

Case Study: Nashville International Airport's (BNA) Concourse D



Airside View of Concourse D
(Courtesy: Hensel Phelps)

Taking Sustainability to New Heights at BNA

Nashville International Airport (BNA) has a longstanding commitment to sustainability and, over the years, has incorporated a variety of "green" strategies into design, construction, and operations. Now, with the airport's dynamic *BNA Vision* expansion and renovation plan conceived by Design Architect Corgan, Nashville International Airport is taking its sustainability efforts to new heights.

With nearly 18.3 million passengers in 2019, BNA has been one of the fastest growing airports in North America, and *BNA Vision* will meet the need for a bigger airport with significantly more parking, additional aircraft gates (domestic and international), an expanded security checkpoint, new ticketing wings, larger Baggage Claim, terminal lobby renovation, a variety of new dining, retail, and service locations, a hotel, a new airport administrative building, and an expanded roadway system.

Recognizing the short-term and long-term benefits of sustainability, BNA is upholding the triple bottom line as it grows—balancing people, planet, and profit as it builds for the future.

BNA identified energy efficiency as the most important sustainability feature; followed by water efficiency and healthy spaces. With an overall commitment in place and these priorities established—and the acknowledging that the more traditional first cost filter does not consider the long-term benefits of true sustainable design—all Project Teams for *BNA Vision* projects developed strategies and performance metrics that will derive the best long-term benefits of true sustainable design.

“Green” Certification

To validate that the sustainability goals of *BNA Vision* projects are executed, BNA required third-party certification where possible, recognizing the structure and oversight that programs like LEED (Leadership in Energy and Environmental Design) and Parksmart can provide to a project.

BNA and its consultant team evaluated each of the *BNA Vision* projects to determine which components will be appropriate to achieve third-party certification.

The US Green Building Council (USGBC) and Green Business Certification Inc. (GBCI), the developers and administrators of LEED and Parksmart, respectively, have provided invaluable guidance enabling BNA to achieve its sustainability and certification goals. BNA encouraged the project teams to be innovative and creative, leveraging USGBC and GBCI resources to the extent needed.

LEED Certification

LEED is the most widely-used green building rating system in the world. Available for virtually all building types, LEED provides a framework for healthy, highly efficient, and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement and leadership.

At the outset of *BNA Vision*, the airport committed to pursuing LEED certification for two new construction projects: Concourse D and BNA’s Airport Administrative Building. The Design-Build Team of Hensel Phelps and Fentress Architects completed Concourse D to open in July 2020 with a variety of "green" strategies and components.

Likewise, the new Airport Administrative Building will open in late 2020 with sustainability integrated into its design, construction, and operation.

Parksmart Certification

Parksmart is the world’s only rating system designed to advance sustainable mobility through smarter parking structure design and operation. The Parksmart framework enables parking structures to become more sustainable and improve their overall performance through thoughtful siting and design, best-in-class facility management practices, and the use of innovative technologies. Parksmart encourages projects to follow an integrated design process that helps maximize the value of their structure over its lifetime, embrace rapidly evolving technology, cut operational costs, reduce environmental impact, increase energy efficiency, minimize waste, offer better lighting and ventilation, provide access to alternative modes of transport, and more.

In addition to pursuing LEED certification for new building construction, BNA set its sights on Parksmart certification for its future parking garages. The first of a three-phased Terminal Garage expansion was completed in December 2018 and received Parksmart Bronze certification in August 2019. The second phase will be completed in early 2021 and is on track for Parksmart certification. The third and final phase will be completed in 2023.

Parksmart, like LEED, awards points for parking structures implementing water, energy, and material conservation techniques, along with many other environmentally sound strategies. The program identifies 48 strategies in the following categories: management, programs, innovation, technology, and structure design. These strategies can provide guidance and benefits to building owners, designers, engineers, users, and operators of the garage.

LEED certification recognizes Parksmart as an innovation approach to a LEED Campus design.

