are 'Right to Work States'. This means that the unions have only voluntary control of the labor markets. Supply of labor also has a bearing on the various US markets. With current population trends, availability of labor in the south central US is greater than in the northeast or central US.

Taxing Authorities - Taxing authorities vary from state to state as well. In some states there is no state income tax while in others it is imposed by the state. This has an affect on the cost of doing work within the various US regions.

Material Supply - Material production, delivery and supply is also affected by the labor market. This has less impact than the local labor markets but still affects costs.

The area adjustment factor was determined using historical data as well as project specific costs gathered from the USDA National Center for Animal Health and the DHS National Biodefense Analysis and Countermeasures Center which were recently completed or are in the process of being completed. These two projects are representative of similar programmatic spaces that will be found in the NBAF. Attempting to solely use published data which is representative of national averages for construction costs as well as building types does not reflect the costs that are anticipated with a high containment facility. The larger metropolitan areas that would most likely provide the prime trade contractors to support this complex project were also used in this evaluation. Therefore, the final area adjustment factors are blended rates of all available data as described above.

The table below represents the anticipated area adjustment factors for each of the six sites.

Site	Area Adjustment Factor
Athens, Georgia	0.95
Manhattan, Kansas	0.97
Flora, Mississippi	0.90
Butner, North Carolina	0.95
Plum Island, New York	1.32
San Antonio, Texas	0.90

Table 2.8.1 - Area Adjustment Factors

The table below represents an analysis of the closest cities to each of the six sites noting their current population and actual distances from each of the sites. The cities in red represent the anticipated metropolitan area that the major prime trade contractors and material suppliers may be located. Cities with less than 100,000 inhabitants are not noted. The criteria used in determining which city is expected to provide the majority of prime subs was cities with a population over 150,000, < 250,000 preferred, and within 100 miles of the site.

Site	Cities	Population	Distance Miles
KS - Manhattan			
	Topeka, KS	122,642	55
	Kansas City, MO	450,375	120
	Wichita, KS	361,420	135
GA - Athens			
	Athens, GA	112,760	0
	Atlanta, GA	519,145	73
MS - Flora			
	Jackson, MS	175,710	20
	Baton Rouge, LA	227,071	195
	Shreveport, LA	199,569	215
	Birmingham, AL	229,800	260
	Montgomery, AL	204,086	270
NC - Butner			
	Durham, NC	217,847	15
	Raleigh, NC	375,806	35
NY - Plum			
	Hartford, CT	124,563	70
	Providence, RI	172,459	80
	New York, NY	8,274,527	110
TX - San Antonio			
	San Antonio, TX	1,328,984	0
	Austin, TX	743,074	80
	Houston, TX	2,208,180	200

Table 2.8.2 – Largest Metropolitan Centers near the Project Sites

CRITERIA	Athens, GA	Manhattan, KS	Flora, MS	Butner, NC	Plum Island, NY	San Antonio, TX
	Comments	Comments	Comments	Comments	Comments	Comments
1. Site Fit						
Initial size	Initial program will fit w/ significant earthwork due to grade change across the site.	Initial program is a very tight fit w/ significant earthwork due to grade change across the site.	Initial program will fit w/ modest earthwork due to minimal grade change across the site. There is a pond on the site along with a possible detention pond.	Initial program will fit w/ significant earthwork due to grade change across the site.	Initial program will fit w/ significant earthwork due to lack of adequate grade change across the site.	Initial program will fit w/ significant earthwork due to grade change across the site.
	Approximately 67 Acres	Approximately 45 Acres	Approximately 150 Acres	Approximately 249 Acres	Approximate acres N/A	Approximately 100 Acres
3. Adjacency						
	Site is relatively remote to immediate buildings. Existing equestrian facility is located adjacent to the site.	Site is within a University urban setting with multiple buildings surrounding the site. The Biosecurity Research Institute, Mosier Hall and a Westar power facility are immediately adjacent to the site.	Site is relatively remote to any buildings. A commercial facility is located to the south of the site and a railroad runs along the eastern boundary line. Overhead Electrical transmission lines were observed near by.	Site is very remote to any immediate buildings. Existing youth detention center is located at the south of the site. All other structures are several hundred feet away.	Island site is immediately adjacent to the existing PIADC.	Site is relatively remote to immediate buildings. Existing equestrian facility is located at the south of the site.
4. Architectural Character						
Entry, View, Access	The majority of the site is pasture with a few trees existing in the stream area. The topography of the site and anticipated placement of the building should provide good views and security. Access to the site will be via South Milledge Avenue. An Exit only Road will be located to the south-east of the property.	The site is on one of the highest elevations on the Kansas University campus thus the facility will be readily viewed from most areas of the campus. Access to the site will be via Denison Road. An Exit only Road will be located to the south of the property line.	As the site has minimal slope and limited trees NBAF will be readily visible from the south and west. The eastern border will be screened by the railroad. Access to the site will be via a four lane dived highway; Hwy 49. An Exit only Road will be located to the south of the property.	NBAF will be sited on one of the highest elevations on the site therefore there should be clear views of major portions of the property however the adjacent property is heavily wooded and will provide substantial screening. Entry onto the site will be from the north along a long access drive which will need to be provided as part of the project. This drive will connect from Range Road. No secondary exit is provided. See drawings.	NBAF will be site adjacent to the existing PIADC. This property is on axis with the entry road from the harbor thus views and access should be acceptable. The building site will require substantial cut as the topography is relatively flat. Access to the site will be provided by government ferries.	Located within a research park which includes its own guardhouse (not part of NBAF's security). Access to the site will be via Lambda Drive. A secondary exit is provided to the south-east of the property.
Surrounding Uses	Open and wooded areas followed by residences and the Middle Oconee river.	Cattle and cattle facilities, a recreational park and University athletic stadium are located within very close proximity of the site.	The surrounding area is primarily rural with multiple residential developments.	The areas surrounding the site are mostly rural grazing fields or heavily undeveloped wooded areas. A small cemetery was located near the site.	All surrounding facilities belong to DHS.	The areas surrounding the site are wooded undeveloped ranch land w/ dense vegetation, tall grasses, shrubs, and a stock pond approximately 300' west of the site along a tributary of Big Sous Creek. The University of Texas Health Center is to
5. Security Set Backs & Code Issues						
[redacted]						
Storm water Management	All storm water will be managed within the property.	All storm water will be tied to the existing storm water sewer system.	All storm water will be managed within the property.	All storm water will be managed within the property.	All storm water will be managed within the property.	All storm water will be managed within the property.
Impact on Terrain	Some tree removal will be required by the stream area. Slope stabilization will be required.	Minimal tree removal will be required. Some slope stabilization will be required. Re-routing or termination of Serum Plant Road is also required.	Minimal tree removal will be required. Minimal slope stabilization will be required. Possible restructuring of pond damn will be required.	Significant tree removal will be required. Slope stabilization will be required. Jurisdictional wetlands and waters were identified. No suitable habitat was encountered for the federally protected species.	Minimal tree removal will be required. Some slope stabilization will be required. Wetlands found but no wetlands found on immediate proposed site area.	Minimal tree removal will be required. Slope stabilization will be required.
6. Constructability						
Earthwork	Substantial earthwork due to amount of topography.	Substantial earthwork due to amount of topography.	Modest earthwork required due to gradual topography.	Substantial earthwork due to amount of topography.	Relatively flat site causes substantial soil to be removed to construct the basement.	Substantial earthwork due to amount of topography.
Soils	See Section 2A.1- Site Impact Analysis.	See Section 2B.1- Site Impact Analysis.	See Section 2C.1- Site Impact Analysis.	See Section 2D.1- Site Impact Analysis.	See Section 2E.1- Site Impact Analysis.	See Section 2F.1- Site Impact Analysis.
7. Logistics						
Speed of Delivery	Nothing to slow construction.	Limited site area may impact construction.	Nothing to slow construction.	Remoteness of site may impact construction.	Remoteness of site on an island will impact construction. Access to both materials and labor will be a challenge.	Nothing to slow construction.
Construction Access & Staging	Access should be provided using the same primary entry drive. The site is large enough for on-site construction staging.	Access should be provided using the same primary entry drive. The site is large enough for on-site construction staging.	Access should be provided using the same primary entry drive. The site is large enough for on-site construction staging.	Access should be provided using the same primary entry drive. The construction drive will most likely need to be paved due to the difficulty of maintaining a gravel drive in excess of 2,000 feet. The site is large enough for on-site construction staging.	Construction vehicles and deliveries will need to be coordinated with DHS due to security and a barge will be anchored and used to transfer materials.. The site is large enough for on-site construction staging.	Access should be provided using the same primary entry drive. The site is large enough for on-site construction staging.
Disruption of Ongoing Activity	None	Construction may have some impacts on adjacent properties due to a more confined and urban setting.	None	None	Construction will have some impacts to the existing PIADC operations due to the scale of construction and proximity between sites.	None
8. Infrastructure						
Roadways	Existing municipal roadways will be adequate.	Denison Ave and Kimball Ave are the only two paved roads which access the site.	Existing municipal roadways will be adequate.	Existing municipal roadways will be adequate however an extensive site entry drive will be required. The entry road will be fed off of Range road which is a two lane county road with minimal traffic.	Existing roadways will be adequate.	Existing municipal roadways will be adequate.
Utilities	All Utility extensions are adjacent to the site. Sanitary will be required to be pumped via a force main to the municipal waste water treatment plant.	All Utility extensions are adjacent to the site.	All Utility extensions are adjacent to the site.	All Utilities will need to be routed a couple thousand feet to the nearest utility connection point towards the southern end of the site.	All Utility extensions are adjacent to the site. Sanitary will be required to be pumped via a force main to the waste water treatment plant on the island. Based on final analysis of this plant the NBAF project may need to provide additional treatment capacity. A new underwater cable will also need to be installed.	All Utility extensions are adjacent to the site.
9. Area Adjustment Factors						
	0.95	0.97	0.90	0.95	1.32	0.90

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2.10. EARTHWORK ANALYSIS SUMMARY

Table 2.10.1 represents the estimated earthwork quantities as represented by the preliminary site concept diagrams included in this report. The data used in this analysis included the preliminary geotechnical site specific reports, phase I site specific reports and conceptual site diagrams which indicate proposed building structures, building pad elevations and other site features such as roadways and miscellaneous support structures.

