Sustainable Building Practices Used for The Aerospace Corporation East Coast Corporate Campus

The new campus will enable Aerospace to improve support to our customers. We currently have employees working in several buildings in Chantilly; the new campus will bring them together and make them more accessible to our customers.

-Dr. Wanda Austin, President and CEO, Aerospace

Background

For more than 50 years, The Aerospace Corporation has been dedicated to providing critical solutions for complex systems in space. Aerospace provides expertise for military, civil, and commercial customers in all fields and disciplines of research, architecture, engineering, design, development, acquisition, operations, and program management for space and related systems.

Aerospace has offices located across the United States. Aerospace leased spaces in the Northern Virginia area to provide services to the National Reconnaissance Office (NRO), one of its larger clients on the east coast. This arrangement had Aerospace staff located in multiple office buildings in Chantilly, near the NRO.

Aerospace required enhancements and modifications to the leased spaces over the years as a result of complying with federal security standards and meeting emerging technical requirements. Analysis of real estate needs led senior management at Aerospace to conclude that owning a building would have several long-term advantages such as:

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- Owned buildings cost less over time.
- Owned buildings are corporate assets.
- Fixed mortgages have stable pricing unlike lease costs, which tend to increase annually.
- Future building improvements would benefit Aerospace, not the landlord.
- Acquisition of a new building with a high degree of energy efficiency would lead to long term operational savings.

Beyond cost benefits, the need for a modern data center to serve customer and corporate needs had been a growing need at Aerospace. Senior management at Aerospace also was convinced that consolidating a dispersed workforce would lead to greater collaboration and productivity, thus putting Aerospace in a position to better serve its clients.

A further benefit of moving to a new campus was the opportunity to enhance Aerospace’s visibility in the region. Rather than being located prominently near a major highway or thoroughfare, the leased spaces were set back from VA-28 and nestled deeper in the neighborhood.

As a result of the above considerations, Aerospace made the decision to purchase land in Chantilly for the construction of a new Aerospace corporate campus on the East Coast.

**Program Requirements**

The primary program consisted of secure and unsecure office space, conferencing facilities, secure and unsecure meeting rooms, collaboration spaces, fitness center and a kitchen. Some of the features that the project incorporated are:

- A visual tie to the NRO
- Appropriate secure areas and laboratory space
- Set-back of 82 feet from major roads for inhabited buildings and controlled perimeter area.
- Effective, but unobtrusive, security arrangements to avoid the appearance of a fortress, this included the treatment of gates and fences
- Surface and structured parking
- Individual buildings that work in harmony to connect with the NRO, yet establish a sense of identity for Aerospace

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2 See Appendix A for a more detailed description of Aerospace’s design criteria.
• A distinctive roof line
• Interior spaces with 9’-0” of floor to ceiling height
• Closed offices for a majority of the office spaces
• Collaborative workplace to promote employee well-being and retention
• The outdoor feel of the West Coast campus within the limitations of the East Coast climate
• A natural setting of the site, its streams, and forests utilized to create outdoor areas that are celebrated and connected to the buildings
• Plazas, which include seating and outdoor dining areas, with planter walls that incorporate additional seating
• Major plazas to create outdoor rooms as spaces between buildings
• Landscape design to reinforce the architectural design objectives, soften views of parking areas, and screen mechanical yards
• A Visitor Center, with an underground tunnel to provide connection between initial phase and future phase of the site

Corporate Identity

The design of the campus and the building had to represent Aerospace’s corporate values:

• Dedication to Mission Success
• Technical Excellence
• Commitment to Our People
• Objectivity
• Integrity

Aerospace has also fostered a culture of fiscal responsibility and all decisions for this project were evaluated from a cost-benefit standpoint.

Data Load Requirements

The inclusion of a data center and secure areas on this project led to additional technological and systems requirements:

• High reliability mechanical and electrical infrastructure
• Sophisticated air-flow schemes utilizing hot/cold aisle isolation designed with advanced CFD modeling of critical spaces

3 Provided by CH2M Hill
• High Performance Compute (HPC) capacity to support technical computing applications
• Power and cooling infrastructure for high performance cabinets (20kW)
• Dedicated information technology (IT) spaces for Network Operation Centers (NOCs), test and setup, and network communications
• Redundant power and cooling for the extended IT communication rooms assuring up-time for the entire IT network
• Dedicated offices for the Enterprise Information Systems (EIS) team monitoring and maintaining the critical IT network and supporting infrastructure
• Energy efficient mechanical chiller plant utilizing elevated chilled water temperatures and an advanced air-side economizer chiller plant that will be able to operate without mechanical cooling for significant hours of the year.

