Executive Summary

This report describes the structure, design, and outcomes of training the Robins Air Force Civil Engineering and Environmental Management/Pollution Prevention Staff on the topic of sustainable facilities and infrastructure. The primary objective of this pilot training was to provide an introduction to the concept of sustainability as it pertains to the built environment, along with an overview of basic tools and methods for sustainability implementation, assessment and evaluation, and economic analysis. The training consisted of three main components: 1) Primer on Sustainable Facilities and Infrastructure; 2) Assessment Tools and Techniques for Sustainable Facilities and Infrastructure; and 3) Economics of Sustainable Facilities and Infrastructure.

The training, held on July 24-25, 2000, included approximately 35 participants from the RAFB staff ranging from planners, architects, and engineers to contract officers, project managers, and operations staff. The training included seven interactive learning exercises, during which participants were required to answer specific questions as individuals, pairs, small groups, or in the context of the whole group.

The outcomes of the training include conclusions, potential barriers to sustainability that must be addressed, and specific recommendations for project sustainability strategies and action items that will move RAFB toward increased sustainability in future capital projects. Identified barriers include:

- Perceived Economic Impacts
- Individual and/or Organizational Resistance to Change
- Lack of Necessary Knowledge
- Lack of Management Buy-In
- Risk of Failure
- Lack of Appropriate Measures of Project Success
- Lack of Resources to Implement Sustainability Concepts
- Unclear Payoff/Lack of Incentives or Rewards

Recommended actions for implementing sustainability in capital projects include:

- Establish a common vision and mission for sustainability for RAFB capital projects
- Establish the knowledge base necessary to implement sustainability in capital projects
- Establish awareness of and alignment with sustainability vision/mission among all RAFB personnel and project team members
- Increase the sustainability of future RAFB capital projects

The report also describes seventeen goals and measurable objectives to achieve the fourth recommended action—increasing the sustainability of future RAFB capital projects—as well as specific suggestions for overcoming the nine barriers identified during the training.

Part 1 – Roadmap to the Report

This report contains the results and recommendations of the Sustainable Facilities and Infrastructure (SFI) training that Georgia Tech Research Institute (GTRI) performed for the Robins Air Force Base (RAFB) staff on July 24 and 25, 2000. Approximately thirty-five participants took part in the two-day training session, with additional staff participating in portions of the training as time allowed. The objective of this report is to provide RAFB with conclusions and recommendations in the following areas:

- Assessment of learning and team alignment
- Suggestions for sustainability objectives to be adopted by RAFB
- Barriers likely to be encountered in implementing sustainability in RAFB capital projects
- Set of sustainability strategies with likelihood of success on RAFB capital projects
- Specific action items to be undertaken to implement sustainability on RAFB projects, along with responsibilities and target dates
- Recommendations for future activities to implement sustainability, including training and technical support recommendations

Trainees provided the basis for these conclusions and recommendations during the training sessions. Interactive class participation took place in several forms during the training, including think-pair-share activities, group discussions, round robins, and completion of individual input sheets. This report includes both raw data generated by these activities (included in the Attachments) and summaries identified by the training facilitators. Further analysis is provided in the sections corresponding to each exercise, as well as in Part 3: Conclusions and Recommendations.

Table 1 shows the content covered during the two days of training. The training began with an overview of the context of sustainable capital projects, in which the participants were introduced to the basic theoretical concept of sustainability and how it pertains to built environment systems. This module included a Think-Pair-Share exercise to assess the participants' initial understanding of the concept of sustainability with respect to the built environment. This module was followed by an overview of eight categories of sustainable facility strategies, including:

- Planning strategies
- Site-related strategies
- Energy-related strategies
- Water-related strategies
- Material- and system-related strategies
- Indoor environment and user-related strategies
- Project management strategies
- Sustainable project specifications

Table 1: Training Content

Day 1 – Introduction to Sustainable Facilities & Infrastructure **Monday, July 24, 2000**
Setup and Welcome – 7:30 a.m. - 8:00 a.m.
Session 1 – 8:00 a.m. - 9:45 a.m. (105 minutes) "The Context for Sustainable Capital Projects" Lecture and active learning exercises to include: • Motivation for making the built environment more sustainable • The impacts of built facilities on humans and the environment • Sustainability from a systems perspective: Impact and flow model • Project planning, design, and execution processes in a typical capital project • Strategic entry points for sustainability in the capital project realization process
9:45 a.m. - 10:00 a.m. – Coffee Break (15 minutes)
Session 2 – 10:00 a.m. - 12:00 noon (120 minutes) "Sustainable Facility Strategies, Part 1" Lecture and active learning exercises to include: • Planning for sustainable capital projects • Sustainable site strategies • Sustainable energy systems • Sustainable water and wastewater systems
12:00 noon - 1:00 p.m. Lunch Break (60 minutes)
Session 3 –1:00 p.m. - 3:00 p.m. (120 minutes) "Sustainable Facility Strategies, Part 2" Lecture and active learning exercises to include: • Alternative building materials and systems • Indoor environmental quality • Project management strategies for sustainability • Sustainable project specifications
3:00 p.m. - 3:15 p.m. – Coffee Break (15 minutes)
Session 4 – 3:15 p.m. - 5:00 p.m. (105 minutes) "Barriers to Project Sustainability: Integrated Strategy Design" Lecture and active learning exercises to include: • Typical barriers to implementing sustainability in capital projects • The role of strategy integration Facilitated discussion on: • Barriers to sustainability in Air Force capital projects
5:00 p.m. Dismissal

Day 2 – Assessment and Economics of Sustainable Facilities & Infrastructure
Tuesday, July 25, 2000

Welcome – 7:30 a.m. - 8:00 a.m.