Site	Cut	Fill	Net		Average Slope; Grade Change	Comments
Athens, GA	(292,678)	254,840	(37,838)	Cut / Balanced	2.2%, +34' / -36'	The borings indicate that the building can likely be supported on conventional shallow foundations and that the soils encountered should be suitable for engineered fills. However, it notes that **auger refusal** occurred at depths ranging from **17' to 71'**, with the shallowest being in the vicinity of the proposed cGMP wing and that **blasting may be required**.
Manhattan, KS	(284,770)	245,580	(39,190)	Cut / Balanced	3.2%, +24' / -39'	The borings indicate a 3'-5' layer of **existing fill material**, followed by layers of either **expansive (clayey) soils**, which are exacerbated by wetter or drier conditions, **and/or limestone** which is susceptible to erosion. The report notes it may not be feasible to reduce the risk of movement, but may be reduced with the removal of more of the plastic clays. It is possible that driller pier foundations extending to moderately hard bedrock will be needed.
Flora, MS	(166,089)	137,176	(28,913)	Cut / Balanced	1.5%, +14' / -20'	Of the two borings taken in April 2007, one (B-1) was in the vicinity of the proposed CUP and the other near the southern edge of the security fence. Focusing on B-1, there were **expansive clay soils** noted below 14' which appears typical of this area and suggests that deep drilled piles would be needed to minimize vertical movement. The silty clays above this layer should be usable for engineered fills below some slabs and pavements. Of more concern is the **potential for groundwater**, which was encountered at 16.5' ft in B-1, but it rose to 6.7' below the ground surface within 5 minutes. Based on an interpretation of the ground surface elevation at the borings, it appears **groundwater will be encountered during building excavation**.
Butner, NC	(244,235)	216,701	(27,534)	Cut / Balanced	2.7%, +37' / -33'	The borings noted in the 10-29-07 GeoTechnologies report were not performed in the area of the proposed facility. The closest borings were approximately 1300 ft away. The area tested typically showed a **layer (6'-10') of high and low plasticity, which were described as relatively difficult to work with** One of the closest borings hit refusal at 13', and the next closest hit **partially weathered rock** at 10' which may not be much of an issue for the building excavation, but will impact the utility installation which typically uses smaller machines.
Plum Island, NY	(264,544)	49,242	(215,302)	Cut	1.9%, +16' / -30'	Information provided by staff indicates that the wells draw water from 50'. However, it was commented that water was generally hit at about 10' near the coast line and at approximately 20' in the vicinity of the existing building. Soils were described as variable: sand, gravel and rock at greater depths. Given the proposed design, you would expect to encounter **rock and the water table during construction**.
San Antonio, TX	(324,900)	277,165	(47,735)	Cut / Balanced	4.4%, +26' / -31	The borings indicate a **2'-3' thick layer of expansive clay** which would need to be removed in order to consider the use of conventional shallow foundations. If not completely removed, the use of deep drilled piles and grade beams would be needed. It should be noted that even with the expansive layer removed, shallow foundations may not be desirable at this location due to potential soil movement in the deeper clayey layers.

Notes:

1) Groundwater does not appear to be an issue at the GA, KS, TX or NC sites.

2) Foundation design will be largely dependent on building design / loads and the tolerance for potential vertical movement.

3) It is anticipated that all sites, except KS, will have sufficient area to distribute any excess material.

4) Average slope is based on the existing contours in the area of the proposed construction.

5) Grade change refers to the maximum fill (+) and cut (-) anticipated.

Table 2.10.1 – Earthwork Analysis Summary

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Section 3: Waste Stream Analysis

3.1. Liquid Effluent Sterilization Options

3.2. Pathological Waste Disposal Options

3. Waste Stream Analysis Summary

Decontamination is required of any substance exposed to a BSL-3(E), BSL-3Ag and BSL-4 agent. This section presents the variables for liquid and solid waste decontamination, sterilization methods and available technologies.

For a decontamination system to be effective it must conform to the following design criteria:

- Ease of transport and loading into treatment equipment
- Worker protection and reduction of biohazard aerosol generation
- Decontamination based on proven consistent technologies
- Validate and repeatable
- Volume reduction for final disposal
- Compliant with local, state and federal environmental requirements
- Cost effective (capital and operating)
- Technical degree of automation to achieve effective labor savings
- Maintenance friendly

The technologies available to meet the above conditions vary and do not always consistently meet all the objectives, suggesting that compromise is required in some of the categories. Most of the technologies are classified into three waste processing technologies: chemical, thermal, and irradiation. These technologies are described in greater detail in this section.

Liquid Biowaste Treatment System

A dedicated biowaste gathering and treatment systems would be provided for BSL-3(E), BSL-3Ag and BSL-4 functions. Each of the laboratories and associated, procedure rooms, animal rooms and storage/centrifuge rooms are provided with a biological liquid waste collection and treatment system. All liquid waste would be treated by utilizing a batch sterilization process. The biowaste system would employ gravity drainage to the liquid effluent decontamination system using double-wall piping. The effluent decontamination system tanks would be housed in a dedicated space located below the functional floor area served in a “containable” service space.

Solid Waste Treatment System

A dedicated solid waste treatment system would be utilized for BSL-3Ag and BSL-4 areas. The ARS 242.1 manual contains a requirement to provide for incineration of animal carcasses infected with BSL-3Ag agents and BSL-4 agents, or to have an alternative solution presented for consideration based on a comparative analysis. Incinerators are being phased out due to permitting and maintenance issues and replacement technologies are currently being investigated. Incineration is still however considered the most effective method for disposal of infected carcasses at many universities and research establishments.

Sterilization is only part of the challenge in managing carcass disposal. Emissions and by-products generated from carcass sterilization must also be managed as part of the waste stream processes. Because of these emissions and by-products generated and the limited ability to attain permits to construct incinerators, the design team is evaluating alternative disposal systems.

3.1. Liquid Effluent Sterilization Options

Various technologies exist for the sterilization of liquid effluent emanating within a biological containment facility. Technologies being evaluated include but are not limited to the following:

A. Steam Sterilization Systems
   1. Steam Jacketed
   2. Direct Steam Injection
   3. Steam Coils
B. Reverse Polymerization Systems
C. Chemical Systems
D. Heat & Chemical Systems
E. Irradiation Systems
F. Incineration Systems
G. New Technology Options

3.1.A. Steam Sterilization Systems

Stream sterilization systems represent most of the systems in use today at comparable institutions. There are various alternatives but all of them provide heat via high temperature/high pressure steam to a load that increases the temperature and holds these temperatures for a set period of time prior to release. The pressure of the steam can vary however steam pressures between 80 and 125 psi are typical. The variations of the steam systems are based on the following:

- Materiality of tanks, piping and accessories
- Steam pressure range usually based on temperature levels and volumes
- Typical minimum temperature is 121°C
- Direct and/or indirect application (injection of steam) of steam to the load
- Condensate recovery or release
- Batch vs. continuous
- Heat exchangers vs. cooking tanks
- Holding tanks and/or cooking tanks and/or heat exchangers
- Pressurized and non-pressurized holding & discharge vessels
- Forced agitation
- Heat recovery alternatives
- Gravity and/or pumped flow systems

Continuous flow systems move pressurized effluent through a length of piping and measure the temperature at the beginning and end of the piping loop to maintain temperature and achieve decontamination. The length of piping and flow rate determine the time that the effluent is held at temperature (this is relatively fixed for the system). There are manufacturers that provide a manufactured continuous flow system with a limited time at temperature (2 minutes or less) but operate at a higher temperature (135°C).

Steam jacketed - Is the most common method and consists of an outer vessel surrounding the liquid decontamination (inner) vessel. The issue with this method is the reduced heat transfer capability in the event that the inner vessel is coated with solid build up from the effluent stream.

Direct Steam Injection - Employs steam spargers and directly injects steam into the contaminated vessel. This method offers a quicker heat up time as well as the ability to agitate the fluid in the vessel. If not designed properly there may be issues with noise and vibration during the heating cycle. The vessel needs to be sized approximately 10% to 20% larger to account for the condensate load in the tank.

Steam Coils **-** Can be installed in the contaminated vessel and allows for a more inexpensive alternative to heating the vessel than steam jacketed. There is currently insufficient history with this method over extended periods of time to evaluate the life cycle of the coils and the ability of the coils to maintain heat up efficiencies under conditions where solids present in the waste stream may affect the ability to accurately maintain adequate temperatures.

3.1.B. Reverse Polymerization Systems

Reverse Polymerization Systems use high-energy microwave energy and applied higher temperature to inactivate biological organisms. The system uses holding and treatment vessels, pumps, heat exchangers, high energy magnetrons and pipes to transfer and treat the waste via a batch methodology. Studies have confirmed this systems effectiveness for biological sterilization however there are no confirming studies on its effectiveness towards prion (BSE/TSE) inactivation. It has been suggested that once the molecule bonds are broken via microwaving that this technology may be applicable for prion destruction.

3.1.C. Chemical Systems

Chemical treatment systems exist world-wide and have continued to be used in various global regions. Application and agitation of known disinfectant liquids with liquid effluent have been used effectively for the treatment of potentially infected liquid wastes. Chemical treatment systems can be accommodated both in batch and continuous flow systems incorporating a combination of pumps, holding and mixing tanks, chemical dosing meters/pumps, agitators, corrosion resistant materials, ph monitoring and discharge test ports. Liquid treatment systems can be purchased via vendors or by engineering components with on-site installation and coordination.

