AIR COMBAT COMMAND

INSTALLATION SUSTAINABILITY ASSESSMENT REPORT

An Installation Landmark

Revised/Updated Draft
May 2012

Shaw Air Force Base
South Carolina

Sustainability assessment summary of Shaw Air Force Base to establish baseline metrics, to identify actionable opportunities and investment strategies, and year-over-year comparisons.

TABLE OF CONTENTS

"So we have a choice to make. We can remain one of the world's leading importers of foreign oil, or we can make the investments that would allow us to become the world's leading exporter of renewable energy. We can let climate change continue to go unchecked, or we can help stop it. We can let the jobs of tomorrow be created abroad, or we can create those jobs right here in America and lay the foundation for lasting prosperity."–President Obama, March 19, 2009

EXECUTIVE SUMMARY

Due to expanding requirements and diminishing resources as well as lacking holistic/integrated design approaches, HQ ACC/A7PS has formulated a process for measuring sustainability at Air Combat Command (ACC) installations. This process will establish baseline metrics to identify actionable opportunities and investment strategies, and facilitate year-to-year comparisons. There are many individual efforts already in place at HQ ACC/A7PS and at the installation level. It is within this context that the ACC Installation Sustainability Assessment (ISA) process and report was developed. This report summarizes the current and recommended sustainability efforts at Shaw Air Force Base (Shaw AFB) and provides a basis for comparison and benchmarking.

Numbers have been calculated for the five sustainability indicators at Shaw AFB for their mission support functions. Additionally, flying mission numbers have been established for the total carbon footprint and energy intensity to show their additional effect on the installation's overall impact on sustainability. The circle indicators, as shown in the chart below, represent how Shaw AFB compares to industry-recognized benchmarks[1]. Green indicates a metric is on target or better than target. Yellow indicates a metric is slightly off target. Red indicates a metric is off target.

MISSION SUPPORT			
Carbon Footprint[1]:	153,499	mTons	○
Energy Usage:	2,303,079	MMBTU	○
Water Conservation:	231.18	Mg	○
Waste Production:	1,898	tons	●
Land Utilization:	7,105	SF/acre	○

FLYING MISSION			
Carbon Footprint:	88,687	mTons	○
Energy Usage:	1,249,427	MMBTU	●

[1]Does not include commuting.
SF = square feet; mTons = metric tones; Mg = million gallons; MMBTU = million British thermal units

Fiscal year (FY) 10 is the inaugural year for the ISA report; therefore, this report does not provide year-to-year comparisons but it does establish a baseline for all future measurements.

ACC has a solid history of successes with sustainability initiatives; however, progressive action must continue. This report outlines a concise, measurable, and repeatable process that can be utilized year to year. Upon this installation's yearly assessment and data analysis, recommendations and actionable items will be established and monitored. ACC HQ/A7PS's role includes identifying synergies between installations to implement new and bridge existing sustainability initiatives. The ACC HQ/A7PS ISA will deliver a positive return on investment and promote leadership in sustainable initiatives.

[1]Industry recognized benchmarks are noted where referenced within the report.

I. INTRODUCTION

A. Installation Sustainability Assessment (ISA) Definition

The Installation Sustainability Assessment (ISA) is a process by which an installation's relative level of sustainability can be measured, identifies and recommends installation-specific improvement strategies, and it is expressed in five key indicators: (1) Carbon Footprint, (2) Energy Usage, (3) Water Conservation, (4) Waste Reduction, and (5) Land Utilization. Identified improvement strategies will allow for the bridging of diverse sustainable initiatives (i.e., energy, heat island effect, water conservation, habitat/watershed protection, and restoration, new construction practices) and a more efficient implementation of these initiatives as it will account for installation-wide conditions. Additionally, overall review of completed ISAs will provide valuable trend analysis across installations. Direct comparison of installations is not the focus due to differing missions, climate variations, and unique installation attributes.

Sustainable design is a design philosophy that seeks to maximize the quality of the community and the built environment while minimizing or eliminating the negative impact to the natural environment. The word installation is defined as the grounds and buildings that belong to a given institution, and specifically refers to the Air Force installation in this document. Sustainability initiatives include conscious efforts to protect habitats, optimize land use, produce zero waste, reduce heat islands, improve air quality, reduce light pollution, use energy efficiently, and maintain the health and well-being for a community.

Initiatives to improve on a particular established indicator typically will also have an effect on other indicators. In determining and prioritizing actionable items, it is important to take into account this interaction to determine which initiatives will result in the most positive outcome and highest return on investment.

B. ISA and the DoD Strategic Sustainability Performance Plan

The *Installation Sustainability Assessment* (ISA) process, metrics, and indicators were initially developed in 2009 by HQ ACC as a means for measuring the overall "green posture" of the installation. In late 2010, the Department of Defense (DoD) published the Strategic Sustainability Performance Plan (SSPP) which identified department wide goals.

HQ ACC reevaluated the ISA process, metrics, and indicators in light of policy established in the SSPP in order to determine if there were conflicts or if changes were needed in the ISA.

The following table provides a summary of the evaluation. The ISA anticipated and aligned favorably with the broad goals and policy in the SSPP. Few modifications in the ISA data collection were needed and those have been fully incorporated into this updated ISA. The SSPP identified some goals which are completely outside the ability of the ISA to collect and report as, to the best of our knowledge, this information is not currently being collected (recall that the ISA relies on collecting data from existing sources).

Bottom Line: The ISA will remain ACC's tool for evaluating the progress of an installation towards the goals and performance expectations of the SSPP.

The following headers are provided in the following table.

- *SSPP Goals* are the goals and sub-goals taken directly from DoD's SSPP.
- *Changes to Align ISAs with SSPP Goals* shows three categories addressing how the ISA aligned with the SSPP.
  - *Few/No ISA Changes* indicates that the original data collect and the data input format of the ISA aligned very closely with the SSPP. *Modifications* that were needed have been incorporated into the ISA.
  - *ISA Additions (data available)* means that the ISA did not originally collect or have a data input format for these goals that were eventually identified in the SSPP. For the most part the data is available *for* collection. However, some of the data may not be easily accessible. Modifications to the ISA spreadsheet have been made for inputting the new data.
  - *Goals outside the ability of the ISA to collect and report* refers to goals that are not applicable to ACC *installations*. It also includes goals for which installations do not have the ability to collect the data for measuring progress against the goal.
- *Data Status and Location* addresses the location within the electronic ISA worksheet where data can be found and inputted in order to calculate progress towards meeting the SSPP goals. It also identifies what data has been collected for each goal.

COMPARISON AND ALIGNMENT OF ISA AND SSPP

SSPP Goals		Changes to Align ISAs with SSPP Goals: Few/No ISA Changes	ISA Additions (Data Available)	Goals Outside the Ability of the ISA to Collect and Report	Data Status and Location
Goal 1	**Use of Fossil Fuels Reduced**				
Sub-Goal 1.1	Energy intensity of facilities reduced by 30% of FY03 levels by FY15 and 37.5% by FY20.	●			• Data collected in the ISA is acceptable. • Data input under the Energy Tab Spreadsheets.
Sub-Goal 1.2	18.3% of energy consumed by facilities is produced or procured from renewable sources by FY20	●			• Data collected in the ISA is acceptable. • Data input under the Energy Tab Spreadsheets. • Sustainable Measures Tab worksheet shows a separate table for facilities with the energy intensity bar chart showing the renewable component.
Sub-Goal 1.3	Use of petroleum products by vehicle fleets reduced by 30% by FY20 relative to FY05	●			• Data collected in the ISA acceptable. • Data input under the Energy Tab Spreadsheets. • Sustainable Measures tab shows reduction in transportation energy use and separates petroleum and renewable sources.
Goal 2	**Water Resources Management Improved**				
Sub-Goal 2.1	Potable water consumption intensity by facilities reduced by 26% of FY07 levels by FY20 Assessment of ISA:	●			• Data collected in the ISA is acceptable. • Data input under the Water Tab Spreadsheets. • Sustainable Measures Tab shows the percent improvement from baseline in the per built SF table.
Sub-Goal 2.2	Reduce industrial and irrigation water consumption 20% by FY20 from FY10 baseline.			●	• Water Tab spreadsheet updated to provide data entry points for when data becomes available. • Data not currently available for input in the ISA for this metric. No separate metering for industrial uses.
Sub-Goal 2.3	All development and redevelopment projects of 5,000 square feet or greater maintaining pre-development hydrology to the maximum extent technically feasible		●		• Water Tab spreadsheet modified to add a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Goal 3	**Greenhouse Gas Emission from Scope 1 and 2 Sources Reduced 34% by FY20, Relative to FY08**	●			• Data collected in the ISA is acceptable. • Data input under the Energy Tab Spreadsheets.
Goal 4	**Greenhouse Gas Emission from Scope 3 Sources Reduced 13.5% by FY20, Relative to FY08**				
Sub-Goal 4.1	Greenhouse gas emission from employee air travel reduced 15% FY20 relative to FY11		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Sub-Goal 4.2	30% of eligible employees teleworking at least once a week, on a regular, recurring basis, by FY 2020		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Sub-Goal 4.3	50% of non-hazardous waste diverted from disposal in landfills not owned by DoD by FY 2015, and thereafter through FY2020	●			• Data collected in the ISA is acceptable. • Waste Management Tab has a check box for verification of the waste is going to non-DoD landfill.

COMPARISON AND ALIGNMENT OF ISA AND SSPP

SSPP Goals		Changes to Align ISAs with SSPP Goals: Few/No ISA Changes	Changes to Align ISAs with SSPP Goals: ISA Additions (Data Available)	Changes to Align ISAs with SSPP Goals: Goals Outside the Ability of the ISA to Collect and Report	Data Status and Location
Goal 5	**Solid Waste Minimized and Optimally Managed**				
Sub-Goal 5.1	All DoD organizations implementing policies by FY14 to reduce the use of printing paper.		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Sub-Goal 5.2	50% of non-hazardous solid waste diverted from the waste stream by FY15, and thereafter through FY20—not including construction and demolition debris	●			• Data collected in the ISA is acceptable. • Data input under the Waste Management Tab Spreadsheets.
Sub-Goal 5.3	60% of construction and demolition debris diverted from the waste stream by FY15, and thereafter through FY20		●		• Waste Management Tab spreadsheet modified to add a header for C&D debris. • Data not originally collected for sub-goal.
Sub-Goal 5.4	Ten landfills recovering landfill gas for use by DoD by FY20			●	• Not applicable to ACC installations.
Goal 6	**The Use and Release of Chemicals of Environmental Concern Minimized**				
Sub-Goal 6.1	On-site releases and off-site transfers of toxic chemicals reduced 15% by FY20, relative to FY07		●		• Waste Management Tab spreadsheet modified for listing reportable quantities. • Data not originally collected for sub-goal.
Sub-Goal 6.2	100% of excess or surplus electronic products disposed of in environmentally sound manner		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Sub-Goal 6.3	100% of DoD personnel and contractors who apply pesticides are properly certified through FY20		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Goal 7	**Sustainability Practices Become the Norm**				
Sub-Goal 7.1	95% of procurement conducted sustainably				• Operations Tab spreadsheet modified to a yes/no box with a percent compliance.
Sub-Goal 7.2	15% of existing buildings conform to the guiding principles on high performance and sustainable buildings by FY15, holding through FY20			●	• ACC/A7PS is evaluating how to implement this goal.
Goal 8	**Sustainability Built into DoD Management Systems**				
Sub-Goal 8.1	All environmental management systems effectively implemented and maintained		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal. Data is available.
Sub-Goal 8.2	Sustainability of transportation and energy choices in surrounding areas optimized by coordinating with related regional and local planning		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal. Data is available.
Sub-Goal 8.3	All DoD installations have Integrated Pest Management Plans prepared, reviewed, and updated annually by pest management professionals		●		• Operations Tab spreadsheet modified to include a year and review date. • Data not originally collected for sub-goal. Data is available.

C. Goals and Objectives

The ISA has been established to formulate a process for measuring sustainability at the installation level. ISAs take a comprehensive look at ACC installations and will address, at a minimum, current use of renewable energy, green procurement practices, infrastructure systems, existing facility operations, conservation plans, environmental compliance, biological resources, habitat protection, watershed restoration, land use, and environmental stewardship.

The ISA will be used to:

- Report the findings
- Establish a baseline for year-to-year comparisons
- Define sustainable initiatives
- Identify synergistic opportunities between diverse initiatives
- Support the Mission, improve the quality of life, and conserve resources over time
- Create an awareness of impacts and a catalyst for cultural change

D. Setting the Context

Flying Mission:

Flying Mission includes anything that directly affects or has direct participation in flight. The flying mission calculations currently take into account fuel usage only.

Mission Support:

Mission Support includes all other activities on the installation. Mission support calculations include resources consumption for everything except flying mission fuel consumption. .

E. Process

1. Data Collection Categories

The ISA categories are a way of grouping data that was collected and used to calculate a set of sustainability criteria. In summary, the ISA data collection categories are:

1. **Development—**Includes land use, building utilization, transportation, noise, and light emissions.
2. **Energy—**Includes electrical, gas, oil, and liquid propane gas consumption; power purchased from utility or generated on site; and transportation and mission fuels for government vehicles and support equipment.
3. **Water—**Includes domestic, irrigation, and storm water as well as its source and its usage.
4. **Waste—**Includes solid and liquid waste production and its usage.
5. **Operations—**Includes best management practices (BMPs) such as procurement, training, maintenance, and purchasing program for energy efficient equipment.

The following defines the five data collection categories in more detail:

Development:

Expanding human requirements and economic activities are placing ever-increasing pressures on land resources, creating competition and conflicts and resulting in suboptimal use of resources. By examining all land uses in an integrated manner, it is possible to minimize conflicts, make the most

efficient tradeoffs, and link social and economic development with environmental protection and enhancement, thus helping to achieve the objectives of sustainable development.

Land use refers to the activities practiced by humans on land. Land supports uses such as residential, industrial, and commercial facilities; recreational areas; natural infrastructure areas; and transportation functions. Integrating a green infrastructure with community connectivity in land use planning is essential to achieving sustainable developments as they incorporate multiple environmental benefits including:

- Reducing storm water runoff volumes and reducing peak flows by using the natural retention and absorption capabilities of vegetation and soils.

