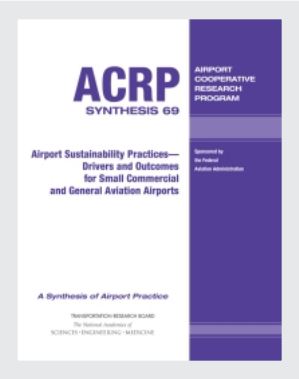

Airport Sustainability Practices—Drivers and Outcomes for Small Commercial and General Aviation Airports

DETAILS

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP SYNTHESIS 69

Airport Sustainability Practices—Drivers and Outcomes for Small Commercial and General Aviation Airports

A Synthesis of Airport Practice

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

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Cover figure: Frame of capped brood ready to hatch at Jackson County Airport, Gainesboro, Tennessee.
Credit: Jim Young.

FOREWORD

Airport administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the airport industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire airport community, the Airport Cooperative Research Program authorized the Transportation Research Board to undertake a continuing project. This project, ACRP Project 11-03, "Synthesis of Information Related to Airport Practices," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an ACRP report series, *Synthesis of Airport Practice.*

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Gail R. Staba
Senior Program Officer
Transportation Research Board

Over the last several years airport operators have introduced green initiatives in order to improve the overall sustainability of their airports. Drivers could include financial viability, staffing considerations, or other social or environmental factors. There is a significant compilation of sustainability practices from larger airports, but a less robust description of initiatives for smaller airports. This report focuses on drivers and outcomes of green initiatives undertaken at small commercial and general aviation airports.

Information used in this study was acquired through a review of the literature and survey or interviews with airport operators at small and general aviation airports.

C. Daniel Prather, California Baptist University and DPrather Aviation Solutions LLC, Riverside, California, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

Note: Photographs, figures, and tables in this report may have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

AIRPORT SUSTAINABILITY PRACTICES—DRIVERS AND OUTCOMES FOR SMALL COMMERCIAL AND GENERAL AVIATION AIRPORTS

SUMMARY

Although definitions of sustainability vary, ACI-NA has perhaps the most comprehensive definition as it applies to airports:

> Airport Sustainability, in effect is a holistic approach to managing an airport so as to ensure the integrity of the Economic viability, Operational efficiency, Natural Resource Conservation and Social responsibility (EONS) of the airport. Airport Sustainability as a business strategy has both immediate and long-term benefits that can be measured and when persistently managed, should be rewarded (Airports Council International–North America n.d., para. 1, p. 7).

This consideration of sustainability as being much more than "green" initiatives is an important distinction. As this report reveals, much can be done at small airports to enhance sustainability, and these initiatives need not solely produce environmental benefits. For the purpose of this study, sustainable initiatives were categorized in one or more of the following areas:

- Economic viability (E)
  - Economic vitality
- Operational efficiency (O)
  - Operational efficiency
- Natural resource conservation (N)
  - Air quality enhancement/climate change
  - Energy conservation/renewable energy
  - Noise abatement
  - Water quality protection and water conservation
  - Land and natural resources management
  - Land/property use
  - Pavement management
  - Materials use and solid waste reduction/recycling
  - Hazardous materials and waste management/reduction
  - Surface transportation management
  - Buildings/facilities.
- Social responsibility (S)
  - Socioeconomic benefits and community outreach/involvement [Global Reporting Initiative (GRI) 2011; Thomson and Delaney 2014].

To understand better the degree to which small airports in the United States are adopting sustainable initiatives and to understand current guidance on the topic of sustainability, this Synthesis study was undertaken during the summer of 2015. With 2,942 total small U.S. airports categorized as general aviation (GA), reliever, or nonprimary commercial service, 340 small airports were randomly selected for a sample. Each of the nine FAA regions was represented in the sample, resulting in 303 responses (representing an 89% response rate).

Survey findings include:

- Sixty-three percent of small airports have adopted one or more sustainable initiatives.
- The most common categories of sustainable initiatives are energy conservation/renewable energy (adopted by 82% of airports), water quality protection and water conservation (42%), materials use and solid waste reduction/recycling (36%), and hazardous materials and waste management/reduction (18%).

TABLE 1
DRIVERS AND OUTCOMES FOR MOST POPULAR CATEGORIES
OF SUSTAINABLE INITIATIVES

Category	Drivers (%)	Outcomes (%)
Energy conservation/renewable energy	Cost reductions (84)	Cost reductions (73)
	Desire for improved sustainability performance (42)	Improved sustainability performance (41)
Water quality protection and water conservation	Compliance concerns (80)	Improved compliance and regulator relationships (81)
Materials use and solid waste reduction/recycling	Addressing global concerns (93)	Addressing global concerns (94)
Hazardous materials and waste management/reduction	Addressing global concerns (64)	Addressing global concerns (64)
	Compliance concerns (47)	Improved compliance and regulator relationships (47)

Drivers motivating these initiatives and the outcomes experienced varied by project category and FAA region. The four most common categories, and typical drivers and outcomes, are presented in Table 1.

Most airports measure the results of their sustainable initiatives in the form of cost savings in utility bills and reduced maintenance hours. Long-term success generally is measured through cost savings over time. Almost 100% of airports reported that sustainable projects met expectations as far as actual benefits realized. Benefits included improved neighbor and community relations, a benefit that generally was not expected.

Airports reported barriers to sustainable initiatives in the form of lack of funding, lack of staff, lack of awareness of grants, and a lack of awareness of benefits of sustainable initiatives. Reasons given for not pursuing sustainable initiatives included rural airport, minimal to no environmental impact, costs too high, cost/benefit doesn't work, competing priorities, and no funding. Small airports can be encouraged to focus more on sustainability through the use of incentives, education on the benefits, and additional funding opportunities.

Of airports that had not yet pursued sustainable initiatives, 20% intend to pursue one or more sustainable initiatives in the future. Most of these airports intend to pursue LED lighting projects, with a handful considering solar options or efficient building construction. The main motivating force, or driver, is cost reduction. The main outcomes expected are reduced costs and enhanced efficiency.

Airports were asked to indicate agreement or disagreement with several sustainability statements. Results are presented in Table 2.

Although the study found that more than half of small airports have adopted one or more sustainable initiatives and almost 20% have a formal sustainability plan in place, many of those participating in the study do not believe that their airport has an impact on the environment, and because of lack of funding and different priorities, they choose not to pursue sustainable initiatives. However, sustainability is more than environmental initiatives. These are barriers, but more airports will pursue sustainable initiatives if more funding is made available, sustainability incentives are created, or sustainability becomes a mandate. The findings in this Synthesis report are intended to enlighten and encourage the staff of small airports to consider pursuing various sustainable initiatives in the future.

TABLE 2
AGREEMENT AND DISAGREEMENT WITH STATEMENTS ON SUSTAINABILITY

Statement	Agree (%)	Disagree (%)
I am familiar with the triple bottom line.	55	44
Our airport has little impact on the environment.	96	4
Environmental sustainability is not a priority for us.	89	8
Environmental sustainability costs too much.	86	2
Environmental sustainability has too long a payback period.	91	1

CHAPTER ONE

INTRODUCTION

BACKGROUND

According to the EPA,

> Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations. Sustainability is important to making sure that we have and will continue to have, the water, materials, and resources to protect human health and our environment ("What Is Sustainability" n.d.).

The EPA definition contains the "triple bottom line" addressing economic responsibility, social responsibility, and environmental responsibility (Thomson and Delaney 2014) (Figure 1).

As shown in Figure 1, the three areas of the triple bottom line overlap. Rather than being considered in isolation, these three areas can be considered as a whole. In this way, the concept of sustainability becomes part of the organization's decision-making process.

It can be noted that ACI-NA has purposefully redefined the triple bottom line. According to this group, "Airport sustainability, in effect is a holistic approach to managing an airport so as to ensure the integrity of the Economic viability, Operational efficiency, Natural Resource Conservation and Social responsibility (EONS) of the airport" (ACI-NA n.d., para. 10). This definition is similar to the triple bottom line, with the addition of "operational efficiency." As ACI-NA (n.d.) explains:

> Broadening this definition for the business of managing an airport is particularly important because while not all airports can or need to build new facilities, all have opportunities within the construct of their business model to leverage their O&M [operations and maintenance] dollars in ways that promote sustainability. The EONS model defines "pay-back" through proven business practices that pay benefits to our customers, our employees, our neighborhood, our bottom line and our industry (para. 6).

Using the ACI-NA's broadened definition of sustainability (EONS), sustainability also should address operational efficiency to include

- operating costs (e.g., airport infrastructure, information technology, fleet management),
- maintenance costs,
- component renewal costs,
- life-cycle costs (e.g., debt service, component renewal, and O&M), and
- ability to holistically trade off priorities in the life cycle (ACI-NA n.d., para. 5).

The inclusion of operational efficiency in the definition of sustainability is important. As the Sustainable Aviation Guidance Alliance (SAGA n.d.) explains,

> For some airports, broadening the definition to include the business of managing an airport may be particularly important because while not all airport operators can or need to build new facilities, all have opportunities within their business models to leverage their operations and maintenance (O&M) dollars in ways that can promote sustainability (pp. 8–9).

Thus, it is clear that according to the triple bottom line, principle, airports need to consider each of these areas when evaluating potential projects and sustainable initiatives. Specifically, potential initiatives would be evaluated on the degree to which they (1) reduce environmental impacts, (2) realize economic

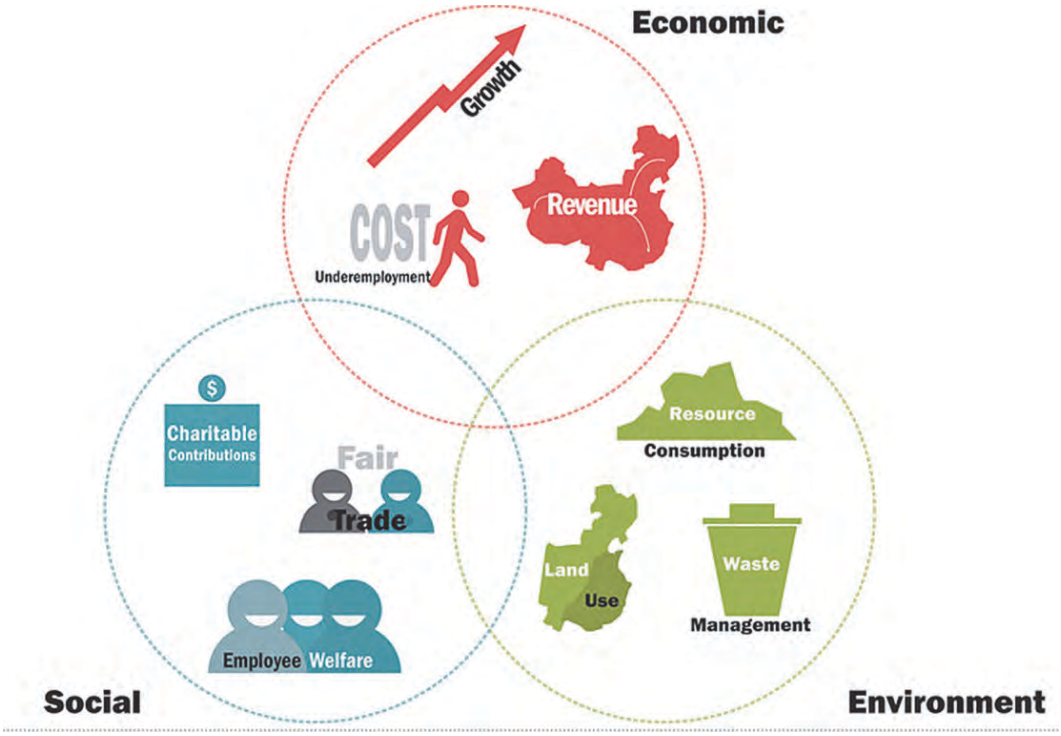

FIGURE 1 Triple bottom line (*Source*: https://commons.wikimedia.org/wiki/File:Triple_Bottom_Line_graphic.jpg).

benefits, and (3) improve community relations. If an initiative addresses only one or two of these areas, additional evaluation would take place before adoption.

According to Thomson and Delaney (2014), "an organization, instead of focusing solely on its finances [or environmental benefits], should improve upon its social, economic, and environmental impact for the long-term survival of itself and society" (p. 7). As FAA (2012) explains, "To encourage sustainable solutions, a business case needs to be made that a return on investment exists for sustainable design and construction" (p. 4). This is especially true for small airports. According to FAA (2012), "Small airports should prioritize the economic pillar of sustainability more than larger airports that have more resources to pursue sustainability initiatives" (p. 5).

This need to balance these objectives could be of comfort to staff of small airports that may have felt pressure to pursue sustainable projects without regard to cost or social benefits. However, as staff manage their airports, let's not forget that these airports must be well-managed, which requires a focus on economic responsibility, social responsibility, and environmental responsibility—among other areas. Indeed, FAA grant assurance 24 requires airports to "maintain a fee and rental structure for the facilities and services at the airport which will make the airport as self-sustaining as possible under the circumstances existing at the particular airport" (FAA 2014a, p. 12). This is an important point because many small airports point to costs as the main deterrent to pursuing sustainability initiatives.

Airports are encouraged to either use an existing definition of sustainability or create their own definition. There are many different ways to define sustainability. As explained by SAGA (n.d.), "An airport operator's definition of sustainability should relate to its unique circumstances and role within its community and environment" (p. 7). SAGA encourages airports to

> [D]etermine what sustainability means to that specific organization or the individual facility, taking into account the unique nature of the airport and its community. Depending on your organization, sustainability to some small airports may mean just 'keeping the doors open.' That said, it is generally accepted that sustainability includes essential elements under the 'Triple Bottom Line' (SAGA n.d., p. 8).

SYNTHESIS CONTENT

The report is organized into the following chapters:

- Chapter two: Study Methodology
- Chapter three: Literature Review
- Chapter four: Case Examples
- Chapter five: Survey Results
- Chapter six: Conclusions and Future Research.

CHAPTER TWO

STUDY METHODOLOGY

This study was designed to build upon and expand the results of *ACRP Synthesis 53: Outcomes of Green Initiatives: Large Airport Experience* but with the focus on small airports. *ACRP Synthesis 53* examined sustainability initiatives at 15 large airports. This Synthesis examines sustainability initiatives at 303 small airports nationwide. Small airports, as defined in this report, include general aviation (GA), reliever, and nonprimary commercial service. This study is intended to fill the gap in the available literature by focusing on sustainable initiatives at small airports.

To synthesize current sustainability practices at small airports, it was important to define the population for this study. Using the 2015–2019 National Plan of Integrated Airport Systems (NPIAS) Report, the categories of GA, reliever, and nonprimary commercial service were selected as the population for this study. Although these were the airports decided upon for this study, the findings presented here may also benefit small hub and nonhub airports. As of the 2015–2019 NPIAS, there are 2,553 GA airports, 264 reliever airports, and 125 nonprimary commercial service airports, resulting in a total population of 2,942 airports appropriate to this study (Table 3).

With the total population determined for each region, a sample size of 340 airports was determined. A sample of airports was randomly selected from each region and the states within each region. Once specific airports to be included in the study were determined, the region-specific *Airport Facility Directory* was used to ascertain telephone numbers for the airport manager of each selected airport.

Two data collection instruments were developed for this study. First, a survey questionnaire was developed for the purpose of gathering the bulk of the data for this Synthesis. The survey questionnaire aimed to determine the degree to which airports had pursued sustainable initiatives and the drivers and outcomes associated with those projects. The survey also aimed to determine why airports had not pursued sustainable initiatives, including what might encourage airports to pursue such initiatives in the future.

For the purpose of this study, sustainable initiatives were grouped in the following categories:

- Economic viability (E)
  - Economic vitality
- Operational efficiency (O)
  - Operational efficiency
- Natural resource conservation (N)
  - Air quality enhancement/climate change
  - Energy conservation/renewable energy
  - Noise abatement
  - Water quality protection and water conservation
  - Land and natural resources management
  - Land/property use
  - Pavement management
  - Materials use and solid waste reduction/recycling
  - Hazardous materials and waste management/reduction
  - Surface transportation management
  - Buildings/facilities

TABLE 3
POPULATIONS OF SMALL AIRPORTS FOR STUDY

Airport Type	Population Size
General aviation (GA)	2,553
Reliever	264
Nonprimary commercial service	125
Total	2,942

Source: National Plan of Integrated Airport Systems Report 2015–2019.

- Social responsibility (S)
  - Socioeconomic benefits and community outreach/involvement (GRI 2011; Thomson and Delaney 2014).

Because of the number of airports to be contacted and the detail desired in their responses, a decision was made to conduct a telephone survey, rather than a more commonly accepted online survey (see Appendix A).

Second, a telephone interview script was developed. The survey questionnaire was designed to gather broad findings from the entire sample, but the telephone interview script was developed to guide data collection that would lead to the development of a small number of case examples (see Appendix B). The 13 airports and one state aeronautics division selected to highlight as case examples were chosen based on their innovative sustainable projects, drivers and outcomes, and lessons learned.

All telephone calls were made during June, July, August, and September 2015.

In total, 340 airports were randomly contacted according to this methodology, and the managers of 303 airports agreed to participate in this study. This represents an 89% response rate. With this high response rate, results may be generalized to the population of 2,942 small airports across the United States.

CHAPTER THREE

LITERATURE REVIEW

BENEFITS OF SUSTAINABILITY

The benefits of sustainability are well documented. FAA explains that sustainable actions

> (a) reduce environmental impacts, (b) help maintain high, stable levels of economic growth, and (c) help achieve 'social progress,' a broad set of actions that ensure organizational goals are achieved in a way that's consistent with the needs and values of the local community (Federal Aviation Administration 2015, para. 1).

SAGA (n.d.) points to the following benefits for airports adopting sustainability initiatives:

- increased competitiveness through lean operations and reduced operating and life-cycle costs,
- greater utilization of assets,
- reduced environmental footprint,
- optimization of new and better technologies,
- reduced costs of asset development,
- improved bond ratings,
- improved benefits to and greater support from the community,
- improved work environment for employees, leading to higher productivity, and
- reduced environmental, health, and safety risk (p. 9).

COSTS

Most small airports do not have the financial resources to dedicate to sustainability efforts, which is why this Synthesis is focused on presenting realistic sustainable solutions for airports without significant funding options. FAA, through the Airport Improvement Program, makes funds available for sustainability initiatives. Perhaps the most complete reference to date of funding sources for airports pursuing sustainable initiatives is *ACRP Synthesis 24: Strategies and Financing Opportunities for Airport Environmental Programs*, which provides strategies for identifying and pursuing funding opportunities. This resource presents federal, regional, state, local, and nongovernmental funding opportunities for airports. Strategies for identifying and pursuing funding, as presented by Molar (2011), include:

- Start thinking like a government; stop thinking like an airport.
- Rely on outside experts.
- Partnering and teaming may provide access to funding opportunities.
- Planning and preparation are essential.
- Weigh the costs and benefits of the financial assistance.
- Program contacts can be helpful.
- A proactive, not reactive, approach is helpful.
- Consider multiple funding sources for an environmental initiative.
- Be nimble.
- Leverage the hidden value streams at the airport.
- Develop and use networks of support for environmental initiatives (pp. 5–8).

As Lau et al. (2010) explain, airports looking for low-cost ways to enhance their sustainability efforts could "reach for 'low hanging fruit.'" By focusing on initiatives that are eligible for rebates,

tax credits, and energy funding, airports might pursue sustainable projects with minimal cost. Molar (2011), in *ACRP Synthesis 24*, also provides information on additional sources of funding for sustainable initiatives.

SUSTAINABILITY PLANS

One concept that is gaining momentum in the airport industry, especially as a result of FAA funding provided in this area, is airport sustainability planning. This trend allows airports to adopt a more formal and holistic approach to sustainability planning. As FAA (2010) explains, "There are many benefits of airport sustainability planning, including reduced energy consumption, reduced noise impacts, reduced hazardous and solid waste generation, reduced greenhouse gas emissions, improved water quality, improved community relations, and cost savings" (p. 1).

There are two types of sustainability plans in use at airports. A "sustainable master plan" is integrated into the master planning process and document. A "sustainable management plan" is a separate document that focuses on sustainability. Although "balancing sustainability objectives and aviation needs is challenging in a Sustainable Master Plan," the FAA (2012) explains that, "Despite the challenges, integrating sustainability into a master plan affords more opportunities to align sustainability and planning" (p. 2). For example, as part of all master plans, FAA now requires a waste management plan.

To address recycling and waste management at airports, FAA in April 2013 released *Recycling, Reuse and Waste Reduction at Airports: A Synthesis Document*. The agency states:

> Over the past several years, the Federal Aviation Administration (FAA) has been encouraging airport sponsors to incorporate sustainability in airport planning, design, and operations. In our continuing efforts to assist airport sponsors in incorporating sustainability into airport planning, design, and operations, the FAA has decided to provide specific guidance to airports in two key focus areas: programs to encourage recycling, reduction and reuse of materials, and programs to encourage airports to reduce their energy consumption (p. 1).

The FAA's *Recycling, Reuse and Waste Reduction at Airports* presents guidance in establishing a municipal solid waste recycling program and a construction and demolition waste program, with many case examples of actual airport practices in these areas. In September 2014, FAA issued a memorandum to provide guidance to airports in preparing recycling, reuse, and waste reduction plans as an element of a master plan or master plan update, within a sustainability planning document, or as a stand-alone document. It also is important to note the Airport Improvement Plan (AIP) eligibility of these efforts (FAA 2014c).

As of July 2015, FAA had provided grants to 44 airports to develop a sustainable master plan or sustainable management plan. One of these grants was awarded to the Colorado Department of Transportation to develop a state sustainability toolkit (see chapter four). According to FAA (2015), "These documents include initiatives for reducing environmental impacts, achieving economic benefits, and increasing integration with local communities" (para. 3). This funding for developing projects that will contribute to the airport's triple bottom line is evidence of FAA support of this multifaceted approach to future airport development.

Although formal sustainability plans provide many advantages, staff of small airports are encouraged to consider sustainable initiatives that may be pursued with or without such a plan. Rather than being discouraged from pursuing sustainable initiatives that lack a formal plan, staff are encouraged to pursue reasonable initiatives even in the absence of such a plan.

SUSTAINABILITY GUIDELINES AND RESOURCES

More information on sustainable master plans may be found on the FAA website. Additional resources on sustainability to which airports may refer are presented in Table 4. Summary information on each of these resources is presented in Appendix C.

TABLE 4
SUSTAINABILITY GUIDELINES AND RESOURCES

FAA *Report on the Sustainable Master Plan Pilot Program and Lessons Learned*
ACRP Report 119: Prototype Airport Sustainability Rating System—Characteristics, Viability, and Implementation Options
ACRP Report 43: Guidebook of Practices for Improving Environmental Performance at Small Airports
GRI *Sustainability Reporting Guidelines & Airport Operators Sector Supplement*
Advisory Circular 150/5050-8, Environmental Management Systems for Airport Sponsors
ISO 14000
Sustainable Aviation Resource Guide
ACRP Synthesis 21: Airport Energy Efficiency and Cost Reduction

SMALL AIRPORT CONSIDERATION

Certainly, smaller airports (including the airports that were the focus of this study) have only a fraction of the resources (funds, staff, facilities) that larger airports have. However, this need not prohibit such airports from pursuing sustainable initiatives. Smaller airports have been quite innovative in their approach to sustainability, allowing for low-cost solutions to be implemented.

According to SAGA (n.d.), "The difference among airports may be the breadth at which initial programs are implemented (i.e., the scale)" (p. 15). Many sustainable initiatives are scalable and can be made more appropriate for smaller airports with adjustments to project scope. Small airports can be encouraged by SAGA (n.d.), in that "[a]irport operators are encouraged to view sustainability as a process and not an end goal" (p. 13). In essence, the focus is not be on the number or scale of sustainable projects implemented but rather on the transformed thought processes that lead staff to "think sustainable" in all business decisions. This clearly will lead a smaller airport to initiate some sustainable initiatives, but the success of the airport's efforts need not be equated to the number of projects completed.

For airport staff overwhelmed at the prospect of being more sustainable, a pilot program could be considered. Rather than a risky all-or-nothing approach, it can be useful to focus on one initiative, gain experience with the process, and learn from that project before initiating additional projects. As SAGA (n.d.) explains, "Through the pilot program, the airport operator will gain experience with the basic premises of the management system approach and will determine how to modify the steps to fit the airport's unique operating environment and set of resources" (p. 19).

To ensure success, each sustainable initiative needs a champion. This person will be the "driver" for the project, bring stakeholders together through the formation of an advisory council, develop the steering committee, and oversee the creation of implementation teams, moving from strategy to action (see Figure 2).

SAGA presents a comprehensive approach to the development and implementation of sustainable initiatives. Starting with a champion and sustainability team, the process presents several steps (see Figure 3).

FIGURE 2 Various roles from strategy to action (*Source*: SAGA n.d.).

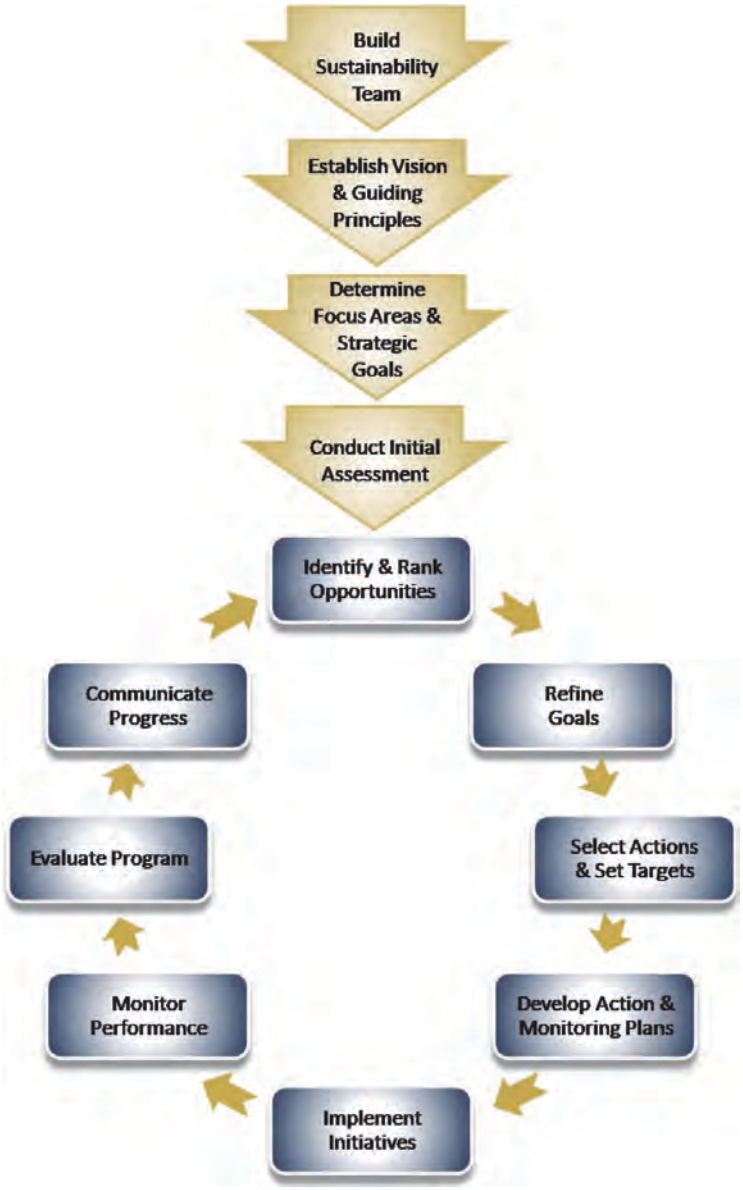

FIGURE 3 SAGA approach (*Source*: SAGA n.d.).

CHAPTER FOUR

CASE EXAMPLES

This chapter presents in-depth case examples of 14 selected small airports that participated in this study. One state division of aeronautics is also highlighted in a case example to showcase the division's efforts at encouraging sustainability plans at airports throughout the state. The purpose of these case examples is to present ideas of sustainable initiatives that have been successfully implemented (or soon will be) so that readers can obtain ideas about potential initiatives, including barriers and lessons learned, that their airport may pursue. Table 5 presents a summary of each of the 14 case examples.

CASE EXAMPLE 1: IN-KIND CONTRIBUTIONS

Piggott Municipal Airport, Piggott, Arkansas
FAA General Aviation
Socioeconomic Benefits and Community Outreach/Involvement; Economic Vitality

Some airports are implementing innovative sustainable initiatives. In Piggott, Arkansas, the Piggott Municipal Airport has pursued sustainable initiatives as many airports have, but this airport has contributed toward its 10% or 5% match in an unusual way—with in-kind contributions (Table 6). The use of in-kind contributions has been received warmly by those overseeing projects funded by the Arkansas Department of Aeronautics, and it appears that FAA would also consider in-kind contributions for FAA-funded projects.

Jeff Puckett, Piggott Municipal Airport manager, described how, in building a new airport access road and parking area, the airport secured a state grant to fund a large portion of the project. Rather than provide matching funds in the form of cash, the airport petitioned the Arkansas Department of Aeronautics to accept in-kind contributions in the form of donated heavy equipment to be operated by airport volunteers, namely Airport Board members. With approval granted, the airport was able to secure heavy equipment from a local equipment rental company that always provides strong community support. Several board members volunteered their time, with one driving the heavy equipment to clear the area and level the base. A contractor then poured the road and parking area pavement and finished the work with striping and such. The equipment rental company provided a pure donation, with a receipt for cost of equipment, but was not financially reimbursed.

According to Office of Management and Budget (OMB) Circular A-110 Section 215.23 Cost Sharing or Matching, "All contributions, including cash and third party in-kind, shall be accepted as part of the recipient's cost sharing or matching when such contributions meet all of the following criteria:

1. Are verifiable from the recipient's records.
2. Are not included as contributions for any other federally-assisted project or program.
3. Are necessary and reasonable for proper and efficient accomplishment of project or program objectives.
4. Are allowable under the applicable cost principles.
5. Are not paid by the Federal Government under another award, except where authorized by Federal statute to be used for cost sharing or matching.
6. Are provided for in the approved budget when required by the Federal awarding agency.
7. Conform to other provisions of this Circular, as applicable (FAA 2014b, para. 1)."

TABLE 5
SUMMARY OF CASE EXAMPLES

Case Example	Practice Category	Airport
1. In-kind contributions	Socioeconomic benefits and community outreach/involvement; economic vitality	Piggott Municipal Airport, Piggott, Arkansas
2. Statewide sustainability toolkit for general aviation airports	Socioeconomic benefits; economic vitality/operational efficiency; multiple additional areas on a per-airport basis	Colorado Department of Transportation Division of Aeronautics
3. Electric/diesel utility vehicles and terminal retrofit	Economic vitality/operational efficiency; air quality enhancement; energy conservation; buildings/facilities	Monroe County Airport, Bloomington, Indiana
4. Efficient lighting and hardscape installation	Energy conservation; water conservation	Riverside Municipal Airport, Riverside, California
5. Multiple measures	Energy conservation; solid waste reduction/recycling	Eastern Sierra Regional Airport, Bishop, California
6. LEED equivalency	Energy conservation; water conservation; buildings/facilities	College Park Airport, College Park, Maryland
7. Potential photovoltaic solar field	Energy conservation/renewable energy	Chautauqua County/Dunkirk Airport, Dunkirk, New York
8. LED airfield lighting	Energy conservation	Centennial Airport, Denver, Colorado
9. Photovoltaic solar field	Energy conservation/renewable energy	Lakeland Linder Regional Airport, Lakeland, Florida
10. Photovoltaic solar field and rotating beacon	Energy conservation/renewable energy; land/property use; operational efficiency	Smyrna/Rutherford County Airport, Smyrna, Tennessee
11. Reclaimed water	Water quality protection and water conservation; land and natural resources management	Livermore Municipal Airport, Livermore, California
12. Sensitive environment	Land and natural resources management; land/property use	Ocean County Airport, Toms River, New Jersey
13. Honeybees	Land and natural resources management	Jackson County Airport, Gainesboro, Tennessee
14. Recycling	Materials use and solid waste reduction/recycling	San Bernardino International Airport, San Bernardino, California

FAA (2014b) also states:

> Volunteer services furnished by professional and technical personnel, consultants, and other skilled and unskilled labor may be counted as cost sharing or matching if the service is an integral and necessary part of an approved project or program. Rates for volunteer services shall be consistent with those paid for similar work in the recipient's organization. In those instances in which the required skills are not found in the recipient organization, rates shall be consistent with those paid for similar work in the labor market in which the recipient competes for the kind of services involved. In either case, paid fringe benefits that are reasonable, allowable, and allocable may be included in the valuation.

Airport manager Puckett encouraged other airports considering in-kind contributions to:

- Partner with the granting authority early to determine if in-kind contributions will be accepted.
- Be careful with volunteers; they may not be skilled professionals and could be well-meaning but cause cost overruns by creating problems that a contractor must correct.

TABLE 6
PIGGOTT MUNICIPAL AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
In-kind contributions	Lower cost, ensure timely project completion, allow community to support	Less costly, timely completion, allowed for community support	Project cost; completion date; goodwill	Expertise and willingness of volunteers, granting authority acceptance of in-kind contributions	Insist on professionals; partner with granting authority early.

- Insist on professionals. Most board members, for example, have other skills used in their full-time line of work that may benefit an airport in a unique way.
- Most contractors for rural airports are based hundreds of miles away, enabling the airport or municipality to partner with the contractor to ensure project completion.
- By using in-house personnel, the project bid specifications will reflect only that portion of the project not performed by in-house personnel, effectively lowering the final project cost.

CASE EXAMPLE 2: STATEWIDE SUSTAINABILITY TOOLKIT FOR GENERAL AVIATION AIRPORTS

Colorado Department of Transportation Division of Aeronautics
Socioeconomic Benefits; Economic Vitality/Operational Efficiency; Multiple Additional Areas on a Per-Airport Basis

Colorado is the first state to receive FAA funding to develop a web-based platform for the state's GA airports to develop customized airport sustainability plans (Table 7). This test case provides funding for the Colorado Division of Aeronautics to develop this web-based platform. The division currently has a web-based information management system (WIMS) that is accessible to all Colorado airports and is used to administer all state airport grants. The airport sustainability toolkit is simply an extension of this existing web-based information management system.

Colorado Department of Transportation (CDOT) created a statewide sustainability plan, but the Division of Aeronautics was motivated to see airports throughout the state develop individual airport sustainability plans that would complement the statewide plan (Figures 4 and 5). However, the division recognized that most GA airports throughout the state were minimally staffed and operated within small budgets, factors that likely interfered with their ability to develop their own airport sustainability plan. Therefore, the division embarked on an FAA-funded effort to develop a web-based toolkit that allows airport staff to enter various parameters and respond to various questions. Once all the data are entered and selections made, the toolkit generates an airport sustainability plan. The toolkit is simple and free to use.

Three airports (Rifle–Garfield County Airport, Canon City–Fremont County Airport, and Denver–Centennial Airport) are the three test cases for the sustainability toolkit. Results thus far are encouraging. The Aeronautics Division is planning for a spring 2016 rollout to all GA airports in the state.

Although lessons learned are minimal at the current phase of the project, reported issues include:

- The staffs of many small airports are not aware of the potential value in sustainability plans.
- The state can bring about economies of scale, making it easier and less costly for small airports to pursue sustainability.
- An easy process must be created for airports to develop a sustainability plan and pursue sustainable initiatives.
- Those already using the toolkit are hopeful there will be a snowball effect: One airport will see the benefits another airport enjoys by virtue of having developed a sustainability plan, which will then provide motivation for that and other airports to pursue a sustainability plan (Figure 6).

TABLE 7
CDOT DIVISION OF AERONAUTICS

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Web-based sustainability toolkit	Make it easier for small airports to develop sustainability plans	Economies of scale with statewide web-based airport sustainability toolkit	Number of Colorado general aviation airports with sustainability plans	IT programming time; initially securing FAA funding	Encourage sustainability plans by making the process easier and free.

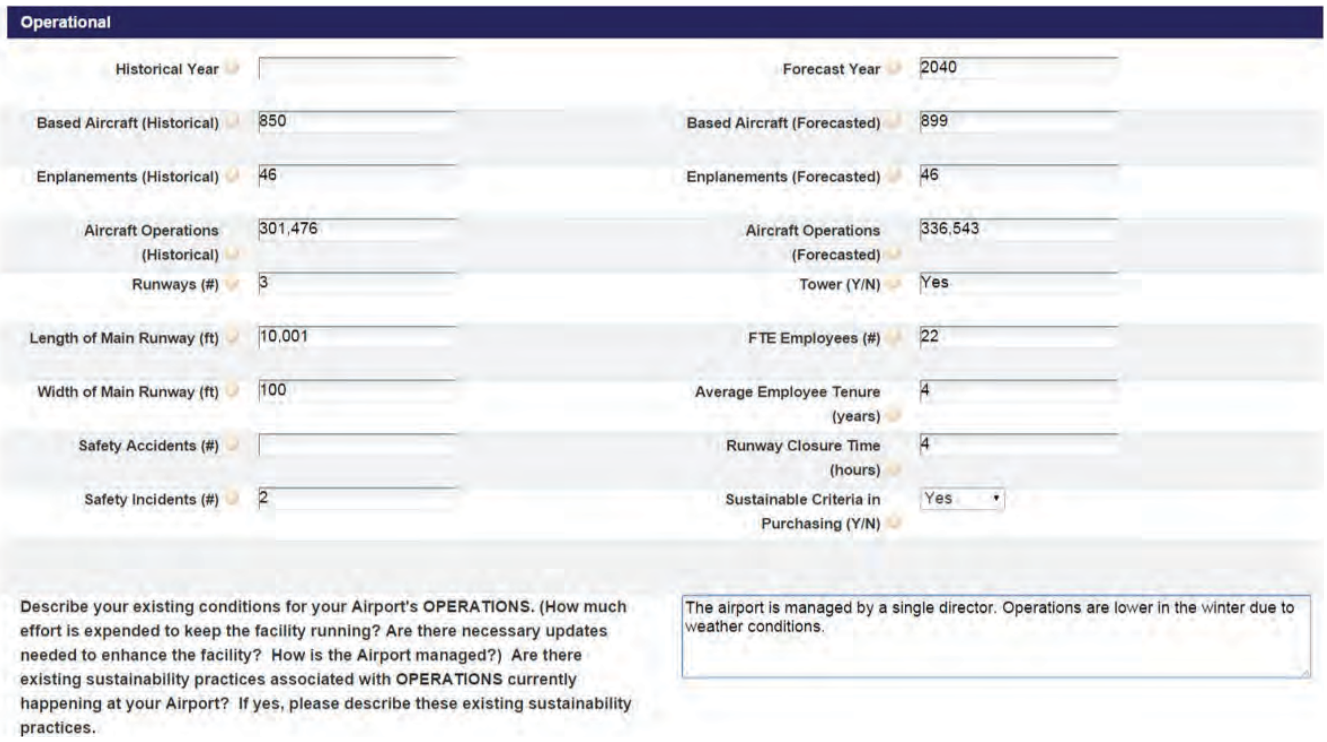

FIGURE 4 CDOT sustainability initiative profile (*Source*: CDOT Division of Aeronautics WIMS 2015).

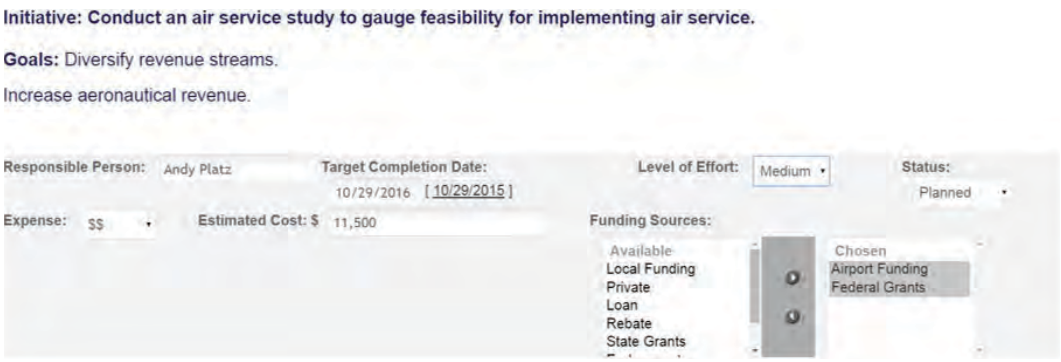

FIGURE 5 CDOT sustainability initiative (*Source*: CDOT Division of Aeronautics WIMS 2015).

