ID: FLHROAD

Green Guide for Roads Rating System

A Major Qualifying Project Report

For the Stantec Sustainable Design Project Site

Submitted to the faculty

of the

WORCESTER POLYTECHNICAL INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

by

_____

Matthew Clark

_____

Christopher Paulli

_____

Zachary Tetreault

_____

Justin Thomas

Date: 3/5/2009

Approved:

_____

Professor Fred Hart, Advisor

_____

Professor Rajib Mallick, Co-Advisor

Abstract

The goal of this project was to further develop Stantec Consulting Ltd.'s Green Guide for Roads concept document. The guide went through two revisions based on a literature review, comparison to other sustainable transportation rating systems, meetings with transportation experts, and scoring of roadway projects. This resulted in a more comprehensive guide and a set of recommendations for further development. An online forum and databank were also created to promote discussion and future advancement of the guide.

Authorship

This project report was produced through the equal efforts of all four team members; Matthew Clark, Christopher Paulli, Zachary Tetreault, and Justin Thomas

Acknowledgements

The Project Team worked with many individuals over the course of the project, and without their help and guidance the project would have been impossible. The project team would like to thank the following persons for all their input:

-Carl Clayton
-Daniel Vriend
-Dean Cooper
-Fred Hart
-Gerry Devine
-Jake Vanderburg and WorksAlberta
-Kelsey D'Agostini
-Klaas Rodenburg
-Rajib Mallick
-Stantec
-Stephani Carter and GreenAlberta/Ecoammo
-Tori Liu
-Tyler Golly
-Victor Saly
-Wilf Auger
-Yvan Gagnon

Thanks,

Matthew Clark
Christopher Paulli
Zachary Tetreault
Justin Thomas

Executive Summary

Sustainability has become a popular issue in today's society, with people becoming more aware of the need for green practices. The negative impacts from current living conditions have led the push towards sustainable practices worldwide. The building construction industry has been at the forefront of the shift toward sustainable practices through the success of the Leadership in Energy and Environmental Design (LEED) rating systems. The transportation industry is a large contributor of harmful environmental impacts and needs to follow their example by incorporating sustainable practices.

There are organizations in the process of addressing this problem by creating sustainable transportation guides. One example is Greenroads, which originated as a thesis at the University of Washington and is scheduled for release in early 2009 for use on a national level. GreenLITES (Leadership In Transportation and Environmental Sustainability) is another green rating system that was developed from the ideas and concepts of Greenroads. It is currently in use by the New York State Department of Transportation (NYSDOT) as a self-certification process for their roads.

Stantec Consulting Ltd. is a global design firm that is persistently striving to balance economic, environmental and social responsibilities, and is considered to be a world leader and innovator in sustainable solutions (*Stantec*, 2008). Stantec developed an internal concept document, Green Guide for Roads, which promotes sustainable practices in the transportation industry. Stantec's goal is to further develop the guide in hopes that it will be adopted by the Canadian Green Building Council (CaBGC) and used as a bench mark in sustainable transportation.

The goal of this project was to further develop the Green Guide for Roads for use by Stantec as a marketing tool to gain a competitive edge with potential clients. Stantec will also present the work accomplished during this project to the Transportation Association of Canada (TAC) to assist their task force in the completion of the guide for publication and use.

To accomplish this goal the team had to enhance the current rating system. First a literature review was completed on transportation and green practices and the guide was

compared to the two other transportation rating systems. The literature review provided information on the concepts of sustainability and main topics presented in the guide. The team compared the point totals of each category in the original concept Green Guide and found that it was heavily weighted in just two categories, with 60% of the points allocated to *Mobility for All* and *Materials & Resources*. When comparing all three of the guides under a common set of categories it was found that each guide placed an emphasis on a different category. The comparison also provided ideas for additional credits and the common set of categories was adopted to make the guide a more well-rounded and comprehensive document.

A credit assessment was performed on the entire guide, with points being added to new credits and the guide was shifted to a 100 point scale. The change to a 100 point system required the credits to be reweighed, with emphasis placed on credits with greater sustainable impacts. The point breakdown was reevaluated and indicated that the points were more evenly dispersed throughout the categories. The biggest point spread between categories was now 14 points, compared to the original 20 points. The preliminary draft of the Green Guide was created from these changes.

This new guide was presented at meetings with transportation experts for discussion and review. The meetings brought insight on current practices in transportation, feasibility of credits, and knowledge needed to accurately score the projects. The team scored six road projects with the preliminary guide each receiving an actual score and potential score, had they been aware of the guide. None of the six projects would be certified based on their actual scores. However, the potential scores of four projects would earn Certification and the other two would receive Silver certification. This confirmed that the Green Guide is above current standards, but certification is still possible with the incorporation of sustainable practices.

The outcome of the scores and meetings was used to make additional changes to the preliminary Green Guide and create a revised version. These changes included the addition and subtraction of credits, adjustment and clarification of requirements, and reweighting of credits to maintain the 100 point system. These changes and source materials gathered were then posted on a website.

The website was provided by GreenAlberta for use by Stantec in the development of the Green Guide for Roads. Its purpose was to be utilized as a databank of resources as well as a forum for discussion. The website contains the current version of the guide and is an on-going process that will continually grow with more information, keeping the guide up to date with leading technologies and practices.

The team accomplished the goal set by Stantec to further develop the Green Guide for Roads by producing a revised version of the guide and the creation of the website. The project team also developed a list of recommendations for the continuing progression of the guide consisting of areas for future research, the possible incorporation of new credits, applicability of context sensitive solutions and defining credit relevancy and scoring of various roadway project types.