Some of our LEED buildings consume more energy than the other non-LEED buildings; we want to design a high-performance, energy-efficient building, and not pursue LEED simply because everyone else is doing it.

-Daniel Barbee, General Manager of Facilities at Aerospace

Do we use LEED\(^4\) or not?

During the design process, energy-efficiency, high-performance and sustainability were the main considerations. Pursuing LEED certification was not a requirement just for the sake of getting a certificate. Subsequently, Fairfax County’s approval conditions made it a county requirement with a monetary penalty if certification was not obtained. Aerospace chose each LEED point rationally and was prepared to pay the penalty if the building became inefficient simply due to a pursuit of LEED points.

The Data Center was part of the building and because of its energy consumption\(^5\) the building was not a single-use office building, nor was it a single-use data center. This factor made the process of comparing this building to a standard office building base model difficult. When initially included in the scope of the project, it was thought that the Data Center would have to provide a capacity of 7 megawatts. At that time,

\(^4\) LEED, or Leadership in Energy and Environmental Design, is a program that provides independent, third-party verification that a building, home or community was designed and built using strategies aimed at achieving high performance in key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. LEED certification is awarded to projects that have provided documentation of compliance with the requirements of the relevant LEED rating system developed by the U.S. Green Building Council.

\(^5\) See Appendix B.
Aerospace commissioned a study on the added cost of pursuing LEED certification with the inclusion of the Data Center. Based on the study, Aerospace concluded that it would be more cost effective to pay the County fine than to modify the project to meet LEED requirements.

In the end, Aerospace opted to design the East Coast Data Center in such a way that it would work in tandem with its West Coast facility. This change allowed the Data Center capacity to be dropped down to 3.6 megawatts thus making LEED certification more feasible within the project budget.

_When you see the NRO, and you see Aerospace going up, you know that they are both playing a leading role in the development of our national security and our technologies._

-Michael Frey, Member of the Fairfax County Board of Supervisors

**The Site**

The location of the leased facilities so close to the NRO had allowed the exchange of technical information and communication between Aerospace and its customer. The proximity of the two organizations also led to reduced transportation costs and carbon emissions. Maintaining these benefits was of great importance to Aerospace. Proximity to the NRO was a driving factor in the selection of the site for the building.

Aerospace purchased over 40 acres of available land on a site adjacent to the southern perimeter of the NRO headquarters in Chantilly, Virginia. This area, known as Parcel-35 in the Westfields Business Park, is west of Sully Road (VA-28), on the southeast quadrant of the intersection of Stonecroft Boulevard and Lee Road.

The site was bordered by undisturbed wooded forest to the east and southeast. The topography of the land was such that on the east side was an established stream (Flatlick Branch), and running west to east was an intermittent stream that divided the northern and the southern areas. This configuration created northern and southern lobes that had to be connected to create a cohesive campus. A major portion on the west side of the site was undevelopable due to the inclusion of a wetlands preservation area.

Also of relevance was the fact that the governing zoning ordinance capped building heights at a level below that desired by Aerospace. However a special zoning exception was granted to the project that allowed additional building height. The county granted

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6 See Appendix C for a map of the site and surrounding area.
Aerospace the right to more than double the height of the buildings in exchange for various site and building enhancements. The most notable of these was a provision for stream restoration.

_Environmental responsibility has been a factor in every decision we’ve made on this project, from concept through design. We have worked very hard to minimize the impact of the project on the environment and protect the surrounding preserve._  

- Daniel Barbee, General Manager of Facilities at Aerospace

**The Master Plan and Building Massing**

The project was an integrated campus of several buildings. The buildings created an environment that reflects and reinforces Aerospace’s corporate identity and provides an attractive and welcoming environment for their employees and clients.

The placement of the buildings on the plan responded to the program and site conditions. The garages are placed adjacent to the road and act as a buffer between the buildings and the roads; this arrangement was driven by security requirements. The buildings are placed as far away from the street as possible to comply with force protection standards. The buildings are closest to the land area associated with Flatlick Branch and thus take advantage of the Preserve.

