AIR COMBAT COMMAND

INSTALLATION SUSTAINABILITY ASSESSMENT REPORT

A-10

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Davis-Monthan Air Force Base
Arizona

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

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"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, and 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 were developed. This report summarizes the current and recommended sustainability efforts at Davis-Monthan Air Force Base (AFB) and provides a basis for comparison and benchmarking.

Numbers have been calculated for the five sustainability indicators at Davis-Monthan 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 bullet indicators, as shown in the chart below, represent how Davis-Monthan 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]:	13,677	mTons	
Energy Usage:	437,548	MMBTU	
Water Conservation:	176.37	Mg	
Waste Production:	4,254	tons	
Land Utilization:	971	SF/acre	

FLYING MISSION			
Carbon Footprint:	194,669	mTons	
Energy Usage:	2,742,525	MMBTU	

[1]Does not include commuting
SF = square feet, mTons = metric tons, Mg = million gallons, and MMBTU = million British thermal units

Fiscal Year (FY) 09 was the inaugural year for Davis-Monthan AFB's ISA report; therefore, this report does not provide year-to-year comparisons but does establish a baseline for all future measurements. This report demonstrates that the Base is performing well on Mission Support Carbon Footprint, Mission Support Energy Usage, Water Conservation, and Waste Reduction relative to energy benchmarks; however, it is underperforming on Land Utilization and at or near the benchmarks for Flying Mission Carbon Footprint and Flying Mission Energy Usage.

Davis-Monthan AFB has already implemented a number of sustainability initiatives, initiating the design process for thirteen facilities that will implement Sustainable Design and High Performance Green Building (SD&HPGB) strategies through design and construction, using treated effluent for irrigation, and making installation-wide lighting improvements to improve energy efficiency. There are a number of practices Davis-Monthan AFB should consider implementing to improve each of the sustainability indicators. Some examples include identifying an electricity supplier who can provide renewable energy in accordance with Federal guidelines, considering the use of bio-aviation fuel and limiting future development to infill areas on the installation.

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. It is expressed in five key indicators: (1) Carbon Footprint, (2) Energy Usage, (3) Water Conservation, (4) Waste Reduction, and (5) Land Utilization, and identifies and recommends installation-specific improvement strategies. 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 Air Force installations 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 of 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) that 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 that 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 table on page 4.

- *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* refer 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 FY20		●		• 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 FY15, and thereafter through FY20	●			• 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	ISA Additions (Data Available)	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 or deployment operations. The flying mission calculations currently take into account energy usage (i.e. transportation and aviation fuels) and mission-specific building and land use areas to calculate the installation's Flying Mission carbon footprint and energy usage. In the future, once sub-metering is in place, additional measures for Flying Mission may be established for water consumption and waste production.

Mission Support:

Mission Support includes all other activities on the installation that do not directly affect flight and deployment operations.

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 consumption, its source and its usage.
4. **Waste—**Includes solid and liquid waste production and its usage.
5. **Operations—**Includes best management practices 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 uses of land in an integrated manner, it is possible to minimize conflicts, to make the most efficient trade-offs and to 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 utilizing 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 melt water 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, thereby reducing 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 about 40% 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 utilizing 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 that 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 such things as run several errands at the same time or to interact with others.

- 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 traveling 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 (EPA), the U.S. Department of Housing and Urban Development (HUD), and the U.S. 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 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. Utilizing 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 allows 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.)
- Firefighting
- 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 grey water, rainwater, or storm water).

Per the Energy Independence and Security Act of 2007, any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet 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, re-using storm, grey, and wastewater 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 50-80% 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 best management practices 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 such things 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 fewer 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 Natural Resources Plan, Integrated Cultural Resources Management Plan, Stormwater Pollution Prevention Plan, Water Management Plan, Drinking Water Management Plan, Pollution Prevention Management Plan, Hazardous Waste Management Plan, Solid and Hazardous Waste Compliance, Economic Impact Analysis, Environmental Restoration Program, Transportation Master Plan, Department of Energy Report, Transportation Fuel Reports, Real Property Reports, and GIS 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 nine-person A/E team consisting of a Project Manager, Architect, Landscape Architect, Civil Engineer, Mechanical Engineer, Planner, CADD Technician, and two GIS Specialists met with personnel at Davis-Monthan AFB on 19-22 April 2010. While at the installation, the A/E team interviewed available civil engineering flight staff, such as, but not limited to, contracting, engineering, maintenance, and real property personnel to supplement the data collected previously from HQ ACC/A7PS as well as to collect data not previously obtained. The A/E team observed and measured existing conditions such as nighttime light levels along the flight line and sound levels throughout the installation.

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, Energy Policy Act 2005, Energy Independence and Security Act 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 Davis-Monthan 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, trees and wood products, and as a result of other chemical reactions.
- **Methane (CH_4)—**Methane is emitted during the production and transport of coal, natural gas, and oil. Methane 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)—**Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

- **Fluorinated Gases—**Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes.

In the U.S., our 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 about a 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 United States. (EPA)

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, Scopes I and 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 look-up 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 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 green, bio-, 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, and to provide a fair comparison to other public campuses or corporate entities.

Water Conservation:

As 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 generating higher levels of runoff, while more natural areas decrease the amount of runoff. There is the potential to become water-self-sufficient by harvesting rainwater and reducing use of domestic water.

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 2-year post development calculation to a 2-year predevelopment (greenfield) calculation utilizing the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (Soil Conservation Service) Method as outlined in Urban Hydrology for Small Watersheds Technical Release 55 (TR-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 45-85 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 we throw into our 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 and EPA recommended guidelines, and is 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 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 isolate employment locations, shopping and services, and housing locations from each other creating excessive transportation requirements and excessive hard surfaced areas.

For reporting land utilization, 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, two times the code recommended square footage per FTE is being used to provide a comparison of building area against the installation's population and to depict the utilization of the building space.

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 for projects that would have a direct and viable impact on 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

Davis-Monthan AFB is a U.S. Air Force installation located in southern Arizona, approximately five miles southeast of Tucson, in Pima County. Davis-Monthan AFB is home to the 355th Fighter Wing, the 12th Air Force, 563rd Rescue Group, 55th Electronic Combat Group, and the Air Force Materiel Command's 309th Aerospace Maintenance and Regeneration Group. Davis-Monthan AFB is named in honor of Lieutenants Samuel H. Davis and Oscar Monthan, two Tucsonans and World War I era pilots who died in separate military aircraft accidents.