3.1.D. Heat and Chemical Systems

Heat combined with chemical injection systems have recently proved effective for dealing with prions (BSE/TSE). This particular system uses steam energy and pumped alkali to render the liquid effluent inactivated. This system effectively combines the use of two other separate technologies and can incorporate many of the similar features and differences. There have been some examples where high pH has been recorded in the discharge of these systems without addition of dilution fluids normally programmed as part of the system's process. Chemicals considered effective for inactivating prions including sodium hydroxide and potassium hydroxide. Other chemicals including sodium hypochlorite, liquid chlorine dioxide, phenol disinfectants, gluteraldehydes and paracetic acid would all be viable candidates for consideration and would depend on the target organisms and tank & process component materiality.

3.1.E. Irradiation Systems

A conceptual design study developed for a comparable animal disease center in Ottawa in the early 1980's suggested that an irradiation system using cobalt-60 as its energy source would inactivate liquid effluent. Large sources of cobalt-60 are increasingly used for sterilization of spices and foods. This powerful gamma ray kills bacteria and other pathogens, without damaging the product. After the radiation ceases, the product is not left radioactive. This process is sometimes called "cold pasteurization." Cobalt-60 undergoes radioactive decay with the emission of beta particles and strong gamma radiation. Cobalt-60 ultimately decays to non-radioactive nickel and its half-life is 5.27 years however there are no know examples of this technology used in similar applications. Additional precautions as with all radioactive material would be necessary due to cancer-causing potential of its use. It was confirmed in the feasibility study that it would be quite expensive to replace and discharge the source material.

3.1.F. Incineration Systems

Incineration systems are typically used for solid waste combustion; however waste liquids and solvents have been injected via atomizers to vaporize and combust flammable liquids.

3.1.G. Other Potential Systems

Systems using e-beam, gas plasma, electron accelerators and UV are several newer technologies that some day may be employed for the sterilization of contaminated liquid effluents. Presently there are no known institutions that use these sorts of technology and thus were not considered for application on NBAF. UV is also not known for its penetrating effectiveness and when considering the effluent nature which includes animal feces, its sole applicability is in question.

3.1.H. Recommendation

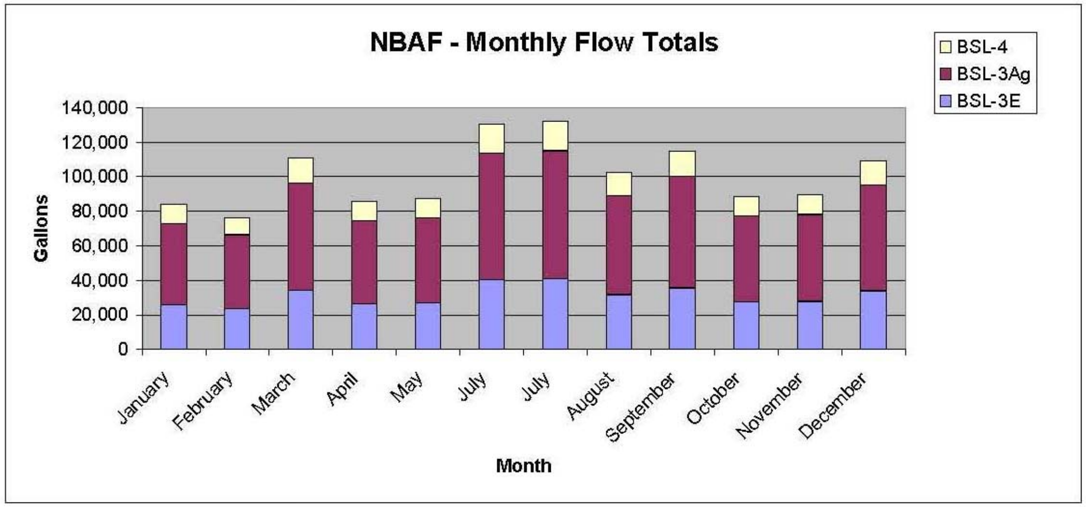
The design team recommends proceeding with the design of the steam sterilization system as described in 3.1.A. This is a proven methodology that has been implemented and operated at the majority of containment facilities for several years. There are multiple vendors and manufacturers to provide a more cost competitive solution. Within this technology there still remains several outstanding issues that will need to be coordinated during the design process including:

- Energy Recovery Options
- Chemical usage and material selection
- Solid waste management in the liquid effluent waste stream

Refer to the following liquid effluent sterilization flow analysis on the following page.

LIQUID EFFLUENT STERILIZATION FLOW ANALYSIS

Month	Total NBAF (gallons)	31% BSL-3E (gallons)	56% BSL-3Ag (gallons)	13% BSL-4 (gallons)
January	83,773	25,970	46,913	10,890
February	76,246	23,636	42,698	9,912
March	110,752	34,333	62,021	14,398
April	85,509	26,508	47,885	11,116
May	87,224	27,039	48,845	11,339
July	130,519	40,461	73,091	16,967
July	132,270	41,004	74,071	17,195
August	102,388	31,740	57,337	13,310
September	114,986	35,646	64,392	14,948
October	88,706	27,499	49,675	11,532
November	89,772	27,829	50,272	11,670
December	109,391	33,911	61,259	14,221
Totals	1,211,535	375,576	678,460	157,500



	Total NBAF				31% BSL-3E				56% BSL-3Ag				13% BSL-4			
Month	m (kg)	q (kW)	m_s (kg/h)	m_s (lb/h)	m (kg)	q (kW)	m_s (kg/h)	m_s (lb/h)	m (kg)	q (kW)	m_s (kg/h)	m_s (lb/h)	m (kg)	q (kW)	m_s (kg/h)	m_s (lb/h)
January	316,535	1,326,283	556,681	1,227,271	98,126	411,148	172,571	380,454	177,260	742,718	311,742	687,272	41,150	172,417	72,369	159,545
February	288,094	1,207,114	506,663	1,116,999	89,309	374,205	157,065	346,270	161,333	675,984	283,731	625,519	37,452	156,925	65,866	145,210
March	418,475	1,753,412	735,961	1,622,513	129,727	543,558	228,148	502,979	234,346	981,911	412,138	908,608	54,402	227,944	95,675	210,927
April	323,094	1,353,763	568,216	1,252,700	100,159	419,666	176,147	388,337	180,932	758,107	318,201	701,512	42,002	175,989	73,868	162,851
May	329,575	1,380,918	579,614	1,277,828	102,168	428,085	179,680	396,127	184,562	773,314	324,584	715,584	42,845	179,519	75,350	166,118
July	493,165	2,066,360	867,315	1,912,099	152,881	640,572	268,868	592,751	276,172	1,157,162	485,696	1,070,775	64,111	268,627	112,751	248,573
July	499,782	2,094,087	878,952	1,937,756	154,932	649,167	272,475	600,704	279,878	1,172,689	492,213	1,085,143	64,972	272,231	114,264	251,908
August	386,870	1,620,986	680,377	1,499,974	119,930	502,506	210,917	464,992	216,647	907,752	381,011	839,985	50,293	210,728	88,449	194,997
September	434,473	1,820,442	764,095	1,684,540	134,687	564,337	236,870	522,207	243,305	1,019,448	427,893	943,342	56,482	236,657	99,332	218,990
October	335,173	1,404,374	589,459	1,299,533	103,904	435,356	182,732	402,855	187,697	786,450	330,097	727,738	43,572	182,569	76,630	168,939
November	339,203	1,421,260	596,546	1,315,158	105,153	440,590	184,929	407,699	189,954	795,905	334,066	736,488	44,096	184,764	77,551	170,970
December	413,333	1,731,867	726,918	1,602,577	128,133	536,879	225,344	496,799	231,467	969,846	407,074	897,443	53,733	225,143	94,499	208,335
Totals	4,577,772	19,180,865	8,050,796	17,748,946	1,419,109	5,946,068	2,495,747	5,502,173	2,563,552	10,741,285	4,508,446	9,939,410	595,110	2,493,513	1,046,604	2,307,363

3.2. Pathological Waste Disposal Options

Various technologies exist for the treatment of pathological waste generated within a bio-safety laboratory containment facility. The technologies include the following:

A. Incineration
B. Heat Pressure Rendering
C. Digestion (Alkaline Hydrolysis)
D. Reverse Polymerization
E. Plasma Arc
F. Irradiation
G. New Combined Technologies:
    1. Combined NaOH and Heat Pressure Rendering

3.2.A. Incineration

The use of incineration as a method of treating hazardous or toxic waste, including infectious animal waste, is an established technology in this country. The method is based on heating the waste to a temperature that will result in complete combustion of the material to carbon dioxide and water vapor. These end products are suitable for release to the atmosphere with no adverse chemical or pathological impact on the environment.

Advantages of Incineration
The principle advantage of incineration in treating infectious waste material is that the technology is mature. The combustion products are well established and understood. The operating characteristics are well understood and the control of the process is state of art. The equipment is commercially available, with some modifications required to achieve the bio-containment criteria. Maintenance of the equipment is typically minor in nature and spare or replacement parts are readily available. The life cycle of an incinerator is generally 20 years or more. Training of operating personnel is routinely available through the manufacturers of the equipment as well as other sources which provide certification of operators.

Disadvantages of Incineration
The principle disadvantage of this process is a negative public perception and resulting regulatory requirements which must be met. These regulations are generally clear and documented in terms of the criteria to be met. Regulation of incinerator installations is handled by the State in which they are installed and operated. Public opposition has occasionally led to delays in obtaining the required State approvals.

Facility Requirements
In operations where containment is critical, the primary containment (incinerator) is located inside a secondary containment area (facility). This is necessary to provide backup for any out of specification operating conditions may lead to a breach of the primary containment. The secondary containment features typically include controlled access, sealed doors, sealed building penetrations, airlock entry and exit zones, decontamination systems, including equipment such as personnel showers and clothing change rooms. The secondary containment area is operated at a negative pressure to the outside environment to insure any leakage is inward to the containment area rather than out of the containment area.

