Measuring Sustainability in Civil Engineering: Development, Testing and Implementation of the Greenroads™ Rating System

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Abstract

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There is no commonly accepted way to measure sustainability performance in civil engineering projects. The Greenroads™ Rating System was developed to bridge this gap in performance measurement for transportation projects and is an international standard for sustainable design and construction of roadways. Greenroads is a voluntary tool intended to aid roadway owners, designers, and contractors in choosing activities that result in a more sustainable project, while also recognizing successful implementation and encouraging innovation.

This research presents the results of testing the Greenroads metric on 120 roadway projects. The results provide perspectives on the state of the practice in roadway sustainability, as measured by Greenroads, and the potential for improvement in environmental stewardship, materials management, and construction activities. On average, most projects do not meet the minimum scores to achieve certification, but the potential exists to do so with minimal or no additional construction cost and effort.

Multivariate statistical tests show that there are five qualitative properties of roadway projects that are significant to resulting performance in Greenroads: a sustainability emphasis or mandate applied during project development, alternative contracting, pavement type, location, and budget. The properties of pavement type and location are recommended for further examination to determine the reason behind apparent advantages conferred on specific pavement types and locations. Sustainability policies, integrated project delivery, and financial leverage appear to present

unrealized opportunities for improved sustainability performance. Overall, Greenroads is found to be a reasonable standard for measuring sustainability in the design and construction of transportation projects.

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For Dad

1950-2009

1.0 INTRODUCTION

There is no consistent way to measure sustainability in civil engineering, even though it is generally recognized to be an important issue. While there are tools and standards for measuring sustainability in related industries, none are sufficiently scoped for the transportation sector of civil engineering. Therefore, sustainability on roadway and bridge projects remains elusive. It is difficult to motivate practitioners to be more sustainable since the purpose in doing so is unclear and there are no tools available to execute sustainability on projects. This gap represents a substantial challenge and a remarkable opportunity for a rating system like Greenroads™, which can play a leading role in affecting fundamental change in sustainability performance for roadway projects.

Greenroads was collaboratively developed over five years by this author and over 100 others with the purpose of answering the question "what makes a roadway sustainable?" Greenroads represents the leading edge of sustainability best practices in design and construction. This dissertation represents the final phase in the development of the Greenroads Rating System, which includes statistical testing and measuring performance on 120 roadway projects. These projects represent a wide variety of types of projects, locations, stages of project development, and typical roadway design and construction practices used over the last ten years. In addition to the main question, there are three more questions which this research seeks to answer:

- Is Greenroads fair, balanced and applicable to all roadway projects?
- What is the current state of the practice as measured by Greenroads?
- Does Greenroads meet the intent of its designers?

The testing process is important to the overall success of the system because it will help direct future research, determine strengths and weaknesses in existing practice and the Rating System itself, and ultimately show whether or not the system fits its purpose and goal. Results of testing will provide new perspective on sustainability in roadway projects, show whether Greenroads can be used as a viable performance measurement tool on real road and bridge projects, and help determine what such a tool means to the transportation industry for sustainability.

1.1 STUDY APPROACH AND OBJECTIVES

This study has several parts, outlined below.

1. Provide a definition of sustainability for use in this research (Chapter 2).
2. Review existing literature to identify the state of the market for sustainability in the transportation discipline of civil engineering (Chapter 3) and the state of the practice in performance measurement for sustainability in transportation (Chapter 4).
3. Provide a brief background on the initial development and iterations of the Greenroads Rating System and its objectives (Chapter 5) (Muench, Anderson, Hatfield, Koester & Söderlund, 2011).
4. Collect roadway project data for use in testing the performance measurement tool (Chapter 6).
5. Discuss the scoring method used for this research to score the roadway projects (Chapter 7)
6. Test the tool determine if it is viable in the proposed context and meets the proposed goals of its designers (Chapter 8).
7. Review the results to determine which project properties and conditions contribute most significantly to the sustainability performance of a roadway project (Chapters 9-10).
8. Discuss the results and provide suggestions for possible future studies related to this research (Chapters 11-12).

1.2 RESEARCH SIGNIFICANCE

This research is significant because:

- Roadway projects represent a majority of public spending in transportation (U.S. Census Bureau, 2011), meaning that such a tool can have a high impact by creating a new market for sustainable roadway projects.
- A performance measurement tool called the Greenroads™ Rating System was developed over several years and meets a variety of economic, social, policy and educational needs in the transportation sector.
- Greenroads was tested on 120 different roadway projects to understand how well it can measure sustainability performance.
- The research captures 24 new ideas that could be incorporated into Greenroads and discovers some important areas for improving the system in the future.
- The statistical tests show that Greenroads is a viable tool for measuring transportation project sustainability. The scores of these projects effectively establish a benchmark for sustainability in transportation projects where none previously existed.

1.3 BRIEF HIGHLIGHTS OF FINDINGS

Project score results show some general trends, such as:

- Typical roadway projects are within reach of earning the minimum level of certification with minimal additional effort and low to no additional cost to the initial construction price.
- Most typical projects do not meet the minimum Project Requirements necessary for certification because some of these activities require effort beyond what is traditionally considered in early decision making for a roadway project. However, these activities are all documented to have been achieved on many roadway projects in the sample, demonstrating that they are possible to complete.
- Despite all significant existing research in the area of lifecycle cost and environmental impacts, these activities appear to be rarely considered on roadway projects during decision making.
- Typical projects do no more than the minimum required for environmental stewardship; however, some projects excel in this area due to a sustainability emphasis or mandate.
- Great potential exists for contributions from the roadway project contractor, especially in the Construction Activities category.
- Some voluntary credits are more commonly achieved than others, potentially indicating an already well-established best practice.

Additionally multivariate analyses show that:

- Project scores are most influenced by five independent qualities: high budget, concrete pavement surface, location in an urban environment, alternative contracting approaches, and the deliberate emphasis of sustainability in project development. A sixth property, if the project was deliberately using the Greenroads Rating System as a design tool or pursuing certification, also resulted in significantly higher scores than typical projects.
- Data quality scores also significantly influence the project's score if it was scored during alignment selection or conceptual planning due to the lack of detailed project information.
- The weighting of credits in the rating system appears to soften the discrepancies between different qualitative project properties, with the exception of pavement surfacing and location.

2.0 AN OVERVIEW OF SUSTAINABILITY

This Chapter provides the functional definition of sustainability for this research, the background of its development, a brief overview of other sustainability definitions as are currently understood in general, and also presents some definitions that are used within (or were specifically developed for) the transportation context. This chapter draws heavily from work previously reported by Anderson (2008) in developing a generalized definition of sustainability for civil engineering. This definition forms the foundation for measuring sustainability in roadway projects within the Greenroads Rating System (Muench et al., 2011).

The purpose of stating a definition is to provide a brief review of the foundational context for discussion and background information included in this research. This Chapter does not collect and display all of the possible definitions of sustainability which are currently being used in any number of contexts and applications. The definition used is specific to this research and to the Greenroads Rating System; however, it is consistent with and supportive of several of the definitions proposed by many, if not all organizations.

2.1 A SYSTEMS-BASED DEFINITION

This work builds on previous writings by the author (Anderson, 2008) in which sustainability was defined in the civil engineering context as follows:

- **Sustainability is a characteristic of a system that reflects its capacity to support natural laws and human values.**

This definition manifested from research in several major areas, summarized briefly below (with applicability for the proposed context of this study as noted).

- **Construction industry drivers**, including popular and political thought about sustainability and broad global environmental, economic and social issues (see Chapter 3 for updates in these areas specific to the research context of transportation). The majority of early research focuses on framing and identifying key environmental issues (MA, 2005; Solomon et al., 2007) since sustainability is usually associated with a particular environmental benefit or number of benefits. This emphasis on environment is also indicated in the dictionary definition of "sustainable" (American Heritage Dictionary, n.d.) which can be considered representative of common knowledge. Finally, ecosystem services (the monetization of processes that ecosystems provide to humans and the world) play a role in driving the market (MA, 2005; Costanza et al., 1997).

- **Practicing sustainable development**, specifically through sustainable design and sustainable construction applications and activities. Generally, sustainable development means making choices that are considered more environmentally, socially or economically beneficial (ideally, all three if possible). However, it is not always clear if evidence exists to support such a choice, if tradeoffs will be present, or if the risks of unintended consequences were investigated (WCED, 1987; ASCE, 2007; Kibert, 2005, 2008; McDonough, Inc. 2000; Kibert, Sendzimir, Guy, 2000). Those three concerns can be generally summarized by the biggest underlying fear about adopting a sustainable approach: uncertainty. While a transportation project, such as a roadway, can be considered a type of development, the term "sustainable" was not well defined for such projects (Anderson, 2008) or for transportation in general. The absence of this definition was one of the motivators for the development of the Greenroads Rating System described in Chapter 5, which defines specific design and construction activities that are intended to be more sustainable than conventional practice. More recent work by Zietsman et al. (2011) described in Section 2.4 attempts to further clarify sustainability and sustainable development in terms of transportation.
- **Sustainability science** (Clark and Dickson, 2003; Mihelcic et al. 2003; Clark, 2007) and its corollary sustainable ("green") engineering (Anastas and Zimmerman, 2003). This area is probably most relevant to the engineering culture and reflects how many engineers approach decision-making for sustainability, as well as offering to expand the traditional approach to problem-solving through interdisciplinary collaboration. Later in this document, the reader will discover that interdisciplinary collaboration is also an important part of sustainable roadway project development.
- **Economic theories** of strong and weak sustainability (Daly, Cobb and Cobb, 1989; Daly, 1996, 2005; Hawken, Lovins and Lovins, 1999). Overall, the intent of these several authors is to indicate that economic drivers provide a significant influence and, importantly, that there are ways to promote sustainable growth and sustainable development without substantial impacts to resources or environmental, human, manmade and financial capital.

- **Coupled human-environmental systems**, which address the level of integration we have with the natural environment, and the ability (or inability) of us and nature to adapt and be resilient under stress (Liu et al., 2007; Holling, 2001; Wilson, 2002). A key concept behind sustainable development and the Greenroads Rating System is reducing impacts due to these complex interactions by careful selection of design and construction activities (see Muench et al., 2011).
- **Environmental performance measurement**, such as lifecycle assessment (LCA) and lifecycle cost analysis (Rees and Wackernagel, 1996; Matthews and Lave, 1998). Rating system tools are also one means of performance measurement, usually comprised of a number of performance indicators: Greenroads includes environmental performance measurement as well as other human-centered performance measures.

There are seven pervasive themes or principles inferred from the above major areas that consistently appear in any reference to sustainability. These seven ideas are also used to frame each of the activities that are included in the Greenroads Rating System.

The first three principles (called here: Ecology, Economy, and Equity) are most prevalent and explicit in sustainability definitions. Each of these principles is described briefly below with reference to the most relevant works on the subject (if any).

- **Ecology.** Preserve, restore and protect ecosystems; prevent damage to ecosystems. (Robert 2000; 2002; Caldwell, 1999)
- **Economy.** Spend financial resources wisely; reduce costs where possible to promote saving; promote competition and add value through innovation. (Hawken, Lovins and Lovins, 1999; Goodland, 1993; Daly, Cobb and Cobb, 1989; Daly, 1996, 2005)
- **Equity.** Improve quality of life for people, meet basic human needs (i.e. health and safety), assign human value; share values with others. (Maslow, 1943; Max-Neef, 1991; Fisher, 2000; A/RES/42/187; A/CONF.151/26/REV.1[VOL.I] and Corrigendum).

Four additional principles can also be identified and are usually implicit in the research.

- **Extent.** Define boundaries in time and space (where and when does it exist, and for how long) (Rees and Wackernagel, 1994)

- **Expectations.** Set performance goals and outcomes, examine uncertainty, and investigate risks (Holmberg, Lundquist, Robèrt, and Wackernagel, 1999)
- **Experience.** Having and retaining knowledge, teaching.
- **Exposure.** Gaining knowledge, sharing information, learning.

The last four principles appear most frequently in association with tools, models, proposed applications, or practices deemed "sustainable" or "green." A common theme that ties them together is often implementation associated with sustainability, and, more specifically, the measurement of its performance. This author uses the additional principles in order to help frame and discuss sustainability throughout this paper; however, it should be noted, with the exception of the broad theme of education (Experience and Exposure), few of these principles are widely known or used outside of this author's personal research. It is also worth noting the purpose of a common theme in some sustainability literature, education, is split into two parts for this definition — teaching and learning — which indicates the presence of human interaction, communication and also feedback. By design, educational activities are embedded and promoted in Greenroads as well.

2.2 COMPATABILITY AND UTILITY

The proposed definition is compatible with other definitions of sustainability or sustainable development used in international policy (A/RES/42/187; A/CONF.151/26/REV.1[VOL.I] and Corrigendum), resource management, professional engineering organizations, educational institutions with green engineering programs, and also by transportation owner-agencies (Zietsman et al., 2011). It is also consistent with the system assessment principles used in lifecycle evaluation approaches such as lifecycle cost analysis (LCCA), social and economic cost-benefit analysis, and lifecycle assessment (LCA).

While many of definitions offered by other organizations and authors address the three central and well-recognized themes of sustainability (Ecology, Economy and social Equity), none of the definitions are directly actionable in a system like a roadway project. Looking separately at the ideas of Ecology, Economy and Equity defeats the commonly understood purpose of sustainability, which many take to mean thinking of all three principles simultaneously (a.k.a. the "triple bottom line"). However, a true balance of these three areas always seems elusive without addressing sustainability in the initial stages of developing a system such as a roadway project.

A definition must be applied to produce meaningful results. Most sustainability definitions offered in the above topic areas lack utility and are difficult to implement because the meaning cannot be tracked or measured. The proposed definition, however, requires only the context-specific definition of key human values, which are specific to the stakeholders in any system or process. The process of defining values can be useful to help organize behavior in decision-making, prioritize values, and identify final characteristics of a roadway project system based on specific needs of stakeholder groups.

2.3 KEY IDEAS IN THE DEFINITION

There are three key ideas in this definition of sustainability that are described in detail in Anderson (2008). Natural laws, human values, and the emphasis on systems are briefly summarized below in terms of the seven principles of sustainability.

2.3.1 Natural Laws

"Natural laws" encompass the essential sustainability principle of Ecology. Humans live and operate within the context of ecosystems and are governed by natural laws. Natural laws can be understood and illustrated by the simple, albeit oxymoronic, idea that ecosystems are too complex to be fully controlled or understood by humans. The best human understanding and control comes from basic sciences: physics, chemistry and biology. Effectively, mathematics and sciences are the tools by which the limits and current status of the environment are measured. These natural laws form the physical constraints, or Extent, within which all projects must fit.

2.3.2 Human Values

Robèrt (2002) offers a systems-based paradigm as an alternative to the conventional paradigm for development called The Natural Step. The fourth principle in The Natural Step addresses the idea of fair and efficient resource management, which forms the basis of "human values" used in the operational definition of sustainability and represents the two principles of Equity and Economy. However, equitable and wise management of finances offer only a partial description of what is meant by human values. Human values are better understood in terms of fundamental human needs and interactions with each other, which is a well-studied and debated area in psychological literature, social sciences and also economics. So, Equity can be broadly understood as seeking quality of life for all: ultimately this means satisfaction of basic human needs within a specific cultural context which can change and will vary with time. Human needs have been well studied in psychology and social sciences and value is often assigned to things based on how well these needs have been satisfied (Maslow. 1943; Max-Neef et al., 1991; Fisher, 2000). It is important to define "human values" because if they are observable and definable, they can be measured qualitatively or quantitatively. Additionally, it is important to note that these needs shape human behavior and dictate the choices that people make every day.

Choices often involve tradeoffs, which are an inherent part of sustainability decisions. There are a number of tradeoffs that occur when meeting more than one human need simultaneously. These societal constraints, including regulations and policy, govern the idea of Economy, which means, simply, management of financial, natural, manufactured, and human capital resources (Hawken, Lovins, & Lovins 1999; Goodland, 1993). The concept of economy can be scaled down to apply to project-level financial choices or broadly scaled to practices of resource management such as sustainable forestry, waste management or carbon cap-and-trade arrangements.

2.3.3 Systems: Context and Drivers

A civil engineering project system's context is sensitive to whatever human needs and values are defined by the management team and stakeholders and its environmental setting. These are the constraints, or boundaries, within which project decisions must be made and by which performance will be judged. Therefore, two critical pairs of sustainability components can be identified: Extent and Expectations, and Experience and Exposure. The former pair of principles acts to define the system boundaries, providing scope and context to sustainability. The latter pair provides momentum for the system to adapt and grow with changing environments and values.

Importantly, how well a particular project fits project-specific natural law and human value constraints is a characteristic or trait of that system that is measurable (in terms of quantity and/or quality). Value or meaning is conferred on this measurement when it is compared to another similar measurement, provided both measures are made based on the same criteria in a comparably bounded system (Extent). This means sustainability on one civil engineering project can be compared to other civil engineering projects based on its features (Expectations). Ultimately, sustainability becomes manageable on both short- and long-term time scales by using a systems-based definition.

Experience and Exposure translate the philosophical concept of sustainability into implementable practices. Experience represents both what has been learned and the learning process itself, which is ongoing. So, Experience includes technical expertise, innovation, and knowledge of applicable historical information, which is critical in decision-making processes. For example, most successful project teams are comprised of interdisciplinary experts that can bring specialized experience to design or construction.

Finally, if the concept of sustainability is to cause a paradigm shift in individual, community and societal behavior, then it must include an active educational component; or more specifically, a teaching or outreach component. Exposure represents the idea that implementing sustainability in practice requires ongoing educational and awareness programs for the general public, professionals, agencies, and stakeholders. Without these two driving components, civil engineering systems would remain static, and sustainability would be absent, unmanageable, or simply unrecognized.

2.4 SUSTAINABILITY IN THE TRANSPORTATION CONTEXT

Zietsman et al. (2011) recently reviewed the definitions of sustainability in the transportation context and also provide a broad definition of sustainability that is intended to be generally applicable for transportation planning, projects and operations (see additional detail in Chapter 4). The definition recommended by these authors, based on a review of the majority of other formative research on the topic of sustainability performance measurement is (Zietsman et al., 2011, p. 2):

Sustainability entails meeting human needs [Equity] for the present and future [Extent], while:

- *Preserving and restoring environmental and ecological systems. [Ecology]*
- *Improving quality of life. [Equity]*
- *Promoting economic development and prosperity. [Economy]*
- *Ensuring equity between and among population groups and over generations [Extent].*

As noted in brackets, the definition can be dissected to point out which principles of sustainability are addressed to demonstrate compatibility. Several sustainability principles are omitted; however, the authors conclude that training is a necessary element to implement sustainability. They also discuss expectations in terms of performance measurement in detail (see Chapter 4), but few appear to integrate sustainability into what is done on a daily basis (Amekudzi et al. 2011). It may be noted that there is a heavy emphasis on the “Equity” or human component as well, which is prevalent in transportation planning literature due to the nature of transportation being a basic societal service. In general, the above definition is compatible with that used in this research.

Sustainability is not an add-on feature of projects or internal activities. It is a fundamental and comprehensive system characteristic. Realistically, practicing sustainability means thoughtful consideration of sustainability principles and embedding them in daily practices at an organization. Simply adopting a definition of sustainability is not enough. The sustainability definition must be applied and integrated, and it must be measured and monitored.

In sum, a sustainable roadway project fits the natural environment and human values context within which it is planned, designed, built and operated. A roadway project, thus, by definition becomes unsustainable when it no longer fits this context, as measured by specific environmental or human criteria.

2.5 SUMMARY

- Sustainability is a characteristic of a system that reflects its capacity to support natural laws and human values.
- The definition used herein includes seven principle components: Ecology, Equity, Economy, Extent, Expectations, Experience and Exposure. These seven principles are the resulting interactions of natural laws and human values considered in the context of a defined and dynamic system and driven by education.
- The process of defining values can be useful to help organize behavior in decision-making, prioritize values, and identify final characteristics of a system based on specific needs of stakeholder groups.
- As shown in Zietsman et al. (2011), many have tried to define sustainability in transportation; some definitions are narrow and others, broad. This is a positive effort, but few appear to be used in practice, especially on transportation projects (Amekudzi et al. 2011).
- An operable definition is a necessary starting point to create meaningful reform of practice, as shown in Anderson (2008).
- Sustainability is not an add-on feature of projects or internal activities. It is a fundamental and comprehensive system characteristic.

3.0 RESEARCH CONTEXT

The idea of sustainability is most effectively discussed when confined to a manageable, definable scope. Defining the context of sustainability requires a definition of sustainability as a foundational component, which was described in Chapter 2. For purposes of this research, the context is the transportation branch of civil engineering. Specifically, the scope of research includes the highest transportation impact areas of highway, street, and bridge projects which represent the bulk of annual public expenditures in the transportation sector — approximately $80-100 billion per year (U.S. Census Bureau, 2011, August 2) in put-in-place construction value. Chapter 4 completes the background research for sustainability performance measurement in the transportation context and Chapter 5 provides the details on the development of the Greenroads Rating System.

The purpose of this Chapter is to introduce how roadways, which are long, linear features that connect people and places, have become important issues to address for sustainability. There are several opportunities stemming from many high impacts areas of concerns, including environmental, social, economic, political and educational issues. In this context, it makes sense to consider fundamental changes to the way roadways are designed and built. This Chapter provides a foundation for understanding some of the primary goals of the Greenroads Rating System tool developed as part of this research and discussed in detail in Chapter 5. Specifically, it provides a number of examples of the impacts of roadway projects with respect to some of the principles of sustainability without focusing on a single metric or set of measures.

3.1 ENVIRONMENTAL IMPACTS OF ROADWAY CONSTRUCTION

A plethora of statistics and studies show that roadways have both direct and indirect impacts on the environment. While specific details about the environmental impacts of roadway construction reach far beyond the scope of this research, generally, these impacts are perceived to be problematic or otherwise worthy of human concern and interference. Notably, with the exception of the first two items listed below, none of these impacts are directly regulated by environmental law (discussed later in Section 3.3) during roadway design and construction.

- Southerland (1994), Forman and Alexander (1998) and Mortenson et al. (2009) showed that roadways often destroy, degrade or fragment sensitive habitat areas which can threaten fish and wildlife and disconnect them from their native areas and spread invasive and noxious plants. Roadway projects, especially in rural locations or greenfield areas, can cause significant impacts on environmentally sensitive areas and watersheds. For these reasons, habitat impacts are substantially regulated and addressed through the environmental review process required by the National Environmental Policy Act (NEPA) and similar local and state regulations.

- The U.S. Environmental Protection Agency (EPA) enforces water quality rules for non-point source pollution control through the National Pollution and Elimination Discharge System (NPDES) Phase II program, which incorporates construction projects like roads and bridges. The EPA provides substantial guidelines and best practice information that roadway projects can use to meet their standards for water quality during construction. In sensitive areas, these controls can be very strict in order to help mitigate pollution impacts. However, pavement weathering, slope erosion and tire wear are a few contributors to poor water quality in runoff that flows into water bodies near roadways over the lifetime of the roadway (Clark et al., 2007; EPA, 1995, 2000, 2005, 2006, 2009; Quigley et al. 2009). Often, these long-term effects of stormwater runoff and resulting water quality impacts remain unmitigated during roadway design because they are not required to be controlled.
- Building roads and bridges require substantial inputs of energy intensive materials. According to Muench (2010), the cradle-to-site energy in one lane of pavement, one mile long, requires about as much energy to build as 50 American households use in one year (approximately two to four terajoules).
- Construction of roadways produces substantial waste (Rajendran & Gambetese, 2006). It is critical to note that the amount of waste generated by transportation projects is not measured or tracked like building industry construction and demolition waste. The Construction Materials Recycling Association projects that the amount of waste generated by roadways is equal to or greater than that generated by buildings annually, at over 325 million tons (Johnson, 2009).
- Use of roadways by vehicles currently requires a substantial amount of fossil fuel in order for people and freight to move from place to place. This ranks the transportation sector as the second largest generator of greenhouse gas (GHG) emissions, behind the residential and non-residential building sector (EPA, 2011; Energy Information Administration, 2010). Traffic congestion and lack of modal mobility on roadways tend to exacerbate emissions generation in urban areas (Schrank and Lomax, 2010), where air quality is a key concern for human health.

3.2 ECONOMIC OPPORTUNITIES AND CHALLENGES IN TRANSPORTATION

Many public agencies are currently struggling with the volatile U.S. economic conditions that threaten to undermine public spending on a host of public services, which includes transportation infrastructure. However, the need to build, improve and maintain infrastructure remains regardless of economic conditions.

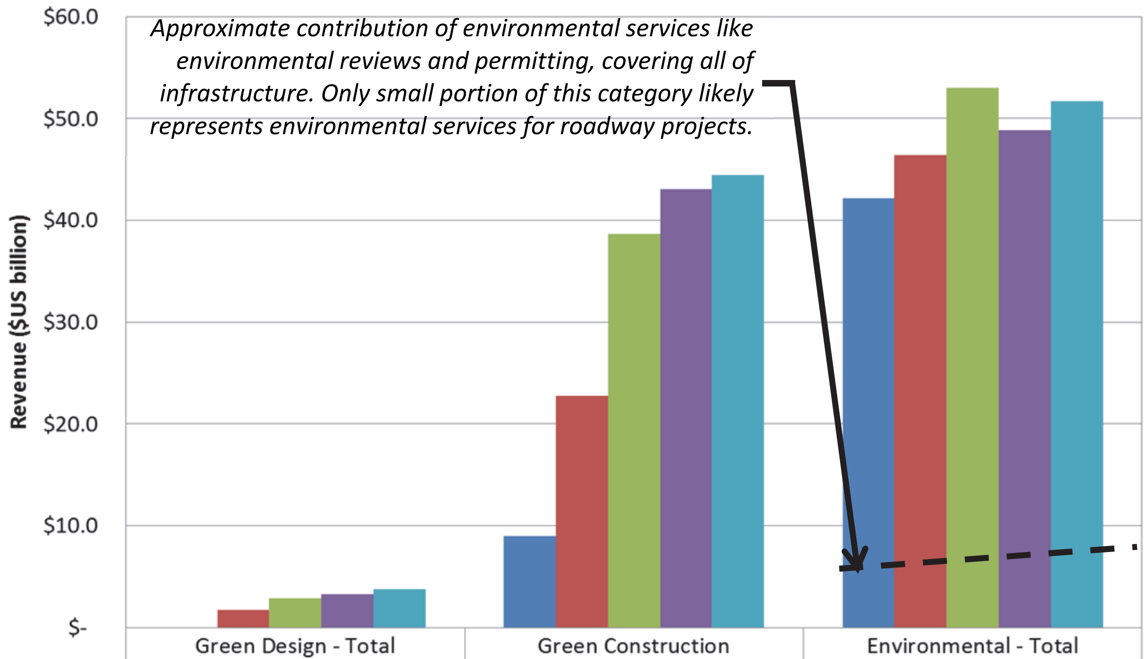
Despite the conditions, the recent statistics indicate that the outlook is positive for construction spending on transportation in the coming decade for a few reasons. First, there is growing public and political support for infrastructure spending, motivated by an urgent need to replace and maintain aging transportation infrastructure (BLS, 2010, December 3). In fact, sustainability has become such an important issue, the Federal Highway Administration plans to spend 12.5% ($8.8 billion) of its 2012 annual budget to achieve its strategic goal of environmental sustainability (FHWA, 2011a). Additionally, the desire to save money on roadway projects remains a strong motivator; perhaps the economic climate simply makes this common project priority even more critical.

Furthermore, the opportunity for sustainable design and construction in transportation has already been paved by wide acceptance of more sustainable practices in green building industry. Interest in "green" design has in general been spurred by the development and implementation of the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED®) Green Building Rating System, which is a comprehensive sustainability performance metric for improving building energy efficiency, water practices, and encourages healthy indoor environments for building users (USGBC, 2011a). Largely because of LEED's market contribution, the building industry has experienced rapid growth in green design and construction market in the last five years.

For example, Figure 3.1 (Rubin et al. 2011, 2010, 2009, 2008, 2007; Tulacz & Traynor, 2008; Tulacz, 2007, 2008, 2009a, 2009b, 2010a, 2010b, 2011a, 2011b) shows annual market data from *Engineering News Record* in green design and green construction compared to environmental services, which represent many types of civil engineering activities including water supply management, wastewater treatment, nuclear waste, hazardous and solid waste, and environmental science and management. Interestingly, the $120.9 billion transportation sector (U.S. Census Bureau, 2011), is not included in green design or green construction and is not explicitly noted in the environmental services market. According to Rubin et al., market data for 2011 shows that the environmental science and management areas are valued at about $7.4 billion (about twice in total of the green design market and only about 17% of the green construction market) and includes environmental reviews and permits for all of infrastructure. Roadway projects are likely represented within a small portion of environmental sciences and environmental management.

Also, notably, green design firms have experienced a 12.3% revenue increase from 2009 to 2010, while all other design spending declined, and green construction spending is nearly as much as spending on environmental services for all of infrastructure combined. Impressive growth in green design, green construction, and environmental services is also evident in both the domestic and international markets. Finally, it is important to note that what is considered “green design” or “green construction” by market analysts (Figure 3.1) is revenue gained from projects pursuing independent third-party certification.

Thus, sustainability, environmental stewardship, and being green can easily be seen as important economic drivers. Not only does this clearly present an opportunity for a similar metric in transportation, it indicates that there is substantial potential for green growth in transportation design and construction projects if the sector follows suit.



	Green Design - Total	Green Construction	Environmental - Total
2006		$9.0	$42.2
2007	$1.7	$22.8	$46.4
2008	$2.9	$38.7	$53.0
2009	$3.3	$43.1	$48.8
2010	$3.7	$44.4	$51.7

Figure 3.1 A view of the "green" market (green design, green construction and environmental services) and overall growth between 2006-2010. The transportation sector is not included in green design or construction and is not explicitly identified in environmental services. Roadway projects are likely represented by less than 17% of the subcategories of environmental services (environmental sciences and environmental management) according to the most recent data from 2010 (Rubin et al. 2011).

3.3 SUSTAINABILITY IN POLICY AND LAW

It is not surprising, then, that in the last decade the building industry has seen greater integration of sustainable practices into public policy. Adoption of sustainability into building design and construction as standard practice has largely been led by the wide acceptance of the LEED Rating System. Many public agencies that own buildings are federally or locally required to meet minimum levels of a third-party certification standard for sustainable buildings; usually, that standard is one of the LEED Green Building Rating Systems. The U.S. Green Building Council (2011) notes that government projects comprise over one quarter of all LEED certification projects, stemming from adopted policies at federal, state, and local levels: in over 45 states and at 14 government agencies. So by virtue of sustainability mandates, all levels of government are seeing better sustainability performance in their buildings. But there is not yet wide adoption of such mandates for transportation because of lack of a similar accepted standard or rating system.

A schematic federal policy timeline is shown in Tables 3.1-3.3 for a perspective of the progress of social and environmental policy since the first interstate highway spending bills were passed over five decades ago. Since then, 23 environmental laws (noted as “E”), 12 social policy laws (“S”), 26 transportation funding bills (“T”) and six sustainability policies (“G”) have been implemented (EPA, 2011; FHWA, 2011b; Equal Employment Opportunity Commission, 2009; Morris, 2008). What appears to be happening politically is an infusion of sustainability ideas in place of purely social and environmental measures, as noted by gradual replacement of social policies by sustainability policies in the 1990s and early 2000s. These are marked with an asterisk in Tables 3.2 and 3.3. However, the timeline also shows that transportation remains a separate issue and that the majority of recent public policy and regulations related to sustainability fall into four major categories — energy, waste, water quality, and air quality. For example, even Executive Order (E.O.) 13243 “Strengthening Federal Environmental, Energy, and Transportation Management” addressed fuel use and fuel efficiency improvements in vehicles and transport fleets, but does not directly address project-level elements or improvements (Morris, 2008).

Table 3.1 Timeline of federal laws passed in a changing environmental and social context.

Year	Symbol[1]	Name of Regulation or Spending Bill[2]
1952	**T**	Federal Aid Highway Act
1953		
1954	**T**	Stopgap funding for Federal Aid Highway Act
1955		
1956	**T**	Federal Aid Highway Act (Creation of Highway Trust Find)
1957		
1958	**T**	Federal Aid Highway Act
1959		
1960		
1961	**T**	Federal Aid Highway Act
1962		
1963	**S**	Equal Pay Act
1964	**S**	Civil Rights Act
1965	**T**	Federal Aid Highway Act
1966		
1967	**S**	Age Discrimination in Employment Act
1968	**T**	Federal Aid Highway Act
1969		
1970	**ESST**	National Environmental Policy Act; Occupational Health and Safety Act; Highway Safety At

1. T for Transportation, S for Social Policy, E for Environmental Policy, and G for Sustainability Policy. Asterisks
2. This table is not intended to cover all bills passed by U.S. Congress, and may not be comprehensive.
3. (*) denote a single law that covers both E and S.

Table 3.2 Timeline of federal laws passed in a changing environmental and social context. (cont.)

Year	Symbol[1]	Name of Regulation or Spending Bill[2]
1971	**E**	Clean Air Act
1972	**EET**	Clean Water Act; Noise Control Act
1973	**EST**	Endangered Species; Rehabilitation Act (Section 503, 505); Federal Aid Highway Act
1974	**E**	Safe Drinking Water
1975	**T**	Federal Aid Highway Act
1976	**EE**	Resource Conservation and Recovery Act; Toxic Substances Control Act
1977	**EET**	Clean Air Act; Clean Water Act
1978	**S**	Civil Service Reform Act
1979	**T**	Federal Aid Highway Act
1980	**E**	Comprehensive Environmental Response, Compensation and Liability Act (Superfund)
1981	**T**	Federal Aid Highway Act
1982	**E**	Nuclear Waste Act
1983	**T**	Federal Aid Highway Act
1984		
1985	**T**	Federal Aid Highway Act
1986	**EE**	Superfund Amendments and Reauthorization Act; Summary of the Emergency Planning & Community Right-to-Know Act
1987	**TT**	Surface Transportation and Uniform Relocation Assistance Act; Federal Aid Highway Act
1988	**E**	Shore Protection & Ocean Dumping Act
1989	**T**	
1990	**EES**	Clean Air Act; Pollution Prevention Act; Americans with Disabilities Act
1991	**STT**	Intermodal Surface Transportation Efficiency Act; Civil Rights Act
1992		
1993	**G**	EO 12873 Environmentally Preferable Purchasing for Federal Acquisition, Recycling, and Waste Prevention (Revoked)
1994	**E*S***[3]	Executive Order 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
1995	**T**	National Highway System Designation Act
1996	**EEE*S***	Federal Insecticide, Fungicide, and Rodenticide Act; Safe Drinking Water Act; National Technology Transfer and Advancement Act
1997	**E*S***	Protection of Children From Environmental Health Risks and Safety Risks
1998	**TG**	EO 13101 Greening The Government through Waste Prevention, Recycling and Federal Acquisition 1998; Transportation Equity Act for the 21st Century
1999		
2000		
2001	**E**	Executive Order 13211 - Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use
2002		
2003		
2004		
2005	**TG**	Energy Policy Act; Safe, Accountable, Flexible, Efficient Transportation Equity Act
2006		
2007	**GG**	EO 13243 Strengthening Federal Environmental, Energy, and Transportation Management; Energy Independence and Security Act

1. T for Transportation, S for Social Policy, E for Environmental Policy, and G for Sustainability Policy. Asterisks
2. This table is not intended to cover all bills passed by U.S. Congress, and may not be comprehensive.
3. (*) denote a single law that covers both E and S.

Table 3.3 Timeline of federal laws passed in a changing environmental and social context. (cont.)

Year	Symbol[1]	Name of Regulation or Spending Bill[2]
2008		
2009	**TTSG**	EO 13154 Federal Leadership in Environmental, Energy, and Economic Performance; Stopgap Funding for Transportation; American Recovery and Reinvestment Act; Lilly Ledbetter Equal Pay Act
2010		
2011		

1. T for Transportation, S for Social Policy, E for Environmental Policy, and G for Sustainability Policy. Asterisks
2. This table is not intended to cover all bills passed by U.S. Congress, and may not be comprehensive.
3. (*) denote a single law that covers both E and S.

It is interesting to note that while long-term transportation spending has recently begun to appear simultaneously with the passage of sustainability laws (1998, 2005, 2009), none of these sustainability laws seem to directly impact the way roadway projects are designed and built.

Additionally, spending bills have been extremely limited in the last several years, with the passage of only stopgap measures. For example, of the date of this research, Congress has yet to approve and pass an infrastructure funding initiative at the federal level that expired in 2009 (Halsey, 2011). However, sustainability is starting to appear in award criteria for the discretionary funding and stopgap measures, such as the Transportation Investment Generating Economic Recovery (TIGER) program and also 2009 American Recovery and Reinvestment Act (ARRA) funding for shovel-ready projects (U.S. DOT, 2012; FHWA, 2011b). Thus, it appears that the political environment is primed for adopting sustainability into transportation spending policies; or to be more precise, into transportation project budgets.

3.4 SOCIAL IMPACTS OF TRANSPORTATION PROJECTS

Roadway construction projects have a surprising impact on human needs. Americans spend an annual average of 100 hours commuting to work on roadways (Buckner and Gonzales, 2005). Road construction delays cost upwards of $115 billion in fuel costs and lost productivity, benefits, and wages annually (Schrank and Lomax, 2010) and account for at least one quarter of all non-recurring delays (FHWA, 2008). However, roadways provide a fundamental human service and are in general, designed to support the interests of the general public specifically with respect to human health, community identity, local economies and regional trade. Currently, public and political interest in transportation has also been tightly coupled with the high potential for the transportation industry to create jobs (BLS, 2010, December 3), especially in a recovering job market.

3.4.1 Connecting People and Places

Mode choice, human health impacts of transportation, safety, accessibility to children, the elderly and economically challenged, and community livability are some of the key social impacts that are addressed by transportation infrastructure. The National Complete Streets Coalition (2011) provides several interesting and comprehensive statistics about these characteristics of more sustainable and livable roadway projects. These issues are also largely addressed by adopted regulations for social policy noted previously (EEOC, 2009) and especially for safety and efficiency in transportation policy.

Recently, the majority of transportation planning literature (see Chapter 4) has focused on developing new ways to make communities more vibrant and livable and human-centered. Wide acceptance of these practices and performance measures for multimodal features is evident in hundreds of cities and states in the U.S. with much credit to the Complete Streets Initiative (2011). Importantly, more roadway projects that have multimodal design features result from local plans and policies that have been adopted which reflect integrated bicycle, pedestrian and transit plans as part of a comprehensive transportation master plan or state transportation improvement program.

3.4.2 Key to Economic Security

Because of transportation's contribution to economic development (specifically the ability of construction projects to provide jobs) it is interesting to look at the prevalence of green jobs in transportation sector. Job security and job creation is a key social issue because having work and a job meets individual needs beyond societal needs of economic development, including feelings of personal well-being and satisfaction of individual needs (Maslow, 1943; Max-Neef, 1991).

The Bureau of Labor Statistics (2011) has defined "green jobs" to mean any occupation that 1) produces environmentally beneficial goods and services (including conservation practices or 2) improves the processes used to make products or services better for the environment. Generally, jobs are counted as green if they are relevant to the green building industry, not transportation (Liming, 2011), though it is worth noting that civil engineers are counted as a green profession in the following conditions: if they carry green building credentials for LEED or if they work in the private or public sector in green building design, green construction of buildings, or environmental services (see Section 3.2) that include energy efficiency, renewable energy, reducing pollution, and mitigation or cleanup (Hardcastle, 2009, 2010).

Hardcastle's 2010 report on the Washington State green economy notes that 59% of all green jobs in the public sector (the first year this sector's jobs have been tracked) are held by civil or environmental engineers that spend at least part of their work hours in the areas of preventing and reducing pollution and mitigation or cleanup. The author notes "For both the private and public sectors, these occupations represent those that we might logically expect to see associated with work aimed at providing mitigation or cleanup of environmental pollution" (p. 31). However, while highway, street and bridge construction and heavy civil construction are included in the job counts, they are still far overshadowed by building industry jobs in construction, which account for 38.6% of all green jobs (mostly in the area of increasing energy efficiency). In the public sector, a majority of part-time green jobs are dedicated to this energy efficiency of green buildings. In general, transportation projects do not appear to be tracked for green jobs which could be due to the lack of a formal mechanism to recognize such projects that are using efforts similar to LEED in the building industry. Perhaps lack of transportation project jobs considered green also results from lack of training and education in training programs specific to such a purpose.

3.5 EDUCATIONAL ISSUES

Sustainability calls for a fundamental change in the way roadway projects are developed, which calls for a fundamental change in the way people develop and use knowledge. There is a growing industry requiring green professionals, but the industry lacks a supporting educational infrastructure to meet increasing demand (United States, 2011). For example, in Washington State, 63% of construction employers report difficulty in finding qualified applicants for open jobs in sustainable professions. Also, they identify a dearth in skilled workers of for mid-level occupations of 36% in transportation and 26% in construction which is hindering economic development (Williams, 2009). According to the same report, higher education is responsible for developing an entry-level and has not been developing qualified applicants to fill openings; even though Washington State is known for its professional scientific and engineering workforce, it ranks 44th in providing this education.

Transportation planners, transportation engineers as well as civil engineers have been listed among occupations that have been identified as evolving to be greener (O*NET, 2010; Hardcastle, 2010; Williams, 2009); however, with evolving careers comes a requirement for development of new skills on top of traditional ones for new graduates and also continuing education for members of the current workforce. Many of these professions have already embraced the USGBC's LEED program for professional credentialing. However, there is no comparable program that offers broad-based sustainability accreditation in transportation or sustainability training for civil engineers in general.

3.6 STATE OF THE PRACTICE

Despite the wealth of research in performance measurement for sustainability (see Chapter 4), few DOTs appear to be applying sustainability successfully (Amekudzi et al., 2011). Here, "success" means that DOTs have been able to demonstrate progress toward measurable goals over time. In general, most large roadway agencies have incorporated sustainability ideas into their strategic mission or goals (Muench, 2007; Muench, Scarsella, Bradway, Hormann & Cornell, in press) but only a handful have implemented ideas that are tracked or measured (Amekudzi et al. 2011) as part of an agency's accountability framework. Fewer explicitly state sustainability as a goal or mission (Muench, 2007) and only one state appears to use a structured tool specifically for sustainability performance measurement on roadway projects, GreenLITES (more details in Chapter 4).

Furthermore, motivation to be sustainable does not appear to exist in a way that causes this performance goal to exceed the existing priorities and missions of most DOTs. Only a few DOTs (Zietsman et al., 2011) are proactively managing sustainability and including it in their accountability metrics. However, it is important to note that mandates for sustainability, without holding sustainability as a core value, tend to create a culture of compliance. Importantly, compliance is not usually perceived as a positive motivator within an organization, since the primary goal is generally not to accomplish the task – it is to avoid the repercussions of not doing the task (Pryor, 1998). Since most roadways are publicly owned and managed by the government, it is a basic expectation of the public that the government meet the mandates and rules that they set.

A sense of ownership is also critical to change behavior (Race, 2005; Lehrer, 2009). It is not enough to think that sustainability is an idea that will implement itself – it is the duty of individuals, organizations, and society at large to achieve sustainability within the contexts in which they have direct control or influence. In other words, what appears to be missing is a means to voluntarily participate in more sustainable projects — at both the agency and the employee level — and therefore to make tangible contributions toward a broad goal of improved sustainability performance in transportation.

So, in order for sustainability to permeate in the owner organization effectively, the core values and strategic plans of DOTs must be restructured to explicitly include sustainability and to make it a clear priority. In fact, those that have stated sustainability plans or (Muench et al., in press; Scarsella, 2010) or are environmentally motivated by key stakeholders (Muench, Armstrong & Allen, in press) appear to be the most successful in applying and measuring progress. In other words, a commitment to sustainability must be made by the strategy planners and policy makers, and implemented in the activities that the agency does. Since the majority of public spending in the U.S. is on highways, bridges and streets (U.S. Census Bureau, 2011), then perhaps implementation of sustainability on roadway projects should demonstrate the largest impact that is also quantifiable over time if tracked. Performance measurement can therefore offer a practical, powerful means to differentiate between sustainable and unsustainable performance on roadway projects. Chapter 4 investigates some of the existing research in performance metrics in more detail.

3.7 SUMMARY

- Transportation projects can have substantial environmental impacts.
- There is a significant market opportunity for green projects in transportation, because such a market does not appear to exist yet or is otherwise undefined.
- The political climate is ripe for change and has been advocating for more sustainable practices and mandates.
- Roadways provide a significant social benefit, including a potential for green jobs. They serve a purpose to connect people to place, and communities to each other.
- There is a discontinuity between higher education and professional practice in the knowledge of sustainability and a high demand for trained professionals in green transportation.
- Sustainability must be a clear priority in order for its potential to be realized, regardless of how it is applied in an organization or on a project.
- Performance measurement offers a practical means to differentiate between sustainable and unsustainable performance on roadway projects.

4.0 MEASURING SUSTAINABILITY PERFORMANCE

This Chapter summarizes the existing research in performance measurement for sustainability, with specific emphasis on rating systems and tools that can be used for benchmarking performance. Note that monitoring and evaluation of long-term performance is not specifically part of this discussion, but that these activities can be done relatively easily by applying performance measurement routinely or on an otherwise predetermined schedule.

For purposes of this research, performance means how well an activity or set of activities is executed according to a predetermined set of goals, which are determined to be important based on human values (Expectations) in any defined and bounded system. Performance is judged qualitatively or quantitatively by comparing actual outcomes or results to initial expectations (Jeon & Amekudzi, 2005). A performance measure is thus a subjective evaluation of how well a particular result meets the criteria defined by the stated expectations. These evaluations are a fundamental part of the decision-making process (Cambridge Systematics & High Street Consulting, 2009). Decisions dictate how individuals and organizations behave.

Importantly, there is no such thing as a single sustainability performance measure that addresses all principles and intended outcomes. Oppositely, it is important to note that even the most comprehensive tool cannot possibly capture all of the potential performance measurement ideas, since such a scope would be unmanageable and also not meaningful because it would be impossible to apply in practice.

4.1 MAJOR RESEARCH EFFORTS

An effective way to achieve the integration of sustainability at any organization level is through continuous performance measurement (Cambridge Systematics & High Street Consulting, 2009; Jeon & Amekudzi, 2005; Amekudzi & Meyer, 2005; Muench, Anderson and Söderlund, 2010; Zietsman, et al. 2011; Ramani et al., 2009; Behn, 2003; Amekudzi et al. 2011). The scope of major research efforts includes research reports for organizations seeking to set guidelines for improvement of sustainability or collections of measures.

4.1.1 National Cooperative Highway Research Program Report 708 Framework

The most relevant and comprehensive study of performance measurement was recently completed as part of National Cooperative Highway Research Program (NCHRP) Report 708 by Zietsman et al.

(2011), which reviews each reference above objectively. NCHRP Report 708 summarizes the state of the practice in performance measures at state departments of transportation (DOTs). The goal of this work was to develop a framework that could be generally applied to the core areas of work done by DOTs in order to address and measure performance in sustainability. Major contributions of this report include a comprehensive list of performance measures used by all 50 state departments of transportation that can be used to help assess sustainability performance. Each of these measures were classified and categorized according to their utility, impact area, and sustainability goal. The NCHRP Report 708 team also describes overarching themes of sustainability they identify (generally) as feedback, review, and engagement of stakeholders.

It is helpful to provide a description of what the term framework means according to Zietsman et al. (2011). They present a *framework for sustainability performance measurement application*. In other words, they propose an approach for incorporating sustainability procedurally without specifying an end goal or set of outcomes. Their framework provides a good template for creating a new or editing an existing process without any suggestion or stipulation that the performance should improve; it does provide a process to do so should an alignment with sustainability be desired by an owner-agency. It is difficult to envision what a roadway project might look like that has used this framework and how it could differ from a typical project.

4.1.2 Multi-Criteria Decision-Making Tools

Other notable works authored and co-authored by Amekudzi provide significantly longer and more detailed lists including hundreds of performance measures (Jeon & Amekudzi, 2005; Amekudzi & Meyer, 2005; Amekudzi et al. 2011); this level of detail may be difficult to navigate because the choices could become overwhelming to a non-expert and it can discourage innovation due to the implicit suggestion that such lists are complete and comprehensive. The strength of these lists is in numbers, however; the opportunity to identify several ideas that are both applicable and achievable is high. Still, though each individual metric may be useful to implement on its own, it could incite cherry-picking of values that will cause significant variations in outcomes between organizations using these lists of measures. Generally, this approach does not appear to allow for consistent application or setting standards for sustainability.

4.1.3 Other Efforts

The second Transportation Research Board's Strategic Highway Research Program (SHRP 2) addresses performance measurement in the context of highway decision-making and Ramani et al. (2009) and Zietsman et al. (2011) investigate how performance measurement in the context of different agencies trying to implement sustainable transportation ideas. Amekudzi and Meyer (2005) specifically look at environmentally-oriented performance measures for departments of transportation (DOTs). Finally, a high-level, environmentally-oriented guidelines document for transportation planning was also recently issued by the EPA that addresses land use and public transportation metrics (ICF International, 2011).

4.1.4 Discussion of Research Applicability

These authors all offer a multitude of potential decision points, suggested multi-criteria decision-making tools and a wealth of performance measures for transportation agencies to pick and choose from, but shy from giving many practical applications or examples in agencies that holistically achieve in all areas surrounding sustainability principles. This is likely due to a lack two things: 1) a consistent definition of sustainability and 3) lack of a unified, defined outcome or end goal. For example, the SHRP 2 report concludes the 126 page report with a simple three step process to performance measurement: select factors, select measures, and then use them (Cambridge Systematics & High Street Consulting, 2009). But which ones and how many must be used to become sustainable? And what is the expected level of sustainability?

Additionally, most frameworks and guidelines presented in the literature do not provide guidance or criteria regarding the types of evidence needed to demonstrate that outcomes have been met or achieved in some way. A common theme is that these frameworks and guidelines are to be used as a diagnostic tool for sustainability. To use an analogy in the medical profession, diagnoses are used to identify a pathology or disease based on certain symptoms or maladies. Thus, performance measurement for sustainability is a good way to diagnose where, as an organization, weaknesses in sustainability performance exist (and also positive performance, of course). The measurement itself is important, but 1) will never be able to assess the unknown or unknowable and fully account for all uncertainties 2) does less to address the problem than a tool that specifically addresses the implementation of sustainability and 3) does not incite improvement beyond expected minimum standards.

It is important to note that such guidelines documents and internal tools are often not integrated into design and construction projects systematically, and usually do not challenge current expected minimum performance requirements enough to prompt drastic change in the way projects are designed and built. It is even rarer for guidelines to influence project funding. A key weakness appears to be that while they are often issued by respectable authorities or other credible experts, these groups have limited actual authority for implementation and application; that role ultimately belongs to the roadway owner. Wide adoption of sustainability guidelines and decision-making tools is slow and usually not voluntary if ever adopted. By their nature, guidelines and self-assessment is a rather soft approach to sustainability; they are useful to provide background information, strategic alignment, and some direction to the novice user of performance measurement. However, if there is a place for such activities, there is also a place for a more stringent, clear standard that challenges the status quo and exceeds conventional performance expectations.

4.2 HOW PERFORMANCE MEASUREMENT IS USED

Behn (2003), an author from business administration profession, identifies eight reasons that performance measurement is useful to help address management goals: evaluation, budgeting, management (control), motivation, advancement (promotion), recognition (celebration), learning, and improvement. These reasons are applicable for managing sustainability within and outside of a transportation agency, but can actually be broadly applied to any organization for managing and improving behavior. A common example is annual performance reviews for employees at almost any private or public company or organization.

Transportation agencies must manage and balance complex stakeholder interactions and their own public image. This means that gaining and maintaining credibility through transparency and accountability is also a key purpose of implementing a performance measurement program (Cambridge Systematics & High Street Consulting, 2009). At an organizational level, performance measures are used as forecasting and strategic planning tools. At a project level, performance measurement is often called accountability or compliance since some sort of documentation usually needs to be produced to demonstrate that performance met the standard outlined in the measure.

4.3 CAVEATS OF PERFORMANCE MEASUREMENT

It is important to highlight some of the reasons performance measurement is not a final solution, and why continuous performance measurement provides more meaningful information. Simply, there is little value in the act of measuring alone and that measurement needs to be done thoughtfully from the start in order to be worthwhile. In general, performance measurement allows quantification, but it is important to recognize that measurements alone are susceptible to a host of errors, problems or challenges, including:

- Gross misuse, uneducated use or misrepresentation of results
- Reductionism or over-analyzing a single measure.
- False attribution of performance to the stated input and outcomes.
- Tendency to encourage cherry-picking or the "piecemeal" approach, or selection bias which can tend to misrepresent actual performance.
- Confirmation bias (finding a measurement that confirms the predicted assessment, but does not investigate the alternative).
- Choice of an appropriate metric or rating system can be a challenge, since there are so many to choose from with various levels of applicability.
- Versioning and interpretation of outdated measures.

Understanding of these caveats can help consumers and users of performance measurement tools understand the term "greenwashing" and know how to identify it (Roberts, 2011). All performance metrics, rating systems, and tools that allow for voluntary selection of performance criteria suffer from these caveats, since interpretation of the results is user-dependent. In this way, there is value in a performance rating tool that is managed by an outside or independent administrator.

4.4 EXISTING TOOLS FOR ROADWAY SUSTAINABILITY

An increasing number of performance measurement tools are now available for performance measurement of sustainability in transportation. Generally, these tools can be categorized into three types: product- or feature-specific tools (such as Energy-Star labeled roadway lighting), self-assessment tools like checklists or guidelines, and rating systems. Few of them provide adequate recognition for sustainability performance that is above and beyond minimum requirements. All of them are at varying stages of development and use.

The latter two forms (self-evaluation tools and rating systems) are the focus of this section because they generally represent more comprehensive sets of performance measures that are addressed by single tools. At the time of this writing, there are approximately 26 tools that could be used for measuring sustainability performance on roadway projects. The full list is attached as Appendix A; the most relevant for roadway projects are described briefly below. Note that the Greenroads™ Rating System is excluded below and described in detail in the next chapter.

4.4.1 GreenLITES

GreenLITES (Green Leadership In Transportation and Environmental Sustainability) is a self-evaluation tool (even though it is called a certification program by its owners) that is used by the New York State DOT. It is based on the original version of Greenroads version 0.5, though it has been expanded since its original version and now includes planning as a separate programmatic element. It is currently tied to funding allocations for roadway projects in districts of New York State. Generally, GreenLITES is a tool that incorporated sustainability ideas and performance measures into the existing performance tool used by the DOT (NYSDOT, 2011).

4.4.2 Complete Streets

Complete Streets is a planning initiative that addresses livability, quality of life, and other human-centric improvements for community development. It is significant because it encourages the use of sustainable features on projects during the planning stage that can be considered individual performance measures based on their absence or presence on a project (National Complete Streets Coalition, 2011).

4.4.3 I-LAST

I-LAST (Illinois Livable and Sustainable Transportation) is a guideline document that appears to be intended for internal use at the Illinois DOT. It does not appear that I-LAST is being used, but generally, it provides performance measures, helpful guidance, and some indication on how the performance measure can be demonstrated or documented (Illinois DOT, 2010).

4.4.4 LEED® for Neighborhood Development (LEED-ND)

LEED-ND is a recent addition to the third-party rating systems suite of tools from the U.S. Green Building Council. It is currently administered by the Green Building Certification Institute and addresses broad transportation elements and some street planning and design (USGBC, 2010).

4.4.5 Sustainable Sites Initiative (SITES™)

SITES is a point-based guidelines document for land development projects that peripherally includes roadway projects. Stakeholders in its development include the American Society of Landscape

Architects, the Lady Bird Johnson Wildflower Center at the University of Texas, Austin and the United States Botanical Garden. It is currently in pilot testing stage and it is unclear when this system will be ready for general use, but it appears that the U.S. Green Building Council intends to incorporate the standards into the LEED Rating Systems (Sustainable Sites, 2009).

4.4.6 Sustainable Transportation Engineering and Environmental Design (STEED)

STEED is a checklist-based tool developed by the consultant, H.W. Lochner. It appears that this tool is used internally by the consultant, but not others (H.W. Lochner, 2009)

4.4.7 Green Guide for Roads

This is a guidance document in Wiki-format intended for use by the Transportation Association of Canada (TAC) with the purpose of providing ideas for more sustainable transportation planning, projects, and operations (TAC, 2008). The author, through the Greenroads Foundation, is working as a consultant on the development of this project.

4.4.8 Greenpave

This is a self-certification tool in the Ministry of Transportation (MTO) in Ontario, Canada. It is based on a combination of an older version of Greenroads, with select focus on two of the Greenroads categories (Materials & Resources and Pavement Technologies, see Chapter 4) with a few additional performance measures specific to pavement preservation projects. Similar to I-LAST, it does not appear that Greenpave is in widespread use (MTO, 2010).

4.4.9 CEEQUAL

Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL) is a third-party rating system for infrastructure projects that is based in the United Kingdom. It is broadly applicable to all types of projects, but it is unclear how many roadway projects have been certified. Additionally, it is not clear if the organization that manages CEEQUAL is independent of the projects that have been rated (CIRIA, 2011; CEEQUAL International, 2011).

4.4.10 envision

Similar to CEEQUAL, the envision tool is being developed by the American Society of Civil Engineers, the American Public Works Association and the American Council of Engineering Companies to apply to all infrastructure projects. These groups have created a separate administrative organization called the Institute of Sustainable Infrastructure (ISI) to perform the third-party ratings of projects.

The tool is not currently available for ratings, but is available for public comment with planned release sometime in 2012 (ISI, 2012).

4.4.11 Infrastructure Voluntary Evaluation Sustainability Tool (INVEST)

In 2010, the Federal Highway Administration (FHWA) released its pilot version of the INVEST tool, available at http://www.sustainablehighways.org. INVEST is a self-evaluation tool that is web-based and provides a list of defined activities with suggested documentation requirements to guide roadway owners in planning, building and maintaining more sustainable highways. In general, the unique features of this system are that it is structured similar to a rating system (points can be earned) and that it includes a whole lifecycle approach to highway sustainability (FHWA, 2012).

4.4.12 Integrated VicRoads Environmental Sustainability Tool (INVEST©)

VicRoads in Australia has another similarly named tool called INVEST that is used for strategic performance improvements for sustainability internally. This is largely a project-based tool that allows for internal awards through self-assessment. INVEST includes a set of four minimum requirements and a list of 11 broad sustainability indicators with subsets of specific activities, such as dust control and air quality, habitat management, cultural impacts and other transportation impacts (VicRoads Environmental Sustainability, 2011).

4.4.13 Tools for Bridge Sustainability

A few authors have attempted to produce a LEED-like point-based performance metric specific to bridges or have begun to propose ideas about sustainability in bridges (Hunt, 2005; Yermack, 2010; Snelling, 2009; Whittemore, 2011; Louis, 2010). Notably, Hunt (2005) offers the most comprehensive approach. Many, if not all, of the ideas in her thesis are present in the Greenroads Rating System. It is this author’s opinion that bridges and roadways are not separate entities and can be addressed by the same or similar performance measures.

4.5 THE NEED FOR A ROADWAY RATING SYSTEM

Clearly, there is a need and an interest in a sustainability tools for performance measurement in transportation. Specifically, there is a gap in performance measurement tools specifically designed for roadway projects that are comprehensive, broadly applicable and well-defined. The research shown in this Chapter and in Chapter 3 demonstrates that performance metrics that aim to increase accountability for sustainability can provide direct opportunities to benchmark internal practices.

Such metrics can improve performance and promote innovation from within the DOT, as well as stimulate competition in the transportation industry.

At a network level (transportation planning and operations), it is difficult to measure the progress on current issues like greenhouse gas emissions without a standardized metric, and challenging to apply it consistently throughout the network of diverse projects. At a project level though, measurement is much easier to do because it can be accomplished in manageable, definable pieces. A few performance metric tools for projects exist in the U.S. conceptually as noted above, but none are established beyond guidance or self-assessment tools and none are in widespread use. Additionally, few of them attempt to challenge the status quo for roadway project sustainability.

Of course, any single measure applied at any level, such as vehicle miles traveled (VMT), carbon dioxide emissions, or total suspended solids (TSS) concentration in stormwater, does not alone capture the entire meaning of sustainability. A comprehensive tool is needed that captures the major ideas and goals of sustainability using familiar indicators that also provides a means to recognize efforts that are beyond conventional design and construction practice. Such a tool needs to be transparent, based on empirical data, validated with actual project data, simple to use, and easy to understand. The Greenroads Rating System was developed for these express purposes.

4.6 SUMMARY

- The majority of existing research in performance measurement for sustainability in transportation consists of guidelines documents and multi-criteria decision-making tools.
- These research-based tools and guidelines do not appear to be widely used in design and construction of roadway projects.
- Owners can used these resources to check general alignment with current industry performance for sustainability, but these tools do not challenge the status quo.
- Performance measurement is most widely used as a strategic planning tool. It is not typically seen at a project level.
- In general, performance measurement allows quantification, but it is important to recognize that measurements alone are often not sufficient for improved performance. This indicates a reason to have a performance measurement tool that is administrated by a third-party.

- Several performance measurement tools exist for use on roadway projects, all of which vary by levels of development, detail, comprehensiveness, and active use.
- A comprehensive tool is needed that captures the major ideas and goals of sustainability that is designed specifically for roadway projects.

5.0 DESCRIPTION OF THE GREENROADS RATING SYSTEM

From the background information provided in the previous Chapters, a project-based sustainability rating tool is needed for roadway design and construction. The Greenroads Rating System represents the combined development effort and input of over 100 people in academia and industry over five years. This dissertation provides the missing keystone in the process of research, development, testing, and implementation for Greenroads: testing the Rating System on real roadway projects. The research stage was described in Chapters 2-4. This chapter presents a summary of the development process and various iterations of Greenroads. The next chapters introduce the processes used to select projects for this study (Chapter 6), the scoring method (Chapter 7), and the statistical tests (Chapter 8) that are employed to determine the answers to the following questions:

- Is Greenroads fair, balanced and applicable to all roadway projects?
- What is the state of the practice in roadway project sustainability according to Greenroads?
- Does Greenroads meet the intent of its designers?

The testing process is important to the overall success of the system because it will help direct future research, determine strengths and weaknesses in existing practice and the Rating System itself, and ultimately show whether or not the system fits its purpose and goal. Results of testing will provide new perspective on sustainability projects, show whether Greenroads can be used as a viable performance measurement tool, and help determine what such a tool means to the transportation industry for sustainability.

The work presented in this Chapter represents a summary of the development of Greenroads and its applicability, objectives and structure. Detailed information, including the almost 500-page *Greenroads Manual* (the Manual) can be viewed at the Greenroads website: http://www.greenroads.org. A list of credits is provided in Tables 5.3 and 5.4 at the end of this Chapter.

5.1 BACKGROUND

Greenroads is a collection of sustainability best practices that apply to roadway design and construction, much like the Leadership in Energy and Environmental Design (LEED) Rating System for Buildings that is administered by the U.S. Green Building Council (USGBC) and the Green Building

Certification Institute (GBCI). In general, these sustainability best practices are divided into two types, required and voluntary, and some flexibility is built in to the voluntary practices to promote innovation and continuous development.

5.1.1 Goals of Greenroads

The overall goal of the rating system is to improve sustainability on roadway projects. One way that Greenroads encourages improvement is by setting minimum requirements that exceed conventional design and construction practices but are still achievable. As a voluntary rating program, awards are given to recognize this substantial achievement in improved sustainability, which provides an additional incentive to use Greenroads. As exemplified by USGBC, this voluntary awards-based structure can transform an entire economic sector, drive innovation, promote education and encourage new technologies and research.

5.1.2 Scope of the Rating System

Greenroads was specifically designed to be relevant to roadway projects because they can be easily defined in time and space. In particular, the roadway project begins to be designed as soon as the decision to build a roadway is made and it ends when the owner and contractor agree that the project is complete. A roadway construction project also has a defined set of physical boundaries; usually this includes existing public right-of-way and/or real estate that has been purchased or otherwise acquired for the purpose of roadway project development.

For this reason, Greenroads includes a majority of design and construction practices that can be achieved and documented during this timeframe and within these bounds. It does not include transportation planning or operations of roadway facilities; however, Greenroads does not discount the importance of these activities. In fact, Greenroads is designed to help track and measure performance on all types of projects (including preservation and construction maintenance) for future planning or benchmarking purposes, and also encourages long-term thinking that involves traffic operations and site maintenance of roadway facilities.

For example, for larger projects, Greenroads becomes most applicable upon completion of the selection of the roadway alignment through the environmental review process, which typically contains a no-build alternative. For smaller projects, Greenroads fits best after funding allocations have been decided for proposed transportation improvement plans and preservation projects that contain several small projects. However, results will show later that considering Greenroads before or during alignment selection can help position a project for better success.

5.2 INITIAL DEVELOPMENT AND ITERATIONS

The initial idea for a LEED-like rating system for roadway pavements was developed by Söderlund (2007). Ms. Söderlund's work laid the foundation for some of the key ideas in the rating system that still exist today, including schematic credits were developed including goal statements, credit requirements and suggested calculations and documentation.

To date, the Greenroads Rating System has undergone at least seven iterations, assigning version 0.5 (v0.5) to Ms. Söderlund's original work. In 2008, environmental engineering firm CH2M HILL volunteered their support and expertise to collaborate on further development of some of the credits in Greenroads. Further details on the changes and refinements made over the last four years can be read in the supporting papers presented at the Transportation Research Board annual conferences noted below:

- V0.5 was described in Söderlund et al. (2008) with the initial concept and schematic credits.
- V0.9 was described in Anderson (2008). This version eliminated several credits in v0.5, added new credits, and refined others.
- V0.95 was demonstrated in Muench, Anderson, and Söderlund (2009). This version represents a substantial first draft of a specifications manual with industry examples, approaches and strategies, many of which were contributed by CH2M HILL.
- A draft version of v1.0 (officially v0.99) is documented in the case study provided in Muench, Anderson, and Bevan (2010). This version represents a mid-2009 draft of v1.0 with substantial changes in the names of credits and categories from v0.95, renumbering and reorganizing some credits, and different assignment of point values (weighting) to certain activities.
- V1.0 was written and published online in January 2010 and changed mid-2010 to V1.0.1, which is documented in Anderson (2011). This version was representative of the most stable version of the rating system up until that date, included more revisions to the credits and their names, and was intended to be widely applied to projects to test industry viability, gain experience rating projects, and further refine the system.

The current version, Greenroads v1.5, was published in February 2011 and is currently operational and being used by the Greenroads Foundation, an independent non-profit corporation formed out of this research effort, to certify its first roadway projects. To date, over 100 people, including undergraduate and graduate students, industry experts, government agencies, trade associations, and public works representatives have contributed to the development of Greenroads. It should be noted that while Greenroads is not a conventional consensus-based standard, it likely will evolve to become one in time.

5.2.1 Author's Role in Development of Greenroads

This author has held several roles that are important to the ongoing research and development of the Greenroads standard in addition to this dissertation work. Her primary role has been as lead editor for the latest version of the entire *Manual* and as the main research contributor for the following 14 credits:

- Environmental Review Process
- Lifecycle Inventory
- Waste Management
- Low Impact Development
- Educational Outreach
- Runoff Flow Control
- Runoff Quality
- Context Sensitive Solutions
- Traffic Emissions Reduction
- Site Recycling Plan
- Lifecycle Assessment
- Warm Mix Asphalt
- Custom Credit (a template for how to write a credit)
- Alternative Energy

As a collaborative member of the development and management team, she also provided oversight for the development and refinements to several other credits, including 10 unreleased credits (see Chapter 9), written by graduate and undergraduate students. Finally, the author participated in the visioning and implementation of the Greenroads website (http://www.greenroads.org) and the creation of its main content.

5.2.2 Future Development and Maintenance

In November 2011, the Greenroads Rating System v1.5 (February 4, 2011) and was licensed by the University of Washington to the Greenroads Foundation for ongoing maintenance and future development. Research efforts are still ongoing at the University of Washington with particular interest in learning more about how the rating system applies to international projects. Future versions of Greenroads may also be expanded to include the full life cycle of surface transportation projects by writing credits for planning and operations.

5.3 ATTRIBUTES OF GREENROADS

Zietsman et al. (2011) describes some key features that an ideal performance measurement tool should have or should be which are adapted and expanded below.

- **Working definition of sustainability.** A clear definition of sustainability is critical to the usability of a system, since the scope and measures are all defined around this definition. Greenroads uses the definition of sustainability from Chapter 2.
- **Defined Scope.** A well-defined, manageable scope is critical to establish usefulness and meaning for a performance measurement tool like a rating system. A rating system should have a clearly defined set of values that it supports and tracks.
- **Comprehensive.** Greenroads is a comprehensive collection of different roadway features that are possible to consider on all varieties of projects.
- **Meaningful Activities.** Each activity has a goal which is clearly written and understandable.
- **Defined Performance Criteria.** Each practice in Greenroads is clearly described and has clear performance requirements and documentation requirements that can be reviewed and subsequently measured. This allows quantification of activities because points can be assigned as a currency for activities, and weights can be assigned based on relative impacts.
- **Empirical Support.** Performance should be justified by scientific, objective evidence that demonstrates its benefits or goals. Where such evidence was not available, the performance measure was rejected and excluded from Greenroads.
- **Actionable and meaningful.** It is critical that any performance measure should be able to be implemented; otherwise such a measure is just an arbitrary goal.

- **Tested (a defined reference point).** A performance measurement tool should be tested using actual projects to determine its efficacy and weaknesses. Defining such a reference point is a key purpose of this study.
- **Supplemental to Regulation.** The majority of practices in Greenroads incentivize behavior that exceeds what is required by regulatory standards at the federal level. It is a higher standard of sustainability than other tools.
- **Transparent (addresses costs and benefits).** Because tradeoffs are an important consideration in sustainability, each practice defined in Greenroads also lists known caveats and potential benefits of an activity.
- **Weighted based on impact.** As noted above, defined criteria allow for assignment of points. Points in Greenroads are weighted based on our key values and objectives, which were based on lifecycle assessment studies. An investigation of the impacts of weighting is a key part of this study.
- **Context-sensitive.** Greenroads allows some flexibility such that many different types of projects can fit the system and find it useful.
- **Independent third-party oversight.** The Greenroads Foundation is a third-party non-profit corporation set up to provide independent project ratings. This sets the Greenroads system apart from other approaches to sustainability, such as self-certification programs and other current sustainability initiatives (described in Chapter 4) in transportation.
- **Dynamic.** Over time, Greenroads is designed to evolve and continuously advance the state of practice for sustainability.
- **Relational.** Each activity and credit can be directly traced back to at least one of the seven principles of sustainability, other credits, and one or more sustainability benefits. The ability for a rating system to display these relationships transparently and concisely makes the tool understandable and sets it apart from all of the other sustainability performance measurement tools.

It is worth noting that some of these ideals can be considered to be strengths or weaknesses. For example, if a rating system always changes, it is something that is always current and cutting edge, but also immediately outdated. Similarly, a one-size fits all rating system can be problematic since a project may not be able to complete a number of the activities if the scope may be too small or the project is location-sensitive – this sometimes lends the perception to the user of the rating system that the system is unfairly weighted, or more specifically, not weighted in favor of the project.

The testing approach (Chapter 8) and its results (Chapters 9 and 10) used in this study will clarify some of the potential weighting issues by comparing data from projects scored using the standard version of Greenroads (with points ranging in value from one to five) and an unweighted version (where points are scored in a binary fashion: one if earned and zero if not).

5.4 KEY OBJECTIVES OF GREENROADS

There are some strategic objectives of the Greenroads Rating System that help promote the design and construction of more environmentally-friendly and context-sensitive roadway projects. It is easiest to describe these objectives of the rating system in terms of the benefits it can potentially offer based on a selection of any given activities that can be done on a project. The following ideas and activities roughly correlate with the ideas of "natural laws" and "human values" that were described in Anderson (2008) and summarized in Chapter 2.

Greenroads identifies benefits (sometimes called performance outcomes) for each Project Requirements and Voluntary Credit. This relational feature of Greenroads makes it simple to list and quantify the benefits associated with applying Greenroads on a roadway project. These benefits are listed in Table 5.1.

Table 5.1. Benefits of Greenroads.

Primarily Eco-centric Benefits	Primarily Anthropocentric Benefits
○ Reduces Raw Materials Use	○ Improves Access
○ Reduces Fossil Fuel Use	○ Improves Mobility
○ Creates Energy	○ Increases Service Life
○ Reduces Water Use	○ Improves Human Health & Safety
○ Reduces Air Emissions	○ Improves Local Economies
○ Reduces Greenhouse Gases	○ Reduces First Costs
○ Reduces Water Pollution	○ Reduces Lifecycle Costs
○ Reduces Solid Waste	○ Improves Accountability
○ Restores Habitat	○ Increases Awareness
○ Creates Habitat	○ Increases Aesthetics
○ Reduces Manmade Footprint	○ Creates New Information

It is important to note that each of the activities in Greenroads can be traced to at least one of the seven sustainability principles (Ecology, Equity, Economy, Extent, Expectations, Experience and Exposure) and at least one of the tabulated benefits. Most activities include multiple benefits and address multiple principles. By parsing out each of these benefits and principles, relationships can be mapped and tracked to show connections between certain activities and intended outcomes or goals. This can be a very useful feature of the rating system for agencies and their designers and contractors if they have specific goals or mandates to meet in practice; mapping can facilitate visualization of tradeoffs and provides a way to define strategic direction.

5.5 STRUCTURE OF THE RATING SYSTEM

In general, the Greenroads best practices for sustainability are divided into two types: required and voluntary. The best practices are divided into six categories, with one collection of 11 required activities. The required activities (often simply called "credits") must be completed in order for a roadway to achieve formal certification through the Greenroads Foundation's project certification program. Thirty-seven (37) other voluntary activities are grouped in five categories that are roughly arranged by the interest area of a professional that may be implementing them. Additionally, a sixth voluntary category is available to projects that demonstrate and implement innovative ideas or more sustainable practices and would like to write or submit their own customized or new ideas for points. These categories are described briefly in this section.

A project wishing to earn recognition for its sustainability efforts can choose to pursue a certification award. Required activities do not earn points but voluntary activities do; voluntary credits are weighted based on lifecycle impact on a scale of one to five points. There are four award levels, which demonstrate sustainability achievement above and beyond conventional practice.

Table 5.2 Greenroads certification levels with point thresholds.

	Certified Level	Silver Level	Gold Level	Evergreen Level
Logo	Greenroads CERTIFIED	Greenroads SILVER CERTIFIED	Greenroads GOLD CERTIFIED	Greenroads EVERGREEN CERTIFIED
Project Requirements	Meet all 11	Meet all 11	Meet all 11	Meet all 11
Minimum Points	32	43	54	64
Maximum Points	42	53	63	108
Percent of Total Voluntary Points	30-40%	40-50%	50-60%	>60%

A full list of Greenroads credits is provided at the end of this Chapter in Table 5.3-5.4. The full *Greenroads Manual* (Muench et al. 2011) can be browsed or downloaded at the Greenroads website for free: http://www.greenroads.org.

5.5.1 Project Requirements

This category contains all 11 Project Requirements (PR) that a Greenroads project must meet in order to be considered for a certification award. The general intent of this category is to encourage environmentally responsible decision-making processes and to have management plans in place for construction, and to establish a minimum baseline for every project that applies for certification.

5.5.2 Environment & Water (EW)

This category contains eight (8) voluntary credits worth up to 21 points. The intent of this category is to promote best practices related to stormwater management and ecological resources within the project boundary.

5.5.3 Access & Equity (AE)

This category contains nine (9) voluntary credits worth up to 30 points. The intent of this category is to promote safety, access, and mobility to users of the roadway.

5.5.4 Construction Activities (CA)

This category contains eight (8) voluntary credits worth up to 14 points. The intent of this category is to promote responsible construction management, reduce use of fossil fuels and improve health and safety of construction workers.

5.5.5 Materials & Resources (MR)

This category contains six (6) voluntary credits worth up to 23 points. The intent of this category is to promote responsible materials and energy management by combinations of recycling, reusing and reducing both virgin and waste materials.

5.5.6 Pavement Technologies (PT)

This category contains six (6) voluntary credits worth up to 20 points. The intent of this category is to highlight specific pavement engineering innovations and ideas or broad types of technologies or techniques which are well-established in practice and have direct sustainability benefits.

5.5.7 Custom Credits (CC)

This category contains up to a maximum of 10 points which may be earned by a project that implements sustainable or innovative ideas. The project team may submit applications with a detailed description and explanation of the practice to earn credits in this category ranging in value from 1 to 5 points. Points awarded for the custom credit are determined through review and collaboration with Greenroads Foundation. There is currently no limit established for how many custom credits a project may submit for review.

5.6 SUMMARY

- Greenroads is a flexible collection of performance measurements that allows any user, such as a department of transportation (DOT) to pick and choose measures that support their fundamental values and goals.
- Greenroads is designed to apply to all roadway projects regardless of type, location, or other generic properties of a project.
- Greenroads can help manage and reduce environmental impacts at the instant they occur by influencing design and construction practices.
- Rating system tools that are comprehensive and interdisciplinary promote integration and engagement of all levels of transportation professionals.
- Greenroads allows quantification of a variety of performance measures and represents them in an easy to understand rating that can be used as a communication tool.
- Implementing Greenroads as a third-party certification tool adds recognition to users who are successful, may incite innovation and can confer competitive advantage on early adopters.

Table 5.3 List of Greenroads Credits (version 1.5) – continued on following page.

No.	Title	Pts.	Description
Project Requirements (PR) – Mandatory for all projects			
Goal:	*Encourage environmentally responsible decision-making, have management plans in place for construction, and establish a minimum baseline for every project that applies for certification*		
PR-1	Environmental Review Process	Req	Complete a comprehensive environmental review
PR-2	Lifecycle Cost Analysis (LCCA)	Req	Perform LCCA for pavement section
PR-3	Lifecycle Inventory (LCI)	Req	Perform LCI of pavement section
PR-4	Quality Control Plan	Req	Have a formal contractor quality control plan
PR-5	Noise Mitigation Plan	Req	Have a construction noise mitigation plan
PR-6	Waste Management Plan	Req	Have a plan to divert C&D waste from landfill
PR-7	Pollution Prevention Plan	Req	Have a TESC/SWPPP
PR-8	Low Impact Development (LID)	Req	Complete a LID feasibility study
PR-9	Pavement Management System	Req	Have a pavement management system
PR-10	Site Maintenance Plan	Req	Have a roadside maintenance plan
PR-11	Educational Outreach	Req	Publicize sustainability information for project
Voluntary Credits (VC) – Available for all projects based on context			
Environment & Water (EW)			
Goal:	*Promote best practices for managing stormwater and ecological resources within the project boundary*		
EW-1	Environmental Management System	2	ISO 14001 certification for general contractor
EW-2	Runoff Flow Control	1-3	Reduce runoff quantity
EW-3	Runoff Quality	1-3	Treat stormwater to a higher level of quality
EW-4	Stormwater Cost Analysis	1	Conduct an LCCA for stormwater elements
EW-5	Site Vegetation	1-3	Use native low/no water vegetation
EW-6	Habitat Restoration	3	Restore habitat beyond what is required
EW-7	Ecological Connectivity	1 or 3	Connect habitat across roadways
EW-8	Light Pollution	3	Discourage light pollution
	EW Points Subtotal:	**21**	
Access & Equity (AE)			
Goal:	*Promote safety, access, and mobility to users of the roadway and improve community livability*		
AE-1	Safety Audit	1-2	Perform roadway safety audit
AE-2	Intelligent Transportation Systems (ITS)	2-5	Implement ITS solutions
AE-3	Context Sensitive Solutions	5	Plan for context sensitive solutions
AE-4	Traffic Emissions Reduction	5	Reduce emissions with quantifiable methods
AE-5	Pedestrian Access	1-2	Provide/improve pedestrian accessibility
AE-6	Bicycle Access	1-2	Provide/improve bicycle accessibility
AE-7	Transit Access	1-5	Provide/improve transit accessibility
AE-8	Scenic Views	1-2	Provide views of scenery or vistas
AE-9	Cultural Outreach	1-2	Promote art/culture/community values
	AE Points Subtotal:	**30**	

Table 5.4 List of Greenroads Credits, v1.5 (continued from previous)

No.	Title	Pts.	Description
Construction Activities (CA)			
Goal:	*Promote responsible construction management, reduce use of fossil fuels and improve health and safety of construction workers*		
CA-1	Quality Management System	2	ISO 9001 certification for general contractor
CA-2	Environmental Training	1	Provide environmental training
CA-3	Site Recycling Plan	1	Have a plan to divert waste from landfill
CA-4	Fossil Fuel Reduction	1-2	Use alternative fuels in construction equipment
CA-5	Equipment Emissions Reduction	1-2	Meet EPA Tier 4 standards for non-road equip.
CA-6	Paving Emissions Reduction	1	Use pavers that meet NIOSH requirements
CA-7	Water Tracking	2	Develop data on water use in construction
CA-8	Contractor Warranty	3	Warranty on the constructed pavement
	CA Points Subtotal:	**14**	
Materials & Resources (MR)			
Goal:	*Promote responsible materials and energy management by combinations of recycling, reusing and reducing both virgin and waste materials*		
MR-1	Life Cycle Assessment (LCA)	2	Conduct a detailed LCA of the entire project
MR-2	Pavement Reuse	4-5	Reuse existing pavement sections
MR-3	Earthwork Balance	1	Use native soil rather than import fill
MR-4	Recycled Materials	1-5	Use recycled materials for new pavement
MR-5	Regional Materials	1-5	Use regional materials to reduce transportation
MR-6	Energy Efficiency	1-5	Improve energy efficiency of operational systems
	MR Points Subtotal:	**23**	
Pavement Technologies (PT)			
Goal:	*Highlight innovative technologies or techniques with well-established and direct sustainability benefits*		
PT-1	Long-Life Pavement	5	Design pavements for long-life
PT-2	Permeable Pavement	3	Use permeable pavement as a LID technique
PT-3	Warm Mix Asphalt (WMA)	3	Use WMA in place of HMA
PT-4	Cool Pavement	5	Contribute less to urban heat island effect (UHI)
PT-5	Quiet Pavement	2-3	Use a quiet pavement to reduce noise
PT-6	Pavement Performance Tracking	1	Relate construction to performance data
	PT Points Subtotal:	**20**	
Custom Credits (CC) – Available for all projects based on context and innovation, subject to approval			
Goal:	*Recognize projects that implement sustainable, new or innovative ideas*		
CC-1	Custom Credit 1	1-5	Design a new voluntary credit
CC-2	Custom Credit 2	1-5	Design a new voluntary credit
	CC Points Subtotal:	**10**	
	Greenroads Total Points:	**118**	

6.0 PROJECT EVALUATION

The previous chapters provided background on sustainability (Chapter 2), why it is important for transportation (Chapter 3) and how performance measurement is used to address sustainability in practice (Chapter 4) as a strategic planning tool. These chapters established that there is a clear need for a project-based sustainability rating system in transportation, and that Greenroads was expressly designed to meet this need (Chapter 5). The remainder of this research describes how Greenroads was evaluated to determine if it is a viable tool for applying sustainability in transportation and to use it to measure and benchmark the state of the practice for sustainability in roadway projects.

This section describes the 120 roadway projects that were scored using the sustainability standard established by the Greenroads Rating System, version 1.5 (dated February 4, 2011 with errata). This section describes the project collection method, selection criteria, data types and quality, classification of qualitative attributes of the dataset, and characterizes the data. Each project is scored using the process described in Chapter 7, which is a similar approach to that described in Anderson (2011), and further defines the quantitative portion of this study. An example of a scored project is provided in Appendix B. The defined qualitative attributes of projects ("properties") are used to test the null hypothesis in the trend analyses and multivariate analyses explained later in Chapter 8.

Specific information about each project assessed for this study was collected and categorized such as: location, functional class, contract price (engineer's estimates or actual costs depending on project stage), stage of the project, and the nature of the work (e.g. rehabilitation or new). Data collection and characterization details are provided in this chapter.

6.1 PROJECT DATA COLLECTION

In order to evaluate if Greenroads is a viable way to measure sustainability on transportation projects, 120 roadway projects were collected for evaluation. Project data were collected for use in this evaluation through several means:

- Contracted research projects related to Greenroads through the University of Washington Civil and Environmental Engineering department. Research sponsors included:

    - Transportation Northwest (TransNow)
    - The Coordinated Technology Implementation Program (CTIP) of the FHWA Federal Lands Highway office and Federal land management agencies
    - The Federal Highway Administration
    - Oregon Department of Transportation
    - State Pavement Technology Consortium (SPTC)

- Pilot projects and projects pursuing certification with the Greenroads Foundation including the following local and state agencies:

    - City of Bellingham, WA
    - City of Auburn, WA
    - City of Oak Harbor, WA
    - City of Kirkland, WA
    - City of San Jose, CA
    - Caltrans
    - City and County of Denver, CO
    - City of Houston, TX
    - City of Las Vegas, NV

- Industry research projects, including contributions from the following companies:

    - CH2M HILL
    - AECOM
    - ARUP
    - Parsons Brinckerhoff
    - HNTB
    - Perteet
    - KPG
    - GeoEngineers
    - ISL Engineering

- Independent student research projects completed as part of course requirements at the University of Washington or from other universities and colleges that was volunteered to the research effort by individual authors.
- Additional projects were also identified as candidates through the process of discovery while researching other projects, due primarily to the high volume of publicly available information.

6.1.1 Selection Criteria

Projects were selected for this study with the primary goal of creating a large, diverse sample of projects with some overlapping characteristics. The majority of projects were included because information was readily available. However, a few projects were excluded, for example, two previous projects involving private parking lots were not included due to lack of substantive project information.

6.1.2 Project Resources

Project information was gathered from a variety of resources and references, which are grouped as shown below. Figure 6.1 shows a cross-section of the types of data available.

1. **Verbal.** Interview with project representative by the author or other research associates.
2. **Website.** Project website (publicly accessible).
3. **Public information.** Other public information (public relations materials, flyers, standard specifications, master plans, funding applications).
4. **Site Visit, Maps & Images.** Photos, site visit, maps, videos or other images including Google Streetview®.
5. **Environmental Reports.** Environmental review documents (environmental assessments, permits, environmental impact statements in draft or final form).
6. **Design documents.** Project design documents (plans, reports, special provisions, permits etc.).
7. **Contractor documents.** Documents gathered from the contractor about construction (mix designs, schedules, bid tabulations, etc.).

The project data were tabulated and stored in Microsoft Excel spreadsheets. Due to confidentiality interests associated with some project information, all of the project records used in this study are presented only in aggregate format with no identifying information. Raw data scores are contained in Appendix C. A spreadsheet including the aggregate information in both the weighted and unweighted form is also available for free download at the Greenroads website: http://www.greenroads.org/files/735.xlsx.

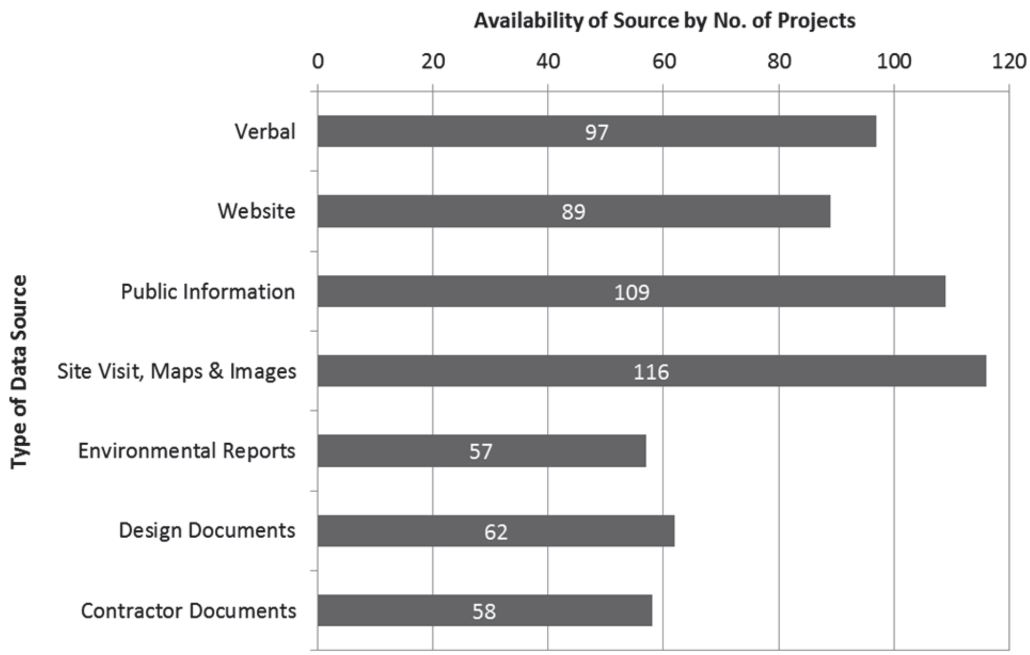


Figure 6.1 Types of data sources and frequency of availability for purposes of this study.

6.2 SOURCE QUALITY

There was wide variability in the amount and type of documentation available for each project. A data quality score (DQ Score or DQS) of one to ten was assigned to each project based on the data sources that were made available or otherwise discovered for review.

To develop an understanding of the general quality of the data available for evaluation, one point is assigned for each document of types 1-4, and two points for comprehensive, project-specific documents (types 5-7). Thus, the highest DQ scores have the most types of information available that is likely to be highly relevant to the project, and lower scores have the fewest types of information with the least detail. DQ score is intended to provide a general indicator of the relevance of the particular document and not a reflection of the project's performance or resulting project score.

The DQ Scores can be grouped according to four categories of "poor," "fair," "good," and "excellent." The median DQ Score is 6, the mode is 8, and the arithmetic mean DQ Score is 6.3±2.2. Only 2 projects received DQ scores in the "poor" category, as shown in Figures 6.2 and 6.3.

Data quality is evaluated based on the project property data by the same method used to compare other scores of the projects (see Chapter 8, Testing the Greenroads Rating System for analytical approach). The results of the data quality analysis are integrated into the reports of test results in the chapters to follow. Key effects of data quality are identified where relevant.

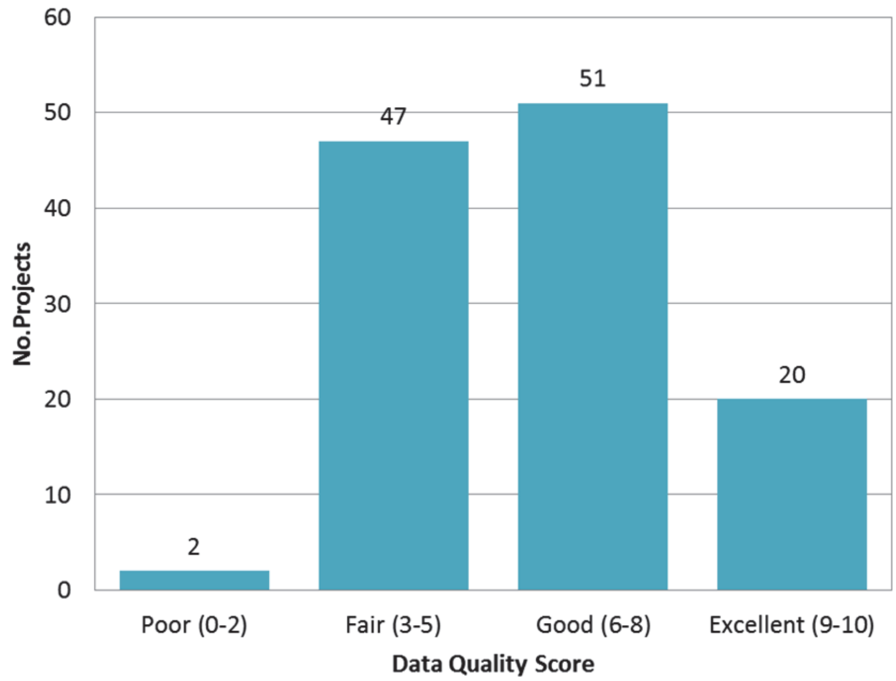


Figure 6.2 Distribution of project DQ scores.

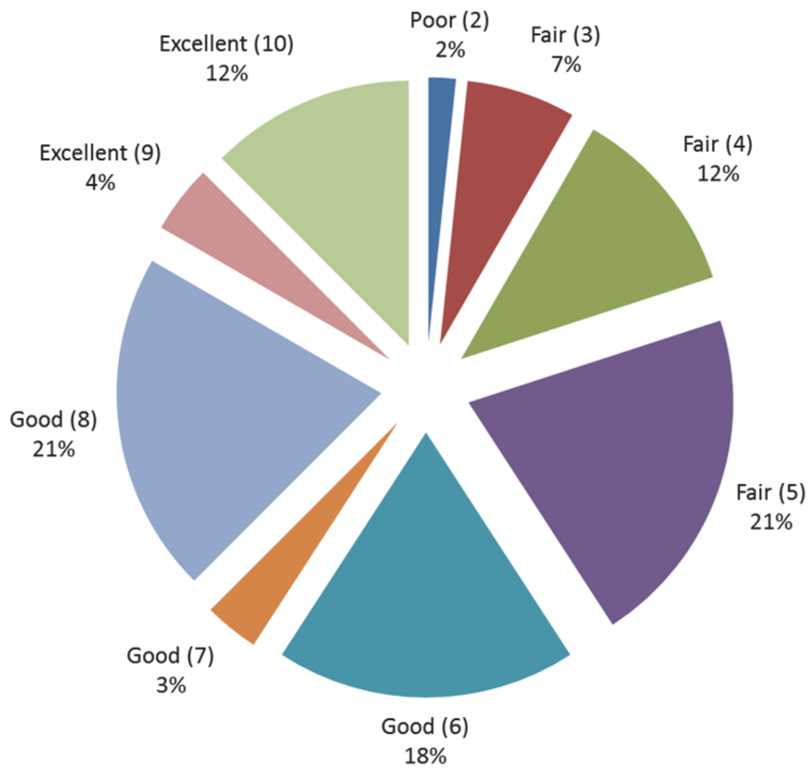


Figure 6.3 : Percent and frequency of projects achieving specific DQ scores (0-10).

6.3 CLASSIFICATION OF PROJECT DATA

This section describes the dependent variables used in this study, with emphasis on the qualitative project properties. Note that the project scoring method is discussed in Chapter 7.

6.3.1 Qualitative Variables ("Properties")

The 120 projects are classified according to the following 15 variables of interest shown in Table 6.1, 6.2 and 6.3.

Table 6.1 Qualitative Project Variables

Variable Name	Description	Categories	Frequency	%
GreenroadsProject	Project deliberately used any version of the Greenroads standard in design or construction	Not Greenroads Greenroads	99 21	82.5 17.5
GreenEmphasis	Project deliberately emphasized sustainability during planning or design, such as through funding mandate or experimental features	Typical Greener	83 37	69.2 30.8
MajorStructures	Project includes major structures, such as bridges, walls or tunnels and pavements.	Structures No Structures	55 65	45.8 54.2

Table 6.2 Qualitative Project Variables (cont.)

Variable Name	Description	Categories	Frequency	%
Northwest	Project is located in the Northwest region of North America. States and Provinces include Washington, Oregon, Montana, Idaho, and British Columbia. Alaska would be included but this sample does not include any Alaska projects.	Northwest	60	50.0
		Other Regions	60	50.0
Country	Project is located in the United States or its territories.	International	12	10.0
		USA	108	90.0
Owner	The primary owner-agency of the project. Private roadway owners (such as toll authorities) and multiple-owner partnerships are considered to be state-level organizations due the tendency of the maintenance responsibility belonging to the state agency. Note that this is a unique situation that applies to the sample only; ideally there is also a category called "private."	City/County	37	30.8
		State/Provincial	69	57.5
		Federal/National	14	11.7
Contract	Alternative contracts include DB, CMAR, DBOM, PPP, DBBV and GCCM.* Unknown projects will eventually belong to either the conventional or alternative category.	Conventional DBB	92	76.7
		Alternative	22	18.3
		Unknown	6	5.00
Phase	This is the phase during which the project documentation was reviewed.	Planning	16	13.3
		Finished	51	42.5
		Construction	31	25.8
		Design	22	18.3
Purpose	New projects involve a greenfield or undeveloped area, reconstruction projects involve major construction work within an existing right of way and change of alignment including bridge replacements, and maintenance projects involve rehabilitation, resurfacing, and restoration activities with no major alignment changes.	New	18	15.0
		Maintenance	45	37.5
		Reconstruction	57	47.5

*DB, CMAR, DBOM, PPP, DBBV and GCCM are, respectively: design-build, construction manager at-risk, design-build-operate and maintain, public-private partnership, design-build-best-value and general contractor construction management.

Table 6.3 Qualitative Project Variables (cont.)

Variable Name	Description	Categories	Frequency	%
Motivation**	Capacity improvement or expansion, new access and adding modes	Mobility	49	40.8
		Preservation	33	27.5
	Facilities that provide access improvements	Economic	16	13.3
	Stand-alone safety projects	Safety	9	7.5
	Retrofits for water, animals, noise, aesthetics and trying ex	Environmental	10	8.3
		Other	3	2.5
Surfacing	Hot mix asphalt (HMA), bituminous surface treatments (BST)	HMA	79	65.8
	Portland cement concrete (PCC), including concrete maintenance and bridges	PCC	17	14.2
	Mixed pavements where both HMA and PCC are present	Mixed	19	15.8
	Includes steel, wood and other materials	Other	5	4.2
Place	Populations <50,000 and predominantly natural*** or agricultural features	Rural	36	30.0
	Populations of 50,000-100,000, mix of manmade and natural features	Small Urban	44	36.7
	More than 100,000 people and predominantly manmade features	Urban	40	33.3
FunctClass	Generalized roadway functional classes based on FHWA Functional Classification Guidelines Section 2.1 (1989)	Collector	31	25.8
		Arterial	78	65.0
		Local	11	9.2
Length	Mileage of the project.	0-1 miles	38	31.7
		1-5 miles	27	22.5
		5+ miles	55	45.8
Budget	In millions of 2011 US dollars.	$0-10	63	52.5
		$10-100	39	32.5
		$100+	18	15.0

**Definitions from Washington Department of Transportation regarding project prioritization based on need (WSDOT, 2011)
***From (Croft, 2009)

6.3.2 Quantitative Variables

Two continuous variables, project mileage and cost, are treated as qualitative categorical variables as “Length” and “Budget” above. Project costs were adjusted to 2011 U.S. dollars using construction date information and the annual average consumer price index (CPI) (BLS, 2011). Costs of international projects were converted to U.S. dollars using best available information for exchange rates as of the date of the estimate or bid award, or else the average annual exchange rate was used based on data available at http://www.exchange-rates.org. For projects rated during the planning phase or design (i.e. no known construction cost), in the absence of an engineer's estimate, the date of the source where cost information was discovered was used as the reference year. The cost information presented in the specified ranges above is at best a representation of approximate construction value, since it involves a mixture of actual construction costs and estimated costs. Due to this variability, the qualitative approach appears to be a reasonable mitigation strategy.

Project scores for each credit, category, and aggregate scores are dependent quantitative variables that are discussed in further detail in Chapter 7.

6.4 DATA CHARACTERIZATION

This section presents remarks on the characterization of the data, specifically with respect to how well it conforms to requirements for statistical testing and discusses characteristics of the sample of 120 projects such as randomization, control, representativeness, independence and uniformity. Distributions and tests for normality are included in Chapter 7.

6.4.1 Project Locations

Figure 6.4 shows a distribution the projects on a map of the U.S. A majority of the projects are from the northwestern part of the United States (Washington and Oregon account for 48 projects), while the rest are scattered across the U.S. The states with the next highest frequency of projects are New York and California. The projects located in New York represent the bulk of the projects shown in the category "Northeast" in Figure 6.5. Twelve projects are located internationally, with 67% located in Canada. Due to the large numbers of transportation projects that occur in each state every year, it should be noted that this dataset is a relatively sparse in its geographic distribution, and heavily focused in some particular regions. To account for potential regional influences based on the prevalence of projects (half of them) located in the northwestern United States and Canada, this quality is tracked separately.

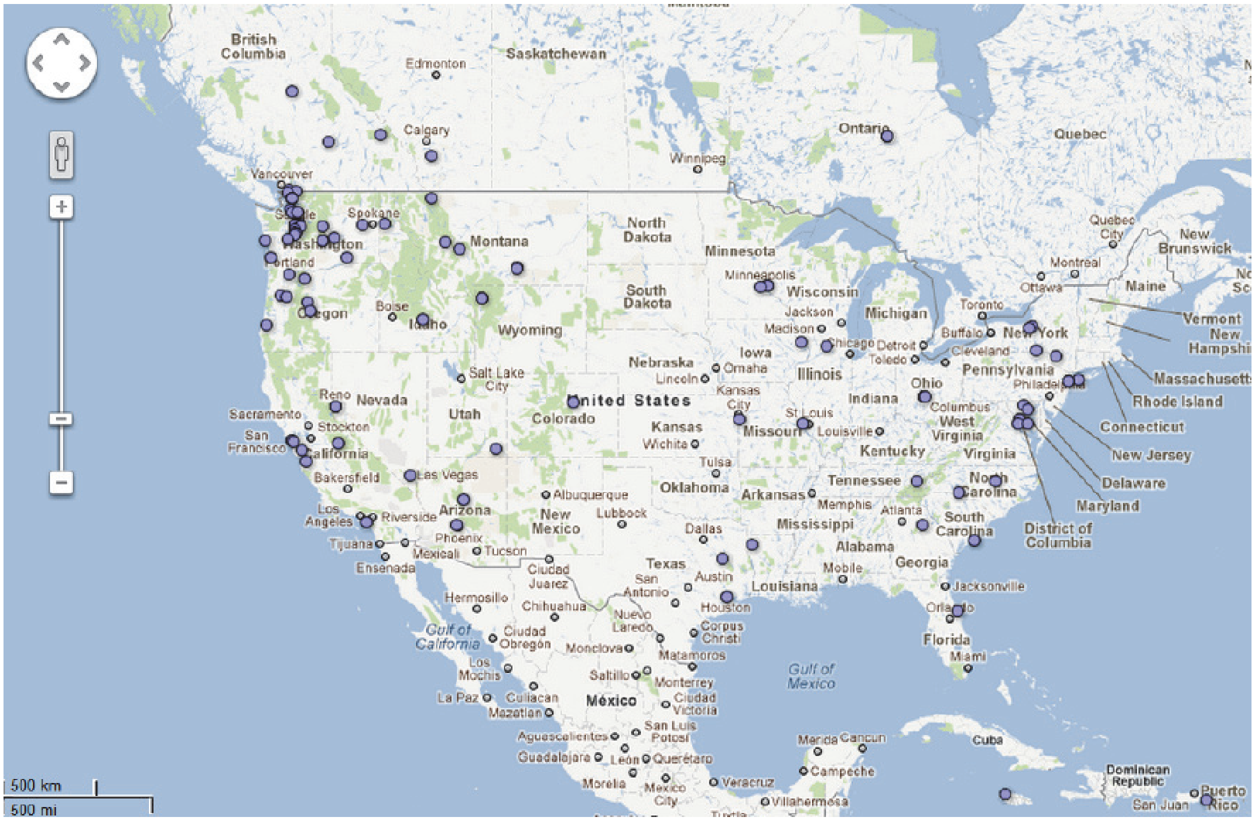


Figure 6.4 Map of Test Project Locations (City, State, Country). Image produced with Google Fusion Tables (beta). Three projects in Hawaii, New Zealand, and South Africa are not pictured.

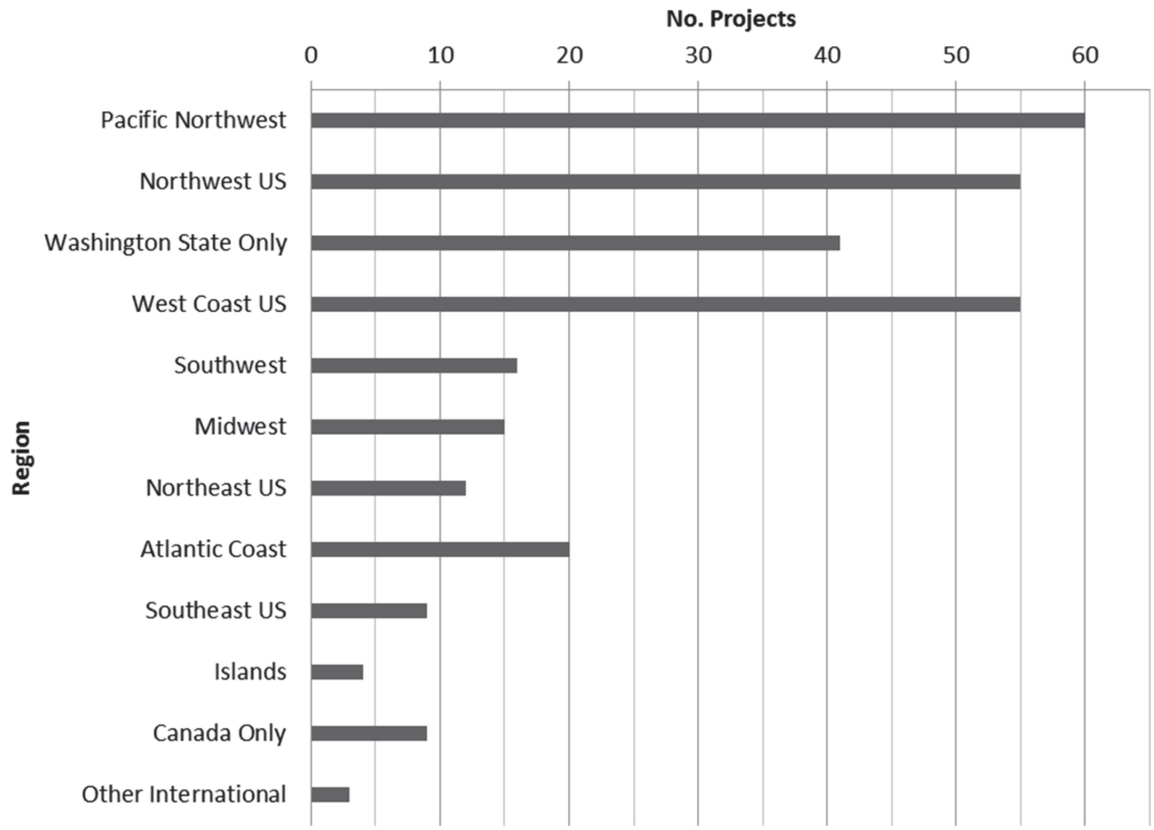


Figure 6.5 Frequency of projects sorted by various regional locations.

6.4.2 Independence of Properties

XLSTAT 2012.2.01 was used to perform a similarity/dissimilarity analysis of correlation between the qualitative variables using a dissimilarity threshold of 0.95. The results showed that there is no significant agreement between any of the qualitative properties within the confidence interval. The resulting Burt Table is split into Tables 6.4 and 6.5. No objects have been found to be similar for the selected dissimilarity threshold. Therefore, the qualitative variables can be considered independent. Only two properties are identified to be remotely correlated (though not significant): Surfacing type and project Motivation. This is likely due to the tendency of hot-mix asphalt (HMA) projects in the sample set to be preservation projects and the tendency of concrete pavement (PCC) projects to be related to mobility improvements.

Table 6.4. Burt Table results for similarity of Project Properties (cont. in next table).

Variable Name	Greenroads Project	Green Emphasis	Major Structures	Northwest	Country	Owner	Contract
Greenroads Project	1	0	0	0	0	0	0
Green Emphasis	0	1	0	0	0	0	0
Major Structures	0	0	1	0	0	0	0
Northwest	0	0	0	1	0	0	0
Country	0	0	0	0	1	0	0
Owner	0	0	0	0	0	1	0
Contract	0	0	0	0	0	0	1
Phase	0	0	0	0	0	0	0
Purpose	0	0	0	0	0	0	0
Motivation	0	0	0	0	0	0	0
Surfacing	0	0	0	0	0	0	0
Place	0	0	0	0	0	0	0
FunctClass	0	0	0	0	0	0	0
Length	0	0	0	0	0	0	0
Budget	0	0	0	0	0	0	0

Table 6.5 Table results for similarity of Project Properties (cont. from previous). Very minor correlation is noted in the highlighted cells.

Variable Name	Phase	Purpose	Motivation	Surfacing	Place	FunctClass	Length	Budget
Greenroads Project	0	0	0	0	0	0	0	0
Green Emphasis	0	0	0	0	0	0	0	0
Major Structures	0	0	0	0	0	0	0	0
Northwest	0	0	0	0	0	0	0	0
Country	0	0	0	0	0	0	0	0
Owner	0	0	0	0	0	0	0	0
Contract	0	0	0	0	0	0	0	0
Phase	1	0	0	0	0	0	0	0
Purpose	0	1	0	0	0	0	0	0
Motivation	0	0	1	0.01	0	0	0	0
Surfacing	0	0	0.01	1	0	0	0	0
Place	0	0	0	0	1	0	0	0
FunctClass	0	0	0	0	0	1	0	0
Length	0	0	0	0	0	0	1	0
Budget	0	0	0	0	0	0	0	1

6.4.3 Independence of Observations According to Property

XLSTAT 2012.2.01 was used to perform a similarity/dissimilarity analysis of correlation between the qualitative variables and the project observations using a dissimilarity threshold of 0.95. The results of this test show that, generally, the majority of projects represent a good mix of similarities and differences with respect to the qualitative variables. Nine pairs of projects were identified to be very similar according to the threshold. Specifically, these similarities can be explained according to the remarks in Table 6.6.

Table 6.6 Noted similarities between projects.

ID No. 1	Similarity	Reason
103 & 104	1.00	Same owner, same purpose and scope, same research effort, same standard specifications. Both are reconstruction projects to provide mobility improvements in rural environment.
107 – 110 (all combinations)	1.00	107-110 are projects in the same capital improvements program and have been scored as separate segments.
164 & 199	1.00	Projects are similar in purpose and scope as relatively long maintenance and preservation projects. Different owners and states, small urban location.
187 & 200	1.00	Projects are similar in purpose and scope: relatively long maintenance and preservation projects with low data quality scores. Different owners and states, rural location.

6.4.4 Other Limitations and Assumptions

It must be noted that substantial efforts were made to include a wide variety of projects while obtaining a reasonable sample size for the numerical data analysis methods (Chapter 8). The data set is therefore very sparse compared to what is theoretically possible, though it appears that it is representative of a general majority of roadway projects.

It is also important to note that some research sponsors deliberately chose projects for testing that demonstrated their best current practice. So, while some research efforts were able to obtain high quality documents, others were not. Due to wide variation in projects in the sample and in industry, the sample is neither random nor is it reasonably possible to achieve a random sample while also obtaining the documentation necessary to perform this analysis. With these considerations in mind, a few points are important to highlight:

1. While these projects are intended to be a representative sample, any specific project may fare differently when compared to the sample.

2. Due to the requirement for documentation to be present in order to score the project, it is likely that if more documentation were present, the results of testing these projects could be considered a conservative estimate.
3. With a high number of qualitative and quantitative variables comes high variability. It is not possible to control all of the variables that are necessary to make this a statistically valid experiment given the real context of these projects. The results contained in this research therefore can only be taken to apply to the sample presented. Extrapolations beyond this sample should be made only upon thoughtful considerations of these limitations.
4. Some of the projects submitted for research efforts were deliberately representative of the owner's best foot forward on sustainability or a certain experimental practice. Therefore, this sample may not accurately capture what is typical current practice since such deliberate cherry-picking of projects could potentially skew or confound the test results. Where possible and known, this property was tracked throughout the analysis to reduce the potential effects of these data points.
5. Level of detailed documentation on large projects was limited by size of the project, which may be counterintuitive. The amount of documentation that actually exists and what was reviewed are significantly different, and extremely limited. In actual certification, these projects would be broken down into smaller segments and addressed individually.
6. It is important to note that, with the exception of a few projects pursuing certification, none of the projects provided 100% of the documents available for the project according to the strict requirements described in the *Greenroads Manual*. No Project Requirement or Voluntary Credit was attempted or documented in the same manner by all projects.
7. Some assumptions were made consistently in order to make this amount of documentation manageable while assigning an objective score. These assumptions are described in further detail in the next chapter.

6.5 SUMMARY

- Data was collected from 120 roadway projects in order to test the Greenroads Rating System and establish a baseline score of sustainability in current practice.
- Projects were selected for this study with the primary goal of creating a large, diverse sample of projects with some overlapping characteristics in order to test the hypothesis that Greenroads is applicable to all types of roadway projects.

- Projects were sourced from a variety of means including funded research, industry, current Greenroads projects and volunteered or discovered information.
- There was wide variability in the amount and type of documentation available for each project so a data quality score is assigned to each project.
- There are a number of limitations and assumptions that should be thoughtfully considered prior to extrapolating the results of this study beyond the sample itself.

7.0 SCORING METHOD

Greenroads is a tool that can be used to measure sustainability on a roadway project by identifying the presence or absence of certain qualities, activities or features through detailed review of project documents. Documentation used in this study was discussed in detail in previous chapter. Data collection procedures and the analytical methods used to test the tool are described in the prior and following chapters, respectively.

The first part of this chapter describes the method used to score a project using Greenroads for the purposes of this study. A brief discussion of Greenroads Certification Review is also provided to help distinguish between this study and actual projects pursuing certification through the non-profit Greenroads Foundation. The second part of this chapter provides descriptive statistics about the scores in the sample of projects, with the intent of establishing a baseline to which future studies similar to this, or future projects, can be compared. These scores will be used and interpreted later in the statistical analysis in order to identify the state of the practice according to Greenroads scores and to identify significant properties that may influence the score.

7.1 PROJECT EVALUATION PROCESS

Project documentation was reviewed for conformance with the current version of the Greenroads Rating System v1.5, dated February 4, 2011. The definition of "conformance" used herein is the synthesis of the three assessments described below, after review of all pieces of information provided by or discovered for the projects. Custom Credit points are not included in the scoring analysis, but the frequency of particular activities has been tracked. All voluntary credits are scored out of a total potential of 108 points.

It is important to note that the definition of a "project" for this study may not exactly match the definition used by the project team because a majority of the scores used in this section and the statistical testing reflect counts of projects and not total construction value or mileage. For example, some projects are actually several smaller, often unconnected and distinct segments that have been treated as separate projects. However, these projects may all part of the same contract for a capital improvements program in a small city. Oppositely, a few very large projects are included in this sample that have been rated as one project, when in reality this project is likely phased and segmented somehow in order to make it manageable to build. Generally, if there is a high degree of similarity between projects, it is likely that they are from the same owner, or possibly from the same contract or phases of the same project. The previous section provides some of these instances near the end of the chapter.

7.1.1 Documented Evidence (Raw Scores)

First, documentation is closely evaluated to identify the presence of certain activities that meet the intended goal of the credits in the *Greenroads Manual*. This is called the Raw Score. Activities can be evidenced by written documents, interviews or visually; no particular mix of documentation was required, nor were documents that are explicitly noted with each credit in the *Manual*. Points are awarded according to what is presented only. It is important to note that points are generally awarded based on appearance that the intent of the credit was met. At times this result comes from logical conclusions and other times from hard evidence, and some variation in interpretation is expected. However, the Raw Score is assigned such that another person should be able to look at the same project, evaluate the same documents and project conditions, and come to the similar conclusions with minimal variability. It is also important to note that this study represents the collection of scores from a number of reviewers, who at times, may have been more (or less) stringent in their assessments. This may result in lower or higher scores than those scored by the author in accordance with the present method (where intent is sufficient to demonstrate the completion of an activity).

7.1.2 Points Not Available (NA Scores)

Next, given the project information available, points that are not applicable to the project or otherwise impractical are assigned. These points are called "NA Scores." Importantly, this score assignment is unrelated to stated project scope. This assignment can be best understood by considering the scenario of a project with an unlimited amount of money and identifying what traits of the local project environment actually constrain or limit the decisions made. In short, these credits are not a good expenditure of budget due to the environmental or social context of a project. An example of a NA Score can be shown easily with AE-7 Transit Access by noting that, for instance, installation of a bus stop in a remote location where no bus service exists appears to be a poor decision.

7.1.3 Economical Points (Econ Scores)

Finally, credits are identified that are likely to be economical, meaning saving money on initial or lifecycle costs, given the environmental context of the project. These points are categorized as by the shorthand “Econ” or “Econ Scores” throughout this document. This is a subjective assessment by the author but is based on data about cost savings already described in the *Greenroads Manual*, an understanding of current practice, a check for availability of certain materials or equipment in some locations, and a basic understanding of the intent of the project that is gathered from reviewing project documents. Credit MR-5 Regional Materials offers a good example of one common activity that requires some additional background information about the location and boundaries of the project before the cost-effectiveness can be determined.

The caveat that is important to note is that Econ credits represent activities that can be economical if considered early in project development, such as the planning or design stages. As the project progresses through design and construction, cost effectiveness of completing these activities steeply declines (Roberts, 2008). The Econ assessment is made without regard to project type, purpose, motivation, budget, or other qualitative properties. It starts with the assumption only that a road will be built in a specific location, so the only constraints are the environment within which the roadway will eventually exist. Additionally, as intended by their design, all 11 Project Requirements are considered to be economically feasible so that certification can be achieved by any project.

7.1.4 Other Computed Scores

Three other scores can be computed using the resulting point distribution of Econ, NA and Raw Scores and are defined below.

Reasonable Potential Scores (Reas Scores)

A reasonable expectation for sustainability performance can be computed using the results of the Raw Scores and the Econ Scores. This reasonable score (Reas Score) represents credits that are possible and economical for the project, plus those that have already been shown to be completed in the Raw Score. The purpose of this score is to demonstrate incremental potential to improve sustainability performance, and is especially telling to look at the difference between the Raw Scores and the Reas Scores on the histogram later in this section.

Remaining Possible Credits (Rem Score)

Remaining possible credits can be calculated by subtracting the Raw Score and the NA Score from the total points available for that credit. These are the credit points that remain that were not awarded or deemed impractical (i.e. the balance) and are denoted in the master spreadsheet as

“Rem Scores” or “Rem.” This score is not used in this study, but is the broadest measure of potential additional achievement beyond what was already completed by a project and can be understood by considering what extra money could potentially buy or build.

Maximum Possible Credits (Max Score)

Similarly, the maximum possible score (Max Score) can be represented by the difference of what is impractical for the project on the project (NA Score) and the total points available in the system (108). Max Score can be interpreted as the ultimate potential achievement assuming there would be unlimited money to spend on being sustainable, regardless of what is documented. Max Score is not used specifically in this study, since it has little practical meaning.

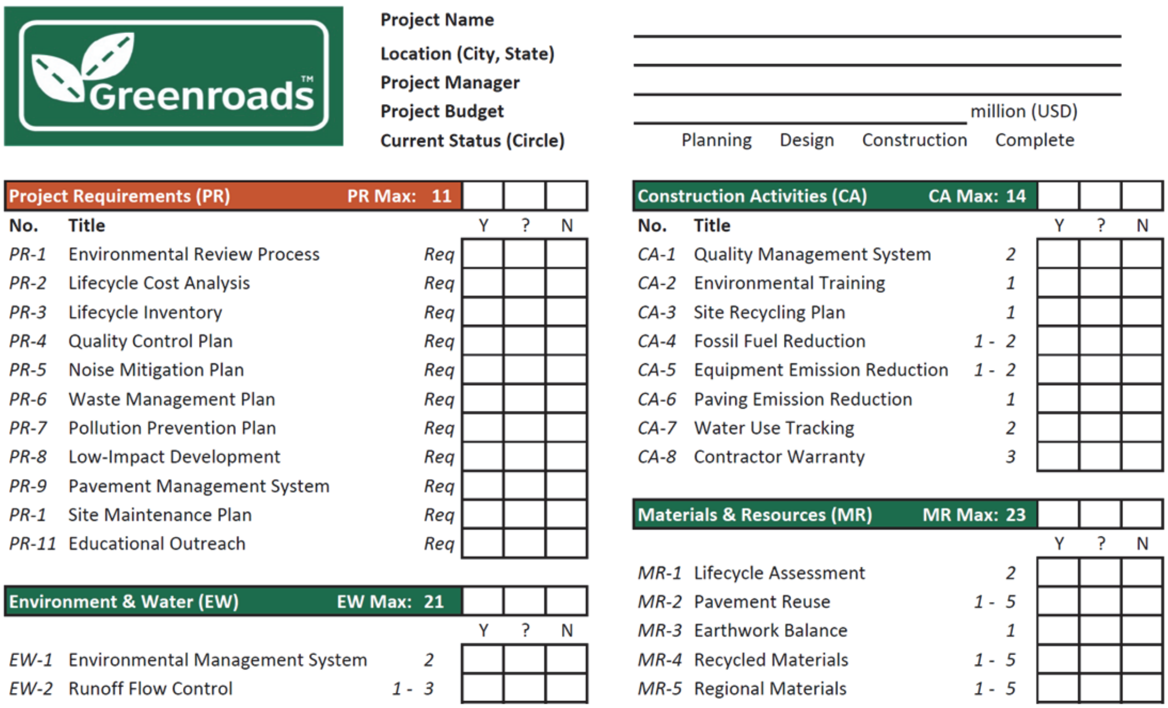
7.1.5 Greenroads Certification Reviews – Key Differences

A certification review is a rigorous review of project documentation to identify if explicit credit requirements have been achieved on a real roadway project. The certification process is managed by a third-party non-profit organization, Greenroads Foundation, and involves registration of the project, payment of fees, uploading project documents to the Greenroads website, and review by staff employed by the Foundation. Typically, the purpose of such a review is to earn a certification, which is recognized by an award if successful. Project data for eight of the Greenroads projects currently pursuing certification was provided for this study by Greenroads Foundation and is used with permission. The remaining 13 projects in the “GreenroadsProj” variable either deliberately used Greenroads in design documents or are currently registered as pilot projects with Greenroads Foundation, used with permission. It is important to note that the scoring method explained in this chapter differs substantially in its intent from actual scores for certification that have been or may be received by these projects. Additionally, the results of this study have no influence on scores awarded by Greenroads Foundation.

7.2 PROJECT EVALUATION TOOLS

Greenroads Foundation provides a free Greenroads Project Scorecard (see Figure 7.1) which was used in modified form to complete an analysis for each project. A modified version of the Greenroads Project Scorecard is shown in Figure 7.2 and explained in the previous section. The results of each project are stored in individual Excel spreadsheets and combined into one master spreadsheet. Projects were then classified according to the qualitative properties noted in the previous chapter.

In order to investigate the influence of weighting (see Chapter 5), two sets of the project data were created to represent the existing (weighted) version of scores and also an unweighted (binary) version where each credit is worth either one point or zero points for all Raw, NA and Econ Scores.



Greenroads™

Project Name

Location (City, State)

Project Manager

Project Budget ______ million (USD)

Current Status (Circle): Planning Design Construction Complete

Project Requirements (PR)		PR Max: 11			
No.	Title		Y	?	N
PR-1	Environmental Review Process	Req			
PR-2	Lifecycle Cost Analysis	Req			
PR-3	Lifecycle Inventory	Req			
PR-4	Quality Control Plan	Req			
PR-5	Noise Mitigation Plan	Req			
PR-6	Waste Management Plan	Req			
PR-7	Pollution Prevention Plan	Req			
PR-8	Low-Impact Development	Req			
PR-9	Pavement Management System	Req			
PR-1	Site Maintenance Plan	Req			
PR-11	Educational Outreach	Req			

Environment & Water (EW)		EW Max: 21			
			Y	?	N
EW-1	Environmental Management System	2			
EW-2	Runoff Flow Control	1 - 3			

Construction Activities (CA)		CA Max: 14			
No.	Title		Y	?	N
CA-1	Quality Management System	2			
CA-2	Environmental Training	1			
CA-3	Site Recycling Plan	1			
CA-4	Fossil Fuel Reduction	1 - 2			
CA-5	Equipment Emission Reduction	1 - 2			
CA-6	Paving Emission Reduction	1			
CA-7	Water Use Tracking	2			
CA-8	Contractor Warranty	3			

Materials & Resources (MR)		MR Max: 23			
			Y	?	N
MR-1	Lifecycle Assessment	2			
MR-2	Pavement Reuse	1 - 5			
MR-3	Earthwork Balance	1			
MR-4	Recycled Materials	1 - 5			
MR-5	Regional Materials	1 - 5			

Figure 7.1 Sample checklist provided for use by Greenroads. Partial view only.

Sample Project Title

Project Requirements (PR)		PR Subtotal:	11	11	5	0	6
No.	**Title**			Econ	Raw	NA	Rem
PR-1	Environmental Review Process	*Req*		x	x		
PR-2	Lifecycle Cost Analysis	*Req*		x			x
PR-3	Lifecycle Inventory	*Req*		x			x
PR-4	Quality Control Plan	*Req*		x			x
PR-5	Noise Mitigation Plan	*Req*		x			x
PR-6	Waste Management Plan	*Req*		x			x
PR-7	Pollution Prevention Plan	*Req*		x	x		
PR-8	Low-Impact Development	*Req*		x	x		
PR-9	Pavement Management System	*Req*		x	x		
PR-10	Site Maintenance Plan	*Req*		x	x		
PR-11	Educational Outreach	*Req*		x			x

Environment & Water (EW)		EW Subtotal:	21	10	9	0	12
				Econ	Raw	NA	Rem
EW-1	Environmental Management System	*2*		0	0	0	2
EW-2	Runoff Flow Control	*1 - 3*		1	0	0	3
EW-3	Runoff Quality	*1 - 3*		1	0	0	3
EW-4	Stormwater Cost Analysis	*1*		1	0	0	1
EW-5	Site Vegetation	*1 - 3*		3	3	0	0
EW-6	Habitat Restoration	*3*		0	0	0	3
EW-7	Ecological Connectivity	*1 - 3*		1	3	0	0
EW-8	Light Pollution	*3*		3	3	0	0

Figure 7.2 Modified Greenroads Scorecard for Use in this Study (partial view only).

7.3 SCORE DISTRIBUTIONS OF SAMPLE

Descriptive statistics were produced for the aggregate score categories of Raw, NA and Econ and Reas using MATLAB 2011a chi-square goodness of fit (chi2gof) test function for both the weighted and unweighted condition. This test was selected because it is robust even when the normal distribution assumption is not correct and it requires only a minimum representative sample size. A significance level of $\alpha = 0.05$ was used (default). The MATLAB script including this test is provided in Appendix D. To supplement this test, histograms and descriptive statistics were produced with 10 bins in XLSTAT® for both the weighted and unweighted conditions.

The MATLAB results (Appendix E) show that the Raw Scores, Reas Scores and NA Scores are normally distributed in the weighted condition. For the unweighted condition (Appendix E), the Raw

Scores are determined to be the only normally distributed variable. For all other conditions, the null hypothesis should be rejected.

Table 7.1 Descriptive Statistics for Weighted Aggregate Scores. Certification levels provided for reference.

Variable	Observations	Minimum	Maximum	Mean	Std. deviation	Normal	Award Level
EconTotalScore	120	37	95	59	17	No	Gold
NATotalScore	120	1	43	18	9	Yes	-
RawTotalScore	120	7	47	26	8	Yes	None
ReasTotalScore	120	33	94	62	17	No	Gold

Table 7.2 Descriptive Statistics for Unweighted Aggregate Scores (No Defined Awards in this Condition)

Variable	Observations	Minimum	Maximum	Mean	Std. deviation	Normal
EconTotalScore	120	17	34	25	5	No
NATotalScore	120	1	14	6	3	No
RawTotalScore	120	3	22	9	4	Yes
ReasTotalScore	120	14	34	24	5	No

However, the tabulated descriptive statistics (Tables 7.1-7.2) and histograms (Figures 7.3-7.10) of each of these variables tell a slightly different story for the Reas Scores in both conditions and the NA Scores in the unweighted condition. It appears that the sample size may not be large enough to approximate an appropriate normal distribution since the histograms show that the data matches reasonably well to the distribution (see Figures 7.8 and 7.10) but there are some areas where the curve does not perfectly match. Nevertheless, it is acceptable for use in this research in the absence of no historical information to which the sample could be compared.

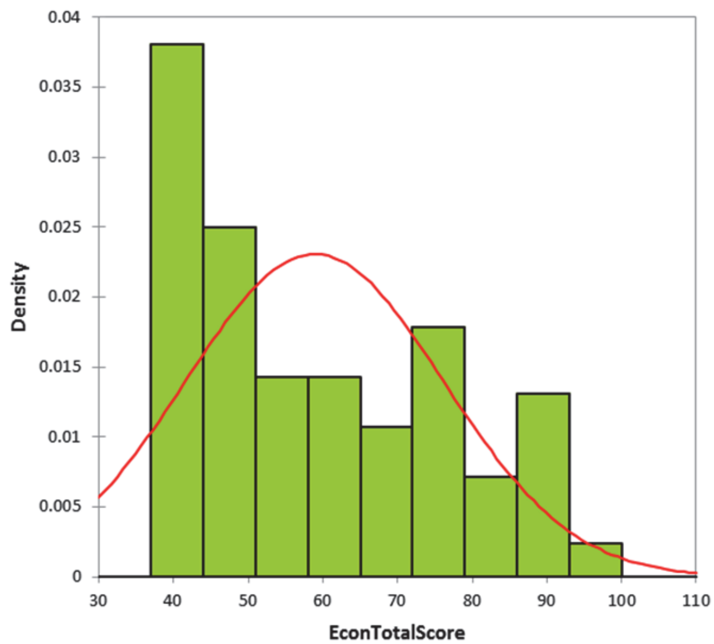


Figure 7.3 Histogram of economical scores overlaid by normal distribution. Weighted condition.

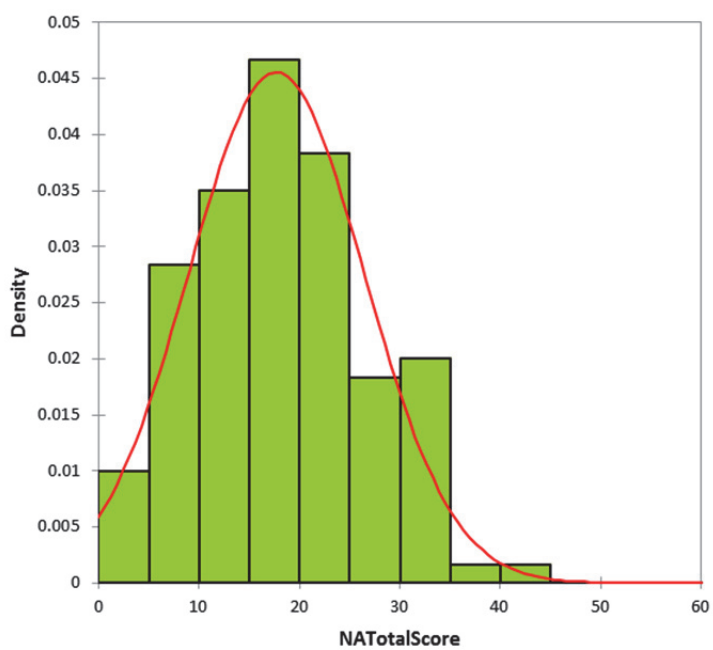


Figure 7.4 Histogram of total points not available overlaid by normal distribution. Weighted condition.

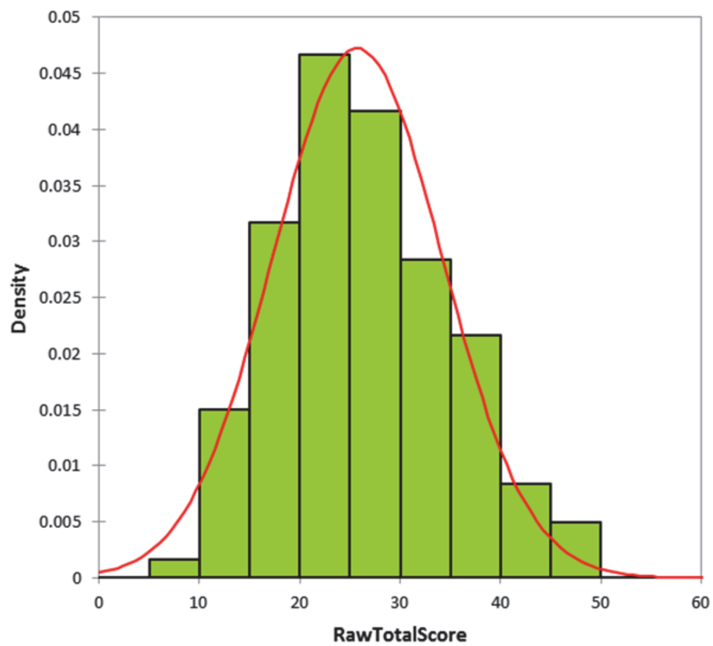


Figure 7.5 Histogram of documented total points overlaid by normal distribution. Weighted condition.

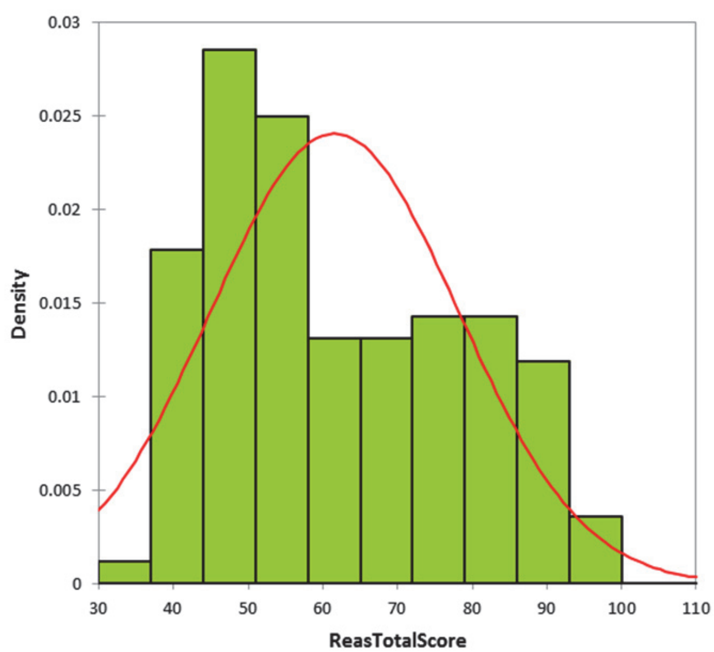


Figure 7.6 Histogram of reasonable points possible overlaid by normal distribution. Weighted condition.

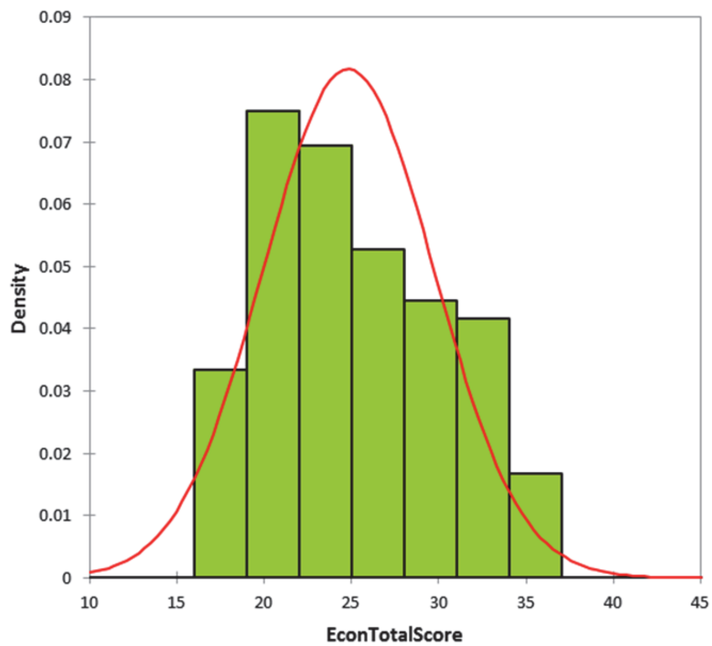


Figure 7.7 Histogram of economical scores overlaid by normal distribution. Unweighted condition.

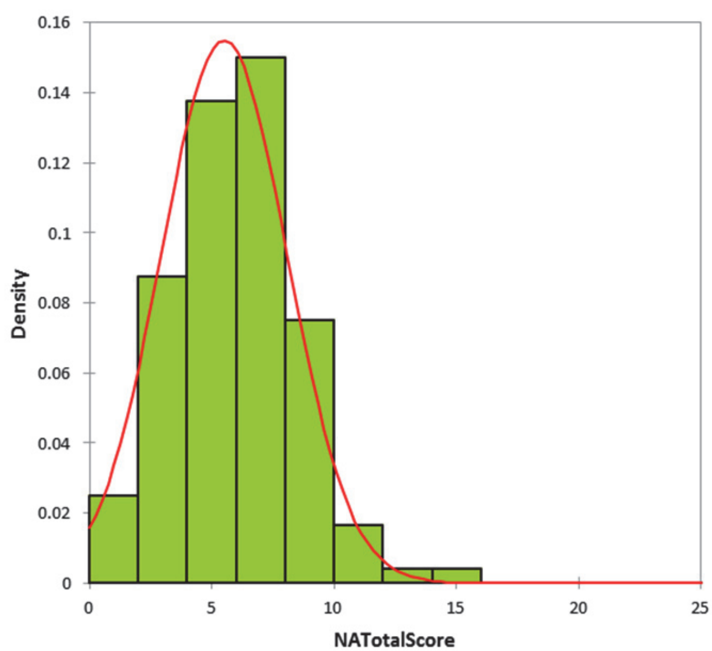


Figure 7.8 Histogram of total points not available overlaid by normal distribution. Unweighted condition.

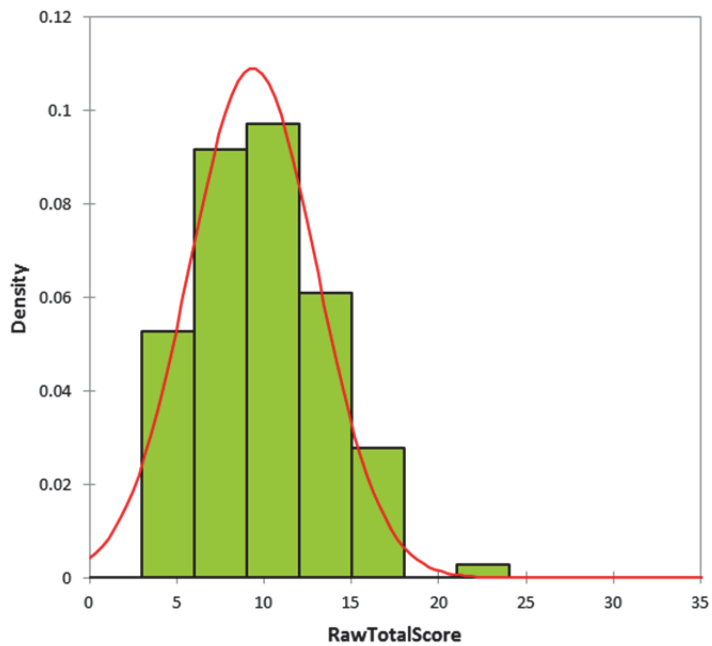


Figure 7.9 Histogram of documented total points overlaid by normal distribution. Unweighted condition.

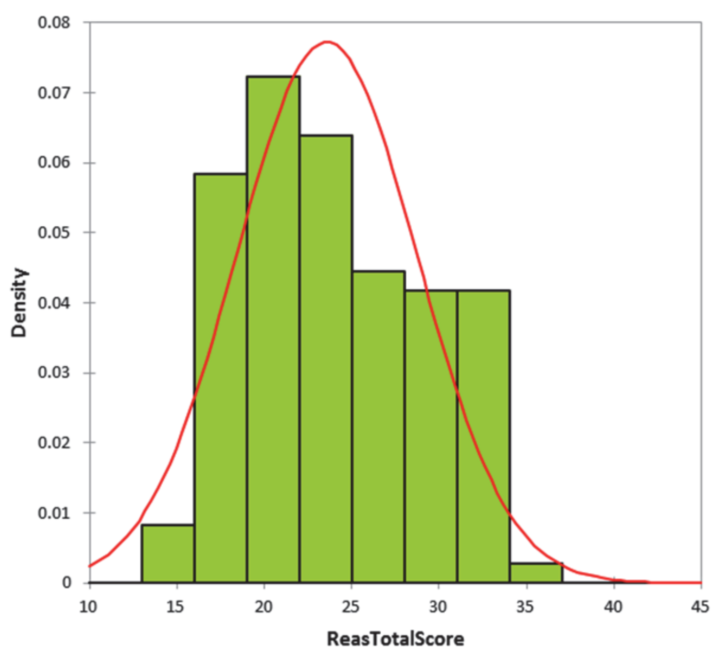


Figure 7.10 Histogram of reasonable points possible overlaid by normal distribution. Unweighted condition.

Therefore, both the Raw Scores and NA Scores are assumed to be normally distributed and qualified for the multivariate tests explained in Chapter 8. Additional notes in the following chapter explain why such an assumption is not particularly influential for the selected multivariate tests.

However, Econ Scores and Reas Scores will conservatively not be evaluated using the testing approach due to the lack of a close match to the normal distribution. Because these two categories are closely related (recall the mathematical relationship), the shared result is not surprising in the unweighted condition. Non-parametric multivariate tests or correlation analyses could be done to provide more information about the distributions and relationships between these two scores.

7.4 ADDITIONAL REMARKS

1. Some projects were in early project planning stages, design or currently out to bid at the time of review, so sometimes no contract information was available. In this condition, the project evaluation relied on review of initial design documents, which are subject to change, and the scope of work stated in these documents.
2. While it is very likely that every project will be able to meet all 11 Project Requirements, not all projects will be eligible to earn 108 Voluntary Credit points. This means no project can achieve a 100% score or 108/108 points.
3. Evaluations default to the integrity of the designer or contractor, meaning that good faith efforts toward a Project Requirement or Voluntary Credit were considered satisfactory to justify its substantial completion. For example, it was common for some reviewers to award credits because of a verbal confirmation from the designer during interview in lieu of substantiating documentation.

7.5 SUMMARY

- This chapter presents the method used for scoring individual roadway projects using Greenroads v1.5.
- There are six scores that can be assigned to each project, three are evaluated based on project documentation and three others are computed from those results.
- The evaluation of project documents allows the assignment of a Raw Score. Then, it is determined which activities in Greenroads do not apply to the project (NA Score). Finally, an assessment is made about the economical sustainability potential of the project (Econ Score).

- The three computed scores represent what is reasonably possible for the project (Reas Score), the remaining credits (Rem Score) left beyond the Raw Score, and the maximum sustainable potential of the project (Max Score). Rem and Max Scores are not used in this study.
- 18 points (16.7%) are not available to most projects, on average, with many points remaining.
- The average Raw Score is 26 points, the average number of Economical points available is 59 (Gold), and the average Reasonable Score is 62 points (Gold). Therefore it appears that sustainability certification is within easy reach for most projects with minimal effort.

8.0 STATISTICAL ANALYSIS GOALS AND METHODS

This chapter presents the approach for testing the Greenroads Rating System with actual roadway project data. This analysis represents a wide variety of types of projects, locations, stages of project development, and typical roadway design and construction practice used over the last ten years.

The ultimate purpose of this testing is to determine the applicability of the rating system to real road and bridge projects. The null hypothesis being tested is that all of the projects may be treated equally when scored using Greenroads. It is the general intent of this research to determine if this assumption holds; or if it does not hold, to discover what conditions or qualities of roadway projects significantly influence the results of the scores. Additionally, testing will help determine the answers to the following general questions:

- **Is Greenroads fair, balanced and applicable to all roadway projects?**

This is a key question that includes developing an understanding of the influence of applying weights to the credit points (Chapter 5) and if the certification thresholds are fair to all projects. If it is not fair or balanced, how can it be adjusted?