B. History

In 1925, Tucson's City Council purchased 1,280 acres of land southeast of town to relocate the city's municipal airport. On September 23 of the same year, Charles Lindbergh, who months earlier crossed the Atlantic in the "Spirit of St. Louis", formally dedicated the site.

Military presence at the new Davis-Monthan Field began in October 1927 when Staff Sergeant Dewey Simpson transferred the military aircraft refueling and service operations from the old municipal airport. As a result of the expanding conflict in Europe, in September 1940 the War Department officially announced a decision to establish an Army Air Base in Tucson. Army Air Base, Tucson, Arizona was officially activated in April 1941. The first assigned units, 1st Bombardment Wing, 41st Bombardment Group, and 31st Air Base Group, began arriving in late May. In December the base was formally named Davis-Monthan Field.

World War II brought major changes to Davis-Monthan. In January 1942 jurisdiction of the field transferred from Fourth Air Force to Second Air Force. The following month the 39th Bombardment Group (BG) arrived and by mid-year B-24 Liberator training was the sole mission of the 39th BG. Davis-Monthan became home to the B-29 Superfortress until Victory over Japan (V-J) Day.

At war's end Davis-Monthan's mission transitioned from training to separation and aircraft storage. Through November 1945, Davis-Monthan was one of three installations in Second Air Force responsible for separation processing. The 4105th Army AFB Unit was activated in November 1945 with the mission of extended aircraft storage for Army Air Force planes. Tucson's dry climate and alkali soil made it an ideal location for aircraft storage and preservation, a mission that continues today.

The Strategic Air Command (SAC) ushered in the Cold War era at Davis-Monthan when in March 1946 the newly activated SAC assumed control. Both the 40th and 444th Bombardment Groups, both equipped with the B-29 Superfortress, deactivated and their personnel and aircraft were transferred to the newly activated 43rd Bombardment Group (BG). In September 1947 the Air Force became a separate branch of service and the 43rd BG achieved "Wing" Status. In January 1948 Davis-Monthan Field was officially redesignated Davis-Monthan AFB. The following month the first B-50 Superfortress II, A-Model, arrived and was delivered to the 43rd BW. In June, the 43rd Air Refueling Squadron (ARS) was assigned. In March 1949 the Lucky Lady II, a Boeing B-50A Superfortress II, completed the first nonstop round-the-world flight while being refueled four times in air by KB-29M tankers assigned to the 43rd ARS. In September 1951 the 43rd was joined by another B-29 unit, the 303rd BW. It was also on this date that the first Air Division, the 36th, was activated.

Davis-Monthan AFB entered the "Jet Age" in February 1953 when the 303rd BW received four Lockheed T-33 Shooting Star training jets. Following construction of a new runway the B-47 Stratojet arrived and was assigned to the 303rd BW. Fighter interceptor jets arrived the following month when the Air Defense Command (ADC) activated the 15th Fighter Interceptor Squadron (FIS). The unit was initially equipped with the F-86A Sabres and then upgraded to the supersonic F-86D. In 1959 the F-86D was replaced by the F-89 Scorpion which in turn was replaced in 1960 with the F-101B Voodoo. The Voodoos remained the unit's interceptor until the 15th FIS inactivated in December 1964.

Three strategic wings were established in the 1960's. As the 36th AD was inactivated and the 43rd BW departed, Davis-Monthan was selected to become home to an Intercontinental Ballistic Missile (ICBM) wing. Eighteen Titan II missile silos were sited around Tucson. In January 1962, the 390th Strategic Missile Wing (SMW) was activated. In June 1963 the 570th Strategic Missile Squadron (SMS) was activated as the first Titan II missile squadron in the U.S. Air Force. In November, the final missile went on alert and the following day the 570th SMS and 390th SMW were declared operational. The 390th SMW become the first operational Titan II missile wing in the U.S. Air Force. In July 1963 the 4080th Strategic Wing (SW) transferred to Davis-Monthan AFB and conducted global strategic reconnaissance functions operating the WU-2 high-altitude aircraft. The unit's relocation resulted in a three wing base with three diverse missions: Strategic Bombardment, Strategic Reconnaissance, and Strategic Missile alert.

In early 1964 the 303rd BW was deactivated and its aircraft and facilities reassigned to the inbound wing, Tactical Air Command's (TAC) 4453rd Combat Crew Training Wing (CCTW). In July 1964 Combat Crew Training (CCT) officially returned with the activation of the 4453rd CCTW, which trained a majority of F-4 crews for the conflict in Southeast Asia. In June 1966 the 4080th SRW inactivated and all personnel and equipment were transferred to 100th SRW. The 100th SRW continued the U-2 reconnaissance missions of the 4080th SRW and as a result of the conflict escalating in Vietnam, more forward operating locations were set up throughout Southeast Asia for reconnaissance and drone missions.

In July 1971 the Air Force reactivated the 355th Tactical Fighter Wing (TFW) at Davis-Monthan with the Vought A-7D Corsair II as the primary weapon system. In September 1971 the 4453rd CCTW was inactivated and its F-4s relocated. After 30 years under SAC, in October 1976 the base was transferred to Tactical Air Command (TAC). The 335th TFW accepted the first A-10 Thunderbolt II in 1976. The 335th TFW was redesigned the 355th Tactical Training Wing in September 1979 and was later redesignated the 355th Fighter Wing. The last A-10 mission was flown October 1979.

During the 1980s and 1990s, Arms Reduction brought new missions to the base. The 836th Air Division, activated January 1, 1981, was charged with overseeing the base. The AD trained crews to operate, maintain, and defend Ground Launch Cruise Missiles systems throughout the European Theater. The 41st Electronic Combat Squadron arrived in July 1980. The 602nd Tactical Air Control Wing, responsible for the Air Force's tactical air control system west of the Mississippi River, activated in September 1982. In May 1984, the 390th SMW's last Titan II came off alert status and the SAC subsequently deactivated the 390th SMW in June 1984.

Davis-Monthan AFB became an Air Expeditionary Force in the 1990s. The 355th TTW continued to train A-10 crews for assignments to units in the United States, England and Korea. The 355th TTW deployed Airborne Forward Air Controllers in their A-10 aircraft to Operation Desert Storm, providing nearly all of this capability. In October 1991 the 355th TTW was redesignated as the 355th Fighter Wing (FW).

In May 1992 the Air Force policy of "one base-one boss" was implemented and all Air Divisions, including the 836th AD, were inactivated and the 355th FW once again became the host wing. The 41st Electronic Control Squadron (ECS) and 43rd ECS were assigned to the 355th FW, resulting in its redesignation as the 355th Wing (WG). The 355th WG began supporting Operation Southern Watch in 1995, deploying to Al Jaber, Kuwait to ensure compliance of the 32nd parallel southern no-fly zone.