Operational and Maintenance Issues
Incinerators are typically operated by a single operator (per shift), plus a full time maintenance person. The Air Pollution Control System will add additional equipment and chemical maintenance requirements which are included in the duties of the single, full time maintenance person. The principle maintenance items for the incinerator would be replacement of filters, burners, thermocouples, and seals. Maintenance of the chemical feed, spray nozzles (Wet), bag filters (dry), mechanical chiller and general cleaning will be required for the Air Pollution Control System.

3.2.B. Heat Pressure Rendering

The basis of this technology uses a jacketed pressure vessel with steam as the indirect heating medium. The vessel usually sits below or close to the necropsy room floor and is loaded via a chute that is integrally sealed to the necropsy floor. The temperatures created within the vessel are a variable of the supply steam and the pressure vessel rating. Temperatures can exceed 200 degrees C depending on the design. The higher than normal sterilization temperatures typical of that of an autoclave (121-132 degree C) reaching up to 140 degree C meets the current standards for treating TSE/BSE carcasses as per the European Union.

Advantages of Heat Pressure Rendering
- Has been tested effectively for biological sterilization and can be retested with relative ease.
- Produces no hazardous air emissions.
- Produces recyclable bi-products
- Is a closed pressure vessel allowing the vessel location to be outside of primary containment.
- Can accommodate sterilization within three hours.
- Can be modified for secondary treatment – e.g. NaOH, steam or chemical injection.
- Is perceptively better than inefficient burn (incineration) processes.

Disadvantages of Heat Pressure Rendering
- Has not been effectively tested for prion management.
- Requires special attention to construction tolerances and shaft seal design.
- Has a higher solids residue compared to incineration.
- Requires a secondary support services such as a stream boiler and cold room.
- Requires elevation height access for top loading – if program floor is on grade, then the rendering equipment floor room would be below grade causing solid/oil residue challenges – a conveying or hoist system is possible to mitigate this.

Facility Requirements
This option allows the equipment to be housed in a non-BSL3 area and can allow access directly to the outside. The overall dimensional parameters are dependent of the number of cookers. The ability to load the animal into the receiving chute depends on the location and height of an overhead monorail. Ideally the rail height should allow for approximately 16’ (feet) hanging height above the chute to allow a clear movement of the animal from a loading dock, into possible storage, onto a necropsy table or into the receiving chute of the treatment system.

Operational and Maintenance Issues

The primary challenge to operating and maintaining this equipment is focused in the controls area, maintaining the seals and managing the residue waste of protein meal and oils after the cook cycle. The service supporting this option including high pressure steam will require close attention to state pressure vessel laws. By using a steam boiler on demand during a normal work cycle, may mitigate for not abiding to a 24X7 arrangement normally associated with high pressure steam. The ability of on site staff to operate the controls needs to be reviewed. It is anticipated that with contractor supplies training to the on-site staff additional expertise is not required. The seals of all open able pressure vessels require regular maintenance and inspection. This includes the chute closing lid and the shaft seals.

3.2.C. Digestion (Alkaline Hydrolysis)

This particular technology has been used chemically for many years but has been marketed and developed for waste management for the past five years. The digestion system combines an alkaline solution (50% NaOH) and heat to reduce animal, human and microbial tissue to a sterile aqueous solution. The total solids reduction is estimated at 97%. This sterile liquid (hydrolysate) comprises of an inorganic and metal concentration. The residual solids are captured in a straining basket and are primarily comprised of teeth and bone easily crushed into sterile bone meal (calcium phosphate powder). This technology is also effective in treating organic wastes that are filled with cytotoxics, formaldehyde and low level radioisotopes.

Advantages of Digestion

- The process has been effectively tested for biological sterilization capability against pathological wastes.
- There is a high degree of solids reduction (97%).
- The cost of processing is comparatively lower than other technologies.
- No air emissions.
- Has very few moving parts thus diminishing downtime.
- Can be considered for combining with other technologies such as the rendering equipment.

Disadvantages of Digestion

- Requires secondary support services such as steam boiler and cold room (required for most options).
- Requires elevation height access for top loading – if program floor is on grade, then the hydrolysis equipment floor room would be below grade causing possible pumping of residual hydrolysate fluids to sanitary systems.
- Has not been formally tested for prion management – however, various tests and studies to date indicate that alkaline hydrolysis combined with heat is effective for TSE/BSE (transmissible spongiform encephalopathy) control.
- Produces a high TSS, pH and BOD liquid slurry at end of cycle may require neutralization or additional treatment depending on local or state codes. (CO2, settlement pond, bioremediation, high pressure filtering, neutralization tank).

Facility Requirements
The facility requirements (space planning and service support) need to consider additional space for pumps, NaOH storage vessel, maintenance access and support. Because the system is designed as a containment pressure vessel and with the loading chute/lid integrally designed to the necropsy floor, the containment design needs of the equipment floor needs to considered and may be reduced based on a local risk assessment. The sealing of the lid is done with hydraulics and can be opened and closed in approximately one minute. The design of the flange seal of the lid to the floor would require a soft or flexible design to not negate the use of the load cells of the equipment.

Operational and Maintenance Issues
The need to store and receive liquid NaOH to treat the waste needs to be considered in addition to the volumes of water needed for each cycle. On all systems the ratio of tissue to water is by weight and is generally 40% tissue to 60% water. The NaOH is measured as 7.5% of the tissue weight which would be 15% of 50% NaOH solution to tissue ratio.

3.2.D. Reverse Polymerization

The technology uses microwave technology to heat waste up to such an extreme temperature that the only residue left is pure carbon ash.

Advantages and Disadvantages
The technology has been successfully validated against most biological pathogens, and is currently undergoing validation testing of TSE waste. Based on the temperatures required to reduce the products to a Carbon Ash, it is assumed that the tests for validation against prions and cytotoxics will be successful.

Facility Requirements
The system is completely customizable to any capacity desired.

Operational and Maintenance Issues
The technology has not yet been commercially implemented for solid waste disposal and thus there is limited information on maintenance. The unit operates mainly on electricity at a rate of approximately 1.7kWH per kg of waste processed.

3.2.E. Plasma Arc

Plasma technology is already widely used in the metallurgical processing and material synthesis industries. Its potential as a method of hazardous waste disposal has been recognized, and in recent years much research and development has been done on methods of processing waste by plasma heating. Plasma (sometimes referred to as the fourth state of matter) is a highly energized form of ionized gas that is capable of conducting electricity. Since the plasma itself acts as the resistive heating element, its arc is capable of maintaining temperatures of 1,000 – 10,000°C, thus creating a far more intense thermal environment than incineration or autoclaving. It is important to note that plasma treatment is not combustion process, but rather an alteration in the molecule characteristics of the treated material.

Advantages and Disadvantages
Although there is very little published information on the efficacy of this treatment, the chamber of the technology is maintained at a temperature far above that required to effectively destroy all biological pathogens, TSE waste, and cytotoxic waste.

Facility Requirements
The smallest plasma torch is capable of processing approximately 10,000Kg per day, in a 12 hour shift. This unit covers approximately 50 square meters of area, and would require a room approximately 225 square meters in area. And 7 meters high. Ventilation would be required for this space to mitigate and heat buildup. The plasma torch requires an electrical service to accommodate 300kW per torch.

Operational and Maintenance Issues
Little information is available on the operations and maintenance of the Plasma torch. It is fairly unique technology, and would assume to have a high learning curve, and as such maintenance would likely be costly. Each torch (electrode) has a life between 200 and 1,000 hours, and after which requires replacement. Estimated annual maintenance costs are over $400,000. Just like an incineration plant, a scrubber and afterburner are required to treat the gases before discharge into the atmosphere. Chemicals and water are required in a continuous process as part of the scrubbing process. Operating costs are almost directly associated with the cost of electricity.

3.2.F. Irradiation

A conceptual design study developed for a comparable animal disease center in Ottawa in the early 1980's suggested that an irradiation system using cobalt-60 as its energy source. This powerful gamma ray kills bacteria and other pathogens, without damaging the product. After the radiation ceases, the product is not left radioactive. This process is sometimes called "cold pasteurization." Cobalt-60 undergoes radioactive decay with the emission of beta particles and strong gamma radiation. Cobalt-60 ultimately decays to non-radioactive nickel and its half-life is 5.27 years and there are no know examples of this technology used in similar applications. Additional precautions as with all radioactive material would be necessary due to cancer-causing potential of its use. It was confirmed in the study it would be quite expensive to replace and discharge of the source material. The biggest obstacle to irradiation as an intervention is consumer acceptance.

Low-dose/low-penetration electron beam (E-Beam) irradiation has now evolved to the point where large non-uniform surface areas can be effectively treated, which allows whole carcasses to be treated after chilling. Gamma irradiation (e.g., 60 Co) can be used for the decontamination of heat-sensitive materials and is an effective means of decontaminating chemicals and solvents removed from a containment facility. The efficacy of the treatment technology depends on the penetration of the treated items by gamma irradiation and, therefore, on the density of the treated substance as well as the strength of the irradiation source (2).

Microwave irradiation is not widely used for decontamination in containment facilities. As in steam autoclaving, heat is the critical factor for eliminating viable microorganisms. The factors that affect microwave treatment include the frequency and wavelength of the irradiation, the duration of exposure and the moisture content of the material to be decontaminated(15,16).

Ultraviolet irradiation (UV) should not be relied upon as the sole method of decontamination for materials removed from containment facilities. UV has limited penetrating power and is primarily effective against unprotected microbes on exposed surfaces or in the air (1). It can be effective in reducing airborne and surface contamination provided that the lamps are properly cleaned, maintained and checked to ensure that the appropriate intensity is being emitted.