Session 1 – 8:00 a.m. - 9:00 a.m. (60 minutes)
"Decision Making and Selection Strategies for Project Sustainability"

Lecture and active learning exercises to include:

- The role of measurement in making decisions for project sustainability
- The AGES process for identifying and prioritizing sustainability strategies
- Selecting indicators and managing data streams for tracking project impacts
- Introduction to the LEED Green Building Rating System

Session 2 –9:00 a.m. – 9:45 a.m. (45 minutes)
"Economics of Sustainable Facilities & Infrastructure"

Lecture and active learning exercises to include:

- Myths and realities of the economics of sustainable capital projects
- Project classification by cost: The 3-D quantitative/qualitative cost model
- Itemizing, pricing, and comparing costs for capital project alternatives

9:45 a.m. - 10:00 a.m. – Coffee Break (15 minutes)

Session 3 – 10:00 a.m. - 12:00 noon (120 minutes)
"The LEED Green Building Rating System"

Lecture and active learning exercises to include:

- Structure of the LEED rating system
- LEED point categories and rationale
- Calculating a LEED rating and preparing documentation

12:00 noon - 1:00 p.m.
Lunch Break (60 minutes)

Session 4 –1:00 p.m. – 2:30 p.m. (90 minutes)
"The LEED Green Building Rating System, cont'd."

Lecture and active learning exercises to include:

- Team exercise on barriers, benefits, and next steps for selected LEED points

2:30 p.m. –2:45 p.m. – Coffee Break (15 minutes)

Session 4 – 2:45 p.m. - 5:00 p.m. (135 minutes)
"Implementation: Avenues for Change"

Lecture and active learning exercises to include:

- Basics of organizational change
- Project team alignment for sustainability

Facilitated discussion on:

- Strategies for incorporating sustainability into Air Force capital projects

5:00 p.m.

Course Evaluations and Dismissal

Day 1 of training concluded with a session on the barriers to project sustainability, including an interactive exercise to elicit individual and group reactions to and perceptions of the benefits and risks of sustainability for RAFB capital projects.

Day 2 began with an introduction to sustainable decision making and introduced concepts of problem framing and challenges of information management. This module was followed by a presentation on the economics of sustainable facilities and infrastructure that covered assessment of project sustainability, expectations of the costs of sustainable projects, and strategies for achieving economically sustainable projects. An interactive exercise during this module included participants identifying strategies for increasing the sustainability of the building in which training was being conducted, and discussing the costs and benefits of each strategy.

The Economics module was followed by an introduction to the LEED building rating system, the most widely used sustainability assessment tool in the United States. The LEED system contains five categories of points, each of which was discussed in turn:

- Sustainable sites
- Water efficiency
- Energy and atmosphere
- Materials and resources
- Indoor environmental quality

The LEED module included two related interactive exercises. First, after each of the five LEED point categories was presented, participants were asked to choose which three points they believed would be most easily implemented in RAFB capital projects using a Think-Pair-Share voting technique. The votes were tallied to identify the three (or four) most easily implementable points for each category. The second part of the exercise involved dividing the trainees into five teams (corresponding to the five LEED categories) and tasking each team to identify the key barriers, benefits, and next step toward implementation for each of the top ranking points. At the end of this exercise, a spokesperson for each team reported the findings to the class as a whole.

The final session of Day 2 addressed the challenges of implementing sustainability for RAFB capital projects. The training concluded with two exercises to identify action items to increase the sustainability of RAFB projects and to articulate specific personal commitments from each trainee toward the goal of increasing the sustainability of RAFB projects.

Table 2 shows the nature and purpose of the seven interactive exercises that were conducted over the course of the training. The next section of this report, Input Questions and Answers, describes the findings of each exercise in turn.

Table 2: Interactive Exercises Conducted during the Training

	Module	Exercise	Purpose
1	The Context for Sustainable Capital Projects	The meaning of sustainability for the built environment (Think-Pair-Share)	To assess initial understanding and alignment of trainees with respect to built environment sustainability
2	Barriers to Project Sustainability	Reactions to, benefits of, and risks of implementing sustainability (Individual input sheet; Small group discussion and round-robin)	To assess participants' perceptions about sustainability for RAFB capital projects following an introduction to the concept and specific project strategies
3	Decision Making and Project Economics	Identification and discussion of the costs and benefits of candidate strategies for improving the facility in which training took place	To allow participants to identify specific strategies that could be applied to improve facility sustainability, and to identify the costs and benefits of each
4	The LEED Green Building Rating System	Ease of implementation rating of LEED points (Individual ranking of points within categories; Think-Pair-Share selection of top three points for each pair; Selection of top three points for each category based on pair votes)	To identify specific LEED-related strategies that have the greatest likelihood of success on RAFB capital projects
5	The LEED Green Building Rating System	Barriers to, benefits of, and next steps for implementing top-ranking points (Small group discussion; report back to group)	To identify challenges, motivations, and action items for implementing specific LEED strategies
6	Implementation: Avenues for Change	Action Items Input Sheet (Input sheet completed and submitted by individuals)	To identify action items that trainees feel RAFB must take to increase the sustainability of their capital projects, along with benefits, resources required, actions, and target dates
7	Implementation: Avenues for Change	Personal Commitment Input Sheet (Input sheet completed and submitted by individuals)	To identify specific commitments that each trainee is willing to undertake to increase the sustainability of RAFB capital projects

Part 2 – Input Questions and Answers

As shown in Table 2, a total of seven interactive exercises were conducted during the two days of training. Part 2 presents descriptions of each of the interactive exercises, along with a summary of the findings and conclusions from each exercise.

Input 1 – The Meaning of Sustainability and the Built Environment

At the beginning of day 1 of training (July 24, 2000) a question was posed to the entire group, "What does sustainability mean for the built environment?" This question was posed prior to beginning the formal training in order to create a benchmark for participants' understanding of the meaning of sustainability, the built environment, and how the two relate to one another. Using a Think-Pair-Share technique, participants were asked to provide answers out loud while the answers were written on a white board in the classroom. Answers that were stated more than one time had a check mark put next to them to provide a count. After all answers were listed on the board, an open discussion of the concepts took place.