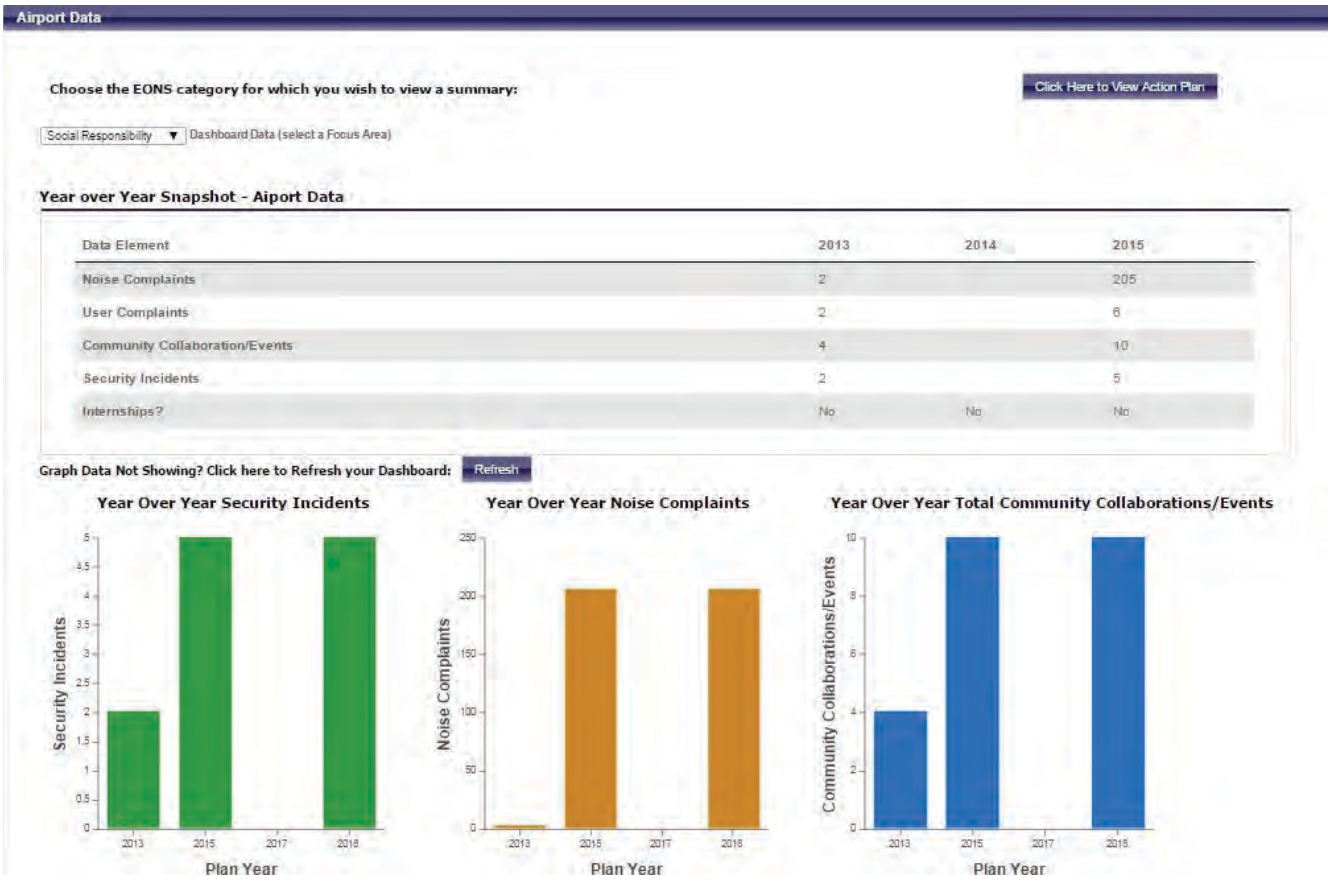

FIGURE 6 CDOT sustainability dashboard (*Source*: CDOT Division of Aeronautics WIMS 2015).

CASE EXAMPLE 3: ELECTRIC/DIESEL UTILITY VEHICLES AND TERMINAL RETROFIT

Monroe County Airport, Bloomington, Indiana
FAA General Aviation Airport
Economic Vitality/Operational Efficiency; Air Quality Enhancement; Energy Conservation; Buildings/Facilities

The staff of the Monroe County Airport, located in Bloomington, Indiana, was exploring ways in which to be more environmentally friendly. Because the airport had a small budget for sustainable initiatives, it was important to consider initiatives that were affordable yet created the intended environmental impact. Airport staff decided upon three initiatives (Table 8). First, the airport purchased one electric golf cart and two small, diesel-powered utility vehicles. With a desire to "go green" and minimize fossil fuel use (thus saving money on fuel), this was an easily supported initiative. Whereas airport maintenance personnel once used full-size, gasoline-powered, pickup trucks, these personnel

TABLE 8
MONROE COUNTY AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Electric and diesel utility vehicles	Reduce fuel costs, benefit the environment	Environmental benefits, reduced fuel costs, and high utilization of new vehicles	Fuel costs, maintenance personnel comments	Determining which initiative to pursue, considering budget	Utility of these vehicles is superb.
Terminal retrofit	Reduce HVAC demands, enhance aesthetics	Reduced HVAC demands through lower utility costs, enhanced aesthetics	Utility costs, patron comments	Cost–benefit of project	Benefits can be greater than costs; think outside the box.

now carry out many of the same tasks using the smaller and more efficient, diesel-powered utility vehicles and electric-powered golf cart. Although the pickup truck remains in the airport's fleet and is used to travel to the store for supplies, for example, maintenance personnel mostly use the new vehicles in their daily work. As Amy Gharst, airport administrative assistant, explained, "With the new vehicles, maintenance personnel can load up the weed eater, chainsaw, and other tools to repair fences, apply pesticides and fertilizer, and in general, maintain the airfield and terminal as they did before, yet we have reduced our fuel use and had a positive impact on the environment."

The second initiative pursued by the Monroe County Airport was replacing the water heater that supplies hot water to the food and beverage concessionaire with an energy-efficient, on-demand, tankless water heater. Previously, the gas water heater was located in a supply closet behind the men's restroom. The concessionaire had to turn on the faucet and wait some time with the water running before hot water traveled the distance from the water heater to the concessionaire's kitchen. The tankless water heater has been installed in the concessionaire's kitchen, providing instant, on-demand hot water. This initiative has significantly reduced water use as well as natural gas use because it is no longer necessary to keep many gallons of water hot at all times.

The third initiative was more expensive than the previous two but allowed the airport to retain the 1965-era terminal building while transitioning the building to a more energy-efficient facility. The terminal building had been constructed with walls of concrete block, which were visible within the terminal; the walls were painted. In an effort to enhance the energy efficiency of this older building, the airport manager decided to install insulation and drywall on the interior of the concrete block walls. This not only enhanced the efficiency of the building, resulting in reduced heating, ventilation, and air conditioning (HVAC) costs, but also enhanced the aesthetics of the space.

In general, as Gharst explained, "While costs of a sustainable project may initially discourage a small airport from pursuing such a project, there are sustainable initiatives that can actually reduce airport costs and enhance the bottom line, all the while benefiting the environment." Staff of small airports must be willing to think outside the box and consider that each initiative, regardless of how insignificant it may appear, can have a positive impact on the environment and the airport's bottom line.

CASE EXAMPLE 4: EFFICIENT LIGHTING AND HARDSCAPE INSTALLATION

Riverside Municipal Airport, Riverside, California
FAA Reliever
Energy Conservation; Water Conservation

The Riverside Municipal Airport, owned and operated by the city of Riverside, California, has developed a comprehensive approach to reducing the facility's environmental impact (Table 9).

TABLE 9
RIVERSIDE MUNICIPAL AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Efficient lighting	Budget, electricity costs	Reduced utility use	Month-over-month reduction in utility bill	Expenses of contracting out; expense of trying to do it all in one year	Look for local rebate programs through local utilities; try to do all the work in-house.
Hardscape installation	Drought, state mandate	Reduced water use	Month-over-month reduction in water bill	Expenses of contracting out; expense of trying to do it all in one year	Consider all water use; look for local rebate programs through local utilities; try to do all the work in-house.

The airport has pursued two sustainable initiatives. In an effort to reduce electricity use, the airport replaced 39 flood lights that illuminated the ramp—at 400 watts each—with the same number of 152-watt LED lights. Light output has improved, and energy use has declined significantly. Riverside used the city's own maintenance personnel to perform this lightning replacement, thereby reducing costs for the airport compared with the work being performed by contractors. In addition, the airport installed motion sensors on most interior office lights in the main terminal building, allowing the lights to automatically turn off when an office is not occupied. The installation of these motions sensors also was performed by city maintenance personnel. The airport is in the process of replacing parking lot lighting with LED lights. The airport has also replaced taxiway edge lights with LED lights and has plans to transition runway lights to LED lights as grant funds become available.

In April 2015, for the first time in state history and as a result of the state's historic drought, California Governor Jerry Brown directed the State Water Resources Control Board to implement mandatory water reductions in cities and towns across California to reduce water usage by 25%. Rainfall in the Riverside area, located in the "Inland Empire," amounts to less than 10 in. annually ("Rainfall Summary" 2015). Because of this minimal rainfall, most residential and commercial areas rely on irrigation to maintain green spaces. The city of Riverside developed a comprehensive program to comply with the mandated water use reduction, and the Riverside Municipal Airport was part of the solution. The airport removed grass and vegetation from almost 30% of their areal and replaced them with a hardscape (gravel, concrete, and the like) (Figure 7). The airport's irrigation system was adjusted so these areas would no longer receive water. In addition, the irrigation system for the entire airport was adjusted for all irrigation zones to water less frequently. Much of the work to replace green spaces with hardscape was performed at no cost to the airport by personnel enrolled in the Riverside County Sheriff Department's Full-Time Work Release Program. This program allows low-risk offenders who have been sentenced to jail time to work 8 to 10 h per day in lieu of 1 day of jail time ("Full-Time Work Release Program" 2015). In another measure, urinals in the men's restrooms were replaced with low-flow urinals, reducing the amount of water used per flush from 1 to 0.5 gal.

Kim Ellis, Riverside Municipal Airport manager, encouraged other airports to "Do it! Don't wait." Airport managers have an obligation to their tenants to keep costs down, so if the sustainability initiative will produce greater benefits than costs, an airport is obligated to pursue it. With some

FIGURE 7 Riverside Municipal Airport hardscape (*Source*: D. Prather 2016).

sustainability initiatives, the payback is almost immediate, whereas others have longer-term payback periods. As Ellis explained, “By contracting out work, the cost will be higher, which will extend the payback period.” He encouraged airports to be innovative in their approach and discover ways to perform work in-house, either with airport labor or city or county labor.

CASE EXAMPLE 5: MULTIPLE MEASURES

Eastern Sierra Regional Airport, Bishop, California
FAA General Aviation
Energy Conservation; Solid Waste Reduction/Recycling

The Eastern Sierra Regional Airport, located in Bishop, California, is managed by Ken Babione. This airport, which has three runways, is located just east of the Sierra Nevada mountain range at an altitude of 4,124 ft above mean sea level. A unique aspect of this airport is the comprehensive sustainability mind-set displayed by Babione. The airport has adopted common sustainability measures, including recycling; installing double-paned windows and energy-efficient fluorescent lighting in a new building; installing motion sensors to automatically turn off interior lights when not in use; installing LED lighting on the airfield, including lights and internally illuminated signs; and installing pilot-controlled lighting to minimize energy use during the nighttime hours when airfield lighting is not being used (Table 10). The airport has even adopted some less common sustainability measures, including placing the engine block heater on the fuel truck on a timer to reduce electrical use.

Manager Babione said that sustainability, even at the small airport he oversees, “makes sense.” As he explained, “If you don’t spend more than you save, you’re good.” Although most of his efforts to reduce the airport’s environmental impact are motivated by cost control, with environmental sustainability an unplanned-for benefit, Babione encouraged other small airports to consider, as an item or piece of equipment reaches the end of its useful life, “Is there a more efficient replacement?” In other words, rather than embarking on a grand, and often expensive, sustainability program, as airport assets break down and need replacing, it is important for the airport manager to consider all options, especially those that are more efficient. It is hoped these measures will result in cost savings and possibly even environmental benefits. As Babione explained, “It doesn’t have to be thousands of dollars, but over time, it adds up.”

Barriers, according to Babione, include funding and logistics. Sustainable initiatives can be costly, and if rebates or shared funds are unavailable, a proposed initiative may have to be tabled until later. Likewise, at small airports with few staff, personnel to implement such projects may not be available, or it may take longer to complete a project being done by in-house personnel. Babione also recommended that other small airports place an emphasis on hiring personnel who are skilled in multiple areas. For example, cost savings can be realized by using airport personnel to conduct on-site maintenance.

TABLE 10
EASTERN SIERRA REGIONAL AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Common sustainability measures	Reduce costs	Cost reduction and environmental benefits	Electricity use	Funds, logistics	Use in-house personnel for projects.
Fuel truck engine block heater on timer	Reduce costs	Cost reduction and environmental benefits	Electricity use	Minimal	Consider periods of time when equipment (or lighting) is not needed.

TABLE 11
COLLEGE PARK AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Airport Operations building designed to LEED Silver equivalency	Focus on sustainability, ease in obtaining sustainable building materials	Community goodwill, reduced operational costs, positive environmental impact	Utility use, goodwill	Funding, costs	Do whatever you can, but be smart about it.

CASE EXAMPLE 6: LEED EQUIVALENCY

College Park Airport, College Park, Maryland
FAA General Aviation
Energy Conservation; Water Conservation; Buildings/Facilities

College Park Airport, located in College Park, Maryland, is recognized as the world's oldest continually operating airport. Established in 1909 as the military demonstration site for the Wright brothers, the airport is owned and operated by the Maryland National Capital Park and Planning Commission (MNCPPC). Airport manager Lee Sommer has an eye on sustainability. The airport's newest building, an airport operations building, is designed to LEED (Leadership in Energy & Environmental Design) Silver equivalency (Table 11). The LEED certification program was developed by the U.S. Green Building Council. Although the new building is designed to LEED Silver standards, the airport will not pursue LEED certification because of the expense and paperwork involved. The LEED certification process would have placed the project over budget. It is rare for a small airport to have a building designed to LEED standards.

The building was funded by grants from the Maryland Aviation Administration and the MNCPPC. The building uses ultra-efficient HVAC, energy-efficient windows, energy-efficient lighting, sustainable materials in building construction, trash and recycling receptacles for separation of materials, low-flow toilets and water fixtures, and a vegetative roof. The site was rebalanced to minimize the proximity to a flood plain. A filtration pond was created and lined with native grasses to allow storm water to recharge the groundwater aquifer.

According to Sommer, the airport manager, and Derrick Adams, the architectural project manager for MNCPPC, they were motivated to design the new building to LEED Silver equivalency because of the historic site of the airport and the general awareness of the need for and focus on sustainability by the commission. As Adams stated, "With so many building products now made sustainably and from renewable sources, you can't help but use them." In other words, being sustainable is often easier than one might think. As Sommer shared, "Nowadays, you have to do whatever you can." Even so, both admit that costs are often a barrier to sustainable initiatives. Airports are encouraged to be on the lookout for rebates, grants, and shared funding for sustainable projects. These airport professionals also encourage airport managers to consider LED lighting, solar energy, permeable pavers, and smaller wind turbines.

CASE EXAMPLE 7: POTENTIAL PHOTOVOLTAIC SOLAR FIELD

Chautauqua County/Dunkirk Airport, Dunkirk, New York
FAA General Aviation
Energy Conservation/Renewable Energy

The Chautauqua County/Dunkirk Airport, located in Dunkirk, New York, is owned and operated by Chautauqua County. Airport manager Bill Tucker explained that as the airport has searched for ways

TABLE 12
CHAUTAUQUA COUNTY/DUNKIRK AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Install solar (PV) field	Lower utility costs, community goodwill, support the environment	Project not yet complete	Utility bills, energy produced	Municipality approval; selection of solar contractor; public utility subsidies; meet FAA requirements, including grant assurances for use of airport land	Coordinate early with FAA to ensure compliance with grant assurances; glare analysis is a necessity.

to be more sustainable, it became clear that installing a solar field was one way to accomplish the goal (Table 12). However, as of this writing, this project is still in the planning stages.

Although there is a great deal of support for this airport and sustainability in the rural county in which the airport is located, the airport has a small, part-time staff. Thus, any sustainability initiative would need to place little to no demands on staff, once implemented. A solar field was seen as a viable option, especially considering the vacant land, community and county support of renewable energy, and low demands on staff once installed.

A request for proposal was issued for this project; several proposals were received, and a firm was selected. The firm currently is assisting the airport staff in selecting several potential sites and developing a time line for the project. This is a no-cost project for the airport and county. Land for the photovoltaic (PV) panels will be leased at fair market value (to comply with grant assurances). The solar contractor will receive New York State Public Service Commission solar subsidies and be able to sell power generated to the local utility at a subsidized, profitable rate. The airport will then be able to benefit from a lower electricity rate from the utility as a result of the renewable energy being produced on airport property.

Tucker explained that, as with most projects, barriers exist, but with innovative thinking they can be overcome. It is important to coordinate with FAA to ensure compliance with all grant assurances. In addition, municipality approval may be an obstacle in some areas. Many solar subsidies and various suitability rebates have restrictions that require close attention and coordination between the contractor and the entity providing subsidies. Especially for solar, the airport needs to insist that a glare analysis be performed to ensure the project, once complete, will not cause problems for pilots.

CASE EXAMPLE 8: LED AIRFIELD LIGHTING

Centennial Airport, Denver, Colorado
FAA Reliever
Energy Conservation

Centennial Airport, located in Denver, Colorado, is owned and operated by the Arapahoe County Public Airport Authority. This airport, in an effort to reduce electricity usage and associated costs, increase the life of bulbs, reduce maintenance costs and pavement downtime, and benefit the environment, has transitioned all internally illuminated airfield signage from incandescent to LED and replaced all taxiway lighting with LED (Table 13). The airport is now in the process of transitioning runway lighting to LED. Although the airport also supports tenant sustainability initiatives and has transitioned to a more energy-efficient fleet of vehicles, the move toward LED lighting is the airport's most significant sustainable project to date.

TABLE 13
CENTENNIAL AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
LED airfield lighting	Reduce electricity usage and associated costs, increase the life of bulbs, lower maintenance costs and pavement downtime, and benefit the environment	Lower electricity use, removal of regulator no longer needed, reduced maintenance hours	Utility bills, personnel hours, pavement closure time	Use of LED in cold area, persuading FAA to approve installation of LED without supplemental heaters	Include learning that LED is significantly brighter than incandescent or quartz lamps. If part of airfield is LED and part is not, pilots will notice the difference, possibly to the point of confusion.

Assistant airport director Lori Hinton explained that the airport has worked closely with the FAA Airport District Office to include LED lighting in appropriate projects already in the Airport Capital Improvement Plan. Concern was expressed by FAA that LED lights on the airfield would need supplemental heater coils in Denver's winter climate. However, Hinton was concerned that the electricity required to power the heater coils would negate any energy savings produced by the LED lights. Airport staff persuaded the FAA to allow a small test area of LED lights on the airfield without supplemental heater coils. The test revealed that the lights would perform well, even during winter conditions, without supplemental heater coils. The FAA agreed and allowed the airport to include the LED lighting in their grant application for two taxiway projects (Figure 8).

Hinton explained that the LED lighting has produced such positive benefits in electricity usage that the airport has been able to remove an old regulator from the airfield electrical vault. As with the

FIGURE 8 LED signage lighting retrofit (*Source*: L. Hinton 2015).

experiences of other airports undertaking sustainable projects, Centennial Airport was able to use in-house electricians to upgrade all of the internally illuminated airfield signs to LED, which reduced the overall cost of the project. Lessons learned, according to Hinton, include learning that LED is significantly brighter than incandescent or quartz lamps, and if part of the airfield is LED and part is not, pilots will notice the difference, possibly to the point of confusion. Her final encouragement to other small airports considering a transition to LED was "Not only is it good for the environment, but it is actually going to save the airport money."

CASE EXAMPLE 9: PHOTOVOLTAIC SOLAR FIELD

Lakeland Linder Regional Airport, Lakeland, Florida
FAA Reliever
Energy Conservation/Renewable Energy

The Lakeland Linder Regional Airport, located in and owned and operated by the city of Lakeland, Florida, is a reliever airport. In an effort to reduce utility costs, airport staff discussed the possibility of generating renewable energy on available airport property (Table 14). Through a public–private partnership between the city of Lakeland and Sun Edison, the local utility company, the plan was for the airport to make 40 acres available for the solar field (Figure 9). Sun Edison would pay for the construction of the solar field, and the city of Lakeland would purchase the electricity for a long-term fixed rate over the next 25 years. In exchange for airport land, the airport would receive energy credits at a rate of $0.02/kWh. This agreement would generate nearly $250,000 annually for the airport with no cost associated with planning or construction.

As part of the design of the solar field, the FAA required a glare analysis to ensure that the PV panels would not negatively affect pilot visibility with a reflective glare. The glare analysis showed that the PV panels would absorb nearly two-thirds of all light reaching the panels. Technology has allowed the manufacture of PV panels with an antireflective coating, further reducing any reflective glare from the panels. The actual glare to be produced by the panels would be similar to that produced by grassy vegetation.

More than 18,000 solar panels were installed, creating the first on-airport solar field of this size in the FAA southern region. The solar field generates more than 9 million kWh of solar electricity per year. It also generates more than $250,000 in energy credits annually, nearly eliminating the airport's electricity costs.

Lessons learned, shared by Brett Fay, operations supervisor, and Gene Conrad, airport director, include:

- Even when a project is inherently environmentally friendly, there can be unintended environmental impacts associated with the construction.
- Public–private partnerships can make large-scale sustainable projects affordable.

TABLE 14
LAKELAND LINDER REGIONAL AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Solar field	Reduce utility costs, utilize airport land	Reduced electricity costs	Utility costs	Environmental concerns, glare potential, funding	Beneficial public–private partnerships; renewable energy can substantially improve bottom line.

FIGURE 9 Lakeland Linder Regional Airport PV solar field (*Source*: B. Fay 2014).

- Consider airport land that may not be beneficial for aviation use but could be used for renewable energy projects.

CASE EXAMPLE 10: PHOTOVOLTAIC SOLAR FIELD AND ROTATING BEACON

Smyrna/Rutherford County Airport, Smyrna, Tennessee
FAA Reliever
Energy Conservation/Renewable Energy; Land/Property Use; Operational Efficiency

The Smyrna/Rutherford County Airport, located 12 nautical mi south of Nashville International Airport is an FAA-designated reliever airport located on more than 1,700 acres, some of which is designated as nonaviation use (Table 15). Several years ago, airport staff

TABLE 15
SMYRNA/RUTHERFORD COUNTY AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
PV solar field	Use of nonaviation land and revenue generation	Land lease revenue, environmental benefits	Land lease revenue	Coordination between solar contractor and utilities	Be open to sustainable opportunities.
Rotating beacon	New location for rotating beacon	New rotating beacon tower, land lease revenue	Land lease revenue	None	Think outside the box.

were approached by a solar contractor in search of land to build a solar field. This field would be partially funded by the Tennessee Valley Authority (TVA) Generation Partners program, and the airport would incur no costs. Realizing that revenue could be generated through a ground lease for land utilized for the PV panels, the airport decided to pursue this partnership (Figure 10).

The 1,000-kW system now generates a significant amount of renewable energy that is placed back into the grid of the Middle Tennessee Electric Membership Corporation. The solar contractor maintains the system, with access required two to three times annually for system maintenance. Thus, the PV field cost the airport nothing to install and costs the facility nothing to maintain. In addition, it generates revenue for the airport through the land lease. As airport manager Lois Vallance explained, "This land was doing nothing but growing trees, and it made sense to generate revenues, while also providing environmental benefits."

In addition to the PV field, the airport's rotating beacon had been mounted atop a water tank owned by the city. Because the water tank was aging, the beacon needed to come down. As airport staff searched for a new location for the rotating beacon, they were approached by a cell phone operator looking for a new place to install a cell phone tower. Staff asked if the cell phone tower could house the airport's rotating beacon on top, and the answer was affirmative. Thus, the airport entered into a land lease with the cell phone tower operator, allowing the firm to install a 170-ft cell phone tower on airport property with the airport's rotating beacon atop (Figure 11). The airport is allowed to maintain the beacon, but electricity is supplied through the cell phone tower by the cell phone operator. After 7 years into a 20-year land lease, the cell phone tower operator paid the airport a lump sum to buy out the land lease. Vallance explained, "This was the easiest thing in the world to do. We now have a new tower for our rotating beacon that did not cost the airport a single cent. And it has generated revenues for the airport."

Vallance reported no barriers with these projects: they were barrier-free and benefit-rich. To be fair, the projects were not pursued by airport staff; rather, the airport served as an attractive location for each project, and staff were pleased to act on these sustainable opportunities.

FIGURE 10 Smyrna/Rutherford County Airport PV solar field (*Source*: D. Prather 2016).

FIGURE 11 Rotating beacon atop cell phone tower (*Source*: J. Black 2015).

CASE EXAMPLE 11: RECLAIMED WATER

Livermore Municipal Airport, Livermore, California
FAA Reliever
Water Quality Protection and Water Conservation;
Land and Natural Resources Management

Another airport located in the drought-stricken state of California, the Livermore Municipal Airport, which is owned and operated by the city of Livermore, is located next to a water treatment plant that produces thousands of gallons of treated water monthly (Table 16). Although this water may

TABLE 16
LIVERMORE MUNICIPAL AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Reclaimed water	Close proximity to water treatment plant, which makes reclaimed water available to the airport; drought	Less water use; reclaimed water use is seen as having less of an environmental impact	Utility bills, goodwill	Reclaimed water restrictions	Think outside the box; consider how to reduce water use; consider how to use reclaimed water; encourage thinking on sustainability.

not be used to water food crops, it can be used to irrigate airport land, including more than 100 acres of adjoining golf course owned by the city. Because of water pressure requirements, the reclaimed water is effectively provided in only a 2- to 3-mi radius from the treatment plant. The airport is in prime location to benefit (Figure 12).

Airport landscaping, where not removed in favor of desert scape, uses reclaimed water. Trees need only minimal water once they are established and provide much-needed shade, so consideration is suggested before removing trees to minimize water use. Even fire hydrants on airport property use reclaimed water. The adjoining Las Positas Golf Course is also irrigated with reclaimed water. The golf course website states, "While doing our part to cut back on water usage, we are using recycled water during the drought to help keep the course green AND help the environment" (Las Positas n.d., para. 5).

Airport manager Leander Hauri explained that there were no real barriers in implementing the use of reclaimed water at the airport. The change was not sought by airport staff so much as it became available by virtue of the water treatment plant being built adjacent to the airport. The airport simply was in the right place and capitalized on the opportunity to use reclaimed water. The airport is billed a meter charge of $40,000 annually, which pays for all reclaimed water used. Hauri also encouraged other airports to consider how landscaping that requires little water may replace thirsty grass and shrubs. He explained, "Low-water–use plants actually enhance the aesthetics and benefit the airport." He said all airports "need to encourage thought on sustainability and be willing to think outside the box."

FIGURE 12 Livermore Airport reclaimed water irrigation (*Source*: L. Hauri 2015).

CASE EXAMPLE 12: SENSITIVE ENVIRONMENT

Ocean County Airport, Toms River, New Jersey
FAA General Aviation
Land and Natural Resources Management; Land/Property Use

Ocean County Airport, located in Toms River, New Jersey, is owned and operated by Ocean County. The airport is uniquely located within the Pinelands National Reserve, a 1.1-million–acre environmentally protected region established by Congress through the passage of the National Parks and Recreation Act of 1978. The Pinelands National Reserve is the first national reserve in the nation. The airport was built in the 1960s. Roughly two-thirds of the airport's 822 acres are within a Preservation Area District that has stringent environmental controls; the remainder of the airport is located within a Forest Area District, which is the second-most strictly regulated environment. As a result, airport staff must exert special effort to ensure the facility is environmentally sensitive in all it does, including day-to-day operations and capital improvements (Table 17). This requirement is similar to the requirements of the National Environmental Policy Act of 1969.

In 2012, a Memorandum of Understanding between the Pinelands Commission and Ocean County restricted all future land use and development to the extent proposed in the airport's original master plan from the 1960s. All other areas of the airport are not to be disturbed.

Because of these restrictions, when a new 3,599-ft crosswind runway (part of the 1960s Master Plan) was proposed, the approval process before ground could be disturbed took 5 years. In addition, once the project was approved, there were significant environmental constraints. Because the Pinelands National Reserve is home to "dozens of rare plant and animal species, as well as the Kirkwood-Cohansey aquifer system, which contains an estimated 17 trillion gallons of water," careful planning was required by airport staff regarding the project ("The Pinelands National Reserve" 2015, para. 3).

First, the airport had to consider the sickle-leaved golden aster, a sensitive plant species with slender, curved, sickle-like leaves and a yellow flower. Because of the amount of plants that would be destroyed in the process of constructing the new runway, the airport was required to perform a relocation project. An environmental consultant was employed to transplant these plants to parts of the airport that would not be disturbed in the future. The project enjoyed an 80% transplant success rate. Second, the airport had to consider the snakes of the Pine Barrens, approximately 20 species of snakes that inhabit the Pinelands. Because of the extensive ground disturbances and number of snake dens that would be destroyed in the process of excavation and construction, the airport was required to build snake dens to replace the lost habitat (Figures 13 and 14). The New Jersey Pinelands Commission oversaw these restoration projects.

TABLE 17
OCEAN COUNTY AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Plant/animal accommodation	Pineland Commission requirement	Sickle leaf golden aster transplanted, snake dens constructed	Transplant success rate; new snake dens occupied	Expense of transplanting and building snake dens; environmental approvals; environmental restrictions	Know who significant stakeholders are, open communication.
Trees in approach surface	Obstruction clearing	Obstructions removed, with little ground disturbance	Obstructions in approach surface	Expense of pruning tree crowns rather than clear cutting where trees can be used	Know who significant stakeholders are, open communication.

FIGURE 13 Newly created snake den (*Source*: Ocean County Airport 2015).

FIGURE 14 Thermal window shades (*Source*: Ocean County Airport 2015).

In addition to these environmental restoration projects, the airport was prohibited from creating ground disturbances that are not reflected in the airport layout plan (ALP). As trees grew in height, the result was potential obstructions in the runway protection zone and approach surfaces. The removal of such trees was prohibited, so airport staff had to think creatively about how to solve the dilemma while producing the least environmental impact. As a result, trees were topped (pruned) at an angle so as to stay below any surfaces or zones that needed protection. This tree crown reduction minimized wildlife disturbance and achieved airport safety goals.

According to Steve Simmone, senior planner, the prohibition on ground disturbance for any project not reflected in the original ALP requires the airport to adopt an innovative mind-set with regard to sustainability. To some degree, every project the airport carries out is done only after the environmental impact is considered. At the same time, there are some environmentally sustainable initiatives that will not be possible at Ocean County Airport, such as the installation of solar fields, because of the extensive ground disturbance that would be required. However, the airport has installed low-flow toilets to reduce water use, solar tubes to bring natural light to interior spaces and minimize interior

electricity use, and thermal window shades to minimize heat loss during winter and heat gain during summer, which minimizes HVAC demands and subsequently lowers utility use.

According to Simmone, the location of the airport in an environmentally protected National Reserve affects programmatic decisions most significantly. For instance, he said, "We have an even more heightened focus on sustainability, including small initiatives such as recycling, than we might if not located in this environmentally sensitive area." By working with the New Jersey Department of Environmental Protection and the Soil Conservation District, airport staff continually monitor the facility's storm water pollution prevention plan, underground storage tanks (fuel and septic), and seeding and landscaping to avoid attracting invasive plant and animal species.

Simmone said other small airports should know and understand their significant stakeholders and partners and keep communication lines open. In addition, according to Simmone, "If an area doesn't need to be disturbed, don't disturb it." In other words, he encouraged airport managers to tread lightly on the environment.

CASE EXAMPLE 13: HONEYBEES

Jackson County Airport, Gainesboro, Tennessee
FAA General Aviation
Land and Natural Resources Management

The Jackson County Airport is located in Gainesboro, Tennessee, and is owned and operated by Jackson County, which has a population of approximately 11,000. This single-runway airport is adjacent to the Cumberland River, in a rural area, on land leased from the Army Corps of Engineers. The staff of this low-use airport initially indicated they had not pursued any environmental initiatives. When they were queried further, it became clear the airport has pursued a rather innovative, environmentally sustainable initiative (Table 18).

Airport manager Jim Young noticed that although the airport property had 100 acres of clover, mostly in a river bottom area, there were no honeybees, insects that play a significant role in pollination. Young, who was aware of the decline in the honeybee population caused primarily by colony collapse disorder, decided that airport land possibly could play a role in sustaining the honeybee population in Jackson County. First, Young contacted the Army Corps of Engineers about developing a honeybee colony on airport land, but the group was not interested in such a project. Young then contacted the Tennessee Department of Agriculture and encountered enthusiastic support. With the help of the Tennessee Department of Agriculture, Young again talked with the Army Corps of Engineers, who approved of the concept but stipulated that honey could not be sold for profit. This stipulation was fine with Young, whose primary goal for the project was to increase the honeybee population.

The colony cost approximately $500 to establish (hive and bees), and with a ready source of water (Cumberland River), the colony was set up in a remote location on airport property. Young said that his

TABLE 18
JACKSON COUNTY AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Honeybee colony	Vacant airport land with clover; awareness of honeybee colony collapse disorder causing honeybee decline	Newly established honeybee colony on airport land	Success of original colony and any new colonies established by bees	Approvals by landowner; remote area to prevent tampering with hive	Be innovative in approach to sustainability; high-cost projects are not the only option.

FIGURE 15 Frame of capped brood ready to hatch at Jackson County Airport (*Source*: J. Young 2015).

FIGURE 16 Jackson County Airport beehive (*Source*: J. Young 2015).

being married to a beekeeper made the establishment of the bee colony easier, but he encourages all airports with a remote land area and available course of water to consider such an initiative and contact a local beekeeper for advice. Once established, maintenance of the colony is low, with regular visits to the hive by a beekeeper required simply to check on the health of the hive and ascertain that enough honey (40–60 lb) has been stored by the bees for feeding during the winter (Figures 15 and 16).

CASE EXAMPLE 14: RECYCLING

San Bernardino International Airport, San Bernardino, California
FAA Reliever
Materials Use and Solid Waste Reduction/Recycling

The San Bernardino International Airport, which is classified by the FAA as a reliever airport, is located in southern California on approximately 1,800 acres of land. Although this airport has pursued a number of sustainable initiatives, this case example focuses on the airport's recycling efforts

TABLE 19
SAN BERNARDINO INTERNATIONAL AIRPORT

Initiative	Drivers	Outcomes	Metrics	Barriers	Lessons Learned
Recycling	Benefit the environment and remove waste from airport	Waste removed; environmental benefits; some revenue generated	Costs	Coordination; state compliance	Piggyback on existing municipal programs/resources.

(Table 19). First, during past runway and taxiway rehabilitation and repaving, the airport retained removed concrete, crushed it, and stored it on airport property to use as base for other projects (Figures 17 and 18). Airport manager Liliana Valle says the crushed concrete also can be sold if not needed by the airport. Second, the airport owns and operates the fixed-base operations (FBO), including the FBO fuel farm. Fuel is sumped daily for quality checks; if the removed fuel is not contaminated, it is placed in a vessel for additional filtering and ultimately returned to fuel storage (Figure 19). Third, with a good deal of heavy aircraft maintenance being performed on the field by various tenants, a request to defuel occurs regularly. In the instances when an aircraft operator does not want

FIGURE 17 Stockpiled pavement for future crushing (*Source*: L. Valle 2015).

FIGURE 18 Crushed material (*Source*: L. Valle 2015).

FIGURE 19 Sump recovery tank (*Source*: L. Valle 2015).

the fuel returned to the aircraft, the airport has the ability to have the fuel recertified for future use. This recertification requires sending a sample of the fuel to the analytical laboratory that tests fuel, a process that may take 1 to 2 weeks. Fourth, the airport regularly recycles hazardous waste, including used motor oil. Through competitive quotes received through a solicitation for recycling services, the airport has entered into a contract with a local hazardous waste recovery company to remove and properly recycle or dispose of hazardous water generated at the airport, including waste generated by airport tenants. Depending on the waste, the company may remove it free of charge or for a minimal fee. The airport may even generate some revenue from the waste removal process. In addition, airport-generated waste, such as large appliances, can be sold to a recycling company.

When asked to share words of wisdom with other small airports, Valle stated, “Most small airports are part of a city or county that has resources that may be made available to the airport. Most small airports could ‘piggyback’ on these existing programs.”

CHAPTER FIVE

SURVEY RESULTS

This chapter presents a synthesis of current practice as it relates to sustainable initiatives pursued by small airports throughout the United States. The chapter first presents the entire survey results on a nationwide basis and then presents types of projects, outcomes, and drivers on the basis of FAA regions. This is for the benefit of airport staff interested in results for airports in their FAA region. The parameters differ by FAA region.

Fully 303 of 340 airports (representing an 89% response rate) participated in this Synthesis. Adopted initiatives represent one or more of the following categories:

- Socioeconomic benefits (health/welfare of employees) and community outreach/involvement
- Economic vitality/operational efficiency
- Air quality enhancement/climate change
- Energy conservation/renewable energy
- Noise abatement
- Water quality protection and water conservation
- Land and natural resources management
- Land/property use
- Pavement management
- Materials use and solid waste reduction/recycling
- Hazardous materials and waste management/reduction
- Surface transportation management
- Buildings/facilities.

AIRPORTS WITH SUSTAINABLE INITIATIVES

Sustainable Projects

Nationwide

Of the 303 airports participating in the survey, 189 (representing 63%) have adopted at least one sustainable initiative. The most common sustainable initiative is in the category of energy conservation/renewable energy (reported by 155 airports, representing 82% of the 189 airports with sustainable initiatives). The next most common category of sustainable initiatives is water quality protection and water conservation (79, representing 42%) and then materials use and solid waste reduction/recycling (68, representing 36%) (Figure 20).

Regions

There were differences among the nine FAA regions, as presented in Table 20 and Figure 21.

In the category of buildings/facilities, not many airports pursued sustainable initiatives. Only the regions of Great Lakes, New England, and Western Pacific reported sustainable initiatives in this category.

In the category of hazardous materials and waste management/reduction, more airports reported sustainable initiatives. All regions reported efforts in this area, with the exception of the Alaskan. The Great Lakes and Eastern regions are more active in this category.

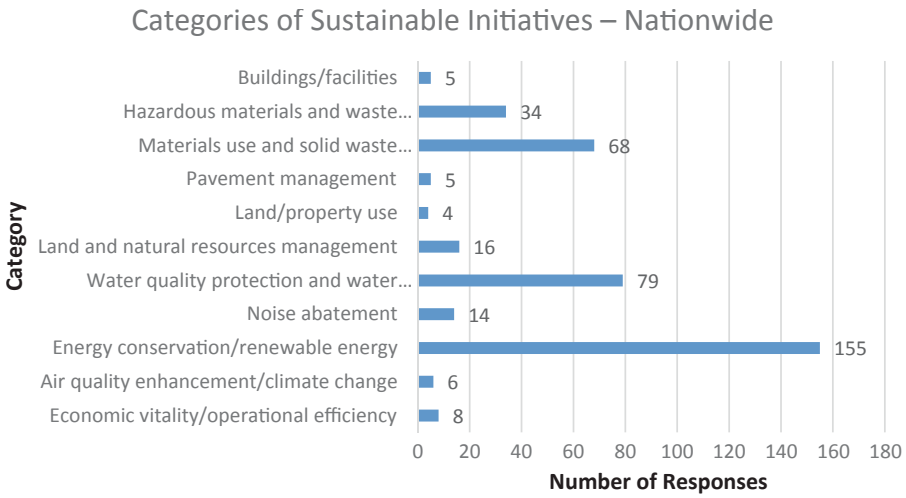

FIGURE 20 Categories of sustainable initiatives—nationwide (*Source*: D. Prather 2016).

In the category of materials use and solid waste reduction/recycling, all regions reported sustainable initiatives. The Southern and Western Pacific regions are more active in this category.

In the category of pavement management, only three regions reported sustainable initiatives. A handful of airports in the Great Lakes, Southwest, and Western Pacific regions have pursued sustainable initiatives in this category.

In the category of land and property use, only three regions reported sustainable initiatives. A small number of airports in the Great Lakes, Southern, and Southwest regions have pursued sustainable initiatives in this category.

In the category of land and natural resources, five regions reported sustainable initiatives. Sixteen airports in the regions of Eastern, Northwest Mountain, Southern, Southwest, and Western Pacific have pursued sustainable initiatives in this category.

In the category of water quality protection and conservation, all regions except the Alaskan reported sustainable initiatives. This proved to be a favorite category, with a total of 78 airports among eight regions reporting initiatives. In the New England region, this category was as prominent as the energy conservation/renewable energy category.

TABLE 20
SUSTAINABLE INITIATIVE CATEGORIES IN USE BY FAA REGION

Category	Alaskan	Central	Eastern	Great Lakes	New England	NW Mountain	Southern	Southwest	W Pacific
Buildings/facilities				1	2				2
Hazardous materials and waste management		3	8	11	2	1	3	2	3
Materials use and solid waste/recycling	1	5	7	10	5	3	15	6	14
Pavement management				1				2	2
Land/property use				1			2	2	
Land and natural resources			5			1	4	2	4
Water quality protection/conservation		5	14	17	7	5	14	7	9
Noise abatement			4	1		1	2	1	5
Energy conservation/renewable energy	4	11	23	25	7	16	27	19	19
Air quality enhancement/climate change	1		1	1		1			1
Economic vitality/operational efficiency					2	1	4		1

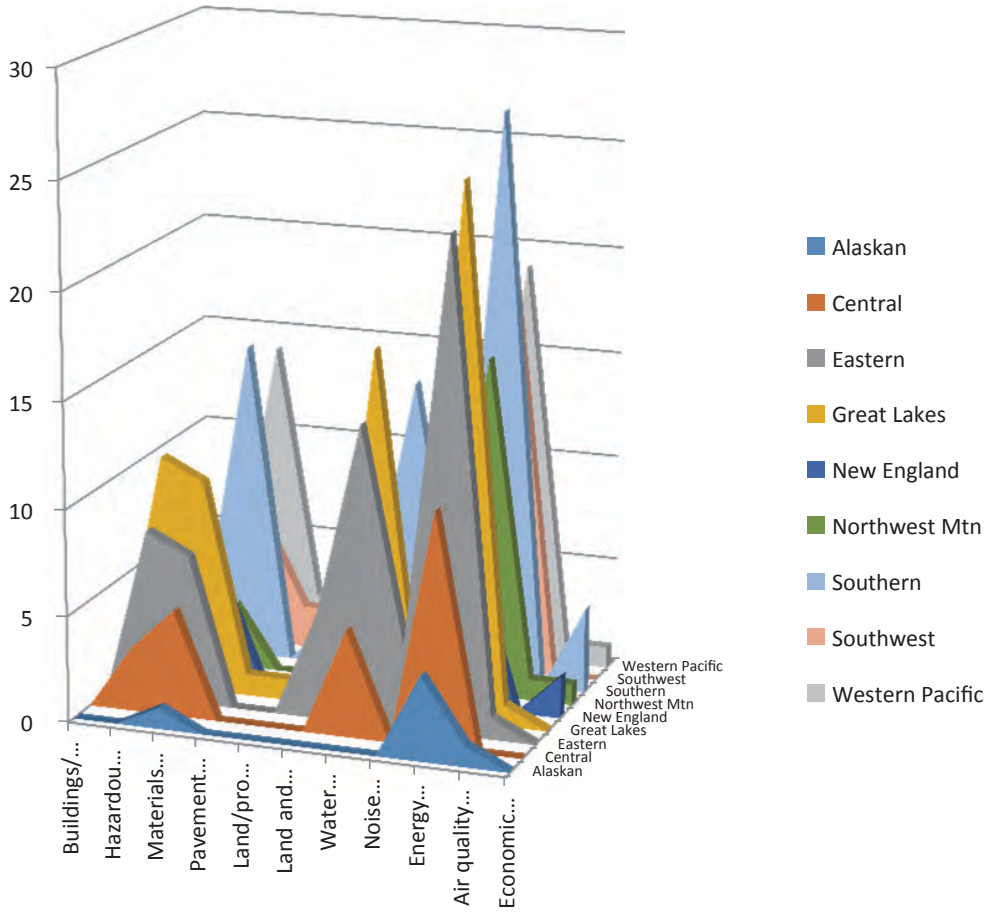

FIGURE 21 Categories by region (*Source*: D. Prather 2016).