The attacks on September 11, 2001, led to the initiation of three missions--Operation Enduring Freedom (OEF) in Afghanistan, Operation Iraqi Freedom, and Operation Noble Eagle. After the execution of OEF eight A-10s from the 355th Wing were deployed to Bagram Air Base, Afghanistan to fly close air support missions supporting multinational ground forces.

Several realignments occurred in 2002 and 2003. In September 2002, the 48th, 55th, and the 79th Rescue Squadrons (RQS) transferred under control of the 355th WG and the 41st and 43rd ECSs realigned under the 55th Electronic Combat Group (55th ECG). With activation of the 563rd Rescue Group on October 1, 2003, control of the 48th, 55th, and 79th RQS was passed to the new group with the 23rd WG assuming operational command.

In 2003 and 2005, the 354th Fighter Squadron "Bulldogs" conducted five-month deployments to Bagram Air Base providing 24-hour air presence and support during national elections. In April 2007 they provided 24-hour presence and Close Air Support to OEF coalition forces during a six-month deployment.

On April 26, 2007, with only A-10 fighter aircraft assigned, the 355th WG was redesignated once again as the 355th Fighter Wing. Today, the 355th Fighter Wing is composed of four groups: the 355th Operations Group, the 355th Maintenance Group, the 355th Mission Support Group and the 355th Medical Group. Together, along with their tenant organizations, they make up the Airmen and civilian personnel of Davis-Monthan AFB.

C. Mission and Vision

Davis-Monthan AFB is the home of the 355th Fighter Wing, an important element of ACC. The 355th Fighter Wing mission statement is: “Provide expeditionary combat and combat support forces, while enabling critical Air Force capabilities and Homeland Security operations.”

The 355th Fighter Wing mission and installation vision provide the overarching concept for the Fighter Wing and the base. The 355th Fighter Wing has prescribed the following vision in order to achieve mission accomplishment:

- Vision 1 - Fight When Called
- Vision 2 - Nurture and Develop Airmen
- Vision 3 - Prepare to Deploy
- Vision 4 - Installation Stewardship

D. Geography

According to the United States Census Bureau, the Base has a total area of 16.52 square miles, of which, 16.519 square miles is land and 0.001 square miles is water.

Coordinates: 32° 09'N 110° 52'W

State: Arizona

County: Pima

Elevation: 2,704 feet

Terrain: Flat, sloping

Soils: Silts, clays, sands, and gravels

E. Climate

Temperature: Average July maximum and minimum temperatures are 100°F (38°C) and 73°F (23°C) respectively.

Average January maximum and minimum temperatures are 65°F (18°C) and 39°F (4°C) respectively.

Precipitation: Average yearly precipitation is 12 inches (30.48 cm), of which an average yearly snowfall around 1.2 inches (30.48 cm).

Humidity: Arid climate

Humidity Range between 57% rh and 26% rh

Wind: Wind Power Classification between 1 and 2 (from US DOE National Renewable Energy Laboratory)

WIND POWER CLASSIFICATION	WIND POWER DENSITY	WIND SPEED
1	0-200 w/m² @ 50m	0-12.5 mph
2	200-300 w/m² @ 50m	12.5-14.3 mph
Source: National Renewable Energy Laboratory, http://www.nrel.gov/gis/wind.html w/m² = watt per square meter, m = meter, and mph = miles per hour		

F. Demographics

As of the census of 2009, there were 5,423 people, 1,451 households, and 1,394 families residing on the Base. The population density was 319.4 people per square mile. There were 1,467 housing units at an average density of 86.4/square mile.

III. FINDINGS

A. Description

A set of five sustainability indicators have been established to summarize the installation's level of sustainability. The five indicators are 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.

B. Current Sustainability Indicators

Refer to the following pages for a summary of findings for the five sustainability indicators for Davis-Monthan AFB.

DAVIS-MONTHAN AFB INSTALLATION SUMMARY

Demographics

Total Population	16,437	FTE
Military Personnel	6,671	FTE
Civilian Personnel	3,197	FTE
Dependents	6,569	FTE
Note: Population Data based on the 2007 Economic Impact Statement		

Land Characteristics

Acreage	10,589	Acres
Useable Building SF	14,932,987	SF
People per Acre of Developable Area	1.97	People
People Supported by Building Area	14,341	People
Note: Based on 2007 population, and excludes dependents and non-developable acreage.		

2009 Energy Use[1]		
Electricity	78,747,000	kWh
Natural Gas	110,701,000	cf
Oil	0	Gal
Potable Water	208,364,000	Gal
Note: Energy Use Data based on 2009 DUERS Report		

Waste Management		
Solid Waste	3,110	Tons
Solid Waste Recycled	1,090	Tons
Waste Water	194,283,800	Gal
Note: Waste Data based on the 2009 Refuse Diversion Report and Water Pollution Control Plan Operating Log Supplementary AF Form 1462 [1] Include base only, no housing		

Fuel Consumption

Mission Fuels		
Aviation Fuels	20,348,221	Gal
Diesel Fuel	67,717	Gal
Ethanol	127,212	Gal
Bio-Diesel (B20)	159,518	Gal
Non-Mission Fuels		
Diesel Fuel	2,696	Gal
Gasoline	117,302	Gal
Ethanol	48	Gal
Note: Fuel Consumption Data based on ACC provided data		

1. Davis-Monthan 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 Davis-Monthan AFB is 208,346 mTons (includes Flying and Support Missions)

ACC and Davis-Monthan AFB jointly need to establish a goal for the installation's carbon footprint. Currently, based on industry benchmarks, the base produces a smaller carbon footprint for mission support transportation and facilities and a larger one for flying mission shown on the following page.