  The capacity of the land can be generally categorized as either pervious or impervious. Pervious includes areas that allow rainwater to pass through them and soak into the ground instead of flowing into storm drains. Impervious includes areas that are mainly constructed surfaces covered by impenetrable materials such as asphalt, concrete, brick, and stone. These materials seal surfaces, repel water, and prevent precipitation and meltwater from infiltrating soils. Impervious surface areas include rooftops, sidewalks, roads, and parking lots. The impacts of increased impervious surfaces to storm water runoff should be controlled to mimic natural conditions and to protect water quality. Increasing the amount of pervious ground cover increases storm water infiltration rates which reduces the volume of runoff entering our combined or separate sewer systems, and ultimately our lakes, rivers, and streams.

- Improving the rate at which groundwater aquifers are recharged or replenished.

  Groundwater provides approximately 40 percent of the water needed to maintain normal base flow rates in our rivers and streams. Enhanced groundwater recharge can also boost the supply of drinking water for private and public uses.

- Preventing pollutants from being transported to nearby surface waters.

  Once runoff is infiltrated into soils, plants and microbes can naturally filter and break down many common pollutants found in storm water.

- Limiting the frequency of sewer overflow events by using the natural retention and infiltration capabilities of plants and soils which will reduce runoff volumes and delay storm water discharges.

- Capturing and removing carbon dioxide (CO_2) from the atmosphere via photosynthesis and other natural processes of plants and soils which serve as sources of carbon sequestration.

- Mitigating the effects of urban heat islands and reducing energy demands by providing increased amounts of urban green space and vegetation.

  Urban heat islands form as communities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat. Heat from the sun is absorbed by impervious surface areas and is radiated back into the atmosphere, increasing temperatures in the surrounding area. Additionally, buildings and streets trap and concentrate waste heat from vehicles, factories, and air conditioners. The displacement of trees and vegetation minimizes their natural cooling effects. Trees, green roofs, and other green

infrastructure lower the demand for air conditioning energy, thereby decreasing emissions from power plants.

- Improving air quality by incorporating trees and vegetation in urban landscapes.

  Trees and vegetation absorb certain pollutants from the air through leaf uptake and contact removal. If widely planted throughout a community, trees and plants can even cool the air and slow the temperature-dependent reaction that forms ground-level ozone pollution.

- Providing increased access to recreational spaces and wildlife habitats including greenways, parks, urban forests, wetlands, and vegetated swales.

- Impacting overall human health by providing vegetation and green space.

  Research has linked the presence of trees, plants, and green space to provide a stronger sense of community, improved performance, and even reductions in physical and mental illnesses.

- Improving accessibility by reducing travel distances and improving transportation options by creating nodes such as rideshare and bus stops.

  Community connectivity, or clustering, refers to land use patterns in which related activities are located in proximity to one another. Clustering makes it easier to do things such as run several errands at the same time or socialize.

- Protecting greenfields and preserving habitat and natural resources by clustering buildings.

- Reducing greenhouse gas emissions contributing to the carbon footprint as a result of decreased vehicle use travelling to and from sites.

  Transportation fuel consumption and emissions contribute to climate change, smog, and particulate pollution, all of which have negative impacts on human health.

- Controlling noise levels below 65 decibels which is considered an acceptable level in suitable living environments.

  The Noise Control Act of 1972 (Public Law 92-574) directs federal agencies to comply with applicable federal, state, interstate, and local noise control regulations. Sound quality criteria disseminated by the U.S. Environmental Protection Agency (USEPA), the U.S. Department of Housing and Urban Development (HUD), and the Department of Defense (DOD) have identified noise levels to protect public health and welfare with an adequate margin of safety. Responses to noise vary depending on the type and characteristics of the noise, the expected level of noise, the distance between the noise source and the receptor, the receptor's sensitivity, and the time of day. These levels are considered acceptable guidelines for assessing noise conditions in an environmental setting.

- Reducing light pollution through fixture types, direction of light, lighting control, and improved airfield lighting.

Energy:

Energy is constantly consumed for the operations of every installation. Data is already being collected by installation personnel to capture all energy sources used at the installation, including transportation fuels and mission fuels. Energy sources may include petroleum, natural gas, electricity, coal, and renewable resources such as hydropower, solar, wind, geothermal, biomass, and ethanol. Using existing data, the amount and type of energy consumed is further analyzed to establish a baseline measure for year-to-year comparisons and to monitor the reduction of energy consumption.

Energy usage results in undesired emissions into the environment. Installations typically do not monitor all emissions. Collecting the installation energy data provides the opportunity to calculate a carbon footprint measure (Flying Mission and Mission Support) for the installation that can be monitored year to year.

Water:

The current water distribution systems at most installations and communities are designed to meet multiple supply needs:

- Potable requirements (e.g., drinking, cooking, cleaning, etc.)
- Fire fighting
- Municipal, commercial, and industrial needs
- Non-potable applications (e.g., toilet flushing, landscape irrigation, heating, cooling, etc.)

In some areas of the United States, dual distribution systems have been implemented that provide a primary system for delivering high-quality drinking water and a secondary system for non-potable water applications. By using alternative sources for water supplies either to meet non-potable needs or to replenish existing water sources, higher-quality sources of drinking water can be preserved. Capacity and functionality of alternative infrastructure systems need to be considered in cases where separate systems are provided for potable and non-potable applications (e.g., water reuse and recovering gray water, rain water, or storm water).

Per the Energy Independence and Security Act (EISA) of 2007, any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet (SF) shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to temperature, rate, volume, and duration of flow. As mentioned under the Development category, storm water is critical to sustainable development. The combination of reducing water consumption; reusing storm, gray, and waste water as water sources; and treating runoff are sustainability goals related to water/storm water.

Waste:

Solid and liquid waste on an installation consists of paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, and hazardous wastes, each of which take their own time to degenerate. The size of the annual waste stream is determined from monthly waste-hauling reports detailing the total tons and cost of the waste that has been hauled. Waste streams include landfill, recycling, hazardous, compost, and any others that are being used on the installation.

Responsible waste management of hazardous and nonhazardous waste is essential to protecting human health and the environment. This includes conserving resources by reducing waste,

preventing future waste disposal problems by enforcing regulations, and cleaning up areas where waste may have been improperly disposed.

Wastewater is any water that has been adversely affected in quality by human influence. In the most common usage, it refers to the municipal wastewater that contains a broad spectrum of contaminants resulting from the mixing of wastewaters from different sources. Grey water comprises 50 to 80 percent of the wastewater produced from such activities as dish washing, laundry, and bathing. The amount of the annual wastewater produced on an installation is calculated as a percentage of the reported total monthly gallons and cost of the municipal domestic water consumption.

Treated wastewater can be used for irrigation, fire protection, toilet flushing, artificial wetlands, processing, and cooling towers. Reusing wastewater contributes to conserving water and protecting waterways.

Operations:

Operational BMPs that have been found to be an effective and practical means in protecting or enhancing the environment include such activities as green procurement of goods and services, training, maintenance, and purchasing programs for energy-efficient equipment.

Green procurement is the purchase of environmentally preferable products and services for things such as recycled paper, green cleaning supplies, office products, and printing services. In addition to being cost effective, green procurement reduces the amount of solid and hazardous waste generated and reduces consumption of energy and natural resources.

Proper training of operations and maintenance staff on the use of building systems results in energy savings with minimal upfront investment. The environment benefits from less energy being consumed and less emissions being put into the atmosphere and the building owner benefits from the cost savings associated with less energy being used.

In commercial buildings, use of equipment is the fastest-growing consumer of electricity. Purchasing and using energy-efficient equipment and appliances saves on the total energy being used and the costs associated with their use.

2. Preliminary Research and Data Collection

HQ ACC/A7PS obtained applicable data and reports for the installation from available resources. Examples of reports used as data sources include the Integrated Natural Resources Management Plan, Integrated Cultural Resources Management Plan (ICRMP), Storm Water Pollution Prevention Plan, Integrated Water Quality Management Plan, Drinking Water Management Plan, Pollution Prevention Management Plan, Hazardous Waste Management Plan, Solid and Hazardous Waste Compliance, Economic Impact Statement, Environmental Restoration Program Site Summaries Report, Department of Energy Report, Transportation Fuel Reports, Real Property Reports, and geographical information system database. Information gathered is from resources that already exist. Creation of new reports/data by installation personnel is not required.

3. On-Site Evaluation and Data Collection

A four-person A/E team consisting of an architect, a civil engineer, and two urban planner/designers met with base personnel and surveyed and documented base assets the week of 20 June 2011. While at the installation, the A/E team interviewed available environmental,

engineering, and operations flight staff, such as, but not limited to, natural and cultural resources; air, water, and solid and hazardous waste managers; civil, electrical, and mechanical engineering; community planning; energy and lighting, including high-voltage alternating current (HVAC) maintenance; engineering; procurement; and real property personnel to supplement the data collected previously from HQ ACC/A7PS as well as to collect data not previously obtained.

4. Data Analysis

The data collected was entered in the pre-established spreadsheet form. Pre-established sustainability indicators were calculated that are quantifiable, repeatable, simple, and represent installation-wide sustainability conditions. The metrics establish a baseline for year-to-year comparison, and document compliance or non-compliance with Federal guidance and other applicable agency governances (e.g., Executive Orders (EOs), Energy Policy Act (EPAct) 2005, EISA 2007, MAJCOM directives, etc.).

5. Findings Summary

This report and supporting documentation is a compilation and summary of the information collected and the sustainability indicators calculated for Shaw AFB. The data was evaluated using criteria and protocol that is standard to this initiative and provides a consistent reporting structure. HQ ACC/A7PS will review these results and conclusions to identify potential projects, policy changes, incentives, and year-to-year comparisons.

The following defines the sustainability indicators and methodologies in more detail.

Carbon Footprint:

Carbon Footprint is the measure of the impact human activities have on the environment in terms of greenhouse gas emissions produced, measured in tons of CO_2.

Gases that trap heat in the atmosphere are referred to as greenhouse gases. Some greenhouse gases, such as CO_2, occur naturally and are emitted to the atmosphere through natural processes and human activities. Other greenhouse gases are created and emitted solely through human activities. Human activities typically produce the following greenhouse gases:

- **CO_2—**CO_2 is produced through the burning of fossil fuels (oil, natural gas, and coal), solid waste, and trees and wood products. CO_2 is also produced as a result of other chemical reactions.
- **Methane (CH_4)—**CH_4 is emitted during the production and transport of coal, natural gas, and oil. CH_4 emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- **Nitrous Oxide (N_2O)—**N_2O is emitted during agricultural and industrial activities as well as during combustion of fossil fuels and solid waste.
- **Fluorinated Gases—**Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes.

In the U.S., energy-related activities account for three-quarters of our human-generated greenhouse gas emissions, mostly in the form of CO_2 emissions from burning fossil fuels. More than half the energy-related emissions come from large stationary sources such as power plants, while approximately one-third comes from transportation. Industrial processes (such as the production of cement, steel, and aluminum), agriculture, forestry, other land use, and waste management are also important sources of greenhouse gas emissions in the U.S. (USEPA).

For reporting carbon footprint, the General Reporting Protocol v1.1 May 2008 from The Climate Registry was used. This protocol was used to calculate the carbon footprint as it is one of the most widely accepted systems in the U.S. and offers a relatively simple approach that can be adapted to installation-wide systems. Where data was available, Scope I and Scope II emissions and some of Scope III emissions have been included. Scope I emissions are all direct greenhouse gases from combustion sources to refrigerant leaks. Scope II includes indirect greenhouse gas emissions from offsite power generation. For this report, Scope III includes an estimate of employee commuting greenhouse gas emissions. Where possible, direct calculations of materials consumed or released to calculate the equivalent greenhouse gas emissions have been used. In some cases, the use of generalized lookup figures and/or averages to generate quantities of emissions has been allowed. It is important to track the greenhouse gas emissions relative to mission fuels and transportation fuels to allow comparisons to other public and corporate entities.

Energy Usage:

Energy usage is integral to every facet of our daily lives and is a critical component of a sustainable installation. The long-term reliance on non-renewable resources can be decreased and renewable resources can be developed in an environmentally and economically responsible manner. This potential for improved energy usage is important as carbon-based energy sources are the most significant contributor to greenhouse gas emissions.

For reporting energy use, actual usage data from the base was captured from reporting practices in the government. For the purposes of this project, the energy usage data was separated into building/site energy and transportation categories. Transportation data was further broken down into flying mission and mission support categories along with quantifying which energy sources are from bio-based (green) and/or renewable sources. These numbers are used to provide energy consumption relative to full-time equivalent (FTE) and installation building square footages along with allowing analysis of green/renewable sources and Flying Mission versus Mission Support consumption. It was important to separate mission energy consumption from standard transportation due to the large amount of fuels required for aircraft. This separation also provides a fair comparison to other public campuses or corporate entities.

Water Conservation:

As the demand for fresh, clean water for irrigation and industry increases, underground aquifers are being drained faster than they can be refilled. Pollution and changing climatic conditions are adding to the burden on fresh water supplies. Poor land development creates more impervious surfaces which generate higher levels of runoff, while more natural areas decrease the amount of runoff..

For reporting water conservation, the domestic water use is captured and compared to the installation population and building square footages for comparison year to year.

Storm water conservation is based on comparing the two-year post development calculation to a two-year pre-development (greenfield) calculation using the U.S. Department of Agriculture, Natural Resource Conservation Service(NRCS), Soil Conservation Service Method as outlined in Urban Hydrology for Small Watersheds Technical Release 55. Any increase in runoff has the potential for contaminated or polluted waters from parking lots, streets, and the airfield to reach water systems off site, resulting in a need for improved containment and/or treatment.

Waste Reduction:

Every economic activity produces waste. The average human uses 45 to 85 tons of materials each year. Due to diminishing resources and recent legislation, bases need to reduce the amount of waste produced and increase the amount of waste recovered. Composting has the potential to significantly alter the amount of waste thrown into local landfills.