Capstone Design Experience

The capstone design consisted of further developing the Green Guide for Roads. One of the credits from the guide, Recycled Content, was used to create four designs of Hot Mix Asphalt (HMA) base course. The credit requirement called for a minimum of 15% Recycled Asphalt Pavement (RAP); the four designs consisted of 15%, 20%, 30%, and 40% RAP. The mix designs can be seen in Appendix H.

In accordance with the Accreditation Board of Engineering and Technology (ABET) General Criterion for capstone design, this Major Qualifying Project has incorporated six realistic constraints, which are:

Economic

The Green Guide for Roads addresses reduction in both capital costs and the costs associated with the operation and maintenance of a roadway. The capital cost reduction was observed when designing a HMA base course with recycled asphalt. The team did a cost analysis for the four HMA base course designs and from the analysis it was found that the larger the amount of recycled asphalt used the greater the cost savings were. An example of operational and maintenance cost reduction can be seen in the credit for *Water-Efficient Landscaping*, where the use of indigenous plant species can reduce the required maintenance of the landscaping.

Constructability

The green guide allows for change and manipulation of current industry standards and practices, to produce more sustainable roads and raise the bar of road design and construction. The four designs of HMA base course are an example of this by using RAP, which is just as accessible as virgin materials for use in HMA. This allows the four designs to be duplicated on a large scale basis.

Sustainability

One of the most important practices in today's society, this guide encompasses all areas needed for sustainable transportation. These practices covered in the guide pertain to the planning, design, construction and operation phases of a roadway or network of roadways.

Environmental

The environmental aspects are covered in several of the guide's categories. The main environmental concerns addressed by the green guide are energy use, emission outputs, natural resources, and impacts of a road. Examples of this can be seen in the four HMA base course designs, which reduce the amount of virgin materials needed and allow for the preservation of non-renewable resources.

Social

The social aspects of the Green Guide for Roads are primarily seen in the *Mobility for All* and *Community Impacts* categories. *Mobility for All* demonstrates how to create a more multimodal community, allowing for all modes of transportation to be addressed and planned for. *Community Impacts* deals with the problems that a roadway may have on a community during its construction and operation.

Health & Safety

The Green Guide for Roads promotes health and safety of all people building, using, and maintaining the roadway. Specifically, there are credits in *Energy & Atmosphere* that directly promote roadway worker safety and health. *Mobility for All* supports a healthier lifestyle, providing an emphasis on multimodal transportation, primarily walking and cycling. In addition, there are credits in the category that address the safety of walkers and cyclists.

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

The construction industry is the largest producer of waste in the United States. It contributes 350 million tons of waste from construction and demolition activities (C&D) each year, nearly 30% of the waste stream. The transportation sector generates an estimated 190 million tons of C&D waste, roughly 54% of the total industry waste estimated by Bill Turley in October, 2008 (Muench, S., 2009, Rating Your Project for Sustainability).

Transportation is a large contributor to environmental impacts, especially harmful CO_2 emissions that increases global warming. To ease the impacts on the environment, sustainable practices should be implemented, so the needs of today can be met without affecting the needs of the future (Bruntland, G. (ed.), 1987). There are programs and tools available that promote sustainability and reduce environmental impacts such as the popular LEED™ (Leadership in Energy and Environmental Design) rating systems developed by the United States Green Building Council (USGBC). The rating systems produced by the USGBC have been a huge success, its membership has quadrupled since 2000 and it continues to raise the bar for sustainable building practices and operation (USGBC, 2009). Unfortunately, there are currently no nationwide standard rating systems like that of LEED available to promote sustainable transportation planning, construction and operation. However, there are programs attempting to reduce environmental impacts through government regulated recycling programs and material reuse. These current practices are a start but do not promote sustainable transportation over the entire life cycle of a road.

Research has been conducted over the past few years to determine sustainable transportation practices. The first successful efforts were done by a graduate student, Martina Soderlund, at the University of Washington in 2007. In Martina's master's thesis she researched sustainable transportation practices and developed a rating system. The frame work of the rating system incorporated many aspects from LEED, such as using credits to award sustainable choices and practices, different levels of certification, and the general layout of each credit(Soderlund, M., 2007). Her advisor, Steve Muench, continued on with her work and further developed the rating system into what is now called Greenroads. Its current edition, Version 0.95, is a very comprehensive guide that breaks down each credit by explaining its requirements,

goal, explanation, potential issues, submittals, strategies, research, and case studies. It is expected that Greenroads will be published in early 2009 and is speculated to be used on a national level. Another rating system, GreenLITES (Leadership In Transportation and Environmental Sustainability), was developed by the New York State Department of Transportation (NYSDOT) and began reviewing projects on September 25, 2008 for certification. GreenLITES was derived from the ideas and concepts behind Greenroads, but is self-certifying and only used for New York State transportation projects (NYSDOT, 2008).

Stantec Consulting Ltd. is a global design firm that persistently strives to balance economic, environmental and social responsibilities, and is considered to be a world leader and innovator in sustainable solutions (*Stantec*, 2008). Stantec is in the process of developing its own rating system, Green Guide for Roads, which would promote sustainable practices in the transportation sector. Currently, the guide is an internal document that needs further research in all areas of sustainable transportation (Green Guide for Roads). In the near future, Stantec wants to use this guide as a marketing tool for potential clients and possibly propose the guide to the Canadian Green Building Council (CaGBC), in hopes that it will be adopted and become a benchmark for sustainable practices in roadway construction and design.