Annual Total Mission Support Carbon Footprint for Davis-Monthan AFB is 13,677 mTons

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

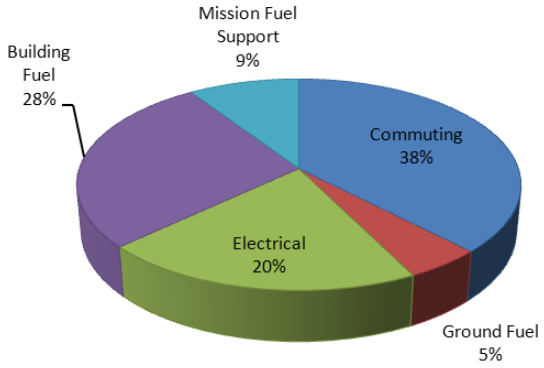
Annual Total Carbon Footprint:	3,120	mTons
Baseline (2005):	(A)	mTons/FTE/year
Previous Year (2008):	(A)	mTons/FTE/year
Current Year (2009):	0.32	mTons/FTE/year
Benchmark[1]:	7.54	mTons/FTE/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

Baseline (2005):	(A)	mTons/1,000 SF/year
Previous Year (2008):	(A)	mTons/1,000 SF/year
Current Year (2009):	0.64	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:	10,557	mTons
Baseline (2003):	1.43	mTons/FTE/year
Previous Year (2009):	1.14	mTons/FTE/year
Current Year (2010):	1.07	mTons/FTE/year
Benchmark[1]:	7.54	mTons/FTE/year
% Reduction from Baseline:	25%	
% Reduction from Previous Year:	6%	

Baseline (2003):	3.31	mTons/1,000 SF/year
Previous Year (2009):	2.33	mTons/1,000 SF/year
Current Year (2010):	2.17	mTons/1,000 SF/year
Benchmark[2]:	20.44	mTons/1,000 SF/year
% Reduction from Baseline:	34%	
% Reduction from Previous Year:	7%	



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. Davis-Monthan Carbon Footprint—Flying Mission

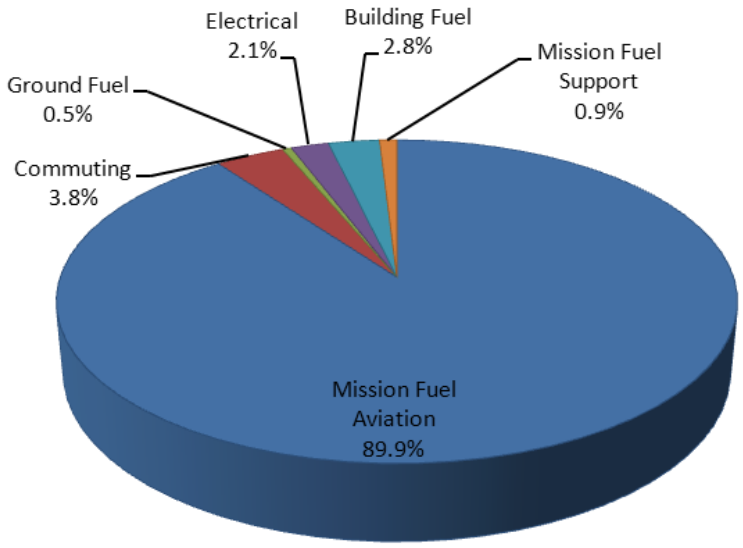
Annual Total Flying Mission Carbon Footprint for Davis-Monthan AFB is 194,669 mTons

FLYING MISSION[1]

Annual Total Carbon Footprint:	194,669	mTons	
Baseline (2003):	(A)	mTons/FTE/year	Per FTE
Previous Year (2009):	22.05	mTons/FTE/year	
Current Year (2010):	19.73	mTons/FTE/year	
Benchmark[2]:	7.54	mTons/FTE/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	11%		

Baseline (2003):	(A)	mTons/1,000 SF/year	Per Built SF
Previous Year (2009):	45.03	mTons/1,000 SF/year	
Current Year (2010):	40.02	mTons/1,000 SF/year	
Benchmark[3]:	20.44	mTons/1,000 SF/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	11%		

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 30,124 acres = 2.8 times the installation area
  for Flying Mission is 289,683 acres = 27.4 times the installation area
- The Flying Mission carbon footprint is equivalent to 55 Pentagons
  1 Pentagon = 77,015,000 cu. ft.

[1]From May 2011 to September 2011 (roughly four months) the F-22 was at stand downs. no operations were conducted.
[2]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.
[3]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.
[4]Definitions for pie chart categories can be found in IV. Glossary of Terms and Abbreviations.
(A) = Data is incomplete.

2. Davis-Monthan Energy Usage

Total Energy Usage Davis-Monthan AFB is 3,180,073 MMBTU (includes Flying and Support Missions)

ACC and Davis-Monthan AFB jointly need to establish a goal for the installation's energy intensity. Currently, based on industry benchmarks, Davis-Monthan AFB has relatively low energy usage for mission support transportation and facilities and a higher use for mission flying shown on the following page.

Annual Total Mission Support Energy Usage for Davis-Monthan AFB is 437,548 MMBTU

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

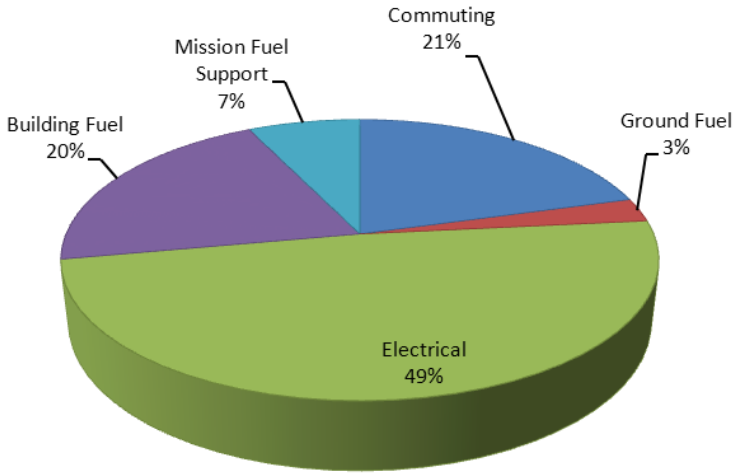
Annual Total Energy Usage:	55,064	MMBTU
Baseline (2005):	(A)	MMBTU/FTE/year
Previous Year (2008):	(A)	MMBTU/FTE/year
Current Year (2009):	5.58	MMBTU/FTE/year
Benchmark[1]:	327.00	MMBTU/FTE/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

Baseline (2005):	(A)	MMBTU/SF/year
Previous Year (2008):	(A)	MMBTU/SF/year
Current Year (2009):	0.01	MMBTU/SF/year
Benchmark[2]:	0.13	MMBTU/SF/year
% of Energy from Renewable Source:	23.4%	
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

MISSION SUPPORT—Facilities[6]

Annual Total Energy Usage:	382,484	MMBTU
Baseline (2003):	46.70	MMBTU/FTE/year
Previous Year (2009):	40.64	MMBTU/FTE/year
Current Year (2010):	38.76	MMBTU/FTE/year
Benchmark[1]:	327.00	MMBTU/FTE/year
% Reduction from Baseline:	17%	
% Reduction from Previous Year:	5%	