For reporting waste reduction, data is captured regarding total waste, landfill, recycling, compost, hazardous, and the costs associate with each. The data is compared to installation population, USEPA recommended guidelines, and tracked year to year.

Land Utilization:

Community sustainability requires a transition from poorly managed sprawl to land use planning practices that create and maintain efficient infrastructure, ensure a sense of community, and preserve natural systems. Many current land use practices have converged to generate haphazard, inefficient, and unsustainable sprawl. Stratified land use policies and inadequate funding for demolition of obsolete facilities isolates employment locations, shopping and services, and housing locations from each other, thereby creating excessive transportation and creating excessive hard surfaced areas.

For reporting land use, source data was gathered on the installation that provides a baseline site area along with area breakdowns for buildable, non-buildable, and habitat areas. Combining this information with building footprints and building areas by category/use codes allows the breakdown of land use and utilization of the installation. Some of the starting basic calculations include total building area relative to the buildable land along with the total non-built or green area relative to the entire site. An attempt was made to provide a reference of built area relative to the site occupancy. Currently, the square footage per FTE being used to provide a comparison of building area against the installation's population and to depict the utilization of the building space is twice the code-recommended square footage.

6. Recommendations

The recommendations described in this report are derived from the specific information obtained at the installation and are intended for further definition and development of projects that would have a direct and viable impact for the sustainability of the installation. The recommendations are categorized within the pre-established sustainability indicators. Ultimately, this list will be used to develop a prioritized group of projects.

II. INSTALLATION INFORMATION

A. Background

Shaw AFB is located in Sumter County, in central South Carolina, approximately 30 miles east of Columbia. The main base is comprised of 3,367 acres and is north of SC Highway 378/76, west of the city of Sumter (see Figure 1-1). Shaw AFB also manages the Poinsett Electronic Combat Range (PECR), which is 12, 521 acres approximately 10 miles south of the main base. Another tract managed by Shaw AFB is the Wateree Recreational Area (WRA), located 35 miles northwest of the base on Lake Wateree in Kershaw County.

Shaw AFB is located in the sandhills region of South Carolina. The Sandhills is a strip of ancient sand dunes that generally divide the piedmont and the coastal plain of the state. Since the area is underlain by sandy soils, the uplands of the region are generally vegetated with longleaf pine, loblolly pine, turkey oak, and blackjack oak vegetation communities.

B. History

As a result of Sumter County officials' lobbying for a military facility during the buildup prior to World War II, the military announced that a large tract along Highway 76 was chosen for a new Army air base and flying school. As a result of these actions, the Shaw Army Airfield was activated on August 30, 1941, as part of the Army Air Corps. The field was named in honor of First Lieutenant Ervin D. Shaw, a Sumter County resident who was a pilot in the Royal Canadian Air Force during World War I and was killed in action in France. While pilot training was the primary mission during World War II, 175 German POWs were also housed at the base and used as labor on local farms.

In late 1945, Shaw was transferred to the Army Tactical Air Command (TAC) and became home to the 20th Fighter Group (FG) (later the 20th Fighter Wing) (FW) flying the P-51 Mustang. In January 1948, Shaw Airfield was redesignated Shaw AFB and transferred to the Continental Air Command (ConAC), receiving its first jet aircraft-the P-84 Thunderjet. After a year under the ConAC, the base was reassigned to the TAC. On January 20, 1950, the 20FG and the 20FW had their designations changed to Fighter Bomber Group (FBG) and Fighter Bomber Wing (FBW), respectively. The 363rd Tactical Reconnaissance Wing (TRW), flying the RF-101 Voodoo, transferred to Shaw in 1951 and became the host wing with the departure of the 20FBW to Langley AFB, Virginia. In 1954, the Ninth Air Force transferred its headquarters to Shaw AFB, where it remains today.

In the 1970s, training of reconnaissance crews was a central mission at the base. However, in 1981, the 363rd TRW was redesignated the 363TFW and in 1982, the wing received its first F-16 Fighting Falcon. F-16s from Shaw were deployed to the Persian Gulf in 1990 within weeks of Iraq's invasion of Kuwait. In 1994, the 363 FW became the 20FW. In 1991, the 363TFW was redesignated the 363rd Fighter Wing and was placed under the command of ACC in 1992. However, in 1994, the 363FW was redesignated back to the 20FW. (ICRMP, 2008).

The 20FW enforced the no-fly zones over Iraq in the 1990s during Operation Northern and Southern Watch. In the Kosovo crisis in 1999, the 20FW was called in to support NATO operations. Since the 9/11 terror attacks, the 20FW has supported Operation Noble Eagle by providing domestic patrols and providing fighter cover for the President. In February 2003, the 20FW deployed 1,300 service members and 15 aircraft to Prince Sultan air base in support of Operation Iraqi Freedom. The 20FW has deployed personnel and aircraft to Afghanistan to support Operation Enduring Freedom from 2009-2010. (Proud Birds of the 20th Fighter Wing, December 2010).

C. Mission

Shaw AFB is the headquarters of the 20FW, flying the F-16 *Fighting Falcon*. The mission of the 20FW is to provide, project, and sustain combat ready air forces-any challenge, anytime, anywhere. As host wing at Shaw AFB, the 20FW is responsible for providing facilities, personnel, and materiel for the operation of the base. Shaw AFB is also responsible for the PECR and the WRA. PECR is an auxiliary facility, providing a combat training environment for aircrews. WRA is also an auxiliary facility that provides boating, camping and picknicking opportunities on Lake Wateree. (2007 INRMP)

Major tenant units located on Shaw AFB are:

- Headquarters Ninth Air Force
- United States Air Forces Central
- Headquarters United States Third Army
- Coalition Forces Land Component Command
- United States Army Central

Other associate units/functions that SAFB supports include:

- 682d Air Support Operations Center Squadron
- Detachment 718, Air Force Office of Special Investigations (OSI)
- 337th Recruiting Squadron
- Detachment 307, Field Training
- Detachment 212, Air Force School of Instruction (AFSOI)
- Detachment QD 20, Area Defense Council
- Defense Commissary Agency
- Detachment 261, Air Force Audit Agency
- Army Air Force Exchange Service
- Defense Reutilization and Marketing Office
- SMALC Depot Task Force

D. Installation Context

1. Geography

The base has a total area of 3,367 acres. The PECR is 12,521 acres.

Coordinates: 33°58′12″N 80°28′34″W

State: South Carolina

County: Sumter County and Kershaw County

Elevation: 243 feet above mean sea level

Terrain: Nearly level

Soils: Soils at Shaw AFB consist mainly of the Orangeburg-Lucy-Greenville association, which is generally well drained with a sandy or loamy surface layer, and a loamy or clayey subsoil. Typical soil types at Shaw AFB include Lakeland sand, Lucy sand, and

Wagram sand. These soils are well drained, but are susceptible to erosion as slopes increase. Wetlands of the area are usually underlain by Osier loamy sand. (Soil Survey of Lee County, South Carolina 2007).

2. Climate

Shaw AFB is located in a humid sub-tropical region resembling other similar regions with hot summer days and mild winters.

Temperature: December through February are the coolest months with average minimum temperatures of 35°F. July is typically the hottest month, with average maximum temperatures of 91.5°F.

Precipitation: Rainfall averages 47.2 inches annually. Most of this rainfall occurs during the summer months, with an average of approximately five inches of rainfall per month. Snowfall averages 0.5 inches annually, but this happens infrequently.

Humidity: The average relative humidity in the midafternoon is approximately 51 percent. Humidity is higher at night, with the average humidity at dawn being 87 percent. (2007 Lee County Soil Survey).

Wind: Shaw AFB is occasionally subjected to hurricane and tropical force winds, generally every five to 10 years. Tornadic activity can occur as a result of severe thunderstorms during the summer.

Air Quality: Shaw AFB is located in the Camden/Sumter Intrastate Air Quality Control Region and is considered in attainment for NO_2, SO_2, O_3, CO, and PM_{10}, and based on collected data, is expected to be designated as in attainment for the PM2.5 and the 8-hour O_3 standards. (EA to Implement BRAC Recommendations, 2007)

3. Demographics

There are a total of over 6,500 active-duty Air Force personnel at Shaw AFB, as well as 1,000 civilians and 438 contractors. There are 8,200 active duty military personnel dependents. The total annual payroll at Shaw AFB is $282.9 million, including military, appropriated, and non-appropriated personnel. According to Shaw's Real Property office, there is a total of 3,172,061square feet of usable building space.

4. Water

Surface Waters

Naturally occurring surface waters on the base include Long Branch along the northeast boundary and one of its tributaries, Spann Branch, along the northern boundary, as well as Mush Branch, originating at the southwest corner of the base just south of US 76/378.

Four artificial impoundments exist on-base, including Chapel Pond, Memorial Lake, #1 Hole Golf Course Pond, and #8 Hole Golf Course Pond. Memorial Lake has problems with weeds and algae because of the design, golf course runoff, and waterfowl population.

According to a recent jurisdictional determination, there are approximately 53 acres of wetlands on Shaw AFB, located along the northern boundary associated with Long Branch. The PECR contains

extensive Carolina bay wetlands comprising approximately 5,044 acres. Other wetlands at the PECR occupy Brunson Swamp and isolated wetlands interspersed in the dry sandhills.

Groundwater

Groundwater under the main base occurs within three aquifer systems. The aquifer system depths are 10 to 100 feet for the shallow aquifer system, approximately 200 feet for the Black Creek aquifer, and over 325 feet for the Middendorf aquifer system. The dissolved-solids content in area streams is low since the groundwater discharging to streams in the area spends relatively little time in contact with soluble minerals. This results in streams with low flood peaks, high base flows, and good water quality.

Potable Water

The base produces all of its potable water from six on-base wells. The wells withdraw water from the Black Creek Aquifer. Water is treated at each of the well sites before storage in one of three aboveground storage tanks.

5. Plants and Animals

The base contains suitable habitats for a wide variety of plants and animals. However, currently, no federally-listed species are known to occur on Shaw AFB.

A total of 84% of Shaw AFB land is developed with urban and airfield land uses. The remainder of the base includes pine plantations adjacent to the airfields, a creek with associated wetland along the north edge of the base, and four ponds. PECR is largely forested with large areas of Carolina bay wetlands. WRA is developed with cabins and facilities for camping, boating, and picnicking.

6. Cultural Resources

The Shaw AFB area was attractive to prehistoric populations due to the presence of well-drained soils adjacent to drainages and wetlands. Surveys of the base have identified a total of nine archaeological sites. Some of these sites have begun to reveal a great deal more about the prehistoric inhabitants of this area.

Detailed information is available in the Shaw Air Force Base Integrated Cultural Resources Management Plan (ICRMP).

7. Recreation

Numerous outdoor recreation facilities at Shaw AFB are available to military and government personnel and their families. Recreational activities include swimming pools, a golf course, camping, and a skeet and trap shooting range.

Off-base recreational areas located near the base include Wateree Recreation Area, several state parks, and a unit of the National Park Service. These recreation areas include:

- **Wateree Recreation Area:** Along Lake Wateree with swimming, boat rental, large recreation center, cabins, RV sites, primitive overnight camping, and picnicking.
- **Congaree National Park:** South of Shaw AFB, along the Congaree River, with a museum-quality exhibit area within the Harry Hampton Visitor Center, a 2.4 mile boardwalk loop trail, over 20 miles of backwoods hiking trails, canoeing, kayaking, and fishing.

- **Lee State Park:** North of Sumter County with fishing, boating, hiking trails, canoeing, kayaking, equestrian camping and trails, and picnicking.
- **Manchester State Forest:** Partially in Sumter County with hunting, fishing, and rifle and pistol range.

8. Regional Priority Credits (RPC)

Regional Priority Credits (RPC) were introduced in the Leadership in Energy and Environmental Design (LEED®) 2009 rating systems to provide an incentive to the achievement of credits that address geographically-specific environmental priorities. RPCs are not new LEED credits, but instead are existing credits that the U.S. Green Building Council (USGBC) chapters and regional councils have designated as particularly important for their areas. The incentive to achieve the credits is a bonus point. If an RPC is earned, then a bonus point is awarded to the project's total points. The following RPC's are listed by USGBC for the 29152 zip code:

SSc4.1 Alternative Transportation-Public Transportation Access

Intent: To reduce pollution and land development impacts from automobile use.

SSc6.1 Storm Water Design and Quantity Control

Intent: Limit disruption of natural hydrology by reducing impervious coverage, increasing on-site infiltration, reducing or eliminating pollution from on-site stormwater runoff and eliminating contaminants.

WEc.3 (Percentage Reduction Required, 40 percent)–Water Use Reduction

Intent: Further increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

EAc.1 (Option 1-Whole Building Simulation-Achieve 30% for new buildings/25% for existing buildings increased building energy performance)-Optimize Energy Performance

Intent: To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

EAc.2 (Percentage of Renewable Energy Required, 1 percent)–Onsite Renewable Energy

Intent: Encourage and recognize increasing levels of on-site renewable energy self-supply to reduce environmental and economic impacts associated with fossil-fuel energy use.

IEQc7.1 Thermal Comfort Design

Intent: To provide a comfortable thermal environment that promotes occupant productivity and well-being.

III. FINDINGS

A. Description

A set of five sustainability indicators has been established to summarize the installation's level of sustainability: 1) Carbon Footprint, 2) Energy Usage, 3) Water Conservation, 4) Waste Reduction, and 5) Land Utilization. These indicators have been established to consolidate the large amount of data analyzed into a few comprehensive outputs.

The findings associated with the indicators presented below are based on the population and consumption numbers presented in the following table.