The master plan proposed two buildings for Phase I and two buildings for the future phase. Phase I of the project consisted of two Class “A” office/research buildings and incorporated the secure areas and laboratory space. The buildings on the entire site range from 7 to 10 stories and thus are visible from Route 28 to the east of the site. As the majority of the buildings in the immediate area were five to six stories, the Aerospace buildings are prominent by comparison.

The design took advantage of the topography of the site by building the first and second levels of the development (cellar) into grade. The plaza between the buildings is large enough to create space for gathering and contemplation, true to creating a campus environment.

A tunnel was incorporated to connect the concourse levels (cellar space) from phase one to future phase and is located below the road between the two phases. All along the length of the tunnel is a glass wall that opens out to the restored stream and green areas.
The buildings are composed of intersecting volumes, with horizontal bands of glazing contrasting with spandrel panels that form the main mass of the buildings. The penthouse screen walls and fin intersect with the main mass of the buildings thus creating a prominent and distinctive roof line. It was decided to use metal on the skin in a silver color to tie it to the technological shape of the buildings, and for performance reasons as the buildings needed to be designed as a fifty-year facility.

Sustainable Features

Sustainable Sites

Erosion and Sedimentation Control - Soil composition for the project site was analyzed in detail to uncover potential site problems and develop mitigation strategies. The Erosion Control Plan (ECP) created by the civil engineering firm of Burgess and Niple compared the projected post-development stormwater runoff conditions with the predevelopment conditions. Temporary and permanent erosion control and stormwater control measures were implemented on the site. The type and frequency of maintenance activities for the control measures were defined in the ECP. The following are salient features of the ECP:

- Temporary Seeding
- Permanent Seeding
- Mulching
- Stabilizing Temporary Wall
- Silt Fence
- Sediment Trap
- Sediment Basin

Alternative Transportation – In order to reduce pollution and other negative environmental impacts associated with automobile usage, Aerospace included several design elements that encourage the use of alternative modes of transportation. To accommodate cyclists, bike racks, showers and locker rooms were incorporated into the building design. Bus shelters were included in the master plan to allow mass transit service directly to the site. In addition, some of the parking spaces are designated for use by low-emitting and fuel-efficient vehicles.
Reduced Site Disturbance – The major ecological features of the site were identified and assessed including site geology, hydrology, vegetation, wildlife and prior site history. As a result of this analysis, the property on eastern side of the campus was protected from development. It included oak hickory forests and a portion of a restored stream. Construction occurred in several phases. The site was prepared in advance to create adequate stream restoration. No construction equipment was placed on the preserved areas to ensure complete protection of the wetland area. The “site phase” allowed site development separate from initial construction.

A stream restoration plan was implemented for approximately 800 linear feet of the unnamed tributary that ran west to east and connected to Flatlick Branch. The restoration design consisted of modifications to the existing channel dimension, pattern and profile, a reinforced bed, and numerous native plantings to improve the existing riparian corridor. The master plan created a campus that bridged over the stream via a pedestrian tunnel and more than half the land was dedicated as a Resource Protection Area and remained green.

Many features of the site are oriented towards this protected area. The tunnel that connects the Visitor Center to the towers hugs the edge of the protected area and provides direct views to the restored stream. At the plaza level, there are two platforms which extend towards the wooded area giving the site user elevated views into the surrounding landscape. This visibility provides an outdoor experience even for occupants who are primarily in an indoor environment.

Stormwater Management – Rain gardens were utilized to divert stormwater and prevent the disruption and pollution of natural water flows. Stormwater runoff from the top floor of the garage was directed into two rain gardens which have a total area of 11,275 square feet. The rain gardens help to filter pollution from the runoff of the parking garages. Additionally, they help to slow down the water as it enters the stormwater sewer system. The rain garden is planted with native plants which will provide habitat for beneficial insects and birds. Additionally, the gardens provide a visually interesting landscape that changes seasonally.