Baseline (2003):	0.11	MMBTU/SF/year
Previous Year (2009):	0.08	MMBTU/SF/year
Current Year (2010):	0.08	MMBTU/SF/year
Benchmark[2]:	0.13	MMBTU/SF/year
% of Energy from Renewable Source:	3.5%	
% Reduction from Baseline:	27%	
% Reduction from Previous Year:	5%	



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. Davis-Monthan Energy Usage - Flying Mission

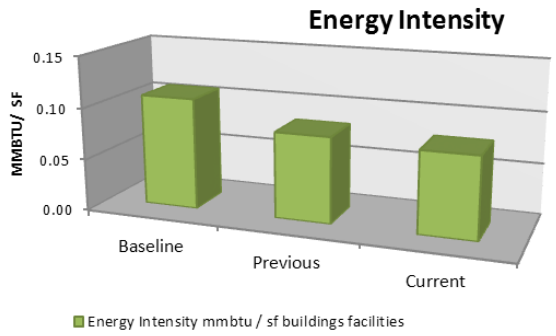
Total Flying Mission Energy Usage for Davis-Monthan AFB is 2,742,525 MMBTU

FLYING MISSION

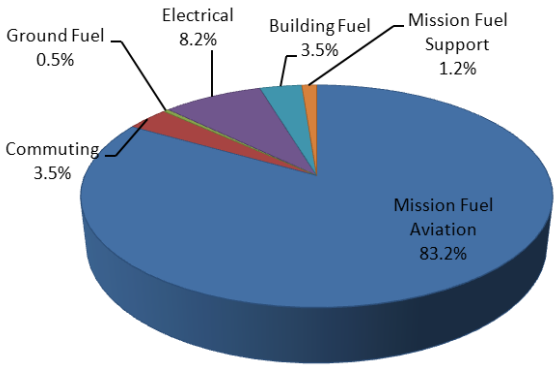
Annual Total Energy Usage:	2,742,525	MMBTU	
Baseline (2003):	(A)	MMBTU/FTE/year	**Per FTE**
Previous Year (2009):	310.66	MMBTU/FTE/year	
Current Year (2010):	277.92	MMBTU/FTE/year	
Benchmark[1]:	327	MMBTU/FTE/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	11%		

Baseline (2003):	(A)	MMBTU/SF/year	**Per Built SF**
Previous Year (2009):	0.63	MMBTU/SF/year	
Current Year (2010):	0.56	MMBTU/SF/year	
Benchmark[2]:	0.40	MMBTU/SF/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	11%		

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 10%
  for Flying Mission is 1%

[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.

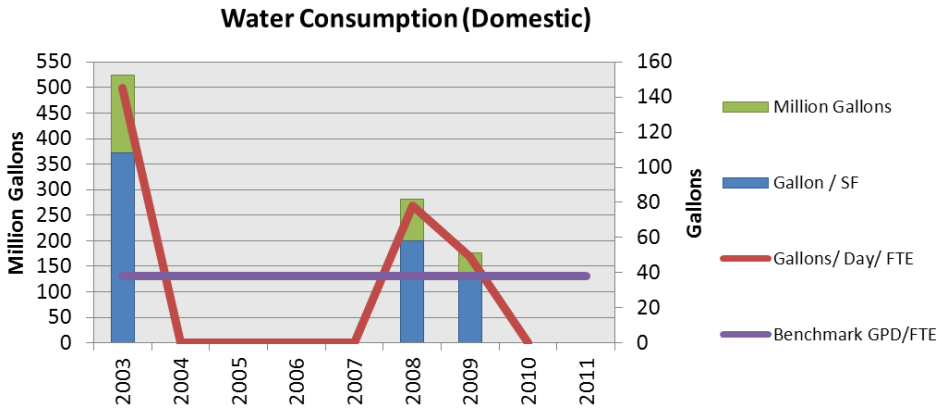
3. Davis-Monthan Water Conservation

ACC and Davis-Monthan AFB jointly need to establish a goal for the installation's water conservation. Currently, based on industry benchmarks, Davis-Monthan AFB has water consumption per FTE slightly above the benchmark range.

MISSION SUPPORT

Annual Total Water Consumption:	176.37	Million Gallons	
Baseline (2007):	(A)	Gallon/FTE/day	**Per FTE**
Previous Year (2009):	77.88	Gallon/FTE/day	
Current Year (2010):	48.97	Gallon/FTE/day	
Benchmark[1]:	28-38	Gallon/FTE/day	
% Reduction from Baseline:	37%		
% Reduction from Previous Year:	-		

Baseline (2007)):	(A)	Gallon/SF/year	**Per Built SF**
Previous Year (2009):	58.06	Gallon/SF/year	
Current Year (2010):	36.50	Gallon/SF/year	
Benchmark[2]:	-	Gallon/SF/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	37%		



[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.

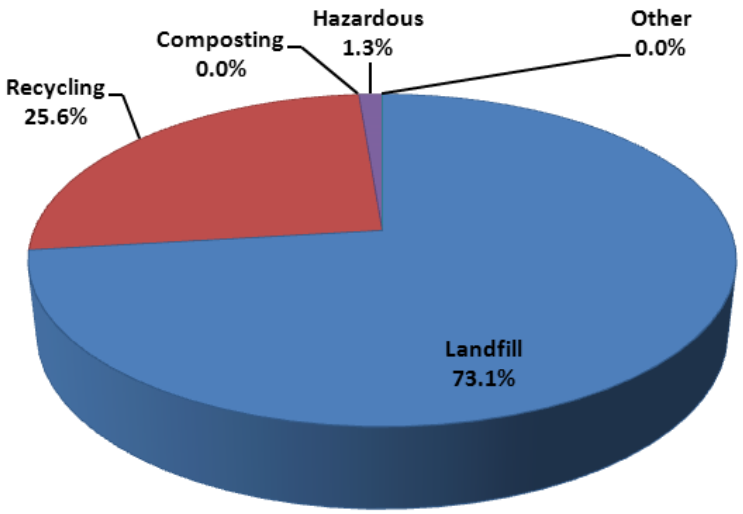
4. Davis-Monthan Waste Reduction

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

MISSION SUPPORT

Annual Total Waste Production:	4,254	Tons	
Current Year (2009):	2.36	LBS/FTE/day	Per FTE
Benchmark[1]:	4.62	LBS/FTE/day	

Current Year (2009):	1.75	LBS/SF/day	Per Built SF
Benchmark[2]:	-	LBS/SF/day	
% Non-Hazardous Waste Diverted from Landfill	26%		



- 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 through an additional research project.