- **What is the state of the practice in roadway project sustainability according to Greenroads?**

The purpose of answering this question is to identify general trends in which credits are achieved, which are not, and which are cost effective to consider for most projects. Such results would be useful to owners and practitioners to gain an understanding of what could be done with reasonable effort to improve sustainability on their projects.

The testing approach uses two distinct methods. First, trends are identified at the system level, the category level, and the credit level. New ideas for credits are also uncovered and discussed briefly. Next, two types of multivariate analyses are performed to identify relationships within each qualitative property of projects.

The following sections describe the purpose and scope of two separate parts of the data analysis, the goals of each part of the testing approach, the utility of each test, and the software tools used. Data collection, sources, scores and quality are discussed in detail in Chapter 6.

8.1 TREND ANALYSES METHOD

Trends can be recognized through graphical methods, such as bar graphs and dendrograms, and descriptive statistics; these methods help to develop an understanding of the prevalence or absence of certain activities within a sample. For Greenroads, such information is valuable because it helps users of the rating system understand the potential achievement of their project relative to other similar projects.

Goal

Identify general trends at the credit level, the category level and in the overall rating system.

Example

Common achievement of a voluntary credit could imply a standard practice that may not need to be included in Greenroads or should be required. Lack of achievement could mean an activity is too difficult or obscure.

Scope

Trend Analysis is limited to the Raw and NA Scores only in the weighted case because these data represent what was observed in the available documentation. Further trends could be investigated in the remaining categories in future studies, since other scores also contain interesting information about transportation projects that is relevant to sustainability and project performance.

Specifically, the following trends are analyzed:

- Aggregate Raw Scores
- Aggregate NA Scores
- Frequency of points earned by credit
- Frequency of points not applicable to projects by credit.

Additionally, a cluster analysis of the Raw Score Credits was performed using the weighted condition of credits in order to identify similarities between points earned and specific credits.

8.2 MULTIVARIATE ANALYSES METHOD

Raw and NA Scores can be considered the backbone of a project’s sustainability potential with Greenroads. These two variables are studied together in the multivariate analysis to identify relationships within each qualitative project property (Chapter 6) and develop an understanding of the significance of property variables. The overall goal for tests described in this section is to determine which properties are most significant and how weighting influences this significance. From these results, inferences can be made to help structure future investigations using more targeted analyses, such as detailed multiple correspondence analysis (MCA) or agglomerative hierarchical clustering (AHC). For example, the properties determined to be most significant can be used to help reduce dimensionality in preparation for MCA or AHC. An example of AHC is given in the next chapter as part of the trend analysis.

Three types of tests were used to identify trends within the project properties and identify significant properties that contribute to the scores of the project.

8.2.1 One-Way Analysis of Variance (ANOVA)

It is interesting and important to understand how much variance is present in the project scores relative to the independent properties of the projects. One-way ANOVA is a useful statistical test that can help identify these relationships and the magnitude of their significance. Additionally, boxplots can be developed that help to graphically depict the relationships within certain categories that may be non-parametric.

Goal

Extract relationships that cannot be seen with simple trend analysis but exist between qualitative properties and determine their significance.

Example

A significant p-value ($\alpha = 0.05$) indicates that the resulting score is sensitive to a particular project property, which could be interpreted as a bias.

Scope

ANOVA tables and boxplots are produced for each property. Resulting P-values are examined for significance. The independent variables are the qualitative properties of the projects and the dependent variables are the score observations of each project.

Specifically, all 15 properties were studied in these four conditions:

- Weighted Condition: Raw Scores
- Weighted Conditions: NA Scores

- Unweighted Condition: Raw Scores
- Unweighted Condition: NA Scores

Null Hypothesis

All roadway project observations are the same regardless of qualitative property.

Assumptions

There are a few assumptions for one-way ANOVA tests:

- The data is continuous, or measured on an equal interval scale.
- The data was randomly sampled and observations are independent.
- The data represents a sample from a normal population distribution.
- Samples have equal or nearly equal variances.

It is noted that one-way ANOVA tests are very robust even in circumstances where not all four of these assumptions hold true (Washington, 2002; Box, Hunter & Hunter, 1978).

8.2.2 Multiple Comparison of Means Tests

It is useful to understand the expected performance between independent properties, but also useful to understand how information presented by boxplots are related to the means and their significance. A multiple comparison of means test can be used to compare arithmetic means within categories to quantify the differences.

Goal

Evaluate the differences in the means of each categorical variable. Specifically, this test measures the distance between pairs of means.

Example

If the average score is determined to be significant ($\alpha = 0.05$) for a particular property, that indicates a bias toward projects with that property.

Scope

This test is performed using the direct results of the ANOVA tests.

Specifically, all 15 properties were studied in these four conditions:

- Weighted Condition: Raw Scores
- Weighted Conditions: NA Scores
- Unweighted Condition: Raw Scores
- Unweighted Condition: NA Scores

Null Hypothesis
A null hypothesis is not required; this test is performed on the computed results of the ANOVA.

Assumptions
There are no additional assumptions for this test. Note that quantities presented in the results are rounded to more accurately reflect the interval nature of project scores.

8.2.3 One-way Multivariate Analysis of Variance Tests (MANOVA)

Numerical relationships between the means of different groups of data can also be determined with a MANOVA tests (Schatz, n.d.; StatSoft, Inc., 2011; Marenco, n.d.). In particular, MANOVA helps to identify the main effect of a particular project property. Therefore, the process and results are similar to the one-way ANOVA, and in fact, this test generates p-values that can be used to check the tests performed using ANOVA (the ANOVA tests will show the most significant results whereas MANOVA can identify additional within-group variations that ANOVA cannot). MANOVA analysis used also produces canonical coefficients and vectors that can be used for cluster analysis.

MANOVA analyses can also help identify potential properties for later, more detailed, cluster analysis. Cluster analysis can be used to identify or justify groups or classes of data – it can identify, usually in a visual form called a dendrogram, which classes of a property are similar and the relative magnitude of the similarity. Cluster diagrams are useful for all project property data that is classified into more than two categories, such as by functional class of local, arterial and collector. In this study, cluster diagrams are created for each property based on the results of the MANOVA tests.

Use of more than one dependent variable (Scores) is important because it results in increased likelihood that significant in-group variation can be identified. These results can be used to verify results of the ANOVA as well as highlight important qualities that may be significant and require further investigation.

Goal

Determine if the relationship established by the linear combination of Raw and NA Scores for an observation is statistically significant within a given qualitative property.

Example

Results of a MANOVA tests show sensitivity variance within a particular independent variable (project properties) with respect to the scores, such as between three pavement types.

Scope

This test is performed using the Raw scores and NA scores. Simple dendrograms are generated to supplement these results. The independent variables are the 15 qualitative properties of the projects and the two dependent variables are the score observations of each project in both the Raw and NA assessments.

Specifically, all 15 properties were studied in these two conditions:

- Weighted Condition: Linear combinations of Raw Scores and NA Scores
- Unweighted Condition: Linear combinations of Raw Scores and NA Scores

Null Hypothesis

Each group within a property is equal.

Assumptions

These tests are appropriate for categorical and continuous or interval data with multiple variables and multiple categories (Marenco, n.d.). It follows that these assumptions, similar to ANOVA, hold for MANOVA as well.

- The data is continuous, or measured on an equal interval scale.
- The data was randomly sampled and observations are independent.
- The data represents a sample from a normal population distribution.
- Samples have equal or nearly equal variances and covariance.

Recall that the NA Scores in the unweighted condition were noted in the previous section not to follow a normal distribution. For the unweighted condition, this sample data is not ideal for this test.

8.3 ANALYTICAL TOOLS USED

Trend analyses are performed using Excel spreadsheets with XLSTAT® for select statistical tests (noted in previous sections).Trends are presented graphically or tabulated.

For the multivariate analyses, MATLAB R2011a is used. A short script was developed in MATLAB 2011a to access the data stored in spreadsheet format. A program was developed to access the data in spreadsheet format. The scripts for the MATLAB script is provided in Appendix D. Output files and figures of all results are contained in Appendices E and F, respectively, and select results are discussed in the following chapter.

Bar chart and pie chart figures are created using Microsoft Excel. Boxplots, scatterplots, mean comparison charts and dendrograms are produced for each property by the MATLAB figure handler. Only select figures are presented in the following results sections. However, all figures are provided in Appendix F.

8.4 SUMMARY

- The ultimate purpose of this testing is to determine the applicability of the rating system to real road and bridge projects with the primary goal of discovering if the projects are independent of their qualitative properties.
- The null hypothesis being tested to find the answers to two questions is: all of the projects may be treated equally when scored using Greenroads.
- Multivariate analysis with one-way ANOVA, multiple comparison of means, and one-way MANOVA tests are used to answer the question: Is Greenroads fair, balanced and applicable to all roadway projects?
- Trends are studied to answer the question: What is the state of the practice in roadway project sustainability according to Greenroads?

9.0 TREND ANALYSES RESULTS

A total of 120 projects were scored using the Greenroads Rating System v1.5 (February 4, 2011). This section presents the results of this study in three sections. First, key trends in the achievement of credits are described according to category level information and then system-wide. Next, the results of the multivariate analyses are described. Then, the key results from the unweighted analysis are discussed followed by the data quality analysis.

The results presented in this section are limited to those determined to be significant defined by a 95% confidence interval. The majority of these results are displayed graphically. All tabulated results and figures are provided in Appendices E and F as supplemental information.

This section describes the general trends in project scores for Raw and NA Scores only. Other measures of scores (Econ) and computed scores (Reas, Rem and Max) were not analyzed for reasons previously noted. This section also lists the frequency of achievement for potential new Custom Credits.

9.1 PROJECT REQUIREMENTS CATEGORY

The Project Requirements (PR) category technically does not have points associated with any of the activities, but for purposes of this analysis, values of zero or one were assigned to the project scores where documentation was available to support that these activities were completed. Note that the PR category scores are consistent regardless of scoring the projects with a weighted or an unweighted method. Figure 9.1 shows the overall percentage of projects achieving the Project Requirements.

Overall, the top three most frequently achieved PRs are:

1. PR-9 Pavement Management System, which addresses asset management systems for both pavements and bridges despite the title.
2. PR-7 Pollution Prevention Plan, which requires the development of a stormwater pollution protection plan during construction. This is a requirement for most projects from the Clean Water Act and it is likely most cases that if this credit was not achieved the documentation was simply not available for study or the project was located internationally where the US EPA NPDES regulation for the Construction General Permit (CGP) does not apply.

3. PR-1 Environmental Review Process, which is commonly completed for transportation projects because it is required in the U.S. for federally funded projects subject to the National Environmental Policy Act and by some states, but is less likely for smaller projects or maintenance and preservation projects depending on the state where the project is located. Usually these projects are categorically excluded (CE) and this does not meet the requirements stated in the *Greenroads Manual*.

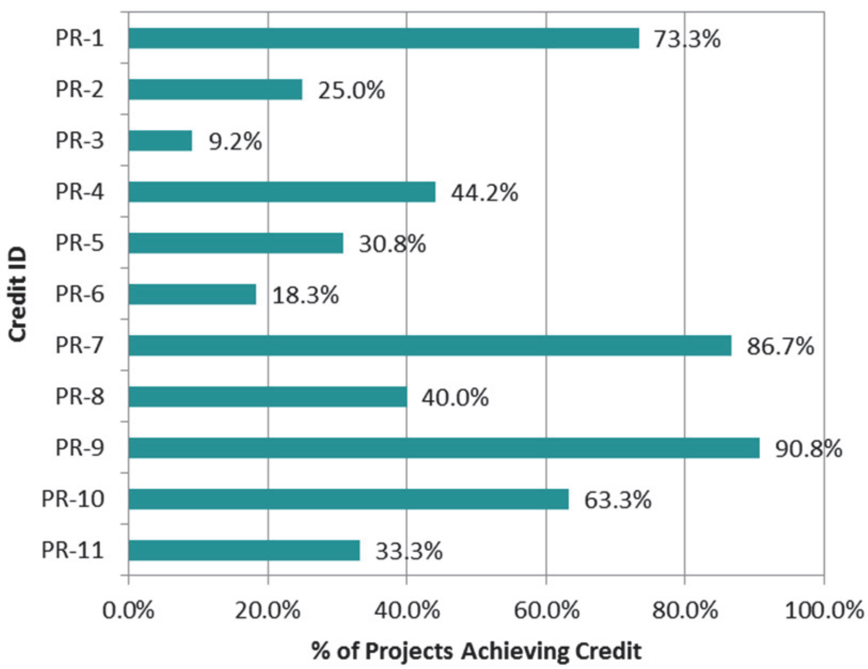


Figure 9.1 Overall frequency of achievement of Project Requirements category in percent.

The least frequently achieved credits are PR-3 Lifecycle Inventory, PR-2 Lifecycle Cost Analysis and PR-6 Waste Management Plan. Because these three concepts are fundamental to the idea of sustainability, the trends seen here are important. There is little evidence these concepts are widely implemented in transportation projects, despite the wide body of research supporting their use and the tools available to do them (the reader is referred to the *Greenroads Manual* for detailed references).

It is interesting to note that not one of the Project Requirements has 100% achievement, even considering the projects actively pursuing Greenroads certification. The reason for this is clarified by parsing out the 21 projects that are using Greenroads purposefully. These results are shown in Figure 9.2. A few points should be noted about the bar chart. First, the achievement of the commonly achieved PRs is higher in typical projects than in Greenroads projects. This is clearly due to the status of the information that was currently available for review for the Greenroads projects – by definition, Project Requirements must be done by projects pursuing certification. Therefore, evidence must, at some point in the certification process, be produced that these activities were completed. This information was instead simply unavailable or in production. Later, results discussed will show that the phase of the project during which it was reviewed plays a role in the score due to the quality of data.

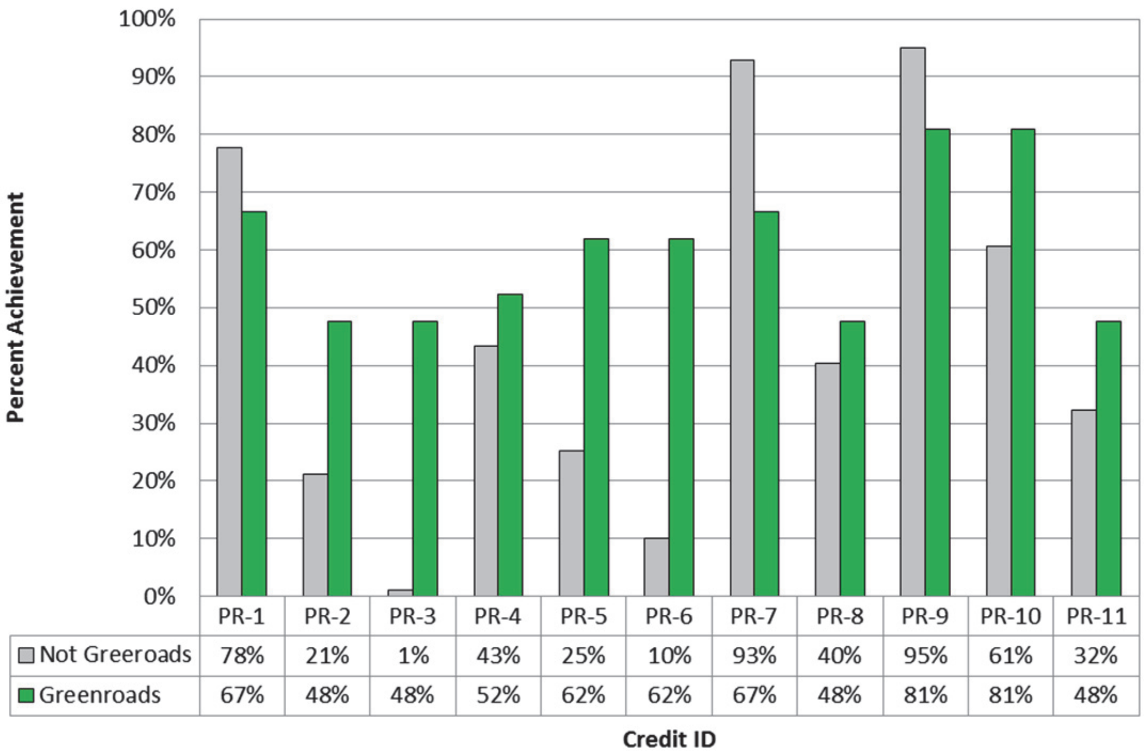


Figure 9.2 Project Requirements Category split according to projects pursuing certification or not.

Oppositely, the disparity between the commonly achieved and the rarely achieved PRs is even more pronounced. In fact, projects actually doing these things fall into the category of "sustainability emphasis" as noted before. Lifecycle considerations and waste management are either clearly uncommon practices in typical projects or else not well-documented.

Finally, it is perhaps most critical to note that each one of these eleven suggested activities can, in fact, be achieved by a broad range of transportation projects types. This was the intended design of the rating system, and an expected result.

9.2 CREDIT TRENDS

Figures 9.3-9.12 show the trends according to credit category for the weighted condition of the Raw Scores and the NA Scores. Figures 9.13 and 9.14 show the trends in achievement of specific point, providing some insight to how credit weighting plays a role in those trends.

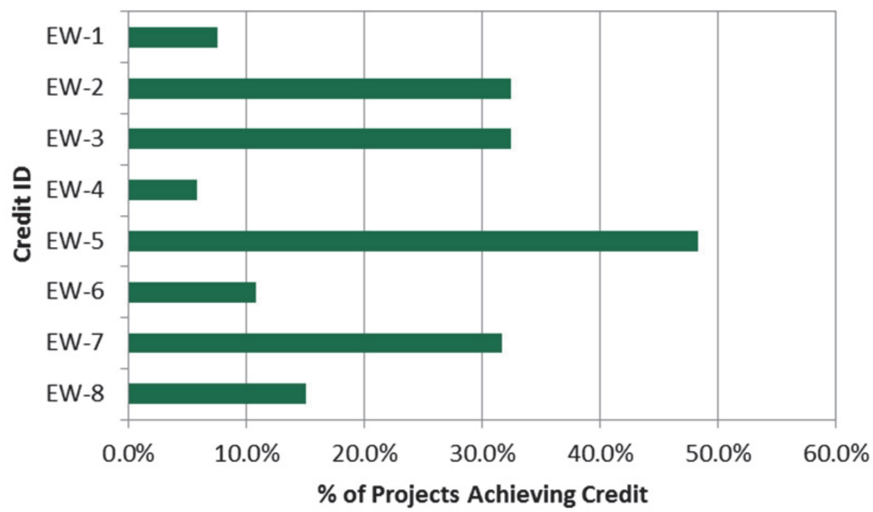


Figure 9.3: Achievement frequency of EW credits. Weighted condition, Raw Scores.

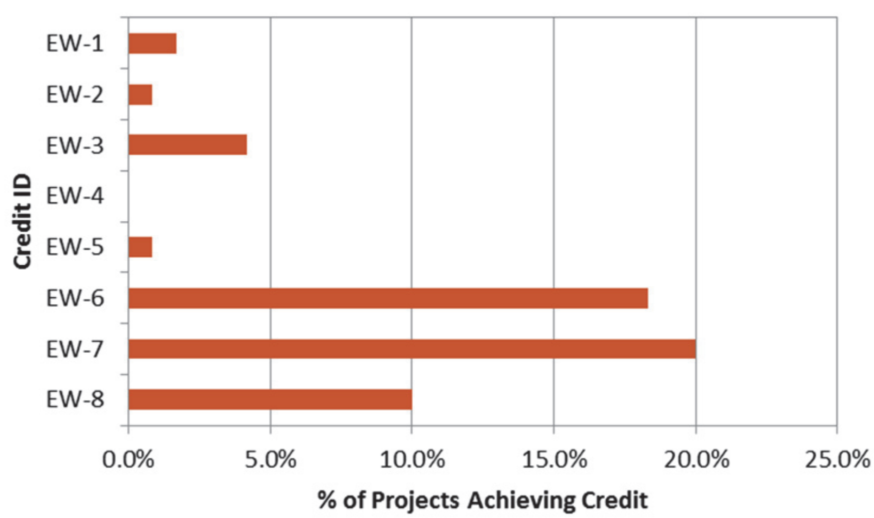


Figure 9.4 Frequency of inappropriate points for EW credits. Weighted condition, NA Scores.

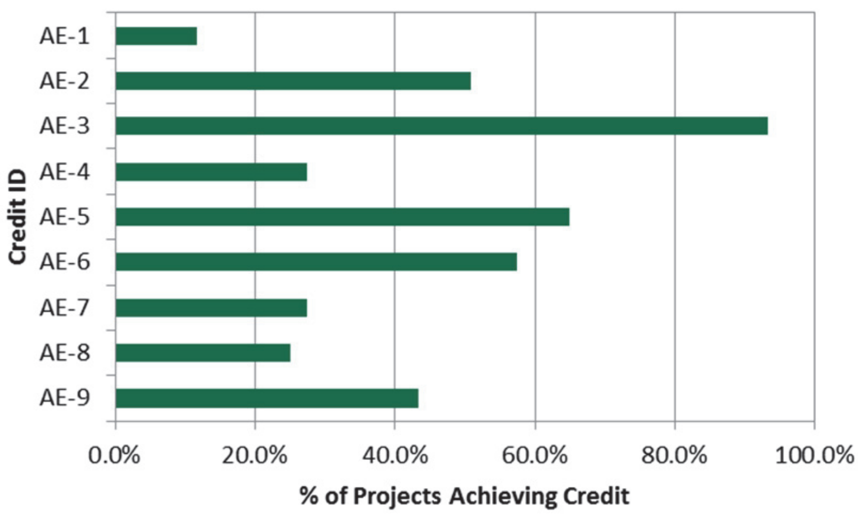


Figure 9.5: Achievement frequency of AE credits. Weighted condition, Raw Scores.

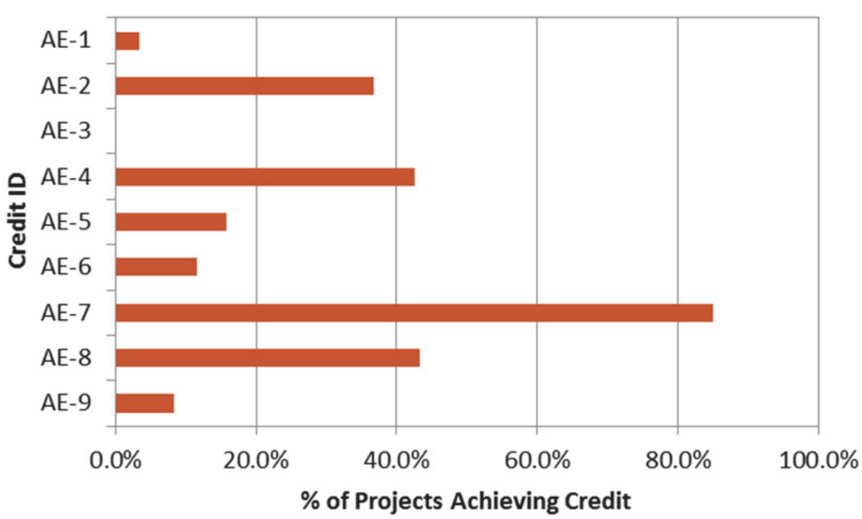


Figure 9.6 Frequency of inappropriate points for AE credits. Weighted condition, NA Scores.

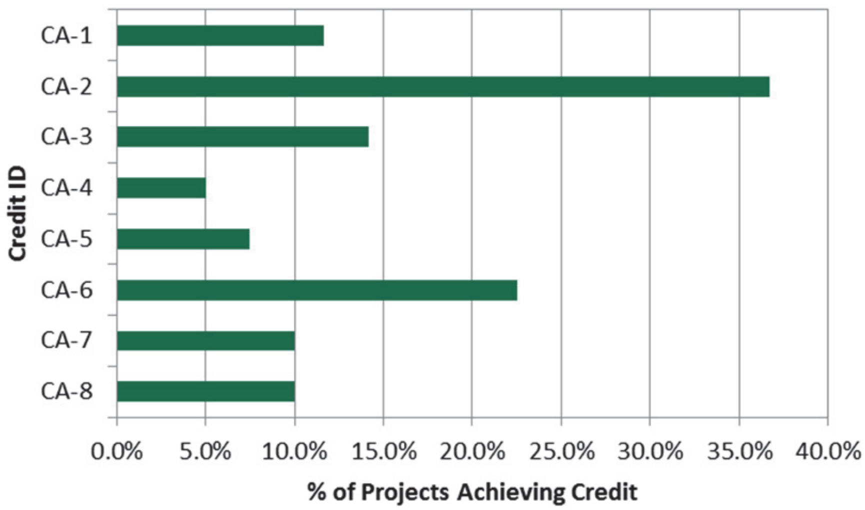


Figure 9.7 Achievement frequency of CA credits. Weighted condition, Raw Scores.

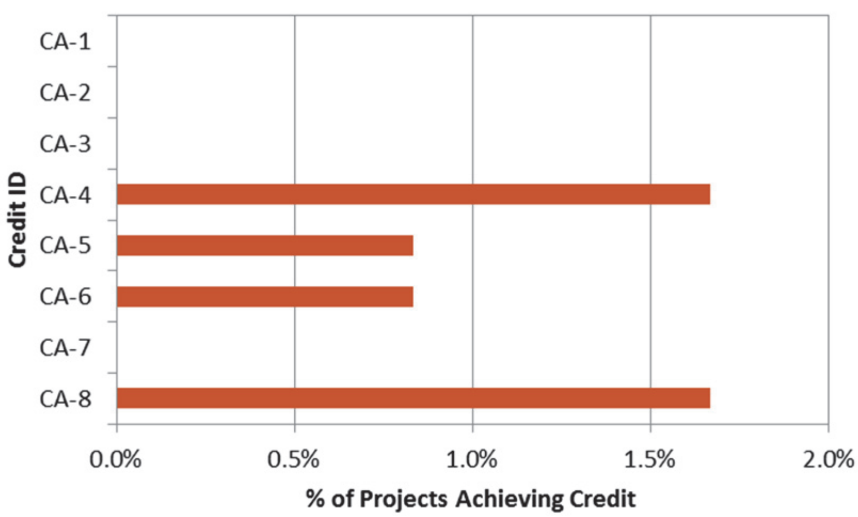


Figure 9.8 Frequency of inappropriate points for CA credits. Weighted condition, NA Scores.

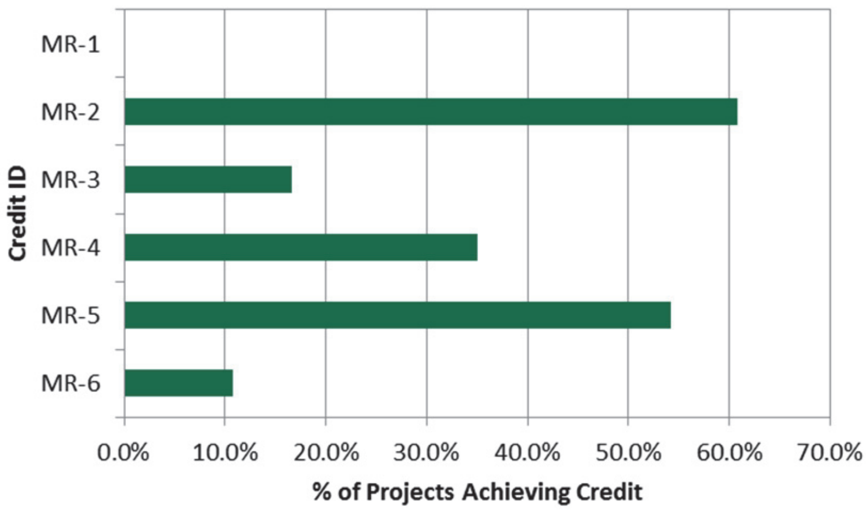


Figure 9.9 Achievement frequency of MR credits. Weighted condition, Raw Scores.

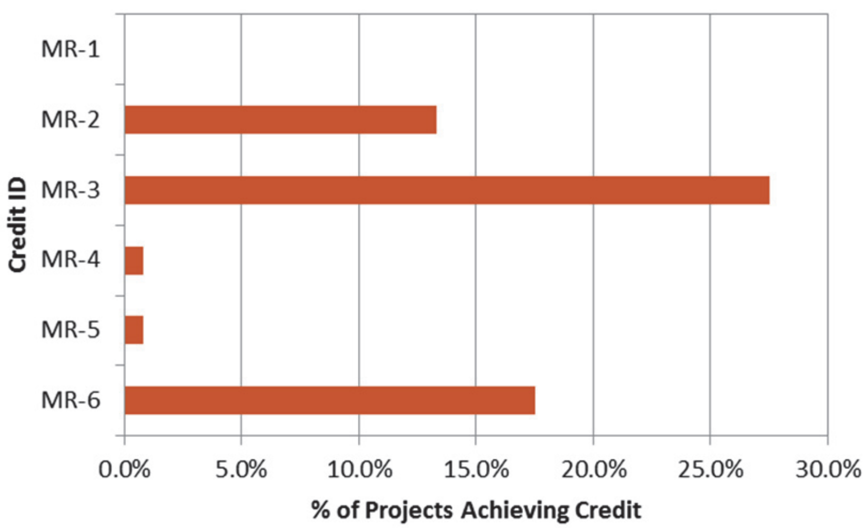


Figure 9.10 Frequency of inappropriate points for MR credits. Weighted condition, NA Scores.

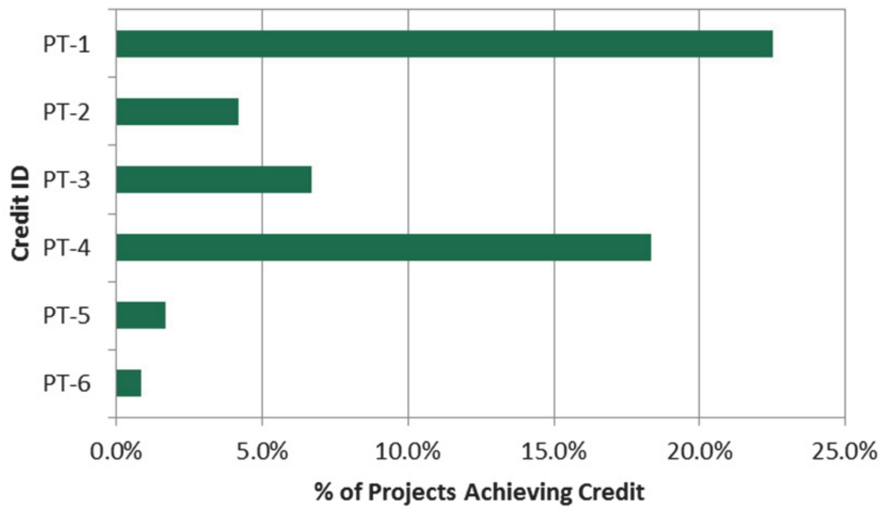


Figure 9.11 Achievement frequency of PT credits. Weighted condition, Raw Scores.

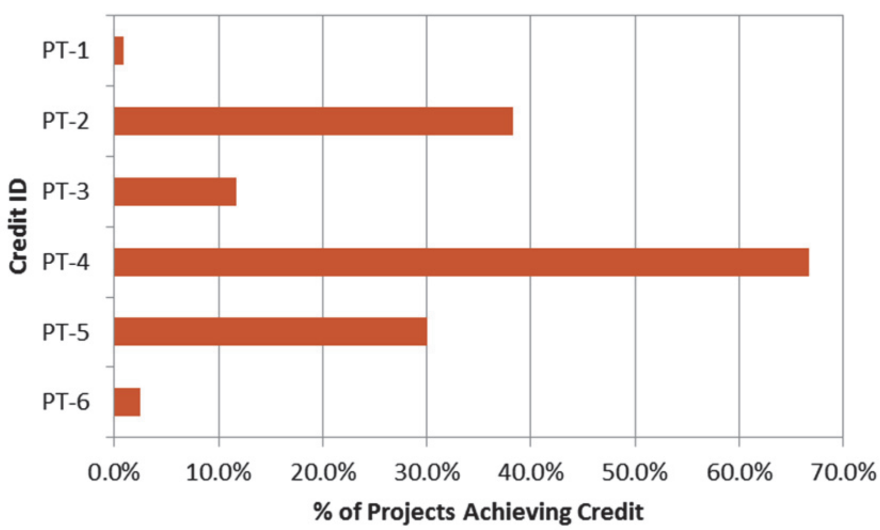


Figure 9.12 Frequency of inappropriate points for PT credits. Weighted condition, NA Scores.

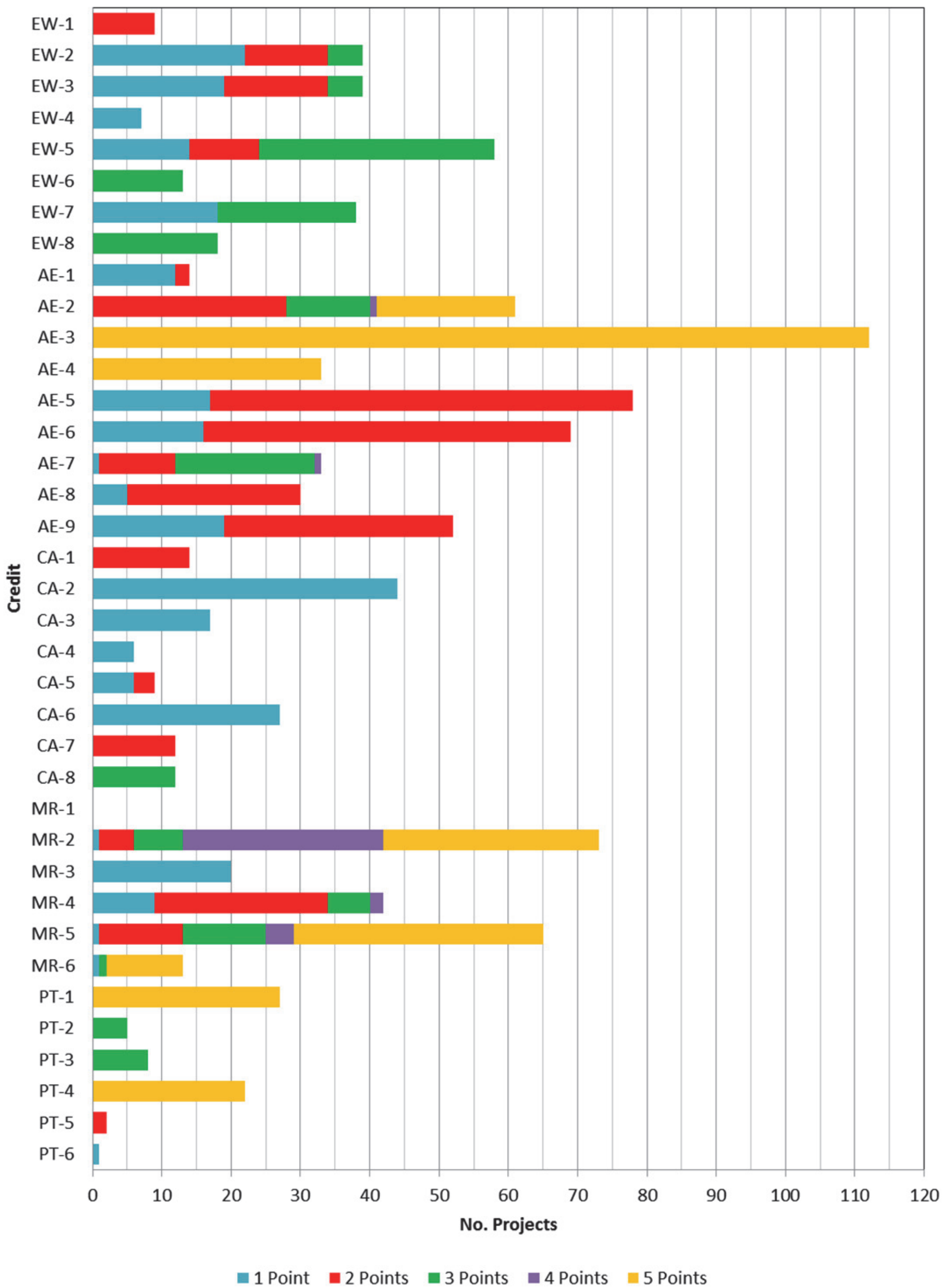


Figure 9.13 Raw Scores sorted by number of points achieved. Note that this figure represents frequency of achievement and does not reflect total point value.

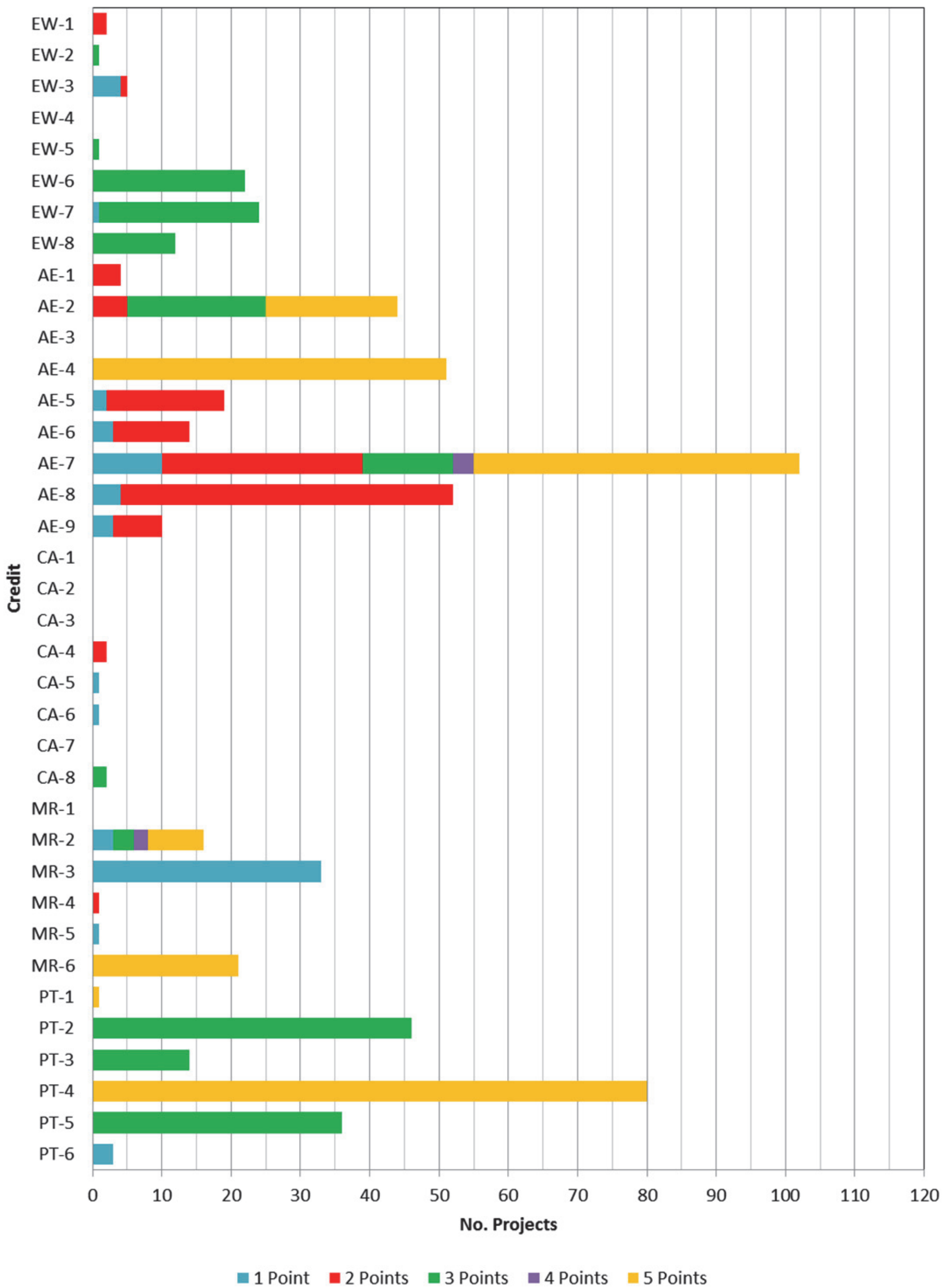


Figure 9.14 NA Scores sorted by number of points achieved. Note that this figure represents frequency of achievement and does not reflect total point value.

9.3 MAJOR CATEGORY TRENDS

The results shown in the previous figures indicate several interesting trends. A few of these trends are highlighted below.

9.3.1 Environment & Water

In general, a significant potential for improved environmental performance is present. Most roadway projects can achieve credits in this category, but typical projects do not achieve them unless required.

The Environment & Water (EW) category is the epitome of the Greenroads Rating System because each credit represents efforts that go above and beyond the minimum environmental requirements for roadway projects. It is not surprising that achievement is relatively low across the category, with the highest frequency of achievement associated with site vegetation that is ecologically innocuous (Credit EW-5 Site Vegetation).

It is unexpected that results show almost 33% of roadway projects in this study are using some form of infiltration based stormwater control technology and achieving at least a few points for credits EW-2 Runoff Flow Control and EW-3 Runoff Quality. Over half (55%) of these projects are located in the Northwest in Washington State or Oregon where low impact development is widely implemented or otherwise required as in the Seattle area. All but 2 of the 46 projects achieving this credit are located in the Northwest, pursing Greenroads certification, located in environmentally sensitive watersheds, or subject to an active sustainability mandate of some kind (typically tied to project funding). Therefore, the results should be extrapolated with care and it is likely that these results are not perfectly representative of typical transportation projects. On the other hand, projects that meet similar constraints could be expected to achieve the credits.

It should be noted that the frequencies reported in the EW category represent what would most likely be considered the best of intentions, if all situations are ideal, and not actually measured outcomes. For example, with the exception of a few projects pursing Greenroads certification and specific regulations in Oregon and Washington State, no stormwater information was available that provided the level of detail necessary to assess if these credit requirements were fully met. Awarding of these credits relied heavily on the reviewers interpretation that eventually that credit would be met based on the limited evidence available and was not based on actual evidence of completion as required by the manual. With respect to stormwater and habitat creation (EW-6) these results should be extrapolated with due caution. In practice, it is suspected that the above and beyond requirement stipulated by Greenroads is less common than might be portrayed by these results because these credits often have significant costs associated with their implementation.

9.3.2 Access & Equity

In general, the Access & Equity category represents the best successes from transportation projects in sustainability performance. Most roadway projects can and do achieve credits in this category, and most roadway projects adopt a context-sensitive approach.

The Access & Equity category highlights practices that are natural considerations for transportation projects (Chapter 3). These practices are also the easiest to identify in absence of detailed design and construction documentation, so the high achievement in this category is not surprising. The opposite is also true – it is easiest to identify which of these credits do not apply as well.

Opportunities still exist for most projects to achieve more points by considering additional context sensitive solutions, intelligent transportation systems, and safety improvements beyond the minimum requirements of design standards.

9.3.3 Construction Activities

In general, the Construction Activities category represents the greatest opportunity for easy impact, especially for roadway contractors.

Achievement in the Construction Activities category is highly correlated to the presence and availability of construction documents. However, even for those projects where documents were present, the opportunities were still present, indicating that these activities are beyond conventional practice. However, all of these practices have been tried on at least five projects, demonstrating that they are achievable.

9.3.4 Materials & Resources

In general, the Materials &Resources category represents an area where preservation and maintenance projects excel. The opportunity for improved management of materials is also clear.

The Materials & Resources category shows modest frequency of achievement in the areas of reuse and recycling, as expected. However, it appears that there is still ample opportunity for improved performance for materials management. Importantly, most if not all of these credits are applicable to most roadway projects. Data quality also plays an important role in understanding the performance of this category. The trends noted here based on the Raw Scores achieved may not be actually representative of what was actually completed on the project. Construction projects that are motivated by preservation frequently achieve credits in these categories due to the nature of the projects being driven by costs of materials.

Notably, credit MR-1 Lifecycle Assessment appears to have never been attempted.

9.3.5 Pavement Technologies

In general, the Pavement Technologies category represents an area of opportunity for most projects but one that is often limited by materials choices and environmental context. It is possible that this category could be restructured to be more applicable to a broader range of projects due to the specificity of some of the practices.

The Pavement Technologies category shows limited achievement of a large majority of credits. This is likely due to the narrow scope of many of the credits themselves. The level of difficulty may be too high for typical projects, and frequently the only projects that achieve these credits are those that are specifically emphasizing newer pavement technologies as an experiment or test. Additionally, this category appears to be highly specific to pavements, especially by pavement surfacing type, and bridge projects often find it difficult to achieve credits in this category. Simple adjustments could be made to the credits to be more flexible: for example, PT-1 Long Life Pavement could be expanded to include long-life design of bridge decks. It is recommended that the majority of credits in this category are expanded to be more inclusive of all projects.

9.4 OVERALL TRENDS

The histogram in 9.15 shows that on average, most projects do not meet the minimum points needed to become certified (shown by the Raw Score). However, with the addition of limited effort at no to low additional cost to the construction price of the project (the Reas Score), most projects should be able to achieve an average score of Silver or better. This sample can be considered a benchmark for conventional practice and compared to future changes and sustainability goals.

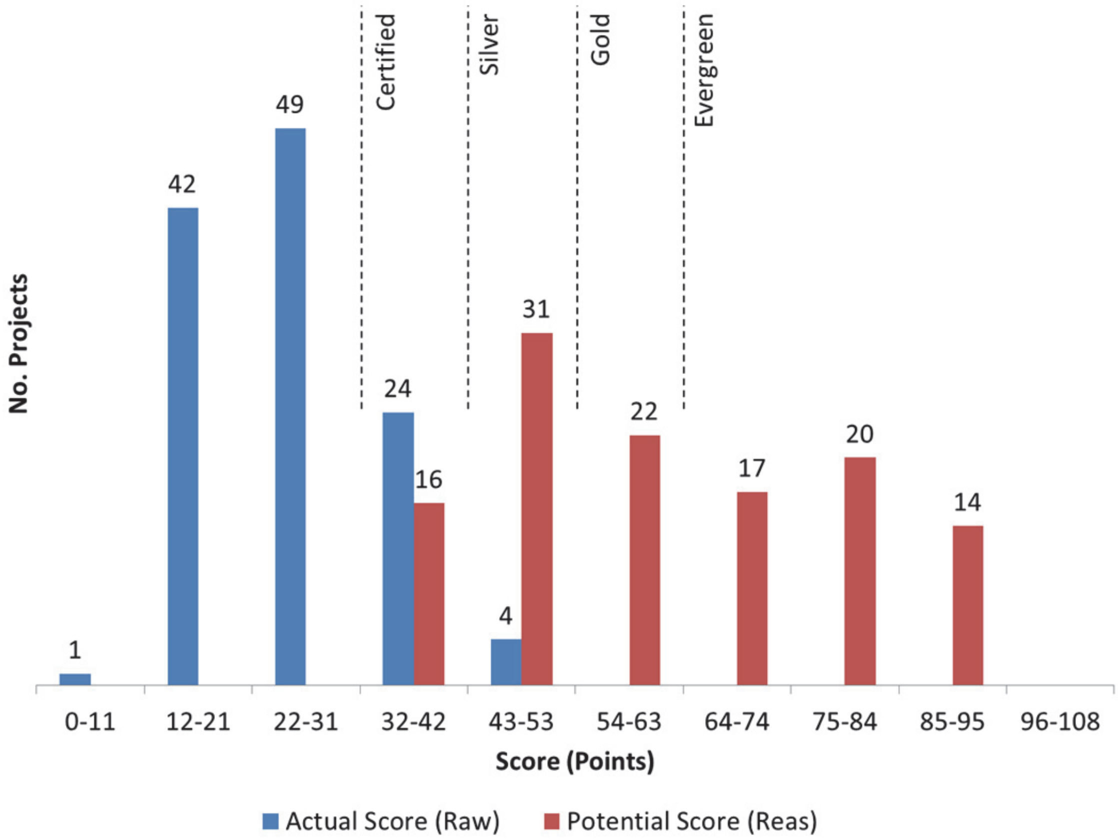


Figure 9.15 Histogram of what was earned and what is potentially reasonable at low to no additional cost.

XLSTAT 2012.2.01 was used to perform an agglomerative hierarchical cluster analysis of all of raw score credits using a dissimilarity threshold of 0.95. The dendrogram in Figure 9.16 points out some interesting relationships between credits in the weighted condition. No weighting factors were used, so this dendrogram identifies some relationships between frequency of achievement as well as the weight of the credit. The dendrogram can be used to note additional relationships across different categories and credits.

First, the credits MR-5 Regional Materials and AE-4 Traffic Emissions Reduction (congestion pricing) are the most different, least achieved and highest value. However, AE-3 Context Sensitive Solutions is achieved on nearly all projects and is high value which is similar to another commonly achieved high value credit MR-2 Pavement Reuse. The rest of the figure shows in the pink connections the most commonly achieved credits in the rating system. These could be considered activities that are commonly completed by many projects and are therefore probably relatively easy to achieve, or at least are economical given an amenable context. Notice PT-4 Cool Pavement and PT-1 Long Life

Pavement – these are two credits that are high value and are closely related to concrete pavements. The remaining menu is a set of credits that are infrequently achieved and generally are lower in point value but are often done on projects that have a sustainability emphasis. It is also interesting to see where the PR activities show up on the dendrogram in relation to the voluntary activities.

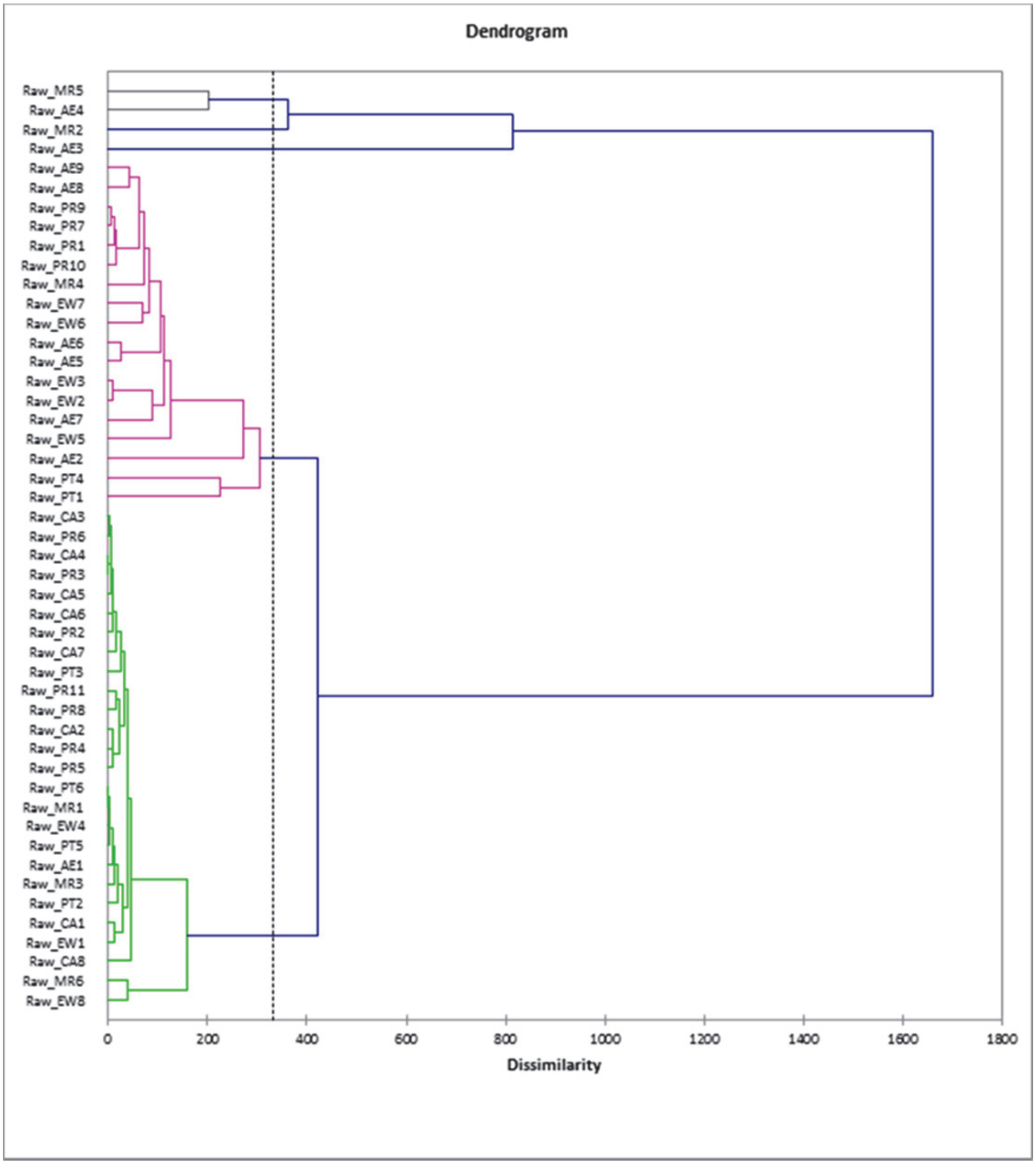


Figure 9.16 Dendrogram of Project Requirements and Voluntary Credits in Raw Scores (Weighted).

9.5 POTENTIAL CUSTOM CREDITS

Twenty-four potential custom credits were identified for possible incorporation into future versions of Greenroads and listed in Table 9.1 below. The credits with the highest prevalence should be considered for inclusion into future versions of the rating system. These potential new credits could be subject to the same research standards as other credits in Greenroads prior to integration.

Table 9.1 Potential new ideas for custom credits.

No.	Name	Goal	Freq.
CC-1	Freight Access	Improve mobility and access for freight traffic in key corridors	17
CC-2	Safety Improvement	Improve user safety through quantifiable methods	7
CC-3	Regional Employees	Hire construction employees from the same region as project	4
CC-4	Anti-Idling Policy	Have an anti-idling policy in place at construction sites	5
CC-5	Certified Wood	Use certified wood materials and products	1
CC-6	Vegetation Reuse	Use clearing and grubbing waste, duff and other vegetative sources in place as mulch or compost	6
CC-7	Habitat Creation Urban Habitat	Dedicate portions of new structures for wildlife where there previously was none or plant trees in an urban environment	3
CC-8	Non-Potable Water Use	Use non-potable water sources for construction	1
CC-9	Aesthetics	Increase visual quality to match project context	17
CC-10	Monitoring Controls	Use technology to monitor bridge performance	1
CC-11	Low VOC Products	Use materials with low emissions for human health	2
CC-12	Electric Vehicles	Install electric vehicle charging stations	2
CC-13	Alternative Energy	Use renewable energy sources for electricity on the project	2
CC-14	Photocatalytic Concrete	Improve air quality with self-cleaning concrete	1
CC-15	Pavement Smoothness	Improve ride quality	1
CC-16	Long-Life Decks	Design bridge decks for 100 years or more	3
CC-17	Design for Disassembly	Design structures and pavements to have use at end-of-life	1
CC-18	Dust Control	Exceed dust control standards	1
CC-19	Bioengineered Slopes	Use geotechnical methods to reinforce slopes	2
CC-20	Rapid Construction	Reduce user delay through accelerated methods	3
CC-21	Adaptive Design	Design for climate disasters	1
CC-22	Flood Control	Design stormwater features to accommodate flooding	1
CC-23	Brownfield Redevelopment	Improve in-place soils in a brownfield	1
CC-24	Workzone Safety	Improve workzone safety through job hazard analysis	4

9.6 SUMMARY

- In general, a significant potential for improved environmental performance is present.
- Most roadway projects can and do achieve credits in the Access & Equity category, and most roadway projects adopt a context-sensitive approach.
- In general, the Construction Activities category represents the greatest opportunity for easy impact, especially for roadway contractors.

- In general, the Materials &Resources category represents an area where preservation and maintenance projects excel.
- In general, the Pavement Technologies category represents an area of opportunity for most projects but one that is often limited by materials choices and environmental context.
- Most projects do not meet the minimum points needed to become certified.
- This sample of roadway projects can be considered a benchmark for conventional practice and compared to future changes and sustainability goals.
- Twenty-four new custom credit ideas were identified.

10.0 MULTIVARIATE ANALYSES RESULTS

This section provides the results of the one-way ANOVA, multiple comparison of means, and one-way MANOVA tests. All tables and figures are provided in Appendices E and F. This section only discusses the qualitative factors that were determined to be significant with a confidence interval of 95% or greater.

This chapter is organized according to the variables that were significant and all three tests are discussed for the weighted condition of both Raw Scores and NA Scores.

10.1 ONE-WAY ANOVA RESULTS

Table 10.1 shows the results of the ANOVA tabulated by variable. Values shaded in gray are within the confidence interval. Non-shaded values are significant according to $\alpha = 0.05$, and ranked by significance to the Raw Score (Weighted).The positive (More) or negative (Less) change in p-values between the weighted and unweighted conditions indicate weighting may affect the Score. In some cases, the table shows that weighting can appear to exacerbate variance in the Raw Score, indicating potential preferential treatment or advantage in the rating system that should be addressed.

Similarly, Data Quality Scores (DQS) of significance are highlighted where it may influence the significance of the ANOVA result.

Table 10.1 One-way ANOVA p-value results for Raw Scores, NA Scores and DQ Scores in the Weighted and Unweighted Conditions.

Variable Name	Raw Scores	NA Scores	Raw Scores	NA Scores	Weighting Effect Raw	NA	DQS
Budget	4.13E-04	8.29E-11	4.05E-05	4.86E-11	More	Less	7.26E-01
GreenEmphasis	1.99E-03	7.38E-01	2.23E-03	9.28E-01	Less	More	2.53E-01
Place	4.61E-03	1.26E-02	1.09E-01	8.31E-01	More	Less	8.52E-01
Surfacing	4.82E-03	1.46E-03	1.06E-01	2.76E-02	More	Less	1.68E-01
Contract	6.24E-03	2.51E-02	6.91E-03	2.42E-02	Less	Less	2.29E-01
Phase	8.89E-03	1.70E-01	7.04E-04	3.10E-01	Less	More	1.78E-02
GreenroadsProject	1.59E-02	1.44E-01	3.29E-04	1.06E-01	Less	Less	3.04E-01
Motivation	1.40E-01	1.10E-03	3.21E-03	5.24E-05	More	Less	8.52E-02
Owner	2.83E-01	1.06E-05	1.91E-01	4.69E-04	More	Less	5.10E-03
Purpose	2.91E-01	1.92E-03	1.98E-02	3.88E-04	More	Less	1.95E-01
Northwest	2.91E-01	2.20E-01	2.04E-01	1.68E-02	Less	More	8.40E-03
MajorStructures	3.67E-01	4.96E-05	4.83E-02	3.90E-07	More	Less	7.26E-01
Length	4.19E-01	3.66E-02	3.43E-01	3.55E-02	More	Less	9.79E-01
FunctClass	4.88E-01	2.65E-09	9.44E-01	1.71E-06	More	Less	1.38E-02
Country	7.20E-01	5.71E-01	5.23E-01	2.84E-01	Less	Less	3.71E-01

10.2 COMPARISON OF MEANS RESULTS

Table 10.2 shows the results of the ANOVA tabulated by variable.

Table 10.2 Group count, means of weighted and unweighted Raw and NA Scores, and data quality scores for each qualitative variable.

Group Name	No. of 120	Weighted Raw Scores Mean	Error	Weighted NA Scores Mean	Error	DQ Scores Mean	Error	Unweighted Raw Scores Mean	Error	Unweighted NA Scores Mean	Error
Not Greenroads	99	25	1	17	1	6	0	9	0	5	0
Greenroads	21	30	2	20	2	7	0	12	1	6	1
Typical	83	24	1	18	1	7	0	9	0	5	0
Greener	37	29	1	17	1	6	0	11	1	6	0
Structures	55	27	1	14	1	6	0	10	0	4	0
No Structures	65	35	1	21	1	6	0	9	0	7	0
Northwest	60	27	1	19	1	7	0	9	0	6	0
Other Regions	60	25	1	17	1	6	0	10	0	5	0
International	12	27	2	16	3	6	1	10	1	5	1
USA	108	26	1	18	1	6	0	9	0	6	0
City/County	37	27	1	21	1	7	0	10	1	7	0
State/Provincial	69	25	1	15	1	6	0	9	0	5	0
Federal/National	14	24	2	24	2	8	1	10	1	6	1
Conventional DBB	92	25	1	19	1	7	0	9	0	6	0
Alternative	22	31	2	14	2	6	0	12	1	4	1
Unknown	6	24	3	15	3	5	1	9	1	5	1
Planning	16	23	2	13	2	6	1	9	1	4	1
Finished	51	24	1	18	1	6	0	8	0	6	0
Construction	31	27	1	19	2	7	0	10	1	6	0
Design	22	30	2	18	2	7	0	12	1	6	1
New	18	25	2	18	2	6	1	9	1	5	1
Maintenance	45	24	1	21	1	7	0	8	1	7	0
Reconstruction	57	27	1	15	1	6	0	10	0	5	0
Mobility	49	28	1	15	1	6	0	11	0	4	0
Preservation	33	23	1	21	1	7	0	8	1	7	0
Economic	16	25	2	16	2	6	1	10	1	5	1
Safety	9	28	3	21	3	8	1	11	1	5	1
Environmental	10	26	3	21	3	6	1	8	1	7	1
Other	3	20	5	29	5	5	1	6	2	9	1
HMA	79	24	1	19	1	6	0	9	0	6	0
PCC	17	31	2	15	2	6	1	11	1	6	1
Mixed	19	28	2	12	2	7	0	10	1	4	1
Other	5	20	4	28	4	4	1	7	2	8	1
Small Urban	36	27	1	17	1	6	0	10	1	5	0
Rural	44	23	1	21	1	6	0	8	1	6	0
Urban	40	28	1	15	1	7	0	10	1	6	0
Collector	31	25	2	21	1	7	0	9	1	6	0
Arterial	78	26	1	15	1	6	0	9	0	5	0
Local	11	24	3	29	2	6	1	9	1	9	1
0-1 miles	38	27	1	21	1	6	0	10	1	6	0
5+ miles	27	25	2	17	2	6	0	9	1	5	0
1-5 miles	55	25	1	16	1	6	0	9	0	5	0
$0-10 mil	63	24	1	22	1	6	0	8	0	7	0
$10-100 mil	39	26	1	15	1	6	0	10	1	4	0
$100+ mil	18	32	2	9	2	6	1	12	1	3	0

10.3 ONE-WAY MANOVA RESULTS

Table 10.3 shows the results of the MANOVA tabulated by variable. The weighting effect is highlighted for results that appear to exacerbate variance between the linear combinations of Raw Scores and NA Scores (the thumbprint of a project). Similarly, DQ Scores of significance are highlighted where it may influence the significance of the MANOVA result – note that the two categories where data quality is significant do not appear in the ANOVA results, indicating that these two properties (Owner and Functional Class) are not main effects. With these exceptions, the MANOVA and ANOVA results agree on the top four results of Budget, Surfacing, Place and Contract.

Table 10.3 One-Way MANOVA p-value Results

	MANOVA - Weighted		MANOVA Unweighted		Weighting Impact		DQS
Variable Name	**Dimension (Dim) 1**	**Dim 2**	**Dim1**	**Dim 2**	**Dim 1**	**Dim. 2**	**Effect?**
Budget	8.01E-12	2.58E-01	9.31E-14	5.72E-01	Less	More	No
FunctClass	5.59E-08	7.26E-01	2.34E-05	8.61E-01	More	More	Yes
Owner	2.36E-05	1.19E-01	2.36E-04	9.41E-01	More	More	Yes
MajorStructures	2.70E-04	2.70E-04	9.11E-07		Less	More	No
Surfacing	2.73E-04	2.35E-01	2.88E-02	3.80E-01	More	More	No
Place	1.94E-03	7.52E-01	3.25E-01	6.45E-01	More	Less	No
Contract	3.86E-03	3.07E-01	3.24E-03	3.71E-01	Less	More	No
Motivation	4.00E-03	8.11E-01	5.17E-06	9.79E-01	Less	More	No
Phase	4.81E-03	2.05E-01	1.42E-03	2.12E-01	Less	More	Yes
Greenroads Project	7.87E-03	7.87E-03	1.34E-04		Less	More	No
Green Emphasis	8.38E-03	8.38E-03	8.32E-03		Less	More	No
Purpose	8.99E-03	7.29E-01	2.40E-04	8.72E-01	Less	More	Yes
Length	4.21E-02	6.24E-01	3.83E-02	7.41E-01	Less	More	No
Northwest	2.02E-01		3.59E-02		Less	More	No
Country	8.24E-01		4.98E-01		Less	More	No

MANOVA results also identify significant differences between projects with structures and those without. However, this within-group variation does not appear to be significant to the mean score of the project based on ANOVA results. Instead it appears to indicate that projects with structures may have certain opportunities that other projects do not – since structures are usually made of portland cement concrete, it is possible that this result is tied to the significance of surfacing type, explained in more detail below.

10.4 MOST SIGNIFICANT RESULTS

The following qualitative variables were found to be significant in both the ANOVA and MANOVA tests for the Raw Scores in the weighted condition. Generally, NA Scores agree with the findings of the Raw Scores tests. MANOVA test results also confirm results of the ANOVA tests, with some minor interaction effects as expected. Detailed investigation of within-group variations are recommended for future studies. Results of all tests can be found in Appendix E with figures in Appendix F.

10.4.1 Greenroads Projects ("GreenroadsProj")

Greenroads projects score significantly higher than projects not using Greenroads. See Figure 10.1. The explanation for this result is straightforward and has a confidence interval of 98.4%. If Greenroads is to be the standard by which sustainability is measured for roadway design and construction, projects using Greenroads deliberately naturally score higher. Note that the sample size includes only 21 projects that were scored at various stages of certification, documentation and completion. The mean score of Greenroads projects is 30±2, while projects not using Greenroads score 25±1. Recall that the minimum score required for certification is 32 points, which barely falls within the error for the mean of even Greenroads projects. This is likely the result of the technicality that most of the Greenroads projects pursuing certification were scored early in their design and documents may not have been present to review. It is expected that this average score will increase over time.

However, for the typical project, certification appears to be within reach with minimal additional effort. Most of the projects pursuing Greenroads are local projects less than $10 million in value. It is worth noting that at the time of this study, only one project pursuing certification has achieved certification (at the Silver level, 44 points) and all others are still in progress. (This project is included in the results but was rated during design, scoring only 30 points at that stage).

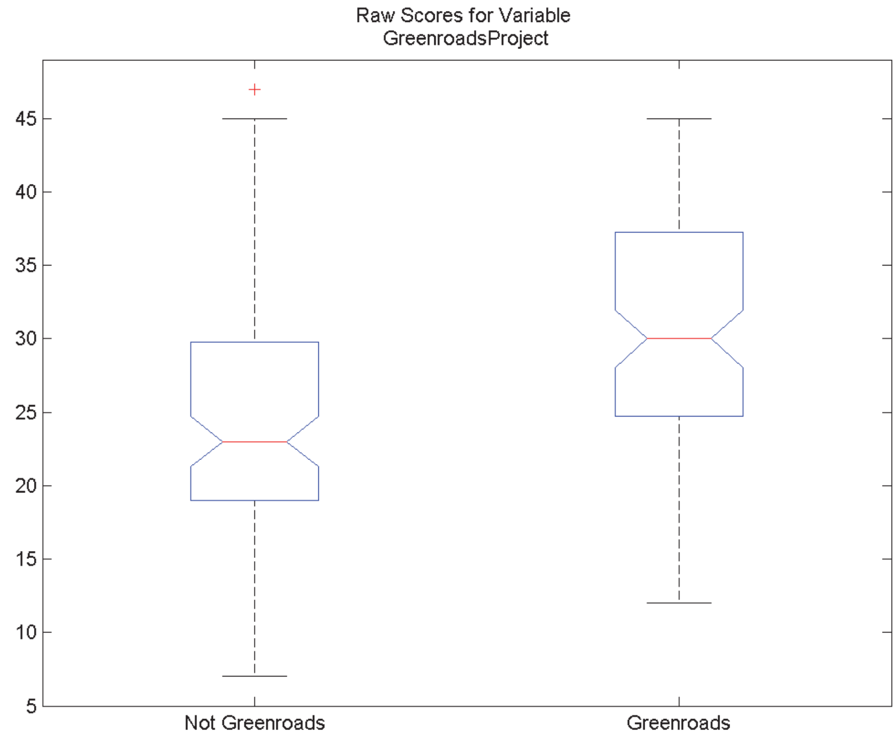


Figure 10.1. Boxplot of Raw Scores for Greenroads projects compared to typical projects (Not Greenroads). Greenroads projects have median scores that exceed typical projects, though the high end of the range is about equal. The mean scores were determined to be significantly different.

10.4.2 Sustainability Emphasis ("GreenEmphasis")

Greener projects score significantly higher than typical projects with 99.0% confidence. See Figure 10.2. Greenroads was deliberately designed to recognize more sustainable practices, so those projects that employ such practices do better when measured against the Greenroads standard. This is especially true if the project is subject to a mandate or funding criteria that places weight on sustainability. The mean Raw Scores of greener projects is 29±1 with a slightly larger sample size of 37 projects. Typical projects score 24 ± 1 points. Note that there is overlap with the majority of the Greenroads projects; 17 of the Greenroads projects are meet the criteria to be included in this category as well. Thus, it may be suggested that Greenroads is a reasonable way to meet and exceed sustainability goals and that this approach is already being used by several projects as part of a strategy to do so.

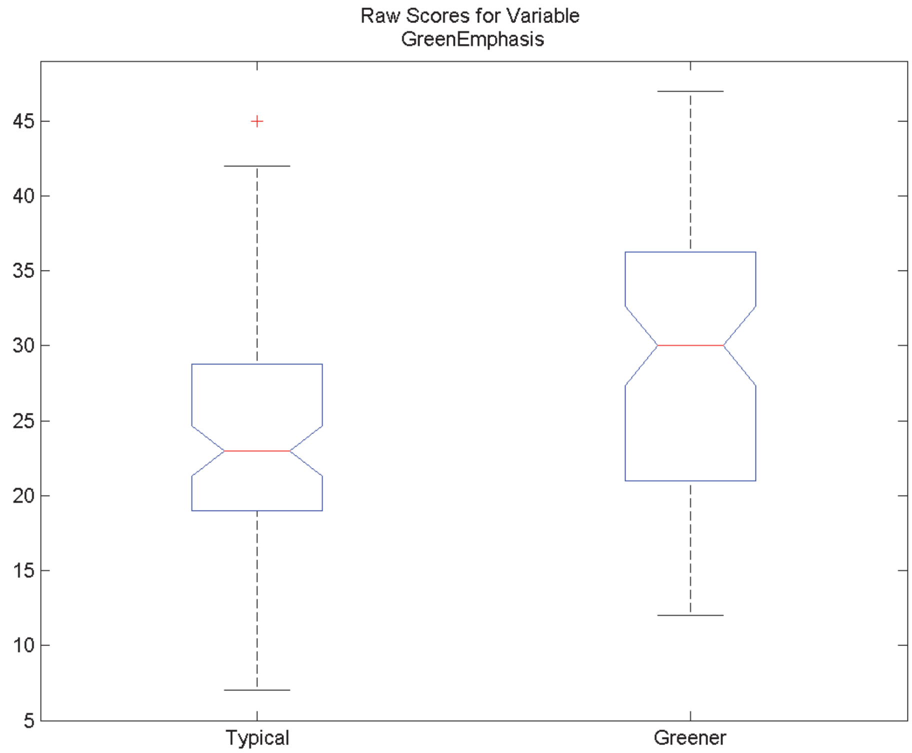


Figure 10.2. Boxplot of Raw Scores for greener projects compared to typical projects. Greener projects have median scores that exceed typical projects, and a range that has higher upper and lower bounds. The mean scores were found to be significantly different.

10.4.3 Contract Type ("Contract")

Projects that use an alternative contracting approach score higher than projects that use the conventional design-bid-build (DBB) approach to construction projects. See Figures 10.3 and 10.4. The sample includes 22 projects that do not use a conventional contracting method, including design-build, design-build-operate-maintain (DBOM), public-private partnerships (PPP) and variations on construction manager at-risk (CMAR). Note that six projects in this category were reviewed prior to knowing what type of contract would be used.

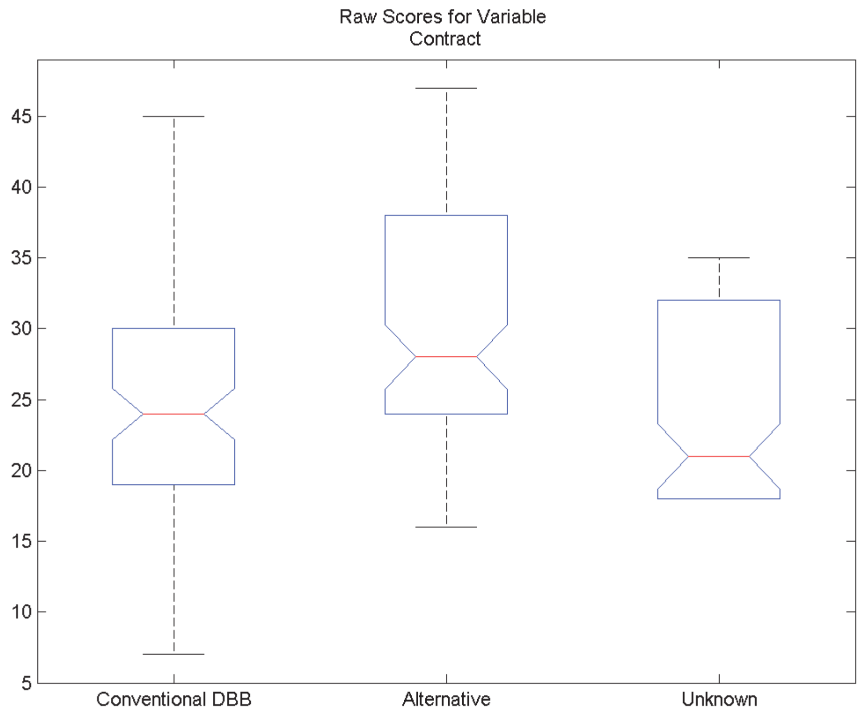


Figure 10.3. Boxplot of Raw Scores for type of contract. The mean scores of conventional DBB and Alternative were found to be significantly different.

Figure 10.4 Dendrogram showing relationship between conventional and alternative contracts.

This is an interesting result for several reasons and may be indicative of a need to recognize this practice as a separate credit or practice in Greenroads. The results are significant with a 99.0% confidence interval: traditional DBB projects score 25±1 while alternative contract approaches result in an average score of 31±2.

It suggests that transportation projects that use an alternative contracting approach are already implementing what the building industry calls “integrated project delivery” or “lean construction” practices (Vollmer et al., 2009; Kibert (2008). Roberts (2008) note several different advantages to the integrated project delivery model; however, it is potentially easiest to use the MacLeamy Curve to illustrate why this is often the case, shown in Figure 8. This figure clearly emphasizes why considering sustainability during project planning often results in a more holistic and economical result. This is why Econ Scores are assessed first as part of the scoring method used in this study. It is important to recognize opportunities early to minimize effort and cost.

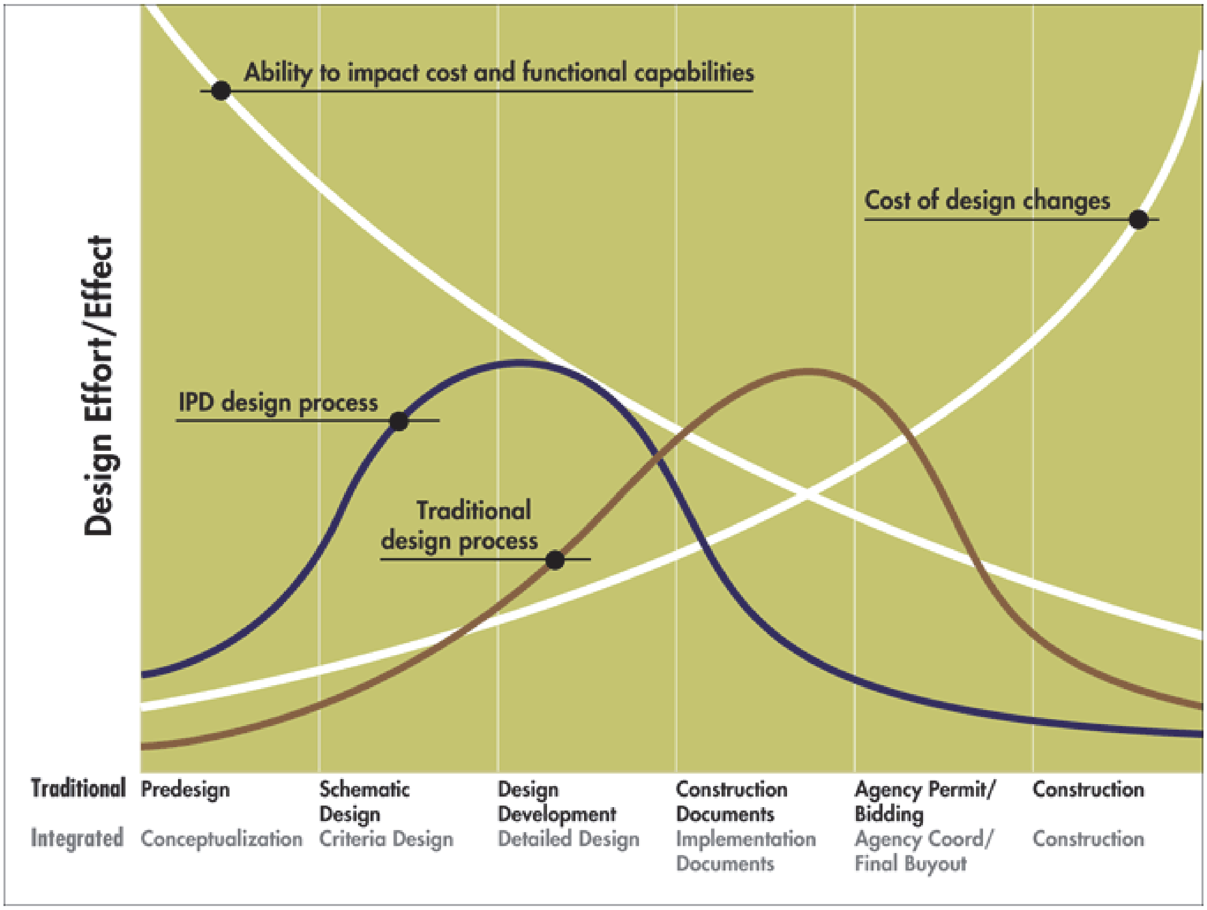


Figure 10.5 The "MacLeamy Curve" credited to architect Patrick MacLeamy, CEO of HOK, Inc. Image above from Roberts (2008) at http://www.buildinggreen.com/articleimages/1711/MacLeamy_Curve.gif.

10.4.4 Phase of Rating ("Phase")

Results of the comparison of means test indicate that the average score of projects rated in design and in planning are significant. See Figures 10.6 and 10.7. The results are significant with a 99.0% confidence interval: 16 planning projects score on average 23±2 while ratings in design (22 projects) result in an average score of 30±2.

The reason for this discrepancy can be easily be attributed to the significance of the DQ Score with 98.9% confidence – no design or construction documentation existed for most of the projects rated in planning, resulting in necessarily lower scores but high potential scores. Construction and finished projects tend to score lower as well because there was no intent to design with sustainability or Greenroads in mind.

The cluster diagram in Figure 10.7 shows offers a perspective of how lack of documentation makes projects rated in planning differ from other projects. The potential scores were not tested here, but it is important to note that projects in planning also cannot receive certification so this result is somewhat moot. A strategy could easily be adopted during project development to better incorporate sustainability and plan to document these activities along the way. In fact, at least three projects are included in the sample that did this and are now registered for certification.

Interestingly, this result is related to the previous significance of choice of contracting approach. It seems that the planning projects are best positioned to create an integrated solution through alternative contracting which can ultimately result in a more sustainable project. A simple strategy that could be implemented at this stage might include involving a representative from a construction firm on the planning and design team.

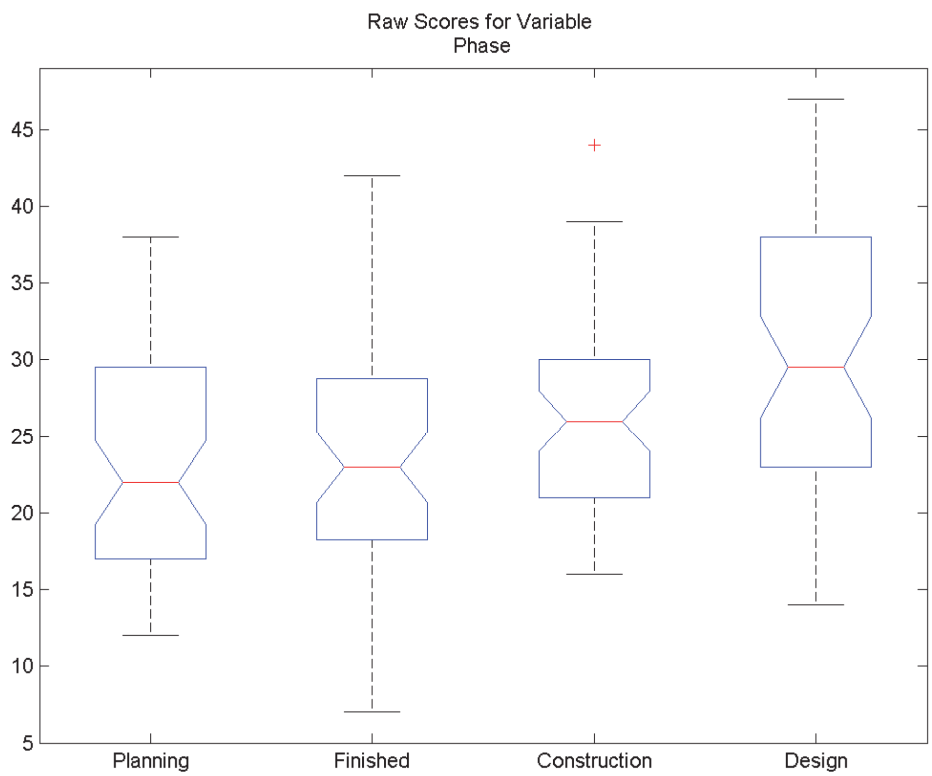


Figure 10.6 Boxplot of phase of rating. The means of planning and design are significantly different.

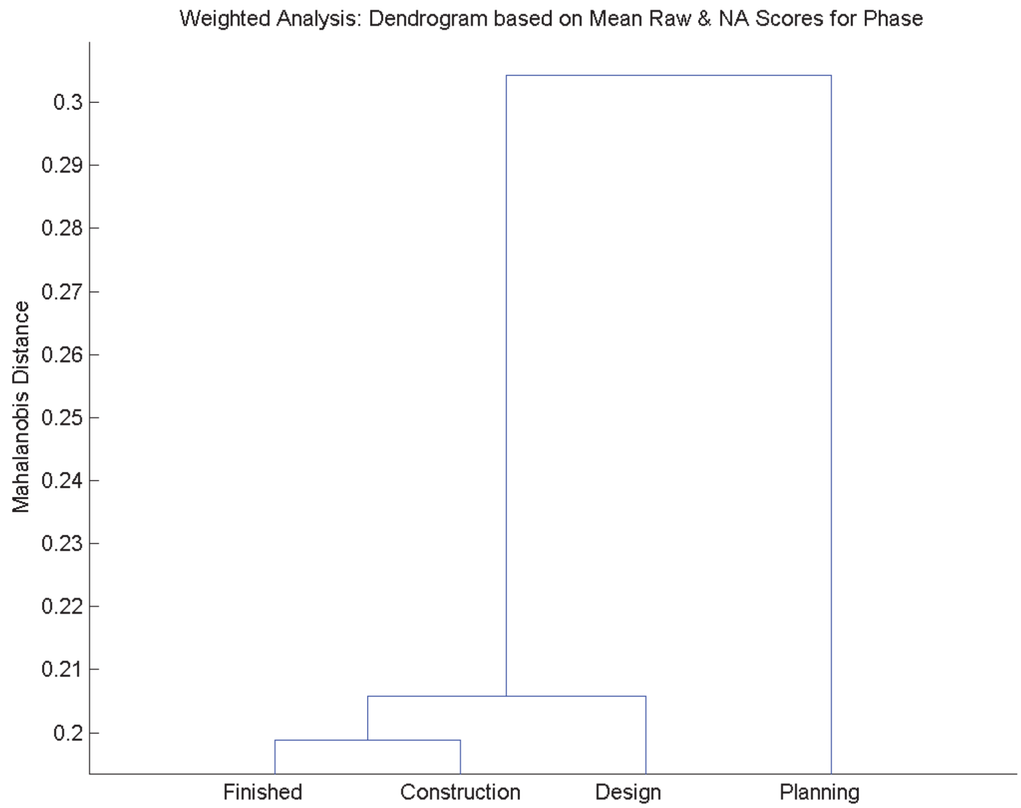


Figure 10.7 Dendrogram showing the relationships between the four project lifecycle phases.

10.4.5 Type of Pavement Surfacing ("Surfacing")

The results shown in Figures 10.9 and 10.10 indicate that HMA projects have a lower sustainability performance than PCC projects. The results are significant with a 99.0% confidence interval: 79 HMA projects scored 24±1 while 17 PCC projects result in an average score of 31±2.

This result tends to be exacerbated by weighting of the rating system, particularly with respect to the Pavement Technologies category. This can be partly explained by the fact that PCC projects typically achieve both the PT-1 Long Life Pavement Design and PT-4 Cool Pavement credit, two of the highest value credits in the rating system. This result clearly indicates a need to revisit the applicability and the weighting of these credits. Secondarily, this result is also likely tied to the high occurrence of PCC projects in urban areas and on large, high value projects. From the MANOVA tests, it does not appear that choice of PCC or HMA is the main effect and instead it is more likely these results are affected by other properties. It should be noted that the variability within this category is related to the comparison of material types. It may not be wise to extrapolate these results purely based on material type alone, because only a few projects made from other materials such as steel and wood were not adequately represented.

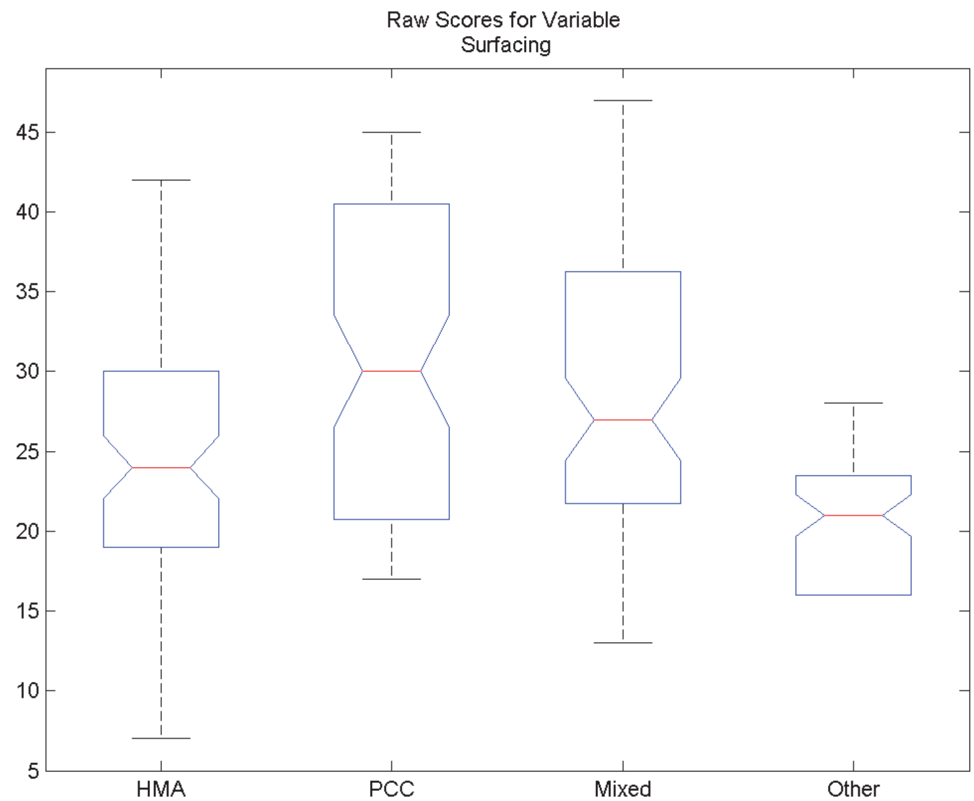


Figure 10.8 Boxplots of pavement types. It is likely the Mixed and Other categories are either HMA or PCC. The means of HMA and PCC are significantly different.

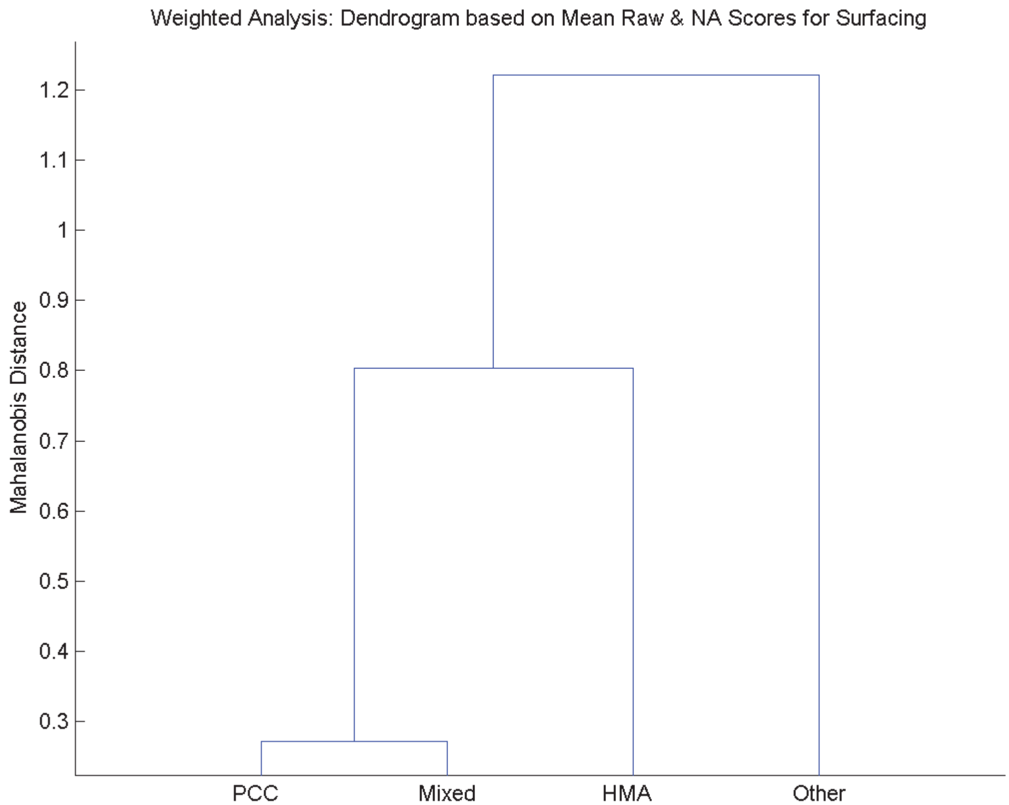


Figure 10.9 Dendrogram showing the relationship between pavement types.

10.4.6 Project Location ("Place")

The results shown in Figures 10.11 and 10.12 indicate that projects located in an urban location have a higher achievement of credits than do projects in rural locations. The results are significant with a 99.0% confidence interval: 44 rural projects scored 23±1 while 40 PCC projects result in an average score of 28±1.

This unbalanced result also appears to be exacerbated by weighting of the rating system, particularly with respect to the Access & Equity category, where multimodal features of roadways have a strong presence. In many rural environments, several of these credits are often not appropriate. This result could also be influenced by the types of projects within the rural group of projects – for example, rural projects tend to be highway preservation projects made of HMA. Importantly, no local roads in rural areas were included in this sample and only a handful of rural collectors are represented. In fact, the only local road in a rural environment was actually a bridge replacement project made of wood. The results therefore may not be representative of actual practice in rural areas and it cannot be stated with certainty that Greenroads has a bias toward urban projects. Furthermore, examination of the unweighted credit scores shows that urban projects are actually completing two more Greenroads activities than rural projects on average. Nevertheless, the apparent unbalanced result is worth further consideration due to the result that weighting appears to influence the overall score of projects.

It is also important to note that owner type plays a role in the type of project, its budget, and its location. For example, most of the rural projects investigated were owned by federal or state agencies. Future research could be done with the primary motivation of collecting more information about roads in rural environments.

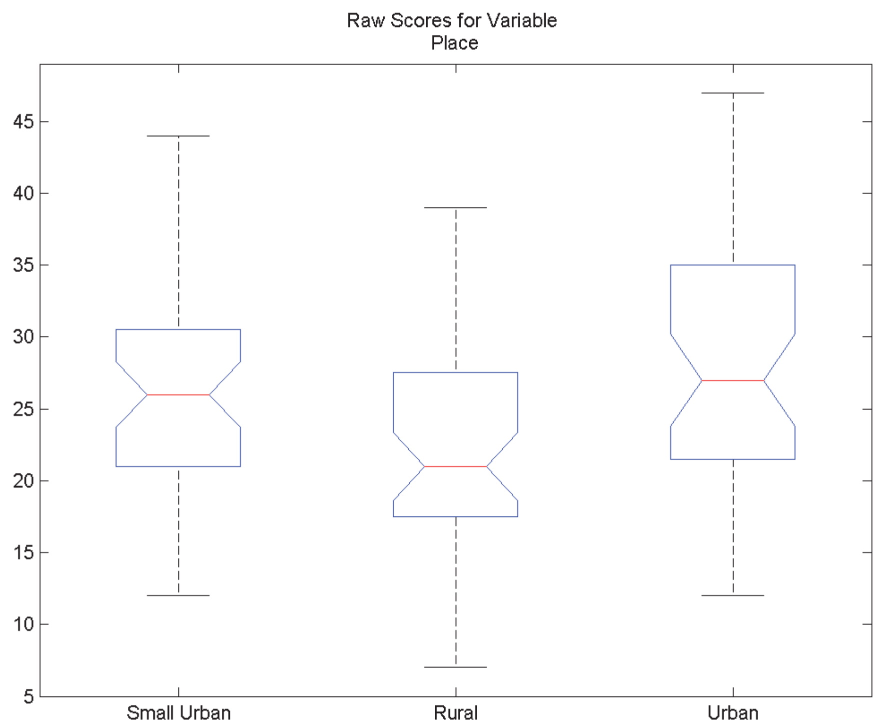


Figure 10.10 Boxplots showing location. Means of rural and urban scores are significantly different.

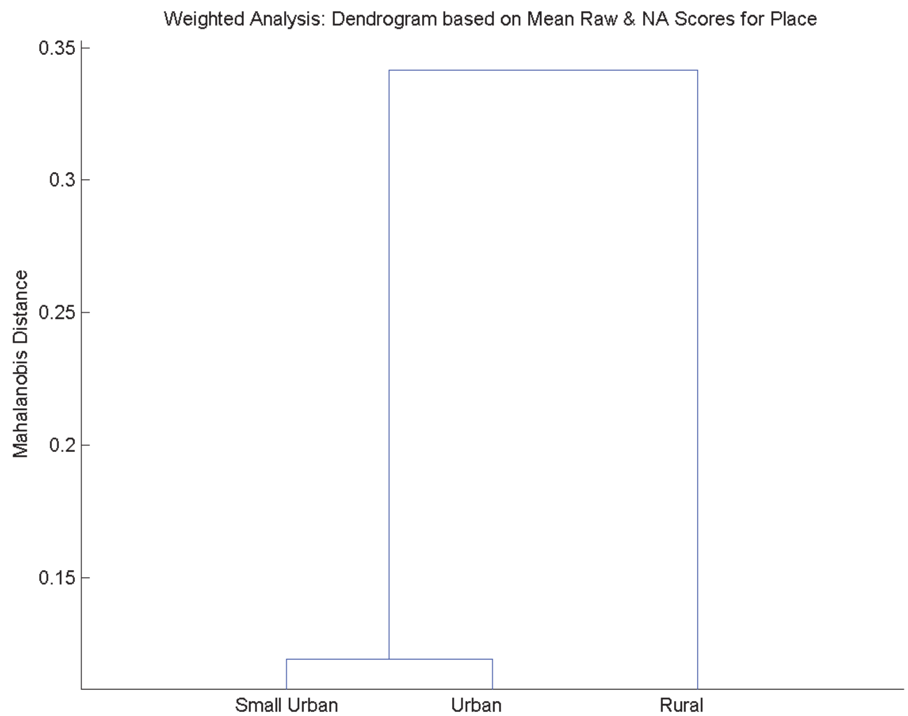


Figure 10.11 Dendrogram showing the relationship between location groups.

10.4.7 Project Budget ("Budget")

Project construction cost appears to have the most significant influence over the expected mean and median scores as shown in Figures 10.14 and 10.15. Projects over 100 million dollars in construction value outperform both small and medium budget projects. This result should not be unexpected for two reasons, which are shown graphically in Figures 10.16-10.21. Owner type and contract type are distinctly tied to project budget. Furthermore, higher budgets are more frequently tied to funding mandates that more recently tend to address sustainability. The results are significant with a 99.0% confidence interval: 18 projects over \$100 million scored 32±2 while 39 medium-sized projects with budgets of between \$10-\$100 million scored far lower at 26±1. The gap is even wider when comparing small budget projects to large budget: 63 small projects less than \$10 million scored 24±1.

A few items should be noted about these results. First, the average score for largest projects is the minimum number of points required for certification award with only a small error. This means with minimal effort, activities that are already being done on this project would qualify it for certification. Next, again, comparing the results from Table 10.2 allows us to compare the gross number of activities that each of these projects are actually completing. Large projects are doing more sustainable activities, so it logically follows that these projects score higher.

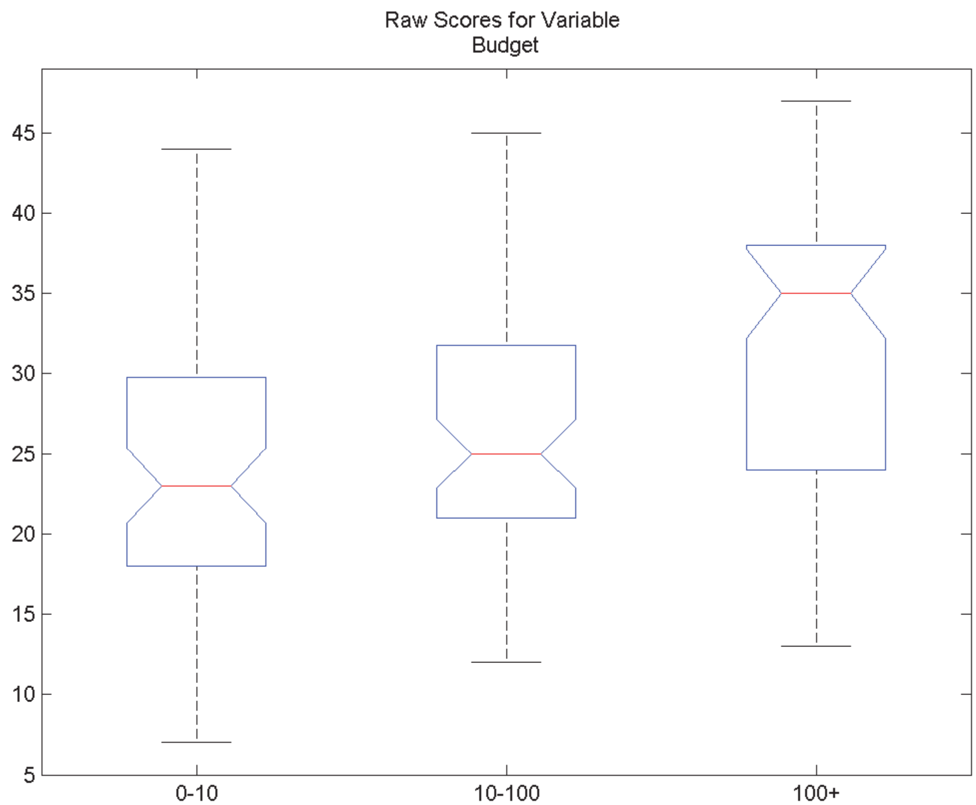


Figure 10.12 Raw Scores for variable "Budget." Large projects more than $100 million dollars score higher than projects with lower budgets and the difference in the means of the $0-10 million and $100+ million groups are significant.

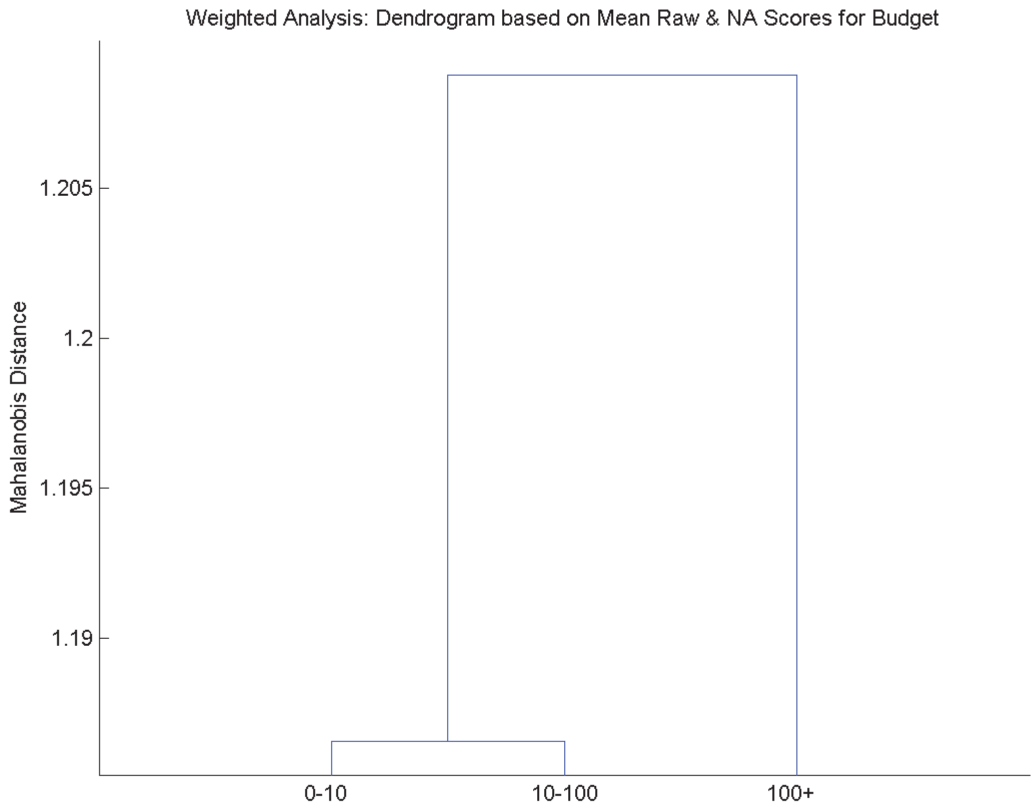


Figure 10.13 Dendrogram showing budget. Note that this category shows the largest distance from the other groups. Results of ANOVA and MANOVA showed this was the most significant property that influences the Raw Score.

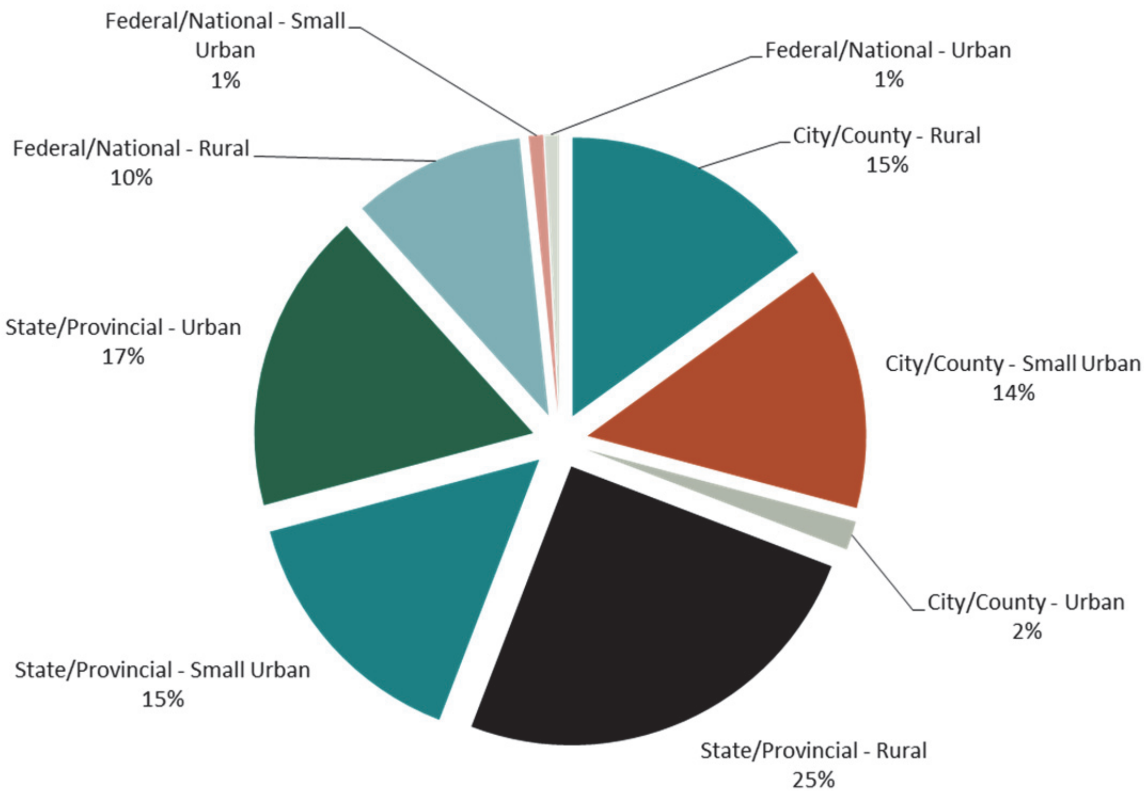


Figure 10.14 Number of projects sorted by Owner Type and Location. This is where budgets are spent. 50% of projects are rural, but none are local roads (most are arterial projects).

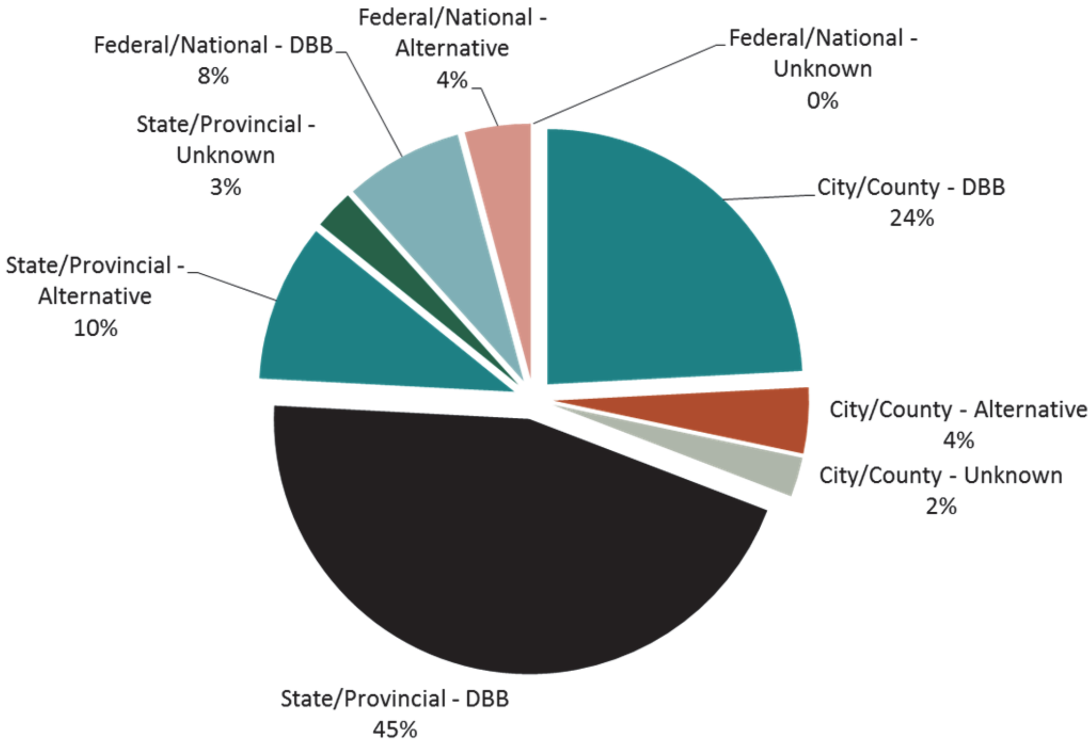


Figure 10.15 Number of projects sorted by owner and type of contract. 18% of projects are contracted through alternative methods.

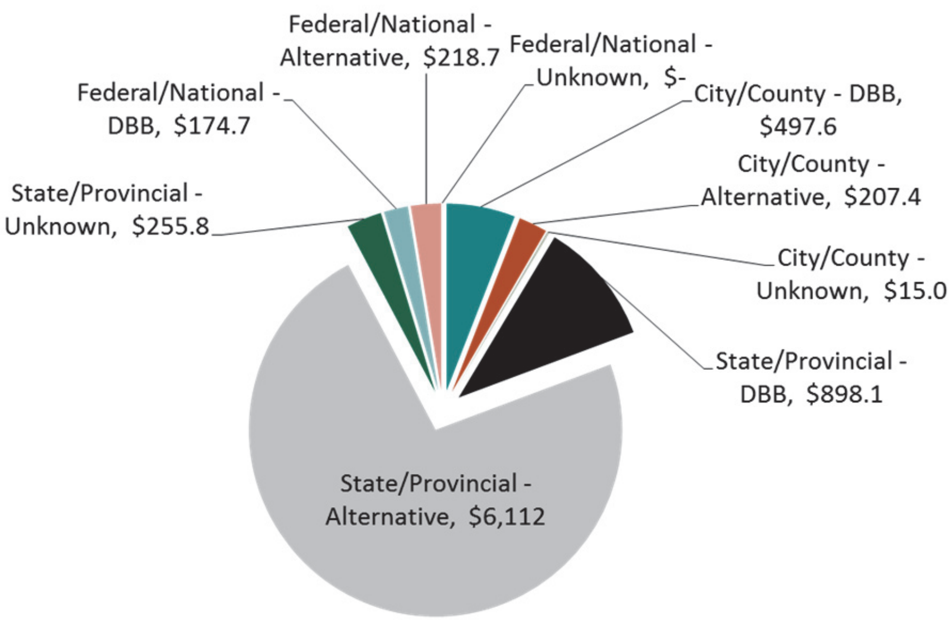


Figure 10.16 Total value and type of contracts sorted by owner. This figure puts in perspective the amount of financial leverage that exists with specific types of owners. Note that this figure does not indicate the frequency of projects in each wedge. By far, the most money is spent on alternative contracts. Approximately half of the total alternative contracts are from three projects located in Canada.

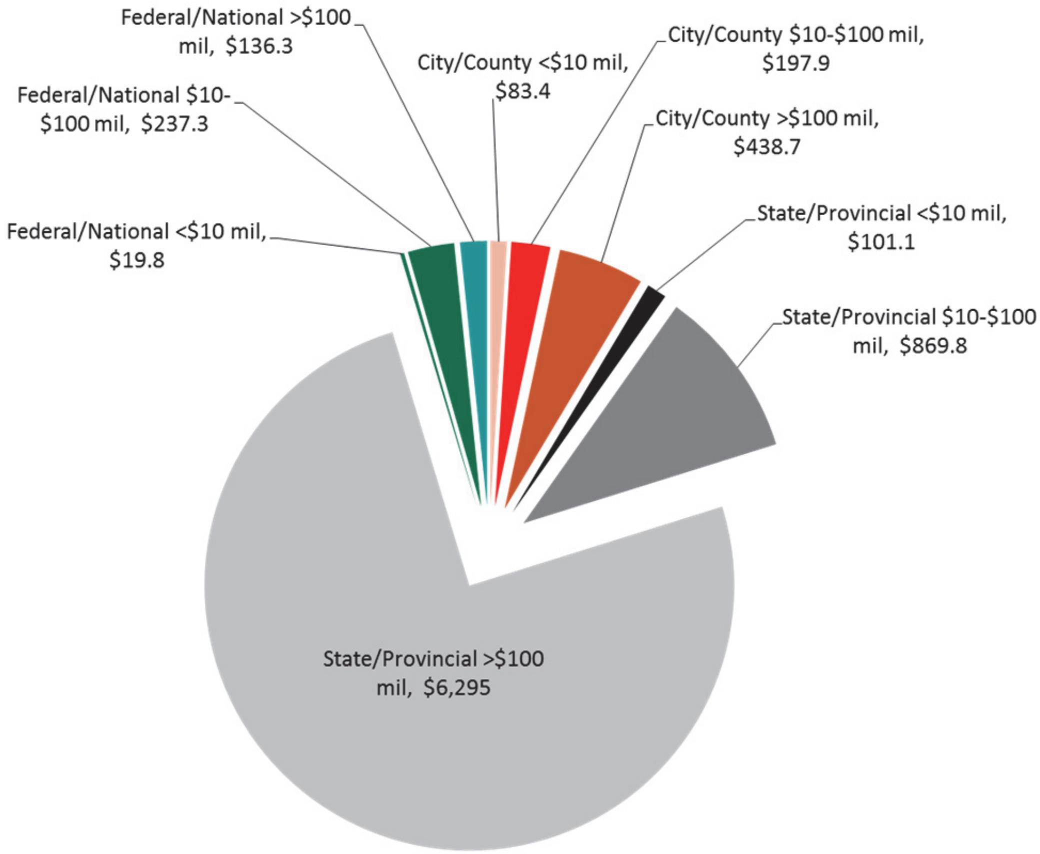


Figure 10.17 Total value of projects sorted by budget tier and owner, without respect to project type or number of projects in each category. More than half of the projects rated were for local agencies, but less than 15% of the total value. Again, about half of the state/provincial agency wedge is accounted for on just three Canadian projects.

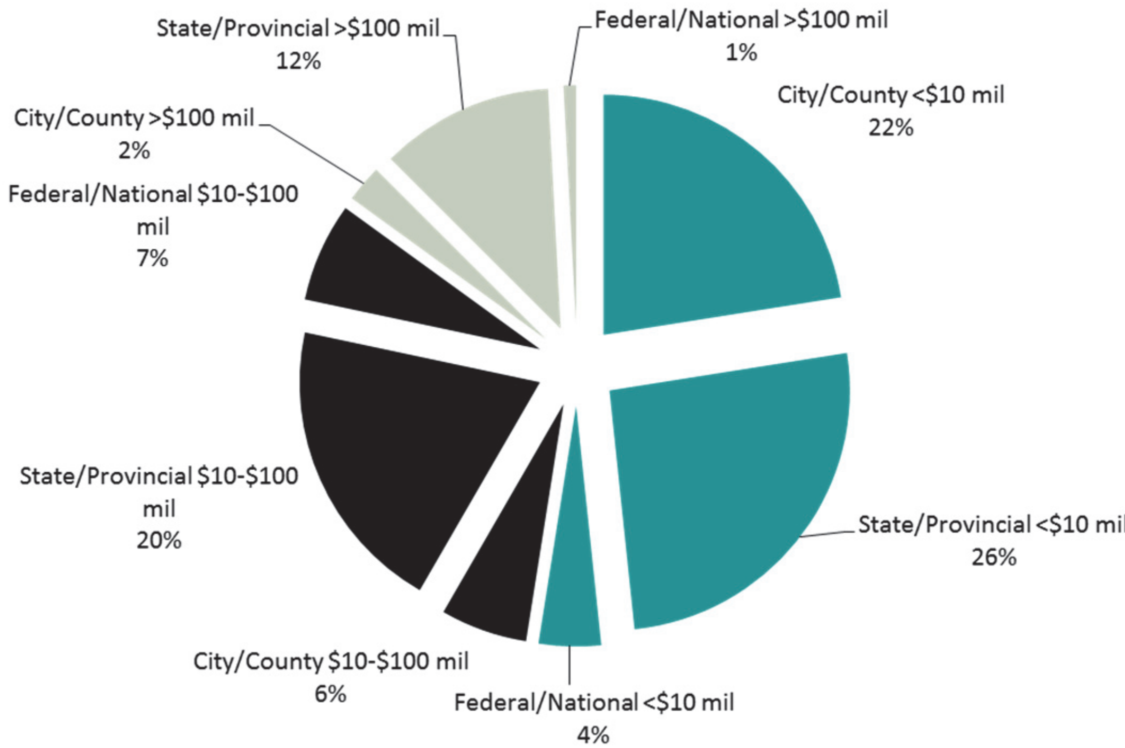


Figure 10.18 Owner type as related to Budget by count of projects in sample. More than half of the projects rated were small budgets of less than $10 million.

It is noteworthy that the majority of projects scored were less than $10 mil in value (Figure 10.21). Less than half of the projects scored only account for 2.4% of the total value of projects. While there are thousands of cities and towns, there are only 51 state agencies and one federal agency in the U.S. A few more projects less than $10 million were rated for state owners, but generally, local owners represent the bulk of the projects rated. This is interesting because it provides perspective on how money is handled in transportation projects and how it is being spent. Also, note that the approach used to assess the Raw Score projects in this study is independent of the cost of the projects and there are no Greenroads credits specifically for saving money.

Even more interesting is the relationship shown in Figure 10.19. This boxplot shows that the highest scores based on Owner are coming from projects in local agencies that happen to be located in urban or small urban areas (recall there were no local roads in rural locations in the sample). Performance of local agencies is substantially higher than state and federal agencies – despite the financial leverage of the larger agencies.

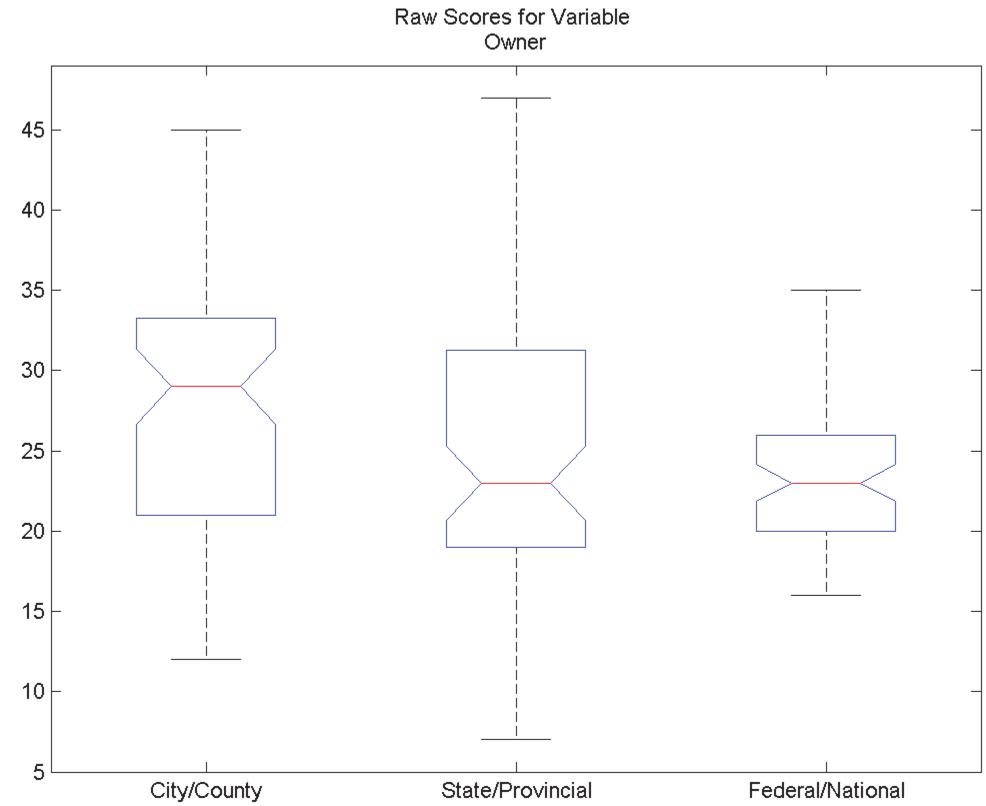
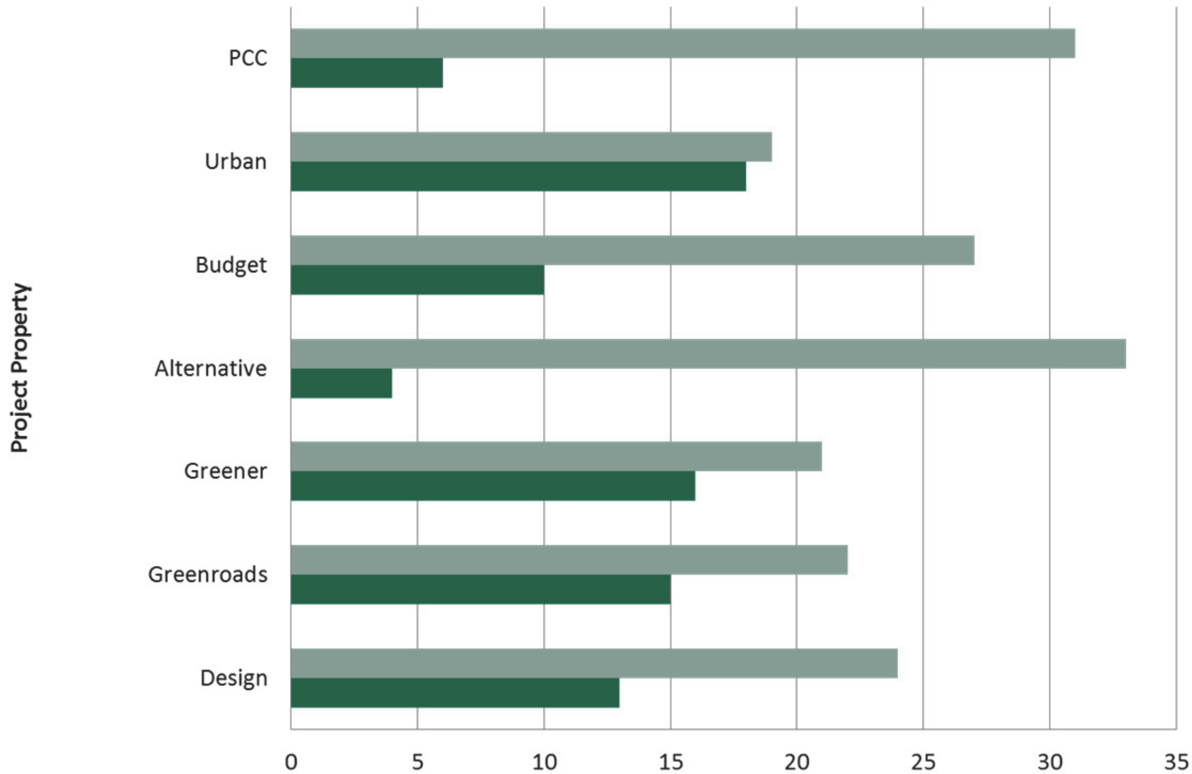


Figure 10.19 City/County projects, while having more constrained budgets and smaller projects and representing less than one third of the projects reviewed, appear to excel in Greenroads despite these limitations when compared to other owner types.

We can see from Figures 10.19 and 10.20 that local owners tend to have more policy flexibility to implement new technologies and that they are currently the majority of groups actively pursuing Greenroads certification or have an emphasis of sustainability. It is suggested that the relationships between each property shown in Figure 10.19 and 10.20 are further examined through a sensitivity analysis or a multivariate method.



	Design	Greenroads	Greener	Alternative	Budget	Urban	PCC
Does Not Have Property	24	22	21	33	27	19	31
Has Property	13	15	16	4	10	18	6

No. City/County Projects With and Without Property

Figure 10.20 Bar chart of the seven key factors that may be significant in the leading performance from City and County agencies.

From the first result shown for Greenroads Projects in this Chapter, it follows that sustainability can in fact be implemented without a large project budget with great success. There is no indication that sustainable activities cost more or require more effort based on the Raw Scores. Instead, it appears there are several cost effective strategies that can be reasonably implemented to raise the standard of practice, which can be seen in the difference between the Raw Scores (what is currently done) and the Econ Scores (what appears to be reasonable based on what the project has achieved and what is within the environmental context to try).

Clearly, the few owners with the greatest financial leverage stand to make the greatest improvements in sustainability performance of their transportation projects. But, to date no state or federal agency has adopted Greenroads as a tool to meet sustainability goals. In particular, leverage is increased substantially through alternative contracts in part due to the likelihood these contracts will be of high dollar value and subject to funding constraints specific to sustainability. Alternative contracts appear to offer a significant opportunity to these owners, and less so to local owners, but with successful certification within easy reach regardless of owner.

Furthermore, where funding is shared between multiple agencies, it is more probable that the project is larger, involve many diverse parties, will be subject to sustainability policy mandates, and tend to outperform typical roadway projects when scored with Greenroads.

10.5 SUMMARY

- Results of one-way ANOVA tests and MANOVA tests show that seven properties are significant, disproving the null hypothesis that Greenroads is fair and balanced for all projects. Two of these properties were found to have a higher significance as expected: projects that use Greenroads score higher in Greenroads and projects rated in planning do not have enough information available to score using a design and construction rating tool.
- A sustainability emphasis, policy or mandate appears to significantly improve the overall average score of the project. However, while this impacts the score positively, it does not indicate a bias or imbalance. Instead, it appears that Greenroads is achieving its objectives by recognizing sustainability efforts where they exist.
- Alternative project delivery results in higher scoring projects than conventional design-bid-build projects. This result does not suggest a bias or unfairness in the rating system.
- Results show that there is an unfair bias toward concrete projects and projects located in urban areas. It is recommended that these properties are considered for future study to correct this oversight. It is likely additional data points will be needed, especially for rural projects.
- Budget is the most significant property to a project that indicates its overall Raw score for sustainability as well as its leverage to implement sustainability cost-effectively.

11.0 FINDINGS

This section summarizes and expands on the key results noted in the previous chapter.

11.1 STATISTICAL CONCLUSIONS

Recall that in Chapter 7-9, the stated hypothesis for statistical testing was that all projects will score the same in Greenroads regardless of project properties. The following questions were posed to answer as a result of the trend analysis and multivariate analyses.

Is Greenroads fair, balanced and applicable to all roadway projects?

It appears that weighting of the credits in the rating system provides small advantage to at least two project properties: projects in an urban location and concrete pavement projects. It may not be appropriate for a rating system tool to favor one environmental context over another or one type of material. This may mean that the weighting introduces a bias and that the null hypothesis that Greenroads is fair and applicable to all projects should be reinvestigated to better balance these features. It should be noted, however, that the unweighted analysis shows that more activities are also being completed by these projects, so higher scores may actually be a result of simply doing more for sustainability and not weighting alone.

However, the results did not indicate that the rating system is unbalanced based on other project qualities. As shown in Chapter 7, the average number of points not available only represent about 16.7% of the total system available and that from Chapter 5, certification requires a minimum of only 30% achievement. Tests do show significant sustainability improvement if using alternative approaches, environmental or sustainability emphasis, or more money. The latter two were indicated in Chapter 3 as areas of significant potential for sector application of sustainability.

What is the state of the practice in roadway project sustainability according to Greenroads?

Current practice falls just short of Certified level based on the total Raw Score, but it appears from Chapter 8 that this award level is within easy reach with minimal no to low construction cost. In fact, it appears that the average project is likely to be doing some of the Greenroads activities already.

Does Greenroads meet the intent of its designers?

From Chapter 7, The average Raw Score is 26 points, the average number of Economical points available is 59 (Gold), and the average Reasonable Score is 62 points (Gold). Generally, yes, Greenroads does appear to show that sustainability certification is within easy reach for most projects with minimal effort. The evaluated projects included projects that have already been successful, so therefore it does appear that Greenroads is a viable tool for measuring sustainability on roadway projects.

11.2 KEY RESULTS

Current Greenroads Projects Demonstrate that Project Requirements Can Be Achieved

- No project meets all 11 Project Requirements on first pass. However, it is important to note that this is due to a technicality in the way the study was designed to test projects that were planned, designed, or built prior to development of the standard (without knowledge of its minimum requirements). Currently, the projects that are pursing certification are demonstrating that these 11 minimum tasks can in fact be accomplished regardless of the project type.

Considering Social Context and Environmental Performance Matters

- Roadway projects tend not to go above and beyond environmental regulations and score relatively low points in the Environment & Water category.
- Sustainability emphases result in substantially higher environmental performance, though often as a result of mandate; a majority of these projects are high value with greater leverage too.
- Most projects use context sensitive approaches and excel in the Access & Equity category. Strong performance in this category represents an area where transportation projects by their very nature are expected to excel. However, there is room for additional improvement for all types of projects.
- Results show that projects with emphasis on materials management also score very well in the Materials & Resources category, but that there is a great potential for improvement.

Innovation as a Project Purpose and Sustainability Mandates Lead to Better Performance

- Experimental projects and projects that are linked to funding requirements with a tieback to sustainability score higher than average projects.
- However, such projects are more than likely to have some sustainable features that are add-ons instead of a fully comprehensive approach to sustainability. Innovation does not necessarily mean sustainable – often a clear reason for doing something innovative is motivated by cost savings with environmental benefits justified as an afterthought.

- It is important to recall that Custom Credits were not included in this study, but these points represent a significant opportunity for innovation and easy way to capture good ideas.

Contractors Have Unrealized Opportunities to Contribute

- The trends show that roadway contractors are somewhat disengaged from the practice of implementing sustainability. The evidence does not indicate that construction practices are achieving their sustainability potential.
- One way to improve contractors' performance within the restrictions of the low-bid design-bid-build model is for designers to specify best practices from the Construction Activities category in the project contract documents. However, this approach is not integrative.
- Policy makers can also adopt new standards for materials management, such as waste or recycled materials.
- The savvy contractor might also see that a great opportunity exists, similar to that tracked in the building industry, for early adopters of these practices to excel and gain a competitive advantage. Adopting such a position or strategy may result in better opportunities to participate on sustainable projects.

Integrated Design and Construction Practices Offer Greater Sustainability Performance

- It appears that the integration of the design and construction team, much like in the green building industry, results in significantly higher voluntary participation and interaction that results in an overall more sustainable project.
- Because these types of contracts are rare in local projects (the majority of projects that occur are low bid design-bid-build contracts), it may be prudent for policy makers interested in sustainability to thoughtfully reconsider the policies that are in place regarding how contracts are awarded.
- Larger agencies appear to have the greatest leverage, through alternative project delivery and financial resources, to make big improvements in sustainability performance.

Financial Leverage Results in Sustainable Projects but Sustainability Need Not Cost More

- High budget projects usually result in more sustainable projects. This is likely due to the social and community buy-in that is often needed for such projects to be built. Additionally, some high budget projects exhaust a majority of the economical credits that could incrementally increase scores. Because cost is a significant influence on the outcome of the project, it is important to recognize the need for sustainability to be integrated into transportation policies and mandates. It also appears that local owners, with substantially less financial leverage are able to implement Greenroads successfully regardless of budget. This suggests sustainability is not adding substantially to project costs for small projects.

11.3 SUMMARY

- Based on the ANOVA, multiple comparison of means, and MANOVA test results the null hypothesis that all projects are equal when scored by Greenroads should be rejected, though this result should be interpreted with caution.
- The results do not mean that Greenroads is unfair or unbalanced, and instead may suggest that the resulting properties that were determined to confer significant advantages constitute an opportunity for projects to be more sustainable with limited extra effort.
- Most projects are likely to be doing some of the Greenroads activities already.
- The results show that sustainability certification is within easy reach for most projects with minimal effort and low to no additional cost.
- The evaluated projects included some that have already been successful with Greenroads, so therefore it appears that Greenroads is a viable tool for measuring sustainability on roadway projects.
- Current Greenroads projects demonstrate that project requirements can be achieved.
- Innovation as a project purpose and sustainability mandates lead to better performance.
- Contractors have unrealized opportunities to contribute.
- Financial leverage results in sustainable projects but sustainability need not cost more.
- Local owners seem to implementing sustainability more successfully than other types of owners even though typical budgets at the local level are commonly under $10 million, suggesting sustainability is not adding substantially to project costs.

12.0 CONCLUSIONS & RECOMMENDATIONS

The results of this study show that Greenroads is a viable tool for sustainability performance measurement on roadway projects. Because most sustainability performance measurements in transportation are used for strategic planning and not for roadway design and construction projects, a tool like Greenroads is needed and can be helpful to track and monitor performance. Furthermore, the economic, political, educational and social climate is ripe for integrating sustainability into transportation as a core value.

The Greenroads Rating System was developed to bridge this gap and is an international standard for sustainable design and construction in the transportation sector. It was designed and tested over five years with the help of hundreds of individuals from industry, academia and roadway owner-agencies. This study finds that Greenroads meets the intents of its designers by encouraging more sustainable roadway design and construction practices. Greenroads is intended to be a helpful, voluntary tool for roadway owners, designers, and contractors to choose activities that result in a more sustainable project while also providing recognition of successful implementation and encouragement for innovation.

This research also develops the empirical evidence to support that Greenroads can achieve these objectives when implemented: 120 roadway projects from around the United States and the world are scored using the Rating System and subject to a variety of statistical analyses. The objectives of this testing are threefold: 1) use Greenroads to benchmark current practice, 2) determine if the rating system applies broadly to all projects, and 3) evaluate if the intent of the rating system is met: set a higher standard for sustainability in design and construction of roadway projects.

Results show that most roadway projects score about 26 points but could easily and economically reach Certified or Silver level with little additional effort. Multivariate statistical tests show that there are five qualitative properties of projects that are significant to resulting performance in Greenroads and confer advantage to the projects: a sustainability emphasis or mandate applied during project development, alternative contracting, pavement type, location, and budget. It is recommended that the properties of pavement type and location are revisited to reduce the perception of bias and determine the reason for the apparent advantage. Sustainability policies, integrated project delivery, and financial leverage appear to offer unrealized opportunities for improved sustainability performance. Overall, Greenroads is found to be a reasonable standard for measuring sustainability in transportation projects.

12.1 SIGNIFICANCE

The results of this research are significant because:

- Roadway projects represent a majority of public spending in transportation, meaning that such a tool can have a high impact by creating a new market for sustainable roadway projects.
- The scores of these projects effectively establish a benchmark for sustainability in transportation where none previously existed.
- This study shows that Greenroads is a broadly applicable tool that can be used on all types of projects regardless of size, budget, location or purpose but that some of these qualities may indicate opportunities for improved sustainability performance.

Greenroads is a flexible collection of performance measurements that allows any user, such as a department of transportation (DOT) to pick and choose measures that support their fundamental values and goals. It appears that Greenroads can help manage and reduce environmental impacts by positively influencing design and construction practices. In sum, Greenroads is a comprehensive and interdisciplinary tool that can be used to promote integration and engagement of all levels of transportation professionals. Greenroads is useful because it allows quantification of a variety of performance measures and represents them in an easy to understand rating that acts as a simple public communications tool.

12.2 FUTURE RESEARCH

Several opportunities for future studies are identified in this report. In particular, it is strongly recommended that Greenroads Foundation revisit the weighting structure and consider the development of some of the more commonly occurring custom credits. Additionally, future studies could be completed similar in nature to this one to increase the sample size, monitor performance changes over time, or investigate interrelationships between specific credits and project types.

Furthermore, several intertwined relationships appear between different project properties that may be interesting to investigate. This list is, of course, not all-inclusive. A few ideas are below:

- The relationships between variables determined to have significant influence on the overall performance in Greenroads should be examined. This includes relationships between cost and ownership with alternative contracts and also with owner, location, and functional class.
- Local and collector roads in rural areas are severely underrepresented in this study. These roadways should be scored and included to help better understand the implications of the significant results found in this study in a rural environmental context.
- Sensitivity analyses would be useful for all project scores and the most significant results found herein. It appears that many of the average and median aggregate scores are sensitive to the number of high scoring projects within that property. Data quality can also be looked at in more detail to determine if particular documents lead to higher scores with the goal of minimizing paperwork for certification. These analyses could help determine relationships between specific documents and scores that might help reduce paperwork needs for certification.
- The datasets are not currently well-suited for many multivariate methods due the mix of numerical and categorical variables. In order to test the interactions between properties, each property would need to be assigned to a numerical variable instead of a categorical variable and decomposed into zeros and ones for each subgroup. Some suggested methods that might be appropriate for these data would be multiple correspondence analysis (MCA), agglomerative hierarchical clustering and regression analysis. MCA and regression analysis could both potentially be used to predict the outcome of a project's score based on certain properties.
- In future versions of the rating system, a similar analysis to the one used in this research could be helpful to assign weights to new credits or to help balance any variation within a project property. Similarly, a closer look at the NA Scores might be able to help guide the development or discussion associated with any future change in award thresholds in the future. If Greenroads represents what is ahead of the curve for design and construction practice, it is important that it is not an exclusive tool that only applies in certain conditions.
- Finally, it is recommended that Greenroads' 22 sustainability benefits are analyzed using a similar approach to that used here to identify trends and common outcomes and potential relationships between the benefits and credits. Such an analysis can be used to determine what benefits are priorities in most transportation projects and may be helpful to strategic planning and for alignment with overall organizational values.

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APPENDIX A: RATING SYSTEMS TABLE

The table below constitutes a brief list of the sustainability performance measurement tools available in practice as of early 2011. This list may not be inclusive, but in general lists the available tools that are relevant for roadways. The background research for this table was completed as part of the author's sponsored research work in 2010 for the Federal Highway Administration (FHWA) project DTFH61-10-Q-00112: "Criteria and Tools for Sustainable Highways" Task 1.1, Literature Review (this is the work for developing the current rating system called InVEST noted below). The table has been slightly amended from its original form to include a few new resources and some other updates, but otherwise remains intact.

Key: P = Planning D = Design C = Construction O = Operations

System or Program Name	Champion	Starting Year	Status	Focus	Phase PDCO	Reference
CEEQUAL (Civil Engineering Environmental Quality Assessment and Awards Scheme)	CIRIA and Crane Environmental contracted by CEEQUAL, Ltd.	2007	Used in UK	Broad, all infrastructure projects	DC	CIRIA (2007) CEEQUAL International (2011)
Complete Streets	Complete Streets Coalition	2005	Exists with guidance available	Planning elements, mostly urban	P, some O	http://www.completestreets.org/complete-streets-fundamentals/complete-streets-faq/
EcoLogical	USDOT	2006	Published by FHWA	Planning elements, mostly ecosystem, wetlands, etc.	P	Brown (2006)
Great Streets	Tom Kloster, AICP with Metro in Oregon	1999	Website copyright expired 2003	Has walkable street design elements/ features	PD, some C	http://www.greatstreets.org/MainStreets/MainStSisters.html
Green Alleys	City of Chicago	2006	Pilot program in 2006, >80 Green Alleys installed between 2006-2008	Low impact development in alleyways, some recycling and lighting also addressed	DC	Daley et al. (n.d)
Green Bridges	None	2009	Unknown	Bridges (highway and also mechanically operated)	DC, some P, some O	Snelling (2009)
Green Guide for Roads	Transportation Association of Canada	2008	Incomplete	Detailed BMP guide	PDCO	TAC (2008). Author is consultant on this project.

System or Program Name	Champion	Starting Year	Status	Focus	Phase PDCO	Reference
Green Highways Partnership	Green Highways Partnership	2005	Recently moved website	most emphasis on stormwater management and LID, out of date presentations for Greenroads	PDC	http://www.tfhrc.gov/FOCUS/june06/04.htm (origins), http://www.greenhighwayspartnership.org/
Green Streets - "LEED for Roads"	Stantec	2007	Internal only, concept developed	Transportation planning and also some minor ops, also site development general	P	Stantec (2007)
GreenLITES (Green Leadership in Transportation and Environmental Sustainability)	NYSDOT	2008	Used now by NYSDOT	Road projects, bridges included peripherally	DC	NYSDOT (2008)
GreenLITES Operations & Maintenance	NYSDOT	2009	Draft	Most emphasis on maintenance *design and construction*, not "operations", and also facilities and fleet mgmt., some bridge mgmt. (not beyond regulation)	DC, some O	NYSDOT (2009)
Greenpave	MTO	2009 estimated	Unknown	Paving projects	DC	http://www.mto.gov.on.ca/english/transtek/roadtalk/rt16-1/#a6
Greenroads	Greenroads Foundation and University of Washington	2006	Fully developed, tested on 120 road and bridge projects, operated by independent non-profit third party.	Above and beyond best practices for design and construction, comprehensive decision-making for sustainability	DC, some PO	www.greenroads.org. This rating system is the author's current employer and the subject of this dissertation.