3.2.G. New/Combine Technologies

Combine NaOH and heat pressure rendering
There are two options to consider when combining sodium hydrolysis with heat pressure rendering. The first option has the two existing processes separated with two independent vessels with interconnections for fluids and solids transfer. The second option combines the two processes into a single vessel. By combining the sodium hydrolysis into a pressure rendering vessel, the time to complete the tissue digestion and sterilization is reduced because of the maceration qualities of the rotating shaft and paddles. Each tank can be used with sodium hydrolysis or without, thereby creating various options for the material destruction/treatment. The NaOH and liquid can be added at the loading chute.

Advantages and Disadvantages
Testing method and viruses used to test the sterilization systems. None, so far in direct comparison, but similar in design to all heat pressure rendering installations.

Facility Requirements
Requirements to house sterilization systems and maintain bio-containment barrier similar in design to combining the heat pressure rendering.

3.3. Recommendations

For the treatment and disposal of solid waste, the design team recommends a multi tiered approach. Incineration, High pressure rendering and chemical digestion should all be considered. These are all proven methodologies that are dependent on specific program needs and individual site requirements and restrictions. Several criteria will need to be evaluated including:

- Air emissions
- Liquid waste stream byproducts
- Requirement for prion deactivation
- Operational and maintenance support.

Based on ongoing program analysis it is advantageous to implement more than one type of solid waste treatment technologies which provides the following advantages:

- Provides most effective remediation and disposal of carcasses and solid waste.
- Provides best possible combination of current technologies to reduce waste to an acceptable treatable composition.
- Provides the most effective approach to decontaminate waste using these latest technologies.

Refer to the following pathological waste disposal comparison tables on the following page.

PATHOLOGICAL WASTE DISPOSAL OPTION

Technology	Operating Principles	Advantages	Disadvantages
Incineration	Carcass material is dropped into a fired primary chamber via a double-door chamber, followed by burning and passage to a secondary chamber for total combustion of solids, ash, and gases. Temperature levels in primary and secondary chamber are in the 800°C-1100°C (1472°F-2012°F) range, respectively	• Large reduction in volumes of waste • Complete sterilization and total inactivation of prions • High throughput • Large volume loading characteristic • Small nonhazardous residue to manage • Incinerator companies have many years of experience	• High initial and ongoing maintenance costs • Difficult to attain approval for new incinerators • Potential elevated toxic emissions • Difficult ash management system • Negative public image • Loading doors difficult to seal with changing temperature
Alkaline Hydrolysis	This technology patented by employs a strong alkali (sodium hydroxide [NaOH] or potassium hydroxide [KOH] pumped and recirculated inside a steam-jacketed pressure vessel. The temperature reaches approximately 150°C (302°F) during the digestion process, followed by a dilution and risining process, completed by removal of solids residue.	• Effectiveness in sterilizing infectious agents confirmed with biological test spores • Large volume reductions • Small friable bones and teeth all that remain • Comparatively low capital and maintenance costs • Designed as a pressure vessel with no release of infectious agents during cycle followed by a dilution and rinsing process, completed by removal of solids residue.	• Total environmental effects not known or tested • Hydrolyzate by-product high in total suspended solids (TSS) and biological and chemical oxygen demand (BOD/COD) and extremely high in pH • Hydrolyzate can create solids buildup in sewage system when temperature becomes ambient
Rendering	This technology employs a steam-jacketed pressure vessel with an internal (steam) heat exchange-rotating shaft with spokes and paddles. Temperature, time and pressure parameters are typically 140°C (284°F), 1-hr cook cycle (total cycle is approximately 3 hr), 65 psig internal pressure. Animal carcasses are top loaded, water is added. Vessel is closed and sealed before running a warm-up cycle, a cook cycle, and a drying cycle.	• Equipment used for many years in animal rendering industry. • Successfully tested for sterilization of infectious agents using in situ biological indicators • Loading chute is adjustable in size to accommodate whole carcasses. • Equipment can be housed in containable or noncontainable areas. • No hazardous emissions • Low initial and operating costs • Water is reduced during the process to produce a semisolid oily substance capable of being transported to landfill	• May not be effective against prions without chemicals or higher temperatures. • Reduction in volume waste comparatively higher at 55%-60% than previously stated incineration technology • Requires special construction monitoring for tolerance design of seals and shaft • Requires secondary service steam utility support • Depending on building elevations, equipment may create a minor challenge of removing residual solids from a lower below-grade floor.

PATHOLOGICAL WASTE DISPOSAL OPTION

Technology	Operating Principles	Advantages	Disadvantages
Reverse Polymerization	The technology uses microwave technology to heat waste up to such an extreme temperature that the only residue left is pure carbon ash.	• Successful against most biological pathogens • The system is completely customizable to any capacity desired	• not been commercially implemented for solid waste disposal
Plasma Arc	Plasma technology is already widely used in the metallurgical processing and material synthesis industries. Its potential as a method of hazardous waste disposal has been recognized, and in recent years much research and development has been done on methods of processing waste by plasma heating. Plasma (sometimes referred to as the fourth state of matter) is a highly energized form of ionized gas that is capable of conducting electricity. Since the plasma itself acts as the resistive heating element, its arc is capable of maintaining temperatures of 1,000 – 10,000°C, thus creating a far more intense thermal environment than incineration or autoclaving. It is important to note that plasma treatment is not combustion process, but rather an alteration in the molecule characteristics of the treated material.	• the chamber of the technology is maintained at a temperature far above that required to effectively destroy all biological pathogens, TSE waste, and cytotoxic waste.	• very little published information

PATHOLOGICAL WASTE DISPOSAL OPTION

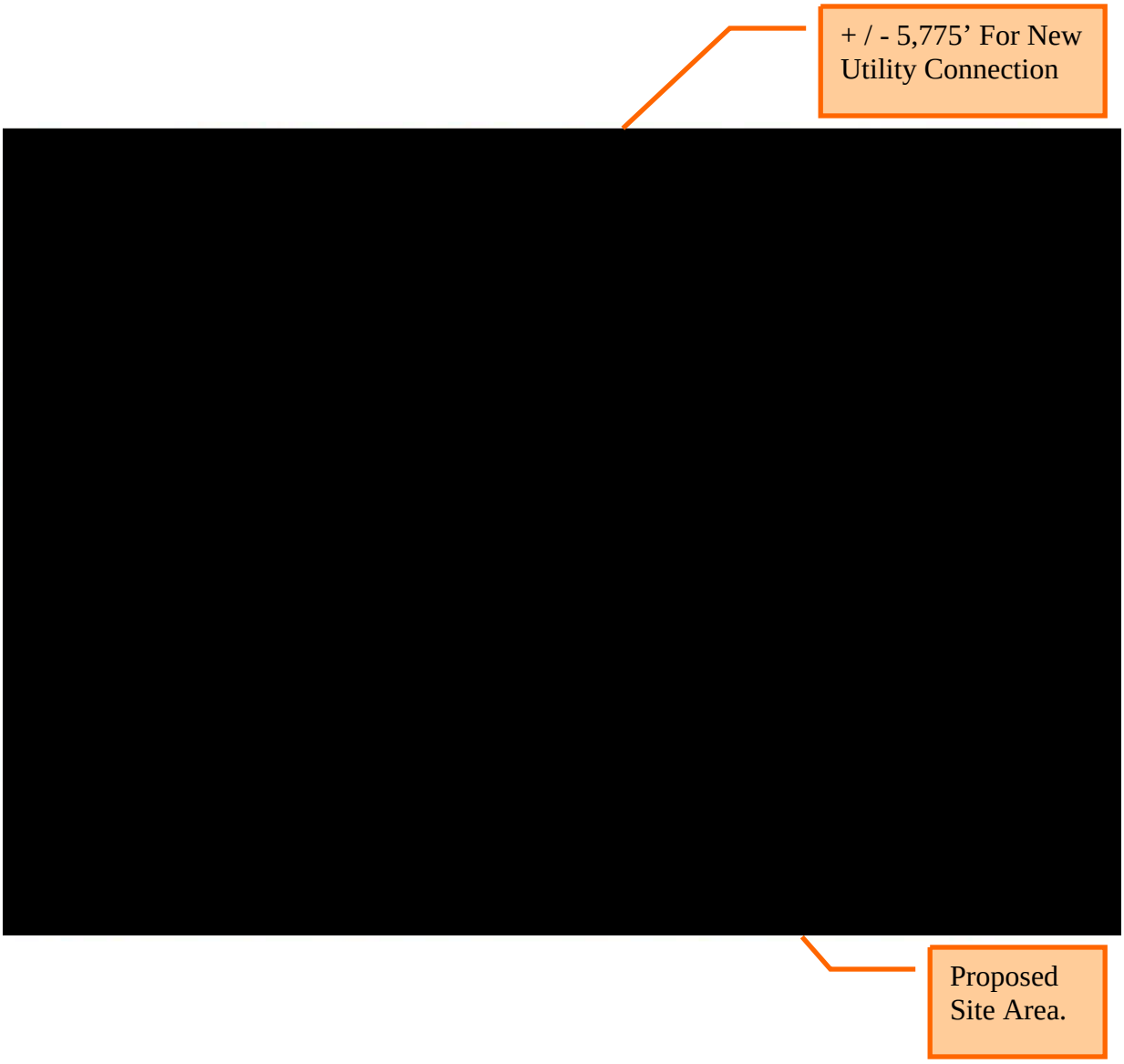
Technology	Operating Principles	Advantages	Disadvantages
Irradiation	A conceptual design study developed for a comparable animal disease center in Ottawa in the early 1980's suggested that an irradiation system using cobalt-60 as its energy source. This powerful gamma ray kills bacteria and other pathogens, without damaging the product. After the radiation ceases, the product is not left radioactive. This process is sometimes called "cold pasteurization." Cobalt-60 undergoes radioactive decay with the emission of beta particles and strong gamma radiation. Cobalt-60 ultimately decays to non-radioactive nickel and its half-life is 5.27 years and there are no know examples of this technology used in similar applications. Additional precautions as with all radioactive material would be necessary due to cancer-causing potential of its use. It was confirmed in the study it would be quite expensive to replace and discharge of the source material. The biggest obstacle to irradiation as an intervention is consumer acceptance.	• gamma ray kills bacteria and other pathogens	• consumer acceptance. • cancer-causing potential • quite expensive