Answer 1

A total of twenty-seven different answers were provided by class participants to the question, "What does sustainability mean to the built environment?" Concepts identified by participants ranged from the environment (long-term minimal environmental impact) to economics (cost effective). The broad range of answers prior to the start of training indicates that participants had a solid understanding of sustainability, its definition, and how it relates to the built environment.

Out of the twenty-seven separate concepts discussed, ten (or 37%) of them were repeated by more than one individual. The following concepts were answered by more than one participant, with the frequency of response in parentheses:

- Material durability (5)
- Energy effectiveness/efficiency for long term cost savings (5)
- Minimal environmental impact, all of which is mitigatable (4)
- Future generations in mind – modular design (4)
- Low resource use (4)
- Environmentally friendly (3)
- Recycled materials within reason (3)
- Long term economic benefits (2)
- Maintainability – economic (2)
- Biodegradable (2)

Attachment 1 includes a list of the answers received during this participant input session, along with the frequency with which each response was given by trainee pairs.

Input 2 – Reactions to, Benefits of, and Risks of Implementing Sustainability

The second time for participant input was during the last session of the first day, Barriers to Project Sustainability. Concepts discussed in this session included types of innovation

development, types of change, rates of change, possible outcomes to change, reasons for resistance to change, sources of resistance to change, and errors in affecting change.

After this initial instruction, the group moved into a facilitated workshop to further express ideas about barriers to implementing sustainability in the RAFB. The workshop objectives were to:

- provide course participants with an opportunity to explore in more depth some of the concepts discussed in previous sessions;
- foster collaborative learning among course participants with a focused exercise;
- stimulate teamwork, creativity and innovation; and
- provide a more focused forum for the exchange of ideas and experiences.

The class was divided into four groups. Each team chose a leader to moderate the brainstorming session and a recorder to capture all answers. For each question posed by Dr. Vanegas, individuals were given two minutes to write down their individual thoughts on an input sheet. Then in a round robin within each group, without discussion or debate, each person shared their answers with the group in a six-minute period. The group recorder summarized all ideas discussed in the round robin and then reported back to the class after the conclusion of the exercise.

The questions posed during this workshop are listed below.

1. Please state briefly your individual reaction to sustainability, as presented in previous sessions, and within the specific context of Robins AFB.
2. Please list three (3) potential benefits of implementing sustainability within the specific context of Robins AFB.
3. Please list three (3) potential risks of implementing sustainability within the specific context of Robins AFB.
4. Please list two (2) potential barriers for implementing sustainability within the specific context of Robins AFB.
5. Please list a barrier-breaker for each of the barriers identified above.

At the end of the facilitated workshop, individuals were instructed to keep their input sheets and add comments as appropriate during Day 2 of training. At the end of Day 2, participants turned in their input sheet and the group recorder turned in the summary sheets from the round-robin discussions.

Answer 2

Individual comments can be found in Attachment 2. Selected comments for each category that are representative of the comments as a whole or otherwise notable are listed in the following sections.

What are your individual ***reactions*** to sustainability, based on everything you've heard today?

- Extra time and effort – we already have a very heavy workload
- Overall good idea with a desirable goal
- Payoff is too low now
- There is no "legitimate" sense of urgency
- The risk is much higher than the benefits
- Vague and idealistic, but the more tangible aspects can be implemented
- It is difficult to identify cost savings. Decisions are cost driven
- Great concept, but must have top-level support to happen
- Will be like other government programs – all talk with no actual results
- I think we have to do this in order to leave the world for the next generations
- Right thing to do
- Not cost effective
- Problematic due to sole sourcing
- Teamwork is essential
- Whether a product is green or not is kind of fuzzy
- This will slow down the design process

What are the ***benefits*** of implementing sustainability within the specific context of Robins Air Force Base?

- Better environment
- Can create some cost savings in some areas
- More responsible use of resources
- Decrease waste
- Improve quality of life
- Better end products
- Reduced manpower/maintenance
- Less pollution
- Energy savings/better use of energy resources
- Good publicity
- Lower cost in the future

What are the ***risks*** of implementing sustainability? What can go wrong?

- Commanders have a short term mentality and will not support if greater first cost
- Not guaranteed to succeed
- Unknowns
- Not enough?
- Higher costs now/costs might be prohibitive
- Negative results/unintended consequences
- Too time consuming
- Higher A/E/C costs
- Lack of full team participation
- Cost and time lead to failure of projects
- Changes to management
- Loss in productivity when implementing
- No definite measurements or metrics
- New technology could create errors
- Backlash to program when mistakes occur
- Lack of materials availability
- Product/process failure risks

What are the primary barriers to sustainability for Robins AFB? What barrier breakers can be used to match them?

BARRIER	BARRIER BREAKERS
Cost	♦ Do more with less ♦ Implement green design procedures to reduce cost
Management resistance	♦ Define vision ♦ Educate ♦ Promote open-mindedness ♦ Provide top-down direction
Too much individual responsibility; not enough time	♦ Reward trying ♦ Provide "canned" specs and other informational resources ♦ Start from the top and do not burn the bottom by pressure and effort without reward or resources ♦ Provide better, more objective measures

Input 3 – Strategies for Increasing the Sustainability of the Training Facility

The first two sessions of Day 2 of the training focused on evaluating the sustainability of project alternatives, and making decisions about the strategies that would have the most "bang for the buck" in terms of sustainability. During these sessions, participants were asked to identify strategies discussed on the previous day that could be used to improve the sustainability of the facility in which training took place.

Answer 3

The class as a whole identified six different strategies for improving the sustainability of the facility, listed below. Attachment 3 contains a description of the discussion surrounding each of these options, including the costs and benefits of each as identified by members of the class during the discussion.