In the category of noise abatement, six regions reported sustainable initiatives. Even so, only 14 airports among these six regions have pursued sustainable initiatives in this category.

In the category of energy conservation and renewable energy, every region reported sustainable initiatives. This category represented more than 50% of sustainable initiatives reported in the Alaskan and Northwest Mountain regions. It represented at least 30% of sustainable initiatives in the remaining regions, except the New England region. This category represented the single most noted category in which airports are pursuing sustainable initiatives in each FAA region.

In the category of air quality enhancement/climate change, five airports in as many regions reported sustainable initiatives. The five regions are Alaskan, Eastern, Great Lakes, Northwest Mountain, and Western Pacific.

In the category of economic vitality/operational efficiency, eight airports in four regions reported sustainable initiatives. These four regions are New England, Northwest Mountain, Southern, and Western Pacific.

Drivers and Outcomes

Drivers are the motivating factors that lead an airport to pursue a sustainable initiative. Outcomes are the results of those sustainable initiatives. To enable comparison of drivers and outcomes, the categories for both in the survey were the same. Often, the driver that motived the airport is identical to the outcome the airport experienced.

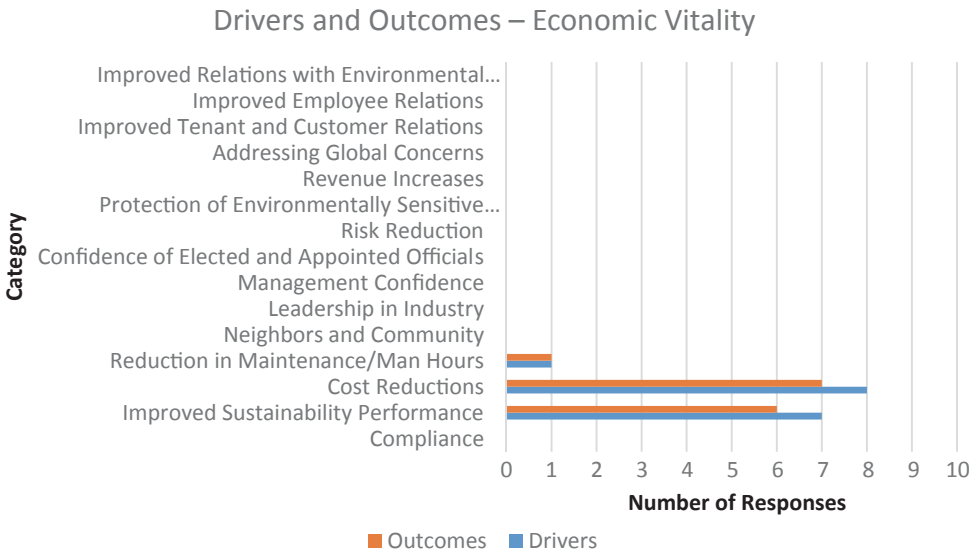

FIGURE 22 Drivers and outcomes—economic vitality and operational efficiency (*Source*: D. Prather 2016).

Economic Vitality and Operational Efficiency

Three drivers and identical outcomes were reported by airports with sustainable initiatives in the category of economic vitality/operational efficiency. The most common driver and outcome are cost reductions. Additional driver and outcomes are improved sustainability performance and reduction in maintenance hours (Figure 22).

Air Quality Enhancement and Climate Change

Five drivers and identical outcomes were reported by airports with sustainable initiatives in the category of air quality enhancement/climate change. The most common driver and outcome is addressing global concerns. Additional drivers and outcomes reported are management confidence, reduction in maintenance/man hours, cost reductions, and improved sustainability performance (Figure 23).

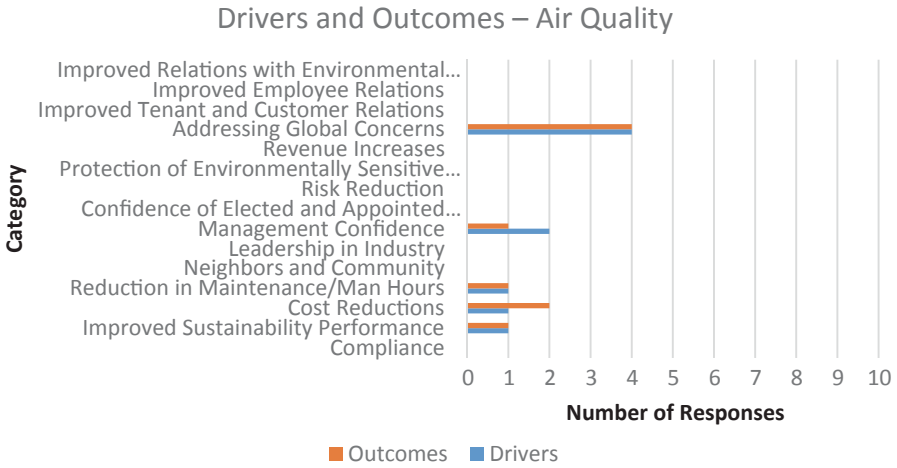

FIGURE 23 Drivers and outcomes—air quality enhancement/climate change (*Source*: D. Prather 2016).

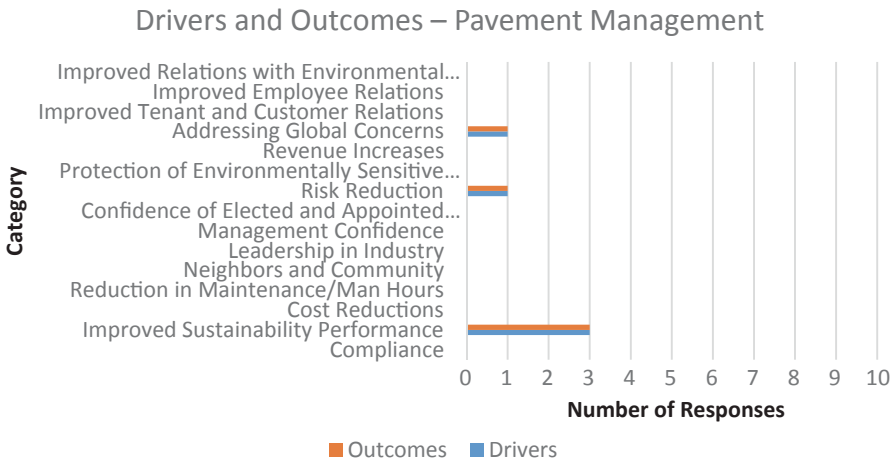

FIGURE 24 Drivers and outcomes—pavement management (*Source*: D. Prather 2016).

Pavement Management

Three drivers and identical outcomes were reported by airports with sustainable initiatives in the category of pavement management. The most common driver and outcome is improved sustainability performance. Additional drivers and outcomes include addressing global concerns and risk reduction (Figure 24).

Materials Use and Solid Waste Reduction/Recycling

Four drivers and identical outcomes were reported by airports with sustainable initiatives in the category of materials use and solid waste reduction/recycling. An additional driver was reported without a matching outcome. The most common driver and outcome reported is addressing global concerns. Additional drivers and outcomes are revenue increases, management confidence, and improved sustainability performance. One driver that is not also reported as an outcome is cost reductions (Figure 25).

Land and Natural Resources Management

Four drivers and identical outcomes were reported by airports with sustainable initiatives in the category of land and natural resources management. The two most common drivers and identical outcomes are compliance and addressing global concerns. One additional driver and identical outcome

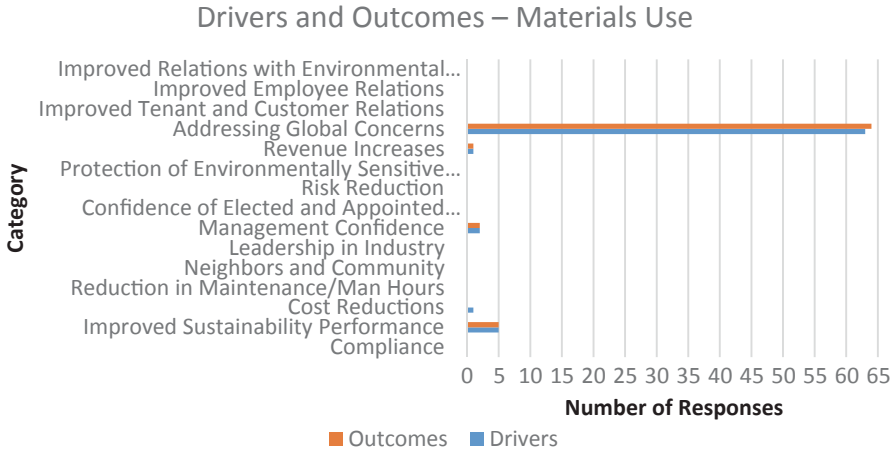

FIGURE 25 Drivers and outcomes—materials use and solid waste reduction (*Source*: D. Prather 2016).

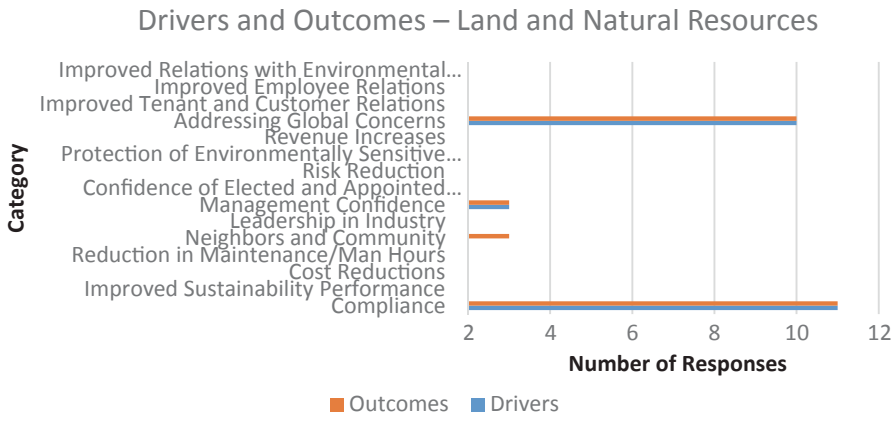

FIGURE 26 Drivers and outcomes—land and natural resource management (*Source*: D. Prather 2016).

is management confidence. One outcome that was not also reported as a driver is neighbors and community. This final finding means that neighbor and community relations were improved but were not expected (Figure 26).

Land/Property Use

Airports with sustainable initiatives in the category of land/property use reported only one driver and identical outcome. Addressing global concerns was the only driver and outcome reported (Figure 27).

Buildings/Facilities

Airports with sustainable initiatives in the category of buildings/facilities reported only one driver, with an identical outcome. Improved sustainability performance was the only driver/outcome reported (Figure 28).

Hazardous Materials and Waste Management/Reduction

Airports with sustainable initiatives in the category of hazardous materials and waste management/ reduction reported two drivers and identical outcomes. The most commonly reported driver/outcome was addressing global concerns. The other remaining driver/outcome was compliance (Figure 29).

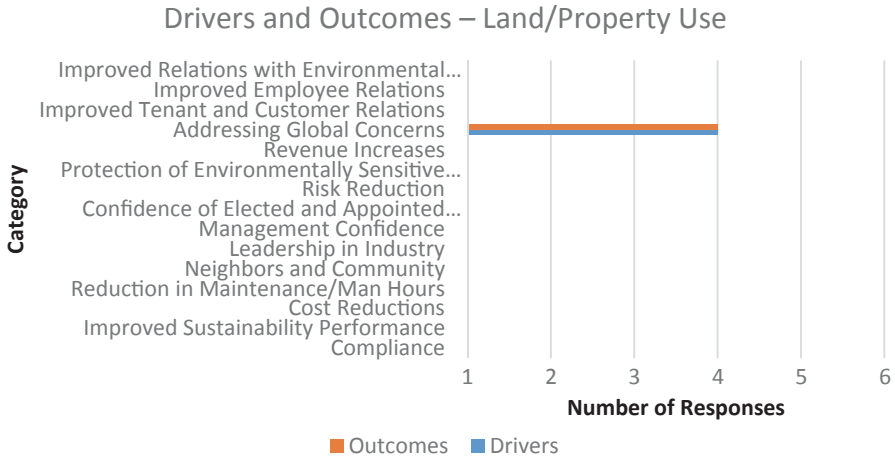

FIGURE 27 Drivers and outcomes—land/property use (*Source*: D. Prather 2016).

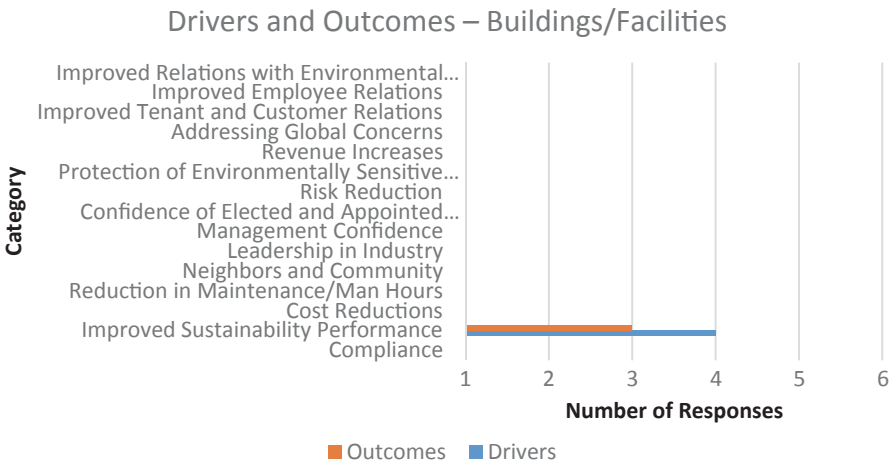

FIGURE 28 Drivers and outcomes—buildings/facilities (*Source*: D. Prather 2016).

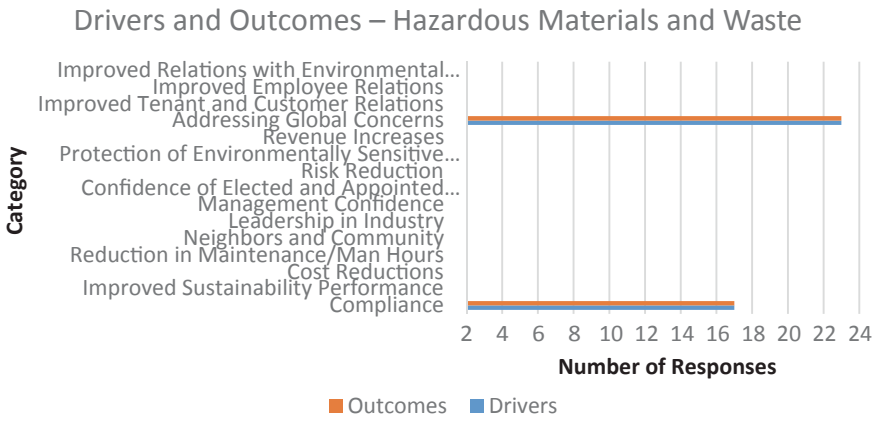

FIGURE 29 Drivers and outcomes—hazardous materials and waste management/ reduction (*Source*: D. Prather 2016).

Noise Abatement

Airports with one or more sustainable initiatives in the category of noise abatement reported several drivers and outcomes. In general, the drivers were identical to outcomes. The three most commonly reported drivers and outcomes were reduction in maintenance/man hours, cost reductions, and improved sustainability performance. Addressing global concerns was also listed as a driver and outcome. Risk reduction, although not identified as a driver, was listed as an outcome (Figure 30).

Water Quality Protection and Water Conservation

Airports with one or more sustainable initiatives in the category of water quality protection and water conservation reported four divers with identical outcomes. The most commonly reported driver and outcome was compliance. Additional drivers and outcomes were addressing global concerns, cost reductions, and improved sustainability performance (Figure 31).

Energy Conservation/Renewable Energy

The most prominent category of sustainable initiatives at small airports, energy conservation/ renewable energy, is associated with three drivers and identical outcomes. The most commonly reported driver and outcome was cost reductions. Additional drivers/outcomes were reduction in maintenance/man hours and improved sustainability performance (Figure 32).

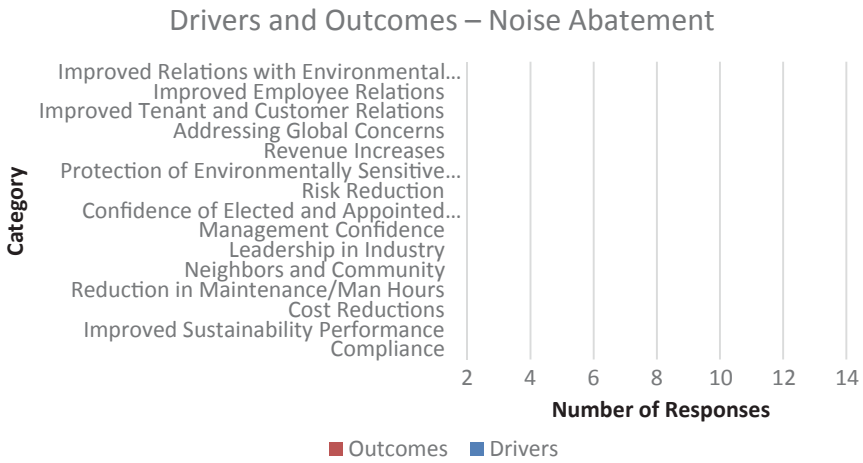

FIGURE 30 Drivers and outcomes—noise abatement (*Source*: D. Prather 2016).

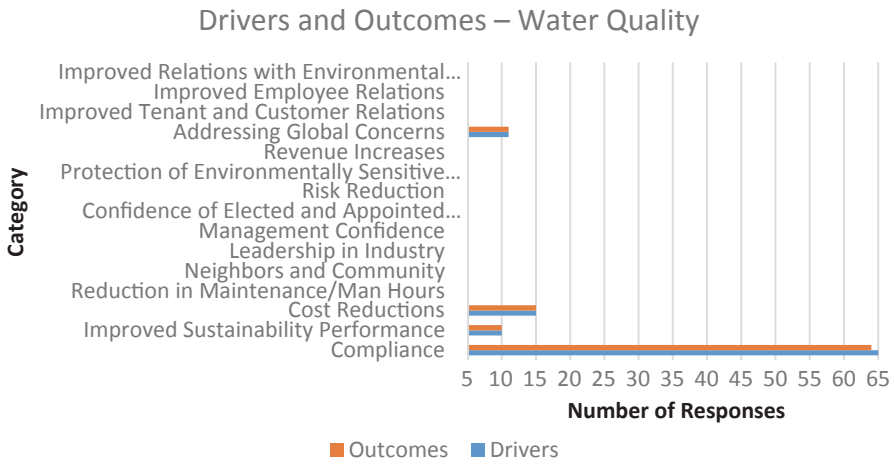

FIGURE 31 Drivers and outcomes—water quality protection and water conservation (*Source*: D. Prather 2016).

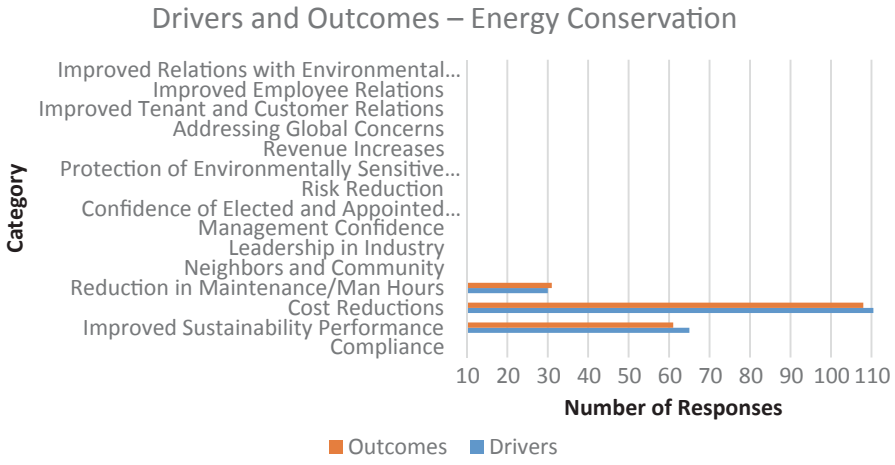

FIGURE 32 Drivers and outcomes—energy conservation/renewable energy (*Source*: D. Prather 2016).

Metrics

When asked how outcomes from sustainable initiatives were measured, several common themes emerged. These themes are:

- Utility bills
- Maintenance costs
- Maintenance/man hours
- Usage
- Wildlife hazards
- Life of equipment/parts.

In general, to track long-term project success, cost savings over time was a commonly used measure. One hundred seven participating airports responded with this identical long-term measure (representing 57% of the 189 participating airports with sustainable initiatives).

Expectations Versus Actual Benefits Realized

When asked if sustainable projects met expectations as far as benefits realized, 93 participating airports responded in the affirmative. In other words, for these airports, the outcomes closely matched the drivers. This is true across categories and initiatives. Of the 95 participating airports that answered this question, only one indicated their sustainable initiatives did not meet expectations, indicating that most often, sustainable initiatives are successfully meeting the expectations airports have in pursuing these initiatives in the first place.

Lessons Learned

Depending on the airport, different measures may be more successful than others. Size of airport, geographic area, and sustainable goals affect the initiative undertaken and the degree of success enjoyed. Lessons learned from the study, including the literature, include:

- It is less expensive to build sustainability into a project than retrofit later.
- There is a general lack of understanding about sustainability among small airport staff.
- An airport does not have to develop a sustainability master plan to implement sustainable initiatives.
- Many sustainable initiatives at small airports are in place not because the airport wanted them but because the municipality did. The airport was part of a larger project.
- Whether or not airport staff believe their airport has environmental impact, sustainability is an option.
- A business case can be made for sustainability.
- Sustainability is a mind-set. What is a better, more efficient, way to do this?
- Good planning needs to be sustainable.
- Sustainability can be part of any airport's portfolio.
- Environmental, although the first piece generally recognized, is only one piece of sustainability.
- There is great deal of literature available on sustainability that staff of small airports may not be aware of.
- Many airports have implemented energy efficiency measures, with energy, water, and materials the top three.
- Staff of small airports may be unaware of sustainability definitions, think sustainability initiatives cost too much, and think their airport does not have any impact on the environment.

Twenty-five participating airports provided anecdotes and comments on lessons learned from their sustainability experiences. These lessons, grouped by category of sustainable initiative, are shared here. Note that duplicate comments have been removed.

- Economic vitality/operational efficiency
  - The importance of patience, cooperation, and compromise.
  - Our state spends a lot on compliance.

  - Airports are like households. You have to pick and choose what you need/can afford. If you can't afford a Lamborghini, don't buy one.
  - Retrofitting is expensive. Choose efficiency during construction.
  - Use reliable products and products best for the region.
  - Not much cost reduction but have seen maintenance reduction.
  - Small city airport. Not worth investing in sustainability.
- Air quality enhancement/climate change
  - Try to be as conscious of the environment as possible.
- Energy conservation/renewable energy
  - Not yet seen cost reduction in LED.
  - Like LEDs. Want to switch all lights in the future.
  - Old lights were from 1973, so LEDs are much better. Looking into LED taxiway.
  - Hoping for LED in future depending on AIP from FAA.
  - Will replace runway with LED when lights get old.
  - Trying to switch buildings and runway to LED.
  - LEDs don't melt snow so wouldn't work there. Want solar but would need a grant.
  - Stainless fixtures are not a good choice for ocean areas. Cannot withstand salt.
  - Efficient lighting has cut costs by $200/month, and lighting is much better.
  - Changing all lights to LED eventually.
  - LEDs don't emit heat, an important consideration in areas receiving cold temperatures.
  - Had LEDs, but they were problematic.
  - Not yet seen cost reduction in LED, but they stay brighter
  - FAA is behind the curve on setting standards for LEDs—still haven't made up their minds.
- Pavement management
  - In future will change to recycle pavement for redoing runway.

Funding and Payback

As specified in chapter three, there are multiple sources of funds to support sustainable initiatives at airports. Funds for sustainable initiatives, although not always available, generally are secured from the following sources:

- FAA
- State Department of Transportation Aeronautics/Aviation
- Local municipality
- Utility company
- State energy/environmental protection.

Most sustainable projects have a payback period, which depends on the initial capital investment, ongoing costs, funding received, and the revenue or cost savings generated by the project. Installing motion sensors on lighting in restrooms may have a short payback period, whereas hosting the community for an open-house event to learn more about the airport's master planning update process may have a much longer payback period. Indeed, depending on the initiative, payback may be difficult to measure.

Barriers

Most participating airports shared barriers to implementing sustainable projects. For example, barriers include not only costs but also competing priorities. Possibly the greatest barrier and one that is not necessarily understood is the need for a changed mind-set. According to Global Reporting Initiative (GRI 2011, p. 6), "One of the key challenges of sustainable development is that it demands new and innovative choices and ways of thinking." To develop strategies to overcome barriers and ensure project success, it is important to be aware of common barriers. Themes of commonly reported barriers were shared by 166 survey participants (representing 88% of airports with sustainable initiatives). The themes include:

- Funding
- Lack of political will (champion)

- Different priorities
- Costs
- Lack of matching funds
- Unaware of grant opportunities.

It is important for an airport pursuing a sustainable initiative to perform the necessary research so that funding sources are known, costs are understood, and supporters can be nurtured.

It is important to note that although developing a sustainability plan may prove beneficial, an airport may implement sustainable initiatives without having a formal sustainability plan in place. Staff of small airports need not let the perceived obstacle of developing a sustainability plan or sustainability master plan interfere with their efforts to be sustainable.

Reasons for Not Pursuing Sustainable Initiatives

When asked why more small airports do not implement sustainable projects, 171 participating airports (representing 91% of airports with sustainable initiatives) responded. Common themes include:

- No need
- Costs
- Funding
- Minimal staff
- Unaware of grants
- Lack of matching funds
- Different priorities
- Too small of an airport
- Too little airport activity
- Small budget.

Encouragement for Small Airports to Consider Sustainable Initiatives

In an effort to seek encouragement for staff of small airports to pursue sustainable initiatives, participating airports were asked, "How can small airports be encouraged to be more sustainably focused?" Responses were gathered from 139 participating airports (representing 74% of participating airports with sustainable initiatives). Common themes emerged, including:

- More funding
- More incentives
- More education on benefits of sustainability
- More education on cost/benefits of sustainability
- Example set by peer airports
- Ease application requirements for sustainability grants
- Communication of sustainability plans by municipalities to airport.

AIRPORTS WITHOUT SUSTAINABLE INITIATIVES

Future Sustainable Plans

In an effort to determine if the 113 participating airports not yet having adopted one or more sustainable initiatives had plans to pursue sustainable initiatives in the future, these airports were asked, "Does your airport have plans to implement any sustainable initiatives in the near future?" Ninety-one (representing 80%) answered in the negative, whereas 23 (representing 20%) responded affirmatively. Thus, approximately one of five of these airports has plans to pursue sustainable initiatives in the near future.

Twenty-three of these airports shared the types of projects they plan to pursue, including:

- LED lighting
- LED windsock
- Energy-efficient building
- Pilot-activated airfield lighting
- Refurbishing pavement
- Energy-efficient terminal lighting
- Energy-efficient ramp lighting
- PV solar panels.

When asked why these airports were motivated to pursue these initiatives in the future, 20 airports responded with several themes:

- Cost reduction
- Energy efficiency
- Increased safety
- Maintenance reduction
- Longevity
- Quality
- Reliability.

These 20 airports also shared the benefits they expect to receive in pursuing these sustainable initiatives. Themes include:

- Cost savings
- Increased efficiency
- Greater safety
- Usage reduction
- Reduced maintenance expenses and time
- Revenue generation
- Increased longevity.

Reasons for Not Pursuing Sustainable Initiatives

Ninety-two of the 113 participating airports (representing 81%) that have not yet pursued sustainable initiatives shared their reasons for not yet having done so. Common themes include:

- Small airport
- Little to no environmental impact
- Different priorities
- Sustainability costs too much
- Small budget
- No cost–benefit to sustainability
- More focused on operational costs
- Not required by regulatory agency.

When asked what would convince airport staff to begin a sustainable project at their airport, 87 of the 113 participating airports (representing 77%) without sustainable initiatives responded. Common themes include:

- More funding
- More federal grants
- Neighbors expressing environmental concerns and demanding airport action
- Financial return on costs
- More aircraft activity.

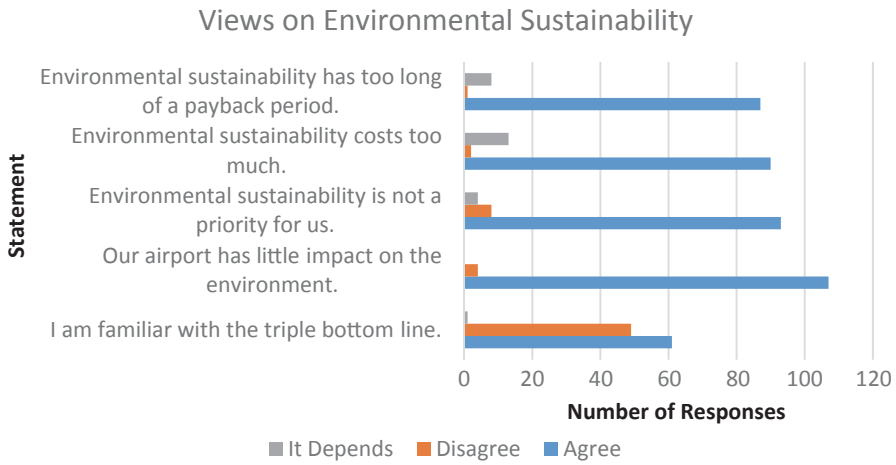

FIGURE 33 Views on environmental sustainability (*Source*: D. Prather 2016).

Eighty-four of these airports (representing 75%) shared negative drivers they associate with sustainable projects at airports of their size. Common negative drivers include:

- Cost
- Lack of AIP funding.

Clearly, the cost of sustainability is the most significant and commonly reported negative driver.

Participating airports not yet having pursued sustainable initiatives were also presented five statements to which they were asked to indicate their agreement or disagreement with. These statements were designed to determine (1) an airport's awareness of sustainability benefits, (2) the perceived impact that airport has on the environment, (3) whether or not environmental sustainability is a priority, and (4) if environmental sustainability is perceived to cost too much and have too long of a payback period. Responses are presented in Figure 33 and Table 21.

The staff of most small airports that have not implemented sustainable initiatives responded that their airport has little impact on the environment. Although sustainability is much more than environmental sustainability, this belief leads them to not make sustainability a priority, believing it costs too much and has too long of a payback period.

Regions

Among the various FAA regions, airports express differing views on sustainability (Table 22 and Figure 34). First, across regions (except the Alaskan and Central) there is a general lack of familiarity with the concept of the triple bottom line. In the Alaskan region 82% of airports surveyed were familiar with the triple bottom line, and in the Central region 67% were familiar with the concept.

TABLE 21
AGREEMENT AND DISAGREEMENT WITH STATEMENTS ON SUSTAINABILITY, BY AIRPORTS NOT YET PURSUING INITIATIVES

Statement	Agree	Disagree	It Depends
I am familiar with the triple bottom line.	61	49	1
Our airport has little impact on the environment.	107	4	0
Environmental sustainability is not a priority for us.	93	8	4
Environmental sustainability costs too much.	90	2	13
Environmental sustainability has too long of a payback period.	87	1	8

TABLE 22
AGREEMENT AND DISAGREEMENT WITH STATEMENTS ON SUSTAINABILITY BY REGION

Statement	Alaskan (%)	Central (%)	Eastern (%)	Great Lakes (%)	New England (%)	Northwest Mountain (%)	Southern (%)	Southwest (%)	Western Pacific (%)
I am familiar with the triple bottom line.	82	67	0	0	0	20	0	21	17
Our airport has little impact on the environment.	98	100	100	100	100	100	80	100	83
Environmental sustainability is not a priority for us.	94	100	50	100	100	75	56	83	100
Environmental sustainability costs too much.	91	100	100	33	100	75	100	67	67
Environmental sustainability has too long of a payback period.	100	100	100	67	100	75	100	67	50

Airport staff in all regions believe their airports have little impact on the environment. Six regions had 100% agreement with this statement. This was generally because of the size and geographic location (often rural in nature) of these airports.

Airport staff in all regions believe that environmental sustainability is not a priority. However, fewer airports (50% and 56%, respectively) in the Eastern and Southern regions share this sentiment.

Airport staff in all regions believe that environmental sustainability costs too much. However, only 33% of airports in the Great Lakes region share this sentiment. Four regions had 100% agreement with this statement.

Airport staff in all regions also believe that environmental sustainability has too long a payback period. Five regions had 100% agreement with this statement.

These data show that there is a general lack of awareness of and interest in sustainability among small airports, specifically as it relates to the more common concept of environmental sustainability.

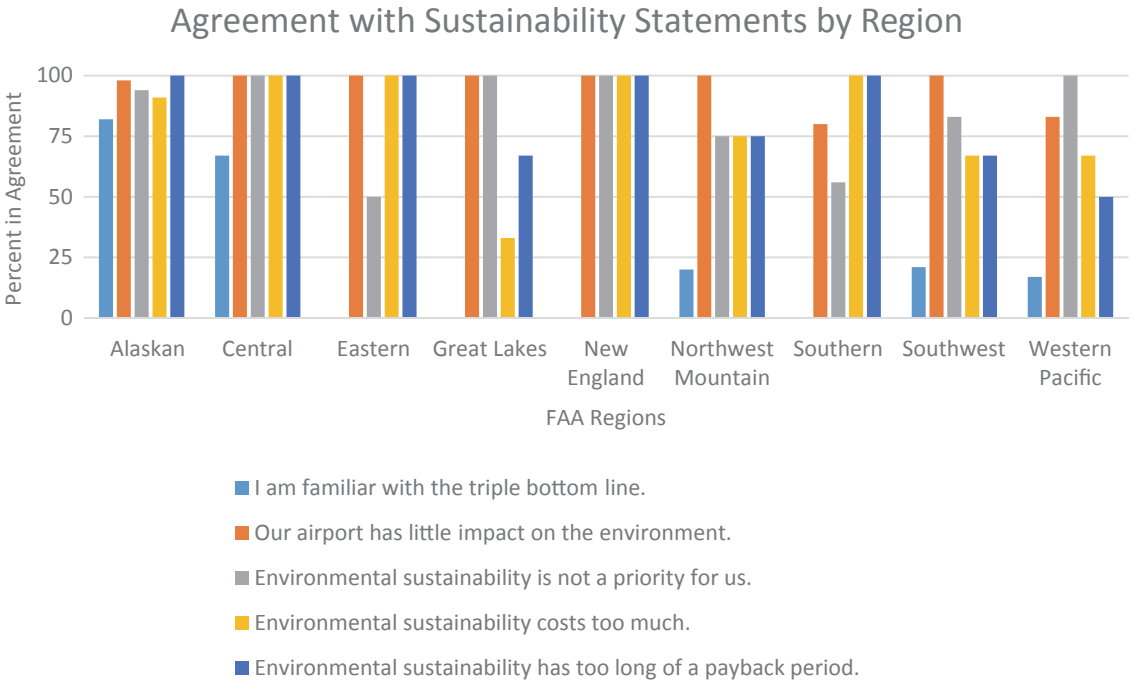

FIGURE 34 Agreement with sustainability statements by region (*Source*: D. Prather 2016).

Forty-seven airports (representing 17% of respondents) reported having a formal sustainability plan or program. Twenty airports shared benefits of having such a plan in the following themes:

- adherence to guidelines,
- prioritization in use of funds,
- FAA preference,
- environmental benefits,
- minimization of liability, and
- facilitation of environmental review for each project.

AIRPORT SURVEY COMMENTS AND LESSONS LEARNED

Participating airports were provided an opportunity at the end of the survey to share lessons learned or any additional words of wisdom. Half of the airports (representing 151 actual responses) shared lessons learned. Actual comments are grouped into themes and presented here. Duplicate comments have been removed.

- Sustainability planning
  - Not sure about sustainability plan but probably because it was written by an engineer.
  - Attention in master toward triple bottom line.
  - Will consider sustainability plan in future.
  - Master may include sustainability.
  - In future will make sustainability plan.
  - Next year will create a sustainability plan.
  - May create sustainability plan in the future.
  - In process of updating master.
  - Master needs to be updated.
  - Will consider sustainability plan in future with more funding.
  - Soon will have environmental plan.
  - Not a master plan type of airport.
  - Will consider sustainability plan in future.
  - Would consider formal sustainability plan if granted.
  - Not sure what the environmental section covers.
  - Going to renew environmental impact study.
  - Will consider sustainability plan in future.
  - Master has an overview of environmentally sensitive areas.
  - Will consider sustainability plan in future (2017).
  - Didn’t know about grants before you called.
  - May create sustainability plan in the future.
  - Master plan includes environment.
  - In process of creating sustainability plan.
  - Would like to have a sustainability plan in the future if they grow.
  - Sustainability plan would not work here.
  - Still updating—will try to incorporate environment into master.
  - County itself has sustainability group.
  - Will consider sustainability plan in future—not sure what it would mean.
  - Lacking in long-term planning.
  - All planning is up to the city.
  - Yes to sustainability plan in future.
  - Working on environmental plan.
  - Plan is not financially beneficial but keeps you out of trouble later.
  - Included sustainability in ALP.
  - Contract sustainability out.
  - Have environmental section in master.
  - In future ALP will have sustainability addressed.
  - In 2016 master will include environment.

  - Environment included in the strategic business plan.
  - Master includes potential impact on the environment only.
- Future projects
  - New sustainable building scheduled 2016.
  - Want to renovate terminal and make it as efficient as possible.
  - May try for solar in 5–10 years.
  - Have grant to change lights to LED in 2 years.
  - Want to redo runway in 2–3 years—grant dependent.
  - Changing runway and parking lot to LED; 25% local funds.
  - AIP in 5 years—LED. State funded.
- Funding
  - Applied for LED grant.
  - Most small airports are broke.
  - It would be extremely expensive to create a sustainability plan.
  - 16% budget reduction from state.
  - Grants have too many regulations.
  - Wants sustainability but has no money.
  - Wanted LED but too expensive.
  - In future with more funding would make sustainability plan.
- Priorities and support
  - Elected officials are only in office for 4 years and want to spend as little money as possible. Taxpayers don't want to see their money spent at airports.
  - Sustainability is not a priority.
  - Our state doesn't value airports.
  - Our state is pro-conservation.
  - Airport too small for environment to be priority.
  - If there was a demand for sustainability we would comply.
  - State handles sustainability.
  - Very interested in protecting environment.
  - Need to start running airports like a business and not a boys club.
  - We try to get the community involved and invite them to events at the airport, which is a way to make the community not have negative feelings toward airports.
  - We have to be responsible for humanity.
  - Wasn't aware FAA had approved LEDs.
  - City specifications are too high.
  - People are resentful toward funding airports. They think they are only useful for the rich.
  - Have state-mandated air quality and noise analysis.

These comments further validate survey responses, including findings that small airports are concerned with costs, have small staff, and generally have little aircraft activity. In addition, findings reveal that:

- Sustainability is more than environmental initiatives.
- There is a lack of awareness among staff of small airports about the types of sustainable initiatives that may be pursued to enhance the triple bottom line.
- Funding is available to support sustainable initiatives.
- More small airports are considering sustainable initiatives.

CHAPTER SIX

CONCLUSIONS AND FUTURE RESEARCH

CONCLUSIONS

Sustainability in all its forms, including economic viability, operational efficiency, natural resource conservation, and social responsibility (EONS), is being pursued by three of five small airports in the United States, according to the results of this Synthesis. Although most sustainable initiatives reported are in the category of natural resource conservation, airports are also reporting unexpected benefits in the areas of economic viability, operational efficiency, and social responsibility. Most small airports appear to be pursuing sustainability only in the "environmental" sense, possibly owing to a belief that sustainability exists only in the environmental sense. The staff at 45% of airports are not familiar with the concept of the triple bottom line (environmental stewardship, economic growth, social responsibility). However, as this Synthesis has shown, environmental or natural resource conservation is but one leg of the four-legged EONS approach to sustainability. There are numerous initiatives being pursued by small airports in these other areas as well.

The finding that three of five small airports are pursuing sustainable initiatives is encouraging, but surprising, considering other findings of the study. Although environmental initiatives often are equated with the concept of sustainability among small airports, staff at 96% of small airports believe their airport has little impact on the environment. Similarly, staff at 89% of small airports indicate that environmental sustainability is not a priority for them and their airport. Staff at 86% of small airports believe that environmental sustainability costs too much. Staff at 91% of small airports without sustainable initiatives report that sustainability has too long of a payback period.