System or Program Name	Champion	Starting Year	Status	Focus	Phase PDCO	Reference
I-LAST (Illinois - Livable and Sustainable Transportation Rating System and Guide)	IDOT Highway Division, Illinois Joint Sustainability Group	2009	Presumably used internally at IDOT	Some project development and community planning, also traffic ops, otherwise mostly same as GreenLITES	PDCO	IDOT, IRTBA, and ACEC-IL (2010)
LEED-ND (Leadership in Energy & Environmental Design for Neighborhood Development)	USGBC	2010	Operational.	Mostly building-related site development and general urban planning	P	USGBC (2010)
PSM (Project Sustainability Management)	FIDIC	2005	Appears to be used in UK, unknown extent, training seminars and courses available	All types of projects	P	http://www1.fidic.org/resources/sustainability/
Rating System for Sustainable Bridges	None	2005	Unknown	Bridges (general), some toll facilities	DC	Hunt, L. (2005)
Smarth Growth	Smart Growth Initiative	1996	Large network, educational series	Very broad urban planning, not transportation focus	P	http://www.smartgrowth.org/
STARS (Sustainable Transportation and Access Rating System)	CH2M HILL, TriMet, Brightworks, David Evans & Associates, Green Building Services, Portland BoT, PSU, City of Vancouver, WA, various consultants	2008	Developing, approximately v0.5	Transportation planning process, modal access, some project development	PO, D	Burkhardt et al. (2010)

System or Program Name	Champion	Starting Year	Status	Focus	Phase PDCO	Reference
STEED (Sustainable Transportation Engineering for Environmental Design)	HW Lochner	Unknown	Unknown	Unclear	DC most likely	H.W. Lochner, Inc. (2009) presentation
Sustainable Highway Bridges	None	2010	Presented very recently at NCBC, February 2010, unknown	Highway bridges	PD, little CO	Yermack (2010)
Sustainable Sites	Sustainable Sites Initiative (ASLA, Lady Bird Johnson, United States Botanic Garden)	2005	In two-year pilot program phase, reference guide due 2013, at least 4 case studies completed	Site and/or land development projects, roads not specifically included, emphasis on ecosystems and water, no construction activities, just construction planning	DC	Sustainable Sites Initiative (2009)
Sustainable Streets	NYCDOT	2009	Plan in place	Internal agency goals program for all transportatio n activities	PO, DC a little	NYCDOT (2009)
Integrated VicRoads Environmental Sustainability Tool	VicRoads, Australia	2011	In use	Road projects	PDC	VicRoads Environmental Sustainability (2011)
Infrastructure Voluntary Evaluation Sustainability Tool (INVEST)	Federal Highway Administration	2010	In pilot/beta	Highway projects	PDCO	www.sustainablehighways.org. This is one of the author's sponsored research projects.
Zofnass Program for Sustainable Infrastructure	Paul Zofnass, Harvard	Unknown	Merging with envision rating tool	All of infrastructure	PDCO	http://www.gsd.harvard.edu/research/research_centers/zofnass/

APPENDIX B: PROJECT SCORING EXAMPLE

Sample Project Scorecard - Highway 35 Betterment (Western Federal Lands Highway Division)

Project Requirements (PR)		PR Subtotal:	11	11	8	0	3
No.	**Title**			Econ	RAW	NA	Rem
PR-1	Environmental Review Process		*Req*	x	x		
PR-2	Lifecycle Cost Analysis		*Req*	x			x
PR-3	Lifecycle Inventory		*Req*	x			x
PR-4	Quality Control Plan		*Req*	x	x		
PR-5	Noise Mitigation Plan		*Req*	x	x		
PR-6	Waste Management Plan		*Req*	x			x
PR-7	Pollution Prevention Plan		*Req*	x	x		
PR-8	Low-Impact Development		*Req*	x	x		
PR-9	Pavement Management System		*Req*	x	x		
PR-10	Site Maintenance Plan		*Req*	x	x		
PR-11	Educational Outreach		*Req*	x	x		

Environment & Water (EW)		EW Subtotal:	21	16	3	0	18
				Econ	RAW	NA	Rem
EW-1	Environmental Management System		*2*	0			2
EW-2	Runoff Flow Control	*1 -*	*3*	3	1		2
EW-3	Runoff Quality	*1 -*	*3*	3			3
EW-4	Stormwater Cost Analysis		*1*	1			1
EW-5	Site Vegetation	*1 -*	*3*	3	1		2
EW-6	Habitat Restoration		*3*	3			3
EW-7	Ecological Connectivity	*1 -*	*3*	3	1		2
EW-8	Light Pollution		*3*	0			3

Access & Equity (AE)		AE Subtotal:	30	15	14	12	4
				Econ	Raw	NA	Rem
AE-1	Safety Audit	*1 -*	*2*	2	1		1
AE-2	Intelligent Transportation Systems	*2 -*	*5*	3	3		2
AE-3	Context Sensitive Solutions		*5*	5	5		
AE-4	Traffic Emissions Reduction		*5*	0		5	
AE-5	Pedestrian Access	*1 -*	*2*	1	1	1	
AE-6	Bicycle Access	*1 -*	*2*	1	1	1	
AE-7	Transit & HOV Access	*1 -*	*5*	0		5	
AE-8	Scenic Views		*2*	2	2		
AE-9	Cultural Outreach	*1 -*	*2*	1	1		1

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Construction Activities (CA)		CA Subtotal:	14	5	2	0	12
				Econ	Raw	NA	Rem
CA-1	Quality Management System		*2*	0			2
CA-2	Environmental Training		*1*	1			1
CA-3	Site Recycling Plan		*1*	1			1
CA-4	Fossil Fuel Reduction	*1 -*	*2*	0			2
CA-5	Equipment Emission Reduction	*1 -*	*2*	0			2
CA-6	Paving Emission Reduction		*1*	1			1
CA-7	Water Use Tracking		*2*	2	2		
CA-8	Contractor Warranty		*3*	0			3

Materials & Resources (MR)		MR Subtotal:	23	12	4	6	13
				Econ	Raw	NA	Rem
MR-1	Lifecycle Assessment		*2*	0			2
MR-2	Pavement Reuse	*4-*	*5*	4	2	1	2
MR-3	Earthwork Balance		*1*	1			1
MR-4	Recycled Materials	*1 -*	*5*	2	2		3
MR-5	Regional Materials	*1 -*	*5*	5			5
MR-6	Energy Efficiency		*5*	0		5	

Pavement Technologies (PT)		PT Subtotal:	20	10	0	8	12
				Econ	Raw	NA	Rem
PT-1	Long-Life Pavement		*5*	5			5
PT-2	Permeable Pavement		*3*	0		3	
PT-3	Warm Mix Asphalt		*3*	3			3
PT-4	Cool Pavement		*5*	0		5	
PT-5	Quiet Pavement	*2 -*	*3*	2			3
PT-6	Pavement Performance Tracking		*1*	0			1

Custom Credit (CC)		CC Subtotal:	10	10	1	0	9
				Econ	Raw	NA	Rem
CC-1	Freight Mobility	*1 -*	*5*	5			5
CC-2	Workzone Safety	*1 -*	*5*	2	1		1
CC-3	Regional Employees	*1 -*	*2*	2			2
CC-4	Sustainability Cost Tracking	*1 -*	*2*	2			2
CC-5	Anti-Idling Policy		*1*	1			1
CC-6	FSC Certified Wood		*1*	1			1
CC-7	Vegetation Reuse		*1*	1			1
CC-8	Habitat Creation		*3*	3			3
CC-9	Non-Potable Water Use		*1*	1			1
CC-10	Aesthetics		*1*	1			1

	All 11 PR Met?			Yes	No		
	Greenroads Total	of	118	**68**	**24**	**26**	**68**

APPENDIX C: RAW DATA

Raw Scores - Documented or Evident Activities

No.	Title	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
Project Requirements (PR)		**5**	**5**	**5**	**5**	**5**	**6**	**9**	**9**	**9**	**9**	**9**	**6**	**5**	**5**	**3**	**3**	**6**	**6**	**7**	**7**
Total Raw Score		**20**	**25**	**39**	**21**	**19**	**27**	**30**	**30**	**30**	**30**	**30**	**38**	**25**	**18**	**30**	**23**	**24**	**21**	**25**	**22**
Environment & Water (EW)		**9**	**0**	**9**	**1**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**3**	**5**	**4**	**6**	**6**	**4**	**3**
Access & Equity (AE)		**4**	**12**	**16**	**7**	**7**	**16**	**5**	**5**	**5**	**5**	**5**	**20**	**15**	**13**	**11**	**11**	**12**	**7**	**11**	**8**
Construction Activities (CA)		**1**	**3**	**3**	**3**	**3**	**0**	**10**	**10**	**10**	**10**	**10**	**1**	**1**	**1**	**4**	**2**	**1**	**1**	**1**	**0**
Materials & Resources (MR)		**6**	**10**	**11**	**10**	**9**	**0**	**7**	**7**	**7**	**7**	**7**	**6**	**9**	**1**	**10**	**3**	**5**	**7**	**9**	**6**
Pavement Technologies (PT)		**0**	**0**	**0**	**0**	**0**	**5**	**8**	**8**	**8**	**8**	**8**	**5**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**5**
PR-1	Environmental Review Process	x	0	x	x	x	x	0	0	0	0	0	x	x	x	0	0	x	x	x	x
PR-2	Lifecycle Cost Analysis	0	x	0	0	0	x	x	x	x	x	x	0	0	0	0	0	0	0	0	x
PR-3	Lifecycle Inventory	0	0	0	0	0	0	x	x	x	x	x	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	x	x	x	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-5	Noise Mitigation Plan	0	0	0	0	0	0	x	x	x	x	x	0	0	0	0	0	0	x	x	x
PR-6	Waste Management Plan	0	0	0	0	0	x	x	x	x	x	x	0	0	0	0	0	0	0	0	0
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-8	Low-Impact Development	x	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	0
PR-9	Pavement Management System	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	0	0	0	x	0	0	x
PR-11	Educational Outreach	0	0	0	0	0	0	x	x	x	x	x	x	0	x	0	0	x	0	x	0
EW-1	Environmental Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
EW-2	Runoff Flow Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-3	Runoff Quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-4	Stormwater Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	3	0	3	0	0	3	0	0	0	0	0	3	0	3	3	3	3	3	3	3
EW-6	Habitat Restoration	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
EW-7	Ecological Connectivity	3	0	3	1	0	3	0	0	0	0	0	3	0	0	0	1	0	3	1	0
EW-8	Light Pollution	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-1	Safety Audit	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	0	0	0	0	0	5	0	0	0	0	0	3	3	0	0	0	0	0	2	2
AE-3	Context Sensitive Solutions	0	5	5	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AE-4	Traffic Emissions Reduction	0	5	5	5	5	5	0	0	0	0	0	5	5	5	5	0	0	0	0	0
AE-5	Pedestrian Access	2	0	0	0	0	1	0	0	0	0	0	2	1	2	0	1	2	0	0	0
AE-6	Bicycle Access	2	1	2	2	2	0	0	0	0	0	0	2	1	0	0	1	1	0	0	0
AE-7	Transit & HOV Access	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
AE-8	Scenic Views	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	2	2	2	2	0
AE-9	Cultural Outreach	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	2	2	0	0	1
CA-1	Quality Management System	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	0
CA-3	Site Recycling Plan	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	1	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	2	2	2	2	2	0	0	0	2	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	0	5	4	4	4	0	4	4	4	4	4	0	4	0	5	0	0	4	4	4
MR-3	Earthwork Balance	1	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0
MR-4	Recycled Materials	0	0	1	0	0	0	0	0	0	0	0	3	2	0	2	1	2	0	0	0
MR-5	Regional Materials	5	5	5	5	5	0	3	3	3	3	3	3	3	0	2	1	2	2	5	2
MR-6	Energy Efficiency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	5	5	5	5	5	5	5	0	0	0	0	0	0	0	5
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-3	Warm Mix Asphalt	0	0	0	0	0	0	3	3	3	3	3	0	0	0	0	3	0	0	0	0
PT-4	Cool Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-5	Quiet Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Raw Scores - Documented or Evident Activities

No.	Title	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
Project Requirements (PR)		**7**	**5**	**6**	**4**	**7**	**3**	**5**	**7**	**6**	**5**	**3**	**3**	**1**	**2**	**3**	**3**	**6**	**8**	**10**	**5**
Max Econ Score		**31**	**25**	**26**	**29**	**29**	**27**	**40**	**30**	**31**	**34**	**32**	**15**	**15**	**19**	**22**	**14**	**34**	**38**	**37**	**21**
Environment & Water (EW)		**3**	**2**	**5**	**3**	**6**	**0**	**2**	**0**	**4**	**8**	**3**	**0**	**0**	**0**	**0**	**0**	**7**	**2**	**0**	**3**
Access & Equity (AE)		**14**	**14**	**16**	**13**	**16**	**16**	**18**	**15**	**20**	**12**	**12**	**10**	**7**	**12**	**14**	**8**	**10**	**25**	**19**	**7**
Construction Activities (CA)		**1**	**0**	**0**	**3**	**0**	**0**	**1**	**1**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**	**1**
Materials & Resources (MR)		**10**	**9**	**5**	**10**	**7**	**9**	**9**	**9**	**6**	**12**	**12**	**5**	**8**	**7**	**8**	**6**	**11**	**9**	**11**	**10**
Pavement Technologies (PT)		**3**	**0**	**0**	**0**	**0**	**2**	**10**	**5**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**5**	**0**
PR-1	Environmental Review Process	x	x	x	x	x	0	x	x	x	x	0	0	0	0	0	0	x	x	x	0
PR-2	Lifecycle Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	0
PR-3	Lifecycle Inventory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	0	0	0	x	0	0	x	x	x	0	0	0	0	0	0	0	x	x	x
PR-5	Noise Mitigation Plan	x	0	0	x	x	0	x	x	x	0	0	0	0	0	0	0	x	0	x	0
PR-6	Waste Management Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	x	x	x	x	x	x	0	x	x	x	x	x	x	x
PR-8	Low-Impact Development	x	x	x	0	x	0	0	x	0	0	0	0	0	0	0	0	x	x	x	0
PR-9	Pavement Management System	x	x	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	x	x	x	x	x	x	x	x	x	x	x	0	0	x	x	x	x	x	x
PR-11	Educational Outreach	x	0	x	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	0
EW-1	Environmental Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	3	1	3	0	1	0	0	0	0	1	0	0	0	0	0	0	2	1	0	0
EW-3	Runoff Quality	0	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	2	1	0	0
EW-4	Stormwater Cost Analysis	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	0	0	0	3	3	0	2	0	3	3	3	0	0	0	0	0	3	0	0	3
EW-6	Habitat Restoration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-7	Ecological Connectivity	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0
EW-8	Light Pollution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-1	Safety Audit	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	0	0	2	3	3	5	5	5	3	2	2	0	2	2	2	2	0	5	2	0
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	0	5	5	5	0
AE-4	Traffic Emissions Reduction	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AE-5	Pedestrian Access	2	2	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	2	2	2
AE-6	Bicycle Access	2	2	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0
AE-7	Transit & HOV Access	0	0	0	0	3	0	3	0	3	0	0	0	0	0	0	0	0	4	3	0
AE-8	Scenic Views	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-9	Cultural Outreach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	0
CA-1	Quality Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	1	1	0
CA-3	Site Recycling Plan	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	1	0	0	1	0	0	1	0	1	1	1	0	0	0	0	0	1	0	1	1
CA-7	Water Use Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	5	4	0	5	0	4	4	4	0	5	5	5	5	5	5	4	4	4	4	5
MR-3	Earthwork Balance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-4	Recycled Materials	0	0	0	0	2	0	0	0	1	2	2	0	0	0	0	0	2	0	2	0
MR-5	Regional Materials	5	5	5	5	5	5	5	5	5	5	5	0	3	2	3	2	5	5	5	5
MR-6	Energy Efficiency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5	0
PT-2	Permeable Pavement	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-3	Warm Mix Asphalt	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
PT-4	Cool Pavement	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0	0	5	0	0	0
PT-5	Quiet Pavement	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Raw Scores - Documented or Evident Activities

No.	Title	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
Project Requirements (PR)		**7**	**6**	**4**	**4**	**5**	**4**	**9**	**5**	**5**	**5**	**5**	**10**	**1**	**5**	**10**	**5**	**4**	**4**	**4**	**5**
Total Raw Score		**45**	**29**	**27**	**25**	**24**	**27**	**33**	**47**	**19**	**29**	**21**	**38**	**12**	**14**	**44**	**21**	**14**	**23**	**22**	**26**
Environment & Water (EW)		**11**	**9**	**0**	**2**	**3**	**0**	**6**	**14**	**0**	**2**	**6**	**4**	**0**	**1**	**7**	**0**	**0**	**0**	**0**	**5**
Access & Equity (AE)		**19**	**10**	**10**	**12**	**9**	**10**	**9**	**16**	**11**	**12**	**11**	**16**	**12**	**10**	**11**	**6**	**5**	**8**	**7**	**12**
Construction Activities (CA)		**0**	**0**	**2**	**1**	**0**	**2**	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**
Materials & Resources (MR)		**5**	**5**	**10**	**10**	**12**	**5**	**12**	**15**	**8**	**5**	**4**	**5**	**0**	**3**	**15**	**10**	**9**	**5**	**5**	**9**
Pavement Technologies (PT)		**10**	**5**	**5**	**0**	**0**	**10**	**3**	**0**	**0**	**10**	**0**	**13**	**0**	**0**	**8**	**5**	**0**	**10**	**10**	**0**
PR-1	Environmental Review Process	x	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-2	Lifecycle Cost Analysis	0	0	0	0	0	0	x	0	0	x	0	x	0	0	x	0	0	0	0	0
PR-3	Lifecycle Inventory	0	0	0	0	0	0	x	0	0	0	0	x	0	0	x	0	0	0	0	0
PR-4	Quality Control Plan	x	x	x	0	0	0	x	0	x	0	0	x	0	0	0	x	0	0	0	0
PR-5	Noise Mitigation Plan	0	x	0	0	0	0	x	0	0	0	0	x	0	0	x	0	0	0	0	0
PR-6	Waste Management Plan	0	0	0	0	0	0	x	0	0	0	0	x	0	0	x	0	0	0	0	0
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	x	x	x	x	x	x	0	x	x	x	x	x	x	x
PR-8	Low-Impact Development	x	x	0	0	x	0	x	x	0	0	x	x	0	x	x	0	0	0	0	x
PR-9	Pavement Management System	x	x	x	x	x	x	0	x	x	x	x	x	0	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	0	x	x	x	0	0	x	x	x	x	x	0	x	x	x	x	x	x	x
PR-11	Educational Outreach	x	0	0	0	0	x	x	0	0	0	0	0	0	0	x	0	0	0	0	0
EW-1	Environmental Management System	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	3	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1
EW-3	Runoff Quality	1	0	0	1	1	0	2	0	0	1	2	0	0	0	2	0	0	0	0	1
EW-4	Stormwater Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	3	3	0	0	1	0	1	3	0	0	3	1	0	0	1	0	0	0	0	3
EW-6	Habitat Restoration	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
EW-7	Ecological Connectivity	1	3	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0
EW-8	Light Pollution	3	3	0	0	0	0	3	3	0	0	0	3	0	0	3	0	0	0	0	0
AE-1	Safety Audit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	2	0	0	0	0	2	0	3	0	3	0	5	0	0	0	0	0	2	2	2
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AE-4	Traffic Emissions Reduction	5	0	0	5	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
AE-5	Pedestrian Access	2	2	2	2	2	0	2	2	1	1	1	2	2	2	2	1	0	0	0	2
AE-6	Bicycle Access	2	2	1	0	2	0	2	2	0	1	2	2	2	2	2	0	0	0	0	2
AE-7	Transit & HOV Access	3	0	2	0	0	3	0	3	0	2	3	0	3	0	0	0	0	0	0	0
AE-8	Scenic Views	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0
AE-9	Cultural Outreach	0	1	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	1	0	1
CA-1	Quality Management System	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-3	Site Recycling Plan	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	0	0	5	5	4	0	5	3	3	0	4	0	0	3	4	5	4	0	0	4
MR-3	Earthwork Balance	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-4	Recycled Materials	0	0	0	0	1	0	2	2	0	0	0	0	0	0	3	0	0	0	0	0
MR-5	Regional Materials	0	4	5	5	2	5	0	5	5	5	0	0	0	0	5	5	5	5	5	5
MR-6	Energy Efficiency	5	0	0	0	5	0	5	5	0	0	0	5	0	0	3	0	0	0	0	0
PT-1	Long-Life Pavement	5	5	5	0	0	5	0	0	0	5	0	5	0	0	5	5	0	5	5	0
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0
PT-3	Warm Mix Asphalt	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-4	Cool Pavement	5	0	0	0	0	5	0	0	0	5	0	5	0	0	0	0	0	5	5	0
PT-5	Quiet Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Raw Scores - Documented or Evident Activities

No.	Title	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179
Project Requirements (PR)		**5**	**7**	**5**	**10**	**4**	**7**	**5**	**2**	**4**	**5**	**8**	**7**	**5**	**6**	**6**	**4**	**4**	**9**	**2**	**8**
Total Raw Score		**26**	**25**	**27**	**45**	**13**	**19**	**38**	**12**	**14**	**23**	**23**	**40**	**32**	**28**	**20**	**26**	**18**	**42**	**16**	**26**
Environment & Water (EW)		**6**	**5**	**5**	**8**	**0**	**1**	**4**	**0**	**2**	**6**	**3**	**9**	**9**	**10**	**7**	**6**	**3**	**8**	**1**	**2**
Access & Equity (AE)		**17**	**13**	**18**	**16**	**6**	**13**	**16**	**9**	**7**	**16**	**14**	**15**	**10**	**9**	**9**	**7**	**9**	**18**	**5**	**13**
Construction Activities (CA)		**0**	**2**	**0**	**12**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**3**	**0**	**0**	**1**	**0**	**1**	**3**	**1**	**2**
Materials & Resources (MR)		**3**	**5**	**2**	**4**	**7**	**0**	**12**	**3**	**5**	**1**	**4**	**8**	**0**	**9**	**3**	**10**	**0**	**3**	**9**	**9**
Pavement Technologies (PT)		**0**	**0**	**2**	**5**	**0**	**5**	**5**	**0**	**0**	**0**	**0**	**5**	**13**	**0**	**0**	**3**	**5**	**10**	**0**	**0**
PR-1	Environmental Review Process	x	x	x	0	x	x	0	0	0	x	x	x	x	x	x	x	x	x	x	x
PR-2	Lifecycle Cost Analysis	0	0	0	x	x	x	0	0	0	0	0	0	0	x	0	x	0	x	0	x
PR-3	Lifecycle Inventory	0	0	0	x	0	0	0	0	0	0	0	0	0	x	0	0	0	0	0	0
PR-4	Quality Control Plan	0	x	0	x	0	x	x	0	0	0	x	x	0	0	x	x	x	x	0	x
PR-5	Noise Mitigation Plan	x	x	0	x	0	x	x	0	0	0	x	x	0	0	x	0	0	x	0	x
PR-6	Waste Management Plan	0	x	0	x	0	0	0	0	0	0	0	0	0	0	0	0	0	x	0	x
PR-7	Pollution Prevention Plan	x	x	x	x	0	x	x	0	x	x	x	x	x	x	x	x	x	x	x	x
PR-8	Low-Impact Development	0	0	0	x	0	0	0	0	x	x	x	x	x	x	0	0	0	0	0	0
PR-9	Pavement Management System	x	x	x	x	x	x	x	x	x	x	x	x	x	0	x	0	x	x	0	x
PR-10	Site Maintenance Plan	x	x	x	x	x	0	0	x	x	x	x	x	x	0	x	0	0	x	0	x
PR-11	Educational Outreach	0	0	x	x	0	x	x	0	0	0	x	0	0	x	0	0	0	x	0	0
EW-1	Environmental Management System	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
EW-2	Runoff Flow Control	0	1	0	2	0	0	0	0	1	1	1	2	2	2	1	0	0	0	0	0
EW-3	Runoff Quality	0	1	0	2	0	0	0	0	1	2	0	2	3	2	2	0	0	0	0	0
EW-4	Stormwater Cost Analysis	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	3	3	2	1	0	1	0	0	0	0	1	2	0	3	3	3	0	0	0	2
EW-6	Habitat Restoration	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
EW-7	Ecological Connectivity	0	0	3	0	0	0	0	0	0	3	1	3	1	0	1	3	3	0	1	0
EW-8	Light Pollution	0	0	0	0	0	0	3	0	0	0	0	0	3	3	0	0	0	3	0	0
AE-1	Safety Audit	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	5	2	2	3	0	0	5	0	0	2	3	5	0	0	0	0	0	5	0	0
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AE-4	Traffic Emissions Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-5	Pedestrian Access	2	2	2	2	1	2	1	1	2	2	1	2	2	0	2	0	2	2	0	2
AE-6	Bicycle Access	1	2	2	2	0	2	1	1	0	2	1	2	1	0	0	0	2	2	0	2
AE-7	Transit & HOV Access	3	0	3	2	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	3
AE-8	Scenic Views	0	0	2	0	0	2	1	0	0	2	2	0	0	2	2	2	0	2	0	0
AE-9	Cultural Outreach	1	2	2	2	0	2	2	0	0	0	1	0	2	2	0	0	0	2	0	1
CA-1	Quality Management System	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
CA-2	Environmental Training	0	1	0	1	0	0	1	0	0	0	0	1	0	0	1	0	1	1	1	0
CA-3	Site Recycling Plan	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	2	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	0	2	2	0	4	0	0	3	5	0	2	1	0	0	3	5	0	0	3	5
MR-3	Earthwork Balance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
MR-4	Recycled Materials	0	1	0	2	3	0	2	0	0	1	2	2	0	0	0	2	0	3	0	0
MR-5	Regional Materials	3	2	0	2	0	0	5	0	0	0	0	5	0	4	0	2	0	0	5	4
MR-6	Energy Efficiency	0	0	0	0	0	0	5	0	0	0	0	0	0	5	0	0	0	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	5	5	0	0
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0	0
PT-3	Warm Mix Asphalt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-4	Cool Pavement	0	0	0	5	0	5	5	0	0	0	0	0	5	0	0	0	0	5	0	0
PT-5	Quiet Pavement	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Raw Scores - Documented or Evident Activities

No.	Title	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199
Project Requirements (PR)		**5**	**11**	**6**	**4**	**5**	**6**	**1**	**1**	**7**	**8**	**7**	**4**	**9**	**6**	**3**	**5**	**3**	**1**	**5**	**1**
Total Raw Score		**25**	**37**	**35**	**16**	**21**	**29**	**17**	**16**	**35**	**28**	**21**	**20**	**35**	**23**	**17**	**21**	**7**	**18**	**18**	**12**
Environment & Water (EW)		**0**	**2**	**8**	**3**	**6**	**11**	**0**	**0**	**8**	**13**	**0**	**3**	**9**	**8**	**7**	**6**	**2**	**0**	**6**	**0**
Access & Equity (AE)		**10**	**20**	**15**	**11**	**13**	**11**	**11**	**7**	**10**	**13**	**15**	**11**	**17**	**14**	**5**	**11**	**0**	**15**	**7**	**7**
Construction Activities (CA)		**4**	**5**	**4**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Materials & Resources (MR)		**11**	**4**	**3**	**0**	**1**	**1**	**6**	**9**	**11**	**1**	**5**	**0**	**8**	**1**	**0**	**4**	**5**	**3**	**0**	**5**
Pavement Technologies (PT)		**0**	**6**	**5**	**0**	**0**	**5**	**0**	**0**	**5**	**0**	**0**	**5**	**0**	**0**	**5**	**0**	**0**	**0**	**5**	**0**
PR-1	Environmental Review Process	x	x	x	0	x	x	0	0	x	x	x	x	x	x	0	x	0	0	0	0
PR-2	Lifecycle Cost Analysis	0	x	x	x	0	x	0	0	x	0	x	0	0	0	0	0	0	0	x	0
PR-3	Lifecycle Inventory	0	x	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	x	0	x	x	0	0	0	x	x	x	0	x	0	0	0	0	0	x	0
PR-5	Noise Mitigation Plan	0	x	0	0	0	0	0	0	0	x	x	0	x	0	0	0	0	0	0	0
PR-6	Waste Management Plan	x	x	0	x	0	0	0	0	0	x	0	0	x	0	0	0	0	0	0	0
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	0	0	x	x	x	x	x	x	x	x	x	0	x	0
PR-8	Low-Impact Development	0	x	x	0	x	x	0	0	x	x	0	0	x	x	0	x	0	0	x	0
PR-9	Pavement Management System	x	x	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	x	x	0	0	0	0	0	0	0	0	0	x	x	x	x	x	0	0	0
PR-11	Educational Outreach	0	x	0	0	0	x	0	0	x	x	x	x	x	x	0	0	0	0	0	0
EW-1	Environmental Management System	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	0	0	2	0	0	2	0	0	2	3	0	0	1	3	0	1	0	0	1	0
EW-3	Runoff Quality	0	0	2	0	1	3	0	0	2	3	0	0	1	3	0	0	0	0	1	0
EW-4	Stormwater Cost Analysis	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	0	2	2	3	0	3	0	0	0	1	0	0	3	2	1	1	1	0	0	0
EW-6	Habitat Restoration	0	0	0	0	0	0	0	0	0	3	0	0	3	0	3	3	0	0	3	0
EW-7	Ecological Connectivity	0	0	0	0	0	0	0	0	0	3	0	3	1	0	3	1	1	0	1	0
EW-8	Light Pollution	0	0	0	0	3	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0
AE-1	Safety Audit	0	2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	2	5	5	0	0	0	5	2	0	3	5	0	2	0	0	0	0	2	0	2
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	5
AE-4	Traffic Emissions Reduction	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
AE-5	Pedestrian Access	1	2	1	2	2	2	1	0	0	1	2	2	2	2	0	2	0	2	0	0
AE-6	Bicycle Access	0	2	2	0	2	2	0	0	0	1	2	2	1	2	0	2	0	2	2	0
AE-7	Transit & HOV Access	0	0	0	0	2	0	0	0	0	1	0	0	2	3	0	0	0	2	0	0
AE-8	Scenic Views	1	2	2	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
AE-9	Cultural Outreach	1	2	0	2	2	2	0	0	0	2	0	2	2	2	0	2	0	2	0	0
CA-1	Quality Management System	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
CA-3	Site Recycling Plan	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	5	0	0	0	0	0	5	5	5	0	5	0	5	0	0	2	5	3	0	5
MR-3	Earthwork Balance	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0
MR-4	Recycled Materials	2	2	2	0	0	0	1	4	3	0	0	0	2	1	0	2	0	0	0	0
MR-5	Regional Materials	4	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
MR-6	Energy Efficiency	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-1	Long-Life Pavement	0	5	5	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-3	Warm Mix Asphalt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-4	Cool Pavement	0	0	0	0	0	5	0	0	0	0	0	5	0	0	5	0	0	0	5	0
PT-5	Quiet Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-6	Pavement Performance Tracking	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Raw Scores - Documented or Evident Activities

No.	Title	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219
Project Requirements (PR)		**3**	**4**	**4**	**4**	**4**	**4**	**6**	**7**	**7**	**3**	**2**	**5**	**2**	**7**	**6**	**5**	**5**	**5**	**5**	**5**
Total Raw Score		**15**	**36**	**30**	**21**	**22**	**13**	**37**	**42**	**38**	**24**	**27**	**18**	**22**	**34**	**33**	**16**	**21**	**18**	**22**	**21**
Environment & Water (EW)		**0**	**6**	**5**	**3**	**3**	**1**	**10**	**10**	**8**	**0**	**6**	**2**	**9**	**5**	**11**	**1**	**1**	**4**	**5**	**0**
Access & Equity (AE)		**8**	**11**	**14**	**16**	**15**	**12**	**22**	**13**	**11**	**19**	**14**	**16**	**7**	**18**	**13**	**7**	**11**	**14**	**16**	**16**
Construction Activities (CA)		**0**	**7**	**0**	**0**	**0**	**0**	**2**	**9**	**9**	**5**	**3**	**0**	**0**	**1**	**3**	**0**	**0**	**0**	**0**	**1**
Materials & Resources (MR)		**7**	**7**	**11**	**2**	**4**	**0**	**3**	**10**	**10**	**0**	**4**	**0**	**6**	**5**	**6**	**3**	**4**	**0**	**1**	**4**
Pavement Technologies (PT)		**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**5**	**5**	**0**	**0**	**0**
PR-1	Environmental Review Process	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-2	Lifecycle Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	x	0	0	0
PR-3	Lifecycle Inventory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	0	0	0	0	0	x	x	x	0	0	0	0	0	0	0	0	0	0	0
PR-5	Noise Mitigation Plan	0	0	0	0	0	0	0	x	x	0	x	0	0	x	0	0	0	0	0	0
PR-6	Waste Management Plan	0	0	0	0	0	0	0	x	x	0	0	0	0	x	0	0	0	0	0	0
PR-7	Pollution Prevention Plan	0	x	x	x	x	x	x	0	0	0	0	x	0	x	x	x	x	x	x	x
PR-8	Low-Impact Development	0	x	x	0	x	0	x	x	x	0	0	x	0	x	x	0	0	x	x	x
PR-9	Pavement Management System	x	x	x	x	x	x	x	x	x	x	0	x	0	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	0	0	0	0	0	x	0	x	x	x	0	0	x	x	0	0	0	0	0	0
PR-11	Educational Outreach	x	0	0	x	0	0	x	0	0	0	0	x	0	0	x	x	x	x	x	x
EW-1	Environmental Management System	0	2	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	0	0	1	0	0	0	2	0	0	0	0	1	2	2	1	0	0	2	1	0
EW-3	Runoff Quality	0	1	1	0	0	0	2	0	0	0	0	1	3	2	2	0	0	2	1	0
EW-4	Stormwater Cost Analysis	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
EW-5	Site Vegetation	0	2	0	0	3	1	3	2	2	0	0	0	3	1	1	0	0	0	0	0
EW-6	Habitat Restoration	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0
EW-7	Ecological Connectivity	0	0	0	0	0	0	3	3	1	0	3	0	1	0	0	1	1	0	3	0
EW-8	Light Pollution	0	0	3	0	0	0	0	3	3	0	0	0	0	0	3	0	0	0	0	0
AE-1	Safety Audit	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	0
AE-2	Intelligent Transportation Systems	2	2	5	5	0	2	5	3	3	5	0	5	0	5	0	0	0	4	2	2
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5	5	5
AE-4	Traffic Emissions Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-5	Pedestrian Access	0	2	2	2	2	2	2	2	1	2	2	2	0	2	2	0	0	1	2	2
AE-6	Bicycle Access	0	0	1	2	2	2	2	2	1	2	2	0	0	2	2	2	2	1	2	2
AE-7	Transit & HOV Access	0	0	0	0	3	0	3	0	0	0	3	2	3	2	3	0	0	2	0	3
AE-8	Scenic Views	0	0	0	0	1	0	2	0	0	2	2	0	2	0	0	0	2	1	2	0
AE-9	Cultural Outreach	1	1	1	2	2	1	2	0	0	2	0	2	2	2	1	0	2	0	2	2
CA-1	Quality Management System	0	2	0	0	0	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
CA-3	Site Recycling Plan	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	3	0	0	0	0	0	3	3	3	3	0	0	0	3	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	5	5	5	2	4	0	0	0	0	0	4	0	5	5	0	0	0	0	0	4
MR-3	Earthwork Balance	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0
MR-4	Recycled Materials	2	2	1	0	0	0	2	2	2	0	0	0	0	0	0	3	4	0	0	0
MR-5	Regional Materials	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0
MR-6	Energy Efficiency	0	0	5	0	0	0	0	5	5	0	0	0	0	0	5	0	0	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-3	Warm Mix Asphalt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-4	Cool Pavement	0	5	0	0	0	0	0	0	0	0	0	0	0	5	0	5	5	0	0	0
PT-5	Quiet Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NA Scores - Out of Context for Project

No.	Title	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
Project Requirements (PR)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total NA Score		**22**	**18**	**15**	**23**	**24**	**14**	**33**	**33**	**33**	**33**	**33**	**15**	**20**	**25**	**23**	**25**	**32**	**25**	**10**	**16**
Environment & Water (EW)		**0**	**0**	**0**	**3**	**3**	**0**	**6**	**6**	**6**	**6**	**6**	**0**	**3**	**5**	**3**	**5**	**9**	**3**	**1**	**0**
Access & Equity (AE)		**12**	**12**	**10**	**10**	**10**	**9**	**19**	**19**	**19**	**19**	**19**	**5**	**7**	**10**	**10**	**10**	**10**	**12**	**4**	**16**
Construction Activities (CA)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**
Materials & Resources (MR)		**5**	**1**	**0**	**5**	**6**	**5**	**0**	**0**	**0**	**0**	**0**	**10**	**7**	**5**	**5**	**5**	**5**	**5**	**0**	**0**
Pavement Technologies (PT)		**5**	**5**	**5**	**5**	**5**	**0**	**8**	**8**	**8**	**8**	**8**	**0**	**3**	**5**	**5**	**5**	**5**	**5**	**5**	**0**
PR-1	Environmental Review Process	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-2	Lifecycle Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-3	Lifecycle Inventory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-5	Noise Mitigation Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-6	Waste Management Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-7	Pollution Prevention Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-8	Low-Impact Development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-9	Pavement Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-10	Site Maintenance Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-11	Educational Outreach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-1	Environmental Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
EW-2	Runoff Flow Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-3	Runoff Quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
EW-4	Stormwater Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-6	Habitat Restoration	0	0	0	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0
EW-7	Ecological Connectivity	0	0	0	0	0	0	3	3	3	3	3	0	3	2	0	2	3	0	0	0
EW-8	Light Pollution	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3	3	3	3	0	0
AE-1	Safety Audit	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	3	3	3	3	3	0	5	5	5	5	5	0	0	5	5	5	5	5	2	0
AE-3	Context Sensitive Solutions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-4	Traffic Emissions Reduction	0	0	0	0	0	0	5	5	5	5	5	0	0	0	0	0	0	0	0	5
AE-5	Pedestrian Access	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
AE-6	Bicycle Access	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	2
AE-7	Transit & HOV Access	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	2	5
AE-8	Scenic Views	2	2	0	0	0	2	2	2	2	2	2	0	2	0	0	0	0	0	0	2
AE-9	Cultural Outreach	0	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0
CA-1	Quality Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-3	Site Recycling Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	5	0	0	0	0	5	0	0	0	0	0	5	1	0	0	0	0	0	0	0
MR-3	Earthwork Balance	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
MR-4	Recycled Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-5	Regional Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-6	Energy Efficiency	0	0	0	5	5	0	0	0	0	0	0	5	5	5	5	5	5	5	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
PT-3	Warm Mix Asphalt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-4	Cool Pavement	5	5	5	5	5	0	5	5	5	5	5	0	0	5	5	5	5	5	5	0
PT-5	Quiet Pavement	0	0	0	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NA Scores - Out of Context for Project

No.	Title	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
Project Requirements (PR)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Max Econ Score		**17**	**24**	**33**	**29**	**13**	**10**	**8**	**18**	**7**	**18**	**27**	**32**	**13**	**21**	**10**	**8**	**2**	**13**	**15**	**24**
Environment & Water (EW)		**6**	**4**	**10**	**6**	**2**	**2**	**0**	**5**	**0**	**0**	**5**	**5**	**0**	**3**	**0**	**0**	**0**	**3**	**4**	**3**
Access & Equity (AE)		**7**	**12**	**9**	**10**	**6**	**8**	**7**	**11**	**2**	**12**	**11**	**15**	**7**	**7**	**5**	**2**	**2**	**2**	**3**	**12**
Construction Activities (CA)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Materials & Resources (MR)		**1**	**0**	**6**	**5**	**0**	**0**	**0**	**1**	**0**	**1**	**6**	**1**	**1**	**6**	**0**	**1**	**0**	**0**	**0**	**1**
Pavement Technologies (PT)		**3**	**8**	**8**	**8**	**5**	**0**	**1**	**1**	**5**	**5**	**5**	**11**	**5**	**5**	**5**	**5**	**0**	**8**	**8**	**8**
PR-1	Environmental Review Process	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-2	Lifecycle Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-3	Lifecycle Inventory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-5	Noise Mitigation Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-6	Waste Management Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-7	Pollution Prevention Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-8	Low-Impact Development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-9	Pavement Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-10	Site Maintenance Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-11	Educational Outreach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-1	Environmental Management System	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-3	Runoff Quality	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
EW-4	Stormwater Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-6	Habitat Restoration	3	2	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
EW-7	Ecological Connectivity	3	2	3	2	2	2	0	2	0	0	2	2	0	0	0	0	0	3	3	3
EW-8	Light Pollution	0	0	0	3	0	0	0	0	0	0	3	3	0	3	0	0	0	0	0	0
AE-1	Safety Audit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	0	5	3	2	0	0	0	0	0	3	2	5	0	0	0	0	0	0	0	5
AE-3	Context Sensitive Solutions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-4	Traffic Emissions Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-5	Pedestrian Access	0	0	0	2	1	2	2	2	0	2	2	2	2	2	0	0	0	0	0	0
AE-6	Bicycle Access	0	0	0	2	1	2	2	2	0	2	2	2	0	0	0	0	0	0	0	0
AE-7	Transit & HOV Access	5	5	4	2	2	2	1	5	0	5	5	5	5	5	5	0	0	0	1	5
AE-8	Scenic Views	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2	2	2
AE-9	Cultural Outreach	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
CA-1	Quality Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-3	Site Recycling Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-3	Earthwork Balance	1	0	1	0	0	0	0	1	0	1	1	1	1	1	0	1	0	0	0	1
MR-4	Recycled Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-5	Regional Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-6	Energy Efficiency	0	0	0	5	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0
PT-3	Warm Mix Asphalt	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
PT-4	Cool Pavement	0	5	5	5	5	0	0	0	5	5	5	5	5	5	5	5	0	5	5	5
PT-5	Quiet Pavement	3	3	3	3	0	0	1	1	0	0	0	0	0	0	0	0	0	3	0	3
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NA Scores - Out of Context for Project

No.	Title	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
Project Requirements (PR)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total NA Score		**9**	**21**	**24**	**23**	**25**	**34**	**25**	**5**	**14**	**19**	**21**	**15**	**19**	**13**	**24**	**26**	**23**	**1**	**14**	**9**
Environment & Water (EW)		**0**	**0**	**5**	**6**	**2**	**10**	**2**	**0**	**5**	**6**	**5**	**3**	**2**	**0**	**5**	**5**	**5**	**0**	**5**	**0**
Access & Equity (AE)		**2**	**10**	**10**	**8**	**13**	**8**	**11**	**2**	**3**	**9**	**7**	**8**	**10**	**11**	**11**	**12**	**9**	**0**	**2**	**4**
Construction Activities (CA)		**0**	**0**	**0**	**0**	**0**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Materials & Resources (MR)		**0**	**5**	**1**	**1**	**2**	**6**	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**
Pavement Technologies (PT)		**7**	**6**	**8**	**8**	**8**	**7**	**8**	**3**	**5**	**3**	**8**	**3**	**6**	**1**	**8**	**8**	**8**	**1**	**7**	**5**
PR-1	Environmental Review Process	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-2	Lifecycle Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-3	Lifecycle Inventory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-5	Noise Mitigation Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-6	Waste Management Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-7	Pollution Prevention Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-8	Low-Impact Development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-9	Pavement Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-10	Site Maintenance Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-11	Educational Outreach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-1	Environmental Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-3	Runoff Quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-4	Stormwater Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-6	Habitat Restoration	0	0	3	3	0	3	0	0	3	3	3	0	0	0	3	3	3	0	3	0
EW-7	Ecological Connectivity	0	0	2	3	2	1	2	0	2	3	2	3	2	0	2	2	2	0	2	0
EW-8	Light Pollution	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-1	Safety Audit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	0	0	0	3	3	0	3	0	0	0	0	0	3	3	3	3	2	0	0	0
AE-3	Context Sensitive Solutions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-4	Traffic Emissions Reduction	0	5	5	0	5	0	5	0	0	5	5	5	5	5	5	5	5	0	0	0
AE-5	Pedestrian Access	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-6	Bicycle Access	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-7	Transit & HOV Access	0	5	3	3	3	0	3	0	1	2	0	3	0	3	3	2	2	0	2	2
AE-8	Scenic Views	2	0	2	2	2	2	0	2	2	2	2	0	2	0	0	2	0	0	0	2
AE-9	Cultural Outreach	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-1	Quality Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-3	Site Recycling Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
MR-3	Earthwork Balance	0	0	1	1	0	1	1	0	1	1	1	1	1	0	0	1	1	0	0	0
MR-4	Recycled Materials	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-5	Regional Materials	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-6	Energy Efficiency	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-2	Permeable Pavement	3	3	0	0	0	3	0	3	0	0	0	0	3	0	0	0	3	0	3	0
PT-3	Warm Mix Asphalt	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3	0
PT-4	Cool Pavement	0	0	5	5	5	0	5	0	5	0	5	0	0	0	5	5	5	0	0	5
PT-5	Quiet Pavement	1	3	3	3	3	1	3	0	0	3	3	3	3	1	3	3	0	1	1	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NA Scores - Out of Context for Project

No.	Title	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179
Project Requirements (PR)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total NA Score		**10**	**17**	**10**	**16**	**22**	**2**	**7**	**17**	**30**	**16**	**26**	**18**	**20**	**43**	**31**	**25**	**32**	**11**	**19**	**18**
Environment & Water (EW)		**0**	**0**	**0**	**6**	**2**	**0**	**0**	**6**	**6**	**0**	**0**	**0**	**2**	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Access & Equity (AE)		**2**	**12**	**5**	**3**	**11**	**2**	**2**	**3**	**15**	**5**	**12**	**9**	**12**	**15**	**15**	**15**	**14**	**6**	**11**	**5**
Construction Activities (CA)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Materials & Resources (MR)		**0**	**0**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**3**	**6**	**1**	**0**	**5**	**5**	**5**	**10**	**1**	**0**	**0**
Pavement Technologies (PT)		**8**	**5**	**5**	**6**	**8**	**0**	**4**	**8**	**8**	**8**	**8**	**8**	**6**	**20**	**11**	**5**	**8**	**4**	**8**	**8**
PR-1	Environmental Review Process	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-2	Lifecycle Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-3	Lifecycle Inventory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-5	Noise Mitigation Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-6	Waste Management Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-7	Pollution Prevention Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-8	Low-Impact Development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-9	Pavement Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-10	Site Maintenance Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-11	Educational Outreach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-1	Environmental Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
EW-3	Runoff Quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-4	Stormwater Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-6	Habitat Restoration	0	0	0	3	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0
EW-7	Ecological Connectivity	0	0	0	3	2	0	0	3	3	0	0	0	2	3	0	0	0	0	0	0
EW-8	Light Pollution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-1	Safety Audit	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0
AE-2	Intelligent Transportation Systems	0	0	0	0	0	0	0	0	5	0	0	0	2	5	5	5	3	0	3	3
AE-3	Context Sensitive Solutions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-4	Traffic Emissions Reduction	0	5	5	0	5	0	0	0	5	5	5	5	5	5	5	5	5	0	0	0
AE-5	Pedestrian Access	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0
AE-6	Bicycle Access	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
AE-7	Transit & HOV Access	0	5	0	1	5	2	2	1	3	0	5	3	5	3	5	5	5	4	5	2
AE-8	Scenic Views	2	2	0	2	0	0	0	2	2	0	0	1	0	0	0	0	1	0	0	0
AE-9	Cultural Outreach	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
CA-1	Quality Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-3	Site Recycling Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	0	0	0	0	0	0	0	0	0	3	1	0	0	5	0	0	5	0	0	0
MR-3	Earthwork Balance	0	0	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0	1	0	0
MR-4	Recycled Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-5	Regional Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-6	Energy Efficiency	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5	5	5	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
PT-2	Permeable Pavement	3	0	0	0	3	0	3	0	0	3	3	3	0	3	3	0	3	3	3	3
PT-3	Warm Mix Asphalt	0	0	0	3	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0
PT-4	Cool Pavement	5	5	5	0	5	0	0	5	5	5	5	5	0	5	5	5	5	0	5	5
PT-5	Quiet Pavement	0	0	0	3	0	0	1	3	3	0	0	0	3	3	3	0	0	1	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

NA Scores - Out of Context for Project

No.	Title	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199
Project Requirements (PR)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total NA Score		**16**	**8**	**10**	**38**	**10**	**5**	**19**	**20**	**12**	**8**	**20**	**18**	**20**	**10**	**29**	**15**	**21**	**9**	**23**	**24**
Environment & Water (EW)		**6**	**2**	**0**	**0**	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
Access & Equity (AE)		**2**	**2**	**2**	**17**	**8**	**2**	**11**	**10**	**4**	**3**	**12**	**11**	**7**	**5**	**17**	**10**	**13**	**7**	**10**	**10**
Construction Activities (CA)		**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Materials & Resources (MR)		**0**	**1**	**0**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**5**	**0**	**0**	**0**	**4**	**6**
Pavement Technologies (PT)		**8**	**3**	**8**	**12**	**0**	**3**	**8**	**8**	**8**	**5**	**8**	**7**	**8**	**5**	**7**	**5**	**8**	**0**	**9**	**8**
PR-1	Environmental Review Process	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-2	Lifecycle Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-3	Lifecycle Inventory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-5	Noise Mitigation Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-6	Waste Management Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-7	Pollution Prevention Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-8	Low-Impact Development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-9	Pavement Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-10	Site Maintenance Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-11	Educational Outreach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-1	Environmental Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-3	Runoff Quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-4	Stormwater Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-6	Habitat Restoration	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-7	Ecological Connectivity	3	2	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0
EW-8	Light Pollution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-1	Safety Audit	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	0	0	0	5	0	0	0	0	0	0	0	3	0	0	5	0	3	0	0	0
AE-3	Context Sensitive Solutions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-4	Traffic Emissions Reduction	0	0	0	5	5	0	5	5	0	0	5	5	5	5	5	5	5	5	5	5
AE-5	Pedestrian Access	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-6	Bicycle Access	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-7	Transit & HOV Access	2	2	2	5	2	1	2	5	2	1	5	3	2	0	5	5	5	0	5	5
AE-8	Scenic Views	0	0	0	0	1	1	2	0	2	2	2	0	0	0	0	0	0	2	0	0
AE-9	Cultural Outreach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
CA-1	Quality Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-3	Site Recycling Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
MR-3	Earthwork Balance	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
MR-4	Recycled Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-5	Regional Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-6	Energy Efficiency	0	0	0	5	0	0	0	0	0	0	0	0	5	0	5	0	0	0	0	5
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-2	Permeable Pavement	3	3	3	0	0	3	3	3	3	0	0	3	3	0	3	0	3	0	3	3
PT-3	Warm Mix Asphalt	0	0	0	3	0	0	0	0	0	0	0	3	0	0	3	0	0	0	3	0
PT-4	Cool Pavement	5	0	5	5	0	0	5	5	5	5	5	0	5	5	0	5	5	0	0	5
PT-5	Quiet Pavement	0	0	0	3	0	0	0	0	0	0	3	1	0	0	1	0	0	0	3	0
PT-6	Pavement Performance Tracking	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NA Scores - Out of Context for Project

No.	Title	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219
Project Requirements (PR)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total NA Score		**19**	**17**	**20**	**1**	**9**	**7**	**3**	**18**	**13**	**3**	**8**	**10**	**15**	**11**	**7**	**10**	**19**	**9**	**7**	**15**
Environment & Water (EW)		**0**	**3**	**3**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**
Access & Equity (AE)		**10**	**10**	**9**	**1**	**2**	**2**	**0**	**2**	**2**	**0**	**0**	**2**	**7**	**1**	**2**	**3**	**13**	**6**	**2**	**7**
Construction Activities (CA)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Materials & Resources (MR)		**1**	**0**	**0**	**0**	**0**	**5**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**
Pavement Technologies (PT)		**8**	**4**	**8**	**0**	**5**	**0**	**3**	**11**	**11**	**3**	**8**	**8**	**8**	**7**	**5**	**7**	**3**	**3**	**5**	**8**
PR-1	Environmental Review Process	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-2	Lifecycle Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-3	Lifecycle Inventory	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-4	Quality Control Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-5	Noise Mitigation Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-6	Waste Management Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-7	Pollution Prevention Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-8	Low-Impact Development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-9	Pavement Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-10	Site Maintenance Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PR-11	Educational Outreach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-1	Environmental Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-3	Runoff Quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-4	Stormwater Cost Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-5	Site Vegetation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-6	Habitat Restoration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-7	Ecological Connectivity	0	3	3	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
EW-8	Light Pollution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-1	Safety Audit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-2	Intelligent Transportation Systems	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
AE-3	Context Sensitive Solutions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-4	Traffic Emissions Reduction	5	5	5	0	0	0	0	0	0	0	0	0	5	0	0	0	5	5	0	5
AE-5	Pedestrian Access	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-6	Bicycle Access	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-7	Transit & HOV Access	5	3	2	1	2	2	0	2	2	0	0	2	2	1	2	3	5	1	2	2
AE-8	Scenic Views	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-9	Cultural Outreach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-1	Quality Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-3	Site Recycling Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-6	Paving Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-7	Water Use Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	0	0	0	0	0	5	0	5	0	0	0	0	0	0	0	0	3	0	0	0
MR-3	Earthwork Balance	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-4	Recycled Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-5	Regional Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-6	Energy Efficiency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-2	Permeable Pavement	3	0	0	0	0	0	3	3	3	3	3	3	3	0	0	3	0	3	0	3
PT-3	Warm Mix Asphalt	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0
PT-4	Cool Pavement	5	0	5	0	5	0	0	5	5	0	5	5	5	0	5	0	0	0	5	5
PT-5	Quiet Pavement	0	1	3	0	0	0	0	3	3	0	0	0	0	3	0	1	3	0	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Economical Scores - Potentially Available Based on Context of Project

No.	Title	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
Project Requirements (PR)		**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**
Total Econ Score		**47**	**37**	**37**	**39**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**47**	**48**	**43**	**43**	**43**	**41**	**43**
Environment & Water (EW)		**10**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**9**	**7**	**7**	**7**	**7**	**5**	**5**
Access & Equity (AE)		**14**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**13**
Construction Activities (CA)		**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**7**	**7**	**5**	**5**	**5**	**5**	**6**
Materials & Resources (MR)		**10**	**10**	**10**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**9**	**11**	**11**	**11**	**11**	**11**	**11**
Pavement Technologies (PT)		**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**10**	**11**	**8**	**8**	**8**	**8**	**8**
PR-1	Environmental Review Process	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-2	Lifecycle Cost Analysis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-3	Lifecycle Inventory	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-4	Quality Control Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-5	Noise Mitigation Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-6	Waste Management Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-8	Low-Impact Development	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-9	Pavement Management System	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-11	Educational Outreach	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
EW-1	Environmental Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW-2	Runoff Flow Control	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0
EW-3	Runoff Quality	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0
EW-4	Stormwater Cost Analysis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
EW-5	Site Vegetation	3	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3
EW-6	Habitat Restoration	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
EW-7	Ecological Connectivity	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
EW-8	Light Pollution	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-1	Safety Audit	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
AE-2	Intelligent Transportation Systems	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AE-4	Traffic Emissions Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE-5	Pedestrian Access	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
AE-6	Bicycle Access	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
AE-7	Transit & HOV Access	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
AE-8	Scenic Views	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
AE-9	Cultural Outreach	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-1	Quality Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA-2	Environmental Training	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-3	Site Recycling Plan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-4	Fossil Fuel Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1
CA-5	Equipment Emission Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
CA-6	Paving Emission Reduction	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-7	Water Use Tracking	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-2	Pavement Reuse	4	4	4	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5
MR-3	Earthwork Balance	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MR-4	Recycled Materials	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
MR-5	Regional Materials	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
MR-6	Energy Efficiency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
PT-3	Warm Mix Asphalt	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
PT-4	Cool Pavement	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
PT-5	Quiet Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Economical Scores - Potentially Available Based on Context of Project

No.	Title	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
Project Requirements (PR)		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Max Econ Score		44	44	44	43	43	43	43	43	44	43	43	41	44	44	64	45	44	43	43	44
Environment & Water (EW)		5	5	5	6	6	6	6	6	6	6	6	4	6	6	14	7	7	6	5	6
Access & Equity (AE)		13	13	13	12	12	12	12	12	13	12	12	12	13	13	18	12	12	12	12	12
Construction Activities (CA)		7	7	7	6	6	6	6	6	6	6	6	6	6	6	8	7	6	6	7	7
Materials & Resources (MR)		11	11	11	11	11	11	11	11	11	11	11	11	11	11	12	11	11	11	11	11
Pavement Technologies (PT)		8	8	8	8	8	8	8	8	8	8	8	8	8	8	12	8	8	8	8	8
PR-1	Environmental Review Process	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-2	Lifecycle Cost Analysis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-3	Lifecycle Inventory	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-4	Quality Control Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-5	Noise Mitigation Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-6	Waste Management Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-8	Low-Impact Development	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-9	Pavement Management System	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-11	Educational Outreach	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
EW-1	Environmental Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
EW-2	Runoff Flow Control	0	0	0	1	1	1	1	1	1	1	1	0	1	1	2	1	1	1	1	1
EW-3	Runoff Quality	0	0	0	1	1	1	1	1	1	1	1	0	1	1	2	1	1	1	0	1
EW-4	Stormwater Cost Analysis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
EW-5	Site Vegetation	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	3	3	3	3	3
EW-6	Habitat Restoration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
EW-7	Ecological Connectivity	1	1	1	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	0
EW-8	Light Pollution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
AE-1	Safety Audit	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
AE-2	Intelligent Transportation Systems	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5
AE-4	Traffic Emissions Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
AE-5	Pedestrian Access	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
AE-6	Bicycle Access	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
AE-7	Transit & HOV Access	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2
AE-8	Scenic Views	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2
AE-9	Cultural Outreach	1	1	1	0	0	0	0	0	1	0	0	0	1	1	2	0	0	0	0	0
CA-1	Quality Management System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
CA-2	Environmental Training	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
CA-3	Site Recycling Plan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
CA-4	Fossil Fuel Reduction	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-5	Equipment Emission Reduction	1	1	1	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	1
CA-6	Paving Emission Reduction	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
CA-7	Water Use Tracking	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
MR-2	Pavement Reuse	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5
MR-3	Earthwork Balance	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
MR-4	Recycled Materials	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2
MR-5	Regional Materials	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3
MR-6	Energy Efficiency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
PT-1	Long-Life Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
PT-3	Warm Mix Asphalt	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	3	3	3	3	3
PT-4	Cool Pavement	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5
PT-5	Quiet Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Economical Scores - Potentially Available Based on Context of Project

No.	Title	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
Project Requirements (PR)		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Total Econ Score		51	48	41	41	51	59	58	79	54	67	62	68	57	70	67	60	50	90	57	87
Environment & Water (EW)		10	10	6	6	12	9	15	21	9	9	11	13	17	19	14	13	7	21	4	19
Access & Equity (AE)		15	12	13	13	13	20	16	26	22	17	20	20	16	15	17	16	14	25	11	25
Construction Activities (CA)		7	7	7	7	7	8	6	11	7	7	7	7	7	7	7	7	7	9	9	9
Materials & Resources (MR)		11	11	12	12	11	12	13	13	13	18	13	20	14	13	18	13	12	20	20	20
Pavement Technologies (PT)		8	8	3	3	8	10	8	8	3	16	11	8	3	16	11	11	10	15	13	14
PR-1	Environmental Review Process	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-2	Lifecycle Cost Analysis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-3	Lifecycle Inventory	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-4	Quality Control Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-5	Noise Mitigation Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-6	Waste Management Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-8	Low-Impact Development	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-9	Pavement Management System	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-11	Educational Outreach	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
EW-1	Environmental Management System	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	2
EW-2	Runoff Flow Control	1	1	1	1	2	1	2	3	1	1	3	3	3	3	3	3	1	3	1	3
EW-3	Runoff Quality	1	1	1	1	2	1	2	3	1	1	3	3	3	3	3	3	1	3	1	3
EW-4	Stormwater Cost Analysis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
EW-5	Site Vegetation	3	3	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	3
EW-6	Habitat Restoration	0	0	0	0	0	0	3	3	0	0	0	0	3	3	0	0	0	3	0	3
EW-7	Ecological Connectivity	1	1	0	0	1	0	1	3	0	0	1	0	1	3	1	0	1	3	1	1
EW-8	Light Pollution	3	3	3	3	3	3	3	3	3	3	0	3	3	3	3	3	0	3	0	3
AE-1	Safety Audit	1	1	1	1	1	1	1	2	2	1	2	2	1	1	1	1	1	1	1	2
AE-2	Intelligent Transportation Systems	2	2	2	2	2	5	2	5	5	3	5	5	2	0	2	2	2	5	3	5
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AE-4	Traffic Emissions Reduction	0	0	0	0	0	5	0	5	5	0	0	0	0	0	0	0	0	5	0	5
AE-5	Pedestrian Access	1	1	1	1	1	0	2	2	1	2	2	2	2	2	2	2	1	2	1	2
AE-6	Bicycle Access	1	1	1	1	1	0	2	2	1	2	2	2	2	2	2	2	1	2	1	2
AE-7	Transit & HOV Access	2	0	2	2	2	2	2	3	2	2	2	2	2	2	1	2	2	3	0	2
AE-8	Scenic Views	2	2	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	0	0	0
AE-9	Cultural Outreach	1	0	1	1	1	2	2	2	1	2	2	2	2	2	2	2	0	2	0	2
CA-1	Quality Management System	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	2	2	2
CA-2	Environmental Training	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-3	Site Recycling Plan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-4	Fossil Fuel Reduction	1	1	1	1	1	1	0	2	1	1	1	1	1	1	1	1	1	1	1	1
CA-5	Equipment Emission Reduction	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
CA-6	Paving Emission Reduction	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-7	Water Use Tracking	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CA-8	Contractor Warranty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	2	2
MR-2	Pavement Reuse	5	5	5	5	3	5	5	5	5	5	5	5	2	5	5	5	5	5	5	5
MR-3	Earthwork Balance	1	1	0	0	1	0	1	1	1	1	1	1	0	1	1	1	0	1	1	1
MR-4	Recycled Materials	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
MR-5	Regional Materials	3	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
MR-6	Energy Efficiency	0	0	0	0	0	0	0	0	0	5	0	5	5	0	5	0	0	5	5	5
PT-1	Long-Life Pavement	0	0	0	0	5	5	5	0	0	5	5	0	0	5	5	5	5	5	5	5
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	0	3	3	0	0	3	3	3	0	0	0	3
PT-3	Warm Mix Asphalt	3	3	3	3	3	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3
PT-4	Cool Pavement	5	5	0	0	0	5	0	5	0	5	0	5	0	5	0	0	0	5	5	0
PT-5	Quiet Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Economical Scores - Potentially Available Based on Context of Project

No.	Title	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179
Project Requirements (PR)		**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**
Total Econ Score		**76**	**67**	**73**	**76**	**58**	**91**	**90**	**60**	**56**	**81**	**58**	**65**	**76**	**45**	**56**	**43**	**47**	**90**	**54**	**57**
Environment & Water (EW)		**21**	**21**	**19**	**15**	**12**	**19**	**21**	**13**	**13**	**21**	**16**	**14**	**15**	**13**	**16**	**13**	**13**	**21**	**17**	**14**
Access & Equity (AE)		**19**	**14**	**18**	**18**	**13**	**28**	**27**	**14**	**12**	**23**	**15**	**20**	**15**	**13**	**14**	**12**	**12**	**29**	**9**	**11**
Construction Activities (CA)		**9**	**9**	**9**	**12**	**9**	**11**	**11**	**7**	**7**	**9**	**5**	**9**	**9**	**7**	**7**	**5**	**5**	**9**	**5**	**4**
Materials & Resources (MR)		**17**	**13**	**17**	**18**	**14**	**18**	**17**	**18**	**13**	**18**	**12**	**12**	**21**	**12**	**11**	**13**	**7**	**16**	**13**	**18**
Pavement Technologies (PT)		**10**	**10**	**10**	**13**	**10**	**15**	**14**	**8**	**11**	**10**	**10**	**10**	**16**	**0**	**8**	**0**	**10**	**15**	**10**	**10**
PR-1	Environmental Review Process	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-2	Lifecycle Cost Analysis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-3	Lifecycle Inventory	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-4	Quality Control Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-5	Noise Mitigation Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-6	Waste Management Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-8	Low-Impact Development	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-9	Pavement Management System	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-11	Educational Outreach	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
EW-1	Environmental Management System	2	2	2	2	0	2	2	0	0	2	0	0	2	0	0	0	0	2	0	0
EW-2	Runoff Flow Control	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	0	3	3	3	1
EW-3	Runoff Quality	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	0	3	3	3	2
EW-4	Stormwater Cost Analysis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
EW-5	Site Vegetation	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
EW-6	Habitat Restoration	3	3	3	0	0	3	3	0	0	3	3	0	0	0	3	3	3	3	3	3
EW-7	Ecological Connectivity	3	3	1	0	1	3	3	0	0	3	3	1	0	0	3	3	0	3	1	1
EW-8	Light Pollution	3	3	3	3	3	3	3	3	3	3	0	3	3	3	0	3	0	3	3	3
AE-1	Safety Audit	1	1	1	1	1	2	2	1	1	2	2	1	1	0	1	2	2	1	2	0
AE-2	Intelligent Transportation Systems	5	2	2	3	3	5	5	2	0	5	3	5	2	0	0	0	0	5	0	0
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AE-4	Traffic Emissions Reduction	0	0	0	0	0	5	5	0	0	0	0	0	0	0	0	0	0	5	0	0
AE-5	Pedestrian Access	2	2	2	2	1	2	2	2	2	2	1	2	2	1	2	1	2	2	0	1
AE-6	Bicycle Access	1	2	2	2	1	2	2	2	2	2	1	2	1	1	2	1	2	2	2	1
AE-7	Transit & HOV Access	3	0	2	3	0	3	3	2	2	3	0	2	0	2	0	0	0	5	0	3
AE-8	Scenic Views	0	0	2	0	2	2	1	0	0	2	2	1	2	2	2	2	1	2	0	0
AE-9	Cultural Outreach	2	2	2	2	0	2	2	0	0	2	1	2	2	2	2	1	0	2	0	1
CA-1	Quality Management System	2	2	2	2	0	2	2	0	0	2	0	2	2	0	0	0	0	2	0	0
CA-2	Environmental Training	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-3	Site Recycling Plan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-4	Fossil Fuel Reduction	1	1	1	1	2	2	2	1	1	1	0	1	1	1	1	0	0	1	0	0
CA-5	Equipment Emission Reduction	1	1	1	1	2	2	2	1	1	1	0	1	1	1	1	0	0	1	0	0
CA-6	Paving Emission Reduction	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
CA-7	Water Use Tracking	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CA-8	Contractor Warranty	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	2	2	2	0	0	2	2	0	0	2	0	0	2	0	0	0	0	2	0	0
MR-2	Pavement Reuse	2	2	2	5	5	4	2	5	5	0	4	5	5	0	5	5	0	1	5	5
MR-3	Earthwork Balance	1	1	1	0	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1
MR-4	Recycled Materials	2	1	2	3	3	3	3	2	2	5	2	2	3	1	2	2	1	2	2	2
MR-5	Regional Materials	5	2	5	5	5	3	5	5	5	5	5	5	5	5	3	5	5	5	5	5
MR-6	Energy Efficiency	5	5	5	5	0	5	5	5	0	5	0	0	5	5	0	0	0	5	0	5
PT-1	Long-Life Pavement	5	5	5	5	5	5	5	5	5	5	5	5	5	0	5	0	5	5	5	0
PT-2	Permeable Pavement	0	0	0	3	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	0
PT-3	Warm Mix Asphalt	3	3	3	0	3	3	3	3	3	3	3	3	3	0	3	0	3	3	3	3
PT-4	Cool Pavement	0	0	0	5	0	5	5	0	0	0	0	0	5	0	0	0	0	5	0	5
PT-5	Quiet Pavement	2	2	2	0	2	2	0	0	0	2	2	2	0	0	0	0	2	2	2	2
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Economical Scores - Potentially Available Based on Context of Project

No.	Title	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199
Project Requirements (PR)		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Total Econ Score		57	85	78	46	74	90	55	48	94	76	69	77	63	71	50	77	41	78	55	40
Environment & Water (EW)		4	17	21	21	16	21	6	6	21	21	12	21	14	19	16	19	6	15	14	2
Access & Equity (AE)		16	25	22	11	21	27	20	12	26	19	17	19	18	19	11	18	9	17	12	10
Construction Activities (CA)		8	14	10	8	9	10	5	7	11	9	9	9	5	5	5	7	5	9	7	5
Materials & Resources (MR)		19	14	20	6	20	19	13	15	23	16	20	18	18	18	8	20	13	21	9	13
Pavement Technologies (PT)		10	15	5	0	8	13	11	8	13	11	11	10	8	10	10	13	8	16	13	10
PR-1	Environmental Review Process	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-2	Lifecycle Cost Analysis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-3	Lifecycle Inventory	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-4	Quality Control Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-5	Noise Mitigation Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-6	Waste Management Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-8	Low-Impact Development	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-9	Pavement Management System	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-11	Educational Outreach	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
EW-1	Environmental Management System	0	2	2	2	2	2	0	0	2	2	2	2	0	0	0	2	0	2	0	0
EW-2	Runoff Flow Control	0	1	3	3	3	3	0	1	3	3	3	3	3	3	3	3	1	3	3	0
EW-3	Runoff Quality	0	1	3	3	3	3	0	1	3	3	3	3	3	3	3	3	1	3	3	0
EW-4	Stormwater Cost Analysis	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
EW-5	Site Vegetation	0	3	3	3	3	3	3	3	3	3	0	3	3	3	3	3	3	3	3	1
EW-6	Habitat Restoration	0	3	3	3	0	3	0	0	3	3	0	3	3	3	3	3	0	0	3	0
EW-7	Ecological Connectivity	0	3	3	3	1	3	0	0	3	3	0	3	1	3	3	1	0	0	1	0
EW-8	Light Pollution	3	3	3	3	3	3	3	0	3	3	3	3	0	3	0	3	0	3	0	0
AE-1	Safety Audit	1	2	1	0	2	1	1	1	2	1	1	2	1	1	0	2	1	2	1	1
AE-2	Intelligent Transportation Systems	3	5	5	0	5	5	5	2	5	3	5	2	2	3	0	3	0	2	0	2
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AE-4	Traffic Emissions Reduction	0	5	0	0	0	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0
AE-5	Pedestrian Access	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	1	2	2	0
AE-6	Bicycle Access	1	2	2	0	2	2	2	1	2	2	2	2	2	2	2	2	1	2	2	0
AE-7	Transit & HOV Access	3	0	3	0	2	3	3	0	3	4	0	2	2	2	0	0	0	2	0	0
AE-8	Scenic Views	1	2	2	2	1	2	2	1	0	0	0	2	2	2	2	2	1	0	2	2
AE-9	Cultural Outreach	1	2	2	2	2	2	0	1	2	2	2	2	2	2	0	2	0	2	0	0
CA-1	Quality Management System	0	2	2	0	2	2	0	0	2	2	2	2	0	0	0	2	0	2	0	0
CA-2	Environmental Training	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-3	Site Recycling Plan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-4	Fossil Fuel Reduction	1	2	1	1	0	1	0	1	2	1	1	1	0	0	0	0	0	1	1	0
CA-5	Equipment Emission Reduction	2	2	2	2	2	2	0	1	2	1	1	1	0	0	0	0	0	1	1	0
CA-6	Paving Emission Reduction	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-7	Water Use Tracking	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CA-8	Contractor Warranty	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	2	2	0	2	2	0	0	2	2	2	2	0	0	0	2	0	2	0	0
MR-2	Pavement Reuse	5	2	5	0	5	1	5	5	5	1	5	0	5	5	1	5	5	5	0	5
MR-3	Earthwork Balance	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
MR-4	Recycled Materials	3	2	2	2	2	5	2	5	5	2	2	5	2	2	3	2	2	3	3	2
MR-5	Regional Materials	5	3	5	3	5	5	5	5	5	5	5	5	5	5	3	5	5	5	5	5
MR-6	Energy Efficiency	5	5	5	0	5	5	0	0	5	5	5	5	5	5	0	5	0	5	0	0
PT-1	Long-Life Pavement	5	5	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
PT-2	Permeable Pavement	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	3	0	3	0	0
PT-3	Warm Mix Asphalt	3	3	3	0	3	3	3	3	3	3	3	0	3	3	0	3	3	3	3	3
PT-4	Cool Pavement	0	5	0	0	5	5	0	0	0	0	0	5	0	0	5	0	0	5	5	0
PT-5	Quiet Pavement	2	2	2	0	0	0	3	0	2	3	0	0	0	2	0	2	0	0	0	2
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Economical Scores - Potentially Available Based on Context of Project

No.	Title	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219
Project Requirements (PR)		**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**
Total Econ Score		**49**	**63**	**75**	**92**	**63**	**60**	**89**	**87**	**87**	**88**	**95**	**80**	**64**	**81**	**76**	**73**	**70**	**73**	**83**	**77**
Environment & Water (EW)		**4**	**15**	**14**	**21**	**17**	**21**	**21**	**21**	**19**	**21**	**21**	**19**	**18**	**15**	**19**	**19**	**18**	**16**	**21**	**19**
Access & Equity (AE)		**15**	**11**	**17**	**23**	**20**	**10**	**23**	**23**	**23**	**23**	**28**	**20**	**19**	**20**	**20**	**15**	**14**	**21**	**23**	**21**
Construction Activities (CA)		**7**	**9**	**9**	**11**	**5**	**11**	**11**	**12**	**12**	**12**	**10**	**11**	**6**	**9**	**9**	**9**	**9**	**9**	**9**	**9**
Materials & Resources (MR)		**13**	**15**	**19**	**18**	**11**	**13**	**18**	**16**	**18**	**17**	**20**	**20**	**11**	**21**	**20**	**20**	**13**	**13**	**15**	**20**
Pavement Technologies (PT)		**10**	**13**	**16**	**19**	**10**	**5**	**16**	**15**	**15**	**15**	**16**	**10**	**10**	**16**	**8**	**10**	**16**	**14**	**15**	**8**
PR-1	Environmental Review Process	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-2	Lifecycle Cost Analysis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-3	Lifecycle Inventory	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-4	Quality Control Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-5	Noise Mitigation Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-6	Waste Management Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-7	Pollution Prevention Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-8	Low-Impact Development	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-9	Pavement Management System	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-10	Site Maintenance Plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PR-11	Educational Outreach	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
EW-1	Environmental Management System	0	2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
EW-2	Runoff Flow Control	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
EW-3	Runoff Quality	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
EW-4	Stormwater Cost Analysis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
EW-5	Site Vegetation	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
EW-6	Habitat Restoration	0	3	0	3	3	3	3	3	3	3	3	3	3	0	3	3	0	0	3	3
EW-7	Ecological Connectivity	0	0	1	3	1	3	3	3	1	3	3	1	3	0	1	1	3	1	3	1
EW-8	Light Pollution	3	0	3	3	3	3	3	3	3	3	3	3	0	3	3	3	3	3	3	3
AE-1	Safety Audit	2	2	1	2	2	1	2	2	2	2	2	1	1	1	1	2	1	2	2	2
AE-2	Intelligent Transportation Systems	5	2	5	5	2	2	5	5	5	5	5	5	2	5	5	2	2	5	5	5
AE-3	Context Sensitive Solutions	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AE-4	Traffic Emissions Reduction	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
AE-5	Pedestrian Access	0	2	2	2	2	0	2	2	2	2	2	2	2	2	2	0	0	2	2	2
AE-6	Bicycle Access	0	0	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2
AE-7	Transit & HOV Access	0	0	0	3	3	0	3	3	3	3	3	3	3	3	3	0	0	3	3	3
AE-8	Scenic Views	2	0	0	2	2	0	2	2	2	2	2	0	2	0	0	2	2	0	2	0
AE-9	Cultural Outreach	1	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CA-1	Quality Management System	0	2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CA-2	Environmental Training	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-3	Site Recycling Plan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CA-4	Fossil Fuel Reduction	1	1	2	2	0	2	2	1	1	1	0	2	0	0	0	0	0	0	0	0
CA-5	Equipment Emission Reduction	1	1	2	2	0	2	2	1	1	1	0	2	0	2	2	2	2	2	2	2
CA-6	Paving Emission Reduction	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
CA-7	Water Use Tracking	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CA-8	Contractor Warranty	0	0	0	0	0	0	0	3	3	3	3	0	0	0	0	0	0	0	0	0
MR-1	Lifecycle Assessment	0	2	2	2	0	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2
MR-2	Pavement Reuse	5	5	5	3	5	0	2	0	2	2	5	5	5	5	5	2	0	2	0	5
MR-3	Earthwork Balance	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
MR-4	Recycled Materials	2	2	1	2	5	5	3	3	3	2	2	2	2	5	2	5	5	2	2	2
MR-5	Regional Materials	5	5	5	5	0	5	5	5	5	5	5	5	1	5	5	5	5	5	5	5
MR-6	Energy Efficiency	0	0	5	5	0	0	5	5	5	5	5	5	0	5	5	5	0	2	5	5
PT-1	Long-Life Pavement	5	5	5	5	5	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5
PT-2	Permeable Pavement	0	0	3	3	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0
PT-3	Warm Mix Asphalt	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	3	3	3	3
PT-4	Cool Pavement	0	5	5	5	0	0	5	5	5	5	5	0	0	5	0	5	5	5	5	0
PT-5	Quiet Pavement	2	0	0	3	2	2	3	2	2	2	3	2	2	0	0	0	0	0	2	0
PT-6	Pavement Performance Tracking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

APPENDIX D: MATLAB SCRIPTS

Diss.m

```
clear
clc
format shortg

%% Multivariate Analysis of 120 Greenroads Projects
% Author - Jeralee L. Anderson
% Purpose and Scope
% This script requires the Matlab Statistics Toolbox and was written for
% use with educational version R2011a.
%
% This script is designed to test qualitative and quantitative
% relationships in the Greenroads project data set. It is the first of
% three scripts that are intended to be used in succession. Scatterplots
% of scores and continuous variables (mileage and construction cost) are
% separated in another script dissplot.m and Data Quality Scores are
% tested in a separate script called dissdqs.m. Note that these scripts
% will need to be called individually in the command window. They have
% been separated due to the large amount of figures being generated and
% the tendency for this to overload graphics handlers.
%
% Functions Used
% Tests of Normality Chi2gof - Chi-square goodness of fit. This test is
% used on all of the aggregate scores. This function produces a 0 if the
% null hypothesis (that the data is normally distributed) is true, and a 1
% if not. A p-value is also displayed. The default confidence interval is used
% such that alpha = 0.05.
%
% Multivariable Analyses anova1 - One-way Analysis of Variance. This
% function produces an ANOVA table, a box plot of each categorical
% variable, and a dataset array that can be used to perform a multiple
% comparison of means test. The default confidence interval is used
% such that alpha = 0.05.
%
% multcompare - Multiple Comparison of Means test. This function compares the means
% within a group of categorical variables to determine if there are relationships
% within the group. It generates a chart that shows the comparison and tabulated
% results.
%
% manova1 - One-way Multivariate Analysis of Variance. This function produces
% dataset structure that includes several arrays, including the details of a Wilk's
% lambda and conversion of this test statistic to a chi-square distribution,
% eigenvalues, eigenvectors, and canonical
% coefficients. This information can be used to make a dendrogram for the group
% variable. P-values are also displayed and computed using the
% default confidence interval such that alpha = 0.05.
%
% manovacluster - Cluster diagram. Using this function with the resulting dataset
% structure fromthe manova1 test produces a dendrogram that
% helps to show the magnitude of the relationships. This is useful for project
% properties with more than 2 categories. The dendrogram relies
% on the single linkage of clusters and plots the groups according to their
% Mahalanobis distance from each other (default).
%
% gscatter - This is a plotting function that produces a scatterplot according to
% qualitative grouping variables.

disp('MATLAB Results from diss.m')
disp(' ')

%% Weighted Analysis
disp('WEIGHTED ANALYSIS')
```

```
disp('  ')
disp('Loading dataset...')

% Load the dataset "greenroads" from file
greenroads = dataset('XLSFile','DissertationData.xlsx','ReadObsNames',true);
greenroads = greenroads(1:120,:);

% Set dataset properties
greenroads.Properties.Description = '->This dataset contains 120 project
observations tested with the Greenroads Rating System v1.5. Author: Jeralee L.
Anderson. These data represent the weighted condition.';
varnames = greenroads.Properties.VarNames;
varlist = varnames';
projid = greenroads.Properties.ObsNames;

group1 =
[greenroads.GreenroadsProject,greenroads.GreenEmphasis,greenroads.MajorStructures,g
reenroads.Northwest,greenroads.Country,greenroads.Owner,greenroads.Contract,greenro
ads.Phase,greenroads.Purpose,greenroads.Motivation,greenroads.Surfacing,greenroads.
Place,greenroads.FunctClass,greenroads.Length,greenroads.Budget];
groupnames = [varnames([1:14,16])];

group2 = [greenroads.RawTotalScore];
group3 = [greenroads.EconTotalScore];
group4 = [greenroads.NATotalScore];
group5 = [greenroads.ReasTotalScore];
group6 = [greenroads.MaxTotalScore];
group7 = [greenroads.DQS];
group8 = [greenroads.Mileage];
group9 = [greenroads.USD2011];

% Chi-squared Goodness of Fit Tests
disp('Chi Squared Goodness of Fit for Weighted Raw Scores')
RawChi2 = chi2gof(group2)
disp('  ')

disp('Chi Squared Goodness of Fit for Weighted Economical Scores')
EconChi2 = chi2gof(group3)
disp('  ')

disp('Chi Squared Goodness of Fit for Weighted NA Scores')
NAChi2 = chi2gof(group4)
disp('  ')

disp('Chi Squared Goodness of Fit for Weighted Reasonably Possible Scores')
ReasChi2 = chi2gof(group5)
disp('  ')

disp('Check correlation between Reasonable Scores and Economical Points Available -
Weighted Case')
[R P] = corrcoef(greenroads.ReasTotalScore,greenroads.EconTotalScore)
disp('  ')

%% One-way Analysis of Variance - Weighted
% Raw Scores
for j = 1:size(group1,2)
  disp('RAW SCORE ANALYSIS - Weighted')
  disp('Property')
  disp(groupnames(j))
  disp(' ')
  figure
  [p anovatab stats] = anova1(group2(:,1),group1(:,j));
```

```
  title({'Raw Scores for Variable ' char(groupnames(j))})
  p
  if p <=0.05
    disp('P-Value is SIGNIFICANT')
  end
  disp('  ')
  figure
  [comparison means H gnames] = multcompare(stats);
  title(['Comparison of Means - Weighted Analysis, Raw Scores '
char(groupnames(j))])
  disp('Multiple Comparison of Means - Raw Scores')
  meanstab = [gnames num2cell(round(means))];
  tabtitle = [{'Name'}, {'Means'}, {'Error'}];
  results = vertcat(tabtitle,meanstab)
  disp(' ')
  disp('ANOVA Results - Raw Scores')
  anovatab
  disp(' ')
  disp(' ')
  disp(' ')
end

% NA Scores
for j = 1:size(group1,2)
  disp('ANALYSIS OF POINTS NOT AVAILABLE - Weighted')
  disp('Property')
  disp(groupnames(j))
  disp(' ')
  figure
  [p anovatab stats] = anova1(group4(:,1),group1(:,j));
  title({'Points Not Available for Variable ' char(groupnames(j))})
  p
  if p <=0.05
  disp('P-Value is SIGNIFICANT')
  end
  disp('  ')
  figure
  [comparison means H gnames] = multcompare(stats);
  title(['Comparison of Means - Weighted Analysis, NA Scores char(groupnames(j))])
  disp('Multiple Comparison of Means - NA Scores')
  meanstab = [gnames num2cell(round(means))];
  tabtitle = [{'Name'}, {'Means'}, {'Error'}];
  results = vertcat(tabtitle,meanstab)
  disp(' ')
  disp('ANOVA Results - NA Scores')
  anovatab
  disp(' ')
  disp(' ')
  disp(' ')
end

%% Multivariate Analysis - Weighted
for j = 1:size(group1,2)
  disp('MULTIVARIATE ANALYSIS - Weighted')
  disp('Property')
  disp(groupnames(j))
  disp(' ')
  disp('MANOVA Results - Weighted')
  [d p mstats] = manova1([group2 group4],char(group1(:,j)));
  d
  p
  disp(' ')
```

```
  for k = 1:size(p,1)
    if p(k) <=0.05
      P = p(k)
      disp('P-Value is SIGNIFICANT')
    end
  end

  disp(' ')
  figure
  manovacluster(mstats)
  title(['Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for '
char(groupnames(j))])
  ylabel('Mahalanobis Distance')
  disp(' ')
  disp('Canonical Coefficients - Weighted Analysis')

  lambda = mstats.lambda
  chisq = mstats.chisq
  gmdist = mstats.gmdist
  eigenval = mstats.eigenval

  c1 = mstats.canon(:,1); % Raw Scores
  c2 = mstats.canon(:,2); % NA Scores

  % Scatterplots of clusters - canonical analysis
  figure
  gscatter(c2,c1,group1(:,j),'brgkcm',[])
  title(['Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores
for ' char(groupnames(j))])
  ylabel('Points Not Available - Canonical Coefficients')
  xlabel('Raw Score Canonical Coefficients')
  disp(' ')
  disp(' ')
  disp(' ')
end

%% Unweighted Analysis
disp('UNWEIGHTED ANALYSIS')
disp('  ')
disp('Loading dataset...')
% Load the dataset "uwgreenroads" from file
uwgreenroads =
dataset('XLSFile','DissertationDataUnweighted.xlsx','ReadObsNames',true);
uwgreenroads = uwgreenroads(1:120,:);

% Set dataset properties
greenroads.Properties.Description = '-> This dataset contains 120 project
observations tested with the Greenroads Rating System v1.5. Author: Jeralee L.
Anderson. These data represent the unweighted condition.';

% Note that all dataset properties and categorical groups can remain the same
% between the weighted and unweighted datasets because the
% differences between the datasets are only in the scored columns, which are reset
% into new groups below. Note these are only the aggregate
% scores, not the per credit scores or credit category scores.

uwgroup2 = [uwgreenroads.RawTotalScore];
uwgroup3 = [uwgreenroads.EconTotalScore];
uwgroup4 = [uwgreenroads.NATotalScore];
uwgroup5 = [uwgreenroads.ReasTotalScore];
uwgroup6 = [uwgreenroads.MaxTotalScore];
```

```
% Chi-squared Goodness of Fit Tests
disp('Chi Squared Goodness of Fit for Unweighted Raw Scores')
UWRawChi2 = chi2gof(uwgroup2)
disp('  ')

disp('Chi Squared Goodness of Fit for Unweighted Economical Scores')
UWEconChi2 = chi2gof(uwgroup3)
disp('  ')

disp('Chi Squared Goodness of Fit for Unweighted NA Scores')
UWNAChi2 = chi2gof(uwgroup4)
disp('  ')

disp('Chi Squared Goodness of Fit for Unweighted Reasonable Scores')
UWReasChi2 = chi2gof(uwgroup5)
disp('  ')

disp('Check correlation between Reasonable Scores and Economical Points Available - 
Unweighted Case')
[R P] = corrcoef(uwgroup5,uwgroup3)
disp('  ')

%% One-way Analysis of Variance - Unweighted
% Raw Scores
for j = 1:size(group1,2)
  disp('RAW SCORE ANALYSIS - Unweighted')
  disp('Property')
  disp(groupnames(j))
  disp(' ')
  figure
  [p anovatab stats] = anova1(uwgroup2(:,1),group1(:,j));
  title({'Unweighted Raw Scores for Variable ' char(groupnames(j))})
  p
  if p <=0.05
  disp('P-Value is SIGNIFICANT')
  end
  disp('  ')
  figure
  [comparison means H gnames] = multcompare(stats);
  title(['Comparison of Means - Unweighted Analysis, Raw Scores' 
char(groupnames(j))])
  disp('Multiple Comparison of Means')
  meanstab = [gnames num2cell(round(means))];
  tabtitle = [{'Name'}, {'Means'}, {'Error'}];
  results = vertcat(tabtitle,meanstab)
  disp(' ')
  disp('ANOVA Results')
  anovatab
  disp(' ')
  disp(' ')
  disp(' ')
end

% NA Scores
for j = 1:size(group1,2)
  disp('ANALYSIS OF POINTS NOT AVAILABLE - Unweighted')
  disp('Property')
  disp(groupnames(j))
  disp(' ')
  figure
  [p anovatab stats] = anova1(uwgroup4(:,1),group1(:,j));
```

```
  title({'Unweighted Points Not Available for Variable ' char(groupnames(j))})
  p
  if p <=0.05
  disp('P-Value is SIGNIFICANT')
  end
  disp('  ')
  figure
  [comparison means H gnames] = multcompare(stats);
  title(['Comparison of Means - Unweighted Analysis, NA Scores '
char(groupnames(j))])
  disp('Multiple Comparison of Means')
  meanstab = [gnames num2cell(round(means))];
  tabtitle = [{'Name'}, {'Means'}, {'Error'}];
  results = vertcat(tabtitle,meanstab)
  disp(' ')
  disp('ANOVA Results')
  anovatab
  disp(' ')
  disp(' ')
  disp(' ')
end

%% Multivariate Analysis - Unweighted
% One-way Multivariate Analysis of Variance
for j = 1:size(group1,2)
  disp('MULTIVARIATE ANALYSIS - Unweighted Case')
  disp('This section investigates multivariable relationships within project
properties and creates canonical coefficient plots comparing multiple score
conditions')
  disp('Property')
  disp(groupnames(j))
  disp(' ')
  disp('MANOVA Results')
  [d p mstats] = manova1([uwgroup2 uwgroup4],char(group1(:,j)));
  d
  p
  disp(' ')

  for k = 1:size(p,1)
    if p(k) <=0.05
      P = p(k)
      disp('P-Value is SIGNIFICANT')
    end
  end

  disp(' ')
  figure
  manovacluster(mstats)
  title(['Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for '
char(groupnames(j))])
  ylabel('Mahalanobis Distance')
  disp(' ')

  disp('Canonical Coefficients')
  lambda = mstats.lambda
  chisq = mstats.chisq
  gmdist = mstats.gmdist
  eigenval = mstats.eigenval

  c1 = mstats.canon(:,1); % UWGroup2
  c2 = mstats.canon(:,2); % UWGroup4
```

```
  % Scatterplots of clusters - canonical analysis
  figure
  gscatter(c1,c2,group1(:,j),'brgkcm',[])
  title(['Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores
for ' char(groupnames(j))])
  ylabel('Points Not Available - Canonical Coefficients')
  xlabel('Raw Score Canonical Coefficients')
  disp(' ')
  disp(' ')
  disp(' ')
end
```

dissdqs.m

```
%%% Title - Multivariate Analysis of 120 Greenroads Projects
%%% Author - Jeralee L. Anderson
clc
format short

%% Purpose and Scope
% This script requires the Matlab Statistics Toolbox and was written for use with
% educational version R2011a.

% This script is designed to test qualitative and quantitative relationships in the
% Greenroads project data set. It is the second of three scripts that are intended
% to be used in succession. The initial multivariate tests and loading of the
% dataset are separated in another script diss.m. Scatterplots of scores and
% continuous variables (mileage and construction cost) are separated in another
% script dissplot.m. Note that these scripts will need to be called individually in
% the command window. They have been separated due to the large amount of figures
% being generated and the tendency for this to overload graphics handlers.

%% Functions Used
% Tests of Normality Chi2gof - Chi-square goodness of fit. This test is used on all
% of the aggregate scores. This function produces a 0 if the null hypothesis (that
% the data is normally distributed) is true, and a 1 if not. A p-value is also
% displayed. The default confidence interval is used such that alpha = 0.05.

% Multivariable Analyses anova1 - One-way Analysis of Variance. This function
% produces an ANOVA table, a box plot of each categorical
% variable, and a dataset array that can be used to perform a multiple comparison
% of means test. The default confidence interval is used such that alpha = 0.05.

% multcompare - Multiple Comparison of Means test. This function compares the means
% within a group of categorical variables to determine if
% there are relationships within this group. It generates a chart that shows the
% comparison and tabulated results.

% Tests of relationships corrcoef - Correlation Coefficients. This function
% generates the correlation coefficients array between the
% variables being tested.

disp('MATLAB Results from dissdqs.m')
disp(' ')

%% Data Quality Analysis
% Data Quality Scores
disp('DATA QUALITY ANALYSIS')
disp('  ')
disp('Chi Squared Goodness of Fit for Data Quality Scores')
DQSChi2 = chi2gof(group7)
disp('  ')

% Data Quality - Weighted Analysis
% Determine correlation coefficients
disp('Correlation Analysis - Weighted Condition')
Corr = corrcoef([group7 group2 group5 group4]);
toplabels = [{'Weighted Analysis'} {'DQ Score'} {'Raw Score'} {'Reas Score'} {'NA
Score'}];
sidelabels = [{'Data Quality Score'} {'Raw Score'} {'Reasonable Score'} {'Points
Not Available'}]';
DQScorr = vertcat(toplabels,[sidelabels num2cell(Corr)])
disp(' ')
disp(' ')
```

```
% Data Quality - Unweighted Analysis
% Determine correlation coefficients
disp('Correlation Analysis - Unweighted Condition')
Corr = corrcoef([group7 uwgroup2 uwgroup5 uwgroup4]);
toplabels = [{'Weighted Analysis'} {'DQ Score'} {'Raw Score'} {'Reas Score'} {'NA
Score'}];
sidelabels = [{'Data Quality Score'} {'Raw Score'} {'Reasonable Score'} {'Points
Not Available'}]';
uwDQScorr = vertcat(toplabels,[sidelabels num2cell(Corr)])
disp(' ')
disp(' ')

% Test relationships between data quality and categorical properties Note DQS are
% identical in weighted and unweighted case for the below
% categorical analysis, so this test does not need to be repeated.
for j = 1:size(group1,2)
  disp('DATA QUALITY SCORE ANALYSIS')
  disp('Property')
  disp(groupnames(j))
  disp(' ')
  figure
  [p anovatab dqstats] = anova1(group7(:,1),group1(:,j));
  title({'Data Quality Scores for ' char(groupnames(j))})
  ylabel('Data Quality Scores')
  p
  if p <=0.05
  disp('P-Value is SIGNIFICANT')
  end
  disp('  ')
  figure
  [comparison means H gnames] = multcompare(dqstats);
  title('Comparison of Means, Data Quality Scores')
  disp('Multiple Comparison of Means')
  meanstab = [gnames num2cell(round(means))];
  tabtitle = [{'Name'}, {'Means'}, {'Error'}];
  results = vertcat(tabtitle,meanstab)
  disp(' ')
  disp('ANOVA Results')
  anovatab
  disp(' ')
  disp(' ')
  disp(' ')
end
```

dissplot.m

```
%%% Title - Multivariate Analysis of 120 Greenroads Projects
%%% Author - Jeralee L. Anderson
%% Purpose and Scope
% This script requires the Matlab Statistics Toolbox and was written for use with
% educational version R2011a.

% This script is designed to test qualitative and quantitative relationships in the
% Greenroads project data set. It is the third of three scripts that are intended
% to be used in succession. The initial multivariate tests and loading of the
% dataset are separated in another script diss.m and Data Quality Scores are tested
% in a separate script called dissdqs.m. Note that these scripts will need to be
% called individually in the command window. They have been separated due to the
% large amount of figures being generated and the tendency to overload graphics
% handlers.

%% Functions Used
% gscatter - This is a plotting function that produces a scatterplot according to
% qualitative grouping variables.

clc
disp('MATLAB Results from dissplot.m')
disp(' ')
disp('This script makes plots of aggregate scores vs. cost and mileage in both
weighted and unweighted conditions.')
disp('Plotting....')

%% Weighted Analysis
%% Scatter plots of cost and scores
% Scatter plots of cost and scores to check for clustering. Note cost is a
% continuous variable and scores are discrete. In the above analyses, cost has been
% grouped into 3 categories in the variable "Budget."

for j=1:size(group1,2)
  figure
  ylim([0 50])
  gscatter(group9,group2,group1(:,j),'brgkcm',[],[])
  title({'Weighted Analysis: Raw Scores vs. Cost for Variable '
char(groupnames(j))})
  xlabel('Cost (US$2011)')
  ylabel('Raw Score in Voluntary Credits')
end

for j=1:size(group1,2)
  figure
  ylim([0 100])
  gscatter(group9,group3,group1(:,j),'brgkcm',[],[])
  title({'Weighted Analysis: Economical Points Available vs. Cost for Variable '
char(groupnames(j))})
  xlabel('Cost (US$2011)')
  ylabel('Raw Score in Voluntary Credits')
end

for j=1:size(group1,2)
  figure
  ylim([0 50])
  gscatter(group9,group4,group1(:,j),'brgkcm',[],[])
  title({'Weighted Analysis: Points Not Available vs. Cost for Variable '
char(groupnames(j))})
  xlabel('Cost (US$2011)')
  ylabel('Raw Score in Voluntary Credits')
end
```

```
% Scatter plots of mileage and scores to check for clustering. Note mileage is a
% continuous variable and scores are discrete. In the above analyses, mileage has
% been grouped into 3 categories in the variable "Length."
for j=1:size(group1,2)
  figure
  ylim([0 50])
  gscatter(group8,group2,group1(:,j),'brgkcm',[],[])
  title({'Weighted Analysis: Raw Scores vs. Mileage for Variable '
char(groupnames(j))})
  xlabel('Mileage (mi)')
  ylabel('Raw Score in Voluntary Credits')
end

for j=1:size(group1,2)
  figure
  ylim([0 100])
  gscatter(group8,group3,group1(:,j),'brgkcm',[],[])
  title({'Weighted Analysis: Economical Points Available vs. Mileage for Variable '
char(groupnames(j))})
  xlabel('Mileage (mi)')
  ylabel('Economical Score in Voluntary Credits')
end

for j=1:size(group1,2)
  figure
  ylim([0 50])
  gscatter(group8,group4,group1(:,j),'brgkcm',[],[])
  title({'Weighted Analysis: Points Not Available vs. Mileage for Variable '
char(groupnames(j))})
  xlabel('Mileage (mi)')
  ylabel('NA Score in Voluntary Credits')
end

%% Unweighted Analysis
% Scatter plots of cost and scores to check for clustering - unweighted. Note cost
% is a continuous variable and scores are discrete. In the above analyses, cost has
% been grouped into 3 categories in the variable "Budget."
for j=1:size(group1,2)
  figure
  ylim([0 25])
  gscatter(group9,uwgroup2,group1(:,j),'brgkcm',[],[])
  title({'Unweighted Raw Scores vs. Cost for Variable ' char(groupnames(j))})
  xlabel('Cost (US$2011)')
  ylabel('Raw Score in Voluntary Credits')
end

for j=1:size(group1,2)
  figure
  ylim([0 40])
  gscatter(group9,uwgroup3,group1(:,j),'brgkcm',[],[])
  title({'Unweighted Economical Points Available vs. Cost for Variable '
char(groupnames(j))})
  xlabel('Cost (US$2011)')
  ylabel('Raw Score in Voluntary Credits')
end

for j=1:size(group1,2)
  figure
  ylim([0 15])
  gscatter(group9,uwgroup4,group1(:,j),'brgkcm',[],[])
```

```
  title({'Unweighted Points Not Available vs. Cost for Variable '
char(groupnames(j))})
  xlabel('Cost (US$2011)')
  ylabel('Points Not Available in Voluntary Credits')
end

% Scatter plots of mileage and scores to check for clustering. Note mileage is a
% continuous variable and scores are discrete. In the above analyses, mileage has
% been grouped into 3 categories in the variable "Length."
for j=1:size(group1,2)
  figure
  ylim([0 25])
  gscatter(group8,uwgroup2,group1(:,j),'brgkcm',[],[])
  title({'Unweighted Analysis: Raw Scores vs. Mileage for Variable '
char(groupnames(j))})
  xlabel('Mileage (mi)')
  ylabel('Raw Score in Voluntary Credits')
end

for j=1:size(group1,2)
  figure
  ylim([0 40])
  gscatter(group8,uwgroup3,group1(:,j),'brgkcm',[],[])
  title({'Unweighted Analysis: Economical Points Available vs. Mileage for Variable
' char(groupnames(j))})
  xlabel('Mileage (mi)')
  ylabel('Economical Score in Voluntary Credits')
end

for j=1:size(group1,2)
  figure
  ylim([0 15])
  gscatter(group8,uwgroup4,group1(:,j),'brgkcm',[],[])
  title({'Unweighted Analysis: Points Not Available vs. Mileage for Variable '
char(groupnames(j))})
  xlabel('Mileage (mi)')
  ylabel('NA Score in Voluntary Credits')
end

disp('Plotting completed successfully.')
```

APPENDIX E: MATLAB OUTPUT FILES

```
MATLAB Results from diss.m

WEIGHTED ANALYSIS

Loading dataset...
Chi Squared Goodness of Fit for Weighted Raw Scores
RawChi2 =
     0

Chi Squared Goodness of Fit for Weighted Economical Scores
EconChi2 =
     1

Chi Squared Goodness of Fit for Weighted NA Scores
NAChi2 =
     0

Chi Squared Goodness of Fit for Weighted Reasonably Possible Scores
ReasChi2 =
     1

Check correlation between Reasonable Scores and Economical Points Available - Weighted Case
R =
            1      0.95782
      0.95782            1
P =
            1  9.5929e-066
  9.5929e-066            1

RAW SCORE ANALYSIS - Weighted
Property
    'GreenroadsProject'

p =
      0.01591
P-Value is SIGNIFICANT

Multiple Comparison of Means - Raw Scores
results =
    'Name'               'Means'    'Error'
    'Not Greenroads'    [   25]    [    1]
    'Greenroads'        [   30]    [    2]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [ 409.7]    [  1]    [ 409.7]    [5.9841]    [0.01591]
    'Error'     [8078.8]    [118]    [68.464]          []           []
    'Total'     [8488.5]    [119]          []          []           []



RAW SCORE ANALYSIS - Weighted
Property
    'GreenEmphasis'

p =
    0.0019944
P-Value is SIGNIFICANT

Multiple Comparison of Means - Raw Scores
results =
    'Name'       'Means'    'Error'
    'Typical'    [   24]    [    1]
    'Greener'    [   29]    [    1]
```

```
ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [662.91]    [  1]    [662.91]    [9.9959]    [0.0019944]
    'Error'     [7825.6]    [118]    [66.319]          []             []
    'Total'     [8488.5]    [119]          []          []             []



RAW SCORE ANALYSIS - Weighted
Property
    'MajorStructures'

p =
      0.36732

Multiple Comparison of Means - Raw Scores
results =
    'Name'             'Means'    'Error'
    'Structures'       [   27]    [    1]
    'No Structures'    [   25]    [    1]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'          'Prob>F'
    'Groups'    [58.508]    [  1]    [58.508]    [0.81898]    [0.36732]
    'Error'     [  8430]    [118]    [71.441]           []           []
    'Total'     [8488.5]    [119]          []           []           []



RAW SCORE ANALYSIS - Weighted
Property
    'Northwest'

p =
      0.29141

Multiple Comparison of Means - Raw Scores
results =
    'Name'             'Means'    'Error'
    'Northwest'        [   27]    [    1]
    'Other Regions'    [   25]    [    1]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [80.033]    [  1]    [80.033]    [1.1231]    [0.29141]
    'Error'     [8408.5]    [118]    [71.258]          []           []
    'Total'     [8488.5]    [119]          []          []           []



RAW SCORE ANALYSIS - Weighted
Property
    'Country'

p =
      0.72026

Multiple Comparison of Means - Raw Scores
results =
    'Name'             'Means'    'Error'
    'International'    [   27]    [    2]
    'USA'              [   26]    [    1]
```

```
ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'           'Prob>F'
    'Groups'    [9.2593]    [  1]    [9.2593]    [0.12886]    [0.72026]
    'Error'     [8479.2]    [118]    [71.858]           []           []
    'Total'     [8488.5]    [119]          []           []           []



RAW SCORE ANALYSIS - Weighted
Property
    'Owner'

p =
      0.28348

Multiple Comparison of Means - Raw Scores
results =
    'Name'                'Means'    'Error'
    'City/County'         [   27]    [    1]
    'State/Provincial'    [   25]    [    1]
    'Federal/National'    [   24]    [    2]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [180.96]    [  2]    [90.482]    [1.2743]    [0.28348]
    'Error'     [8307.5]    [117]    [71.005]          []           []
    'Total'     [8488.5]    [119]          []          []           []



RAW SCORE ANALYSIS - Weighted
Property
    'Contract'

p =
    0.0062378
P-Value is SIGNIFICANT

Multiple Comparison of Means - Raw Scores
results =
    'Name'                'Means'    'Error'
    'Conventional DBB'    [   25]    [    1]
    'Alternative'         [   31]    [    2]
    'Unknown'             [   24]    [    3]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'        'Prob>F'
    'Groups'    [705.64]    [  2]    [352.82]    [5.304]    [0.0062378]
    'Error'     [7782.9]    [117]    [ 66.52]         []             []
    'Total'     [8488.5]    [119]          []         []             []



RAW SCORE ANALYSIS - Weighted
Property
    'Phase'

p =
    0.0088903
P-Value is SIGNIFICANT

Multiple Comparison of Means - Raw Scores
results =
```

```
    'Name'            'Means'    'Error'
    'Planning'        [   23]    [    2]
    'Finished'        [   24]    [    1]
    'Construction'    [   27]    [    1]
    'Design'          [   30]    [    2]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [804.48]    [  3]    [268.16]    [4.0482]    [0.0088903]
    'Error'     [  7684]    [116]    [66.242]          []             []
    'Total'     [8488.5]    [119]          []          []             []



RAW SCORE ANALYSIS - Weighted
Property
    'Purpose'

p =
      0.29073

Multiple Comparison of Means - Raw Scores
results =
    'Name'              'Means'    'Error'
    'New'               [   25]    [    2]
    'Maintenance'       [   24]    [    1]
    'Reconstruction'    [   27]    [    1]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [177.37]    [  2]    [88.687]    [1.2485]    [0.29073]
    'Error'     [8311.1]    [117]    [71.035]          []           []
    'Total'     [8488.5]    [119]          []          []           []



RAW SCORE ANALYSIS - Weighted
Property
    'Motivation'

p =
      0.13971

Multiple Comparison of Means - Raw Scores
results =
    'Name'             'Means'    'Error'
    'Mobility'         [   28]    [    1]
    'Preservation'     [   23]    [    1]
    'Economic'         [   25]    [    2]
    'Safety'           [   28]    [    3]
    'Environmental'    [   26]    [    3]
    'Other'            [   20]    [    5]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [ 589.7]    [  5]    [117.94]    [1.7022]    [0.13971]
    'Error'     [7898.8]    [114]    [69.288]          []           []
    'Total'     [8488.5]    [119]          []          []           []



RAW SCORE ANALYSIS - Weighted
Property
```

```
    'Surfacing'

p =
    0.0048186
P-Value is SIGNIFICANT

Multiple Comparison of Means - Raw Scores
results =
    'Name'     'Means'    'Error'
    'HMA'      [   24]    [    1]
    'PCC'      [   31]    [    2]
    'Mixed'    [   28]    [    2]
    'Other'    [   20]    [    4]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [890.94]    [  3]    [296.98]    [4.5343]    [0.0048186]
    'Error'     [7597.6]    [116]    [65.496]          []             []
    'Total'     [8488.5]    [119]          []          []             []



RAW SCORE ANALYSIS - Weighted
Property
    'Place'

p =
    0.0046111
P-Value is SIGNIFICANT

Multiple Comparison of Means - Raw Scores
results =
    'Name'           'Means'    'Error'
    'Small Urban'    [   27]    [    1]
    'Rural'          [   23]    [    1]
    'Urban'          [   28]    [    1]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [745.74]    [  2]    [372.87]    [5.6344]    [0.0046111]
    'Error'     [7742.8]    [117]    [66.177]          []             []
    'Total'     [8488.5]    [119]          []          []             []



RAW SCORE ANALYSIS - Weighted
Property
    'FunctClass'

p =
      0.48804

Multiple Comparison of Means - Raw Scores
results =
    'Name'         'Means'    'Error'
    'Collector'    [   25]    [    2]
    'Arterial'     [   26]    [    1]
    'Local'        [   24]    [    3]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'          'Prob>F'
    'Groups'    [103.46]    [  2]    [51.728]    [0.72178]    [0.48804]
    'Error'     [  8385]    [117]    [71.667]           []           []
```

```
    'Total'     [8488.5]    [119]          []           []           []


RAW SCORE ANALYSIS - Weighted
Property
    'Length'

p =
      0.41874

Multiple Comparison of Means - Raw Scores
results =
    'Name'    'Means'    'Error'
    '0-1'     [   27]    [    1]
    '5+'      [   25]    [    2]
    '1-5'     [   25]    [    1]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'        'Prob>F'
    'Groups'    [125.38]    [  2]    [62.688]    [0.877]    [0.41874]
    'Error'     [8363.1]    [117]    [ 71.48]         []           []
    'Total'     [8488.5]    [119]          []         []           []


RAW SCORE ANALYSIS - Weighted
Property
    'Budget'

p =
   0.00041268
P-Value is SIGNIFICANT

Multiple Comparison of Means - Raw Scores
results =
    'Name'      'Means'    'Error'
    '0-10'      [   24]    [    1]
    '10-100'    [   26]    [    1]
    '100+'      [   32]    [    2]

ANOVA Results - Raw Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [1058.7]    [  2]    [529.34]    [8.3357]    [0.00041268]
    'Error'     [7429.8]    [117]    [63.503]          []              []
    'Total'     [8488.5]    [119]          []          []              []


ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'GreenroadsProject'

p =
      0.14433

results =
    'Name'               'Means'    'Error'
    'Not Greenroads'    [   17]    [    1]
    'Greenroads'        [   20]    [    2]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
```

```
    'Groups'    [163.98]    [  1]    [163.98]    [2.1597]    [0.14433]
    'Error'     [8959.2]    [118]    [75.926]          []           []
    'Total'     [9123.2]    [119]          []          []           []
```

```
ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'GreenEmphasis'

p =
      0.73812

results =
    'Name'       'Means'    'Error'
    'Typical'    [   18]    [    1]
    'Greener'    [   17]    [    1]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'          'Prob>F'
    'Groups'    [8.6751]    [  1]    [8.6751]    [0.11231]    [0.73812]
    'Error'     [9114.5]    [118]    [77.242]           []           []
    'Total'     [9123.2]    [119]          []           []           []
```

```
ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'MajorStructures'

p =
  4.9606e-005
P-Value is SIGNIFICANT

results =
    'Name'             'Means'    'Error'
    'Structures'       [   14]    [    1]
    'No Structures'    [   21]    [    1]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [1192.7]    [  1]    [1192.7]    [17.746]    [4.9606e-005]
    'Error'     [7930.5]    [118]    [67.208]          []               []
    'Total'     [9123.2]    [119]          []          []               []
```

```
ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Northwest'

p =
      0.22005

results =
    'Name'             'Means'    'Error'
    'Northwest'        [   19]    [    1]
    'Other Regions'    [   17]    [    1]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [116.03]    [  1]    [116.03]    [1.5201]    [0.22005]
    'Error'     [9007.2]    [118]    [76.332]          []           []
```

```
    'Total'     [9123.2]    [119]          []          []          []


ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Country'

p =
       0.5709

results =
    'Name'             'Means'    'Error'
    'International'    [   16]    [    3]
    'USA'              [   18]    [    1]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'          'Prob>F'
    'Groups'    [24.904]    [  1]    [24.904]    [0.32299]    [0.5709]
    'Error'     [9098.3]    [118]    [77.104]           []          []
    'Total'     [9123.2]    [119]          []           []          []


ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Owner'

p =
  1.0638e-005
P-Value is SIGNIFICANT

results =
    'Name'                'Means'    'Error'
    'City/County'         [   21]    [    1]
    'State/Provincial'    [   15]    [    1]
    'Federal/National'    [   24]    [    2]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [1621.9]    [  2]    [810.95]    [12.649]    [1.0638e-005]
    'Error'     [7501.3]    [117]    [64.114]          []               []
    'Total'     [9123.2]    [119]          []          []               []


ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Contract'

p =
     0.025051
P-Value is SIGNIFICANT

results =
    'Name'                'Means'    'Error'
    'Conventional DBB'    [   19]    [    1]
    'Alternative'         [   14]    [    2]
    'Unknown'             [   15]    [    3]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [557.23]    [  2]    [278.61]    [3.8055]    [0.025051]
```

```
    'Error'     [  8566]    [117]    [73.213]          []            []
    'Total'     [9123.2]    [119]          []          []            []


ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Phase'

p =
      0.16968

results =
    'Name'            'Means'    'Error'
    'Planning'        [   13]    [    2]
    'Finished'        [   18]    [    1]
    'Construction'    [   19]    [    2]
    'Design'          [   18]    [    2]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [385.47]    [  3]    [128.49]    [1.7058]    [0.16968]
    'Error'     [8737.7]    [116]    [75.325]          []           []
    'Total'     [9123.2]    [119]          []          []           []


ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Purpose'

p =
     0.001918
P-Value is SIGNIFICANT

results =
    'Name'              'Means'    'Error'
    'New'               [   18]    [    2]
    'Maintenance'       [   21]    [    1]
    'Reconstruction'    [   15]    [    1]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [925.35]    [  2]    [462.67]    [6.6033]    [0.001918]
    'Error'     [8197.9]    [117]    [70.067]          []            []
    'Total'     [9123.2]    [119]          []          []            []


ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Motivation'

p =
    0.0010978
P-Value is SIGNIFICANT

results =
    'Name'             'Means'    'Error'
    'Mobility'         [   15]    [    1]
    'Preservation'     [   21]    [    1]
    'Economic'         [   16]    [    2]
    'Safety'           [   16]    [    3]
    'Environmental'    [   21]    [    3]
```

```
    'Other'            [   29]    [    5]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [1470.8]    [  5]    [294.16]    [4.3822]    [0.0010978]
    'Error'     [7652.4]    [114]    [67.126]          []             []
    'Total'     [9123.2]    [119]          []          []             []



ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Surfacing'

p =
    0.0014641
P-Value is SIGNIFICANT

results =
    'Name'     'Means'    'Error'
    'HMA'      [   19]    [    1]
    'PCC'      [   15]    [    2]
    'Mixed'    [   12]    [    2]
    'Other'    [   28]    [    4]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'        'Prob>F'
    'Groups'    [1133.7]    [  3]    [377.91]    [5.487]    [0.0014641]
    'Error'     [7989.5]    [116]    [68.875]         []             []
    'Total'     [9123.2]    [119]          []         []             []



ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Place'

p =
     0.012613
P-Value is SIGNIFICANT

results =
    'Name'           'Means'    'Error'
    'Small Urban'    [   17]    [    1]
    'Rural'          [   21]    [    1]
    'Urban'          [   15]    [    1]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [657.12]    [  2]    [328.56]    [4.5406]    [0.012613]
    'Error'     [8466.1]    [117]    [ 72.36]          []            []
    'Total'     [9123.2]    [119]          []          []            []



ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'FunctClass'

p =
   2.653e-009
P-Value is SIGNIFICANT
```

```
results =
    'Name'         'Means'    'Error'
    'Collector'    [   21]    [    1]
    'Arterial'     [   15]    [    1]
    'Local'        [   29]    [    2]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'        'Prob>F'
    'Groups'    [2613.7]    [  2]    [1306.9]    [23.49]    [2.653e-009]
    'Error'     [6509.5]    [117]    [55.636]         []              []
    'Total'     [9123.2]    [119]          []         []              []



ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Length'

p =
     0.036599
P-Value is SIGNIFICANT

results =
    'Name'    'Means'    'Error'
    '0-1'     [   21]    [    1]
    '5+'      [   17]    [    2]
    '1-5'     [   16]    [    1]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'        'Prob>F'
    'Groups'    [501.54]    [  2]    [250.77]    [3.403]    [0.036599]
    'Error'     [8621.7]    [117]    [73.689]         []            []
    'Total'     [9123.2]    [119]          []         []            []



ANALYSIS OF POINTS NOT AVAILABLE - Weighted
Property
    'Budget'

p =
  8.2877e-011
P-Value is SIGNIFICANT

results =
    'Name'      'Means'    'Error'
    '0-10'      [   22]    [    1]
    '10-100'    [   15]    [    1]
    '100+'      [    9]    [    2]

ANOVA Results - NA Scores
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [2988.2]    [  2]    [1494.1]    [28.494]    [8.2877e-011]
    'Error'     [  6135]    [117]    [52.436]          []               []
    'Total'     [9123.2]    [119]          []          []               []



MULTIVARIATE ANALYSIS - Weighted
Property
    'GreenroadsProject'

MANOVA Results - Weighted
```

```
d =
     1
p =
     0.007866

P =
     0.007866
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.92051
chisq =
       9.6904
gmdist =
            0      0.58813
      0.58813            0
eigenval =
     0.086351
   1.249e-016



MULTIVARIATE ANALYSIS - Weighted
Property
    'GreenEmphasis'

MANOVA Results - Weighted
d =
     1
p =
    0.0083769

P =
    0.0083769
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
       0.9215
chisq =
       9.5646
gmdist =
            0      0.39277
      0.39277            0
eigenval =
     0.085183
 -1.0175e-016



MULTIVARIATE ANALYSIS - Weighted
Property
    'MajorStructures'

MANOVA Results - Weighted
d =
     1
p =
   0.00026983

P =
   0.00026983
P-Value is SIGNIFICANT
```

```
Canonical Coefficients - Weighted Analysis
lambda =
      0.86895
chisq =
       16.435
gmdist =
            0      0.59737
      0.59737            0
eigenval =
      0.15082
  1.8388e-016
```

```
MULTIVARIATE ANALYSIS - Weighted
Property
    'Northwest'

MANOVA Results - Weighted
d =
     0
p =
      0.20179
```

```
Canonical Coefficients - Weighted Analysis
lambda =
      0.97301
chisq =
       3.2011
gmdist =
            0       0.1091
       0.1091            0
eigenval =
     0.027737
  3.4694e-017
```

```
MULTIVARIATE ANALYSIS - Weighted
Property
    'Country'

MANOVA Results - Weighted
d =
     0
p =
      0.82396
```

```
Canonical Coefficients - Weighted Analysis
lambda =
       0.9967
chisq =
      0.38728
gmdist =
            0     0.036225
     0.036225            0
eigenval =
    0.0033155
  6.6136e-018
```

```
MULTIVARIATE ANALYSIS - Weighted
Property
    'Owner'

MANOVA Results - Weighted
d =
     1
p =
  2.3581e-005
      0.11889

P =
  2.3581e-005
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.79564
      0.97934
chisq =
       26.633
       2.4319
gmdist =
            0      0.74393      0.35608
      0.74393            0       1.5053
      0.35608       1.5053            0
eigenval =
      0.23089
     0.021094



MULTIVARIATE ANALYSIS - Weighted
Property
    'Contract'

MANOVA Results - Weighted
d =
     1
p =
    0.0038575
      0.30713

P =
    0.0038575
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.87582
      0.99109
chisq =
       15.448
        1.043
gmdist =
            0      0.86646       0.2375
      0.86646            0      0.67647
       0.2375      0.67647            0
eigenval =
      0.13161
    0.0089929
```

```
MULTIVARIATE ANALYSIS - Weighted
Property
    'Phase'

MANOVA Results - Weighted
d =
     1
p =
    0.0048073
      0.20451

P =
    0.0048073
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.85152
      0.97301
chisq =
       18.645
       3.1743
gmdist =
            0      0.30431      0.85228       1.3429
      0.30431            0       0.1988      0.68957
      0.85228       0.1988            0      0.20587
       1.3429      0.68957      0.20587            0
eigenval =
      0.14267
     0.027742



MULTIVARIATE ANALYSIS - Weighted
Property
    'Purpose'

MANOVA Results - Weighted
d =
     1
p =
    0.0089896
      0.72867

P =
    0.0089896
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.89042
      0.99897
chisq =
       13.522
      0.12034
gmdist =
            0      0.12564      0.17416
      0.12564            0      0.56361
      0.17416      0.56361            0
eigenval =
      0.12191
    0.0010335
```

```
MULTIVARIATE ANALYSIS - Weighted
Property
    'Motivation'

MANOVA Results - Weighted
d =
     1
p =
    0.0040008
      0.81096

P =
    0.0040008
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.79895
      0.98629
chisq =
       25.812
       1.5879
gmdist =
            0      0.93735      0.19034     0.053528      0.67707       3.5146
      0.93735            0      0.41764      0.61375     0.084513      0.84683
      0.19034      0.41764            0      0.16007      0.39659       2.4433
     0.053528      0.61375      0.16007            0      0.36544        2.788
      0.67707     0.084513      0.39659      0.36544            0       1.1486
       3.5146      0.84683       2.4433        2.788       1.1486            0
eigenval =
      0.23448
     0.013904



MULTIVARIATE ANALYSIS - Weighted
Property
    'Surfacing'

MANOVA Results - Weighted
d =
     1
p =
   0.00027296
       0.2346

P =
   0.00027296
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.80249
      0.97531
chisq =
       25.524
       2.8997
gmdist =
            0      0.80318      0.81251       1.2211
      0.80318            0      0.27195       3.5213
      0.81251      0.27195            0       4.0102
```

```
       1.2211       3.5213       4.0102            0
eigenval =
      0.21536
     0.025313



MULTIVARIATE ANALYSIS - Weighted
Property
    'Place'

MANOVA Results - Weighted
d =
     1
p =
    0.0019423
      0.75233

P =
    0.0019423
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
       0.8643
      0.99915
chisq =
       16.989
     0.099582
gmdist =
            0      0.34164      0.11904
      0.34164            0      0.84649
      0.11904      0.84649            0
eigenval =
      0.15601
   0.00085514



MULTIVARIATE ANALYSIS - Weighted
Property
    'FunctClass'

MANOVA Results - Weighted
d =
     1
p =
    5.59e-008
      0.72592

P =
    5.59e-008
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.71267
      0.99895
chisq =
       39.463
      0.12289
gmdist =
            0      0.83007       1.1002
      0.83007            0       3.8139
```

```
       1.1002       3.8139            0
eigenval =
      0.40169
    0.0010554



MULTIVARIATE ANALYSIS - Weighted
Property
    'Length'

MANOVA Results - Weighted
d =
     1
p =
     0.042095
      0.62397

P =
     0.042095
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.91851
      0.99794
chisq =
       9.9029
      0.24032
gmdist =
            0      0.26607      0.43808
      0.26607            0     0.036733
      0.43808     0.036733            0
eigenval =
     0.086477
     0.002065



MULTIVARIATE ANALYSIS - Weighted
Property
    'Budget'

MANOVA Results - Weighted
d =
     1
p =
   8.007e-012
      0.25835

P =
   8.007e-012
P-Value is SIGNIFICANT


Canonical Coefficients - Weighted Analysis
lambda =
      0.60835
      0.98909
chisq =
         57.9
       1.2776
gmdist =
            0       1.1866        4.566
       1.1866            0       1.2088
```

```
        4.566       1.2088            0
eigenval =
      0.62585
     0.011027



UNWEIGHTED ANALYSIS

Loading dataset...
Chi Squared Goodness of Fit for Unweighted Raw Scores
UWRawChi2 =
     0

Chi Squared Goodness of Fit for Unweighted Economical Scores
UWEconChi2 =
     1

Chi Squared Goodness of Fit for Unweighted NA Scores
UWNAChi2 =
     1

Chi Squared Goodness of Fit for Unweighted Reasonable Scores
UWReasChi2 =
     1

Check correlation between Reasonable Scores and Economical Points Available - Unweighted Case
R =
            1      0.95789
      0.95789            1
P =
            1  8.6507e-066
  8.6507e-066            1

RAW SCORE ANALYSIS - Unweighted
Property
    'GreenroadsProject'

p =
    0.0003287
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'              'Means'    'Error'
    'Not Greenroads'    [    9]    [    0]
    'Greenroads'        [   12]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [165.05]    [  1]    [165.05]    [13.691]    [0.0003287]
    'Error'     [1422.5]    [118]    [12.055]          []             []
    'Total'     [1587.6]    [119]          []          []             []



RAW SCORE ANALYSIS - Unweighted
Property
    'GreenEmphasis'

p =
    0.0022318
P-Value is SIGNIFICANT

Multiple Comparison of Means
```

```
results =
    'Name'       'Means'    'Error'
    'Typical'    [    9]    [    0]
    'Greener'    [   11]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [121.41]    [  1]    [121.41]    [9.7714]    [0.0022318]
    'Error'     [1466.2]    [118]    [12.425]          []             []
    'Total'     [1587.6]    [119]          []          []             []



RAW SCORE ANALYSIS - Unweighted
Property
    'MajorStructures'

p =
     0.048303
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'Structures'       [   10]    [    0]
    'No Structures'    [    9]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [51.821]    [  1]    [51.821]    [3.9816]    [0.048303]
    'Error'     [1535.8]    [118]    [13.015]          []            []
    'Total'     [1587.6]    [119]          []          []            []



RAW SCORE ANALYSIS - Unweighted
Property
    'Northwest'

p =
      0.20375

Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'Northwest'        [    9]    [    0]
    'Other Regions'    [   10]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [21.675]    [  1]    [21.675]    [1.6333]    [0.20375]
    'Error'     [1565.9]    [118]    [ 13.27]          []           []
    'Total'     [1587.6]    [119]          []          []           []



RAW SCORE ANALYSIS - Unweighted
Property
    'Country'

p =
      0.52349
```

```
Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'International'    [   10]    [    1]
    'USA'              [    9]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'          'Prob>F'
    'Groups'    [5.4898]    [  1]    [5.4898]    [0.40945]    [0.52349]
    'Error'     [1582.1]    [118]    [13.408]           []           []
    'Total'     [1587.6]    [119]          []           []           []



RAW SCORE ANALYSIS - Unweighted
Property
    'Owner'

p =
      0.19093

Multiple Comparison of Means
results =
    'Name'                'Means'    'Error'
    'City/County'         [   10]    [    1]
    'State/Provincial'    [    9]    [    0]
    'Federal/National'    [   10]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [44.307]    [  2]    [22.153]    [1.6795]    [0.19093]
    'Error'     [1543.3]    [117]    [ 13.19]          []           []
    'Total'     [1587.6]    [119]          []          []           []



RAW SCORE ANALYSIS - Unweighted
Property
    'Contract'

p =
    0.0069078
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'                'Means'    'Error'
    'Conventional DBB'    [    9]    [    0]
    'Alternative'         [   12]    [    1]
    'Unknown'             [    9]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [129.43]    [  2]    [64.717]    [5.1928]    [0.0069078]
    'Error'     [1458.2]    [117]    [12.463]          []             []
    'Total'     [1587.6]    [119]          []          []             []



RAW SCORE ANALYSIS - Unweighted
Property
    'Phase'
```

```
p =
   0.00070379
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'            'Means'    'Error'
    'Planning'        [    9]    [    1]
    'Finished'        [    8]    [    0]
    'Construction'    [   10]    [    1]
    'Design'          [   12]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [215.67]    [  3]    [71.891]    [6.0786]    [0.00070379]
    'Error'     [1371.9]    [116]    [11.827]          []              []
    'Total'     [1587.6]    [119]          []          []              []



RAW SCORE ANALYSIS - Unweighted
Property
    'Purpose'

p =
      0.01978
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'              'Means'    'Error'
    'New'               [    9]    [    1]
    'Maintenance'       [    8]    [    1]
    'Reconstruction'    [   10]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [102.97]    [  2]    [51.487]    [4.0576]    [0.01978]
    'Error'     [1484.6]    [117]    [12.689]          []           []
    'Total'     [1587.6]    [119]          []          []           []



RAW SCORE ANALYSIS - Unweighted
Property
    'Motivation'

p =
    0.0032094
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'Mobility'         [   11]    [    0]
    'Preservation'     [    8]    [    1]
    'Economic'         [   10]    [    1]
    'Safety'           [   11]    [    1]
    'Environmental'    [    8]    [    1]
    'Other'            [    6]    [    2]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
```

```
    'Groups'    [226.78]    [  5]    [45.356]    [3.7997]    [0.0032094]
    'Error'     [1360.8]    [114]    [11.937]          []             []
    'Total'     [1587.6]    [119]          []          []             []



RAW SCORE ANALYSIS - Unweighted
Property
    'Surfacing'

p =
      0.10582

Multiple Comparison of Means
results =
    'Name'     'Means'    'Error'
    'HMA'      [    9]    [    0]
    'PCC'      [   11]    [    1]
    'Mixed'    [   10]    [    1]
    'Other'    [    7]    [    2]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [81.275]    [  3]    [27.092]    [2.0863]    [0.10582]
    'Error'     [1506.3]    [116]    [12.985]          []           []
    'Total'     [1587.6]    [119]          []          []           []



RAW SCORE ANALYSIS - Unweighted
Property
    'Place'

p =
       0.1085

Multiple Comparison of Means
results =
    'Name'           'Means'    'Error'
    'Small Urban'    [   10]    [    1]
    'Rural'          [    8]    [    1]
    'Urban'          [   10]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [59.144]    [  2]    [29.572]    [2.2637]    [0.1085]
    'Error'     [1528.4]    [117]    [13.064]          []          []
    'Total'     [1587.6]    [119]          []          []          []



RAW SCORE ANALYSIS - Unweighted
Property
    'FunctClass'

p =
       0.9442

Multiple Comparison of Means
results =
    'Name'         'Means'    'Error'
    'Collector'    [    9]    [    1]
    'Arterial'     [    9]    [    0]
    'Local'        [    9]    [    1]
```

```
ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'         'F'           'Prob>F'
    'Groups'    [1.5573]    [  2]    [0.77867]    [0.057442]    [0.9442]
    'Error'     [  1586]    [117]    [ 13.556]            []          []
    'Total'     [1587.6]    [119]           []            []          []



RAW SCORE ANALYSIS - Unweighted
Property
    'Length'

p =
      0.34285

Multiple Comparison of Means
results =
    'Name'    'Means'    'Error'
    '0-1'     [   10]    [    1]
    '5+'      [    9]    [    1]
    '1-5'     [    9]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [28.786]    [  2]    [14.393]    [1.0803]    [0.34285]
    'Error'     [1558.8]    [117]    [13.323]          []           []
    'Total'     [1587.6]    [119]          []          []           []



RAW SCORE ANALYSIS - Unweighted
Property
    'Budget'

p =
  4.0498e-005
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'      'Means'    'Error'
    '0-10'      [    8]    [    0]
    '10-100'    [   10]    [    1]
    '100+'      [   12]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [252.07]    [  2]    [126.03]    [11.041]    [4.0498e-005]
    'Error'     [1335.5]    [117]    [11.415]          []               []
    'Total'     [1587.6]    [119]          []          []               []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'GreenroadsProject'

p =
    0.0003287
P-Value is SIGNIFICANT

Multiple Comparison of Means
```

```
results =
    'Name'               'Means'    'Error'
    'Not Greenroads'    [    9]    [    0]
    'Greenroads'        [   12]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [165.05]    [  1]    [165.05]    [13.691]    [0.0003287]
    'Error'     [1422.5]    [118]    [12.055]          []             []
    'Total'     [1587.6]    [119]          []          []             []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'GreenEmphasis'

p =
    0.0022318
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'       'Means'    'Error'
    'Typical'    [    9]    [    0]
    'Greener'    [   11]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [121.41]    [  1]    [121.41]    [9.7714]    [0.0022318]
    'Error'     [1466.2]    [118]    [12.425]          []             []
    'Total'     [1587.6]    [119]          []          []             []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'MajorStructures'

p =
     0.048303
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'Structures'       [   10]    [    0]
    'No Structures'    [    9]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [51.821]    [  1]    [51.821]    [3.9816]    [0.048303]
    'Error'     [1535.8]    [118]    [13.015]          []            []
    'Total'     [1587.6]    [119]          []          []            []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Northwest'

p =
      0.20375
```

```
Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'Northwest'        [    9]    [    0]
    'Other Regions'    [   10]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [21.675]    [  1]    [21.675]    [1.6333]    [0.20375]
    'Error'     [1565.9]    [118]    [ 13.27]          []           []
    'Total'     [1587.6]    [119]          []          []           []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Country'

p =
      0.52349

Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'International'    [   10]    [    1]
    'USA'              [    9]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'          'Prob>F'
    'Groups'    [5.4898]    [  1]    [5.4898]    [0.40945]    [0.52349]
    'Error'     [1582.1]    [118]    [13.408]           []           []
    'Total'     [1587.6]    [119]          []           []           []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Owner'

p =
      0.19093

Multiple Comparison of Means
results =
    'Name'                'Means'    'Error'
    'City/County'         [   10]    [    1]
    'State/Provincial'    [    9]    [    0]
    'Federal/National'    [   10]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [44.307]    [  2]    [22.153]    [1.6795]    [0.19093]
    'Error'     [1543.3]    [117]    [ 13.19]          []           []
    'Total'     [1587.6]    [119]          []          []           []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Contract'

p =
```

```
    0.0069078
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'                 'Means'    'Error'
    'Conventional DBB'    [    9]    [    0]
    'Alternative'         [   12]    [    1]
    'Unknown'             [    9]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [129.43]    [  2]    [64.717]    [5.1928]    [0.0069078]
    'Error'     [1458.2]    [117]    [12.463]          []             []
    'Total'     [1587.6]    [119]          []          []             []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Phase'

p =
   0.00070379
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'Planning'        [    9]    [    1]
    'Finished'        [    8]    [    0]
    'Construction'    [   10]    [    1]
    'Design'          [   12]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [215.67]    [  3]    [71.891]    [6.0786]    [0.00070379]
    'Error'     [1371.9]    [116]    [11.827]          []              []
    'Total'     [1587.6]    [119]          []          []              []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Purpose'

p =
      0.01978
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'               'Means'    'Error'
    'New'               [    9]    [    1]
    'Maintenance'       [    8]    [    1]
    'Reconstruction'    [   10]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [102.97]    [  2]    [51.487]    [4.0576]    [0.01978]
    'Error'     [1484.6]    [117]    [12.689]          []           []
    'Total'     [1587.6]    [119]          []          []           []
```

```
ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Motivation'

p =
    0.0032094
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'Mobility'         [   11]    [    0]
    'Preservation'     [    8]    [    1]
    'Economic'         [   10]    [    1]
    'Safety'           [   11]    [    1]
    'Environmental'    [    8]    [    1]
    'Other'            [    6]    [    2]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [226.78]    [  5]    [45.356]    [3.7997]    [0.0032094]
    'Error'     [1360.8]    [114]    [11.937]          []             []
    'Total'     [1587.6]    [119]          []          []             []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Surfacing'

p =
      0.10582

Multiple Comparison of Means
results =
    'Name'     'Means'    'Error'
    'HMA'      [    9]    [    0]
    'PCC'      [   11]    [    1]
    'Mixed'    [   10]    [    1]
    'Other'    [    7]    [    2]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [81.275]    [  3]    [27.092]    [2.0863]    [0.10582]
    'Error'     [1506.3]    [116]    [12.985]          []           []
    'Total'     [1587.6]    [119]          []          []           []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Place'

p =
       0.1085

Multiple Comparison of Means
results =
    'Name'           'Means'    'Error'
    'Small Urban'    [   10]    [    1]
    'Rural'          [    8]    [    1]
    'Urban'          [   10]    [    1]
```

```
ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [59.144]    [  2]    [29.572]    [2.2637]    [0.1085]
    'Error'     [1528.4]    [117]    [13.064]          []          []
    'Total'     [1587.6]    [119]          []          []          []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'FunctClass'

p =
       0.9442

Multiple Comparison of Means
results =
    'Name'         'Means'    'Error'
    'Collector'    [    9]    [    1]
    'Arterial'     [    9]    [    0]
    'Local'        [    9]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'         'F'           'Prob>F'
    'Groups'    [1.5573]    [  2]    [0.77867]    [0.057442]    [0.9442]
    'Error'     [  1586]    [117]    [ 13.556]            []          []
    'Total'     [1587.6]    [119]           []            []          []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Length'

p =
      0.34285

Multiple Comparison of Means
results =
    'Name'    'Means'    'Error'
    '0-1'     [   10]    [    1]
    '5+'      [    9]    [    1]
    '1-5'     [    9]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [28.786]    [  2]    [14.393]    [1.0803]    [0.34285]
    'Error'     [1558.8]    [117]    [13.323]          []           []
    'Total'     [1587.6]    [119]          []          []           []



ANALYSIS OF POINTS NOT AVAILABLE - Unweighted
Property
    'Budget'

p =
  4.0498e-005
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
```

```
    'Name'      'Means'    'Error'
    '0-10'      [    8]    [    0]
    '10-100'    [   10]    [    1]
    '100+'      [   12]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'        'df'     'MS'        'F'         'Prob>F'
    'Groups'    [252.07]    [  2]    [126.03]    [11.041]    [4.0498e-005]
    'Error'     [1335.5]    [117]    [11.415]          []               []
    'Total'     [1587.6]    [119]          []          []               []


MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'GreenroadsProject'

MANOVA Results
d =
     1
p =
    0.0001337

P =
    0.0001337
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.85858
chisq =
        17.84
gmdist =
            0       1.1219
       1.1219            0
eigenval =
      0.16472
 -5.5511e-017



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'GreenEmphasis'

MANOVA Results
d =
     1
p =
    0.0083209

P =
    0.0083209
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
       0.9214
chisq =
```

```
        9.578
gmdist =
            0      0.39334
      0.39334            0
eigenval =
     0.085307
   3.296e-016



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'MajorStructures'

MANOVA Results
d =
     1
p =
   9.111e-007

P =
   9.111e-007
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
       0.7884
chisq =
       27.817
gmdist =
            0       1.0631
       1.0631            0
eigenval =
       0.2684
  1.2143e-016



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'Northwest'

MANOVA Results
d =
     1
p =
     0.035948

P =
     0.035948
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.94474
chisq =
       6.6514
gmdist =
            0      0.23009
      0.23009            0
```

```
eigenval =
     0.058496
  1.4225e-016



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'Country'

MANOVA Results
d =
     0
p =
      0.49822



Canonical Coefficients
lambda =
      0.98816
chisq =
       1.3934
gmdist =
            0       0.1309
       0.1309            0
eigenval =
     0.011981
  -2.949e-017



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'Owner'

MANOVA Results
d =
     1
p =
   0.00023565
      0.94112

P =
   0.00023565
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.83043
      0.99995
chisq =
       21.646
    0.0054558
gmdist =
            0      0.88113     0.022158
      0.88113            0      0.62699
     0.022158      0.62699            0
eigenval =
      0.20413
  4.6832e-005
```

```
MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates
canonical coefficient plots comparing multiple score conditions
Property
    'Contract'

MANOVA Results
d =
     1
p =
     0.003238
      0.37075

P =
     0.003238
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.87285
      0.99315
chisq =
       15.842
      0.80116
gmdist =
            0      0.89388      0.29457
      0.89388            0       0.4545
      0.29457       0.4545            0
eigenval =
      0.13782
    0.0069006



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates
canonical coefficient plots comparing multiple score conditions
Property
    'Phase'

MANOVA Results
d =
     1
p =
    0.0014179
      0.21181

P =
    0.0014179
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.82995
       0.9736
chisq =
       21.621
       3.1041
gmdist =
            0      0.25003      0.59919       1.1559
      0.25003            0      0.39558       1.0265
```

```
      0.59919      0.39558            0      0.14892
       1.1559       1.0265      0.14892            0
eigenval =
      0.17308
     0.027121



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'Purpose'

MANOVA Results
d =
     1
p =
   0.00024032
      0.87247

P =
   0.00024032
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.83074
      0.99978
chisq =
       21.604
     0.025766
gmdist =
            0      0.38259      0.12708
      0.38259            0      0.94335
      0.12708      0.94335            0
eigenval =
      0.20348
   0.00022119



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'Motivation'

MANOVA Results
d =
     1
p =
  5.1739e-006
      0.97945

P =
  5.1739e-006
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.68861
      0.99622
chisq =
```

```
       42.904
      0.43573
gmdist =
            0       1.7178      0.21185     0.043832        1.575       4.9124
       1.7178            0      0.72535        2.001     0.012787      0.82799
      0.21185      0.72535            0      0.34996      0.63177       3.0966
     0.043832        2.001      0.34996            0       1.8836       5.3174
        1.575     0.012787      0.63177       1.8836            0      0.96987
       4.9124      0.82799       3.0966       5.3174      0.96987            0
eigenval =
       0.4467
    0.0037961


MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'Surfacing'

MANOVA Results
d =
     1
p =
     0.028795
      0.37952

P =
     0.028795
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.88573
      0.98343
chisq =
       14.076
       1.9377
gmdist =
            0      0.20933      0.43539       1.1436
      0.20933            0       0.3014       1.9592
      0.43539       0.3014            0       2.9874
       1.1436       1.9592       2.9874            0
eigenval =
      0.11031
     0.016845


MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'Place'

MANOVA Results
d =
     0
p =
      0.32505
      0.64506
```

```
Canonical Coefficients
lambda =
      0.96087
      0.99818
chisq =
       4.6507
      0.21218
gmdist =
            0      0.12624     0.019352
      0.12624            0      0.19489
     0.019352      0.19489            0
eigenval =
     0.038834
     0.001823



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'FunctClass'

MANOVA Results
d =
     1
p =
  2.3392e-005
      0.86051

P =
  2.3392e-005
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.79552
      0.99973
chisq =
        26.65
     0.030879
gmdist =
            0      0.41326      0.97581
      0.41326            0       2.6525
      0.97581       2.6525            0
eigenval =
       0.2567
   0.00026509



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates↙
canonical coefficient plots comparing multiple score conditions
Property
    'Length'

MANOVA Results
d =
     1
p =
     0.038346
      0.74083

P =
```

```
     0.038346
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.91675
      0.99906
chisq =
       10.127
      0.10939
gmdist =
            0      0.44645      0.38446
      0.44645            0    0.0082641
      0.38446    0.0082641            0
eigenval =
     0.089791
   0.00093945



MULTIVARIATE ANALYSIS - Unweighted Case
This section investigates multivariable relationships within project properties and creates
canonical coefficient plots comparing multiple score conditions
Property
    'Budget'

MANOVA Results
d =
     1
p =
  9.3089e-014
      0.57212

P =
  9.3089e-014
P-Value is SIGNIFICANT


Canonical Coefficients
lambda =
      0.56219
      0.99726
chisq =
       67.095
      0.31914
gmdist =
            0       1.8603       5.0791
       1.8603            0      0.81739
       5.0791      0.81739            0
eigenval =
      0.77391
    0.0027432



EDU>>
```

```
MATLAB Results from dissdqs.m

DATA QUALITY ANALYSIS

Chi Squared Goodness of Fit for Data Quality Scores
DQSChi2 =
     1

Correlation Analysis - Weighted Condition
DQScorr =
    'Weighted Analysis'       'DQ Score'    'Raw Score'    'Reas Score'    'NA Score'
    'Data Quality Score'      [       1]    [   0.2279]    [   -0.0572]    [  0.1158]
    'Raw Score'               [  0.2279]    [        1]    [    0.3103]    [ -0.1808]
    'Reasonable Score'        [ -0.0572]    [   0.3103]    [         1]    [ -0.6792]
    'Points Not Available'    [  0.1158]    [  -0.1808]    [   -0.6792]    [       1]


Correlation Analysis - Unweighted Condition
uwDQScorr =
    'Weighted Analysis'       'DQ Score'    'Raw Score'    'Reas Score'    'NA Score'
    'Data Quality Score'      [       1]    [   0.2489]    [   -0.0794]    [  0.1352]
    'Raw Score'               [  0.2489]    [        1]    [    0.3226]    [ -0.1349]
    'Reasonable Score'        [ -0.0794]    [   0.3226]    [         1]    [ -0.6649]
    'Points Not Available'    [  0.1352]    [  -0.1349]    [   -0.6649]    [       1]


DATA QUALITY SCORE ANALYSIS
Property
    'GreenroadsProject'

p =
    0.3041

Multiple Comparison of Means
results =
    'Name'              'Means'    'Error'
    'Not Greenroads'    [    6]    [    0]
    'Greenroads'        [    7]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'        'F'         'Prob>F'
    'Groups'    [  4.9922]    [  1]    [4.9922]    [1.0655]    [0.3041]
    'Error'     [552.8745]    [118]    [4.6854]          []          []
    'Total'     [557.8667]    [119]          []          []          []



DATA QUALITY SCORE ANALYSIS
Property
    'GreenEmphasis'

p =
    0.2529

Multiple Comparison of Means
results =
    'Name'       'Means'    'Error'
    'Typical'    [    7]    [    0]
    'Greener'    [    6]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'        'F'         'Prob>F'
    'Groups'    [  6.1708]    [  1]    [6.1708]    [1.3198]    [0.2529]
    'Error'     [551.6959]    [118]    [4.6754]          []          []
```

```
    'Total'     [557.8667]    [119]          []          []          []


DATA QUALITY SCORE ANALYSIS
Property
    'MajorStructures'

p =
    0.7260

Multiple Comparison of Means
results =
    'Name'              'Means'    'Error'
    'Structures'        [    6]    [    0]
    'No Structures'     [    6]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'        'F'         'Prob>F'
    'Groups'    [  0.5828]    [  1]    [0.5828]    [0.1234]    [0.7260]
    'Error'     [557.2839]    [118]    [4.7227]          []          []
    'Total'     [557.8667]    [119]          []          []          []



DATA QUALITY SCORE ANALYSIS
Property
    'Northwest'

p =
    0.0084
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'              'Means'    'Error'
    'Northwest'         [    7]    [    0]
    'Other Regions'     [    6]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'         'F'         'Prob>F'
    'Groups'    [ 32.0333]    [  1]    [32.0333]    [7.1885]    [0.0084]
    'Error'     [525.8333]    [118]    [ 4.4562]          []          []
    'Total'     [557.8667]    [119]           []          []          []



DATA QUALITY SCORE ANALYSIS
Property
    'Country'

p =
    0.3706

Multiple Comparison of Means
results =
    'Name'              'Means'    'Error'
    'International'     [    6]    [    1]
    'USA'               [    6]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'        'F'         'Prob>F'
    'Groups'    [  3.7926]    [  1]    [3.7926]    [0.8077]    [0.3706]
```

```
    'Error'     [554.0741]    [118]    [4.6955]          []          []
    'Total'     [557.8667]    [119]          []          []          []


DATA QUALITY SCORE ANALYSIS
Property
    'Owner'

p =
    0.0051
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'                'Means'    'Error'
    'City/County'         [    7]    [    0]
    'State/Provincial'    [    6]    [    0]
    'Federal/National'    [    8]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'         'F'         'Prob>F'
    'Groups'    [ 48.0889]    [  2]    [24.0444]    [5.5185]    [0.0051]
    'Error'     [509.7778]    [117]    [ 4.3571]          []          []
    'Total'     [557.8667]    [119]           []          []          []


DATA QUALITY SCORE ANALYSIS
Property
    'Contract'

p =
    0.2288

Multiple Comparison of Means
results =
    'Name'                'Means'    'Error'
    'Conventional DBB'    [    7]    [    0]
    'Alternative'         [    6]    [    0]
    'Unknown'             [    5]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'        'F'         'Prob>F'
    'Groups'    [ 13.8891]    [  2]    [6.9445]    [1.4936]    [0.2288]
    'Error'     [543.9776]    [117]    [4.6494]          []          []
    'Total'     [557.8667]    [119]          []          []          []


DATA QUALITY SCORE ANALYSIS
Property
    'Phase'

p =
    0.0178
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'            'Means'    'Error'
    'Planning'        [    6]    [    1]
    'Finished'        [    6]    [    0]
    'Construction'    [    7]    [    0]
```

```
    'Design'          [    7]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'          'F'          'Prob>F'
    'Groups'    [ 46.3023]    [  3]    [15.4341]    [3.4998]    [0.0178]
    'Error'     [511.5643]    [116]    [ 4.4100]          []          []
    'Total'     [557.8667]    [119]           []          []          []



DATA QUALITY SCORE ANALYSIS
Property
    'Purpose'

p =
    0.1946

Multiple Comparison of Means
results =
    'Name'              'Means'    'Error'
    'New'               [    6]    [    1]
    'Maintenance'       [    7]    [    0]
    'Reconstruction'    [    6]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'         'F'          'Prob>F'
    'Groups'    [ 15.3918]    [  2]    [7.6959]    [1.6598]    [0.1946]
    'Error'     [542.4749]    [117]    [4.6365]          []          []
    'Total'     [557.8667]    [119]          []          []          []



DATA QUALITY SCORE ANALYSIS
Property
    'Motivation'

p =
    0.0852

Multiple Comparison of Means
results =
    'Name'             'Means'    'Error'
    'Mobility'         [    6]    [    0]
    'Preservation'     [    7]    [    0]
    'Economic'         [    6]    [    1]
    'Safety'           [    8]    [    1]
    'Environmental'    [    6]    [    1]
    'Other'            [    5]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'         'F'          'Prob>F'
    'Groups'    [ 44.8069]    [  5]    [8.9614]    [1.9912]    [0.0852]
    'Error'     [513.0597]    [114]    [4.5005]          []          []
    'Total'     [557.8667]    [119]          []          []          []



DATA QUALITY SCORE ANALYSIS
Property
    'Surfacing'

p =
    0.1682
```