The primary goal of this project was to further develop Stantec's Green Guide for Roads concept document. The objective of the project was to enhance the current rating system through several processes consisting of a literature review, comparison to other rating systems, meetings with transportation industry leaders, credit assessment and rating multiple projects. The team reached the goal set by Stantec and produced a list of recommendations for the Green Guide on what needs to be done in the future to have a functional, working document. The recommendations and work done during the project will be presented to the Transportation Association of Canada (TAC) to aid their task force in the completion of Green Guide for Roads.

Chapter 2: Background

This section addresses the current transportation impacts and concerns and the need for the shift towards sustainable practices. It explains what sustainability is and how it pertains to the transportation industry, the history of LEED and its impacts, as well as other rating systems in development and use. Finally, it explains Stantec's original Green Guide for Roads concept.

2.1 Current Transportation Impacts & Concerns

The transportation sector has a large impact on today's society. It is considered that transportation, "represents 10 percent of the world's gross domestic product, is responsible for 22 percent of the global energy consumption and 25 percent of fossil fuel burning across the world, and 30 percent of global air pollution and greenhouse gasses" (AASHTO, 2009). These factors contribute to the growing concerns of the depletion of natural and non-renewable resources, global climate change, disruption of ecosystems, and toxic pollution (AASHTO, 2009).

In an attempt to address these concerns, the American Association of State Highway and Transportation Officials (AASHTO) issued a report called, *Transportation: Invest in Our Future*. It stated that, "America's transportation system has served us well, but now faces the challenges of congestion, energy supply, environmental impacts, climate change, and sprawl that threaten to undermine the economic, social, and environmental future of the nation. With 140 million more people expected over the next 50 years, past practices and current trends are not sustainable" (AASHTO, 2007). The report also suggested that transportation decision makers should start practicing the 'triple bottom line' theory to sustainability. This is accomplished by assessing the performance foundation of economic, social, and environmental impacts and applying equal consideration to these aspects (AASHTO, 2007).

2.2 What is Sustainability?

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Bruntland, G. (ed.), 1987). In order to achieve this, it is necessary to focus on the three pillars of sustainability known as the 'triple bottom line'. These pillars can be seen in Figure 1 and are described below:

- **"Economic Development:** Ensure that the financial and economic needs of current and future generations are met.
- **Environmental Stewardship:** Ensure a clean environment for current and future generations and use resources sparingly.
- **Social Equity:** Improve the quality of life for all people and promote equity between societies, groups, and generations" (AASHTO, 2009).

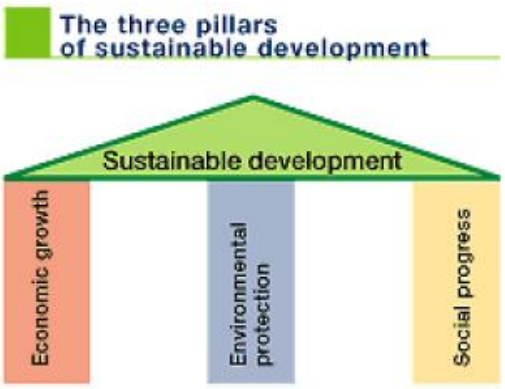


Figure 1: Three Pillars of Sustainable Development
(Adams, W. M., 2006)

Figure 2, shows exactly how each aspect of sustainability interacts with one another. If all three are focused on equally, comprehensive sustainability is achieved. When two of the aspects are concentrated on more it will move the focal point outside of the comprehensive sustainability overlap to community livability, social and economic equity or sustainable development. If only one aspect is considered, the focal point will be within that circle.

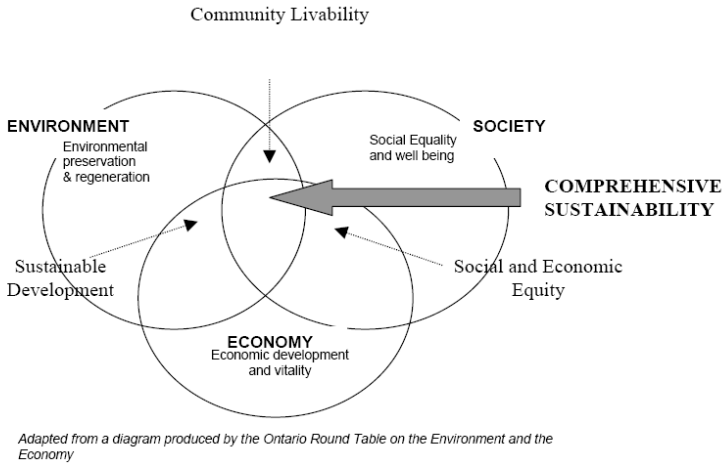


Figure 2: Interaction of the Three Pillars of Sustainable Development
(The Centre for Sustainable Transportation, 2002)

With these aspects in mind, sustainable transportation is defined by the Canadian Center for Sustainable Transportation (The Center for Sustainable Transportation, 2006) as:

- "Allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human ecosystem health, and with equity within and between generations;
- Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy; and

- Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources to sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise."

2.3 Leadership in Energy and Environmental Design (LEED)

LEED is a green building rating system that promotes sustainable practices and products. LEED was first introduced by the United States Green Building Council (USGBC) in 1998 and continued to grow from a single rating system to several. This occurred due to the increased popularity of the rating system, as it was adopted as a nationwide benchmark for green building within the U.S. The impacts of LEED have been and continue to be immense, greatly reducing the environmental impacts and promoting smart economic investment.