Moving forward, targeted efforts can encourage staff of more small airports to think sustainably (adopting a sustainable mind-set) and pursue sustainable initiatives to improve airport economic viability, operational efficiency, natural resource conservation, and social responsibility. Suggestions for moving more small airports toward sustainability, based on the findings of this Synthesis, include:

- Adequate education about the airport's true environmental footprint.
- Adequate education about the varied funding opportunities available in support of sustainable initiatives.
- Adequate education about the EONS approach to sustainability.
- Adequate education about low-cost sustainability measures. Although introducing recycling containers, installing low-flow toilets, or simply installing motion sensor lighting may not cost much, the staff of many small airports appear to think in much more expensive terms when discussing sustainability. Initiatives such as solar panels or LED lighting may be common at larger airports, but the perceptions of these initiatives are that they have a long return on investment or high initial costs. Although this can be the case, it is not always true. If the staff of small airports are aware of only these types of initiatives and have this perception, it would make perfect sense that environmental sustainability costs too much. *ACRP Synthesis 35: Issues With Use of Airfield LED Light Fixtures* provides more information on this topic.
- Adequate education about payback periods and cost–benefit analyses of sustainability measures. Often rebates and tax credits can greatly enhance the payback analysis.

An important finding is that for many airports adopting sustainable initiatives, neighbor and community relations were improved, even though that was not an initial driver. This outcome actually supports the EONS concept of sustainability.

An additional finding is that it is more efficient to include sustainability as a goal in new construction. This is more effective than attempting to retrofit existing construction. Often, it will be more costly to retrofit than to build sustainably in the first place.

In general the driver that motivated the airport to pursue the sustainable initiative generated an identical outcome. This indicates that staff who made a decision to pursue an initiative had a good idea of the results that would be generated, and they selected a particular initiative based on the result they would like to generate. In other words, staff at these airports were well educated about the options, including projected outcomes. For example, pursuing an initiative in the category of energy conservation/renewable energy often was motivated by cost reduction, and these initiatives often produced significant cost savings in utility expenditures. The staff of small airports not yet having pursued a sustainability initiative can learn from their peer airports that have reported success at having a positive impact on the airport's triple bottom line, one sustainable initiative at a time.

Possibly the most important piece of information this report can offer the airport industry, especially the staff of small airports, is an inventory of less-costly sustainable initiatives that can generate positive returns on the triple bottom line. As discussed in Appendix C, the writings of McGormley et al. (2011) present numerous sustainable initiatives at an initial cost of less than $10,000 that staff of small airports may wish to consider. Their inventory is presented in *ACRP Report 43: Guidebook of Practices for Improving Environmental Performance at Small Airports.* The FAA also presents ideas for less-costly sustainable initiatives in the (2012) FAA *Report on the Sustainable Master Plan Pilot Program and Lessons Learned.* In addition to these two insightful resources, staff of small airports may wish to consider some additional low-hanging fruit; as discovered during this Synthesis study, some such projects are eligible for generous federal, state, and/or local rebates/credits. Such projects include:

- Attract honeybees.
- Minimize irrigated turf.
- Utilize reclaimed water for irrigation.
- Transition to native vegetation.
- Install motion sensors on office lights.
- Install low-flow toilets.
- Install efficient window blinds.
- Install a tankless water heater.
- Use recycled office paper.
- Install double-paned windows.
- Recycle waste.
- Replace incandescent lights with fluorescent lights.
- Consider in-kind contributions by skilled personnel.

In addition, airport staff are encouraged to use the Sustainable Aviation Guidance Alliance (SAGA) website to access a wealth of resources on the topic of airport sustainability. The SAGA website is available at http://www.airportsustainability.org/.

In conclusion, sustainability, although possibly not as common among small airports as large ones, is part of the mind-set of staff at many small airports across the country. Although only 14 case examples are showcased in this report, there are many more examples of successful sustainable initiatives at small airports nationwide. These airports have enjoyed great success with their sustainability initiatives. Although the airport industry will benefit with more funding opportunities and enhanced education about sustainability, the results presented in this Synthesis of current practice are encouraging.

FUTURE RESEARCH

Although this was an expansive survey of small airports nationwide on the topic of sustainability, it will be important to conduct a similar data-gathering effort in the near future to gauge the degree of impact this synthesis report had on the number of small airports pursuing sustainable initiatives and the diversity of such initiatives.

More research can be performed in the area of sustainable initiatives that airports could adopt, including information about estimated costs and funding sources, including rebates and credits available. Combining education with funding, as was recognized, will produce a powerful incentive for staff of small airports to pursue sustainable initiatives.

Because lack of funding was a significant barrier reported by airports participating in this Synthesis, it will be helpful to update sustainable funding sources by state, building upon *ACRP Synthesis 24*. Maintaining a current inventory of funding opportunities for sustainable initiatives will benefit airports and increase the number of airports pursuing such initiatives.

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APPENDIX A

Phone Survey Questionnaire Script

PHASE 1: TELEPHONE SURVEY

"Hello, my name is Dr. Daniel Prather and I am conducting research on behalf of the Airport Cooperative Research Program. ACRP is a program of the National Academy of Sciences funded by the FAA through aviation fuel taxes. We are looking to small airports that promote economic, social, or environmental sustainability toward business success at their airport in hopes of discovering most effective practices in sustainability. The results of this study will be available nationwide and widely distributed to small commercial service and GA airports."

1. "May I ask you a few questions about environmental sustainability at your airport?"
   a. No
      i. Is there someone else at your airport that you recommend I speak to (if not, thank them for their consideration and end call)?
   b. Yes (continue).
2. Has your airport adopted any sustainable or environmentally friendly initiatives, such as energy, waste and recycling, green building, or green transportation?
   a. Yes
      i. "Can you tell me about each of these projects?" Note to interviewer: Categorize under:
         1. Socioeconomic benefits (health/welfare of employees) and community outreach/involvement
         2. Economic vitality/operational efficiency
         3. Air quality enhancement/climate change
         4. Energy conservation/renewable energy
         5. Noise abatement
         6. Water quality protection and water conservation
         7. Land and natural resources management
         8. Land/property use
         9. Pavement management
         10. Materials use and solid waste reduction/recycling
         11. Hazardous materials and waste management/reduction
         12. Surface transportation management
         13. Buildings/facilities
      ii. "Which of the following *drivers* motivated your airport to pursue these projects (Please answer yes/no—per project if more than one)?"
         1. Compliance concerns
         2. Desire for improved sustainability performance
         3. Cost reductions
         4. Reduction in maintenance/man hours
         5. Neighbors and community
         6. Demonstrate leadership in industry
         7. Airport management interest
         8. Elected or appointed officials
         9. Risk reduction
         10. Sensitive environmental receptors
         11. Revenue increases
         12. Addressing global concerns
         13. Airport tenant or customer interest
         14. Desire for improved employee relationships
         15. Environmental organizational interest
         16. Other? _____
      iii. "Which of the following *outcomes* did your airport expect/realize (Please answer yes/no—per project if more than one and specify expected or realized)?"
         1. Improved compliance and regulator relationships
         2. Improved sustainability performance
         3. Cost reduction
         4. Reduction in maintenance/man hours
         5. Improved relationships with neighbors and community
         6. Recognition of leadership in industry
         7. Greater management confidence
         8. Greater confidence of elected and appointed officials
         9. Risk reduction

10. Protection of environmentally sensitive receptors
11. Revenue increases
12. Addressing global concerns
13. Improved tenant and customer relationships
14. Improved employee relationships
15. Improved relationships with environmental organizations
16. Other? _____

iv. "How did you measure these outcomes (metrics)?"
v. "How did you track the success of these projects? What metrics were used?"
vi. "Did these projects meet your expectations as far as actual benefits realized?"
1. Yes – "Did any project exceed your expectations?"
a. Yes- "In what way?"
b. No- skip to vii.
2. No – "If not, please explain."
vii. "What were the lessons learned?"
viii. "What was the source of funding for these projects?"
ix. "What is the projected payback period for these projects?"
x. "What are barriers to initiating sustainable projects?"
xi. "Why don't more small airports implement sustainable projects?"
xii. "How can small airports be encouraged to be more sustainably focused?"

b. No
i. "Does your airport have plans to implement any sustainable initiatives in the near future?"
1. Yes-
a. "What type of projects?"
b. "What is motivating your airport to pursue these projects?"
c. "What benefits does your airport expect to realize from these projects?"
2. No-
a. "Why has your airport not considered any sustainable initiatives?"
b. "What would convince you to begin a sustainable project at your airport?"
c. "What negative drivers do you associate with sustainability at airports of your size?"
d. "Please indicate 'agree' or 'disagree' with the following statements:"
i. I am familiar with the triple bottom line (environmental stewardship, economic growth, social responsibility).
ii. Our airport has little impact on the environment.
iii. Environmental sustainability is not a priority for us.
iv. Environmental sustainability costs too much.
v. Environmental sustainability has too long of a payback period.

3. "Does your airport have a formal sustainability plan/program in place?"
a. Yes—("Can you share?") "What benefits has it yielded?"
b. No—"Do you think having a sustainability plan would be advantageous?"
i. Yes—"Do you have plans to develop one? Why/Why not?"
ii. No—"Why not?"

APPENDIX B

Case Example Interview Script

PHASE 2: TELEPHONE INTERVIEW (Min 12 specifically selected airports)

"Hello, my name is Dr. Daniel Prather. Recently, you assisted us with a telephone interview on sustainable initiatives in place at your airport. We would like to highlight your airport and your _____ project as a case example in our ACRP Synthesis report. May I ask you a few more questions about _____ project?

1. What were the specific drivers that motivated the airport to pursue this project?
2. What were the outcomes of this project?
3. What were the barriers in implementing this project?
4. What were the lessons learned?
5. How was this project financed?
6. What is the payback period?
7. Do you have photos of this project you can provide?
8. Would you please e-mail me more details about this project (if necessary)?
9. What would you say to other airports of your size considering a project such as this?
10. Is there anything else we should share with readers about this project or your airport's approach to sustainability?"

APPENDIX C

Sustainable Guidelines and Resources

For airports with a desire to pursue sustainability initiatives, it can be confusing to determine which set of guidelines to adopt. Rather than "reinventing the wheel," airports should adapt existing guidelines to guide their sustainability efforts. Even if planning to utilize only airport-specific guidance, the airport staff will realize there are several significant sources of airport sustainability guidance available.

FAA *REPORT ON THE SUSTAINABLE MASTER PLAN PILOT PROGRAM AND LESSONS LEARNED*

The airport sustainability planning pilot program led the FAA to publish, in December 2012, a *Report on the Sustainable Master Plan Pilot Program and Lessons Learned.* This report presents lessons learned from airports participating in the pilot program. To encourage participation in sustainability planning efforts, airports should "(a) involve staff from all areas in brainstorming, (b) meet regularly to obtain feedback, (c) gain airport board approval of the sustainability mission statement, (d) describe rationale and benefits of sustainability early in the process, and (e) publish annual sustainability reports" (FAA 2012, p. 3).

Although the diversity of sustainable initiatives that may be pursued by airports may lead one to think there is little commonality in airport sustainability, the FAA has grouped the various initiatives into ten common sustainability categories. Additionally, the FAA has proposed sample sustainability initiatives based on actual experience among airports in the sustainable master plan pilot program:

- Energy Reduction
  - Install occupancy sensors to turn off lighting when rooms are unoccupied.
  - Future non-insulated airport buildings such as T-hangars will incorporate applicable energy efficient standards.
- Planned Development
- Construction Methods
- Waste Management and Recycling
- Water Quality and Conservation
- Air Quality
- Emissions Reduction
  - Encourage FBO to install vapor recovery technology to recover evaporative hydrocarbons to prevent them from escaping into the atmosphere.
  - Develop online rideshare board to facilitate ridesharing to airport, especially among college students.
- Airport Connectivity
- Land Use
- Natural Resources Management

Notable sustainability targets, goals, and initiatives, as spelled out in the FAA (2012, pp. 9–11) report, include:

- Make sustainability a significant part of future airport branding and marketing.
- Develop online rideshare board to facilitate ridesharing to airport, especially among college students.
- Effectively communicate all airport sustainability initiatives to airport employees, tenants, users and the community.
- Maximize water use efficiency within buildings and reduce potable water consumption sitewide.
- All new airport construction projects will exceed the guidelines outlined in the local Best Management Practices (BMP) Manual for construction and postconstruction.
- When selecting trees for new plantings, no species shall exceed 10% of the total tree population.
- Implement targeted strategies intended to significantly reduce water use without negatively affecting existing day-to-day airport operations.
- Maintain existing tree canopy cover (32%) in terminal entry road and parking areas.
- Provide a system of sidewalks, pedestrian paths and trails to connect uses throughout the airport. Identify opportunities to connect to the City/County trail system.
- No net loss of wetlands.
- Provide incentives to airport staff, tenants, users and the public to encourage the usage of alternative fuel vehicles.
- Continue to track noise complaints and formalize record keeping.

- Proactively work with the City and County to promote compatible land uses for properties adjacent the airport. Provide incentives to attract “green” businesses and industries.
- Communicate and actively engage with local and regional transit authorities to advance multiple transit connection opportunities.
- Future non-insulated airport buildings such as T-hangars will incorporate applicable energy efficient standards.
- Prioritize projects/opportunities that improve airport connectivity, including a multi-modal airport station, commercial barge, and non-aeronautical development on airport property.
- Install occupancy sensors to turn off lighting when rooms are unoccupied.
- Consider designing storm water storage and conveyance systems to withstand heavier rainfall and more frequent flooding.
- Incorporate skylighting to increase natural daylight and reduce heating costs during the winter. For hangars, skylighting design will need to account for liability issues associated with severe weather including hail storms that may damage planes and associated equipment.
- Develop a wetland mitigation bank to ensure no net loss of wetlands as a result of future airport development.
- Reduce energy consumption through use of alternative fuel options for vehicles and aircraft.
- An Air Quality Management Plan could be developed as part of an Airport Master Plan update or Airport Improvement Program. Following LEED indoor air quality principles, an indoor air quality management plan would specify practices for HVAC operation, housekeeping, maintenance, as well as minimizing pollutants associated with renovations, painting, and pest control.
- When deemed cost-effective, consider conversion of airport fleet vehicles to alternative fuels.
- Encourage FBOs to install vapor recovery technology to recover evaporative hydrocarbons to prevent them from escaping into the atmosphere.
- Provide easily accessible recycling receptacles throughout the airport. Provide signs within these areas that clearly identify what can and cannot be recycled.
- Follow LEED indoor air quality principles by installing ductwork products that can be easily cleaned or those that protect against mold/fiber shredding.
- Avoid using fertilizers and chemicals for landscape maintenance.
- Reduce APU usage by providing 400 Hz electricity and preconditioned air at gates during passenger boarding and deplanement. This feature could be incorporated into future passenger terminal designs (to serve airline aircraft).
- Partner with local schools, colleges and other educational groups to help promote and advance the airport’s sustainability initiatives.
- Develop preferred car rental parking and/or lot locations for car rental fleets that offer low-emissions vehicles.
- Create Design and Construction Standards consistent with achieving LEED Silver or higher for all new construction and major renovations by January 1, 2012.
- Encourage aircraft to use single-engine taxi procedures to reduce aircraft engine usage, save fuel, and reduce aircraft taxi emissions. This practice has a secondary benefit of reducing noise.
- Specify green construction equipment and methods by 2015.
- As electric cars become more prevalent in the future, charging stations could be provided in airport parking areas. The charging stations could be solar-powered to reduce operational costs to the airport.
- Reduce greenhouse gas emissions by 2% of the 2008 level for each of the next 40 years, achieving an 80% reduction in greenhouse gas emissions by 2050.
- Issue a Request for Proposal for a Power Purchase Agreement (PPA) for a solar energy system.
- Divert 75% of the waste stream generated from offices and terminal by 2015; establish intermediate goals to facilitate reaching this goal.
- Use natural gas instead of oil.
- Reduce dependence on fossil fuels to the maximum extent practicable and use clean and renewable energy sources.
- When designing new buildings, the airport should consider incorporation of green roofs.
- Minimize and reuse construction waste wherever possible.
- Purchase renewable/alternative energy generated off-site.
- Dispose 100% of used de-icing fluid within a 25-mi radius of the airport by 2015.
- Shut down airfield lighting during nighttime, off-peak hours.
- Use only environmentally friendly or green products at airport facilities.
- Install solar-powered signage for the airfield and airport buildings and/or security lights.
- Provide efficient and consolidated public parking facilities at the airport. Consider additional long-term parking options to reduce trips generated by drop-off and pick-up of passengers.
- Require regular sustainability progress reports during construction projects (either quarterly or at certain construction progress milestones). Data should be collected based on pre-established sustainability performance metrics.
- Reduce percentage of drop-off/pick-up activity by 15% so that it is not the primary means of transportation to the airport by passengers.
- Establish an aggressive land acquisition program that seeks to prevent residential encroachment, preserve wetlands and green spaces, and allow for future airport development (FAA 2012).

ACRP REPORT 119: PROTOTYPE AIRPORT SUSTAINABILITY RATING SYSTEM—CHARACTERISTICS, VIABILITY, AND IMPLEMENTATION OPTIONS

In *ACRP Report 119*, Lurie et al. (2014) present a prototype airport sustainability rating system. Designed to gauge airport sustainability performance via a Decision Tool, this rating system is intended to assist airports in "evaluating and selecting best practices for airport sustainability" (p. 1). The report proposes eight categories of sustainability initiatives, further divided into 50 sustainability activities:

1. Energy and Climate
   - Terminal Building
   - Overall Airport Energy Use
   - Renewable Energy Use
   - Terminal Building Emission Reductions
   - Overall Airport Emission Reductions
   - Other Indirect Emissions Reductions
   - Climate Change Adaptation
2. Transportation
   - Fleet Vehicle Fuel Economy
   - Airside Equipment Fuel Use
   - Alternative Fuel Vehicles
   - Alternative Passenger Transportation
   - Alternative Employee Commute
3. Economic Performance
   - Socially Responsible Financial Investments
   - Airport Financial Viability
   - Risk Management
   - Regional Economic Contributions
4. Design and Materials
   - Sustainable Design and Operations
   - Material Selection
   - Construction Waste Diversion
   - Construction Impacts Mitigation
   - Sustainable Site Selection
   - Local Sourcing
   - Recycled and Bio-based Content
   - Low-Toxicity Materials
   - Environmentally Preferable Purchasing
5. Engagement and Leadership
   - Airport-Wide Stakeholder Engagement
   - Public Outreach
   - Community Stewardship
   - Integrated Sustainability Management
   - Airport User Engagement and Outreach
   - Tenant and Vendor Sustainability
6. Water and Waste
   - Potable Water Conservation
   - Waste Reduction
   - Waste Diversion
7. Natural Resources
   - Landscape and Grounds
   - Wildlife and Habitat Protection
   - Pervious Surface
   - Airside Storm Water Quality
   - Wildlife Hazard Management
   - Heat Island Reduction
8. Human Well-Being
   - Airport Noise Compatibility
   - Workplace Air Quality
   - Light Pollution
   - Chemicals and Hazardous Materials
   - Passenger Experience
   - Employee Development
   - Labor Relations
   - Diversity and Equal Opportunity
   - Occupational Health and Safety
   - Universal Design (p. 3).

ACRP REPORT 43: GUIDEBOOK OF PRACTICES FOR IMPROVING ENVIRONMENTAL PERFORMANCE AT SMALL AIRPORTS

Published in 2011, *ACRP Report 43*, although not the most current of available guidance, is especially useful for its focus on environmental initiatives at small airports. Although environmental performance is one aspect of sustainability, the report categorizes environmental initiatives into the following areas:

- Air Quality
- Emergency Planning and Response, to include spill prevention, pesticides, underground storage tanks, and hazardous materials transport
- Noise
- Planning and Development, to include fish, wildlife, and plants
- Waste Management
- Water Resources
- Energy Efficiency and Renewable Energy.

The lengthy report does present a comprehensive inventory of sustainable practices that small airports may pursue, which provides staff of small airports great ideas of feasible sustainable initiatives. For those seeking ideas as to the various types of sustainable initiative, this report is an extremely useful resource. Sustainable initiatives identified in the report that are either no cost or low cost (less than $10,000) are presented here. Readers are encouraged to consult *ACRP Report 43* for more detailed guidance on these and other initiatives.

- Air quality
  - Schedule deliveries efficiently
  - Provide commercial vehicle holding area
  - Encourage rental car facility use of “ready and return” systems
  - Use a single engine during aircraft taxi
  - Conduct routine maintenance of equipment and facilities
  - Encourage airlines and pilots to de-rate aircraft takeoffs, rather than using maximum thrust during the entire takeoff and departure phase
  - Limit power-back and/or reverse thrust during flight procedures
  - Institute trip reduction measures
  - Optimize roadway network, to minimize stop-and-go traffic
  - Direct aircraft exhaust away from surrounding sensitive areas
  - Prohibit burning of landscape waste
  - Install vapor recovery technology for fuel storage and transfer facilities
  - Implement low-smoke fire training, using propane, for example
  - Encourage most effective practices for solvent use
  - Provide alternative transportation during construction
  - Use low-emitting construction materials and equipment
  - Alter project construction schedule to accommodate adverse meteorological conditions
  - Minimize fugitive dust emissions during construction
  - Prepare an airport-wide greenhouse gas emissions inventory
  - Establish emissions limits or ceilings
  - Coordinate with air agencies on plans and timelines affecting the airport
  - Prevent mold and asbestos
  - Evaluate the effectiveness of building ventilation systems
  - Review maintenance and janitorial programs to eliminate toxic agents in favor of environmentally friendly choices
  - Implement strategies to limit tobacco smoke exposure indoors and adjacent to entryways
  - Develop an indoor air quality management plan
- Emergency planning and response
  - Develop a database of bulk storage containers
  - Develop and implement a storage tank management plan
  - Develop an airport spill prevention, control, and countermeasure policy
  - Establish a spill reduction training program
  - Establish airport-wide procedures
  - Implement a leak detection inspection program for bulk storage containers
  - Isolate oil storage areas
  - Maintain spill control kits
  - Develop a chemical storage policy
  - Maintain a chemicals database
  - Isolate chemical/hazardous material storage
  - Reduce herbicide/pesticide use
  - Utilize low-toxicity pesticides/herbicides
  - Develop and implement a hazardous material storage tank management plan

- Noise
  - Establish a noise complaint system
  - Produce a “Fly Quiet” report
  - Establish a community noise roundtable
  - Track noise complaints through a geographic information system (GIS)
  - Implement a preferential runway use system
  - Identify aircraft engine run-up areas
  - Implement a voluntary curfew or voluntary restraint from flying
  - Discourage use of reverse thrust
  - Establish real estate disclosures
- Planning and development
  - Implement green buildings construction and design/Leadership in Energy and Environmental Design Standards (LEED)
  - Redevelop previously developed sites
  - Proactively evaluate environmental resource conditions
  - Partner with municipalities to develop compatible land uses
  - Local/Regional transit coordination/cooperation
  - Develop a noise and land use compatibility policy
  - Develop on-site cultural resources management plan
  - Develop an on-site unanticipated discovery plan
  - Develop a public involvement program for master planning
  - Develop a scoping plan
  - Develop a plan for conducting public hearings, workshops, and meetings
  - Adopt a sustainability communication plan
  - Establish a recycling education program
  - Showcase airport initiatives
  - Report annual energy consumption
  - Construct an observation area
  - Develop an on-site conservation area for species of concern
  - Choose non-wildlife attractant plants
  - Conduct long-term vegetation management
  - Avoid the creation of natural open water features on or near airfield sites that attract wildlife
  - Manage vegetation to maintain rare and non-hazardous wildlife habitat
  - Plant nitrogen-fixing vegetation
  - Join in partnerships with environmental nonprofit organizations
  - Review environmental documents prepared by property owner
  - Perform environmental property assessments
  - Perform detailed review of property transfer deed as it pertains to remediation for environmental contamination
  - Perform evaluation of environmental remediation closure level and future use of land
  - Implement procedures and practices to prevent environmental contamination, prevent contamination from spreading, or remediate site
- Waste management
  - Encourage onboard recycling programs for airlines
  - Coordinate recycling collection infrastructure with hauler capabilities
  - Establish a food donation program
  - Establish a food waste composting program
  - Require the use of compostable or reusable tableware
  - Implement incentives to minimize plastics
  - Develop recycling and waste reduction competitions between different airport departments
  - Minimize removal of trees or vegetation and reuse
  - Recycle hot-drained or crushed non–terne-plated used oil filters
  - Product substitution for materials that result in a hazardous waste when disposed
  - Utilize vendors that reclaim products
  - Conduct a Polychlorinated Biphenyls Audit
  - Institute a universal waste handling and disposal policy
  - Recycle used oil
  - Utilize used oil for heating purposes
- Water resources
  - Encourage tenant proactive anti-icing to reduce aircraft deicing fluid usage after winter weather events
  - Monitor tenant aircraft deicer usage
  - Utilize low toxicity/low biochemical oxygen demand deicing materials
  - Reduce potable water used in irrigation systems by limiting irrigation frequency and duration
  - Use high-pressure nozzles in car washes and for aircraft washing
  - Protect drinking water supply
  - Strategically locate construction traffic areas, construction lay-down areas, and stockpiles
  - Develop and maintain a soil erosion and sediment control plan

  - Conduct independent inspections of construction-related storm water best management practices
  - Provide general aviation (GA) tenants with sump fuel disposal containers
  - Store materials and waste in areas sheltered from rain and runoff
  - Perform outdoor maintenance and store equipment in a designated paved area
  - Develop a storm water management master plan
  - Provide training and access to storm water pollution prevention plan
  - Use other properties for regional storm water infiltration
  - Reduce the amount of impervious surface
  - Reuse cut grass instead of applying fertilizer
  - Protect topsoil
  - Reduce flow velocities in storm water conveyance systems
  - Install energy-efficient water aerators to maintain water quality
- Energy efficiency and renewable energy
  - Implement transit-first policy for employees, passengers, and other airport users
  - Provide transit use incentives to employees
  - Utilize energy-efficient lighting
  - Work with airlines to group flights into a given part of the concourse during nonpeak hours
  - Utilize prefabricated equipment
  - Track energy use
  - Track sustainability elements in construction projects
  - Utilize contractors with sustainability experience
  - Include environmental clauses in lease agreements
  - Establish an environmentally preferable purchasing program
  - Encourage use of local vendors/suppliers
  - Specify environmentally preferable materials
  - Purchase environmentally preferable supplies for administration activities
  - Encourage vendors to purchase environmentally preferable products
  - Purchase and install recycled furniture
  - Purchase and install furniture systems that are Greenguard certified
  - Reuse materials or use materials with recycled content, sourced locally/regionally, and/or made of rapidly renewable resources, certified wood, or salvaged materials
  - Create and follow a sustainable vision/mission statement
  - Develop or adopt sustainable design guidelines
  - Establish a sustainability team/committee
  - Integrate all airport departments in sustainability planning
  - Establish a "sustainable meetings" policy
  - Encourage staff to pursue Leadership in Energy and Environmental Design (LEED) Accreditation
  - Establish annual objectives and targets that include quantification on nonmonetary benefits (McGormley et al. 2011).

Also helpful is the chapter two content on establishing an effective environmental program. As McGormley et al. (2011) explain:

> Establishing an effective environmental program can be accomplished within the typical capabilities, financial resources, and environmental expertise of most small airports. With a clear vision, proper organization, and persistence, small airports can implement effective environmental programs as diverse as those at much larger facilities. However, taking on too much and expecting perfection at the onset will almost certainly result in frustration and disappointment (p. 7).

Although the comment by McGormley et al. (2011) specifically references environmental programs, these words of wisdom are appropriate to small airports pursuing sustainability planning in general. Indeed, "a clear vision, proper organization, and persistence" are beneficial for any sustainability initiative.

McGormley et al. (2011) recommend the "Plan-Do-Check-Act (PDCA)" cycle as a proper way to establish an effective environmental program (Figure C1).

Associated with ISO 14001, the PDCA cycle is rather simplistic at its heart. First, the "Plan" phase requires the airport to define the overall environmental program. This phase requires the airport to (a) prepare a clear environmental policy, (b) identify applicable environmental laws and regulations, (c) establish environmental objectives, and (d) assign and communicate program roles and responsibilities (McGormley et al. 2011, pp. 7–8). Specifically regarding environmental objectives, McGormley et al. (2011) state that implementation strategies and performance measures must also be developed for each environmental objective. One example they provide is:

Objective: Minimize landfilled waste.

Implementation Strategy: Institute a recycling program targeting readily separable and recyclable waste streams.

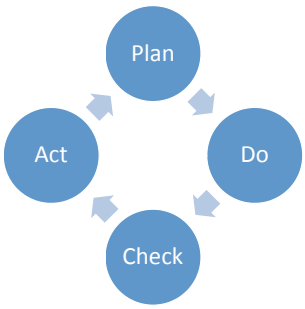

FIGURE C1 Plan-Do-Check-Act cycle (*Source*: D. Prather 2016).

Performance Measure: Capture and recycle 80% of cardboard and 90% of office paper within two years of program implementation (McGormley et al. 2011, p. 9).

Second, the "Do" phase "represents the culmination of environmental program planning efforts" (McGormley et al. 2011, p. 10). Clearly, without this phase, sustainability is nothing more than a discussion. However, by fully implementing the "Do" phase, airports will begin to realize benefits from their sustainability efforts. This phase also includes regulatory compliance and training of personnel.

Third, the "Check" phase "provides airports the opportunity to monitor environmental program performance and assess if observed results align with the environmental policy, achieve program objectives, and meet internal and external airport stakeholder expectations" (McGormley et al. 2011, p. 11). An effective "Check" phase requires (a) monitoring environmental program performance, and (b) tracking a changing regulatory landscape (McGormley et al. 2011, pp. 11–12).

Finally, the "Act" phase "provides airports the opportunity to assess elements within their environmental programs that may require improvement (e.g., identified as gaps during the "Check" phase)" (McGormley et al. 2011, pp. 11–12). By assessing where problems originate and being dedicated to "improve the deficient environmental program components," the airport can ensure an effective "Act" phase of the PDCA cycle (McGormley et al. 2011, p. 12).

GRI *SUSTAINABILITY REPORTING GUIDELINES & AIRPORT OPERATORS SECTOR SUPPLEMENT*

The Global Reporting Initiative (GRI) is an organization that "promotes the use of sustainability reporting as a way for organizations to become more sustainable and contribute to sustainable development" (GRI n.d., para. 1). GRI attempts to provide a "trusted and credible framework for sustainability reporting that can be used by organizations of any size, sector, or location" (GRI 2011, p. 6). In 2011, GRI published the *Sustainability Reporting Guidelines & Airport Operators Sector Supplement* to provide airport-specific guidance on sustainability. This resource is designed to aid airport operators in producing sustainability reports. Although not small airport focused, this resource is beneficial for staff of small airports in developing a sustainability report.

As explained by GRI (n.d., p. 9), "Sustainability reporting is the practice of measuring, disclosing, and being accountable to internal and external stakeholders for organizational performance towards the goal of sustainable development." Clearly, the EONS approach of Economic viability, Operational efficiency, Natural Resource Conservation and Social responsibility (EONS) compels the airport operator to disclose to stakeholders their degree of "organizational performance towards the goal of sustainable development" (GRI n.d., p. 9).

ADVISORY CIRCULAR 150/5050-8, ENVIRONMENTAL MANAGEMENT SYSTEMS FOR AIRPORT SPONSORS

Issued in 2007, AC 150/5050-8 promotes the concept and provides guidance for the development of Environmental Management Systems (EMS). Although specifically intended for public-use large and medium hub airports, this AC provides guidance of benefit to all airports. This AC provides guidance to airport sponsors in developing an EMS. According to the AC, "an EMS must satisfy one of the recognized standards if an airport sponsor is seeking" (FAA 2007, p. 1).

An EMS is a strategic management framework that is based on the Plan-Do-Check-Act model and allows airports to address environmental issues. By assisting airports in "balancing environmental performance with business objectives through a process of continual improvement, [i]t has resulted in significant savings and cost avoidance for many organizations, including airport sponsor" (FAA 2007, p. 1). Benefits for an airport adopting an EMS include (a) improved regulatory compliance, (b) improved environmental performance, (c) increased efficiency and accountability, (d) reduced costs and liability, (e) increased employee awareness of environmental responsibilities, and (f) improved community relations (FAA 2007, p. 3).

According to the FAA (2007), the five components of an EMS are:

1. Senior management commitment to an environmental policy.
2. Identification of significant environmental aspects of the organization.
3. Establishment of implementation plans.
4. Verification of the status of environmental management programs and compliance with applicable regulations.
5. Review of audit results and EMS performance with senior management (pp. 2–3).

The FAA (2007) advises airports to take the following steps in developing an EMS:

- Identify aspects and impacts from airport activities, products, and services.
- Identify the airport's significant environmental aspects.
- Conduct a review of legal requirements.
- Develop objectives and targets.
- Set up a formal program (p. 4).

Finally, implementation requires careful consideration. As with all plans, if not implemented properly, success cannot be ensured. The FAA suggests considering (a) roles, responsibilities, and competency; (b) training and awareness; (c) internal and external communications; (d) document control; (e) operational controls.

ISO 14000

The International Organization for Standardization (ISO), headquartered in Geneva, Switzerland, is composed of 160 national standards institutes whose role is to provide standards for "all three dimensions of sustainable development: economic, environmental, and societal" (International Standard for Standardization 2009, p. 1). As ISO (2007) explains:

> ISO standards for business, government and society as a whole make a positive contribution to the world we live in. They ensure vital features such as quality, ecology, safety, economy, reliability, compatibility, interoperability, conformity, efficiency and effectiveness. They facilitate trade, spread knowledge, and share technological advances and good management practice.

Specifically as these standards apply to airports, ISO 14001 has been developed. As shared by ISO (2007), ISO 14001 is "the world's most recognized framework for environmental management systems (EMS)—implemented from Argentina to Zimbabwe—that helps organizations both to manage better the impact of their activities on the environment and to demonstrate sound environmental management" (p. 6). ISO 14001 contains a step-by-step checklist for organizations to use in assessing their environmental performance. This checklist can serve as a useful roadmap for an airport in developing an EMS.

Although the EPA points out that "ISO 14001 is not a technical standard and as such does not in any way replace technical requirements embodied in statutes or regulations," the agency does promote ISO 14001, stating "if implemented properly, [ISO 14001] could serve as a valuable tool to help organizations improve their environmental performance, increase the use of pollution prevention, and improve compliance" (EPA n.d., para. 3).

ISO 14001 has the following requirements:

- A policy statement which includes commitments to prevention of pollution, continual improvement of the EMS leading to improvements in overall environmental performance, and compliance with all applicable statutory and regulatory requirements.
- Identification of all aspects of the community organization's activities, products, and services that could have a significant impact on the environment, including those that are not regulated.
- Setting performance objectives and targets for the management system which link back to the three commitments established in the community or organization's policy (i.e., prevention of pollution, continual improvement, and compliance).

- Implementing the EMS to meet these objectives. This includes activities such as training of employees, establishing work instructions and practices, and establishing the actual metrics by which the objectives and targets will be measured.
- Establishing a program to periodically audit the operation of the EMS.
- Checking and taking corrective and preventive actions when deviations from the EMS occur, including periodically evaluating the organization's compliance with applicable regulatory requirements.
- Undertaking periodic reviews of the EMS by top management to ensure its continuing performance and making adjustments to it, as necessary (EPA n.d.b, para. 4).

SUSTAINABLE AVIATION RESOURCE GUIDE

Produced by the SAGA, the *Sustainable Aviation Resource Guide* has been developed to provide guidance to airports in the development of a sustainability program. According to SAGA (n.d.), the guide is intended to serve as a "comprehensive resource of options for airport operators to use in evaluating and selecting the sustainable practices that may be applicable within the unique circumstances of each airport" (p. 4). SAGA (n.d.) is quick to point out, however, that "every sustainability program will be unique and that an airport operator should modify and scale this approach based on its specific operating environment and resources" (p. 13).

The approach proposed by SAGA includes the following steps:

- Adopt a consensus-based definition to sustainability, to include building a diverse sustainability team of engaged stakeholders at all levels within the organization, as well as external to the organization.

  A diverse group that represents all levels and departments within an airport combined with outside stakeholders such as tenants, community groups, sustainability experts, and members of the national and global aviation industry will bring varied perspectives, authority for action, opportunities for collaboration, and momentum to a sustainability program (SAGA n.d., p. 15). See Figure C2 (SAGA n.d., p. 16).
- Consider other sustainability initiatives at the local, regional, and worldwide level and the manner by which the airport's sustainability initiatives interconnect with these. According to SAGA (n.d.), "An airport operator may consider collaborating with these groups to broaden the overall perspective of their program, pool resources and expertise, receive guidance, and capture and share information that may assist in decision-making regarding the selection of sustainability activities" (p. 24).
- Consider developing a management system to plan, implement, improve, and maintain a sustainability program. According to SAGA (n.d.), "A management system outlines specific steps, provides a decision making structure and can be used to develop processes and tools that are coordinated with existing business and environmental practices" (p. 18). Whether a sustainability management system is unique to the airport's sustainability efforts (i.e., stand-alone) or integrated within an existing management system (i.e., environmental management system), such a system provides structure and efficiency to the process.
- Establish vision and guiding principles. It is important to develop a "sustainability vision and set of guiding principles for the airport that will serve as the foundation for future sustainability initiatives" (SAGA n.d., p. 21).
- Determine focus areas and strategic goals. Focus areas "will reflect the issues that are most important for the specific airport" (SAGA n.d., p. 21).

FIGURE C2 Various roles from strategy to action (*Source*: SAGA n.d.).

- Conduct initial assessment. "An evaluation of current conditions, programs, important contextual factors establishes a baseline upon which further actions can be selected" (SAGA n.d., pp. 21–22).
- Identify and rank opportunities. Opportunities that advance the airport's sustainability program can be identified through discussions with stakeholders and review of other resources, such as this ACRP Synthesis report.
- Refine goals. Based on findings up to this point, it is helpful to revise strategic goals and focus areas to account for any gaps.
- Select actions and set targets. During this step, opportunities for action are selected for implementation. Measurement metrics and targets are also established.
- Develop action and monitoring plans. This step requires the development of action plans as well as monitoring plans in an effort to "streamline resources, determine roles and responsibilities, and establish accountability for achieving progress" (SAGA n.d., p. 23).
- Implement initiatives. As SAGA (n.d.) explains:

> Implementation may include the development or revision of guidance documents, procedures, standards, specifications, or best management practices. Actions may be initiated during the RFP/RFQ stage, pre-bid or pre-design stage, construction activities, operation and maintenance, or procurement. Implementation may also include the achievement of LEED® certification (p. 23).

- Monitor performance. Previously identified metrics can be used to measure performance toward achieving established goals.
- Evaluate program. As SAGA (n.d.) explains:

> The progress reports can be analyzed to determine gaps in the sustainability initiatives and the impact of the sustainability program, including cost savings. These feedback loops can be combined with the financial plan and budget and growth strategy to appropriately plan for future sustainability activities and business performance (p. 23).

- Communicate progress. It is important to share achievements with stakeholders, including the non-aviation community (SAGA n.d., pp. 21–24). See Figure C3 for a graphic of the entire process.

ACRP SYNTHESIS 21: AIRPORT ENERGY EFFICIENCY AND COST REDUCTION

ACRP Synthesis 21 provides guidelines on planning specifically for energy efficiency. This planning is necessary "to determine the scope of the project, the cost of the project, funding sources, and potential payback or rebates" (Lau et al. 2010, p. 5). Areas of consideration include:

- Ways to identify energy efficiency projects
  - Collect and analyze data with audits and meters
  - Perform an operations assessment
  - Review energy bills
  - Start early
  - Reach for "low hanging fruit"
  - Leverage commissioning efforts
  - Use existing standards to guide energy efficient design
- Strategies to plan energy efficiency projects
  - Ensure success—Incorporate improvements into projects and plans
  - Energy management plan
  - Test-drive strategies with demonstration projects
  - Look to other terminals in your region for practices
  - Designate an energy advocate(s) on project teams
  - Pass it on—Generate tenant improvement planning standards
  - Future proofing
  - Seek out existing documents and programs
- Funding sources for planning
  - Dedicated sustainability budget
  - Planning as part of consultant services
  - Utility programs, rebates, and incentives (Lau et al. 2010).