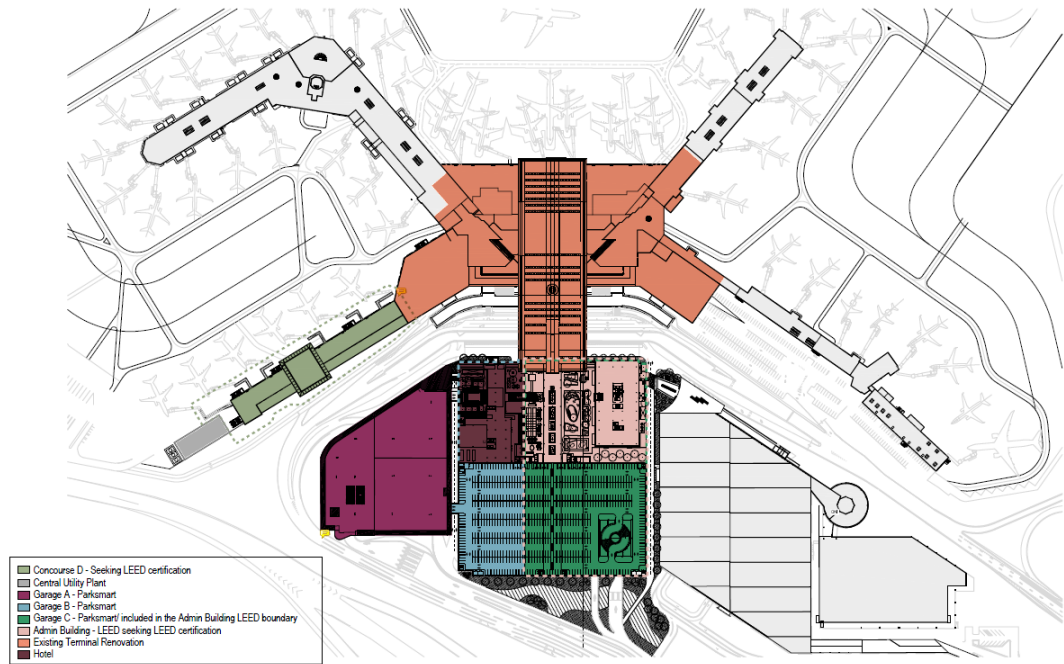
The BNA LEED Campus and Component Projects

BNA is a registered LEED Campus, and as such, may seek sustainability certification for individual components with programs such as LEED or Parksmart. Certification may not be appropriate for other components within the campus, and these are excluded from consideration.



Source: MNAA

Diagram A – BNA Airport Campus LEED Boundary



CORGAN ■

**BNA AIRPORT
NASHVILLE, TN**

PROJECT PHASES
SCALE: 1" = 240'-0"

Source: Corgan

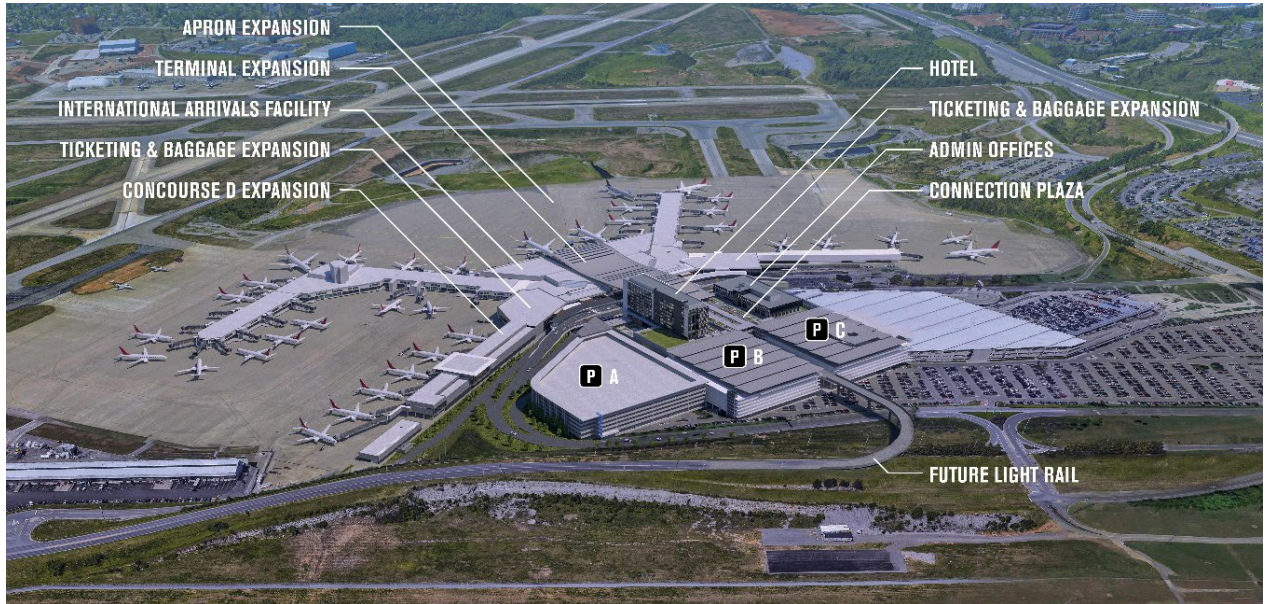
Diagram B – BNA Building Components

LEED offers a range of rating systems to suit various building types. It has been determined that LEEDv4 for Building Design and Construction is the most appropriate for Concourse D and the Administration Building, while Parksmart certification is appropriate for the Terminal Garage expansions.