Section 4: Site Concepts

4.1. Conceptual Site Diagrams

4.1 CONCEPTUAL SITE DIAGRAMS

4.1.1 Athens, GA



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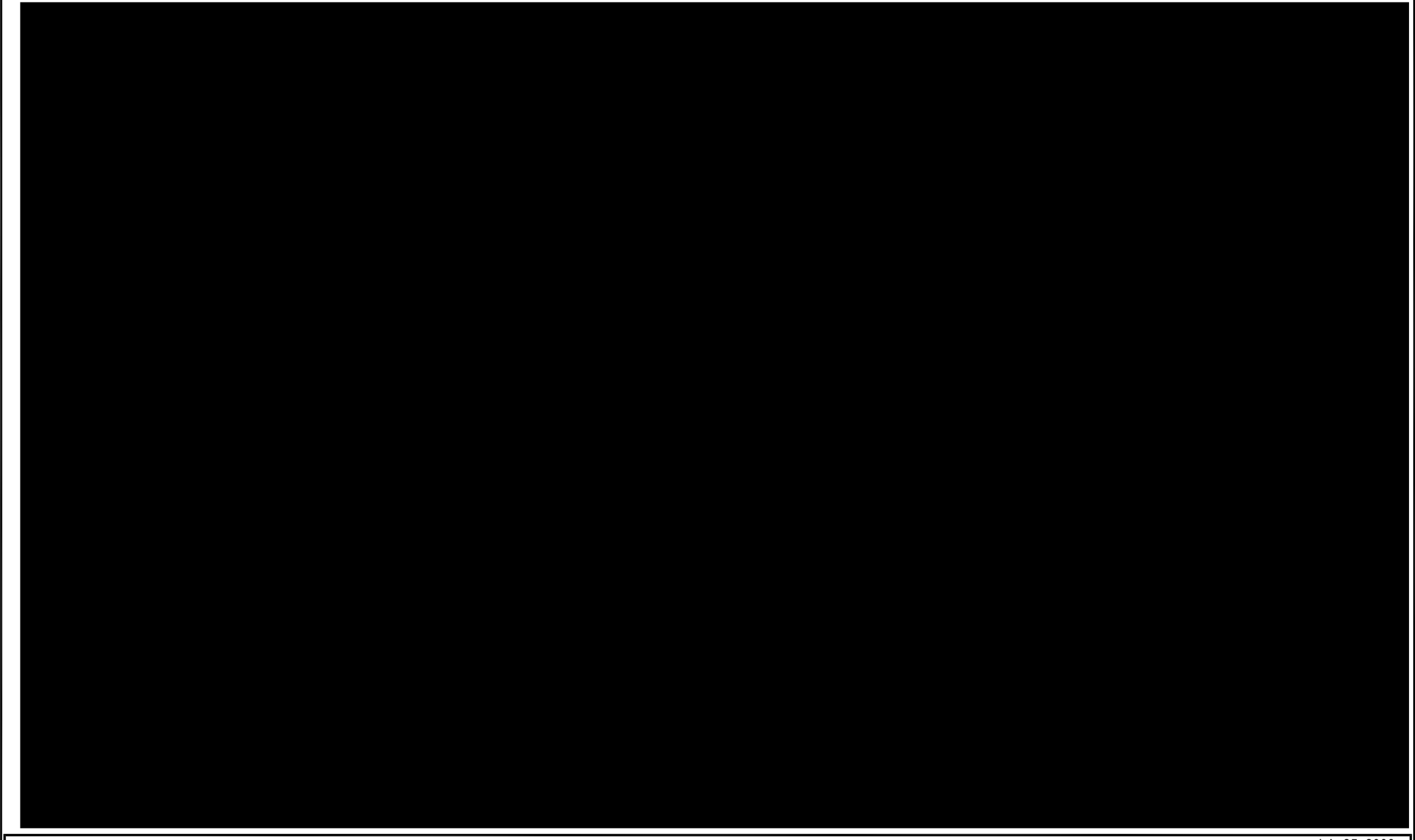

N D P
NBAF Design Partnership

PROPOSED GEORGIA SITE
SITE CONCEPT DIAGRAM

July 25, 2008
SCALE: 1" = 200'-0"

GRAPHIC SCALE — IN FEET
100 0 200 400 600 800

P:\Atlanta\800620.000_NBAF\DOCS\01.0-PredesignPlanProg\01.04-ReportOriginals\NBAF Site CAD Backgrounds\GA\GA_Prelim_Site 7-25-08.dwg

DRWN BY: DR CHKD BY: AGB JN: 1-07-0644 CN: GA_PRELIM_SITE 7-25-08 FN: 151-D-041

4.1.2 Manhattan, KS

Proposed Site Area.

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NBAF Design Partnership

PROPOSED KANSAS SITE
SITE CONCEPT DIAGRAM

July 25, 2008
SCALE: 1" = 200'-0"

GRAPHIC SCALE – IN FEET
50 0 100 200 300 400

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DRWN BY: DR CHKD BY: AGB JN: 1-07-0645 CN: KS_PRELIM_SITE 7-25-08 FN: 151-D-042

4.1.3 Flora, MS

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NBAF Design Partnership

PROPOSED MISSISSIPPI SITE SITE CONCEPT DIAGRAM

July 25, 2008
SCALE: 1" = 200'-0"

GRAPHIC SCALE – IN FEET
100 0 200 400 600 800

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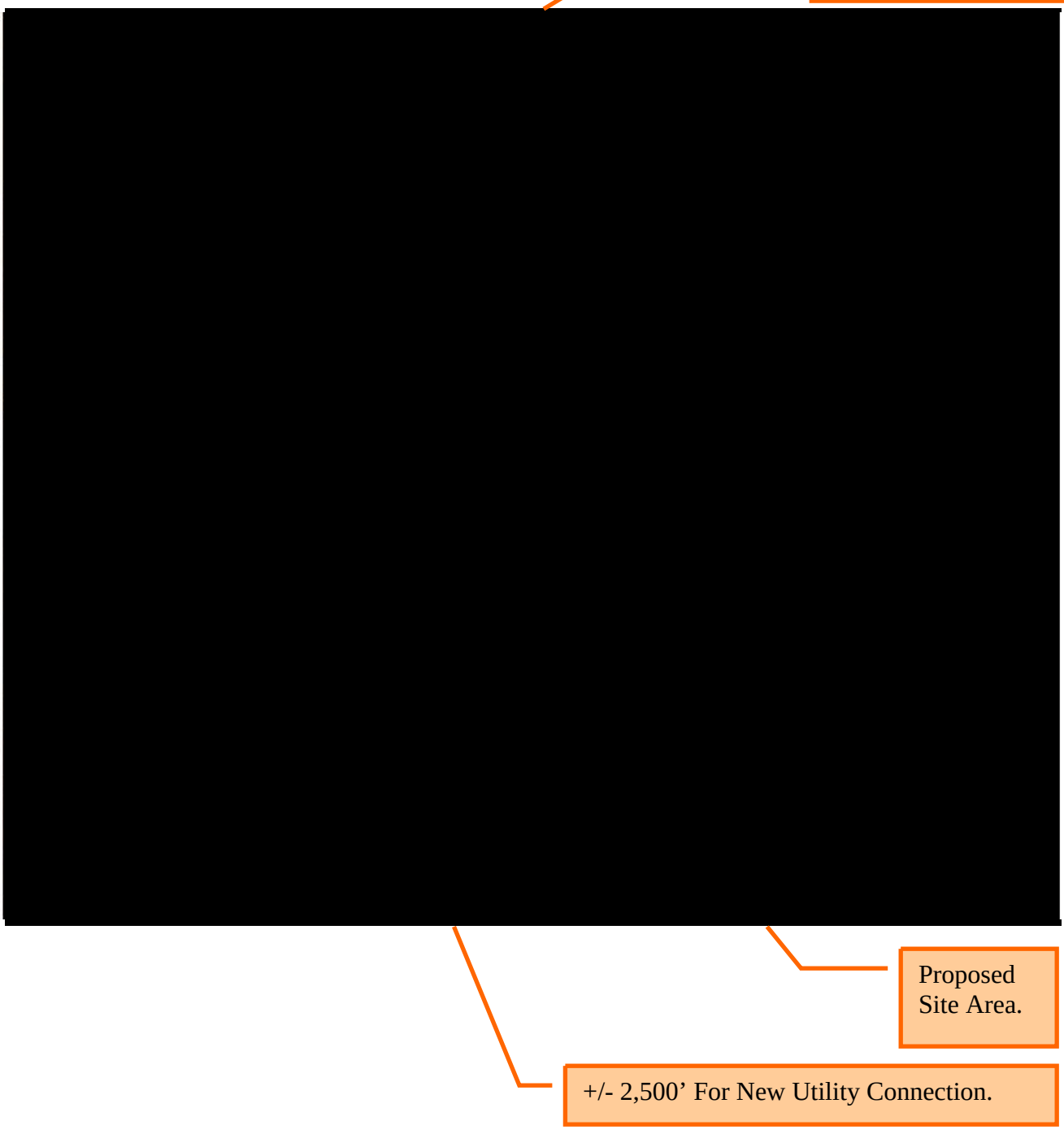
4.1.4 Butner, NC



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NBAF Design Partnership

PROPOSED
NORTH CAROLINA SITE
SITE CONCEPT DIAGRAM

July 25, 2008
SCALE: 1" = 200'-0"

GRAPHIC SCALE – IN FEET
100 0 200 400 600 800

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DRWN BY: DR CHKD BY: AGB JN: 1-07-0648 CN: NC_PRELIM_SITE 7-25-08 FN: 151-D-045

4.1.5 Plum Island, NY

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NBAF Design Partnership

PROPOSED
PLUM ISLAND SITE
SITE CONCEPT DIAGRAM

July 25, 2008
SCALE: 1" = 200'-0"

GRAPHIC SCALE — IN FEET

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DRWN BY: DR CHKD BY: AGB JN:1-07-0647 CN:NY_PRELIM_SITE 7-25-08 FN:151-D-044

4.1.6 San Antonio, TX

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NBAF Design Partnership

PROPOSED
TEXAS SITE
SITE CONCEPT DIAGRAM

July 25, 2008
SCALE: 1" = 200'-0"

GRAPHIC SCALE – IN FEET
100 0 200 400 600 800

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DRWN BY:DR CHKD BY:AGB JN:1-07-0649 CN:TX_PRELIM_SITE 7-25-08 FN:151-0-046

Section 5: Environmental Sustainability

5.1. Overall Building Design

Protect & Conserve Water - In addition to functional and aesthetic considerations, the landscape for the project should consider environmental benefits (stormwater management, foster habitat, build healthy soil). Primary function of stormwater management system is to clean and absorb a maximum amount of rainfall. Design common spaces to incorporate “rain gardens” and surface water courses as a feature of the landscape. Use primarily natives and native cultivar plant materials to minimize the need for irrigation and fertilization

Sustainable design involves a range of early strategic decisions that are evaluated against specific project requirements, goals and the project budget.