Tracking Sustainability Objectives

According to SAGA (n.d.), "As sustainability becomes a larger part of our global business landscape, one emerging trend is that many organizations are setting sustainability goals and targets without a coordinated approach or a system to measure and report on their successes" (p. 13). Indeed, it is important for an airport to track the success of a sustainable initiative. This requires the development of metrics. Whether in the form of decision trees, reports, checklists, or report cards, the method used to track achievement of

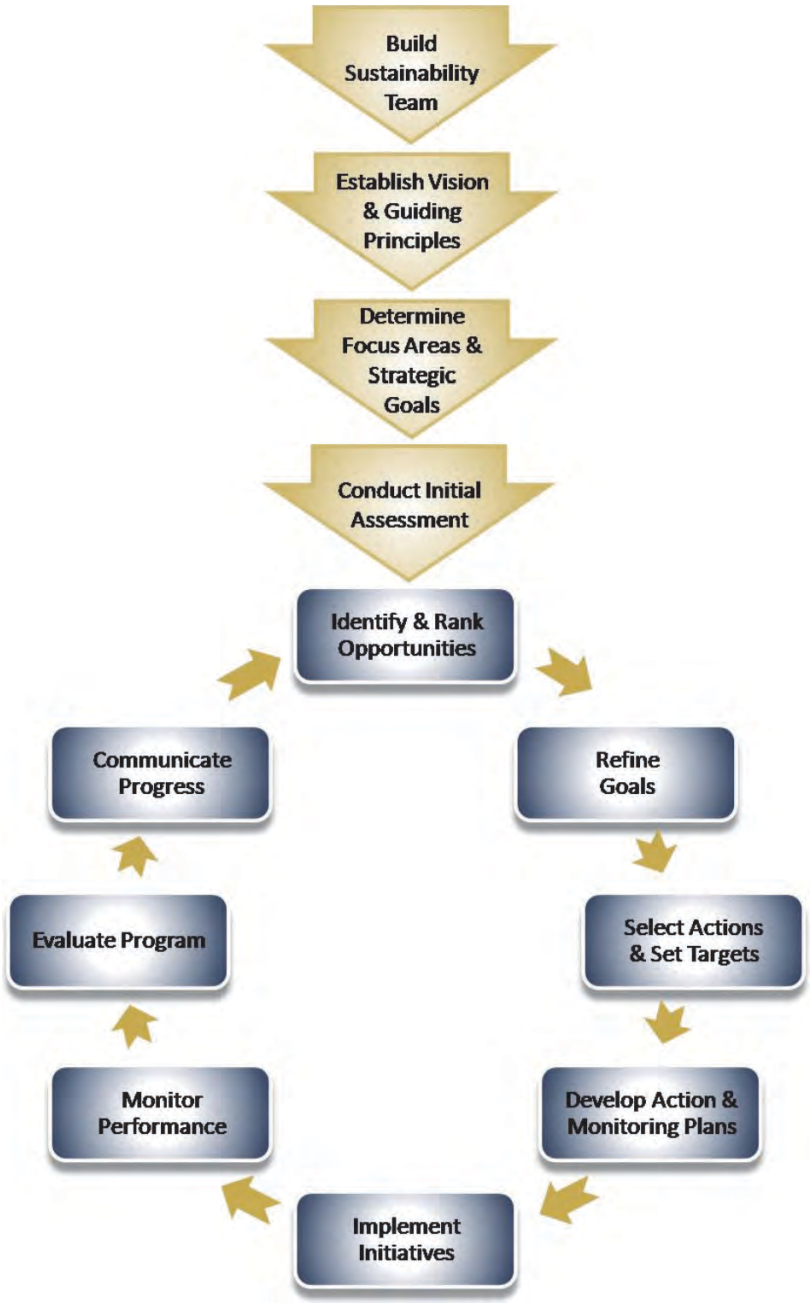

FIGURE C3 SAGA approach (*Source*: SAGA n.d.).

sustainable objectives is not as important as performing the actual tracking of objectives. This concept, although new to some, is no different than an airport tracking the success of an airport marketing plan, for example. Without tracking the success of the various components of the advertising mix, for example, the airport will have difficulty gauging the benefits of each advertising dollar. It would be important to know, for instance, whether a billboard or television ad was more effective in meeting the advertising objectives. The same is true for sustainability initiatives.

According to SAGA (n.d.), "metrics are useful for establishing baselines, identifying trends, predicting problems, assessing options, setting performance goals or targets, and evaluating a particular project or airport organization/enterprise" (p. 11). The FAA (2012) explains that, "Any tracking method should identify the metrics that will be used to analyze future performance" (p. 7). Common metrics should be adopted so that progress may be measured. Careful consideration should be given to the selection of metrics. The initial drivers for the sustainability initiative should be considered, as should the projected outcomes. Sample drivers may include price per square foot, monthly electricity costs, cost per enplaned passenger, etc.

According to the Sustainable Aviation Guidance Alliance (SAGA) website:

> The use of airport-specific sustainability guidelines and metrics will assist an airport operator in tracking, measuring, and reducing water and energy use, waste, reliance on non-renewable materials, and air and greenhouse gases (GHG) emissions related to airport administration, planning, design, construction, operations and maintenance. An airport operator may develop and mandate the use of sustainability guidelines that include performance standards that consistently encourage or require more techniques that reduce GHG emissions, water and energy use, waste, etc. for various types of projects (e.g., capital, tenant, horizontal, vertical, etc.) (n.d., para. 1).

Although there are multiple types of metrics that may be adopted by an airport, Lurie et al. (2014) believe that the GRI's *Airport Operators Sector Supplement* (*AOSS*) and *ACRP Report 19A*: *Resource Guide to Airport Performance Indicators* resources are most appropriate for airports. Although there are many different metrics an airport may adopt, depending on the project, the most common set of metrics include the rating system developed by U.S. Green Building Council (USGBC) and the set of sustainability metrics by the GRI. The LEED program developed by the USGBC refers to Leadership in Energy and Environmental Design. This program is a sustainable building certification program that recognizes environmentally friendly construction and buildings that have met certain standards. LEED certification can be earned at four levels (Certified, Silver, Gold, and Platinum), with points earned based on meeting certain prerequisites (USGBC n.d.).

It is important to note, however, that "in the airport context, LEED is not all inclusive, in that it may not cover the many different types of capital projects at an airport or maintenance activities, nor does it effectively measure sustainable airports operations or administration" (SAGA n.d., p. 11). In the end, each airport must develop metrics for specific sustainable initiatives implemented. Whether following industry guidance or developing a unique metric, it must make sense to airport staff and effectively measure the outcomes of the sustainability initiative.

Sustainability Reporting

According to GRI (2011), "Sustainability reporting is the practice of measuring, disclosing, and being accountable to internal and external stakeholders for organizational performance towards the goal of sustainable development" (p. 9). It is important for stakeholders to understand not only the sustainability initiatives undertaken but also the airport's progress toward meeting sustainability goals. As GRI (2011) explains, "Sustainability reporting is a living process and tool, and does not begin or end with a printed or online publication. Reporting should fit into a broader process for setting organizational strategy, implementing action plans, and assessing outcomes" (p. 12).

"A sustainability report should provide a balanced and reasonable representation of the sustainability performance of a reporting organization—including both positive and negative contributions" (GRI 2011, p. 9). Such reports are useful for (a) benchmarking, to assess performance with respect to standards; (b) demonstrating how the airport is actively pursuing sustainable initiatives that benefit airport economic viability, airport operational efficiency, natural resources, and society (EONS); and (c) comparing performance internally and to peer airports (GRI 2011). "A sustainability report refers to a single, consolidated disclosure that provides a reasonable and balanced presentation of performance over a fixed time period" (GRI 2011, p. 51).

The reporting framework developed by GRI "is designed for use by organizations of any size, sector, or location" (GRI 2011, p. 9). "Organizations should define a consistent and periodic cycle for issuing a report" (GRI 2011, p. 51). This may be annually, biannually, or some other cycle the airport decides upon.

Sample Sustainability Drivers

Drivers for pursuing sustainable initiatives, according to SAGA (n.d.), include:

- Worldwide awareness and a global economy
- Airline industry financial pressures
- Rising energy costs
- Green and environmental mandates
- Resource conservation
- Aging infrastructure
- Facility life-cycle costs
- Enabling technologies.

Drivers, however, are often as varied as the sustainable initiatives themselves.

APPENDIX D

Region-Specific Survey Findings

ALASKAN REGION

Airports with Sustainable Initiatives

Sustainable Projects

Of the 71 participating airports in the Alaskan region, only five (7%) have adopted sustainable initiatives. The majority (66, representing 93%) have not adopted sustainable initiatives.

The most common sustainable initiative adopted by participating airports in the Alaskan region (four, representing 80%) can be categorized as energy conservation/renewable energy (Figure D1). Other initiatives pursued by one participating airport each include air quality enhancement/climate change and materials use and solid waste reduction/recycling.

Drivers and Outcomes

Materials Use and Solid Waste Reduction/Recycling The one participating Alaskan airport with an initiative in materials use and solid waste reduction/recycling shared only one driver motivating this initiative: addressing global concerns. The outcome for this initiative was identical: addressing global concerns (Figure D2).

Air Quality Enhancement/Climate Change The one participating Alaskan airport with an initiative in air quality enhancement/climate change shared only one driver: cost reductions. Likewise, this airport reported an identical outcome: cost reductions (Figure D3).

Energy Conservation/Renewable Energy Of those four participating Alaskan airports having adopted an initiative focused on energy conservation or renewable energy, drivers and outcomes varied, although three drivers and outcomes were shared by these airports. The most common drivers were improved sustainability performance, cost reductions, and reduction in maintenance or man hours. Outcomes for these initiatives matched the drivers, which would indicate that these initiatives were successful in producing the intended results (Figure D4).

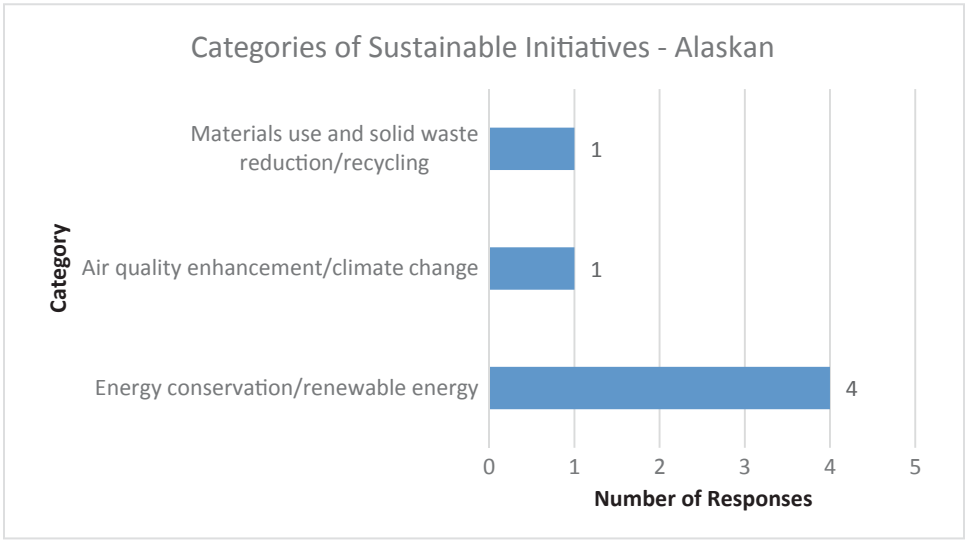

FIGURE D1 Categories of sustainable initiatives—Alaskan (*Source*: D. Prather 2016).

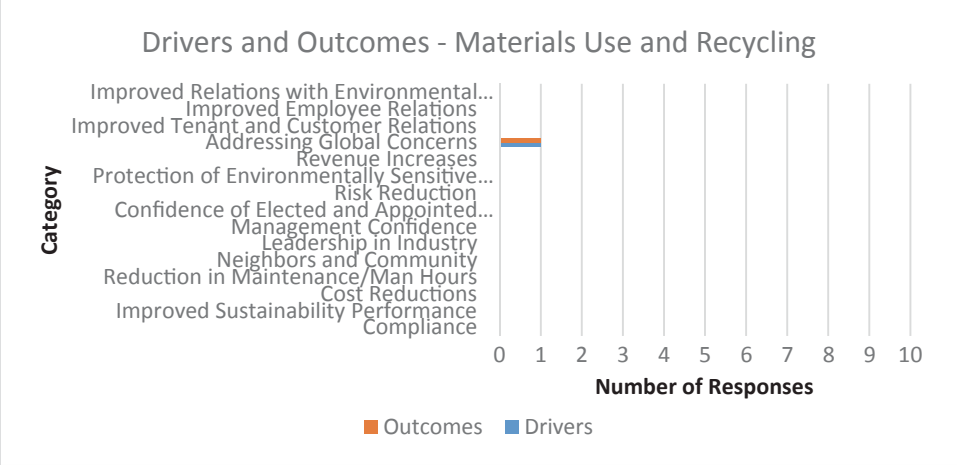

FIGURE D2 Materials use and solid waste reduction/recycling—Alaskan (*Source*: D. Prather 2016).

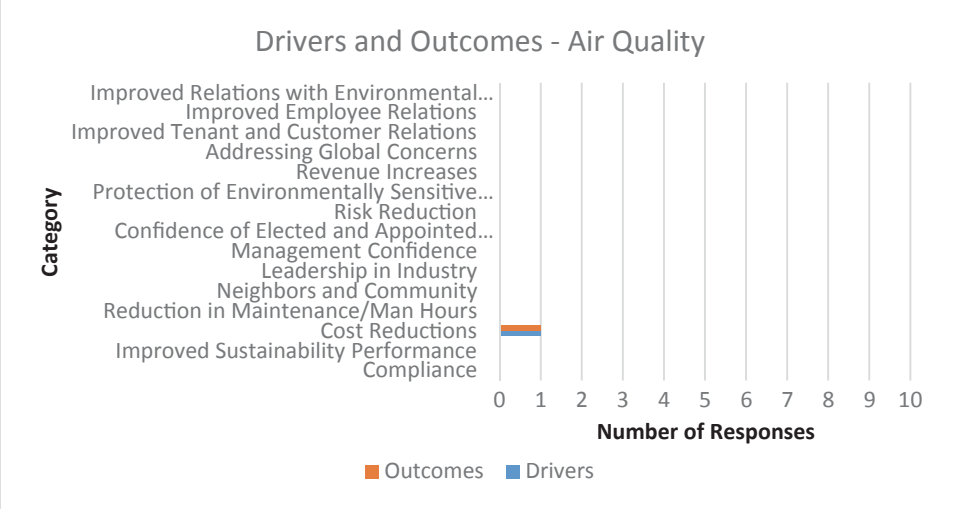

FIGURE D3 Air quality enhancement/climate change—Alaskan (*Source*: D. Prather 2016).

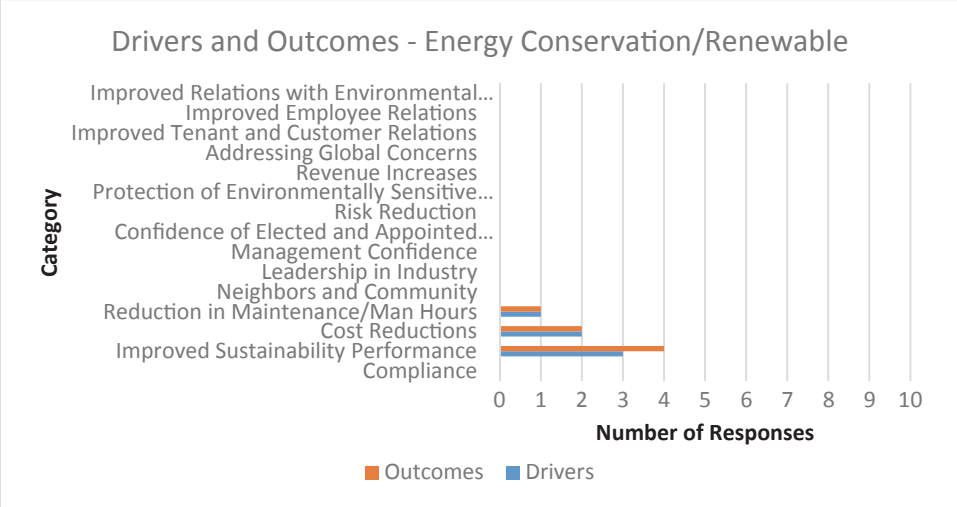

FIGURE D4 Energy conservation/renewable energy—Alaskan (*Source*: D. Prather 2016).

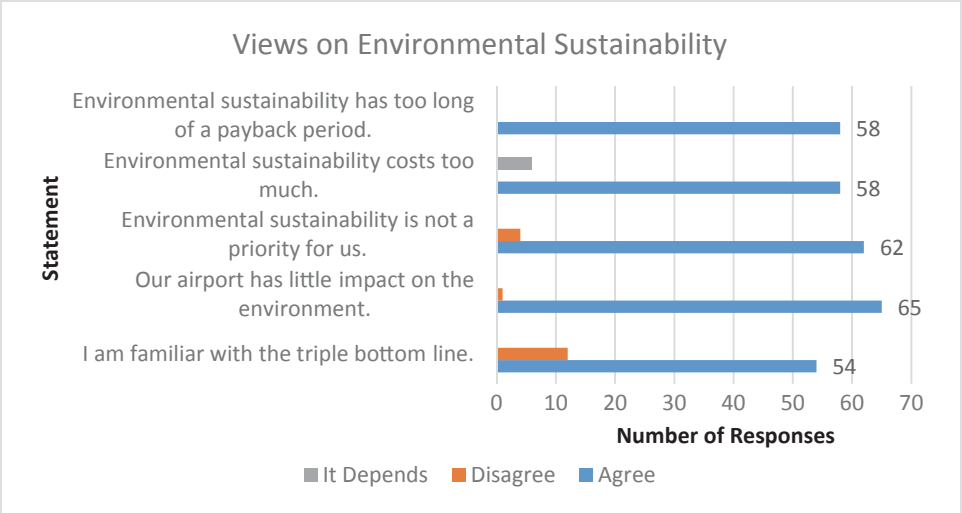

FIGURE D5 Views on environmental sustainability—Alaskan (*Source*: D. Prather 2016).

Airports Without Sustainable Initiatives

Airports not yet having pursued sustainable initiatives were asked to indicate agreement or disagreement with several statements reflecting views specifically of environmental sustainability. Results are presented in Figure D5.

As indicated, most of the participating Alaska airports believe that environmental sustainability has too long a payback period and costs too much. As a result, and because their airport has little impact on the environment, environmental sustainability is not a priority. Interestingly, most of the airports are familiar with the "triple bottom line," although this awareness does not translate into airports pursuing sustainable initiatives.

CENTRAL REGION

Airports with Sustainable Initiatives

Of the 16 airports that participated in the survey in the Central region, 13 (81%) have adopted sustainable initiatives. Three (19%) have not.

Sustainable Projects

The most widely adopted initiative (by 11 participating airports, representing 85%) is categorized as energy conservation/renewable energy. Less common are initiatives categorized as material use and solid waste reduction/recycling (five, representing 38%), water quality protection and water conservation (five, representing 38%), and hazardous materials and waste management/reduction (three, representing 23%) (Figure D6).

Drivers and Outcomes

Materials Use and Solid Waste Reduction/Recycling The five participating airports having adopted a materials use and solid waste/recycling initiative report identical drivers and outcomes. The drivers were airport management interest or confidence, as well as addressing global concerns. The actual outcomes reported by these airports were identical to the drivers, meaning the project met the initial goals (Figure D7).

Hazardous Materials and Waste Management/Reduction The three participating airports having adopted hazardous materials and waste management/reduction initiatives report two drivers (compliance and

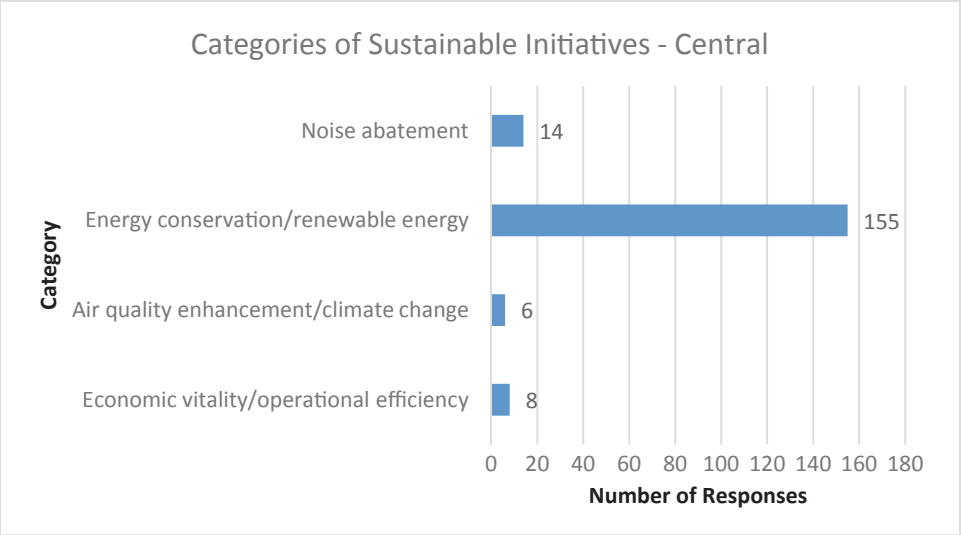

FIGURE D6 Categories of sustainable initiatives—Central (*Source*: D. Prather 2016).

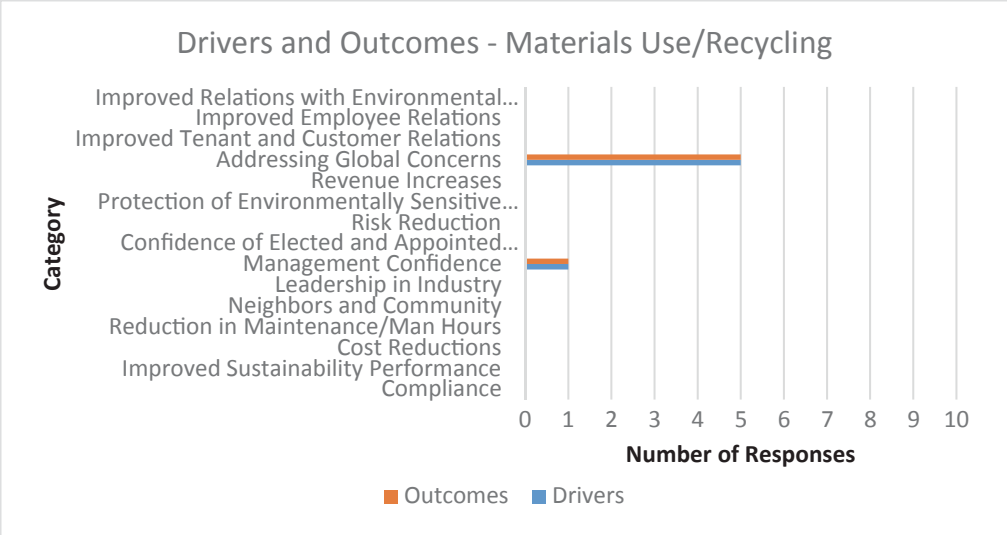

FIGURE D7 Materials use and solid waste reduction/recycling—Central (*Source*: D. Prather 2016).

addressing global concerns) and report the same outcomes (compliance and addressing global concerns) (Figure D8).

Water Quality Protection and Water Conservation Although five participating airports report adopting of water quality protection and water conservation initiatives, only four of these airports report drivers and outcomes associated with these initiatives. Specifically, drivers include compliance (three, representing 60%) and addressing global concerns (one, representing 20%). Outcomes were identical, meaning these initiatives met goals (Figure D9).

Energy Conservation/Renewable Energy The 11 participating airports having adopted energy conservation/renewable energy initiatives report similar drivers and outcomes. Drivers include improved sustainability performance cost reductions, reduction in maintenance/man hours, and management interest and confidence. The most common driver, reported by 11 participating airports, was cost reductions. In essence, these airports were motivated to pursue emergency conservation/renewable energy projects because of expected reductions in costs. Outcomes were identical, with cost reduction the most commonly reported outcome (reported by nine airports). Apparently, for two airports, the intended cost reductions were not realized (Figure D10).

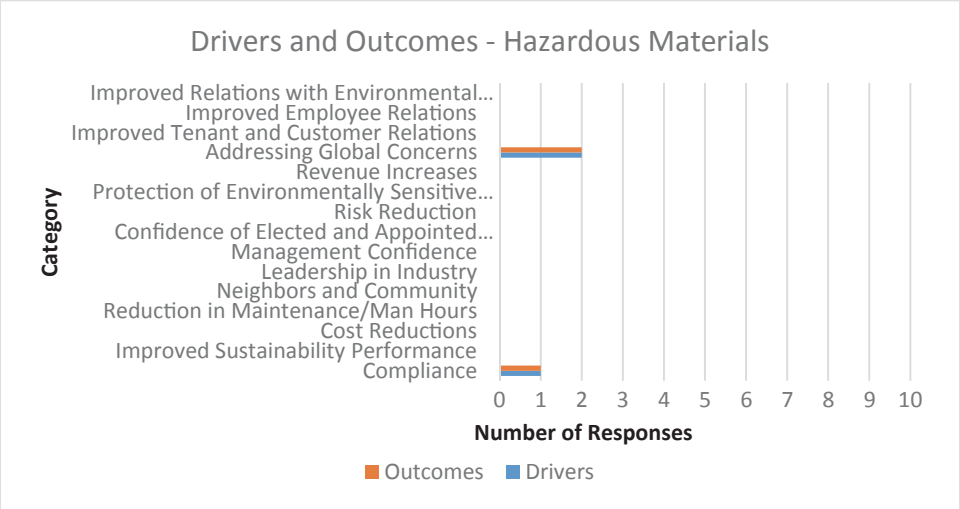

FIGURE D8 Hazardous materials and waste management/reduction—Central (*Source*: D. Prather 2016).

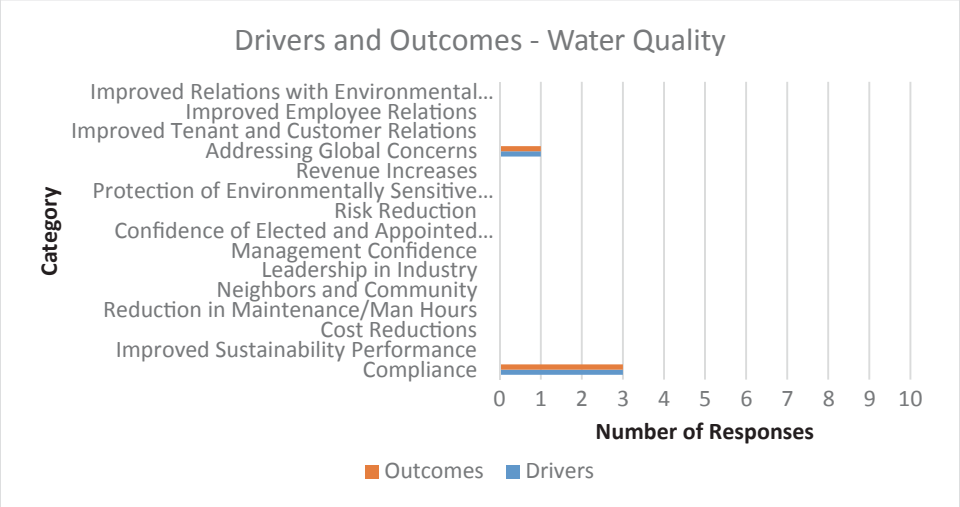

FIGURE D9 Water quality protection and water conservation—Central (*Source*: D. Prather 2016).

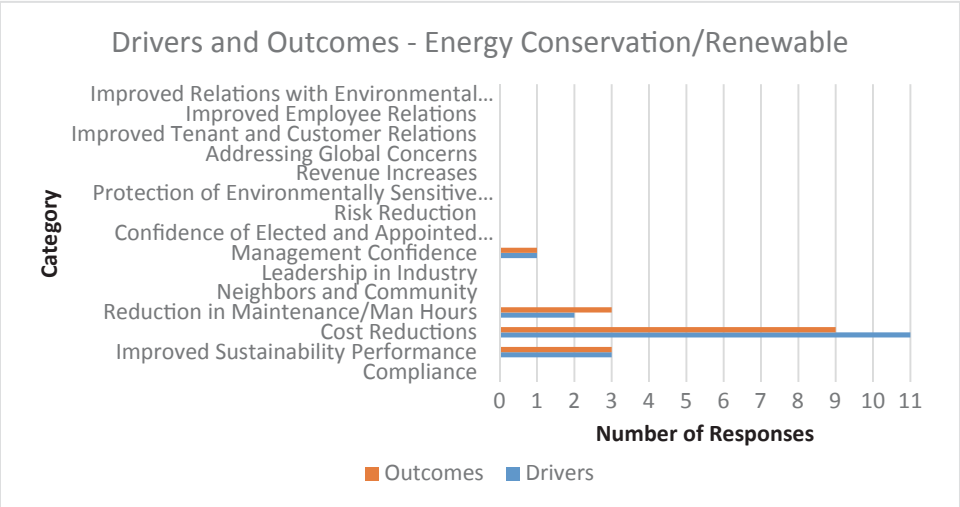

FIGURE D10 Energy conservation/renewable energy—Central (*Source*: D. Prather 2016).

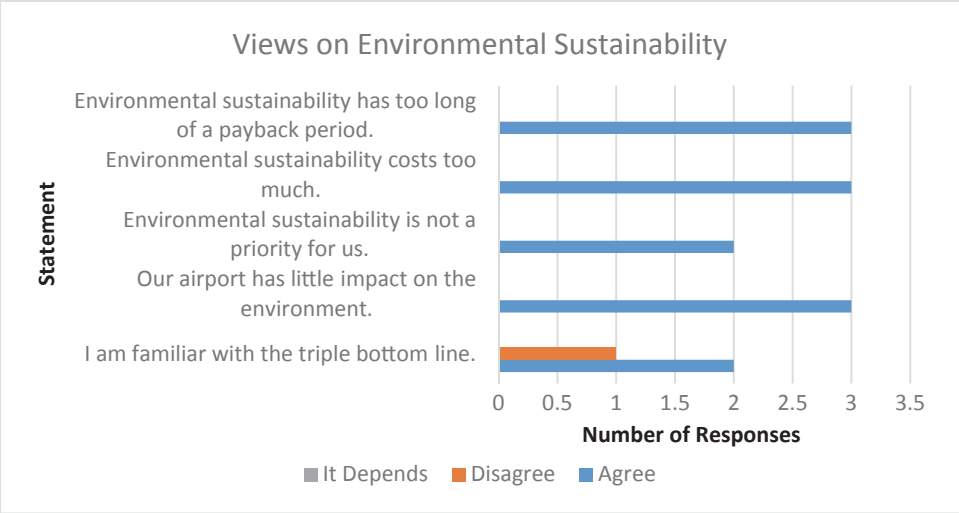

FIGURE D11 Views on environmental sustainability—Central (*Source*: D. Prather 2016).

Airports Without Sustainable Initiatives

Airports not yet having pursued one or more sustainable initiatives were asked to indicate agreement or disagreement with several statements reflecting their beliefs on environmental sustainability. Results are presented in Figure D11.

EASTERN REGION

Of the 30 participating airports in the Eastern region, fully 28 (representing 93%) have adopted a sustainable initiative.

Airports with Sustainable Initiatives

Sustainable Projects

No less than seven sustainable categories were represented by participating airports in the Eastern region. The most common category of sustainable initiative was energy conservation/renewable energy, pursued by 23 (representing 82%) airports. The second most common category was water quality protection and water conservation, pursued by 14 (representing 50%) airports. Additional categories include air quality enhancement/climate change (one, representing 4%), noise abatement (four, representing 14%), land and natural resources management (five, representing 18%), materials use and solid waste reduction (seven, representing 25%), and hazardous materials and waste management/reduction (eight, representing 29%) (Figure D12).

Drivers and Outcomes

Air Quality Enhancement/Climate Change The one participating airport having pursued an initiative in air quality enhancement/climate change, reported three drivers and three identical outcomes. Drivers and outcomes were improved sustainability performance, reduction in maintenance/man hours, and addressing global concerns (Figure D13).

Materials Use and Solid Waste Reduction/Recycling Of the participating airports reporting initiatives in materials use and solid waste reduction/recycling, eight reported identical drivers and outcomes: addressing global concerns (Figure D14).

Land and Natural Resources Management Airports having adopted initiatives in land and natural resources management report compliance as their most common driver, as well as outcome. Other drivers include risk reduction and sensitive environmental receptors. Although compliance, risk reduction, and protection of environmentally sensitive receptors were reported as outcomes, participating

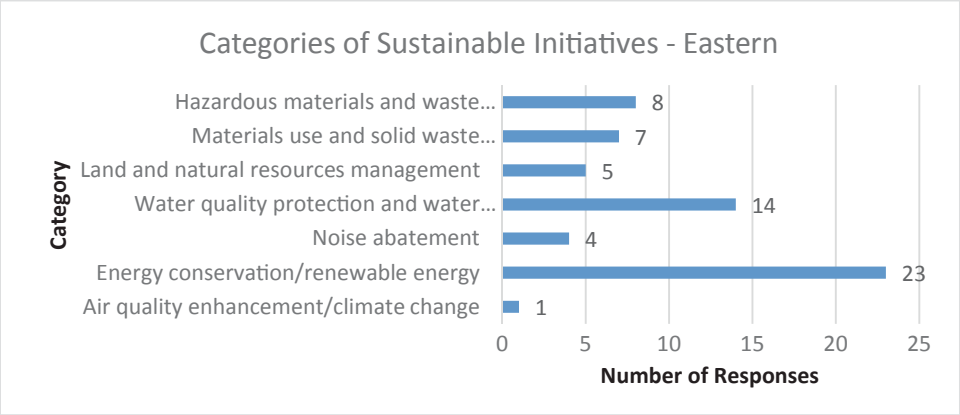

FIGURE D12 Categories of sustainable initiatives—Eastern (*Source*: D. Prather 2016).

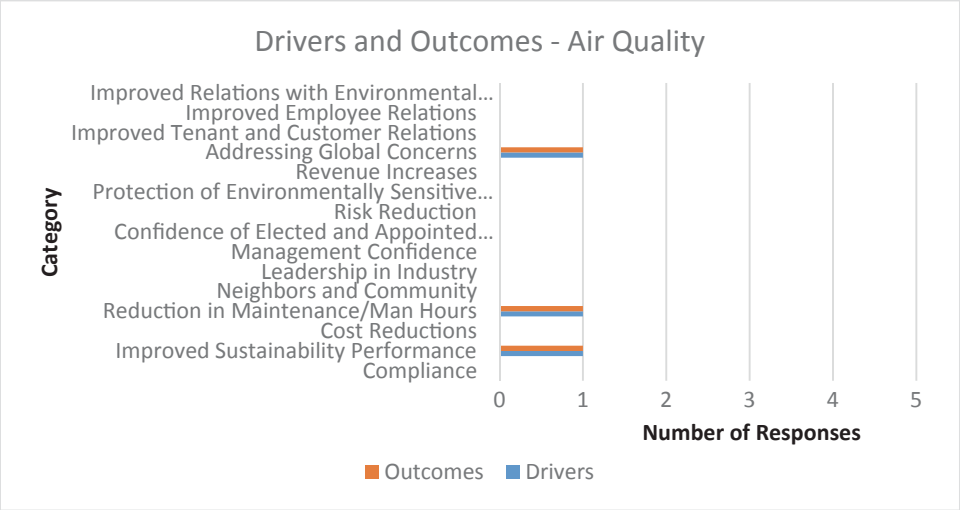

FIGURE D13 Air quality enhancement/climate change—Eastern (*Source*: D. Prather 2016).

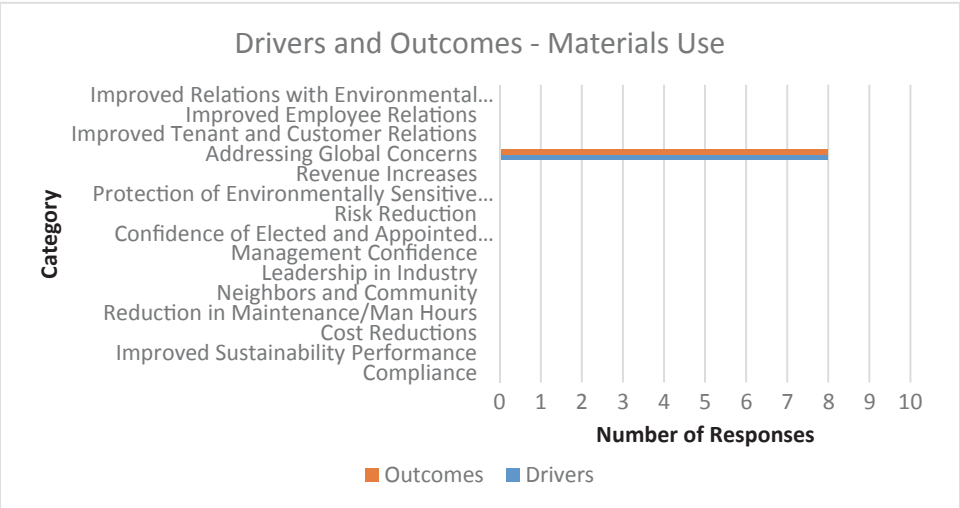

FIGURE D14 Materials use and solid waste reduction/recycling—Eastern (*Source*: D. Prather 2016).

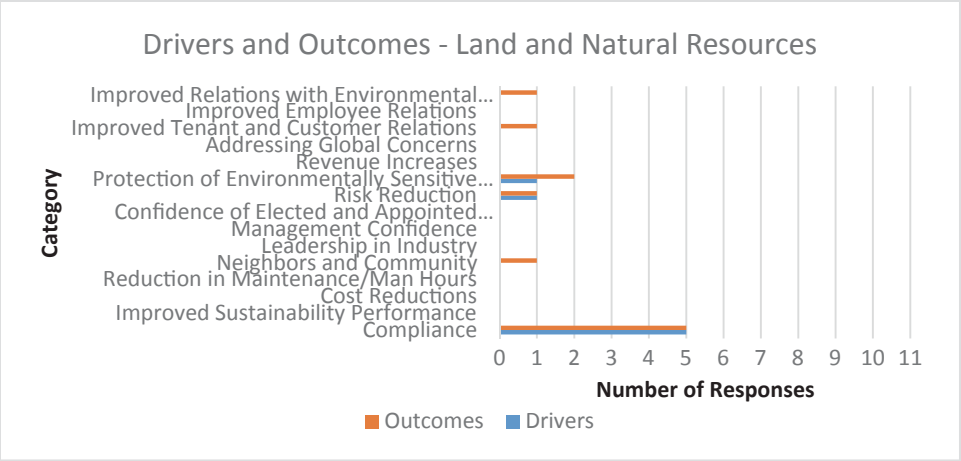

FIGURE D15 Land and natural resources management—Eastern (*Source*: D. Prather 2016).

airports also experienced some unexpected outcomes. These outcomes include improved relationships with neighbors and the community, improved tenant and customer relationships, and improved relationships with environmental organizations. Clearly, these data reveal that pursuing land and natural resources management initiatives can produce unexpected positive benefits to the airport and community (Figure D15).

Hazardous Materials and Waste Management/Reduction Airports having pursued initiatives in hazardous materials and waste management/reduction report three drivers and three identical outcomes. Drivers and outcomes include improved compliance, management confidence, and addressing global concerns (Figure D16).

Noise Abatement Only three participating airports shared drivers and outcomes associated with their noise abatement initiatives. Drivers and outcomes were identical: improved relationships with neighbors and community (Figure D17).

Water Quality Protection and Water Conservation Participating airports reporting water quality protection and water conservation initiatives point to four drivers and seven outcomes. Drivers include compliance, cost reductions, risk reduction, and addressing global concerns. In addition to outcomes that were identical to the drivers, these airports reported unexpected outcomes: improved relationships

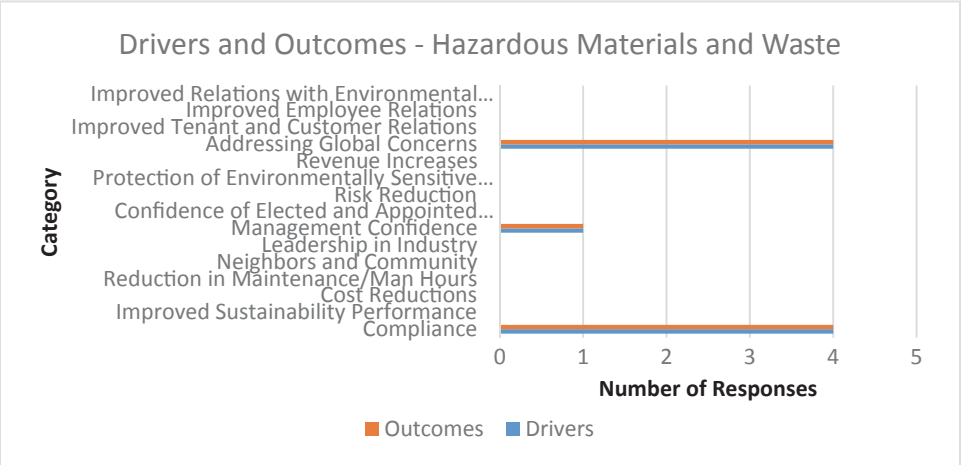

FIGURE D16 Hazardous materials and waste management/reduction—Eastern (*Source*: D. Prather 2016).

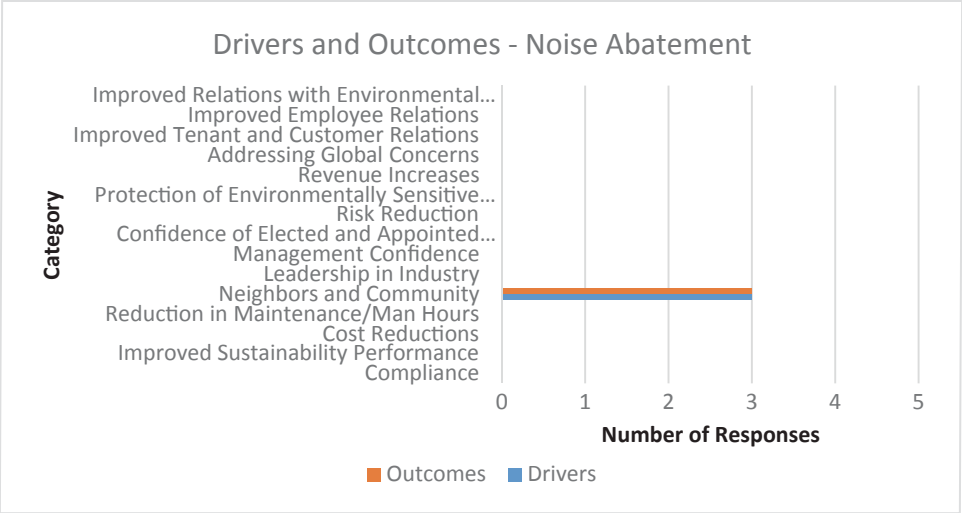

FIGURE D17 Noise abatement—Eastern (*Source*: D. Prather 2016).

with neighbors and the community, protection of environmentally sensitive receptors, improved tenant and customer relations, and improved relations with environmental organizations. The data reveal that sustainable initiatives in water quality protection and water conservation produced unexpected positive benefits for the airport and the community (Figure D18).

Energy Conservation/Renewable Energy Airports that have pursued energy conservation/renewable energy initiatives report a number of drivers and outcomes. By far, the most common driver reported was cost reductions. Additional drivers include compliance, desire for improved sustainability performance, reduction in maintenance/man hours, and risk reduction. Outcomes were similar to drivers but did include some unexpected benefits. Those unexpected outcomes include improved relationships with neighbors and the community, protection of environmentally sensitive receptors, improved tenant and customer relationships, and improved relations with environmental organizations. Again, the data reveal that energy conservation/renewable energy initiatives can produce unexpected benefits for the airport and community (Figure D19).