- Carpet replacement with leased, recycled content carpet
- Changing roof color to a lighter shade to reduce heat gain
- Insulation of the building envelope
- Lowering the dropped ceiling of conditioned areas of the building
- Installation of more efficient HVAC equipment
- Incorporating daylighting into warehouse portions of the building

These six items primarily addressed the energy consumption of the facility, likely due to the fact that many of these strategies have a proven track record when used as retrofits for existing facilities. A variety of barriers were noted for each potential strategy, discussed further in Attachment 3.

Input 4 - Think, Pair, Share: LEED Rating System

The majority of the morning on day 2 of the training centered around teaching participants in detail about the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system. The LEED system provides a mechanism for determining a building's sustainability ranking by assigning credits in five categories for different sustainable practices implemented. These include sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. LEED is the most commonly used tool of its kind in the United States.

Class instruction focused on describing the intent, requirements and strategies for each LEED credit within the five categories. Once all of the credits had been explained, the attendees were asked to work in pairs to select the three LEED points in each of the five categories that they perceived could be most easily be implemented at Robins Air Force Base. Approximately two minutes were provided for the selection process for each category. The instructor asked each pair to verbally share their selections with the entire class, and tallies for each point were recorded. Those points with the highest number of tick marks were perceived to be the most feasible points to further evaluate during another exercise conducted after lunch.

Answer 4

The tally of the whole group's votes can be found as Attachment 4. The following page shows a listing of the top LEED credits per category as voted by the entire class, with the total vote count in parentheses. The implications of implementing these LEED credits were further explored and are explained in the next section.

Input 5 – Barriers, Benefits and Next Steps for Highest Ranking LEED Points

The class was divided into five groups by counting 1-5 continuously until everyone was assigned a number. Everyone with the same number formed a group which was assigned one of the five LEED categories (sustainable sites, water efficiency, energy and atmosphere, materials and resources or indoor environmental quality). Each group was given a Barriers, Benefits and Next Steps sheet for the top ranking LEED points identified in the previous exercise. Using all the resources in the room (including the LEED point category reference guide, course workbook, and other reference material), the group was tasked to answer the following three questions for each LEED credit point:

1. What are the barriers to implementing strategies to score the point?
2. What are the possible benefits of implementing a strategy to score the point?
3. What must occur (e.g., product research, form interdisciplinary teams, etc.) before this strategy can be implemented? What are the next steps?

Approximately forty-five minutes was allotted for this exercise. At the end of the time period, the groups reassembled and a representative from each group shared the results with the class.

The purpose of this input exercise was to encourage class participants to think about real implementation of the LEED credits. Since the credits examined were those that the group felt were most easily implementable within RAFB, the exercise allowed an opportunity for groups to brainstorm on potential steps toward making RAFB facilities more sustainable.

Top Ranked LEED Points According to Ease of Implementation for RAFB

Sustainable Sites
Credit 1: Site selection (8)
Credit 5a: Reduced site disturbance – limit disturbance to site (6)
Credit 7b: Reduce heat island effect – high reflectance roof (5)

Water Efficiency
Credit 3: Water use reduction (17)
Credit 1a: Water efficient landscaping – high efficiency irrigation (12)
Credit 1b: Water efficient landscaping – capture and use rainwater for irrigation (11)

Energy and Atmosphere
Credit 1: Optimize energy performance (13)
Credit 5: Measurement and verification (11)
Credit 4: Eliminate HCFCs and halons (9)
Credit 3: Best practice commissioning (8)

Materials and Resources
Credit 1: Building Reuse (11)
Credit 5: Local/regional materials (11)
Credit 3: Resource reuse/Salvaged materials (9)

Indoor Environmental Quality
Credit 7b: Thermal comfort – Temperature and humidity monitoring systems (9)
Credit 2: Increase ventilation effectiveness (8)
Credit 4: Low-emitting materials – Paints (8)

Answer 5

Attachment 5 contains a summary of groups' answers to the barriers, benefits, and next steps of the top ranked LEED credit points. When evaluating barriers to implementing individual credits of the LEED ranking system, several barriers were common across several credits. These are (including the frequency of response in parentheses):

- Affordability/cost effectiveness/lack of funding/increased cost (10)
- Poor performance/concerns with unproven technology/existence and availability of acceptable alternatives (7)
- Management approval/approval authority (4)
- Manpower/technical expertise/knowledge (3)

Likewise, when evaluating benefits of implementing individual credits of the LEED ranking system, several responses were common across several credits. These are:

- Reduced costs/enhanced savings (9)
- Reduced resource consumption/enhanced conservation (7)
- Lower energy use/greater energy efficiency (6)
- Reduced waste (5)
- Enhanced compliance/reduced liability (3)
- Better comfort/air quality (2)
- Reduced environmental impact (2)
- Green (2)
- Reduced project time/faster delivery (2)

In order for the LEED credits to be implemented, participants also identified specific needs that would have to be met. Several needs were common across several credits. These are:

- Investigate costs and benefits/study process and technologies/research availability of materials and resources (7)
- Educate ourselves and customers/awareness training (4)
- Validate options to management/obtain management commitment (3)
- Program extra funds (2)
- Establish measurement/metering (2)

Input 6 – Action Items

The last session of the training on day 2 was a second facilitated workshop, entitled "Implementing Sustainability." Similar to the workshop on day 1, the participants learned about the major concepts of implementing sustainability within an organization prior to the facilitated portion of the workshop. Concepts covered included classes of change strategies, strategic management of change, sustainability thinking, and action planning for change.

After the initial lecture, participants were given the opportunity to suggest an organizational action and their own individual action item that should be taken to increase the sustainability of RAFB projects. The objectives of the workshop as well as the set-up of the breakout session were the same as on Day 1. Individuals were allotted five minutes to complete the Action Item Input Sheet, which included the following six items:

1. Please describe briefly an Action Item for the Organization that you consider is important to implement sustainability within Warner Robins (Please be as specific as possible).
2. Why is the implementation of this action item of strategic importance to Warner Robins (i.e., anticipated impacts, benefits, or implications)?
3. What are the resources required to implement this action item?
4. Please indicate one specific commitment that the Organization needs to make to implement this action item.
5. Please indicate one specific commitment that you need to take to implement this action item.
6. Please indicate the target date for full implementation of this action item.