Heat Island Effect – Developed areas tend to create large thermal differentials with the surrounding undeveloped environment. These differences in temperature can have a negative impact on wildlife and local ecosystems. For this reason, the master plan

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7 Recognized with Fairfax County Tree Conservation Award for Outstanding Commitment to Tree Planting and Tree Preservation
8 See Appendix D for Aerospace Stream Restoration Case Study.
minimized building footprints, incorporated underground parking and kept impervious surfaces to a minimum where possible. The Visitor Center building is positioned directly above the restored stream and provides a dramatic view of the restoration. The program area of the building is below grade to minimize the impact of development on the site, the roof of the Visitor Center is a 3,000 square foot green roof and an over 800 square foot green wall. The green roof helps to capture stormwater that would otherwise runoff into the storm drain pipes. The soil depth on the greenroof is an average of 18” deep, which retains up to 90% of the precipitation that falls on it. The green roof will also prolong the life of the waterproofing membrane and roof system by protecting it from ultraviolet sunlight. In addition the roof provides added insulation to the building, helping to decrease energy demands. The greenwall on the south façade of the building provides additional insulation to the building. The planting used there also creates a unique landscape that helps to integrate the building into the surrounding natural environment.

**Water Efficiency**

**Water Efficient Landscaping** – Aerospace focused on native plant species and plants with modest watering requirements to reduce the need for irrigation. Along the street frontage, native trees and shrubs provide a framework for the edge of the property. A native meadow mix is used for the understory planting along the portion that borders the perimeter fence. This meadow mix provides a habitat for birds, insects, and other animals. This choice also helps to minimize carbon emissions caused by mowing. One hour of mowing emits emissions equivalent to driving a car for 650 miles. The meadow will require trimming only once or twice a year. Additionally the meadow can thrive on only 1/2” of water every other week and requires much less fertilizer than a traditional lawn. Within the campus space, planting beds filled with native shrubs, perennials, and ornamental grasses were favored over lawns in order to minimize mowing, fertilizing and watering needs. Additionally these planting beds provide seasonal variation that traditional lawns do not.

**Water Use Reduction** – The project team sought to conserve potable water throughout the buildings by utilizing a combination of fixtures that required as little municipal water as possible while still meeting Aerospace’s needs. The primary focus was on high-efficiency bathrooms, as those areas tend to present the greatest opportunities for reducing water usage. The Energy Policy Act (EPAct) of 1992, and as amended was promulgated by the U.S. Government and addresses energy and water use in commercial, institutional and residential facilities. The potable water needs for the project are estimated using EPAct numbers as a baseline for plumbing fixtures.
Through the use of high efficiency plumbing fixtures, the building is calculated to use 40 percent less water than a building using standard fixtures. The calculations are based on estimated occupant usage and include the following fixtures: water closets, urinals, lavatory faucets, showers and kitchen sinks.

**Energy and Atmosphere**

*I want to review every light fixture to make sure that it is easy to maintain and highly energy efficient.*

- Daniel Barbee, General Manager of Facilities at Aerospace

**Fundamental Building Systems Commissioning** – A key tool in implementing facility changes is frequent communication with the future occupants. Information was distributed on a regular basis about changing office sizes, facility amenities and other project details. The Facilities team had recent experience building out Aerospace offices in Colorado and California. Lessons specific to the Aerospace program were learned on those prior projects. By sharing that information with the design team, Aerospace was able to avoid facing similar challenges on the East Coast Campus project. This ongoing exchange was an essential element in the creation of a truly sustainable office environment. Optimal building efficiency is achieved when building systems meet occupant requirements, when all systems work together rather than conflict with one another, and when facilities management is prepared to operate and maintain the systems so that they continue to function as intended in the long term.

Building Information Modeling (BIM) was used throughout the project from design to construction to analyze the building systems, their ability to operate simultaneously, and future maintenance accessibility. This tool facilitated trade coordination among architectural, MEP, security, and data center consultant models. Early modeling with BIM saved time and effort in construction by identifying potential conflicts at an early stage. Long term operating projections were also developed from the model and the systems data was made available to the facilities operations and management team.

Daniel Barbee, General Manager of Facilities at Aerospace, reviewed all options from an operations and management perspective in his decision making process. Decisions were made by considering efficiency and cost effectiveness both at present and in the future. The project team often met with Aerospace maintenance staff to evaluate product performance at other sites before approving final system elements. Every appliance, lamp, building element, maintenance item and fixture was reviewed.
Sustainable Building Practices Used for The Aerospace Corporation East Coast Corporate Campus

and elected by the facilities team and owner representatives. This process was used through all design phases and construction so that the original owner intent would not be lost in the event of late design changes.