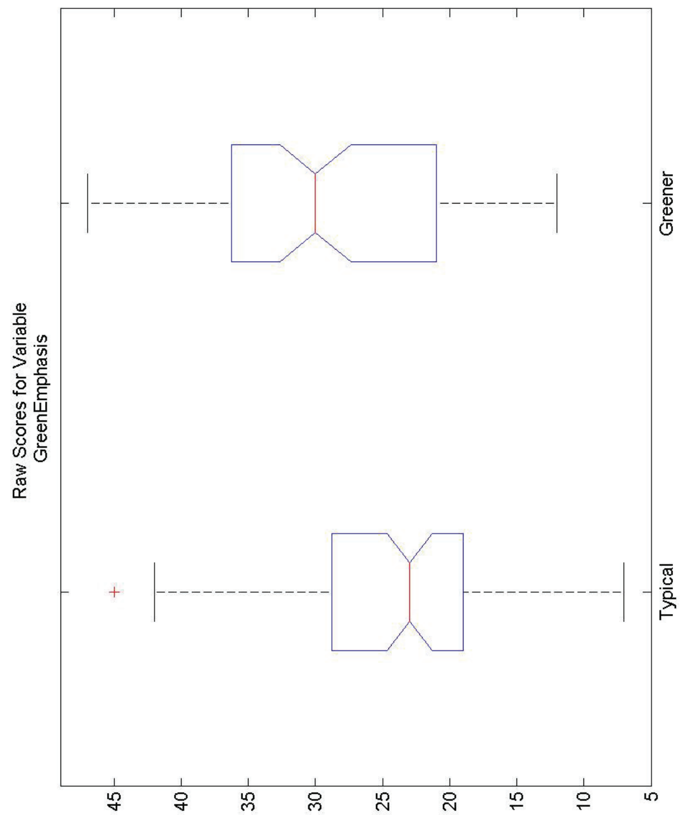
```
Multiple Comparison of Means
results =
    'Name'     'Means'    'Error'
    'HMA'      [    6]    [    0]
    'PCC'      [    6]    [    1]
    'Mixed'    [    7]    [    0]
    'Other'    [    4]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'        'F'         'Prob>F'
    'Groups'    [ 23.6652]    [  3]    [7.8884]    [1.7129]    [0.1682]
    'Error'     [534.2014]    [116]    [4.6052]          []          []
    'Total'     [557.8667]    [119]          []          []          []



DATA QUALITY SCORE ANALYSIS
Property
    'Place'

p =
    0.8520

Multiple Comparison of Means
results =
    'Name'           'Means'    'Error'
    'Small Urban'    [    6]    [    0]
    'Rural'          [    6]    [    0]
    'Urban'          [    7]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'        'F'         'Prob>F'
    'Groups'    [  1.5255]    [  2]    [0.7628]    [0.1604]    [0.8520]
    'Error'     [556.3412]    [117]    [4.7551]          []          []
    'Total'     [557.8667]    [119]          []          []          []



DATA QUALITY SCORE ANALYSIS
Property
    'FunctClass'

p =
    0.0138
P-Value is SIGNIFICANT

Multiple Comparison of Means
results =
    'Name'         'Means'    'Error'
    'Collector'    [    7]    [    0]
    'Arterial'     [    6]    [    0]
    'Local'        [    6]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'         'F'         'Prob>F'
    'Groups'    [ 39.3722]    [  2]    [19.6861]    [4.4422]    [0.0138]
    'Error'     [518.4945]    [117]    [ 4.4316]          []          []
    'Total'     [557.8667]    [119]           []          []          []



DATA QUALITY SCORE ANALYSIS
```

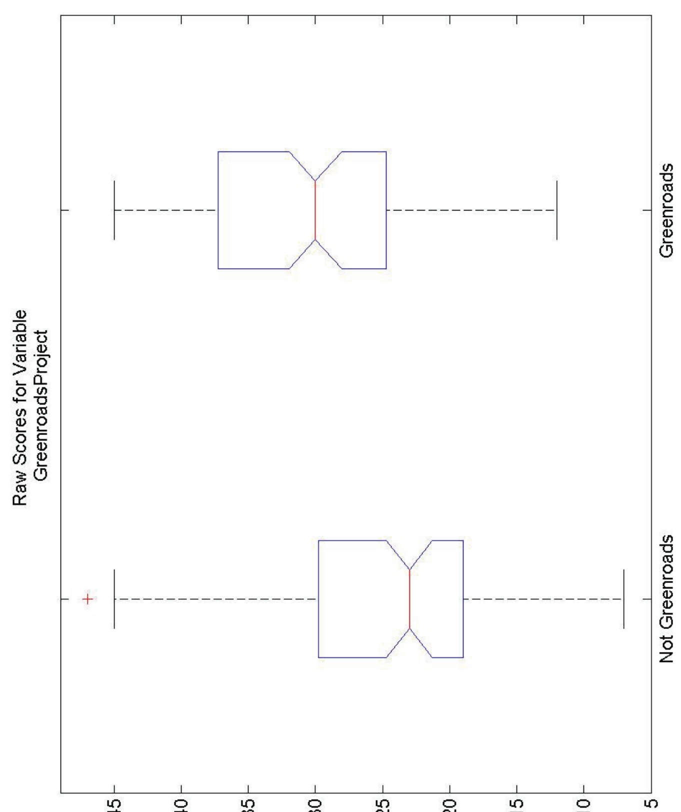
```
Property
    'Length'

p =
    0.9794

Multiple Comparison of Means
results =
    'Name'    'Means'    'Error'
    '0-1'     [    6]    [    0]
    '5+'      [    6]    [    0]
    '1-5'     [    6]    [    0]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'        'F'         'Prob>F'
    'Groups'    [  0.1981]    [  2]    [0.0991]    [0.0208]    [0.9794]
    'Error'     [557.6685]    [117]    [4.7664]          []          []
    'Total'     [557.8667]    [119]          []          []          []



DATA QUALITY SCORE ANALYSIS
Property
    'Budget'

p =
    0.7261

Multiple Comparison of Means
results =
    'Name'      'Means'    'Error'
    '0-10'      [    6]    [    0]
    '10-100'    [    6]    [    0]
    '100+'      [    6]    [    1]

ANOVA Results
anovatab =
    'Source'    'SS'          'df'     'MS'        'F'         'Prob>F'
    'Groups'    [  3.0437]    [  2]    [1.5219]    [0.3209]    [0.7261]
    'Error'     [554.8230]    [117]    [4.7421]          []          []
    'Total'     [557.8667]    [119]          []          []          []


EDU>>
```

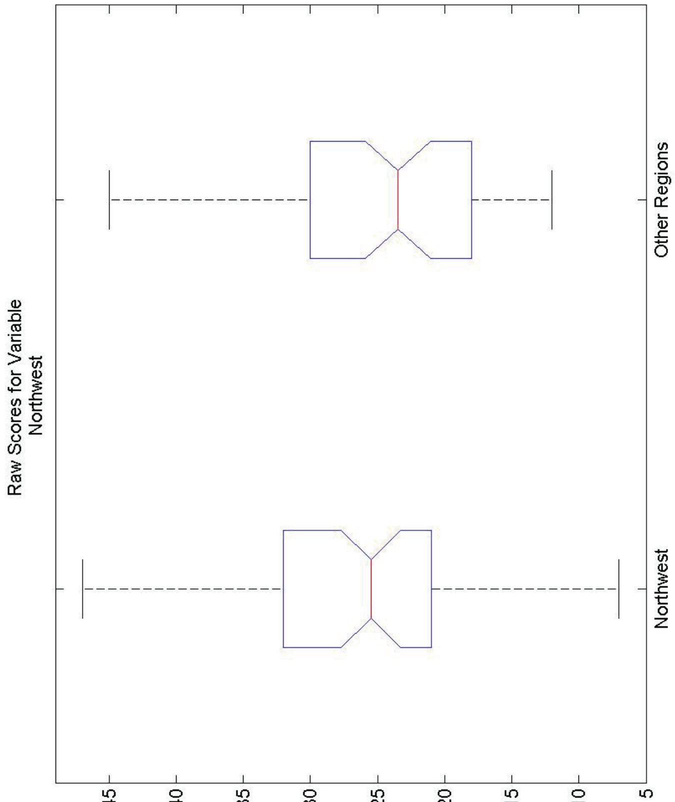
MATLAB Results from dissplot.m

```
This script makes scatterplots of aggregate scores vs. cost and mileage in both weighted and↙
unweighted conditions.
Plotting....
Plotting completed successfully.
EDU>>
```

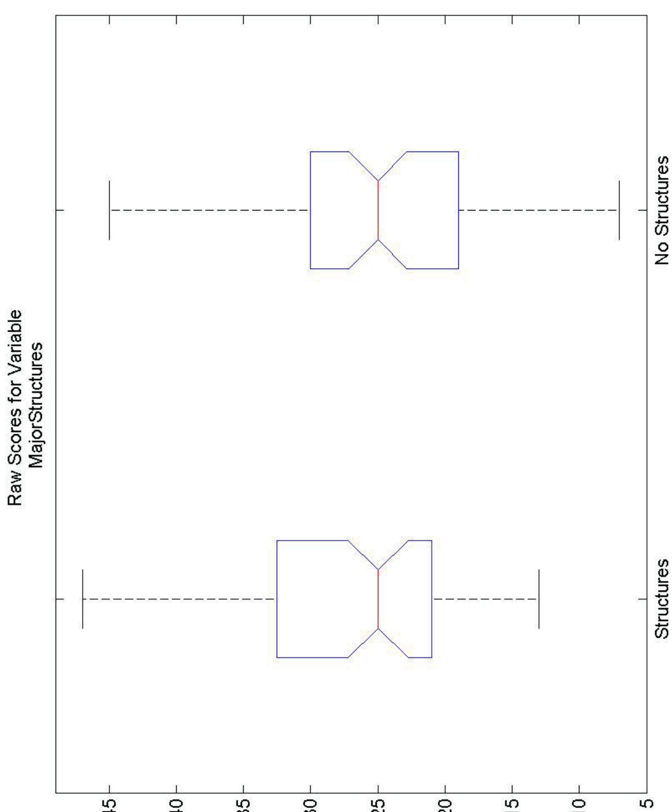
APPENDIX F: MATLAB FIGURES


Raw Scores for Variable
GreenEmphasis
45
40
35
30
25
20
15
10
5
Typical
Greener

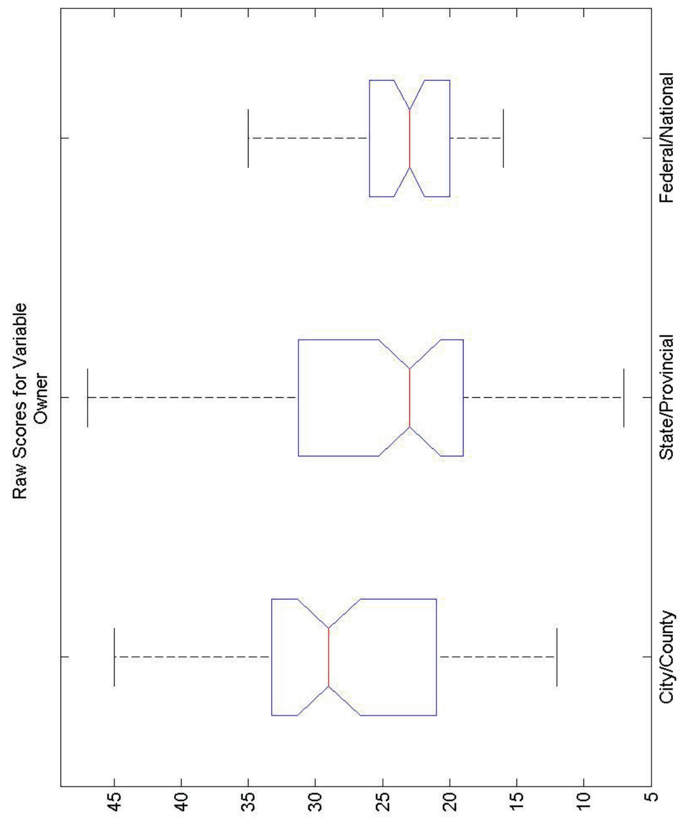

Raw Scores for Variable
GreenroadsProject
45
40
35
30
25
20
15
10
5
Not Greenroads
Greenroads

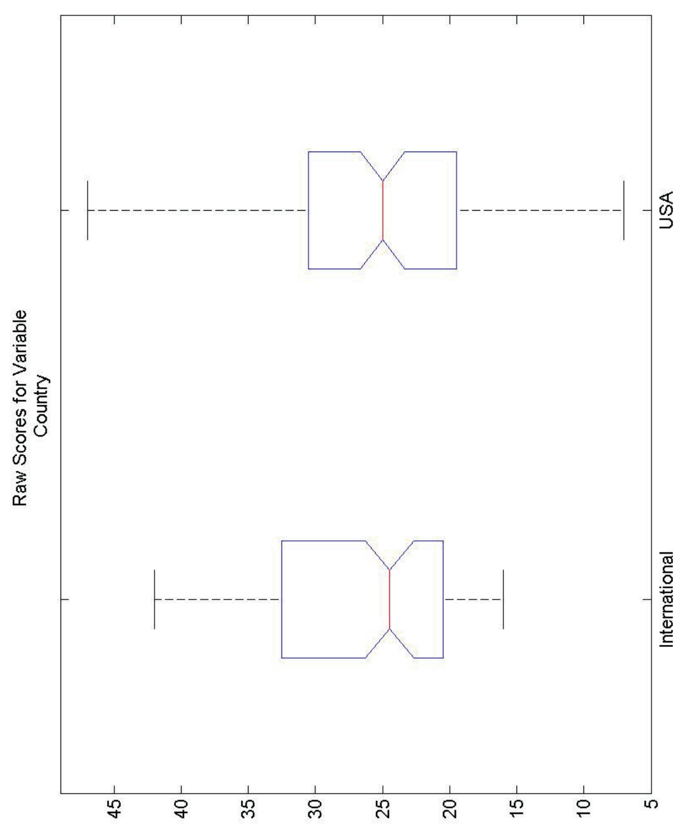


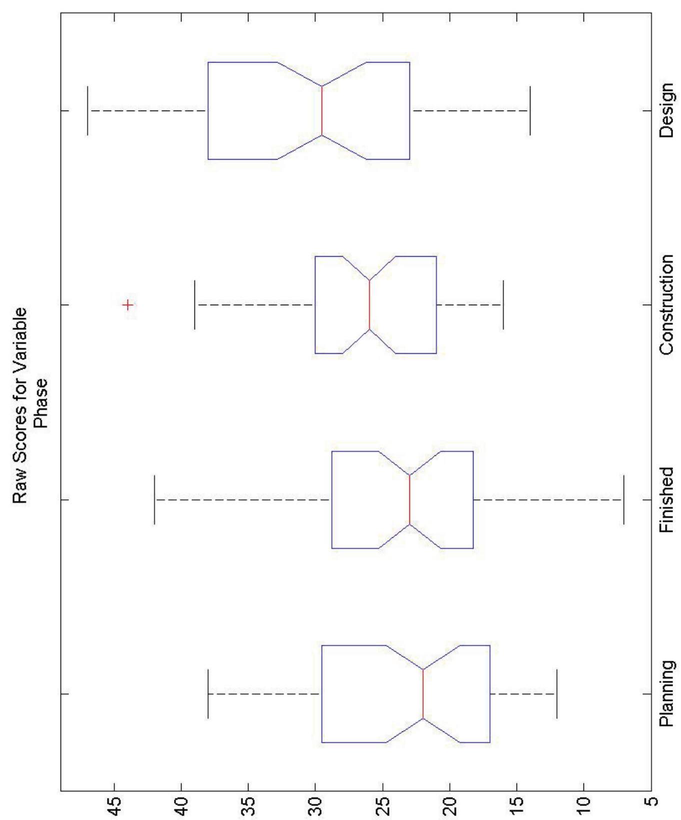
Raw Scores for Variable
Northwest
Northwest
Other Regions
45
40
35
30
25
20
15
10
5

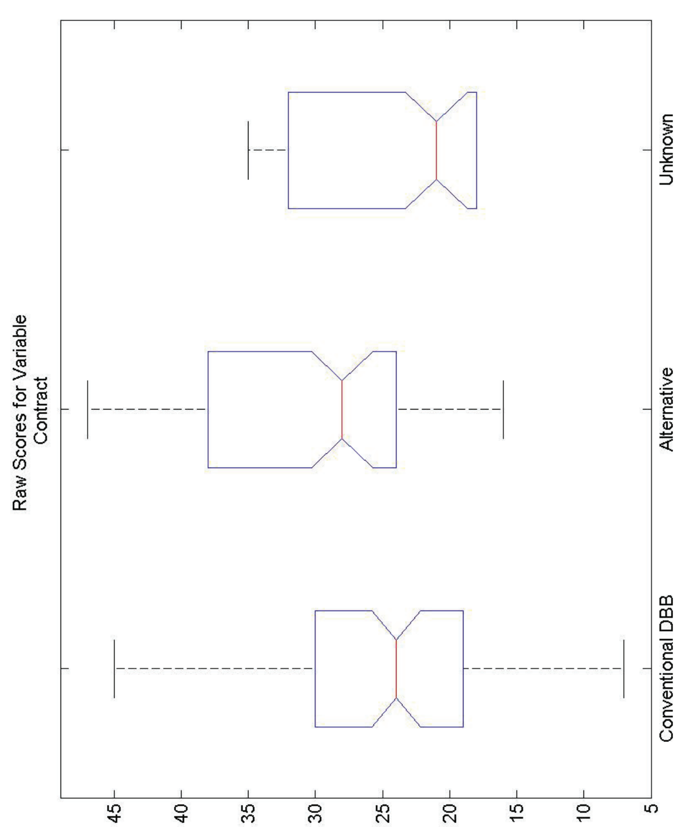


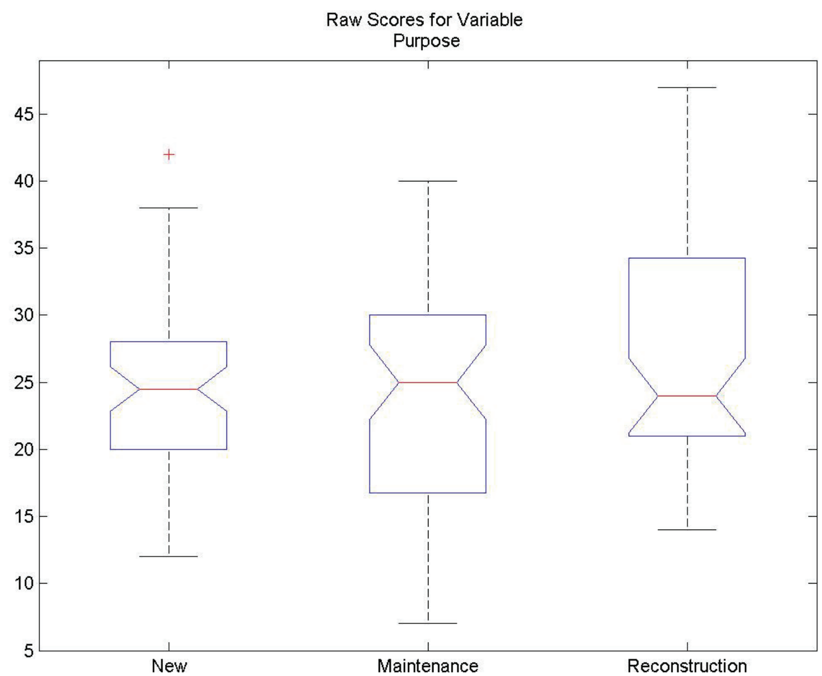
Raw Scores for Variable
MajorStructures
Structures
No Structures
45
40
35
30
25
20
15
10
5

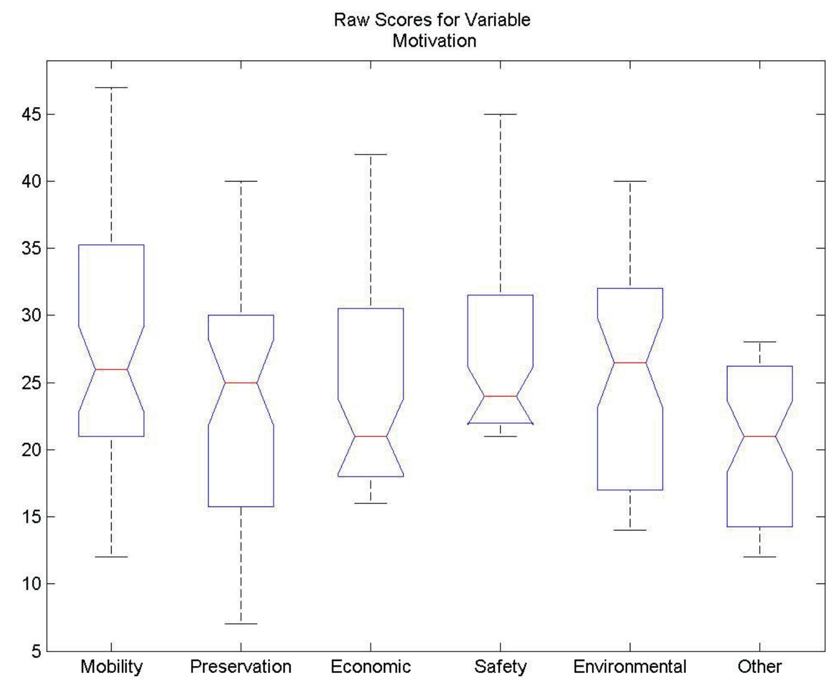

Raw Scores for Variable
Owner
45
40
35
30
25
20
15
10
5
City/County
State/Provincial
Federal/National

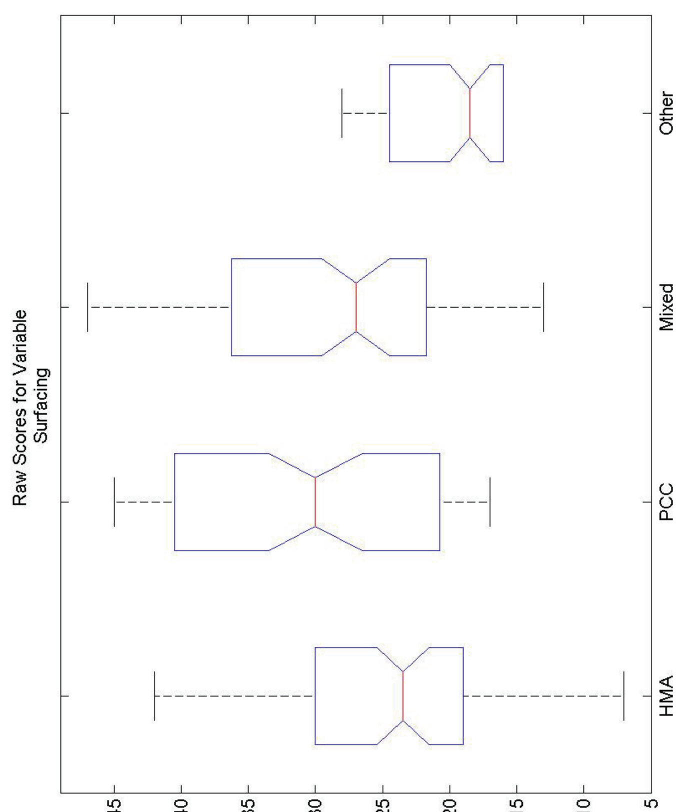

Raw Scores for Variable
Country
45
40
35
30
25
20
15
10
5
International
USA

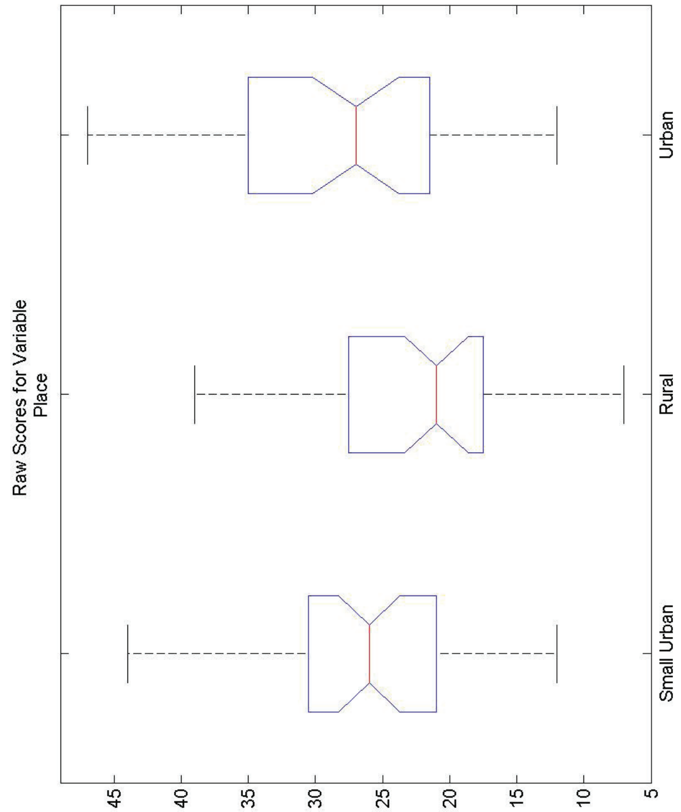

Raw Scores for Variable
Phase
45
40
35
30
25
20
15
10
5
Planning
Finished
Construction
Design

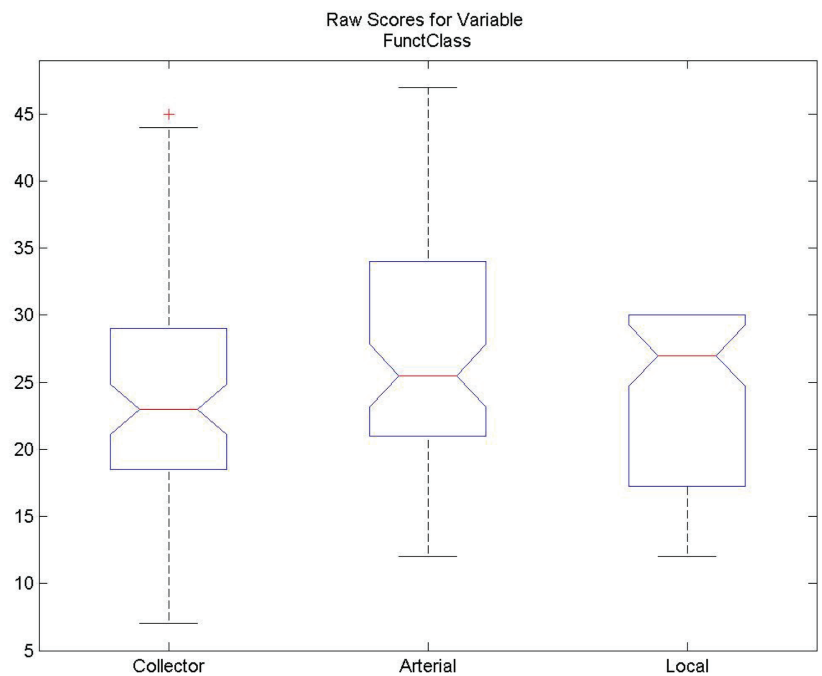

Raw Scores for Variable
Contract
45
40
35
30
25
20
15
10
5
Conventional DBB
Alternative
Unknown

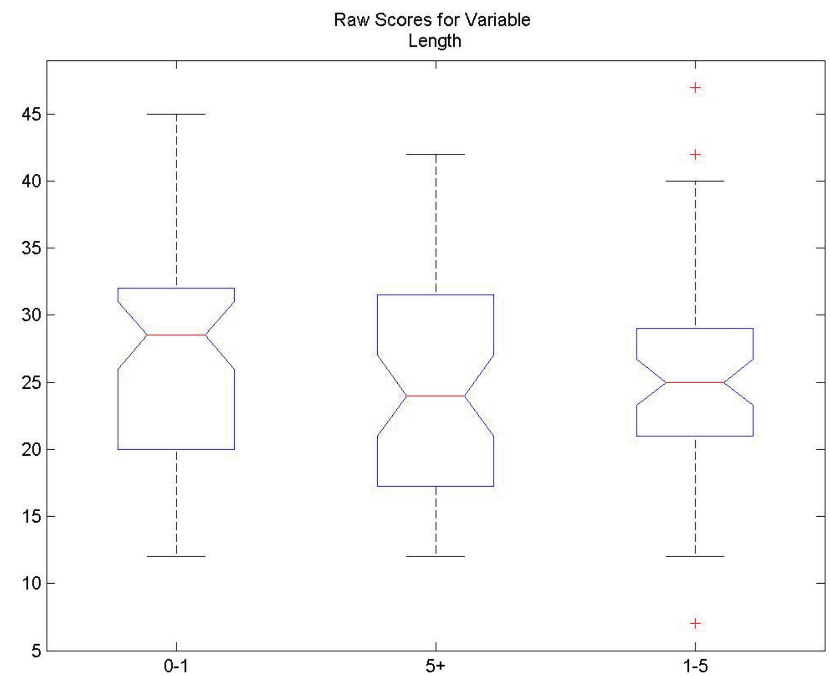

Raw Scores for Variable
Purpose
45
40
35
30
25
20
15
10
5
New
Maintenance
Reconstruction

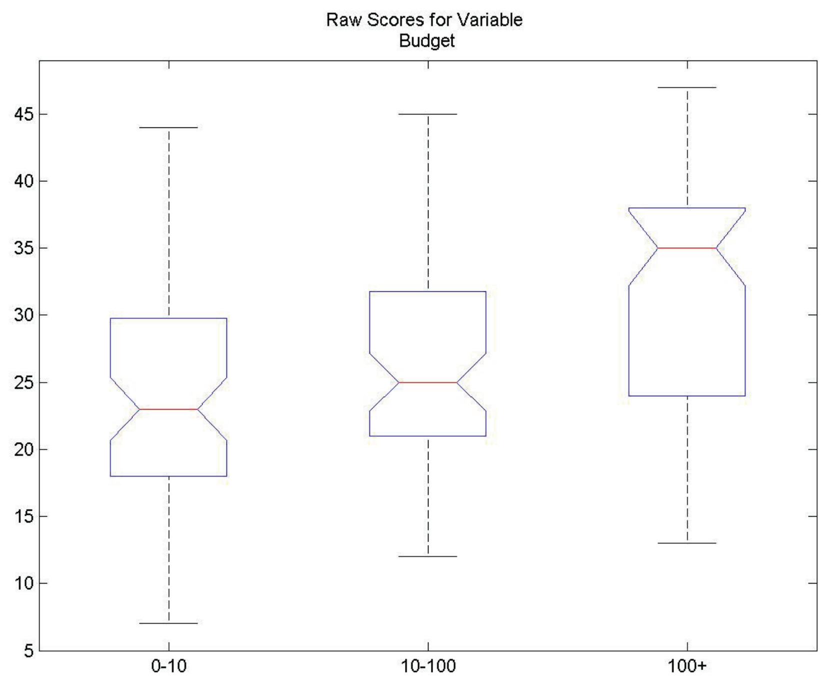

Raw Scores for Variable
Motivation
45
40
35
30
25
20
15
10
5
Mobility
Preservation
Economic
Safety
Environmental
Other


Raw Scores for Variable
Surfacing
45
40
35
30
25
20
15
10
5
HMA
PCC
Mixed
Other

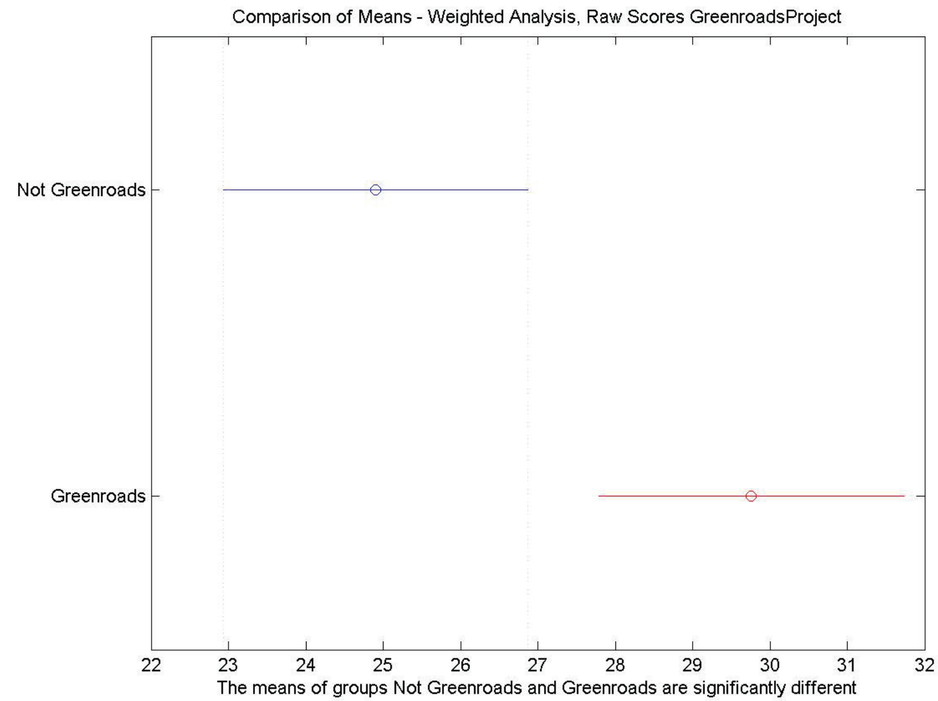

Raw Scores for Variable
Place
45
40
35
30
25
20
15
10
5
Small Urban
Rural
Urban


Raw Scores for Variable
FunctClass
45
40
35
30
25
20
15
10
5
Collector
Arterial
Local

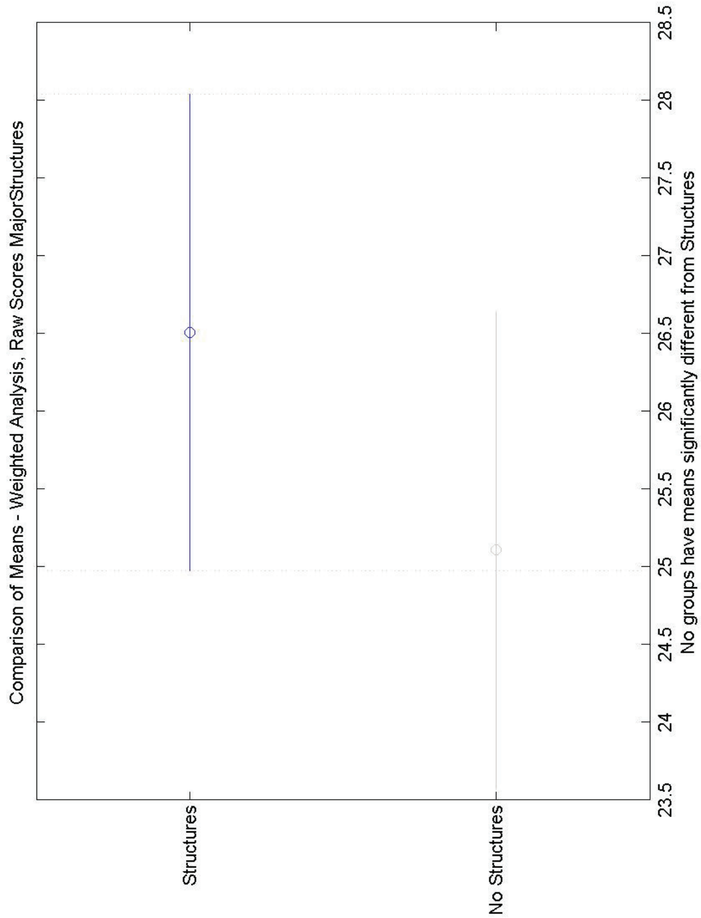

Raw Scores for Variable
Length
45
40
35
30
25
20
15
10
5
0-1
5+
1-5

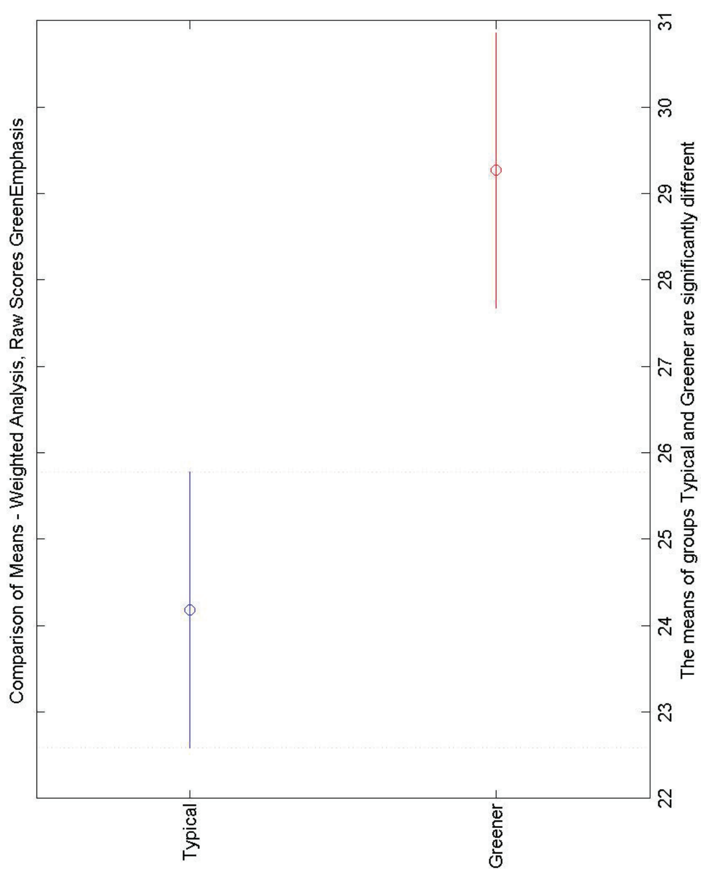


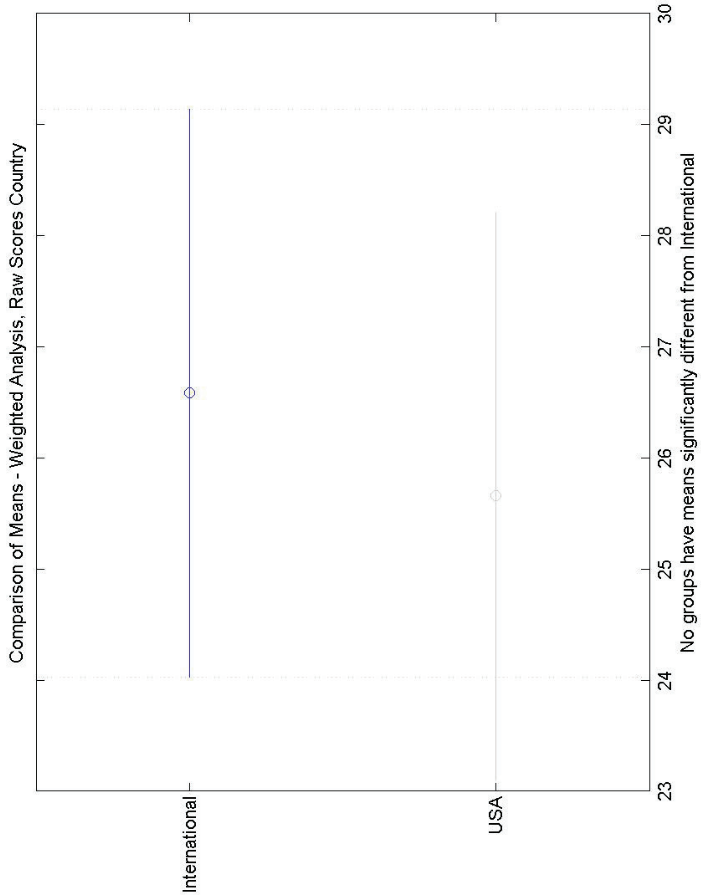
Raw Scores for Variable
Budget
5
10
15
20
25
30
35
40
45
0-10
10-100
100+

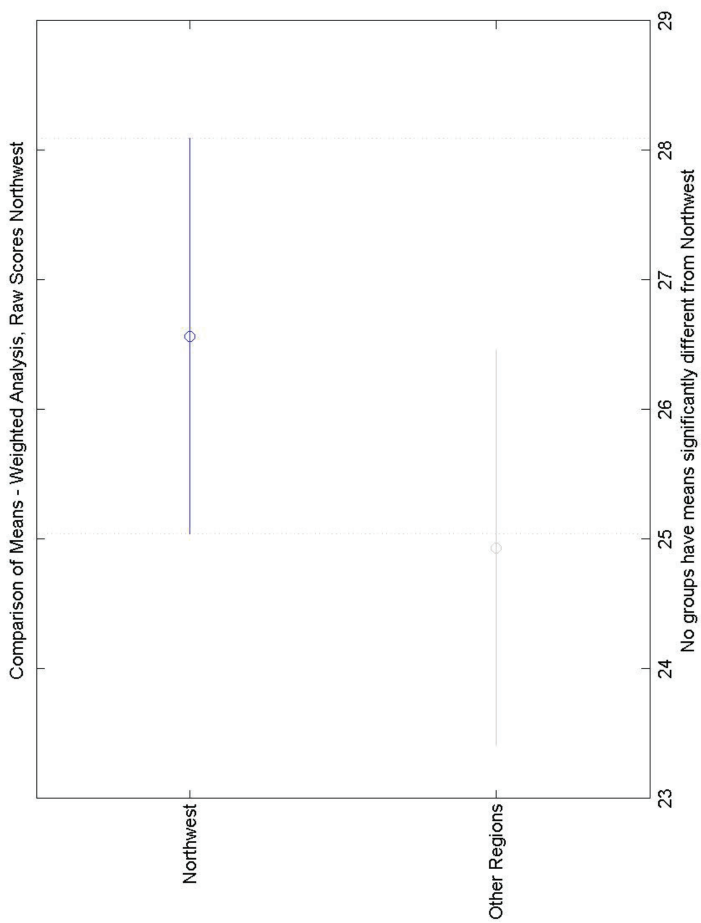


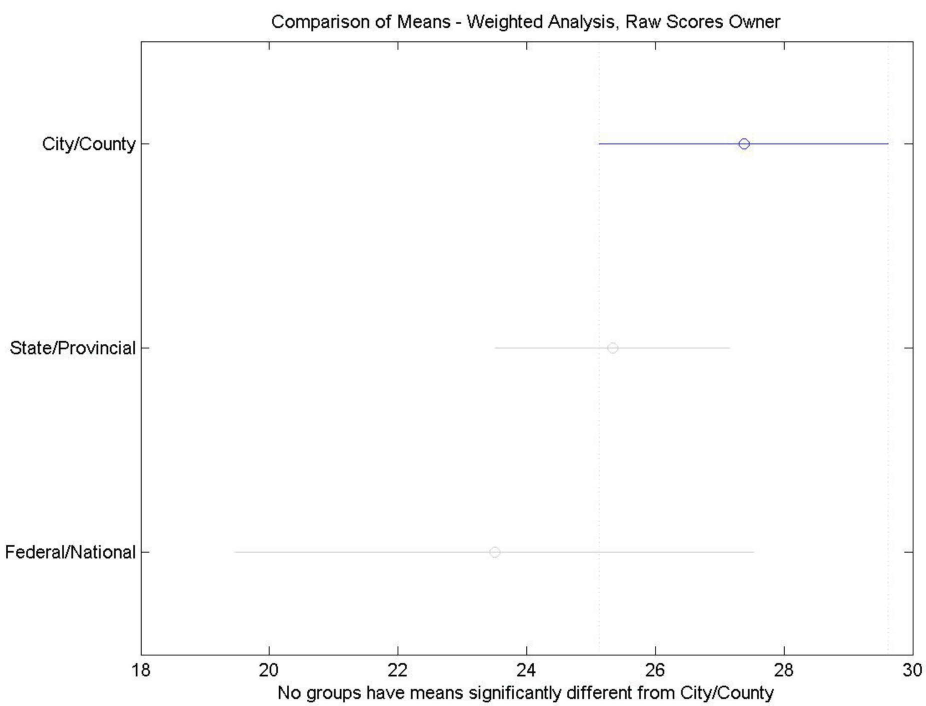
Comparison of Means - Weighted Analysis, Raw Scores GreenroadsProject
Not Greenroads
Greenroads
22
23
24
25
26
27
28
29
30
31
32
The means of groups Not Greenroads and Greenroads are significantly different

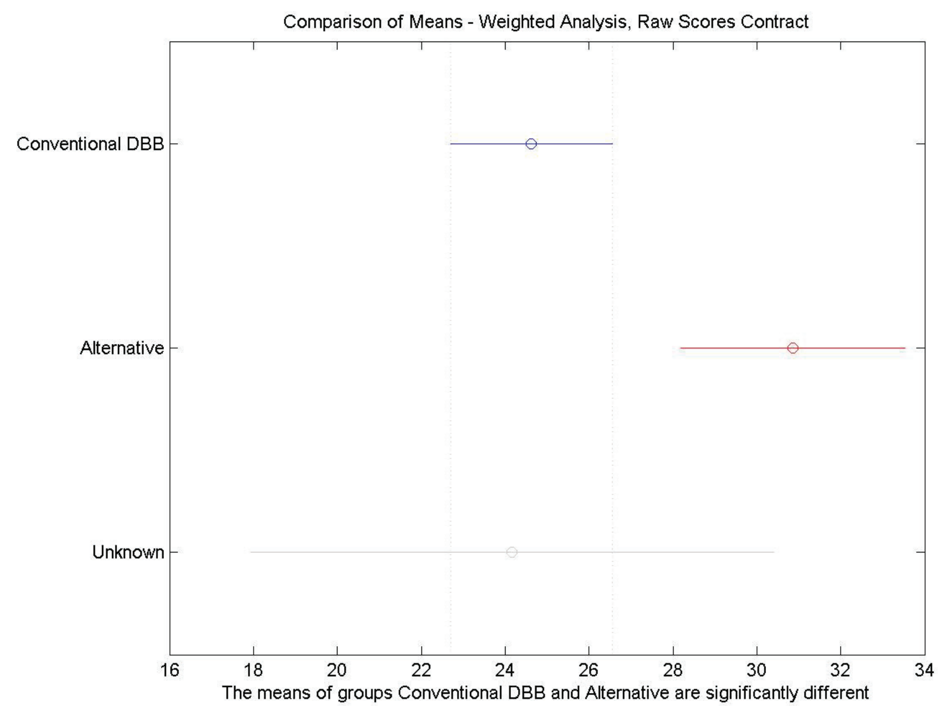

Comparison of Means - Weighted Analysis, Raw Scores MajorStructures
Structures
No Structures
23.5
24
24.5
25
25.5
26
26.5
27
27.5
28
28.5
No groups have means significantly different from Structures

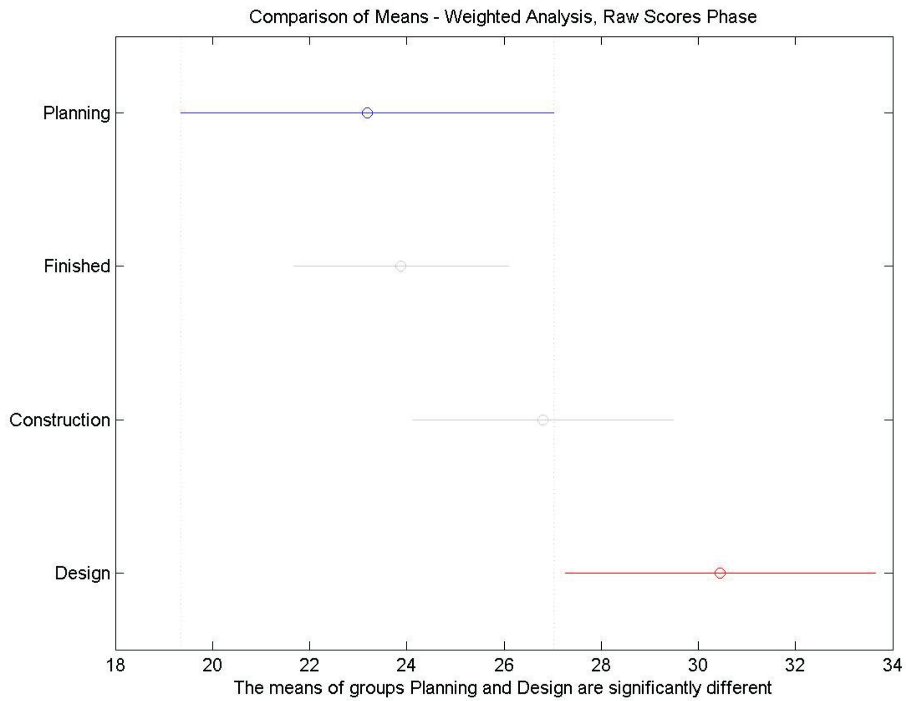

Comparison of Means - Weighted Analysis, Raw Scores GreenEmphasis
Typical
Greener
22
23
24
25
26
27
28
29
30
31
The means of groups Typical and Greener are significantly different

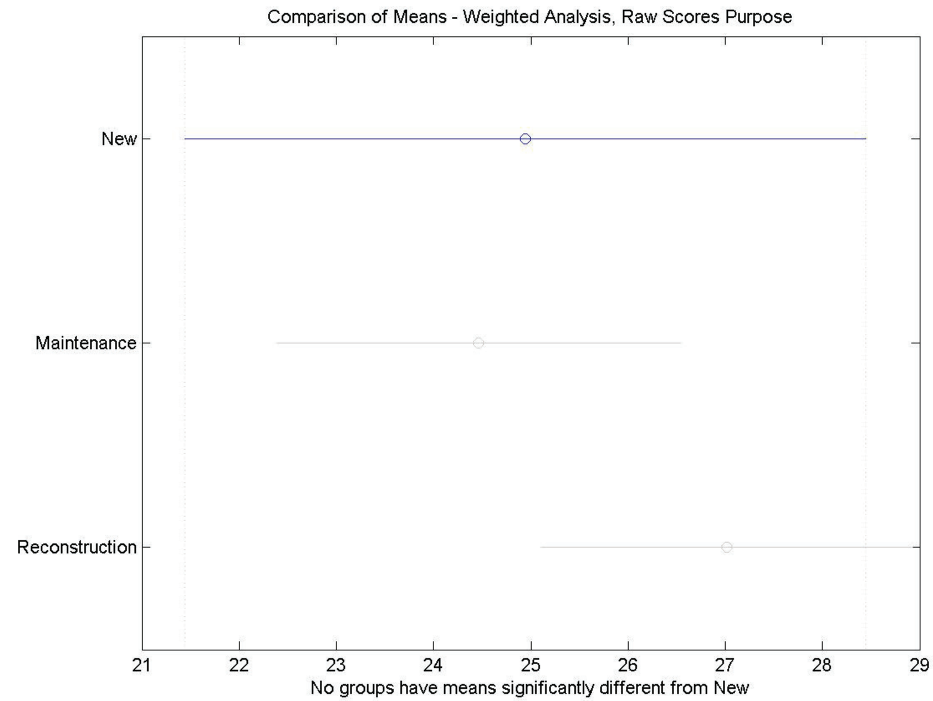

Comparison of Means - Weighted Analysis, Raw Scores Country
International
USA
23
24
25
26
27
28
29
30
No groups have means significantly different from International

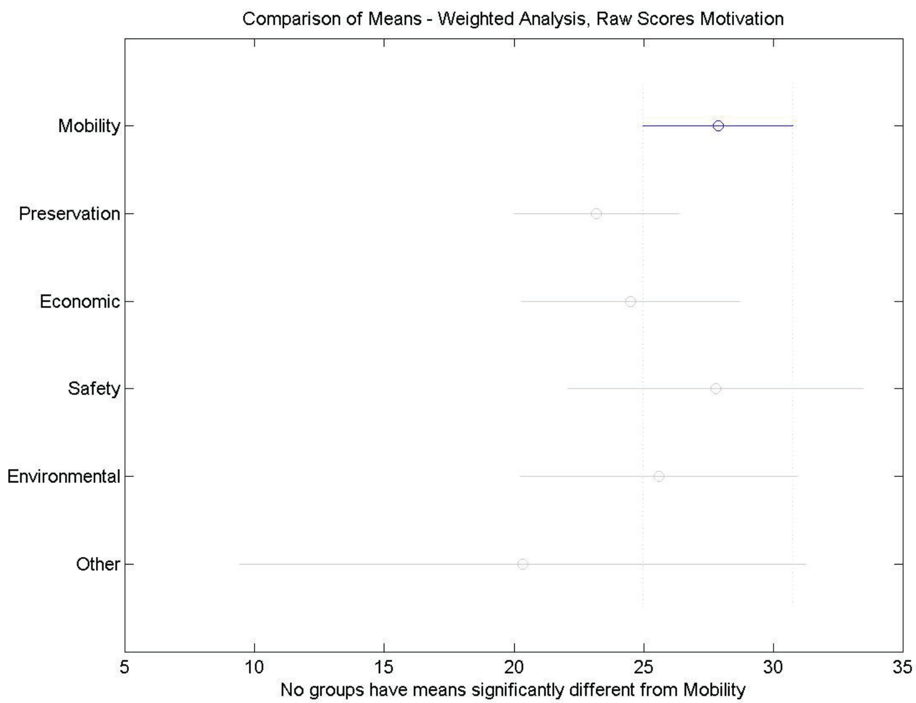

Comparison of Means - Weighted Analysis, Raw Scores Northwest
Northwest
Other Regions
23
24
25
26
27
28
29
No groups have means significantly different from Northwest

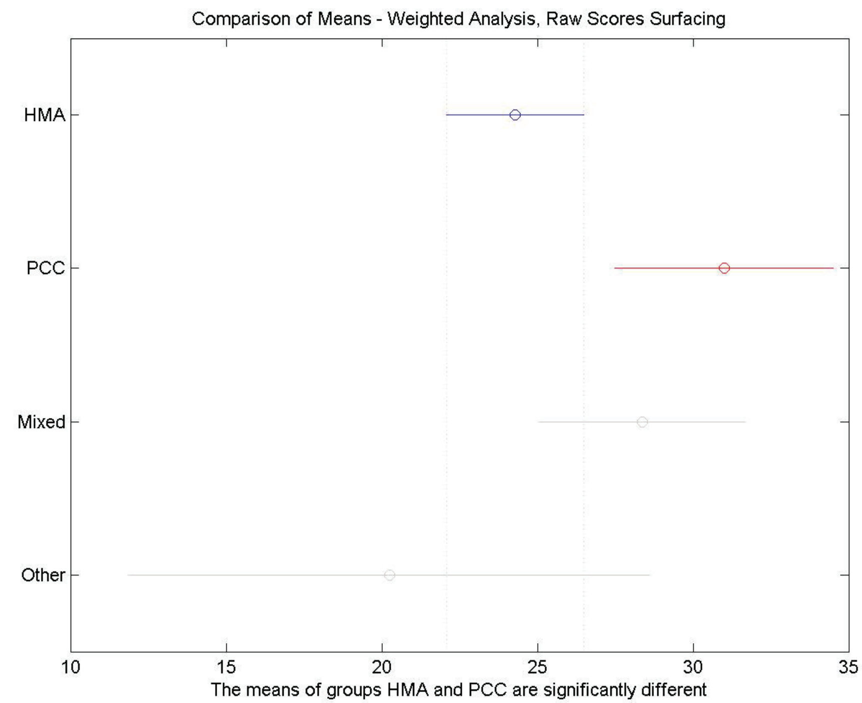

Comparison of Means - Weighted Analysis, Raw Scores Owner
City/County
State/Provincial
Federal/National
18
20
22
24
26
28
30
No groups have means significantly different from City/County

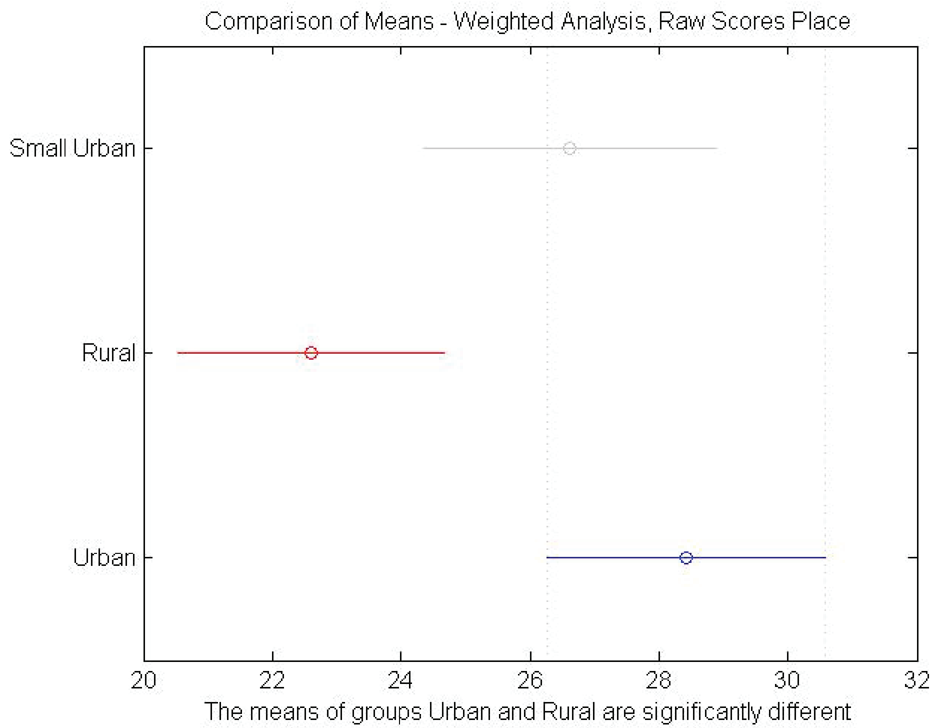

Comparison of Means - Weighted Analysis, Raw Scores Contract
Conventional DBB
Alternative
Unknown
16
18
20
22
24
26
28
30
32
34
The means of groups Conventional DBB and Alternative are significantly different

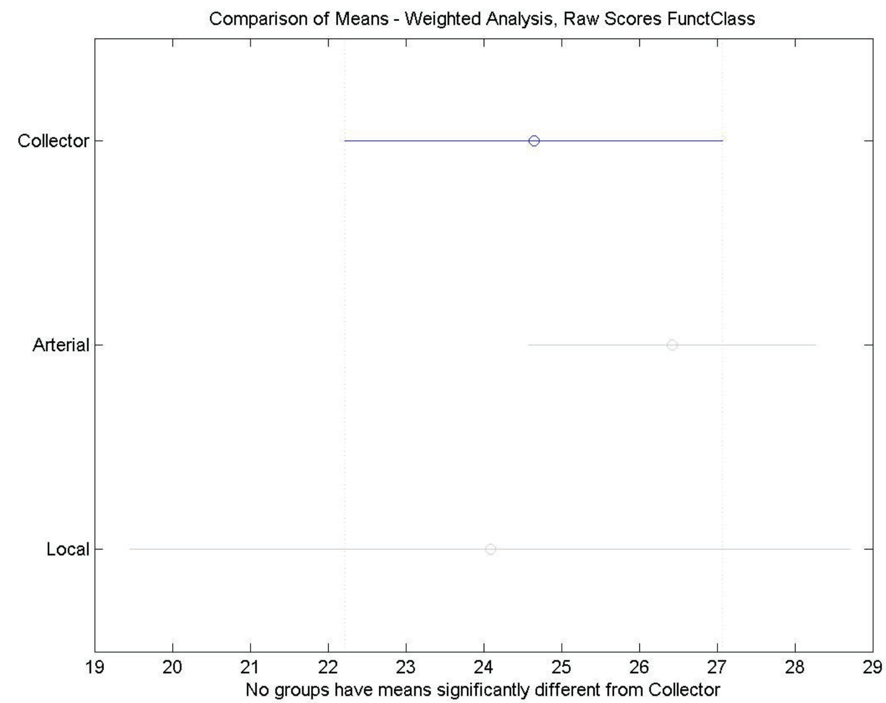

Comparison of Means - Weighted Analysis, Raw Scores Phase
Planning
Finished
Construction
Design
18
20
22
24
26
28
30
32
34
The means of groups Planning and Design are significantly different

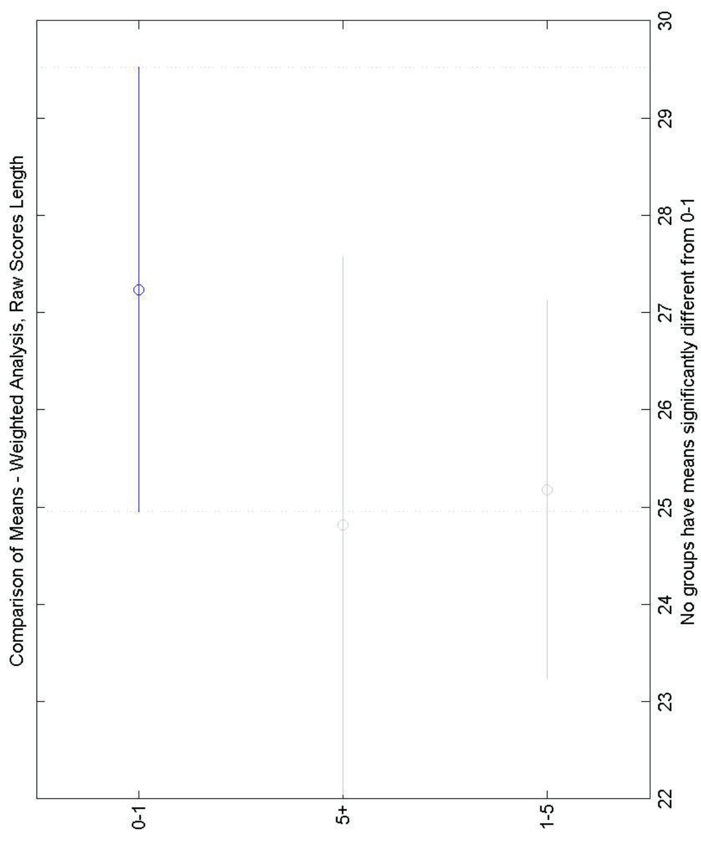

Comparison of Means - Weighted Analysis, Raw Scores Purpose
New
Maintenance
Reconstruction
21
22
23
24
25
26
27
28
29
No groups have means significantly different from New

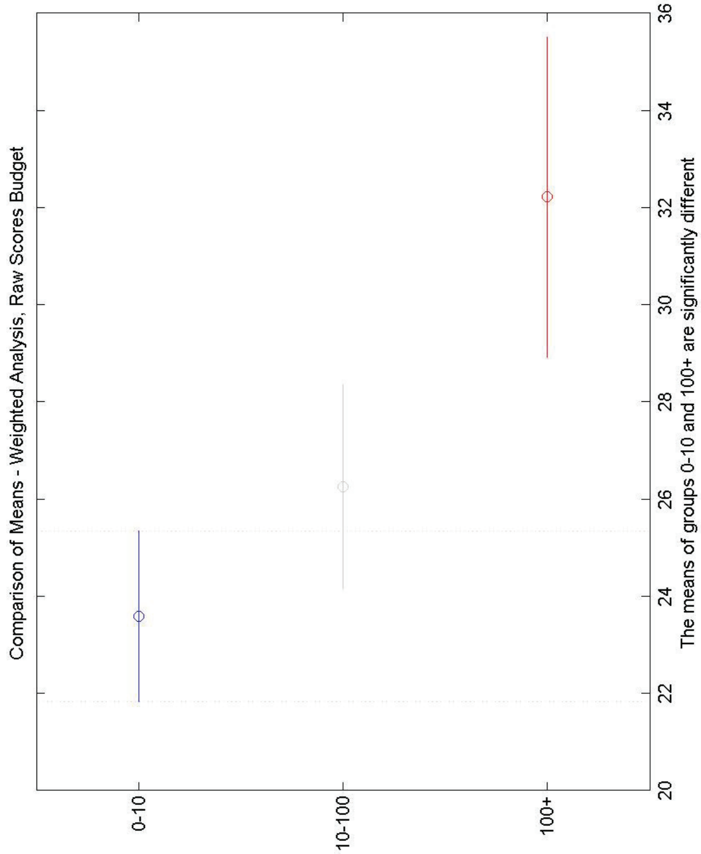

Comparison of Means - Weighted Analysis, Raw Scores Motivation
Mobility
Preservation
Economic
Safety
Environmental
Other
5
10
15
20
25
30
35
No groups have means significantly different from Mobility

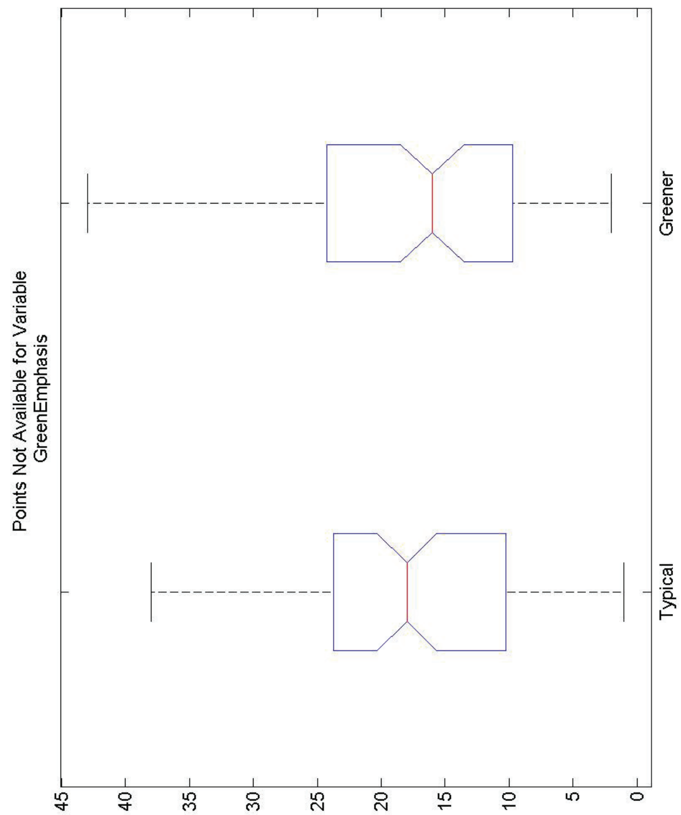

Comparison of Means - Weighted Analysis, Raw Scores Surfacing
HMA
PCC
Mixed
Other
10
15
20
25
30
35
The means of groups HMA and PCC are significantly different

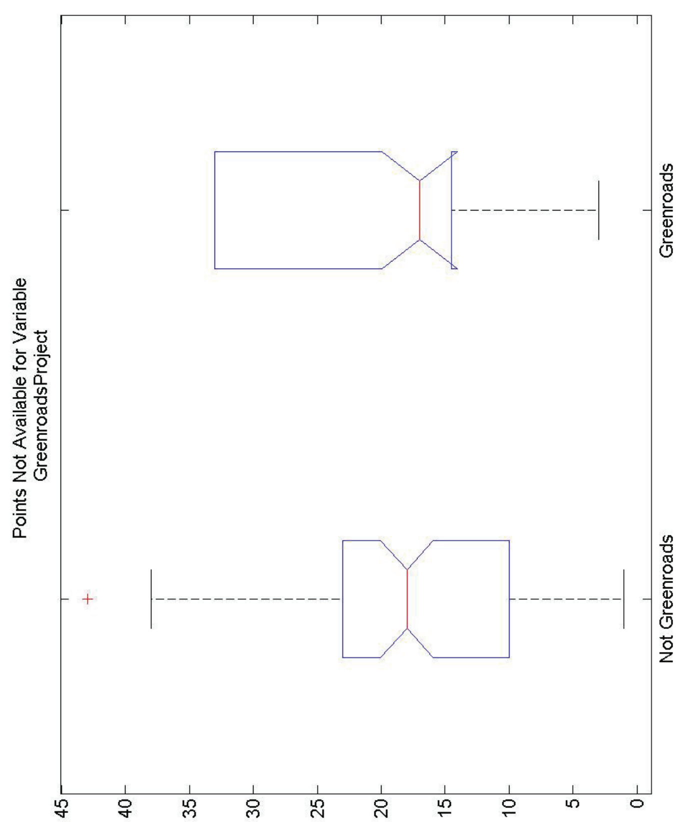

Comparison of Means - Weighted Analysis, Raw Scores Place
Small Urban
Rural
Urban
20
22
24
26
28
30
32
The means of groups Urban and Rural are significantly different

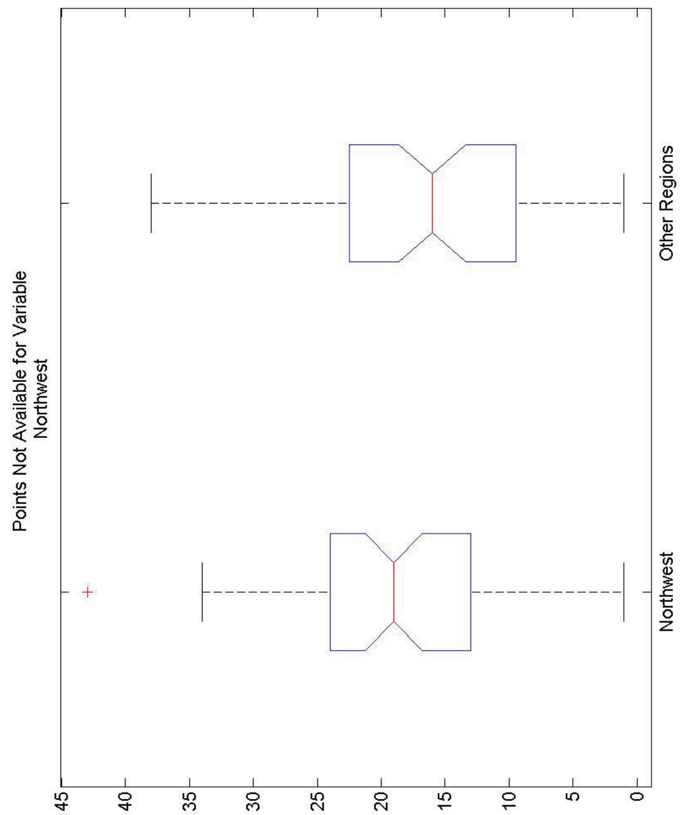

Comparison of Means - Weighted Analysis, Raw Scores FunctClass
Collector
Arterial
Local
19
20
21
22
23
24
25
26
27
28
29
No groups have means significantly different from Collector

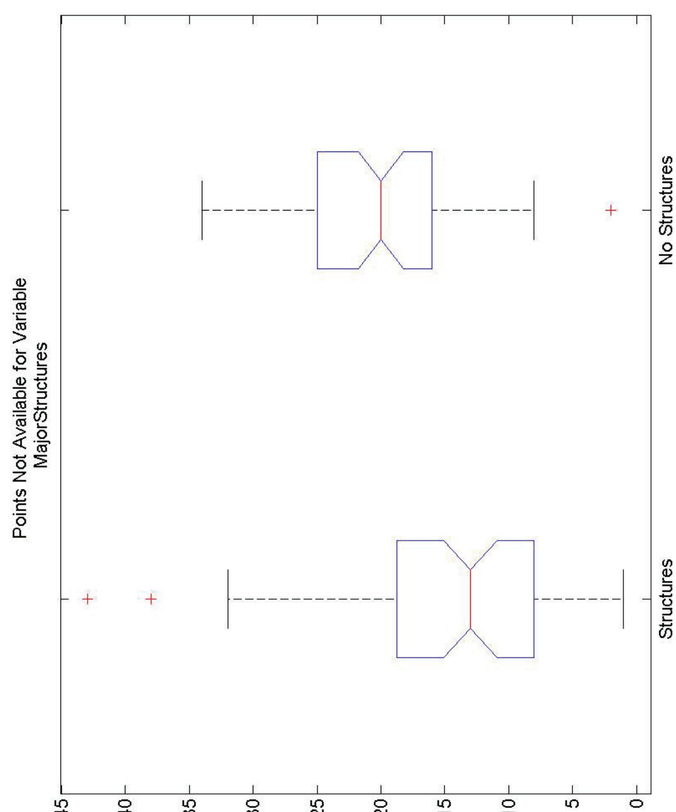

Comparison of Means - Weighted Analysis, Raw Scores Length
0-1
5+
1-5
22
23
24
25
26
27
28
29
30
No groups have means significantly different from 0-1

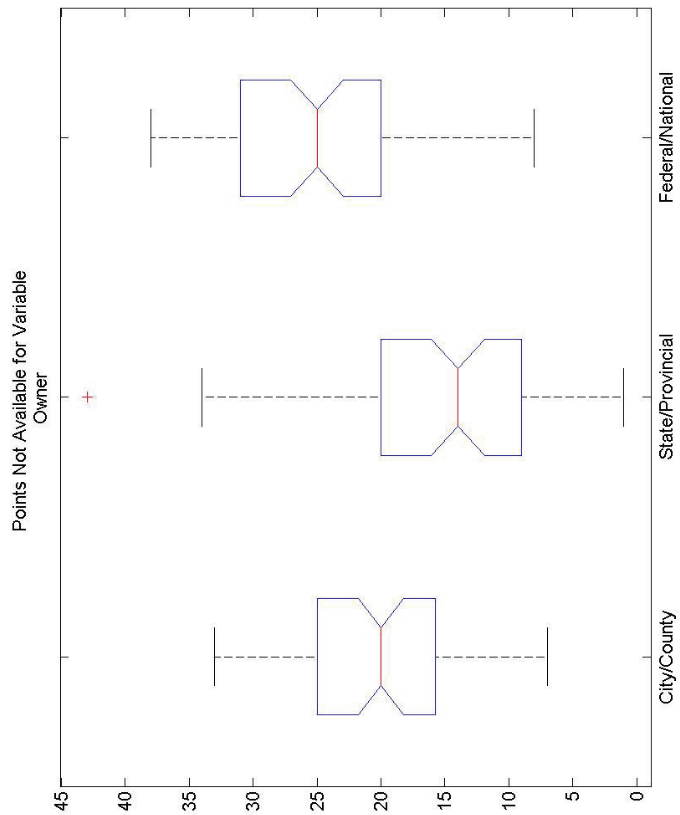

Comparison of Means - Weighted Analysis, Raw Scores Budget
0-10
10-100
100+
20
22
24
26
28
30
32
34
36
The means of groups 0-10 and 100+ are significantly different

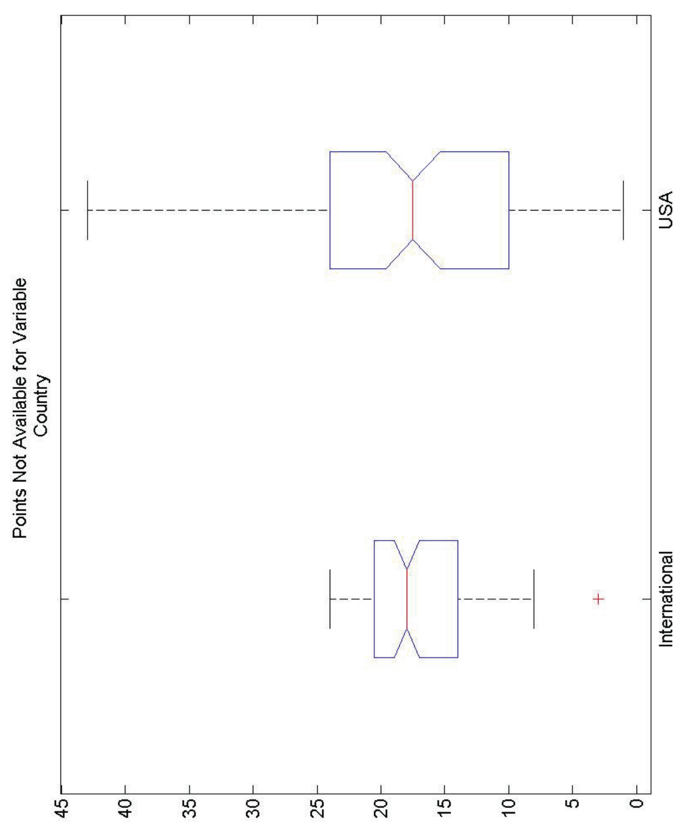

Points Not Available for Variable
GreenEmphasis
Typical
Greener
45
40
35
30
25
20
15
10
5
0

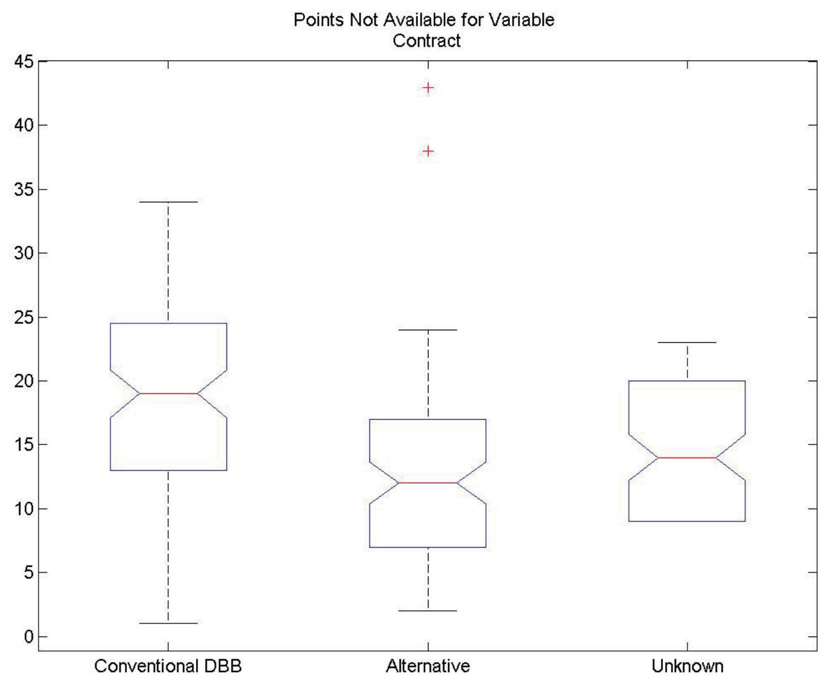

Points Not Available for Variable
GreenroadsProject
Not Greenroads
Greenroads
45
40
35
30
25
20
15
10
5
0

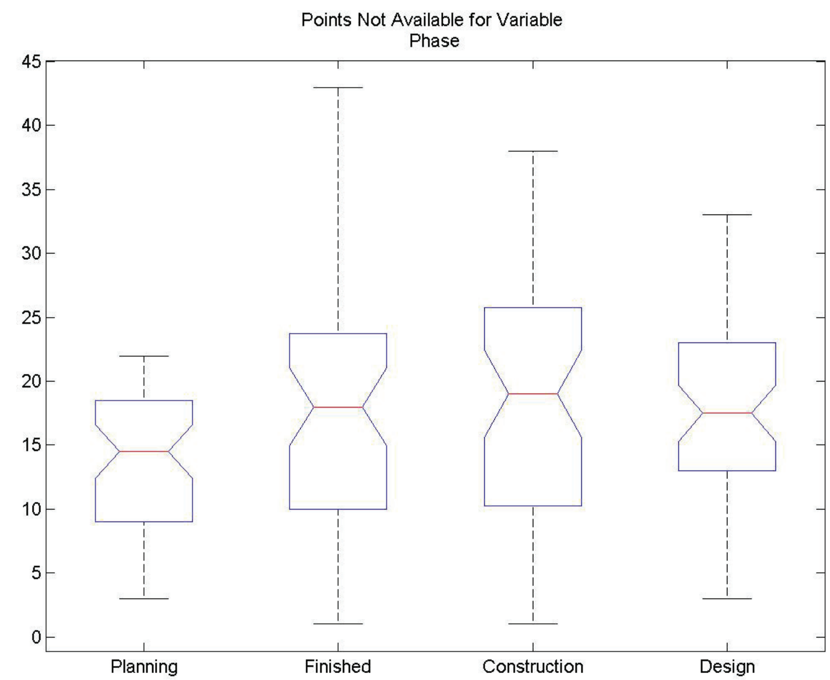

Points Not Available for Variable
Northwest
45
40
35
30
25
20
15
10
5
0
Northwest
Other Regions

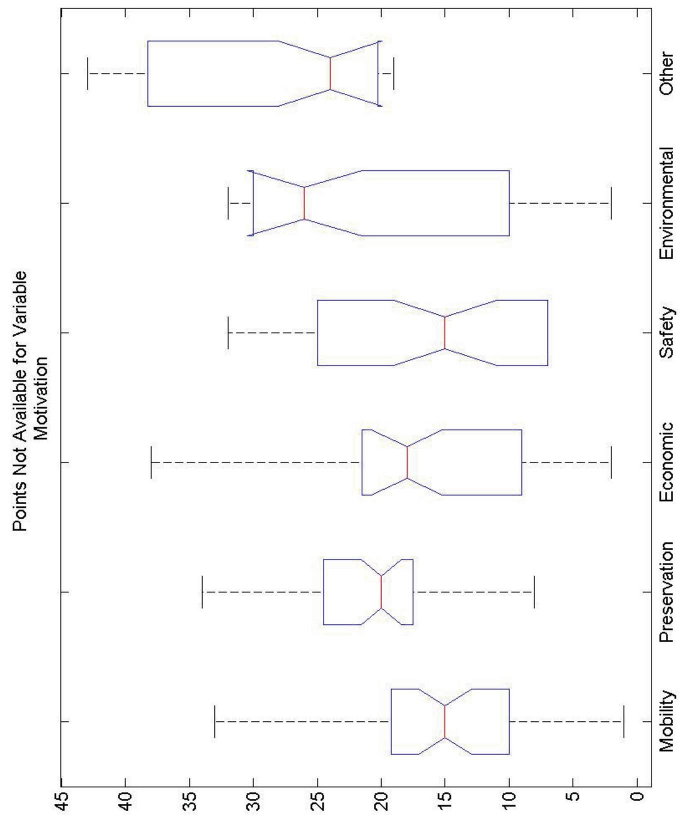

Points Not Available for Variable
MajorStructures
45
40
35
30
25
20
15
10
5
0
Structures
No Structures

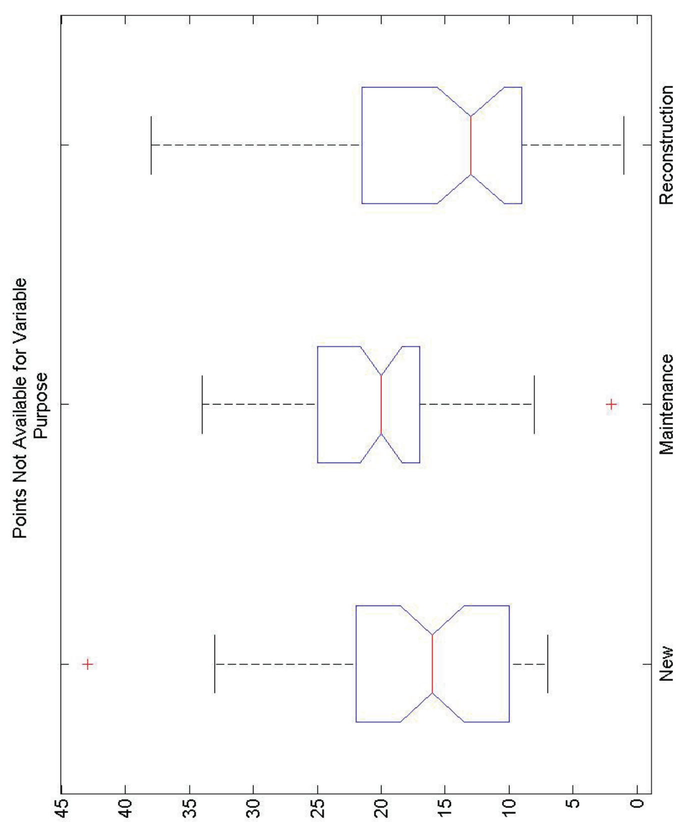

Points Not Available for Variable
Owner
City/County
State/Provincial
Federal/National
0
5
10
15
20
25
30
35
40
45

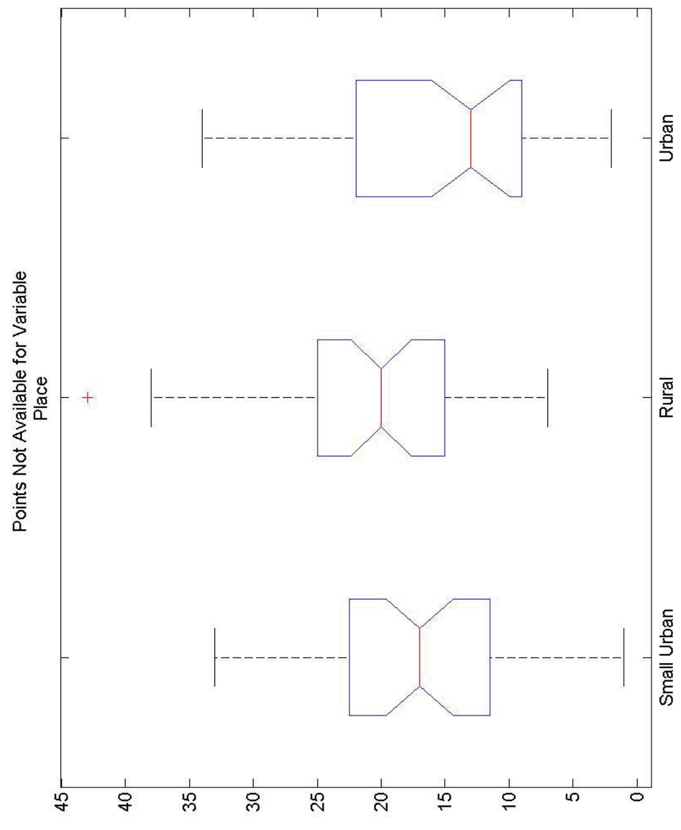

Points Not Available for Variable
Country
International
USA
0
5
10
15
20
25
30
35
40
45

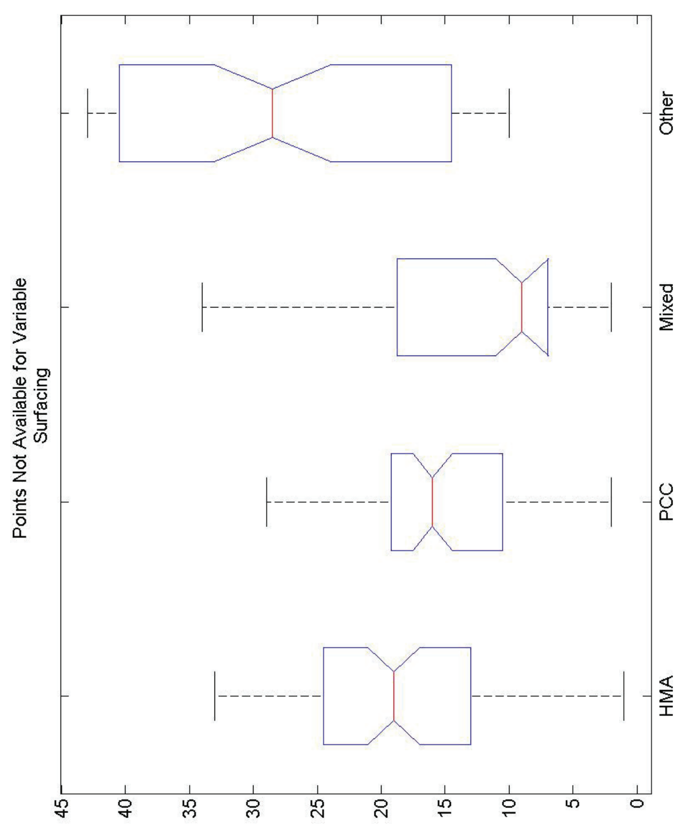

Points Not Available for Variable
Contract
45
40
35
30
25
20
15
10
5
0
Conventional DBB
Alternative
Unknown

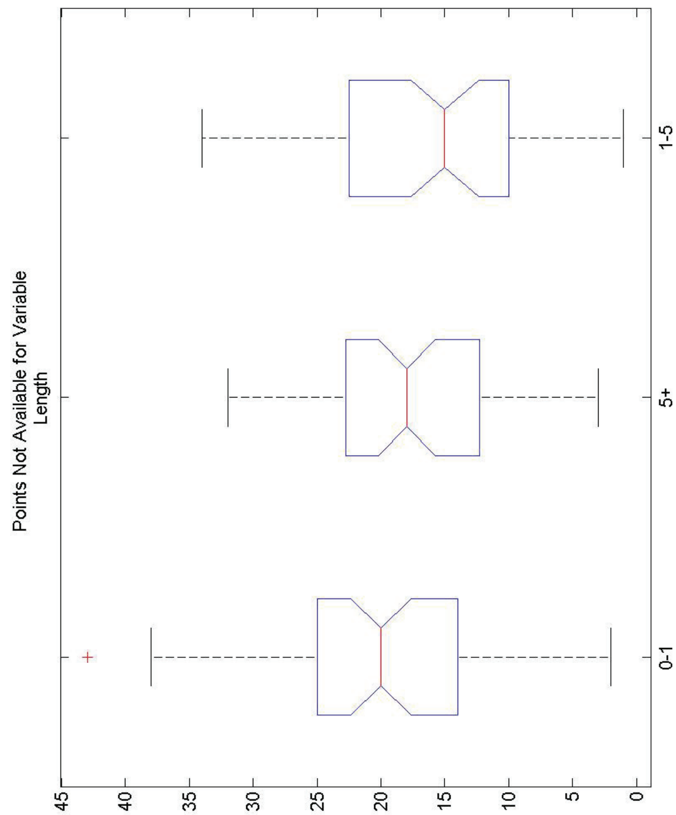

Points Not Available for Variable
Phase
45
40
35
30
25
20
15
10
5
0
Planning
Finished
Construction
Design


Points Not Available for Variable
Motivation
Mobility
Preservation
Economic
Safety
Environmental
Other
45
40
35
30
25
20
15
10
5
0

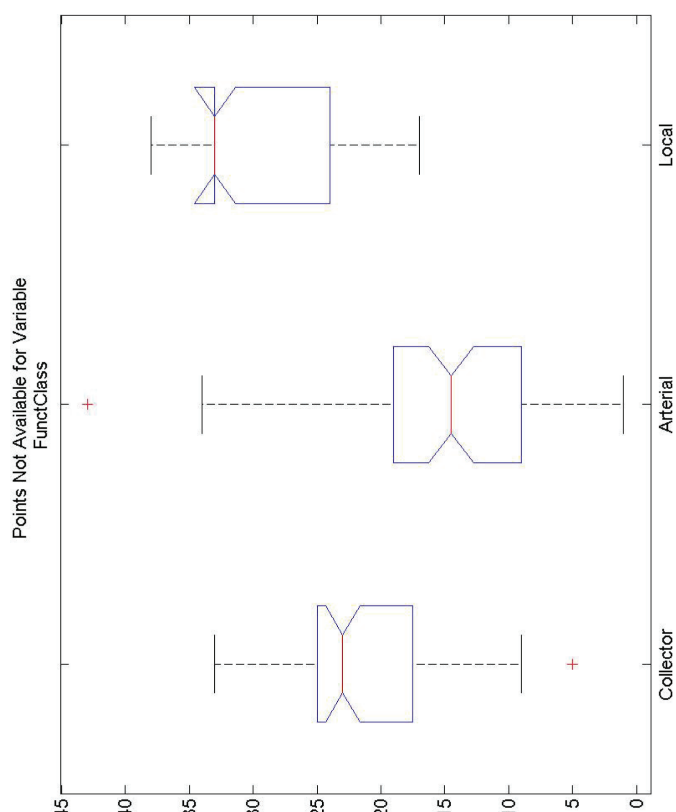

Points Not Available for Variable
Purpose
New
Maintenance
Reconstruction
45
40
35
30
25
20
15
10
5
0


Points Not Available for Variable
Place
Small Urban
Rural
Urban
0
5
10
15
20
25
30
35
40
45

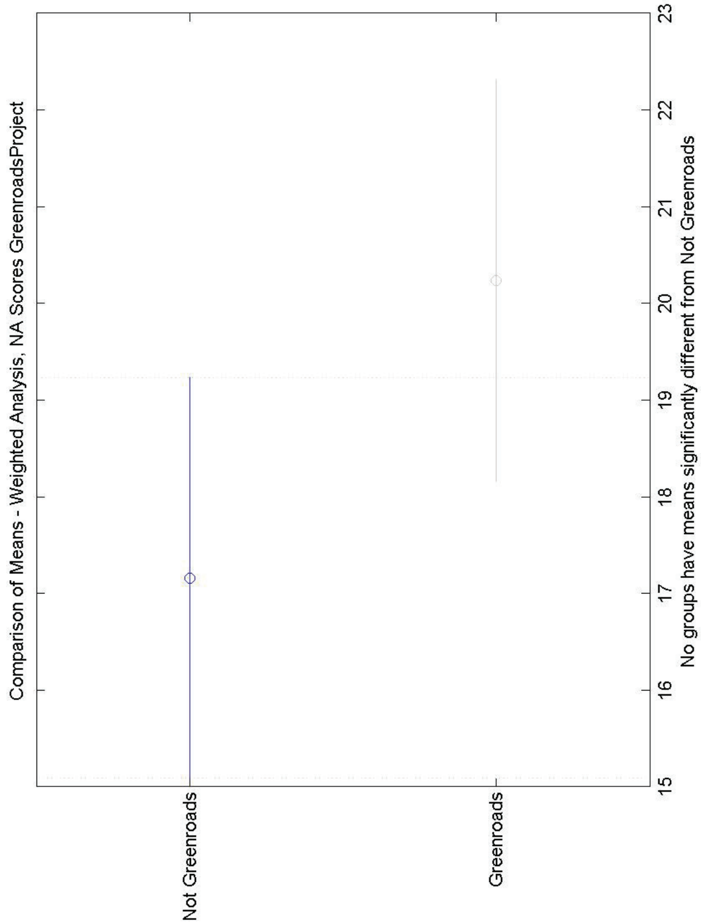

Points Not Available for Variable
Surfacing
HMA
PCC
Mixed
Other
0
5
10
15
20
25
30
35
40
45

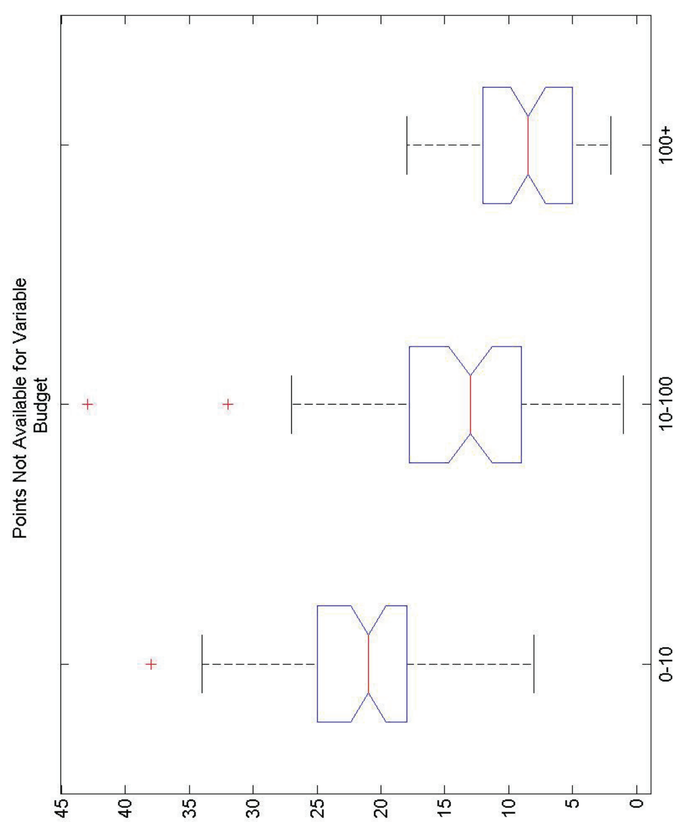


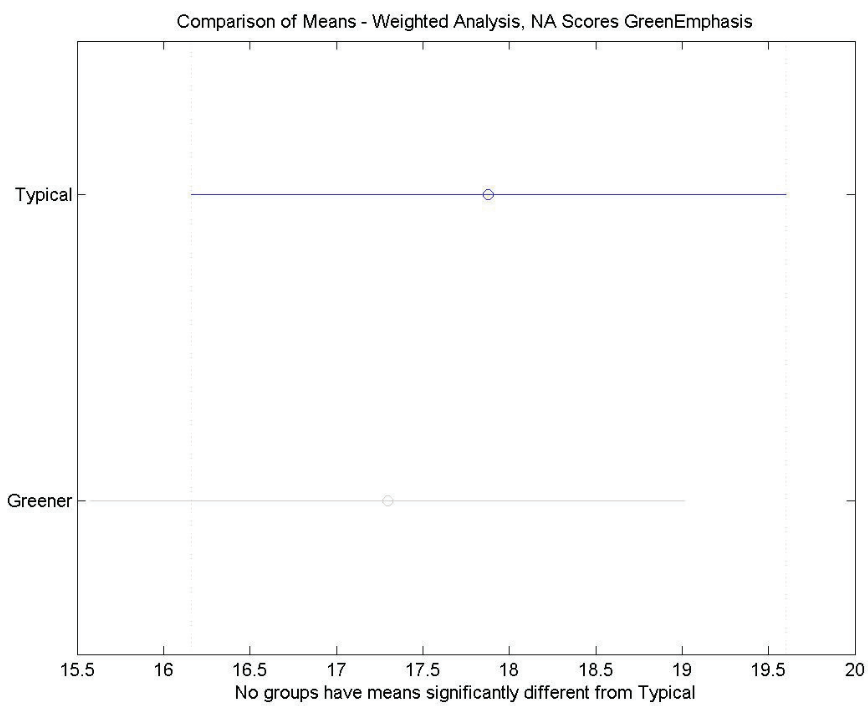
Points Not Available for Variable
Length
0-1
5+
1-5
0
5
10
15
20
25
30
35
40
45

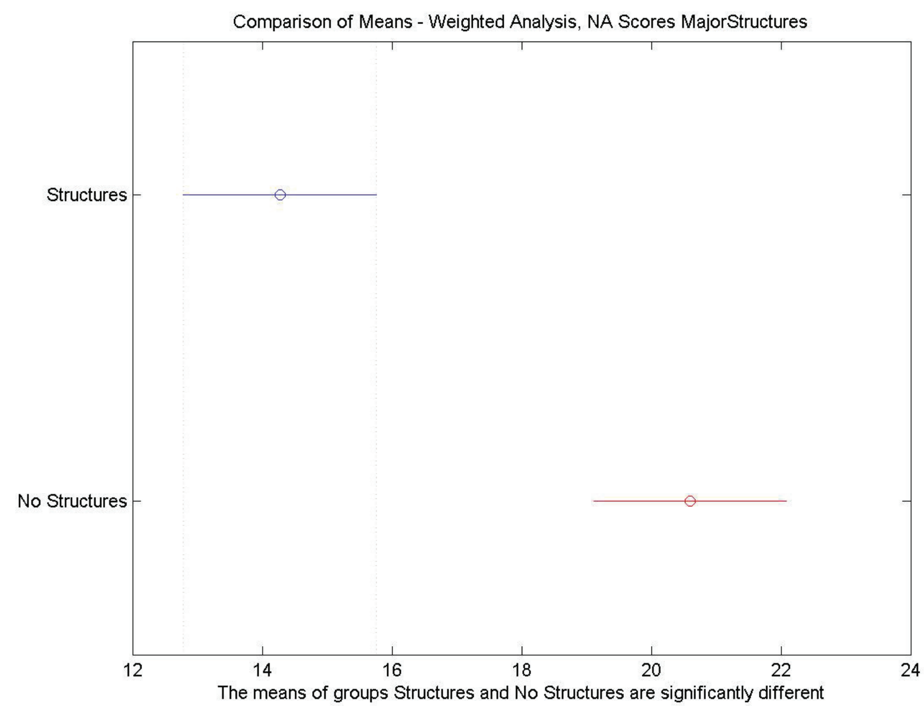


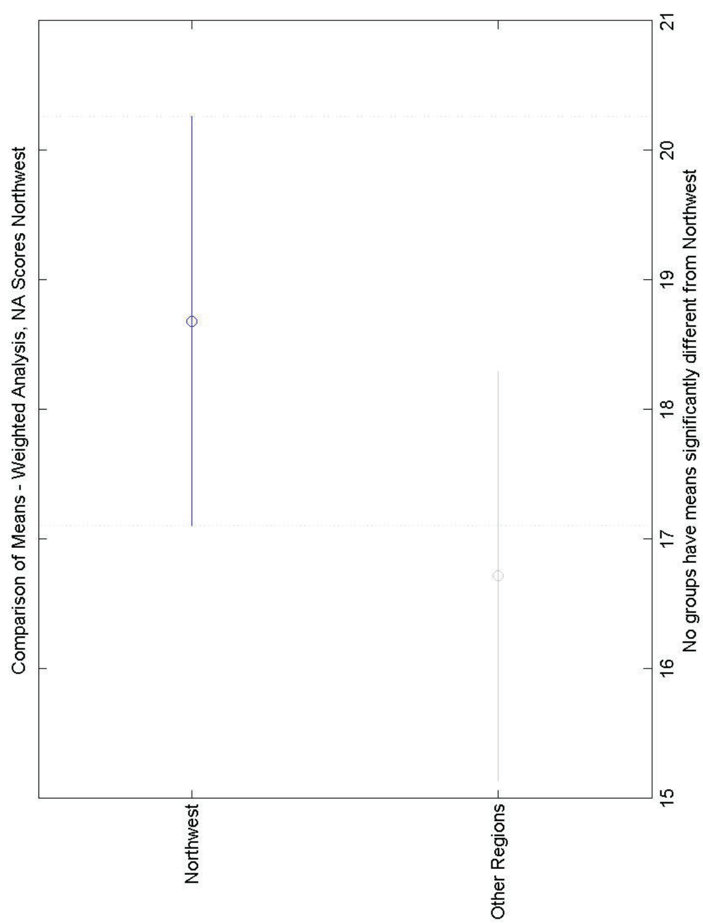
Points Not Available for Variable
FunctClass
Collector
Arterial
Local
0
5
10
15
20
25
30
35
40
45

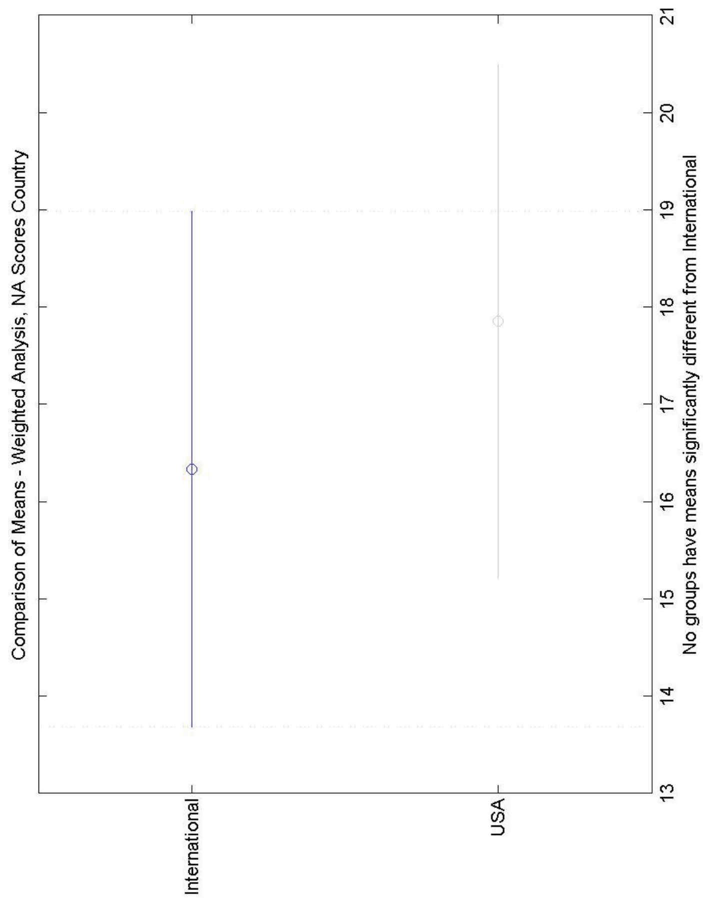

Comparison of Means - Weighted Analysis, NA Scores GreenroadsProject
Not Greenroads
Greenroads
15
16
17
18
19
20
21
22
23
No groups have means significantly different from Not Greenroads

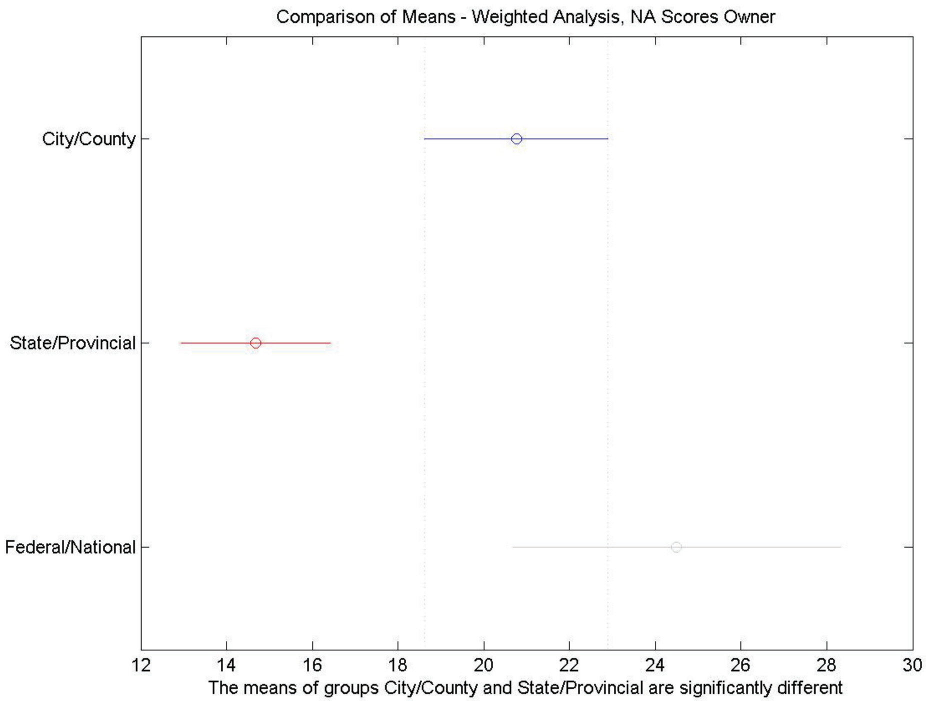

Points Not Available for Variable
Budget
45
40
35
30
25
20
15
10
5
0
0-10
10-100
100+

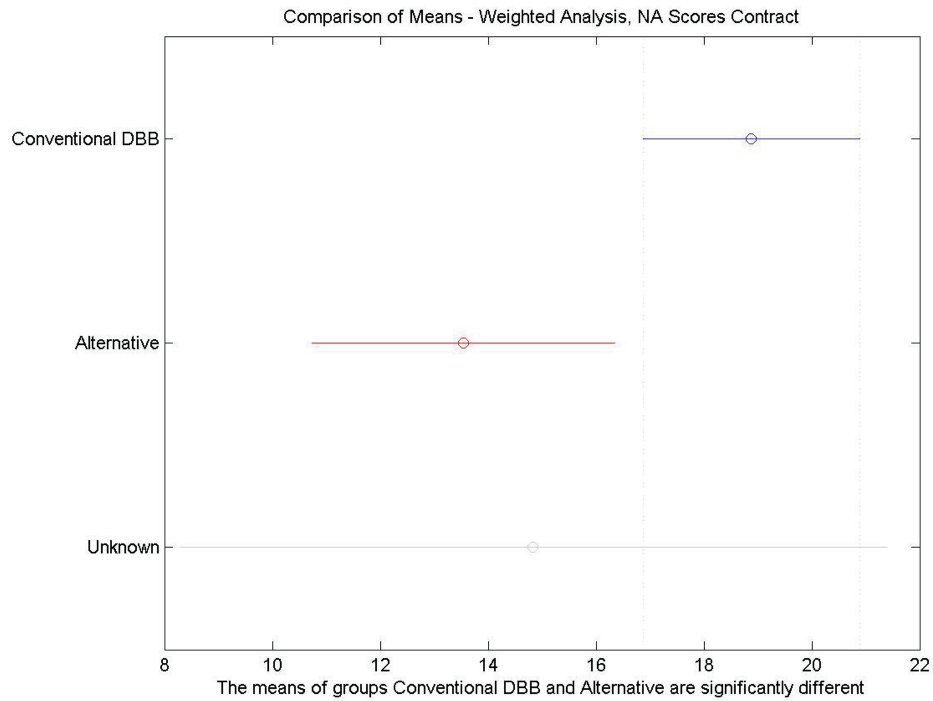

Comparison of Means - Weighted Analysis, NA Scores GreenEmphasis
Typical
Greener
15.5
16
16.5
17
17.5
18
18.5
19
19.5
20
No groups have means significantly different from Typical

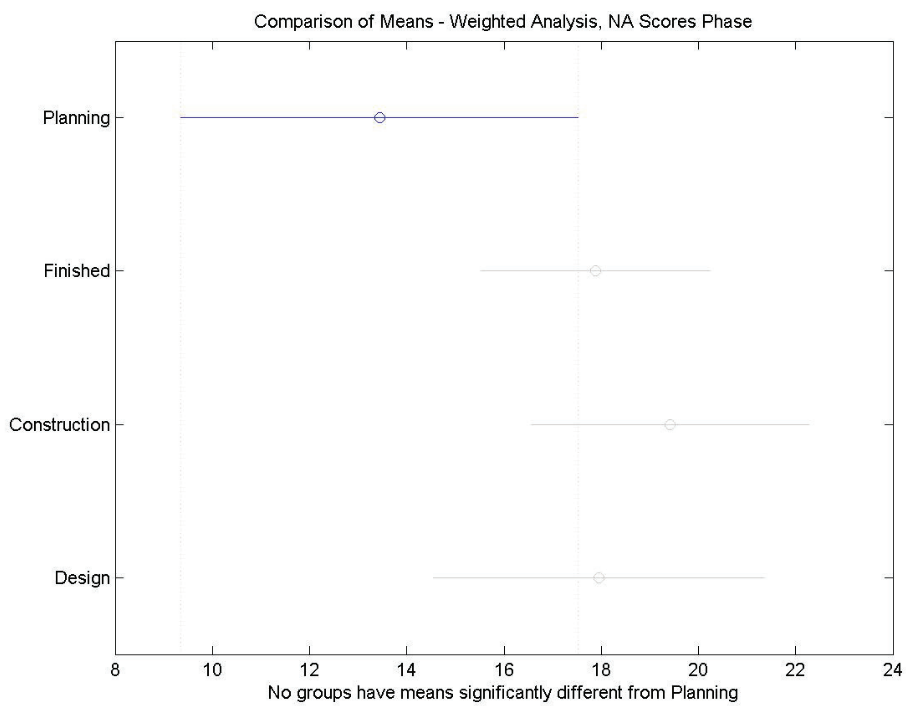

Comparison of Means - Weighted Analysis, NA Scores MajorStructures
Structures
No Structures
12
14
16
18
20
22
24
The means of groups Structures and No Structures are significantly different

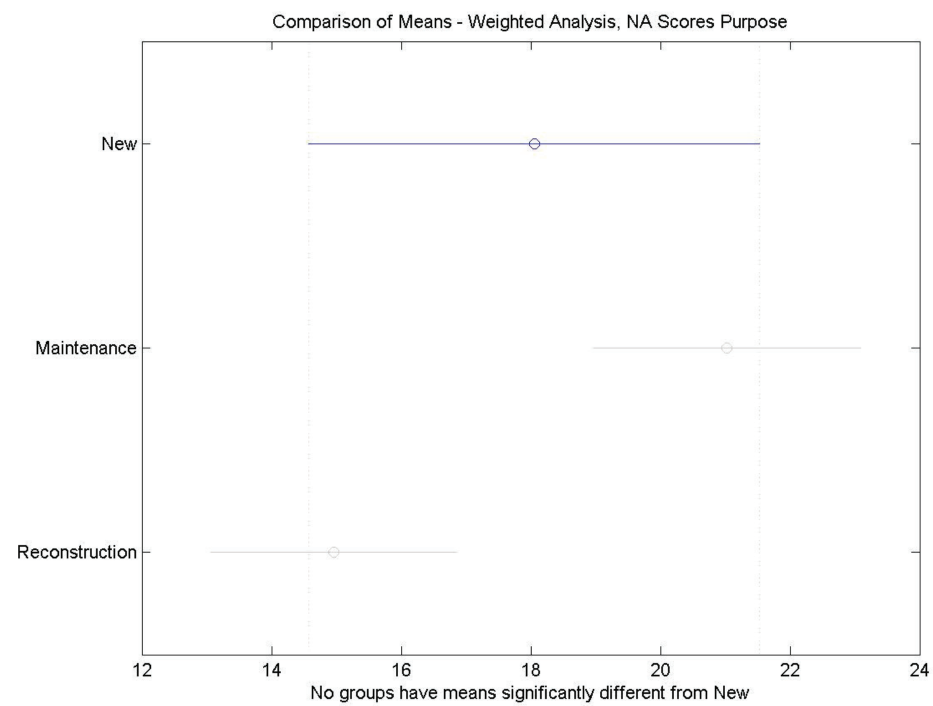

Comparison of Means - Weighted Analysis, NA Scores Northwest
Northwest
Other Regions
15
16
17
18
19
20
21
No groups have means significantly different from Northwest

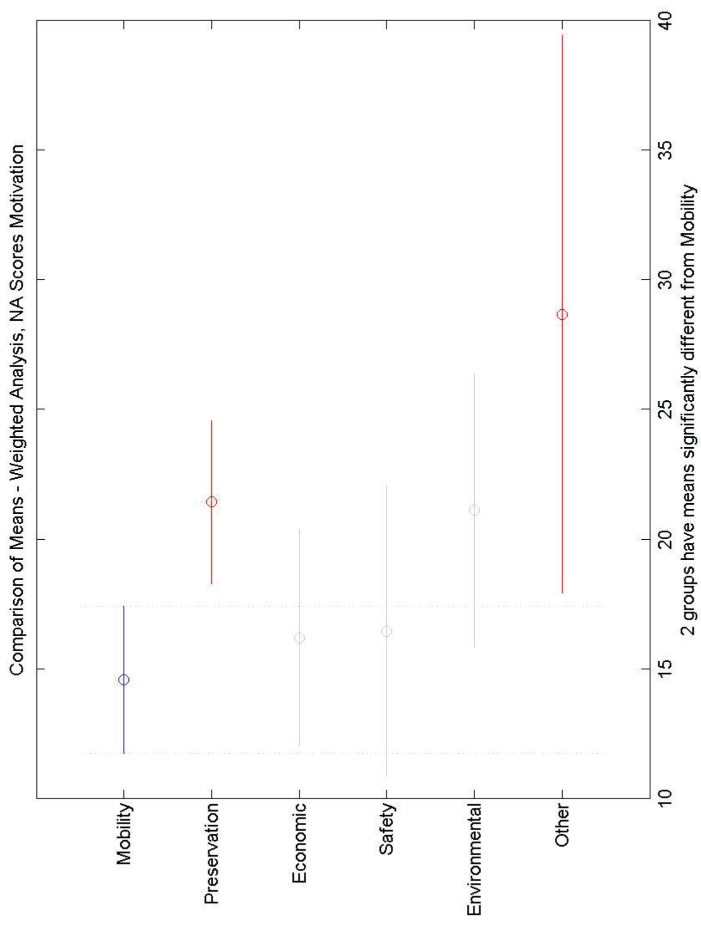

Comparison of Means - Weighted Analysis, NA Scores Country
International
USA
13
14
15
16
17
18
19
20
21
No groups have means significantly different from International

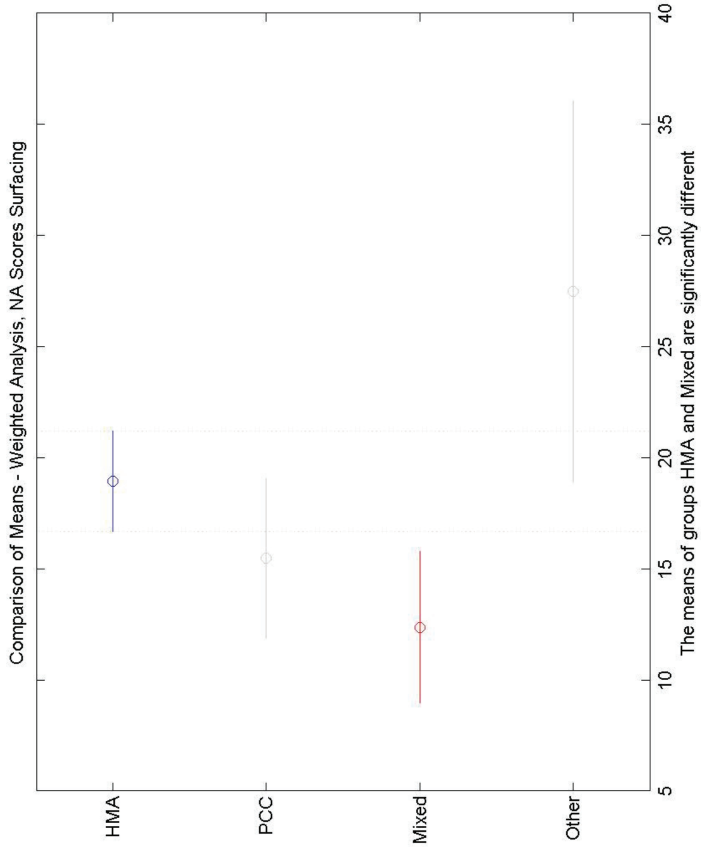

Comparison of Means - Weighted Analysis, NA Scores Owner
City/County
State/Provincial
Federal/National
12
14
16
18
20
22
24
26
28
30
The means of groups City/County and State/Provincial are significantly different

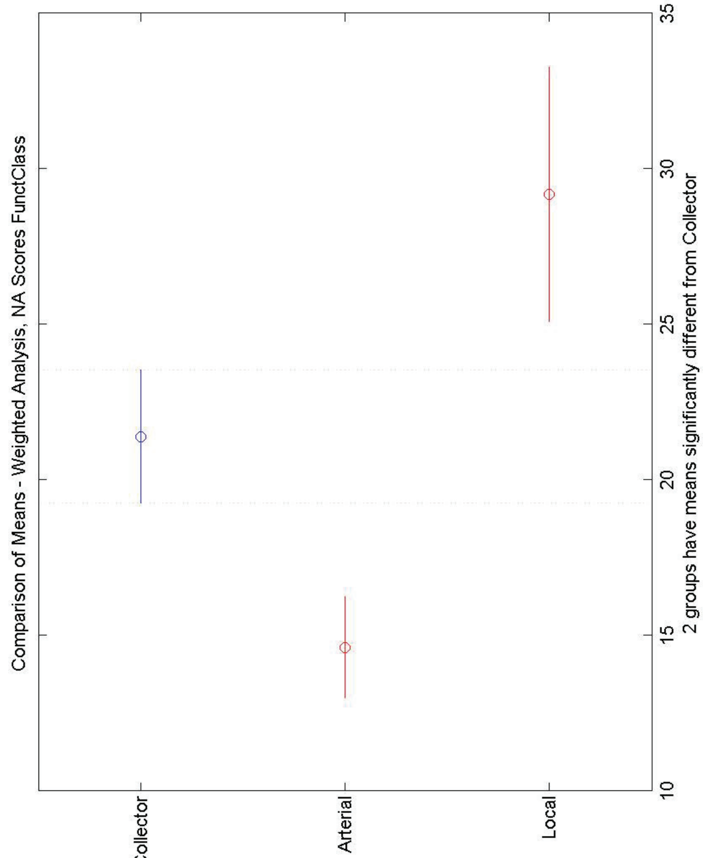

Comparison of Means - Weighted Analysis, NA Scores Contract
Conventional DBB
Alternative
Unknown
8
10
12
14
16
18
20
22
The means of groups Conventional DBB and Alternative are significantly different

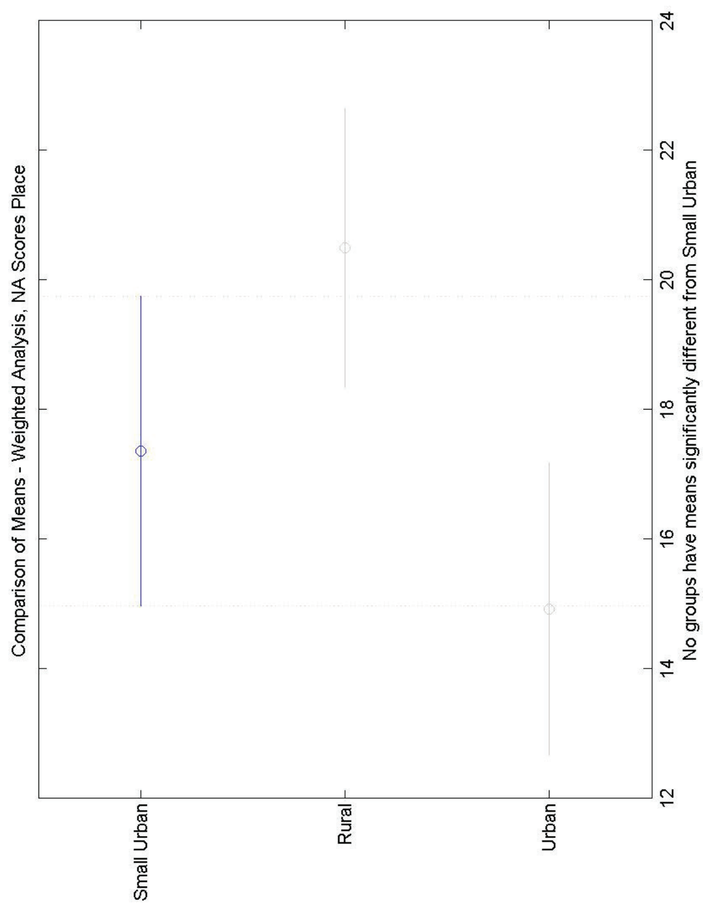

Comparison of Means - Weighted Analysis, NA Scores Phase
Planning
Finished
Construction
Design
8
10
12
14
16
18
20
22
24
No groups have means significantly different from Planning

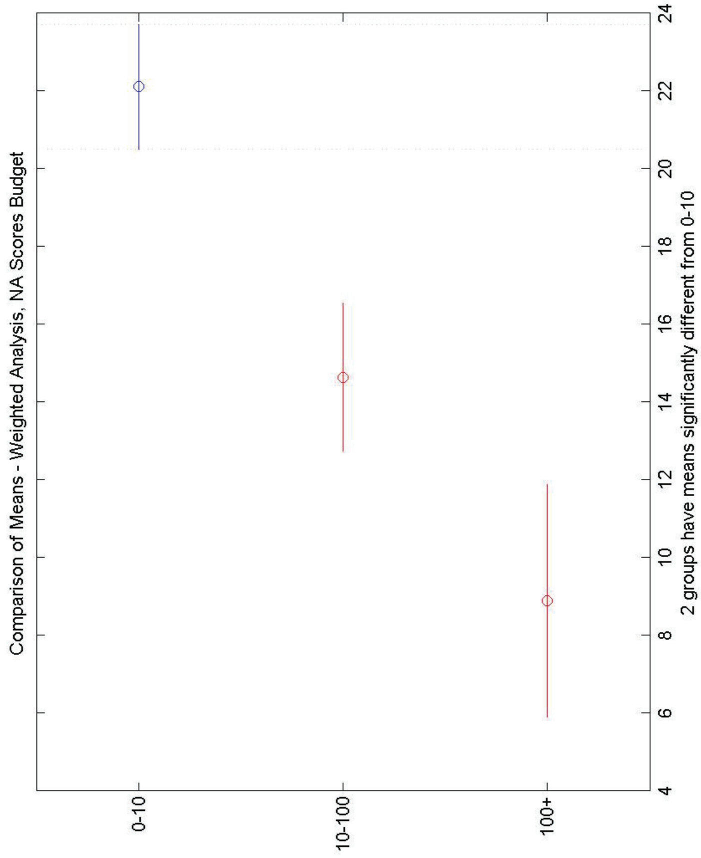

Comparison of Means - Weighted Analysis, NA Scores Purpose
New
Maintenance
Reconstruction
12
14
16
18
20
22
24
No groups have means significantly different from New

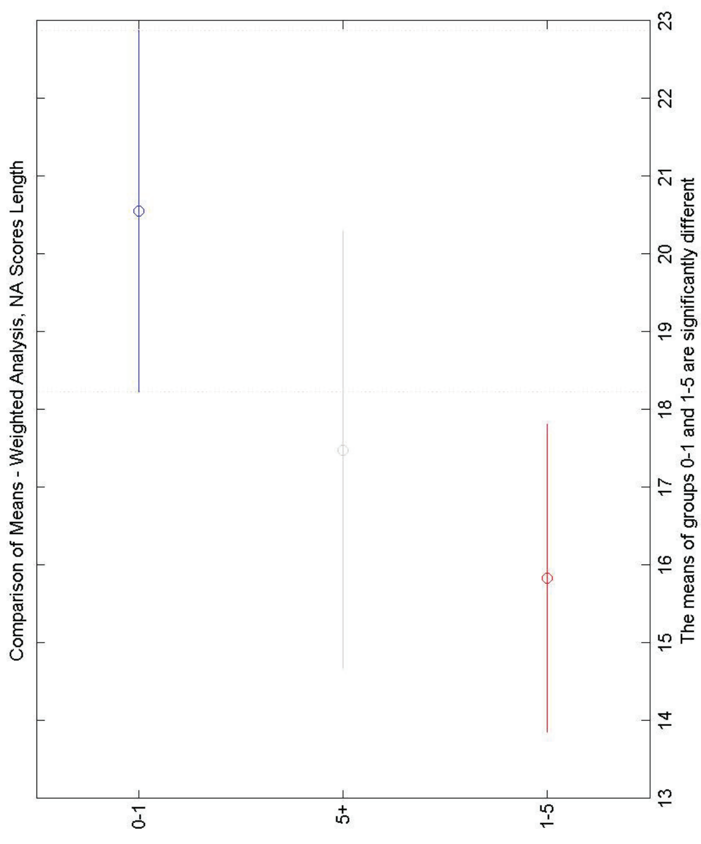

Comparison of Means - Weighted Analysis, NA Scores Motivation
Mobility
Preservation
Economic
Safety
Environmental
Other
10
15
20
25
30
35
40
2 groups have means significantly different from Mobility

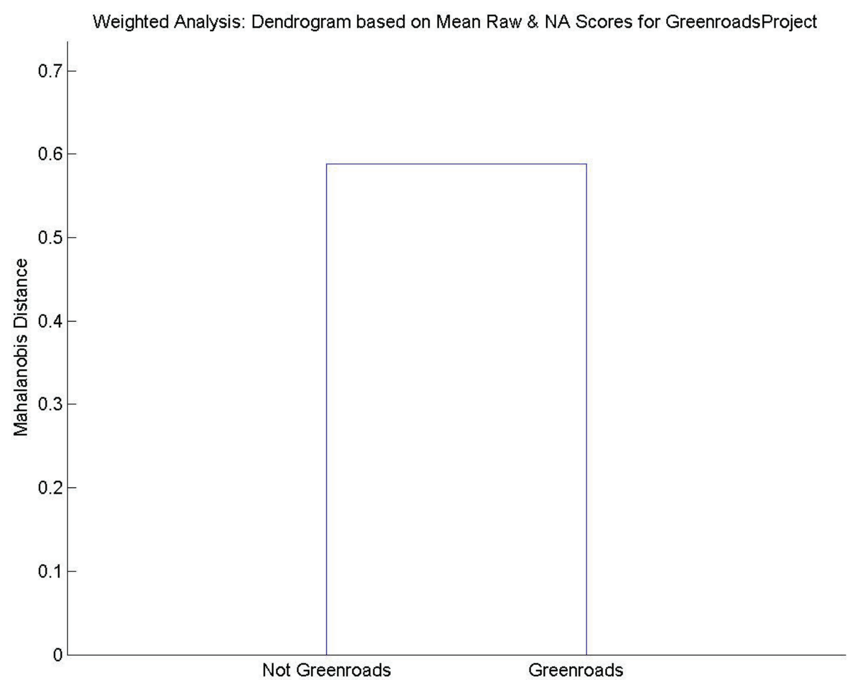

Comparison of Means - Weighted Analysis, NA Scores Surfacing
HMA
PCC
Mixed
Other
5
10
15
20
25
30
35
40
The means of groups HMA and Mixed are significantly different

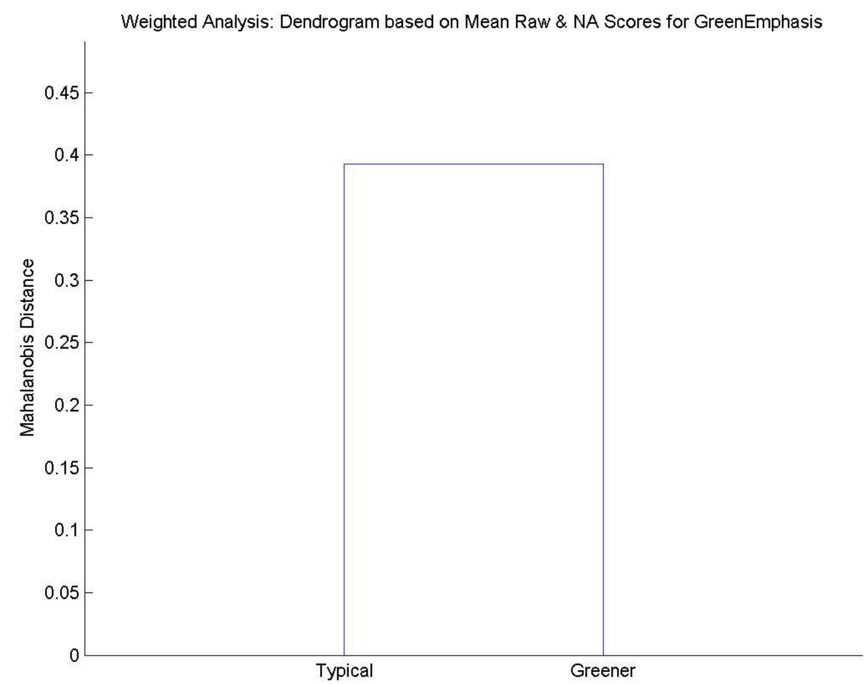

Comparison of Means - Weighted Analysis, NA Scores FunctClass
Collector
Arterial
Local
10
15
20
25
30
35
2 groups have means significantly different from Collector

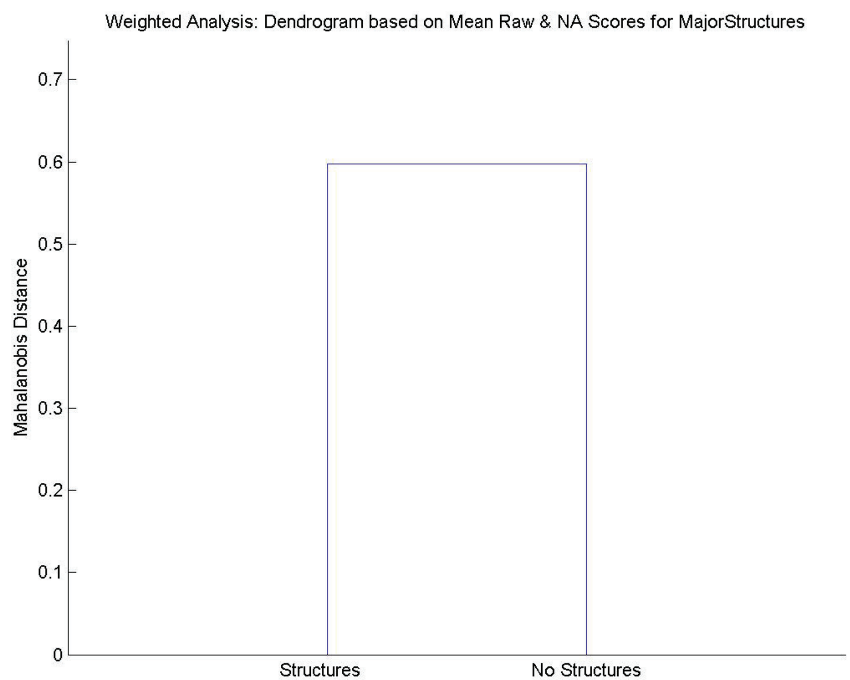

Comparison of Means - Weighted Analysis, NA Scores Place
Small Urban
Rural
Urban
12
14
16
18
20
22
24
No groups have means significantly different from Small Urban


Comparison of Means - Weighted Analysis, NA Scores Budget
0-10
10-100
100+
4
6
8
10
12
14
16
18
20
22
24
2 groups have means significantly different from 0-10

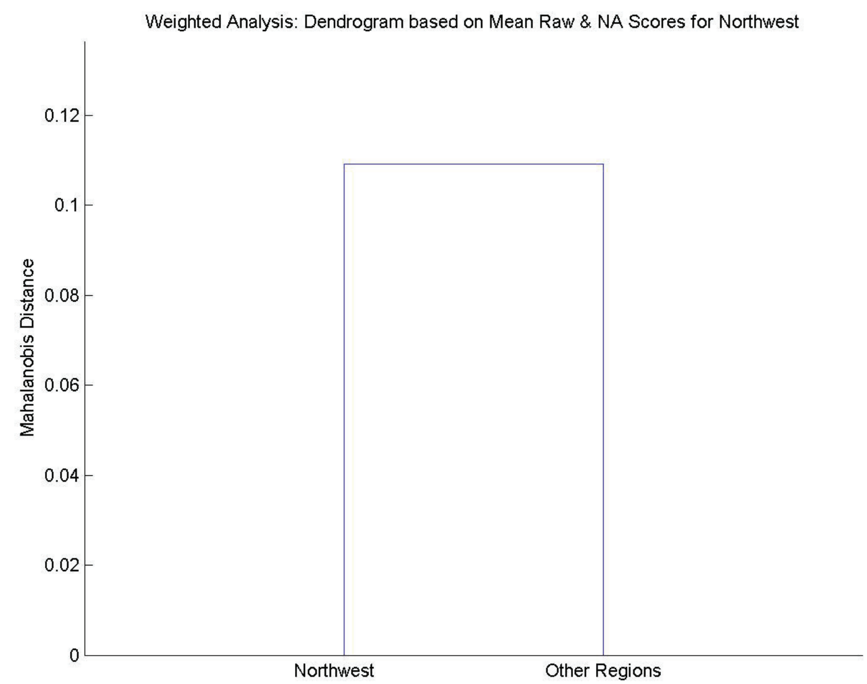

Comparison of Means - Weighted Analysis, NA Scores Length
0-1
5+
1-5
13
14
15
16
17
18
19
20
21
22
23
The means of groups 0-1 and 1-5 are significantly different


Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for GreenroadsProject
Mahalanobis Distance
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Not Greenroads
Greenroads

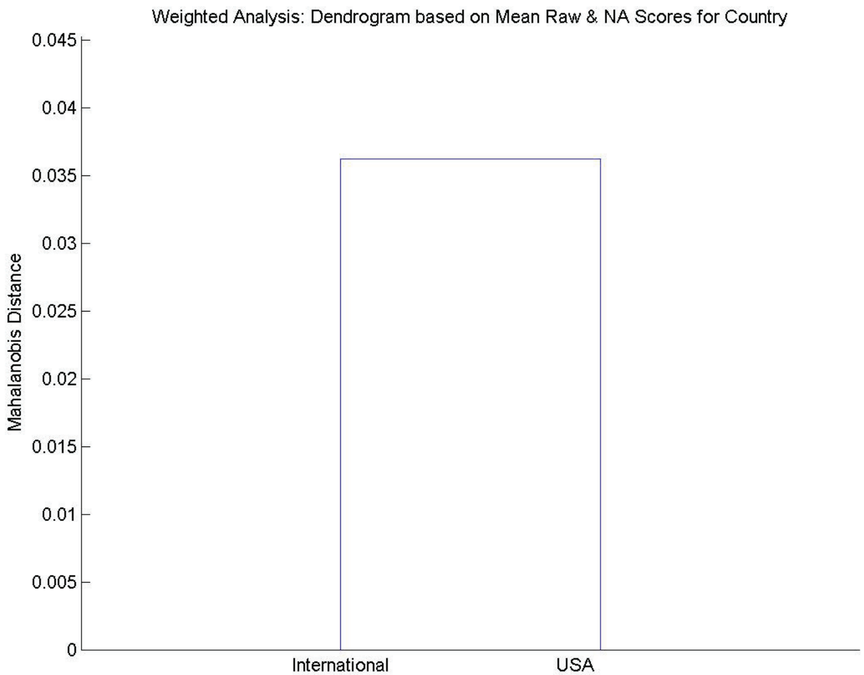

Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for GreenEmphasis
Mahalanobis Distance
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Typical
Greener

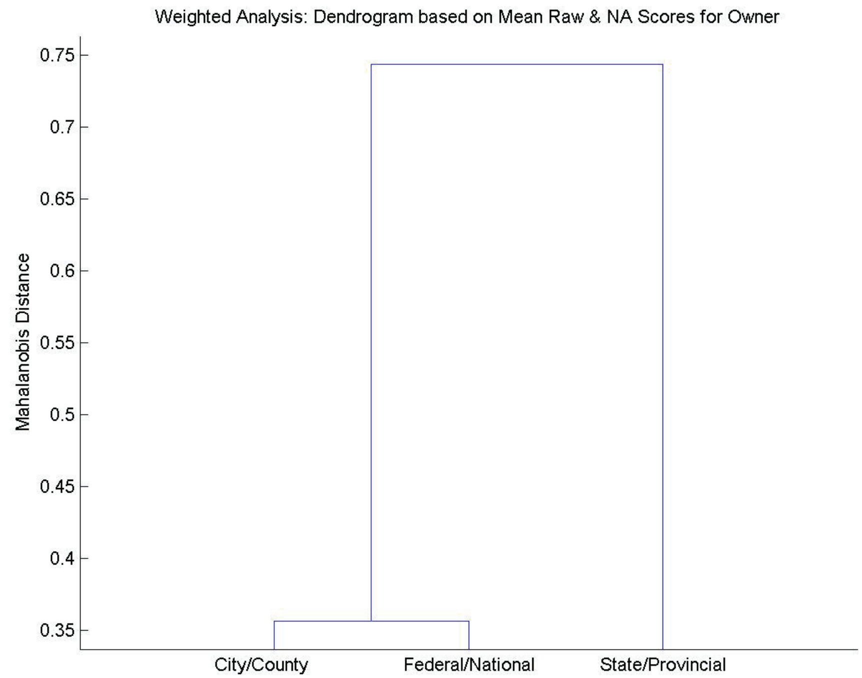


Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for MajorStructures
Mahalanobis Distance
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Structures
No Structures

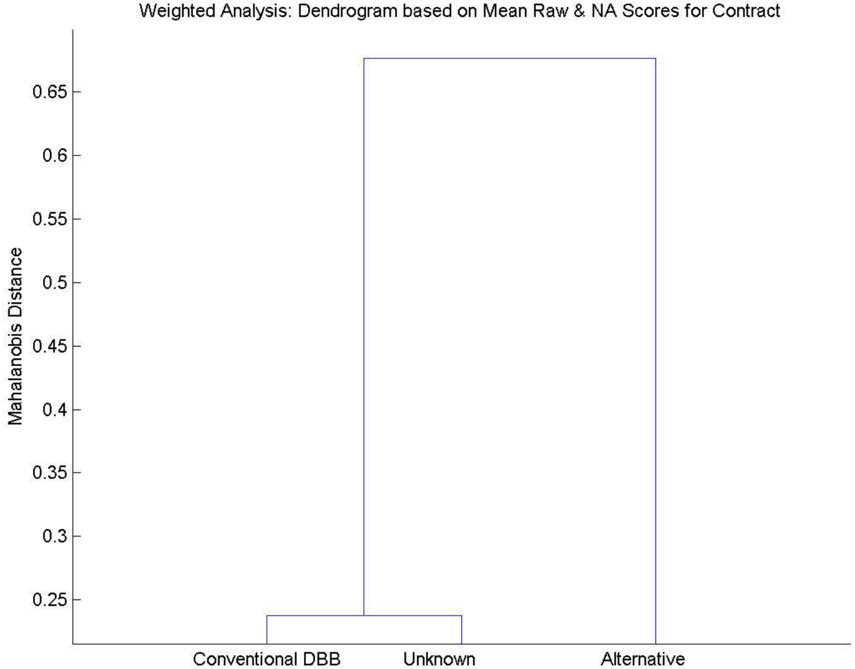


Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Northwest
Mahalanobis Distance
0.12
0.1
0.08
0.06
0.04
0.02
0
Northwest
Other Regions

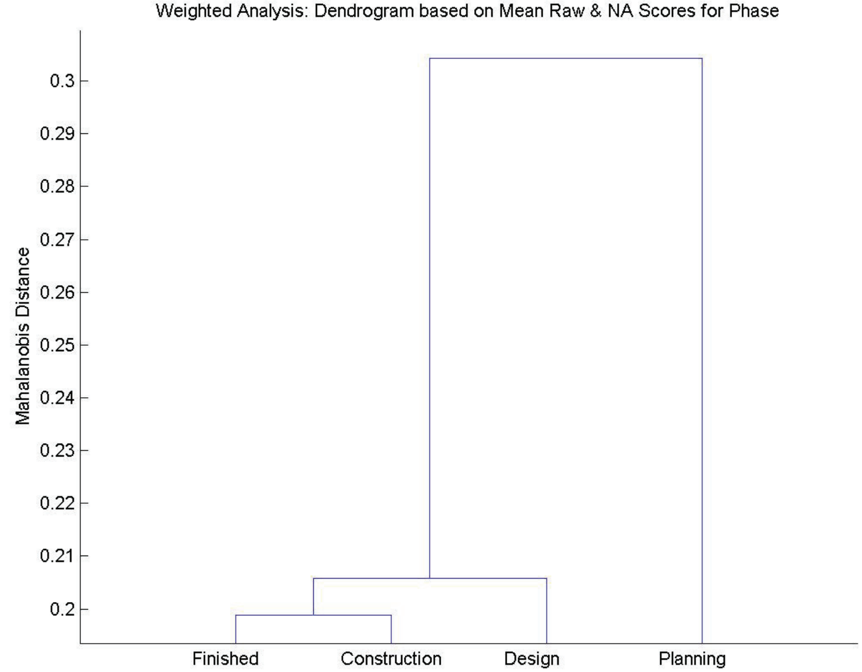

Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Country
Mahalanobis Distance
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
International
USA