Answer 6

After participants completed their input sheets, the sheets were provided to the instructors for analysis and summary. A table summarizing individual responses to questions posed during Workshop 2 can be found as Attachment 6.

Several organizational action items were repeated by more than one individual on the Action Item Input Sheet for Workshop 2. These are:

- Devise training/continuing education effort and educate all personnel
- Incorporate LEED scores for all major projects
- Report wins and provide cross-feed forums on successes
- Dedicate resources, human and otherwise, to implement and sustain sustainability
- Adopt sustainable project procedures, technologies, tools, and methods, and include them in all project language on a continuous basis
- Establish a team to initiate and champion the sustainability implementation process
- Identify areas where sustainability is achievable now
- Program and design a prototype green project
- Provide management support and commitment

Input 7 – Personal Commitment Input Sheet

After individuals developed an action item for the organization, they were asked to shift their focus inward to a personal level and complete a personal commitment input sheet. The input sheet asked the following:

1. Please describe briefly a specific personal commitment that you are willing to make to Warner Robins, in support of implementing sustainability (Please be as specific as possible).
2. Why is this commitment of strategic importance for the success of the implementation of sustainability?
3. What resources will you require to honor your commitment?
4. Please indicate the target date for full execution of this commitment.

Individuals were also asked to voluntarily provide their name and address to permit their commitment sheets to be mailed back to them in approximately three months as a reminder. The personal commitment input sheets were collected by GTRI for inclusion in the final report.

Answer 7

Attachment 7 contains a transcription of the personal commitments reported by individuals on their Personal Commitment Input Sheets. While not all participants included their names or completed these sheets, nonetheless they can provide a point of departure for identifying individual actions necessary to successfully implement the action items recommended in Part 3: Conclusions and Recommendations.

Several answers were common among multiple respondents. They are:

- Remain open-minded and suppress pessimism; be a proactive team player
- Support the efforts of organizational change agents
- Read sustainability articles and other relevant material; research on the web
- Develop training briefings for AFRC/sustainable architecture board/others
- Obtain information about successful projects and maintain a database of successful products used in AF projects

Part 3 – Conclusions and Recommendations

Part 3, the final section of this report, describes the overall conclusions drawn from trainees' input during active learning exercises and makes recommendations for further activities to be undertaken by RAFB to increase the sustainability of their capital projects. This part of the report includes an assessment of learning and alignment of the RAFB team, suggested sustainability objectives to be adopted as part of policy development, recommended project strategies and overall action items, barriers that should be addressed to successfully implement sustainability, and additional recommendations.

Assessment of Learning and Team Alignment

The initial benchmark established in the first interactive learning exercise revealed that most of the trainees had a good overall understanding of the meaning of sustainability for the built environment. The broad spectrum of answers identified in the Think-Pair-Share exercise also illustrated the need for a common operational definition or concept of sustainability as it pertains to buildings, i.e., one that is meaningful in terms of the kinds of facilities commonly encountered by RAFB practitioners. This conclusion was further supported by participant comments throughout the training that sustainability seems like a "fuzzy" or "warm apple pie" concept, fraught with subjectivity and without objective metrics to measure when it has been achieved.

The common occurrence of terms such as "environmentally friendly" leaves room for multiple interpretations of sustainability. While room for interpretation may be key to successfully implementing sustainability on the diverse projects encountered by RAFB, more specific, measurable objectives should be established to aid in evaluating the success of actions taken to increase sustainability on future projects. The next section describes several suggested objectives in greater detail.

Team alignment is another factor that will be critical for successful implementation of sustainability objectives. From a strictly subjective standpoint, many training participants seemed resistant to the concepts presented in training, for reasons varying from "we've tried this all before back in the days of Jimmy Carter", "all talk and no action", and "this won't work for military installations" to comments reflecting active hostility toward the training content being presented.

The quality of questions and comments posed to the instructors showed that trainees were comprehending the material being presented and already had a good deal of knowledge relating to the topic coming into the training. Unfortunately, some of this knowledge was used to express pessimistic comments about the concepts being presented or to point out reasons not to pursue sustainability as a goal.

Along the same lines, not all participants were willing to complete personal or organizational commitment input sheets, and some individuals who did complete the sheets included obviously sarcastic comments, e.g., target completion dates of February 30 or 31. These indicators may reflect the real challenge recognized by many participants of implementing the concept of sustainability – significant personal commitment, management support, economic investment,

and knowledge will be required to undertake the necessary actions. Without full confidence that all resources will be in place, some individuals may not be ready to personally commit to the topic, and some may not yet have a clear picture of what such a commitment will entail.

One step towards clarifying the requirements of committing to project sustainability is the development of clear and measurable objectives to apply both at the level of individual projects as well as across the organization as a whole. The next section identifies suggested objectives that can serve as a starting point for developing an RAFB-specific vision, mission, goals, and statement of objectives for capital projects.

Suggested Sustainability Goals, Objectives, and Recommendations

Among the policy tools necessary to implement sustainability for capital projects are a common organizational vision, mission, overall goals, and specific objectives. Having completed the two days of training, RAFB personnel now have a basis for understanding the concept of sustainability and how it applies to capital projects. One specific step that should be taken at this point is to begin the process of developing these necessary policy tools. As a starting point for this process, this section identifies several goals along with specific, measurable objectives that could form a part of the RAFB's policy for sustainable capital facilities. These goals and objectives derive from participant inputs during the training, and fall into two basic categories: organizational/management goals and objectives, and project-specific goals and objectives. Tables 3 and 4 list suggested goals and objectives in these two categories. The two categories also correspond to recommended RAFB Action Items (Table 3) and Recommended Sustainability Strategies for RAFB Capital Projects (Table 4).