POPULATION AND CONSUMPTION NUMBERS, SHAW AFB

Base Area (acres)	3,319
Usable Building Area (SF, 2010)	3,172,061
Base Population	
Military (2009)	6,511
Civilian (2009)	1,081
Dependent Population (2007)	8,220
2010 Energy Use[1]	
Electric Use (kWh)	66,196,487
Natural Gas (cf)	82,350,000
Potable Water (Mgal)	231.2
2009 Mission Fuel Usage (gal)	
Aviation Fuels	9,270,147
Diesel	50,808
Gasoline Fuel	95,476
2009 Non-mission Fuel Usage (gal)	
Diesel	12,730,049
Gas fuel	1,384,519
Bio Diesel	7,760
Ethanol	104
Waste	
Total Waste (tons[2])	1,897
Waste Recycled (tons[2])	885

[1]Includes base housing
[2]Includes landfill, recycling, compost, hazardous and other
SF = square feet, kWh = kilowatts hour, cf = cubic feet, Mgal = Million gallons, and gal = gallons

B. Current Sustainability Indicators

Refer to the following pages for a summary of findings for the five sustainability indicators for Shaw AFB.

1. Shaw Carbon Footprint

In the context of the ISA, carbon footprint is a measure of the Carbon Dioxide (CO2) and other Greenhouse Gas (GHG) generated to produce energy that is used by the installation. Each energy source has an associated CO2/GHG value based on the source (e.g., gas, coal, solar, etc.) and the process used to convert fuels (e.g. gasoline engine, jet engine, oil furnace, etc.) to a usable form.

Total Carbon Footprint Shaw AFB is 242,186 mTons (includes Flying and Support Missions)

ACC and Shaw AFB jointly need to establish a goal for the installation's carbon footprint. Currently, based on industry benchmarks, Shaw AFB produces an average carbon footprint for mission support transportation and facilities and the flying mission shown on the following page

Annual Total Mission Support Carbon Footprint for Shaw AFB is 153,499mTons

MISSION SUPPORT—Transportation[5] (No Commuting[3])

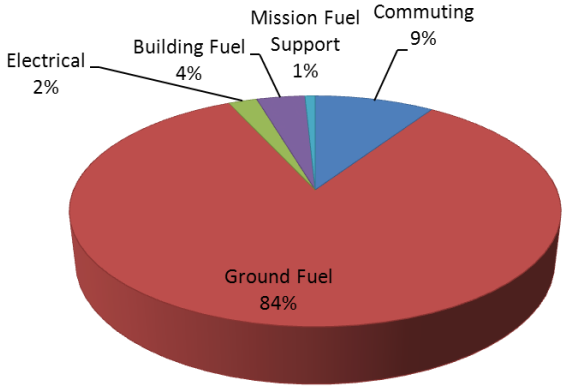
Annual Total Carbon Footprint:	143,251	mTons
Baseline (2005):	(A)	mTons/FTE/year
Previous Year: (2008)	(A)	mTons/FTE/year
Current Year (2009):	18.87	mTons/FTE/year
Benchmark[1]:	7.54	mTons/FTE/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

Baseline (2005):	(A)	mTons/1,000 SF/year
Previous Year (2008):	(A)	mTons/1,000 SF/year
Current Year (2010):	45.16	mTons/1,000 SF/year
Benchmark[2]:	20.44	mTons/1,000 SF/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

MISSION SUPPORT—Facilities[6]

Annual Total Carbon Footprint:	10,248	mTons
Baseline (2003):	7.91	mTons/FTE/year
Previous Year (2009):	1.38	mTons/FTE/year
Current Year (2010):	1.35	mTons/FTE/year
Benchmark[1]:	7.54	mTons/FTE/year
% Reduction from Baseline:	83%	
% Reduction from Previous Year:	2%	

Baseline (2003):	19.51	mTons/1,000 SF/year
Previous Year (2009):	3.40	mTons/1,000 SF/year
Current Year (2010):	3.23	mTons/1,000 SF/year
Benchmark[2]:	20.44	mTons/1,000 SF/year
% Reduction from Baseline:	83%	
% Reduction from Previous Year:	5%	



MISSION SUPPORT CARBON FOOTPRINT[4] (INCLUDES COMMUTING[3])

[1]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 7.54 mTons/FTE.
[2]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 20.44 mTons/1,000 SF.
[3]Greenhouse gases from personal commuting (i.e., back and forth to work) is not included in the Mission Support Transportation calculation table because personal commuting is not part of the SSPP goals. However, in order to gain an understanding of the base's energy/carbon footprint from commuting it is included in the pie chart as a percentage of the Mission Support footprint.
[4]Definitions for pie chart categories can be found in IV. Glossary of Terms and Abbreviations.
[5]Mission Support—Transportation includes ground fuel and mission support fuel quantities shown in the pie chart.
[6]Mission Support—Facilities includes electrical and building fuels shown in the pie chart.
(A) = Data is incomplete.

1a. Shaw Carbon Footprint—Flying Mission

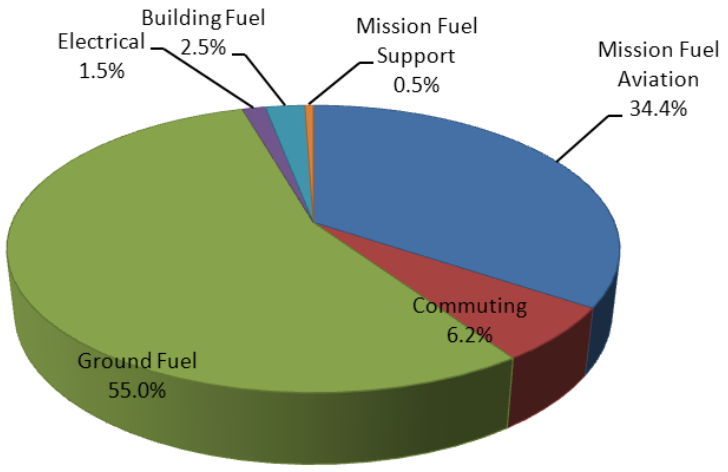
Annual Total Flying Mission Carbon Footprint for Shaw AFB is 88,687 mTons

FLYING MISSION[1]

Annual Total Carbon Footprint:	88,687	mTons	
Baseline (2003):	(A)	mTons/FTE/year	Per FTE
Previous Year (2009):	16.66	mTons/FTE/year	
Current Year (2010):	11.68	mTons/FTE/year	
Benchmark[1]:	7.54	mTons/FTE/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	30%		

Baseline (2003):	(A)	mTons/1,000 SF/year	Per Built SF
Previous Year (2008):	41.04	mTons/1,000 SF/year	
Current Year (2009):	27.96	mTons/1,000 SF/year	
Benchmark[2]:	20.44	mTons/1,000 SF/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	32%		

Flying Mission, Support, and Commuting Carbon Footprint Percentages



TOTAL CARBON FOOTPRINT[4]
FLYING, SUPPORT, AND COMMUTING

- The total grassland needed to offset the total carbon footprint
  for Mission Support is 344,122 acres = 104 times the installation area
  for Flying Mission is 225,873 acres = 68 times the installation area
- The Flying Mission carbon footprint is equivalent to 66 Pentagons
  1 Pentagon = 77,015,000 cu. ft.

[1]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 7.54 mTons/FTE.
[2]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 20.44 mTons/1,000 SF.
[3]Definitions for pie chart categories can be found in IV. Glossary of Terms and Abbreviations.
(A) = Data is incomplete.

2. Shaw Energy Usage

Total Energy Usage Shaw AFB is 3,552,506 MMBTU (includes Flying and Support Missions)

ACC and Shaw AFB jointly need to establish a goal for the installation's carbon footprint. Currently, based on industry benchmarks, Shaw AFB produces an average energy footprint for mission support transportation and facilities and a smaller one for flying mission shown on the following page.

Annual Total Mission Support Energy Usage for Shaw AFB is 2,303,079 MMBTU

MISSION SUPPORT—Transportation[5] (No Commuting[3])

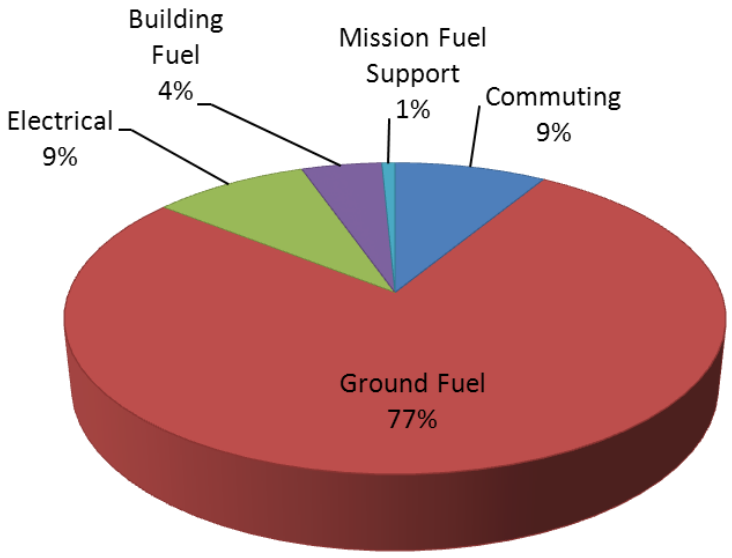
Annual Total Energy Usage:	1,960,752	MMBTU
Baseline (2005):	(A)	MMBTU/FTE/year
Previous Year (2008):	(A)	MMBTU/FTE/year
Current Year (2009):	258.27	MMBTU/FTE/year
Benchmark[1]:	327.00	MMBTU/FTE/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

Baseline (2005):	(A) MMBTU/SF/year
Previous Year (2008):	(A) MMBTU/SF/year
Current Year (2010):	0.62 MMBTU/SF/year
Benchmark[2]:	0.13 MMBTU/SF/year
% of Energy from Renewable Source:	0%
% Reduction from Baseline:	-
% Reduction from Previous Year:	-

MISSION SUPPORT—Facilities[6]

Annual Total Energy Usage:	342,327	MMBTU
Baseline (2003):	67.66	MMBTU/FTE/year
Previous Year (2009):	48.62	MMBTU/FTE/year
Current Year (2010):	45.09	MMBTU/FTE/year
Benchmark[1]:	327.00	MMBTU/FTE/year
% Reduction from Baseline:	33%	
% Reduction from Previous Year:	7%	

Baseline (2003):	0.17 MMBTU/SF/year
Previous Year (2009):	0.12 MMBTU/SF/year
Current Year (2010):	0.11 MMBTU/SF/year
Benchmark[2]:	0.13 MMBTU/SF/year
% of Energy from Renewable Source:	2.6%
% Reduction from Baseline:	35%
% Reduction from Previous Year:	10%



MISSION SUPPORT ENERGY USAGE[4] (INCLUDES COMMUTING[3])

[1]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 7.54 mTons/FTE.
[2]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 20.44 mTons/1,000 SF.
[3]Greenhouse gases from personal commuting (i.e., back and forth to work) is not included in the Mission Support Transportation calculation table because personal commuting is not part of the SSPP goals. However, in order to gain an understanding of the base's energy/carbon footprint from commuting it is included in the pie chart as a percentage of the Mission Support footprint.
[4]Definitions for pie chart categories can be found in IV. Glossary of Terms and Abbreviations.
[5]Mission Support—Transportation includes ground fuel and mission support fuel quantities shown in the pie chart.
[6]Mission Support—Facilities includes electrical and building fuels shown in the pie chart.
(A) = Data is incomplete.

2a. Shaw Energy Usage - Flying Mission

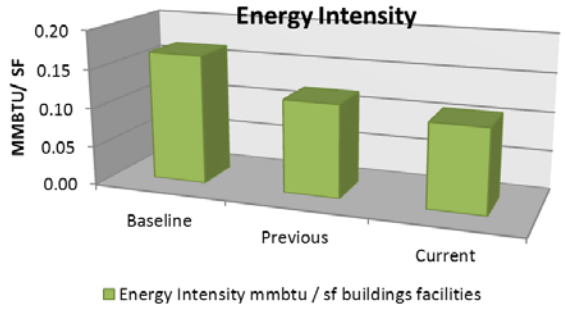
Annual Total Flying Mission Energy Usage for Shaw AFB is 1,249,427 MMBTU

FLYING MISSION

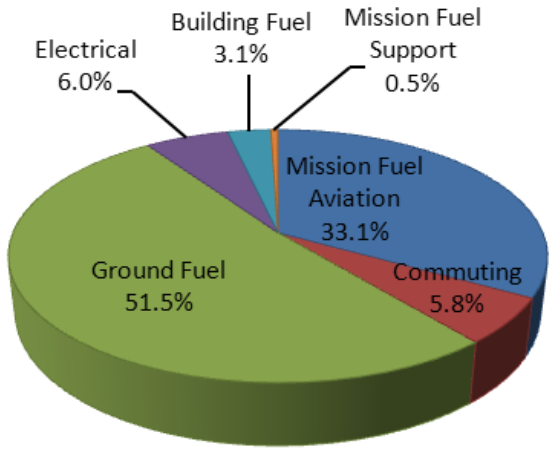
Annual Total Energy Usage:	1,249,427	MMBTU	
Baseline (2003):	(A)	MMBTU/FTE/year	**Per FTE**
Previous Year (2009):	234.66	MMBTU/FTE/year	
Current Year (2010):	164.57	MMBTU/FTE/year	
Benchmark[1]:	327.00	MMBTU/FTE/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	30%		

Baseline (2003):	(A)	MMBTU/SF/year	**Per Built SF**
Previous Year (2009):	0.58	MMBTU/SF/year	
Current Year (2010):	0.39	MMBTU/SF/year	
Benchmark[2]:	0.40	MMBTU/SF/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	32%		

Energy Intensity per Square Foot of Total Building Space



Flying Mission, Support, and Commuting Energy Usage Percentages



TOTAL ENERGY USAGE[3]
FLYING, SUPPORT, AND COMMUTING

- % of total energy from a renewable source
  for Mission Support is 0%
  for Flying Mission is 0%

[1]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 7.54 mTons/FTE.
[2]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 20.44 mTons/1,000 SF.
[3]Definitions for pie chart categories can be found in IV. Glossary of Terms and Abbreviations.
(A) = Data is incomplete.