Within a LEED campus, certain measures and strategies such as open space, an airport-wide art program, or an efficient Central Utility Plant (CUP) offer benefits common to more than one building component. These benefits are tracked as LEED Campus Credits, and individual LEED projects are able to add such Campus LEED Credits to their respective LEED Project performance scores. The Campus Credits achieved are:

- Location & Transportation: Reduced Parking Footprint
- Sustainable Sites: Site Assessment
- Sustainable Sites: Open Space
- Water Efficiency: Cooling Tower Water
- Innovation in Design: O+M Starter Kit
- Innovation in Design: WELL Building Measures
- Innovation in Design: Parksmart (on track)

Concourse D LEED Project <narrative assumes LEED Silver has been attained>



Source: Corgan

Diagram C – BNA Vision

Design for the new construction of the new, two-story, 89,300 GSF Concourse D incorporates contact gates D1 through D6, each serving a range of narrow-body aircraft and regional jets. The existing apron area currently accommodates six RON positions. The concourse expansion replaces these RON positions with an equal number of contact gates. The preferred development does not require any additional aircraft pavement, utilizes existing dual taxi lanes and retains most of the existing configuration of the south service road. In addition to building design, several operational variables dictated the gate layout for Concourse D.

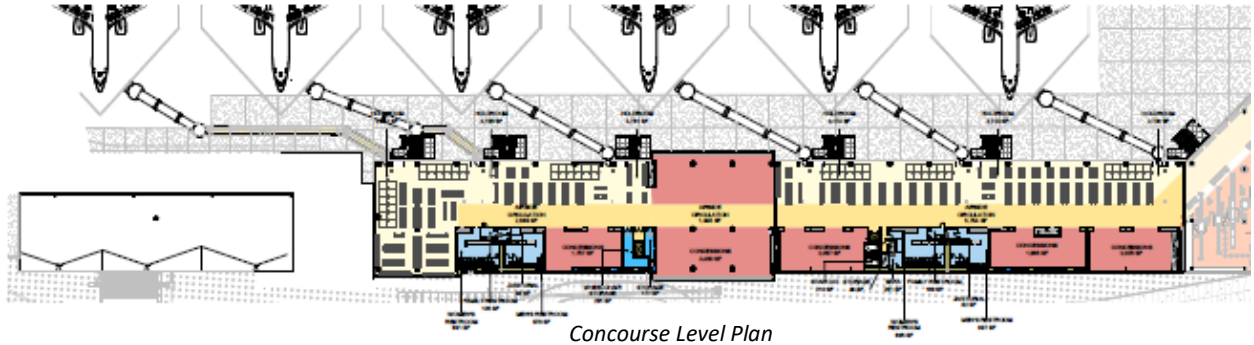
Located south of the Main Terminal, the upper level of Concourse D is designed with holdrooms along the west, affording expansive views of the airfield. A central walk path separates the holdrooms from concessions and services located along its eastern flank. At mid-concourse, a spacious node was incorporated as the completing touch with higher ceilings and clerestories to provide natural light and expansive views (landside and airside), a distinctive, interactive public art installation, and floorspace for future dining and retail amenities.

The ramp level accommodates airside service, office, and mechanical spaces.