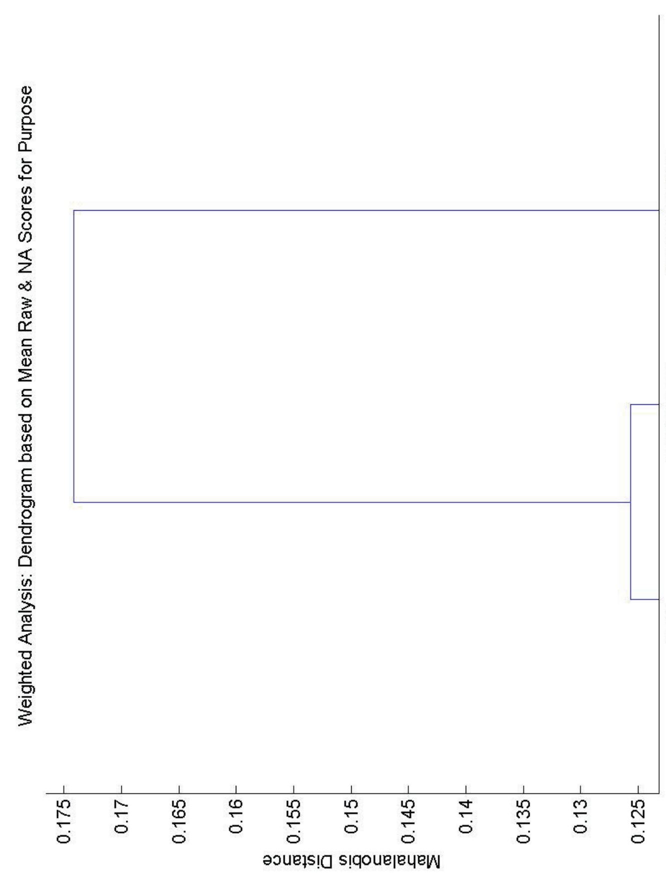

Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Owner
Mahalanobis Distance
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
City/County
Federal/National
State/Provincial

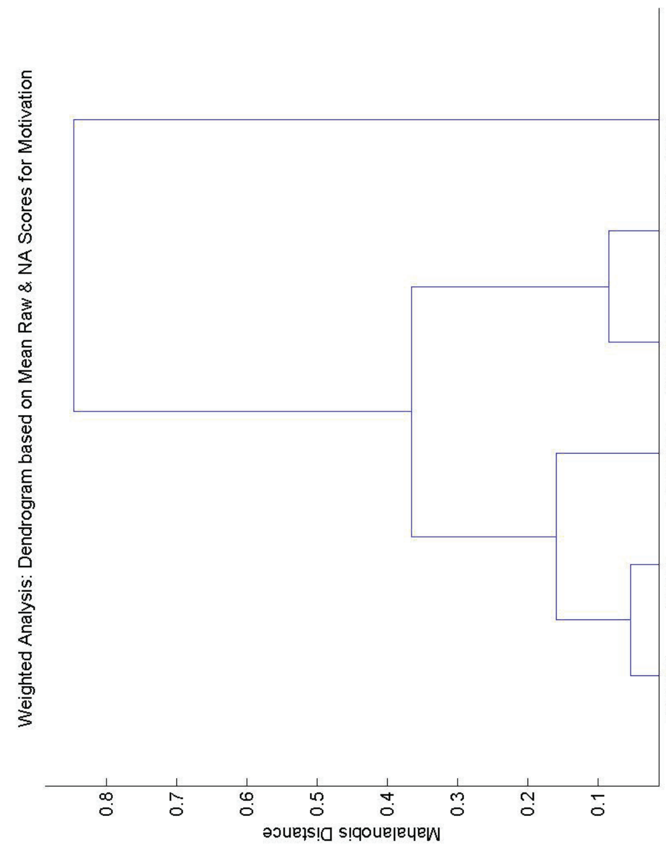
Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Contract

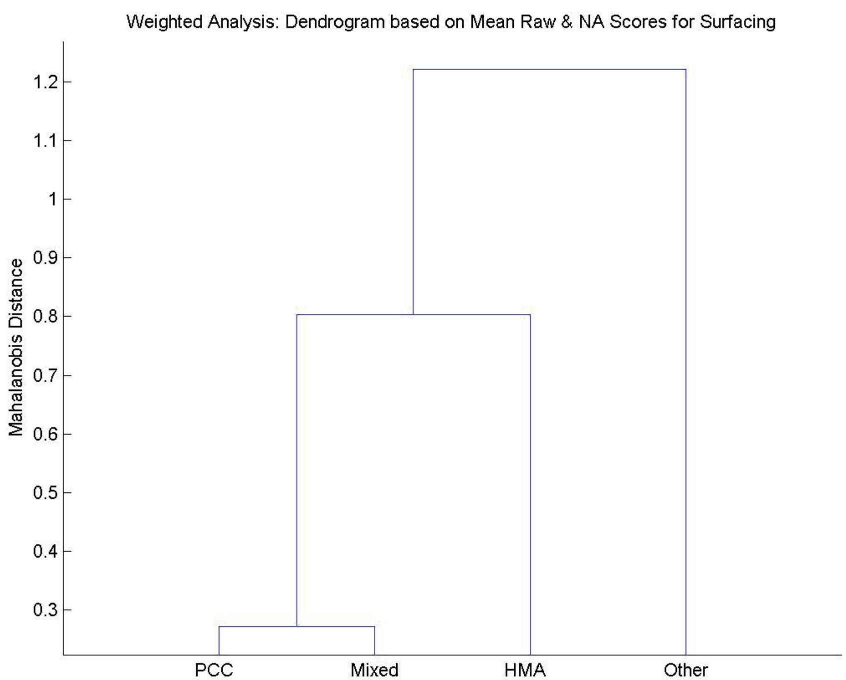


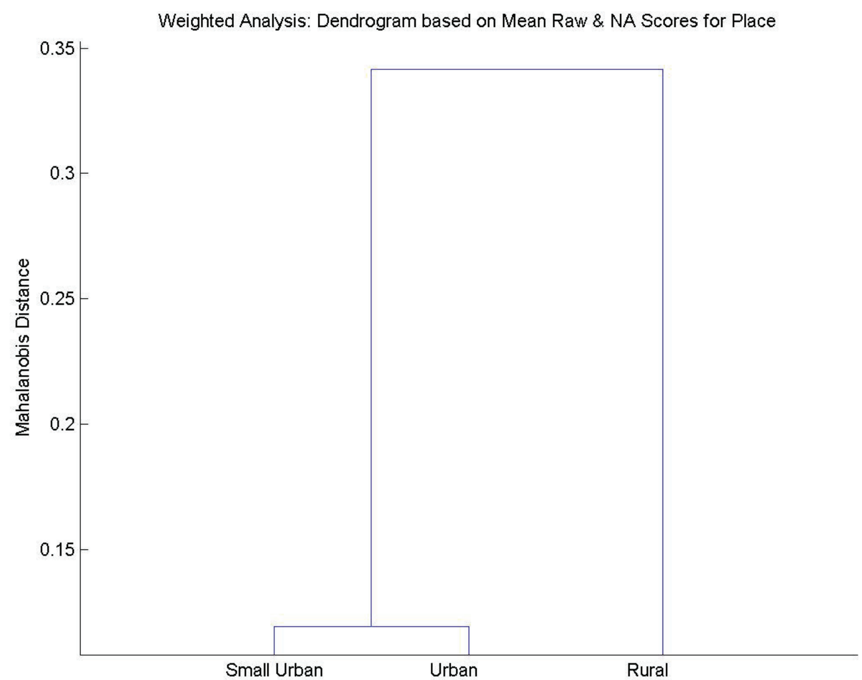
Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Phase



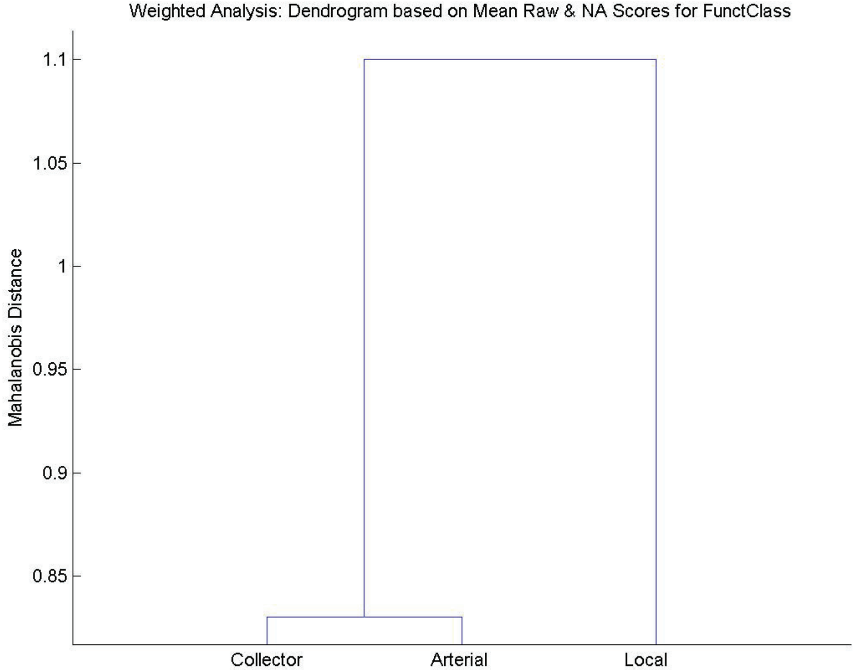

Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Purpose
Mahalanobis Distance
0.125
0.13
0.135
0.14
0.145
0.15
0.155
0.16
0.165
0.17
0.175
New
Maintenance
Reconstruction


Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Motivation
Mahalanobis Distance
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Mobility
Safety
Economic
Preservation
Environmental
Other

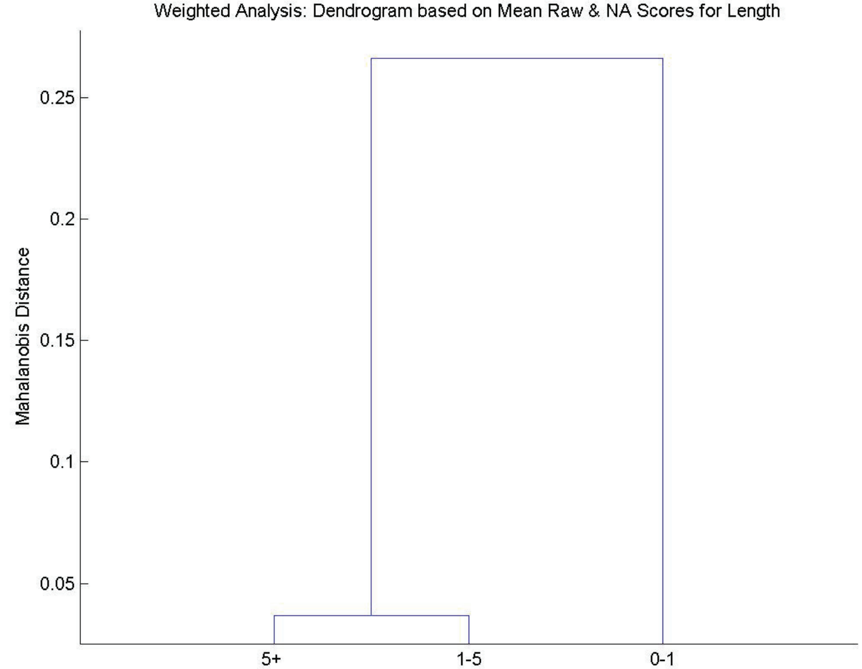

Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Surfacing
Mahalanobis Distance
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
PCC
Mixed
HMA
Other

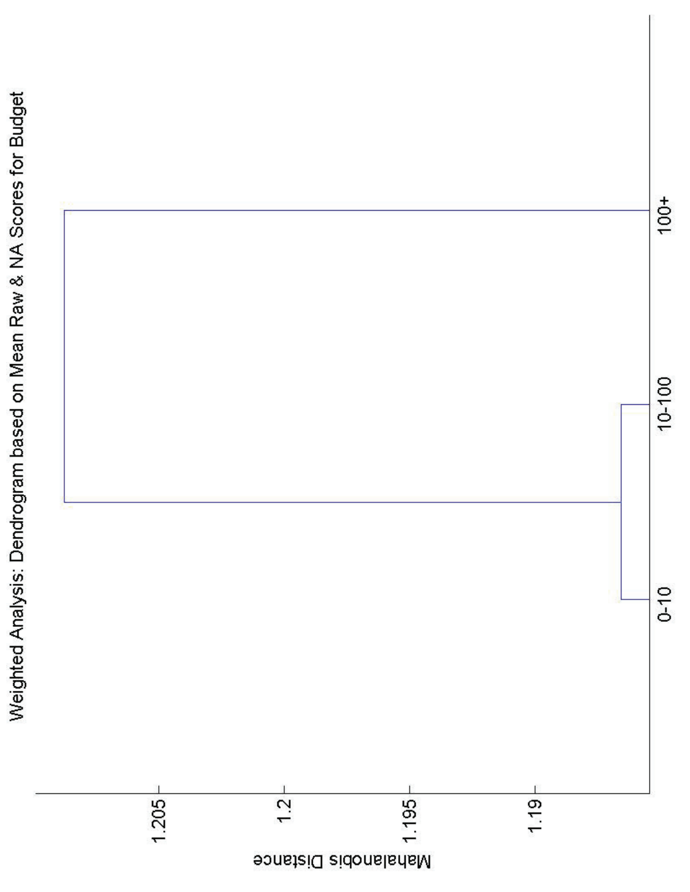

Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Place
Mahalanobis Distance
0.35
0.3
0.25
0.2
0.15
Small Urban
Urban
Rural

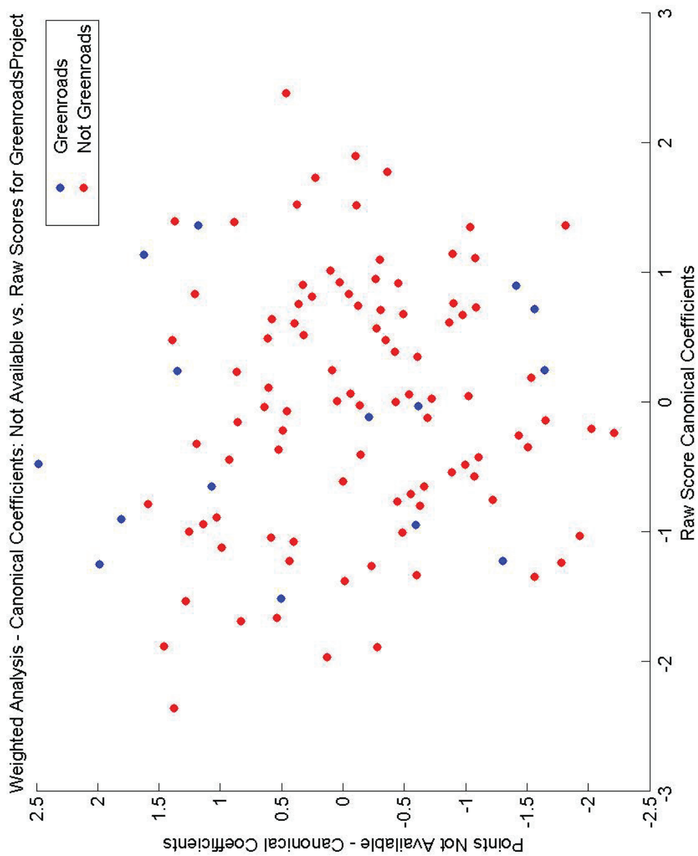
Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for FunctClass

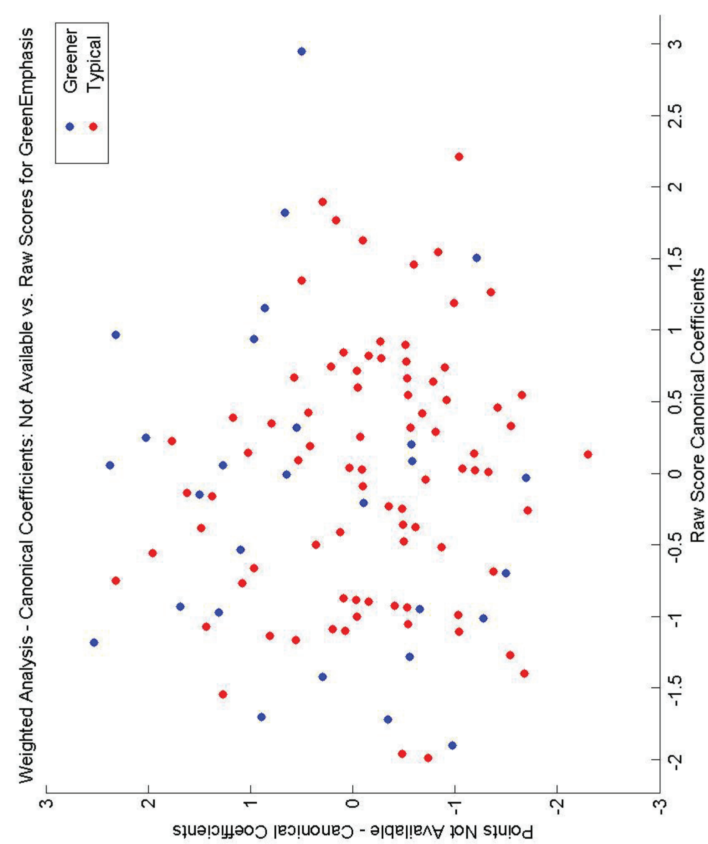


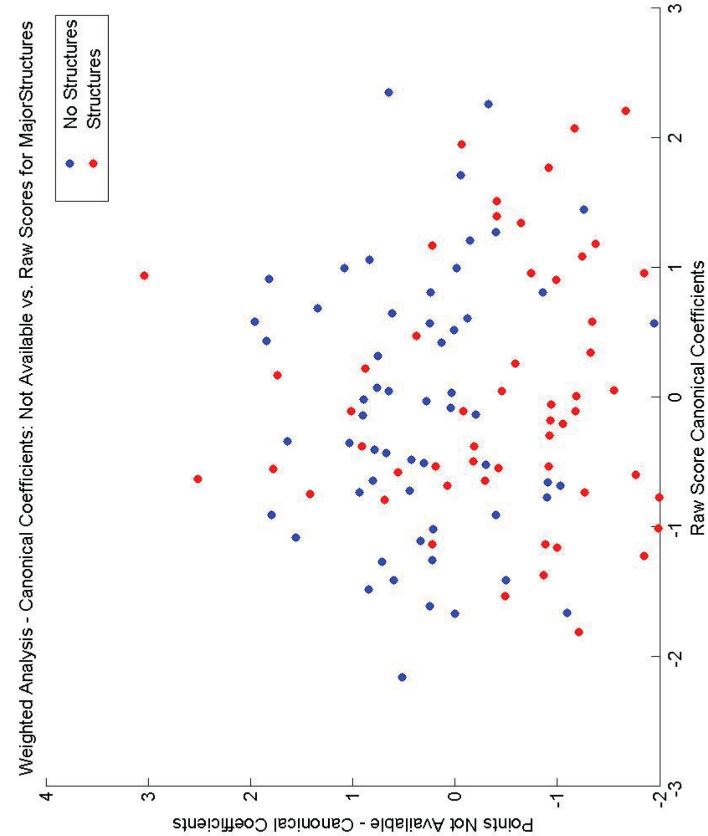
Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Length

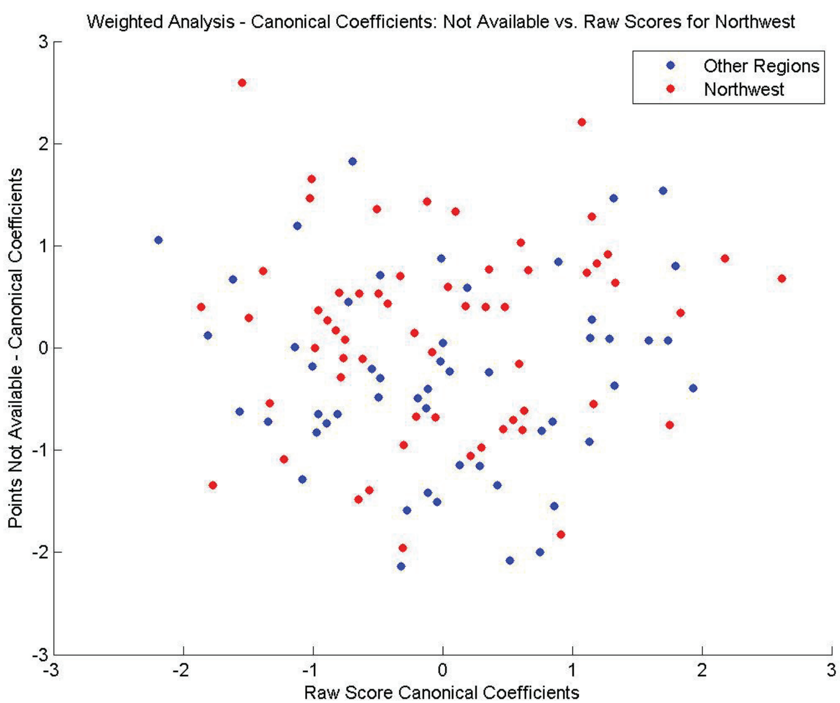


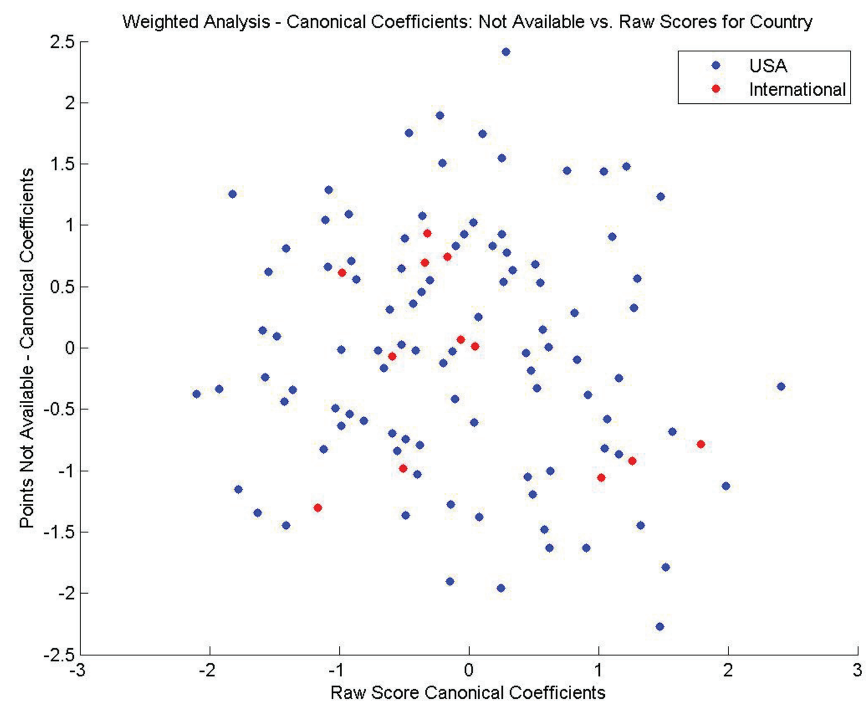

Weighted Analysis: Dendrogram based on Mean Raw & NA Scores for Budget
Mahalanobis Distance
1.205
1.2
1.195
1.19
0-10
10-100
100+

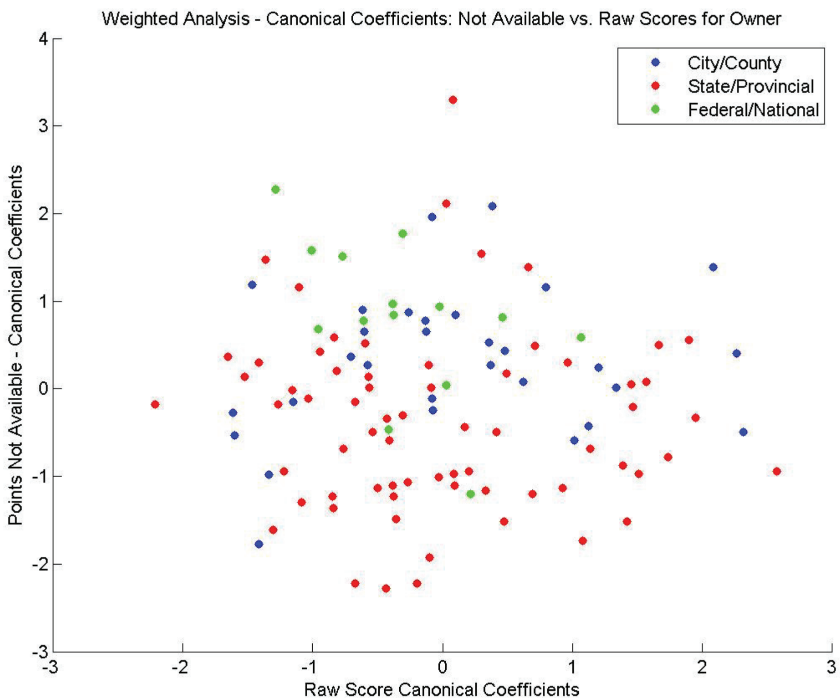

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for GreenroadsProject
Greenroads
Not Greenroads
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-2
-1
0
1
2
3

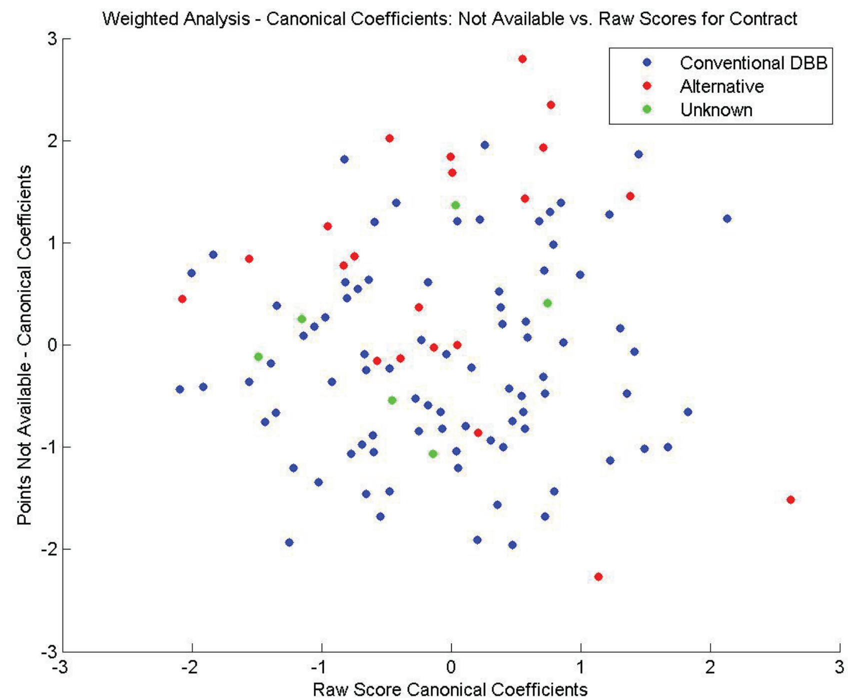

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for GreenEmphasis
Greener
Typical
Raw Score Canonical Coefficients
Points Not Available - Canonical Coefficients

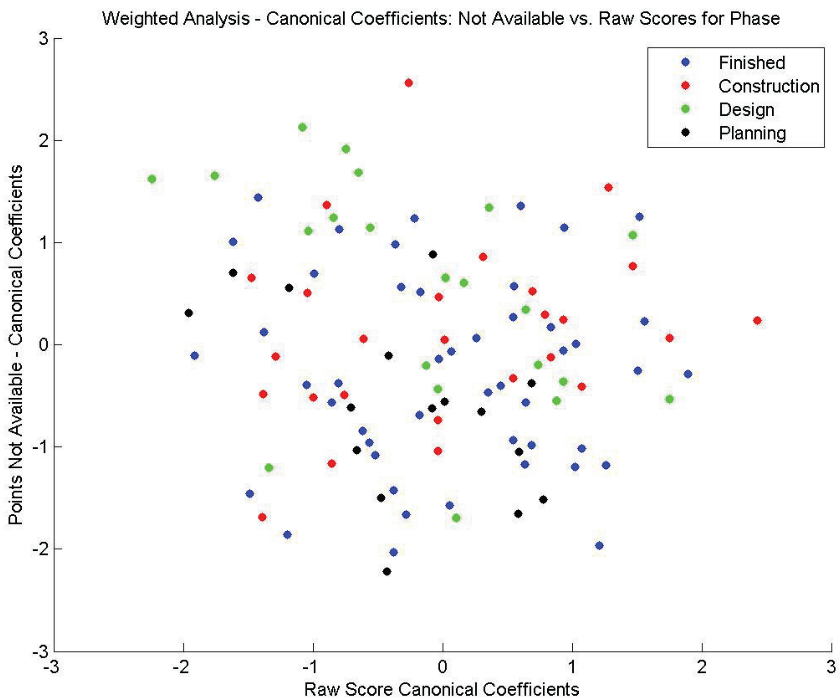

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for MajorStructures
No Structures
Structures
Raw Score Canonical Coefficients
Points Not Available - Canonical Coefficients

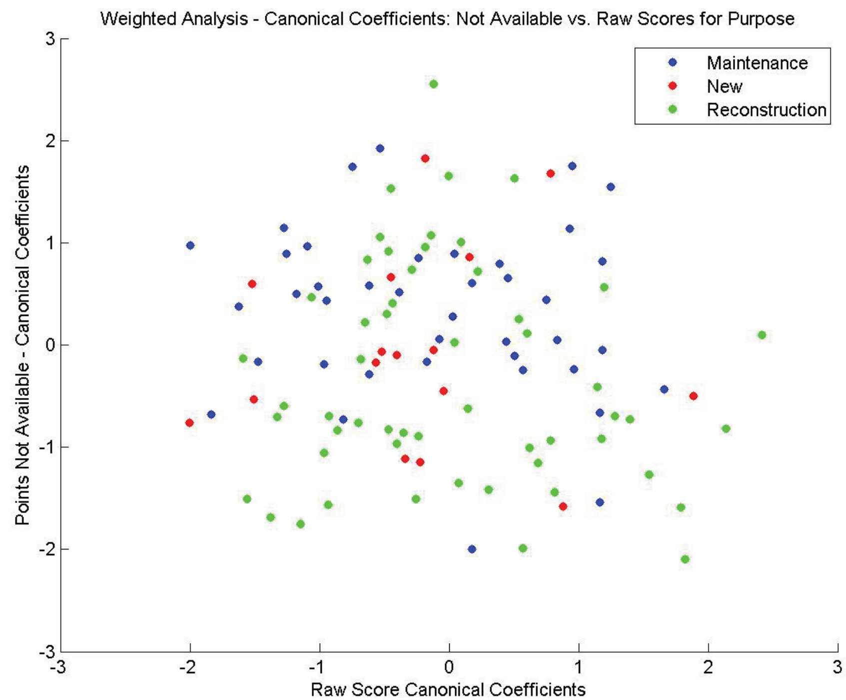

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Northwest
Other Regions
Northwest
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

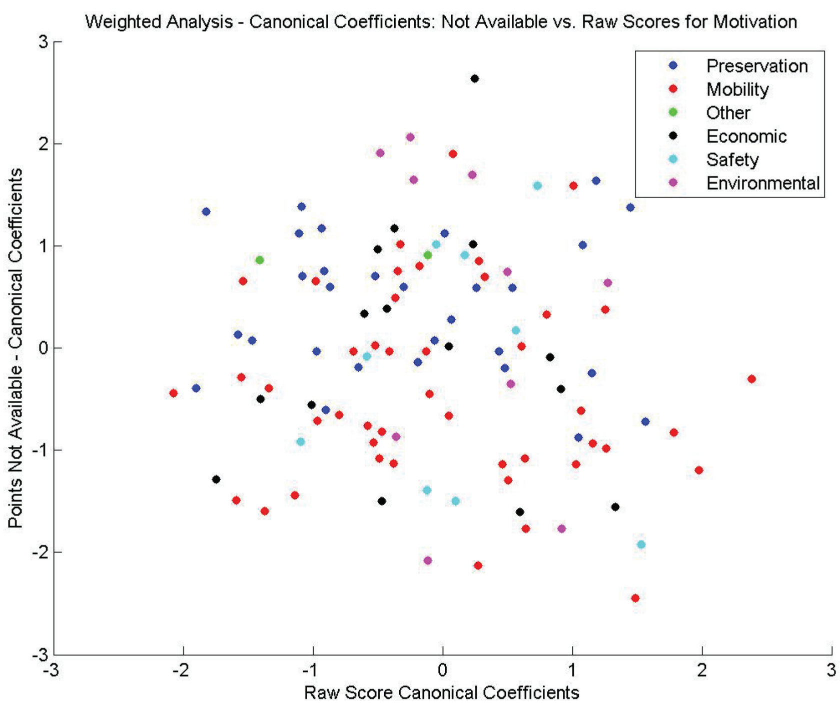

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Country
USA
International
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

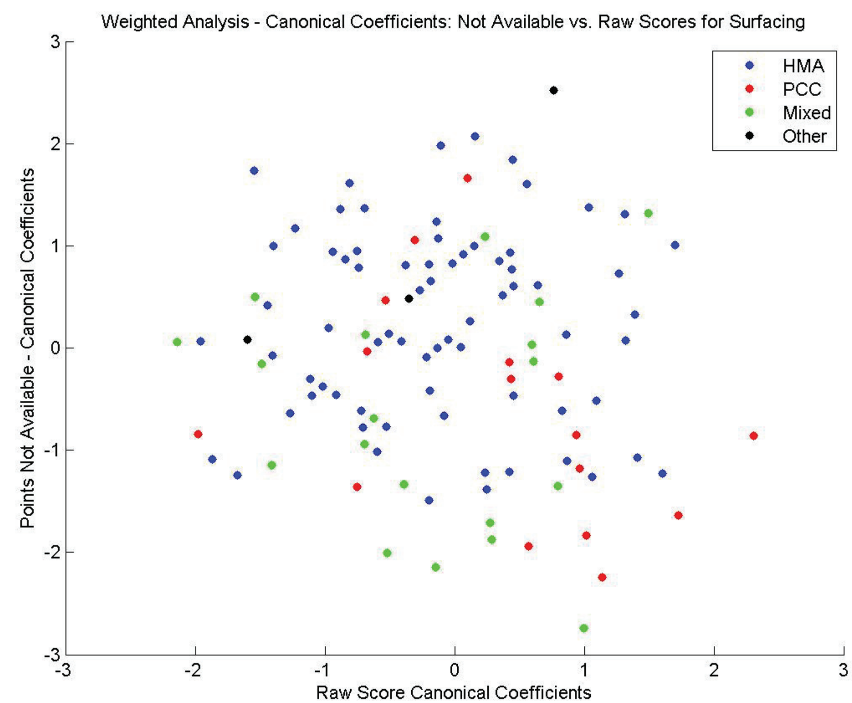

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Owner
City/County
State/Provincial
Federal/National
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

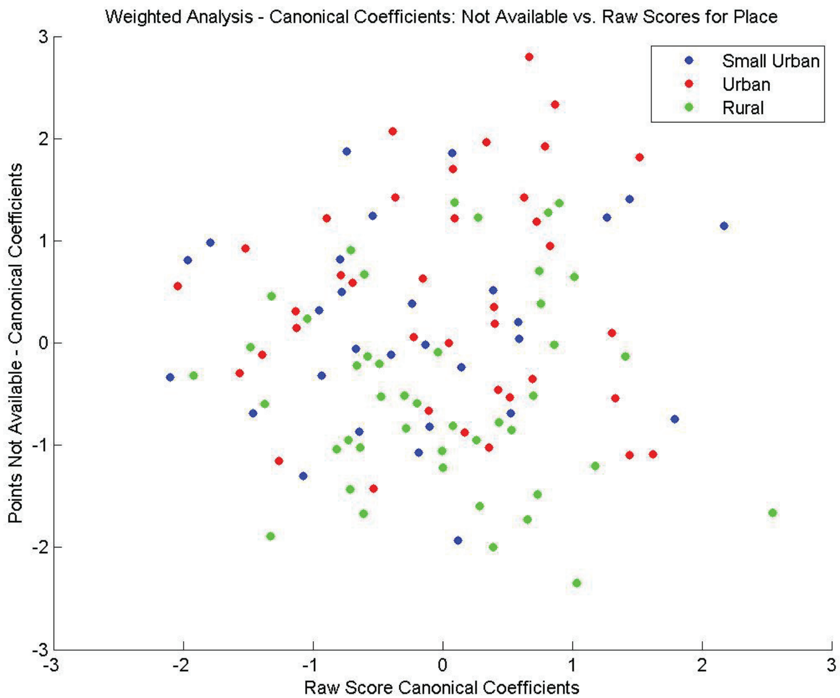

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Contract
Conventional DBB
Alternative
Unknown
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients


Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Phase
Finished
Construction
Design
Planning
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

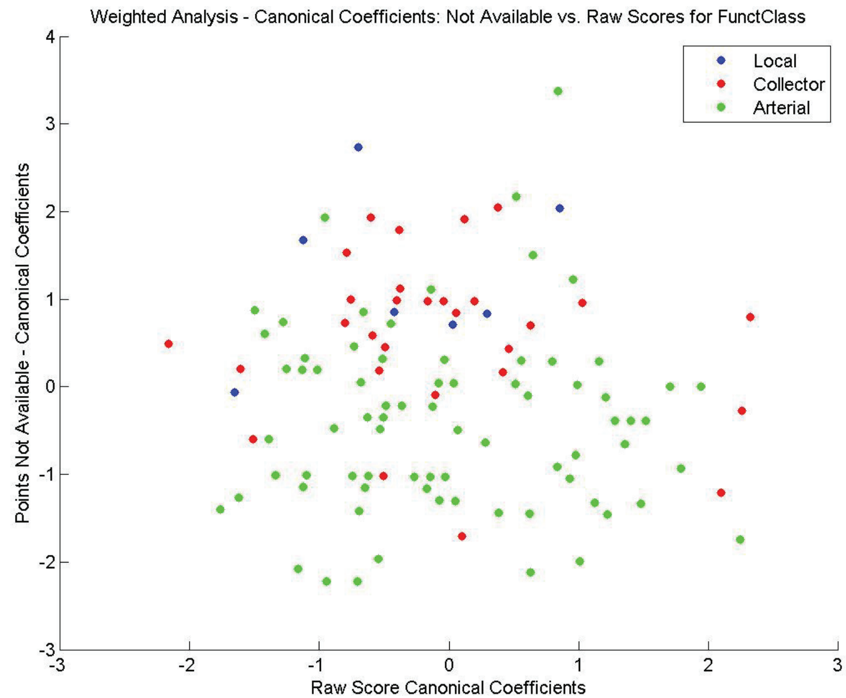

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Purpose
Maintenance
New
Reconstruction
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients


Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Motivation
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
Preservation
Mobility
Other
Economic
Safety
Environmental
3
2
1
0
-1
-2
-3

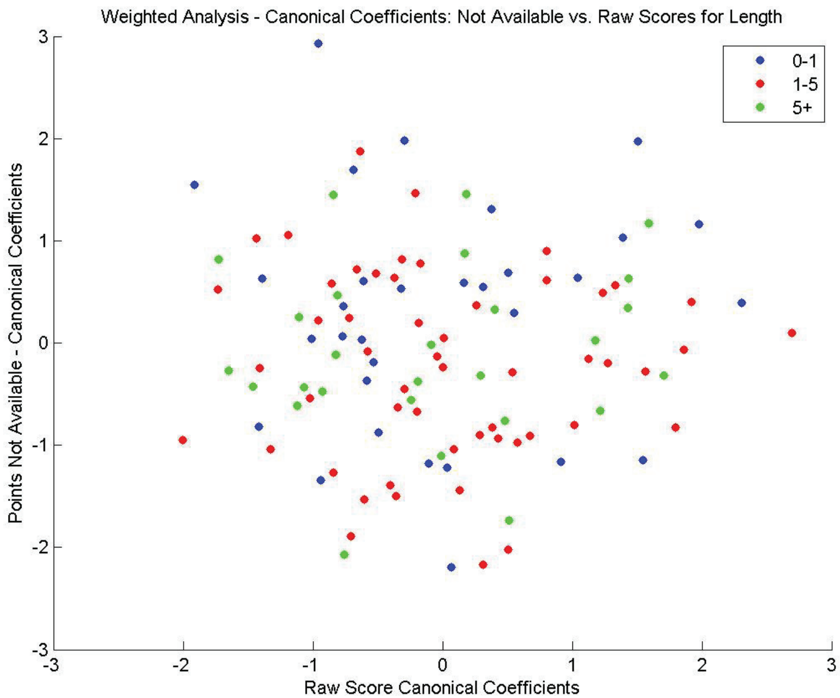

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Surfacing
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
HMA
PCC
Mixed
Other
3
2
1
0
-1
-2
-3

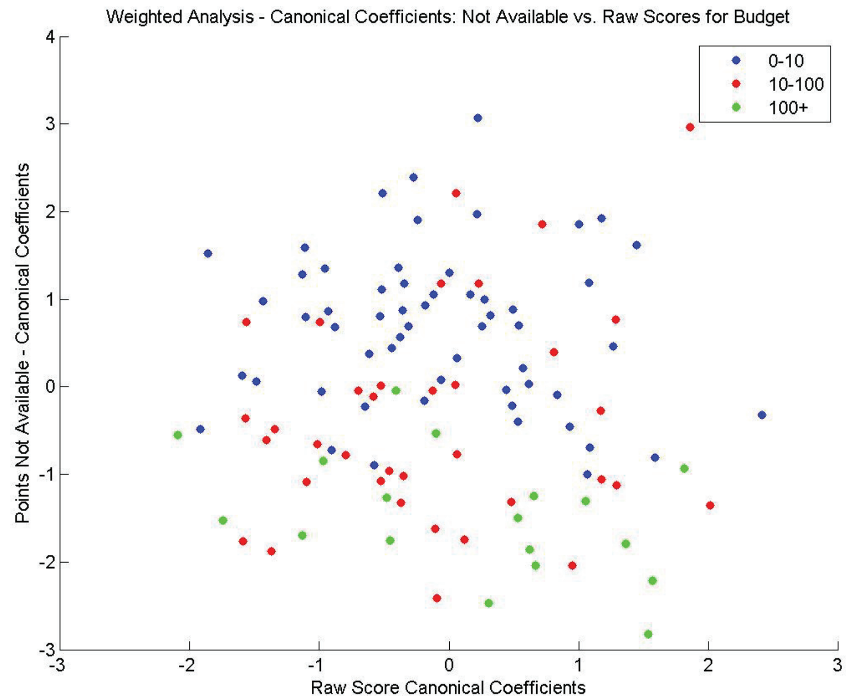


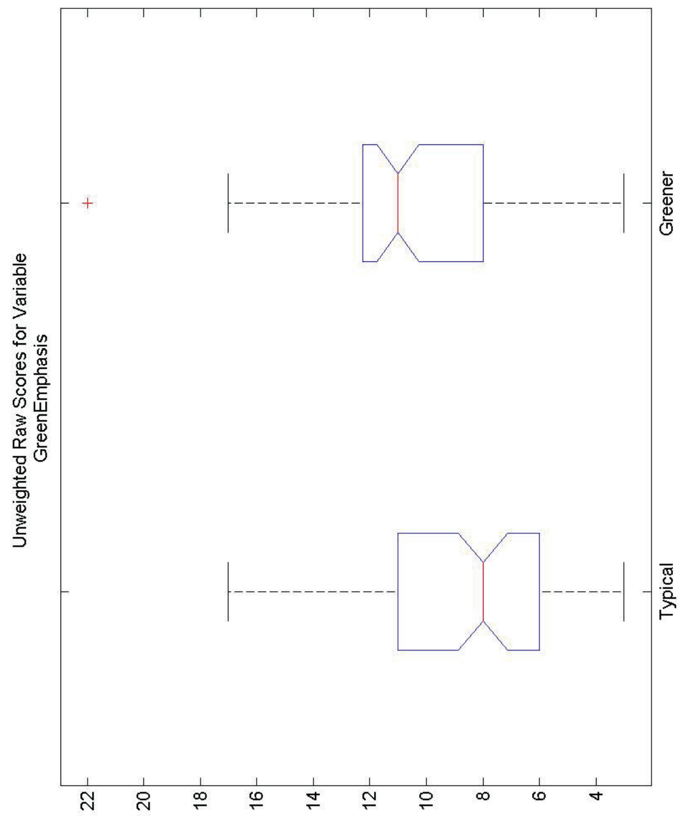
Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Place
Small Urban
Urban
Rural
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

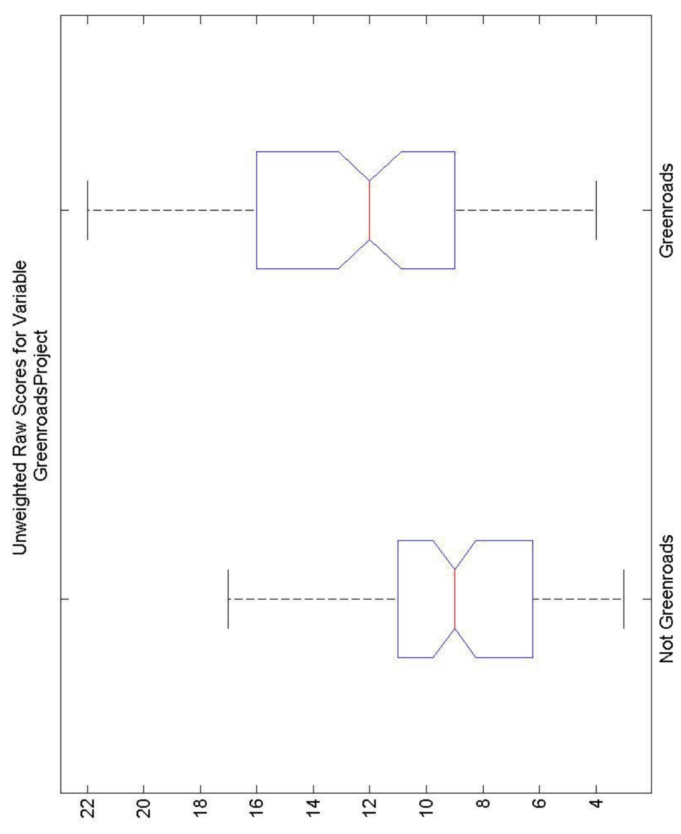


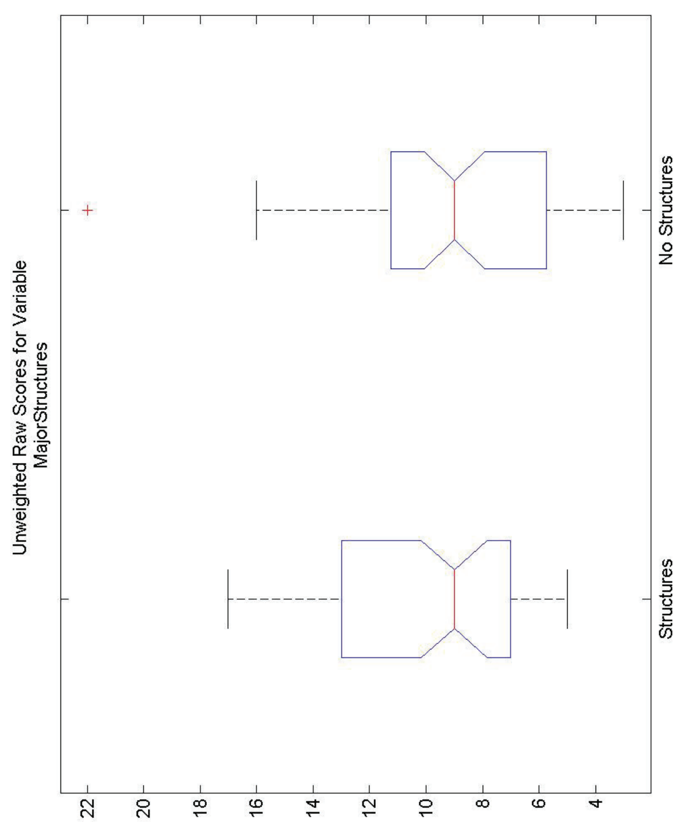
Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for FunctClass
Local
Collector
Arterial
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

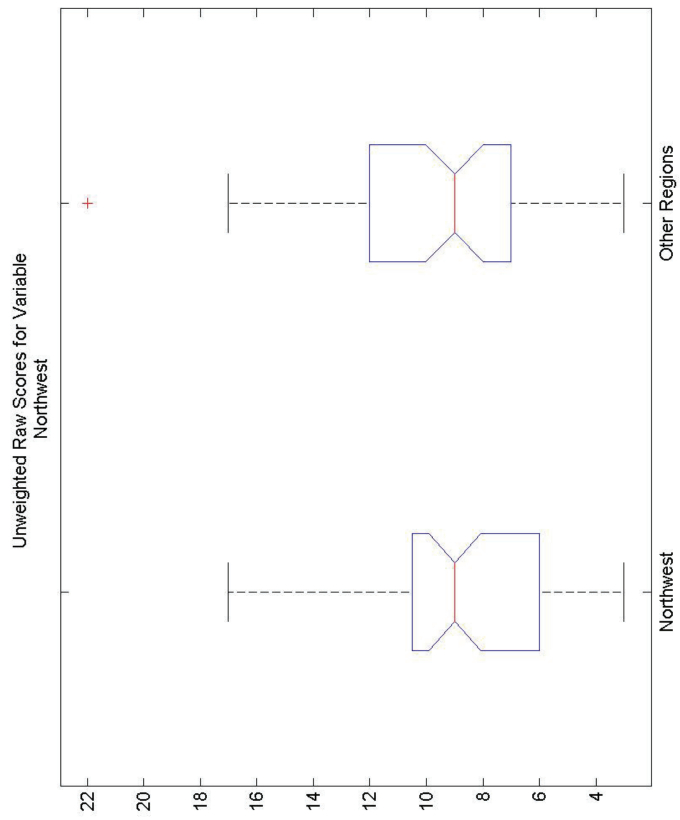

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Length
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
0-1
1-5
5+

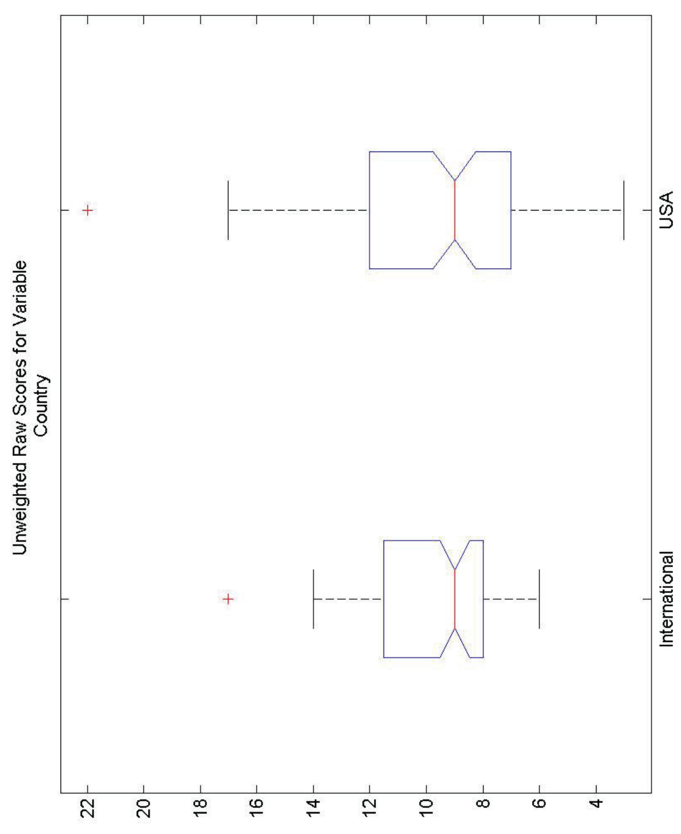

Weighted Analysis - Canonical Coefficients: Not Available vs. Raw Scores for Budget
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
0-10
10-100
100+

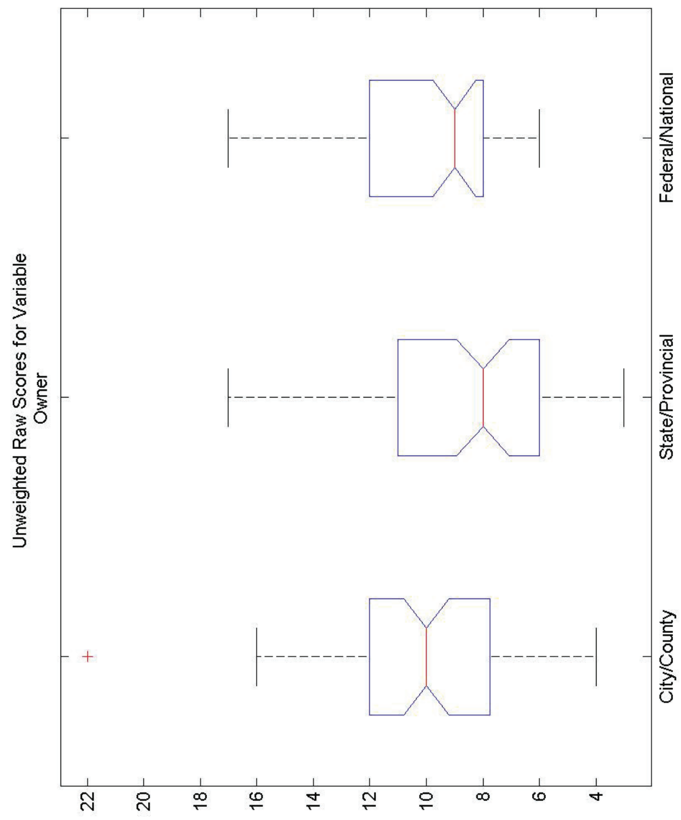

Unweighted Raw Scores for Variable
GreenEmphasis
Typical
Greener
22
20
18
16
14
12
10
8
6
4

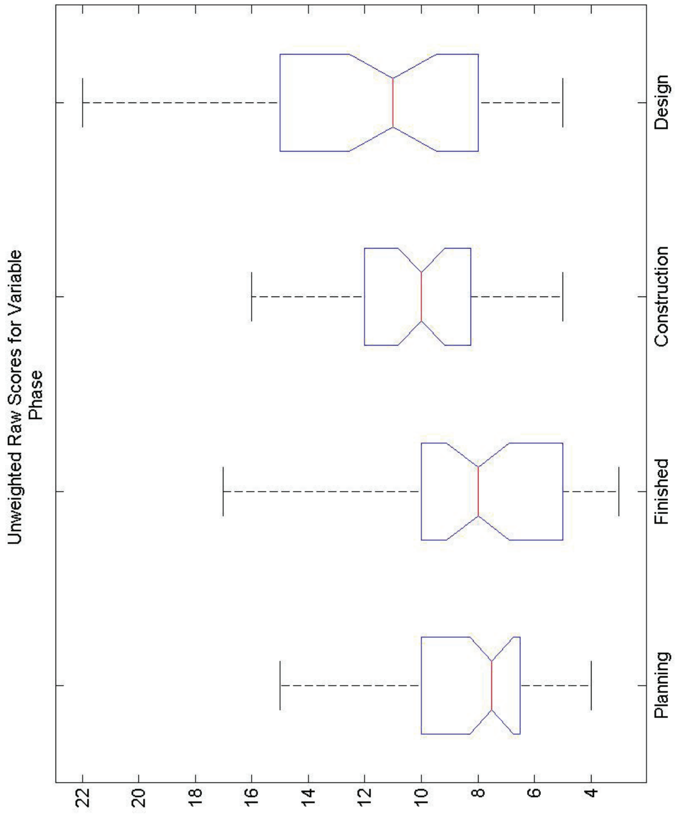

Unweighted Raw Scores for Variable
GreenroadsProject
Not Greenroads
Greenroads
22
20
18
16
14
12
10
8
6
4

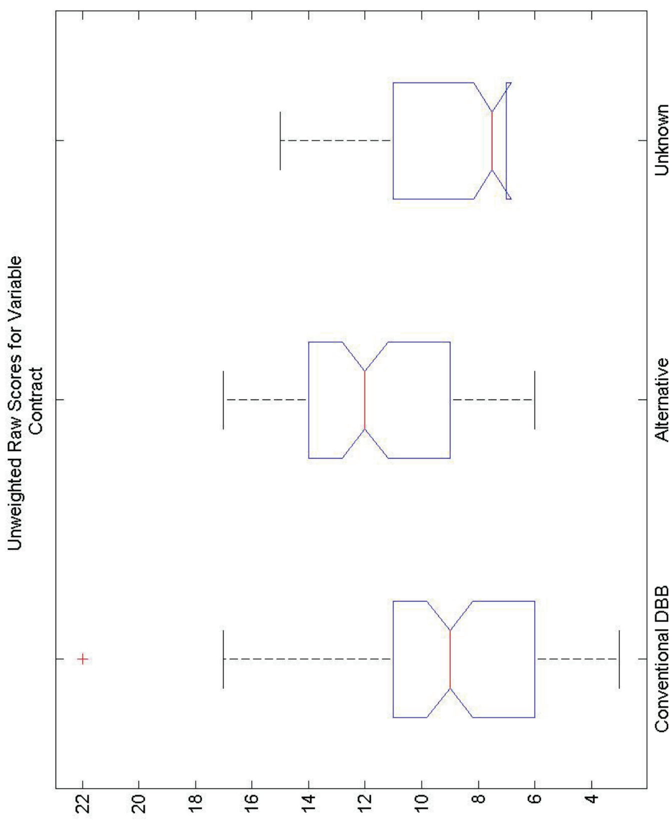

Unweighted Raw Scores for Variable
MajorStructures
22
20
18
16
14
12
10
8
6
4
Structures
No Structures

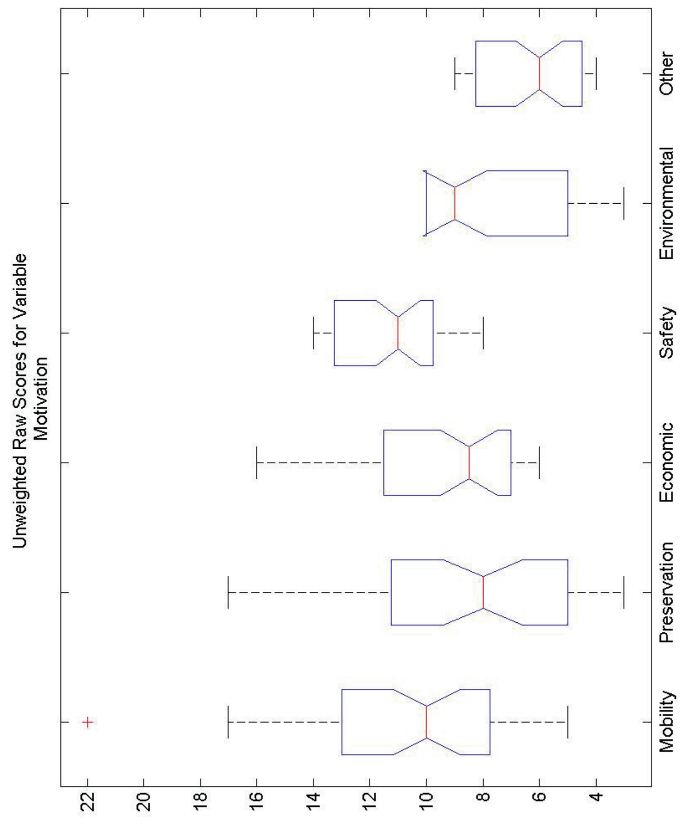

Unweighted Raw Scores for Variable
Northwest
22
20
18
16
14
12
10
8
6
4
Northwest
Other Regions

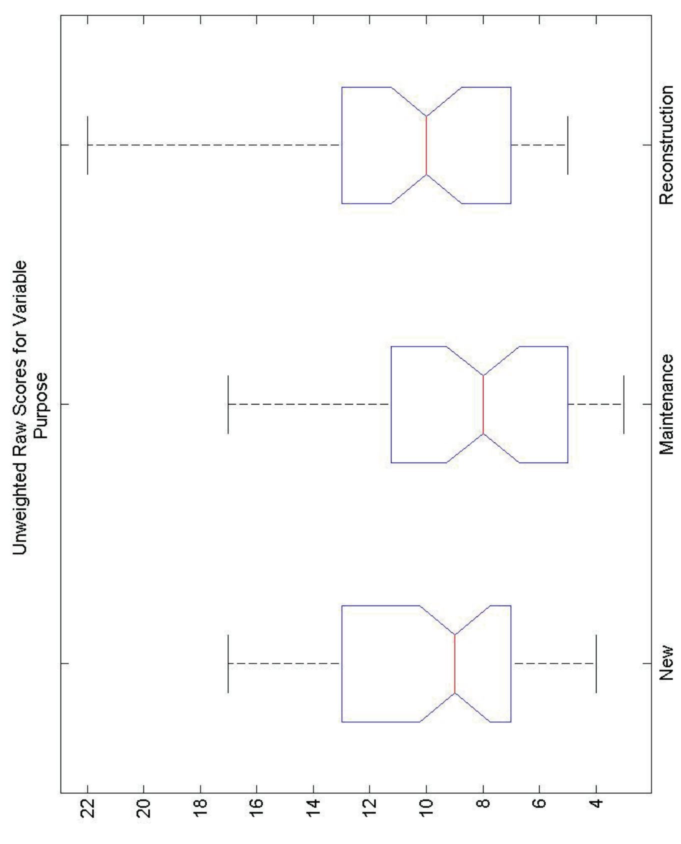

Unweighted Raw Scores for Variable
Country
International
USA
22
20
18
16
14
12
10
8
6
4

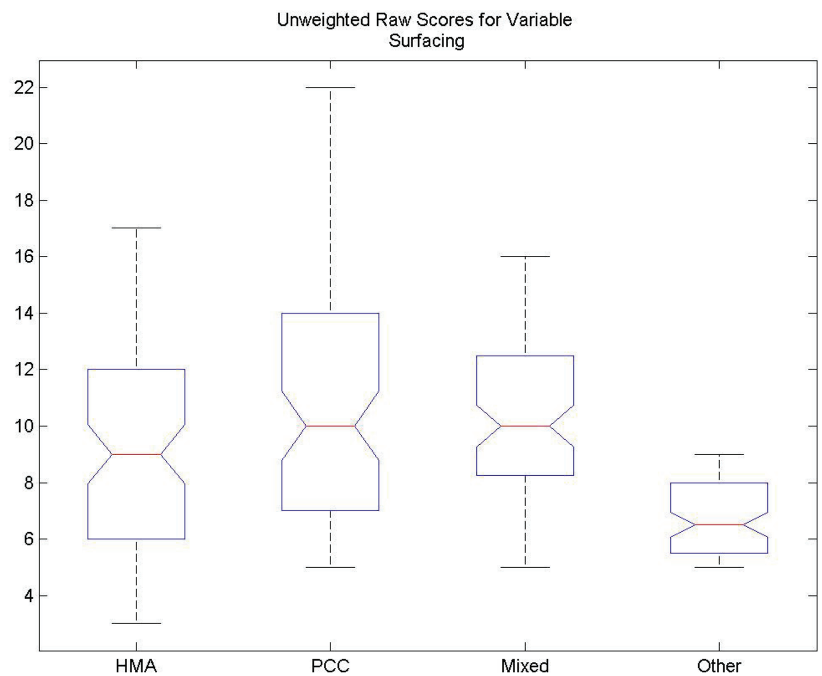

Unweighted Raw Scores for Variable
Owner
City/County
State/Provincial
Federal/National
22
20
18
16
14
12
10
8
6
4

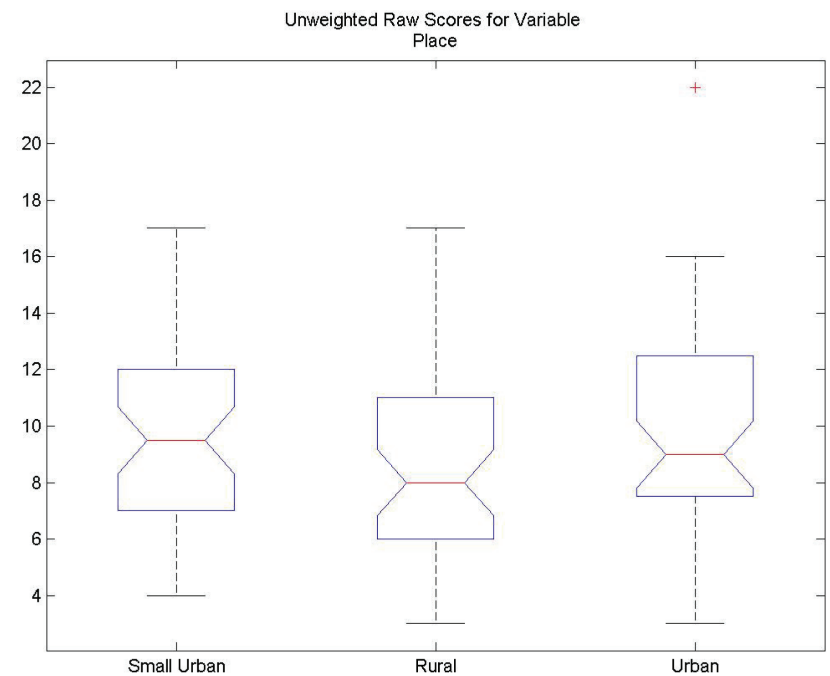

Unweighted Raw Scores for Variable
Phase
22
20
18
16
14
12
10
8
6
4
Planning
Finished
Construction
Design

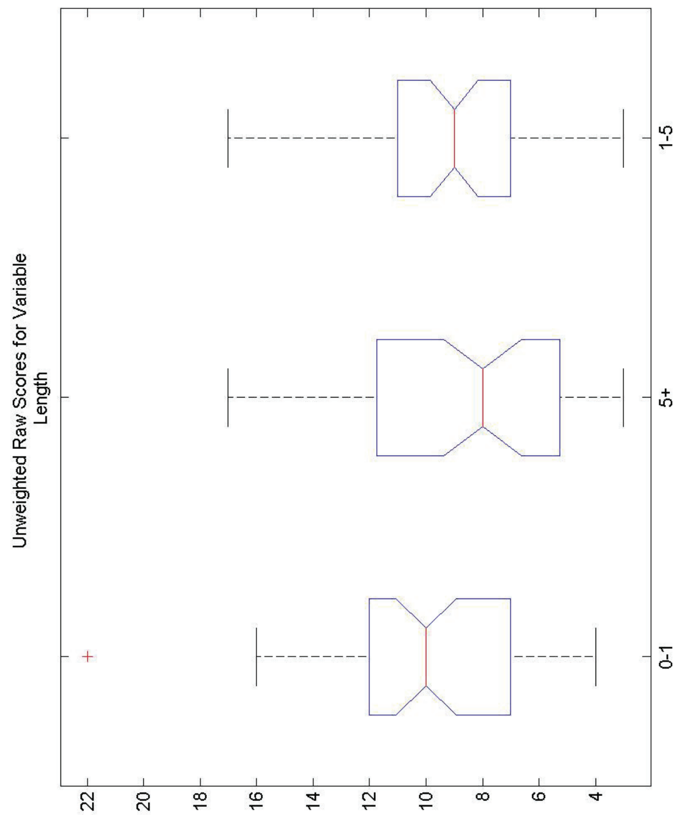

Unweighted Raw Scores for Variable
Contract
22
20
18
16
14
12
10
8
6
4
Conventional DBB
Alternative
Unknown

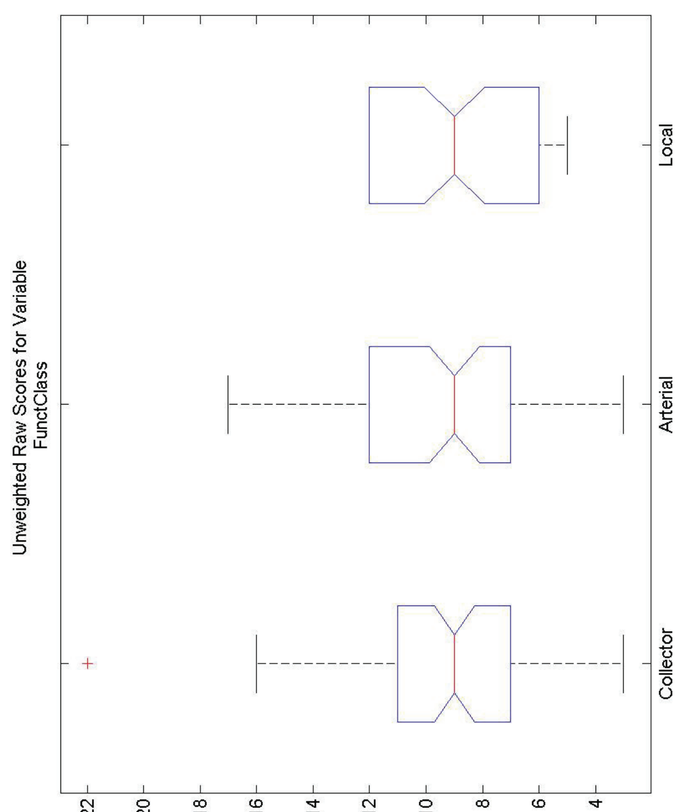

Unweighted Raw Scores for Variable
Motivation
22
20
18
16
14
12
10
8
6
4
Mobility
Preservation
Economic
Safety
Environmental
Other

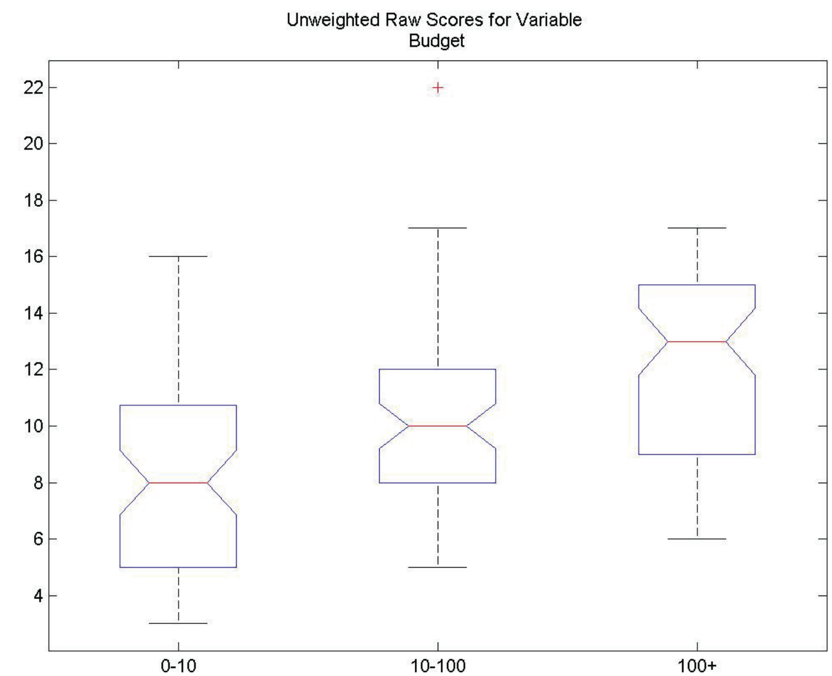

Unweighted Raw Scores for Variable
Purpose
22
20
18
16
14
12
10
8
6
4
New
Maintenance
Reconstruction

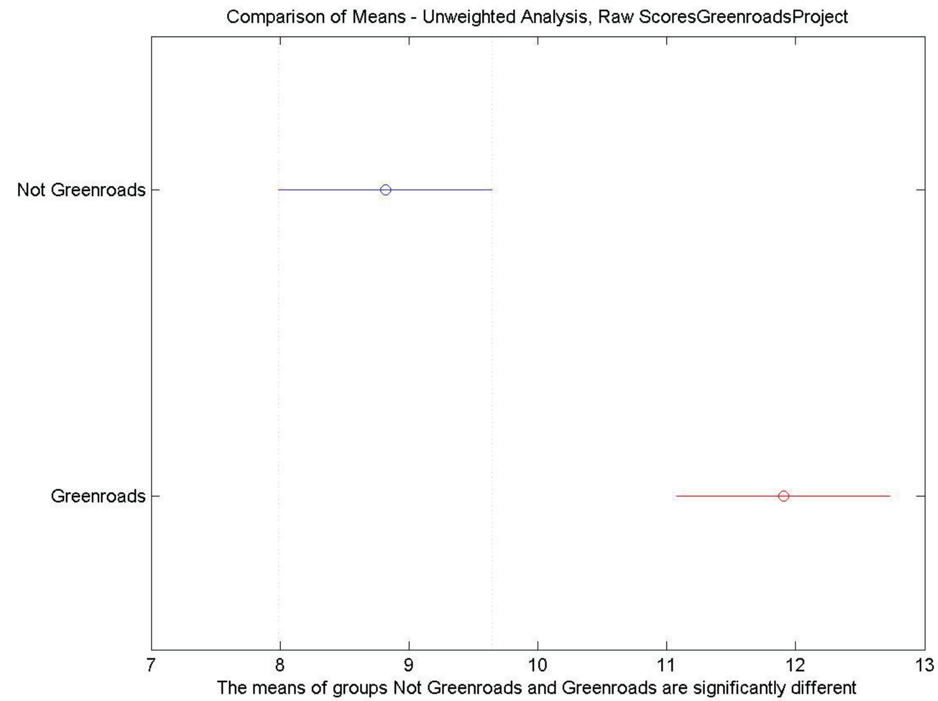

Unweighted Raw Scores for Variable
Surfacing
22
20
18
16
14
12
10
8
6
4
HMA
PCC
Mixed
Other

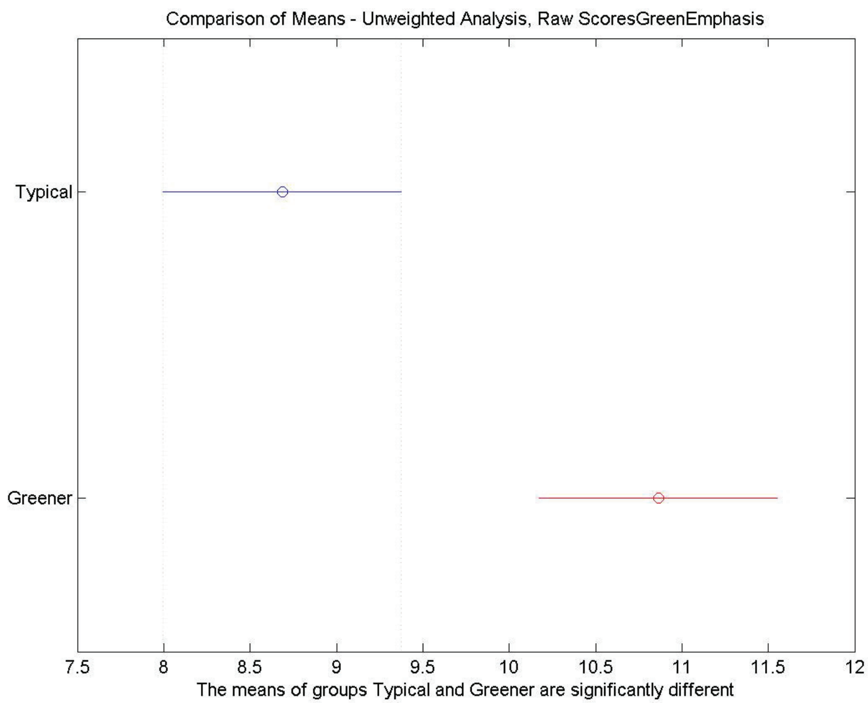

Unweighted Raw Scores for Variable
Place
22
20
18
16
14
12
10
8
6
4
Small Urban
Rural
Urban

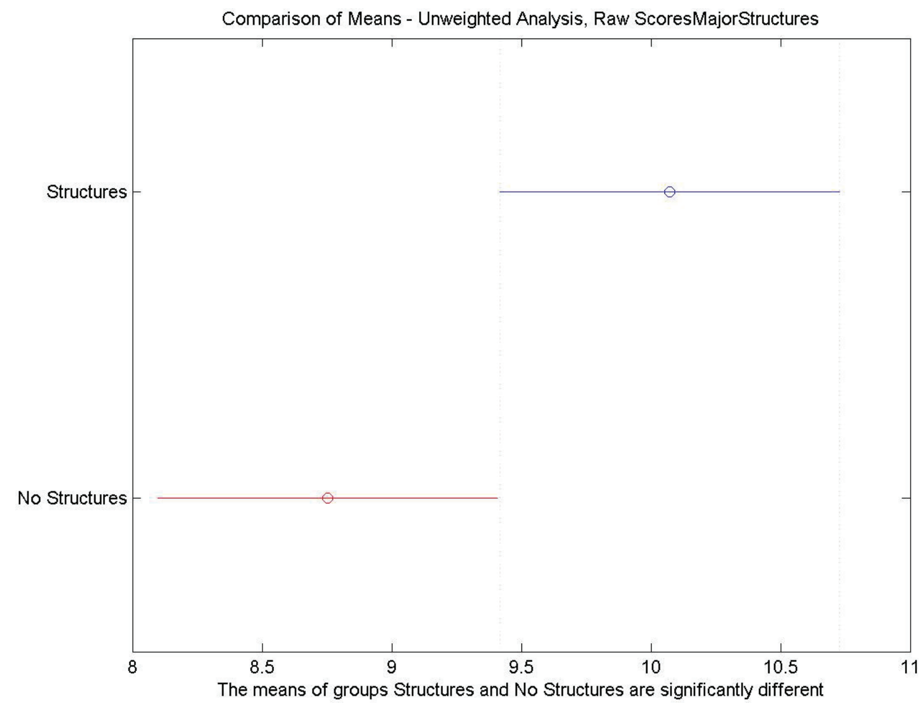

Unweighted Raw Scores for Variable
Length
0-1
5+
1-5
22
20
18
16
14
12
10
8
6
4

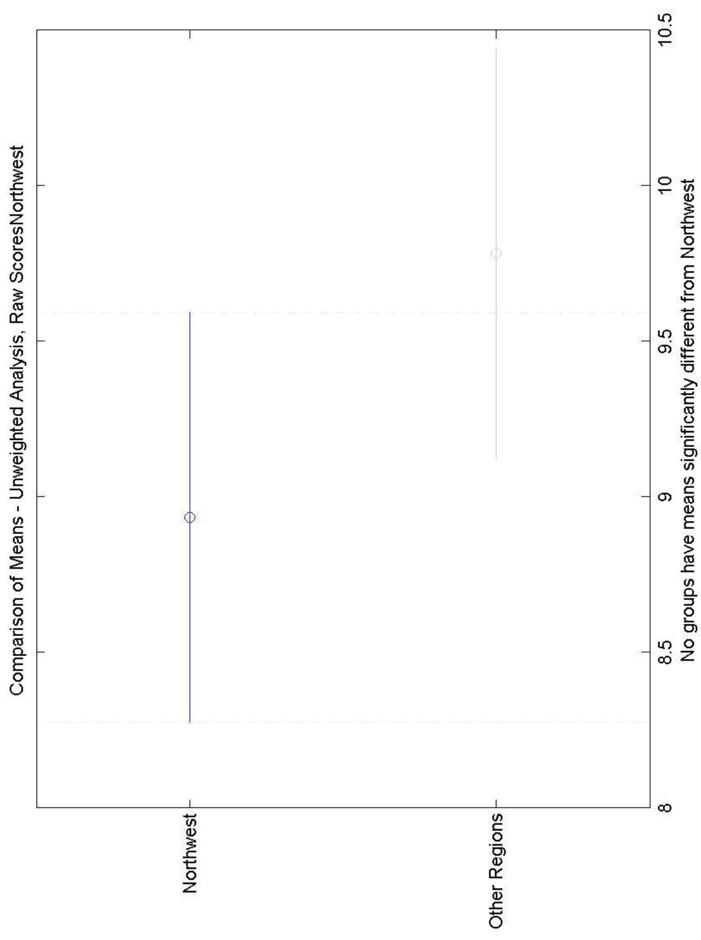

Unweighted Raw Scores for Variable
FunctClass
Collector
Arterial
Local
22
20
18
16
14
12
10
8
6
4

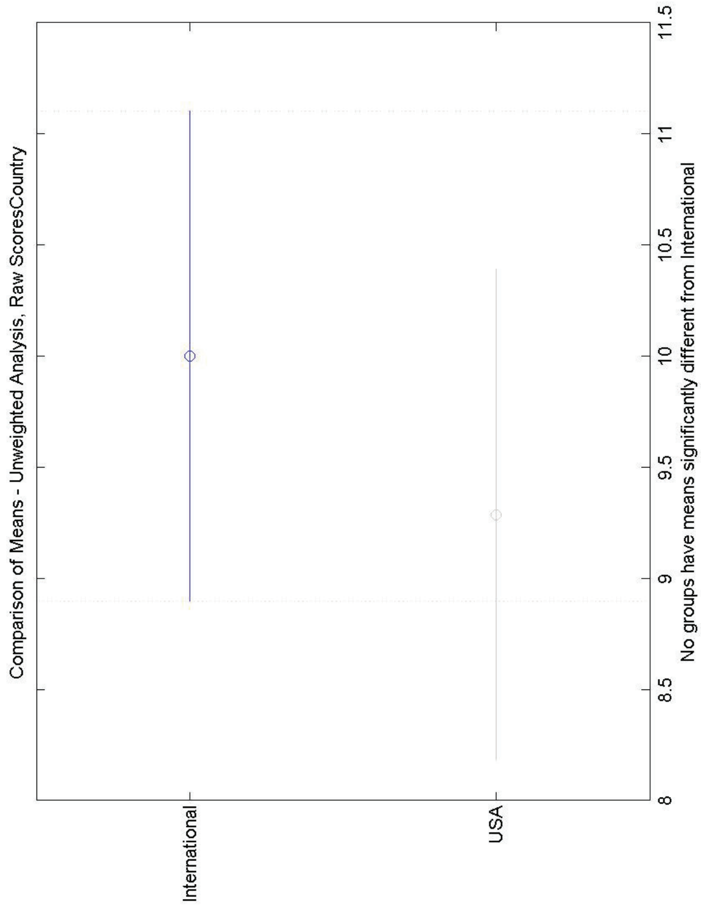

Unweighted Raw Scores for Variable
Budget
22
20
18
16
14
12
10
8
6
4
0-10
10-100
100+

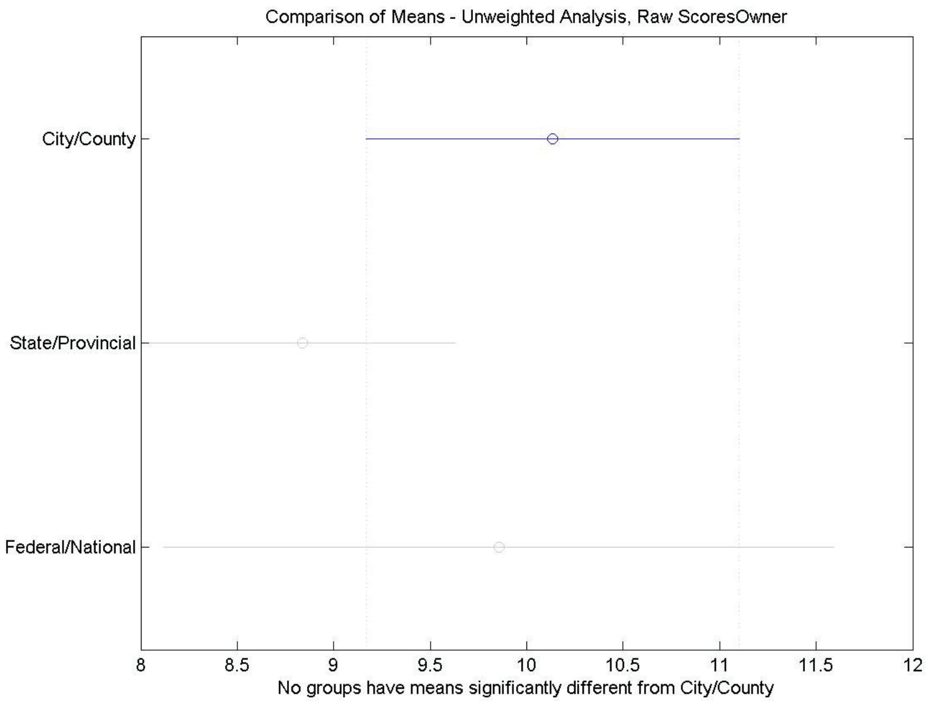

Comparison of Means - Unweighted Analysis, Raw ScoresGreenroadsProject
Not Greenroads
Greenroads
7
8
9
10
11
12
13
The means of groups Not Greenroads and Greenroads are significantly different


Comparison of Means - Unweighted Analysis, Raw ScoresGreenEmphasis
Typical
Greener
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
The means of groups Typical and Greener are significantly different

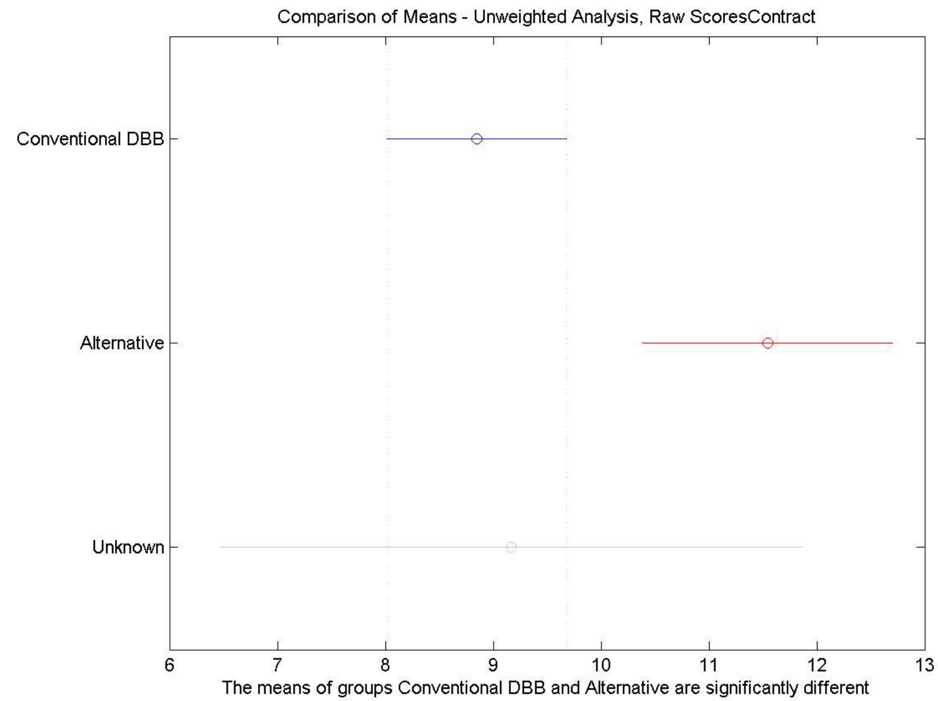

Comparison of Means - Unweighted Analysis, Raw ScoresMajorStructures
Structures
No Structures
8
8.5
9
9.5
10
10.5
11
The means of groups Structures and No Structures are significantly different


Comparison of Means - Unweighted Analysis, Raw ScoresNorthwest
Northwest
Other Regions
8
8.5
9
9.5
10
10.5
No groups have means significantly different from Northwest

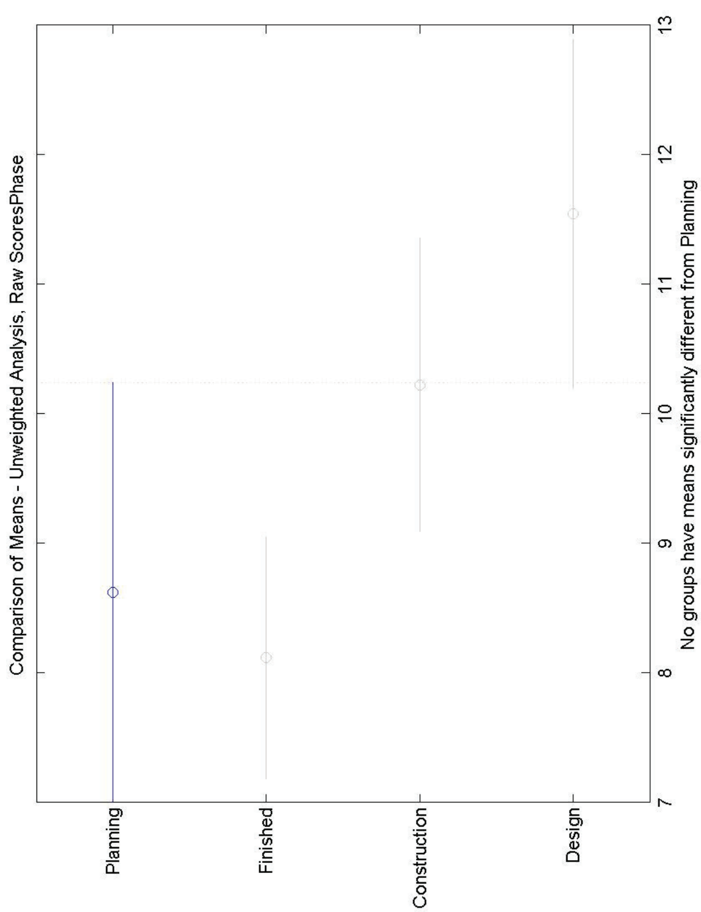

Comparison of Means - Unweighted Analysis, Raw ScoresCountry
International
USA
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from International



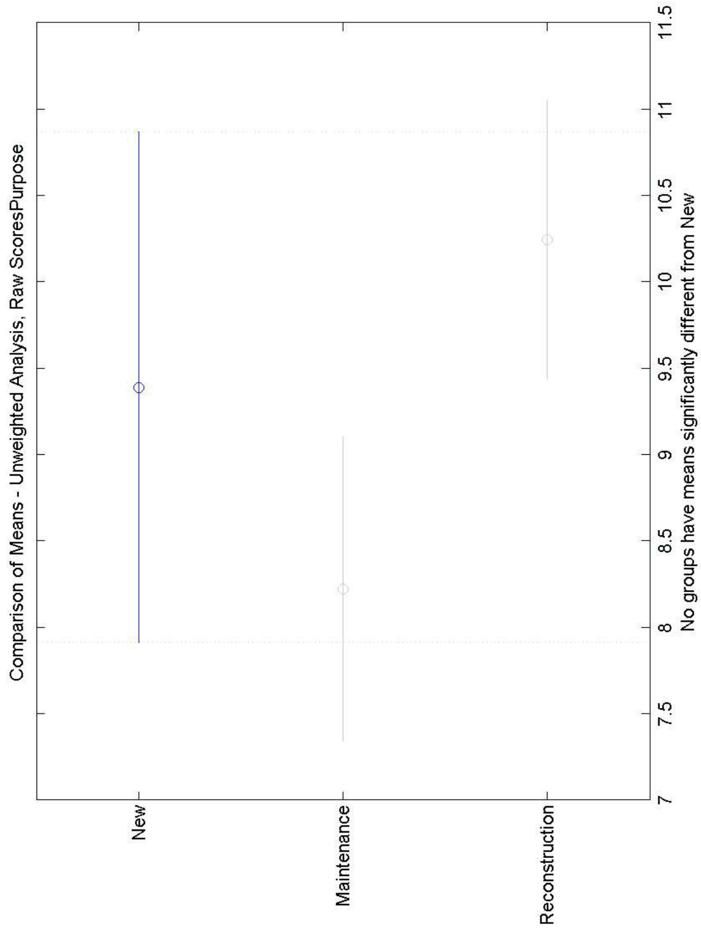
Comparison of Means - Unweighted Analysis, Raw ScoresOwner
City/County
State/Provincial
Federal/National
8
8.5
9
9.5
10
10.5
11
11.5
12
No groups have means significantly different from City/County



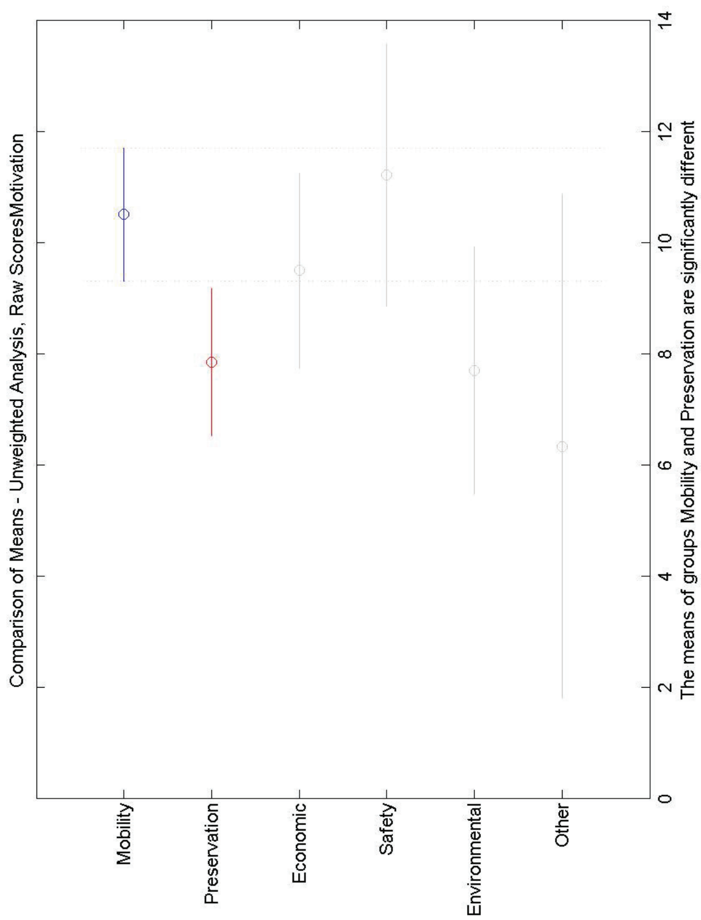
Comparison of Means - Unweighted Analysis, Raw ScoresContract
Conventional DBB
Alternative
Unknown
6
7
8
9
10
11
12
13
The means of groups Conventional DBB and Alternative are significantly different

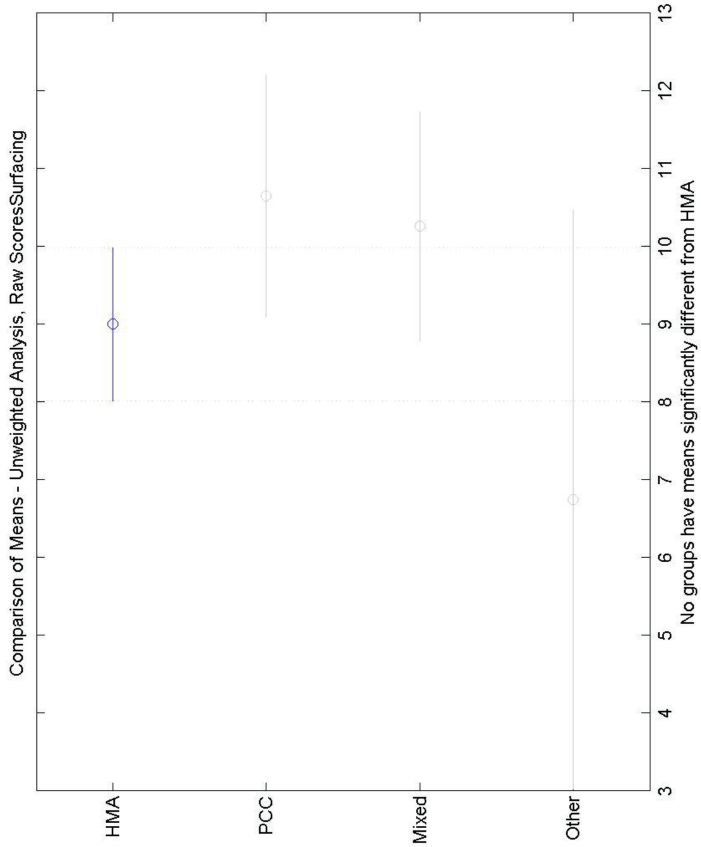


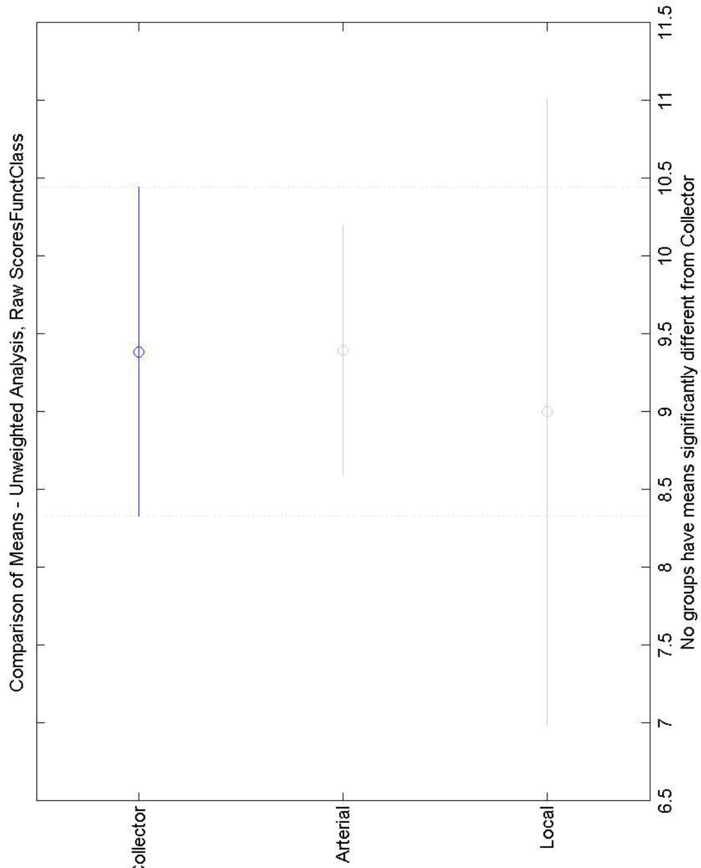
Comparison of Means - Unweighted Analysis, Raw ScoresPhase
Planning
Finished
Construction
Design
7
8
9
10
11
12
13
No groups have means significantly different from Planning

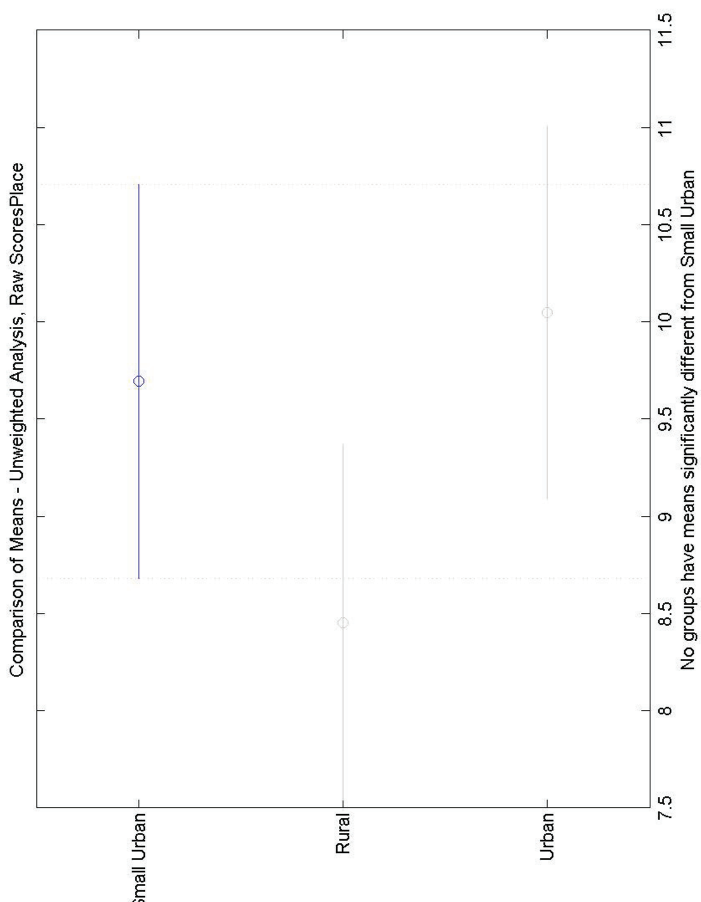


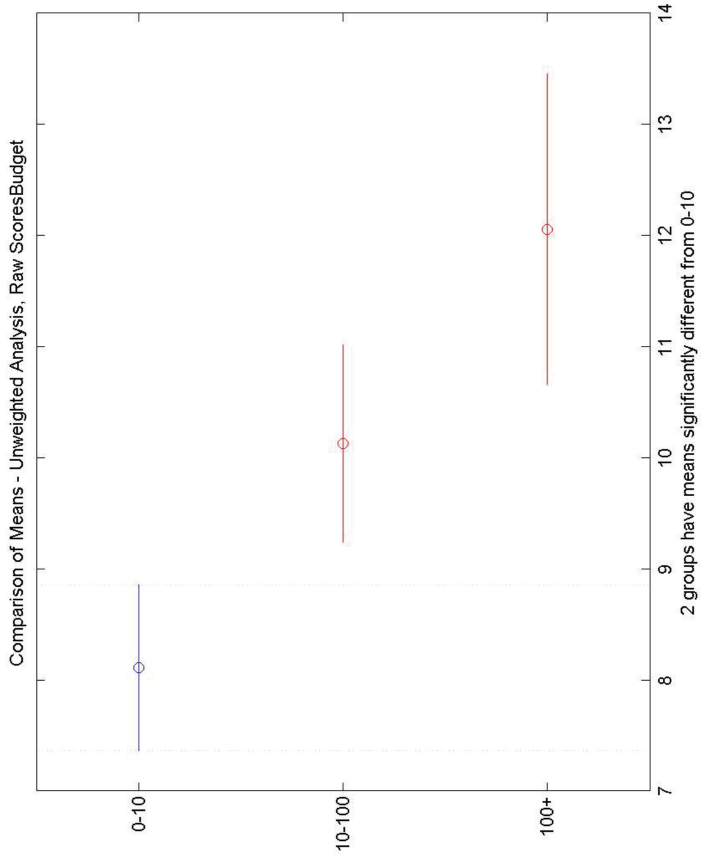
Comparison of Means - Unweighted Analysis, Raw ScoresPurpose
New
Maintenance
Reconstruction
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from New

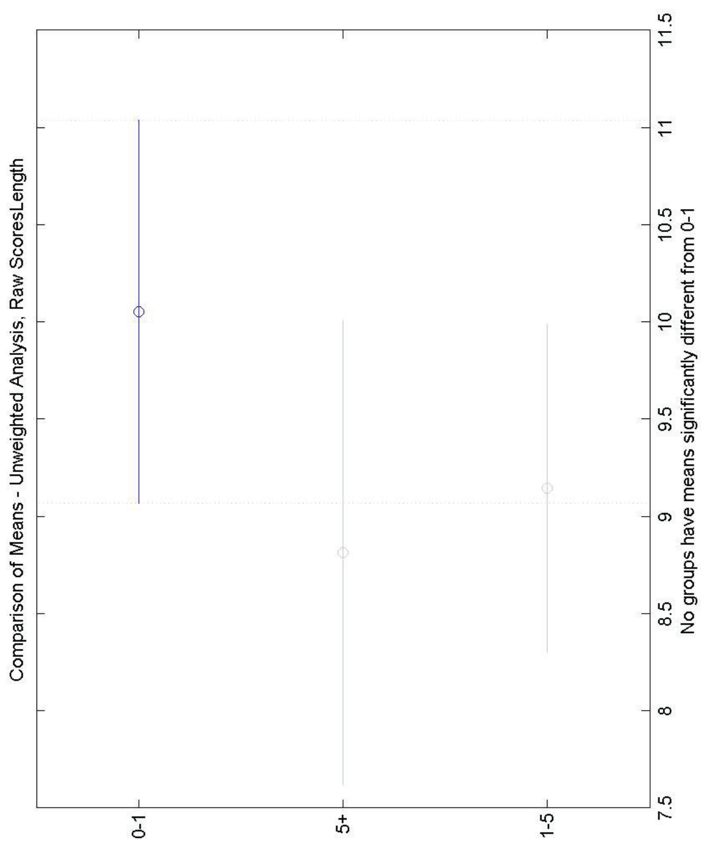

Comparison of Means - Unweighted Analysis, Raw ScoresMotivation
Mobility
Preservation
Economic
Safety
Environmental
Other
0
2
4
6
8
10
12
14
The means of groups Mobility and Preservation are significantly different

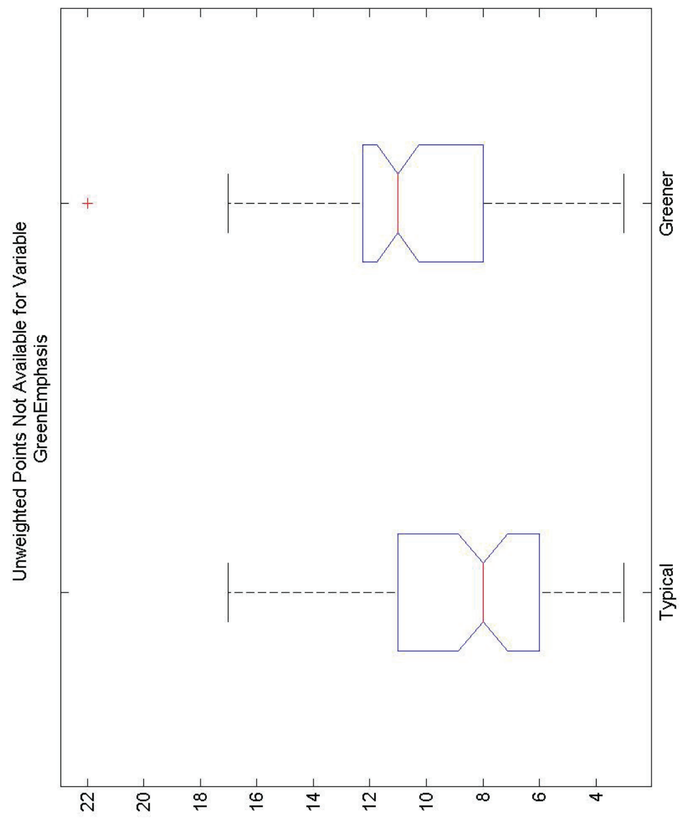

Comparison of Means - Unweighted Analysis, Raw ScoresSurfacing
HMA
PCC
Mixed
Other
3
4
5
6
7
8
9
10
11
12
13
No groups have means significantly different from HMA

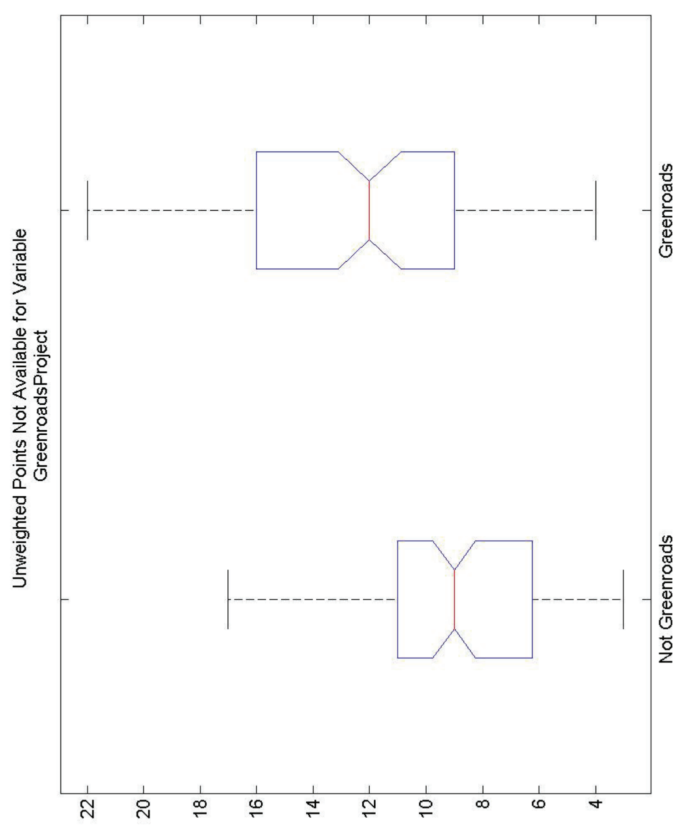

Comparison of Means - Unweighted Analysis, Raw ScoresFunctClass
Collector
Arterial
Local
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from Collector

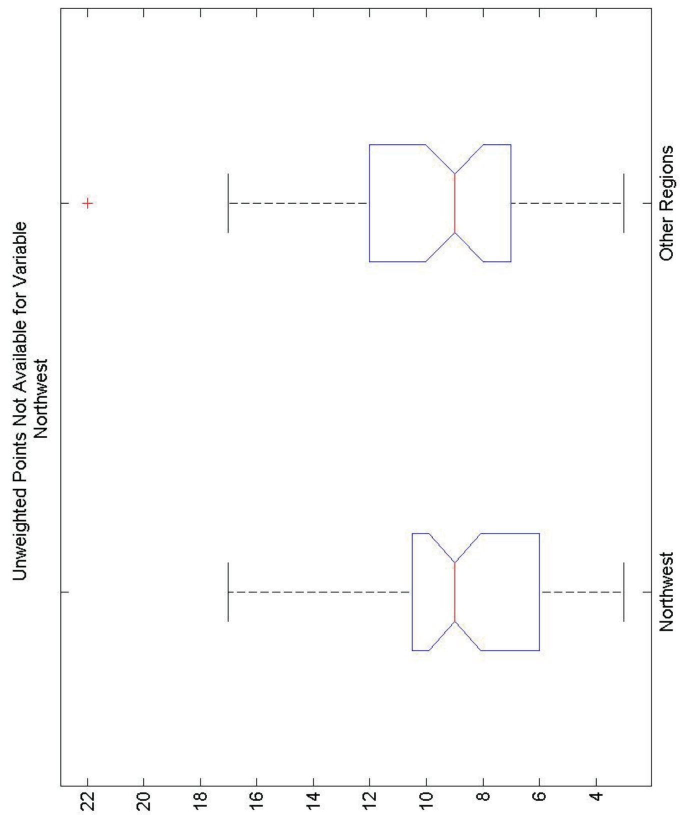

Comparison of Means - Unweighted Analysis, Raw ScoresPlace
Small Urban
Rural
Urban
7.5
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from Small Urban

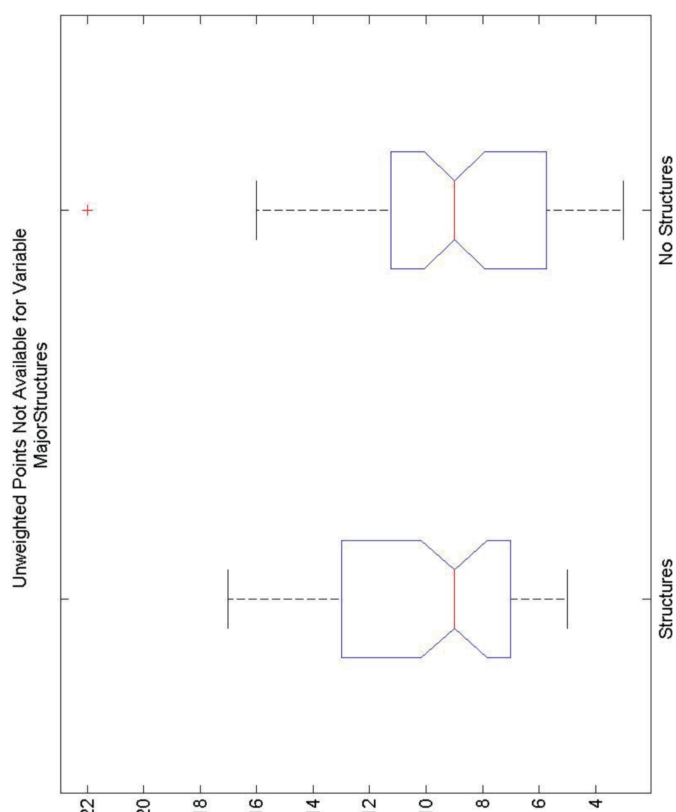

Comparison of Means - Unweighted Analysis, Raw ScoresBudget
0-10
10-100
100+
7
8
9
10
11
12
13
14
2 groups have means significantly different from 0-10

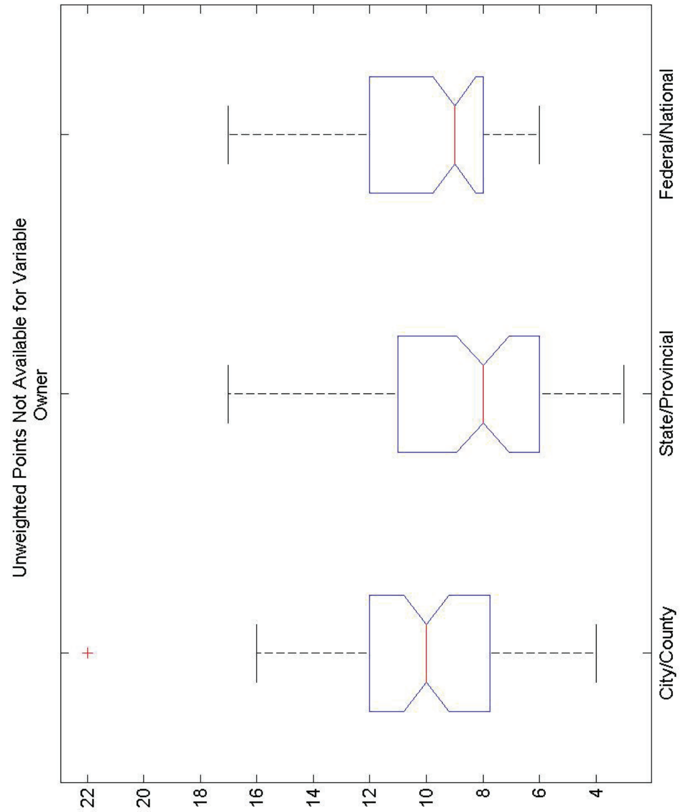

Comparison of Means - Unweighted Analysis, Raw ScoresLength
0-1
5+
1-5
7.5
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from 0-1

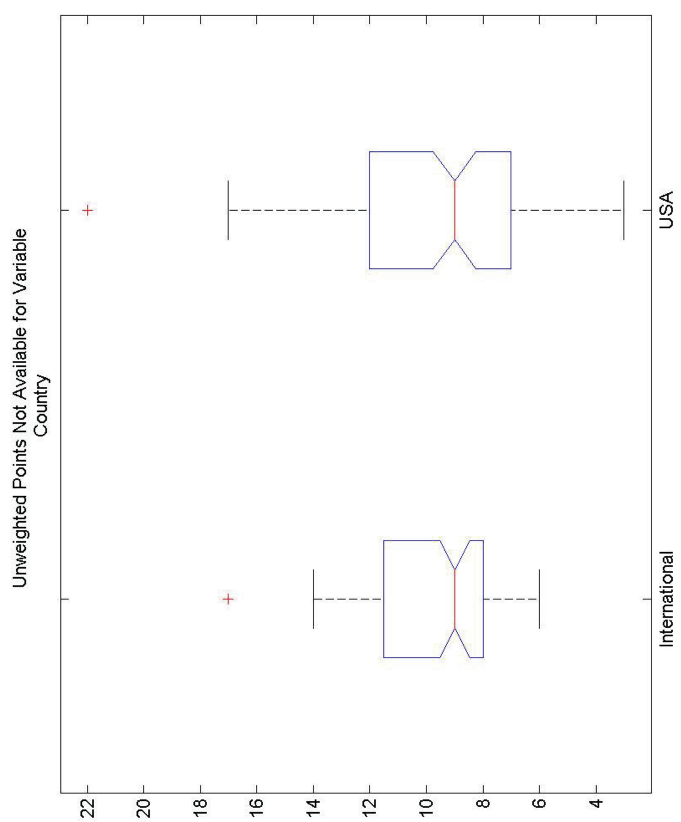

Unweighted Points Not Available for Variable
GreenEmphasis
22
20
18
16
14
12
10
8
6
4
Typical
Greener

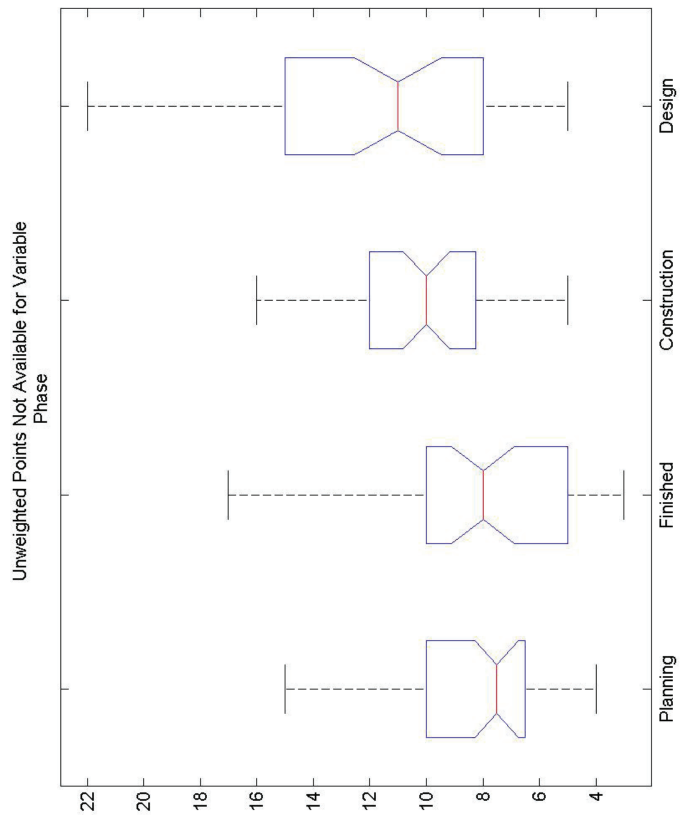

Unweighted Points Not Available for Variable
GreenroadsProject
22
20
18
16
14
12
10
8
6
4
Not Greenroads
Greenroads

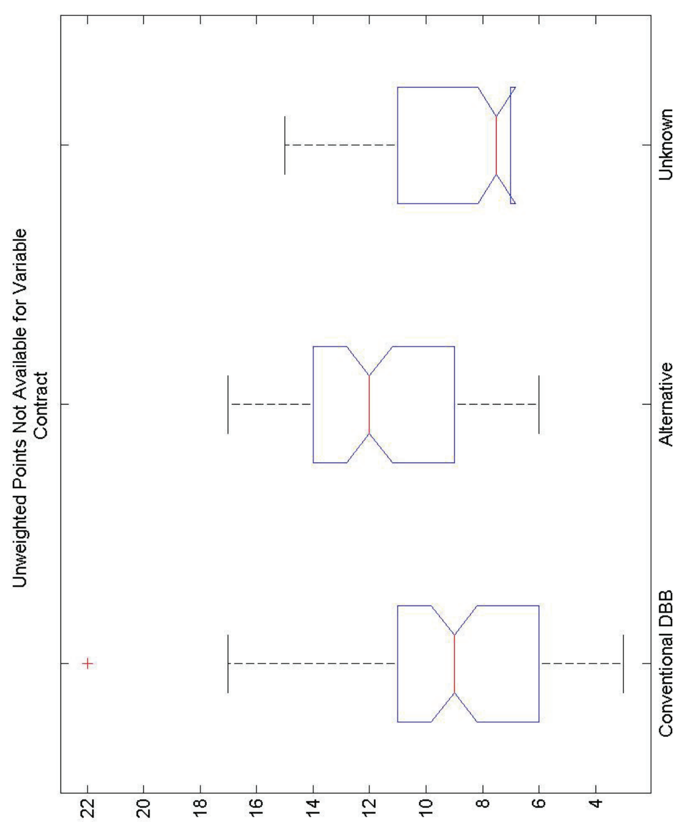

Unweighted Points Not Available for Variable
Northwest
22
20
18
16
14
12
10
8
6
4
Northwest
Other Regions


Unweighted Points Not Available for Variable
MajorStructures
22
20
18
16
14
12
10
8
6
4
Structures
No Structures

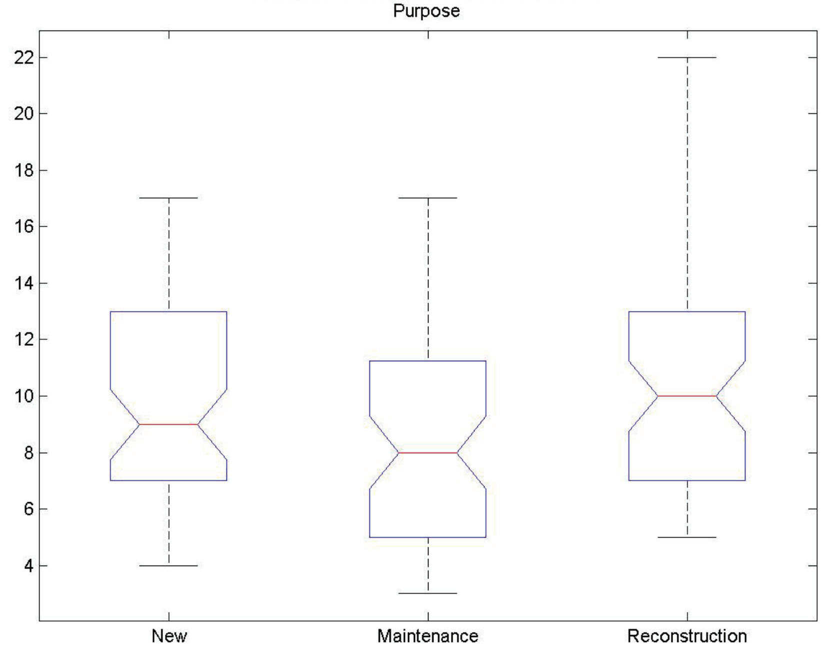

Unweighted Points Not Available for Variable
Owner
22
20
18
16
14
12
10
8
6
4
City/County
State/Provincial
Federal/National


Unweighted Points Not Available for Variable
Country
22
20
18
16
14
12
10
8
6
4
International
USA

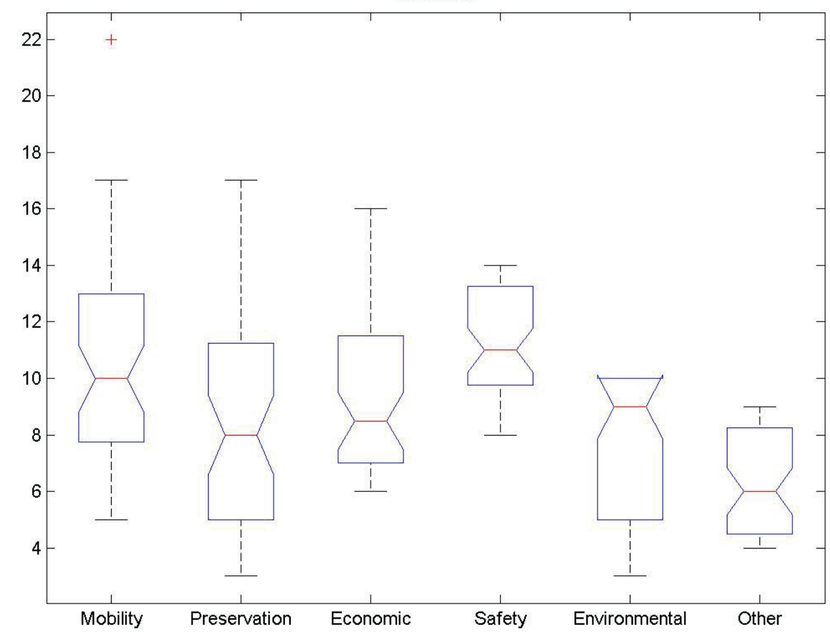

Unweighted Points Not Available for Variable
Phase
Planning
Finished
Construction
Design
22
20
18
16
14
12
10
8
6
4

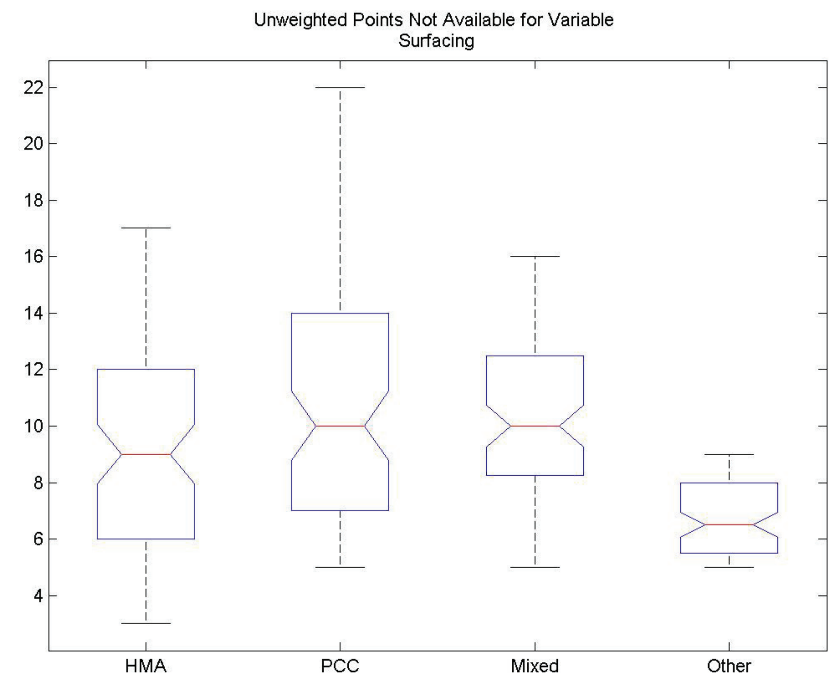

Unweighted Points Not Available for Variable
Contract
Conventional DBB
Alternative
Unknown
22
20
18
16
14
12
10
8
6
4

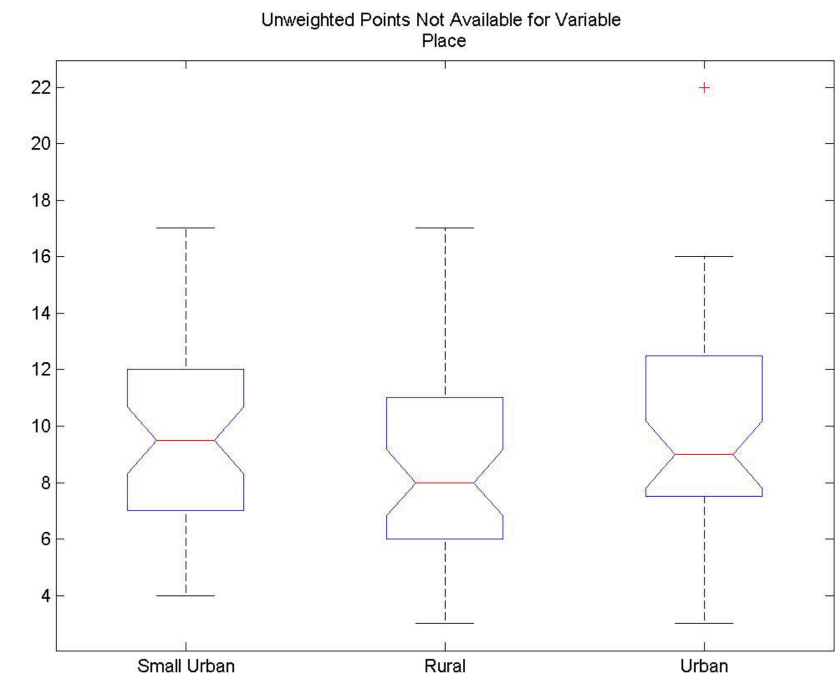
Unweighted Points Not Available for Variable
Purpose

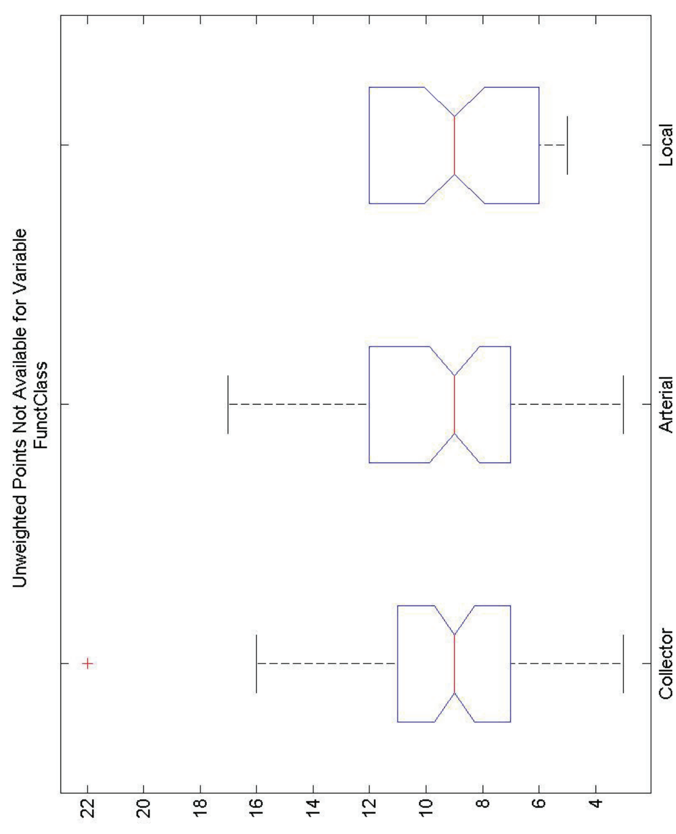


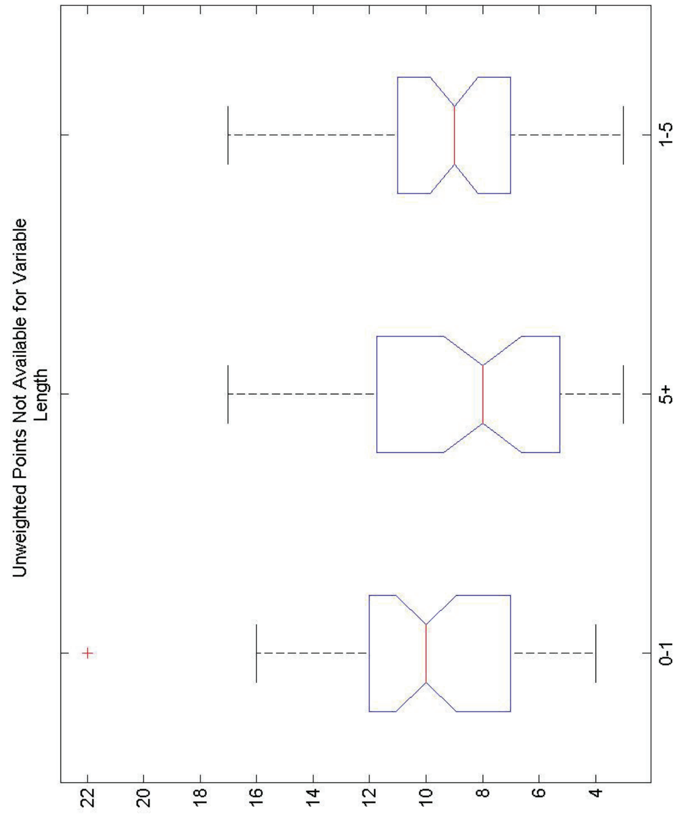
Unweighted Points Not Available for Variable
Motivation

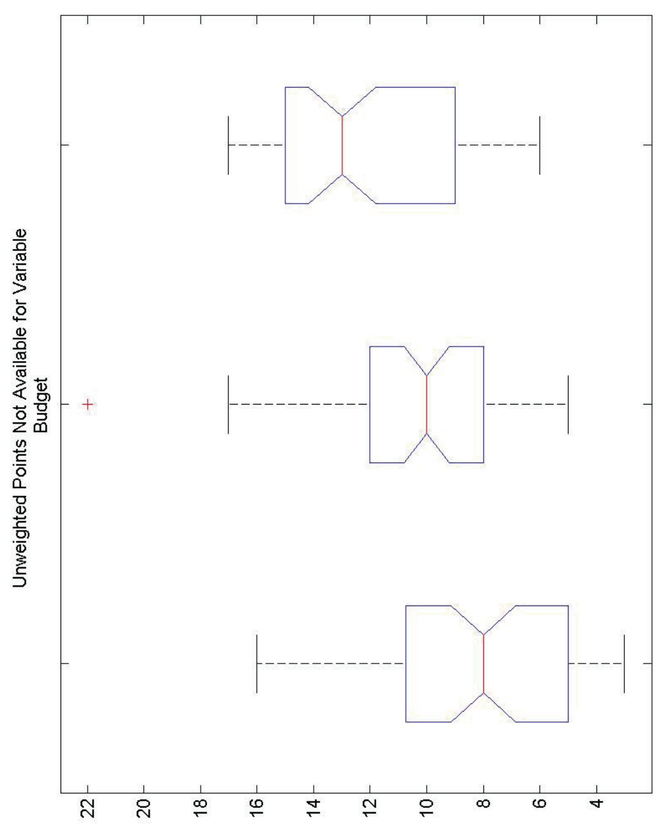


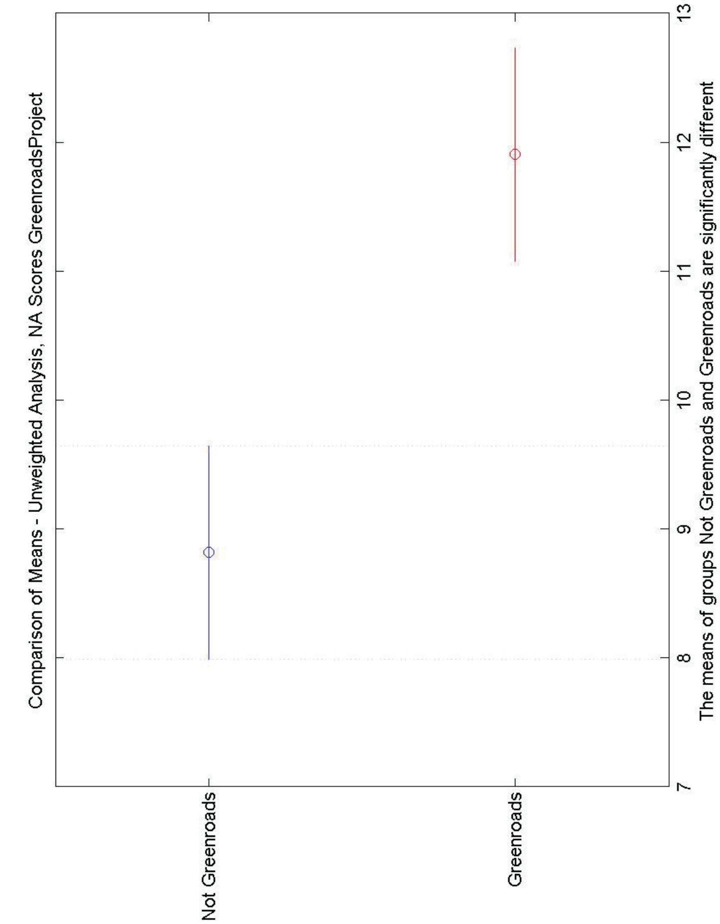

Unweighted Points Not Available for Variable
Surfacing
22
20
18
16
14
12
10
8
6
4
HMA
PCC
Mixed
Other

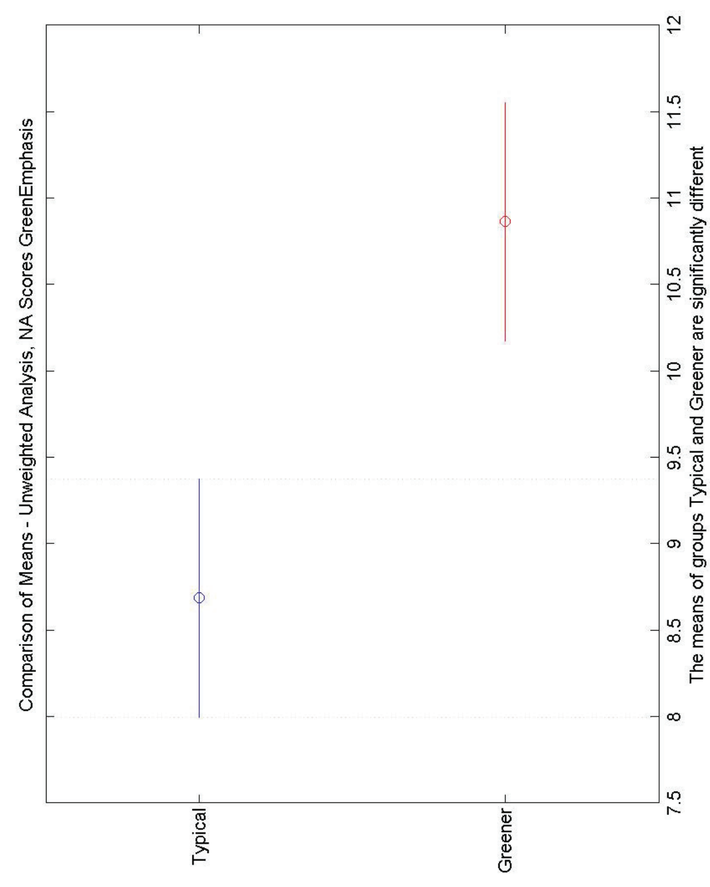

Unweighted Points Not Available for Variable
Place
22
20
18
16
14
12
10
8
6
4
Small Urban
Rural
Urban

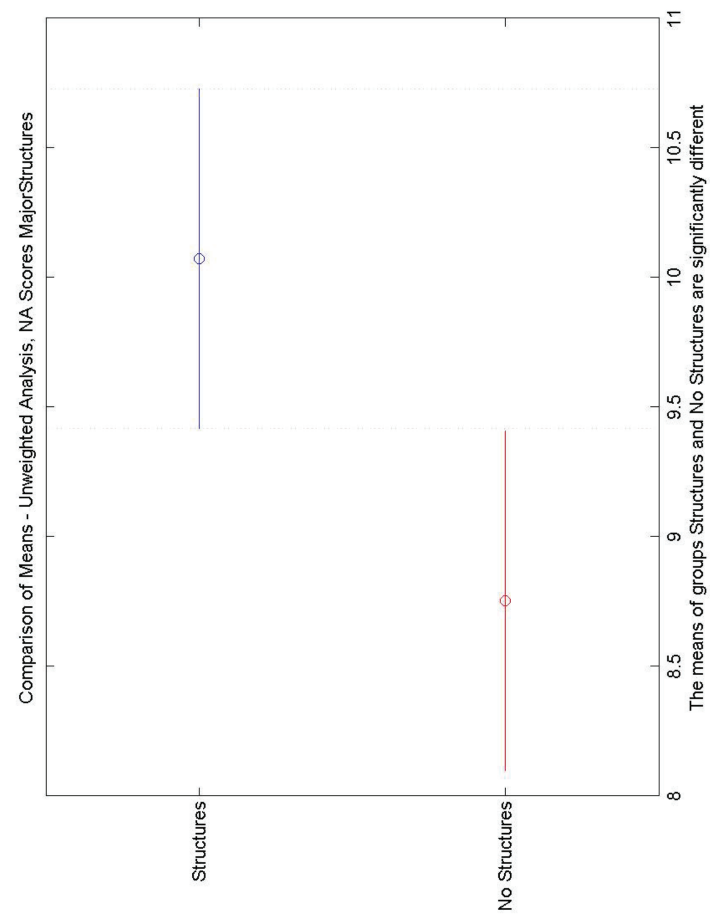

Unweighted Points Not Available for Variable
FunctClass
22
20
18
16
14
12
10
8
6
4
Collector
Arterial
Local

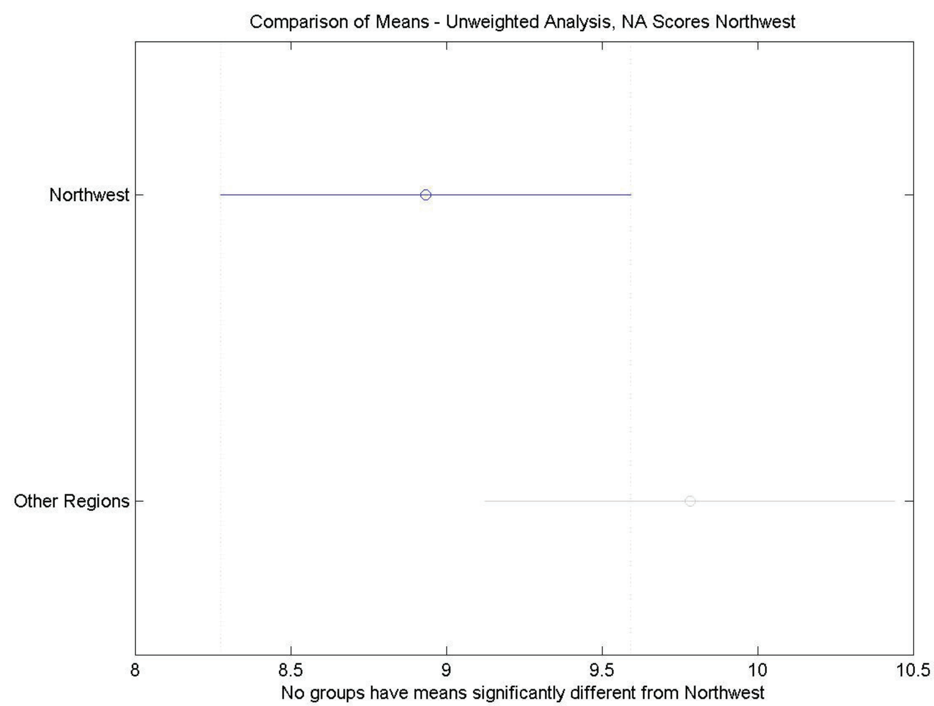

Unweighted Points Not Available for Variable
Length
22
20
18
16
14
12
10
8
6
4
0-1
5+
1-5


Unweighted Points Not Available for Variable
Budget
22
20
18
16
14
12
10
8
6
4
0-10
10-100
100+