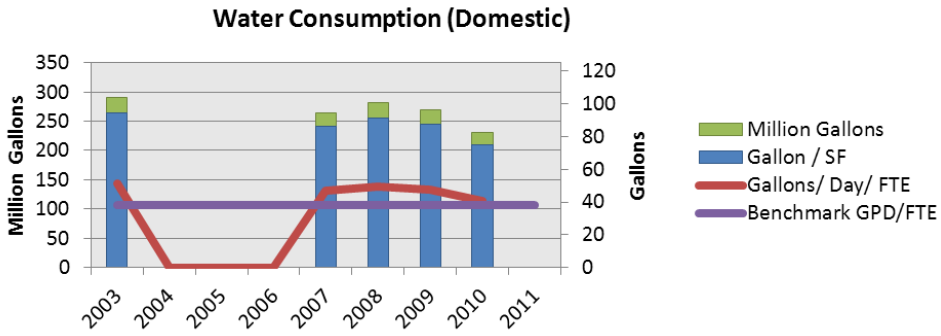
3. Shaw Water Conservation

ACC and Shaw AFB jointly need to establish a goal for the installation's water conservation. Currently, based on industry benchmarks, Shaw AFB has average water consumption per FTE.

MISSION SUPPORT

Annual Total Water Consumption:	231.18	Million Gallons	
Baseline (2007):	46.77	Gallon/FTE/day	**Per FTE**
Previous Year (2009):	47.64	Gallon/FTE/day	
Current Year (2010):	40.83	Gallon/FTE/day	
Benchmark[1]:	28-38	Gallon/FTE/day	
% Reduction from Baseline:	15%		
% Reduction from Previous Year:	14%		

Baseline (2007)):	85.94	Gallon/FTE/day	**Per Built SF**
Previous Year (2009):	87.53	Gallon/FTE/day	
Current Year (2010):	75.02	Gallon/FTE/day	
Benchmark[2]:	-	Gallon/FTE/day	
% Reduction from Baseline:	15%		
% Reduction from Previous Year:	14%		



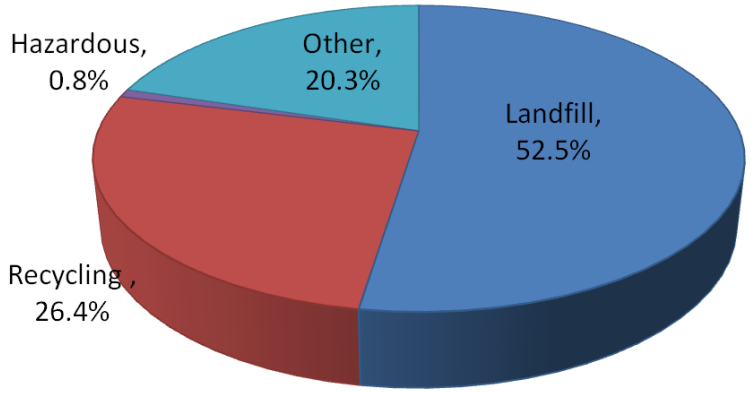
[1]Per Yudelson Associates, Benchmarking Campus Sustainability, 2010.
[2]Benchmark has yet to be established relative to an AFB. This could be established either through the initial ISA investigation or through an additional research project.
(A) = Data is incomplete.

4. Shaw Waste Reduction

ACC and Shaw AFB jointly need to establish a goal for the installation's solid waste reduction. Currently, based on industry benchmarks, Shaw AFB produces a low amount of solid waste.

MISSION SUPPORT

Annual Total Waste Production:	1,896	Tons	
Current Year (2009):	0.67	LBS/FTE	Per FTE
Benchmark[1]:	4.62	LBS/FTE	
Current Year (2009):	1.20	LBS/FTE	Per Built SF
Benchmark[2]:	-	LBS/FTE	
% Non-Hazardous Waste Diverted from Landfill	33%		



- Total % of composted waste material
  Currently is 0%

[1]Per the USEPA Municipal Solid Waste in The United States: 2007 Facts and Figures, the annual municipal solid waste (MSW) generation rate in 1960 was just 2.68 pounds (lbs) per person per day; it grew to 3.66 lbs per person per day in 1980, reached 4.50 lbs per person per day in 1990, and increased to 4.65 lbs per person per day in 2000. Since 2000, MSW generation has remained fairly steady. The generation rate was 4.62 lbs per person per day in 2007.
[2]Benchmark has yet to be established relative to an AFB. This could be established either through the initial ISA investigation or an additional research project.

5. Shaw Land Utilization

ACC and Shaw AFB jointly need to establish a goal for the installation's land utilization. Currently, based on industry benchmarks, Shaw AFB building density is significant under the benchmark of 60,000 SF/acre while the amount of square footage per FTE is significantly higher than the benchmark. Additional studies and comparisons among ACC installations need to be completed to provide a weighted opinion on land utilization.

MISSION SUPPORT

Total Building Density[1]:

Current Year (2010):	7,105	SF/Acre
Benchmark[2]:	60,000	SF/Acre
Previous Year (2009):	6,902	SF/Acre
% Change from Previous Year:	3%	

Total Building Utilization[5]:

Current Year (2010):	204	SF/FTE
Benchmark[3]:	160	SF/FTE
Previous Year (2009):	199	SF/FTE
% Change from Previous Year:	3%	

MISSION SUPPORT

Total % Green Space[6]:

Current Year (2010):	75%	
Benchmark[4]:	-	
Previous Year (2009):	75%	

Total % Building/Impervious[7]:

Current Year (2010):	9%	
Benchmark[4]:	-	
Previous Year (2009):	9%	

Total % Building/Footprint[8]:

Current Year (2010):	65%	
Benchmark[4]:	-	
Previous Year (2009):	65%	

- 19,425 average daily traffic at the gates = 2.56 trips per FTE
- 10.47 people per acre of Mission Support developable area

[1]Building density = ACSES real property records, building square footage/property acreage.
[2]Per the U.S. Green Building Council (USGBC) LEED-NC guidelines, development density must be equal to or greater than 60,000 SF/acre.
[3]Per building code guidelines, the average gross square foot per FTE figured at 2 times code standard is 160.
[4]Benchmark has yet to be established relative to an AFB. This could be established either through the initial ISA investigation or through an additional research project.
[5]Building Utilization = ACSES real property records, building square footage/population
[6]% Green Space = Non-Built Green area/Total Installation area.
[7]% Building-to-Impervious = ACSES real property records and Geobase, usable building square footage/impervious area.
[8]% Building-to-Footprint = ACSES real property records and Geobase, usable building square footage/building footprint area.

E. Year-to-year Sustainability Indicators

This is the initial report for Shaw AFB; therefore, year-to-year comparisons do not exist at this time. For reports in future years, comparisons will be provided for the established sustainability indicators:

1. **Carbon Footprint**
2. **Energy Usage**
3. **Water Conservation**
4. **Waste Reduction**
5. **Land Utilization**

F. Current Sustainability Initiatives

Over the years, Shaw AFB has undertaken a number of initiatives to reduce their consumption of natural resources and their impact on the environment. Future actions planned for the base should enhance and improve upon past actions.

Energy Conservation

The installation has been operating an Energy Monitoring Control System (EMCS), using mostly Barber-Coleman 8000 controllers monitored by a front-end system by Signal. The system is not well integrated and some components may be obsolete. Shaw AFB is currently using the system for monitoring of connected buildings and can only control a few buildings from a central control system. Shaw AFB intends to upgrade the existing system with BACnet-compatible products and a control system front end, produced by Automated Logic.

- Shaw AFB has re-lamped many of the existing light fixtures at the base through Energy Savings Performance Contracts (ESPCs) or Utility Energy Service Contracts (UESCs), which have since been bought out by the Air Force.
- Shaw AFB has completed a program of retrofitting some facilities with occupancy sensors for lighting as well as power strips with occupancy sensors for computer peripheral devices. New construction should also incorporate occupancy sensors in practical applications.
- Shaw AFB is focusing on reducing energy consumption by improving the lighting controls used at the aircraft shelters on the ramp. The shelters currently account for two percent of total base energy. A primary reason for this is the lighting is often left on all day and all night. Shaw AFB is undertaking action to mitigate this problem by educating the users as well as planning simpler lighting controls that are easier to manage.
- Shaw AFB has limited submetering in place for invoicing tenants at the base for utility consumption. Shaw AFB has completed a project to install advanced electric and gas metering in facilities larger than 35,000 SF and a select number of other buildings with high-intensity energy use. The advanced meters are not currently tied into the existing EMCS, which is a goal for updates to the EMCS, as discussed above.

Water Conservation Initiatives

Water conservation at Shaw AFB has so far focused primarily on improved operations of the existing water treatment and delivery system to reduce the occurrence of overflows from water storage tanks. Efforts to date have reduced total water consumption statistics 15 percent relative to the 2007 baseline for evaluation.

- New construction at Shaw AFB is incorporating new water-saving technologies. These technologies should continue to be implemented in new construction and renovations projects, although waterless urinals are not considered desirable at Shaw AFB.
- A Sewer System Evaluation Survey (SSES) was completed for Shaw AFB and a list of four improvement projects was developed from the recommendations.

Waste Reduction Initiatives

Shaw AFB operates a waste management program that maximizes recycling and reuse of materials at the base within the limitations of current funding policies.

- Shaw AFB operates an open-bin recycling center where anyone on base can deliver recyclable materials of a larger variety and size than are accepted at other locations on base. Base staff uses a Pac Bloc to increase density in containers, which are hauled based on unit cost instead of based on weight, to reduce cost for equal quantities.
- An active reuse program at the base has been effective for waste diversion. The primary requirement for the program is space to store items until claimed for reuse. The reuse program has in the past extended to local agencies off-base, but reuse activity is currently restricted to on-base agencies and personnel.
- Shaw AFB previously utilized low-cost inmate help from the state department of corrections for sorting recyclable materials to increase value of material sales. The program was discontinued due to restrictions on sharing revenue with the department of corrections; sharing revenue was necessary to cover costs for the help.
- Shaw AFB operates a used oil and mixed fuel recycling program that generates revenue. Revenue is applied towards purchase of clean absorbents and disposal of used absorbents.
- Shaw AFB staff participates in an Air Force HAZMART forum for redistribution of un-needed HAZMART materials to bases where they are needed.
- Shaw AFB recently discontinued its plastic recycling program because of increasing costs

G. Guidance Compliance Summary and Matrix

Refer to Appendix C to review required compliance with current Federal guidance.

IV. RECOMMENDATIONS

The Shaw AFB team has already implemented programs to reduce energy and potable water use and enhance the environment on base. Shaw AFB stands out for its implementation of an active reuse program, land planning that incorporates sustainable design principles, and self enforcement of stormwater quality programs. The first recommendation to staff at Shaw AFB is to "keep doing what you're doing," because the team has already achieved substantial progress on the front of waste and water quality management. However, even more will be expected in the future. To name just a few of the demanding goals[2] ahead for members of the federal government, by 2030, all new buildings will need to reduce their fossil fuel-generated energy consumption by 100 percent and, by 2020, greenhouse gas emissions must drop by 28 percent and potable water usage must drop by 26 percent. This is not the first round of tough energy and water reduction goals faced by the Air Force and by the Shaw AFB team, and over the last 20 years some of the "low-hanging fruit" has been "picked". Our further recommendations to help achieve the new goals fit into the following categories:

- Further reduce consumption of utilities by continuing with programs that are low-cost, high-return—the rest of the "low-hanging fruit."
- Encourage implementation and/or extension of existing successful programs.
- Enhance sustainability on base for free by making the most of natural solutions that mimic ecosystem services and by capitalizing on existing natural assets such as the sun.
- Implement some high-hanging fruit ideas for long-term, significant improvement, possibly requiring programming and investment. Small, incremental gains alone, in many cases, will not be enough to meet the extremely ambitious requirements mandated by the federal government.

Ultimately, the following recommendations should be used to develop a prioritized group of projects.

A. Carbon Footprint

Shaw AFB receives all of its purchased electricity from two local utility companies, Progress Energy and Black River Electric Co-op. At present, Progress Energy produces electricity from a diverse mix of fuel sources, including hydroelectric (1%), nuclear (19%), coal and oil (38%), natural gas combustion turbine (25%), and combined cycle (17% - mix of gas and oil). Black River Electric Co-op delivers energy generated from a mix of fuel sources, including nuclear (48%), coal (50%), natural gas (<2%), and renewables (including methane gas and solar; <2%).

A.1 Issue/condition: The applicability of renewable energy technologies varies from installation to installation. Shaw AFB has limited application of renewable energy technologies currently in place at the installation (only geothermal was noted during the site visit) to create a basis of comparison. Shaw AFB should incorporate several varieties of technologies into new projects to provide a basis for comparison for incorporating renewable technologies at the project level in the future.

Recommendation: EISA §523 calls for 30 percent of hot water demand to be solar thermal for the federal government as a whole. Shaw AFB has reasonable solar potential (average 5 kWh/m^2/day), which should be sufficient to incorporate solar thermal water heating into new construction and renovation projects. If further examination of solar thermal water heating systems shows them to be cost effective during the life cycle, the base should attempt to achieve a minimum of 30 percent and

[2]See Appendix C for a crosswalk of federal requirements.

potentially exceed the 30 percent goal to mitigate the lack of solar thermal water heating at other installations with climates that are not effective for this technology. If used, thermal panels using evacuated tube technology should be considered for this purpose, since damaged tubes can be easily replaced without water leaks from the panels. In any event, with any new construction the base should consider the potential for adding solar systems and should design the buildings and the mechanical systems in a manner that makes the facility as solar-ready as possible.

Recommendation: Consider strategies for incorporating solar thermal energy to supply heating for buildings, including solar heating walls utilizing thermosiphoning with operable dampers to accept heat input during the winter and discontinue use during warmer summer months. Adaptations with vents, to allow discharge of warmed air to the outside, can also assist with natural air ventilation during more temperate spring and fall months. These principles may be more applicable to shops and warehouse areas than office spaces.

Recommendation: Once more technologies are implemented, Shaw AFB staff should study or engage a consultant in a study to measure and verify the benefit of the project-level installed technologies. The study should include a new or updated projection of life-cycle cost of the technology, based on measured benefit. The study should be summarized in a report identifying the measured benefit and actual perceived life-cycle cost that can be considered by designers to maximize the renewable energy potential of new projects at the installation.