5. Davis-Monthan Land Utilization

ACC and Davis-Monthan AFB jointly need to establish a goal for the installation's land utilization. Currently, based on industry benchmarks, Davis-Monthan 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)	971	SF/Acre
Benchmark[2]:	60,000	SF/Acre
Previous Year (2009)	965	SF/Acre
% Change from Previous Year:	1%	

Total Building Utilization[5]:

Current Year (2010)	493	SF/FTE
Benchmark[3]:	160	SF/FTE
Previous Year (2009)	490	SF/FTE
% Change from Previous Year:	1%	

MISSION SUPPORT

Total % Green Space[6]:

Current Year (2010)	91%	
Benchmark[4]	-	
Previous Year (2009)	91%	

Total % Building/Impervious[7]:

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

Total % Building/Footprint[8]:

Current Year (2010)	76%	
Benchmark[4]	-	
Previous Year (2009)	76%	

- 28,840 average daily traffic at the gates = 2.92 trips per FTE
- 1.96 people per acre of Mission Support developable area

[1]Building density = 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 = Real Property Records building square footage/population
[6]% Green Space = Non-Built Green area/Total Installation area.
[7]% Building-to-Impervious = Geobase and real property records, usable building square footage/impervious area.
[8]% Building-to-Footprint = Geobase and real property records, usable building square footage/building footprint area.

C. Year-to-Year Sustainability Indicators

This is the initial report for Davis-Monthan 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**

D. Current Sustainability Initiatives

The ISA process at Davis-Monthan AFB and the data compiled and analyzed establish baseline sustainability metrics for the installation. The A/E team learned from the data gathering process and interviews that the following sustainable initiatives are currently in place at Davis-Monthan AFB.

1. A hydro source was used for an average of 3% of electrical power at Davis-Monthan AFB in FY08 and FY09. The current Federal guideline requires a renewable energy source for a minimum of 5% by FY10, 7.5% by FY13 and 25% by FY25 of total electric use; other renewable energy sources should be explored to meet this guideline.
2. Davis-Monthan AFB has registered thirteen projects with the Green Building Certification Institute. These projects range from the fire crash rescue station to a dormitory and C-130 corrosion control hangar.
3. A metering program is being implemented by installing sub-metering for electricity on all new buildings and existing buildings greater than 30,000 SF. Davis-Monthan AFB is currently 90% complete with this effort and will have 100% of required buildings sub-metered by the end of FY10.
4. A metering program is being implemented by installing sub-metering for gas on all new buildings and existing buildings greater than 30,000 SF. Davis-Monthan AFB is currently 70% complete with this effort and will have 100% of required buildings sub-metered by the end of FY10.
5. A recycling program is in place in an effort to reduce landfill waste. Recycling efforts at Davis-Monthan include both office and housing waste, as well as used oil, automobile batteries and tires, and household hazardous wastes.
6. Irrigation for the golf course is provided by treated effluent. Other landscape irrigation is provided to establish native plants and then removed.
7. Aircraft and transportation washracks are equipped with water recycling systems.
8. Broken faucets and showerheads are replaced with low flow systems. To date 2,718 faucets and showerheads have been replaced. Low flow toilets and urinals are used where appropriate.

9. Green procurement initiatives are in place. Office paper procured contains 50% recycled fiber content. Other procurement initiatives are also in place for reuse of recovered materials such as toner and printer cartridges.

10. Davis-Monthan family housing contains the largest community-based photovoltaic system in the United States. The system meets 75% of the total housing energy demand during daylight hours.

11. Davis-Monthan AFB is in the process of initiating a land lease for solar electricity production on the installation. The installation has also installed solar hot water pre-heaters in the dormitories, swimming pool and recreation center (99 solar panels installed on Buildings 2301, 2505, 3610, 3750, 6090, and 75032).

12. An energy recovery ventilator was installed at Building 74 to improve air conditioning efficiency.

13. Davis-Monthan AFB has made lighting improvements installation-wide to improve energy efficiency. These improvements included replacing existing T12 fluorescent lights with more efficient T8 bulbs, replacing existing exterior lighting with high pressure sodium fixtures, replacing incandescent exit signs with LED exit signs, and replacing existing high intensity discharge high-bay fixtures, incandescent or quartz fixtures with T5 twin tube systems.

14. Occupancy and plug load control initiatives have been implemented. These initiatives include occupancy sensors and Isolé plugs in areas that are frequently vacated. Occupancy sensors shut down illumination when there is no occupancy for a period of time. Isolé plugs sense when workstations are not occupied and shut down all non-essential loads plugged into the device.

15. Airfield obstruction lights were replaced with energy-efficient LED obstruction lights.

E. Guidance Compliance Summary and Matrix

Refer to Appendix C to review Davis-Monthan AFB compliance with current Federal guidance.

IV. RECOMMENDATIONS

The recommendations described below are derived from the specific information obtained at Davis-Monthan AFB. They are intended for further definition and development of projects that would have a direct and viable impact on the sustainability of the installation. Ultimately, this list will be used to develop a prioritized group of projects. Some of the other currently established expanding requirements that are in various stages of implementation will have an impact on sustainability; however, these efforts are independent from the goal of this report.

A. Carbon Footprint

- The two factors with the greatest impact on the installation's carbon footprint are aviation fuel (70%) and commuting (21%); electricity (6%) is the third largest contributor to the installation's carbon footprint. Use of high efficiency lighting has reduced Davis-Monthan's carbon footprint.
  - Evaluate the potential for using aviation bio-fuels on training missions.
    - Mission fuel constitutes 70% of the carbon footprint at Davis-Monthan AFB. Changing 20% of the aviation fuel to bio-aviation fuel would result in a 15% net decrease in the total carbon footprint for the mission.
  - Develop strategies to decrease the commuting carbon footprint by exploring alternative work schedules, telecommuting or methods of encouraging carpooling to reduce consumption of both commuting and building fuels.
    - Coordinated alternative work schedules such as working 9-hour days with a day off every other week for Mission Support staff will reduce commuting fuels and building systems use by 10%.
    - If the number of vehicles entering/leaving the installation decreased by 10%, there would be a 2.1% net decrease of the total carbon footprint for the Mission and a 7.1% net decrease of the total carbon footprint for Mission Support.
  - Evaluate the potential to reduce the impact of fleet vehicle usage on the installation's carbon footprint. Davis-Monthan AFB currently utilizes 754 fleet vehicles.
    - Fleet vehicle usage should be logged and analyzed to evaluate the potential for reducing the number of fleet vehicles maintained.
    - As fleet vehicles are recapitalized, existing vehicles should be replaced with carbon neutral vehicles (i.e., alternative-fueled, electric, hybrid).
  - Use building meters to track and identify building energy usage. For buildings with inefficient systems, improve on energy efficiency by using cleaner carbon based fuels such as natural gas to reduce total carbon fuel consumed.
    - Typical energy efficiency is 80%. If Davis-Monthan's energy efficiency increased to 95%, there would be a 1.2% net decrease of the total carbon footprint for the Mission and a 4.1% decrease of the total carbon footprint for Mission Support.
  - Identify an electricity supplier who can provide renewable energy to meet Federal guidelines that require a renewable energy source for a minimum of 5% by FY10, 7.5% by FY13 and 25% by FY25.