Table 3: Organizational/Management Goals and Objectives

GOALS	OBJECTIVES
Establish a common vision and mission for sustainability for RAFB capital projects	• Draft, circulate for review, and revise a vision and mission statement for RAFB project sustainability. • Revisit vision annually and revise to reflect new knowledge or project experience.
Establish the sustainability knowledge base necessary to support RAFB personnel in their implementation of capital projects.	• Allocate <budget amount> for the purchase of sustainable facility reference materials. • Allocate <budget amount> to send <# of personnel> to LEED training to become LEED certified. • Allocate <budget amount> for in-depth training on sustainable facility practices for selected personnel. • Allocate <budget amount> for periodic refresher training for all RAFB personnel. • Continue to support the sustainability working group to champion sustainability in RAFB projects, and give them authority to audit processes/projects and make recommendations for change.
Establish awareness of and alignment with sustainability vision/mission among all RAFB personnel and project team members.	• Develop and disseminate web site or other promotional materials to describe vision/mission to all RAFB personnel. • Conduct brief lunch n' learn sessions to introduce base personnel to sustainable facility principles. • Incorporate sustainability criteria in A-E and contractor selection.
Increase the sustainability of future RAFB capital projects	• Utilize the LEED rating system on all applicable future projects, and require a minimum rating of <certified, silver, gold, or platinum>. • Identify at least one project per fiscal year to be developed as a showcase sustainable facility (achieving at least a <specified level> LEED rating), and develop interpretive displays, web sites, or other informational materials to illustrate the sustainable features of the facility. • Consider allocating <budget amount> and/or shifting responsibilities to allow sufficient resources for material and technology research on showcase projects. • Develop sustainability design review criteria, assign responsibility for checking compliance with these criteria, and establish and incorporate into contracts penalties and/or rewards to motivate compliance with the criteria.

Table 4: Project-Specific Goals and Objectives

GOALS	OBJECTIVES
Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.	♦ Do not develop buildings on portions of sites that meet any of the criteria specified in LEED Site Credit 1, Requirements.
Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity	♦ On greenfield sites, limit disturbance including earthwork and clearing of vegetation to 40 feet beyond the building perimeter, 5 feet beyond primary roadway curbs, walkways, and main utility branch trenches, and 25 feet beyond pervious paving areas that require additional staging areas in order to limit compaction in the paved area; OR, on previously developed sites, restore a minimum of 50% of the remaining open area by planting native or adapted vegetation. ♦ Reduce the development footprint (including building, access roads, and parking) to exceed the local zoning's open space requirement for the site by 25%.
Limit disruption of natural water flows by eliminating storm water runoff, increasing on-site infiltration, and reducing contaminants.	♦ Implement a stormwater management plan that meets LEED Site Credit 2 Requirements.
Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.	♦ Use ENERGY STAR Roof compliant, high-reflectance AND low emissivity roofing (initial reflectance of at least 0.65 and three-year-aged reflectance of at least 0.5 when tested in accordance with ASTM E408) for a minimum of 75% of the roof surface.
Limit or eliminate the use of potable water for landscape irrigation.	♦ Use high efficiency irrigation technology; OR use captured rain or recycled site water to reduce potable water consumption for irrigation by 50% over conventional means. ♦ Use only captured rain or recycled site water for an additional 50% reduction (100% total reduction) of potable water for site irrigation needs; OR, do not install permanent landscape irrigation systems.

GOALS	OBJECTIVES
Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.	♦ Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation) after meeting Energy Policy Act of 1992 fixture performance requirements. ♦ Exceed the potable water use reduction by an additional 10% (30% total efficiency increase).
Verify and ensure that fundamental building elements and systems are designed, installed, and calibrated to operate as intended.	♦ Engage a commissioning authority. ♦ Develop design intent and basis of design documentation. ♦ Conduct a focused review of the design prior to the construction documents phase. ♦ Include commissioning requirements in the construction documents. ♦ Conduct a focused review of the construction documents when close to completion. ♦ Conduct a selective review of contractor submittals of commissioned equipment. ♦ Develop and utilize a commissioning plan. ♦ Verify installation, functional performance, training, and documentation. ♦ Develop a system and energy management manual. ♦ Have a contract in place for a near-warranty-end or post-occupancy review. ♦ Complete a commissioning report.
Achieve increasing levels of energy performance above the prerequisite standard (see LEED category 3) to reduce environmental impacts associated with excessive energy use.	♦ Reduce design energy cost compared to the energy cost budget for regulated energy components described in the requirements of ASHRAE/IESNA Standard 90.1-1999, as demonstrated by a whole building simulation using the Energy Cost Budget Method described in Section 11.
Reduce ozone depletion and support early compliance with the Montreal Protocol.	♦ Install building level HVAC and refrigeration equipment and fire suppression systems that do not contain HCFCs or Halon.

GOALS	OBJECTIVES
Provide for the ongoing accountability and optimization of building energy and indoor environmental quality performance over time.	♦ Comply with the installed equipment requirements for continuous metering as stated in Option B: Methods by Technology of the US DOE's International Performance Measurement and Verification Protocol (IPMVP) for the systems stated in LEED Energy Credit 5 Requirements.
Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste, and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.	♦ Reuse large portions of existing structures during renovation or redevelopment projects to levels specified by LEED Materials Credit 1 Requirements.
Extend the life cycle of targeted building materials, reducing environmental impacts related to materials manufacturing and transport.	♦ Specify salvaged or refurbished materials for at least 5% of building materials (by total cost).
Increase demand for building products that are manufactured locally, reducing the environmental impacts resulting from transportation and supporting the local economy.	♦ Specify a minimum of 20% of building materials that are manufactured regionally within a radius of 500 miles. ♦ Of these regionally manufactured materials, specify a minimum of 50% that are extracted, harvested, or recovered within 500 miles.
Provide for the effective delivery and mixing of fresh air to building occupants to support their health, safety, and comfort.	♦ For mechanically ventilated buildings, design ventilation systems that result in an air change effectiveness (E) greater than or equal to 0.9 as determined by ASHRAE 129-1997. ♦ For naturally ventilated spaces, demonstrate a distribution and laminar flow pattern that involves not less than 90% of the room or zone area in the direction of air flow for at least 95% of hours of occupancy.
Reduce the quantity of indoor air contaminants that are odorous or potentially irritating to provide installer and occupant health and comfort.	♦ Paints and coatings must meet or exceed the VOC and chemical component limits of Green Seal requirements.