Post-occupancy evaluations of the building systems were scheduled and modeled to verify performance at the prescribed levels. A training plan was also devised to provide building engineers with the information necessary to run and maintain the systems and assemblies effectively and efficiently.

**Minimum Energy Performance** – The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), in conjunction with the Illuminating Engineering Society of North America (IES), has developed an energy standard for buildings: ASHRAE/IESNA 90.1-2004. This standard outlines baseline requirements for building system performance to reduce energy consumption and negative impacts on the environment. The mechanical, electrical and plumbing systems; building envelope; and lighting for the Aerospace project were all designed in compliance with ASHRAE/IESNA 90.1-2004.

**CFC Reduction in HVAC&R Equipment** – It is well-documented that chlorofluorocarbons (CFCs) lead to a breakdown of the earth’s ozone layer. These holes in the ozone can cause numerous health problems and other adverse effects on the environment. To prevent these negative impacts, no heating, ventilation, air conditioning and refrigeration (HVAC&R) systems using CFC-based refrigerants were specified for the Aerospace facilities.

**Optimize Energy Performance** - The building envelope, HVAC, lighting and other systems were designed to significantly improve the building energy performance when compared to a minimally code compliant building. However, the Data Center component of the project has such a high energy load that all of the other building systems (lighting, glazing, insulation, etc.) had to be of exceptionally high performance in order to achieve the 14-percent energy cost savings improvement over the code minimum baseline building. The garage lighting system design, for example, reduces energy usage by utilizing LED light fixtures instead of more conventional fluorescent light fixtures. Based on reductions in lighting power density throughout the project, the projected energy consumption of the lighting systems alone was reduced by 13-percent. Similarly, the building envelope was designed with high performance glazing and enhanced exterior wall and roof insulation. HVAC system enhancements include a water-side economizer on the central chilled water system, a heat recovery chiller to provide the first step in domestic hot water generation and HVAC preheat during building occupied hours, a total energy recovery wheel to precondition the office tower.
outdoor air, and the use of low-temperature supply air to reduce fan horsepower requirements. These design enhancements, along with other energy efficient design characteristics of the building and building systems, allowed the building to achieve the targeted 14-percent energy cost savings goal.

The Data Center space is buried below the building in a basement area. This was done to limit the amount of land used for the building. This space creates 3.6 megawatts of new mission critical information technology (IT) capacity in the east coast campus. The new east coast facility acts in tandem with the west coast facility to provide much needed, additional IT capacity and capability to Aerospace. Rather than expanding the west coast campus to meet capacity demands, these new IT systems in Chantilly, Virginia improve overall system resilience and allow for the retirement of much less efficient data center systems in the nearby leased office buildings.

**Ozone Protection** – Fire extinguishing technology often utilizes substances that lead to a degradation of the earth’s ozone. Halons are example of these substances and have been shown to be highly detrimental to the earth’s stratosphere. Fire suppression systems that include halons were not used on this project.

**Green Power** – To reduce pollution created through energy generation, Aerospace pursued a contract with Sterling Planet to acquire a portion of its energy from renewable sources.9

**Materials and Resources**

**Storage and Collection of Recyclables** – In order to reduce the amount of waste sent to landfills, recycling areas were designated on the Aerospace campus. These areas include receptacles for paper, corrugated cardboard, glass, plastics and metals to be collected for recycling. The installation of a destroyed document briquetter further contributes to the efficient removal of paper waste, by transforming discarded documents into compacted bricks for easy transport.

**Construction Waste Management** – A waste management plan was implemented during construction to divert recyclables and reusable materials. A goal of diverting over 75% of construction waste materials from landfills to productive reuse opportunities was established. Construction run-off was also filtered to keep pollutants

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9 At the time this report was prepared, the proposal to buy Green Power was still pending, as this action did not improve energy efficiency.
from entering the water stream. Pervious concrete was used to guide rainwater to a filtration system pass through the concrete into the ground.