B. Energy Usage

- Davis-Monthan AFB is currently under industry benchmarks for MMBTU/FTE. Davis-Monthan's energy consumption for Mission Support functions is 40.28 MMBTU/FTE as compared to the

benchmark of 327 MMBTU/FTE. For Mission functions Davis-Monthan consumes 322.26 MMBTU/FTE. Aviation fuel is the largest contributor to this consumption, while electricity and commuting are the next largest contributors.

- Evaluate the potential for increasing mission simulation capacity in lieu of actual flights.
  - Mission fuel constitutes 81% of the energy consumption at Davis-Monthan AFB. A 10% reduction in mission training flights would produce an 8.6% net decrease in the total energy consumption for the mission.
- Include sub-metering on all new construction and add sub-metering to all facilities being renovated, including those under 30,000 SF, in order to capture and analyze the data to improve energy efficiency with future facility projects.
- Implement equipment efficiency programs for appliances, computer equipment, and motors.
  - Energy efficient appliances and computer equipment can reduce energy consumption by at least 20% by purchasing Energy Star products.
  - Energy efficient motors can decrease energy consumption by up to 20%.
- Implement small appliance duplication policies to reduce energy consumption.
  - Small appliances such as printers, copiers, refrigerators, microwaves and coffee makers should not be permitted at individual workstations. Policies should set FTE to appliance ratios for each of these items to reduce energy demand.
- Continue to install solar hot water pre-heaters where appropriate.
  - Solar hot water pre-heaters reduce the energy needed to heat water by using solar energy to pre-heat.
- Continue to upgrade fluorescent lighting fixtures throughout the installation.
  - High efficiency fluorescent lights can reduce power consumption by as much as 40%.
- Maintain site lighting and flight line lighting to minimum requirements, continue to implement motion sensor parking light systems and consider the use of LED fixtures where applicable.
  - In accordance with Engineering Technical Letters 9-12 and 10-2 and as technology improves, replacing existing exterior lighting with LED fixtures should be considered to reduce energy consumption.
- Continue to pursue on-site solar energy projects.
  - Davis-Monthan's Base Solar Renewable Energy Power Purchase program leases government land to a contractor in exchange for solar electricity at low rates. The land available for lease at Davis-Monthan has the potential to produce 24MW of electricity.
- Reduce energy consumption for air conditioning systems through installation of more efficient systems in new buildings and upgrading systems in existing buildings.
  - For new facilities reduce HVAC fan energy by using active chilled beam technology; use chilled beams in conjunction with constant-volume, dedicated outdoor units with energy recovery.
  - Reduce mechanical cooling energy for new facilities by:
    - Using Variable Refrigerant Volume (VRV) systems in buildings where simultaneous heating/cooling demands would occur;
    - Using water source heat pumps in buildings where simultaneous heating/cooling demands would occur and condenser water is available; and
    - Using direct/indirect evaporative cooling HVAC equipment.
  - For existing chilled water systems save pumping energy by changing to a variable speed pumping system. Provide 3-way valves only to maintain the required minimum flow through the chiller(s). Variable Frequency Drive (VFD) pumps are controlled off of

differential pressure which saves energy by more closely matching the cooling load and reduces pump head.
- For existing chilled water systems save fan energy by upgrading cooling tower fan(s) to variable speed fan(s).
- For existing HVAC systems where applicable:
  - Use energy recovery ventilators to meet general building exhaust requirements and to temper fresh outside air required for ventilation;
  - Upgrade air-cooled DX HVAC equipment to water source heat pumps if condenser water is available; and
  - Upgrade air-cooled DX HVAC equipment to direct/indirect evaporative cooling HVAC equipment.

C. Water Conservation

- Water use at Davis-Monthan AFB is nearly half that of the American average of 80-100 gallons per day. Potable water at Davis-Monthan AFB is used for domestic as well as commercial and industrial uses. Davis-Monthan AFB irrigates its golf course with treated effluent. Other landscaped areas at Davis-Monthan are irrigated to establish the plantings after which the irrigation is removed. In addition, all turf is irrigated with potable water at Davis-Monthan AFB.
  - Continue to implement the required 2% reduction per year of water consumption based on Executive Order13423.
    - Implement the next generation of low flow flush toilets and urinals, and automatic faucets on hand wash sinks.
    - Install building water meters in order to capture and analyze the data to improve water conservation with future facility projects.
    - Recover grey water for non-potable uses (irrigation).
  - Replace existing turf with native plantings and xeriscape in accordance with the 2009 Turf Analysis.
    - Replacing 2.49 acres of turf with native plantings and xeriscape and reducing other turf areas by 0.287 acres has the potential to reduce consumption of potable water by 6,874,747 gal per year once the plantings have been established. This reduction in consumption will result in a 3% reduction in water use per FTE.
  - Expand the treated effluent irrigation program to include all irrigation, including turf areas and family housing irrigation. This will bring Davis-Monthan AFB into compliance with ACC's policy of no irrigation with potable water.
  - Implement storm water requirements under Section 438 of the Energy Independence and Security Act.
    - Projects over 5,000 SF must 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.

D. Waste Reduction

- Waste production per FTE at Davis-Monthan AFB is approximately half the U.S. daily average. The production of 2.36 lbs. per FTE includes all landfill, hazardous materials, and recycling waste streams. In addition to low waste production, 25.6% of the waste produced at Davis-Monthan AFB is recycled.
  - Maximize recycling efforts through end user education and improved recycling facilities.