A.2 Issue/condition: There is a tendency to maintain the facility's dependence on the local utility for electricity, which is understandable. However, the more developed the facility's own ability to generate power is, especially through the use of renewables, the more centralized the heating and cooling systems may become. At present, there are no efforts at Shaw AFB to decrease the dependence on outside energy producers. Development of a waste-to-energy plant, using on-site and off-site municipal solid waste as a fuel source, has previously been determined through a Renewable Energy Screening Analysis completed in august 2010 as the most feasible large-scale renewable energy technology for implementation at Shaw AFB. The study determined that an electric generation facility has better economic potential than a thermal facility; although, a co-generation facility that would generate power through combustion, to develop steam to turn turbines to power the electrical grid and provide heating and cooling with steam powered chillers, was not directly considered. Such a facility may also prove economical, depending on the siting of the facility with respect to other facilities that would use the thermal energy.

The use of fewer, larger pieces of equipment in central plants can result in energy savings and decrease maintenance costs. For example, the larger a chiller is, the smaller the cost per ton is for maintenance, and the fewer the number of pounds of refrigerant per ton is required to generate air conditioning. A central location for servicing the equipment and storing parts, tools, refrigerants, and chemicals can minimize maintenance and enhances safety for the maintenance staff and building occupants.

Central heating/cooling systems have lost favor at some Air Force bases due to a misconception that the distribution system is maintenance intensive. This is based on most recent experiences at bases with distribution lines that were nearing the end of their design lives. New distribution lines (pipes) require very little maintenance once they are installed in the ground and have a life expectancy of 50 plus years in most cases. If distribution lines are programmed for maintenance and eventual replacement at the end of their design lives, the overall cost of maintenance should be less. Central systems with underground distribution pipes could include the following:

- Steam and steam condensate at anywhere from 15 to 150 lbs. per square inch
- Heating hot water at anywhere from 120°F to 350°F (medium temperature, pressurized hot water system)
- Ground-source Geothermal with temperatures from 35° to 95°F
- Solar Thermal with temperatures from 120° to 210°F for heating systems or domestic hot water systems
- Compressed air
- Chilled water for air conditioning with temperatures from 38°F to 50°F
- Ice storage water with temperatures from 35° to 45°F
- Condenser water from cooling towers to chillers or heat pumps at temperatures from 35° to 95°F
- River water (another geothermal resource) for condenser water on chillers or heat pumps at temperatures from 35° to 85°F.

Recommendation: Waste-to-energy projects can provide long-term dividends for reducing energy cost and meeting federal requirements. Executive Orders 13423 and 13514 mandate renewable energy goals for the federal government as a whole, and MSW incineration and biomass combustion are considered "renewable" for purposes of compliance. EPAct 2005 §203 dictates that the facility receives double credit towards the renewable energy mandate for generating that energy on a federal facility. In considering this type of project, the base must also account for its impact on other environmental and sustainability considerations, such as potentially negative impacts on air quality and positive impacts on solid waste management and the local economy.

A.3 Issue/Condition: The average commuting distance for Shaw AFB personnel is estimated at 10 miles for appropriated funds employees, and traffic congestion is relatively minor. As a result, alternative modes and methods of transportation to/from the base have never been fully embraced, although a ride-share program has been outlined and only needs staffing in order to be implemented.

Recommendation: Implement the planned ride-share program to encourage carpooling. Provide preferred parking (the closest spots to the building aside from handicap parking) for car/vanpools. Preferred parking spots not only encourage ride sharing but also contribute to Leadership in Energy and Environmental Design (LEED) certification of buildings.[3]

Recommendation: At an average of 15 mph (a reasonable speed for an inexperienced cyclist), a bicyclist can do a four-mile commute in 16 minutes. At 10miles for the average commuter at Shaw AFB, this means over a 40 minute commute, likely along busy roadways, which may not be very appealing to most individuals. However, once on the base, the relatively small size of Shaw AFB's area makes it easy to traverse on a bike for small errands. Therefore, the purchase of unit-owned bikes (with helmets and a lock) for use on and around the installation should be considered. These bikes can be used for free by unit personnel for short-distance errands within the administrative, unaccompanied housing, and flightline areas of the installation without the inconvenience of moving a car and finding a parking spot for a short trip. Installation of bike racks at main facilities on the installation would complement the purchase of unit-owned bikes. Having bikes available for use on base would also support participation in a ride-share program since ride-sharers would have an alternate means of transportation available.

[3]To earn LEED Credit 4.4 "Alternative Transportation: Parking Capacity" under Option 1, a building project must fulfill two requirements: the size of parking capacity must not exceed minimum requirements and the facility must provide preferred parking for carpools and vanpools for 5 percent of the total provided parking spaces.

In conjunction with unit-owned bikes, the base should accommodate bike travel on main thoroughfares by programming key roads with a wide shoulder or bike lane. Bikeways targeting commuters would connect the primary mission areas with the services/administrative areas and the on-base housing. Alternately, the base could consider providing additional combined bike/running trails for access between the identified areas.

A.4 Issue/Condition: The 3rd Army has recently moved to new facilities, located east of the runway at the base. The runway, flightline and industrial facilities create significant separation (approximately 1.5 miles) between the 3rd Army facilities and the community amenities of the base. Personnel currently access these amenities by driving personal vehicles.

Recommendation: Shaw AFB should investigate the feasibility of a shuttle bus between the 3rd Army area and the community amenities area of the base. The shuttle bus would decrease the total POV miles on the base and would support a ride-share program by removing dependence on POVs for on-base access, both for 3rd Army personnel on base, as well as Air Force personnel attempting to travel within the main cantonment. A shuttle bus program may need to include an express route from the ARCENT HQ building to the commissary and BX during lunch hour to make the shuttle convenient for use.

B. Energy Usage

Shaw AFB staff have been involved in number of projects to reduce energy consumption. Some of these initiatives are built around improving efficiency, through the use of improved lamp ballasts and variable frequency drives on some HVAC equipment. Others are built around reducing energy waste, through improving aircraft shelter lighting controls to eliminate unnecessary daytime lighting and installing occupancy sensors to eliminate lighting of unoccupied interior spaces. Future projects at Shaw AFB should continue the trend of previous projects to reduce energy use, as well as supplement fossil-fuel-based energy use with renewable energy technologies.

B.1 Issue/condition: Shaw AFB's operations staff is lacking current and detailed energy use data that would be helpful for evaluating overall real-time performance of the facilities at the base, as well as individual performance of each building. The existing Energy Management Control System (EMCS) was noted by staff as being limited for the most part to system monitoring from a central station, with very little ability to control systems from that central point. The recently-installed advanced metering also does not currently report to a central location for access to data.

Recommendation: Shaw AFB would benefit from an update to the EMCS that would include a uniform system of controls and advanced meters, tied to a central control station. Having access to the advanced metering systems would enable the installation energy managers to monitor and document in real time the largest energy users and their energy profiles in order to establish programs that would potentially minimize energy usage and costs related to energy billing rates. With a system that ties in both the EMCS and advanced meters in existing facilities, buildings with both systems in place can be reviewed by the energy managers to identify energy wasters and implement demand-controlled operations programs. Such programs can be based on daily (instead of average monthly) operations to reduce energy costs and make them more energy efficient. Once buildings with existing systems are fully tied in, EMCS and advanced metering systems can be extended to other facilities based on intensity of energy use.

Recommendation: Level 1, Level 2, or Level 3 energy audits may be appropriate for major energy users at Shaw AFB, as may be identified with the data collected through the advanced metering

systems.. The energy audits may identify that retro-commissioning programs may be appropriate for some major energy users in order to fine tune the mechanical systems already in place and ensure the buildings are operating as efficiently as they were designed. During this process, existing problems with HVAC, plumbing, and electrical systems, which may be affecting energy consumption, will be discovered, and funds will subsequently be justified for necessary repairs. An example of the benefit of audits is the energy savings identified for fixing lighting controllers on the existing aircraft shelter lighting systems. This program should be continued until all major facilities have been placed into as-new conditions.

Recommendation: Install economizers as part of new HVAC systems to use free-cooling when outside air temperatures are low and cooling is required. Some buildings with energy management control systems (EMCSs) can also use CO_2 monitors to reduce ventilation demand in large spaces when they are lightly staffed so that ventilation equipment doesn't run unnecessarily. Continue this practice on new construction and major renovations for energy savings. This practice also contributes to LEED credits for indoor environmental quality and energy savings.[4]

Recommendation: The installation may consider a study of the nighttime uses of lit parking areas to determine if all parking areas require the lighting that is currently used. If carried over to the daytime use of parking areas, the study may also show that a reduction of parking area is appropriate(Refer to recommendations for Land Utilization for additional recommendations of parking area analysis). Staff has been investigating wireless control technology that can assist in limiting the unnecessary lighting of unused areas once they are identified.

B.2 Issue/condition: Reducing the installation's energy intensity (on a BTU/SF basis) and increasing the use of non-fossil-fuel-generated energy is a complex problem that will only be solved by looking at the installation energy situation in a holistic way. The installation's infrastructure and facilities systems need to be evaluated, and a resulting energy master plan and program need to be developed as the result of analyzing a tremendous amount of facility, equipment, and energy usage data. An integrated energy master plan can discover installation-wide energy savings on the order of 50 percent or better and identify geographically-appropriate sources of renewable energy. The function of the master plan is to identify the projects that not only provide the best potential for meeting the goal of 30 percent energy savings by 2015 (EISA §431) and renewable energy goals, but also show economic benefit through a life-cycle cost analysis. An energy master plan goes beyond quick payback periods and individual building projects to illuminate the high-hanging fruit that can provide an order of magnitude improvement in energy savings across the entire installation.

Recommendation: Develop an energy master plan to discover the best alternatives to achieve EO, EISA and EPAct mandates. An energy master plan will identify an installation-wide strategy that not only decreases Shaw AFB's carbon footprint, but also saves energy use and cost. Alternatives that would be studied and vetted by an energy master plan team would include the following:

A. Use combined heat and power plants (co-gen) that burn biomass or biofuel, if possible, and natural gas, if not. The study would weigh the benefit of on-site renewable energy generation against the cost of energy provided by the Progress Energy and Black River Electric Co-op. Consider re-implementing district heating and cooling plants on either a large or a more local district scale. Although a single district heating and cooling plant may not be feasible for serving all of the facilities at Shaw AFB, due to the large separation of the 3rd Army facilities from the

[4]LEED Indoor Environmental Quality (EQ) Credit 1–Outdoor Air Delivery Monitoring and Energy and Atmosphere (EA) Credit 1–Optimize Energy Performance.

main cantonment area, districts could be developed within each area that would still provide net benefits for reducing energy use and maintenance.

- District heating enables the use of co-generation plants to heat and power multiple buildings, independent of local utilities. In lieu of steam distribution, a high-temperature hot water system that distributes hot water under pressure could be used to minimize construction and maintenance costs of the distribution network.

- District cooling plants provide the most energy-efficient means to produce air conditioning and also allow more use of thermal energy storage (TES) (such as ice storage) to perform electrical peak savings. Developing chilled water overnight results in approximately seven percent savings due to the generation occurring during cooler hours of the day.

B. Change over facilities that use electric heat to heat pumps or district heating. A master plan would likely recommend, at a minimum, converting electric-only systems to heat pumps in places that are both heated and air conditioned, which would also allow retrofitting to district heating in the future.

C. Replace existing heating boilers (and hot water heaters) to 94 percent or higher condensing-type boilers in the event that district heating cannot be used.

D. Use ground source geothermal heat pump systems for future heating and cooling projects, if the projects are at remote locations and cannot feasibly be placed on a district system.

E. Use variable refrigerant flow systems that can use internal space heat gains to minimize heating required for the exterior envelope of buildings as an alternative to water-source heat pump systems.

F. Recommend locations for installation of additional advanced meters for electricity and gas to enable individual users to monitor their energy use. Real-time energy use displayed in each facility can result in a significant savings since users take charge of their own habits.

G. Expand the installation of the comprehensive facility-based EMCS that allows trained operations staff to continuously monitor and modify energy use.

B.3 Issue/condition: Air-cooled air conditioning systems require 1.25 to 1.5 kW per ton of air conditioning to develop the required cooling. Water-cooled systems with screw machines or centrifugal compressors can develop chilled water for air conditioning at less than 1 kW per ton. Not only is the low efficiency of the air cooled units creating a greater carbon footprint than water-cooled equipment, but the loss of refrigerant from the systems is increasing greenhouse gas emissions.

Recommendation: Water-cooled systems for larger facilities will save considerable electrical energy and decrease the amount of refrigerant lost from air conditioning equipment. A large central chiller facility providing chilled water to districts of the installation can provide even more significant savings in energy and greenhouse gas emissions. The large distribution system acts as a thermal reservoir (the "flywheel" effect) that a diverse group of buildings use, and a central plant is more efficient in aggregate and easier to maintain than many smaller air conditioning units. Central chilled water plants provide significant opportunities to not only save on energy use (and therefore decrease the carbon footprint), but also can provide the following benefits:

- Potentially lower maintenance costs and staffing requirements
- Less lost refrigerant per year
- Increased occupant safety (because no refrigerants are inside occupied buildings)
- Improved controllability of air conditioning energy use

- Opportunity for use of Thermal Energy Storage tanks to decrease peak demands
- Opportunity for ice storage to decrease peak demands and improve dehumidification capability
- Ability to design chilled water systems for higher temperature gradients, saving energy and installed costs
- Potential for combined heating and cooling with a chiller/heat pump arrangement
- Increased useful space in existing buildings by removing mechanical equipment from buildings
- Elimination of eyesores and the potential for Legionnaires Disease by removing cooling towers where existing water-cooled units are installed. This change would also eliminate the need to store chemicals in occupied facilities.

Recommendation: Consider building Thermal Storage Batteries, similar to ice storage banks, and tie the buildings together with distribution piping to enable the use of either thermal solar systems or ground-source heat pump systems or chiller heat pumps to store low-temperature hot water for heating buildings.