2.3.1 History

The USGBC is a non-profit, non-governmental organization that was founded in 1993. It is a committee-based organization that is comprised of building industry stakeholders such as architects, building product manufacturers, owners, contractors, and various environmental groups who are interested in promoting green building. In the early stages of the council's development they stressed the need for a system that would define what a green building is. From research of other sustainable programs, the USGBC decided to develop its own system for U.S. buildings (Keoleian, A. G., Scheuer, C. W., 2002).

In August of 1998, the USGBC released its first version, the LEED 1.0 pilot program which was headed by Robert K. Watson, founder of the LEED Steering Committee. The committee was composed of volunteers from the building industry to resolve program and interpretation issues and work on revisions to the program. By March 2000, LEED 1.0 had already scored 12 buildings for certification. From the pilot program period of LEED 1.0, a total of 14 buildings would be certified, and a number of problems became apparent. The committee would address these issues and make several modifications to further develop the rating system to make it more comprehensive. By March of 2000, LEED 2.0 was released and renamed LEED for New Construction, which is short for LEED Green Building Rating System for New Commercial Construction and Major Renovations (USGBC, 2006) (Keoleian, A. G., Scheuer, C. W., 2002).

Since the development of the New Construction rating system, LEED has evolved extensively and undertaken new initiatives. These have been to administer a test in green building to be considered an Accredited Professional for LEED as well as different rating systems that apply to six different markets. These markets consist of New Construction, Existing Buildings, Commercial Interiors, Core & Shell, LEED for Homes, and Neighborhood Development. Some of these markets have expanded into more than one rating system like that of New Construction, which has six different rating systems, New Construction, LEED for Multiple Buildings/Campuses, LEED for Schools, LEED for Healthcare, LEED for Retail, and LEED for Laboratories. Some of these rating systems are in use while others are still pilot programs, but the diversification of LEED is apparent. This has made LEED very popular over the past few years, not only can it be applied to many different types of projects, it also gives in depth information on sustainable building practices. (USGBC, 2006).

2.3.2 Structure of the Rating System

LEED is a very straight forward and easy to use rating system, which is why many users like it. Each rating system is broken down into six different categories, each of which promotes a different aspect of sustainability. These categories are Sustainable Sites (SS), Water Efficiency, Energy and Atmosphere (EA), Materials and Resources (MR), Indoor Environmental Quality (EQ), and Innovation and Design Process (ID). Each category is broken down into prerequisites and credits. Prerequisites are required and contain no point value, while credits are optional and have a range of possible points. Each credit is explained in full detail, with potential strategies on how to achieve the allotted points. These details explain the credit intent, requirements, potential technologies & strategies, summary of referenced standards, approach and implementation, calculations, exemplary performance, submittal documentation, considerations, economic issues, resources, and definitions (USGBC, 2006).

The rating system also explains the different levels of certification and the point totals needed to obtain them. The certifications are distinguished by four different levels, starting with least green to exceptionally green. The different levels are Certification, Silver, Gold, and Platinum. The way to determine which category the project falls under is by comparing the certification level to the amount of points awarded by the USGBC on the project (USGBC, 2006).

2.3.3 Impacts

Green buildings use less energy than conventional buildings. The level of certification achieved affects the overall energy reduction from standard code, ranging from 18% reduction at Certification to 37% at Gold. On average, green buildings reduce their energy use by 28%. LEED buildings also use alternative types of energy; these can be green or on-site renewable energy that have no environmental impact. LEED buildings reduce the amount of energy needed for operation and cost, as well as the environmental impact (Kats, Gregory. H., 2003).

An indirect benefit of green building is the increased productivity of workers. LEED buildings make the working environment more attractive, comfortable, and provide healthier conditions for its occupants. This is done by better lighting conditions, better ventilation, and improved thermal control. Better ventilation is possibly the most important, as inside air concentrations of pollutants can range from 10 to 100 times that of the outside air. In LEED buildings this factor is eliminated, in some cases the air quality is improved beyond that of the outside air. Since working conditions are improved, workers are healthier and therefore use less sick days. Completed studies have shown an increase of 1% productivity rate (roughly 5 minutes per working day) in Certified and Silver buildings and a 1.5 % increase (roughly 7 minutes per working day) in Gold and Platinum buildings. While seeming minimal, a 1% increase yields $600 to $700 per employee a year and a 1.5% increase yields $1000. This can result in large financial benefits for the employer (Kats, Gregory. H., 2003).

2.4 Other Rating Systems That Have Been Developed

While LEED is the building industry benchmark in sustainability, there are other rating systems implemented and in various stages of development. The Green Guide for Healthcare was created in 2003 for hospitals and is currently in the process of being incorporated into LEED. Greenroads is a rating system focusing on sustainable transportation practices and is in its final phase of development. From Greenroads, GreenLITES was developed and is a self-certifying rating system used by the NYSDOT.

2.4.1 Green Guide for Healthcare

The Green Guide for Healthcare was started by a group of hospital personnel that wanted to improve the quality of construction and operation of hospitals. They obtained an agreement with the USGBC to use the framework and credit structure of LEED. The guide took the general

concepts of the New Construction rating system and added new credits specifically relating to the operation of hospitals. For example, the recycling of bio waste is an entirely different process from normal waste recycling in a typical building (Green Guide for Healthcare, 2009).

The first version of this guide came out in December 2003 to be reviewed and receive comments from the public. Incorporating revisions from the initial review, version 2.0 was released in November 2004 for use as a pilot program. The program went through 115 projects, generating feedback that was used to substantially update the operations section of the guide as well as edit individual credits. From this, version 2.2 was released in January 2007 as a self-certify rating system (Green Guide for Healthcare, 2009).