Airports Without Sustainable Initiatives

Airports not yet having pursued sustainable initiatives were asked to indicate their level of agreement or disagreement with several statements reflecting beliefs on environmental sustainability. Responses are presented in Figure D20.

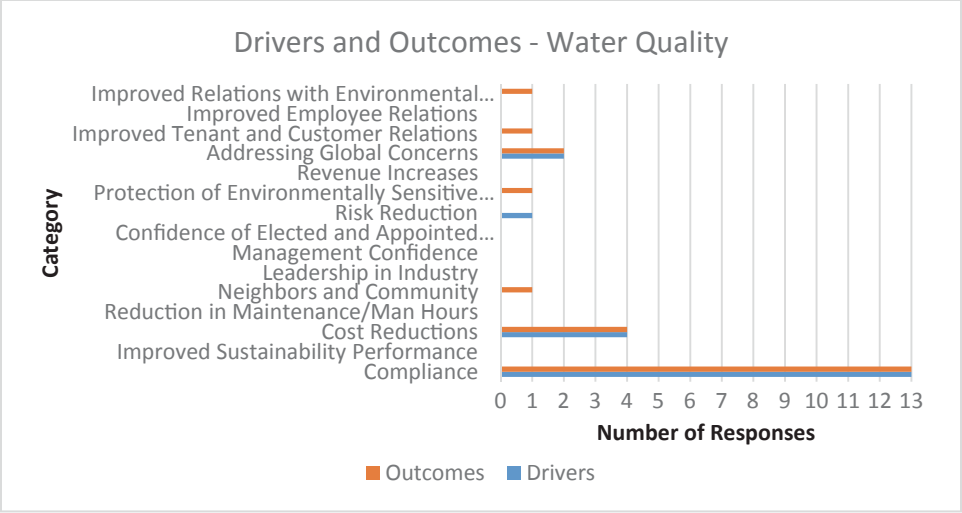

FIGURE D18 Water quality protection and water conservation—Eastern (*Source*: D. Prather 2016).

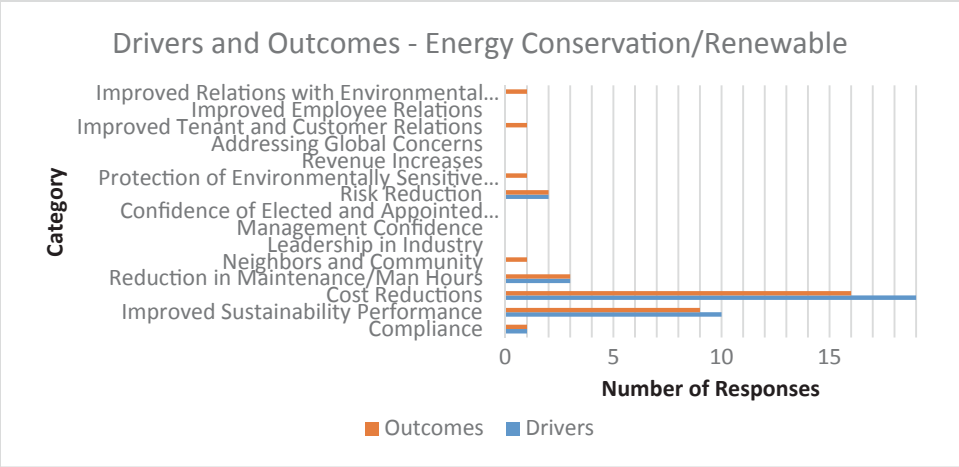

FIGURE D19 Energy conservation/renewable energy—Eastern (*Source*: D. Prather 2016).

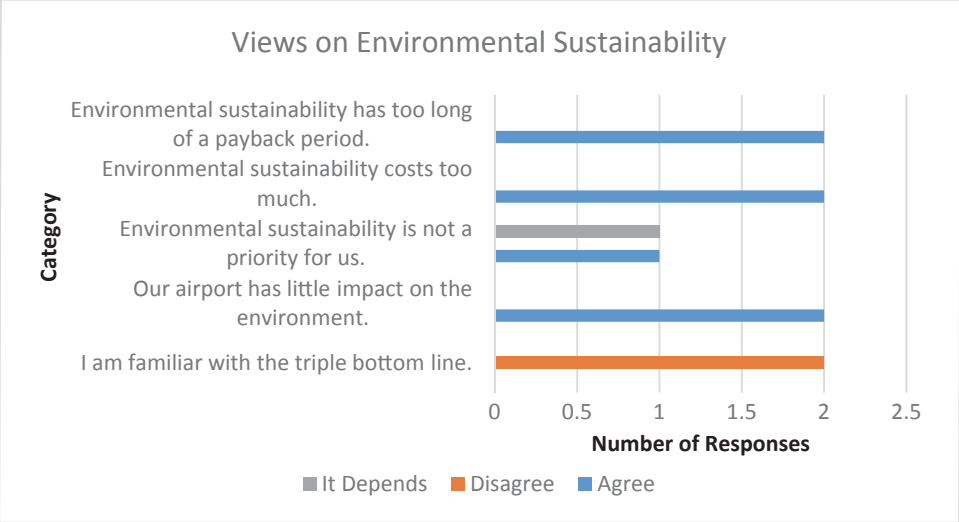

FIGURE D20 Views on environmental sustainability—Eastern (*Source*: D. Prather 2016).

GREAT LAKES REGION

Of the 31 participating airports from the Great Lakes region, 28 (representing 90%) have implemented sustainable initiatives.

Airports with Sustainable Initiatives

Sustainable Projects

Twenty-eight of the participating airports indicated they have implemented one or more sustainable initiatives. The most commonly pursued initiative, reported by 25 of 28 airports (representing 90%), is categorized as energy conservation/renewable energy. Other categories include air quality enhancement/climate change, noise abatement, water quality protection and water conservation, land/property use, pavement management, materials use and solid waste reduction/recycling, hazardous materials and waste management/reduction, and buildings/facilities (Figure D21).

Drivers and Outcomes

Air Quality Enhancement/Climate Change One airport reported a sustainable initiative in air quality enhancement/climate change. This airport reported two drivers with identical outcomes: greater management confidence and addressing global concerns (Figure D22).

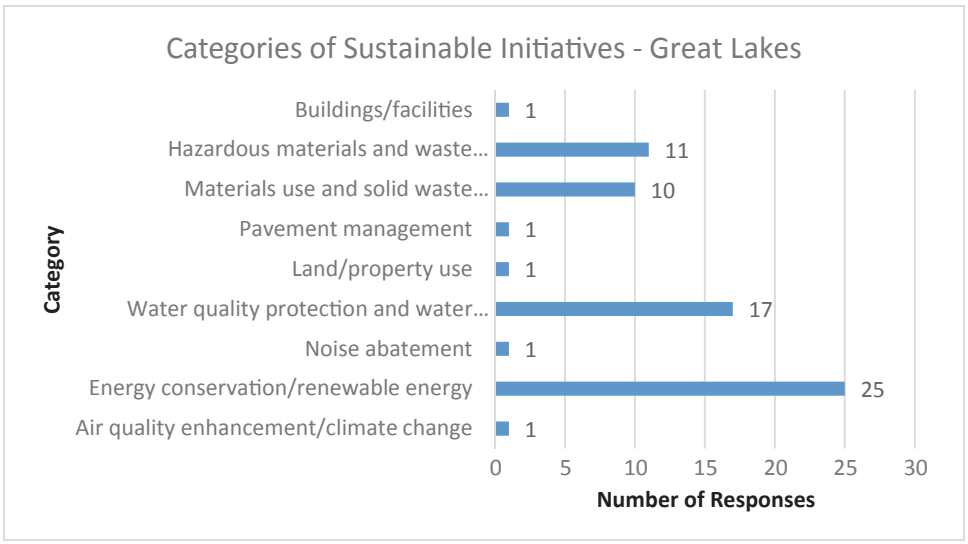

FIGURE D21 Categories of sustainable initiatives—Great Lakes (*Source*: D. Prather 2016).

Pavement Management One participating airport reported a pavement management initiative, and one driver and an identical outcome associated with this initiative: improved sustainability performance (Figure D23).

Materials Use and Solid Waste Reduction/Recycling Ten participating airports report sustainable initiatives in materials use and solid waste reduction/recycling. These airports report two drivers and two identical outcomes: improved sustainability performance and addressing global concerns (Figure D24).

Land and Natural Resources Management The one airport with a sustainable initiative in land and natural resources management reported one driver and identical outcome. Addressing global concerns both motivated this airport and yielded the outcome they desired (Figure D25).

Land/Property Use The one airport reporting a land/property use initiative identifies one driver and an identical outcome: addressing global concerns (Figure D26).

Buildings/Facilities The one airport reporting a buildings/facilities sustainable initiative reports one driver and an identical outcome: improved sustainability performance (Figure D27).

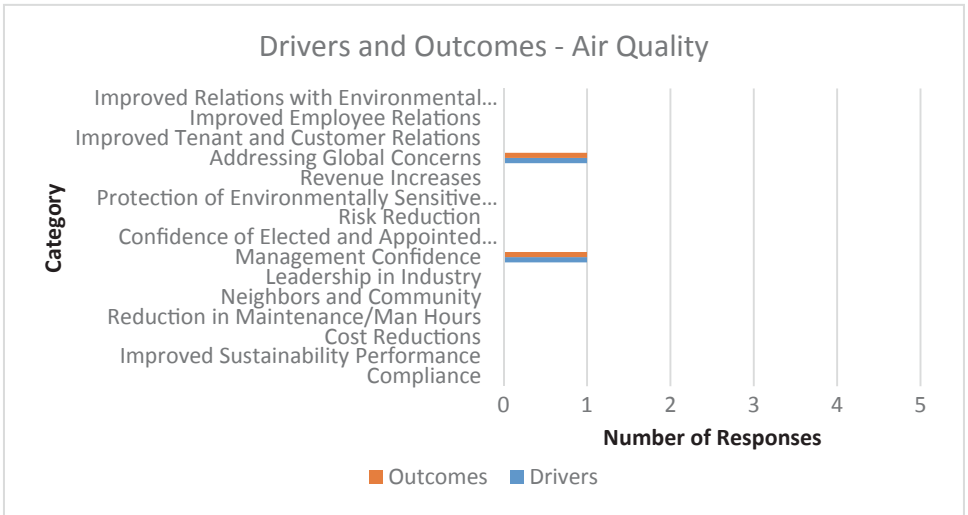

FIGURE D22 Air quality enhancement/climate change—Great Lakes (*Source*: D. Prather 2016).

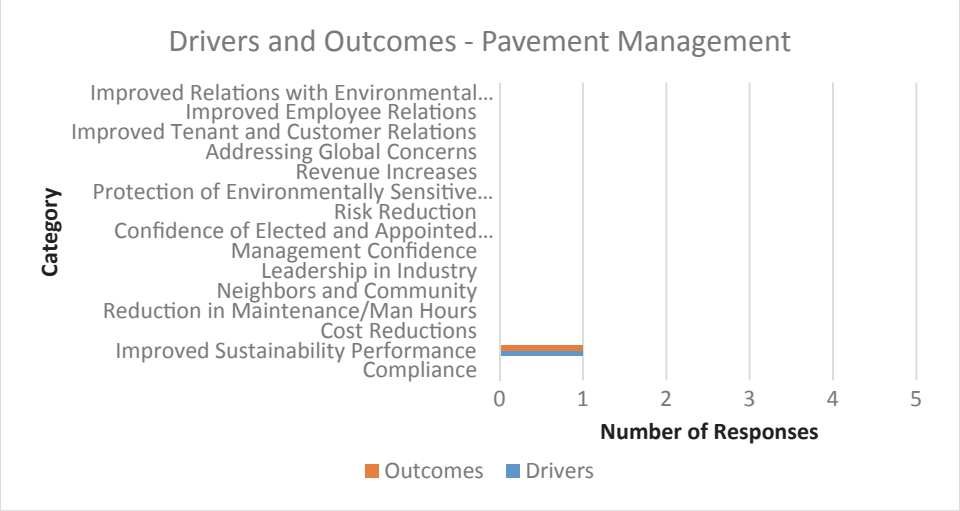

FIGURE D23 Pavement management—Great Lakes (*Source*: D. Prather 2016).

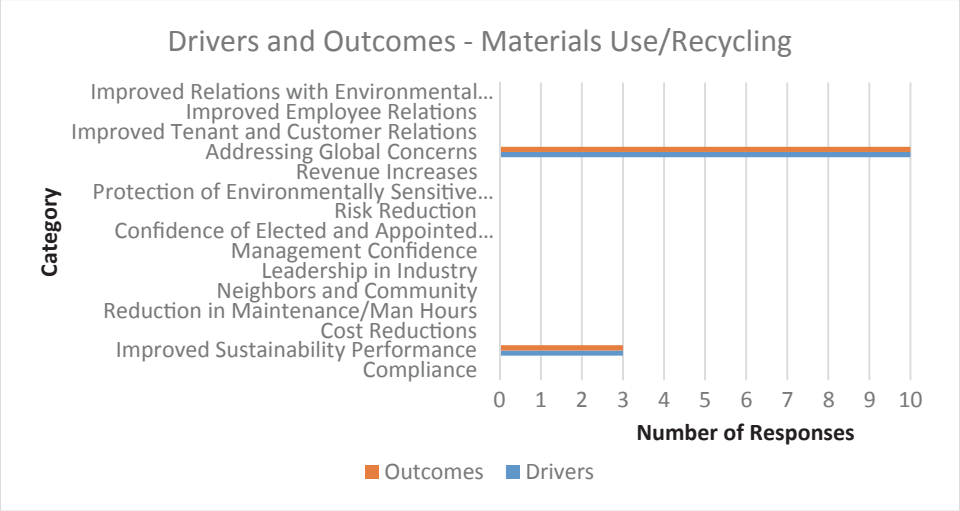

FIGURE D24 Materials use and solid waste reduction/recycling—Great Lakes (*Source*: D. Prather 2016).

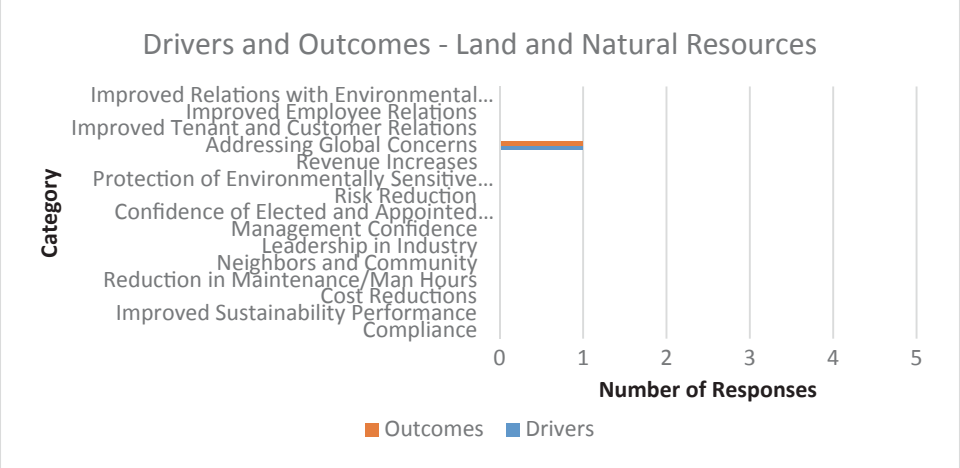

FIGURE D25 Land and natural resources management—Great Lakes (*Source*: D. Prather 2016).

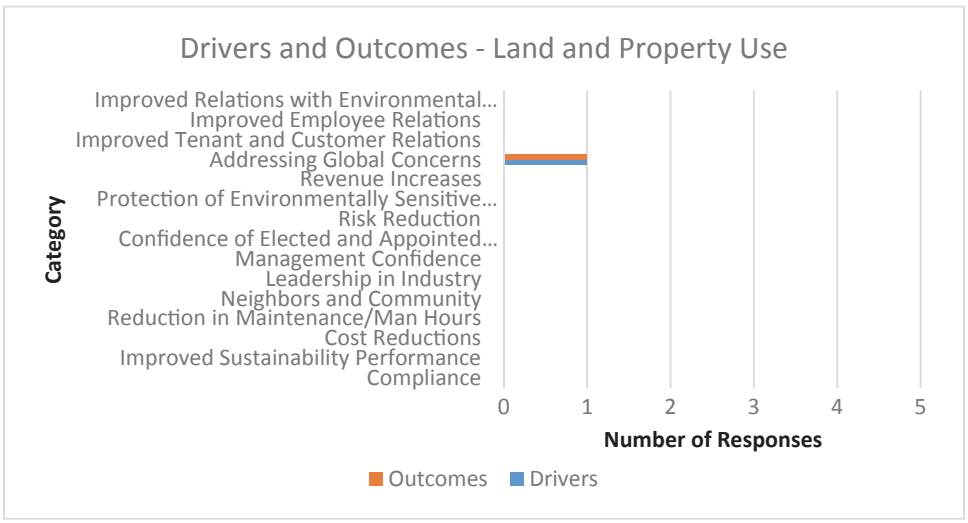

FIGURE D26 Land and property use—Great Lakes (*Source*: D. Prather 2016).

Hazardous Materials and Waste Management/Reduction The 11 participating airports in the Great Lakes region having adopted a hazardous materials and waste management/reduction initiative report two drivers and identical outcomes. Drivers and outcomes are compliance and addressing global concerns (Figure D28).

Noise Abatement The one participating airport having pursued a noise abatement initiative reports that the driver was to ensure improved relations with the community and the outcome verifies the program has met its goal of enhancing relations with the community (Figure D29).

Water Quality Protection and Water Conservation Seventeen participating airports have pursued sustainable initiatives in the area of water quality protection and water conservation. Drivers and outcomes, although several, are identical at these airports. Drivers motivating airports in this area include compliance, improved sustainability performance, cost reductions, and addressing global concerns. Outcomes are identical. It is important to note that compliance is the main driver for water quality protection and water conservation (Figure D30).

Energy Conservation/Renewable Energy The most frequently mentioned of sustainable initiatives among airports in the Great Lakes region, the energy conservation/renewable energy category, has common drivers and outcomes. Drivers include improved sustainability performance, cost reductions, reduction in maintenance/man hours, and addressing global concerns. Outcomes are identical (Figure D31).

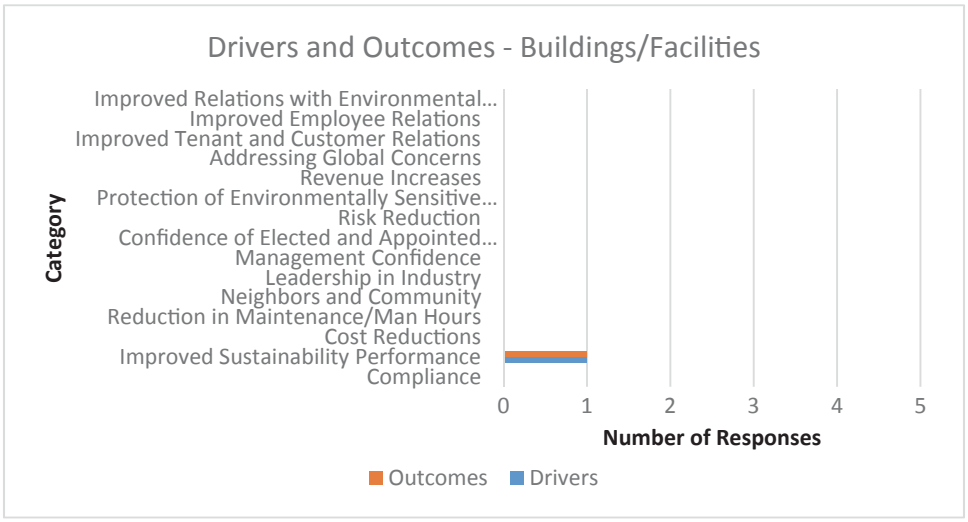

FIGURE D27 Buildings/facilities—Great Lakes (*Source*: D. Prather 2016).

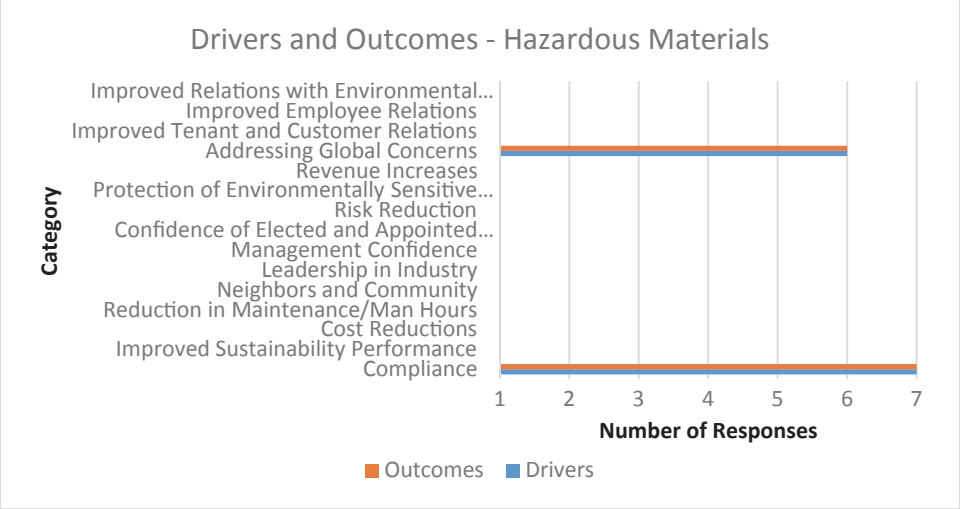

FIGURE D28 Hazardous materials and waste management/reduction—Great Lakes (*Source*: D. Prather 2016).

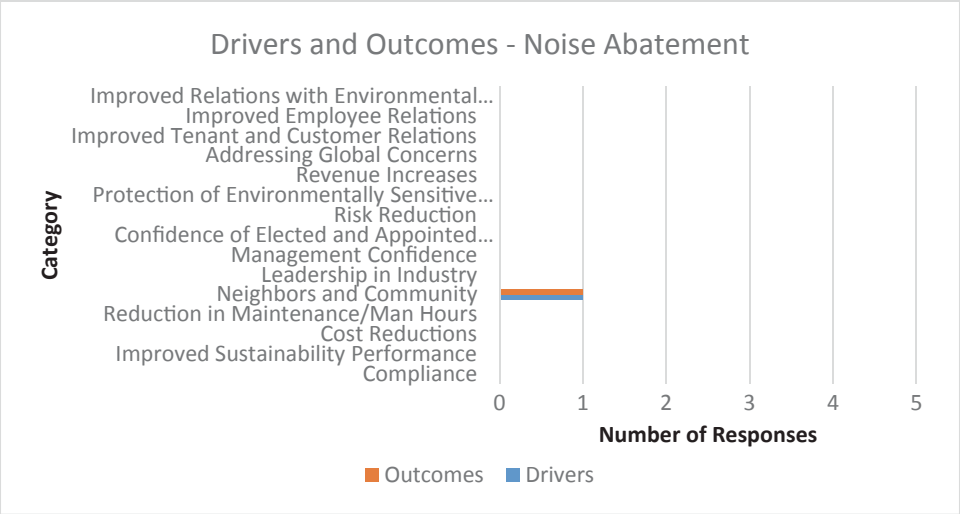

FIGURE D29 Noise abatement—Great Lakes (*Source*: D. Prather 2016).

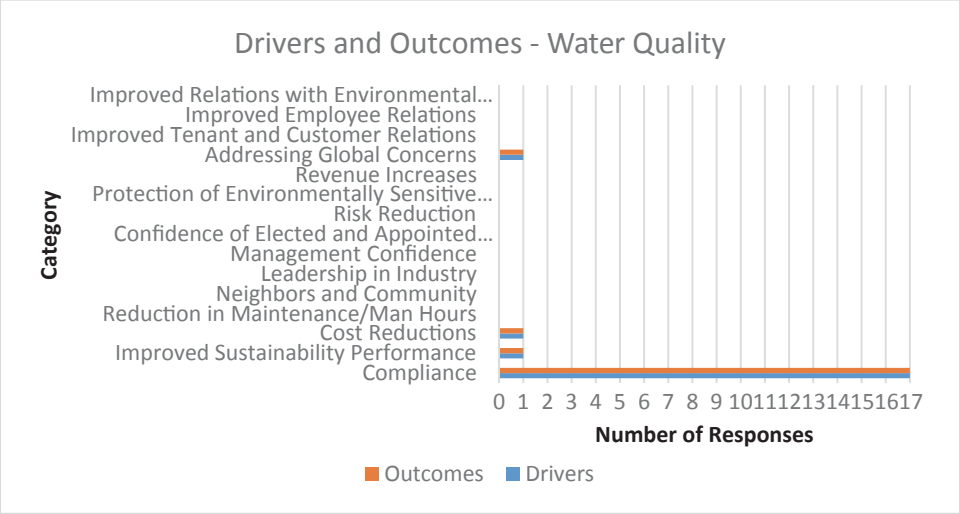

FIGURE D30 Water quality protection and water conservation—Great Lakes (*Source*: D. Prather 2016).

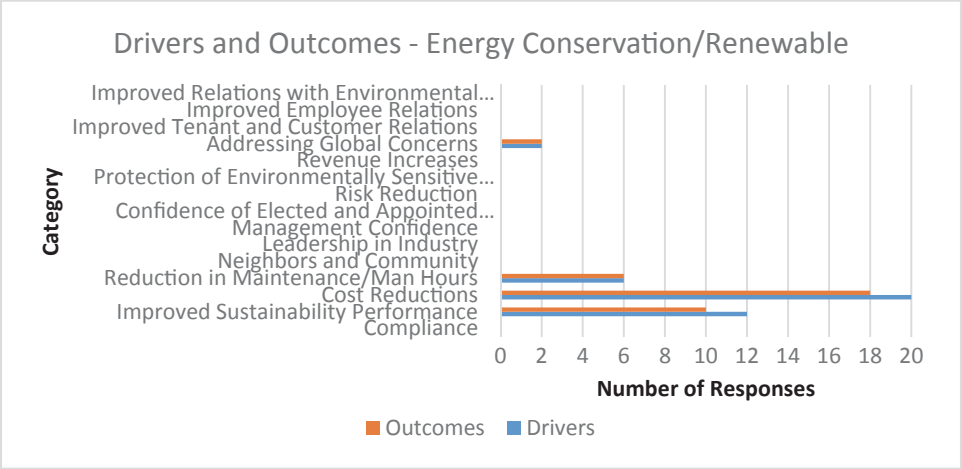

FIGURE D31 Energy conservation/renewable energy—Great Lakes (*Source*: D. Prather 2016).

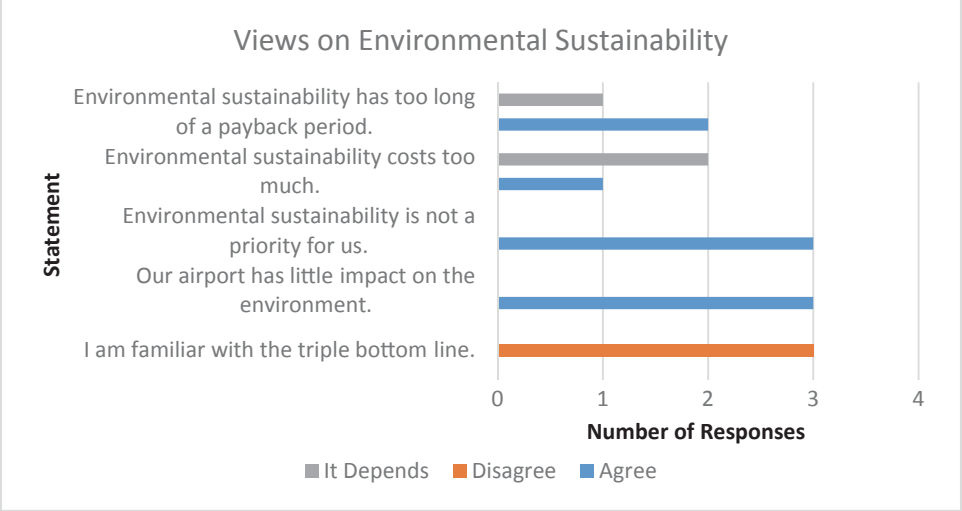

FIGURE D32 Views on environmental sustainability—Great Lakes (*Source*: D. Prather 2016).

Airports Without Sustainable Initiatives

Airports not yet having pursued one or more sustainable initiatives were asked to indicate their level of agreement or disagreement with several statements reflecting beliefs on environmental sustainability. Responses are presented in Figure D32.

NEW ENGLAND REGION

Eleven airports in the New England region participated in the survey.

Airports with Sustainable Initiatives

Most of the airports in the New England region (10, representing 91%) indicate they have adopted sustainable initiatives.

Sustainable Projects

There are six categories of sustainability initiatives reported by participating airports in the New England region. The two most common categories are water quality protection and water conservation and energy

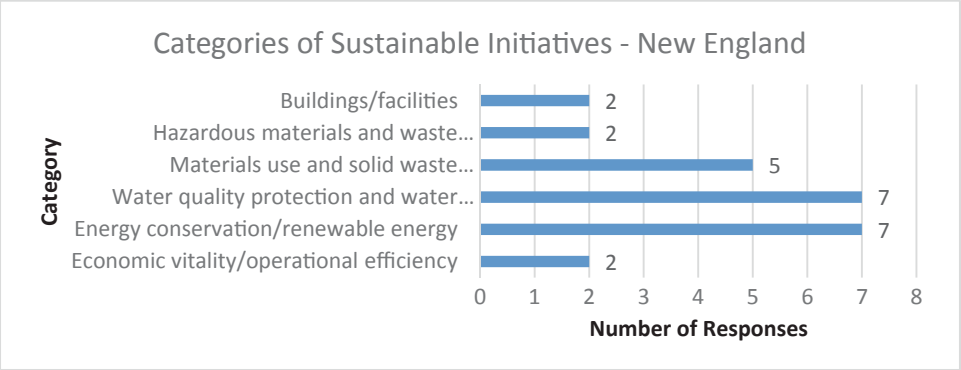

FIGURE D33 Categories of sustainable initiatives—New England (*Source*: D. Prather 2016).

conservation/renewable energy. Additional categories include buildings/facilities, hazardous materials and waste management/reduction, materials use and solid waste reduction/recycling, and economic vitality/operational efficiency (Figure D33).

Drivers and Outcomes

Economic Vitality/Operational Efficiency Airports having adopted initiatives in the category of economic vitality/operational efficiency report only two drivers and identical outcomes. Improved sustainability performance and cost reduction were both drivers and outcomes for projects in this category (Figure D34).

Materials Use and Solid Waste Reduction/Recycling Airports with sustainable initiatives in the category of materials use and solid waste reduction/recycling report only one driver and an identical outcome. The only driver and outcome reported was addressing global concerns (Figure D35).

Buildings/Facilities Airports having pursued sustainable initiatives in the category of buildings/facilities report two drivers and outcomes, which are identical. Improved sustainability performance and cost reduction are the reported drivers and outcomes (Figure D36).

Hazardous Materials and Waste Management/Reduction Two drivers were reported by airports with hazardous materials and waste management/reduction initiatives. Greater management confidence and addressing global concerns were the two drivers and outcomes reported (Figure D37).

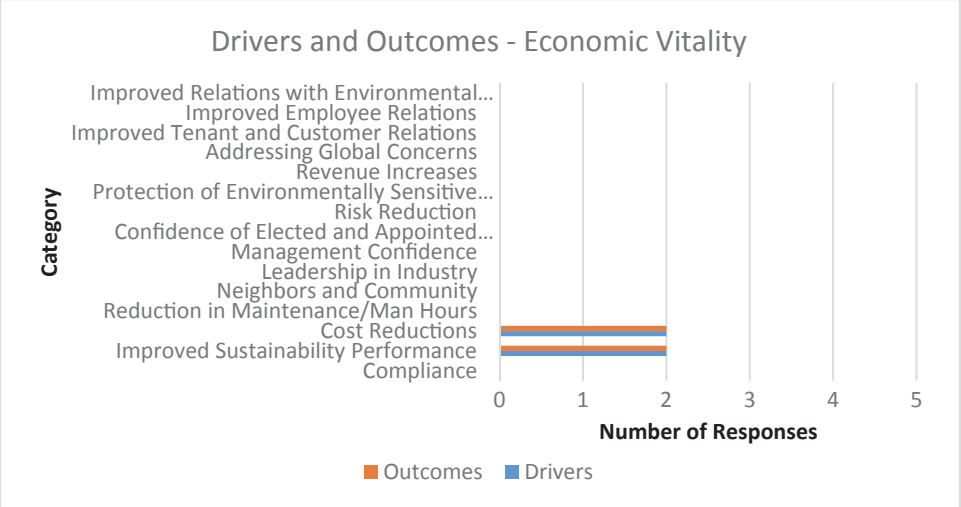

FIGURE D34 Economic vitality/operational efficiency—New England (*Source*: D. Prather 2016).

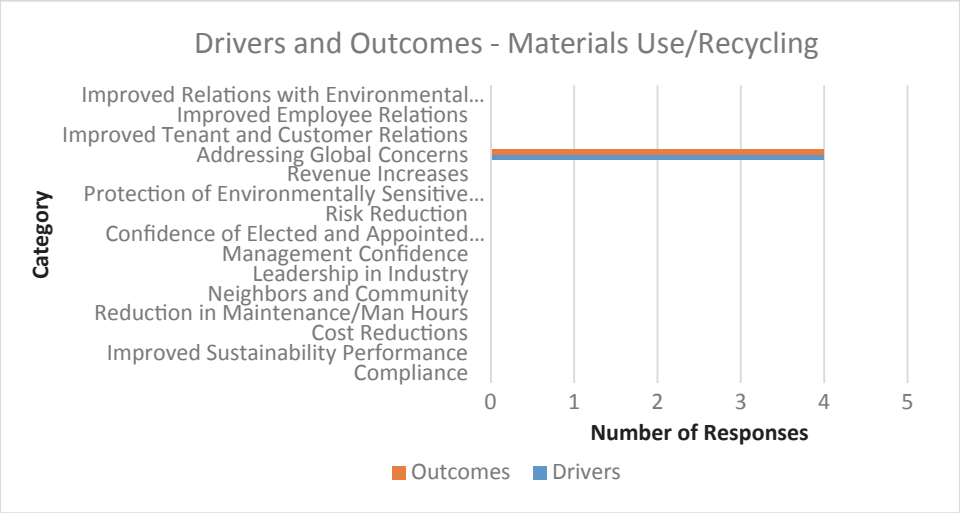

FIGURE D35 Materials use and solid waste reduction/recycling—New England (*Source*: D. Prather 2016).

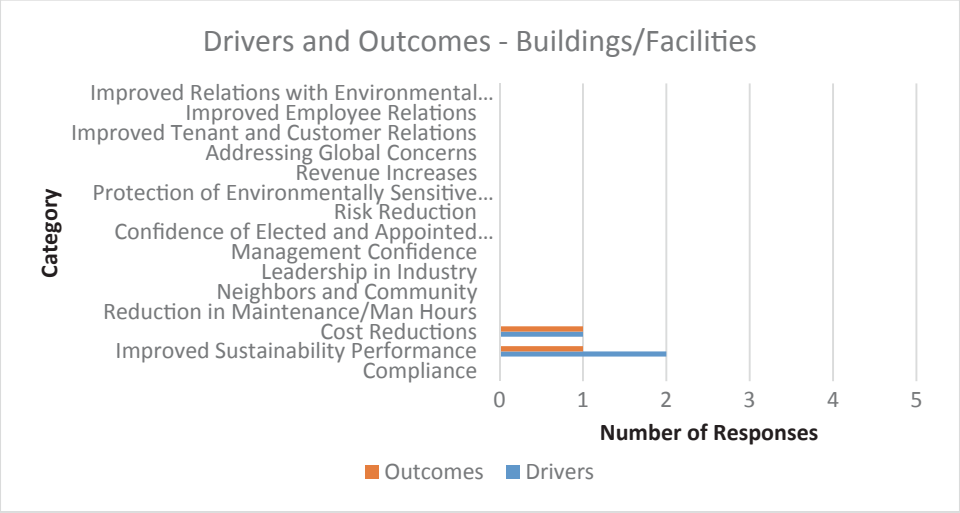

FIGURE D36 Buildings/facilities—New England (*Source*: D. Prather 2016).

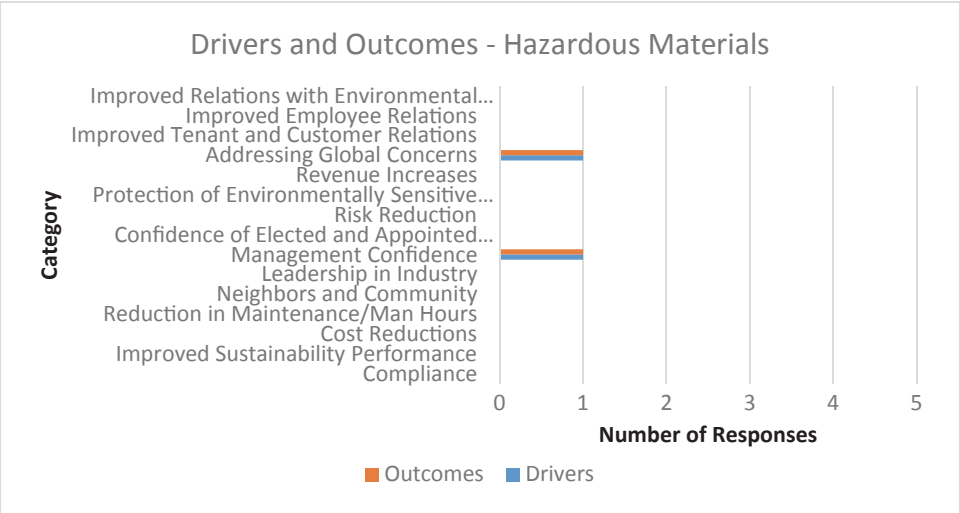

FIGURE D37 Hazardous materials and waste management/reduction—New England (*Source*: D. Prather 2016).

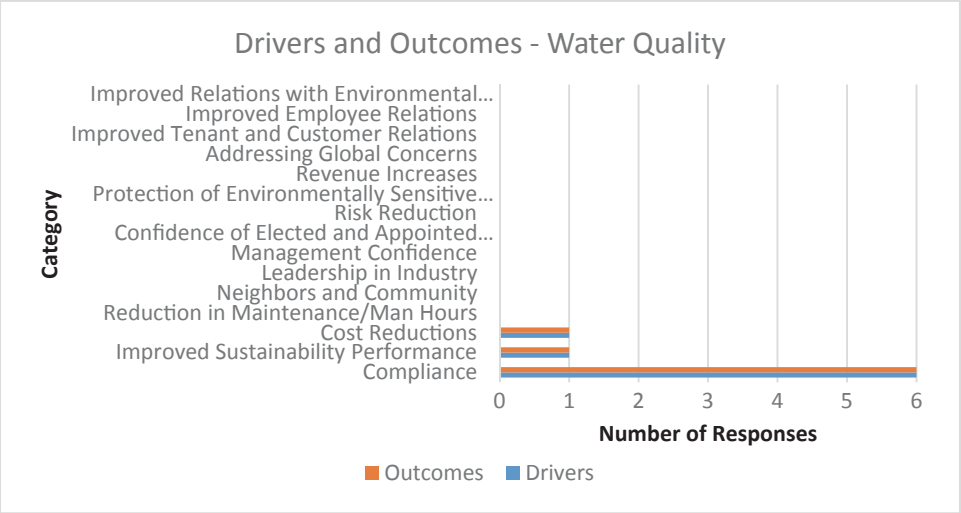

FIGURE D38 Water quality protection and water conservation—New England (*Source*: D. Prather 2016).

Water Quality Protection and Water Conservation Airports with sustainable initiatives in the category of water quality protection and water conservation reported three drivers and identical outcomes. The most commonly reported driver is compliance. Less common are improved sustainability performance and cost reduction (Figure D38).

Energy Conservation/Renewable Energy Airports with sustainable initiatives in the category of energy conservation/renewable energy report drivers and outcomes in the areas of cost reduction, improved sustainability performance, reduction in maintenance/man hours, and addressing global concerns. As was common in other categories, drivers and outcomes are identical for this category (Figure D39).

Airports Without Sustainable Initiatives

Those airports that have not yet pursued a sustainable initiative were asked to indicate their agreement or disagreement with several statements reflecting beliefs on environmental sustainability. Responses are presented in Figure D40.

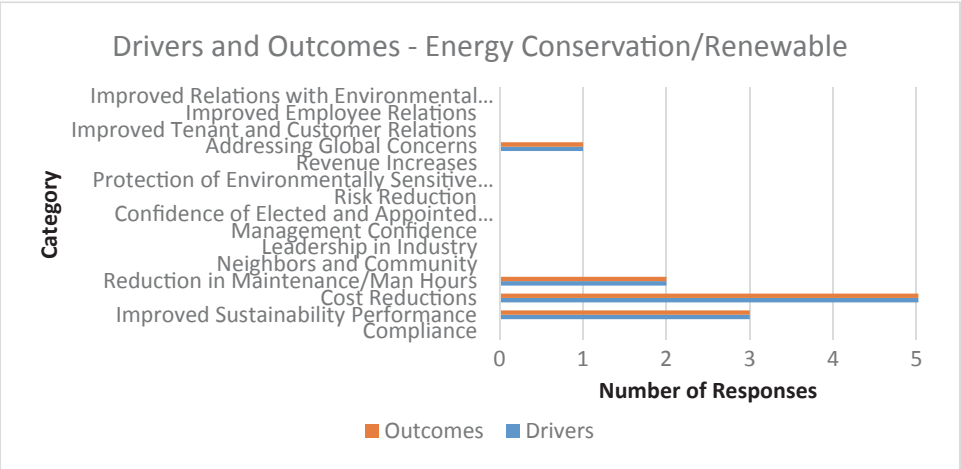

FIGURE D39 Energy conservation/renewable energy—New England (*Source*: D. Prather 2016).