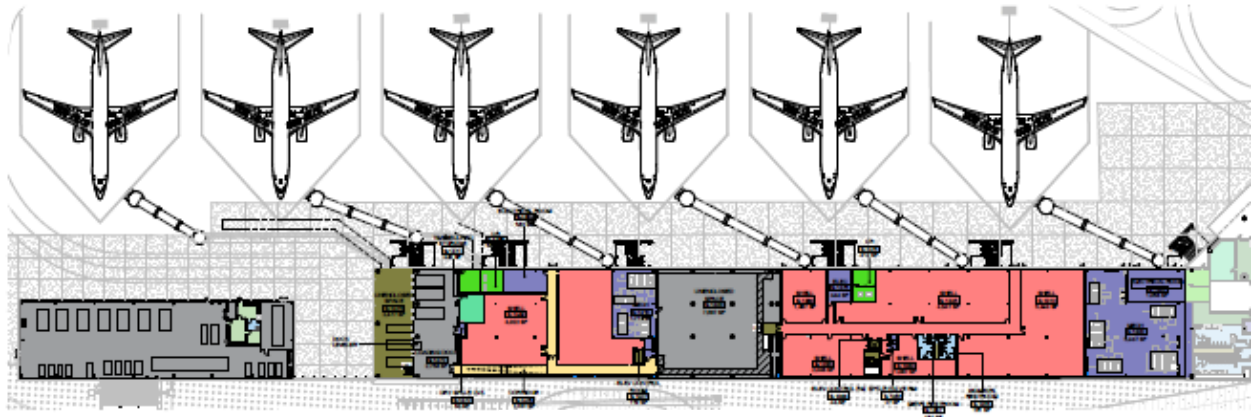


Source: Fentress Architects

Diagram D – Concourse D Airside Elevation



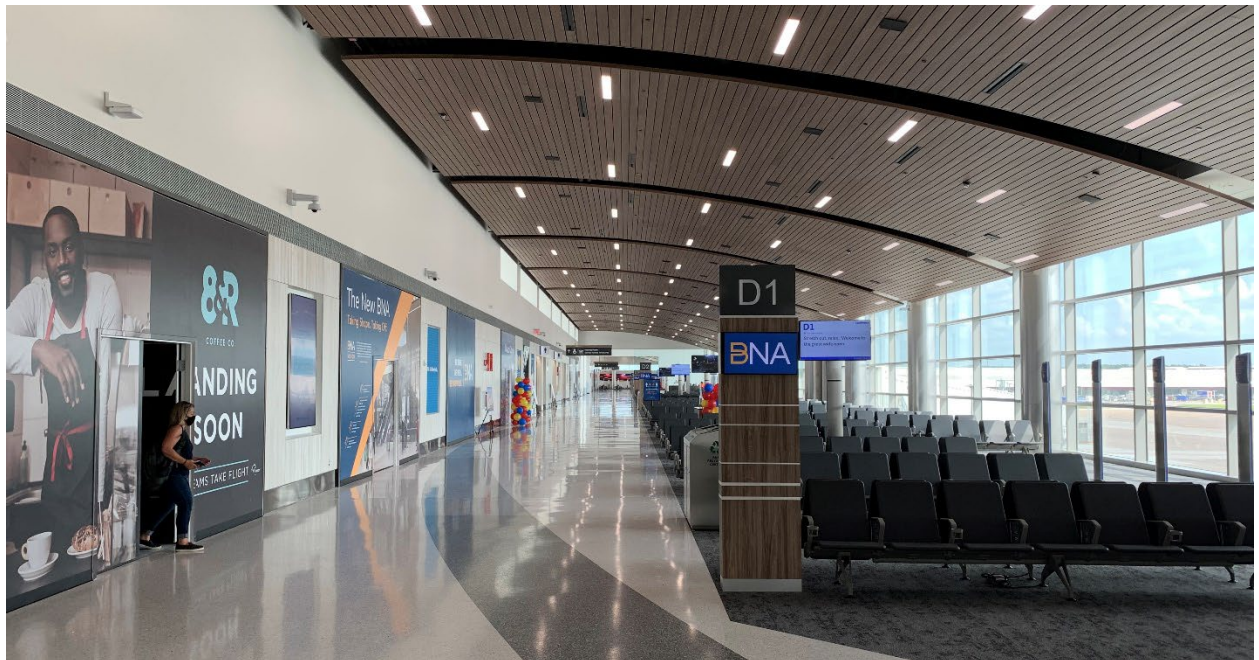
Concourse Level Plan



Ramp Level Plan

Source: Fentress Architects

Diagram E – Concourse D Floor Plans



Interior View of Concourse D (Courtesy: Fentress Architects)

Campus-wide Sustainability Measures

Parking

Parksmart is a voluntary certification empowering high-performance parking facilities to improve mobility while using fewer resources. It has the distinction of being the world's only certification system designed to advance sustainable mobility through smarter parking structure design and operation.

BNA's first new Terminal Garage opened in December 2018 and earned Parksmart Bronze certification in August 2019. Two additional will also pursue Parksmart certification.

All three garages will use the same external and internal wayfinding system and traffic flow measures.

Parksmart measures implemented in the garages include traffic flow management systems consisting of destination wayfinding signage, enhanced signage displaying real-time parking availability inside and outside the garages, a parking space guidance system, electric vehicle charging stations, a tire inflation station, a pay-on-foot toll system, programmed, energy-efficient lighting, and more.