Due to the many similarities with LEED for New Construction, the guide facilitates the process of applying for LEED certification. Due to the success of the program, LEED is currently in the process of reviewing and adopting the rating system as one of their own (Green Guide for Healthcare, 2009).

2.4.1 Greenroads

Greenroads is a sustainable transportation rating system in its final stages of development. Originally the thesis work of Martina Soderland, at the University of Washington (UW) in 2007, it has since been further developed by Steve Muench, her advisor and associate professor. The UW has partnered up with CH2M HILL, an engineering firm with expertise in sustainable solutions in many areas including transportation infrastructure and operations, to complete the guide (Muench, S., 2009, Greenroads).

The guide is designed to be used on new, reconstructed, and rehabilitation roadway projects. The collection of sustainable transportation practices are sorted into 11 prerequisites and 39 credits. The 50 credits are broken down into the seven categories, consisting of Project Requirements, Environment and Water, Access and Equity, Construction Activities, Materials and Resources, Pavement Technologies, and Exemplary Performance. A project is awarded certification by meeting all the prerequisites and fulfilling a number of the optional credits. The certification levels are Certified, Silver, Green, and Evergreen (Muench, S., 2009, Greenroads).

As the guide nears completion, it is acquiring pilot projects to rate with the final version of the guide that is due out in early 2009. The ultimate goal for this guide is to be adopted as a nationwide standard for sustainable roadways (Muench, S., 2009, Greenroads).

2.4.2 GreenLITES (Leadership In Transportation and Environmental Sustainability)

GreenLITES is another sustainable transportation rating system developed by the NYSDOT for state use. The guide was created to display sustainable transportation techniques already in practice by NYSDOT and to promote the improvement of sustainable practices. Many of the ideas and concepts came from the Greenroads guide (NYSDOT, 2008).

The system is based on 20 credits worth 256 points that are distributed amongst the five categories of Sustainable Sites, Water Quality, Materials and Resources, Energy and Atmosphere, and Innovation/Unlisted. Depending on the amount of points earned, a project can obtain one of four certification levels including Certified, Silver, Gold, and Evergreen. The NYSDOT used 26 completed projects in order to determine the point levels and weigh the system correctly (NYSDOT, 2008).

This is a self-certification process. The NYSDOT uses GreenLITES as an internal program to measure themselves, find areas of improvement and as a tool to show the public how they are advancing sustainable practices (NYSDOT, 2008).

2.5 Stantec's Green Guide for Roads

The Green Guide for Roads was originally developed by Stantec to promote sustainable transportation practices. The guide's goal is to be used as a marketing tool for potential clients. To view the original concept document, see Appendix A.

2.5.1 Purpose and Objective

The objective of the Green Guide is to set a benchmark in sustainable transportation practice. This will help Stantec use the guide as a marketing tool to show their clients that they are a leader in sustainable transportation practices. Ultimately, Stantec hopes that the rating system takes the same path as the Green Guide for Healthcare and gets adopted into LEED as a new rating system (Green Guide for Roads).

2.5.2 Content

The Green Guide for Roads is structured after the popular LEED rating systems. The guide is broken up into seven categories consisting of *Mobility for All, Transportation Efficiency, Safety, Materials and Resources, Energy and Atmosphere, Community Impacts, and Innovation in Design Process*. Each category contains both prerequisites which must be met for certification and optional credits. The prerequisites carry no points while each credit has a range of points that can be achieved. Each credit consists of an Intent, Requirements, and Submittals in order to carry out the credit. The intent briefly explains what the credit is trying to achieve, Requirements are the necessary measures or actions that must be done to achieve the possible points, while Submittals are the documentation that provides proof that credit requirements were met (Green Guide for Roads).

Chapter 3: Methodology

The goal of the project was to further develop the Green Guide for Roads. Stantec can use this rating system as a marketing tool for a competitive edge in sustainable transportation and present the work accomplished during this project to TAC for assistance with their task force in further developing the guide for publication and use. To accomplish this goal the team had to fulfill the objective of enhancing the current rating system.

The flowchart on the next page, Figure 3, visually represents the activities done to accomplish the goal of the project. The flowchart is set up so that each process falls into a sequential order, the top representing the activities done at the beginning of the project and the bottom being an end result. The legend of the flowchart is:

- Square Boxes(Blue): Process
- Diamond(Red): Decision
- Box with Curved Bottom(Green): Document

For more information on when each activity was done, see Appendix G.