**Recycled Content** – Aerospace made use of recycled materials in order to reduce the demand for raw materials and to prevent old materials from ending up in landfills. Both post-consumer material (derived from products previously used by consumers for their intended purposes) and pre-consumer material (that which was salvaged from the waste stream during the manufacturing process) were specified for this project. The Aerospace facility established a goal of using materials with recycled content constituting at least 20% of the total value of the materials in the project.\(^\text{10}\)

**Regional Materials** – Aerospace established a goal of having at least 10% of the total building materials be ones that were harvested or manufactured within 500 miles of the building site. The regional sourcing of materials required less travel for product delivery and therefore also established a smaller carbon footprint.

**Indoor Environmental Quality**

**Minimum Indoor Air Quality (IAQ) Performance** – Providing interior spaces with good air quality contributes to a healthy, pleasant and more productive work environment. A ventilation system that provided sufficient outdoor air delivery was used to achieve this goal.

**Environmental Tobacco Smoke (ETS) Control** – In the interest of air quality and building occupant health, smoking was prohibited both in the building and within 25 feet of any entrance to a building.

**Construction IAQ Management Plan** – It was important to maintain good air quality for both construction workers involved in the project and eventual building occupants upon project completion. Material installation was scheduled to prevent contamination of absorbent materials with construction debris. A filtration system was used to clean air during construction and an air quality test was performed prior to final building occupancy.

**Low-Emitting Materials** – Special attention was paid to indoor chemical and pollutant control. Low VOC-emitting materials were selected for adhesives and

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\(^{10}\) As stipulated by LEED, this figure is calculated as the sum of post-consumer recycled content plus one-half of the pre-consumer content.
sealants, paints and coatings, carpet systems, and composite wood and agrifiber products. Plans were also made for a green cleaning process to be implemented upon occupancy.

**Controllability of Systems** – Aerospace considered making individual task lighting available to all occupants for personal comfort and responsibility of resource use.11 Perimeter offices included occupancy sensors to turn off lights when unoccupied. Exterior lighting fixtures are minimized, promoting safety while eliminating unnecessary lighting that could lead to light pollution in the preserved wetland.

**Thermal Comfort** – ASHRAE 55-2004 was followed regarding humidity and temperature controls.

**Innovation and Design Process**

Going far beyond the LEED credit requirements, the project is targeting recognition for several project achievements, including:

1. Select water efficient fixtures such that the water consumption is reduced by 40 percent compared to baseline performance requirements of Energy Policy Act of 1992.
2. Provide additional open space, over and beyond what is required by the local zoning code. The project design achieved 360 percent open space above and beyond the local zoning open space requirement.

Other innovative aspects include Stream Restoration and Improved Stormwater Management. At considerable project expense, Aerospace selected a master plan that conserves existing natural areas and restores damaged areas to provide habitat and promote biodiversity of plants, wildlife and stream flora and fauna.

**Stream Restoration** – Over 750 linear feet of stream restoration were combined with an innovative use of a custom-built level spreader to substantially reduce the total EQC and tree impacts to the site. The stormwater from the project site flows through the restored stream to the level spreader and into the existing wetland area. This unique engineering solution not only exceeded the State and local regulatory requirements, but also created a stable system to adequately handle stormwater flows while promoting biodiversity.

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11 As of the writing of this report, the inclusion of task lighting was still being considered.
In addition to these benefits the stream restoration was and continues to be used as an educational tool. Staff from Fairfax County Land Development Services, U.S. Army Corps of Engineers, the Virginia Department of Environmental Quality, The Aerospace Corporation (and other firms on the project team), and numerous public citizen groups have toured the site for stream walks throughout the course of the project to discuss the project goals, view progress, and observe the success of the completed project. These events serve to educate visitors on the project’s benefits and continue to highlight the project as an example of an innovative solution to address complex regulatory and environmental concerns.

The project has received many accolades for its success. Among these honors are recognition by Fairfax County with 2010 Land Conservation Awards for Erosion and Sediment Control in multiple categories including Large Commercial, Best Protected Environmentally Sensitive Site, Outstanding Site Superintendent, and Outstanding Contractor. On January 21, 2011 the project also received Fairfax County’s Tree Conservation Award for “Outstanding Commitment to Tree Planting and Tree Preservation at The Aerospace Corporation Stream Restoration Project”\(^\text{12}\). As part of the project, all trees six inches or greater in diameter at breast height (dbh) within the project limits were survey located and the sizes and species were identified. This effort allowed the design team to preserve and protect as many trees as possible throughout the restoration process.