Operations and Maintenance Policies and Practices

As part of the LEED certification effort BNA has implemented an Operations and Maintenance "Green Starter Kit" comprising the adoption of a Green Cleaning Policy, and an Integrated Pest Management Policy.



- **Green Cleaning Policy**

The Policy aims to reduce the environmental effects of all cleaning procedures, cleaning material purchases, cleaning equipment purchases, and cleaning services that occur inside and on the building site and grounds for the Nashville International Airport.

Green cleaning protocol focuses on surface cleaners that are not harmful to the environment or building occupants. The cleaning materials is stored at specific places and cleaning occurs at specific times to limit exposure to vulnerable populations. All disinfectants used are non-toxic, yet also must be effective cleaners. Maintenance staff are regularly trained in new methods and products as cleaning protocols inevitably improve over time. Training topics include the potential hazards of cleaning materials, and disposal/recycling of cleaning materials.

- **Integrated Pest Control Policy**

With the goal of eliminating pests while limiting exposure to pesticides, the main directive of the Policy includes the creation of an Integrated Pest Control Team, with the tasks of inspection, communication with the building occupants about pest related matters, and exploration of solutions that are as minimally invasive as possible. Pest Control solutions that involve large applications of pesticide are only to be used as a last resort and must be coordinated to limit occupant exposure to the pesticide.

WELL Building Measures

The WELL Building Standard® is a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and wellbeing through air, water, nourishment, light, fitness, comfort, and mind.



The celebration of Nashville culture focuses on several themes. These themes express Nashville's deep connection to music; connection to its surrounding natural environment; and extending the quintessential Nashville experience to the airport. At the same time, such artworks are selected and placed to contribute to wayfinding clarity and the building's ease of use

View of Node with “Lyrical Journey” by RE:site Studio
(Courtesy: Fentress Architects)

These themes help inform the building's design as well as the concessions and any additional airport programs. As an example, the theme of music is expressed in the building's physical design, but also in the programmatic use of the space. Skylights in the main circulation space are inspired by the sound holes in guitar, and floor patterns mimic sound waves generated by music. Additionally, the main circulation space can serve as a concert venue for local musicians.

As an extension of an existing program called Arts at the Airport started by BNA in 1988, the Integrated Art program includes public art installations such as a Nashville-inspired hanging work of art and a mural, permanent art cases, performance art space, and visual art using digital media. Artistic offerings in Concourse D will have a regional stipulation to showcase local artists and musicians.

Open Space

While open space requirements are not explicitly fulfilled in BNA's Concourse D, it was part of the 2041 Vision plan for BNA. Open vegetative spaces would be implemented on the landside of the airport. These spaces offer public recreational use, and as a buffer from the numerous paved surfaces. Growing and harvesting food for vendors in the airport has also been discussed as a function of this space. BNA will continue to research implementation of this strategy for upcoming phases as part of the 2041 Vision.

Central Utility Plant (CUP)

The Central Utility Plant utilizes condensing boiler and heat pump chillers to produce hot water for the system. Centrifugal chillers are used in combination with cooling towers and a geothermal loop from a former on-site quarry to the terminal to produce chilled water. Both systems use a variable primary pumping system in N+1 configuration to distribute chilled and hot water to the Terminal and Concourses A,B,C and D, and will service the forthcoming Administrative Building, hotel, and future components of airport expansion.

The CUP for BNA has been designed with 7,680 tons of cooling capacity and 52,160 MBH of heating capacity, which is sufficient for the heating and cooling capacity for the completed BNA Vision 1.0 expansion and renovation program. There is additional equipment capacity for future expansion beyond Vision 1.0.



BNA's Central Utility Plant
(Courtesy: Fentress Architects)

The new CUP comprises seven (7) 1200-ton centrifugal chillers, one of which was relocated from the former CUP adjacent to the terminal. The chillers are set up so that one existing chiller and three new chillers are fed by the geothermal lines from the on-site former quarry. The one existing chiller will use refrigerant R-123 and the new chillers will use the more environmentally friendly R-134a. In addition to the geothermal chillers, three new chillers are designed to use the new cooling towers for heat rejection. One chiller sits in between the geothermal chillers and cooling tower chillers as a standby chiller for either system.

The chillers are designed to provide 42°F supply water and handle up to 54°F return water for BNA.

Two heat pump chillers are provided in the new CUP to generate free pre-cooling to the chilled water system and provide 4,000 MBH to the hot water system per heat pump chiller. The heat pump chillers will be the primary source for heating to take advantage of the free cooling that they can provide, as BNA requires both heating and cooling during the entire year. These chillers supply the reduced summer heating load more efficiently with no boiler operation required.