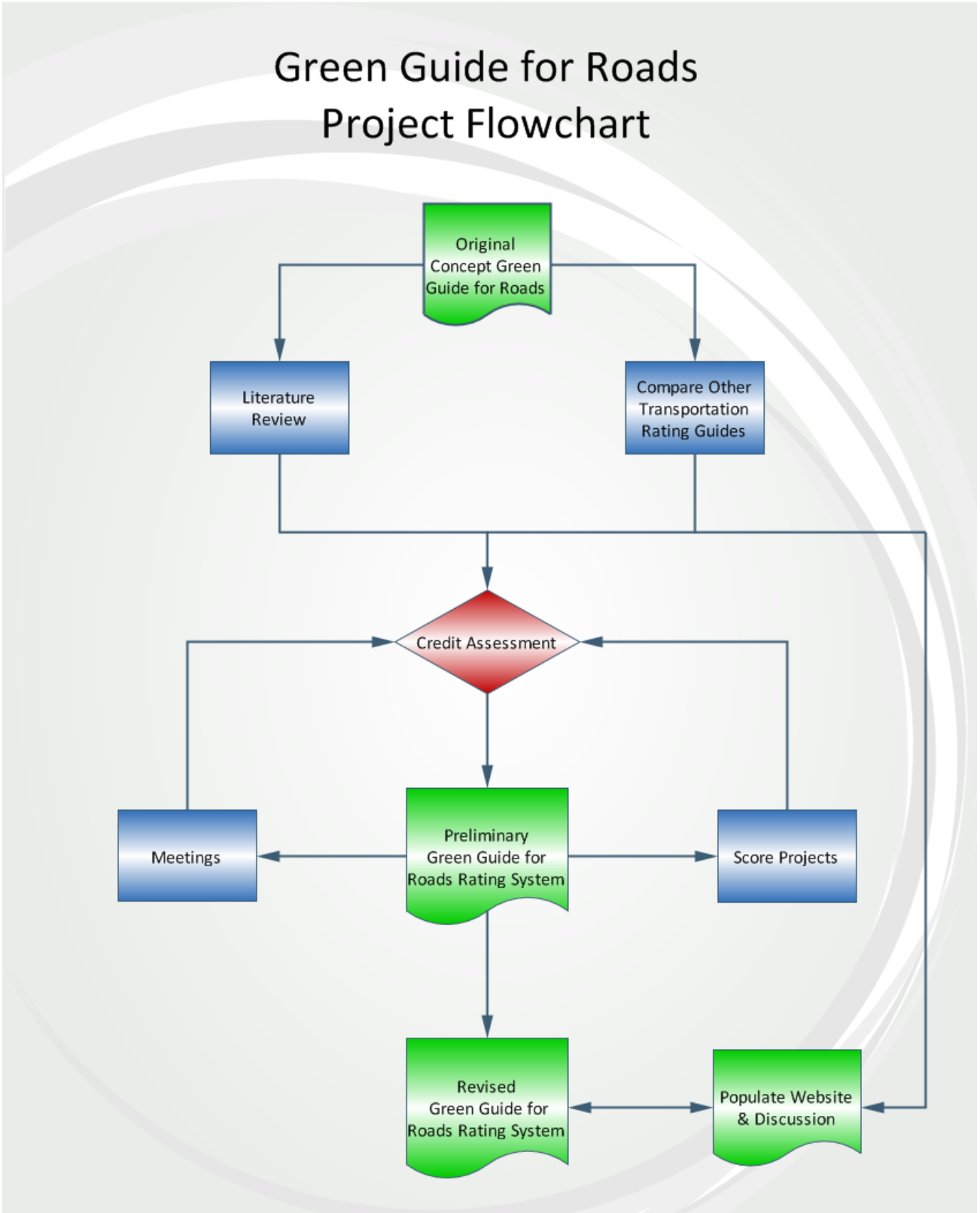


Figure 3: Methodology Flow Chart

3.1 Enhance Current Rating System

In order to further develop the Green Guide for Roads, the team had to enhance the current rating system. To accomplish this objective, the team became familiar with current sustainable transportation practices through a literature review, meetings, and review of other sustainable transportation rating systems. The information gained from the literature review and comparison of guides was used to add and remove credits, alter credit requirements and adjust the weight of credits. This preliminary draft of the Green Guide was then used to score transportation projects and discussed in the meetings. The project scores and feedback gained from the meetings led to the development of the revised draft of the Green Guide for Roads along with a corresponding set of recommendations.

3.1.1 Literature Review

A literature review was conducted to provide the project team with an understanding of the topics presented in the Green Guide. The first topic investigated was the environmental impacts of the transportation industry. Research indicated that there were many sustainable practices that could be incorporated to limit use of virgin materials, promote environmental stewardship and reduce the amount of harmful emissions caused by the industry. This led to an examination of other sectors of the construction industry and how they have integrated sustainable strategies into current practices. The best example of this is LEED, the popular green rating system used by the building industry. This guide provided insight into how a successful green rating system works. Examples of green rating systems specific to the transportation industry include GreenLITES and Greenroads, which the team examined and contributed to the development of the Green Guide.

3.1.2 Comparison to Other Transportation Rating Systems

Comparing the two rating systems, GreenLITES and Greenroads to the Green Guide for Roads was important to its development. The first step in this process was to gain an understanding of the point breakdown of the original version of the guide. The pie chart created to visualize the importance of each section is shown below in Figure 4.