    - Provide an easily accessible area in each building dedicated to collection and storage of materials for recycling, including paper, corrugated cardboard, glass, plastics and metals.
  - Implement operational procedures to reduce the production of waste and hazardous chemicals used.
    - Institute paperless office practices or standards for double-sided printing and copying.
    - Implement additional Sustainable Procurement Programs.

E. Land Utilization

- Since there are no established benchmarks for development density on an AFB, the USGBC LEED-NC Guidelines were used. These guidelines indicate that development density should be 60,000 SF/acre or greater. Davis-Monthan AFB currently has a development density of 25,937 SF/acre, more than two times lower than the guidelines.
  - Future development of the installation should focus on infill of Administration, Community Commercial, Community Service, Manufacturing and Production, and Medical land use classification areas. New development should promote 3 and 4 story buildings. This will increase development density and concentrate development where there are existing utilities.
    - Infill development will protect natural resources and preserve open space by preventing development of greenfields.
    - Vehicle travel will be reduced by locating facilities near services, thereby reducing energy usage and Davis-Monthan's carbon footprint.
    - Promoting vertical development allows for community services on the ground floor of new buildings; this promotes community connectivity and reduces vehicle travel within the installation.
  - Conduct a study to determine existing internal traffic counts and internal commuting to examine the impact of the proximity of services to family housing and the flight line.
  - Future development sites should limit site disturbance to reduce damage to site ecology.
  - Building footprints should be reduced to accommodate current population needs.
    - Aligning current footprints with the current population will reduce the amount of impervious surface on the installation and reduce the carbon footprint by eliminating energy and building fuel requirements.

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	
Acre	A unit of area equal to 43,560 square feet.
BTU	British thermal unit: The quantity of heat required to raise the temperature of 1 pound of water 1°F at or near 39.2°F.
CFC	chlorofluorocarbon
CH_3OH	methanol
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent based on the GWP
cu ft or ft^3	cubic foot: A unit of volume of a cube with sides of one foot in length.
dB	decibel: A logarithmic unit of measurement that expresses the magnitude of a physical quantity (usually power or intensity) relative to a specified or implied reference level.
eCO_2	CO_2 Equivalents
FC	fluorocarbon
FTE	full-time equivalent
FY	fiscal year
GWP	global warming potential
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
J	joule
kW	kilowatt
kWh	kilowatt hour

Term	Definition
lb.	pound
LEV	low emission vehicle
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MMBTU	One Million BTUs. A BTU is the quantity of heat required to raise the temperature of 1 pound of water 1°F at or near 39.2°F.
N_2O	nitrous oxide
NGL	natural gas liquid
NMVOC	non-methane volatile organic compound
NO	nitrogen oxide
NO_x	nitrogen oxides
O_3	ozone
ODS	ozone depleting substance
PFC	perfluorocarbon
PM	particulate matter
ppb	parts per billion
ppm	parts per million
PV	photovoltaic
RCx	retro-commissioning
SF	square feet
SF6	sulfur hexafluoride
SNG	synthetic natural gas
SO_2	sulfur dioxide
SO_x	sulfur oxides
SRI	solar reflectance index
TSS	total suspended solids
VMT	vehicle miles traveled
VOC	volatile organic compounds
Acronyms	
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BMP	Best Management Practice
DADT	Daily Average Daily Traffic
DOE	U.S. Department of Energy
GIS	Geographical Information System
LEED	Leadership in Energy and Environmental Design
MSW	Municipal Solid Waste
SSPP	Strategic Sustainability Performance Plan
EPA or USEPA	U.S. Environmental Protection Agency

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 Davis-Monthan 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 Davis-Monthan 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 Davis-Monthan 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 Davis-Monthan 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 Davis-Monthan AFB.

B. Data Sources

The following are data sources received from HQ ACC/A7PS and Davis-Monthan AFB:

1. Davis-Monthan AFB, Arizona, Final Integrated Natural Resources Management Plan, January 2010
2. Davis-Monthan AFB, Arizona, Integrated Cultural Resource Management Plan, May 2010
3. Davis-Monthan AFB, Arizona, Storm Water Pollution Prevention Plan (SWPPP), September 2004
4. Davis-Monthan AFB, Arizona, Economic Impact Analysis – Description of Real Estate Assets 2007 and Personnel Assigned 2007, October 2007
5. Davis-Monthan AFB, Arizona, Environmental Restoration Program Site Summaries, December 2007
6. Davis-Monthan AFB, Arizona, Entry Control Facility Transportation Engineering Assessment, Draft March 2010
7. The Office of The Air Force Civil Engineer, United States Air Force Infrastructure Energy Strategic Plan, 2008
8. U. S. Air Force, U. S. Air Force Energy, Environment, Safety and Occupational Health: Managing for Operational Sustainability, 2007 Inaugural Report
9. Davis-Monthan AFB, Arizona, FY09 Defense Utility Energy Reporting System (DUERS), February 9, 2010
10. Davis-Monthan AFB, Arizona, FY08 Defense Utility Energy Reporting System (DUERS), February 9, 2010
11. Davis-Monthan AFB, Arizona, FY03 Defense Utility Energy Reporting System (DUERS), February 9, 2010
12. Real Property Reports
13. U.S. Green Building Council (USGBC), LEED Certified Projects List
14. U.S. Green Building Council (USGBC), LEED Registered Projects List
15. Zip Code Distribution of Air Force Active Duty Personnel and Payroll Report, 2010
16. Davis-Monthan AFB, Arizona, GIS Maps

C. Expanding Requirements

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

1. Executive Order 13423
2. Energy Policy Act 2005
3. Energy Independence and Security Act of 2007
4. Higher Level DoD and HAF directives
5. MAJCOM directives
6. Key Air Force Environmental Goals
7. Other Federal Agency rulemaking and guidance

D. References

The following are publications and websites used as resources:

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2. http://www.eere.energy.gov/
3. http://www.un.org/esa/dsd/susdevtopics/sdt_land.shtml
4. http://www.eia.doe.gov
5. ISAUK Research Report 07-01, A Definition of Carbon Footprint, June 2007.
6. http://acupcc.aashe.org/ghg-scope-statistics.php
7. http://www1.eere.energy.gov/femp/program/printable_versions/waterefficiency.html
8. http://oaspub.epa.gov/enviro/pcs_det_reports.pcs_tst?npdesid=AZU000050&npvalue=1&npvalue=2&npvalue=3&npvalue=4&npvalue=5&npvalue=6&rvalue=13&npvalue=7&npvalue=8&npvalue=10&npvalue=11&npvalue=12