Section 6: Code Summary

6.1. General Codes and Standards
6.2. Code Analysis

5.1. OVERALL BUILDING DESIGN

In general, NBAF will comply with executive order 13423 "Strengthening Federal Environmental, Energy and Transportation Management". Executive order 13423 breaks sustainable design into the following categories:

- Integrated Design Principals – Integrated design & Commissioning.
- Optimize Energy Performance – Energy Efficiency & Measurement & Verification.
- Protect and Conserve Water – Indoor Water & Outdoor Water.
- Enhance Indoor Environmental Quality – Ventilation & Thermal Comfort, Moisture Control, Daylighting, Low-Emitting Material & Protect Indoor Air Quality during Construction.
- Reduce Environmental Impact of Materials – Recycled Content, Biobased Content, Construction Waste and Ozone Depleting Compounds.

As the first category in this list of sustainable design parameters it is crucial that once design commences that NBAF begin using a creative and collaborative design approach that realizes synergies between all disciplines. Foundational decisions are made in the early stages of the project which impact siting, orientation of the building, selection of resources and the design of efficient mechanical and electrical systems. These sustainability-oriented design choices result in a project that enhances the local environment, operates more efficiently, and improves indoor environmental conditions for building occupants.

The process of sustainable design is collaborative in nature, defined by client objectives, and results in thoughtful planning and design. While many sustainable design strategies such as landscape plant selections and the reduction of ozone depletion potential from refrigerants and chillers can be applied to any building type, laboratories also harbor a unique set of considerations in design such as ventilation strategies, process water use, and lab flexibility. Due to these unique requirements, laboratory planning would be a highly coordinated effort with NBAF representatives to accommodate user needs and projected requirements.

Initial review and evaluation to determine that each of the six sites can be designed to comply with executive order 13423 was done. The preliminary findings indicated that no significant site costs related to sustainable design is anticipated.

Energy - Some of the strategies that would be studied include run-around coil air heat recovery systems, variable fume hood exhaust during occupied hours, CO2 sensor-controlled OA ventilation for Admin AHU, various glazing types, high performance roofing, and low face velocity AHU's.

Daylighting - Through the use of advanced daylight and energy modeling programs, we are able to create laboratory spaces that are energy efficient and pleasant to occupy. A DOE2 energy study would reveal the effectiveness of energy-related sustainable design strategies and allow for informed decisions to be made with in regards to payback.

Materials & Resources - Recycled content and regional materials would be used whenever possible throughout the project. Interior finishes would consist of rapidly renewable materials where feasible and appropriate. All interior finishes would also be required to meet stringent indoor air quality standards for VOC emissions.

6.1. GENERAL CODES AND STANDARDS

The codes and standards that would apply to the design and construction of NBAF include the current adopted editions of the following codes at the time design commences along with any particular amendments required by the local jurisdiction:

GENERAL CODES

- International Building Code (2006 IBC)
- NFPA 101, Life Safety Code (2006 Edition).
- Energy Conservation Design Standard for New State Buildings (including major renovations), General Services Commission

STRUCTURAL CODES

The design and construction of structural systems for National Bio and Agro Defense Facility would conform to, but are not limited to, the following codes and standards:

- Minimum Design Loads for Buildings and Other Structures, ASCE / SEI 7-02, American Society of Civil Engineers.
- ISC Security Design Criteria for New Federal Office Buildings and Major Modernization Projects, dated October 31, 2003, The Interagency Security Committee.
- Unified Facilities Criteria (UFC), DoD Minimum Antiterrorism Standards for Buildings, dated October 8, 2003, Department of Defense.
- Building Code Requirements for Reinforced Concrete, ACI 318-02, American Concrete Institute.
- Manual of Steel Construction, Allowable Stress Design, Ninth Edition, American Institute of Steel Construction.
- Building Code Requirements for Masonry Structures, ACI 530-02, and Specifications for Masonry Structures, ACI 530.1-03, American Concrete Institute.

MECHANICAL CODES

- Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5th Edition, U.S. Department of Health and Human Services and Centers for Disease Control and Prevention (CDC).
- USDA ARS Facilities Design Standards, Manual 242.1, July 24, 2002.
- Guide for the Care and Use of Laboratory Animals, Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council, National Academy Press, Washington, D.C. Revised 1996
- National Fire Protection Association (NFPA) guidelines and standards including the following:
    - NFPA 30 - Flammable and Combustible Liquids Code.

  - NFPA 45 - Fire Protection for Laboratories Using Chemicals
  - NFPA 54 - National Fuel Gas Code
  - NFPA 90A - Standard for the Installation of Air conditioning and Ventilating Systems.
  - NFPA 101 - Life Safety Code
- ASHRAE Standard 15-1994 Safety Code for Mechanical Refrigeration
- ASHRAE Standard 62-2004 Ventilation for Acceptable Indoor Air Quality
- ASHRAE Standard 90.1-1999 Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASHRAE Standard 110-1985 Method of Testing Performance of Laboratory Fume Hoods
- NSF Standard 49 – Biosafety Cabinets
- Applicable Codes would be determined based on the selected site.

ELECTRICAL CODES

- Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5th Edition, U.S. Department of Health and Human Services and Centers for Disease Control and Prevention (CDC).
- USDA ARS Facilities Design Standards, Manual 242.1, July 24, 2002.
- Guide for the Care and Use of Laboratory Animals, Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council, National Academy Press, Washington, D.C. Revised 1996
- National Fire Protection Association (NFPA) guidelines and standards including the following:
  - NFPA 13 - Installation of Sprinkler Systems
  - NFPA 37 - Standards For The Installation Of Combustion Engine & Gas Turbines (2002)
  - NFPA 45 - Fire Protection for Laboratories Using Chemicals
  - NFPA 70 - National Electrical Code (2005)
  - NFPA 72 - National Fire Alarm Code (2005)
  - NFPA 101 - Life Safety Code (2003)
  - NFPA 110 - Standard for Emergency and Standby Power Systems
  - NFPA 780 - Lightning Protection Systems
- Illuminating Engineering Society of North America (IESNA) Lighting Handbook.
- ADA and ABA Accessibility Guidelines for Buildings and Facilities, July 23, 2004.

- EIA/TIA 568A Communication Building Telecommunications Standard
- EIA/TIA 69A Communication Building Standard For Telecommunications Pathways And Spaces.
- EIA/TIA 606 Administration Standard For Telecommunications Infrastructure Of Commercial Building
- UL Underwriters Laboratories

PIPING CODES

- Biosafety in Microbiological and Biomedical Laboratories, (current edition at time of design, presently 5th Edition), CDC/NIH Publication
- USDA ARS Facilities Design Standards, Manual 242.1, July 24, 2002.
- Guide for the Care and Use of Laboratory Animals, Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council, National Academy Press, Washington, D.C. Revised 1996
- UFAS Uniform Federal Accessibility Standards
- ANSI Z358.1 Emergency Eyewash and Shower Equipment, January 2004
- National Fire Protection Association (NFPA) guidelines and standards including the following:
    - NFPA-54 National Fuel Gas Code, 2006 Edition
    - NFPA 55, Standard for the Storage, Use, and Handling of Compressed and Liquefied Gasses, 2003 Edition
    - NFPA 99C Standard on Gas and Vacuum Systems (as applicable), 2000 Edition, relevant sections, National Fire Protection Association.
    - NFPA 30 - Flammable and Combustible Liquids Code.
    - NFPA-45 - Standard on Fire Protection for Laboratories Using Chemicals 2004 Edition
    - NFPA 13 - Standard for the Installation of Sprinkler Systems 2007 Edition
    - NFPA 14 - Standard for the Installation of Standpipe and Hose Systems 2007 Edition
    - NFPA 20 - Standard for the Installation of Stationary Pumps for Fire Protection 2007 Edition
    - NFPA 22 - Standard for Water Tanks for Private Fire Protection 2003 Edition
    - NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances 2007 Edition
    - NFPA 50 Standards for bulk cryogenic storage of gaseous liquids
- (PDI) Plumbing & Drainage Institute Standards

- ASSE – American Society of Sanitary Engineering
- Required local and adopted national plumbing and safety standards.

FEDERAL REGULATIONS

The following federal regulations are not building codes, but may impact the design, construction, and operation of the project:

- Federal Occupational Safety and Health Act of 1970 (OSHA)
- U.S. Environmental Protection Agency Regulations
- Americans with Disabilities Act, Accessibility Guidelines for Buildings and Facilities

6.1.1. Army Reference Manual

The primary reference source for NBAF's design would be the DoD's Unified Facilities Criteria (UFC) Installation. The design team would also utilize the Army's general guidelines for building design and implementing themes used in similar DoD facilities.