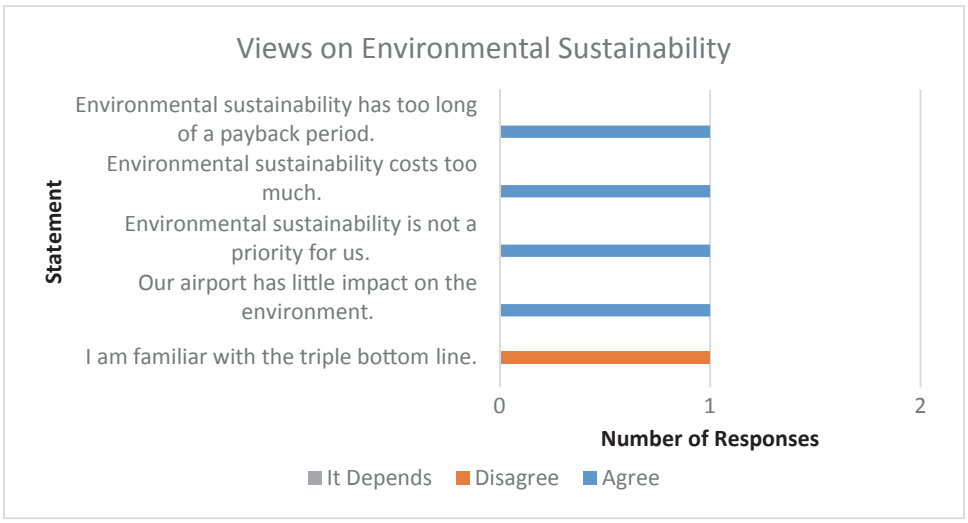

FIGURE D40 Views on environmental sustainability—New England (*Source*: D. Prather 2016).

NORTHWEST MOUNTAIN REGION

Twenty-two airports in the Northwest Mountain region participated in the study. Most (17, representing 78%) have adopted sustainable initiatives.

Airports with Sustainable Initiatives

Sustainable Projects

Participating airports located in the Northwest Mountain region report eight categories of sustainable initiatives. The most common is the category of energy conservation/renewable energy. Additional categories of sustainable initiatives include hazardous materials and waste management/reduction, materials use and solid waste reduction/recycling, land and natural resources management, water quality protection and water conservation, noise abatement, air quality enhancement/climate change, and economic vitality/operational efficiency (Figure D41).

Drivers and Outcomes

Economic Vitality/Operational Efficiency Only one driver and an identical outcome was shared by airports for projects categorized as economic vitality/operational efficiency. This driver and outcome was cost reduction (Figure D42).

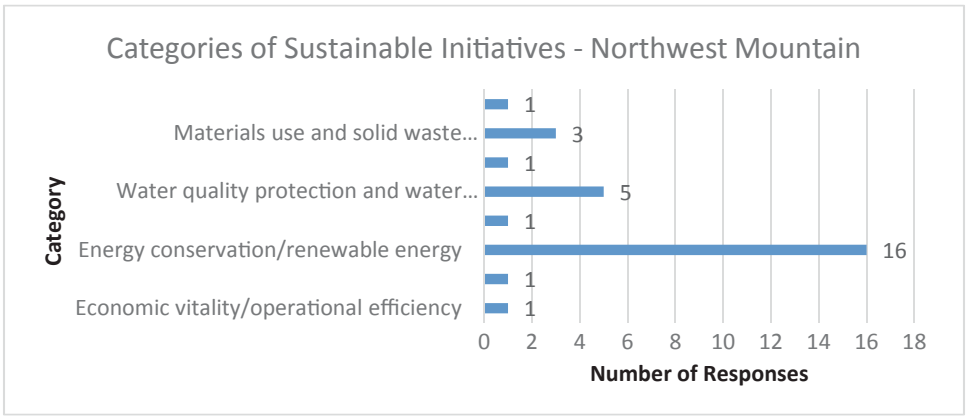

FIGURE D41 Categories of sustainable initiatives—Northwest Mountain (*Source*: D. Prather 2016).

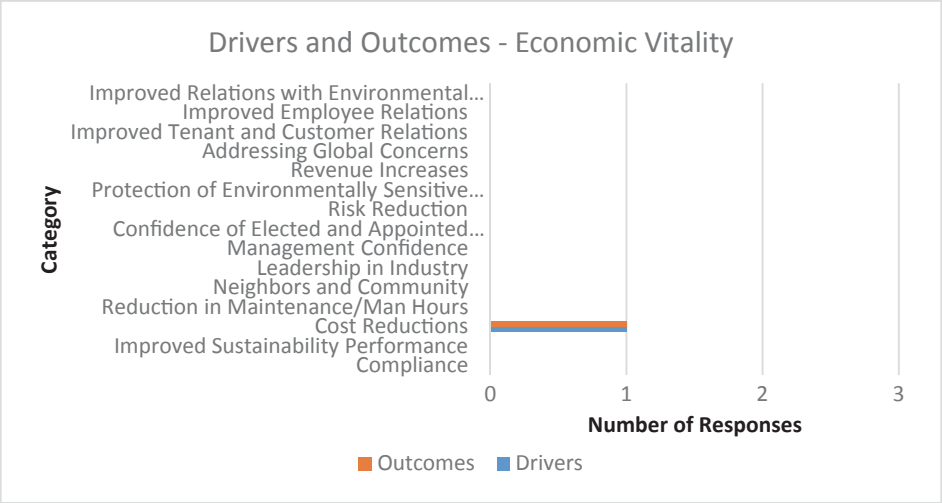

FIGURE D42 Economic vitality/operational efficiency—Northwest Mountain (*Source*: D. Prather 2016).

Air Quality Enhancement/Climate Change According to airports, the pursuit of air quality enhancement/climate change initiatives was driven by the need to address global concerns. Likewise, projects in the category addressed global concerns as their outcome (Figure D43).

Materials Use and Solid Waste Reduction/Recycling Airports with sustainable initiatives in the category of materials use and solid waste reduction/recycling report one driver and an identical outcome: addressing global concerns (Figure D44).

Land and Natural Resources Management Airports with initiatives in the category of land and natural resources management report two drivers with identical outcomes: improved compliance and addressing global concerns (Figure D45).

Land/Property Use Airports with one or more initiatives in the category of land/property use reported one driver and an identical outcome: addressing global concerns (Figure D46).

Hazardous Materials and Waste Management/Reduction Similar to other sustainable initiatives in the Northwest Mountain region, those related to hazardous materials and waste management/reduction have one driver and an identical outcome: addressing global concerns (Figure D47).

Noise Abatement As is common with noise abatement programs, airports pursue initiatives in this category to reduce the noise impact to the local area and improve community relationships. Participating

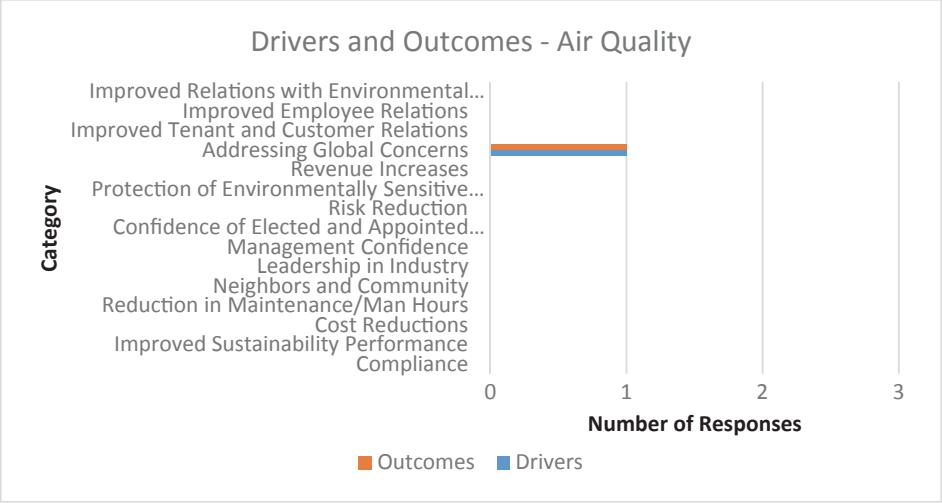

FIGURE D43 Air quality enhancement/climate change—Northwest Mountain (*Source*: D. Prather 2016).

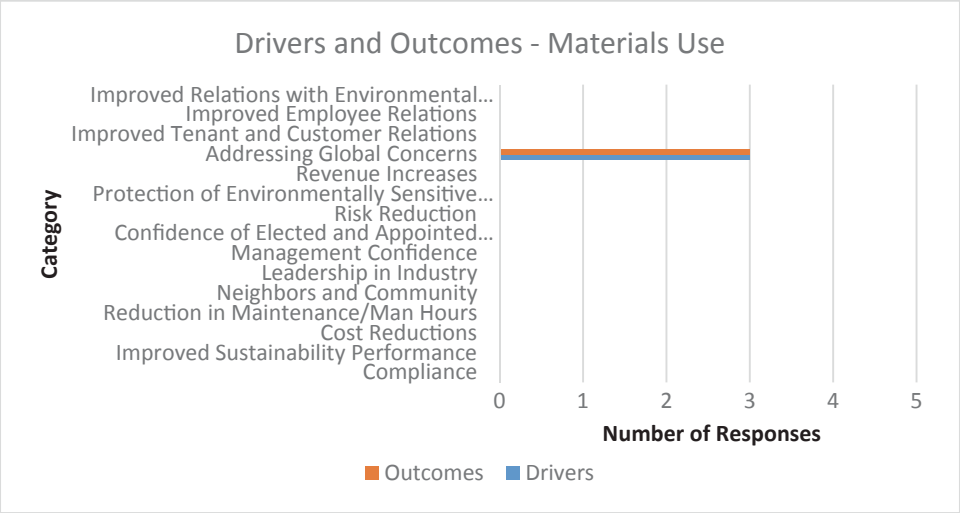

FIGURE D44 Materials use and solid waste reduction/recycling—Northwest Mountain (*Source*: D. Prather 2016).

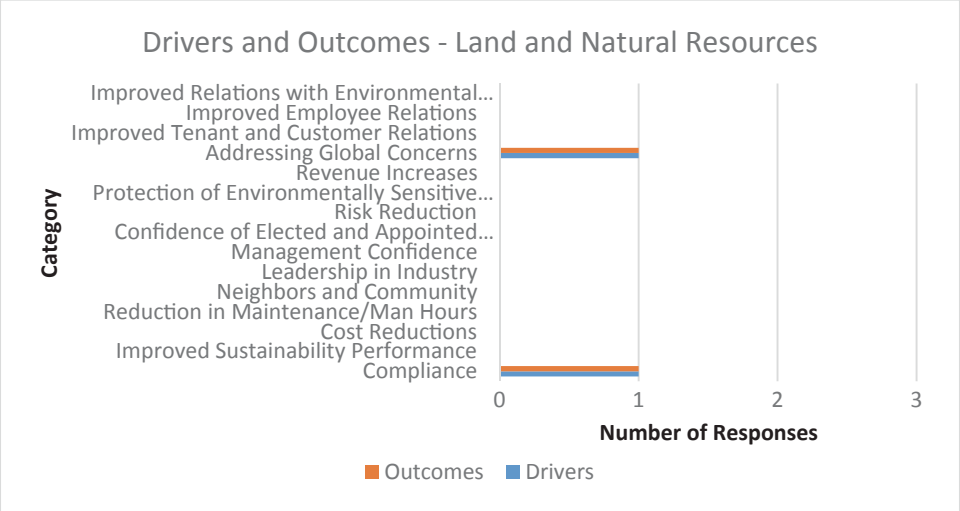

FIGURE D45 Land and natural resources management—Northwest Mountain (*Source*: D. Prather 2016).

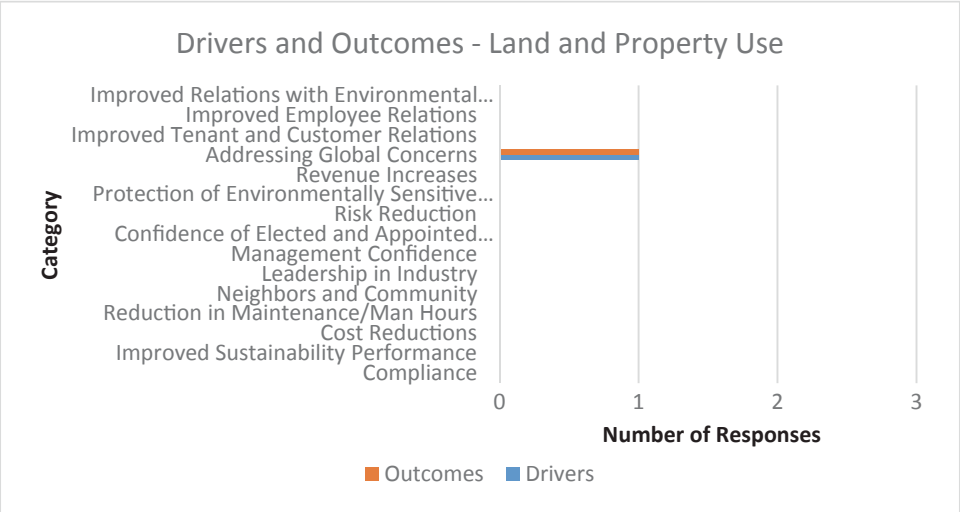

FIGURE D46 Land/property use—Northwest Mountain (*Source*: D. Prather 2016).

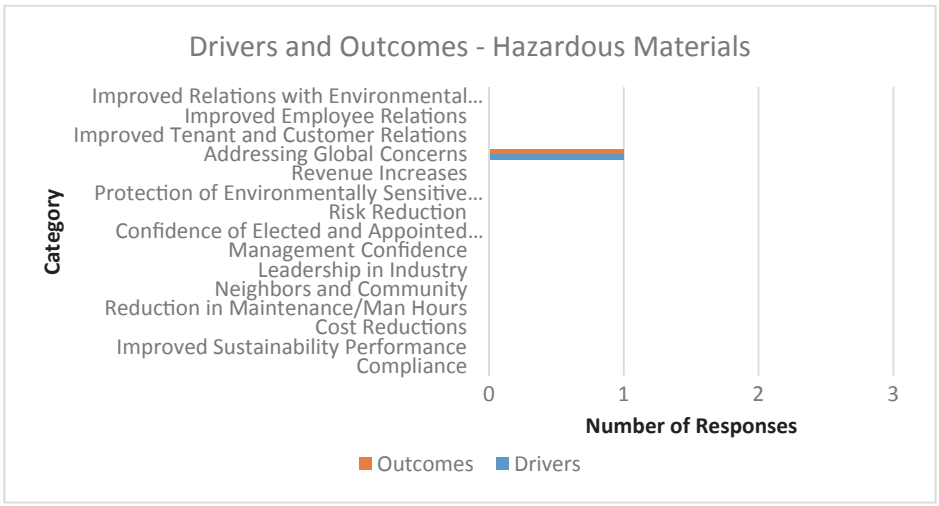

FIGURE D47 Hazardous materials and waste management/reduction—Northwest Mountain (*Source*: D. Prather 2016).

airports in the Northwest Mountain region reported the same driver and the identical outcome, which suggests that noise abatement programs are successful at improving community relations (Figure D48).

Water Quality Protection and Water Conservation Airports pursuing initiatives in the water quality protection and water conservation category report four drivers and outcomes. These drivers and outcomes are identical, meaning that projects were successful at producing the outcomes that initially motivated the airport to pursue the projects. These drivers and outcomes include improved compliance, improved sustainability performance, cost reduction, and addressing global concerns (Figure D49).

Energy Conservation/Renewable Energy Participating airports pursuing energy conservation/renewable energy initiatives report five categories of drivers and three categories of outcomes. Drivers include improved sustainability performance, cost reductions, reductions in maintenance/man hours, risk reductions, and increase in revenue. Outcomes include improved sustainability performance, cost reductions, and reduction in maintenance/man hours. It appears from the data that risk reduction and revenue increase, although initially serving as a motivator, did not actually result from the project. Some of these airports reported their projects were so new, they had not yet seen outcomes, which partially explains the discrepancy between drivers and outcomes reported in the data (Figure D50).

Airports Without Sustainable Initiatives

Airports not yet having pursued sustainable initiatives were presented several statements that reflect beliefs about environmental sustainability. When asked to indicate their level of agreement or disagreement with these statements, responses were received as presented in Figure D51.

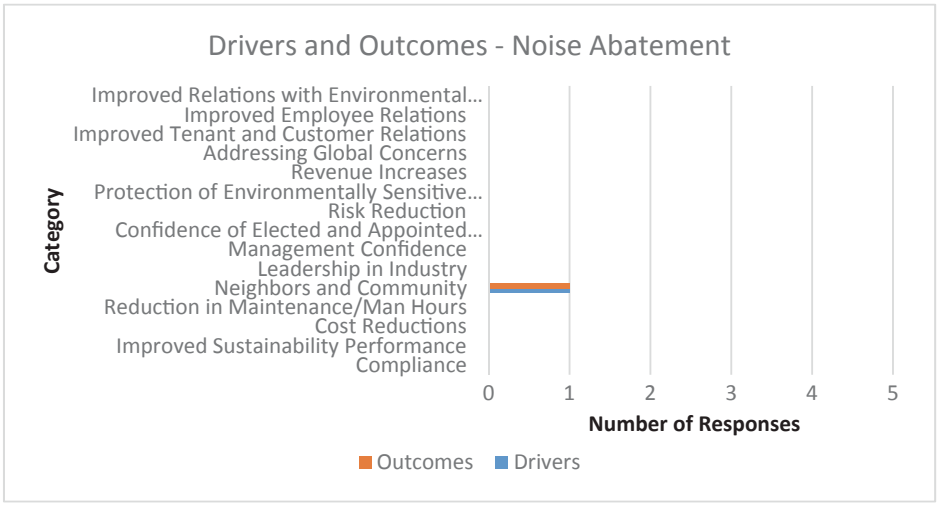

FIGURE D48 Noise abatement—Northwest Mountain (*Source*: D. Prather 2016).

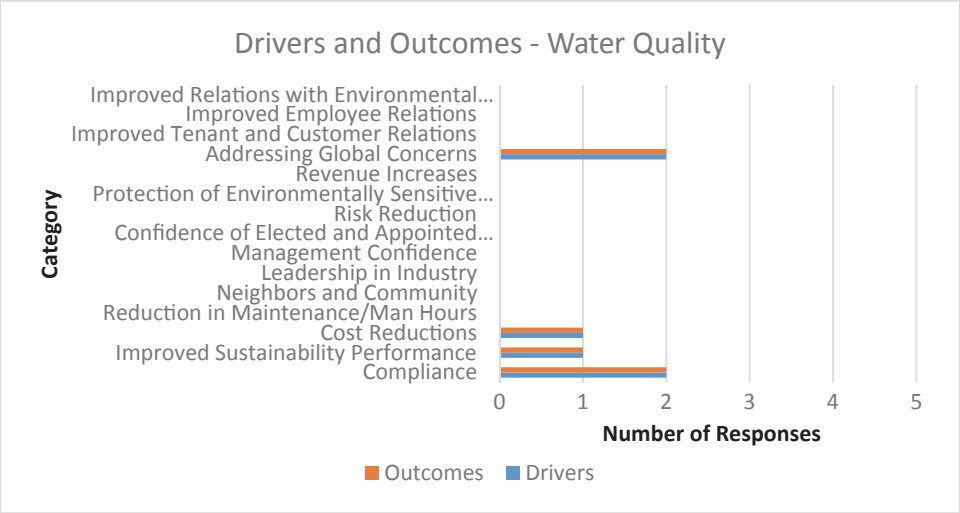

FIGURE D49 Water quality protection and water conservation—Northwest Mountain (*Source*: D. Prather 2016).

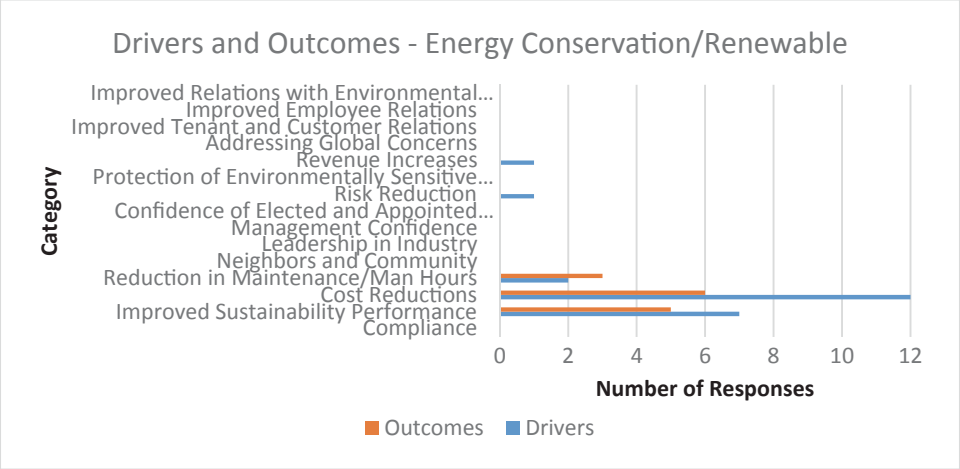

FIGURE D50 Energy conservation/renewable energy—Northwest Mountain (*Source*: D. Prather 2016).

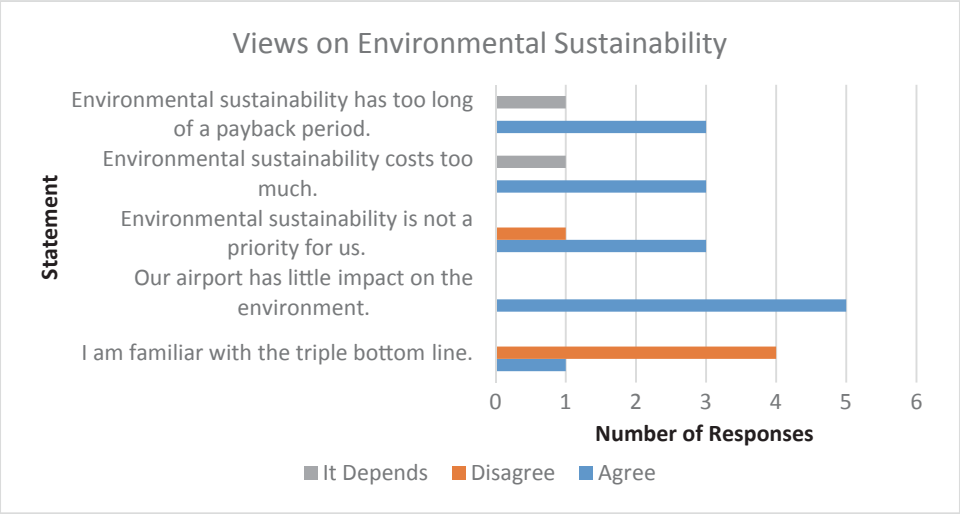

FIGURE D51 Views on environmental sustainability—Northwest Mountain (*Source*: D. Prather 2016).

SOUTHERN REGION

There were 48 participating airports from the Southern region.

Airports with Sustainable Initiatives

Sustainable Projects

Thirty-six of the 48 participating airports have adopted one or more sustainable initiatives. Airports report sustainable initiatives in eight categories. Although the most common is energy conservation/renewable energy, other categories include economic vitality/operational efficiency, noise abatement, water quality protection and water conservation, land and natural resources management, land/property use, materials use and solid waste reduction/recycling, and hazardous materials and waste management/reduction (Figure D52).

Drivers and Outcomes

Economic Vitality/Operational Efficiency Airports with sustainable initiatives in the economic vitality/operational efficiency category report two drivers and identical outcomes: improved sustainability performance and cost reductions (Figure D53).

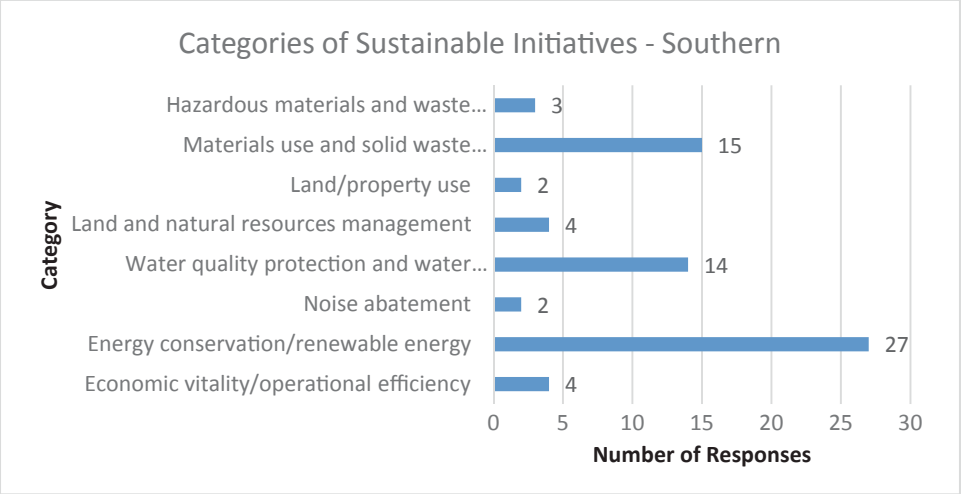

FIGURE D52 Categories of sustainable initiatives—Southern (*Source*: D. Prather 2016).

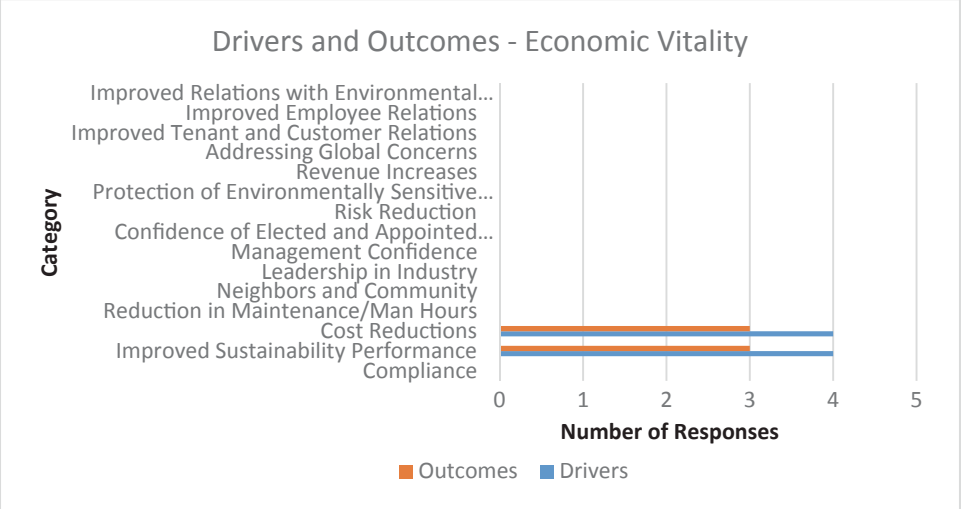

FIGURE D53 Economic vitality/operational efficiency—Southern (*Source*: D. Prather 2016).

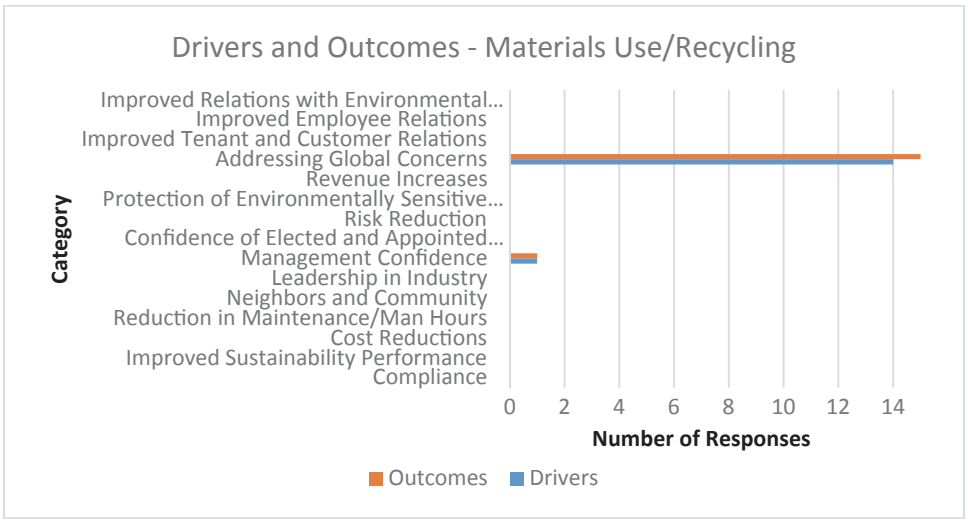

FIGURE D54 Materials use and solid waste reduction/recycling—Southern (*Source*: D. Prather 2016).

Materials Use and Solid Waste Reduction/Recycling Airports with one or more initiatives in materials use and solid waste reduction/recycling report two drivers and identical outcomes: greater management confidence and addressing global concerns (Figure D54).

Land and Natural Resources Management Airports with at least one initiative in the category of land and natural resources management report two drivers and identical outcomes. These two drivers and outcomes were improved compliance and addressing global concerns (Figure D55).

Land/Property Use Airports with one or more initiatives in the category of land/property use report two drivers and identical outcomes. These drivers and outcomes are protection of environmentally sensitive receptors and addressing global concerns (Figure D56).

Hazardous Materials and Waste Management/Reduction Airports that have pursued sustain-able initiatives in the category of hazardous materials and waste management/reduction report two drivers and identical outcomes: improved compliance and addressing global concerns (Figure D57).

Noise Abatement Airports with at least one sustainable initiative in the category of noise abatement report one driver and identical outcome: improved relationships with the community (Figure D58).

Water Quality Protection and Water Conservation Airports with sustainable initiatives in water quality protection and water conservation report several drivers with identical outcomes. The most common driver and outcome was compliance. Additional drivers and outcomes include improved sustainability performance, cost reductions, and addressing global concerns (Figure D59).

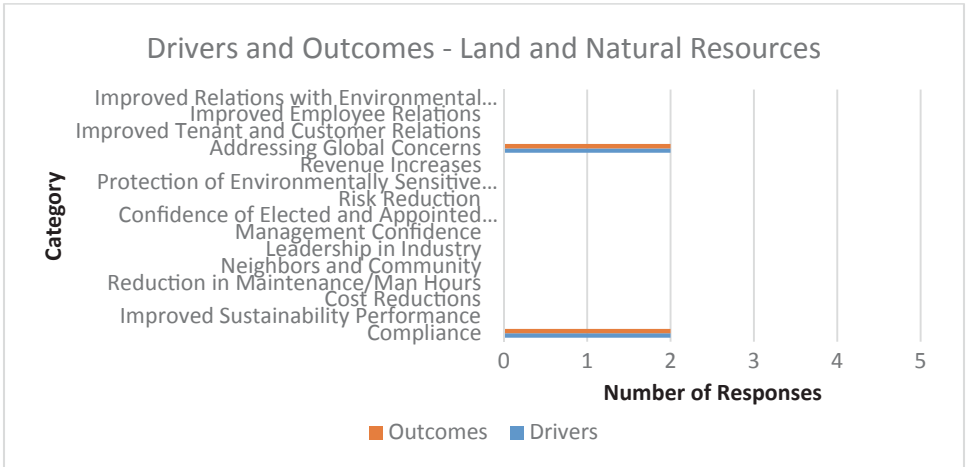

FIGURE D55 Land use and natural resources management—Southern (*Source*: D. Prather 2016).

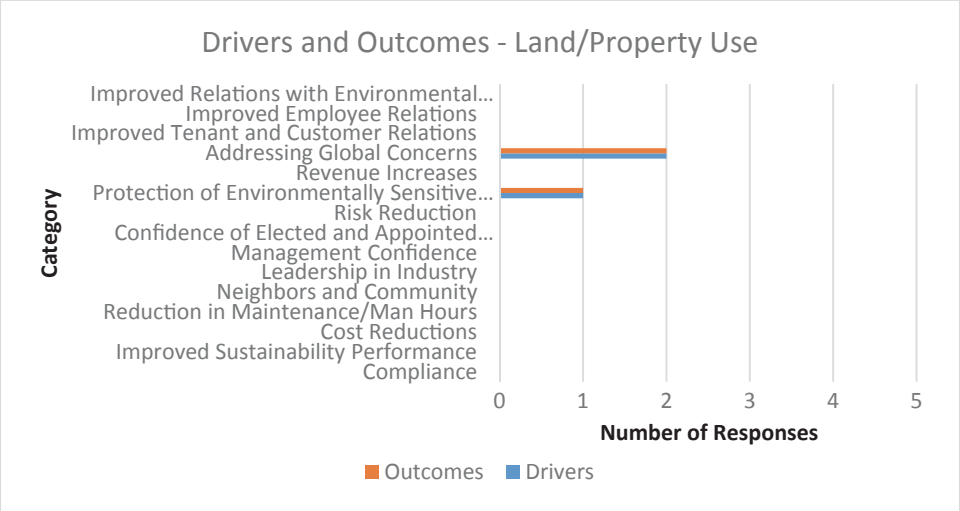

FIGURE D56 Land/property use—Southern (*Source*: D. Prather 2016).

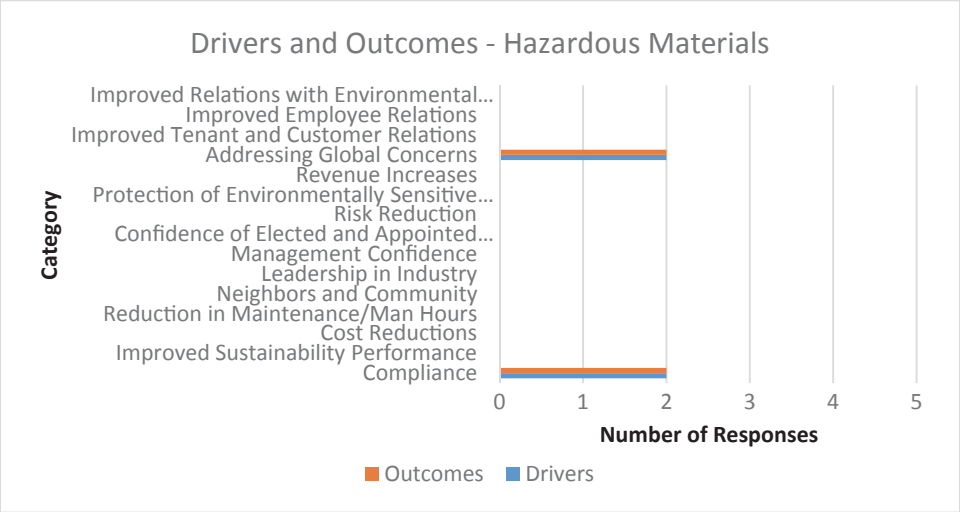

FIGURE D57 Hazardous materials and waste management/reduction—Southern (*Source*: D. Prather 2016).

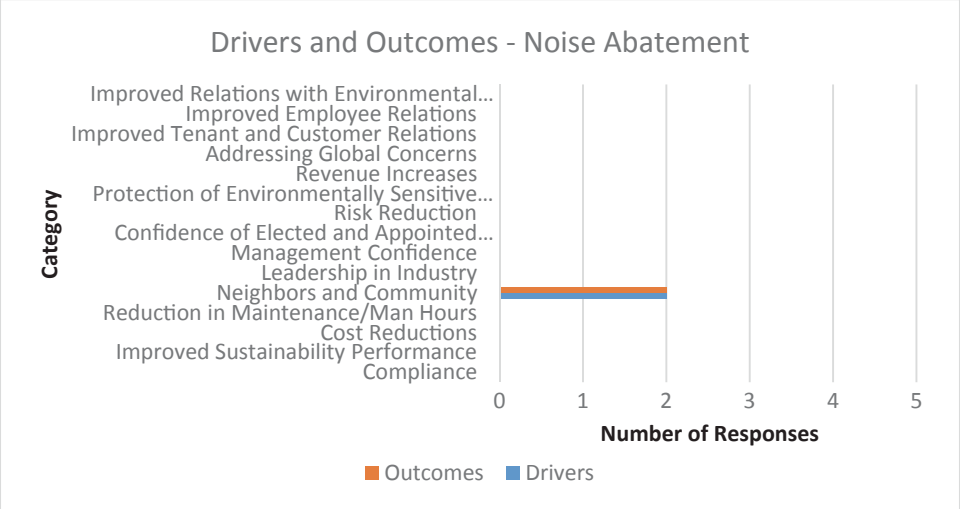

FIGURE D58 Noise abatement—Southern (*Source*: D. Prather 2016).

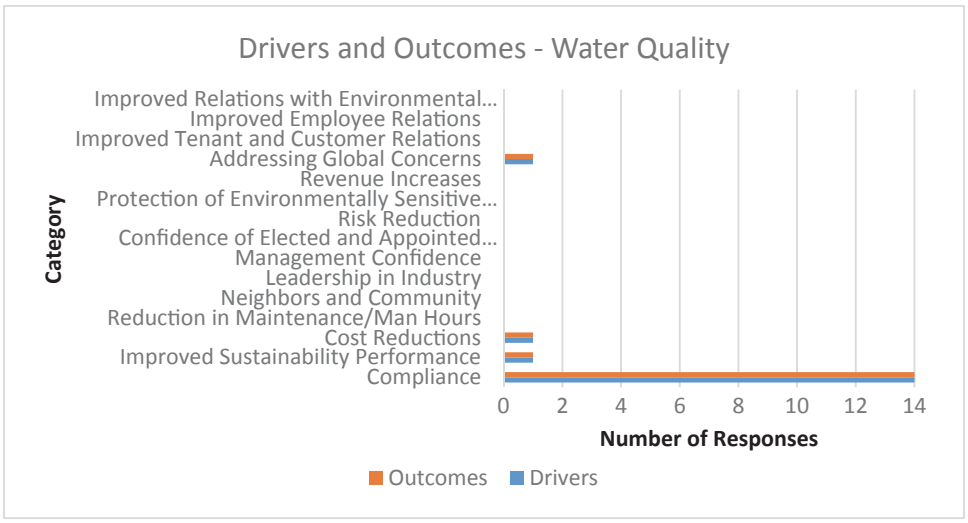

FIGURE D59 Water quality protection and water conservation—Southern (*Source*: D. Prather 2016).

Energy Conservation/Renewable Energy Airports with at least one sustainable initiative in the category of energy conservation/renewable energy report three drivers with identical outcomes. These drivers and outcomes are improved sustainability performance, cost reductions, and reduction in maintenance/man hours (Figure D60).

Airports Without Sustainable Initiatives

For those airports not yet having pursued at least one sustainable initiative, they were asked to indicate their agreement or disagreement with several statements reflecting beliefs of environmental sustainability. Responses are presented in Figure D61.

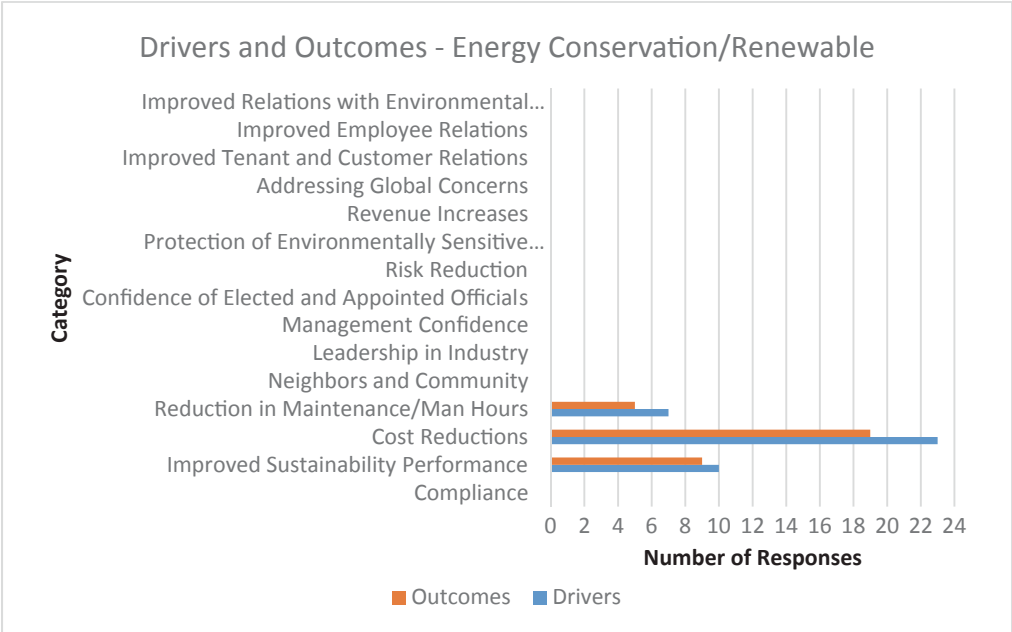

FIGURE D60 Energy conservation/renewable energy—Southern (*Source*: D. Prather 2016).

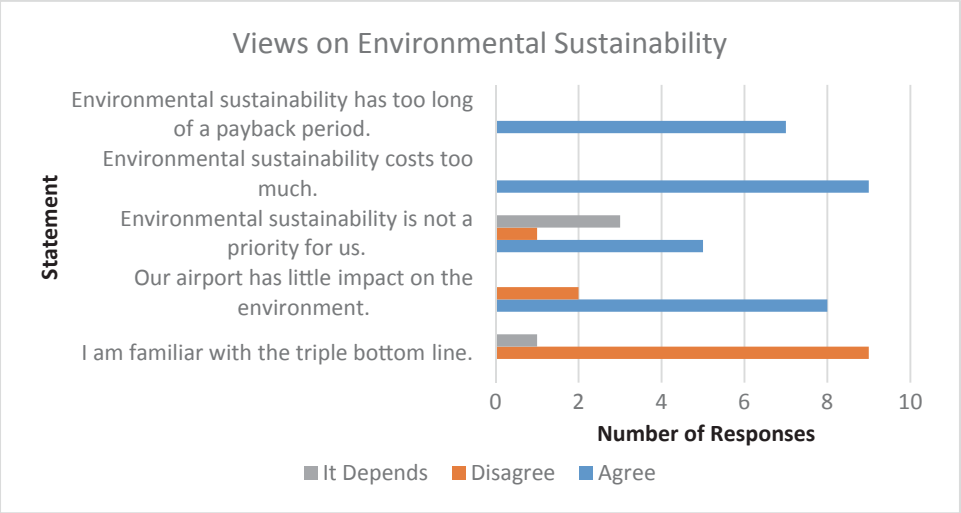

FIGURE D61 Views on environmental sustainability—Southern (*Source*: D. Prather 2016).