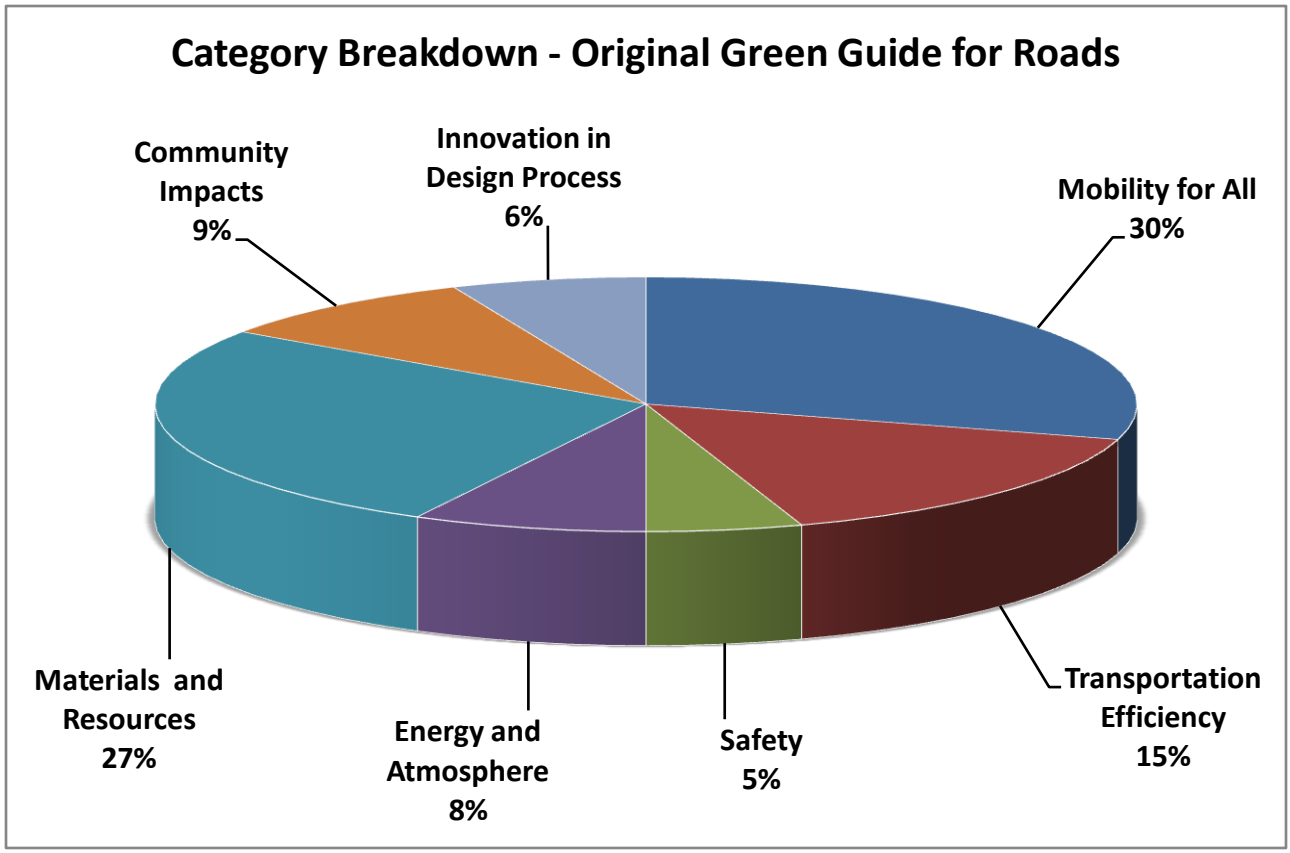


Figure 4: Category Breakdown - Original Green Guide for Roads

After reviewing the credits of each guide, a common set of categories was created to accurately compare the guides. The credits of each guide were organized into these new categories based on their intent and graphed by the percentage of possible points that each category contained, which can be seen in Figure 5.