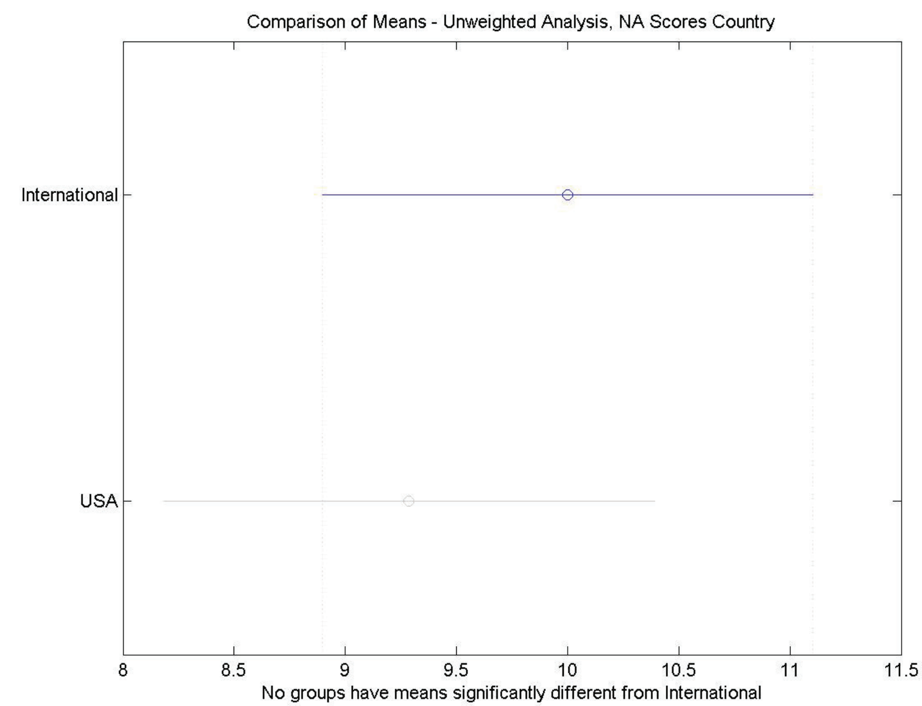

Comparison of Means - Unweighted Analysis, NA Scores GreenroadsProject
Not Greenroads
Greenroads
7
8
9
10
11
12
13
The means of groups Not Greenroads and Greenroads are significantly different


Comparison of Means - Unweighted Analysis, NA Scores GreenEmphasis
Typical
Greener
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
The means of groups Typical and Greener are significantly different

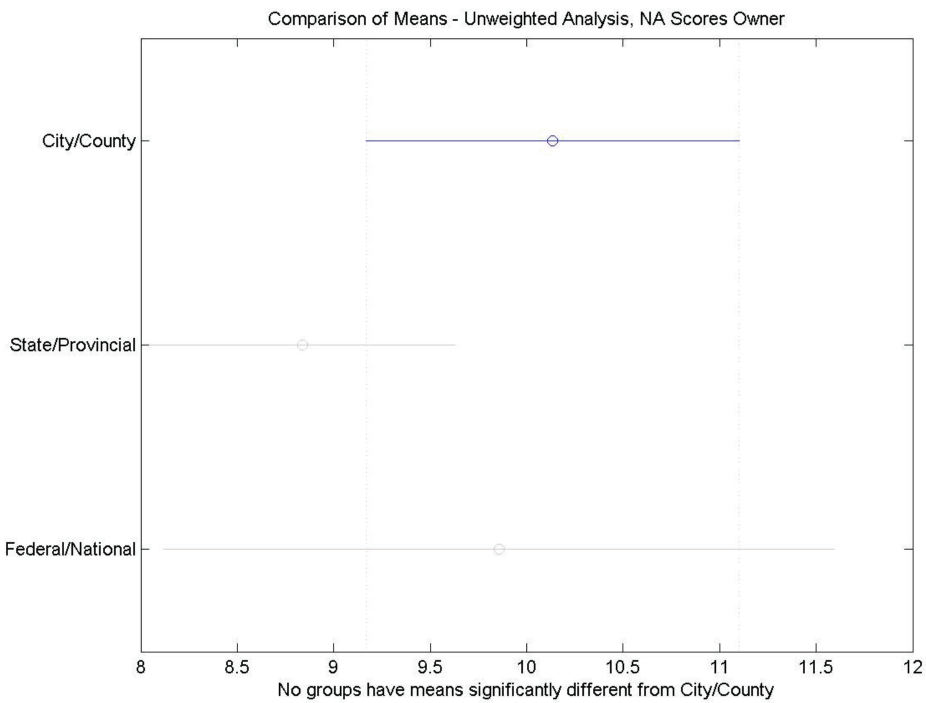

Comparison of Means - Unweighted Analysis, NA Scores MajorStructures
Structures
No Structures
8
8.5
9
9.5
10
10.5
11
The means of groups Structures and No Structures are significantly different

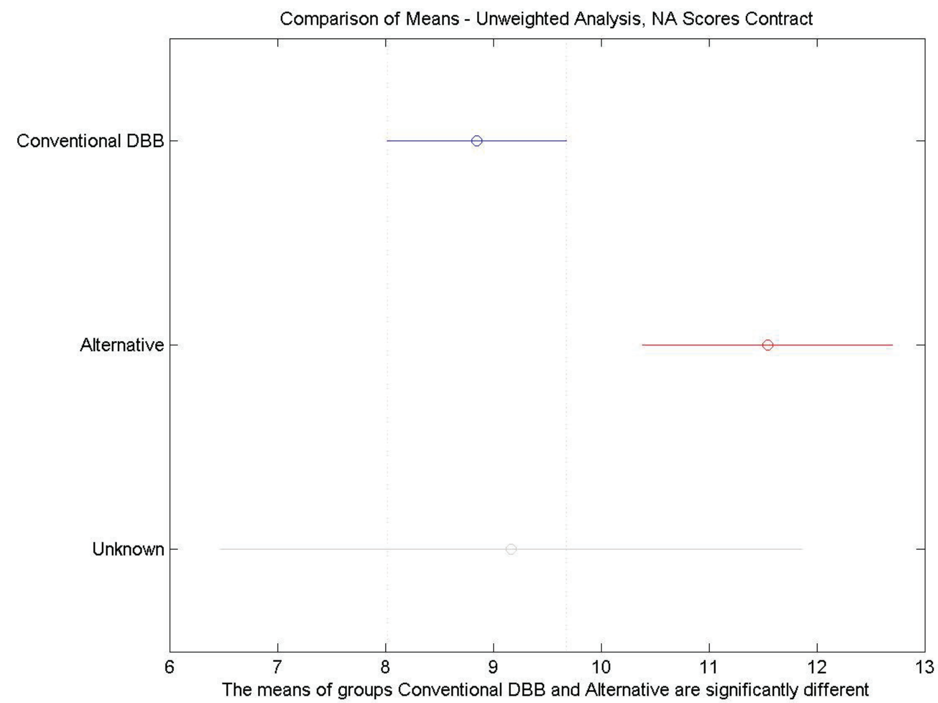


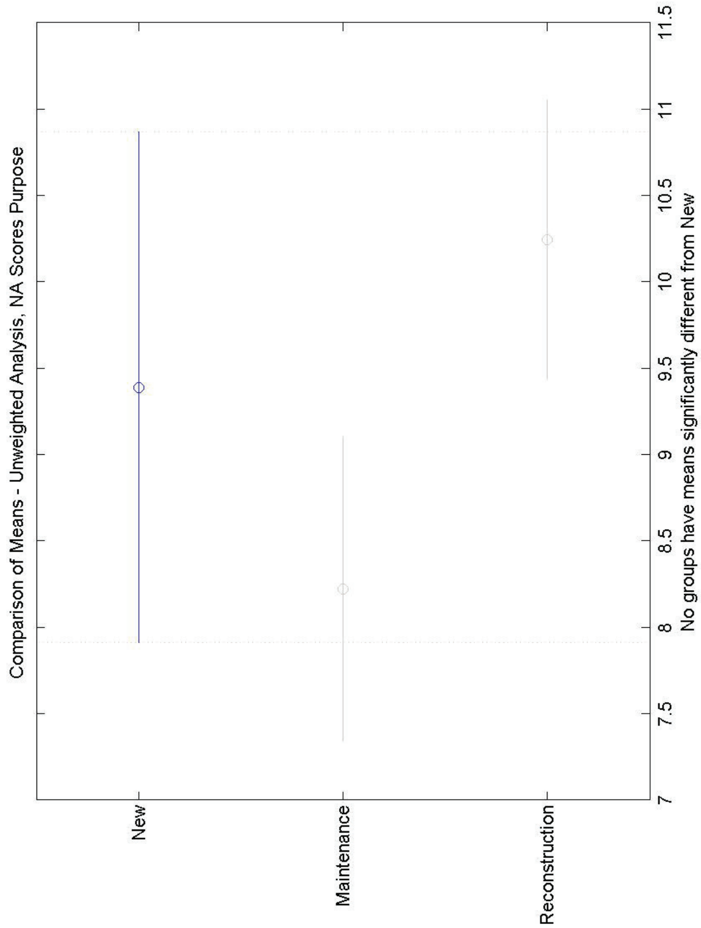
Comparison of Means - Unweighted Analysis, NA Scores Northwest
Northwest
Other Regions
8
8.5
9
9.5
10
10.5
No groups have means significantly different from Northwest

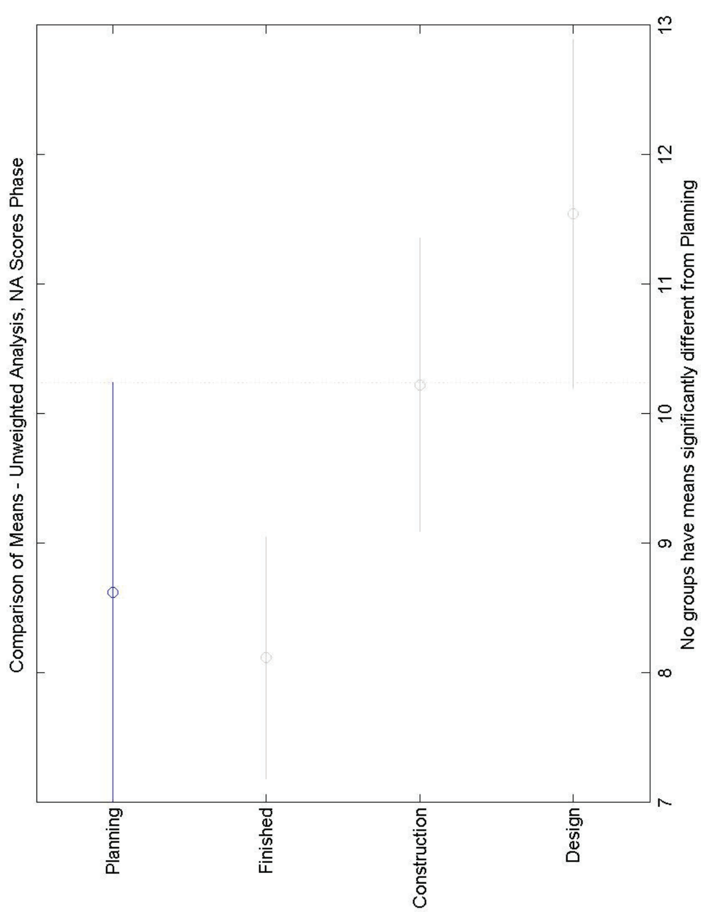


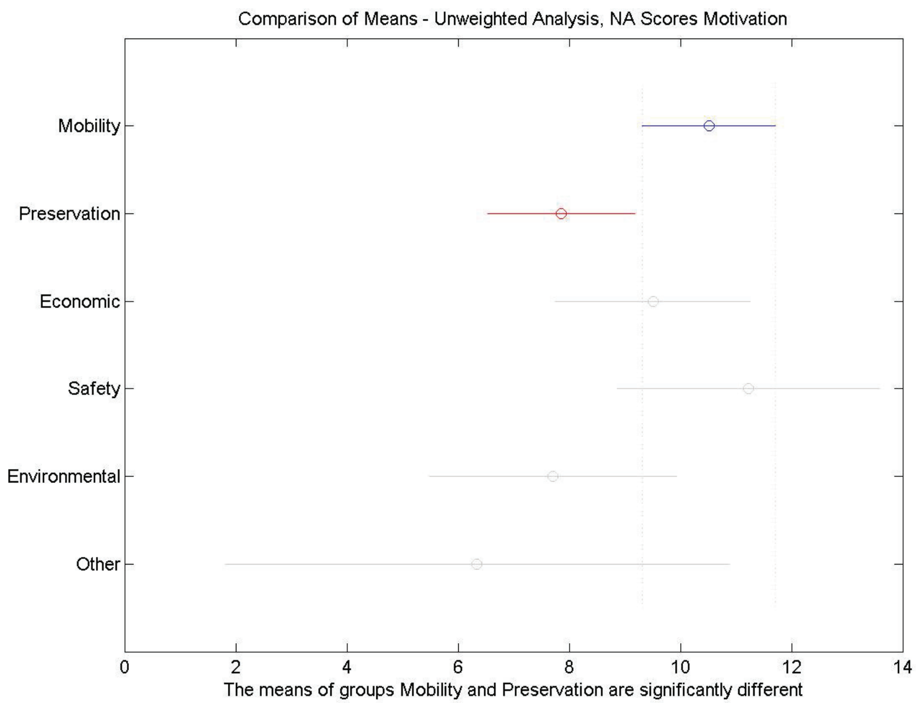
Comparison of Means - Unweighted Analysis, NA Scores Country
International
USA
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from International

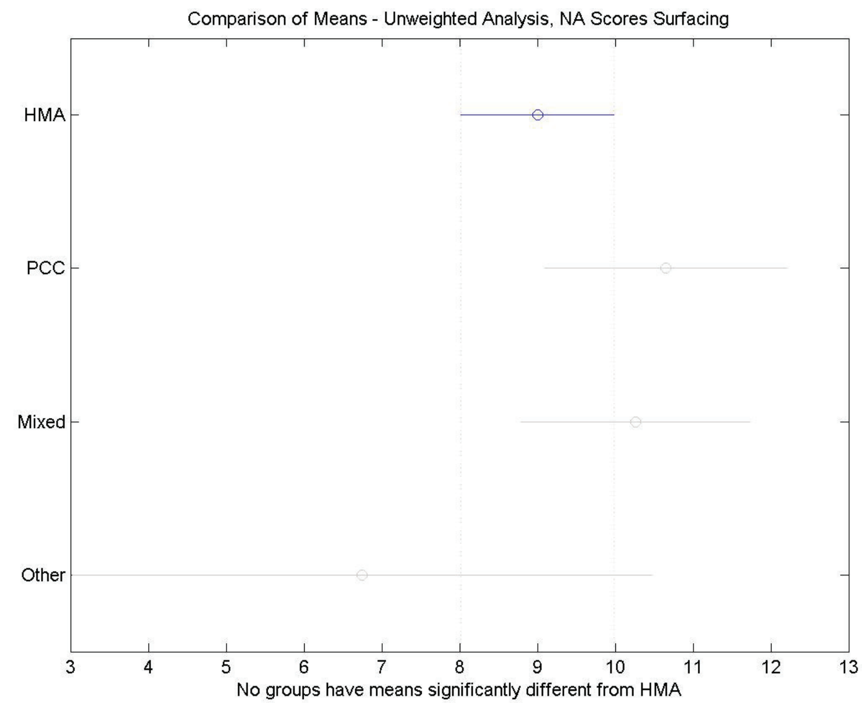

Comparison of Means - Unweighted Analysis, NA Scores Owner
City/County
State/Provincial
Federal/National
8
8.5
9
9.5
10
10.5
11
11.5
12
No groups have means significantly different from City/County

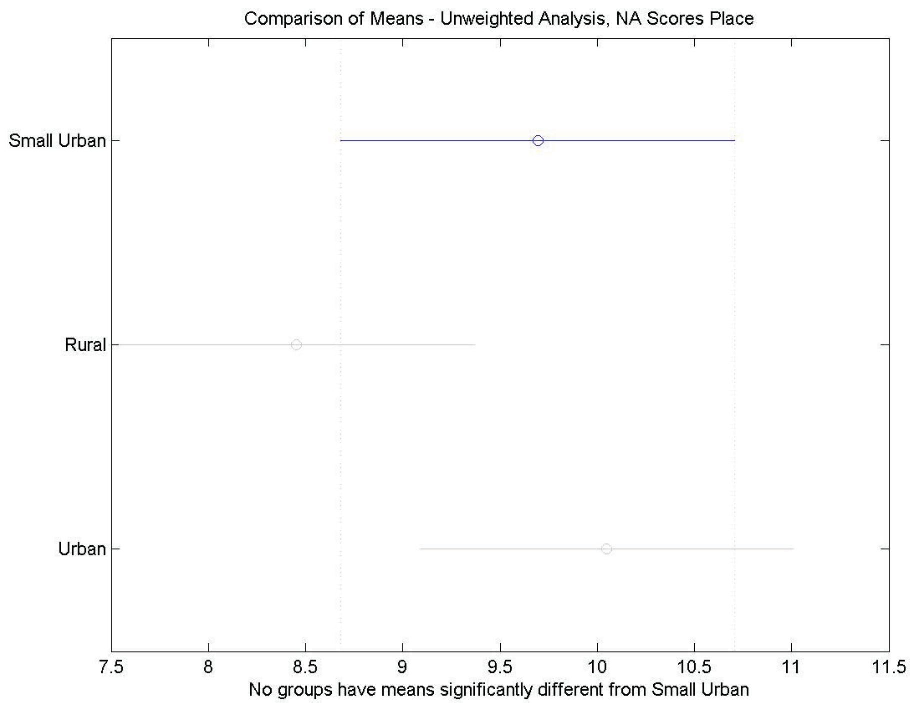

Comparison of Means - Unweighted Analysis, NA Scores Contract
Conventional DBB
Alternative
Unknown
6
7
8
9
10
11
12
13
The means of groups Conventional DBB and Alternative are significantly different

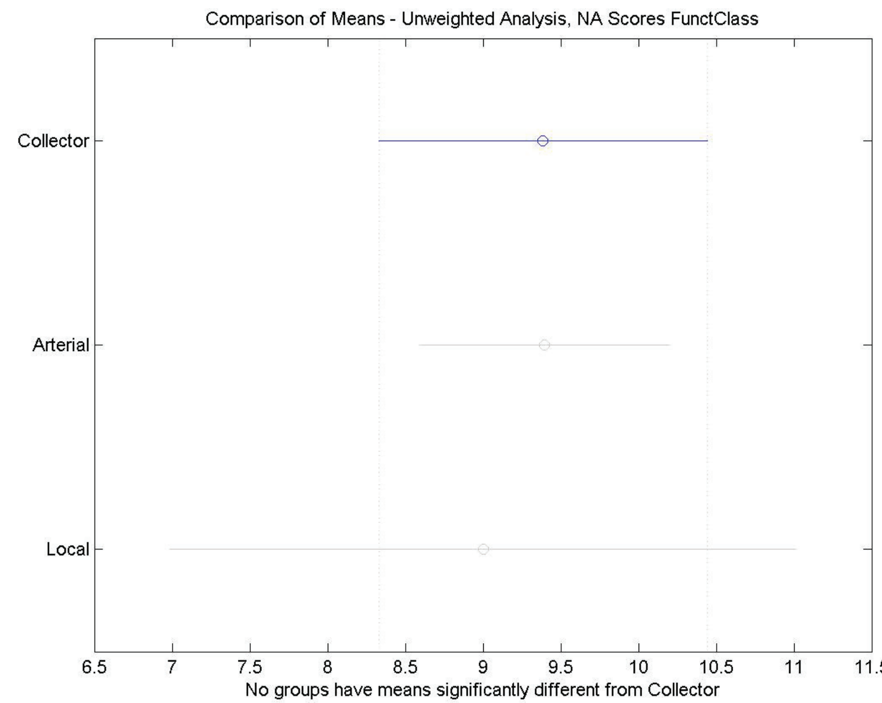

Comparison of Means - Unweighted Analysis, NA Scores Purpose
New
Maintenance
Reconstruction
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from New

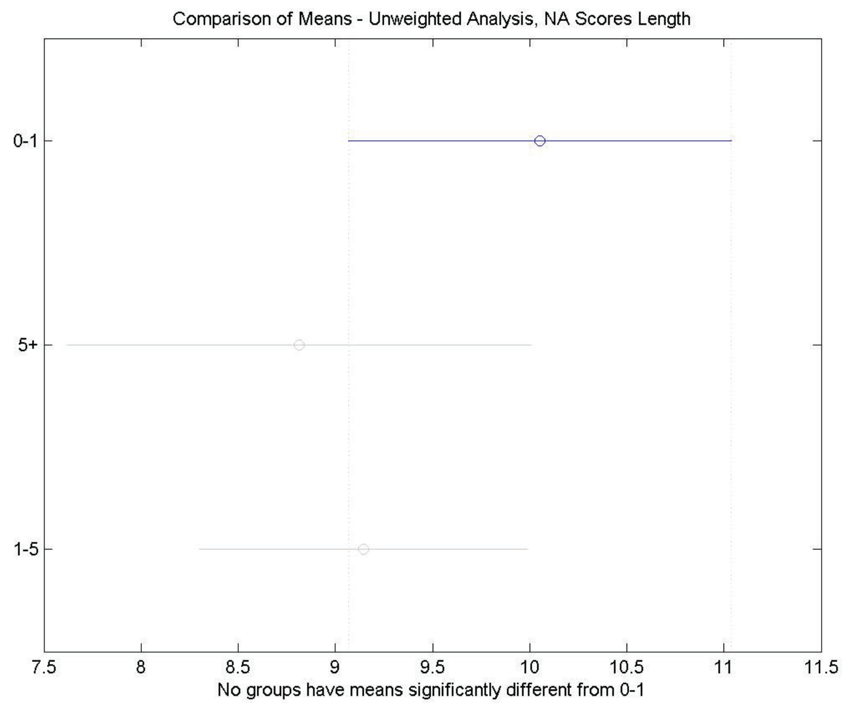

Comparison of Means - Unweighted Analysis, NA Scores Phase
Planning
Finished
Construction
Design
7
8
9
10
11
12
13
No groups have means significantly different from Planning

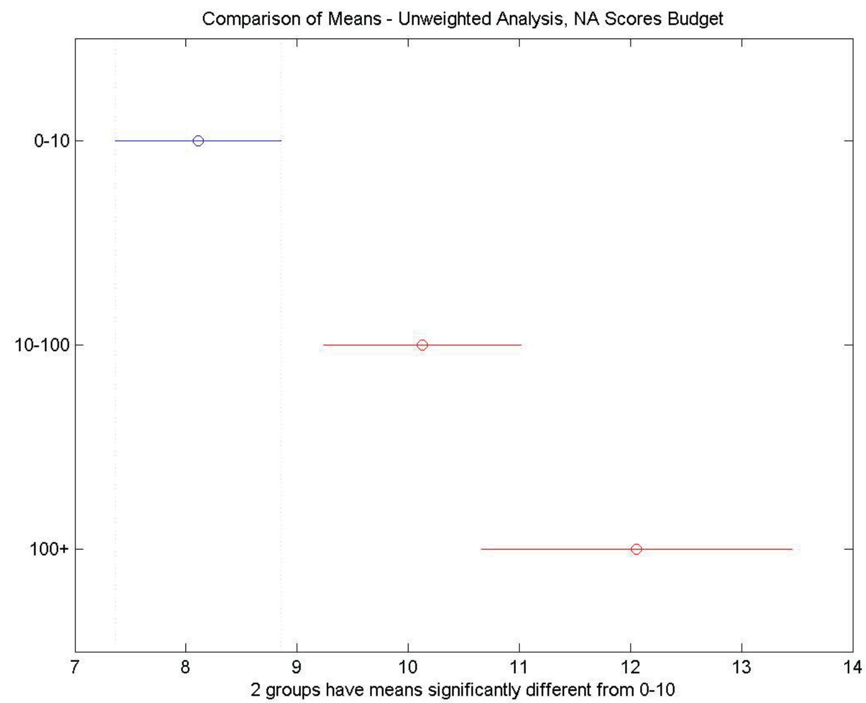

Comparison of Means - Unweighted Analysis, NA Scores Motivation
Mobility
Preservation
Economic
Safety
Environmental
Other
0
2
4
6
8
10
12
14
The means of groups Mobility and Preservation are significantly different

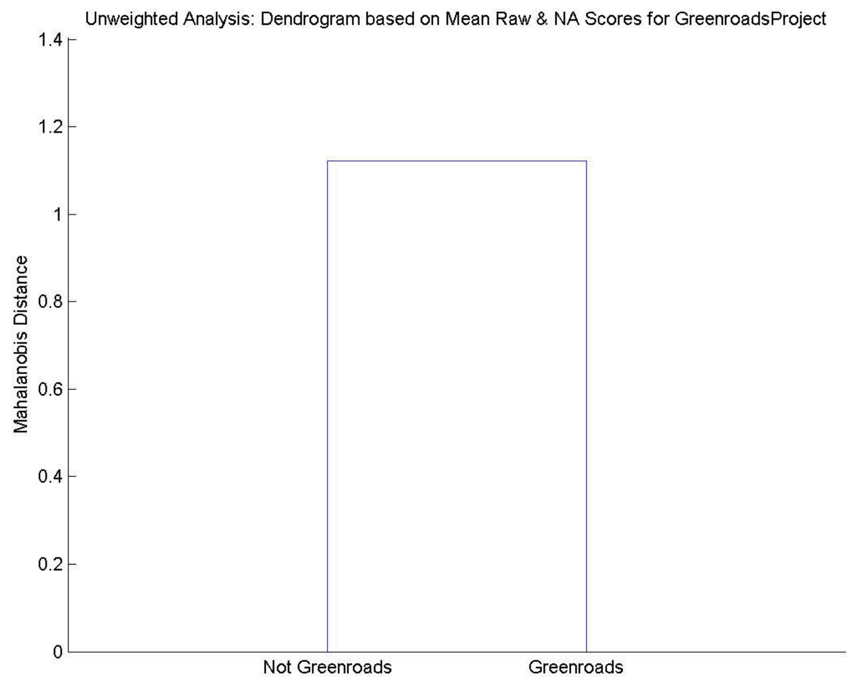

Comparison of Means - Unweighted Analysis, NA Scores Surfacing
HMA
PCC
Mixed
Other
3
4
5
6
7
8
9
10
11
12
13
No groups have means significantly different from HMA

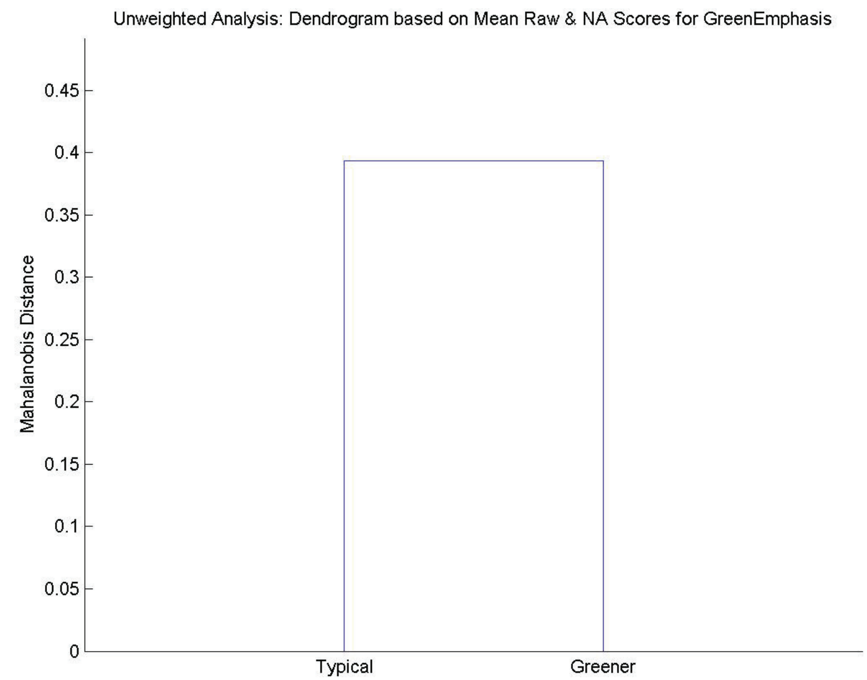

Comparison of Means - Unweighted Analysis, NA Scores Place
Small Urban
Rural
Urban
7.5
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from Small Urban

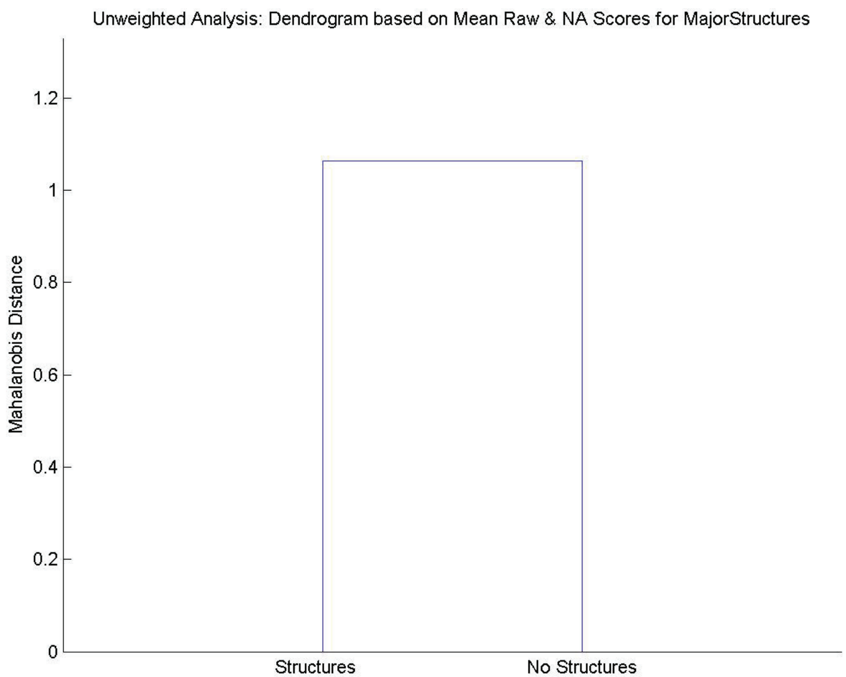

Comparison of Means - Unweighted Analysis, NA Scores FunctClass
Collector
Arterial
Local
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from Collector

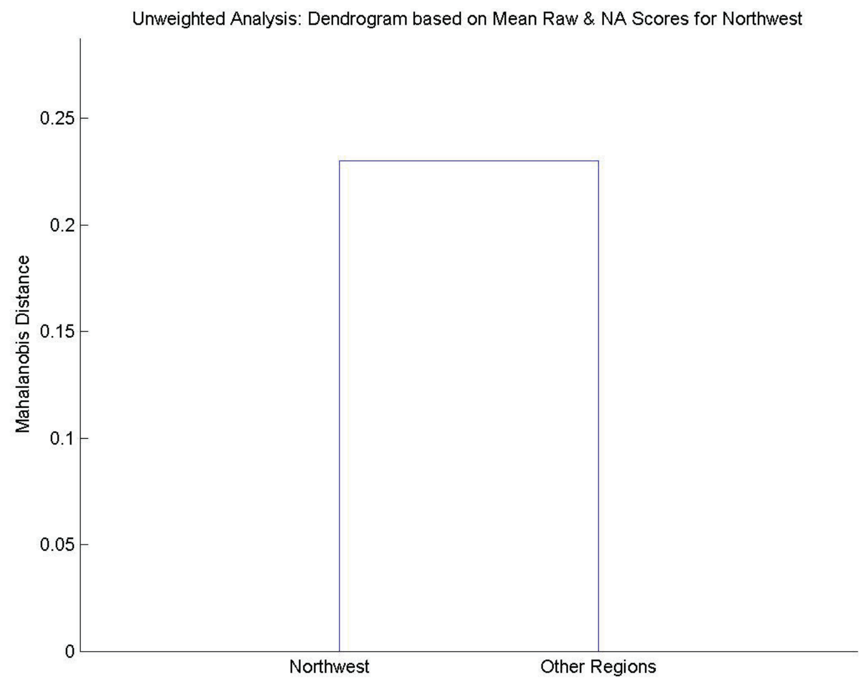

Comparison of Means - Unweighted Analysis, NA Scores Length
0-1
5+
1-5
7.5
8
8.5
9
9.5
10
10.5
11
11.5
No groups have means significantly different from 0-1


Comparison of Means - Unweighted Analysis, NA Scores Budget
0-10
10-100
100+
7
8
9
10
11
12
13
14
2 groups have means significantly different from 0-10

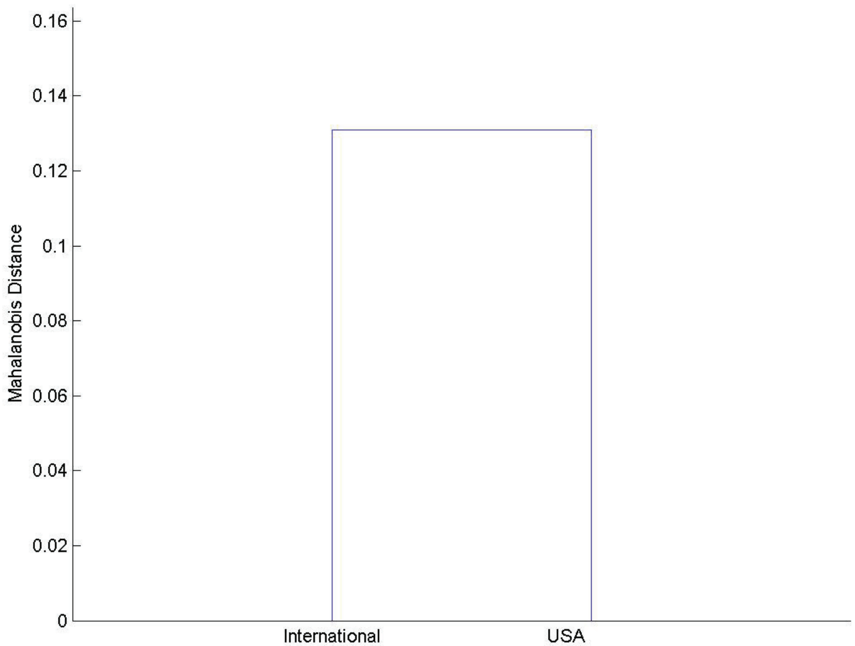

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for GreenroadsProject
Mahalanobis Distance
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Not Greenroads
Greenroads


Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for GreenEmphasis
Mahalanobis Distance
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Typical
Greener

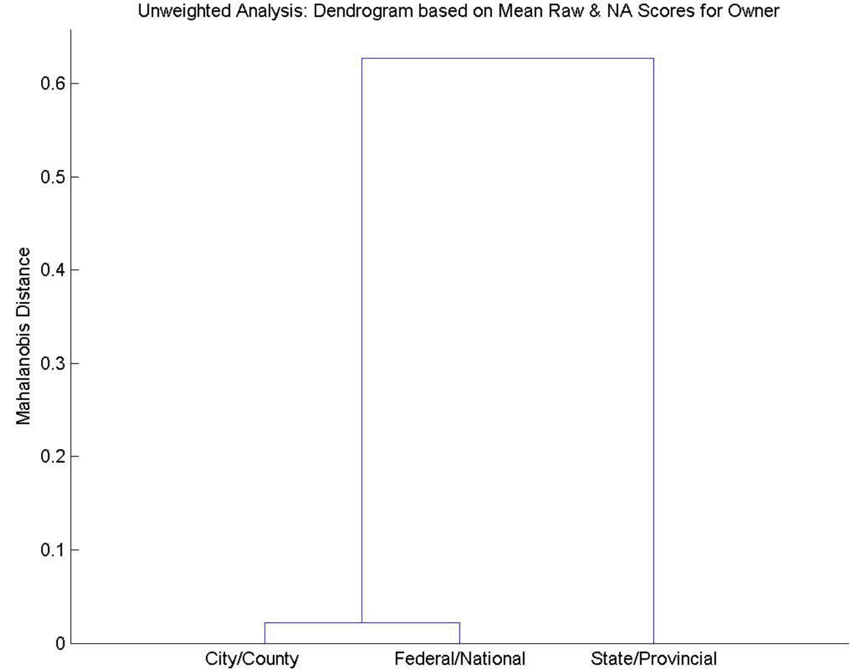

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for MajorStructures
Mahalanobis Distance
1.2
1
0.8
0.6
0.4
0.2
0
Structures
No Structures

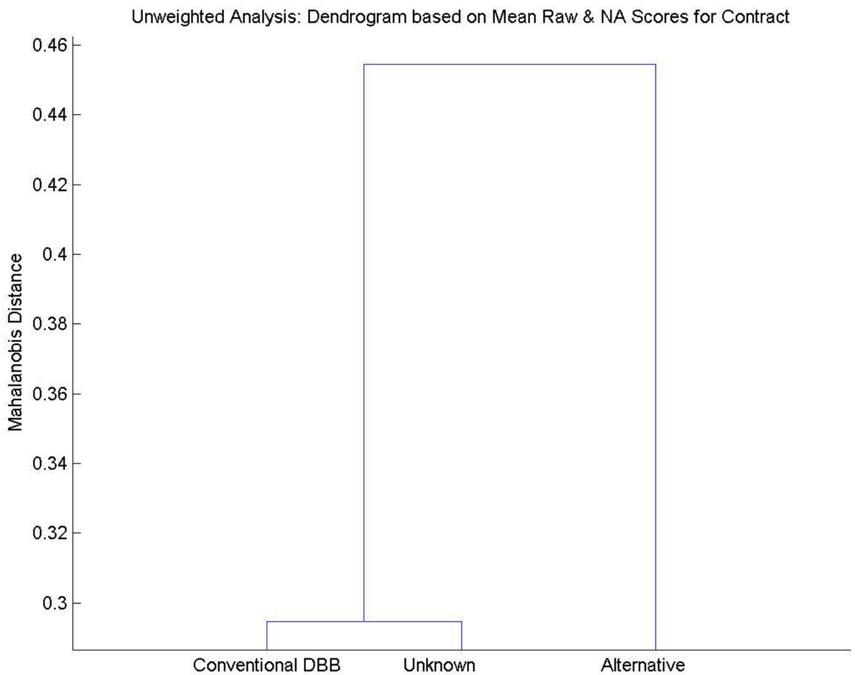

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Northwest
Mahalanobis Distance
0.25
0.2
0.15
0.1
0.05
0
Northwest
Other Regions

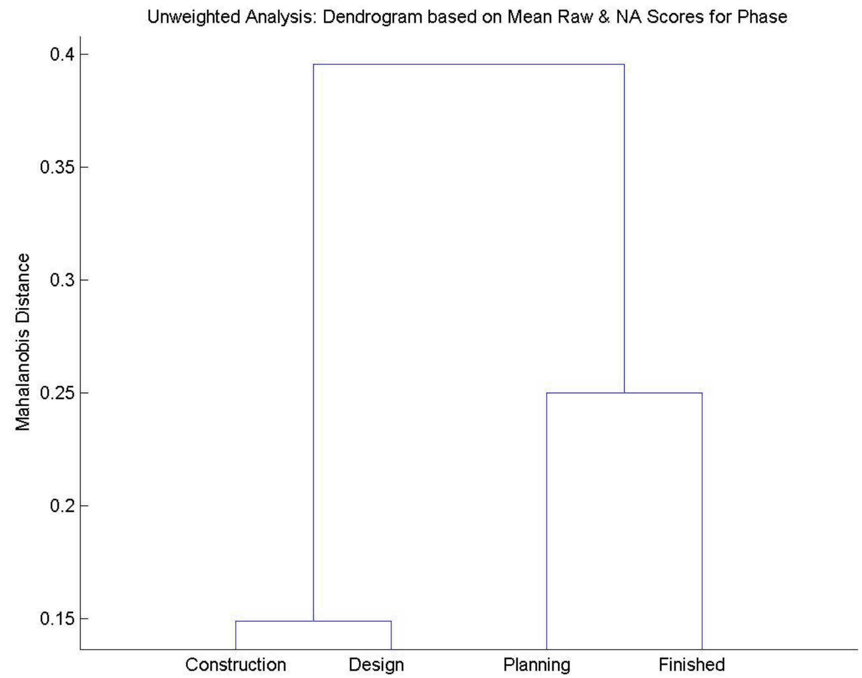
Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Country

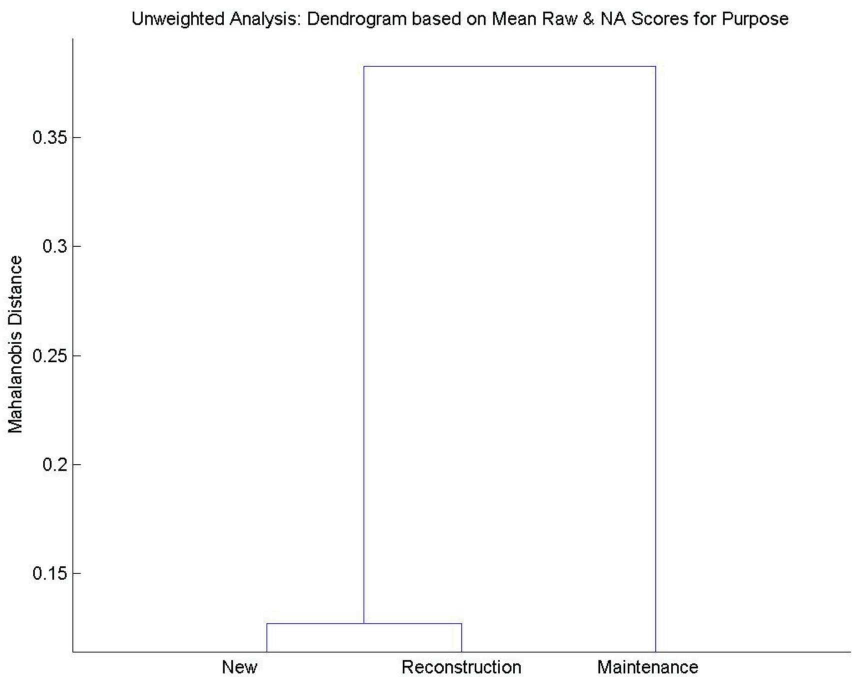


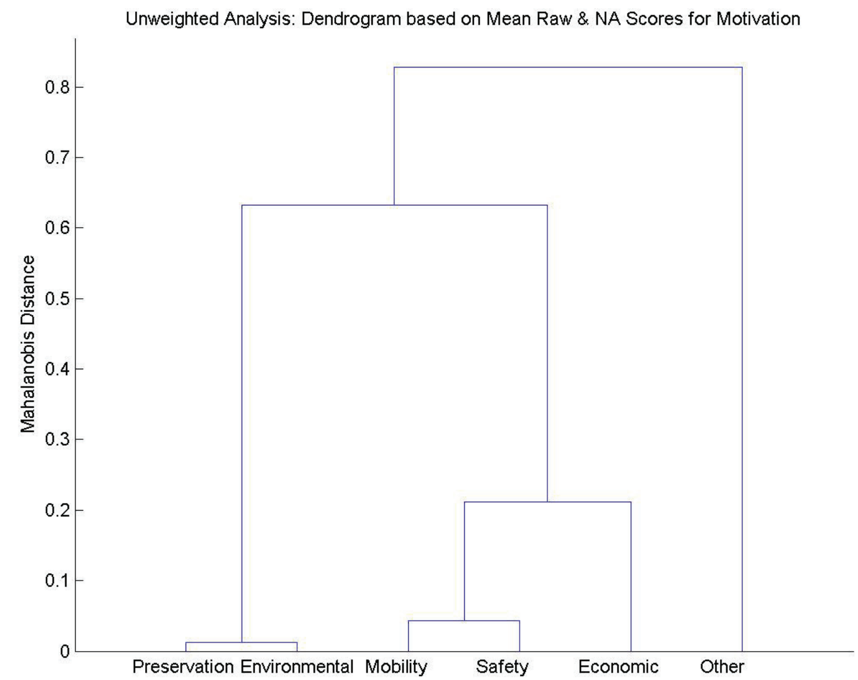
Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Owner

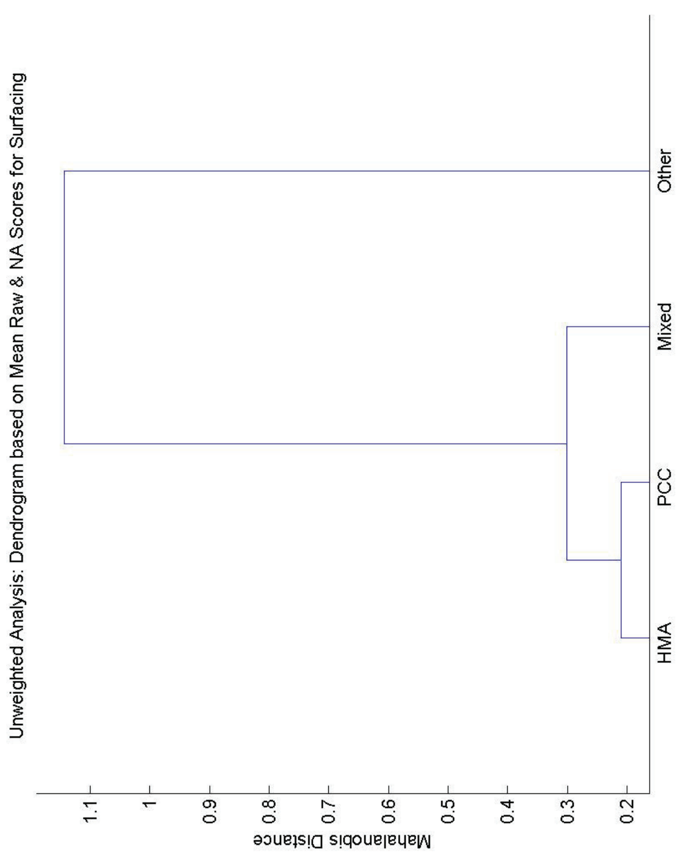


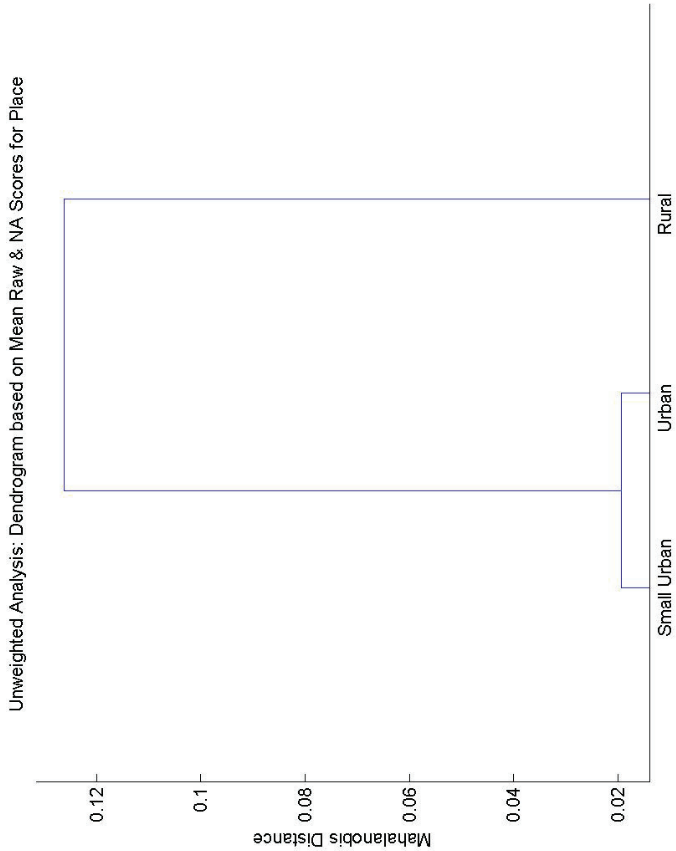

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Contract
Mahalanobis Distance
0.46
0.44
0.42
0.4
0.38
0.36
0.34
0.32
0.3
Conventional DBB
Unknown
Alternative

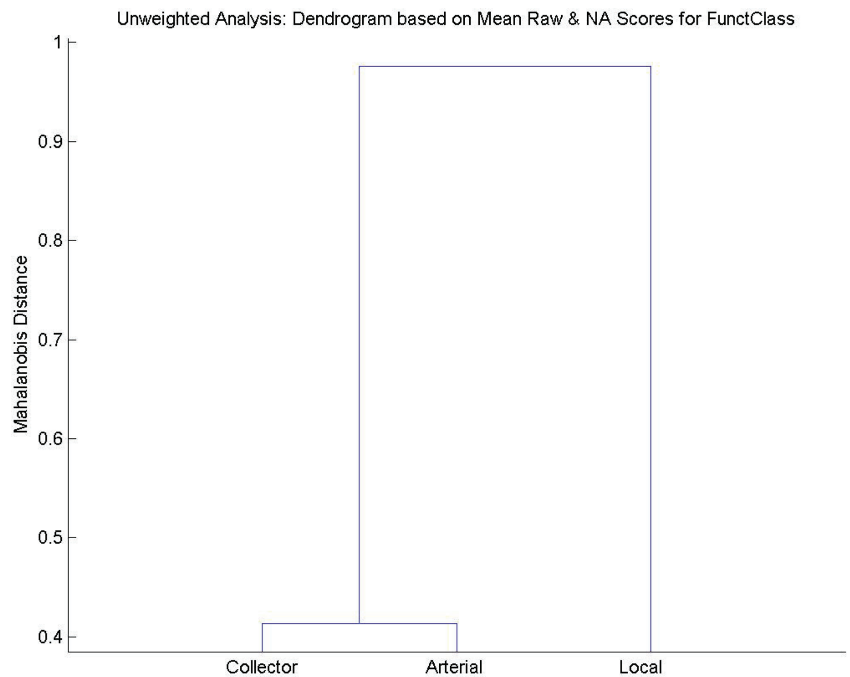

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Phase
Mahalanobis Distance
0.4
0.35
0.3
0.25
0.2
0.15
Construction
Design
Planning
Finished

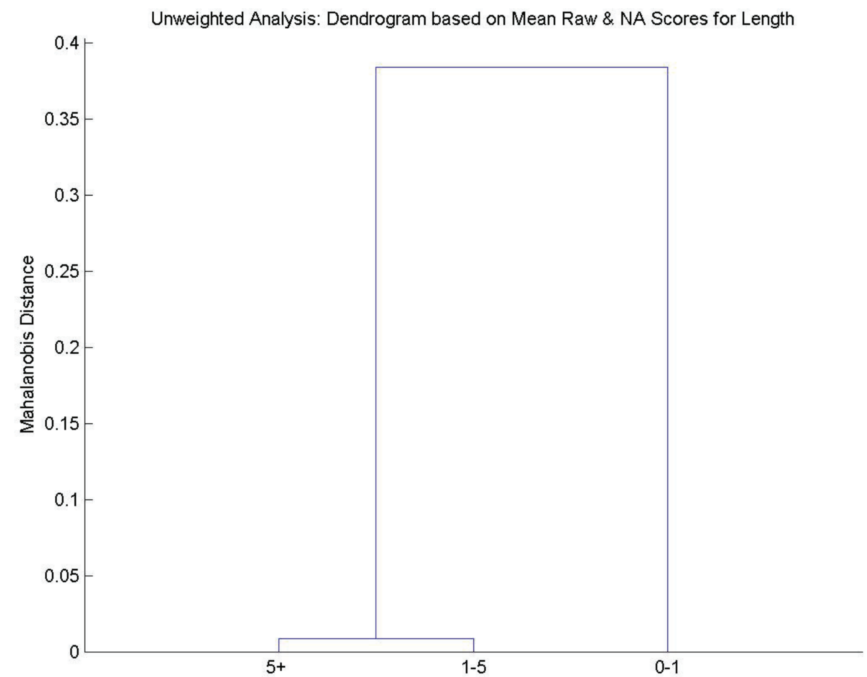

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Purpose
Mahalanobis Distance
0.35
0.3
0.25
0.2
0.15
New
Reconstruction
Maintenance

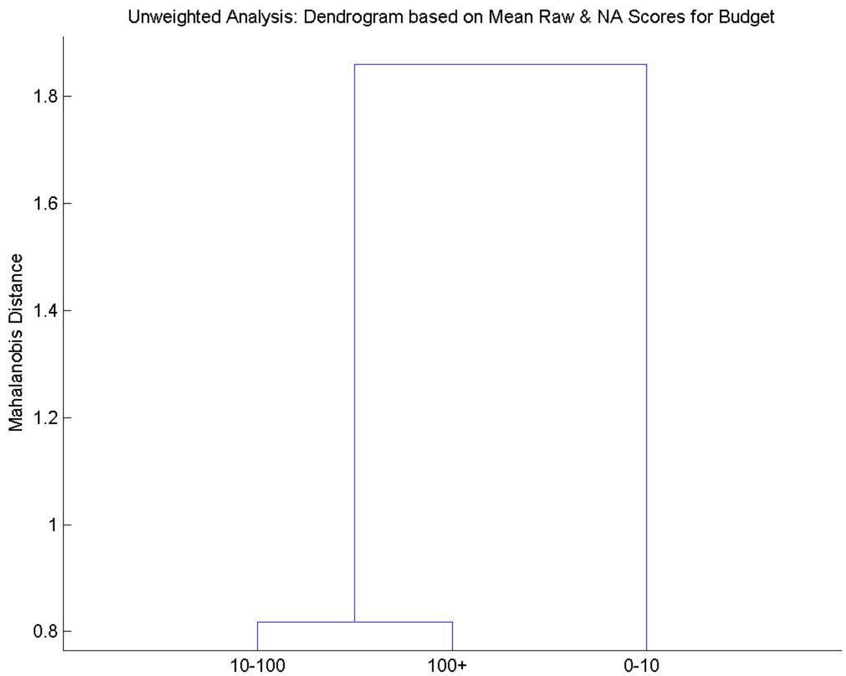

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Motivation
Mahalanobis Distance
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Preservation
Environmental
Mobility
Safety
Economic
Other

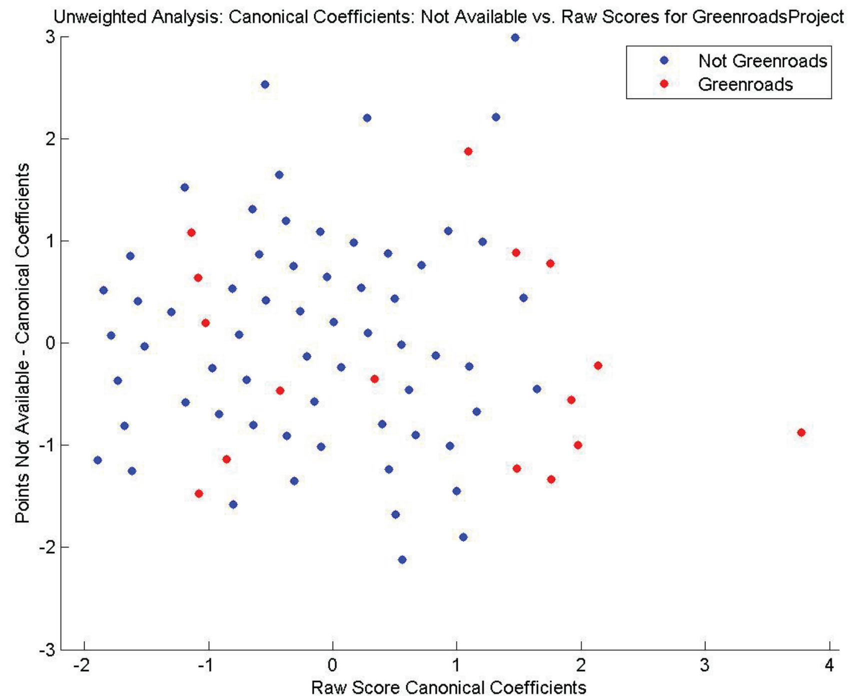

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Surfacing
Mahalanobis Distance
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
HMA
PCC
Mixed
Other

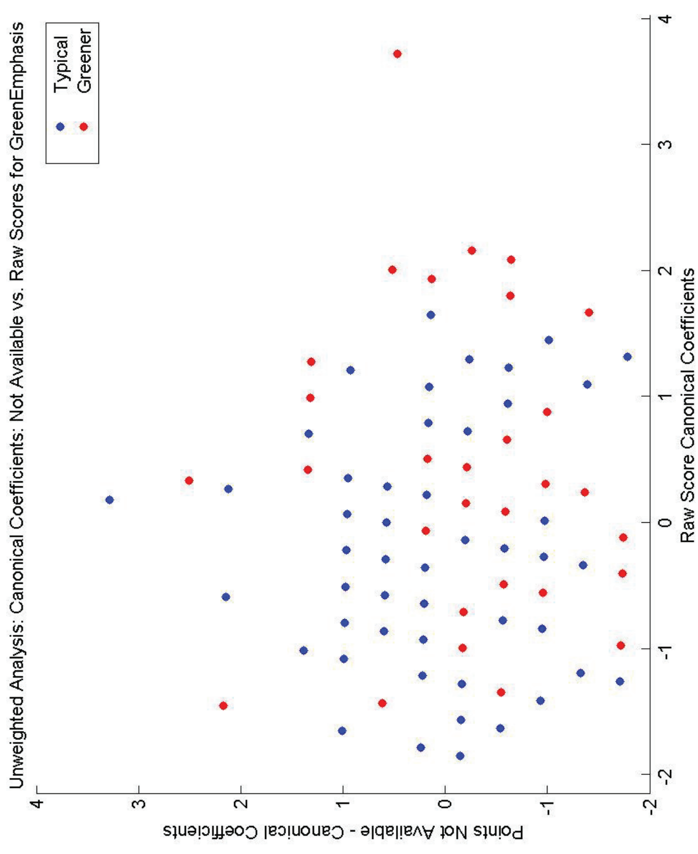

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Place
Mahalanobis Distance
0.12
0.1
0.08
0.06
0.04
0.02
Small Urban
Urban
Rural

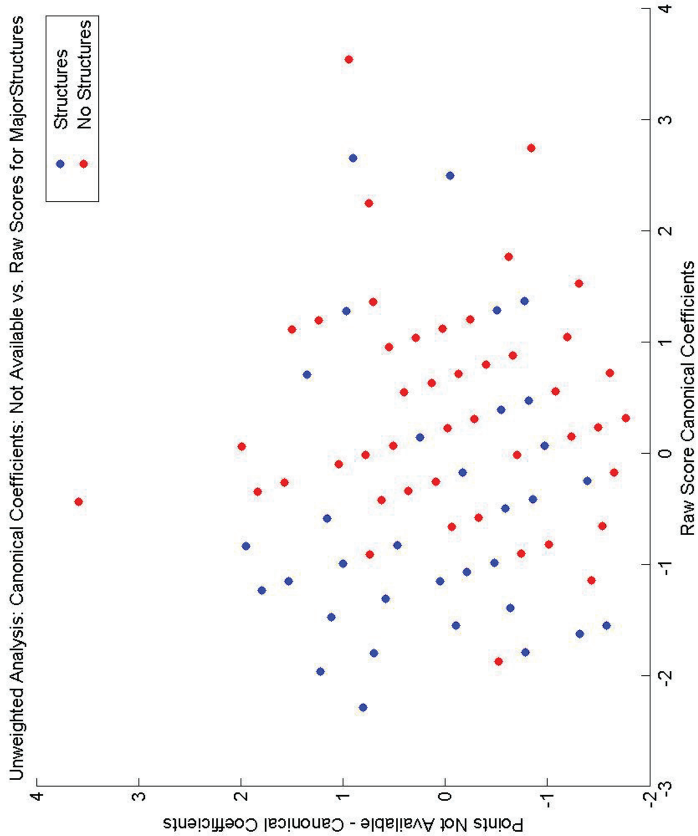

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for FunctClass
Mahalanobis Distance
1
0.9
0.8
0.7
0.6
0.5
0.4
Collector
Arterial
Local

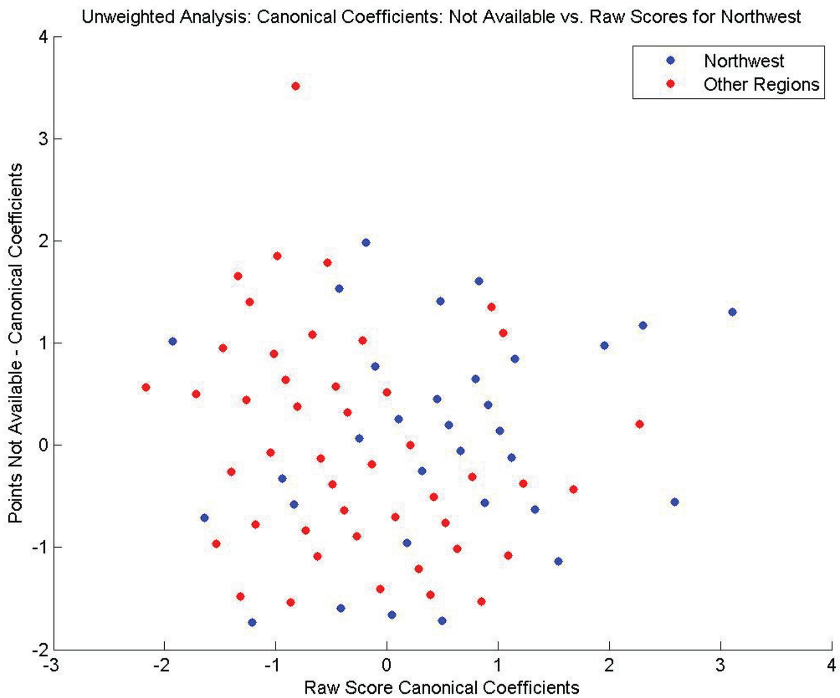

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Length
Mahalanobis Distance
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
5+
1-5
0-1

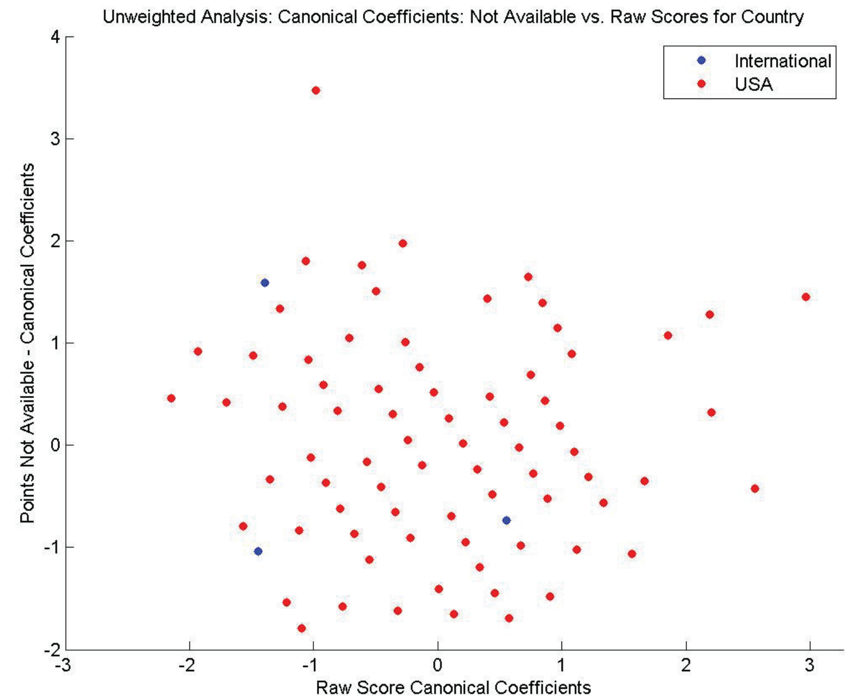

Unweighted Analysis: Dendrogram based on Mean Raw & NA Scores for Budget
Mahalanobis Distance
1.8
1.6
1.4
1.2
1
0.8
10-100
100+
0-10

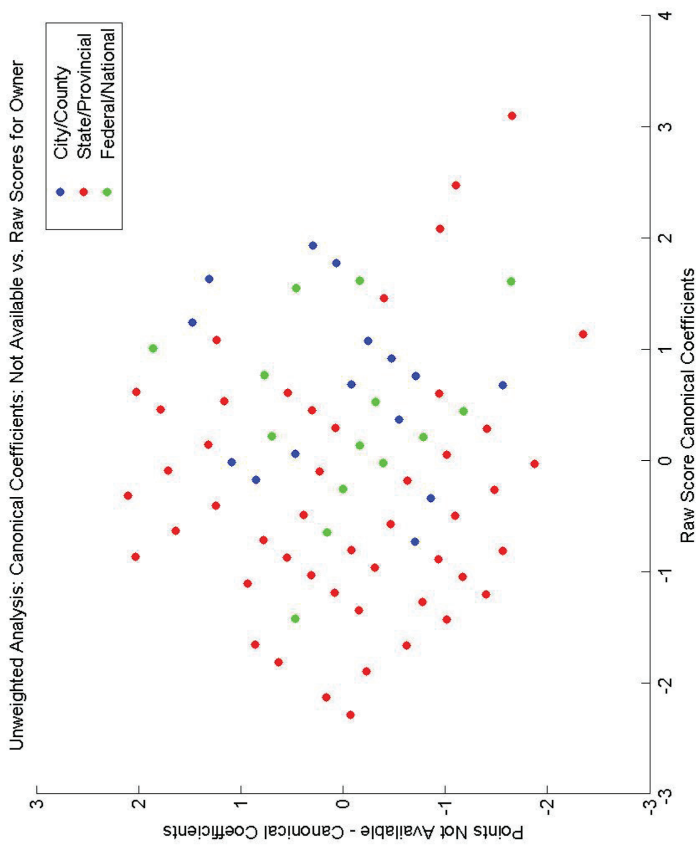

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for GreenroadsProject
Not Greenroads
Greenroads
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
3
2
1
0
-1
-2
-3
-2
-1
0
1
2
3
4


Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for GreenEmphasis
Typical
Greener
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

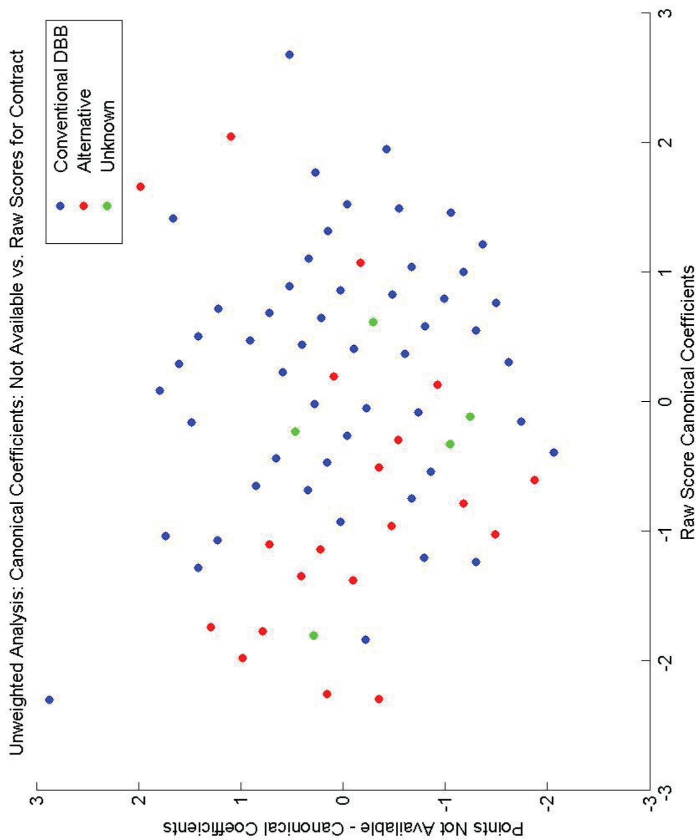

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for MajorStructures
Structures
No Structures
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients


Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Northwest
Northwest
Other Regions
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

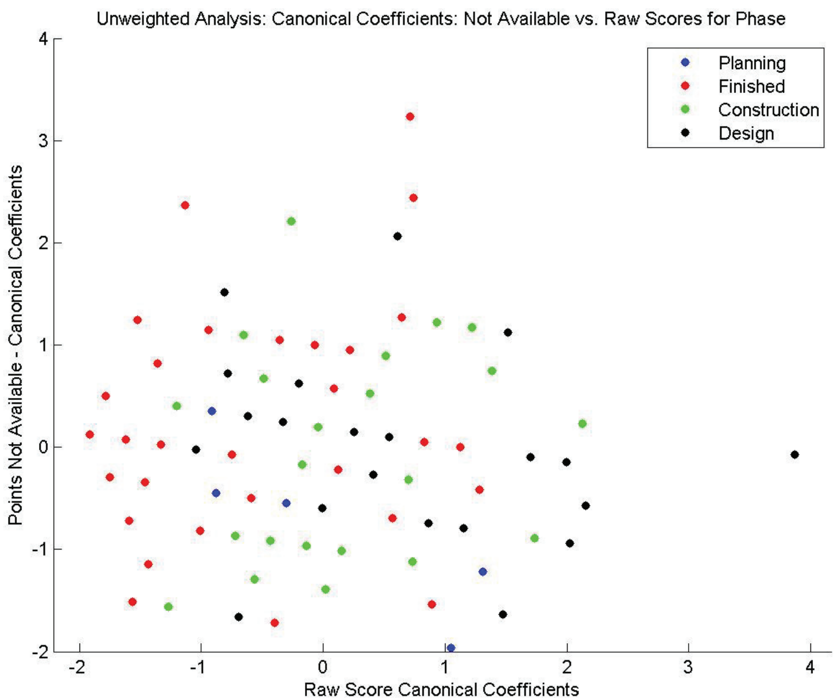

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Country
International
USA
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

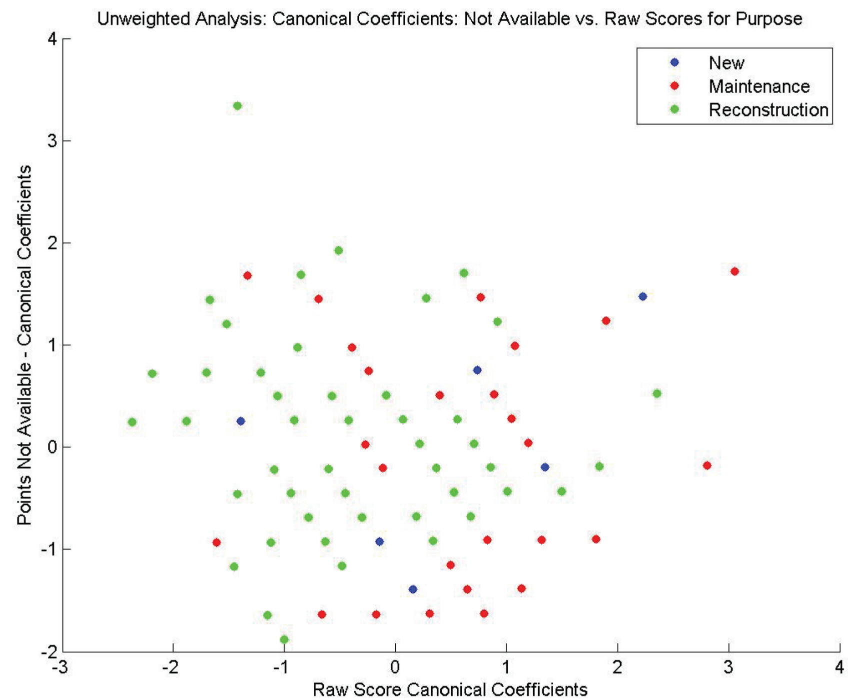


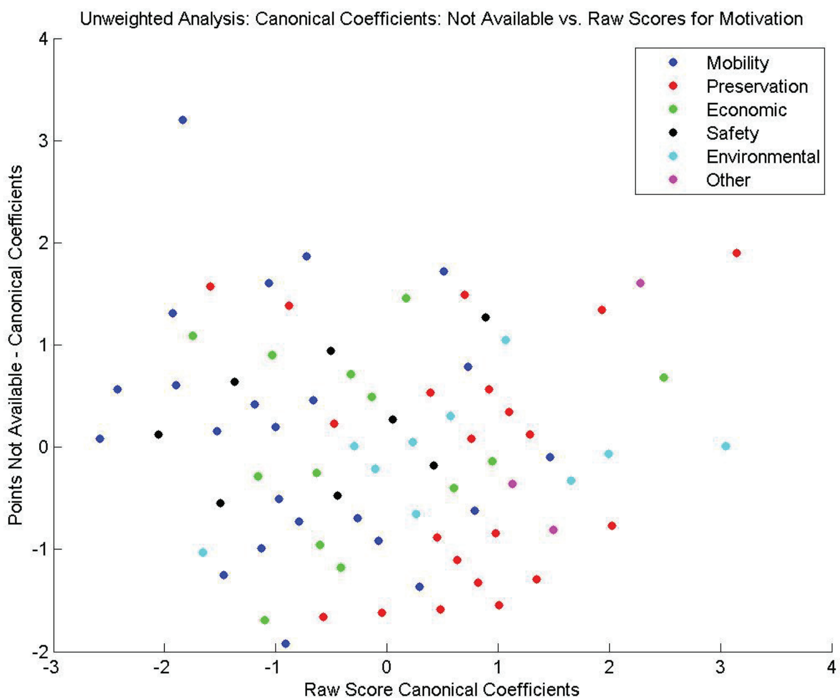
Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Owner
City/County
State/Provincial
Federal/National
Raw Score Canonical Coefficients
Points Not Available - Canonical Coefficients

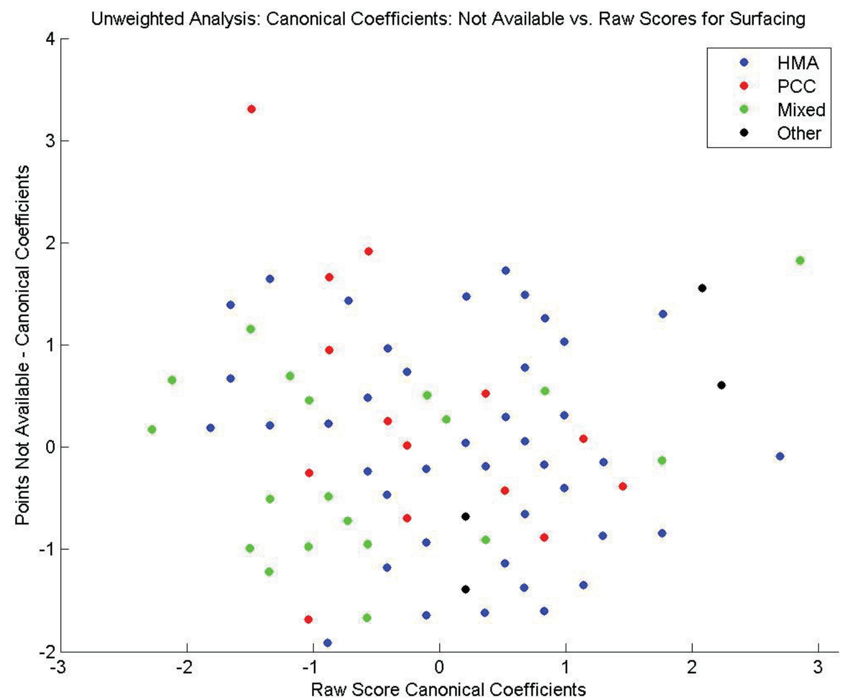


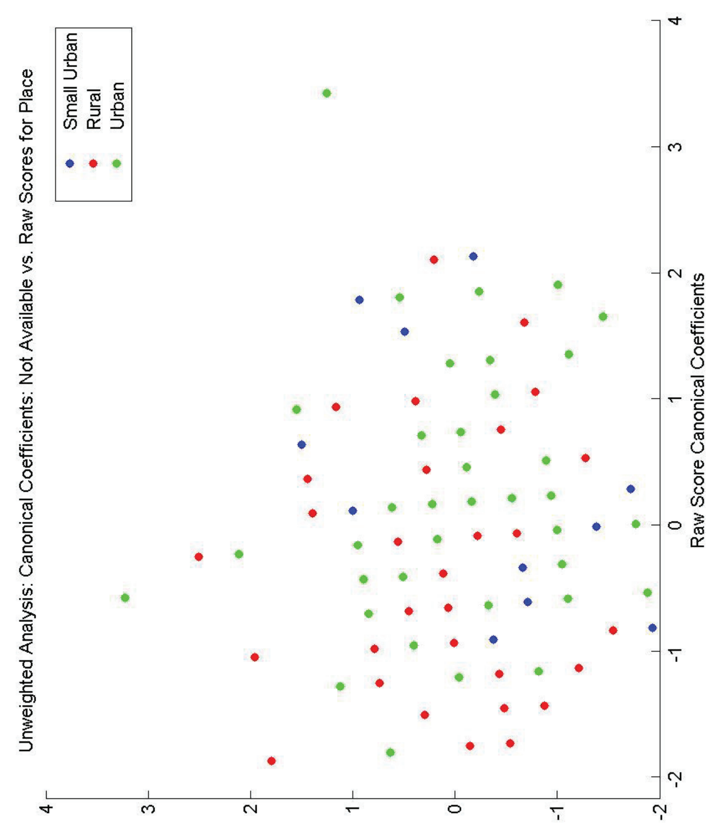
Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Contract
Conventional DBB
Alternative
Unknown
Raw Score Canonical Coefficients
Points Not Available - Canonical Coefficients

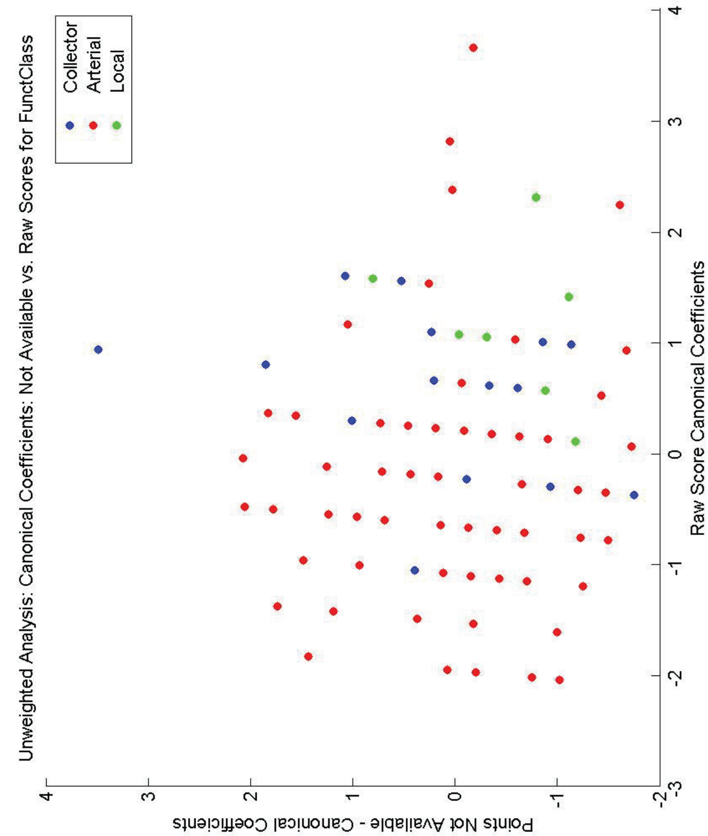

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Phase
Planning
Finished
Construction
Design
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

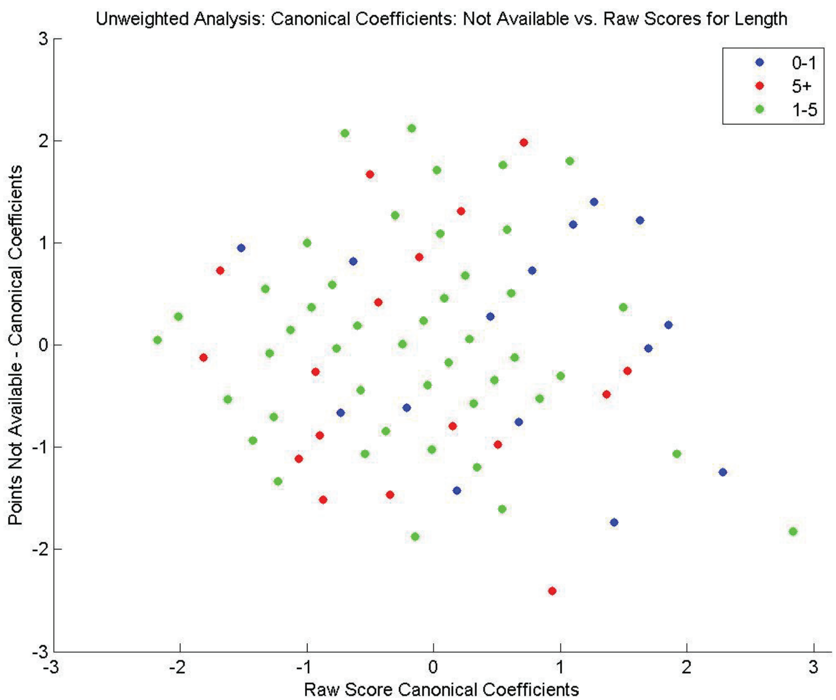

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Purpose
New
Maintenance
Reconstruction
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients

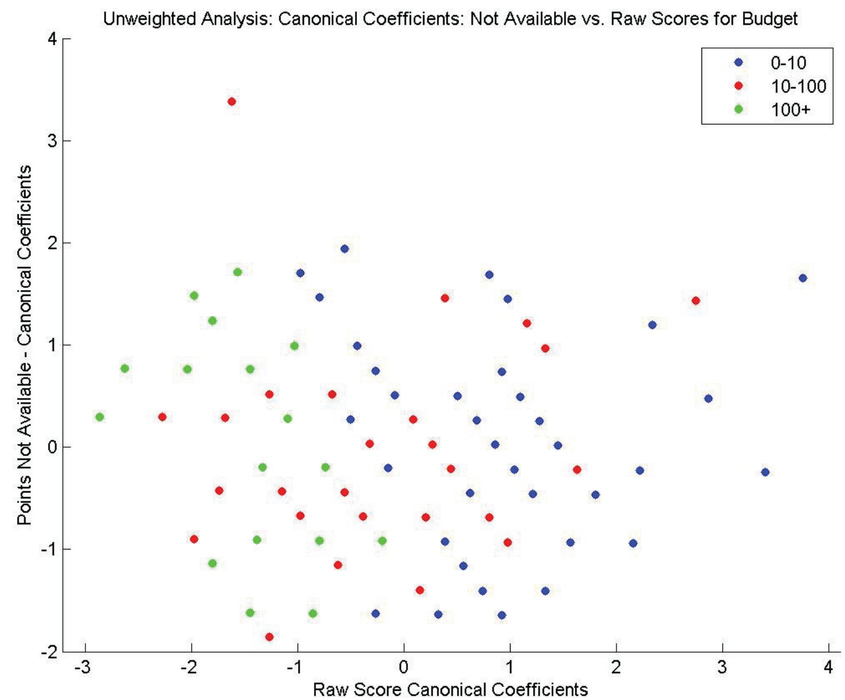

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Motivation
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
Mobility
Preservation
Economic
Safety
Environmental
Other

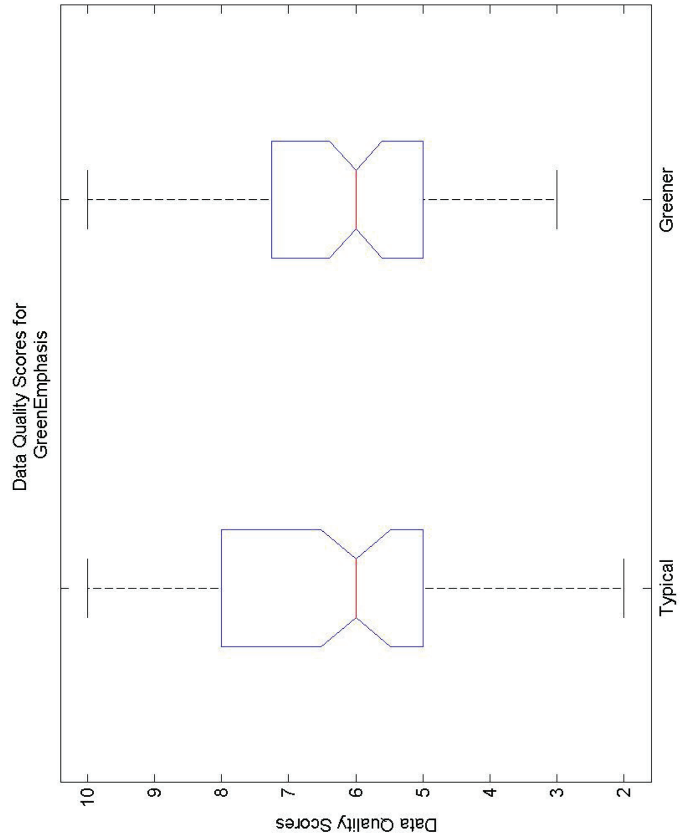

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Surfacing
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
HMA
PCC
Mixed
Other

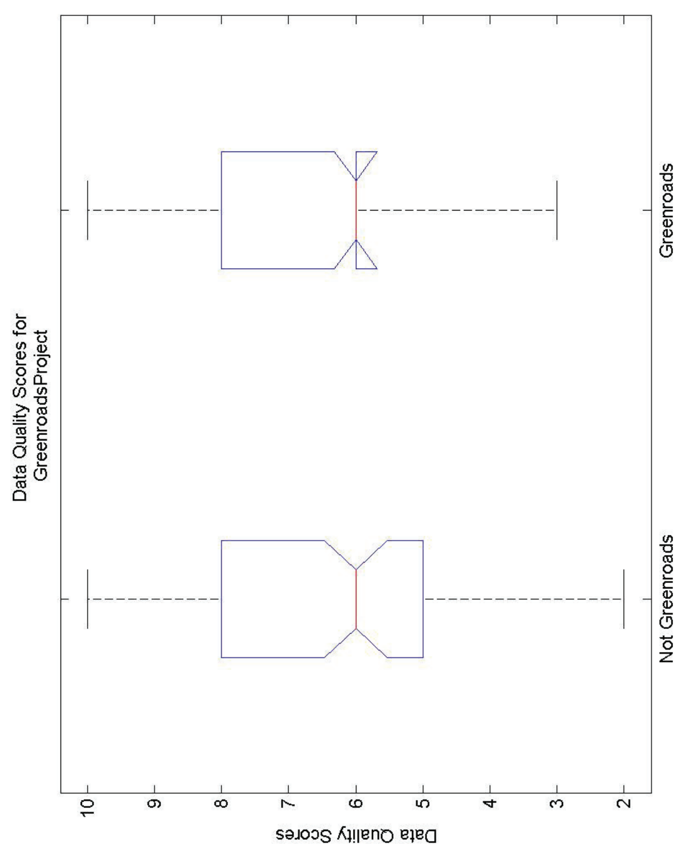

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Place
Small Urban
Rural
Urban
Raw Score Canonical Coefficients
Points Not Available - Canonical Coefficients

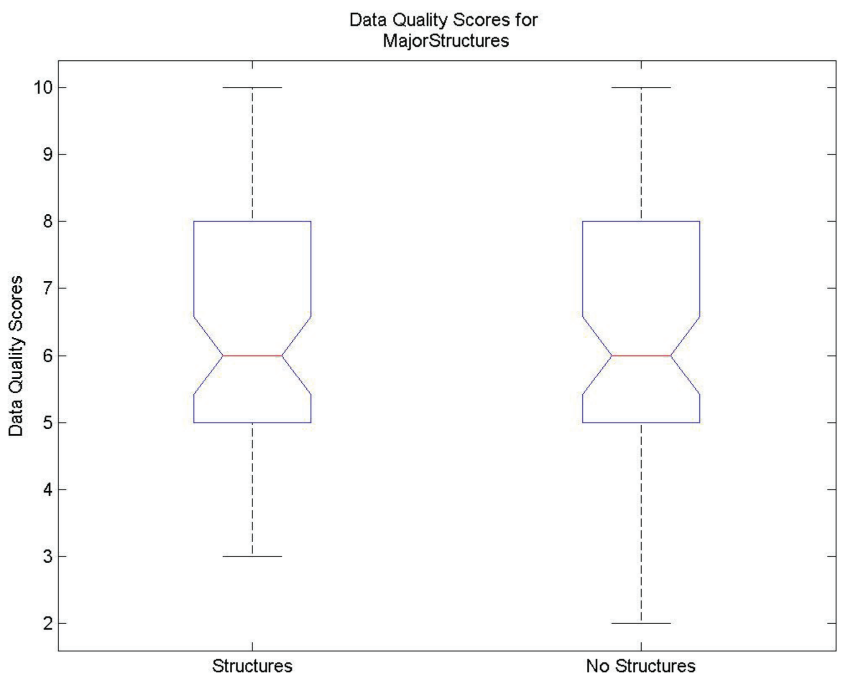

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for FunctClass
Collector
Arterial
Local
Raw Score Canonical Coefficients
Points Not Available - Canonical Coefficients

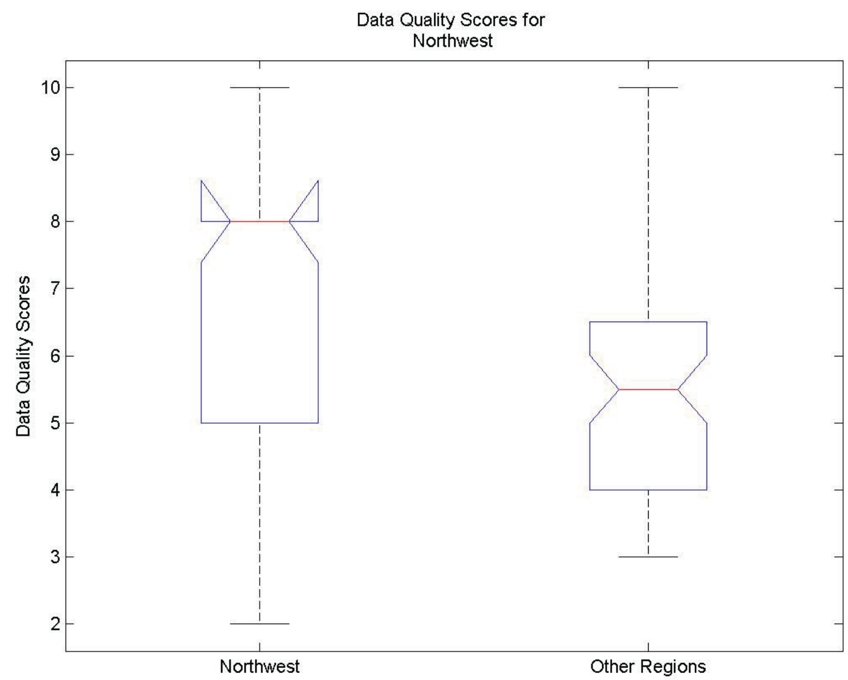

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Length
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
0-1
5+
1-5
-3
-2
-1
0
1
2
3

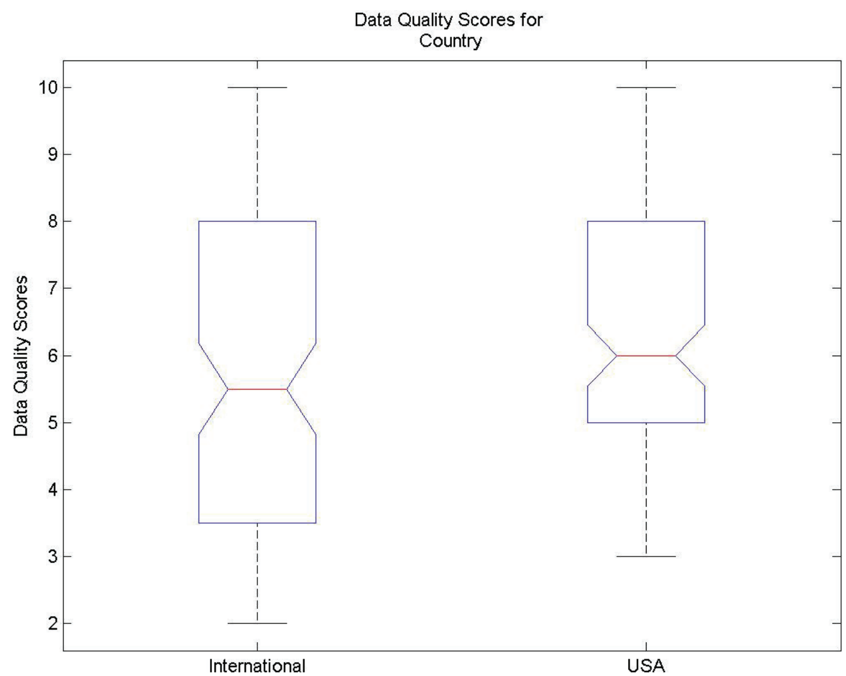

Unweighted Analysis: Canonical Coefficients: Not Available vs. Raw Scores for Budget
Points Not Available - Canonical Coefficients
Raw Score Canonical Coefficients
0-10
10-100
100+
-3
-2
-1
0
1
2
3
4

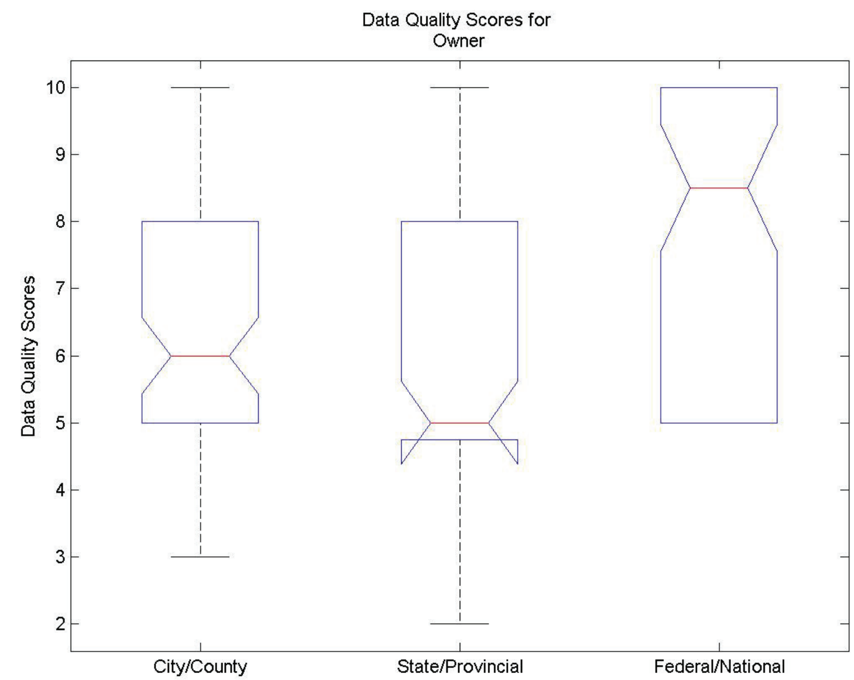

Data Quality Scores for
GreenEmphasis
Data Quality Scores
10
9
8
7
6
5
4
3
2
Typical
Greener

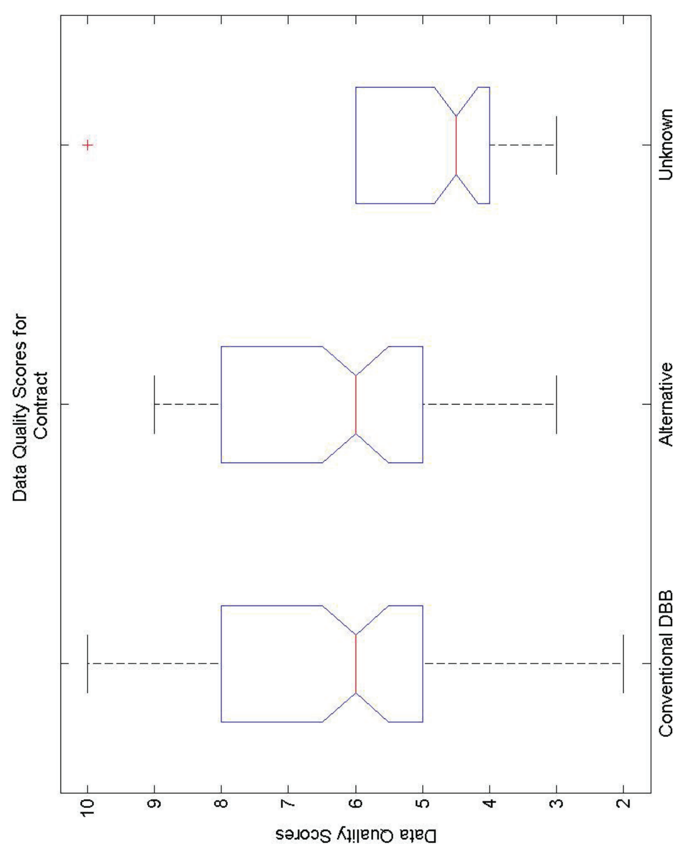

Data Quality Scores for
GreenroadsProject
Data Quality Scores
10
9
8
7
6
5
4
3
2
Not Greenroads
Greenroads

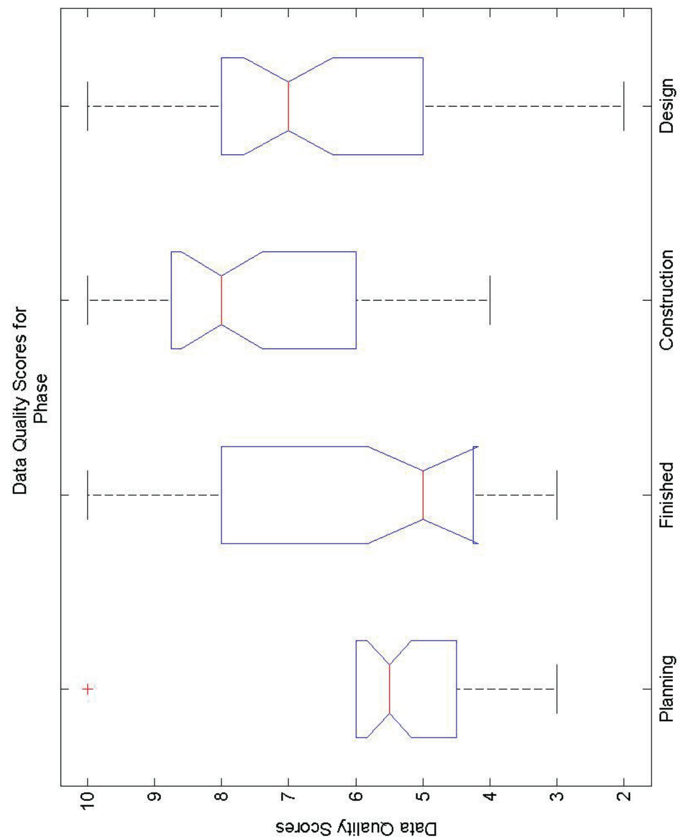

Data Quality Scores for
MajorStructures
Data Quality Scores
10
9
8
7
6
5
4
3
2
Structures
No Structures

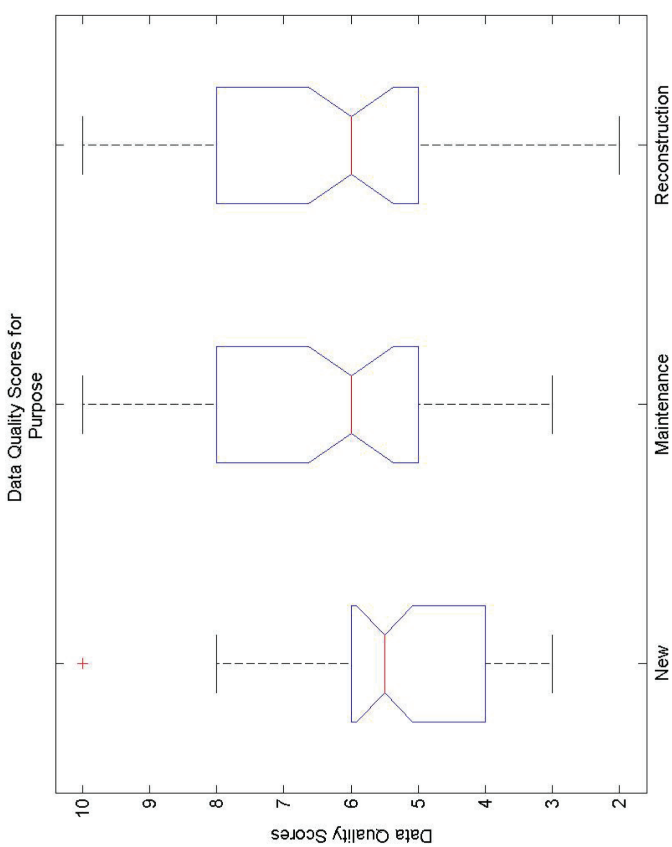

Data Quality Scores for
Northwest
Data Quality Scores
10
9
8
7
6
5
4
3
2
Northwest
Other Regions

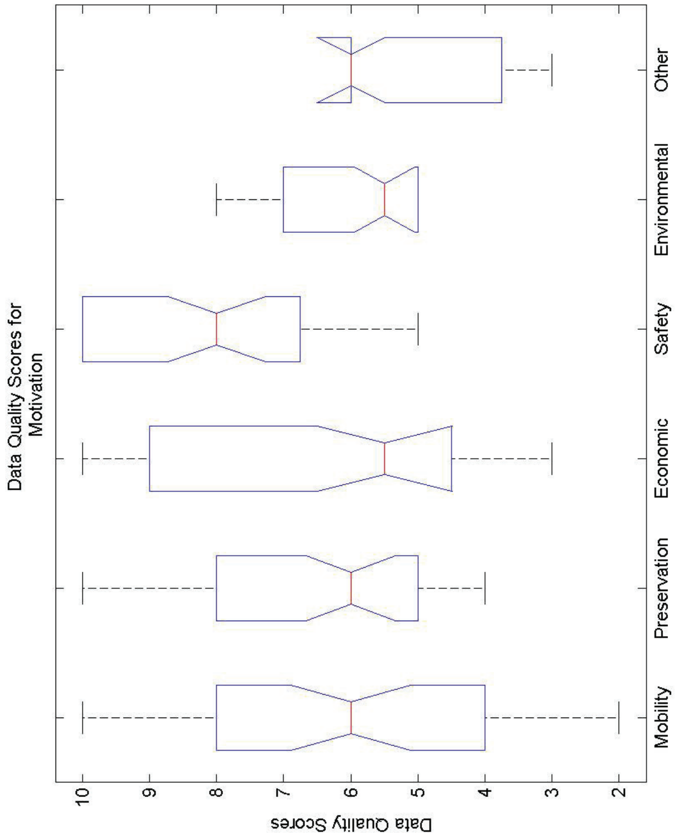

Data Quality Scores for
Country
Data Quality Scores
10
9
8
7
6
5
4
3
2
International
USA

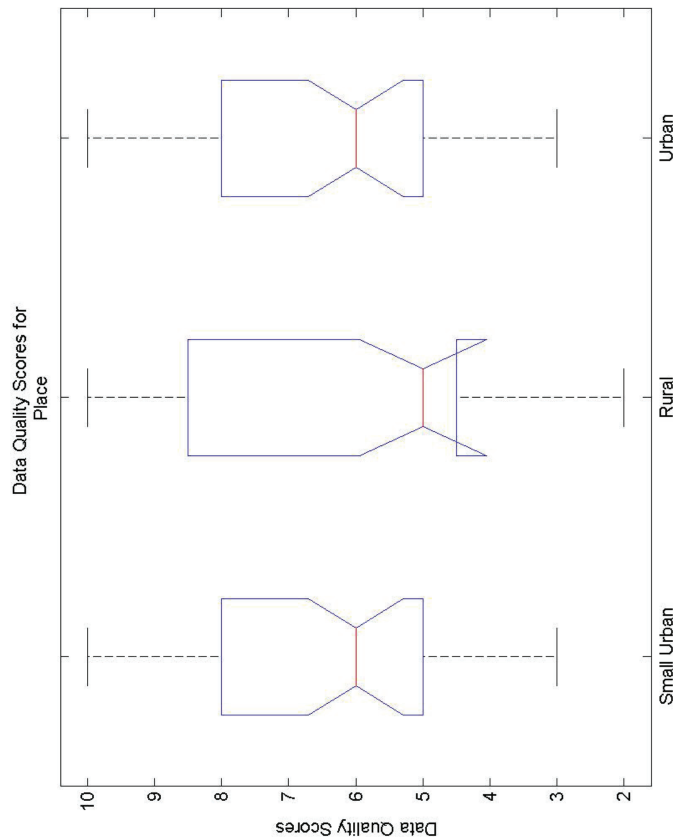

Data Quality Scores for
Owner
Data Quality Scores
10
9
8
7
6
5
4
3
2
City/County
State/Provincial
Federal/National

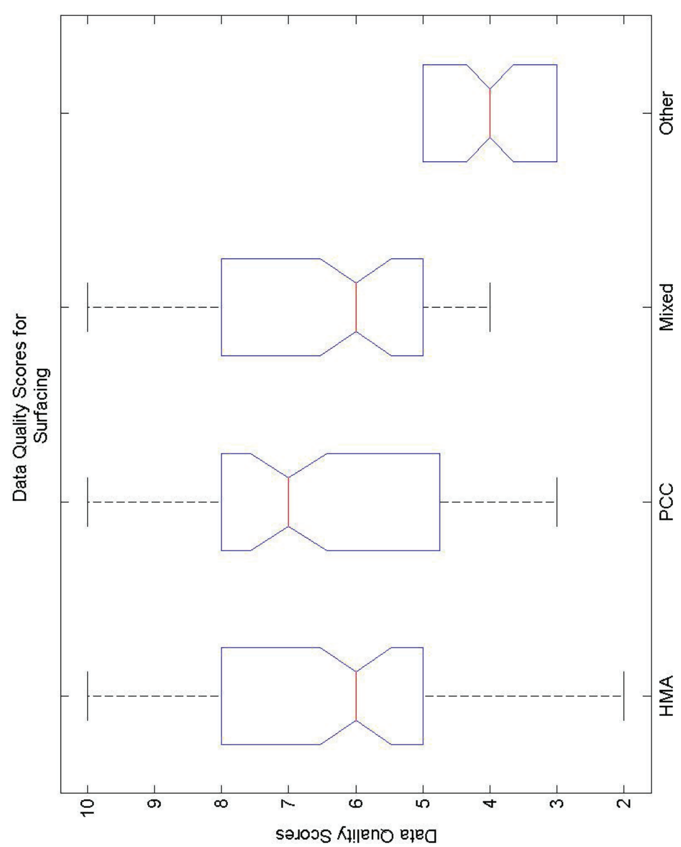

Data Quality Scores for
Contract
Data Quality Scores
10
9
8
7
6
5
4
3
2
Conventional DBB
Alternative
Unknown

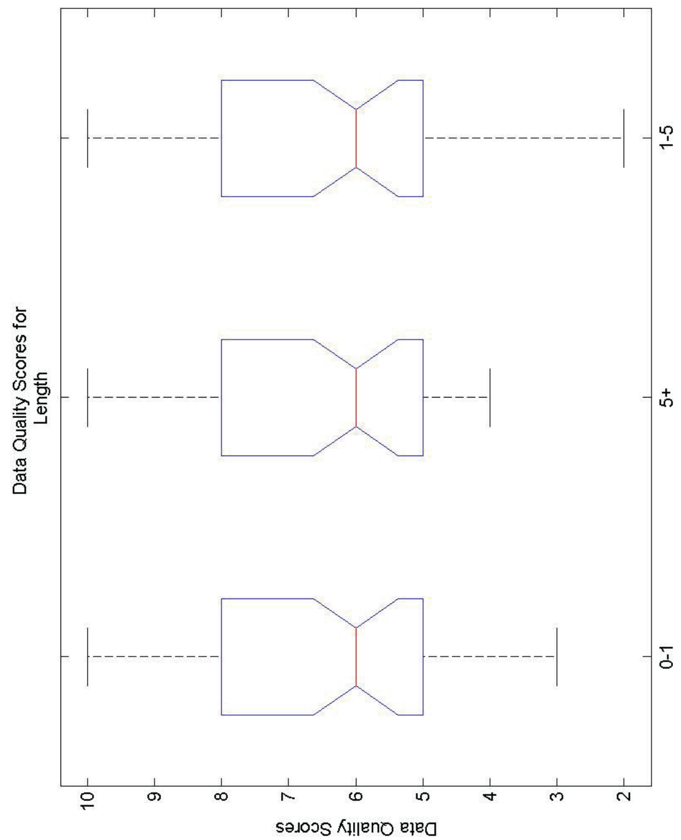

Data Quality Scores for
Phase
Data Quality Scores
10
9
8
7
6
5
4
3
2
Planning
Finished
Construction
Design

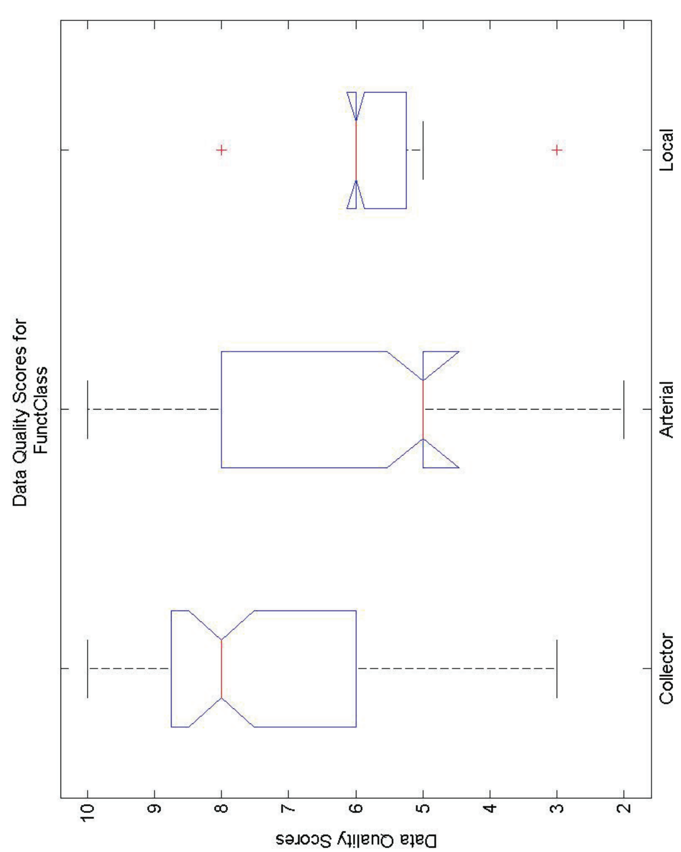

Data Quality Scores for Purpose
Data Quality Scores
10
9
8
7
6
5
4
3
2
New
Maintenance
Reconstruction

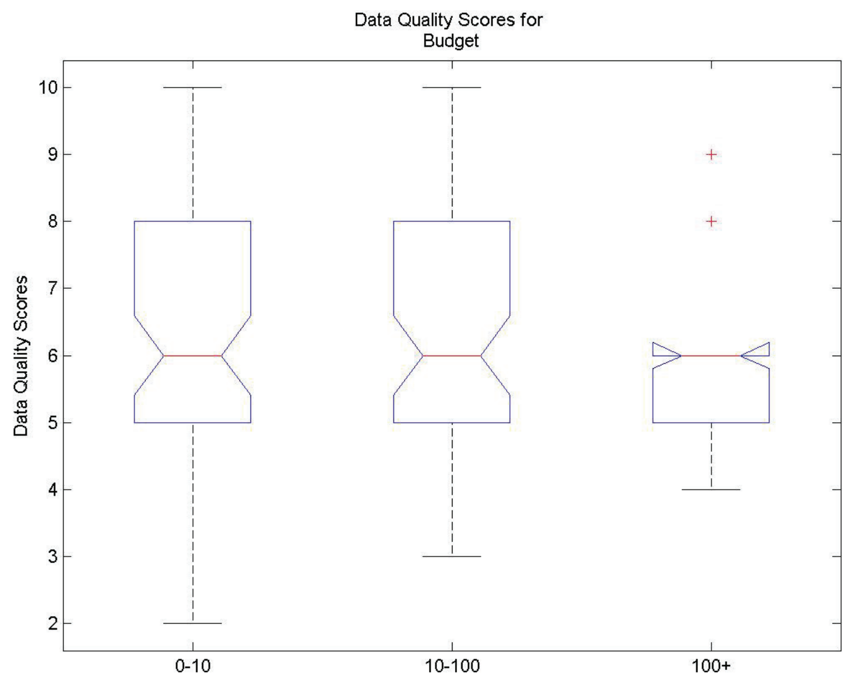

Data Quality Scores for Motivation
Data Quality Scores
10
9
8
7
6
5
4
3
2
Mobility
Preservation
Economic
Safety
Environmental
Other

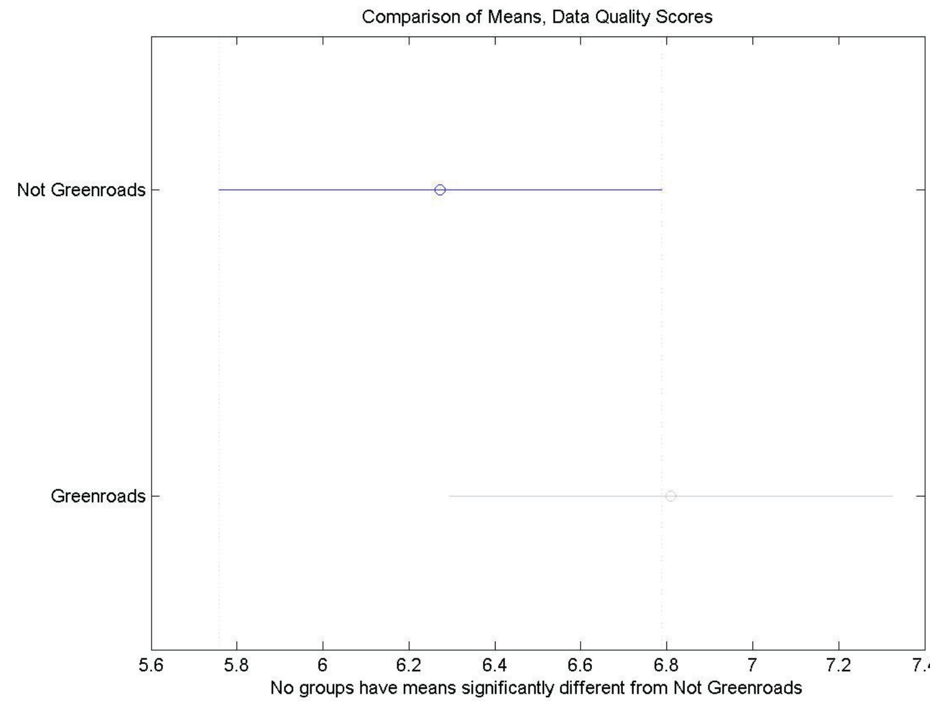

Data Quality Scores for Place
Data Quality Scores
10
9
8
7
6
5
4
3
2
Small Urban
Rural
Urban

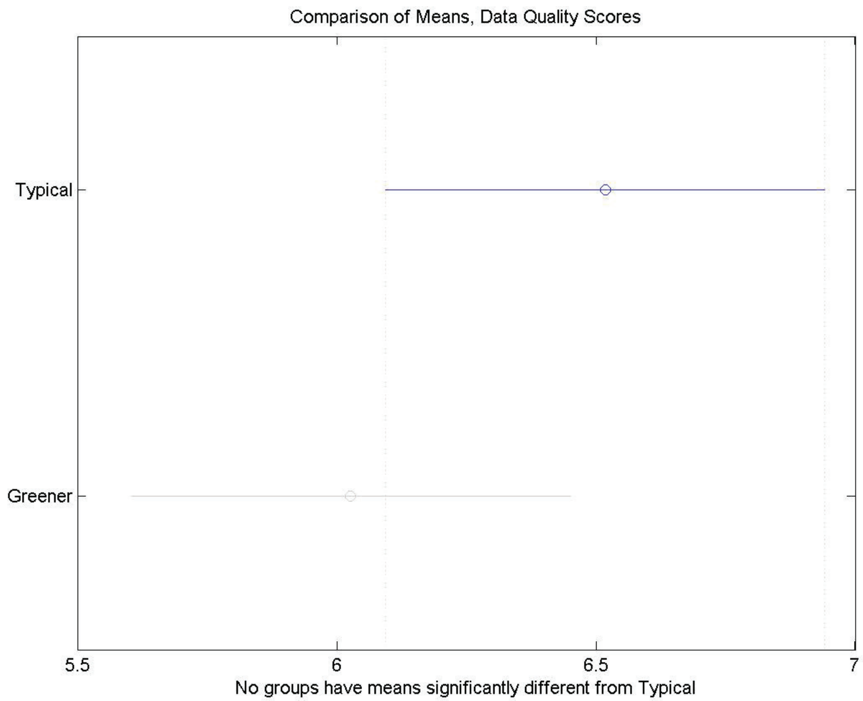

Data Quality Scores for Surfacing
Data Quality Scores
10
9
8
7
6
5
4
3
2
HMA
PCC
Mixed
Other

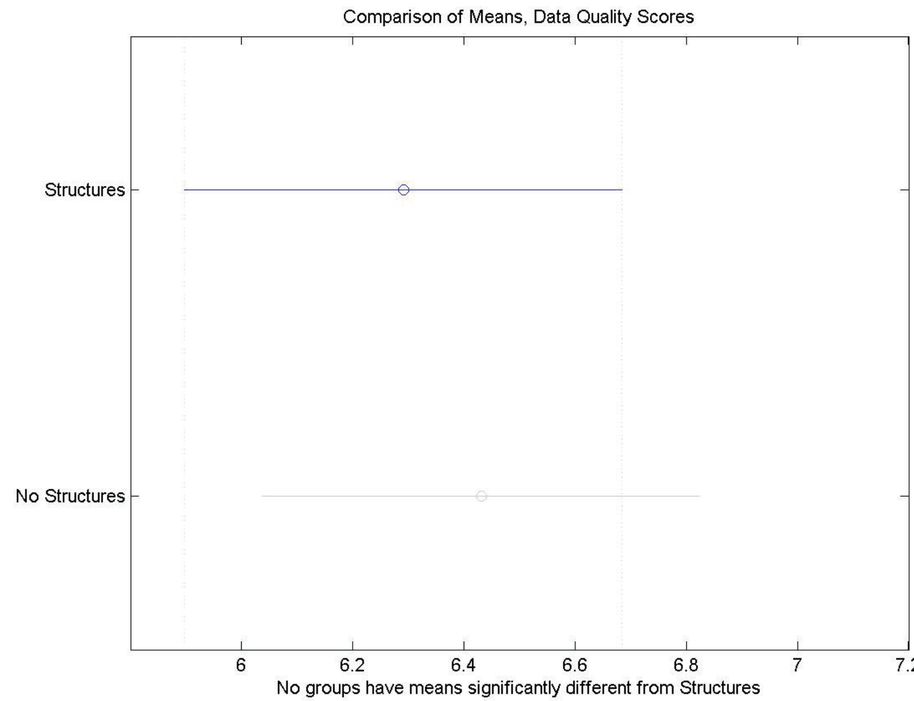

Data Quality Scores for
Length
Data Quality Scores
10
9
8
7
6
5
4
3
2
0-1
5+
1-5

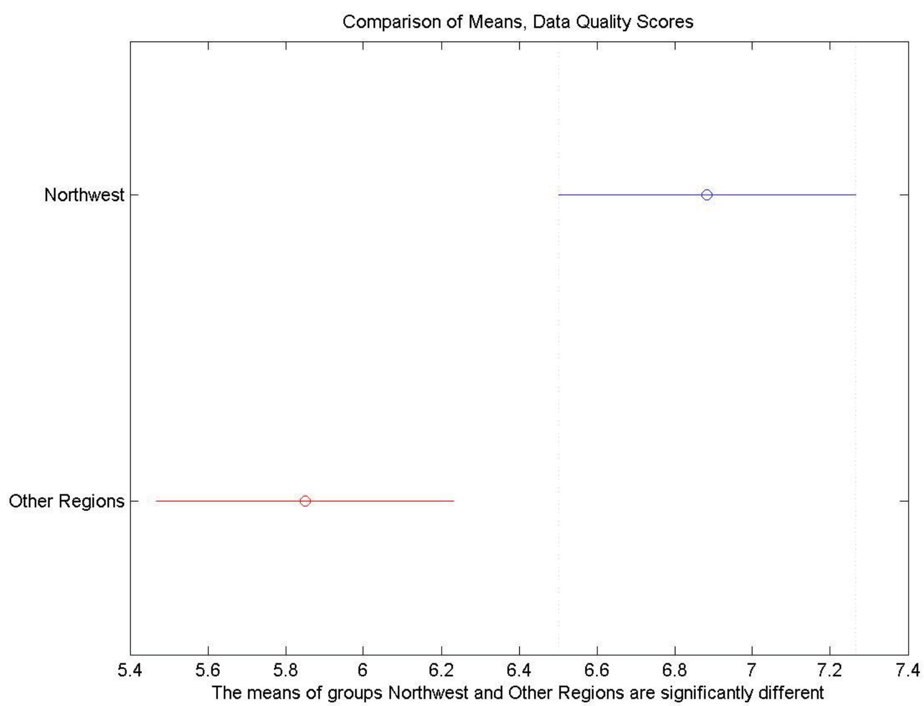

Data Quality Scores for
FunctClass
Data Quality Scores
10
9
8
7
6
5
4
3
2
Collector
Arterial
Local

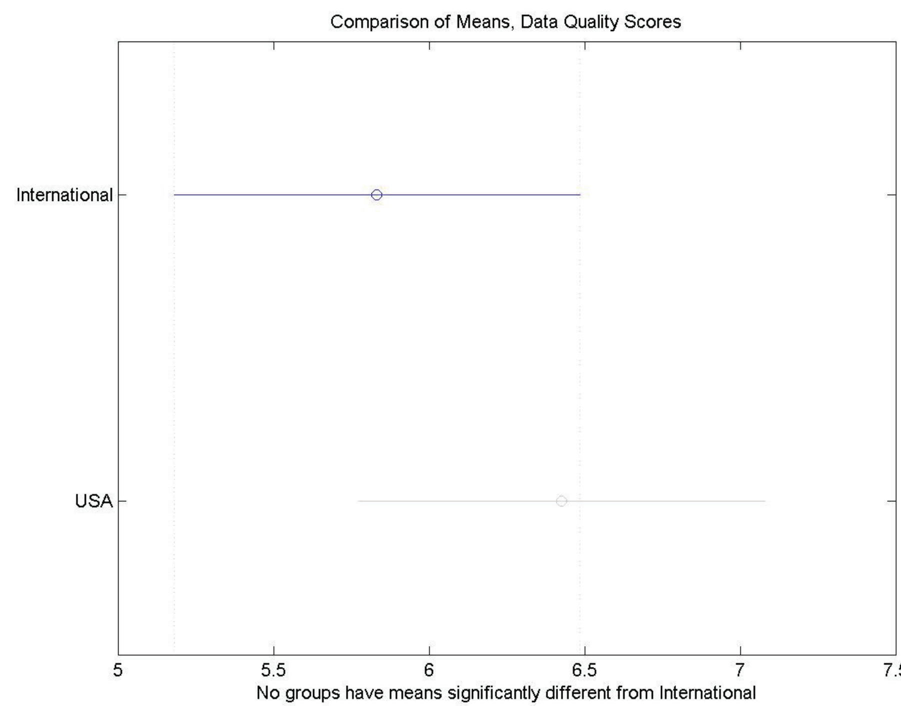

Data Quality Scores for
Budget
Data Quality Scores
10
9
8
7
6
5
4
3
2
0-10
10-100
100+

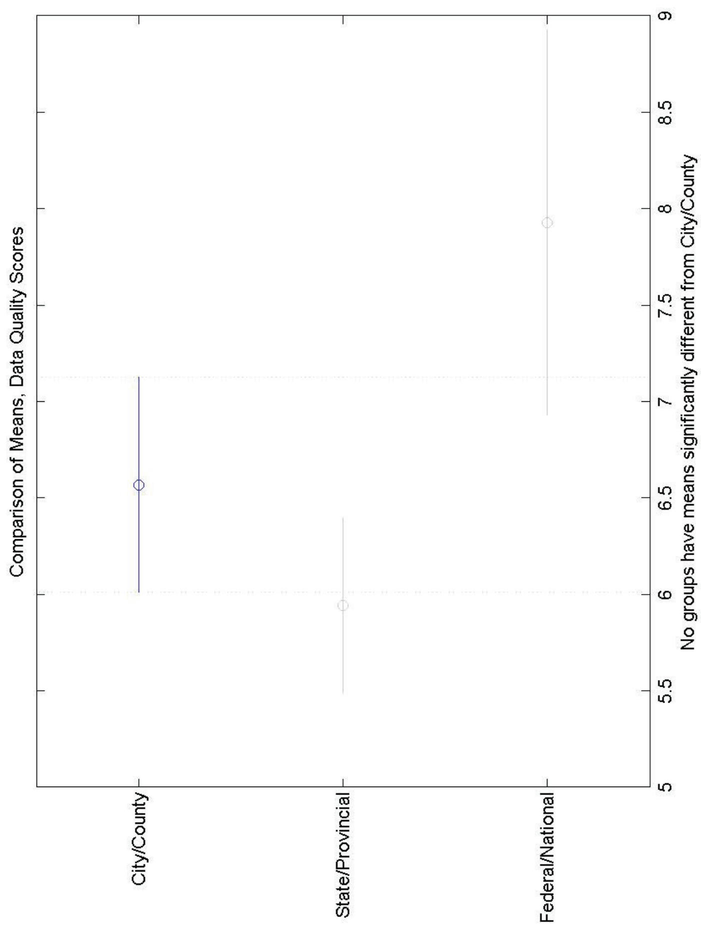

Comparison of Means, Data Quality Scores
Not Greenroads
Greenroads
5.6
5.8
6
6.2
6.4
6.6
6.8
7
7.2
7.4
No groups have means significantly different from Not Greenroads


Comparison of Means, Data Quality Scores
Typical
Greener
5.5
6
6.5
7
No groups have means significantly different from Typical

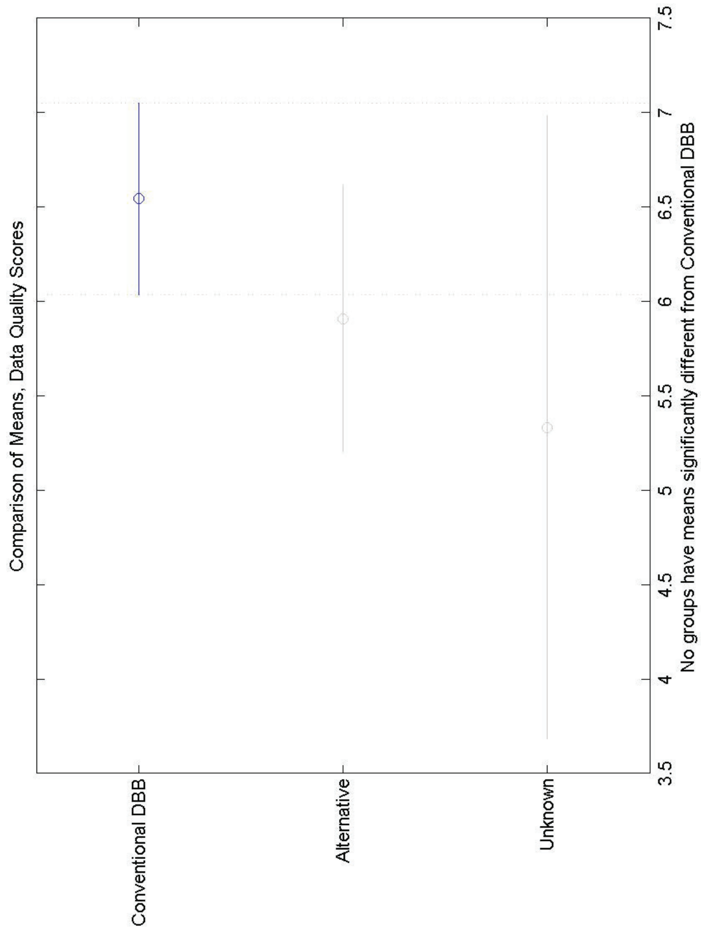

Comparison of Means, Data Quality Scores
Structures
No Structures
6
6.2
6.4
6.6
6.8
7
7.2
No groups have means significantly different from Structures


Comparison of Means, Data Quality Scores
Northwest
Other Regions
5.4
5.6
5.8
6
6.2
6.4
6.6
6.8
7
7.2
7.4
The means of groups Northwest and Other Regions are significantly different

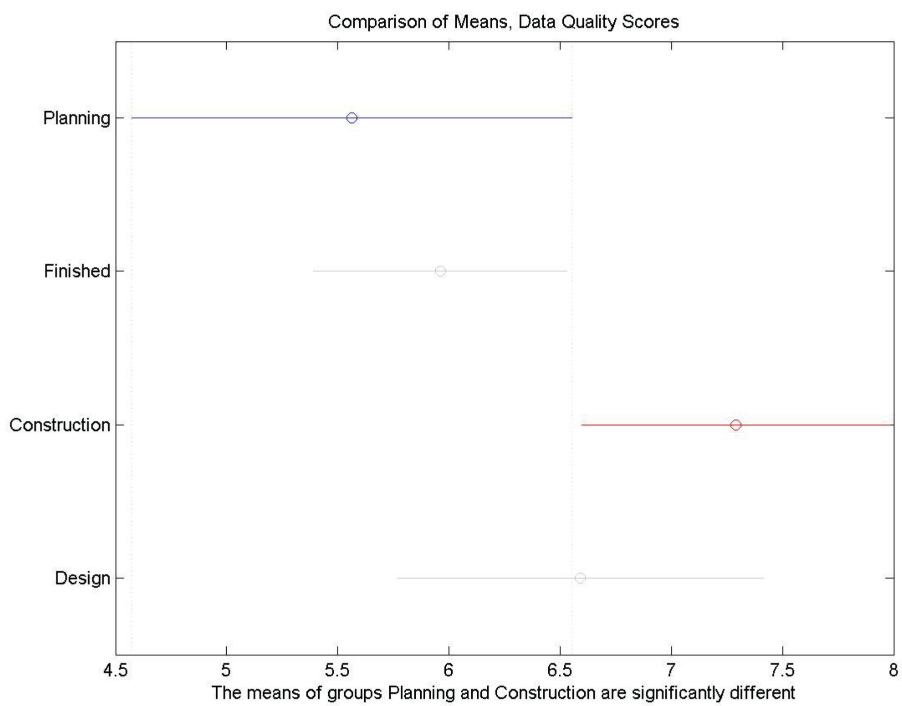

Comparison of Means, Data Quality Scores
International
USA
5
5.5
6
6.5
7
7.5
No groups have means significantly different from International

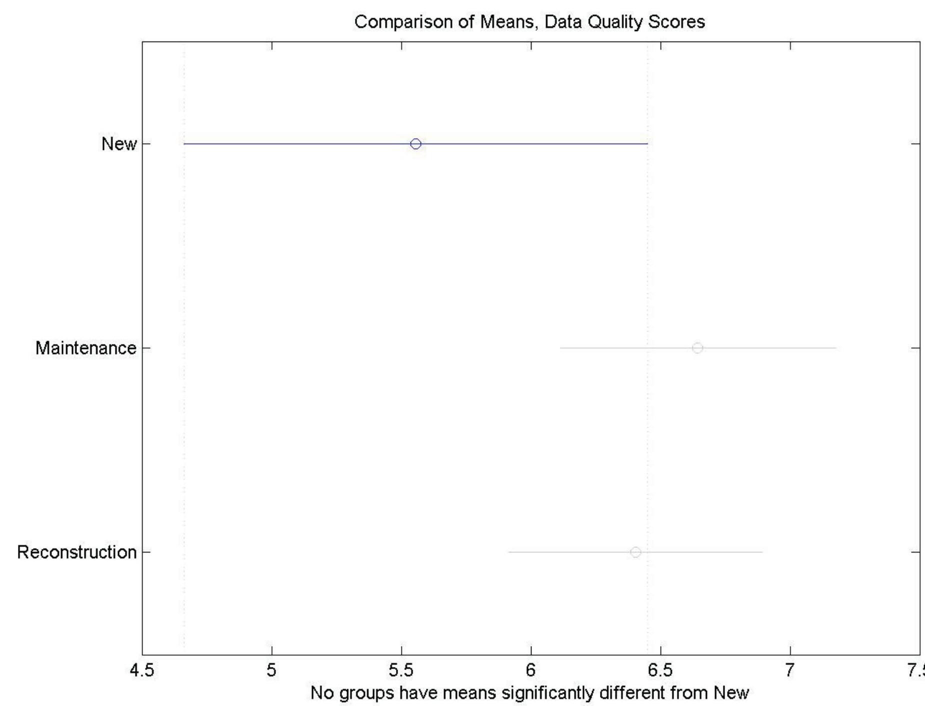


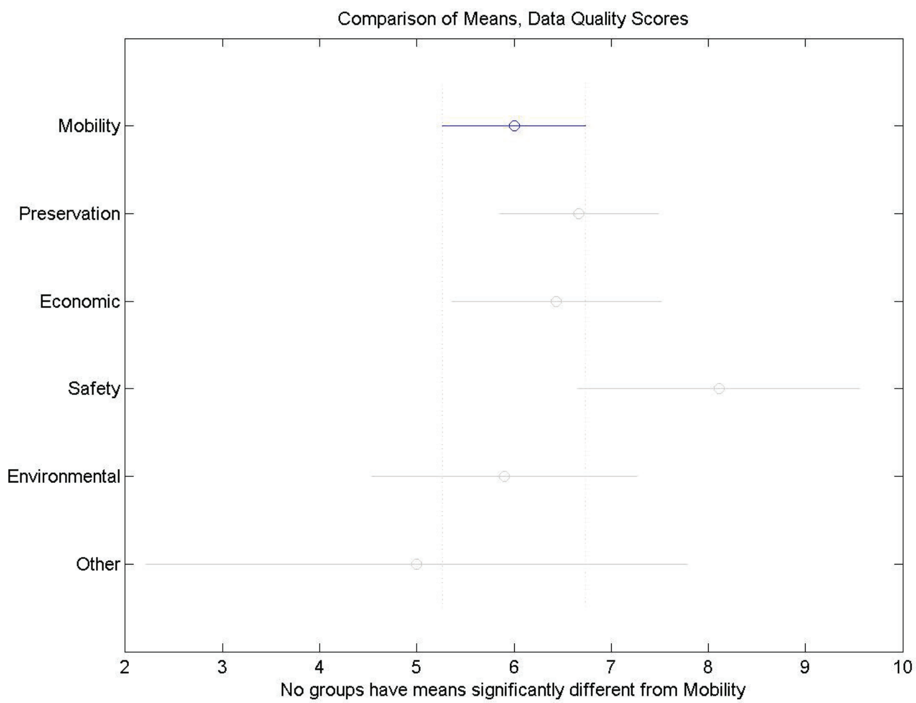
Comparison of Means, Data Quality Scores
City/County
State/Provincial
Federal/National
5
5.5
6
6.5
7
7.5
8
8.5
9
No groups have means significantly different from City/County

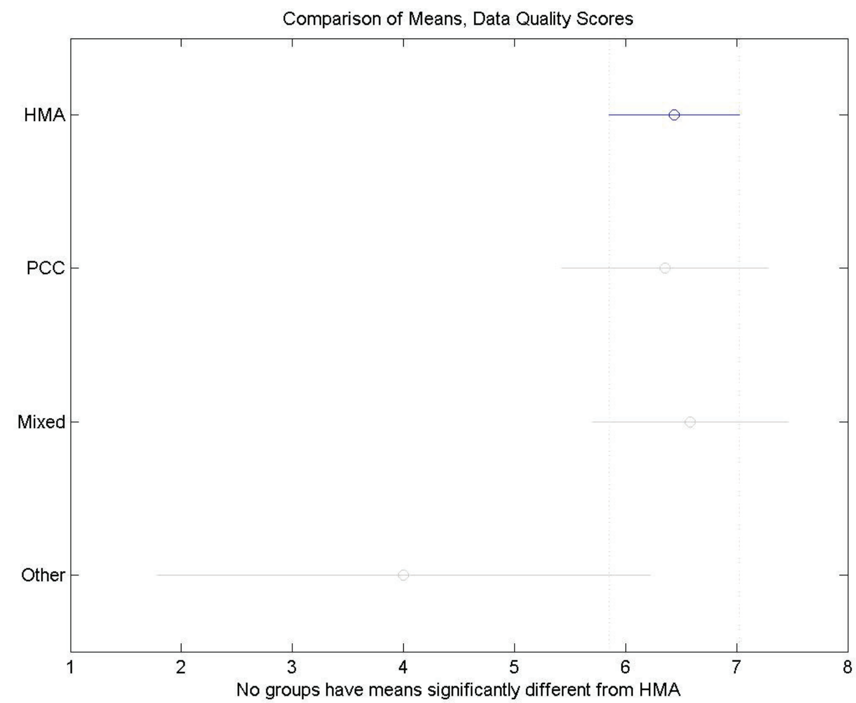


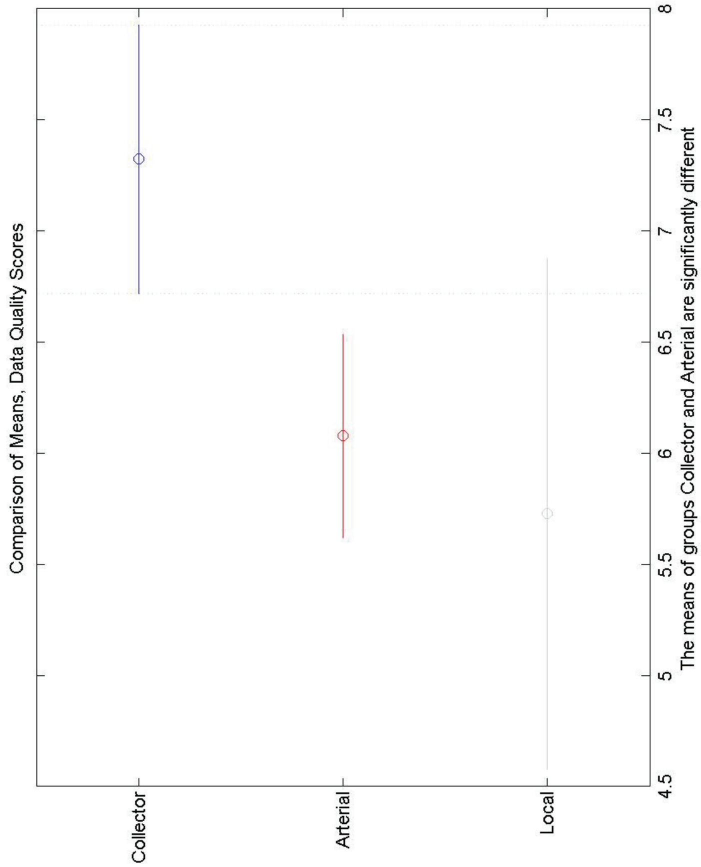
Comparison of Means, Data Quality Scores
Conventional DBB
Alternative
Unknown
3.5
4
4.5
5
5.5
6
6.5
7
7.5
No groups have means significantly different from Conventional DBB

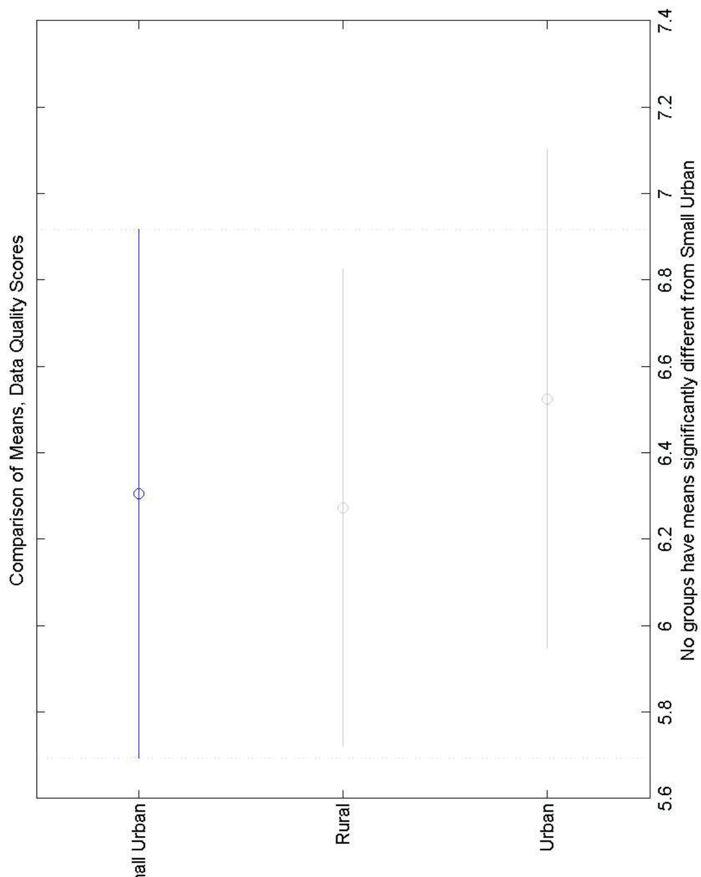

Comparison of Means, Data Quality Scores
Planning
Finished
Construction
Design
4.5
5
5.5
6
6.5
7
7.5
8
The means of groups Planning and Construction are significantly different

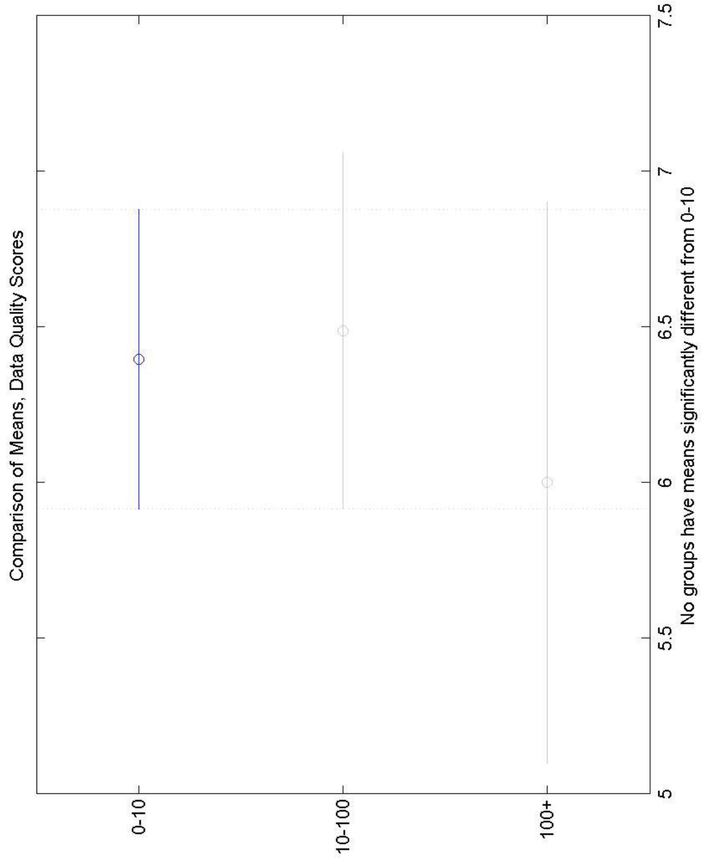

Comparison of Means, Data Quality Scores
New
Maintenance
Reconstruction
4.5
5
5.5
6
6.5
7
7.5
No groups have means significantly different from New


Comparison of Means, Data Quality Scores
Mobility
Preservation
Economic
Safety
Environmental
Other
2
3
4
5
6
7
8
9
10
No groups have means significantly different from Mobility

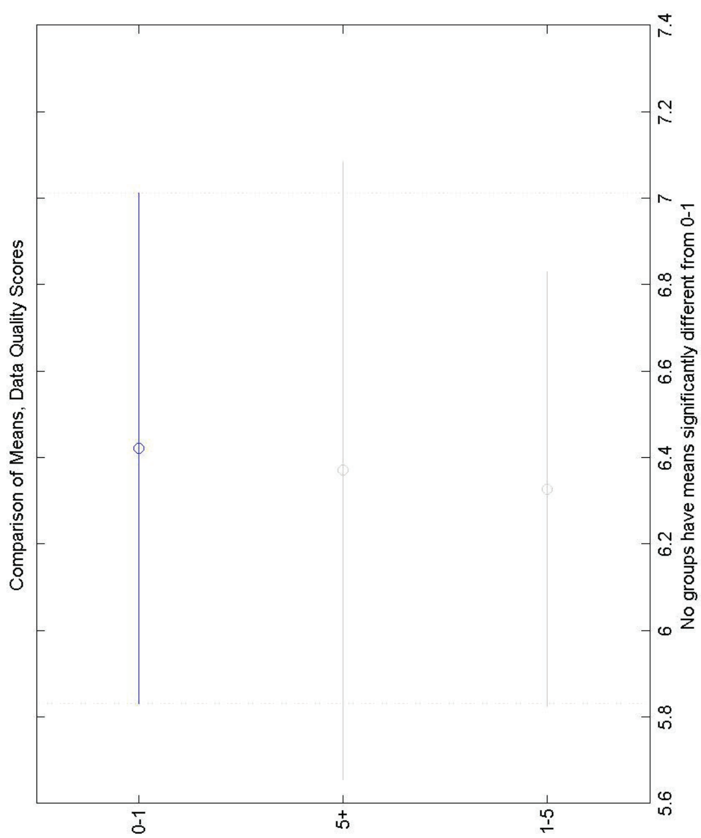

Comparison of Means, Data Quality Scores
HMA
PCC
Mixed
Other
1
2
3
4
5
6
7
8
No groups have means significantly different from HMA