SOUTHWEST REGION

Of the 37 participating airports in the Southwest region, 22 (60%) have pursued one or more sustainable initiatives.

Airports with Sustainable Initiatives

Sustainable Projects

Most commonly, airports report one or more initiatives in the category of energy conservation/renewable energy. Other categories of sustainable initiatives include noise abatement, water quality protection and water conservation, land and natural resources management, pavement management, materials use and solid waste reduction/recycling, and hazardous materials and waste management/reduction (Figure D62).

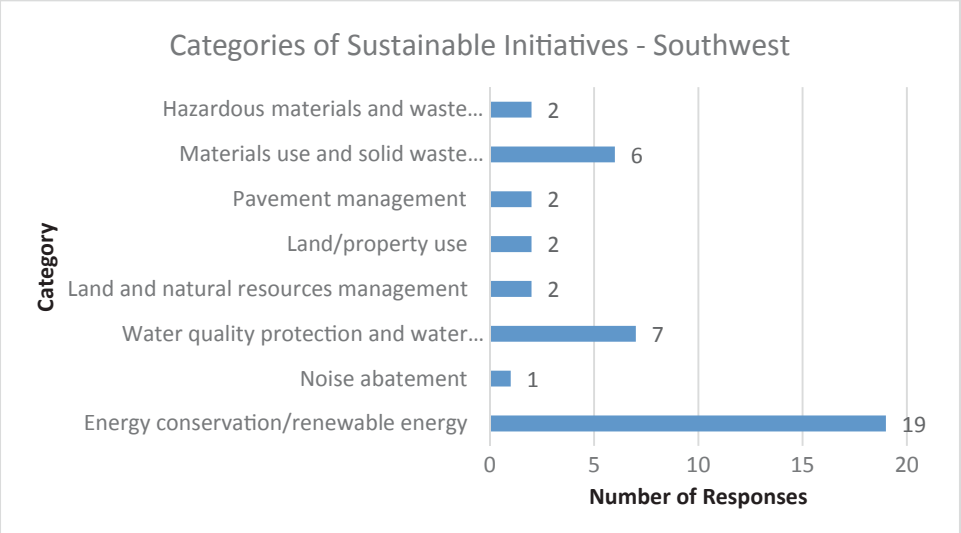

FIGURE D62 Categories of sustainable initiatives—Southwest (*Source*: D. Prather 2016).

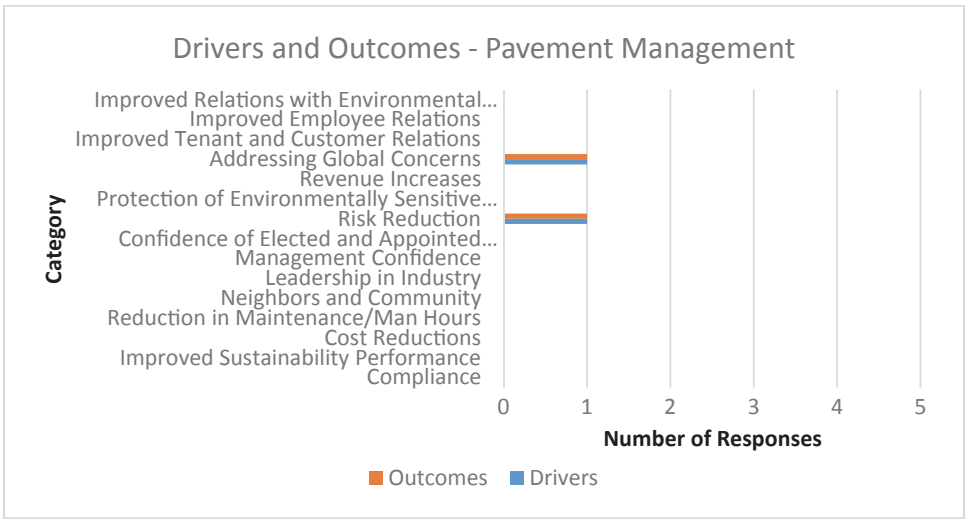

FIGURE D63 Pavement management—Southwest (*Source*: D. Prather 2016).

Drivers and Outcomes

Pavement Management Sustainable initiatives reported by airports in the area of pavement management have only two associated drivers and identical outcomes. These drivers and outcomes are addressing global concerns and risk reduction (Figure D63).

Materials Use and Solid Waste Reduction/Recycling Airports with one or more initiatives in the category of materials use and solid waste reduction/recycling reported only one driver and identical outcome. Addressing global concerns served as both a motivator and outcome for these airports (Figure D64).

Land and Natural Resources Management Airports with one or more initiatives in the category of land and natural resources management report two drivers and identical outcomes. These drivers and outcomes are addressing global concerns and management confidence (Figure D65).

Hazardous Materials and Waste Management/Reduction Airports with one or more initiatives in the category of hazardous materials and waste management/reduction report two drivers and identical outcomes. These drivers and outcomes are compliance concerns and addressing global concerns (Figure D66).

Noise Abatement Airports reporting one or more initiatives in the category of noise abatement report the one driver and identical outcome that is common among all regions—neighbors and community (Figure D67).

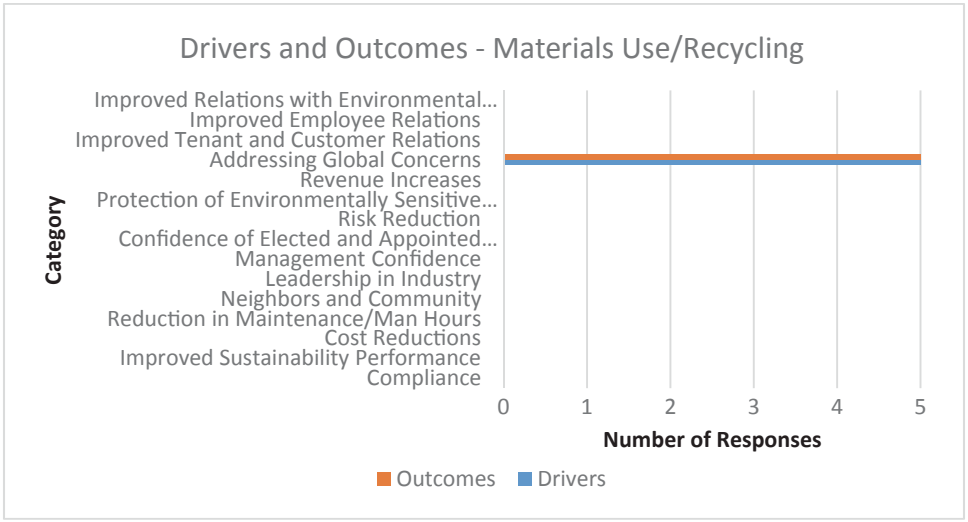

FIGURE D64 Materials use and solid waste reduction/recycling—Southwest (*Source*: D. Prather 2016).

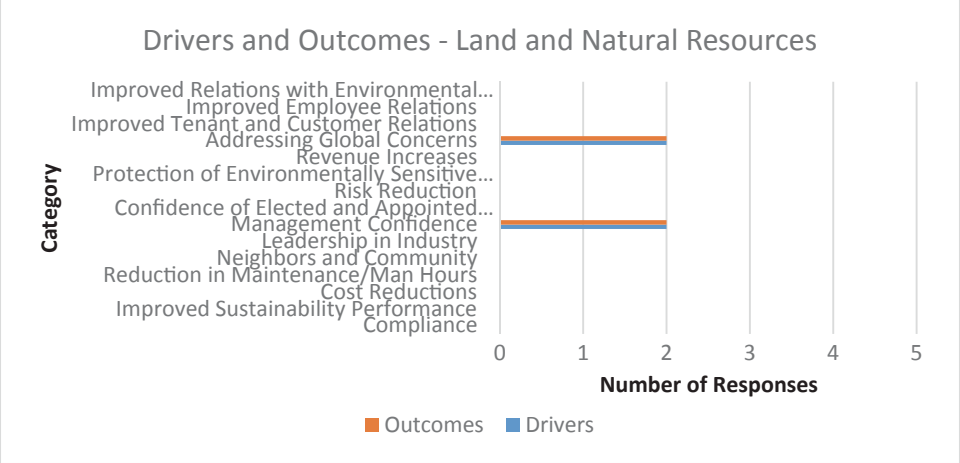

FIGURE D65 Land and natural resources management—Southwest (*Source*: D.Prather 2016).

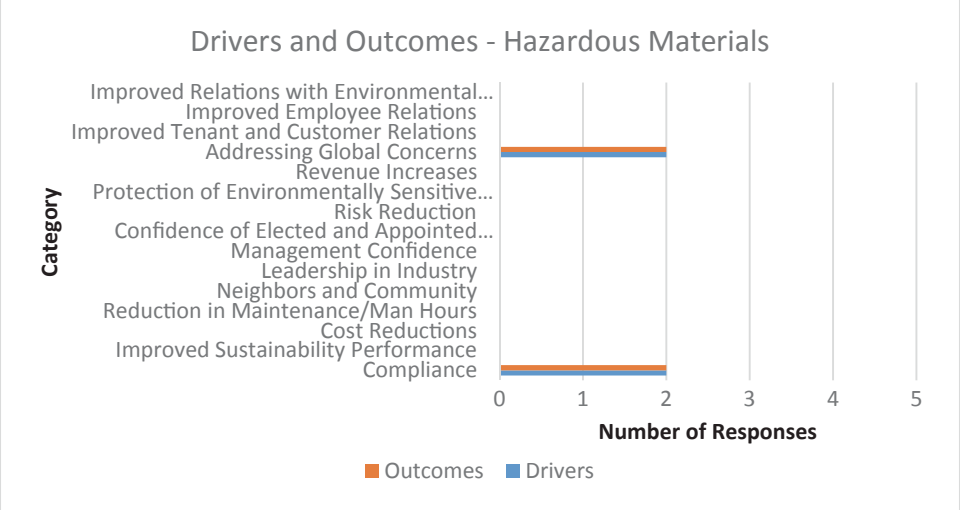

FIGURE D66 Hazardous materials and waste management/reduction—Southwest (*Source*: D. Prather 2016).

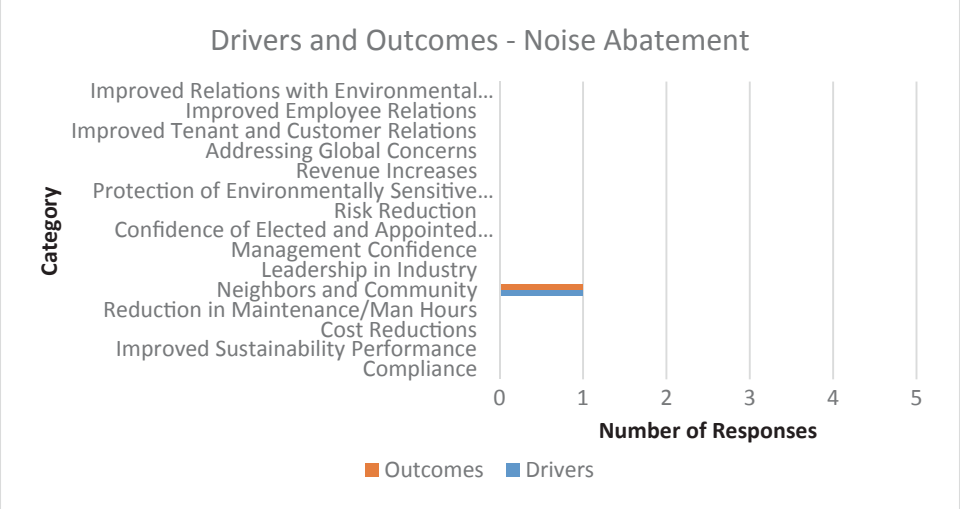

FIGURE D67 Noise abatement—Southwest (*Source*: D. Prather 2016).

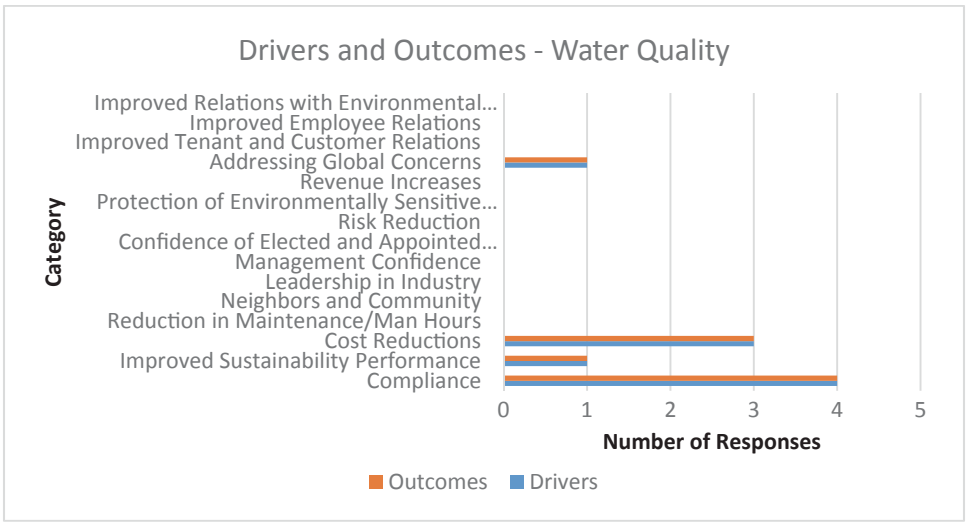

FIGURE D68 Water quality protection and water conservation—Southwest (*Source*: D. Prather 2016).

Water Quality Protection and Water Conservation Airports reporting one or more initiatives in the category of water quality protection and water conservation reported several drivers and identical outcomes. The most commonly reported driver and outcome was compliance. Additional drivers and outcomes were addressing global concerns, cost reductions, and improved sustainability performance (Figure D68).

Energy Conservation/Renewable Energy Airports with one or more sustainable initiatives in the category of energy conservation/renewable energy reported several drivers and identical outcomes. Most commonly reported was the driver and outcome of cost reductions. Additional drivers and outcomes reported include addressing global concerns, reduction in maintenance/man hours, and improved sustainability performance (Figure D69).

Airports Without Sustainable Initiatives

Airports not yet having pursued at least one sustainable initiative were presented several statements reflecting beliefs on environmental sustainability. Their agreement or disagreement with these statements are presented in Figure D70.

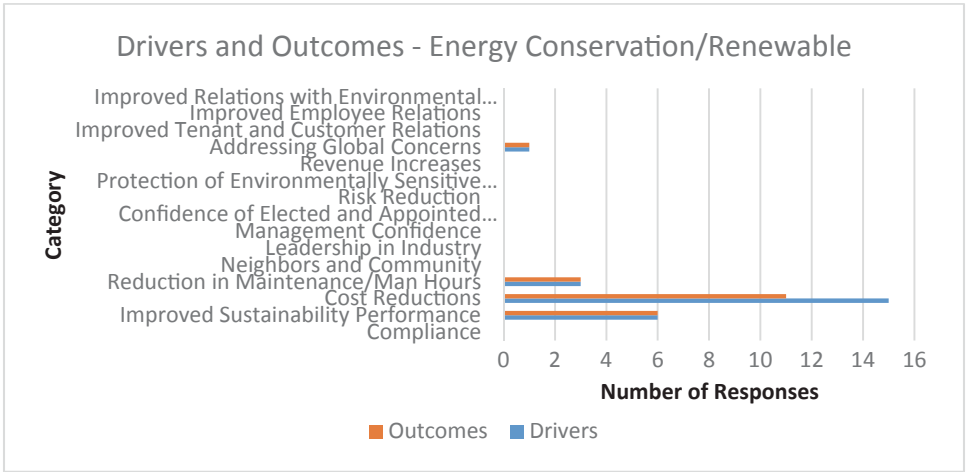

FIGURE D69 Energy conservation/renewable energy—Southwest (*Source*: D. Prather 2016).

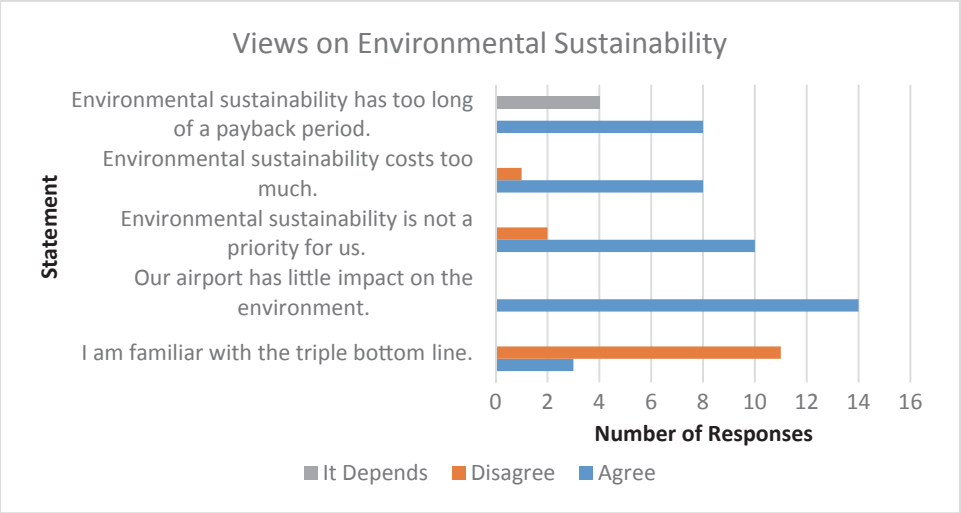

FIGURE D70 Views on environmental sustainability—Southwest (*Source*: D. Prather 2016).

WESTERN PACIFIC REGION

Airports with Sustainable Initiatives

Twenty-five participating airports in the Western Pacific region (representing 81%) have adopted at least one sustainable initiative.

Sustainable Projects

Participating airports in this region report having pursued sustainable initiatives in no less than 10 categories. The two most common categories are energy conservation/renewable energy and material use and solid waste reduction/recycling. Other categories include economic vitality/operational efficiency, air quality enhancement/climate change, noise abatement, water quality protection and water conservation, land and natural resources management, pavement management, hazardous materials waste management/reduction, and buildings/facilities (Figure D71).

Drivers and Outcomes

Economic Vitality/Operational Efficiency Airports reporting one or more sustainable initiatives in the category of economic vitality/operational efficiency reported three drivers and identical outcomes (Figure D72).

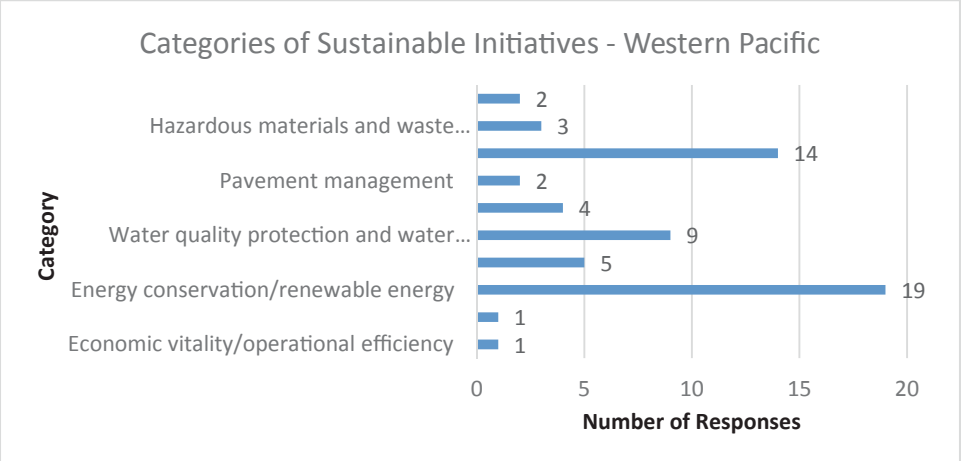

FIGURE D71 Categories of sustainable initiatives—Western Pacific (*Source*: D. Prather 2016).

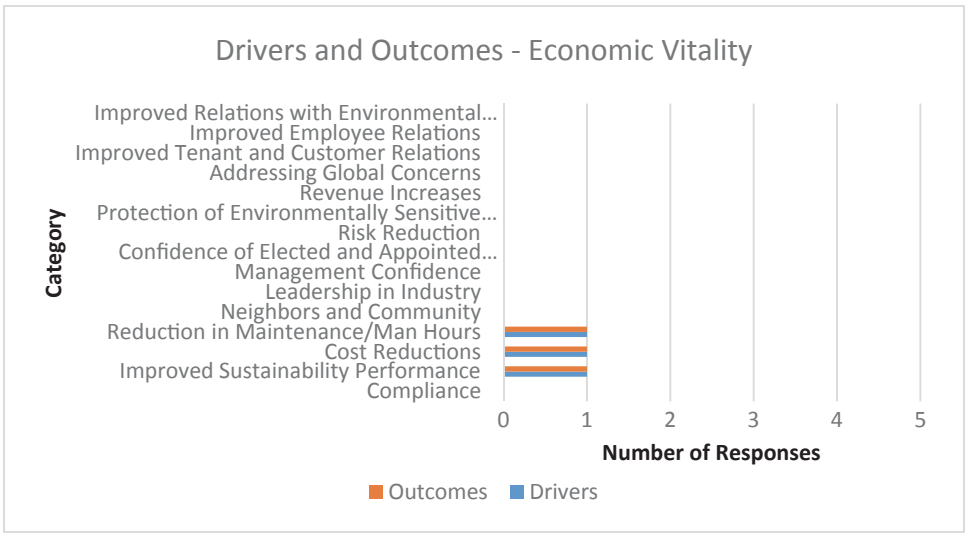

FIGURE D72 Economic vitality/operational efficiency—Western Pacific (*Source*: D. Prather 2016).

Air Quality Enhancement/Climate Change Airports with sustainable initiatives in the category of air quality enhancement/climate change report only one driver and identical outcome. Addressing global concerns was the driver and outcome reported (Figure D73).

Pavement Management Airports with one or more sustainable initiatives in the category of pavement management report only one driver and identical outcome—improved sustainability performance (Figure D74).

Materials Use and Solid Waste Reduction/Recycling Airports reporting one or more initiatives in the category of materials use and solid waste reduction/recycling reported several drivers and outcomes. The most commonly reported driver was addressing global concerns. These airports reported an identical outcome of addressing global concerns. Additional drivers and outcome include desire for improved sustainability performance, and revenue increases. Interestingly, cost reduction was reported as a driver but not an outcome (Figure D75).

Land and Natural Resources Management Airports reporting one or more initiatives in the category of land and natural resources management reported multiple drivers and outcomes. Areas where drivers and outcomes were identical include addressing global concerns, management confidence, neighbors and community, reduction in maintenance/man hours, cost reductions, improved sustainability performance, and compliance. Risk reduction was reported as an outcome but had not been reported as a driver (Figure D76).

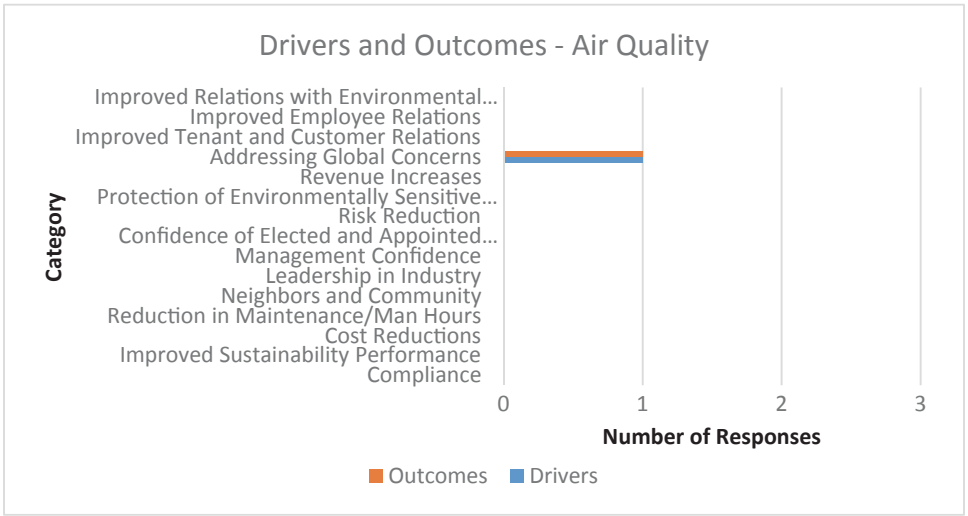

FIGURE D73 Air quality enhancement/climate change—Western Pacific (*Source*: D. Prather 2016).

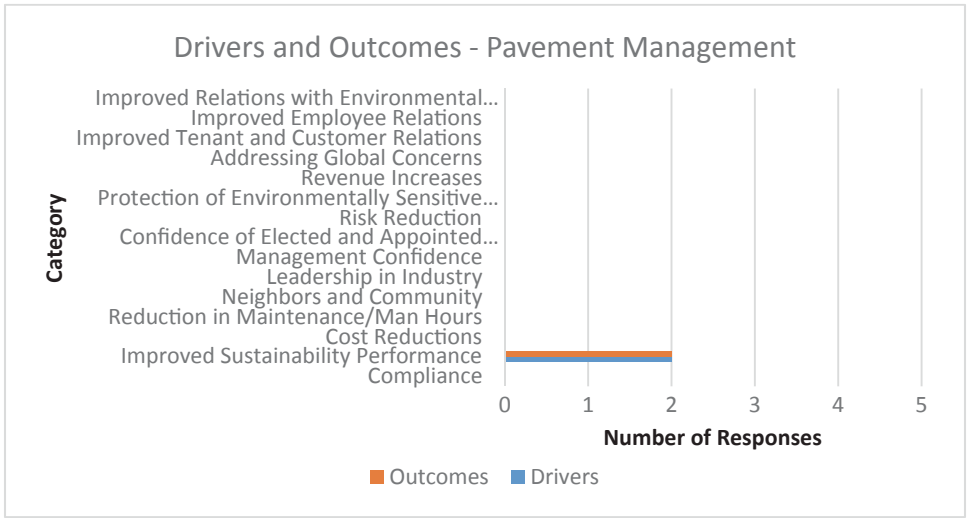

FIGURE D74 Pavement management—Western Pacific (*Source*: D. Prather 2016).

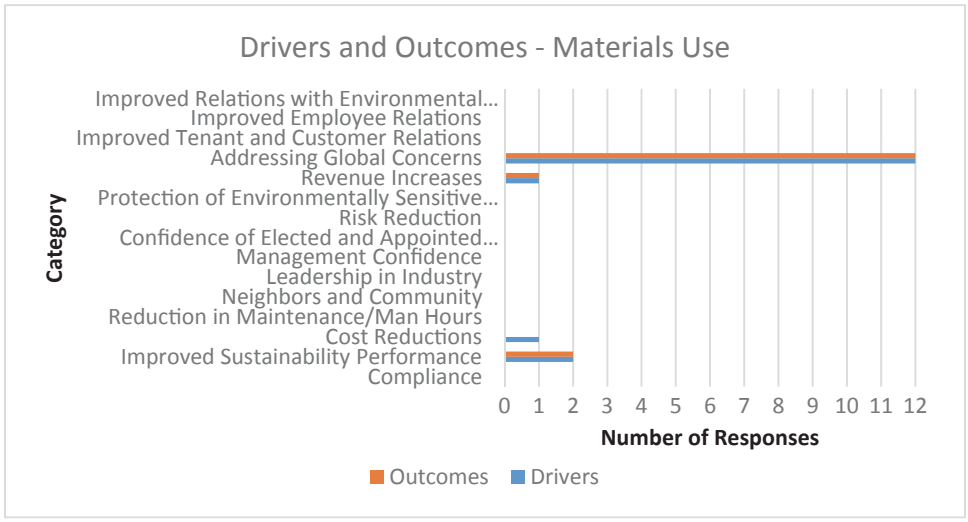

FIGURE D75 Materials use and solid waste reduction/recycling—Western Pacific (*Source*: D. Prather 2016).

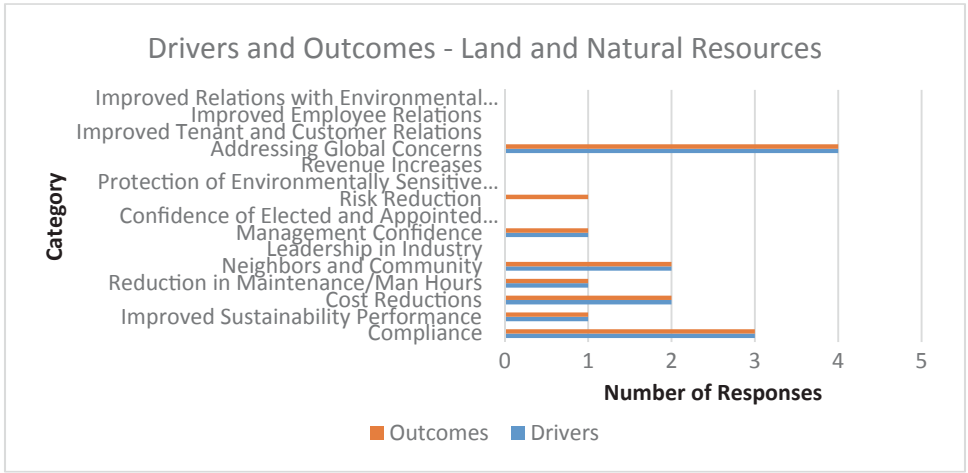

FIGURE D76 Land and natural resources management—Western Pacific (*Source*: D. Prather 2016).

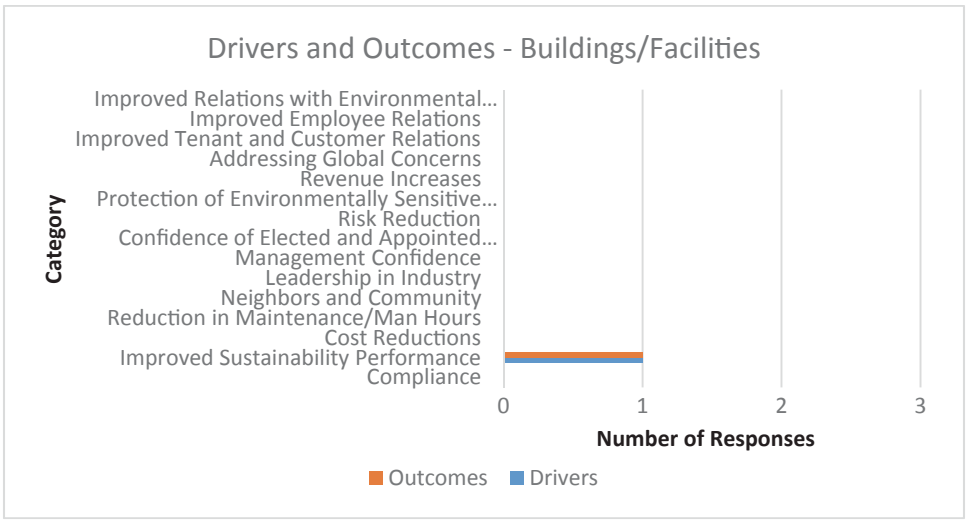

FIGURE D77 Buildings/facilities—Western Pacific (*Source*: D. Prather 2016).

Buildings/Facilities Airports with sustainable initiatives in the category of buildings/facilities report only one driver and identical outcome—improved sustainability performance (Figure D77).

Hazardous Materials and Waste Management/Reduction Airports with one or more initiatives in the category of hazardous materials and waste management/reduction report two drivers and identical outcomes. Addressing global concerns was most commonly reported, but compliance concerns were reported as well (Figure D78).

Noise Abatement Airports reporting one or more initiatives in the category of noise abatement reported the common driver and identical outcome—neighbors and community. However, these airports also reported a driver of risk reduction. This driver was not realized as an outcome, however (Figure D79).

Water Quality Protection and Water Conservation Airports reporting one or more initiatives in the category of water quality protection and water conservation reported multiple drivers and outcomes. Drivers include compliance concerns, desire for improved sustainability performance, cost reductions, neighbors and community, and addressing global concerns. Outcomes include improved compliance, improved sustainability performance, cost reduction, improved relationships with neighbors and community, greater management confidence, addressing global concerns, and improved employee relationships.

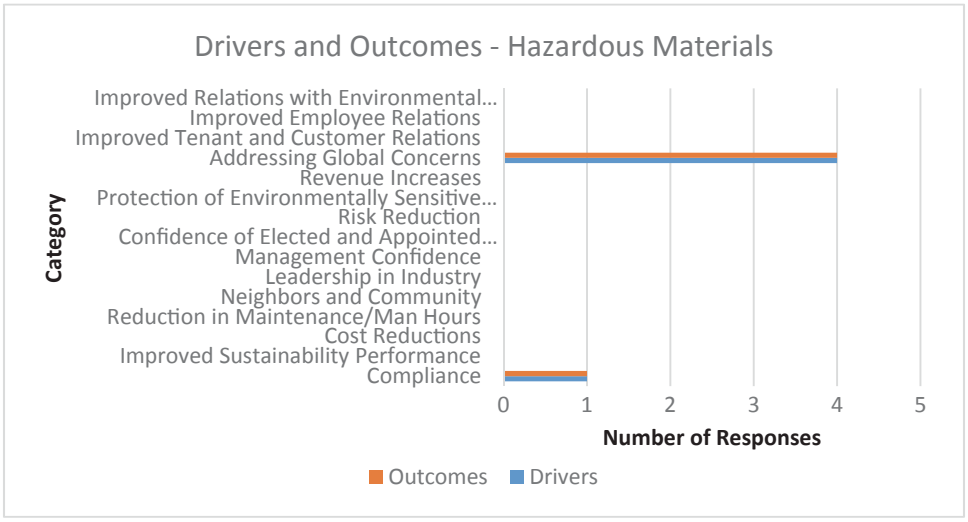

FIGURE D78 Hazardous materials and waste management/reduction—Western Pacific (*Source*: D. Prather 2016).

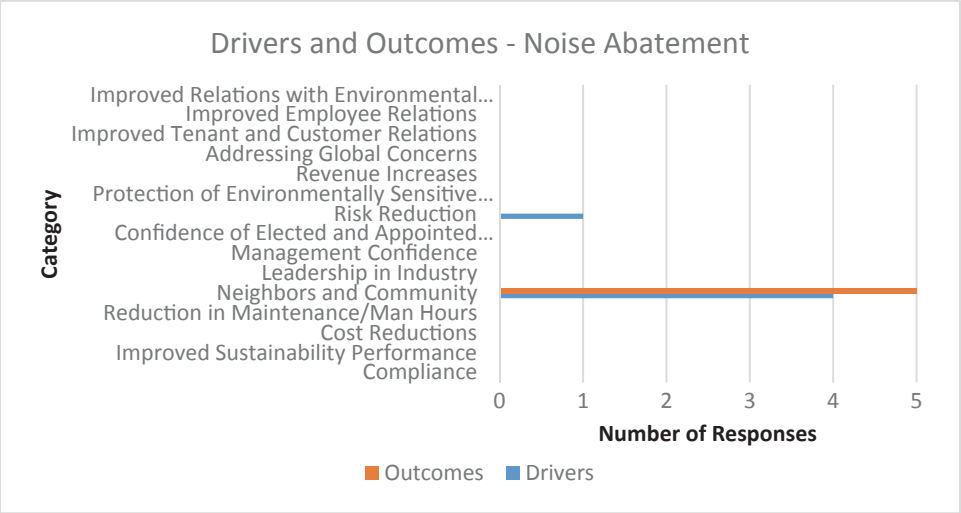

FIGURE D79 Noise abatement—Western Pacific (*Source*: D. Prather 2016).

Interestingly, improved employee relations and management confidence were reported as unexpected outcomes (Figure D80).

Energy Conservation/Renewable Energy Airports reporting one or more sustainable initiatives in the category of energy conservation/renewable energy reported multiple drivers and outcomes. The most commonly reported driver and identical outcome was cost reductions. Additional drivers and outcomes are compliance concerns, desire for improved sustainability performance, reduction in maintenance/man hours, neighbors and community, revenue increases, and addressing global concerns. Drivers that did not have corresponding outcomes include improved relations with environmental organizations, improved tenant and customer interest relations, protection of sensitive environmental receptors, airport management confidence, and confidence of elected or appointed officials (Figure D81).

Airports Without Sustainable Initiatives

Those airports not having reported pursuing any sustainable initiatives were presented several statements reflecting environmental beliefs and asked to indicate their agreement or disagreement. Results are presented in Figure D82.

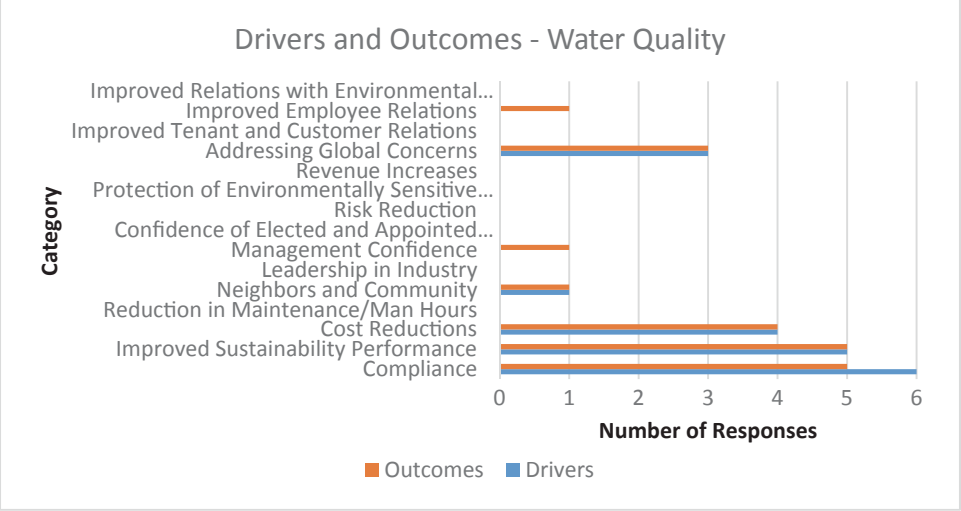

FIGURE D80 Water quality protection and water conservation—Western Pacific (*Source*: D. Prather 2016).

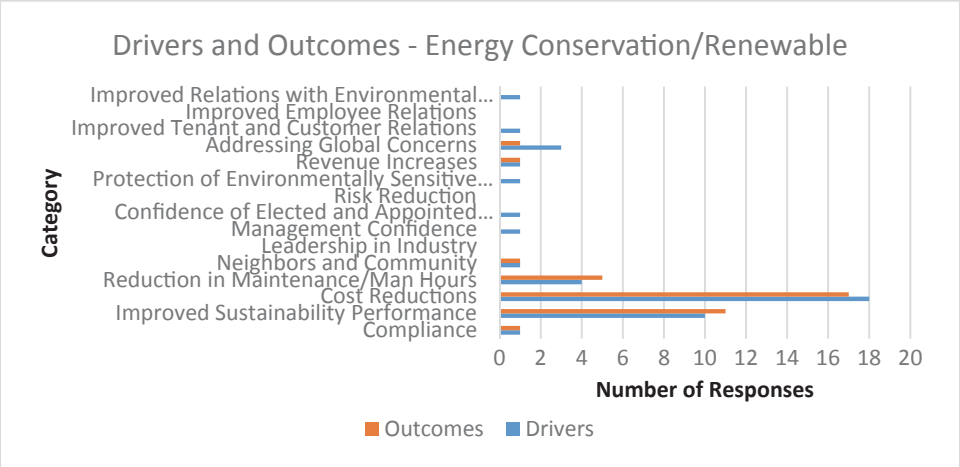

FIGURE D81 Energy conservation/renewable energy—Western Pacific (*Source*: D. Prather 2016).

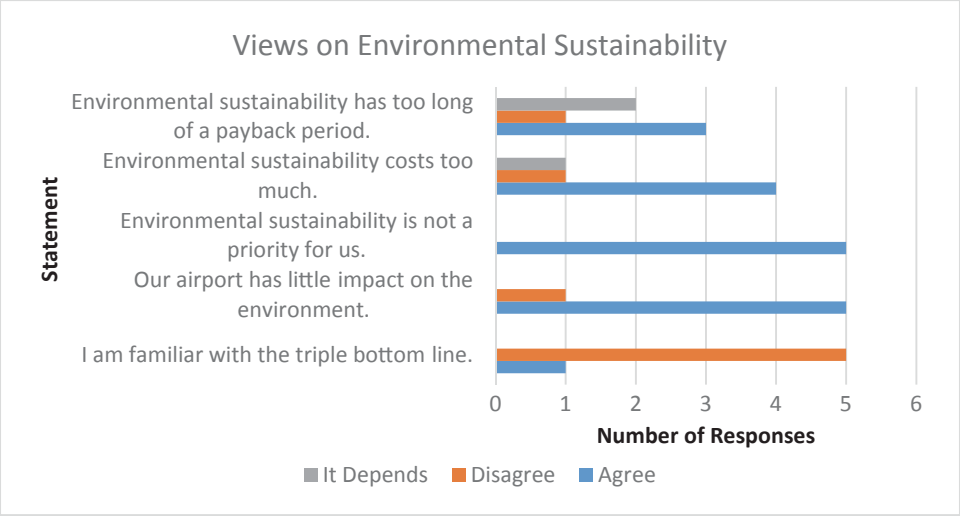

FIGURE D82 Views on environmental sustainability—Western Pacific (*Source*: D. Prather 2016).

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TDC	Transit Development Corporation
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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