6.1.2. Department of Veterans Affairs Fire Protection Design Manual (Interstitial Spaces)

Specific code requirements for construction of Interstitial spaces is not defined in the additions of the International Building Codes or Unified Facilities Design Criteria thus the definition as listed in the Department of Veterans Affairs Fire Protection Manual Fourth Edition 11-05 paragraph 2, 2.2 would be referenced. By conforming to these requirements the floor of the interstitial spaces is not required to be rated construction therefore penetrations are not required to be rated assemblies.

6.1.3. General Noise Requirements

Noise criteria would be evaluated at the time the site is selected. The NBAF facility would conform to the requirements set forth by the governing jurisdiction for industrial and residential noise criteria if applicable.

6.1.4. Designing for High Winds

The basic wind speeds included under sections 2.5.1 represent the prescribed wind speeds as indicated in the ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, and the IBC 2006. As NBAF's design would meet the basic antiterrorism requirements these facilities would therefore exceed the prescribed basic wind speeds.

In the case of tornadoes, neither the IBC nor ASCE 7 requires buildings (including critical facilities) to be designed to resist tornado forces, nor are occupant shelters required in buildings located in tornado-prone regions. Constructing tornado-resistant critical facilities is extremely expensive because of the extremely high pressures and missile impact loads that tornadoes can generate. Therefore, when consideration is voluntarily given to tornado design, the emphasis is typically on occupant protection, which is achieved by "hardening" portions of a critical facility for use as safe havens.

6.2. CODE ANALYSIS

APPLICABLE CODES & REGULATIONS (List of Codes Used for this review)

2006 International Building Code w/ Amendments
2006 International Plumbing Code w/ Amendments
2006 International Mechanical Code
2006 International Fuel Gas Code excluding Chapter 1 - Administration w/ Amendments
2006 International Fire Code w/ Amendments
2006 NFPA 1 Uniform Fire Code w/ Amendments
2005 NEC National Electric Code (NFPA 70) w/ Amendments
2006 Life Safety Code (NFPA 101)
2000 International Energy Conservation Code Chapter 13, Ashrae/IES-93 based on ASHRAE/IES 90.1-1989 w/ Amendments
1996 ANSI A17.1, Safety Code for Elevators and Escalators
1996 NFPA 45, Fire Protection for Laboratories Using Chemicals
Americans with Disabilities Act (ADA)

	Category	IBC	IBC Requirement	NFPA	NFPA Requirement
1	Occupancy Classification	304.1	Group B - Business Occupancy (Offices & Laboratories)	6.1.11	New Business Occupancy. For requirements see chapter 38.
		Table 303.1.3	Assembly areas not considered sep if <750sf		
		Table 307.1.11	Battery Room at Penthouse for UPS backup.		
2	Construction Classification	602.2	Type IB	38.1.6	No min Const req.
3	Fire Sprinklers	903.2.10.1	Sprinklers Req'd	9.7.1.1	Sprinklers Req'd (NFPA 13)
4	Seismic Classification	1607	To be Determined by Site Selected.		
5	Height & Area Limitations	Table 503	Unlimited Area		No Requirements
			11 Stories 160' Height		
6	Fire Protection Requirements	Table 601 Type I-B	Cols/More than 1 Floor-2hr		No Requirements
			Columns/1 Floor Only-2hr		
			Columns/Roof Only-1hr		
			Beams/Floor Only-2hr		
			Floors-Floor/Ceiling-2hr		
			Roofs-Roof/Ceiling-1hr		

		Table 602	Max area of extr wall openings based on property setback > 30 ft = No Limit; 25-30 ft = 70%; 20-25 ft = 45%		
		Table 601	Exterior Nonbearing Walls-See Table 602		
		707.4	Shafts-Same as Flr Rating-2hr.		
		1020.1	Vertical Exit Enclosures-Not less than 2hrs (4 stories or more. 1hr if less than 4 stories.		
7	High Rise Provisions	403	Not Req'd < 75 Ft to Highest Occ Floor (44 Ft).		
8	Occupancy Separations	Table 508.2	If sprink- reduce ratings 1 hour.		
		Table 508.3.3	Battery Rm at Penthouse-1 Hr.		
9	Exit Access Corridors	Table 1017.1	Group B - no rating req'd if sprinklered - smoke detectors req'd in return air to shut down mech systems in corridor ceilings (1017.4.1.3)	38.3.6.1 Exc. 3	Sprinklered - No rating req'd
10	Openings B/W Levels	707.2 Exc. 7	2 stories max if not as part of req'd means of egress	8.6.6	See Section 8.6.6 for requirements.
11	Occ Load	Table 1004.1.1	Business Areas - 100 GSF	Table A-7.3.1.2	Business - 100 GSF
			Assembly - 15 NSF (Unconcentrated)		Assembly - 15 NSF (w/o fixed seats)
			Storage, Mech Eq Rm-300 GSF		Storage - 300 GSF
12	Exit Width	Table 1005.1	Level - 0.15"/Occ (Sprinklered)	7.3.3.1	Level - 0.2"/Occ.
			Stairs - 0.2"/Occ (Sprinklered)		Stairs - 0.3"/Occ.
13	Arrangement of Exits	1015.2.1 Exc. 2	1/3 diagonal	7.5.1.3.3	1/3 diagonal
14	Number of Exit Paths	Table 1019.1	2 Stairs<500 Occ	7.4.1.2	2 Stairs<500 Occ
			3 Stairs 500-1000 Occ		3 Stairs 500-1000 Occ
			4 Stairs >1000 Occ		4 Stairs >1000 Occ
15	Travel Distance	Table 1016.1	Group B - 300 Ft. (Sprinklered)	38.2.6	300 Ft. (Sprinklered)

16	Dead End Corr.	1017.3 Exc. 2	50 Ft. (Sprinklered)	38.2.5.2	50 Ft. (Sprinklered)
17	Common Path	1014.3 Exc. 1	100 Ft. (Sprinklered)	38.2.5.3 Exc.1	100 Ft. (Sprinklered)
18	Corridors	1017.2 Exc. 2	Min. Width - 44" 36" if occ. Load < 50	7.3.4.1	Min. Width - 36"
19	Exit Door Size	1008.1.1	32" Min. Clear/48" Max. Door Width	7.2.1.2 .4	32" Min. Clear
20	Min. Headroom	1003.2	7'-6" Min	7.1.5	7'-6" Min.
		1003.3.1	Ceiling Projection - 6'-8" (80") Min Clr		Ceiling Projection - 6'-8" Min
		1009.2	Stairs - 6'-8" (80") Min Clr	7.1.5.3	Stairs - 6'-8" (80") Min Clr
21	Roof Access	1009.11	Stair Req'd > 4 stories		
22	Stairs & Handrails	1009.1 Exc. 1	Min Width 44" (36" Occ Load<50)	7.2.2.2 .1.2.A	< 2000 persons 44" Min Width ≥ 2000 persons 56" (36" Occ Load<50)
		1009.3	Min. Tread Depth - 11"	7.2.2.2 .1.2	11"
			Max Riser (2R + T = 24" - 25") - 7"	7.2.2.2 .1.1.A	7"
			Min. Riser Height - 4"	7.2.2.2 .1.1.A	4"
		1009.6	Max Vert rise b/w landings - 12'-0"	7.2.2.2 .1.1.A	12'-0"
		1012.2	Handrail Height - 34"-38"	7.2.2.4 .4.1	34"-38"
		1012.2	Max. Dist b/w Handrails - 60"	7.2.2.4 .1.1	60"
		1012.3	Handrail Diameter - 1-1/4" - 2"	7.2.2.4 .4.6	1-1/4" - 2"
		1012.6	Clear Space to Wall - 1-1/2"	7.2.2.4 .4.5	2-1/4"
23	Guardrails	1013.2 & 1012.3	42" high, reject 4" sphere up to 34"	7.2.2.4 .5.3	42" high, reject 4" sphere up to 34"
24	Standpipe Requirements	905.3.1	Class III system req'd if highest floor > 30 Ft.	9.7.4.2	Not req'd, but if provided, comply with NFPA 14
		Exc. 1	Class I standpipe is permitted w/ Automatic Sprinkler System.		
		905.4	Hose Connection at each floor level at each stair & on each side of horizontal exit.		
25	Interior Finish	Table 803.5	Exit Enclosures- Class B (Flame Spread 26-75)	38.3.3.2.1 & 10.2.8.	Exit Enclosures- Class C (Flame Spread 76-200)

				1	
			Corridors- Class C (Flame Spread 76-200)		
			Rooms & Enclosed Spaces - Class C (Flame Spread 76-200)	10.2.8.1 & 38.3.3.2.2	Rooms & Enclosed Spaces - Class C (Flame Spread 76-200)
		8.4.4.1	Floor Finish - Critical Radiant Flux Class II	7.1.4.2.1 & 10.2.8.2	Class II
26	Fire Alarm Systems	907.2	Req'd per NFPA 72	9.6.2	Req'd per 7-6
		907.2.2 Ex.	Manual pull stations not req'd if fire sprk & alarms activate upon sprk flow		
27	Elevators	3002.4	In bldgs. > 4 stories, stretcher access req,d to one elevator serving all floors (24" X 84"stretcher)	9.4.1	Shall not be considered a component in a required means of egress but shall be permitted as a component in an accessible means of egress.
		3004.1	Vent req'd if elev serves > 3 stories		
		3004.3	Hoistway Vents = 3 SF/car or 3.5% hoistawat area		
28	Pressurized Stairs	1020.1.7 & 1020.1.7.1	Req'd if highest flr > 75 Ft		
29	Fire Extinguishers			9.7.4.1 NFPA 10 & 38.3.5	Provided per (NFPA 10) 75' travel distance max
30	Exterior Wall/ Fire Distance	Table 602	5 ft - 30 ft - 1 Hr; > 30 ft - 0 Hr		
31	Laboratories			8.7.4.1	Comply with NFPA 45

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