Comparison of Means, Data Quality Scores
Collector
Arterial
Local
4.5
5
5.5
6
6.5
7
7.5
8
The means of groups Collector and Arterial are significantly different

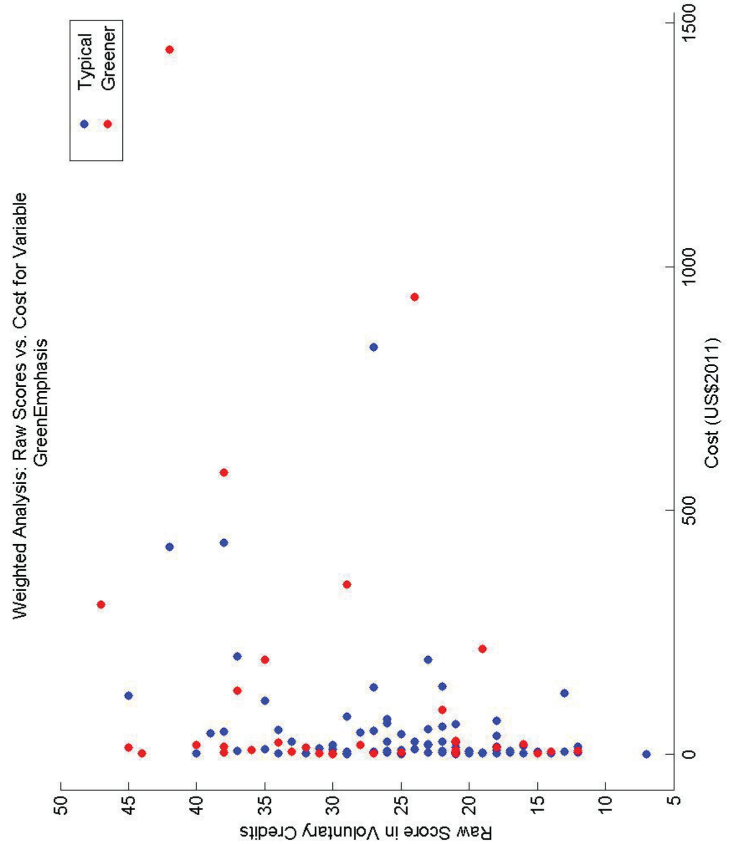

Comparison of Means, Data Quality Scores
Small Urban
Rural
Urban
5.6
5.8
6
6.2
6.4
6.6
6.8
7
7.2
7.4
No groups have means significantly different from Small Urban

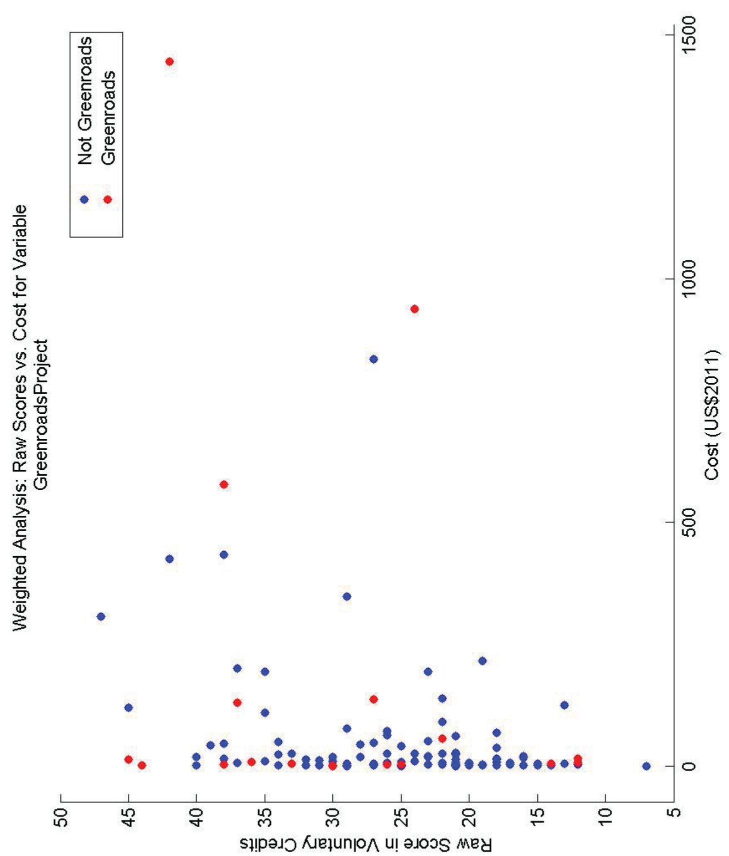


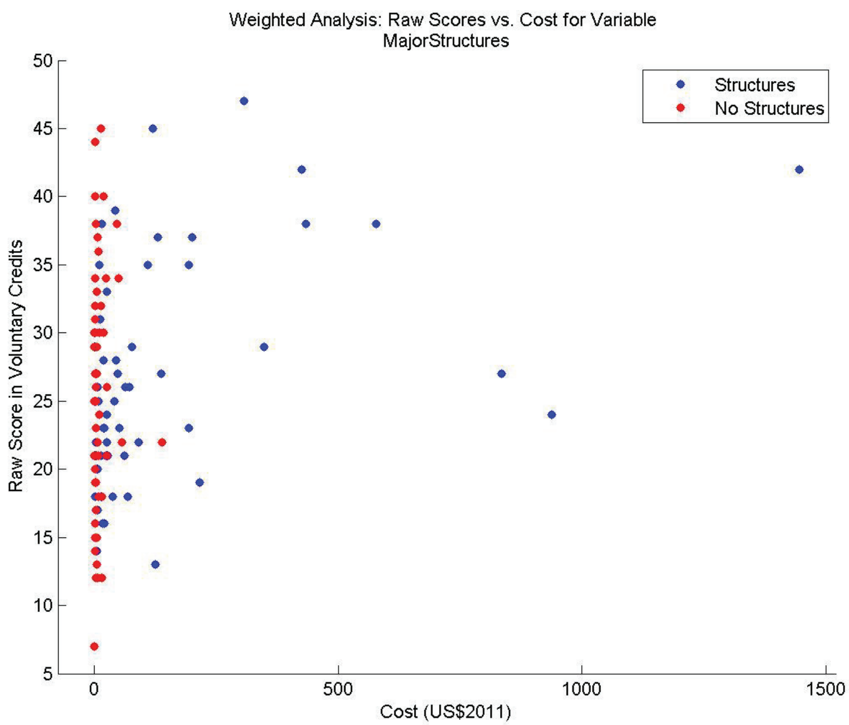
Comparison of Means, Data Quality Scores
0-10
10-100
100+
5
5.5
6
6.5
7
7.5
No groups have means significantly different from 0-10

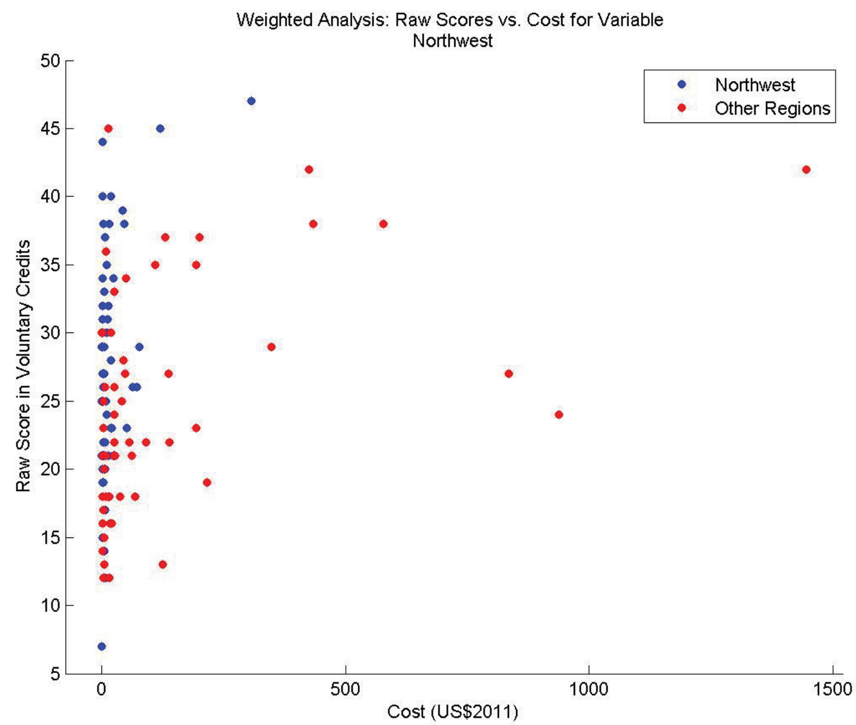


Comparison of Means, Data Quality Scores
0-1
5+
1-5
5.6
5.8
6
6.2
6.4
6.6
6.8
7
7.2
7.4
No groups have means significantly different from 0-1


Weighted Analysis: Raw Scores vs. Cost for Variable
GreenEmphasis
Typical
Greener
Raw Score in Voluntary Credits
Cost (US$2011)


Weighted Analysis: Raw Scores vs. Cost for Variable
GreenroadsProject
Not Greenroads
Greenroads
Raw Score in Voluntary Credits
Cost (US$2011)


Weighted Analysis: Raw Scores vs. Cost for Variable
MajorStructures
Structures
No Structures
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
30
25
20
15
10
5
0
500
1000
1500


Weighted Analysis: Raw Scores vs. Cost for Variable
Northwest
Northwest
Other Regions
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
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20
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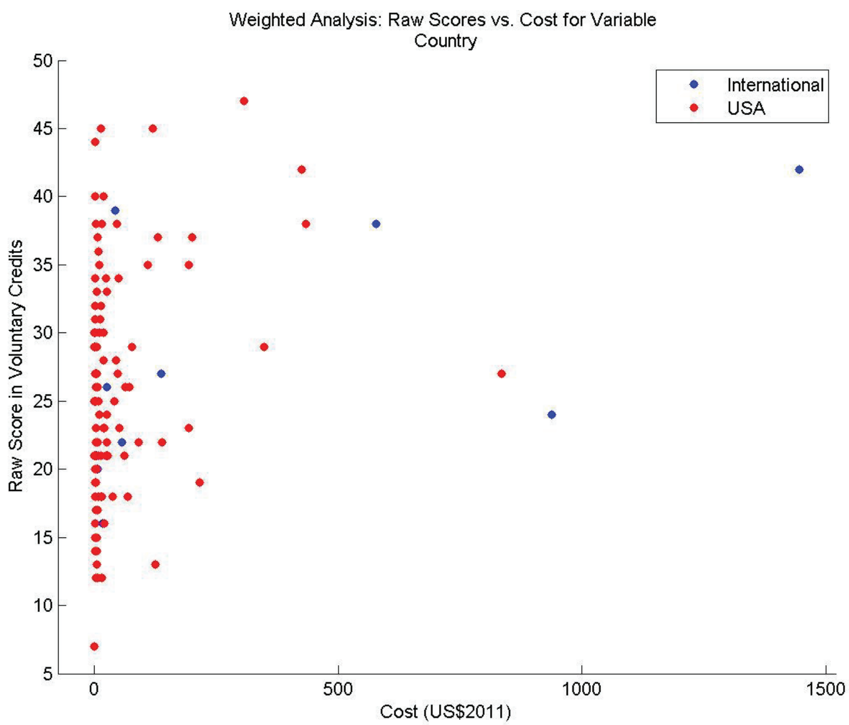
5
0
500
1000
1500


Weighted Analysis: Raw Scores vs. Cost for Variable
Country
International
USA
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
30
25
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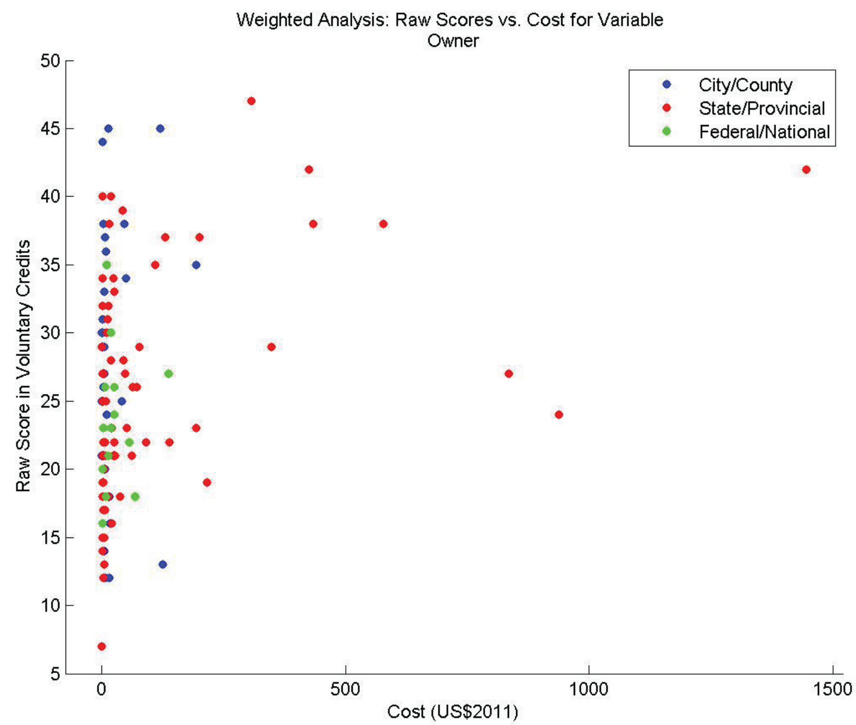
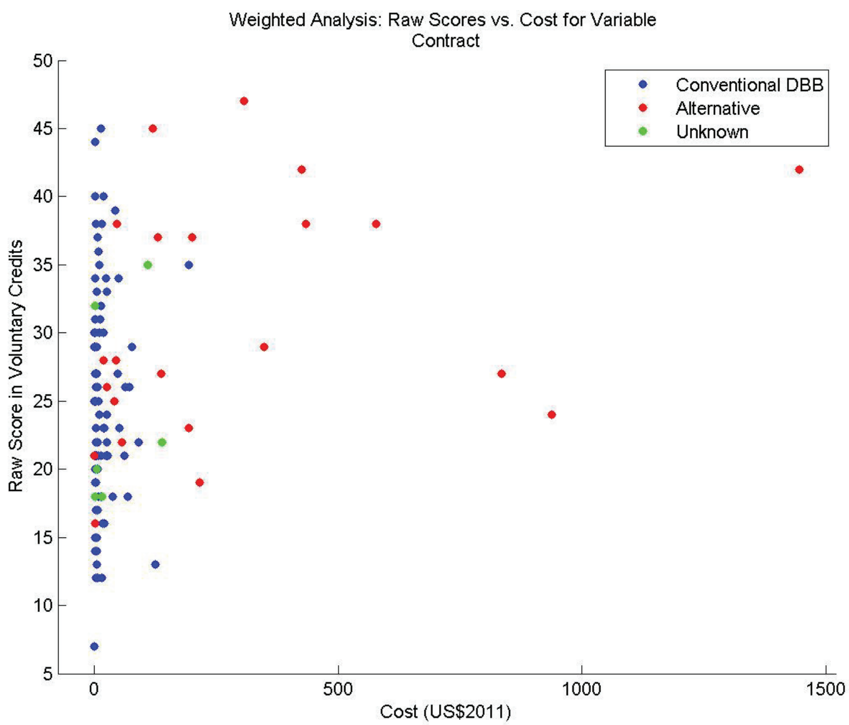
5
0
500
1000
1500


Weighted Analysis: Raw Scores vs. Cost for Variable
Owner
City/County
State/Provincial
Federal/National
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
30
25
20
15
10
5
0
500
1000
1500


Weighted Analysis: Raw Scores vs. Cost for Variable Contract
Conventional DBB
Alternative
Unknown
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
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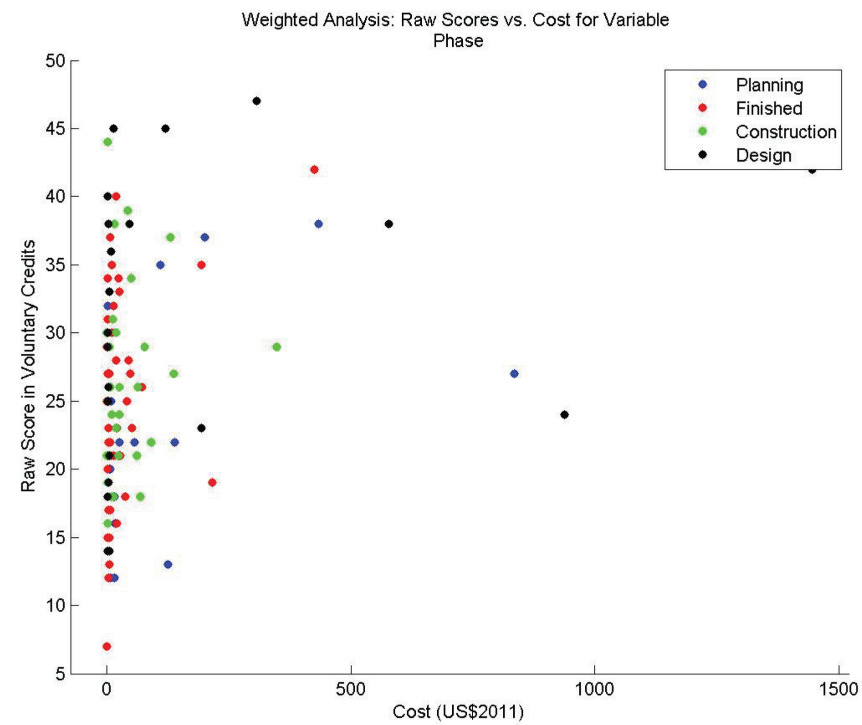
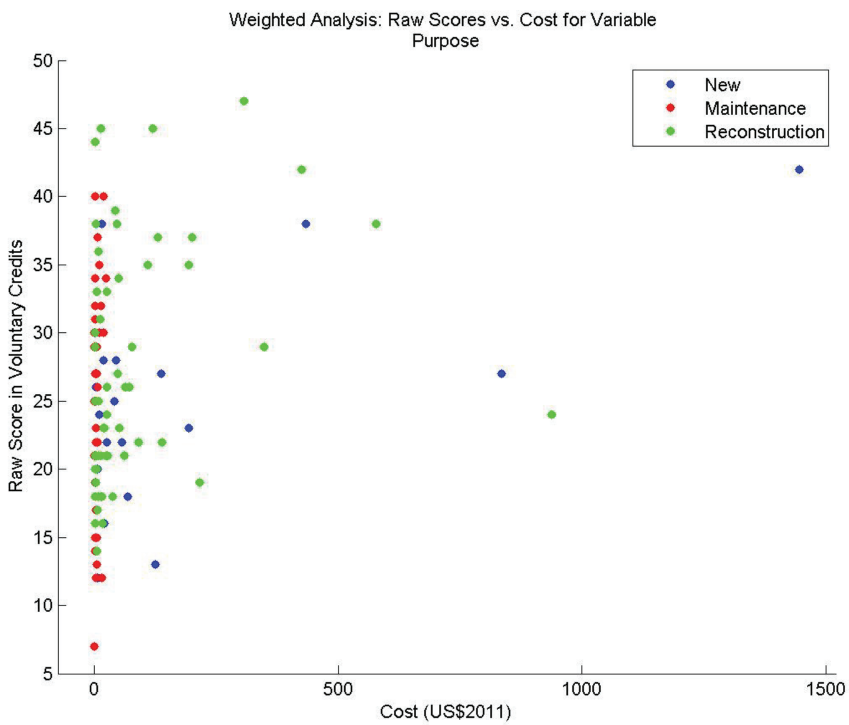
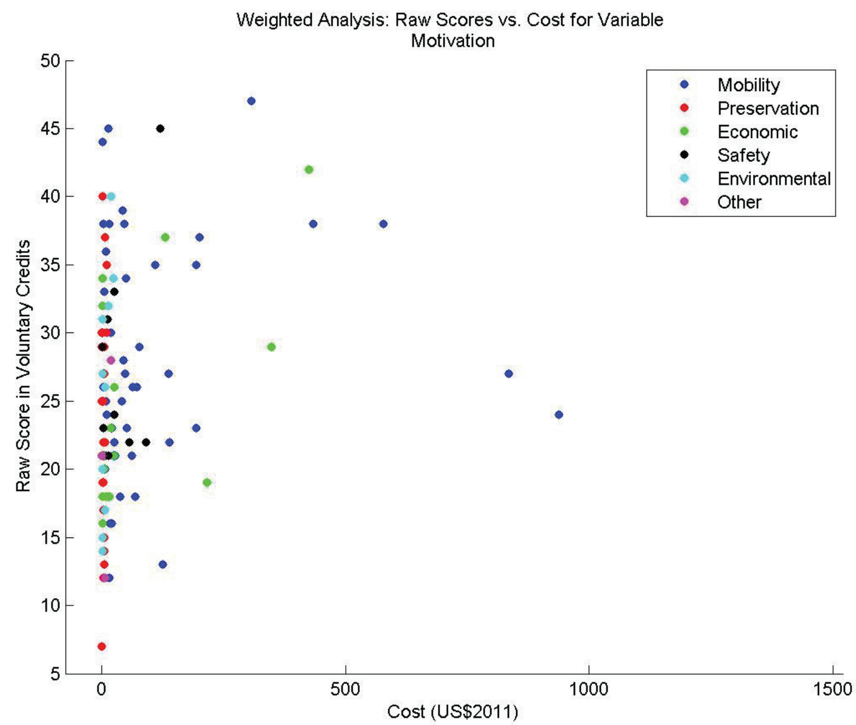
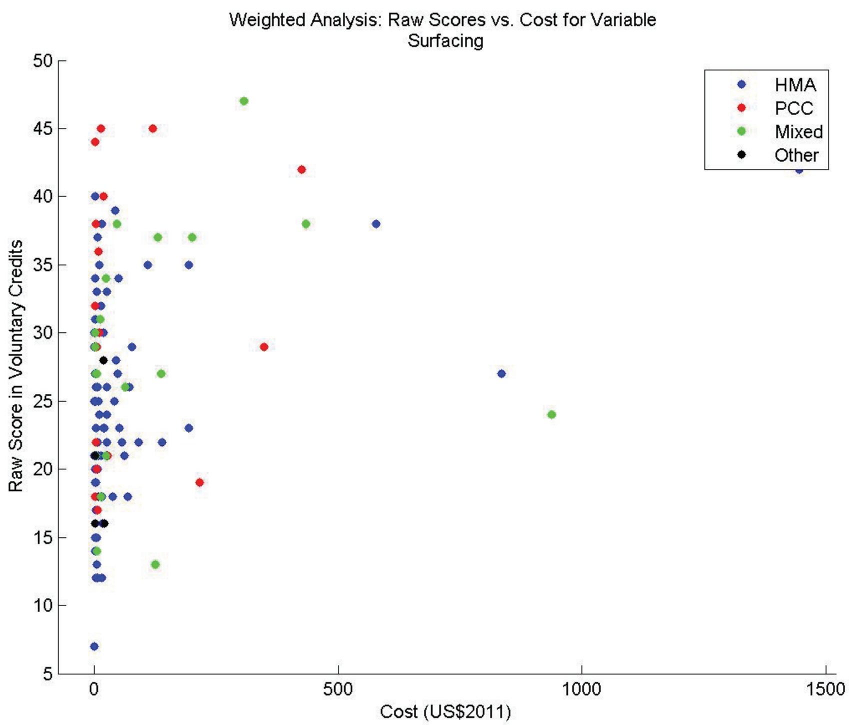
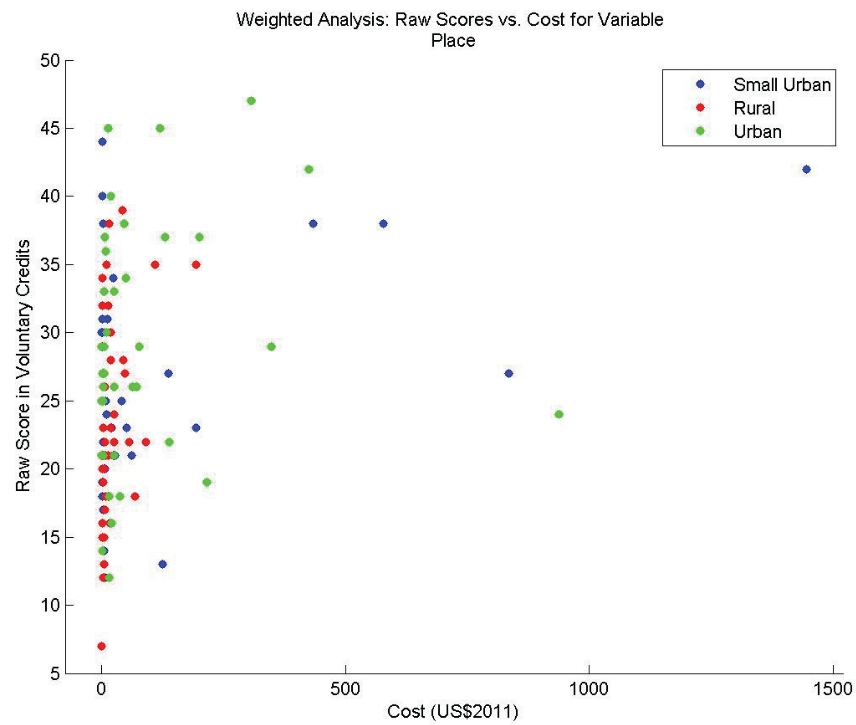
15
10
5
0
500
1000
1500

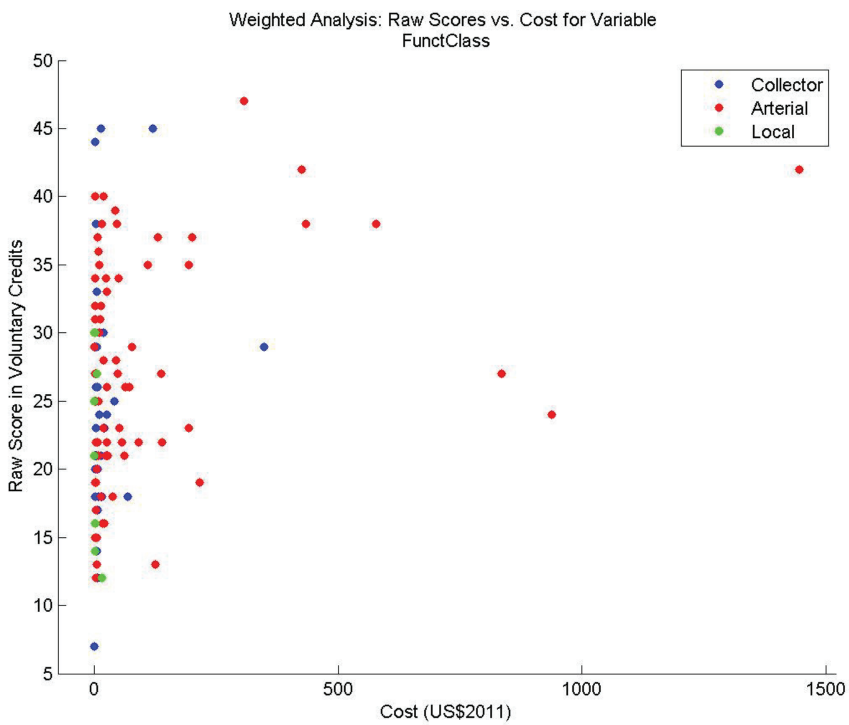

Weighted Analysis: Raw Scores vs. Cost for Variable Phase
Planning
Finished
Construction
Design
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
30
25
20
15
10
5
0
500
1000
1500

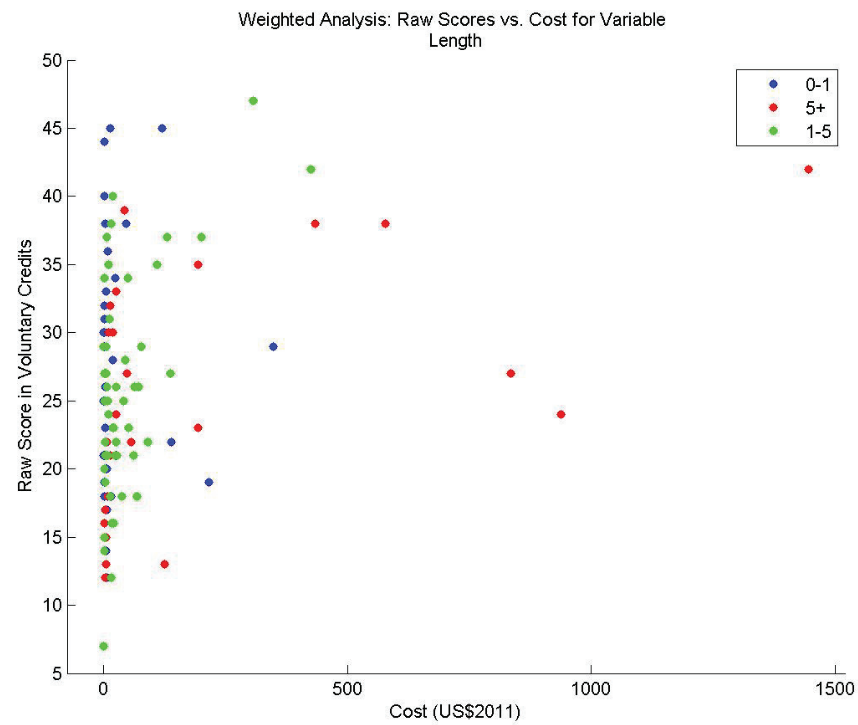

Weighted Analysis: Raw Scores vs. Cost for Variable
Purpose
New
Maintenance
Reconstruction
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
30
25
20
15
10
5
0
500
1000
1500

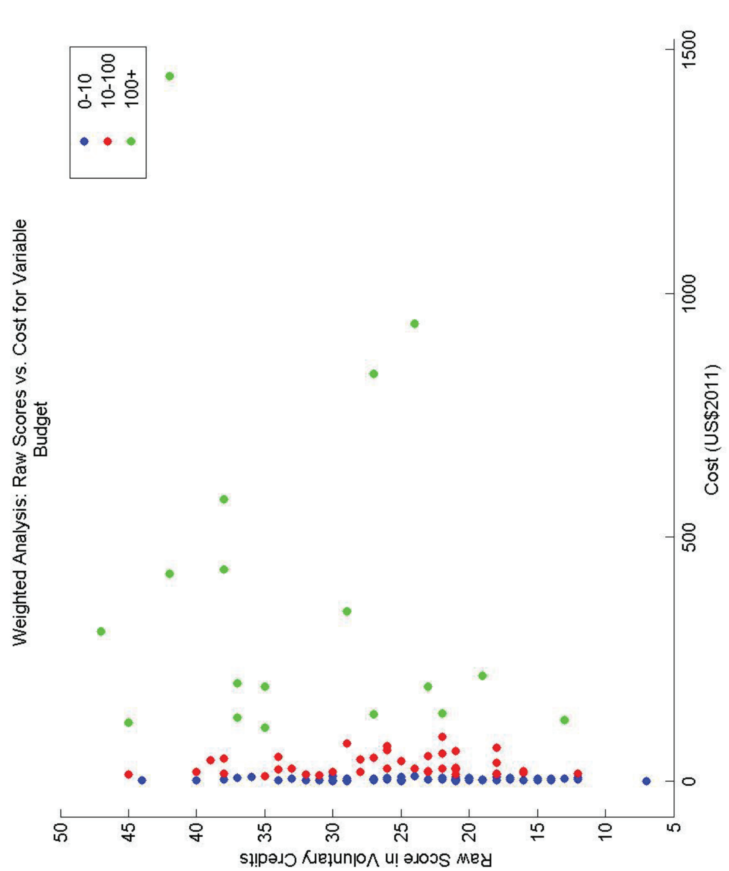

Weighted Analysis: Raw Scores vs. Cost for Variable
Motivation
Mobility
Preservation
Economic
Safety
Environmental
Other
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
30
25
20
15
10
5
0
500
1000
1500


Weighted Analysis: Raw Scores vs. Cost for Variable
Surfacing
Raw Score in Voluntary Credits
Cost (US$2011)
HMA
PCC
Mixed
Other
50
45
40
35
30
25
20
15
10
5
0
500
1000
1500

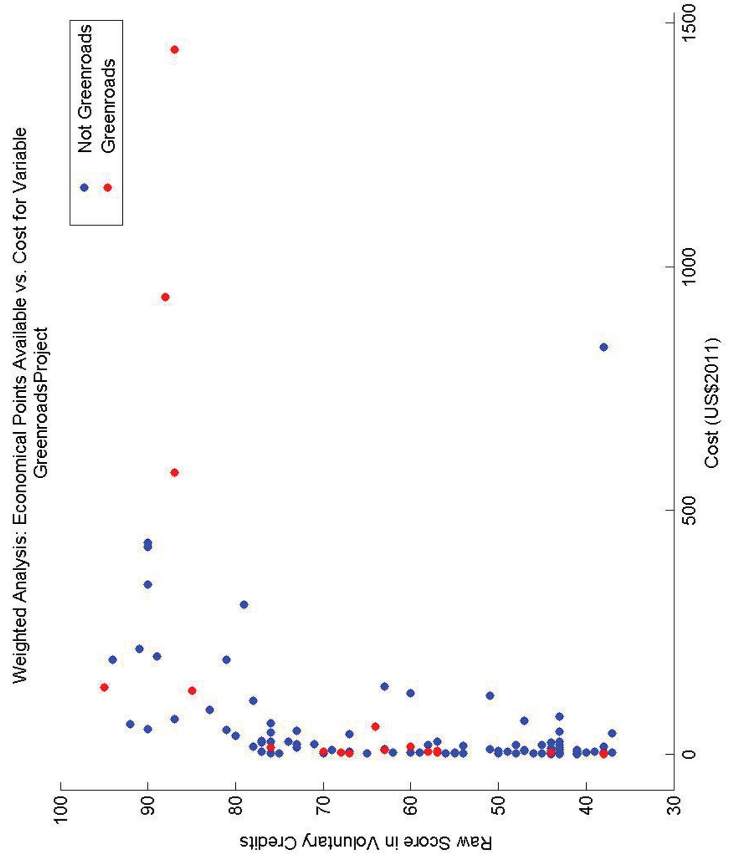

Weighted Analysis: Raw Scores vs. Cost for Variable
Place
Raw Score in Voluntary Credits
Cost (US$2011)
Small Urban
Rural
Urban
50
45
40
35
30
25
20
15
10
5
0
500
1000
1500


Weighted Analysis: Raw Scores vs. Cost for Variable
FunctClass
Collector
Arterial
Local
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
30
25
20
15
10
5
0
500
1000
1500

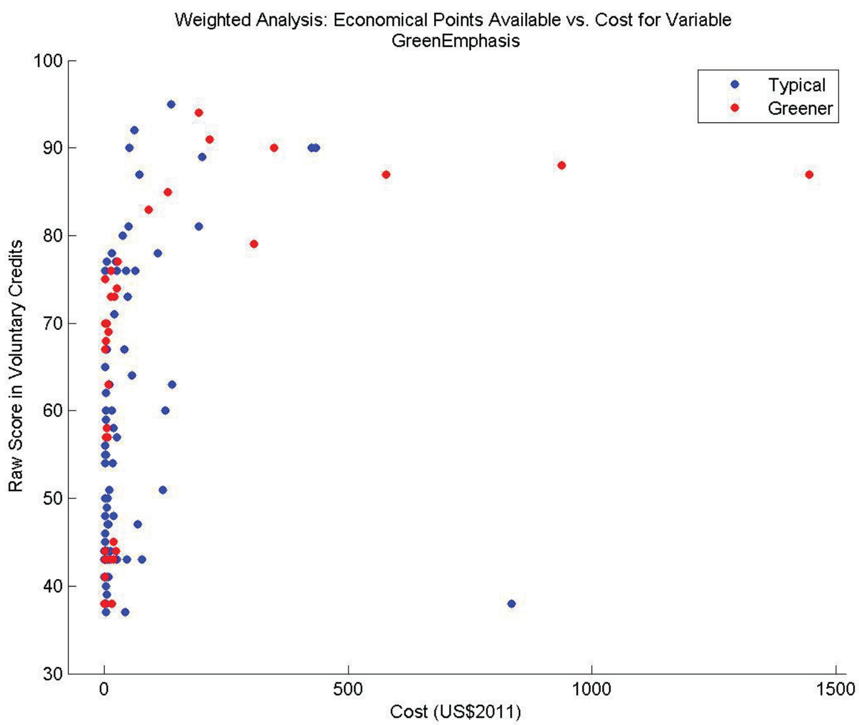

Weighted Analysis: Raw Scores vs. Cost for Variable
Length
0-1
5+
1-5
Raw Score in Voluntary Credits
Cost (US$2011)
50
45
40
35
30
25
20
15
10
5
0
500
1000
1500

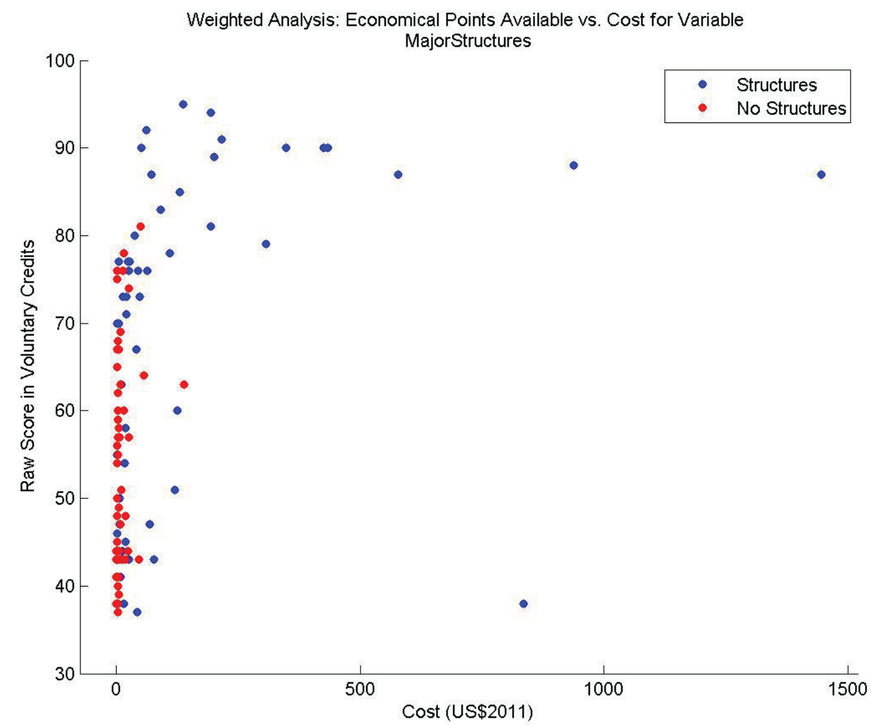


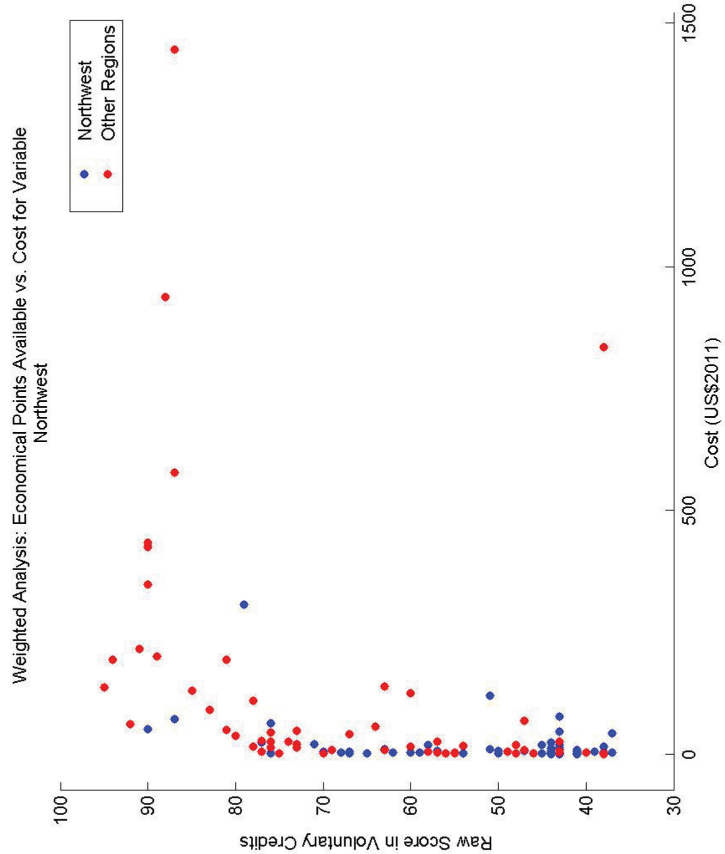
Weighted Analysis: Raw Scores vs. Cost for Variable
Budget
Raw Score in Voluntary Credits
Cost (US$2011)
0-10
10-100
100+

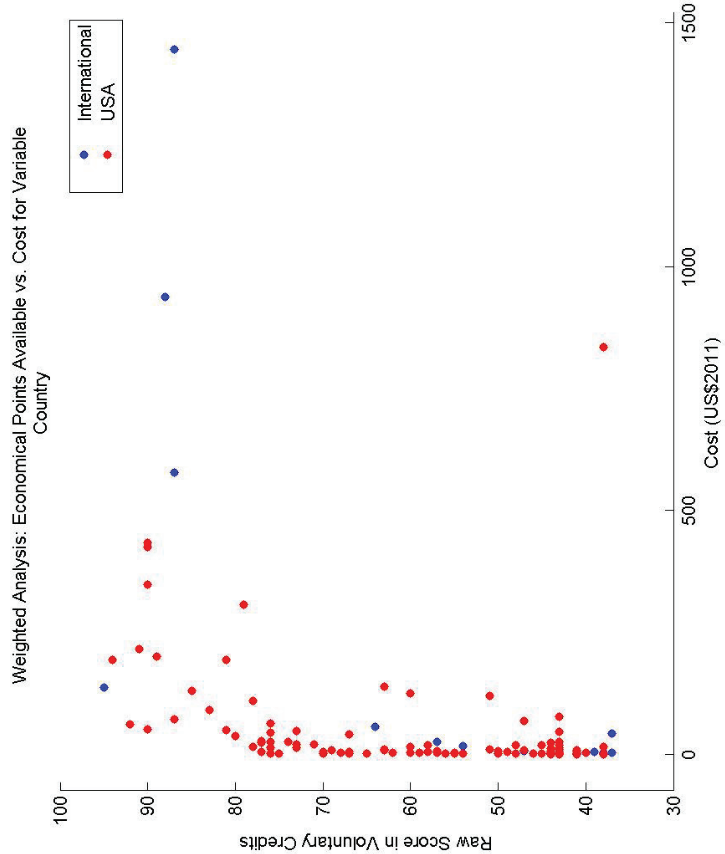


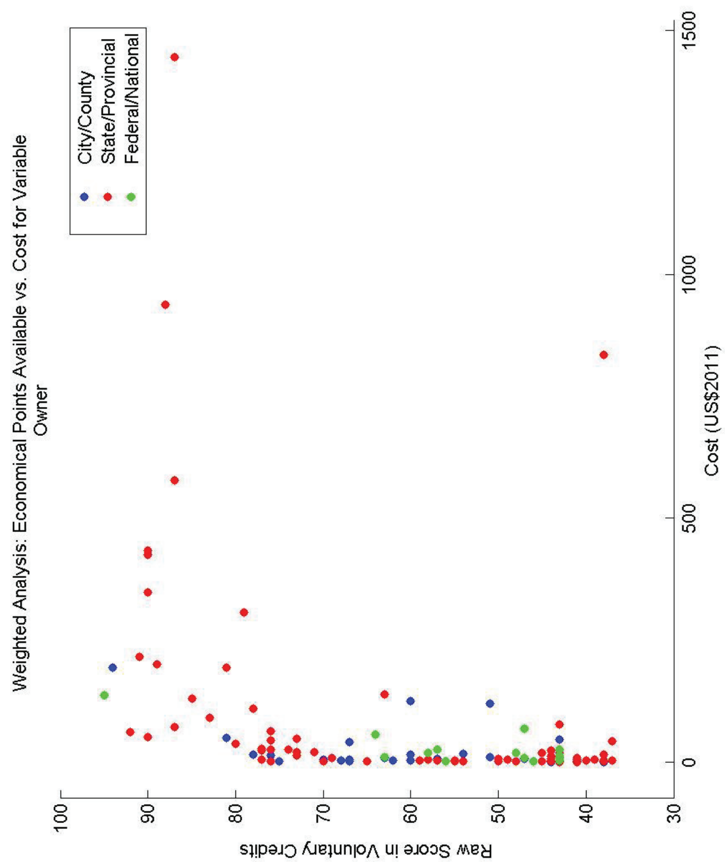
Weighted Analysis: Economical Points Available vs. Cost for Variable
GreenroadsProject
Raw Score in Voluntary Credits
Cost (US$2011)
Not Greenroads
Greenroads

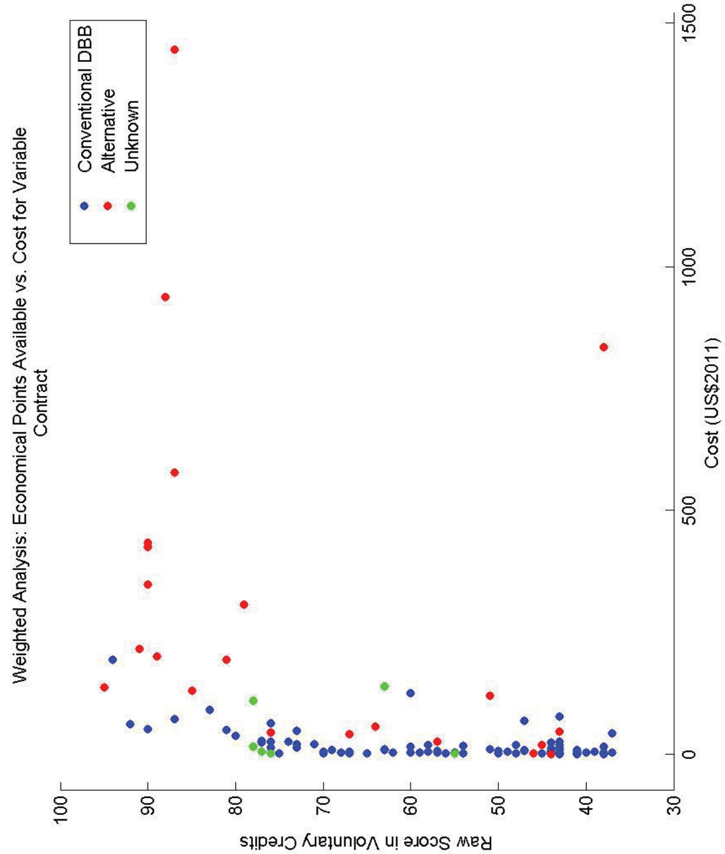

Weighted Analysis: Economical Points Available vs. Cost for Variable
GreenEmphasis
Typical
Greener
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
80
70
60
50
40
30
0
500
1000
1500


Weighted Analysis: Economical Points Available vs. Cost for Variable
MajorStructures
Structures
No Structures
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
80
70
60
50
40
30
0
500
1000
1500


Weighted Analysis: Economical Points Available vs. Cost for Variable
Northwest
Northwest
Other Regions
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
80
70
60
50
40
30
0
500
1000
1500


Weighted Analysis: Economical Points Available vs. Cost for Variable
Country
International
USA
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
80
70
60
50
40
30
0
500
1000
1500


Weighted Analysis: Economical Points Available vs. Cost for Variable
Owner
City/County
State/Provincial
Federal/National
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
80
70
60
50
40
30
0
500
1000
1500


Weighted Analysis: Economical Points Available vs. Cost for Variable
Contract
Conventional DBB
Alternative
Unknown
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
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60
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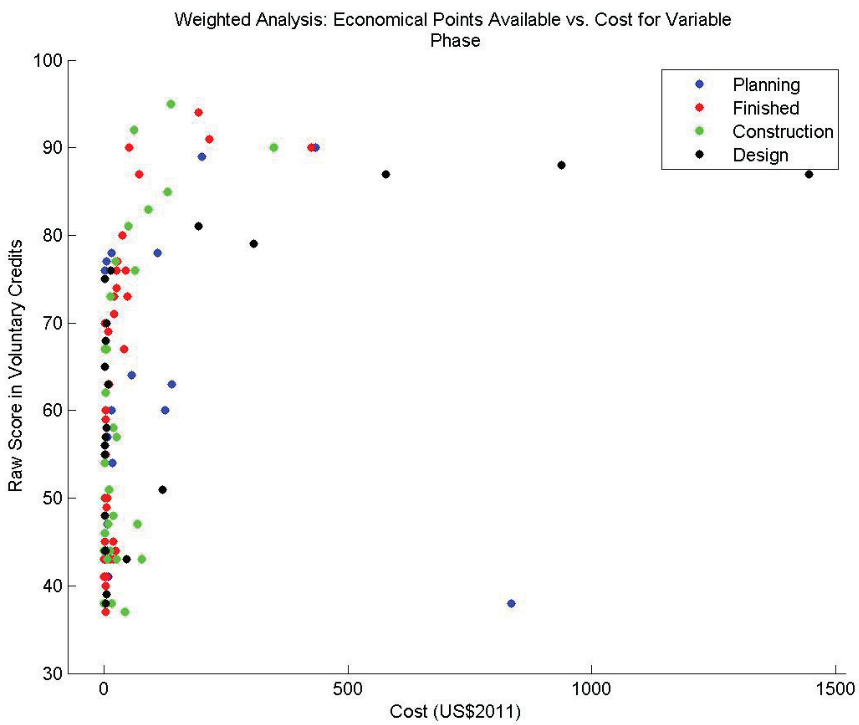
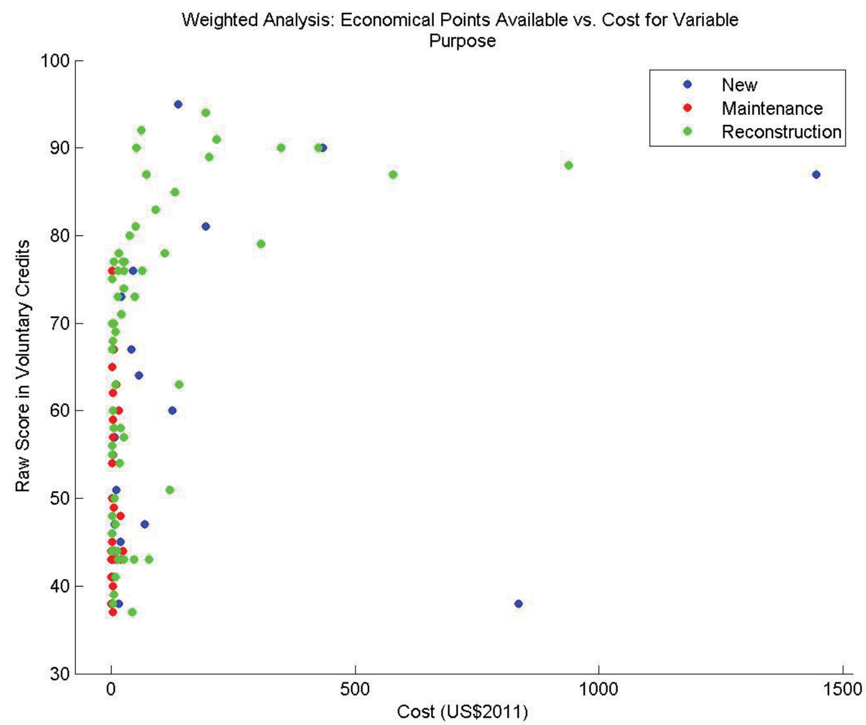
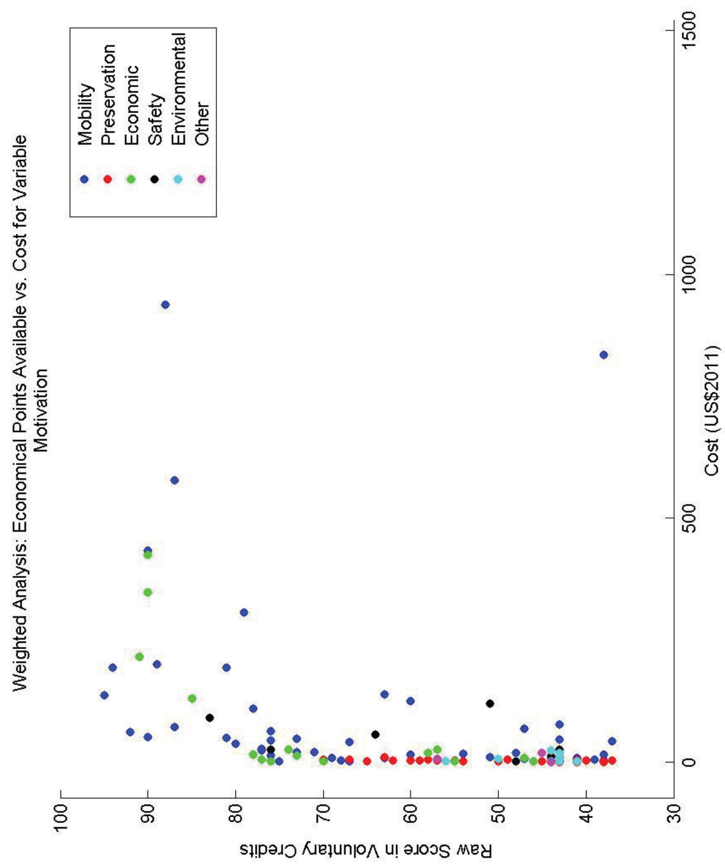
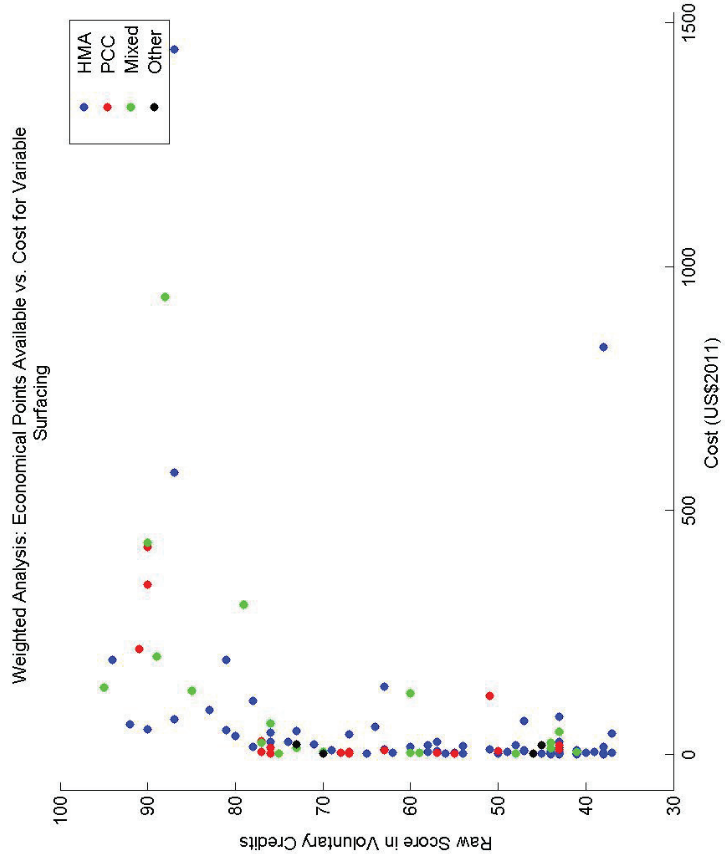
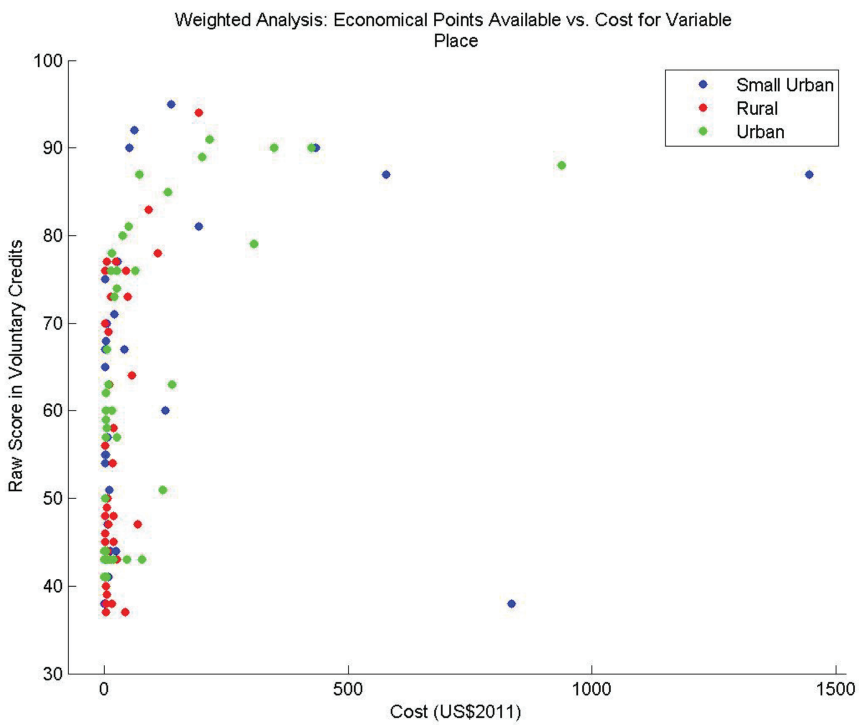
0
500
1000
1500

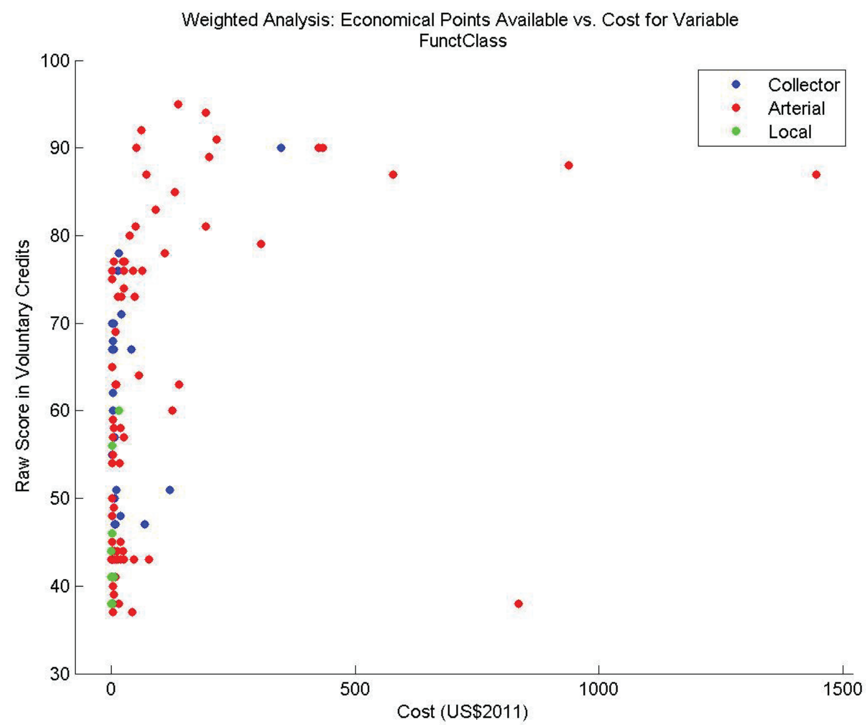

Weighted Analysis: Economical Points Available vs. Cost for Variable
Phase
Planning
Finished
Construction
Design
Raw Score in Voluntary Credits
Cost (US$2011)


Weighted Analysis: Economical Points Available vs. Cost for Variable
Purpose
New
Maintenance
Reconstruction
Raw Score in Voluntary Credits
Cost (US$2011)

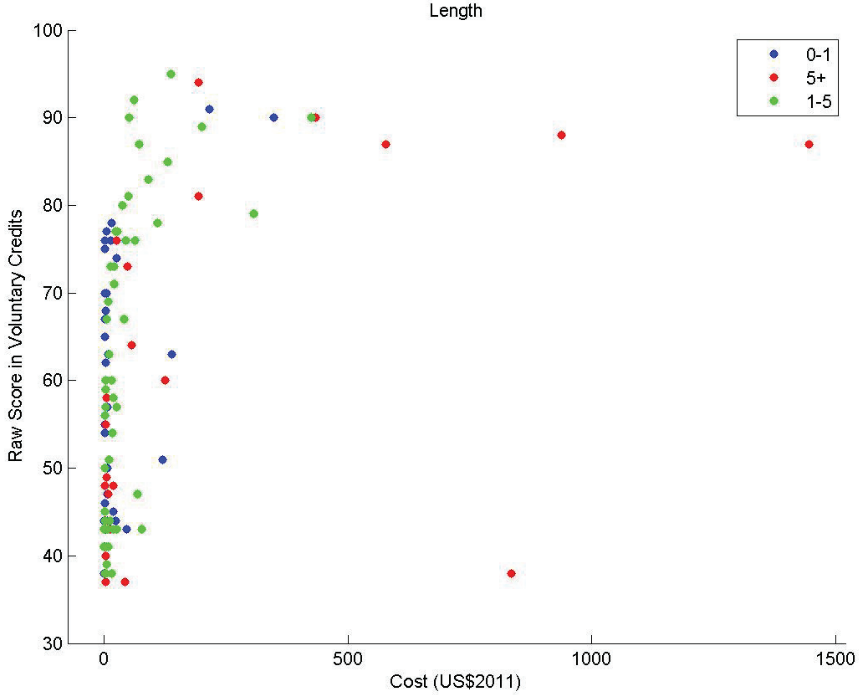

Weighted Analysis: Economical Points Available vs. Cost for Variable
Motivation
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
80
70
60
50
40
30
0
500
1000
1500
Mobility
Preservation
Economic
Safety
Environmental
Other


Weighted Analysis: Economical Points Available vs. Cost for Variable
Surfacing
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
80
70
60
50
40
30
0
500
1000
1500
HMA
PCC
Mixed
Other

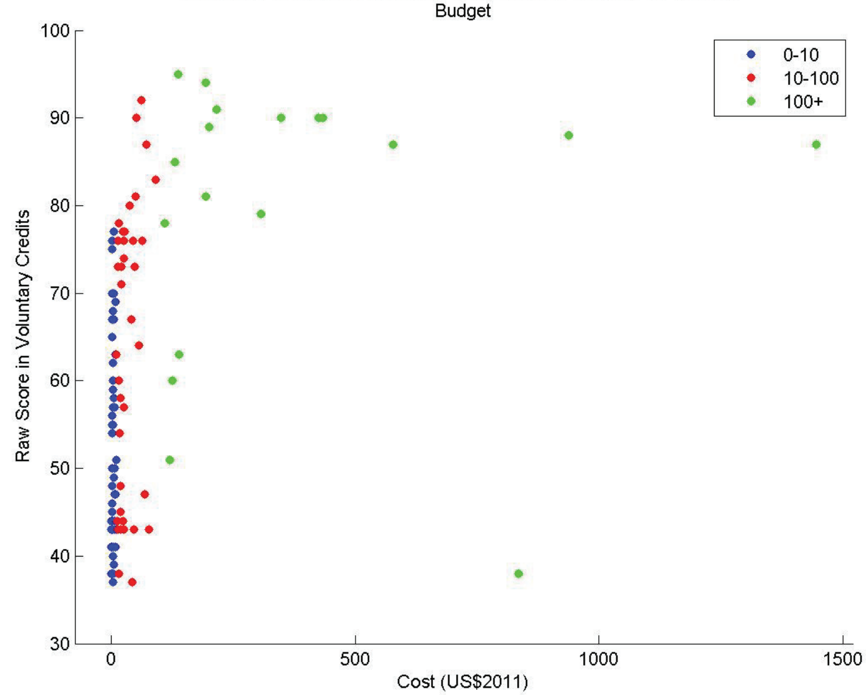

Weighted Analysis: Economical Points Available vs. Cost for Variable
Place
Small Urban
Rural
Urban
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
80
70
60
50
40
30
0
500
1000
1500

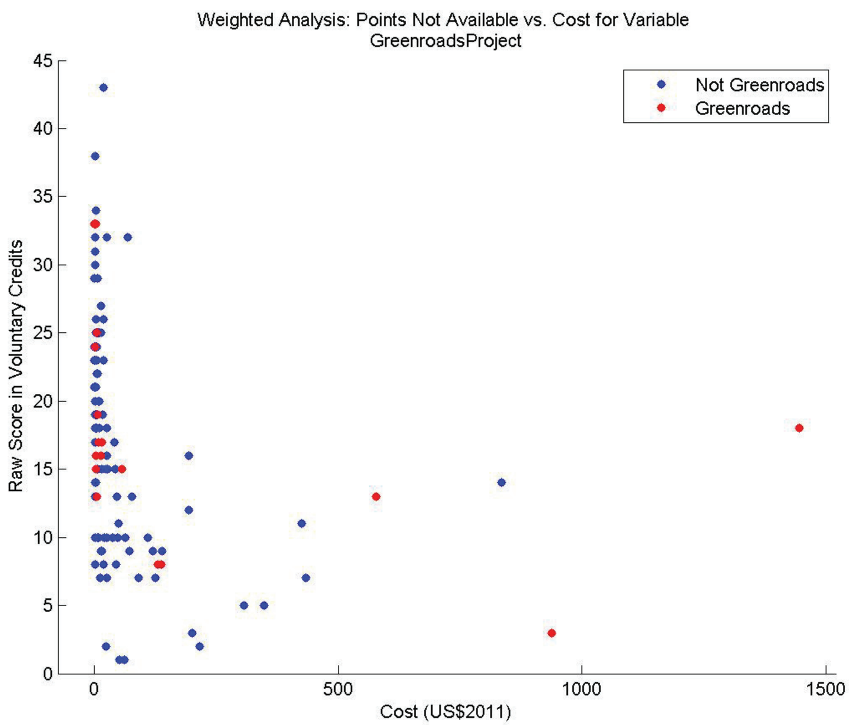

Weighted Analysis: Economical Points Available vs. Cost for Variable
FunctClass
Collector
Arterial
Local
Raw Score in Voluntary Credits
Cost (US$2011)
100
90
80
70
60
50
40
30
0
500
1000
1500

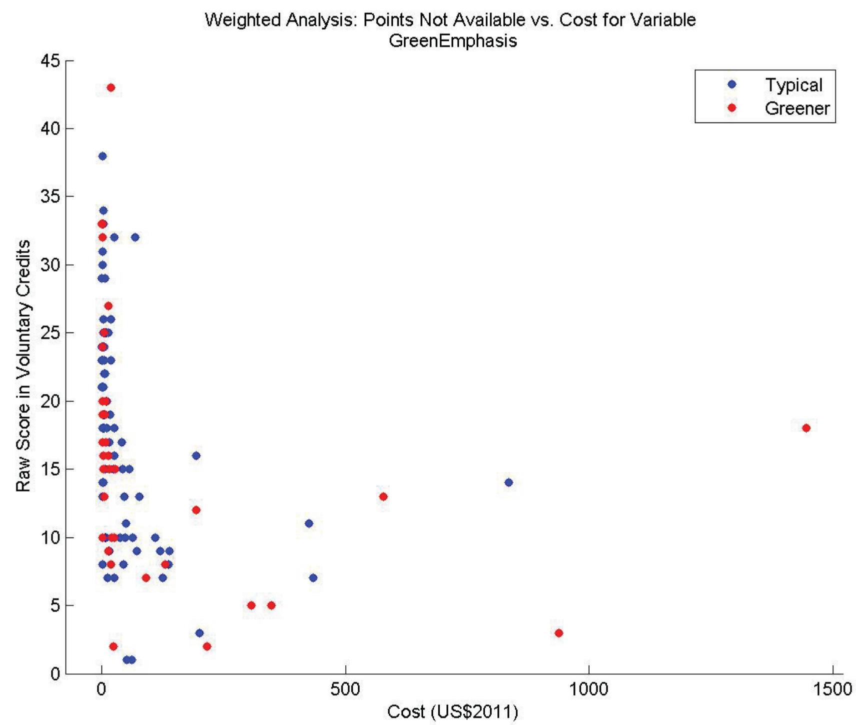
Weighted Analysis: Economical Points Available vs. Cost for Variable Length

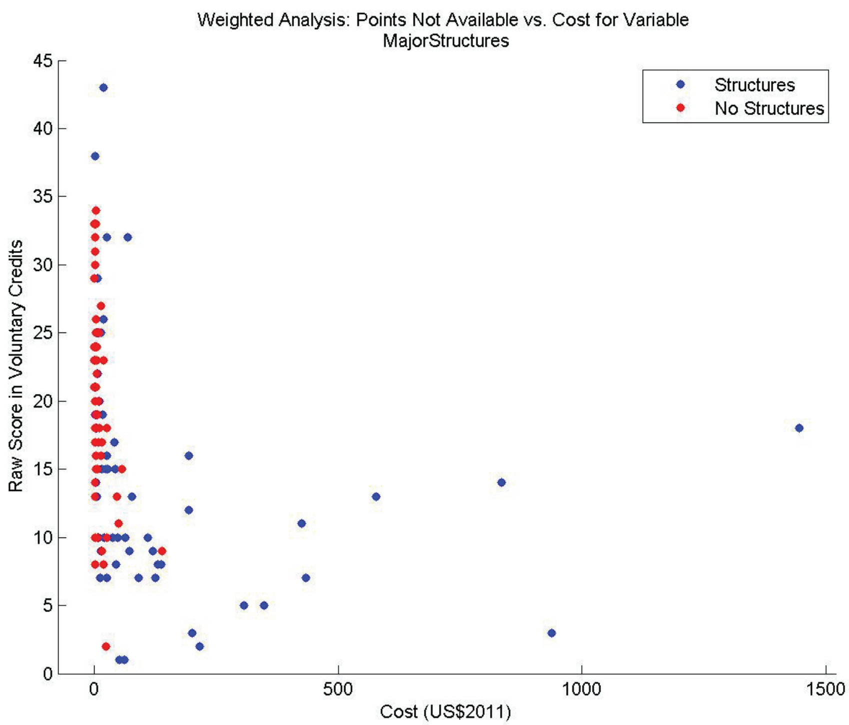


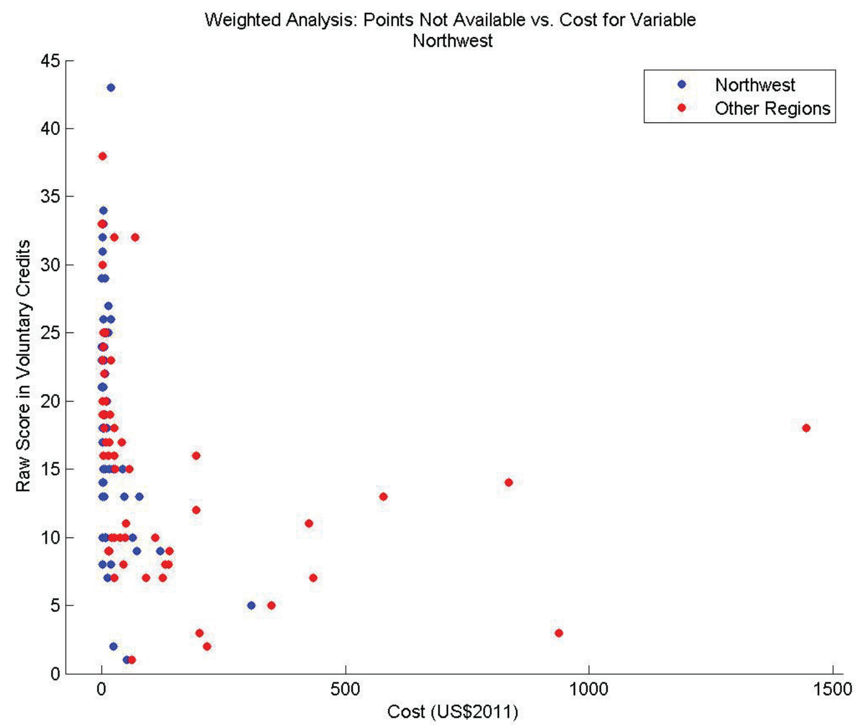
Weighted Analysis: Economical Points Available vs. Cost for Variable Budget

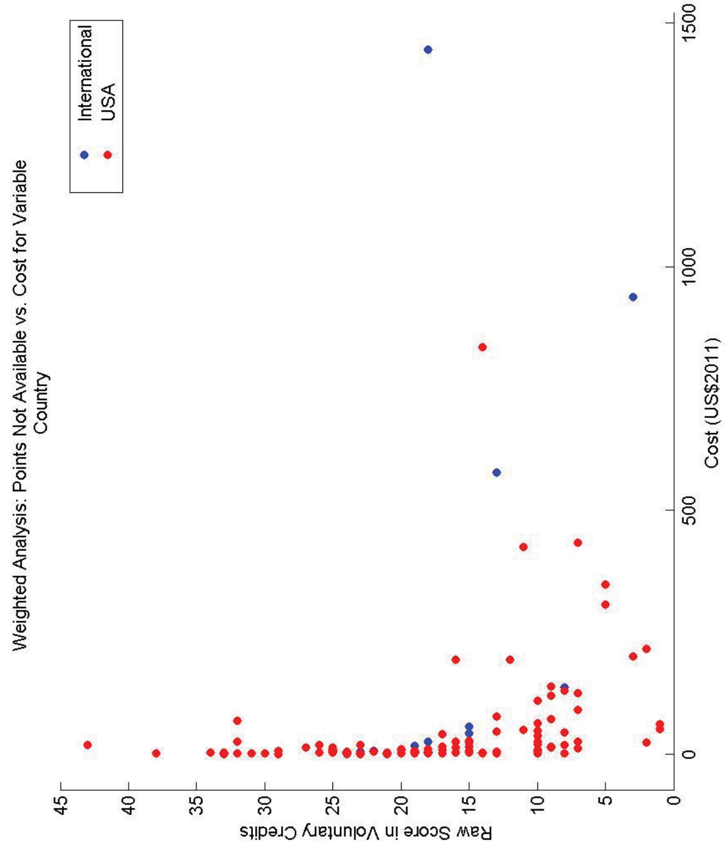



Weighted Analysis: Points Not Available vs. Cost for Variable
GreenroadsProject
Not Greenroads
Greenroads
Raw Score in Voluntary Credits
Cost (US$2011)
0
500
1000
1500
0
5
10
15
20
25
30
35
40
45


Weighted Analysis: Points Not Available vs. Cost for Variable
GreenEmphasis
Typical
Greener
Raw Score in Voluntary Credits
Cost (US$2011)
0
500
1000
1500
0
5
10
15
20
25
30
35
40
45


Weighted Analysis: Points Not Available vs. Cost for Variable
MajorStructures
Structures
No Structures
Raw Score in Voluntary Credits
Cost (US$2011)
0
500
1000
1500
0
5
10
15
20
25
30
35
40
45


Weighted Analysis: Points Not Available vs. Cost for Variable
Northwest
Northwest
Other Regions
Raw Score in Voluntary Credits
Cost (US$2011)
0
500
1000
1500
0
5
10
15
20
25
30
35
40
45



Weighted Analysis: Points Not Available vs. Cost for Variable
Country
International
USA
Raw Score in Voluntary Credits
Cost (US$2011)
0
5
10
15
20
25
30
35
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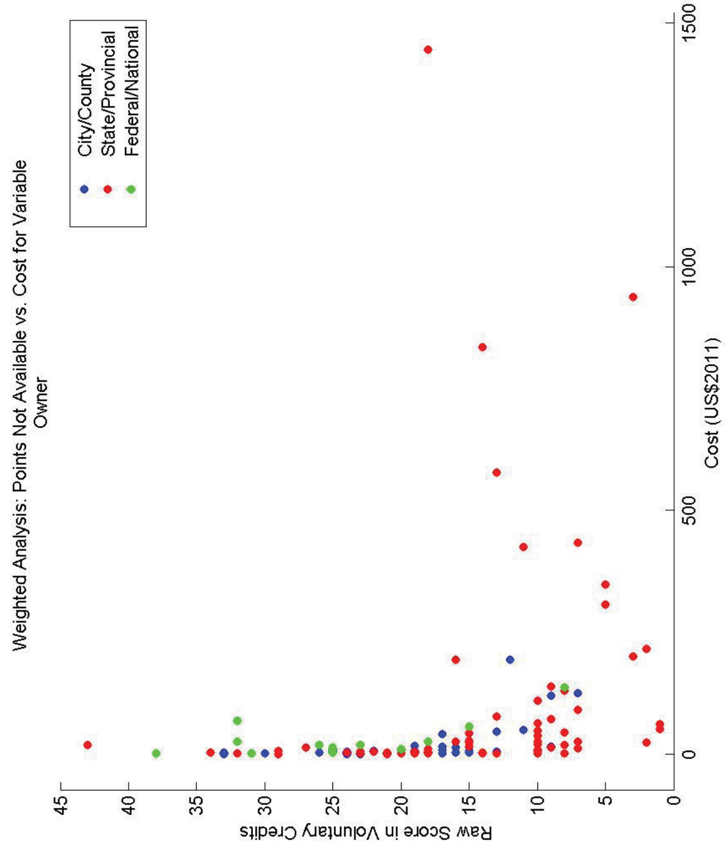
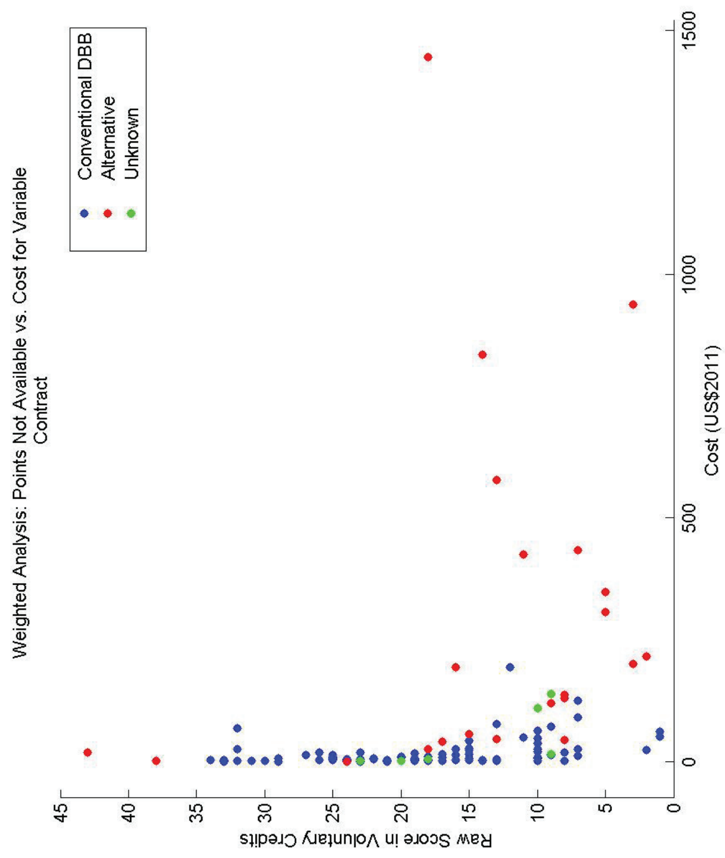
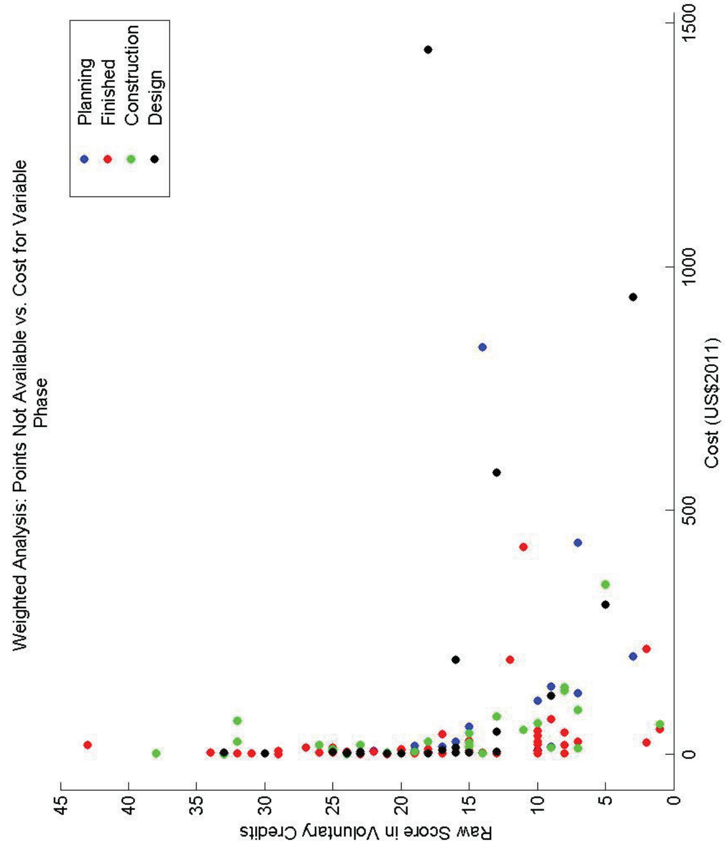
45
0
500
1000
1500



Weighted Analysis: Points Not Available vs. Cost for Variable
Owner
City/County
State/Provincial
Federal/National
Raw Score in Voluntary Credits
Cost (US$2011)
0
5
10
15
20
25
30
35
40
45
0
500
1000
1500


Weighted Analysis: Points Not Available vs. Cost for Variable Contract
Conventional DBB
Alternative
Unknown
Raw Score in Voluntary Credits
Cost (US$2011)
0
5
10
15
20
25
30
35
40
45
0
500
1000
1500


Weighted Analysis: Points Not Available vs. Cost for Variable Phase
Planning
Finished
Construction
Design
Raw Score in Voluntary Credits
Cost (US$2011)
0
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10
15
20
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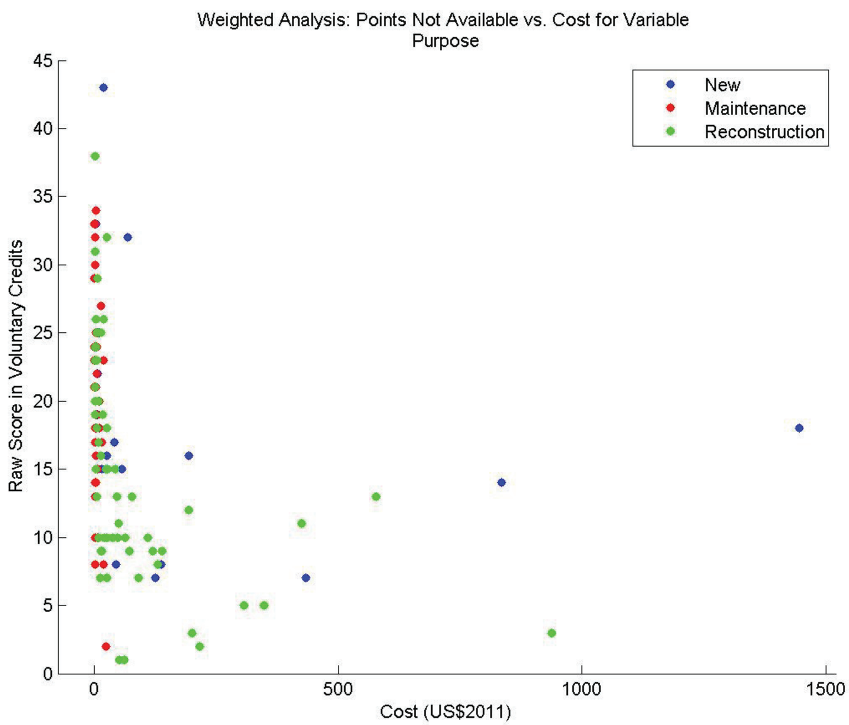
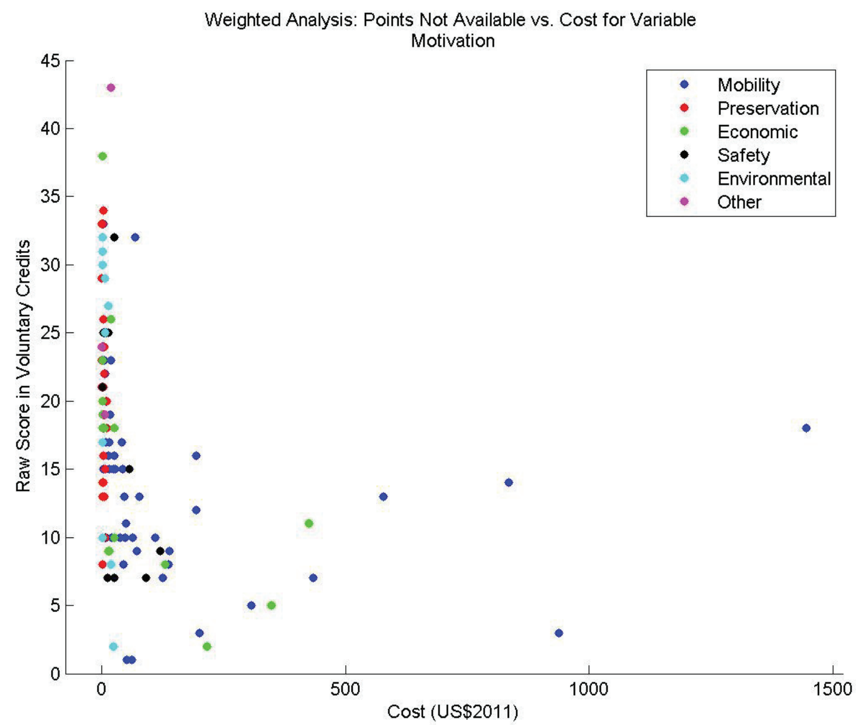
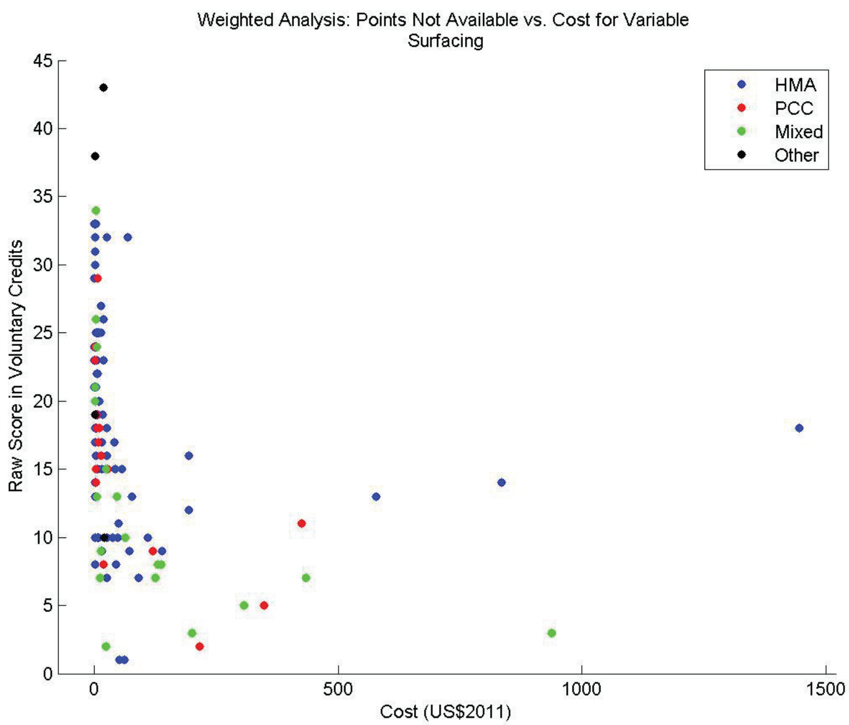
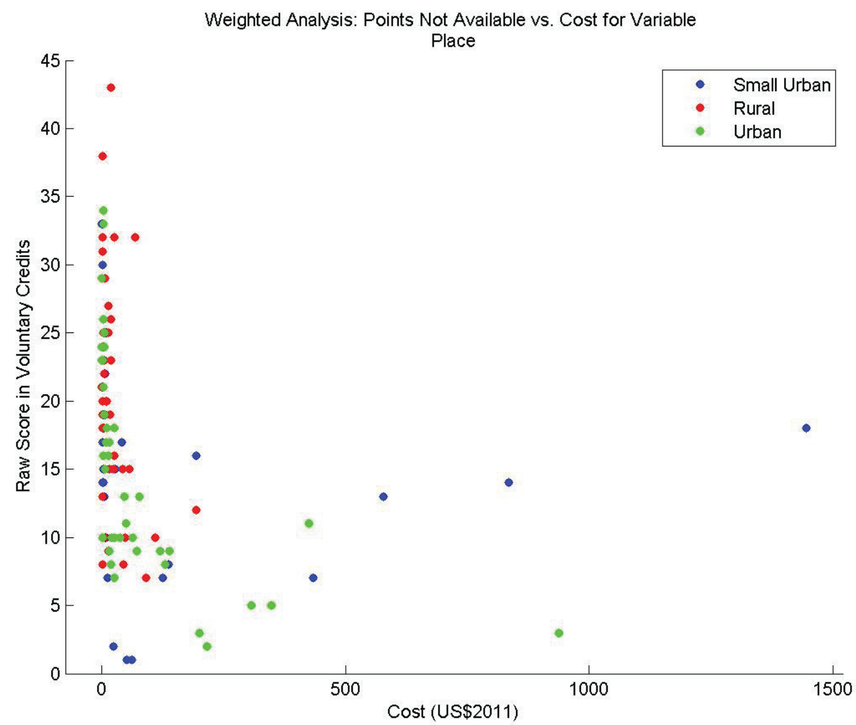
45
0
500
1000
1500

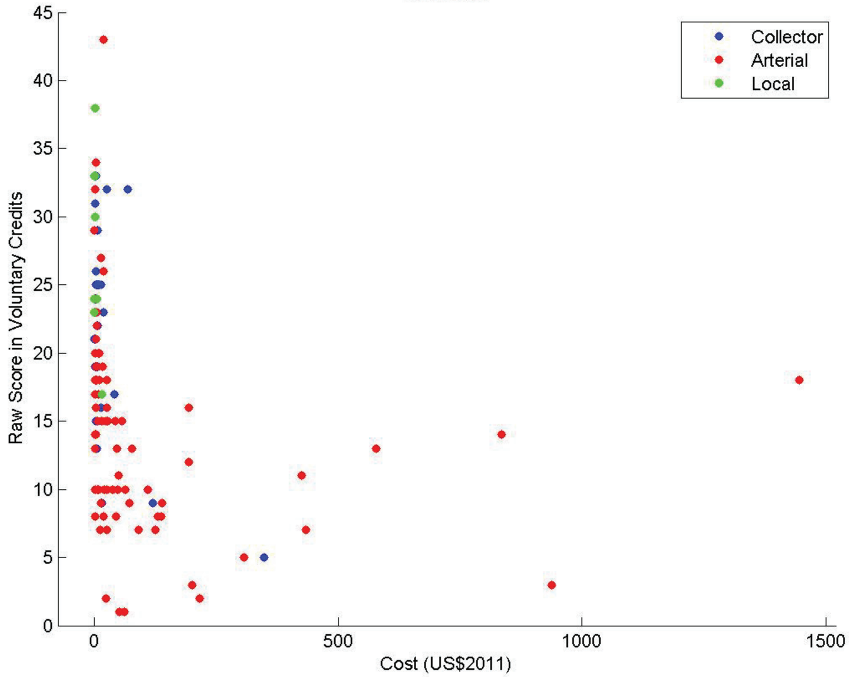

Weighted Analysis: Points Not Available vs. Cost for Variable
Purpose
Raw Score in Voluntary Credits
Cost (US$2011)
New
Maintenance
Reconstruction
0
500
1000
1500
0
5
10
15
20
25
30
35
40
45


Weighted Analysis: Points Not Available vs. Cost for Variable
Motivation
Raw Score in Voluntary Credits
Cost (US$2011)
Mobility
Preservation
Economic
Safety
Environmental
Other
0
500
1000
1500
0
5
10
15
20
25
30
35
40
45

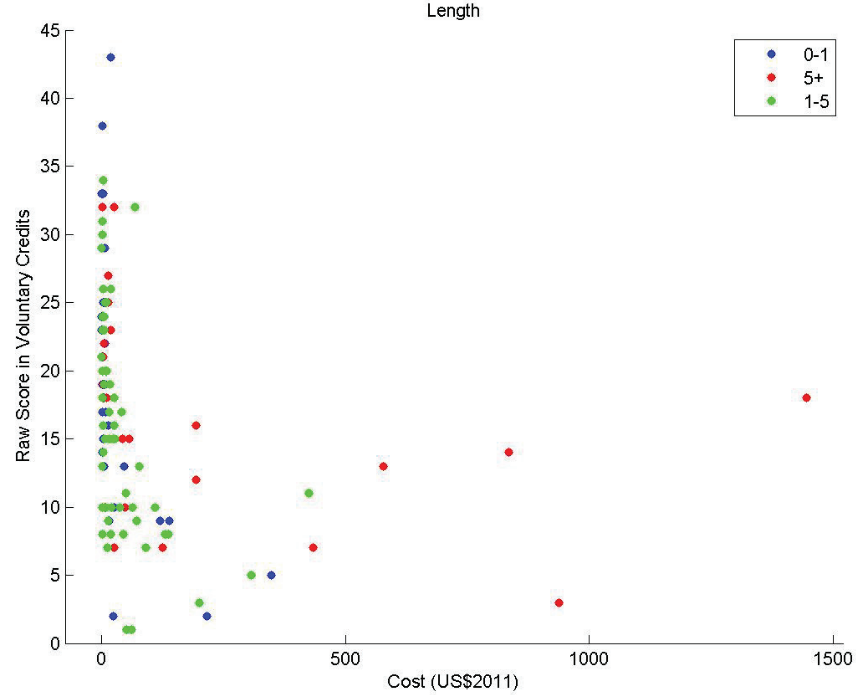

Weighted Analysis: Points Not Available vs. Cost for Variable
Surfacing
HMA
PCC
Mixed
Other
Raw Score in Voluntary Credits
Cost (US$2011)
0
5
10
15
20
25
30
35
40
45
0
500
1000
1500

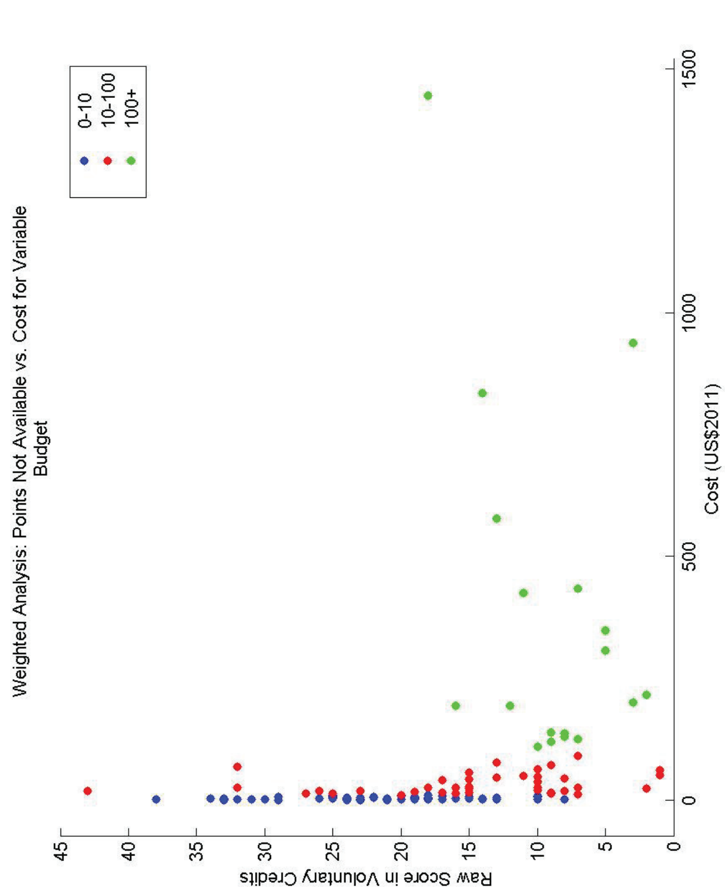

Weighted Analysis: Points Not Available vs. Cost for Variable
Place
Small Urban
Rural
Urban
Raw Score in Voluntary Credits
Cost (US$2011)
0
5
10
15
20
25
30
35
40
45
0
500
1000
1500

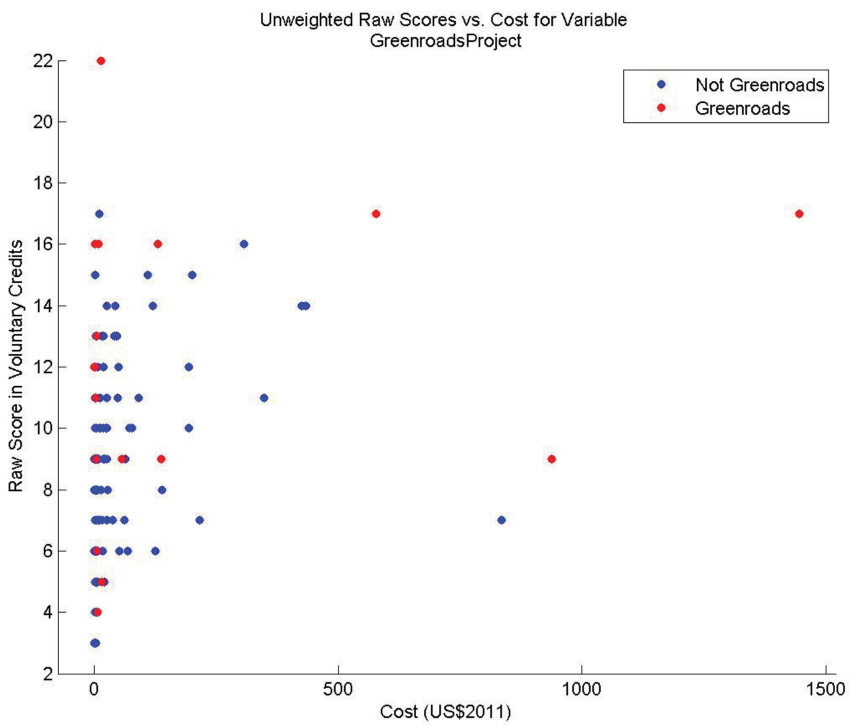
Weighted Analysis: Points Not Available vs. Cost for Variable FunctClass



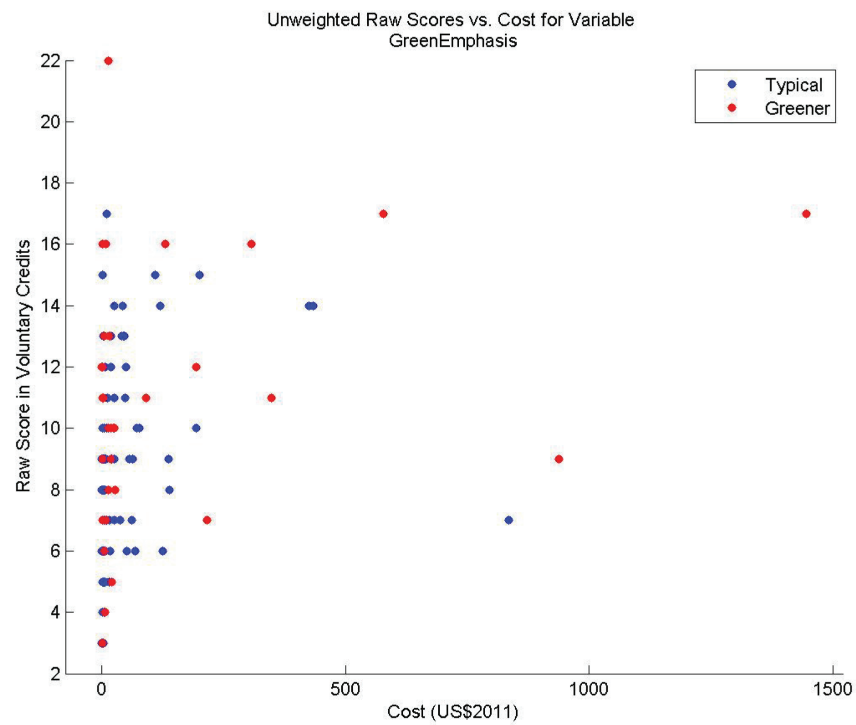
Weighted Analysis: Points Not Available vs. Cost for Variable Length



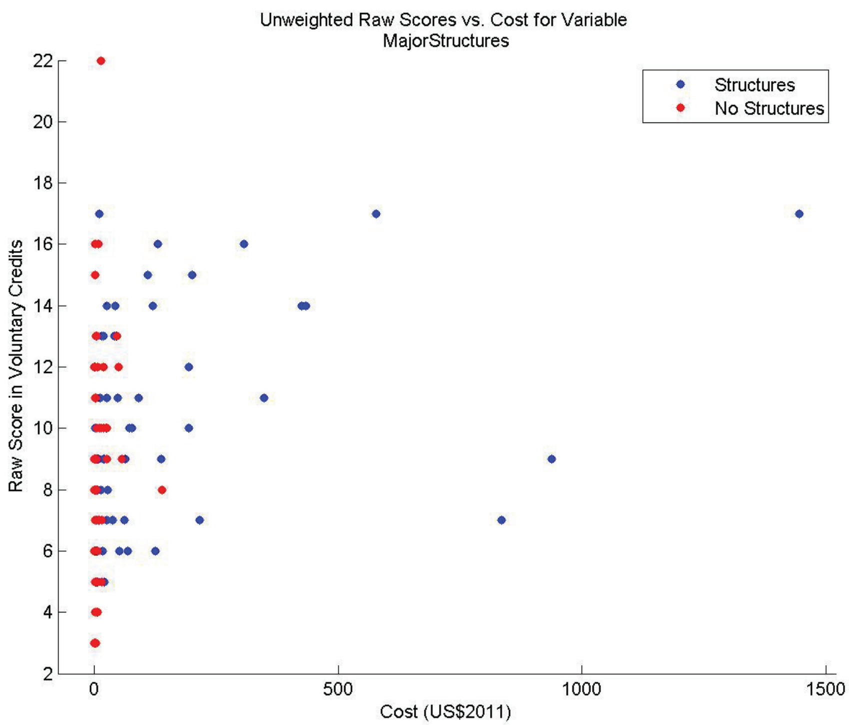

Weighted Analysis: Points Not Available vs. Cost for Variable Budget
Raw Score in Voluntary Credits
Cost (US$2011)
0-10
10-100
100+
0
5
10
15
20
25
30
35
40
45
0
500
1000
1500



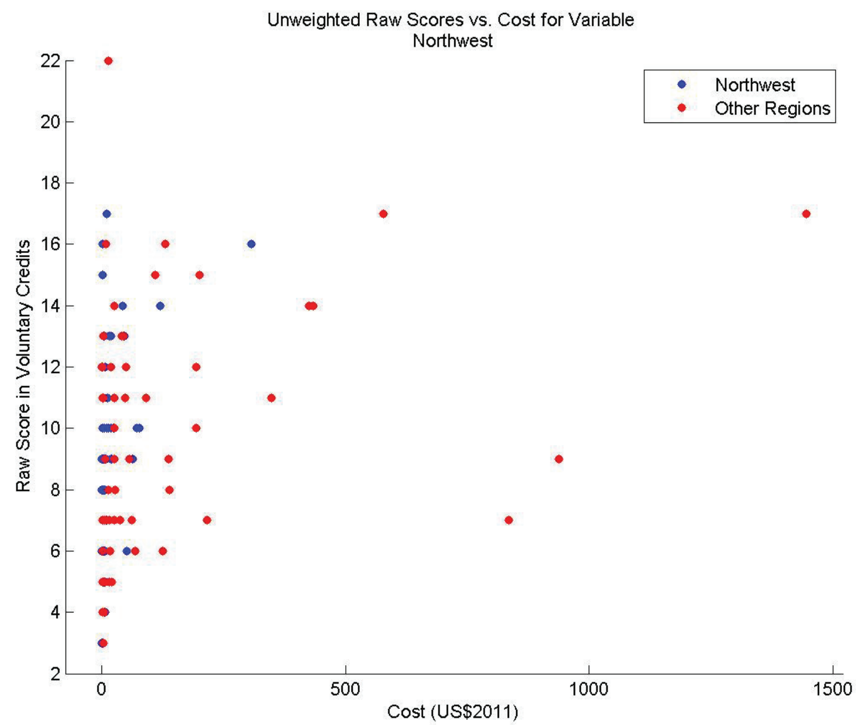
Unweighted Raw Scores vs. Cost for Variable
GreenroadsProject
Not Greenroads
Greenroads
Raw Score in Voluntary Credits
Cost (US$2011)



Unweighted Raw Scores vs. Cost for Variable
GreenEmphasis
Typical
Greener
Raw Score in Voluntary Credits
Cost (US$2011)

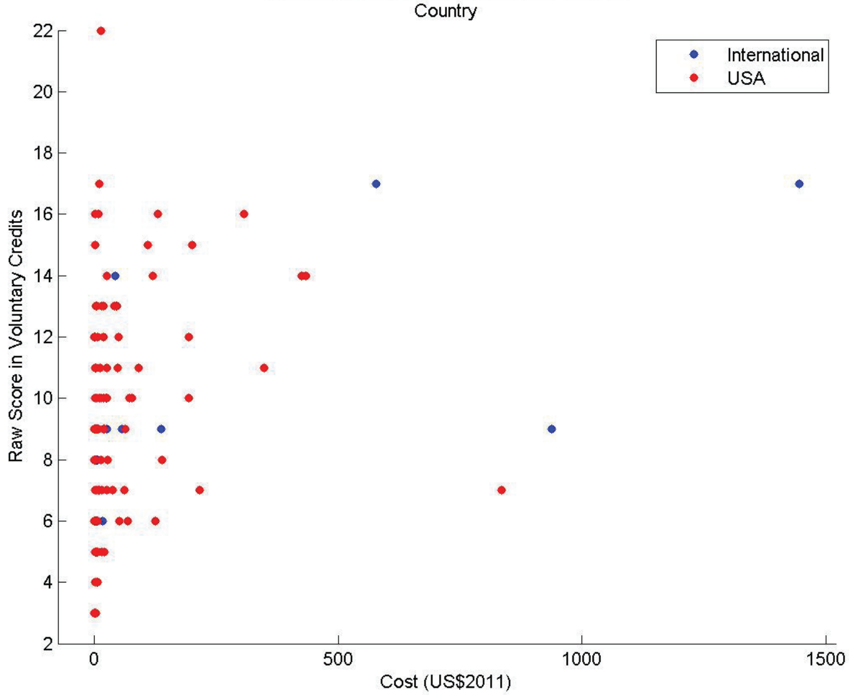


Unweighted Raw Scores vs. Cost for Variable
MajorStructures
Structures
No Structures
Raw Score in Voluntary Credits
Cost (US$2011)

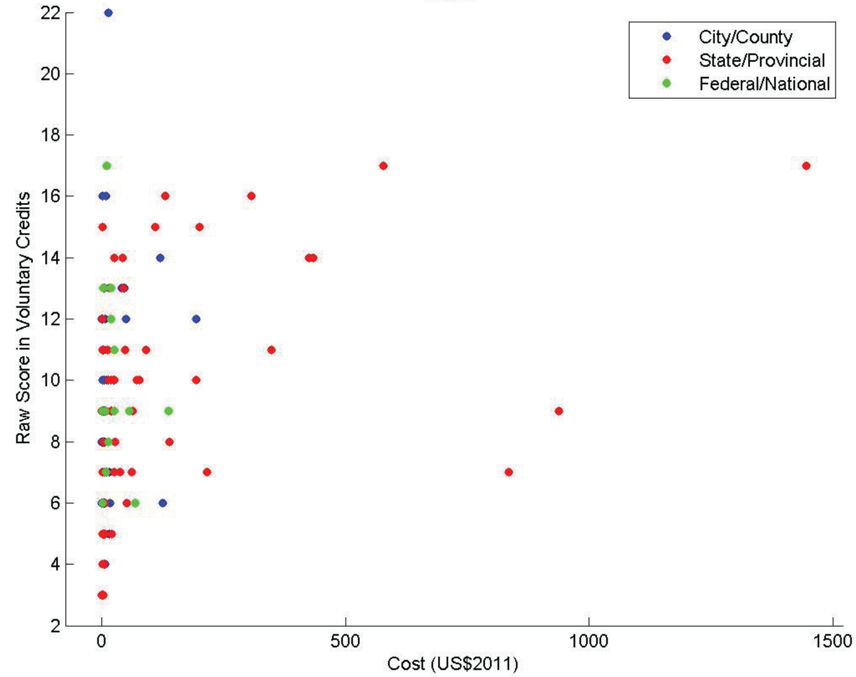


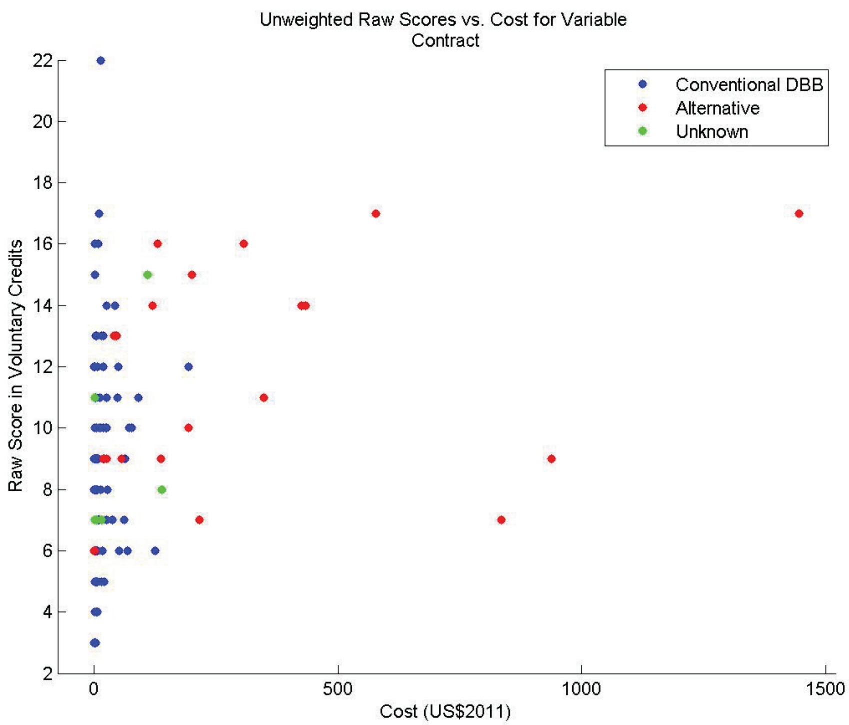
Unweighted Raw Scores vs. Cost for Variable
Northwest
Northwest
Other Regions
Raw Score in Voluntary Credits
Cost (US$2011)

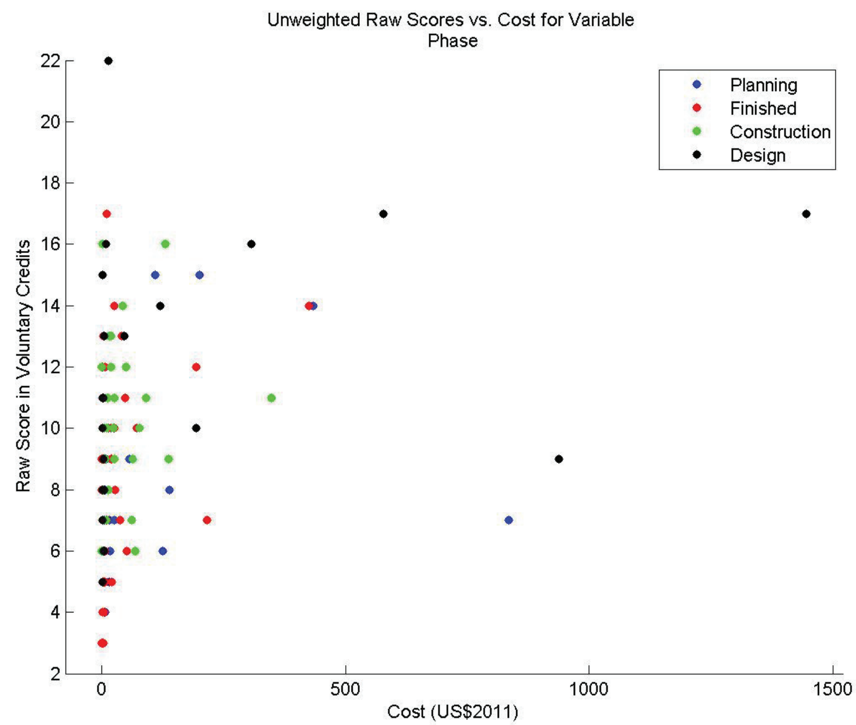
Unweighted Raw Scores vs. Cost for Variable
Country

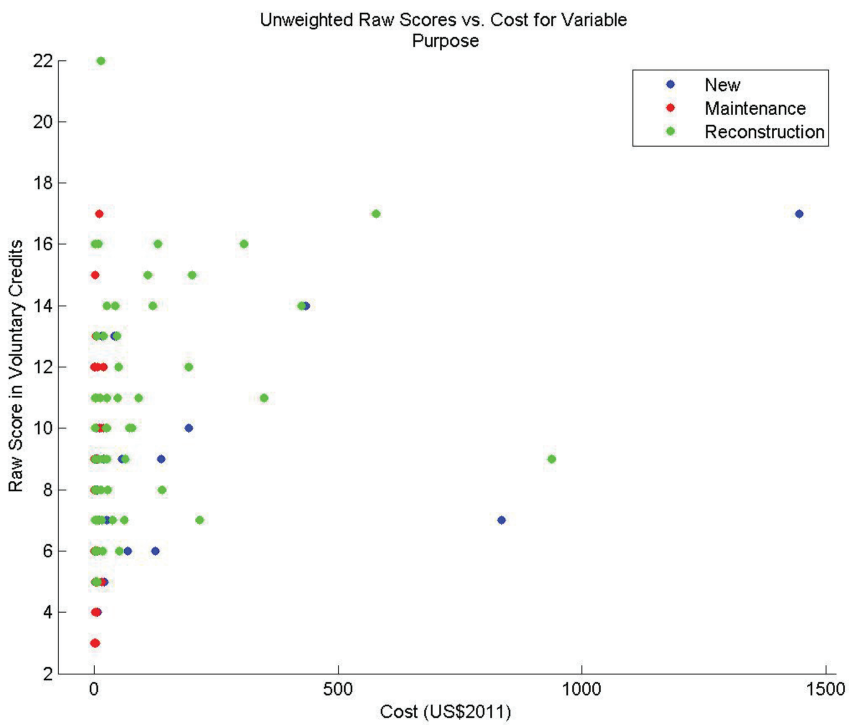


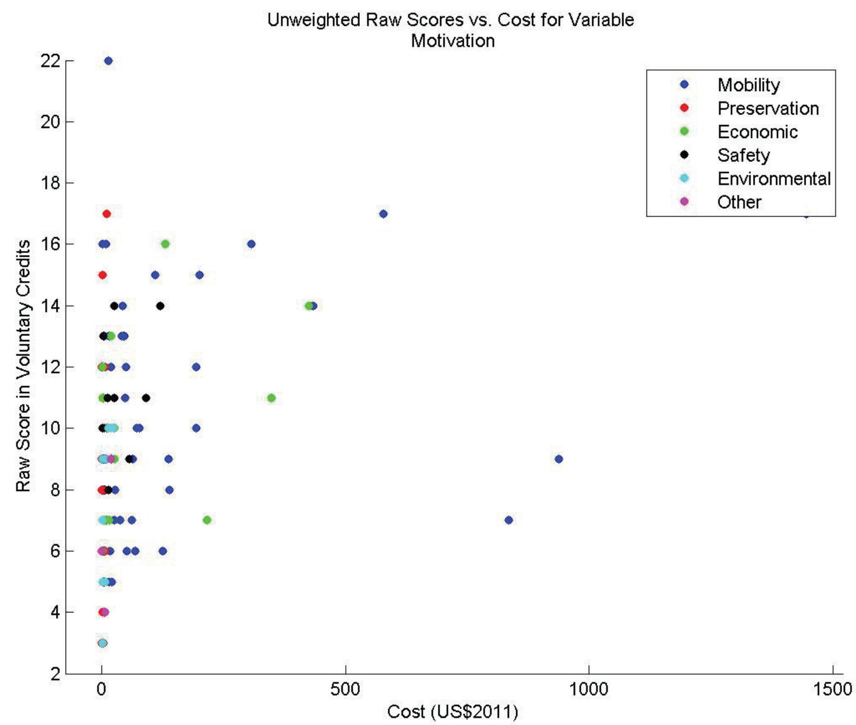
Unweighted Raw Scores vs. Cost for Variable
Owner

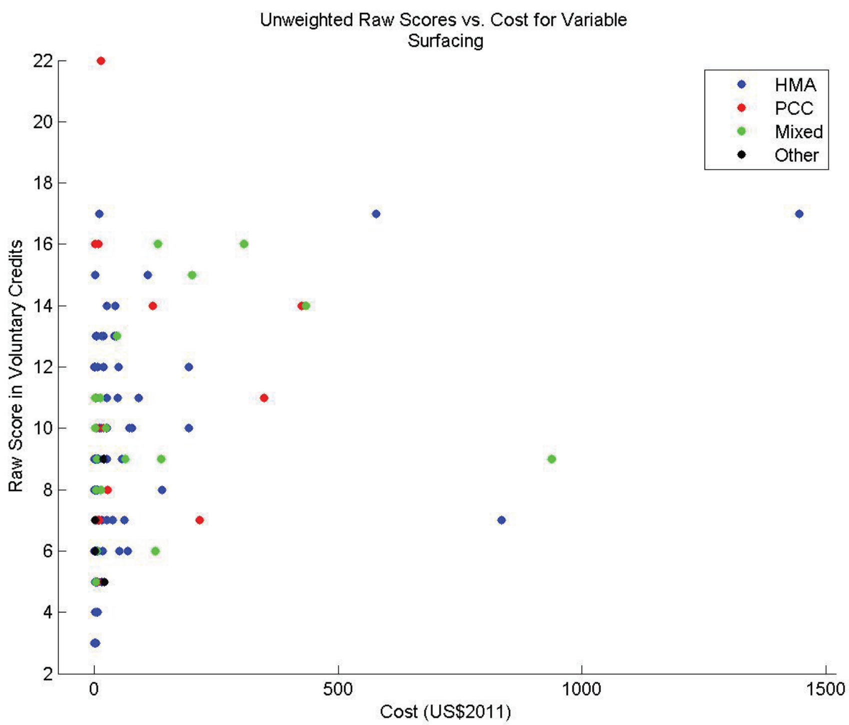


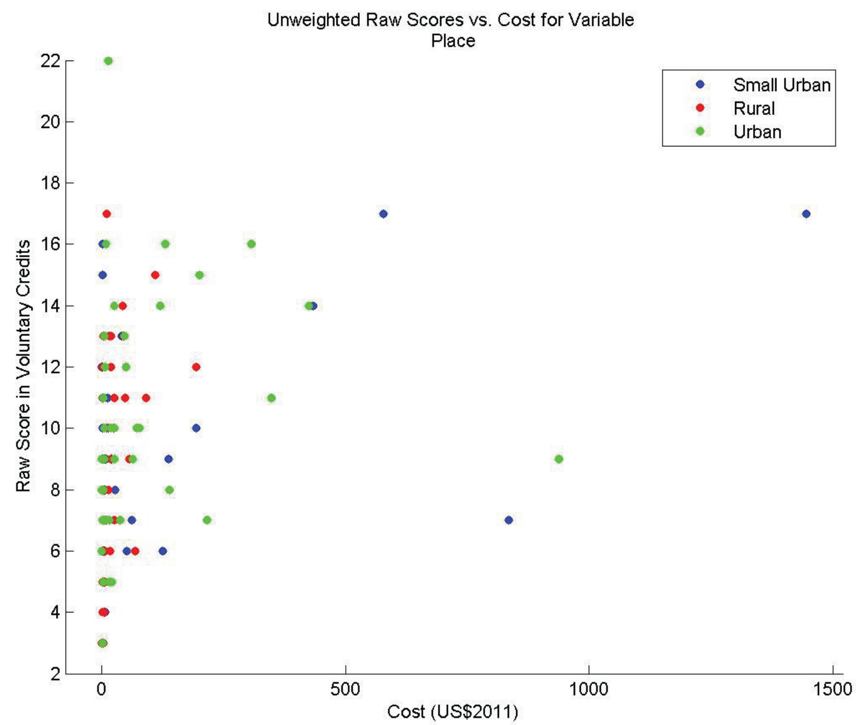

Unweighted Raw Scores vs. Cost for Variable
Contract
Conventional DBB
Alternative
Unknown
Raw Score in Voluntary Credits
Cost (US$2011)
22
20
18
16
14
12
10
8
6
4
2
0
500
1000
1500

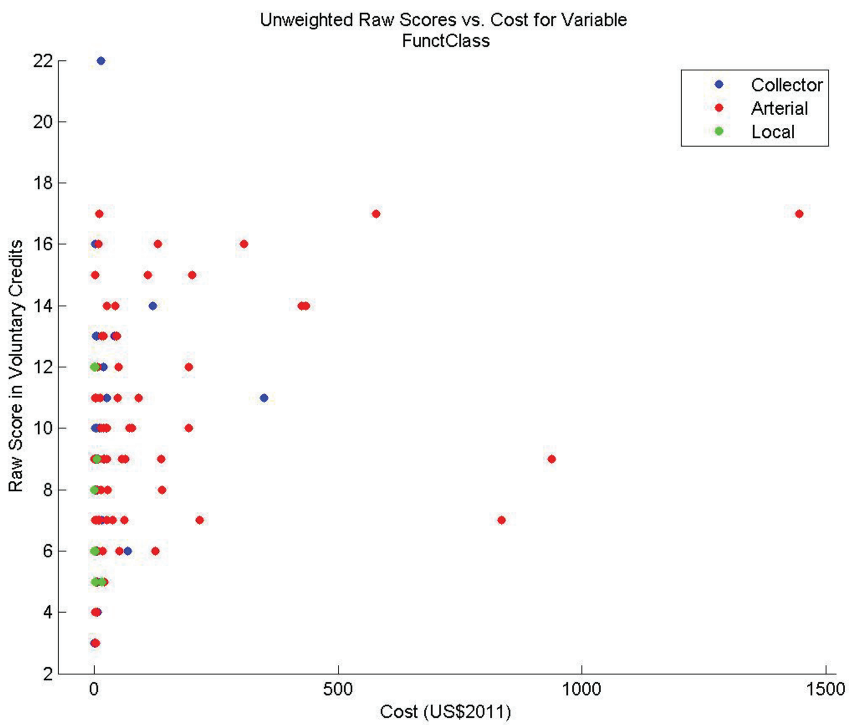

Unweighted Raw Scores vs. Cost for Variable
Phase
Planning
Finished
Construction
Design
Raw Score in Voluntary Credits
Cost (US$2011)
22
20
18
16
14
12
10
8
6
4
2
0
500
1000
1500

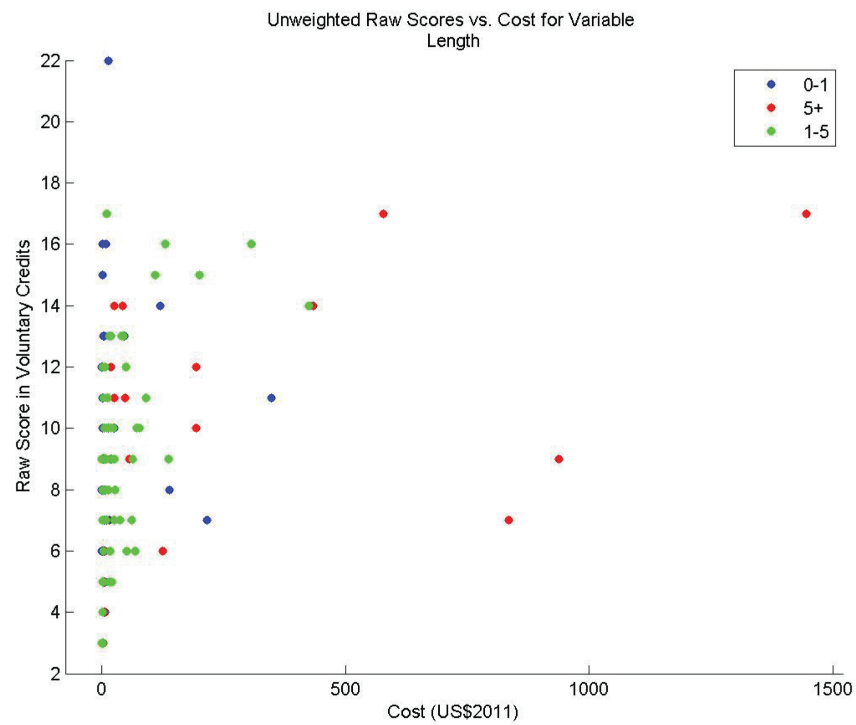

Unweighted Raw Scores vs. Cost for Variable
Purpose
Raw Score in Voluntary Credits
Cost (US$2011)
New
Maintenance
Reconstruction

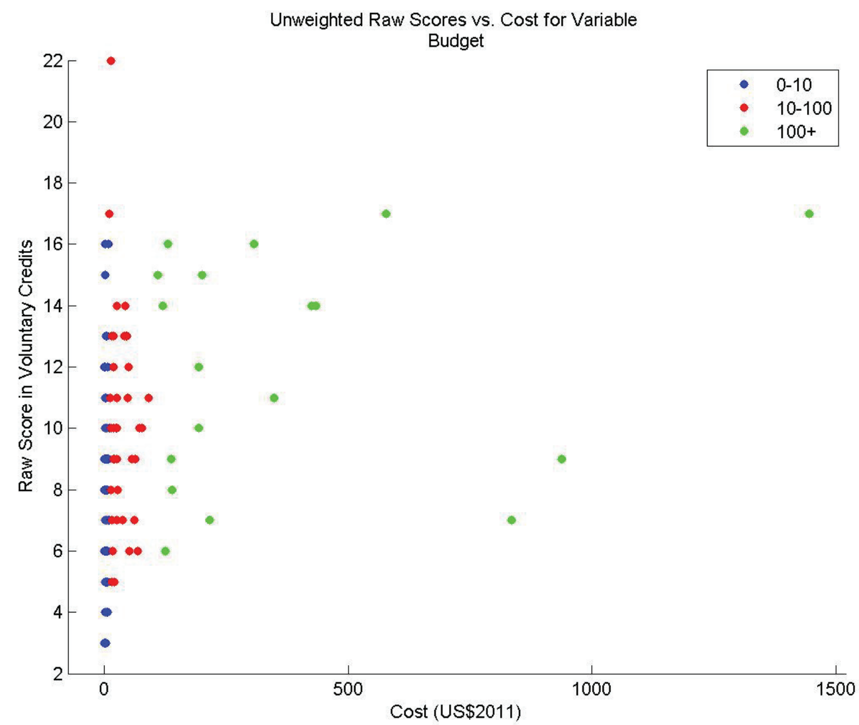

Unweighted Raw Scores vs. Cost for Variable
Motivation
Raw Score in Voluntary Credits
Cost (US$2011)
Mobility
Preservation
Economic
Safety
Environmental
Other

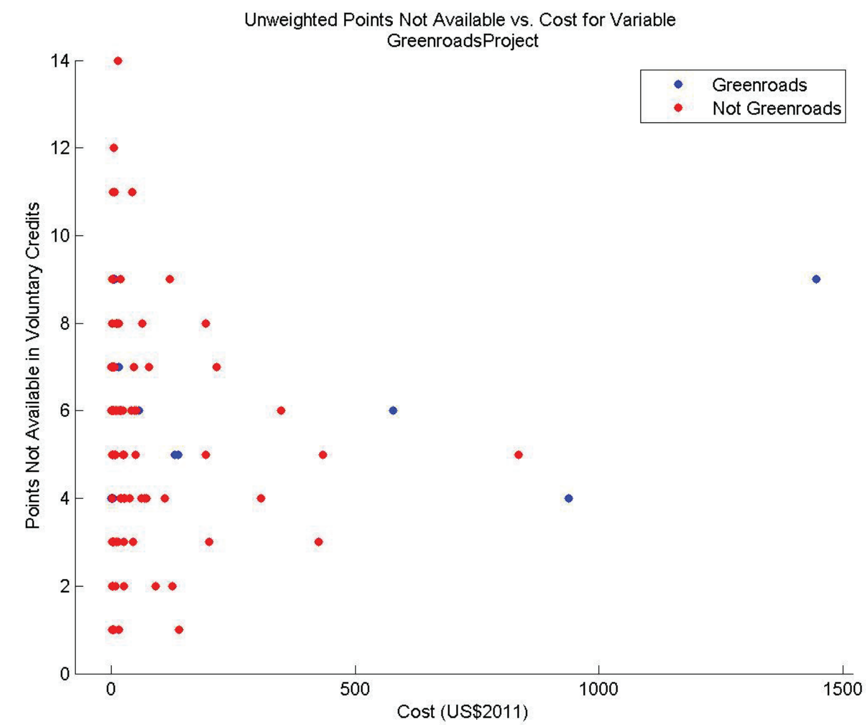

Unweighted Raw Scores vs. Cost for Variable
Surfacing
Raw Score in Voluntary Credits
Cost (US$2011)
HMA
PCC
Mixed
Other

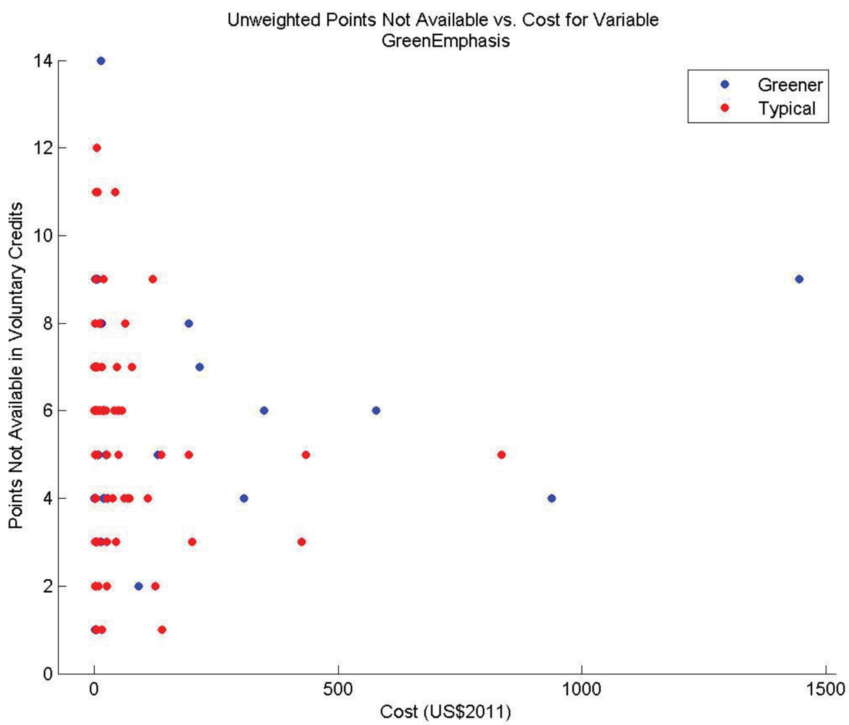

Unweighted Raw Scores vs. Cost for Variable
Place
Raw Score in Voluntary Credits
Cost (US$2011)
Small Urban
Rural
Urban

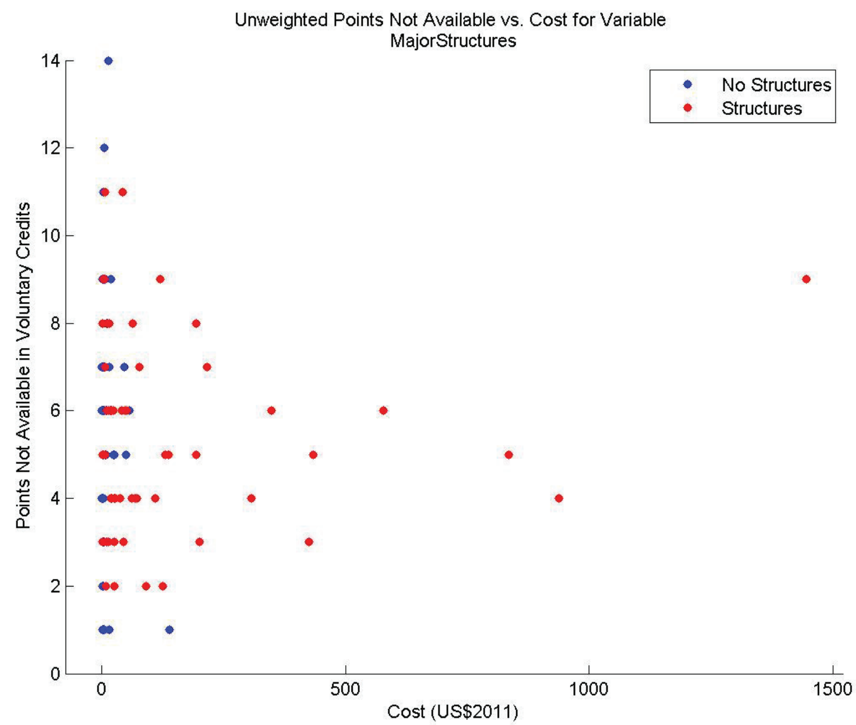

Unweighted Raw Scores vs. Cost for Variable
FunctClass
Collector
Arterial
Local
Raw Score in Voluntary Credits
Cost (US$2011)
22
20
18
16
14
12
10
8
6
4
2
0
500
1000
1500

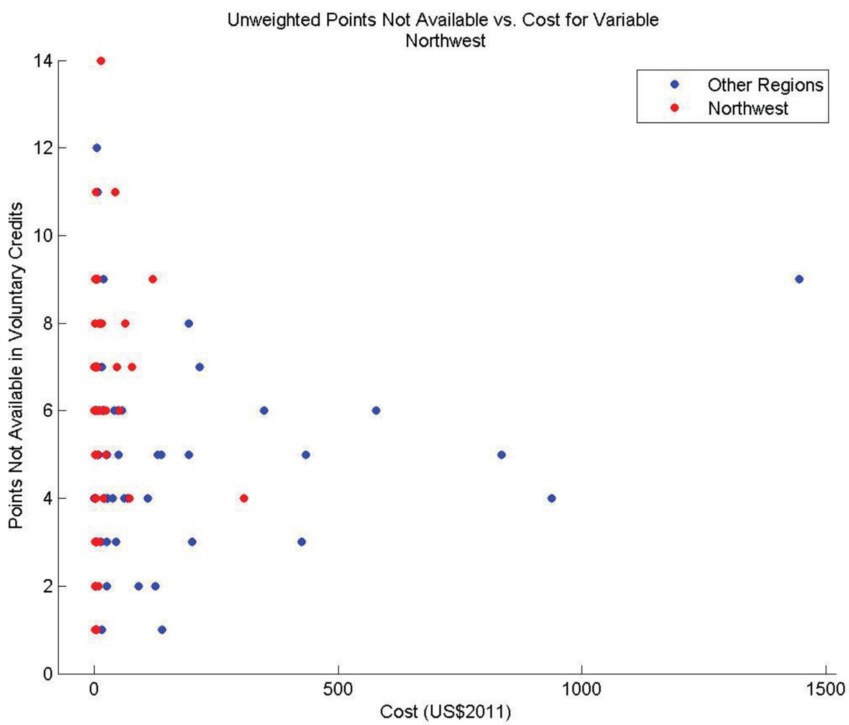

Unweighted Raw Scores vs. Cost for Variable
Length
0-1
5+
1-5
Raw Score in Voluntary Credits
Cost (US$2011)
22
20
18
16
14
12
10
8
6
4
2
0
500
1000
1500


Unweighted Raw Scores vs. Cost for Variable
Budget
Raw Score in Voluntary Credits
Cost (US$2011)
0-10
10-100
100+

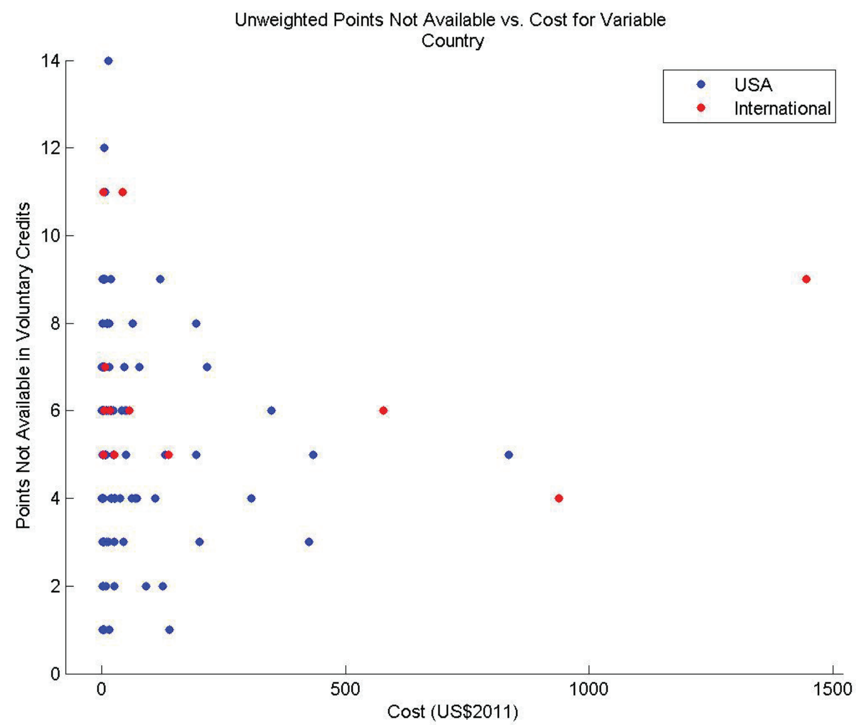

Unweighted Points Not Available vs. Cost for Variable
GreenroadsProject
Points Not Available in Voluntary Credits
Cost (US$2011)
Greenroads
Not Greenroads


Unweighted Points Not Available vs. Cost for Variable
GreenEmphasis
Greener
Typical
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500

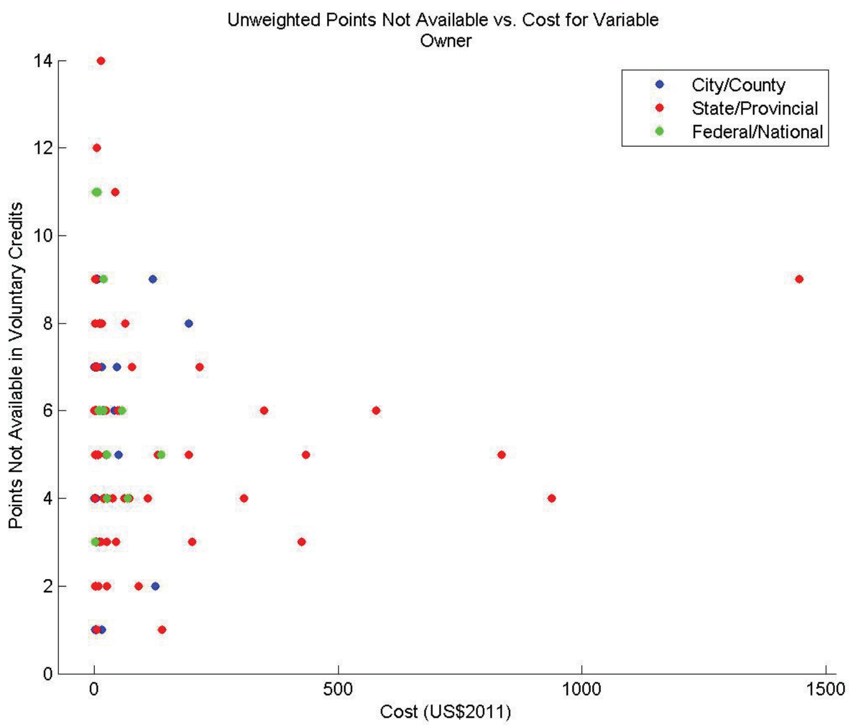

Unweighted Points Not Available vs. Cost for Variable
MajorStructures
No Structures
Structures
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500

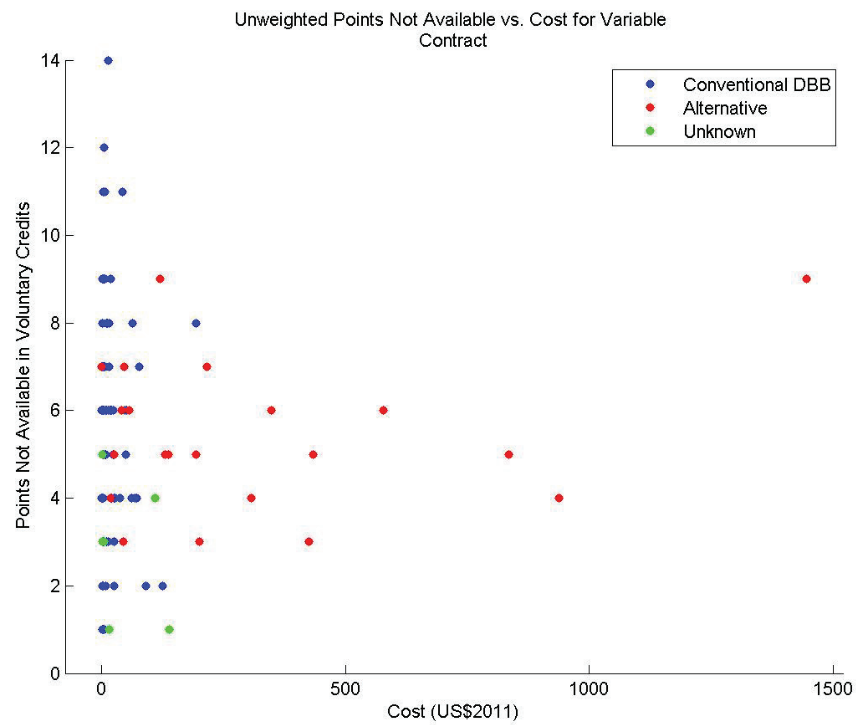


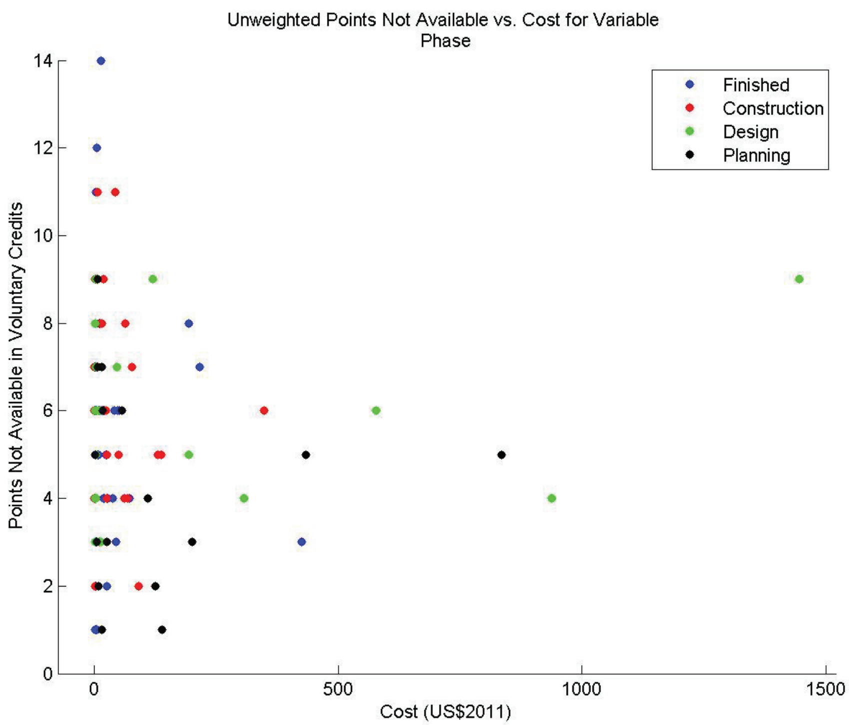
Unweighted Points Not Available vs. Cost for Variable
Northwest
Other Regions
Northwest
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500