B.4 Issue/Condition: Shaw AFB uses the ACC Sustainable Design and High Performance Green Building Design Scorecard as its green building self-assessment metric. The scorecard assembles and consolidates Executive Orders, Public Laws. and Federal Agency rulemaking on Sustainable Development and High Performance Green Building Design requirements with the LEED Rating System. Using the scorecard is a way to achieve the desired LEED rating and meet critical statutory minimum requirements.

When applied in context, the scorecard rating system can illuminate opportunities for sustainable design, often with low- or no-cost choices. Some choices carry an upfront cost, but they provide long-term operational cost savings and value-added building features. Starting with programming, the base can direct the design and construction of a building to achieve certain LEED and other federal requirements; base-level engineers can determine which requirements add the most value and advance the base towards its specific sustainability goals. Without direction otherwise, contractors often choose to satisfy requirements based on up-front cost alone.

Recommendation: Use the ACC scorecard requirements to guide and inform building projects towards lower life-cycle costs and enhanced sustainability.

Recommendation: Train the programming staff and design/engineering staff in the LEED Rating System and scorecard application.[5] A scorecard checklist must be completed for military construction projects, and can also be completed for Sustainment, Restoration, and Modernization building projects to inform their design. The checklist outlines a strategy that will inform all other stages of building design, so it is critical that base-level programmers understand LEED and the application of the scorecard; how it supports broader energy, water, and sustainability goals; and how to choose appropriate points for building projects. The base would do well to have at least one staff member become a LEED AP® or LEED® GA to be a go-to person for assistance with LEED requirements.

Recommendation: Enhanced commissioning of new buildings is a scorecard credit that carries an upfront cost to implement, but provides value to the installation in reducing long-term energy and maintenance costs.[6] As building energy systems become more advanced to meet higher levels of energy efficiency, commissioning becomes even more critical to assure those energy systems function as

[5]AFIT's Civil Engineer School offers a one-week course in LEED, for example.
[6]"The Cost-Effectiveness of Commercial Building Commissioning," by Lawrence Berkeley National Laboratory (LBNL), 15 Dec 2004.

intended. We recommend enhanced commissioning because of the rapid payback period and long-term operational cost savings.

Recommendation: Choose roofing material and color to earn scorecard credits. For low-slope roofs (≤2:12), the roof surface must have a Solar Reflectivity Index (SRI) of 79 or greater, and for steep-slope roofs (>2:12) an SRI of 29 or greater is required. One bronze-colored, standing-seam-metal roof product is now available that meets these requirements; however, lightening the color of the roof would bring greater reflectivity and a reduction of heat gain into facilities. Implementing more of the light-colored beige, standing-seam-metal roof being used on some buildings at the base would help to achieve this goal.

Recommendation: When siting a building and developing early schematic design, maximize the shape and orientation of the building with respect to the sun for passive solar heating, cooling, and daylighting. This siting will maximize the energy performance the building achieves for free as a result of the sun and will help earn points in several categories.

Recommendation: Site buildings in places where occupants can walk or bike to adjacent services and amenities instead of driving, ideally embodying the LEED concept of "Community Connectivity."[7] Include safe pedestrian paths and bikeways in base development plans. As the east part of Shaw AFB grows, consider some community amenities to reduce or eliminate the need to travel across base to the community center.

Recommendation: Set aside 5 percent of parking for car/vanpools and 5 percent for low-emitting vehicles in preferred locations near building entrances. This embodies the LEED concept[8] and encourages alternative transportation.

Recommendation: Maximize water use reduction in all new buildings. By choosing plumbing fixtures that use less water than the fixture requirements passed in the Energy Policy Act of 1992, projects can earn scorecard points[9] and will also assist the base in achieving the potable water reduction goal of 26 percent reduction by 2020 compared to a 2007 baseline.[10]

C. Water Conservation

Water conservation at Shaw AFB has so far focused primarily on improved operations of the existing water treatment and delivery system to reduce the occurrence of overflows from water storage tanks. Efforts to date have reduced total water consumption 15% relative to the 2007 baseline for evaluation. Installation of low-flow fixtures has been mostly limited to new construction projects.

C.1 Issue/Condition: Executive Order 13514 requires a 2% annual reduction in potable water consumption through FY 2020 relative to a FY 2007 baseline, for a total reduction of 26% relative to 2007. This requirement is reinforced in the Department of Defense Strategic Sustainability Performance Plan. Although Shaw AFB is currently ahead of its goal with the improvement in operations, further reductions will be necessary to achieve the 26% total reduction requirement.

[7]Sustainable Site Credit 2.
[8]Sustainable Site Credit 4.3 and 4.4.
[9]Water Efficiency Credit 3.1, 3.2 and Innovation and Design Credit 1 are all achievable by achieving gradually higher water efficiency. Under LEED NC v2.2, a maximum of three points can be earned by reducing water use by 40 percent. Under LEED NC v3, a maximum of five points can be earned with 45 percent water use reduction.
[10]Executive Order 13514 §2(d)(i).

Recommendation: Because Shaw AFB has so far been able to reduce water use by operations improvements, other simple improvements such as retrofitting of existing fixtures with new low-flow fixtures with automatic sensors will be able to provide a significant next step towards the water reduction goal for Shaw AFB. However, the relatively low cost for Shaw AFB to produce the water ($0.59/kGal in FY 2010) does not provide for a significant payback for installing low-flow fixtures.Shaw AFB staff will need to make a case for the expenditure, based on requirements to meet water reduction goals.

Recommendation: A program to educate personnel at Shaw AFB on practices to reduce water use and the importance of reducing water use (environmental and policy enforcement) may also help the base towards attaining the reduction goal. Public education has been demonstrated to reduce per capita water use by over 22% during drought conditions.[11] The challenge to Shaw AFB staff is to create an education program that makes reducing everyday water use to meet policy goals as important as reducing water use during drought periods. Educational opportunities for Shaw AFB could include mock billing based on standard local rates (instead of Shaw's actual per gallon cost that is billed), posting of total daily water use of the base at key locations on base, and educational signage in restrooms on base.

C.2 Issue/Condition: The SCADA system on the water treatment and distribution system of the base currently works only for monitoring the wells and tanks that are part of the system, instead of being able to monitor and control those components. The resulting lack of control has led to overflows of the water tanks, spilling treated water. Improved daily operations have reduced the volume of the spillage by 15%; however, it requires a lot of manhours to sufficiently monitor and adjust the system to operate without overflows.

Recommendation: Shaw AFB can reduce manhours spent on controlling the treatment/distribution system with an update to the SCADA system that will allow control from a central point. Central control with an operating program can help to further reduce or even eliminate overflows of the system. Manhours can be redirected to maintenance and repair of other portions of the system to further improve potable water efficiency at Shaw AFB.

D. Waste Reduction

Shaw AFB operates a waste management program that maximizes recycling and reuse of materials at the base within the limitations of current funding policies. Recycling activities have been maintained by finding innovative ways to reduce program costs, and waste materials are diverted or repurposed to the extent feasible in the region.

D.1 Issue/Condition: Shaw AFB recently had to discontinue its plastic recycling program because of increasing costs of disposal. The plastic recycling program covered standard post-consumer recycling at buildings, as well as recycling of shrink wrap baled by the commissary from goods delivered there.

Recommendation: Recycling of standard materials, including plastic, is a prerequisite for LEED certification of new construction (LEED BD+C 2009, MR Prereq. 1), under which all new building construction projects at the base are to be certified. The rating system requires new buildings provide an area dedicated for collection and storage of recyclable materials, which "include at a minimum paper, corrugated cardboard, glass, plastics and metals." Any project that does not meet this prerequisite cannot be LEED certified. Shaw AFB will need to reinstitute a plastic recycling program

[11]Denver Water Conservation calculated an average per capita reduction from 211 gallons per day to 165 gallons per day.

that will, at a minimum, support all new buildings at the base that are to receive LEED Silver certification. Shaw AFB should investigate reinstituting a base-wide program of plastic recycling to help with base-wide waste diversion. Collecting a larger volume of recyclable plastic material may reduce overall cost per pound to haul the material by shipping in a larger bulk.

D.2 Issue/Condition: Shaw AFB operates an open-bin recycling center where anyone on base can deliver recyclable materials of a larger variety and size than are accepted at other locations on base. Base staff uses a Pac Bloc to increase density in containers, which are hauled based on unit cost instead of based on weight, to reduce the frequency and cost of hauling charges.

The base also operates an active reuse program that has been an effective program for waste diversion. The primary requirement for the program is space to store items until claimed for reuse. The reuse program has in the past extended to local agencies off-base, but reuse activity is currently restricted to on-base agencies and personnel.

Recommendation: As recommended by the Shaw AFB recycling manager, the base should develop a larger, covered recycling center to accommodate storage for a greater quantity of materials that would allow for use of larger containers that would reduce hauling costs. The center could also act as a central waste management point, where waste managers at the base could assist personnel with appropriate assignment of waste items for reuse, recycling, or actual wasting of non-useable material. Joint Base Langley-Eustis has an example of a central waste management facility that increases waste diversion; it could be a model for a similar facility at Shaw AFB.

E. Land Utilization

E.1 Issue/Condition: By 2030, all new buildings will need to reduce their fossil-fuel-generated energy consumption by 100 percent, with intermediate goals in the intervening years (i.e., 50 percent by 2010). The Air Force is also required to reduce its energy intensity (BTUs/SF) by 30 percent by 2015, and to reduce greenhouse gas emissions by 28 percent by 2020. Enacting such dramatic improvements in energy efficiency without dramatic construction cost increases will require taking maximum advantage of "free" energy savings. Passive solar design of buildings can reduce a building's energy demand by as much as 30 percent, at essentially no cost. Shaw AFB cannot afford to develop new buildings without maximizing solar orientation for energy savings.

Recommendation: Maximize solar orientation through land development planning. All future area development plans (ADPs) in areas without an established road system must be laid out and new buildings must be oriented such that solar heat gains/losses are optimized. This is generally with the long axis of buildings east-west and solar exposures to the north and south. The layout of new streets in an ADP often dictates the future orientation of buildings toward the street and as such, aligning the street grid according to the sun is critical. Aligning streets and buildings on an east-west axis will serve the dual purpose of also optimizing those buildings to host rooftop solar panels, should such an opportunity arise. To ensure compliance, any ADP or building not designed to optimize passive solar gains should require permission/review from a higher level of authority.

E.2 Issue/Condition: Shaw AFB uses the ACC Sustainable Design and High Performance Green Building Design Scorecard as its green building self-assessment metric. Use of the scorecard can illuminate opportunities for sustainable development, often with low- or no-cost choices. One

opportunity is called "Community Connectivity," which rewards development within a half-mile radius[12] of at least 10 community amenities (restaurants, library, shopping, churches, etc.) and high-density housing, such as dormitories or apartments. There must also be pedestrian access between the amenities, housing, and the building to earn scorecard credit. Shaw AFB can apply this metric to future developments and ADPs to see if a plan encourages mixed-use development and connectivity and will enhance the walkability and bikeability of Shaw AFB. Developing towards improved connectivity will have many "free" benefits, such as reduced vehicle miles traveled on base, reduced associated greenhouse gas emissions, and improved fitness for those who choose to walk/bike.

Recommendation: Develop, track, and improve over time a community connectivity metric for the installation. Measure the diversity of services/uses within an area with a half-mile radius around future development and use the metric to highlight and encourage mixed-use development. This practice will help achieve "free" but meaningful scorecard points.

Recommendation: Seek opportunities to redevelop existing streets as "complete streets" that encourage safe and comfortable transportation for all modes, including pedestrians, cyclists, motorists and future mass-transit shuttle stops, while incorporating sustainable design techniques to minimize the impact of the built infrastructure on the environment.

E.3 Issue/Condition: Shaw AFB has an attractive community of native, mature trees growing throughout the installation, including significant forested areas located on the east side of the runway in the 3rd Army area and south of the runway. Shaw AFB manages a forestry program as part of maintaining the health of the forested areas and is already recognized as a Tree City USA. The forested areas on base, primarily those adjacent to the boundary of the base, play an important role as a noise and visual buffer to adjacent off-base areas.

Recommendation: Continue to maintain the forested areas as noise and visual buffers. Besides helping to maintain the current relationship with off-base neighbors, the forested areas also provide significant environmental benefits of reducing the heat island generated by the base development (particularly the 3rd Army facility development interspersed in the forested areas) and maintaining storm water quality and runoff levels from those forested areas. Adding trees in in selective areas that are currently lacking tree cover will also provide similar benefits for those areas, as well as help to provide shading that could reduce building energy use and promote walking/biking on shaded paths.

Recommendation: To the extent it is feasible, give preference to deciduous trees that lose their leaves during the fall. All of the shade benefit that trees provide during summer months (reduced cooling load, shade on outdoor paths) is typically not as beneficial during winter months, when direct light on buildings and paths is beneficial for warming those areas.

[12]A half-mile radius was chosen because it is the distance a typical person is willing to walk instead of drive. It equates to roughly a five-minute walk.

V. GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Definition
Alternative work schedule	Work schedules that do not follow the traditional format of an 8-hour day Monday through Friday; alternatively compress the 40 hour work week into fewer days or allow staff to work remotely.
Aviation fuel	All special grades of gasoline for use in aviation reciprocating engines, as given in the American Society for Testing and Materials (ASTM) specification D 910. Includes all refinery products within the gasoline range that are to be marketed straight or in blends as aviation gasoline without further processing (any refinery operation except mechanical blending). Also included are finished components in the gasoline range, which will be used for blending or compounding into aviation gasoline.
Baseline	A standard reference case or condition used as a basis for comparison. Establishing a clearly defined baseline is important and defining a repeatable baseline is essential if the work is to be compared to results of other work.
Baseline year	The year in which the baseline was established.
Benchmark	A standardized problem or test case that serves as a basis for evaluation or comparison. The terms benchmark and baseline are often used interchangeably. Consistent and repeatable benchmarking requires clearly defined performance metrics and protocols for developing the reference case to serve as the baseline.
Buildable area	Land use classification areas including administration, aircraft operations and maintenance, community commercial, community service, manufacturing and production, and medical/dental.
Building Fuel	Includes gas, oil, and liquid propane gas used for buildings.
CO_2 equivalent	A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). CO_2 equivalents are commonly expressed as "million metric tons of CO_2 equivalents (MMTCDE)." The CO_2 equivalent for a gas is derived by multiplying the tons of the gas by the associated GWP. (MMTCDE = (million metric tons of a gas) * (GWP of the gas))
CO_2 equivalent (CO_2e)	A measure for describing how much global warming a given type and amount of greenhouse gas may cause, using the functionally equivalent amount or concentration of CO_2 as the reference. For a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same GWP, when measured over a specified timescale (generally, 100 years).
Carbon equivalent	A metric measure used to compare the emissions of different greenhouse gases based upon their GWP. Greenhouse gas emissions in the U.S. are most commonly expressed as "million metric tons of carbon equivalents" (MMTCE). GWPs are used to convert greenhouse gases to CO_2e–they can be converted to carbon equivalents by multiplying by 12/44 (the ratio of the molecular weight of carbon to CO_2). The formula for carbon equivalents is: MMTCE = (million metric tons of a gas) * (GWP of the gas) * (12/44)
Carbon footprint	The total set of GHG emissions caused directly and indirectly by an individual, organization, event or product.
Climate Registry	A nonprofit collaboration between North American states, provinces, territories, and Native Sovereign Nations to record and track the greenhouse gas emissions of businesses, municipalities and other organizations. Data submitted to the Climate Registry is inputted into the Climate Registry Information System (CRIS), which was developed on EPA's CRAVe-EATS platform.
Commuting	Calculated based on average commuting distance of base FTE using a mix of passenger car and light trucks used for commuting. A typical fuel MPG is calculated for each and summed to calculate the total gallons of fuel used for commuting.
Current year	The FY in progress.
Design guideline	A set of rules and strategies to help building designers meet certain performance criteria such as energy efficiency or sustainability.

Term	Definition
Electrical	Electricity usage entered is for the KWH used by the base annually. Note that the relationship between energy intensity and carbon footprint varies based on the mix of coal, natural gas, diesel, fuel oil, nuclear, wind, solar, and hydro electric energy production within the eGRID region.
Energy	The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. In the United States, electrical energy is often measured in kWh, while heat energy is often measured in BTUs.
Energy efficiency	Using less energy to provide the same level of energy service. Also referred to as efficient energy use and is achieved primarily by means of a more efficient technology or process rather than by changes in individual behavior.
Energy intensity	Ratio between the consumption of energy to a given quantity of output; usually refers to the amount of primary or final energy consumed per unit of gross domestic product.
Energy recovery	Includes any technique or method of minimizing the input of energy to an overall system by the exchange of energy from one sub-system of the overall system with another. The energy can be in any form in either subsystem, but most energy recovery systems exchange thermal energy in either sensible or latent form.
Energy Star	An international standard for energy efficient consumer products. Devices carrying the Energy Star logo, such as computer products and peripherals, kitchen appliances, buildings and other products, save 20%-30% on average.
Fiscal Year (FY)	The period used for calculating the annual ("yearly") sustainability indicators. The U.S. government's FY begins on October 1 of the previous calendar year and ends on September 30 of the year with which it is numbered. For example, FY for 2008 is written as "FY08" or as "FY07–08."
Fleet	Two or more vehicles.
Flying Mission	Includes anything that directly effects or has direct participation in flight or deployment operations.
Footprint	The outline of the total area of a lot or site that is surrounded by the exterior walls of a building or portion of a building, exclusive of courtyards. In the absence of surrounding exterior walls, the building footprint shall be the area under the horizontal projection of the roof.
Full-time Equivalent (FTE)	In the U.S. Federal government, FTE is defined by the Government Accountability Office (GAO) as the number of total hours worked divided by the maximum number of compensable hours in a work year as defined by law. For example, if the work year is defined as 2,080 hours, then one worker occupying a paid full time job all year would consume one FTE. Two employees working for 1,040 hours each would consume one FTE between the two of them.
General aviation	That portion of civil aviation, which encompasses all facets of aviation except air carriers. It includes any air taxis, commuter air carriers, and air travel clubs, which do not hold Certificates of Public Convenience and Necessity.
Geographical Information System	An information system that integrates, stores, edits, analyzes, manages, shares, and displays geographic information that is linked to a specific location.
Grassland	Terrestrial ecosystem (biome) found in regions where moderate annual average precipitation (25 to 76 centimeters or 10 to 30 inches) is enough to support the growth of grass and small plants but not enough to support large stands of trees.
Green space	A land use planning and conservation term used to describe protected areas of undeveloped landscape. Also known as open space.

Term	Definition
Greenhouse effect	The effect produced as greenhouse gases allow incoming solar radiation to pass through the Earth's atmosphere, but prevent part of the outgoing infrared radiation from the Earth's surface and lower atmosphere from escaping into outer space. This process occurs naturally and has kept the Earth's temperature about 59°F warmer than it would otherwise be. Current life on Earth could not be sustained without the natural greenhouse effect.
Ground Fuel	Ground Fuel is considered the total of all government vehicle fuel used outside flightline fuel use.
Incentive program	A formal scheme used to promote or encourage specific actions or behavior by a specific group of people during a defined period of time.
Indicator	A parameter, or a value derived from a set of parameters, that points to, provides information about, or describes the state of a phenomenon. It has significance beyond that directly associated with the parameter value. Indicators are one of many tools for simplifying, quantifying, and communicating vast amounts of information in ways that are more easily understood. They are also useful for alerting us to what areas that need more attention, as well as areas that see improvement.
Industrial sector	Construction, manufacturing, agricultural and mining establishments.
Installation	A facility directly owned and operated by or one of its branches that shelters military equipment and personnel and facilitates training and operations.
Land classification	The analysis of land according to its use. Land classifications include agricultural, industrial, recreational, and residential.
Land use	The human modification of natural environment or wilderness into built environment such as fields, pastures, and settlements.
Land use planning	The term used for a branch of public policy which encompasses various disciplines which seek to order and regulate the use of land in an efficient and ethical way.
Leadership in Energy and Environmental Design (LEED)	Green Building Rating System, developed by the USGBC, provides a suite of standards for environmentally sustainable construction.
Lumen	A measure of the perceived power of light.
Meter	Metering devices used on utility mains for electricity, water and gas.
Metric	Any measurable quantity. A performance metric is a metric of some performance characteristic; however, not all metrics are performance metrics. For example, area is a metric, but it is not a performance metric.
Metric ton	Common international measurement for the quantity of greenhouse gas emissions. A metric ton is equal to 2205 lbs. or 1.1 short tons. See short ton.
Military	Any property or aspect of a military.
Mission Fuel	This includes aviation fuel only. That is, the fuel needed for the aircraft to fly.
Mission Support	Includes all other activities on the installation that do not directly affect flight and deployment operations.
Mission Support Fuel	This fuel is used for vehicles working on the flightline. It does not include fuel used for aircraft.
Offset	An agent, element, or thing that balances, counteracts, or compensates for something else.
Performance goal	A specific statement of a desired level of achievement. Performance goals must be measurable and definite such that progress can be evaluated. Performance metrics should be carefully chosen to measure progress toward performance goals.
Performance indicator	A high-level performance metric that is used to simplify complex information and point to the general state or trends of a phenomenon. Performance indicators are used to communicate general trends and are often used on a program planning level to show progress toward goals. See the definition of indicator for more discussion.

Term	Definition
Performance metric	A measurable quantity that indicates some aspect of performance. Performance metrics should measure and communicate progress toward achieving performance goals. There are different levels of performance metrics.
Performance objective	A general statement of a desired achievement.
Population density	A measurement of population per unit area or unit volume.
Potential energy	Energy stored within a physical system that has the potential to be converted into other forms of energy, such as kinetic energy, and to do work in the process. The standard unit of measure for potential energy is the joule, the same as for work or energy in general.
Power generation	The process of creating electricity from other forms of energy. Also known as electricity generation.
Previous year	12-month period prior to the current year.
Procedure	A standard method or set of methods for determining one or more performance metrics.
Procurement	The acquisition of goods and/or services at the best possible total cost of ownership, in the right quality and quantity, at the right time, in the right place and from the right source for the direct benefit or use of corporations, individuals, or even governments, generally via a contract. Simple procurement may involve nothing more than repeat purchasing. Complex procurement could involve finding long term partners or even 'co-destiny' suppliers that might fundamentally commit one organization to another.
Renewable energy	Energy obtained from sources that are essentially inexhaustible, unlike, for example, the fossil fuels, of which there is a finite supply. Renewable sources of energy include wood, waste, geothermal, wind, PV, and solar thermal energy. See hydropower, PV.
Residential sector	An area or portion consisting only of housing units.
Transportation sector	Consists of private and public passenger and freight transportation, as well as government transportation, including military operations.

Abbreviations/Acronyms

AAAF	Alamogordo Army Air Field
Acre	A unit of area equal to 43,560 SF
AFB	Air Force Base
BACnet	building automation and control networks
BMP	Best Management Practice
BTU	British Thermal Unit: The quantity of heat required to raise the temperature of 1 lb of water 1˚F at or near 39.2˚F.
BWWSA	Boles Wells Water System Annex
CFS	cubic feet per second
CH_4	Methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent based on the GWP
DoD	Department of Defense
EISA	Energy Independence and Security Act
EMCS	Energy Management and Control System
EO	Executive Order
EPAct	Energy Policy Act
F	Fahrenheit
FTE	full-time equivalent
FY	fiscal year
GHG	greenhouse gas
GWP	global warming potential

Term	Definition
kGal	thousand gallon
kW	Kilowatt
kWh	kilowatt hour
HVAC	high-voltage alternating current
I&I	infiltration and inflow
lb	Pound
ICRMP	Integrated Cultural Resources Management Plan
INRMP	Integrated Natural Resources Management Plan
LEED	Leadership in Energy and Environmental Design
m	Meter
MMBTU	One Million British thermal units: A BTU is the quantity of heat required to raise the temperature of one pound of water 1˚F at or near 39.2˚F.
mph	miles per hour
MSW	Municipal Solid Waste
mTons	metric tones
mW	Milliwatt
N_2O	nitrous oxide
NOAA	National Oceanic and Atmospheric Association
NRCS	Natural Resource Conservation Service
PV	Photovoltaic
SD&HPGBD	Sustainable Development and High Performance Green Building Design
SSPP	Strategic Sustainability Performance Plan
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGBC	U.S. Green Building Council
VMT	vehicle miles traveled
w/m2	watt per square meter
WSMR	White Sands Missile Range

VI. APPENDICES (NOT INCLUDED)

A. Data Collection Forms and Supporting Documentation

1. **Development**
2. **Energy**
3. **Water**
4. **Waste**
5. **Operations**

A.1 Development: The following pages include the Development data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Shaw AFB.

A.2 Energy: The following pages include the Energy data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Shaw AFB.

A.3 Water: The following pages include the Water data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Shaw AFB.

A.4 Waste: The following pages include the Waste data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Shaw AFB.

A.5 Operations: The following pages include the Operations data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Shaw AFB.

B. Data Sources

The following are data sources received from HQ ACC/A7PS and Shaw AFB:

1. Reports
   a. Design Compatibility Standards, Shaw AFB, 2010
   b. Integrated Natural Resources Management Plan, 2010
   c. Shaw AFB, eGP, as of December 2009
   d. Installation Environmental Restoration Program (ERP) Site Summary,
2. Shaw AFB, South Carolina, Miscellaneous Data Provided by Shaw AFB
   a. Building Management systems, as of 2010
   b. 7115 Report, as of January 2010
   c. Hazardous Waste Generation/Cost, for 2009
   d. Building Metering Information, as of January 2010
   e. Storm Water Multi-Sector Permit
   f. Hazardous Waste Recycling, for 2009
   g. Buildings Retrofitted with Water Saving Device, as of 2010
   h. Area Development Plans
3. Shaw AFB, South Carolina, Data Provided by HQ/ACC/A7PS
   a. Mission Fuel Data Use for 2010
   b. Non-Mission Fuel Data Use for 2009
   c. Potable water, Electric, and Natural Gas for the Main Base and Military Family Housing (2003, and 2006-2010)
4. Geobase Data
   a. Data provided by both HQ ACC/A7PS and Shaw AFB
5. Meeting Minutes

C. Expanding Requirements

There are expanding requirements for military facilities constantly being developed and issued. The expanding requirements include new EOs, Statutes, Directives, Rulemaking, and Guidance.

1. EO 13514
2. EO 13423
3. EPAct 2005
4. EISA of 2007
5. Higher Level DoD and HAF directives
6. MAJCOM directives
7. Key Air Force Environmental Goals
8. Other Federal Agency rulemaking and guidance

See separate attachment Appendix C for a Crosswalk of regulations

D. References

Building and Electric Metering Data

Cooperative Agreement for the White Sands Pupfish, 2006

Community Center Transportation Improvement Plan, 2010

Shaw AFB, 7115 Report

Shaw AFB Design Compatibility Standards, 2010

Shaw AFB, eGeneral Plan

Shaw AFB, Gate Study Out Brief, June 2009

Shaw AFB, 2010 Integrated Cultural Resource Management Plan, 2010

Shaw AFB, 2010 Integrated Natural Resource Management Plan, 2010,

National Renewable Energy Laboratory, http://www.nrel.gov/gis/wind.html

NOAA, 2008, http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgrh.html

Toxic Release Inventory

Water metering Data

Z-Transit information

Other publications and websites used as resources:

1. http://epa.gov/
2. http://www.eere.energy.gov/
3. www.un.org/esa/dsd/susdevtopics/sdt_land.html
4. http://www.nps.gov/sustain/spop/jtree.htm
5. http://www.eia.doe.gov
6. ISAUK Research Report 07-01, A Definition of Carbon Footprint, June 2007.
7. http://acupcc.aashe.org/ghg-scope-statistics.php
8. http://www1.eere.energy.gov/femp/program/printable_versions/waterefficiency.html