A monitoring and maintenance program\(^\text{13}\) is in place for ten years following construction to guarantee continued longevity of the project. This program includes field surveys of the stream channel dimensions, pattern, and profile and assessments of the vegetation. In addition to the monitoring and maintenance program the project is protected by a permanent easement to ensure that the project will remain in place and continue to function as designed in perpetuity.

**Improved Stormwater Management** - Stormwater management was primarily accomplished using three underground facilities with independent control structures. Vegetated roof and wall on the Visitor Center, along with pervious paving at the Visitor Center are other features used to manage storm water.

Instead of consuming land area for parking which would have disturbed a vast amount of land area, a multi-storied structured parking garage is provided to reduce the building footprint area, thus retaining more undisturbed land area. Out of 40.41

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\(^{12}\) See Appendix E for a copy of the award.  
\(^{13}\) See Appendix F for a copy of the monitoring and maintenance program.
acres of the property, approximately 26.5 acres were preserved as open space of which 21.15 acres are considered to be an Environmental Quality Corridor (EQC). The remaining developable acres are less than half the property, thus there was not enough area to provide a conventional stormwater management pond. A stormwater structure was provided under the visitor parking lot and is in a fill area, thus reducing the amount of required fill material.

The water collected on top of the garage is collected in a retention area and pumped to the rain garden, also known as a bioretention facility. The raingarden is a vegetated closed depression that retains and filters stormwater runoff from an area of impervious surface such as a parking lot or pavement area. Surface runoff is directed into a shallow landscaped depression that incorporates many of the pollutant removal mechanisms that operate in forested ecosystems. The primary component of a raingarden is the filter bed, which has a mixture of sand, soil, and organic material as the filtering media with a surface mulch layer. During storms, runoff temporarily ponds 6 to 12 inches above the mulch layer and then rapidly filters through the bed.

The majority of the stormwater runoff from the developed portion of the site is collected by these various measures and is then directed to an onsite intermittent stream that was restored using natural stream methodology measures and sized to accommodate the ultimate build out of the watershed. A level spreader was installed as the stream reaches an existing wetland allowing the water to spread and recharge the wetland and further reduce the runoff from the site.
Conclusion

The Aerospace Corporation sought to build a new campus in order to consolidate real estate holdings to control costs and boost productivity and capability by collocating workers and improving collaboration spaces. One of the primary aims for the design of the facility was to achieve a high degree of energy efficiency along with lower operating cost. While this project was submitted to USGBC for LEED certification, the true goal was energy efficiency and sustainability. The high energy demands of the onsite data center presented a challenge to pursuing LEED certification. By focusing on innovative design and a commitment to sustainability, the project team was able to achieve a highly efficient campus that met Aerospace’s program requirements, was LEED compliant and was integrated into its natural surroundings in an environmentally responsible way.¹⁴

¹⁴ See Appendix G for a graphic depiction of the project’s notable sustainable features.
### APPENDIX A

#### Aerospace’s Design Criteria

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<th>RELATIONSHIP TO NRO</th>
<th>DESIGN</th>
<th>PROGRAM</th>
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<td>• LEED sustainability/ energy conservation</td>
<td>• 400,000 to 550,000 sq. ft. of Class A, state-of-the-art office space in one or two buildings</td>
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<td>• The natural setting of the site, including its streams and forests, shall be utilized, such that outdoor areas are celebrated and connected to the buildings</td>
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<td>• Parking provided in structured garages and surface parking (3 spaces per 1000 sq feet)</td>
<td>• Plazas shall include seating, and outdoor dining areas, with planter walls that incorporate seating</td>
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</tbody>
</table>

January 16, 2007
APPENDIX B

Energy Consumption

<table>
<thead>
<tr>
<th>Total Building Energy Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>By EKFox</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>City:</th>
<th>Weather Data: Washington, DC (Full)</th>
<th>Date: September 05, 2012</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Energy</th>
<th>Proposed</th>
<th>Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>10^6 Btu/yr</td>
<td>Base %</td>
<td>kBtu</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Total Building Energy Consumption</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>80,810.5</strong></td>
</tr>
</tbody>
</table>