The chemical composition of the cooling tower water is managed and maintained to reduce equipment wear. A sweeper piping system is included in each cell to force dirt and debris to a filtration system and extend the life of the tower.

CUP equipment was commissioned according to similar parameters as Concourse D, which allowed the entire system to be considered when projecting energy efficiencies and potential savings.

Concourse D Sustainability Measures

Integrative Process

The airport design team used an integrative process to explore and evaluate building massing and configuration; location and sizes of fenestrations; thermal properties of building envelope; and building systems.

Location and Transportation

Concourse D is constructed on the footprint of the earlier and smaller wing, without encroaching on any undeveloped land. It is served by public transit that provide connections to Downtown as well as surrounding cities such as Clarksville, Ft. Campbell, and Murfreesboro; There is a shuttle schedule for Chattanooga, stopping in Monteagle; a direct shuttle to Murfreesboro; an on-demand shuttle to the Mt. Juliet Hampton Inn; and at least 600 scheduled daily courtesy shuttles to nearby hotels; all of which contribute to the Campus' ability to reduce the amount of parking by 35% from the industry baseline for commercial airports.

Sustainable Sites

The design of the airport is informed by the *BNA Vision* Environmental Assessment that provided information on site and climate conditions; existing infrastructure including stormwater management systems; and potential of impact on neighboring population centers.

The project design considered both solar orientation and the airport's overall configuration, including the airfield and runways. Light-colored roofs, apron paving, and landside landscaping help to mitigate the Heat Island Effect. All exterior light fixtures conform to the industry's BUG rating system for Backlight(B), Uplight(U) and Glare(G) attributes, thus eliminating light spill beyond the bounds of the airport's campus.

Water Efficiency

Plant species are selected for their adaptive and drought-tolerant characteristics, allowing the project to reduce outdoor water use by at least 30%.

The indoor plumbing system features all WaterSense fixtures. Lavatory faucets have a low flow-rate of .5 gpm or less, while urinal and flush toilets have respective flow rates of .5 gpf and 1.28 gpf; such measures contribute to the project's 25% reduction in Indoor Water Use, compared to baseline.



Turf grass and a mix of adaptive, drought-tolerant plants installed in the project.

(Courtesy: Fentress Architects)

Energy and Atmosphere

MEP and building envelop systems were commissioned and procedures developed to monitor and assess energy and water-consuming systems when the project is occupied and in-use.

The mechanical systems comprise medium-pressure air handlers with hot water and chilled water coils and low-pressure variable volume boxes with hot water re-heat to serve the occupied spaces. Restrooms are exhausted by independent exhaust fans on the roof. With the energy-efficiencies of the CUP taken into account, the annual energy savings of Concourse D is projected to be 23.6% over baseline utility cost, with

7% savings due to the use of daylight and occupancy sensors that coordinate interior lighting with daylight levels within the respective spaces.

Concourse D has dynamic glazing for all its windows, which make up about 19% of the exterior skin. While the main purpose of the dynamic glazing is glare reduction and occupant comfort, the system also contributes to energy performance, resulting in a reduction in Energy Use Intensity (EUI) from 114.2 kBtu/sf/year to 110 kBtu/sf/yr. It should be noted that the utility cost savings is not fully leveraged within this operating environment when compared to a regular office building, as half of the operating cost is incurred at night, when the dynamic glass is not activated.

BNA continues to monitor and manage energy performance, using energy meters at both the overall building and usage-type levels.

Material Resources

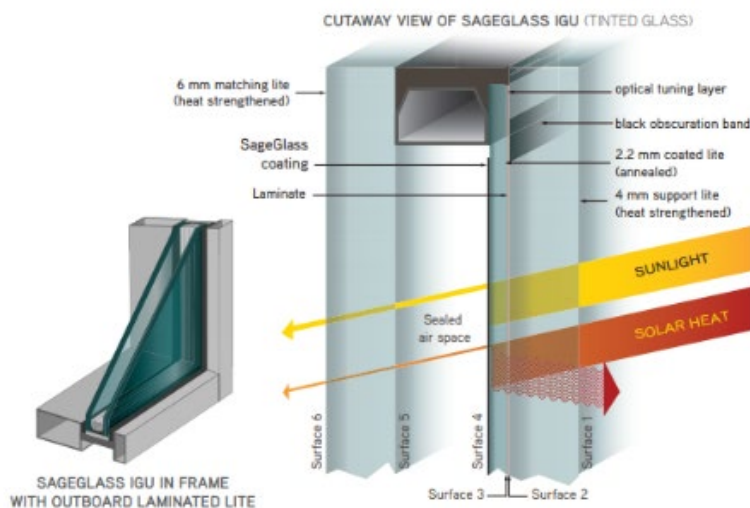
BNA implements a recycling program for all waste generated, both during construction and after the building is in operation. Over 80% of all construction waste generated – estimated to be 7,700 cu. yds – was diverted from landfill and re-used or recycled. Operational recycling throughout the concourse, with specially identified containers, will provide about 12.5% reduction in waste sent to the landfill.