GOALS	OBJECTIVES
Provide for a thermally comfortable environment that supports the productive and healthy performance of the building occupants.	♦ Install a permanent temperature and humidity monitoring system configured to provide operators with control over thermal comfort performance and effectiveness of humidification and/or dehumidification systems in the building.

Barriers to Implementing Sustainability for RAFB

Several key themes emerged throughout the training as potential barriers to implementing sustainability. Proactively addressing these barriers will be important to further aligning the team with the objective of sustainability, and will enhance the probability of successful implementation. These barriers are:

- Perceived Economic Impacts - participants have concerns that sustainable projects will cost more, if for no other reason than more research and management will be required in the early part of the learning curve and/or sustainable materials, contractors, and A-Es are difficult to find.
- Individual and/or Organizational Resistance to Change - always a factor, particularly when some individuals have a stake in the status quo or when not everyone believes there is a need for change
- Lack of Necessary Knowledge - as with any new concept, some participants feel a need for more education and training before implementation, to reduce the potential for failure, mistakes, or other embarrassment. Many participants are also concerned that without awareness of sustainability goals on the part of *all* project stakeholders (e.g., from top management down to the trenches), project team members may inadvertently or intentionally work against each other.
- Lack of Management Buy-In - some participants are not yet confident that their forays into sustainable capital projects will be backed fully by management support, particularly if traditional metrics of project success (e.g., budget, completion time) do not prove to be favorable. Many participants who have spent long careers already with the AF have negative experience with trying to "swim upstream". Moreover, some participants have concern about changes in command, and are unwilling to commit to significant change given the possibility of a shift in management philosophy with personnel changes.
- Risk of Failure – participants emphasized the possibility of unintended consequences resulting from implementing sustainability, ranging from products that do not perform as intended, to reduced safety and loss of life; wanting to wait until new technologies are demonstrated elsewhere is a common barrier to innovation.
- Lack of Appropriate Measures of Project Success - as with management buy-in, this barrier will require top-down rethinking of project metrics and support for projects that do not meet traditional project success metrics.
- Lack of Resources to Implement Sustainability Concepts – the lack of project funding, spare time, and personnel to assist in the implementation of sustainability was perceived as a major barrier; participants commented about their already heavy workloads and expressed concerns that projects not completed in time could be lost or considered to be failures.
- Unclear Payoff/Lack of Incentives or Rewards – While many participants acknowledged the potential benefits of implementing sustainability in RAFB projects, they perceive such implementation to be an additional burden on them *individually*, without any specific incentives or rewards for going the extra mile, as well as the real possibility of backlash if implementation does not go as planned.

Additional Recommendations for Breaking Barriers

In addition to the actions recommended in Tables 3 and 4, each of the barriers identified in the previous section can be addressed in various ways. The following subsections describe suggested barrier breakers for each of the nine barriers described in the previous section.

Perceived Economic Impacts

Given the fact that the A/E/C industry is still in the early part of the learning curve, the perception that sustainable projects cost more is a valid one. In most cases, sufficient data does not exist to support or refute this perception. Given the degree to which most projects are cost-driven due to budget processes, one way to address real or perceived economic barriers is to explicitly build in a cost factor to address potential additional cost items such as time for research or collection of information, delays or additional costs for acquiring unusual materials or building systems, premiums for hiring knowledgeable A-E firms or contractors, and the cost of sustainability evaluation for facility projects.

An alternative approach is to begin with low- or no-cost sustainability solutions in order to establish a history of project economic success. Such solutions could include reuse of existing structures, use of cost-neutral solutions such as waterless urinals or changes in paint colors, or elimination of irrigation systems via the use of native plantings. In other cases, projects with rapid payback (e.g., within a single budget cycle) can provide the basis for demonstrating economic success with sustainable projects.

In either case, documentation of the economic impacts of project sustainability is paramount. Additional training that includes more case studies with economic data can also help to ameliorate perceptions that sustainable projects cost more, as well as provide the economic tools and data to support calculation of true economic costs and benefits to support project decision making.

Individual and/or Organizational Resistance to Change

Many reasons to resist change exist, including difference in perceptions, additional burdens or new responsibilities, lack of management support, or incongruence with organizational or personal norms. One approach to minimizing resistance to change is to explicitly articulate the costs and benefits that can result from the change, thereby providing better information as a basis for a more sound reaction to the possibility of change. As discussed in Modules 3 and 4 of the training, more information and a clear articulation of the vision behind the change can increase alignment of the team behind the change. Identification, education, and top management support of key players is critical to generating the momentum necessary for change. Also critical to facilitating change is the provision of necessary resources, tools, policies, and procedures to ensure that everyone has the same understanding of what the change entails and how to implement it. Finally, choosing battles wisely to ensure short-term victories is important to avoid demoralizing even the most ardent champion of change.

Lack of Necessary Knowledge

Lack of necessary knowledge is an underlying barrier to many of the other barriers described in this section. While the introductory training for stakeholders has provided a point of departure for establishing a common knowledge base and vision for capital project sustainability, it is

likely that additional training will be needed to provide the tools and techniques for actually implementing sustainability techniques on real projects. Additional information in the form of case studies, field trips, and other examples can also help to bridge the gap between idea and implementation, as well as overcome misperceptions about likelihood of success, economics, or stakeholder buy-in.