**Note:** The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

- **Lighting - Conditioned**
  - Energy: 4,606.0
  - Proposed: 6
  - Peak: 937

- **Lighting - Unconditioned**
  - Energy: 846.4
  - Proposed: 1
  - Peak: 110

- **Space Heating**
  - Energy: 1,145.0
  - Proposed: 1
  - Peak: 1,992

- **Space Cooling**
  - Energy: 2,005.0
  - Proposed: 3
  - Peak: 1,255

- **Pumps**
  - Energy: 6,600.0
  - Proposed: 8
  - Peak: 1,089

- **Heat Rejection**
  - Energy: 2,225.5
  - Proposed: 3
  - Peak: 445

- **Fans - Conditioned**
  - Energy: 7,750.2
  - Proposed: 10
  - Peak: 1,439

- **Receptacles - Conditioned**
  - Energy: 63,010.8
  - Proposed: 87
  - Peak: 7,090

- **Stand-alone Base Utilities**
  - Energy: 1,626.1
  - Proposed: 2
  - Peak: 301

<table>
<thead>
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</tr>
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<tbody>
<tr>
<td><strong>80,810.5</strong></td>
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</table>

**Total**

<table>
<thead>
<tr>
<th>Number of hours heating load not met</th>
<th>Number of hours cooling load not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>66</td>
<td>81</td>
</tr>
</tbody>
</table>

**Energy**

<table>
<thead>
<tr>
<th>10^6 Btu/yr</th>
<th>Cost/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>$80,810.5$</td>
<td>$1,556,484$</td>
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</tbody>
</table>

**Total**

<table>
<thead>
<tr>
<th>Energy</th>
<th>Cost/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>$80,810$</td>
<td>$1,556,484$</td>
</tr>
</tbody>
</table>
APPENDIX C

Map of Site and Surrounding Area
APPENDIX D

Aerospace Stream Restoration Case Study

Aerospace Corporation - Westfields Parcel 35 Stream Restoration
Fairfax County, Virginia

Project Owner: Duke Construction Limited Partnership
Services: Ongoing

As compensatory mitigation for stream impacts for the Aerospace Corporation – Westfields Parcel 35 project, WSSI has prepared and obtained approval of a stream restoration plan of approximately 800 linear feet of unnamed tributary to Flatlick Branch using Natural Channel Design (NCD) while providing adequate outfall capacity for the proposed project. The restoration design consists of modifications to the existing channel dimension, pattern and profile, a reforested bed, and numerous native plantings to improve the existing riparian corridor.

To develop the design that will result in environmentally sound, aesthetically pleasing streams with long-term stability, WSSI undertook an analysis that included a review of prior studies and implementation of hydrologic model data (developed by Burgess and Nipple) from the proposed development as well as regional curves. Information from these sources was then considered in order to develop a design that incorporates certain, practicable elements of the NCD philosophy, while also taking into account the significant constraints imposed by the complex urban nature of the project watershed.

For this project, WSSI conducted numerous environmental and cultural resources studies in support of a Special Exception request for the Aerospace Corporation’s future east-coast headquarters. Studies included a WOUS delineation and survey, existing vegetation mapping, a Phase I archeological investigation, ETS surveys, Resource Protection Area mapping, a Water Quality Impact Assessment, and Environmental Quality Corridor mapping. Interaction with numerous members of the development team and key interactions with community stakeholders and County staff, Planning Commissioners, and Board of Supervisors was essential to the success of the project.

Deliverables:
- WOUS Delineation Report
- Jurisdictional Determination
- Unified Stream Methodology Report
- Resource Protection Area Plan
- Environmental Quality Corridor Mapping
- Water Quality Impact Assessment
- Archaeology Phase I report
- ETS Survey
- State Programmatic General Permit
- VA Water Protection Permit
- Stream Restoration Concept Plan
- Stream Restoration Preliminary Plan Set
- Tree List/Survey
- Stream Restoration Plan Set
- VDOT Land Use Permits (Entrance Permits)
- Virginia Stormwater Management Program Permit
- Stormwater Pollution Prevention Plan
- Construction Monitoring Reports
- Stream Restoration Monitoring Reports
- Photo Documentation
- Tree Preservation Area Monitoring Reports

Reach 1: Pre-construction conditions
Reach 2: Post-construction 5 months
APPENDIX E

Fairfax County’s Tree Conservation Award
APPENDIX F

Tree Monitoring and Maintenance Program
APPENDIX G

Summary Graphic of Sustainable Features