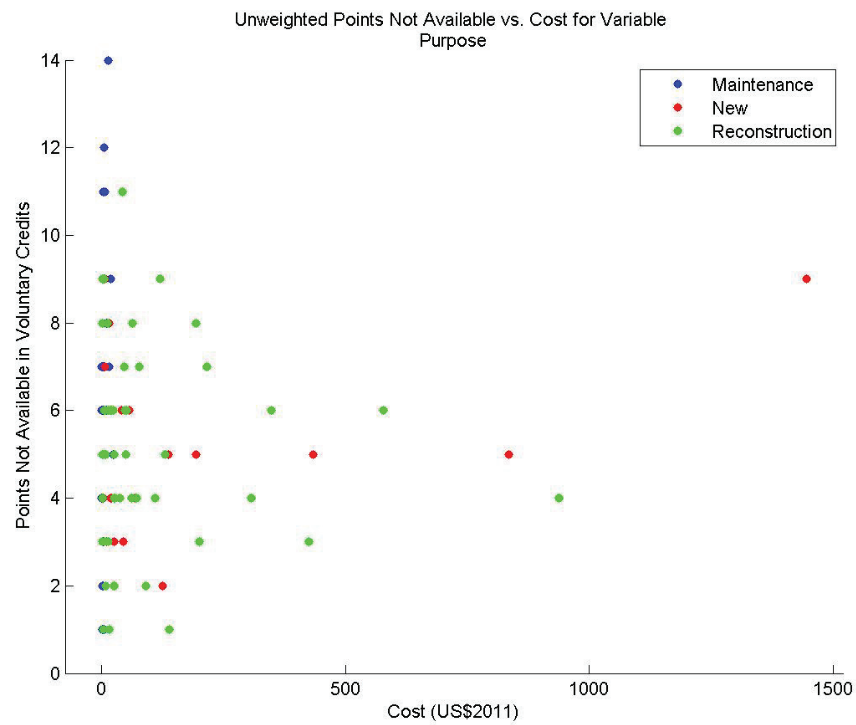


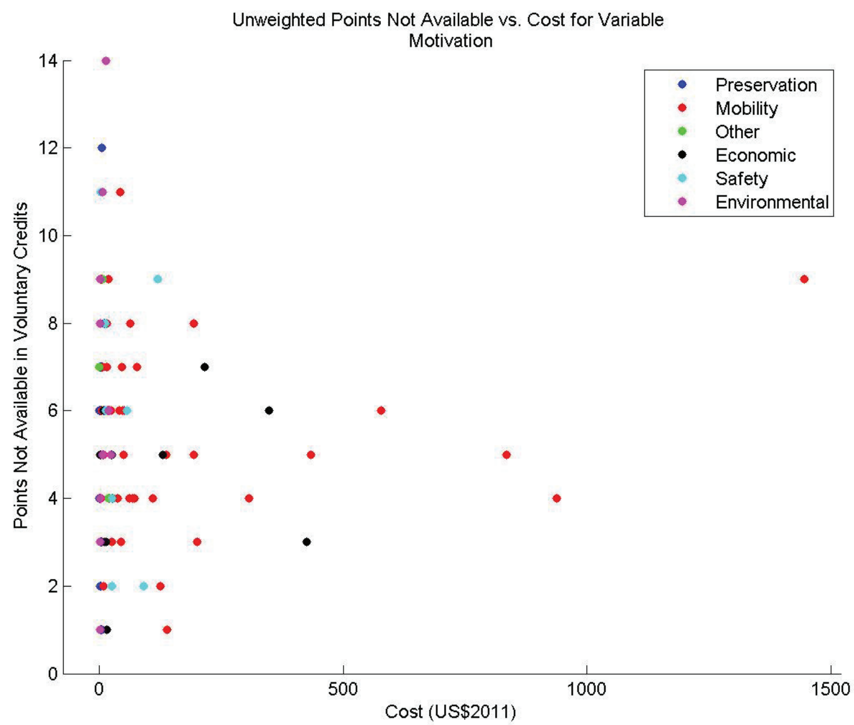
Unweighted Points Not Available vs. Cost for Variable
Country
USA
International
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500


Unweighted Points Not Available vs. Cost for Variable
Owner
City/County
State/Provincial
Federal/National
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500

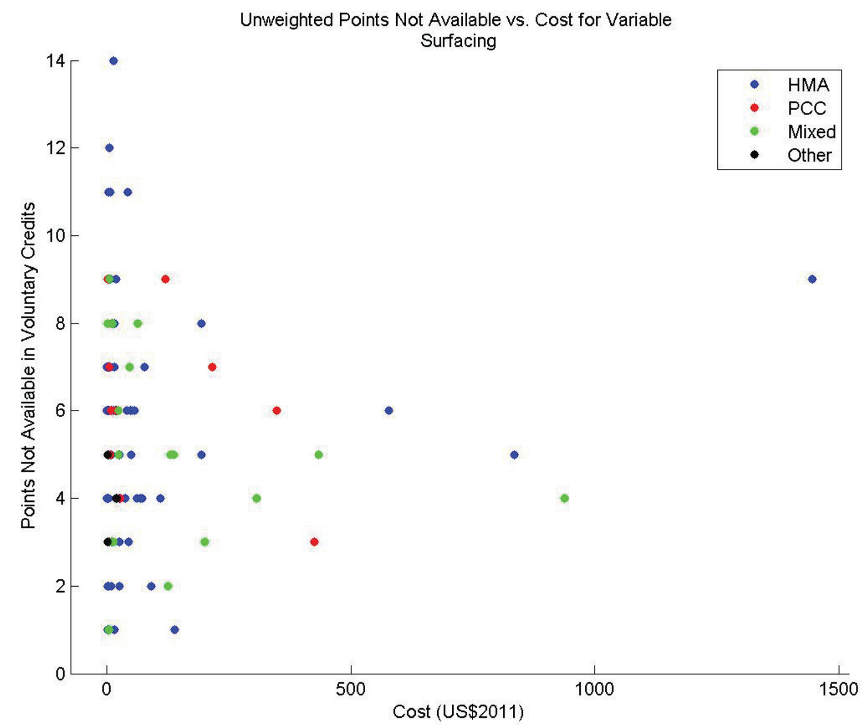

Unweighted Points Not Available vs. Cost for Variable
Contract
Conventional DBB
Alternative
Unknown
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500


Unweighted Points Not Available vs. Cost for Variable
Phase
Points Not Available in Voluntary Credits
Cost (US$2011)
Finished
Construction
Design
Planning

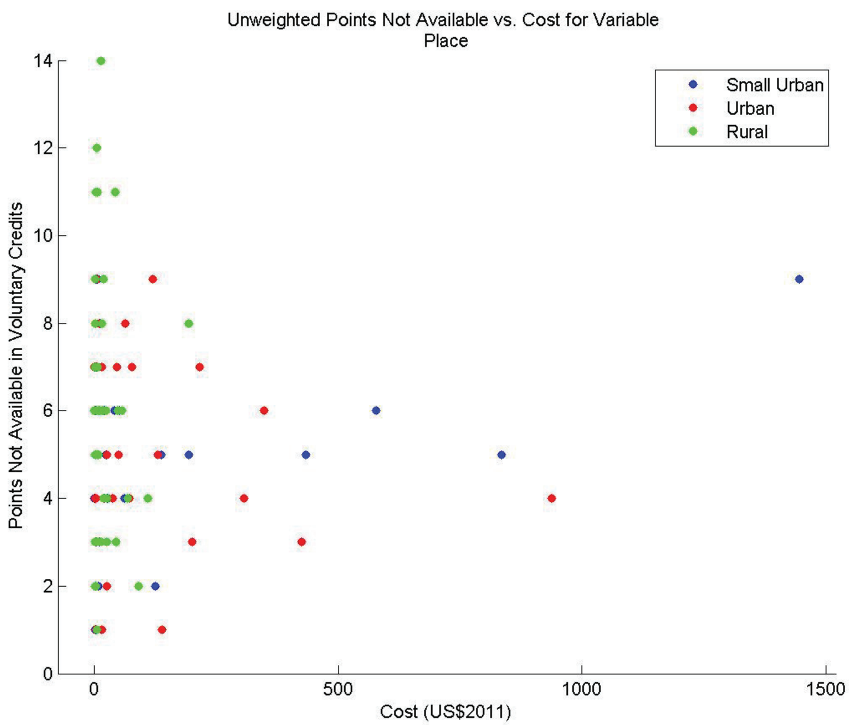

Unweighted Points Not Available vs. Cost for Variable
Purpose
Points Not Available in Voluntary Credits
Cost (US$2011)
Maintenance
New
Reconstruction

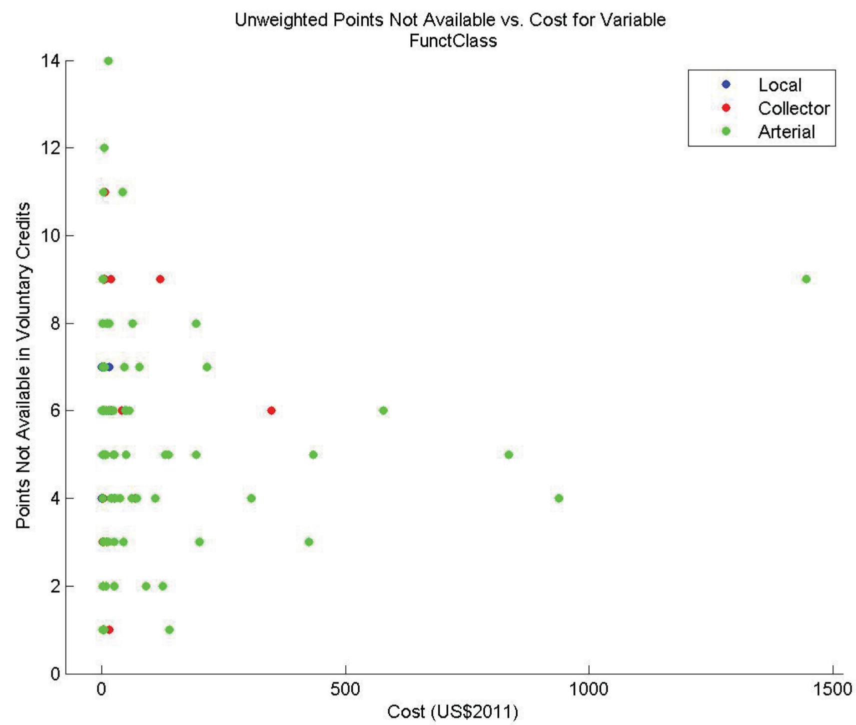


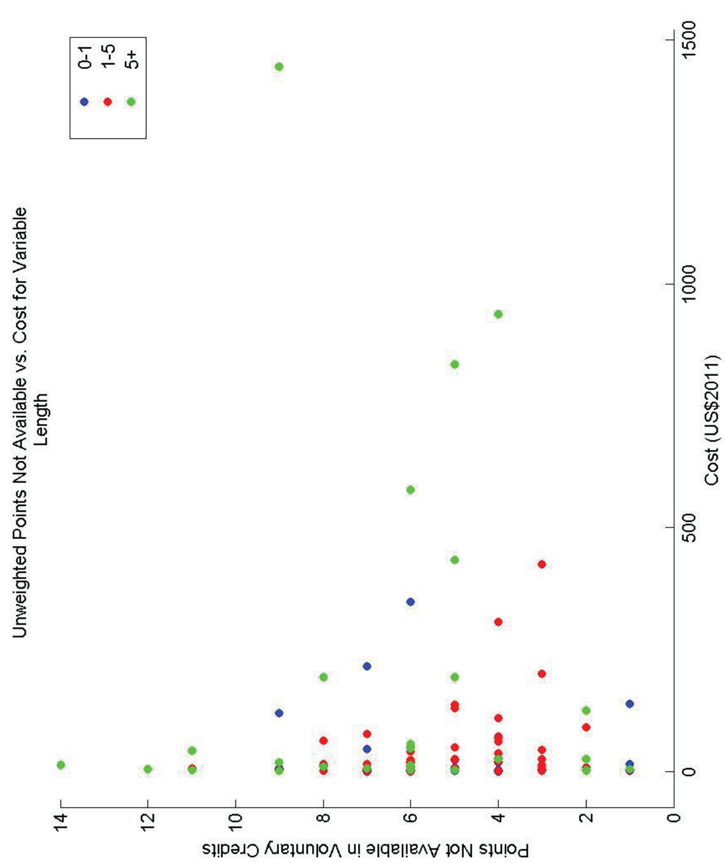
Unweighted Points Not Available vs. Cost for Variable
Motivation
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500
Preservation
Mobility
Other
Economic
Safety
Environmental

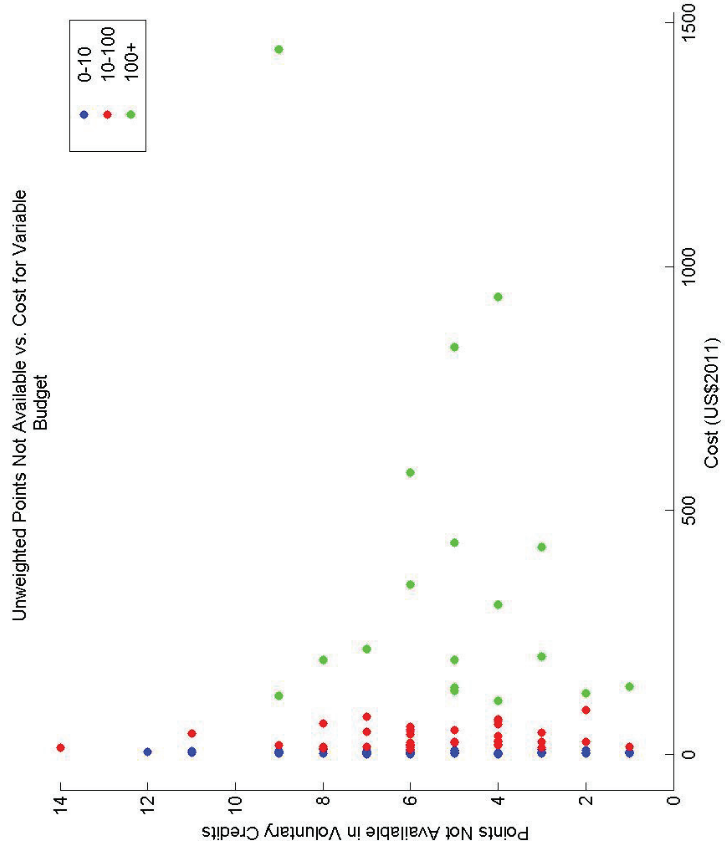


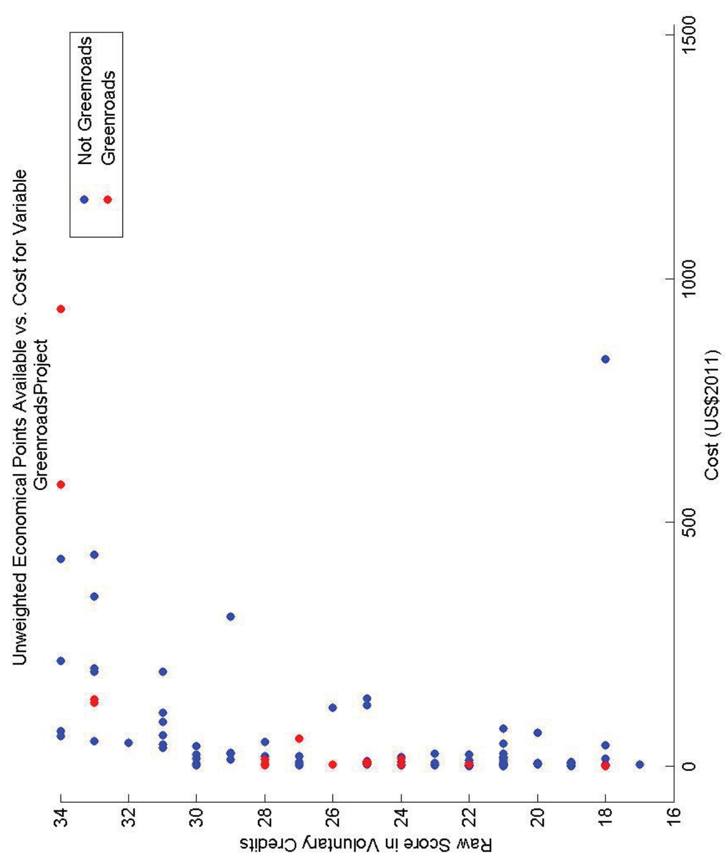
Unweighted Points Not Available vs. Cost for Variable
Surfacing
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500
HMA
PCC
Mixed
Other

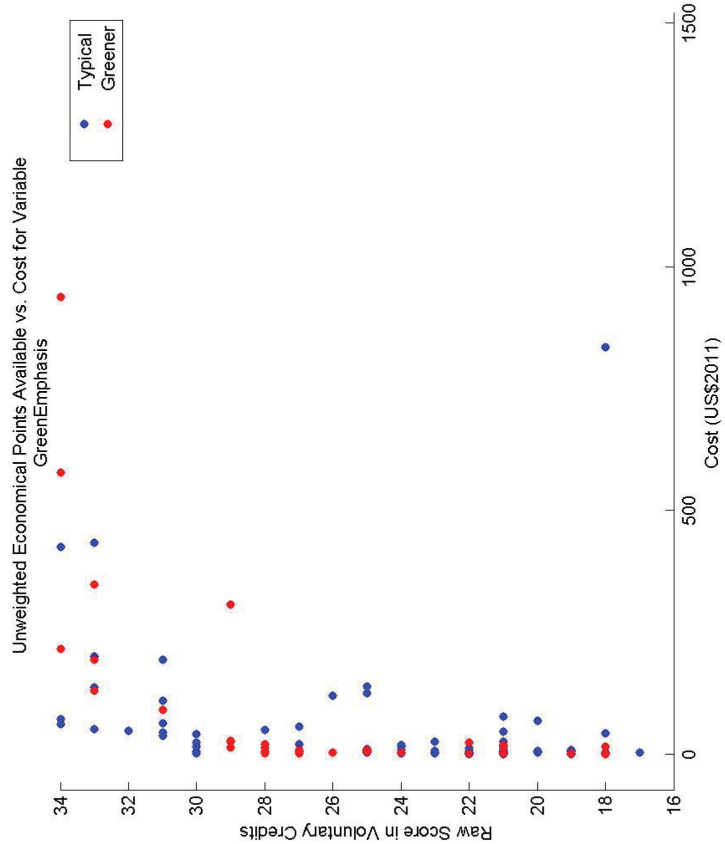

Unweighted Points Not Available vs. Cost for Variable
Place
Small Urban
Urban
Rural
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500

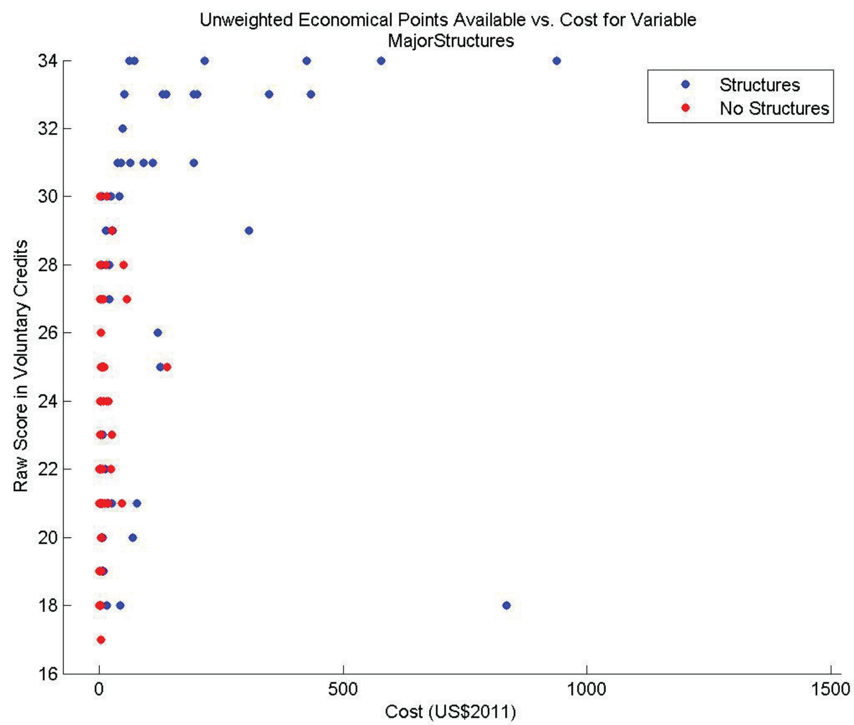

Unweighted Points Not Available vs. Cost for Variable
FunctClass
Local
Collector
Arterial
Points Not Available in Voluntary Credits
Cost (US$2011)
0
2
4
6
8
10
12
14
0
500
1000
1500

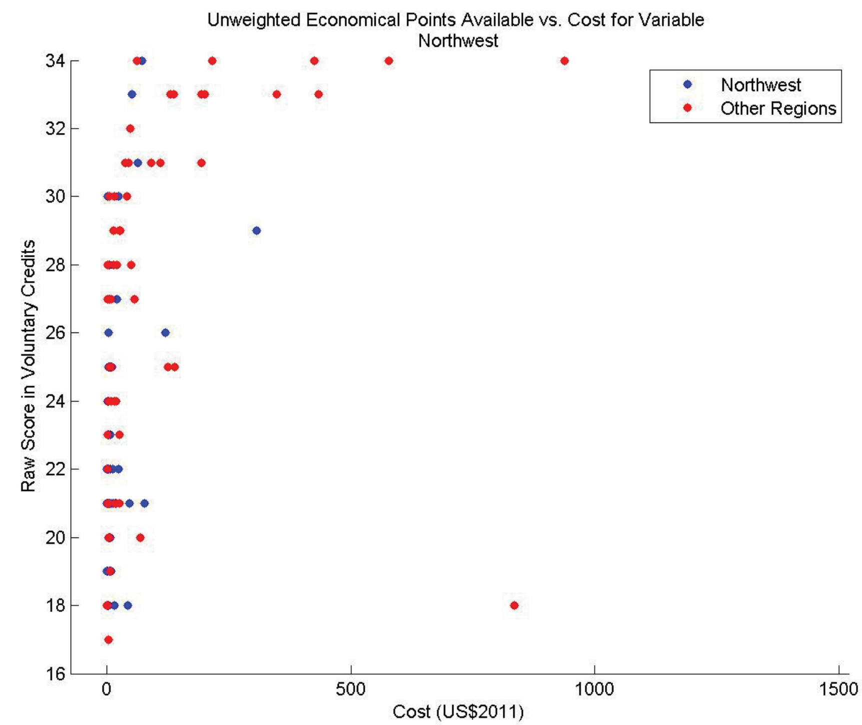

Unweighted Points Not Available vs. Cost for Variable Length
Points Not Available in Voluntary Credits
Cost (US$2011)
0-1
1-5
5+

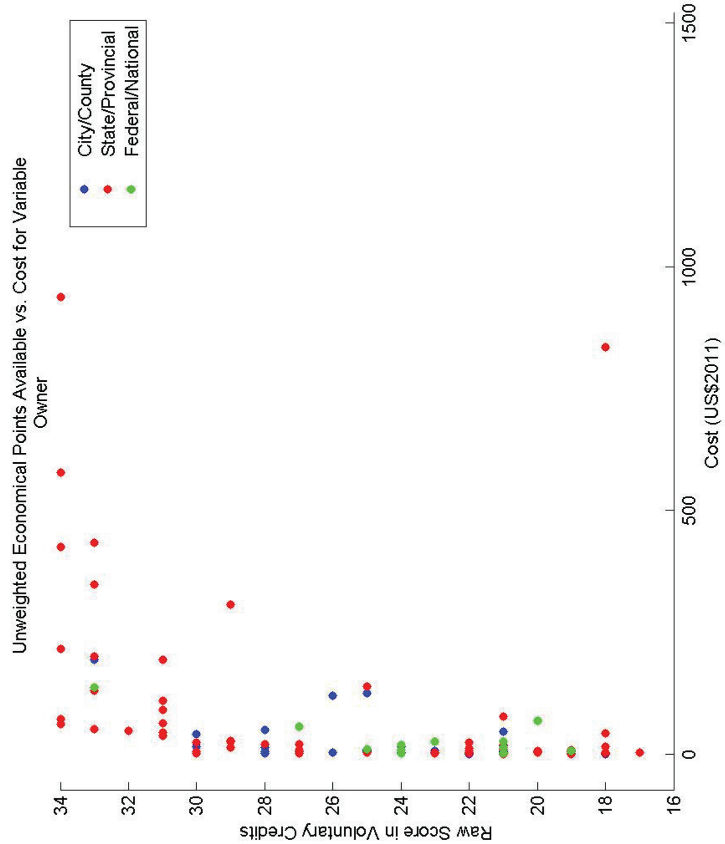

Unweighted Points Not Available vs. Cost for Variable Budget
Points Not Available in Voluntary Credits
Cost (US$2011)
0-10
10-100
100+

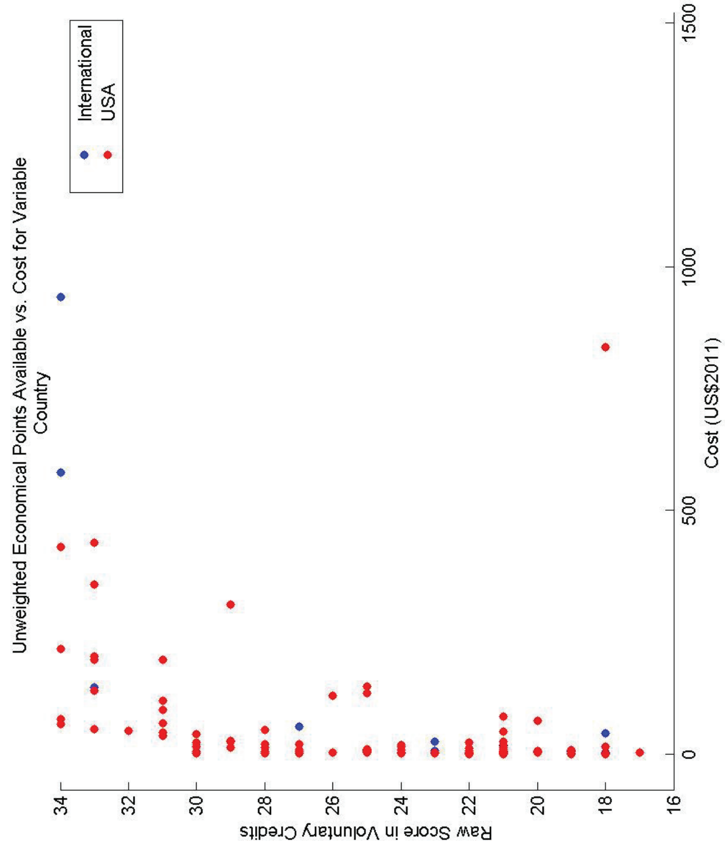

Unweighted Economical Points Available vs. Cost for Variable
GreenroadsProject
Not Greenroads
Greenroads
Raw Score in Voluntary Credits
Cost (US$2011)

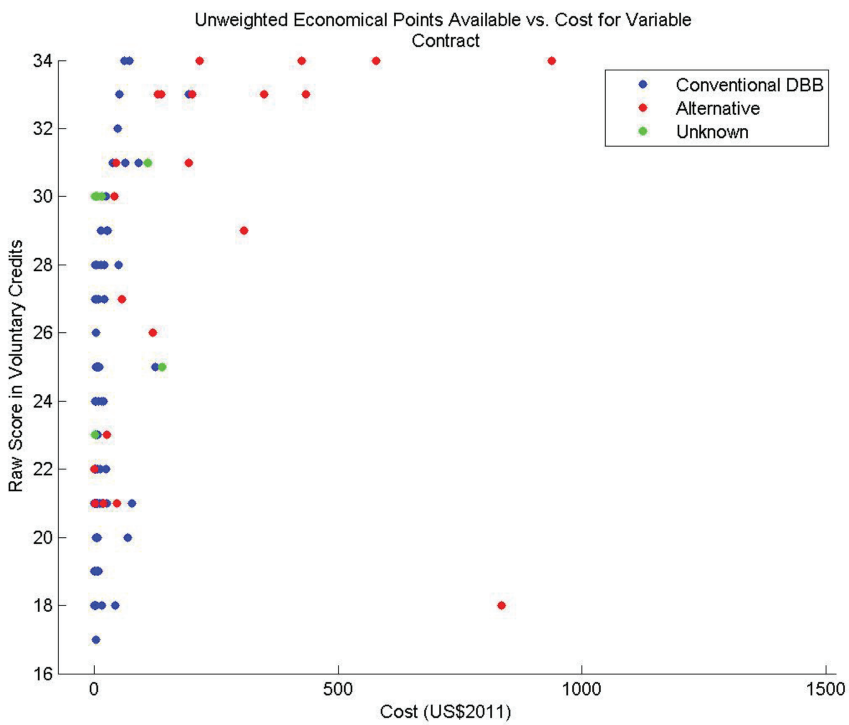

Unweighted Economical Points Available vs. Cost for Variable
GreenEmphasis
Typical
Greener
Raw Score in Voluntary Credits
Cost (US$2011)


Unweighted Economical Points Available vs. Cost for Variable
MajorStructures
Structures
No Structures
Raw Score in Voluntary Credits
Cost (US$2011)
34
32
30
28
26
24
22
20
18
16
0
500
1000
1500

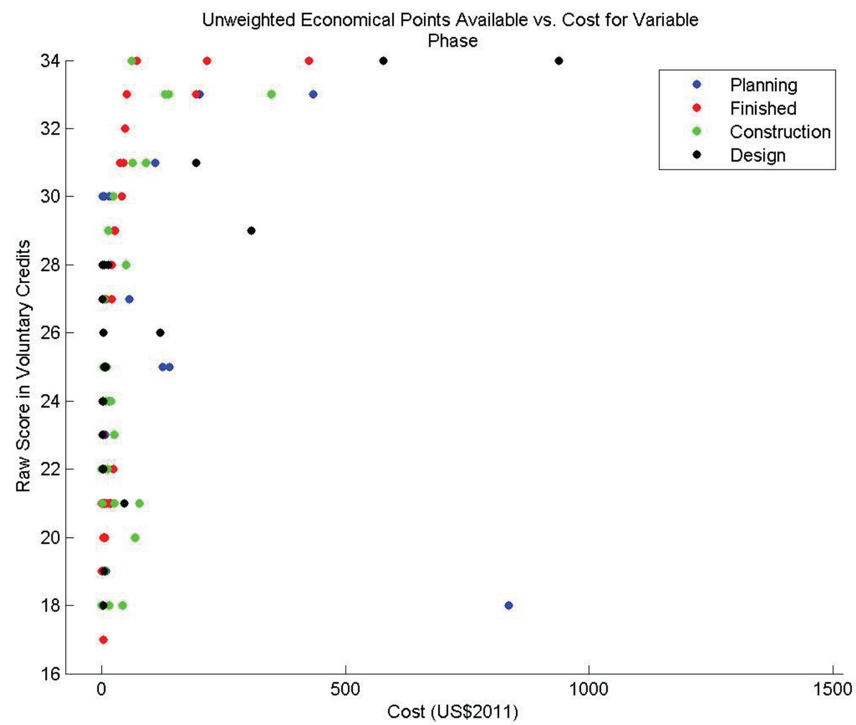

Unweighted Economical Points Available vs. Cost for Variable
Northwest
Northwest
Other Regions
Raw Score in Voluntary Credits
Cost (US$2011)
34
32
30
28
26
24
22
20
18
16
0
500
1000
1500


Unweighted Economical Points Available vs. Cost for Variable
Owner
City/County
State/Provincial
Federal/National
Raw Score in Voluntary Credits
Cost (US$2011)

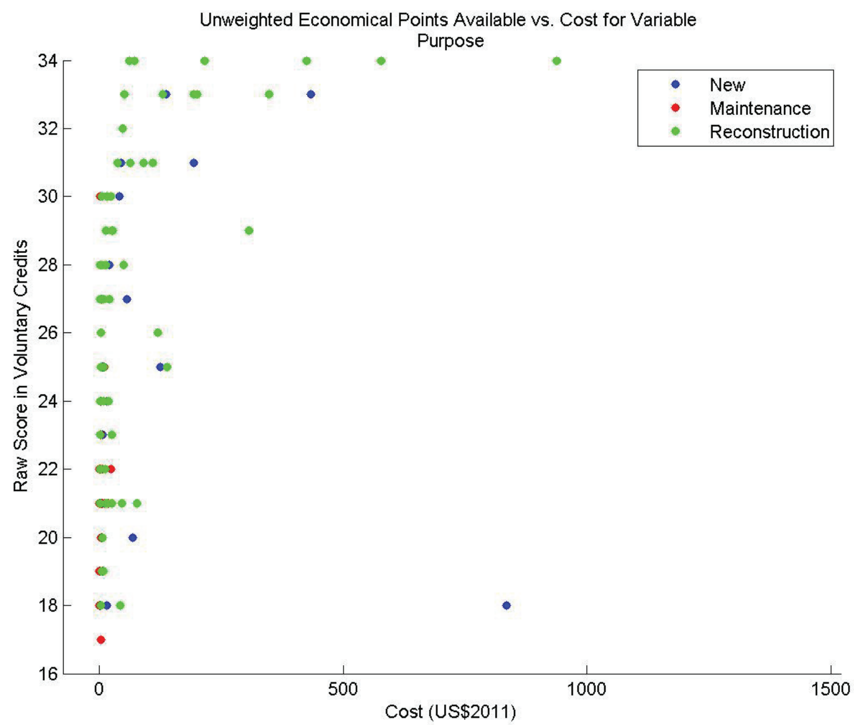

Unweighted Economical Points Available vs. Cost for Variable
Country
International
USA
Raw Score in Voluntary Credits
Cost (US$2011)

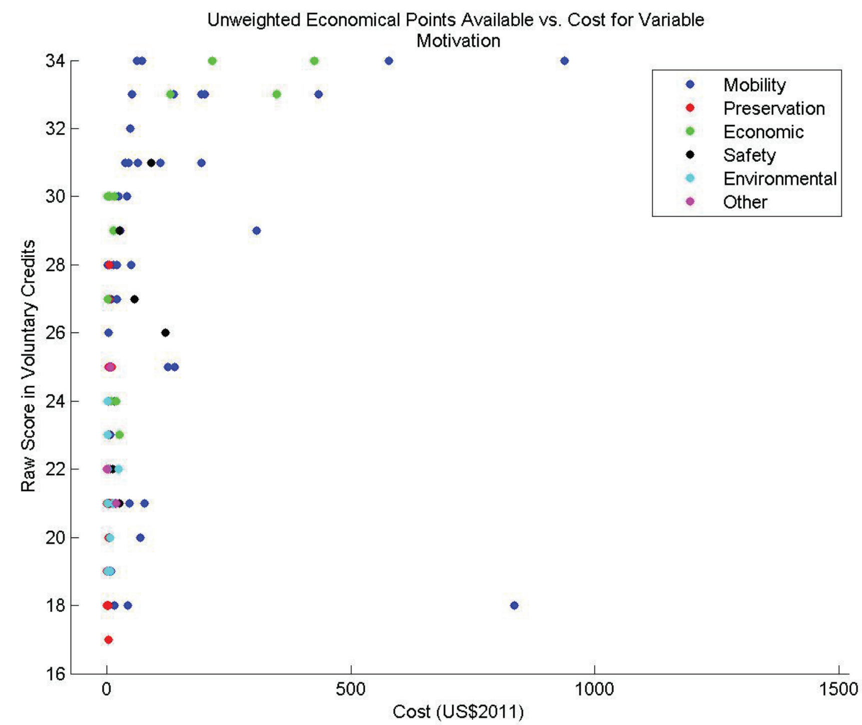


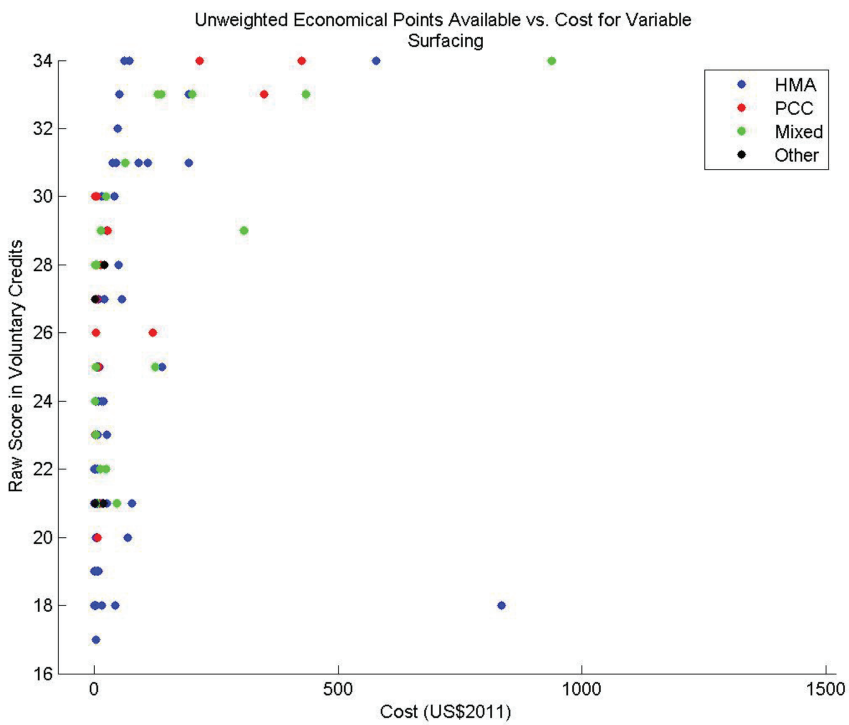
Unweighted Economical Points Available vs. Cost for Variable
Contract
Raw Score in Voluntary Credits
Cost (US$2011)
Conventional DBB
Alternative
Unknown

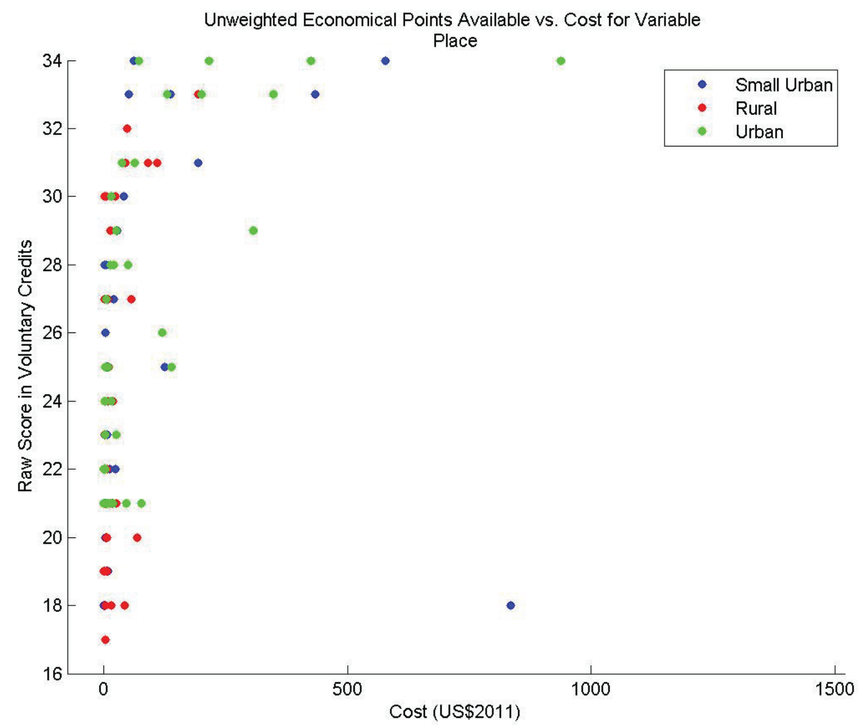


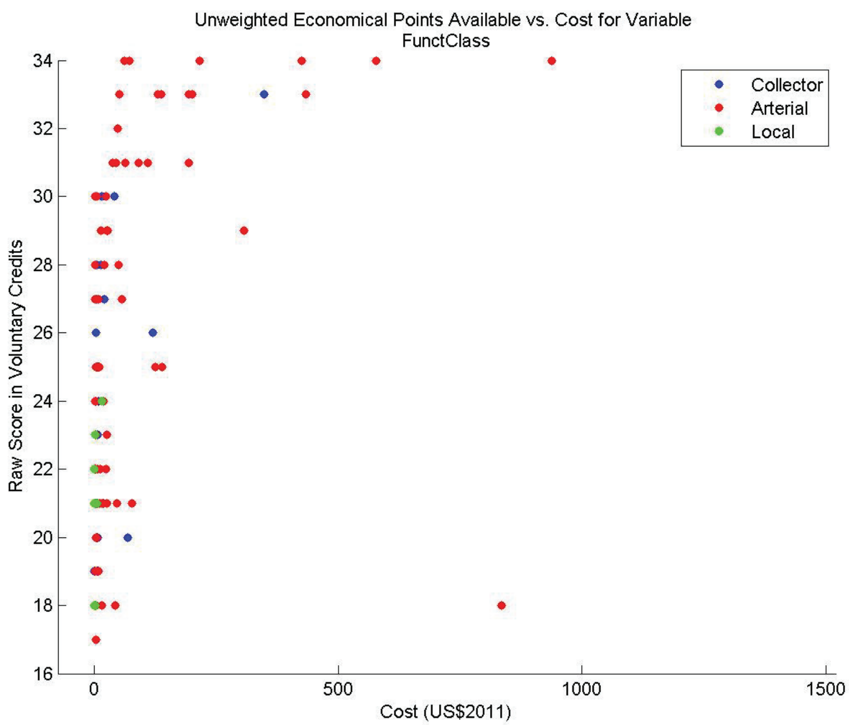
Unweighted Economical Points Available vs. Cost for Variable
Phase
Raw Score in Voluntary Credits
Cost (US$2011)
Planning
Finished
Construction
Design

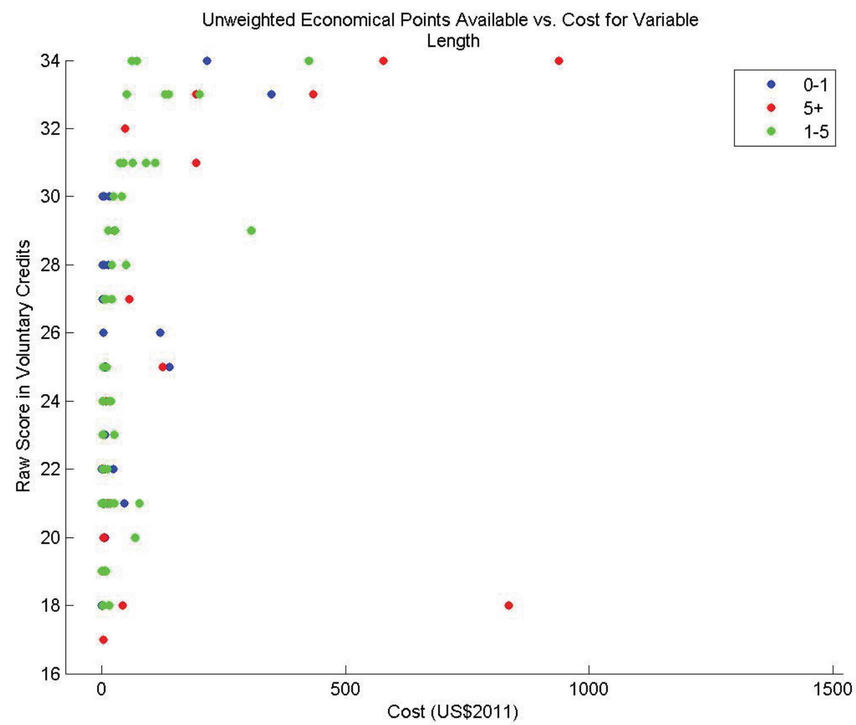

Unweighted Economical Points Available vs. Cost for Variable
Purpose
Raw Score in Voluntary Credits
Cost (US$2011)
New
Maintenance
Reconstruction
34
32
30
28
26
24
22
20
18
16
0
500
1000
1500

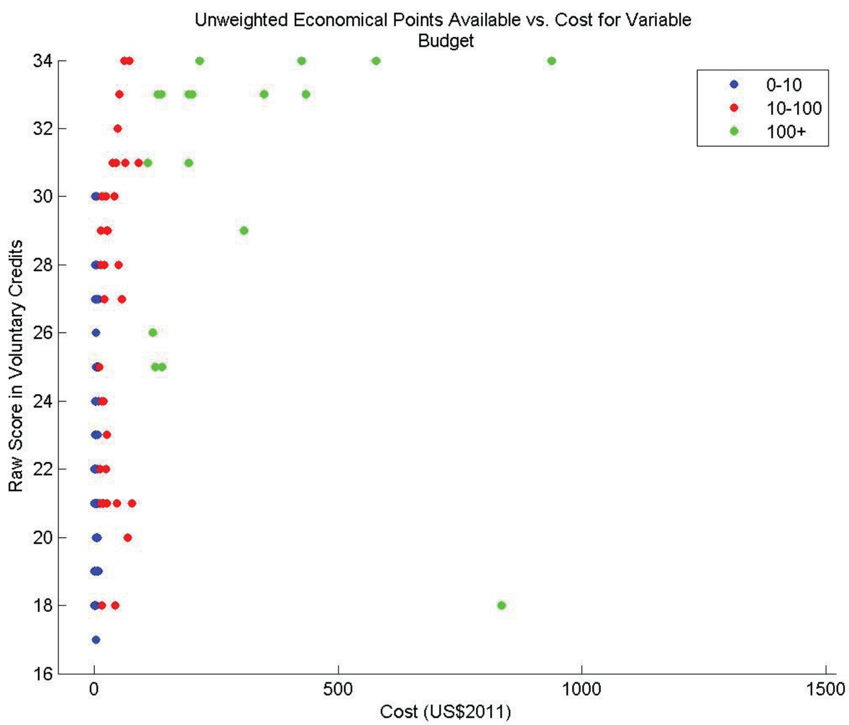

Unweighted Economical Points Available vs. Cost for Variable
Motivation
Raw Score in Voluntary Credits
Cost (US$2011)
Mobility
Preservation
Economic
Safety
Environmental
Other
34
32
30
28
26
24
22
20
18
16
0
500
1000
1500

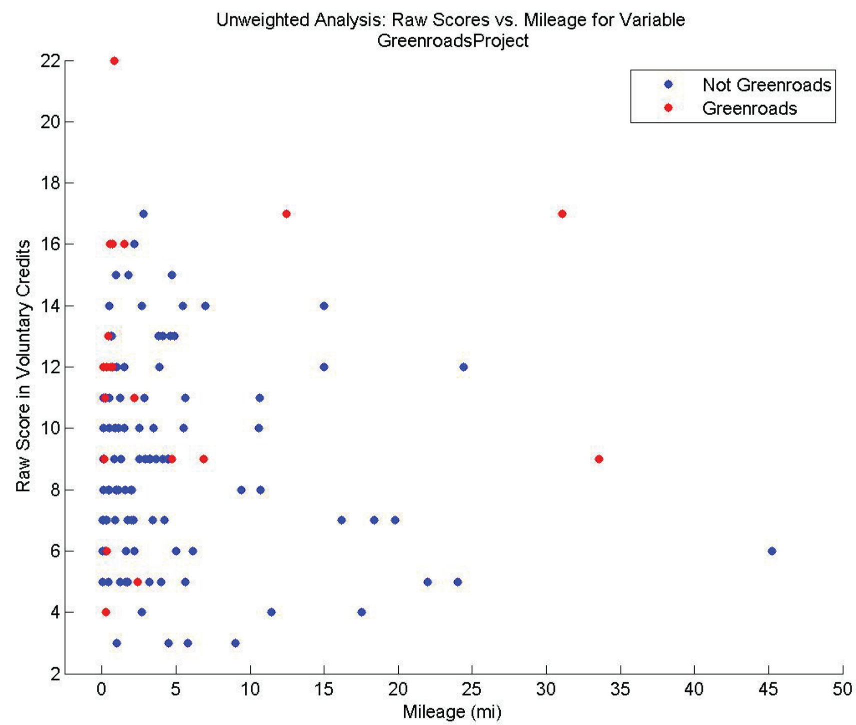

Unweighted Economical Points Available vs. Cost for Variable
Surfacing
HMA
PCC
Mixed
Other
Raw Score in Voluntary Credits
34
32
30
28
26
24
22
20
18
16
0
500
1000
1500
Cost (US$2011)

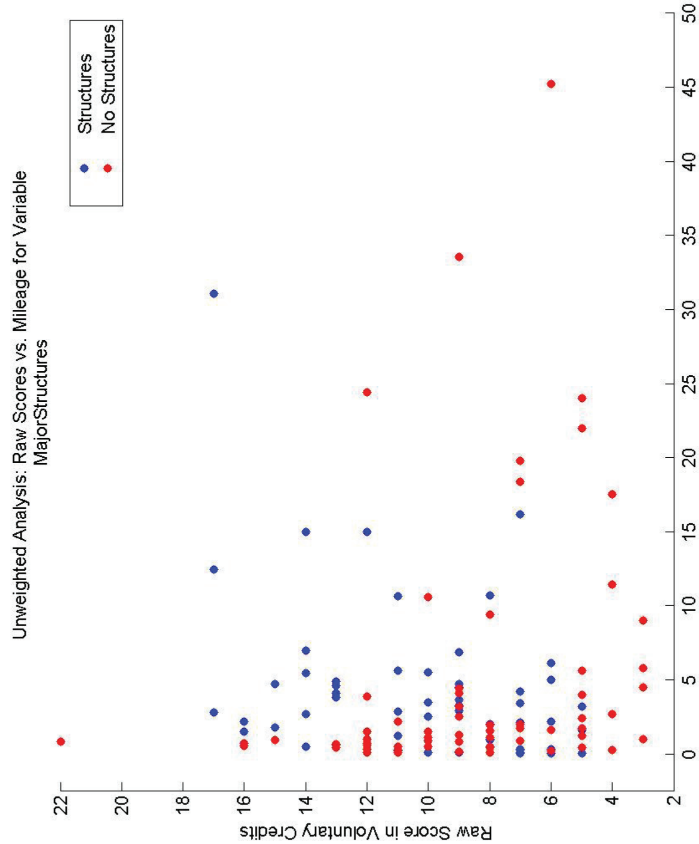

Unweighted Economical Points Available vs. Cost for Variable
Place
Small Urban
Rural
Urban
Raw Score in Voluntary Credits
34
32
30
28
26
24
22
20
18
16
0
500
1000
1500
Cost (US$2011)

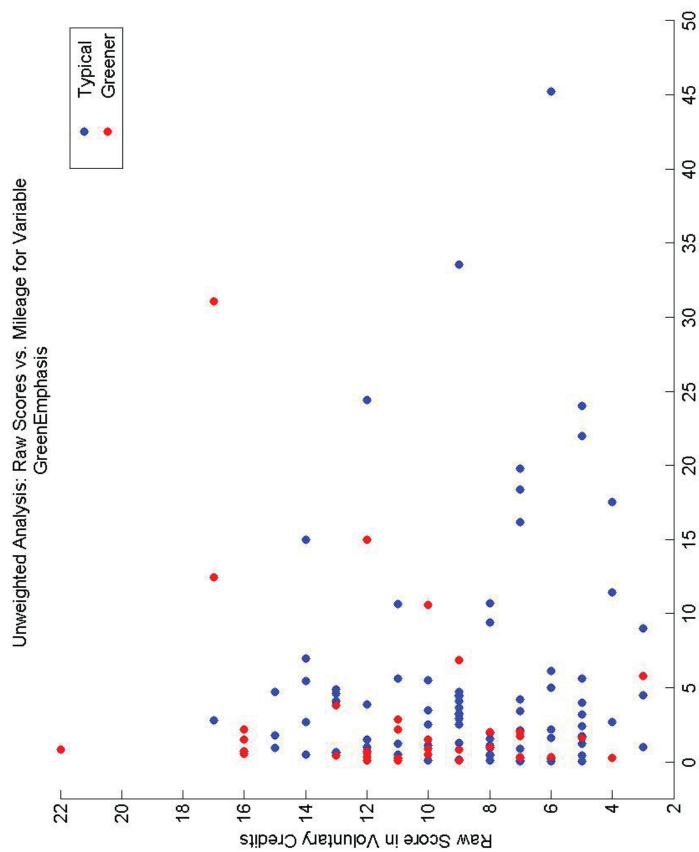

Unweighted Economical Points Available vs. Cost for Variable FunctClass
Raw Score in Voluntary Credits
Cost (US$2011)
Collector
Arterial
Local
34
32
30
28
26
24
22
20
18
16
0
500
1000
1500

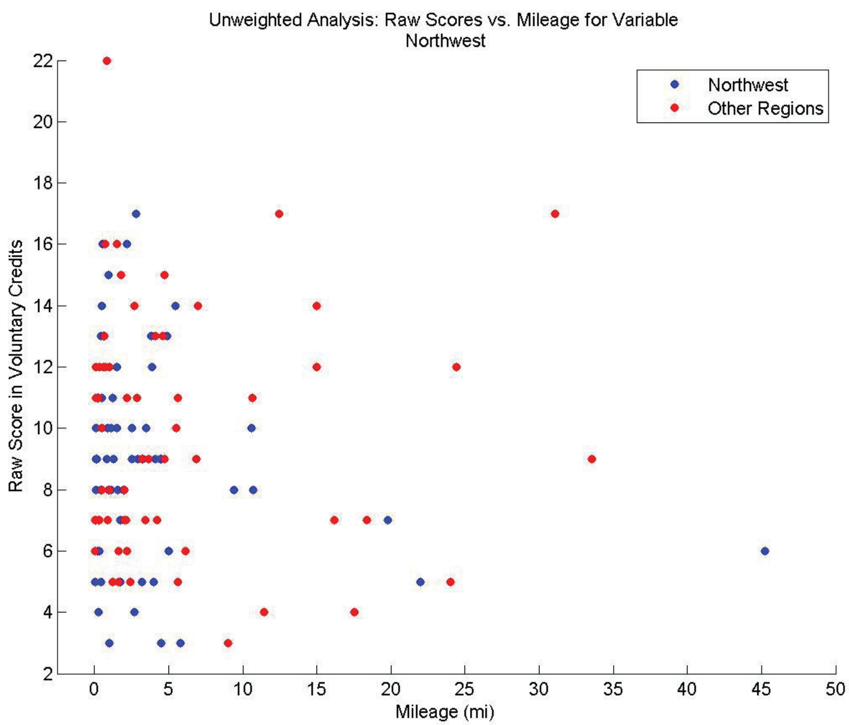

Unweighted Economical Points Available vs. Cost for Variable Length
Raw Score in Voluntary Credits
Cost (US$2011)
0-1
5+
1-5
34
32
30
28
26
24
22
20
18
16
0
500
1000
1500

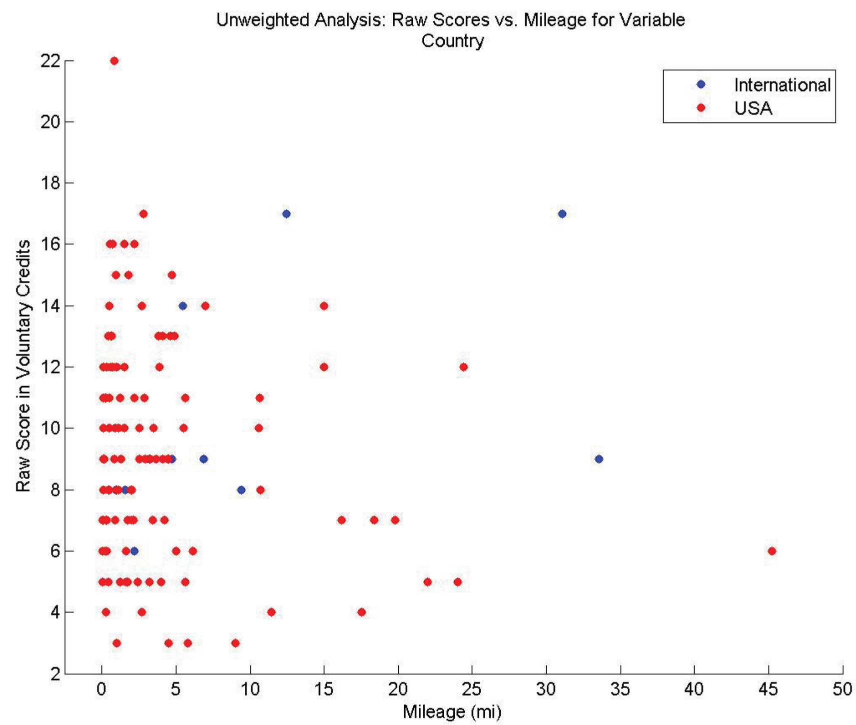

Unweighted Economical Points Available vs. Cost for Variable
Budget
Raw Score in Voluntary Credits
Cost (US$2011)
0-10
10-100
100+

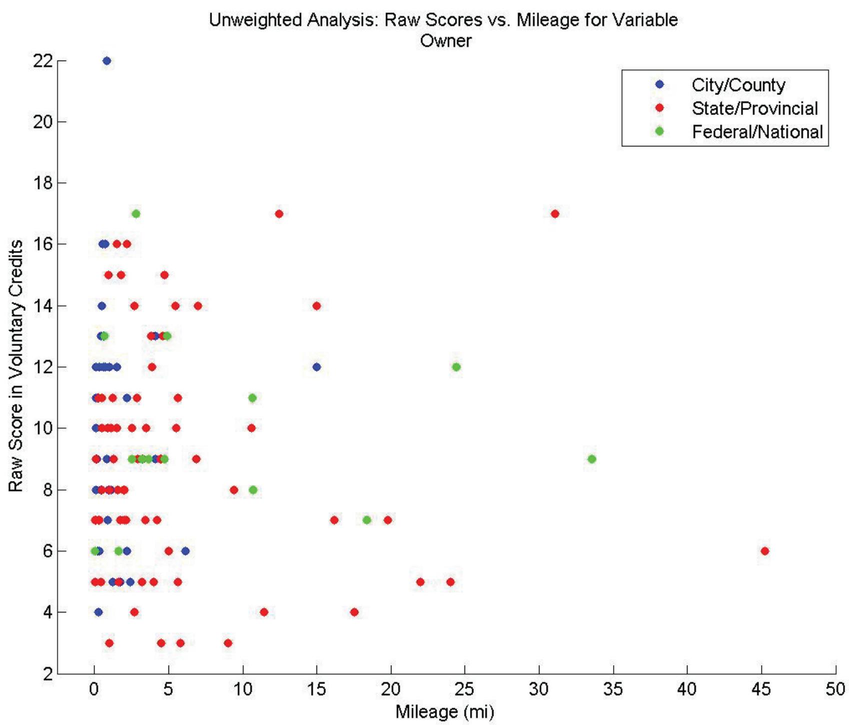

Unweighted Analysis: Raw Scores vs. Mileage for Variable
GreenroadsProject
Raw Score in Voluntary Credits
Mileage (mi)
Not Greenroads
Greenroads

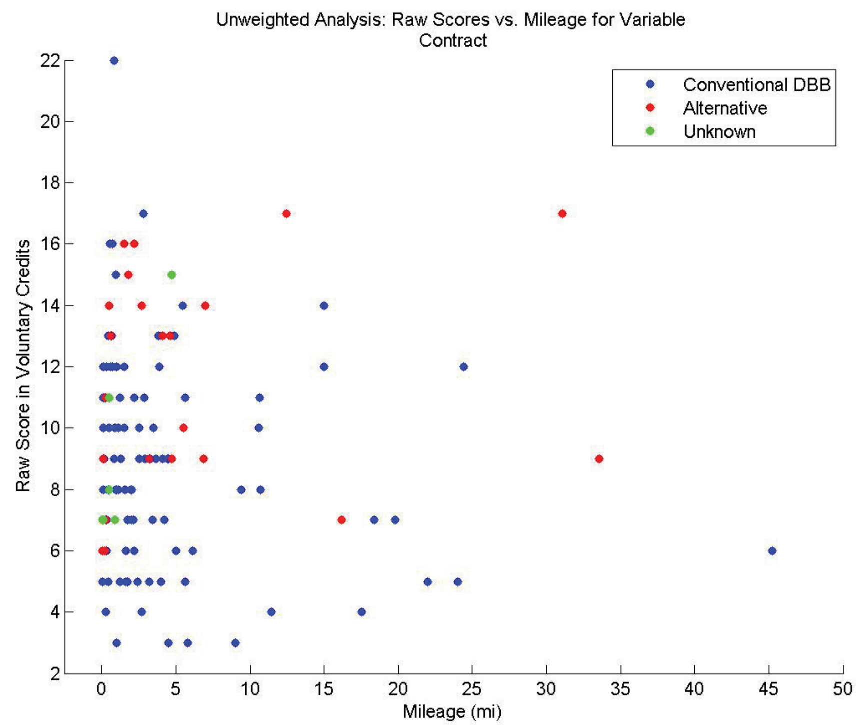

Unweighted Analysis: Raw Scores vs. Mileage for Variable
MajorStructures
Structures
No Structures
Raw Score in Voluntary Credits
Mileage (mi)

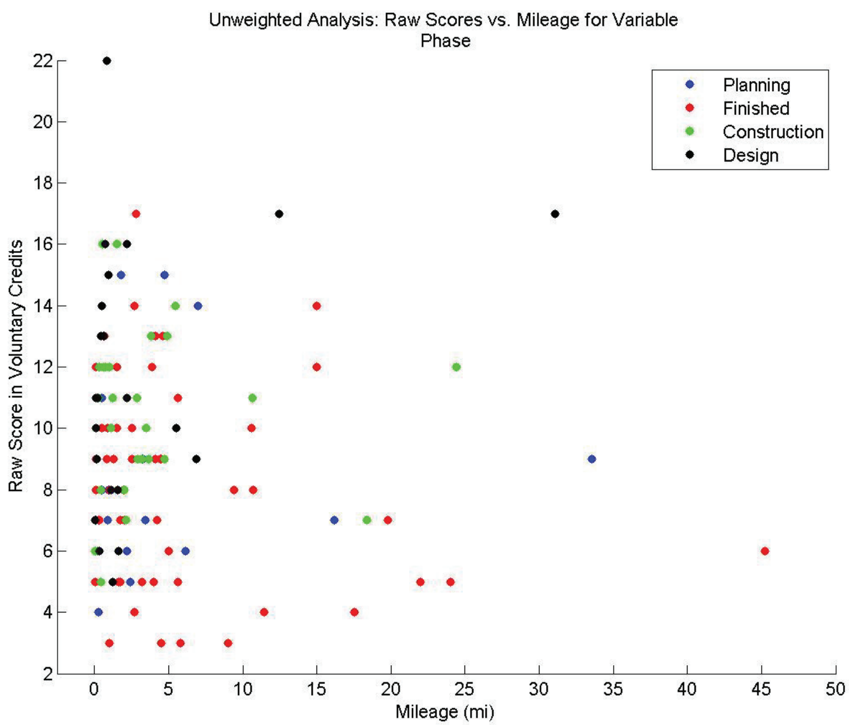

Unweighted Analysis: Raw Scores vs. Mileage for Variable
GreenEmphasis
Typical
Greener
Raw Score in Voluntary Credits
Mileage (mi)

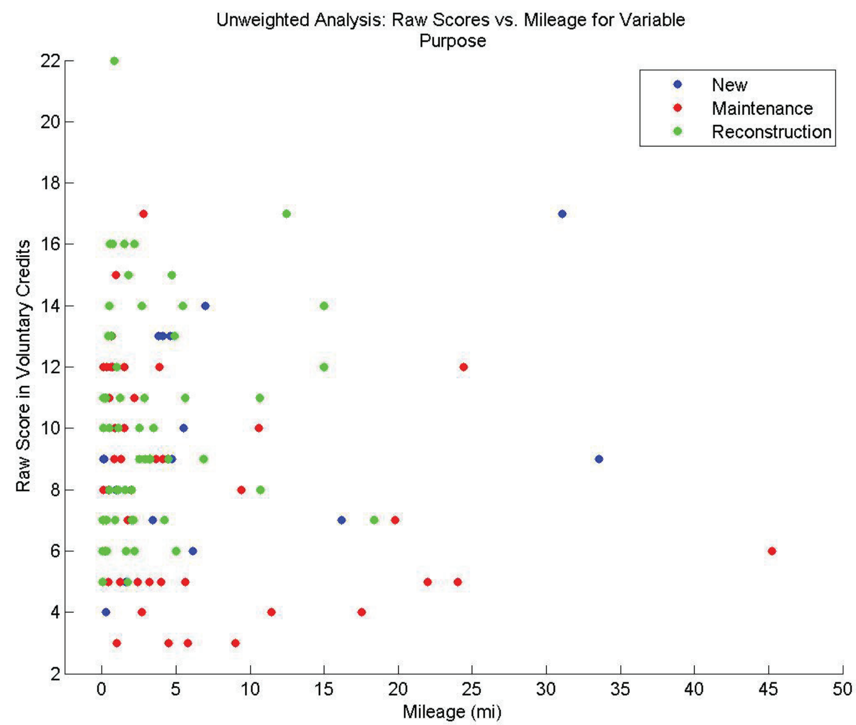

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Northwest
Northwest
Other Regions
Raw Score in Voluntary Credits
Mileage (mi)
22
20
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
50

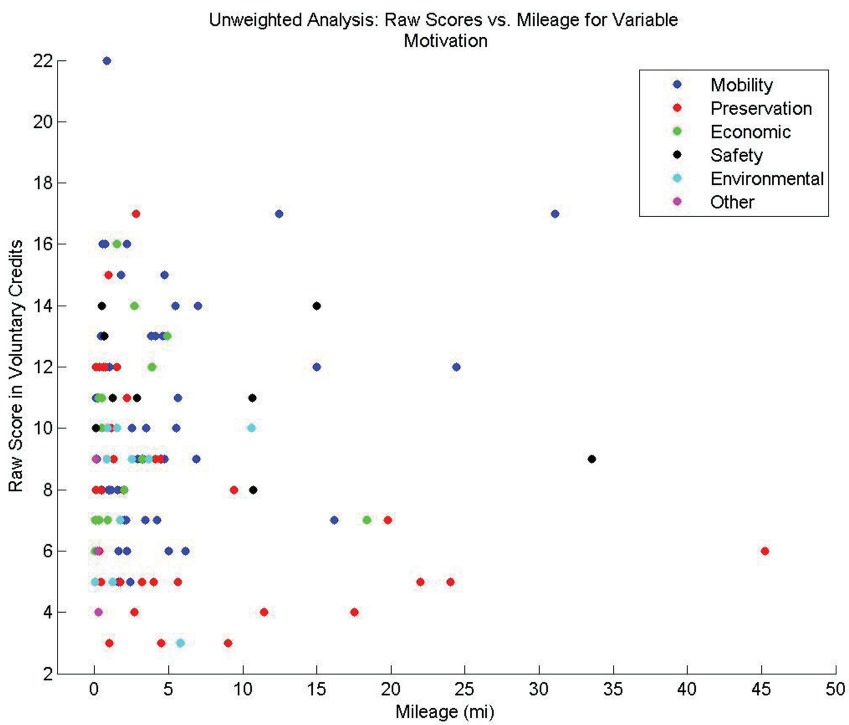

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Country
International
USA
Raw Score in Voluntary Credits
Mileage (mi)
22
20
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
50

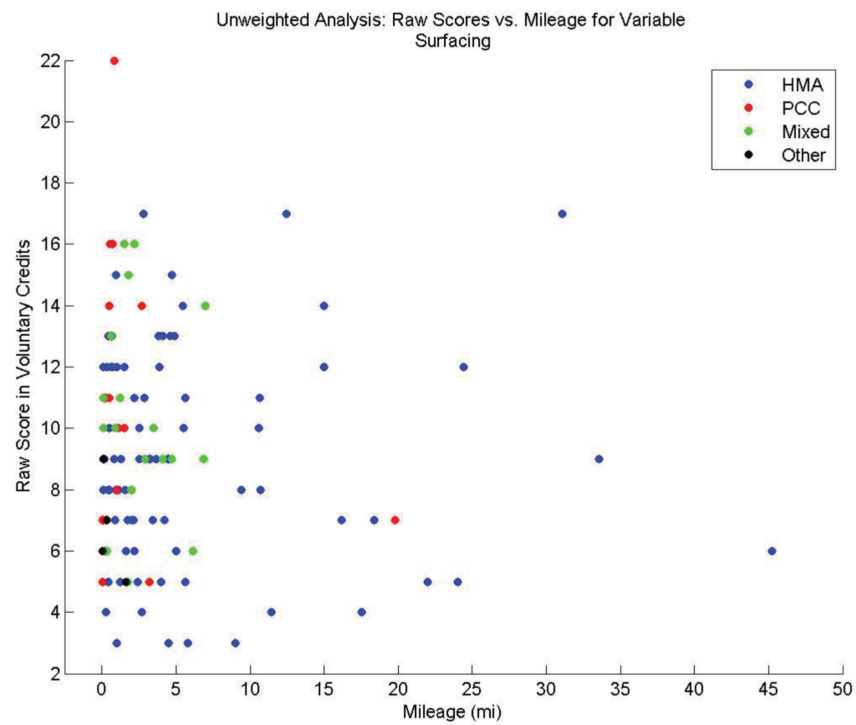

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Owner
City/County
State/Provincial
Federal/National
Raw Score in Voluntary Credits
Mileage (mi)
2
4
6
8
10
12
14
16
18
20
22
0
5
10
15
20
25
30
35
40
45
50

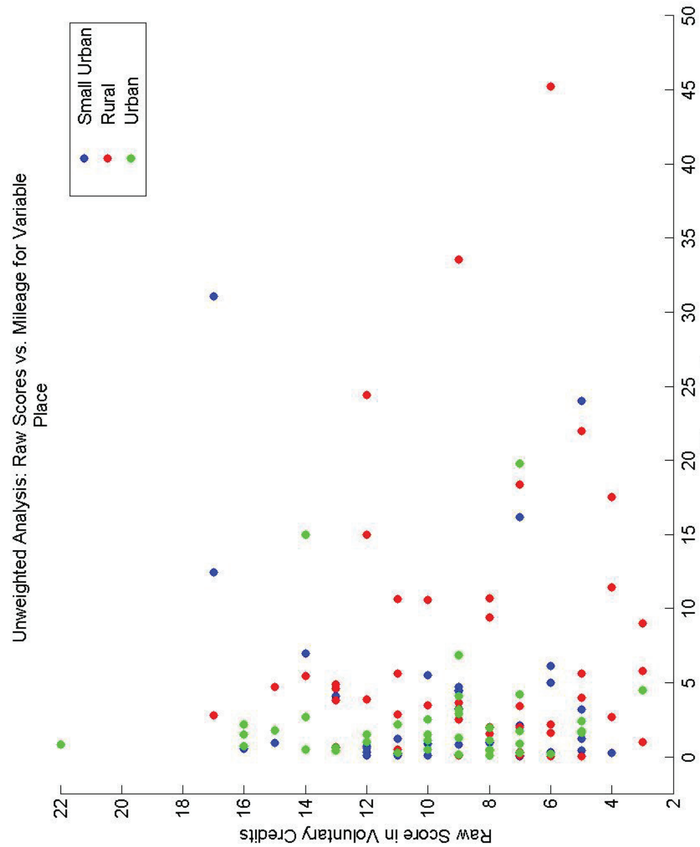

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Contract
Conventional DBB
Alternative
Unknown
Raw Score in Voluntary Credits
Mileage (mi)
2
4
6
8
10
12
14
16
18
20
22
0
5
10
15
20
25
30
35
40
45
50

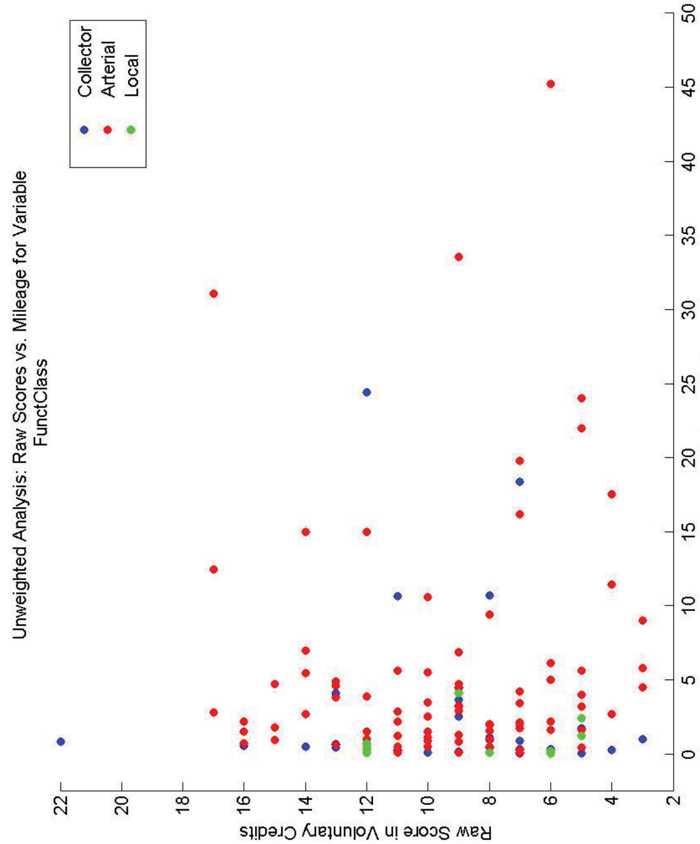

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Phase
Raw Score in Voluntary Credits
Mileage (mi)
Planning
Finished
Construction
Design
22
20
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
50

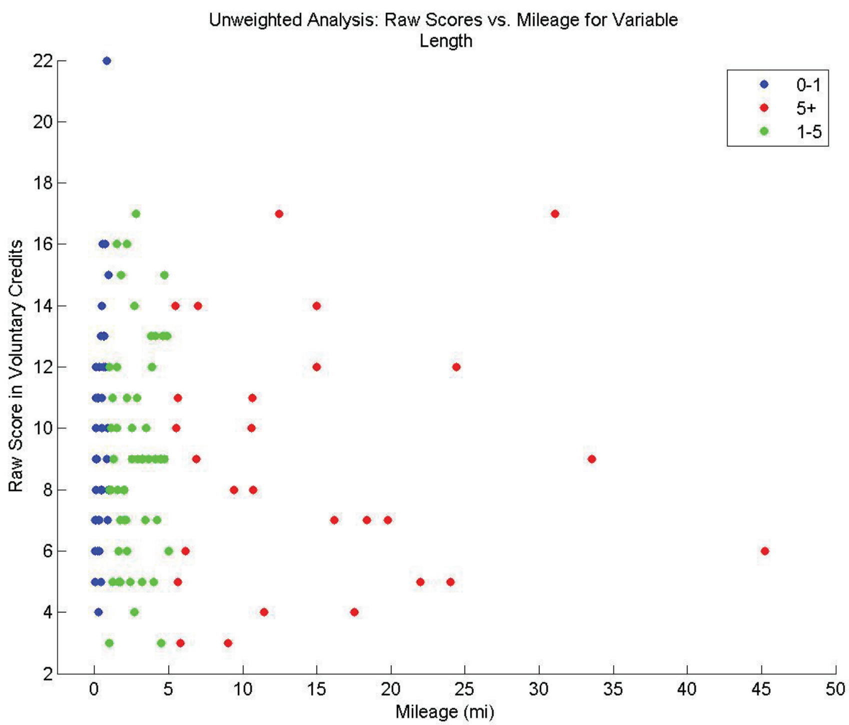

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Purpose
Raw Score in Voluntary Credits
Mileage (mi)
New
Maintenance
Reconstruction
22
20
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
50

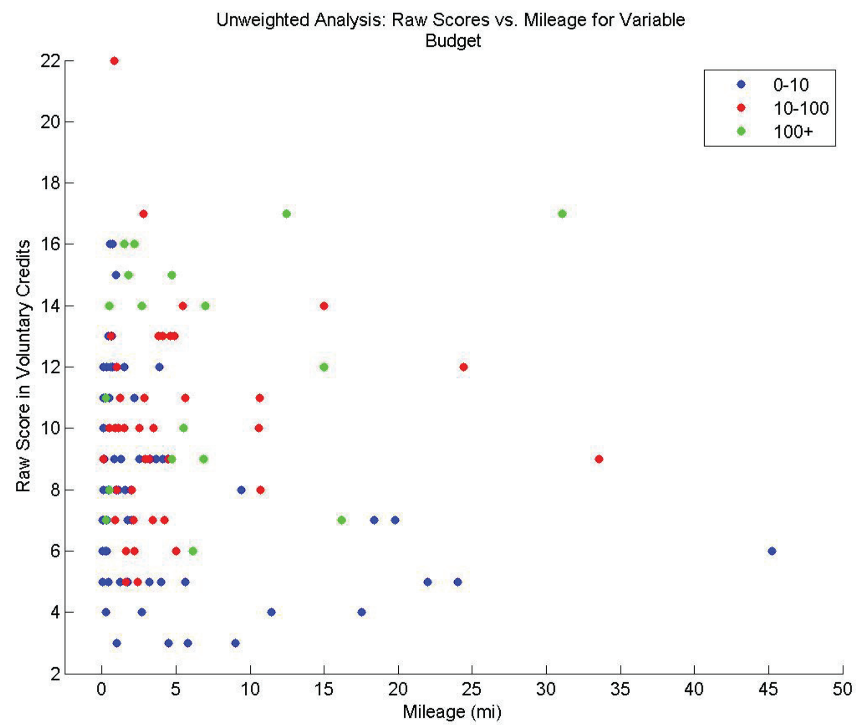

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Motivation
Raw Score in Voluntary Credits
Mileage (mi)
Mobility
Preservation
Economic
Safety
Environmental
Other

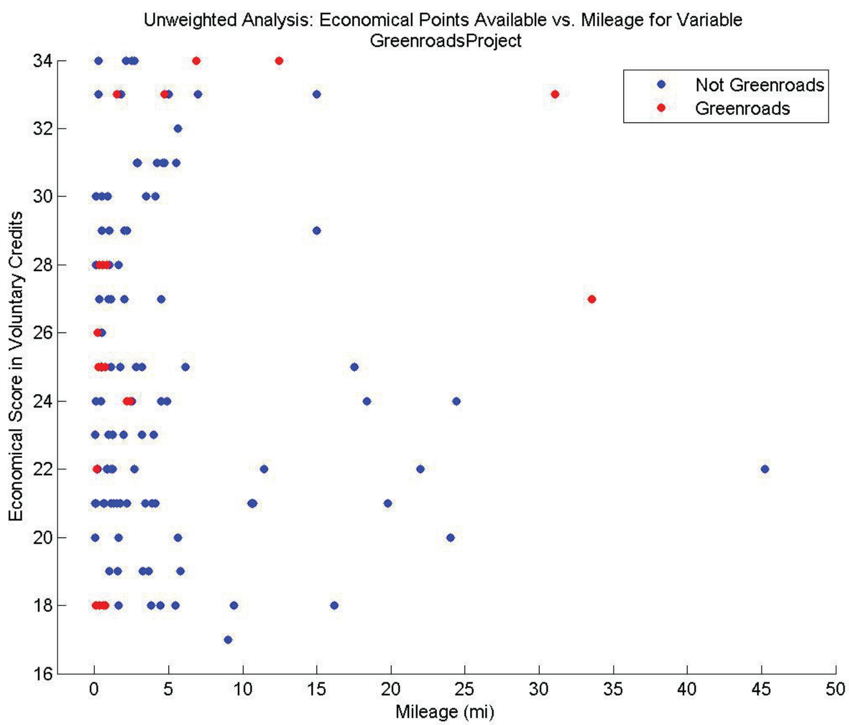

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Surfacing
Raw Score in Voluntary Credits
Mileage (mi)
HMA
PCC
Mixed
Other

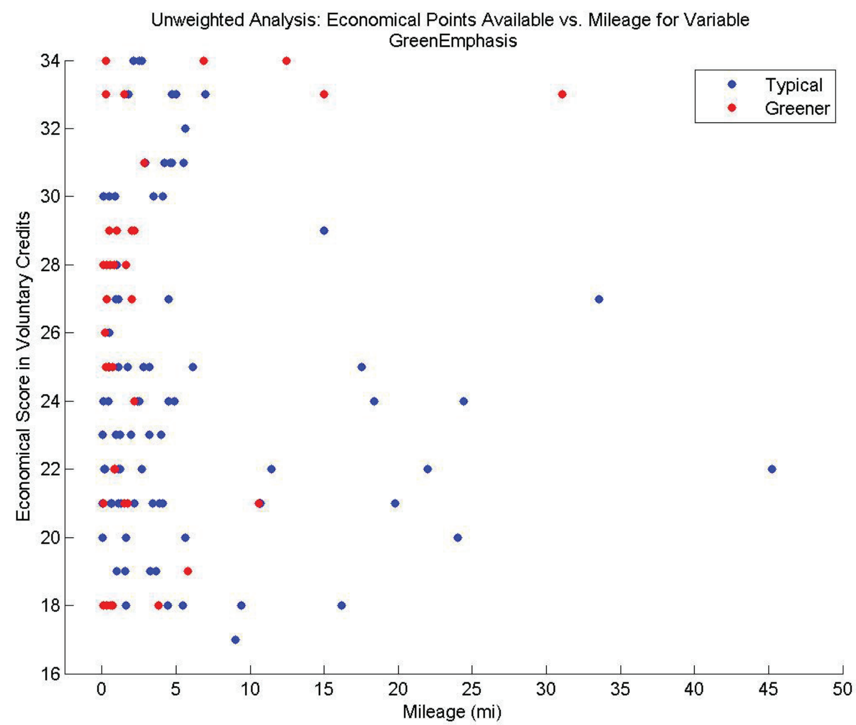

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Place
Small Urban
Rural
Urban
Raw Score in Voluntary Credits
Mileage (mi)

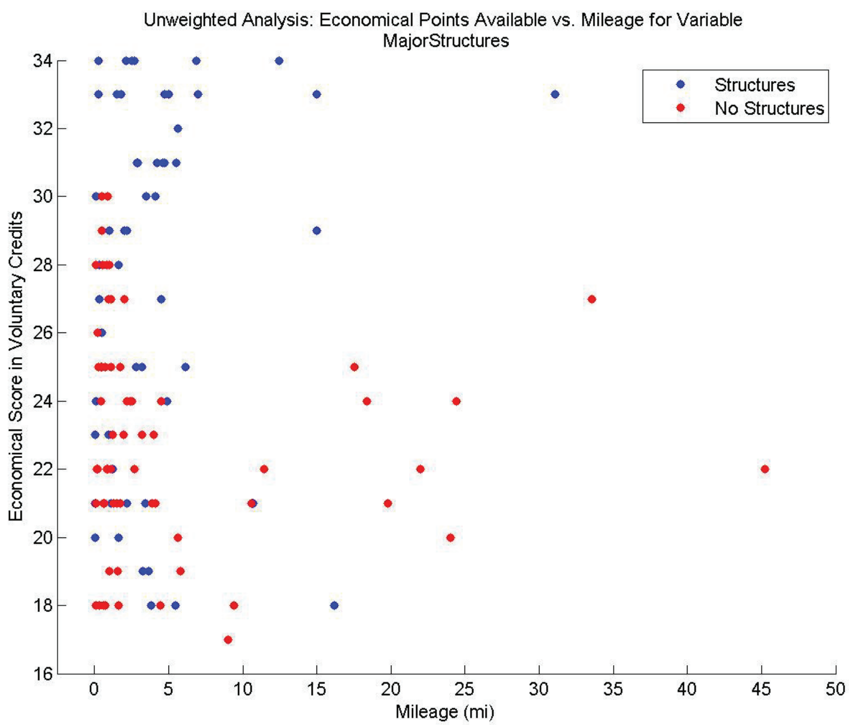

Unweighted Analysis: Raw Scores vs. Mileage for Variable
FunctClass
Collector
Arterial
Local
Raw Score in Voluntary Credits
Mileage (mi)

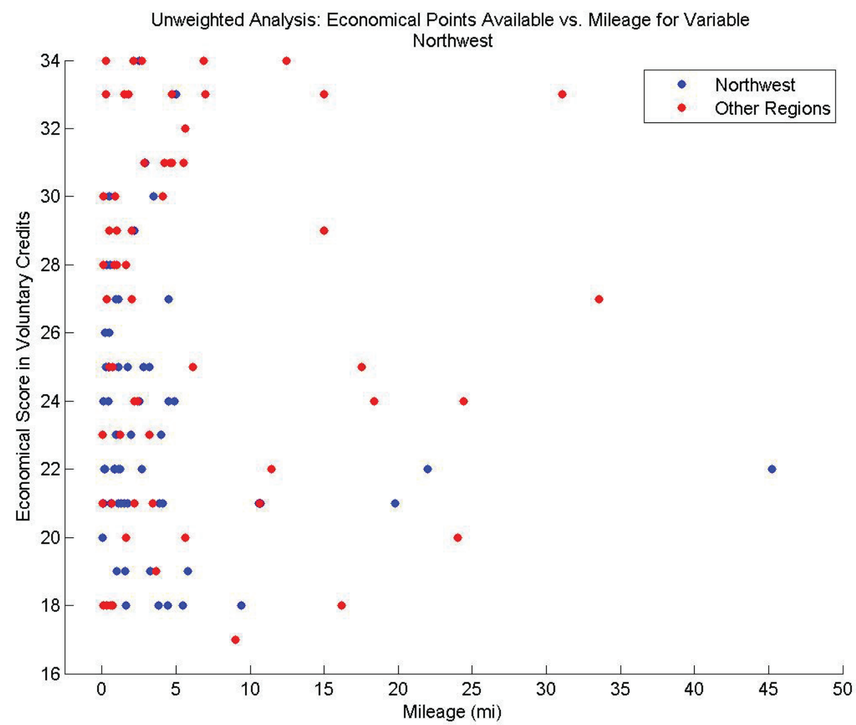

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Length
Raw Score in Voluntary Credits
Mileage (mi)
0-1
5+
1-5
2
4
6
8
10
12
14
16
18
20
22
0
5
10
15
20
25
30
35
40
45
50

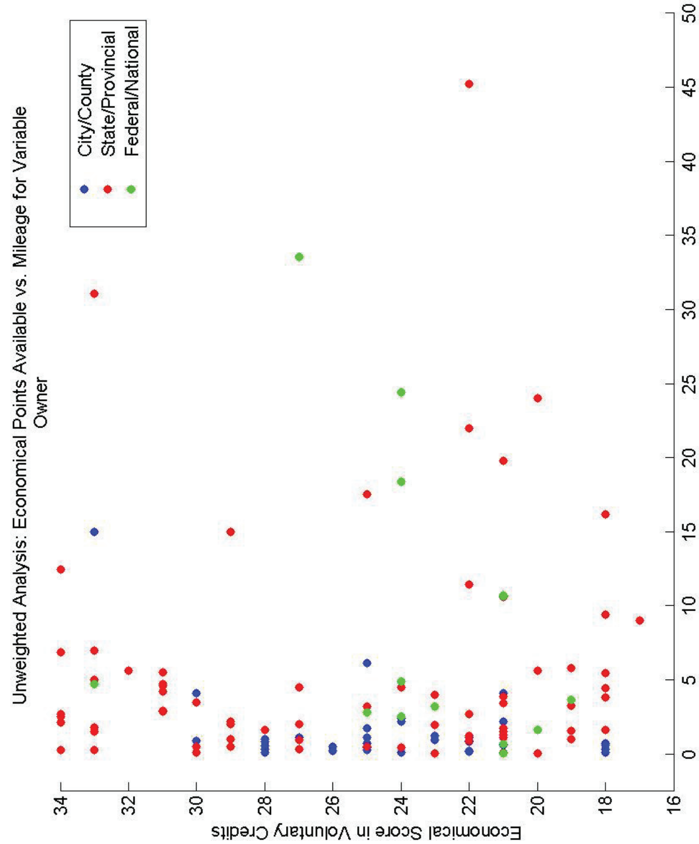

Unweighted Analysis: Raw Scores vs. Mileage for Variable
Budget
Raw Score in Voluntary Credits
Mileage (mi)
0-10
10-100
100+
2
4
6
8
10
12
14
16
18
20
22
0
5
10
15
20
25
30
35
40
45
50

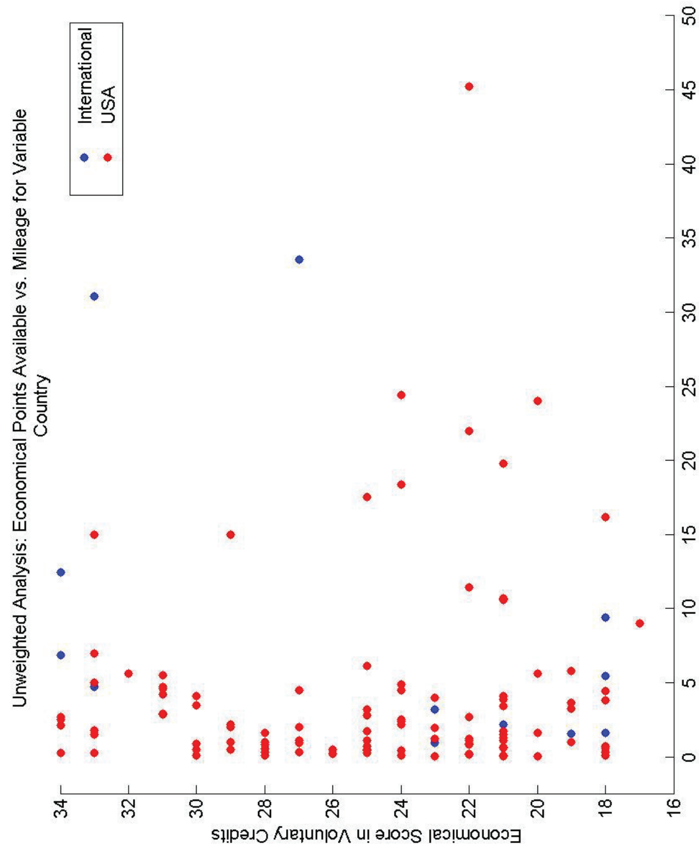

Unweighted Analysis: Economical Points Available vs. Mileage for Variable
GreenroadsProject
Not Greenroads
Greenroads
Economical Score in Voluntary Credits
Mileage (mi)

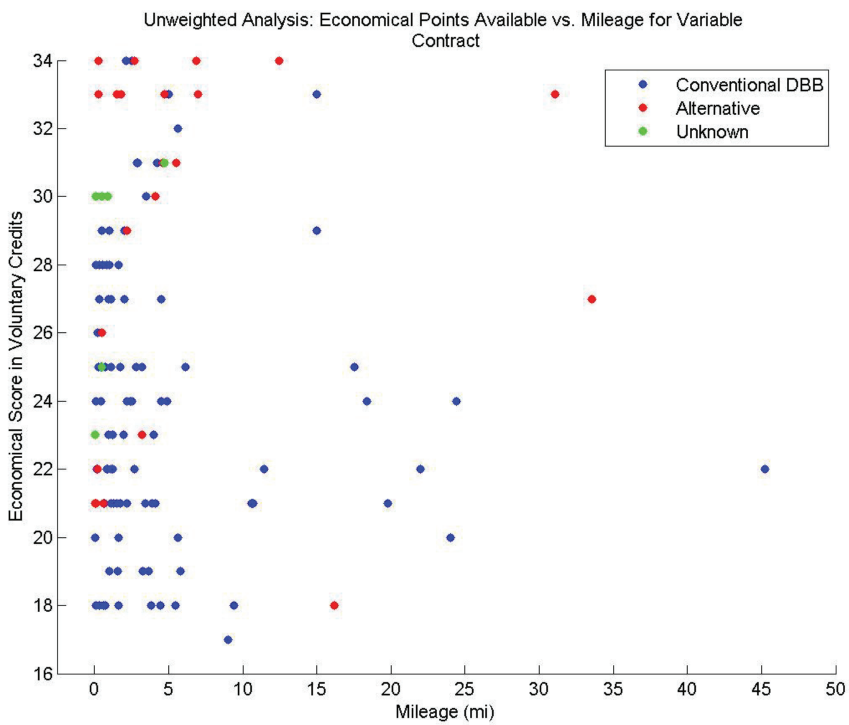

Unweighted Analysis: Economical Points Available vs. Mileage for Variable
GreenEmphasis
Typical
Greener
Economical Score in Voluntary Credits
Mileage (mi)

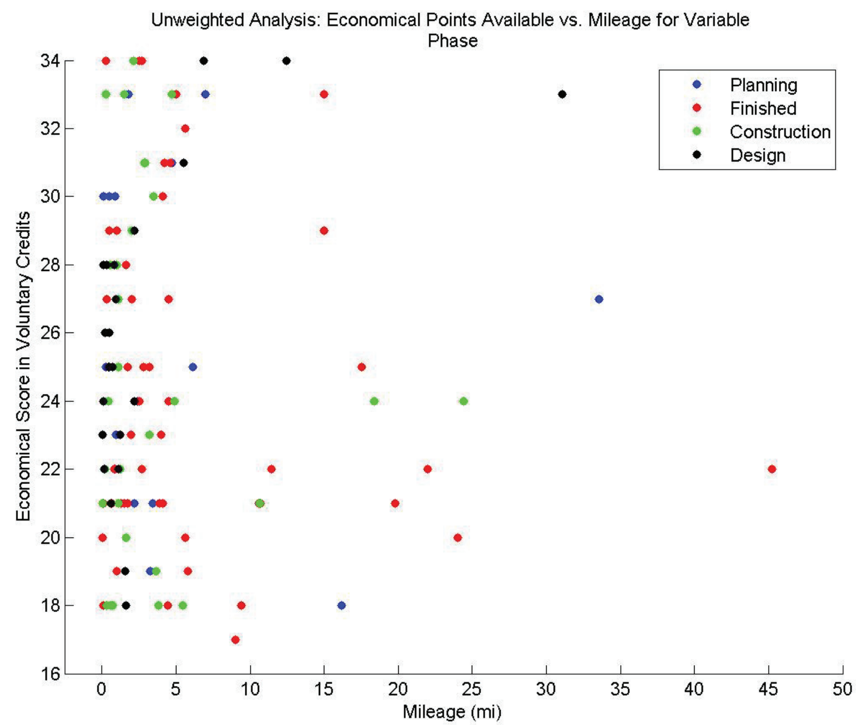

Unweighted Analysis: Economical Points Available vs. Mileage for Variable
MajorStructures
Structures
No Structures
Economical Score in Voluntary Credits
Mileage (mi)
34
32
30
28
26
24
22
20
18
16
0
5
10
15
20
25
30
35
40
45
50

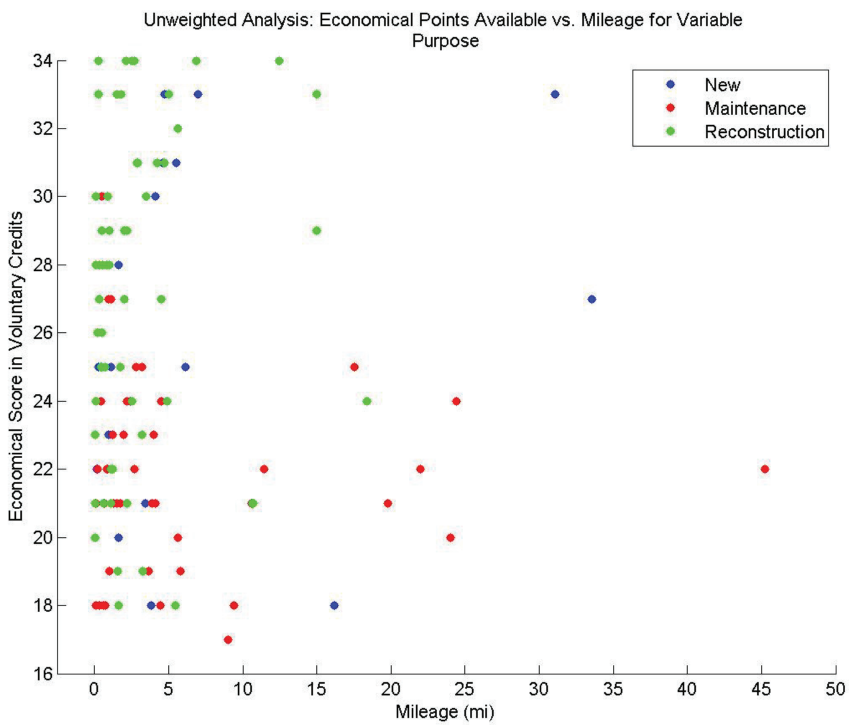

Unweighted Analysis: Economical Points Available vs. Mileage for Variable
Northwest
Northwest
Other Regions
Economical Score in Voluntary Credits
Mileage (mi)
34
32
30
28
26
24
22
20
18
16
0
5
10
15
20
25
30
35
40
45
50

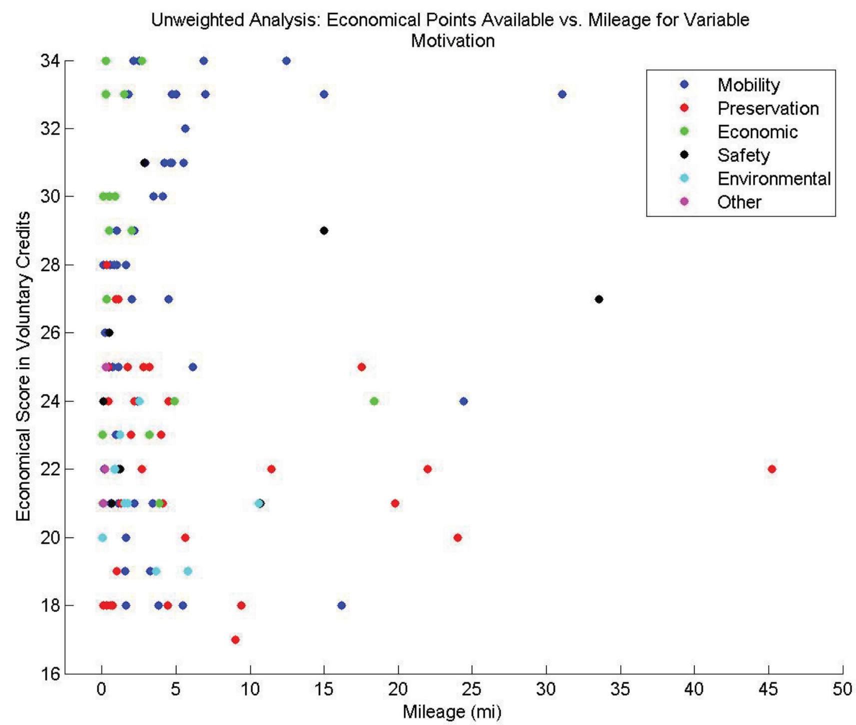

Unweighted Analysis: Economical Points Available vs. Mileage for Variable Owner
City/County
State/Provincial
Federal/National
Economical Score in Voluntary Credits
Mileage (mi)


Unweighted Analysis: Economical Points Available vs. Mileage for Variable Country
International
USA
Economical Score in Voluntary Credits
Mileage (mi)

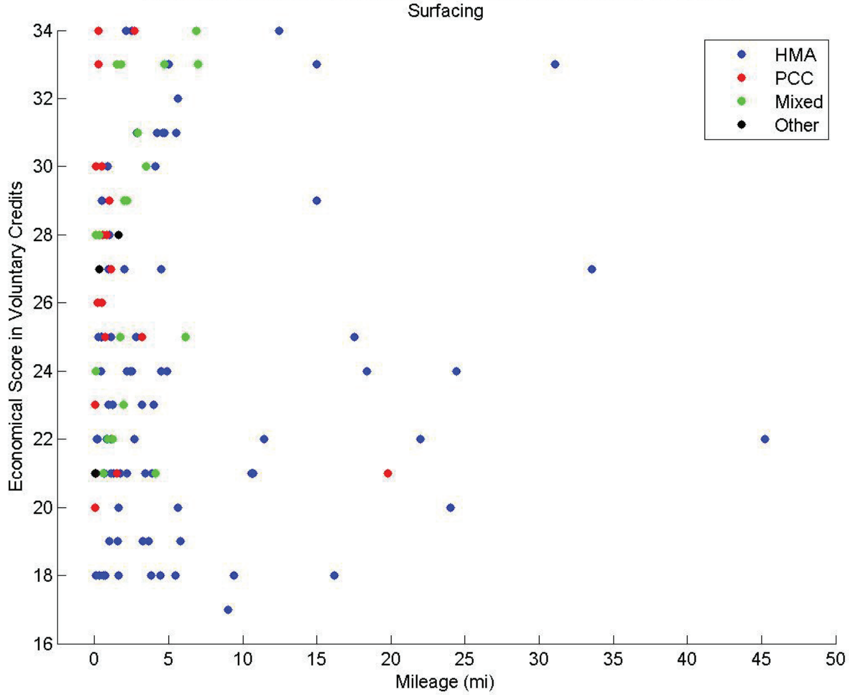

Unweighted Analysis: Economical Points Available vs. Mileage for Variable Contract
Conventional DBB
Alternative
Unknown
Economical Score in Voluntary Credits
Mileage (mi)
34
32
30
28
26
24
22
20
18
16
0
5
10
15
20
25
30
35
40
45
50


Unweighted Analysis: Economical Points Available vs. Mileage for Variable Phase
Planning
Finished
Construction
Design
Economical Score in Voluntary Credits
Mileage (mi)
34
32
30
28
26
24
22
20
18
16
0
5
10
15
20
25
30
35
40
45
50

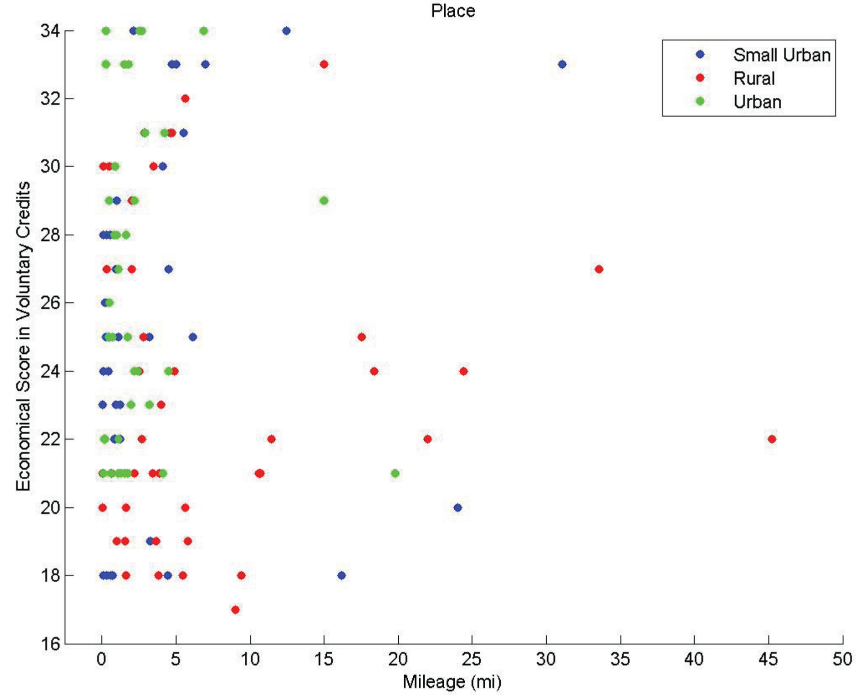

Unweighted Analysis: Economical Points Available vs. Mileage for Variable
Purpose
Economical Score in Voluntary Credits
Mileage (mi)
New
Maintenance
Reconstruction

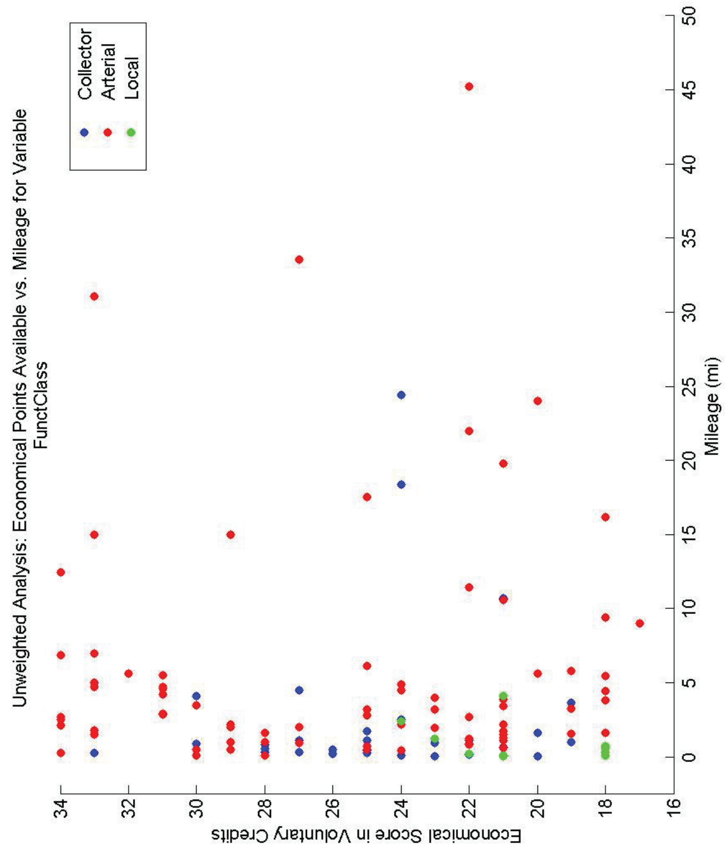

Unweighted Analysis: Economical Points Available vs. Mileage for Variable
Motivation
Economical Score in Voluntary Credits
Mileage (mi)
Mobility
Preservation
Economic
Safety
Environmental
Other

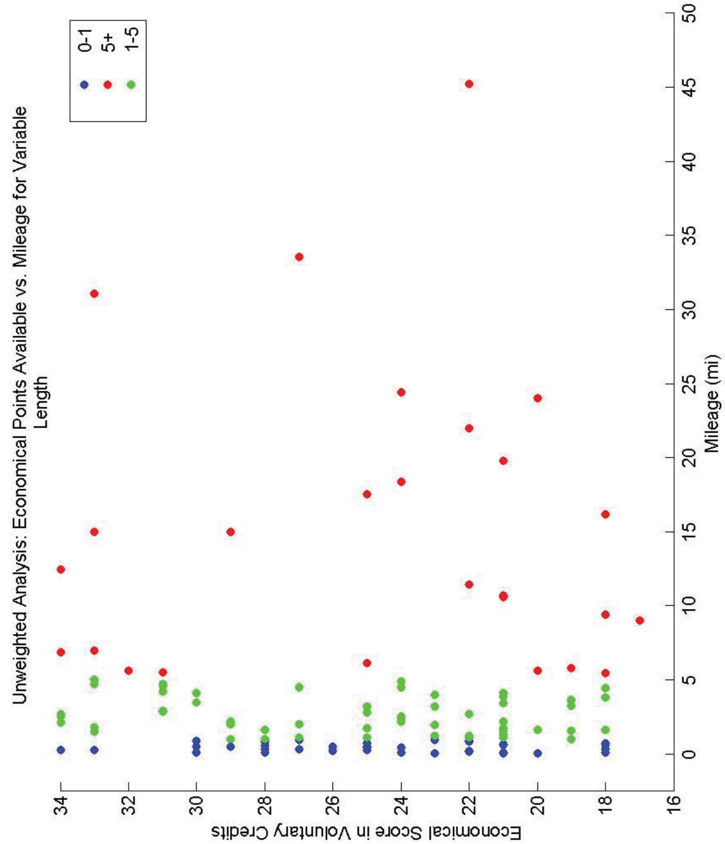
Unweighted Analysis: Economical Points Available vs. Mileage for Variable Surfacing

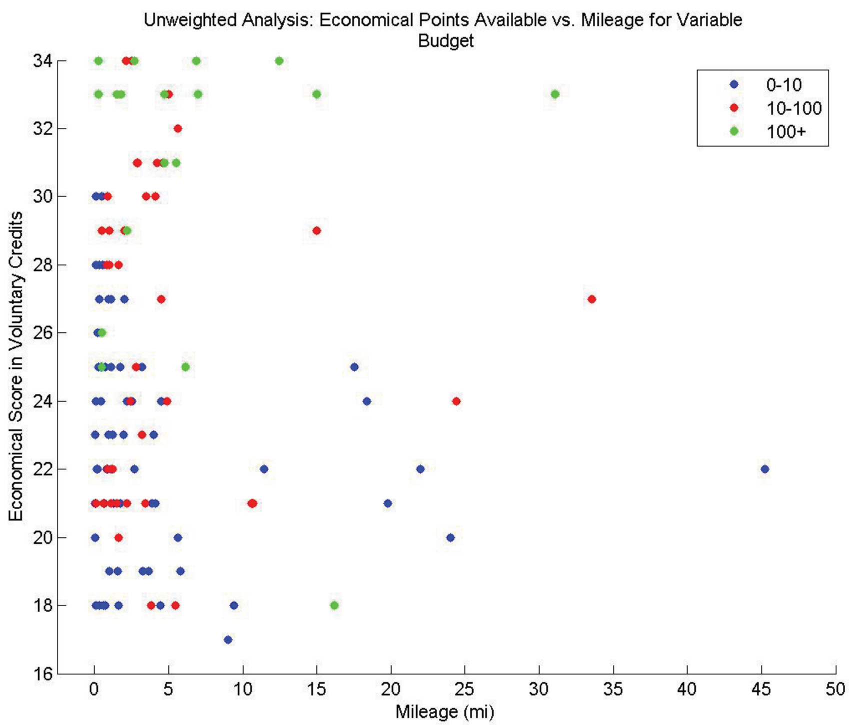


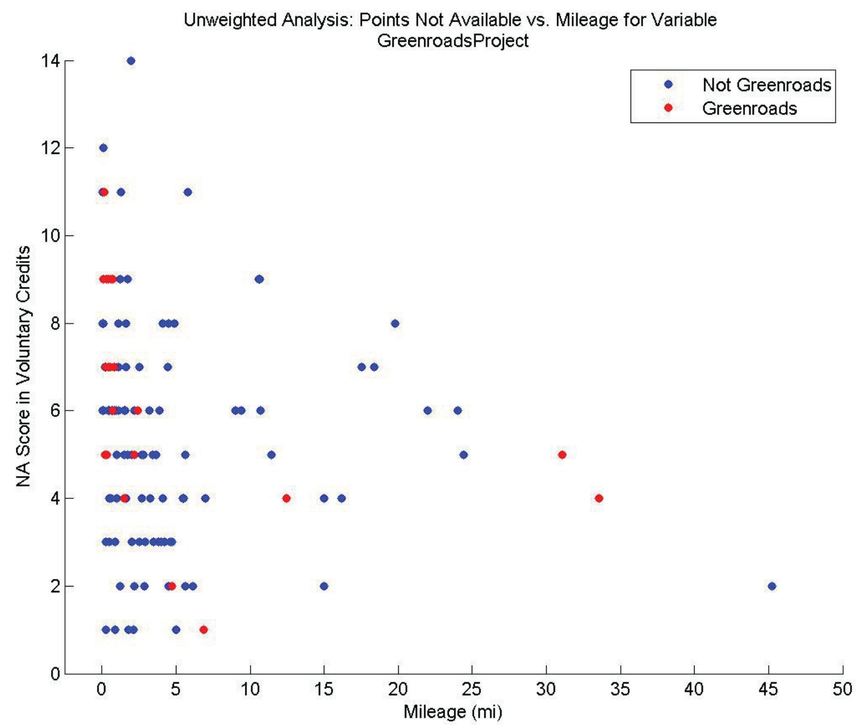
Unweighted Analysis: Economical Points Available vs. Mileage for Variable Place

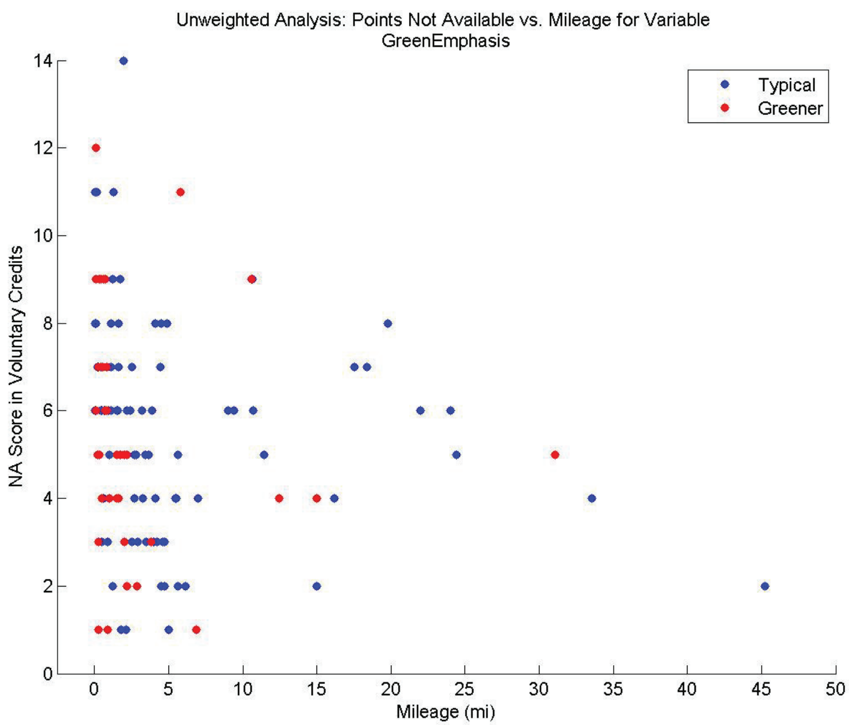


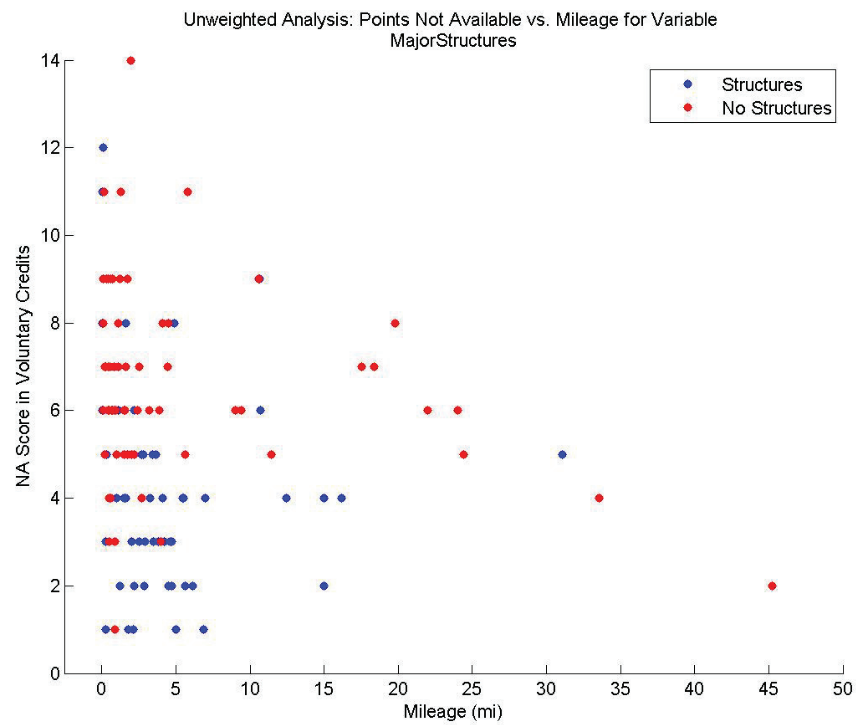

Unweighted Analysis: Economical Points Available vs. Mileage for Variable FunctClass
Collector
Arterial
Local
Economical Score in Voluntary Credits
Mileage (mi)
16
18
20
22
24
26
28
30
32
34
0
5
10
15
20
25
30
35
40
45
50

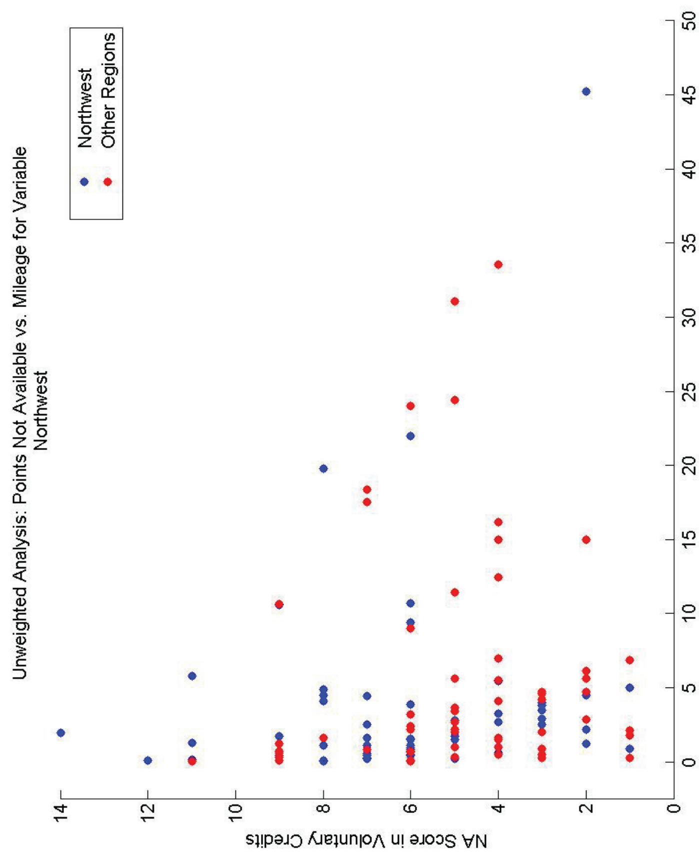

Unweighted Analysis: Economical Points Available vs. Mileage for Variable Length
0-1
5+
1-5
Economical Score in Voluntary Credits
Mileage (mi)
16
18
20
22
24
26
28
30
32
34
0
5
10
15
20
25
30
35
40
45
50


Unweighted Analysis: Economical Points Available vs. Mileage for Variable
Budget
Economical Score in Voluntary Credits
Mileage (mi)
0-10
10-100
100+

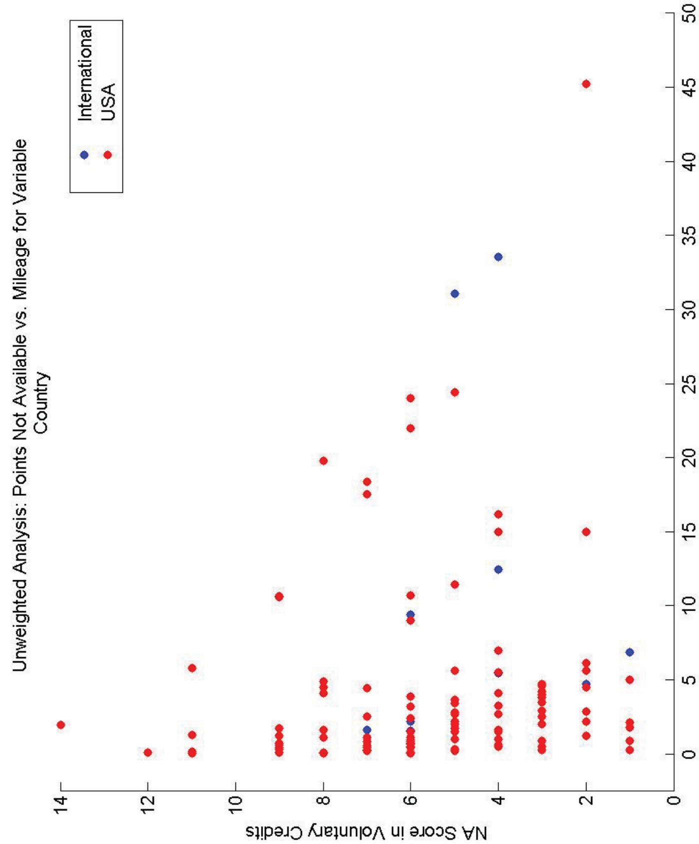

Unweighted Analysis: Points Not Available vs. Mileage for Variable
GreenroadsProject
NA Score in Voluntary Credits
Mileage (mi)
Not Greenroads
Greenroads


Unweighted Analysis: Points Not Available vs. Mileage for Variable
GreenEmphasis
Typical
Greener
NA Score in Voluntary Credits
Mileage (mi)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
50

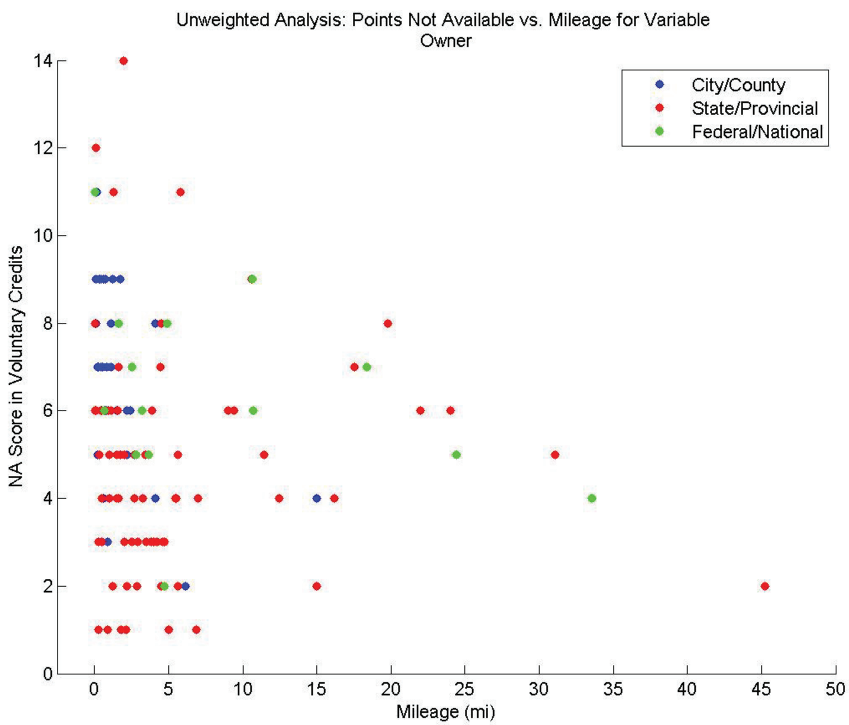

Unweighted Analysis: Points Not Available vs. Mileage for Variable
MajorStructures
Structures
No Structures
NA Score in Voluntary Credits
Mileage (mi)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
50

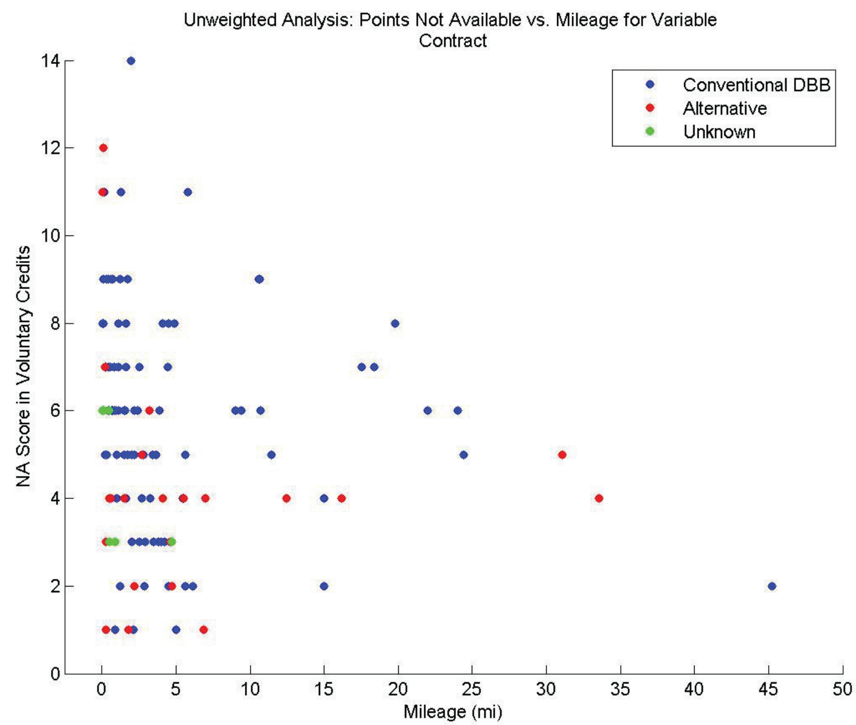


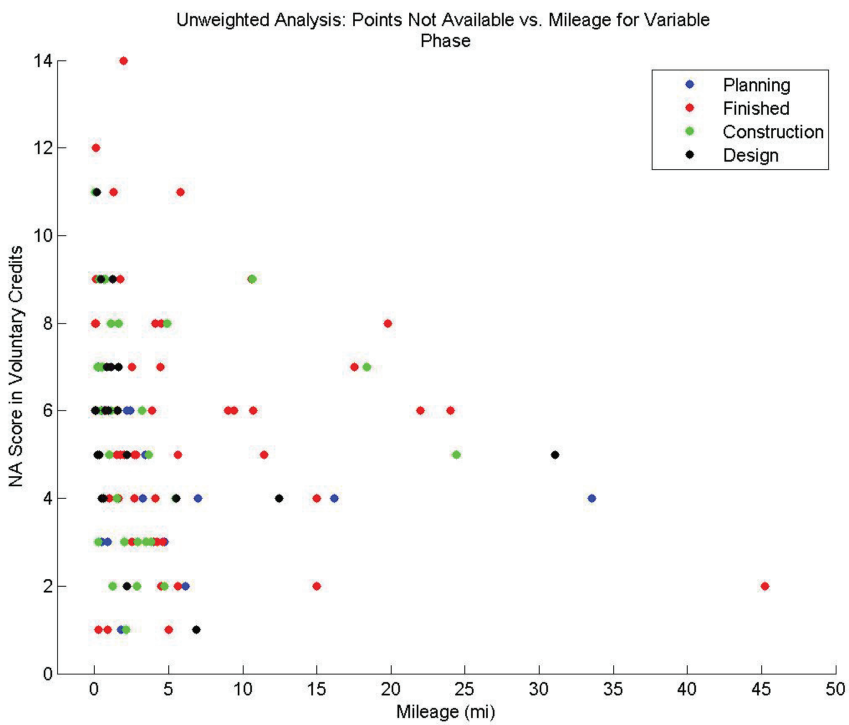
Unweighted Analysis: Points Not Available vs. Mileage for Variable
Northwest
Northwest
Other Regions
NA Score in Voluntary Credits
Mileage (mi)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
50



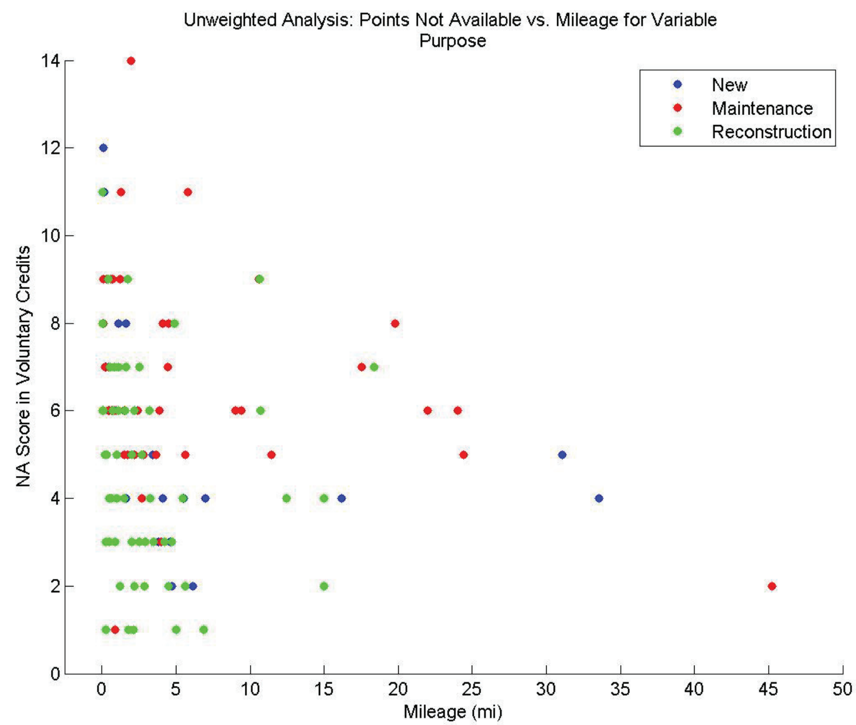
Unweighted Analysis: Points Not Available vs. Mileage for Variable
Country
International
USA
NA Score in Voluntary Credits
Mileage (mi)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
50


Unweighted Analysis: Points Not Available vs. Mileage for Variable
Owner
NA Score in Voluntary Credits
Mileage (mi)
City/County
State/Provincial
Federal/National

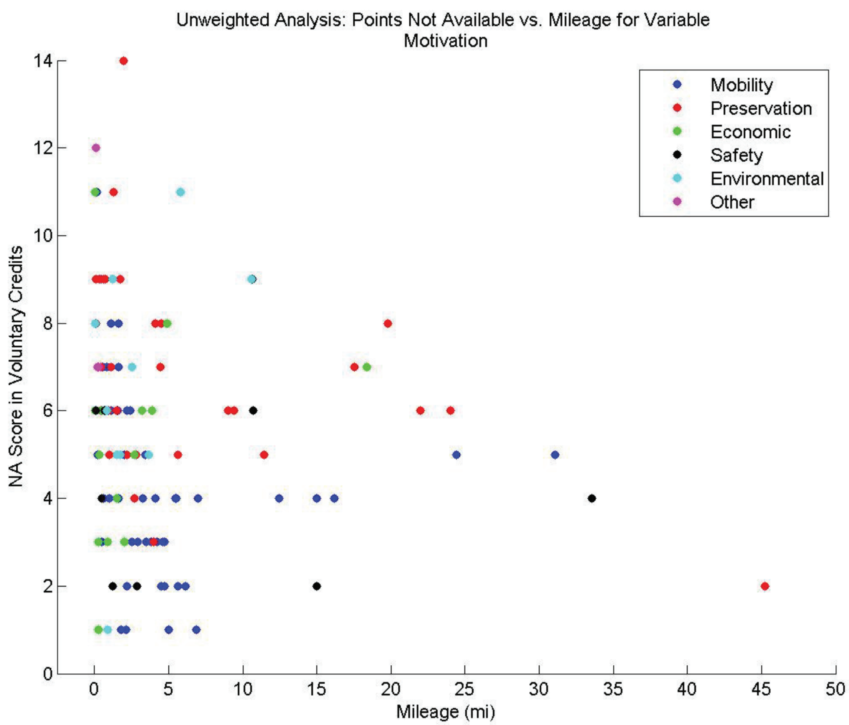

Unweighted Analysis: Points Not Available vs. Mileage for Variable
Contract
NA Score in Voluntary Credits
Mileage (mi)
Conventional DBB
Alternative
Unknown

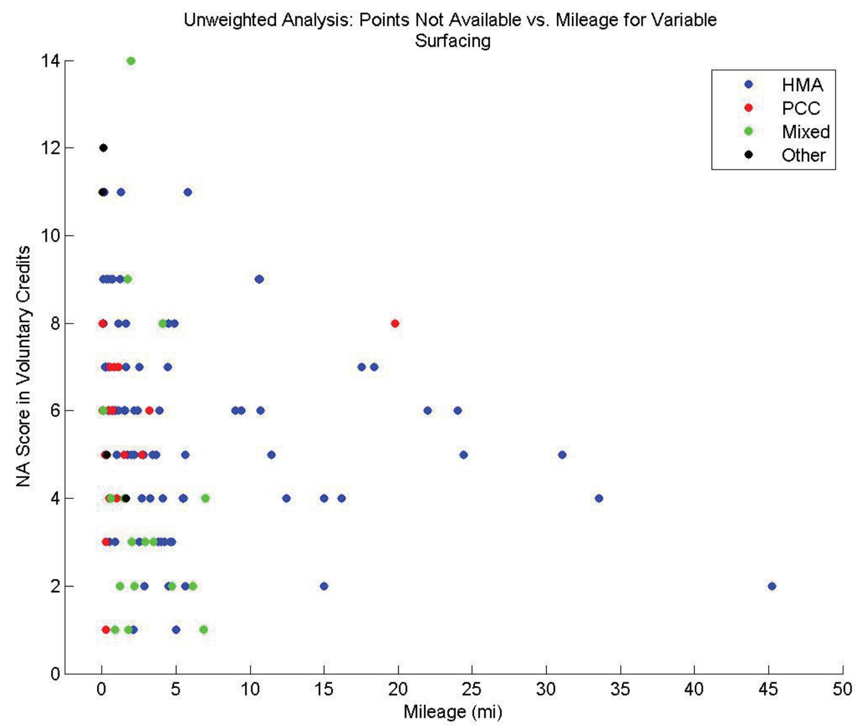


Unweighted Analysis: Points Not Available vs. Mileage for Variable
Phase
Planning
Finished
Construction
Design
NA Score in Voluntary Credits
Mileage (mi)

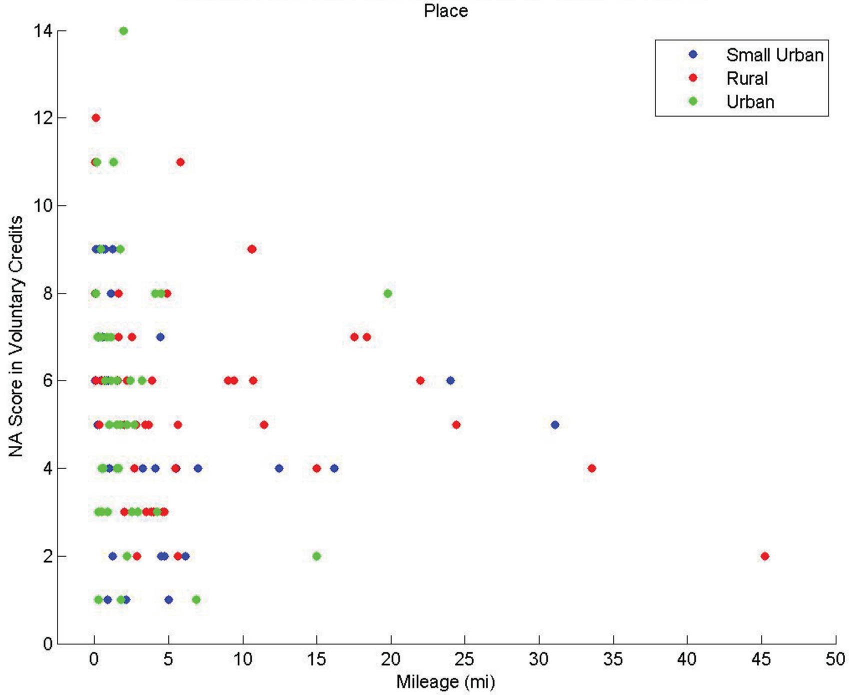


Unweighted Analysis: Points Not Available vs. Mileage for Variable
Purpose
New
Maintenance
Reconstruction
NA Score in Voluntary Credits
Mileage (mi)

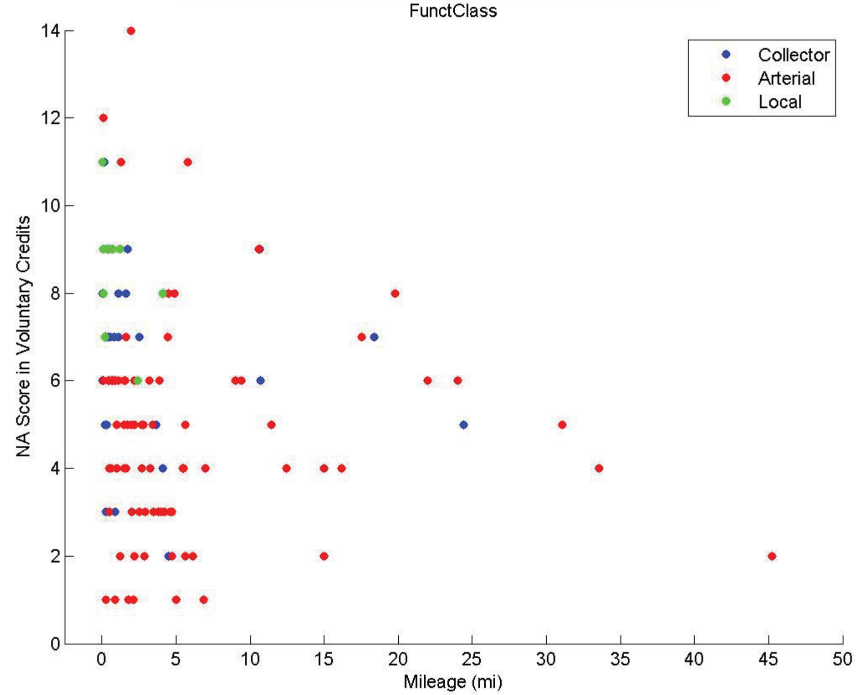

Unweighted Analysis: Points Not Available vs. Mileage for Variable
Motivation
Mobility
Preservation
Economic
Safety
Environmental
Other
NA Score in Voluntary Credits
Mileage (mi)

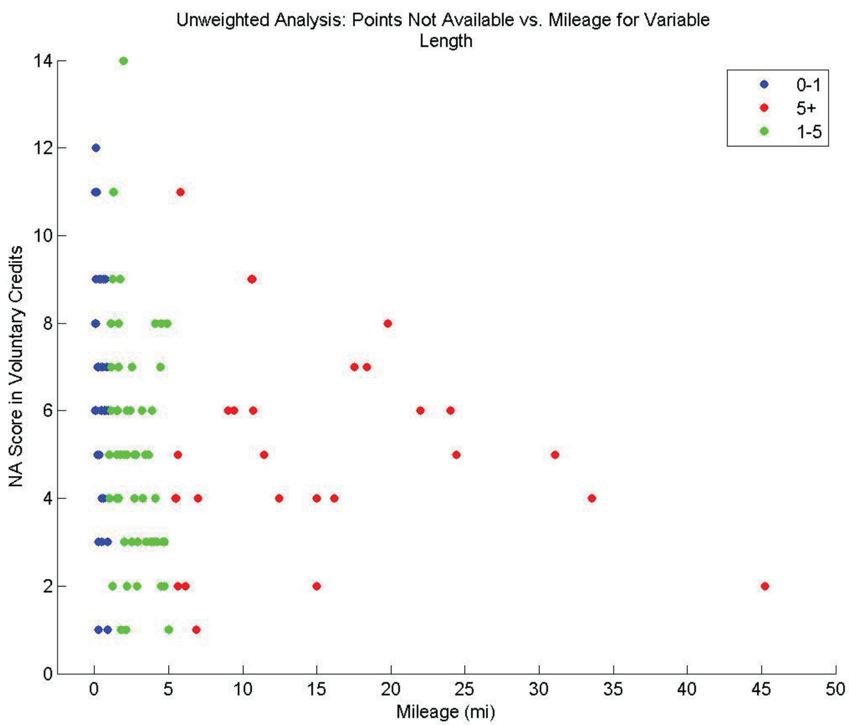

Unweighted Analysis: Points Not Available vs. Mileage for Variable
Surfacing
HMA
PCC
Mixed
Other
NA Score in Voluntary Credits
Mileage (mi)

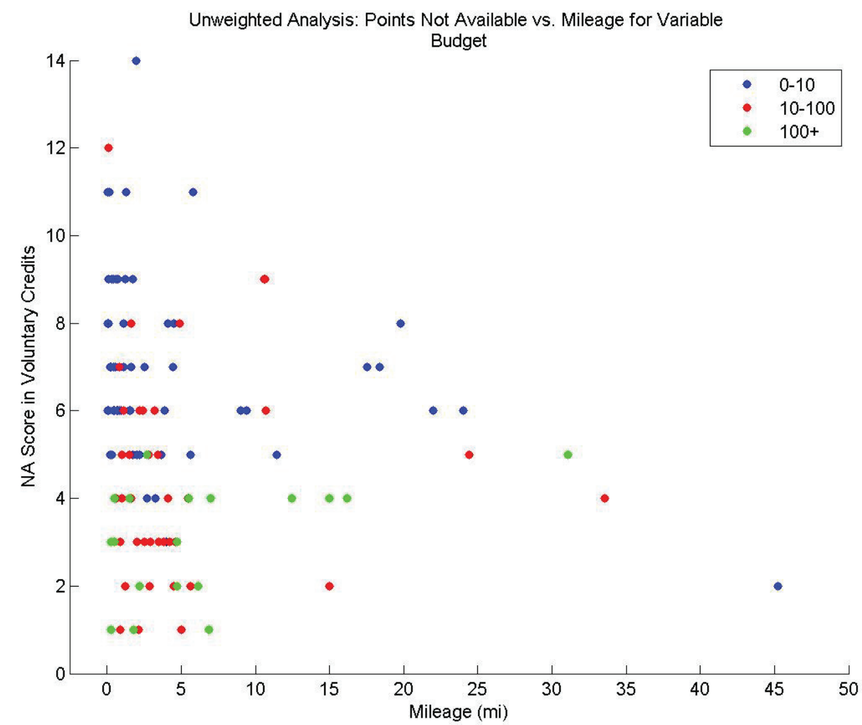
Unweighted Analysis: Points Not Available vs. Mileage for Variable
Place



Unweighted Analysis: Points Not Available vs. Mileage for Variable
FunctClass




Unweighted Analysis: Points Not Available vs. Mileage for Variable
Length
NA Score in Voluntary Credits
Mileage (mi)
0-1
5+
1-5
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
50


Unweighted Analysis: Points Not Available vs. Mileage for Variable
Budget
NA Score in Voluntary Credits
Mileage (mi)
0-10
10-100
100+
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
50

VITA

Jeralee L. Anderson is a licensed professional engineer in Washington State and California and a LEED® Accredited Professional. She received her B.S.C.E. from California Polytechnic State University, San Luis Obispo in 2004 with a Minor in music performance. After working for a few years as a structural and geotechnical engineer, she wanted to learn more about sustainability and wound up back in school at the University of Washington in 2007. Jeralee completed her master's degree at the University of Washington in late 2008 in construction engineering and continued on as a PhD student the following year.

In 2010, she earned a certificate in Business Administration from the University of Washington's Foster School of Business, and co-founded a little non-profit company called Greenroads Foundation with her advisor and friend, Steve Muench.

In 2012, Jeralee received her doctoral degree from the University of Washington Civil and Environmental Engineering Program. After receiving her degree, she accepted a full time position as the Executive Director of Greenroads Foundation.