As part of *BNA Vision*, the airport supported increased material transparency by requiring product certification and information on material ingredients, sourcing, and environmental impact. Over 20% in cost value of all construction materials used in the project contained recycled content.

Indoor Environmental Quality

With priority placed on passenger comfort, Concourse D utilizes indoor environmental standards that require air-quality monitoring; controlling indoor pollutants with MERV 13 filters; and interior finishes that are below stringent low VOC thresholds.

These priorities also drove the airport's decision to install dynamic glass in all the windows in the Concourse.



Many waiting passengers prize a view of aircraft and the airfield. Concourse D is largely west-facing, and subject to direct heat, sunlight and glare for part of the day. The dynamic glass automatically and electronically adjusts its opacity to suit the amount of incident sunlight, while preserving desired views to the outside, and keeping the interior spaces cooler.

Schematic of a Window with Dynamic Glass
(Courtesy: Sage Glass)

Innovation Credits

Innovation Credits are intended to encourage projects to achieve exceptional or innovative performance, either through using a strategy not addressed in the specific project's LEED green building rating system; testing and providing feedback on the more innovative or "Pilot" credits that have not been through USGBC's complete drafting and balloting process; or through exemplary performance, typically achieving double the credit requirements or the next incremental percentage threshold for that credit.

The project is pursuing Innovation Credits in both the campus and project levels. Campus-level Innovation Credits include the O+M Starter Kit, WELL Building Measures, and Parksmart.

Economic Input

The project created 2,100 jobs, and contributed about \$92,000,000 back to the local economy.

Conclusion

Thanks to the concerted efforts of all members of the LEED Campus and Concourse D project teams, Nashville International Airport's *Vision* aspirations for sustainable development are being met and even exceeded under *BNA Vision*. BNA is not only a critical part of Middle Tennessee's transportation infrastructure, but indeed an industry leader in sustainability. BNA prioritized sustainability as a guiding principle of *BNA Vision* as part of its ongoing commitment to green practices. It is prime example of how an airport can not only meet the public need, but do so in a socially and environmentally responsible manner, balancing the triple bottom line of People, Planet, and Profit.

That is BNA's vision, its pursuit, its achievement, and its future.

LEED Scorecard

Fulfilling the mission of MNAA to reduce cost and impact through energy conservation measures and integrative planning. The LEED Scorecard shows the Prerequisites and Credits that have been achieved for the project to attain LEED Silver (provisional pending LEED Final Construction Review).