Alternatives for providing necessary knowledge include establishment of a resource center for personnel (e.g., reference materials, product samples, case studies), follow-on training for specific project strategies, refresher training on a periodic basis, or development of customized, detailed procedures and guidelines for sustainable projects. Finally, nothing works better than actual experience, which may be obtained by trial of new strategies or by adding experienced personnel to project teams.

Lack of Management Buy-In

Lack of management buy-in was frequently mentioned by participants. Some participants commented that "the people who *really* need to be in this training are not here!" and pointed out that change will be a lot easier if started from the top-down. This barrier also stems from the very real concern about what will happen with change of command. Many participants noted that commanders and top management tend to take a short term perspective in providing architectural guidance, and policies established under one commander can be changed 180 degrees when the next commander takes over.

This barrier can be addressed by emphasizing policy trends at a federal level that are increasingly requiring sustainability concerns to be considered in capital projects – in fact, the Commander in Chief has directly ordered that these issues be proactively addressed. Also key is ensuring that *all* stakeholders, from top management down to grass roots, receive training on sustainability, and that proactive measures are taken to align personnel behind a common, well-articulated, operational goal of sustainability. A variety of techniques for team alignment can be used, ranging from command-and-control policies that mandate participation, to third-party facilitation of project alignment and diagnosis of threats to project success.

Other approaches (already being undertaken by RAFB) include establishing a sustainability functional unit or working group of permanent staff that can provide continuity in the event of a change in command. Ultimately, the only way to address this concern is to establish the organizational infrastructure that can sustain itself without management buy-in in the long term. Training, promoting successes, investment in knowledge resources, and creating awareness of (and subsequent demand for) the benefits of sustainable facilities among *all* facility stakeholders can help to achieve this end.

Risk of Failure

Risk of failure is a real concern with respect to any innovation, and can be addressed in two primary ways. First, more information (e.g., raw data, case studies, analysis tools) can lead to better decisions with a lower risk of failure. However, obtaining and processing that information will require an expenditure of additional resources. A second strategy is to manage the penalties associated with failure, particularly when such failure stems from an attempt to be innovative while seeking to achieve sustainability objectives. Establishing a knowledgeable core team that

can provide guidance and review of decisions will help to minimize the risk of failure from innovation.

Lack of Appropriate Measures of Project Success

Traditional metrics of project success such as total installed cost or attainment of schedule are sometimes a barrier to achieving project sustainability. Consideration should be given to establishing additional project metrics that are performance based (e.g., via whole project commissioning to ensure functionality to design specs), life cycle oriented (i.e., that take into account not only front end costs but also operations, maintenance, and end of life cycle costs), and environmental (i.e., that weight as important issues of ecological impact and human health, safety, and livability). While such metrics may be a challenge to calculate, they may significantly impact the perceptions of success at all management levels for facility projects. The LEED system is one established metric in the U.S. that has been widely adopted as a measure of the environmental performance of built facilities. Other approaches that could be adopted include indicator-based measurement, predictive models of facility sustainability, or international environmental performance metrics such as BREEAM, BEPAC, or Green Building Challenge.

Lack of Resources to Implement Sustainability Concepts

The very real issue of available time, money, and human resources to implement sustainability was brought up multiple times by participants. Due to trends in downsizing of the military and outsourcing of tasks that have traditionally been handled in house, participants commented that they were afraid that sustainability would be yet one more burden on top of an already heavy workload. This barrier is also tied to lack of management buy-in: if management is not committed enough to the objective of sustainability to provide the resources necessary to implement it, participants can hardly be expected to go beyond the call of duty to meet these objectives on their own.

Much of the skepticism expressed about sustainability in the workshop can be explained by the participants' fear that they are being asked to do additional work without being given the tools and resources necessary to do so, and with the threat of backlashes or failure if they are unable to complete their projects within traditional budget and time limitations. This barrier may prove to be the most critical to be overcome if RAFB is to successfully adopt sustainable facility practices. To gain (or regain, in some cases) the trust of the personnel in the workshop, management needs to be committed not only in words but also in actions to the concepts they are espousing. Specifically, this trust can be earned by allowing extra time and money for projects (particularly in the early learning curve stages), hiring additional human resources, and providing other tangible support of these efforts as necessary on a situation-specific basis.

Unclear Payoff/Lack of Incentives or Rewards

The final barrier stems from the fact that many participants feel no motivation to incorporate sustainability into their project practices if there is neither reward for doing so, nor penalty for *not* doing so. Many participants commented that sustainability seems "fuzzy", and the issue of how to measure whether or not project actions result in better sustainability performance was a real concern to several participants. The fact that use of innovative technologies or alternative products may result in unintended consequences was brought up in several contexts throughout the training, along with the risks that this unpredictability entails.

Without confidence in the potentially positive outcomes for both the individual and other project stakeholders, additional motivation (beyond the satisfaction of trying to improve the performance of the facility) will likely be necessary. This motivation could be formal (as in programs to officially recognize and reward project team members who take sustainability risks), informal (as in management "pats-on-the-back"), or inverse (as in formal policies that absolve penalties for failure). Specific incentives should be determined by the project team in the context of the organizational environment and constraints; however, the power of even simple reinforcements can have a significant impact on the overall attitude of project teams.

RAFB has taken a small but significant step toward achieving its goal by engaging its personnel in this introductory workshop. Many issues were identified that, unless dealt with proactively and promptly, could seriously compromise progress toward meeting this goal. Georgia Tech's Sustainable Facilities & Infrastructure Program Staff have been pleased to provide the training and assist in this first step toward capital project sustainability, and look forward to working together with RAFB management and staff to continue progress in this direction.

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