LEED v4 for BD+C: New Construction and Major Renovation		Project Name:
Project Checklist		Nashville International Airport, Concourse D
Date: 8/1/2020		
Y	SM	? N
1	0	0
Integrative Process		1
7	0	0
Location and Transportation		16
1	0	0
Credit: LEED for Neighborhood Development Location		16
0	0	0
Credit: Sensitive Land Protection		1
0	0	2
Credit: High Priority Site		2
0	0	5
Credit: Surrounding Density and Diverse Uses		5
5	0	0
Credit: Access to Quality Transit		5
0	0	0
Credit: Bicycle Facilities		1
1	0	0
Credit: Reduced Parking Footprint		1
0	0	1
Credit: Green Vehicles		1
5	0	0
Sustainable Sites		10
Y		
Prereq: Construction Activity Pollution Prevention		Required
1	0	0
Campus: Site Assessment		1
0	0	2
Credit: Site Development - Protect or Restore Habitat		2
1	0	0
Campus: Open Space		1
0	0	3
Credit: Rainwater Management		3
2	0	0
Credit: Heat Island Reduction		2
1	0	0
Credit: Light Pollution Reduction		1
2	0	0
Water Efficiency		11
Y		
Prereq: Outdoor Water Use Reduction		Required
Y		
Prereq: Indoor Water Use Reduction		Required
Y		
Prereq: Building-Level Water Metering		Required
0	0	2
Credit: Outdoor Water Use Reduction		2
1	0	5
Credit: Indoor Water Use Reduction		6
1	0	1
Credit: Cooling Tower Water Use		2
0	0	1
Credit: Water Metering		1
17	0	0
Energy and Atmosphere		33
Y		
Prereq: Fundamental Commissioning and Verification		Required
Y		
Prereq: Minimum Energy Performance		Required
Y		
Prereq: Building-Level Energy Metering		Required
Y		
Prereq: Fundamental Refrigerant Management		Required
8	0	0
Credit: Enhanced Commissioning		6
8	0	3
Credit: Optimize Energy Performance		18
1	0	0
Credit: Advanced Energy Metering		1
0	0	2
Credit: Demand Response		2
0	0	3
Credit: Renewable Energy Production		3
1	0	0
Credit: Enhanced Refrigerant Management		1
0	0	2
Credit: Green Power and Carbon Offsets		2
5	0	0
Materials and Resources		13
Y		
Prereq: Storage and Collection of Recyclables		Required
Y		
Prereq: Construction and Demolition Waste Management Planning		Required
0	0	5
Credit: Building Life-Cycle Impact Reduction		5
1	0	1
Credit: Bldg Product Disclosure & Optimization - Env'tal Product Declarations		2
1	0	1
Credit: Building Product Disclosure and Optimization - Sourcing of Raw Materials		2
1	0	1
Credit: Building Product Disclosure and Optimization - Material Ingredients		2
2	0	0
Credit: Construction and Demolition Waste Management		2
9	1	1
Indoor Environmental Quality		16
Y		
Prereq: Minimum Indoor Air Quality Performance		Required
Y		
Prereq: Environmental Tobacco Smoke Control		Required
2	0	0
Credit: Enhanced Indoor Air Quality Strategies		2
3	0	0
Credit: Low-Emitting Materials		3
1	0	0
Credit: Construction Indoor Air Quality Management Plan		1
0	0	2
Credit: Indoor Air Quality Assessment		2
1	0	0
Credit: Thermal Comfort		1
0	1	1
Credit: Interior Lighting		2
2	0	1
Credit: Daylight		3
0	0	1
Credit: Quality Views		1
0	0	1
Credit: Acoustic Performance		1
5	1	0
Innovation		6
1	0	0
Credit: Innovation Cr Innovation Credit -O+M Starter kit - Green cleaning, pest mgmt		1
1	0	0
Credit: Innovation Cr Innovation Credit - Wellness		1
1	0	0
Credit: Innovation Cr Education Outreach		1
1	0	0
Campus: Pilot - Pilot Credit - Quality Views for non-Regularly occupied spaces		1
0	1	0
Campus: Pilot - Park Smart OR Cleaning and Disinfecting		1
1	0	0
Credit: LEED Accredited Professional		1
3	0	0
Regional Priority		4
1	0	0
Credit: EQC7 Daylight		1
1	0	0
Credit: LTC5 Access to Quality Transit		1
1	0	0
Credit: LTC7 Reduced Parking Footprint		1
0	0	1
Credit: SSC4 Rainwater Management		1
EAC2 Optimize Energy Performance		
LTC4 Surrounding Density and Diverse Uses		
54	2	1
TOTALS		110

Certified: 40 to 49 points, Silver: 50 to 59 points, Gold: 60 to 79 points, Platinum: 80 to 110

Project Team

Owner	Metropolitan Nashville Airport Authority
Design Architect	Corgan
Design-Build Team	
Design Builder	Hensel Phelps
Architect of Record	Fentress Architects
Architecture Support	Jenny Mac Creative TPD Consulting
Cost Estimator	Cape
Civil Engineer/Landscape Designer	S&ME
Geotechnical	Langan Terracon K S Ware & Associates, Inc.
Structural Engineer	Logan Petri Engineering Magnusson Klemencie Associates
Mechanical, Electrical and Plumbing Engineer	I C Thomasson Associates, Inc. DFH Services
Fire/Life Safety	Weiss, Janney, Elstner Associates, Inc.
Commissioning Agent	Smith Seckman Reid, Inc.
Technology /Integration	EJO Ventures
Technology	Burns Engineering, Inc. Win Engineering Johnson Controls, Inc.
Signage & Graphics	Jones Worley

<https://www.usgbc.org/leed/why-leed>

<https://bnavisionnashville.com/site/web/assets/2017/01/BNA-Vision-Overview-July-2019.pdf>

<https://bnavisionnashville.com/site/web/assets/2019/10/Concourse-D-and-Terminal-Wings-Fact-Sheet-October-2019.pdf>