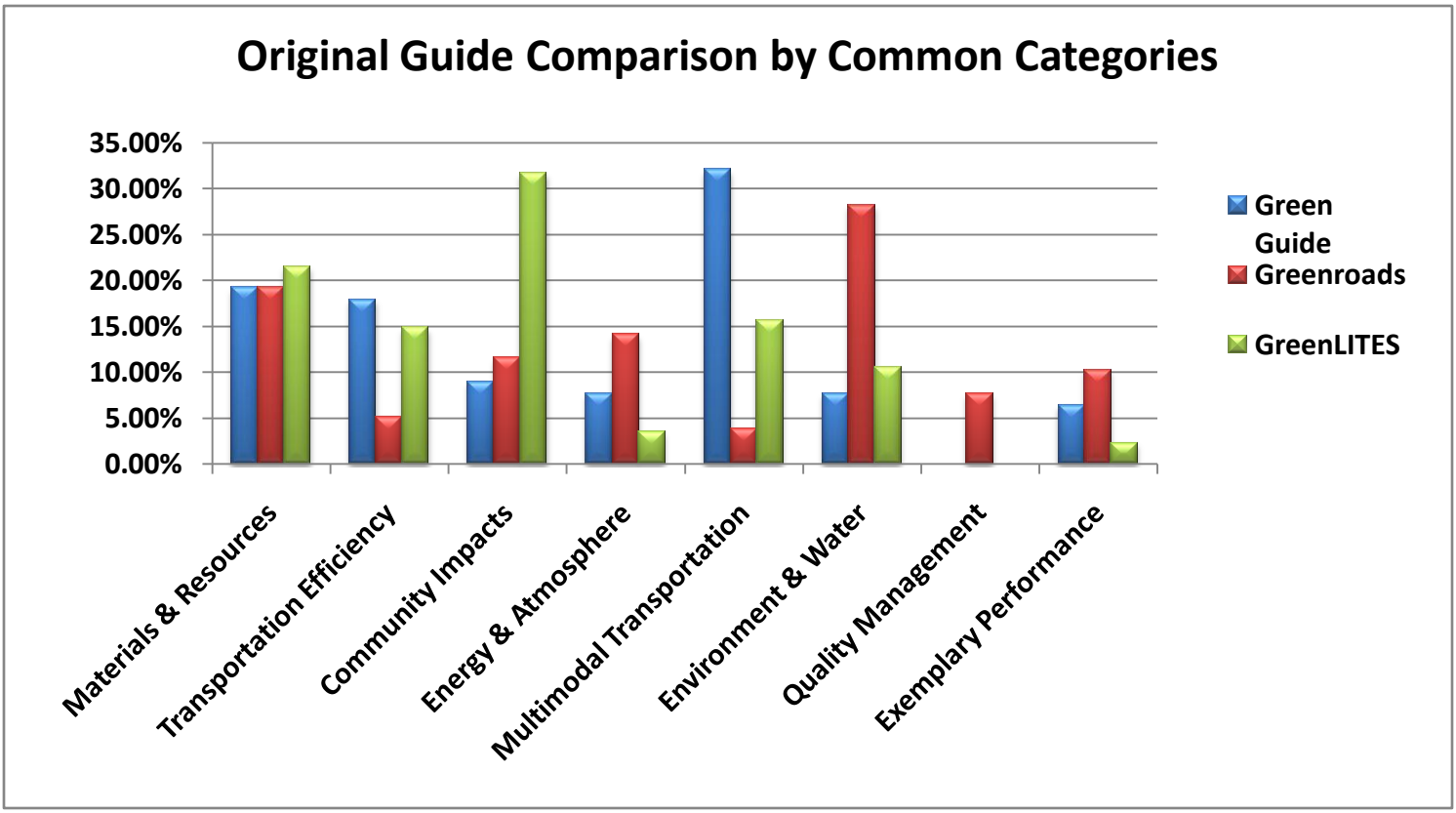


Figure 5: Original Guide Comparison by Common Categories

Comparing the rating systems also allowed the team to see how the Green Guide could improve. Ideas from both guides were incorporated into the Green Guide to create additional credits and fill in missing criteria in existing credits. This new guide was then broken into the same common categories and compared again, to see the effect the new credits had on the breakdown.

3.1.3 Credit Assessment (Preliminary Green Guide for Roads)

The comparison of the green rating systems resulted in the shift to a 100 point scale, addition and removal of credits, and altering of requirements. The guide was moved to a 100 point scale to be more user-friendly and easily convey the value of each credit. The addition of new credits and shift to a 100 point scale necessitated the need to reweigh the credit values. Point totals were assigned based on the literature review, with credits having larger sustainable impacts represented by higher point totals. Lastly, some of the credit requirements needed modification to better characterize sustainable practices. From this a preliminary draft of the Green Guide for Roads was produced, which can be seen in Appendix B.

3.1.4 Meetings

To gain a better understanding of current industry practices and receive feedback on the preliminary guide, the team met with multiple industry experts. An understanding of current practices was necessary to ensure the credits were above and beyond existing standards, while the feedback was used to assess the credits and add subjects not addressed in the guide. These meetings were setup with Stantec advisors, Stantec personnel, Works Alberta and GreenAlberta.

- **Stantec Advisors:** Through weekly meetings, the advisors provided continuous advice and direction relating to the project. They acted as resource managers, directing the team to appropriate personnel as well as pertinent projects and information.
- **Stantec Personnel:** The team met with Stantec personnel with expertise in the areas of stormwater management, transportation planning, strategic asset management and lighting to discuss the Green Guide. The information gathered from these experts was vital to shaping the revised guide and recommendations.
- **Works Alberta:** The team presented the guide to Works Alberta, a local contracting company, to gain insights into the construction aspect of sustainable transportation. They provided input on which credits could be obtained by contractors and different ways to evaluate the credit requirements.
- **GreenAlberta:** The team met with the founder of Green Alberta, a company that evaluates green building products. She talked about the different aspects of the evaluation process and how to potentially apply the same concepts to sustainable transportation.

3.1.5 Score Projects

The team acquired the specifications and construction drawings of six roadway projects from Stantec to score against the Green Guide. During scoring it became apparent that these documents did not include all the necessary information to properly score the project. However, based on the team's meetings with planners, designers, and contractors familiar with general transportation construction, the team was able to make educated assumptions about credits not covered by the drawings and specifications. Each project obtained two scores, the actual score the project would achieve and the highest potential score. The assumptions for the unknown credits were consistent throughout all projects and a detailed explanation is presented in Section

4.5. The individual project scorecard, cross sections, and overhead views can be found in Appendix D and E.

3.1.6 Credit Assessment (Revised Green Guide for Roads)

The results of the meetings and project scorings led to changes in the preliminary Green Guide. The guide was reworked with adjustments to prerequisites, credit requirements, and weighing of credits that resulted into a revised version of the Green Guide. This led to a more comprehensive guide, along with a list of recommendations for further development. The revised Green Guide can be seen in Appendix C.

3.1.7 Populate Website & Discussion

The GreenAlberta website was developed to be a databank of sustainable transportation information and create forums to promote discussion about the Green Guide. The website is an on-going process that will continually grow with more information, keeping the guide up to date with leading technologies and practices. From this, Stantec will gain an edge over its competition by having this viable information in a structured, easy to use system. A detailed breakdown of the website can be seen in Appendix F.

Chapter 4: Results & Analysis

4.1 Literature Review

The results from the literature review were used to help the team better understand the concepts involved in sustainable roadways and to provide content for the website. The research conducted brought insight and provided a background for main topics discussed in the Green Guide for Roads. This information was used to help propel the critiquing of the concept guide, the questions for the conducted meetings, as well as to score the individual projects. The content was posted on the website, which is used as a databank for the guide's resources.

4.2 Comparison to Other Transportation Rating Systems (Concept Document)

The concept document was used to gather more insight into the individual categories and credits, as well as determine how the points were allotted and where the emphasis was placed. The point totals were calculated for each category and graphed in a pie chart, shown below in Figure 6; where the categories were broken down by percentage of total points (78).

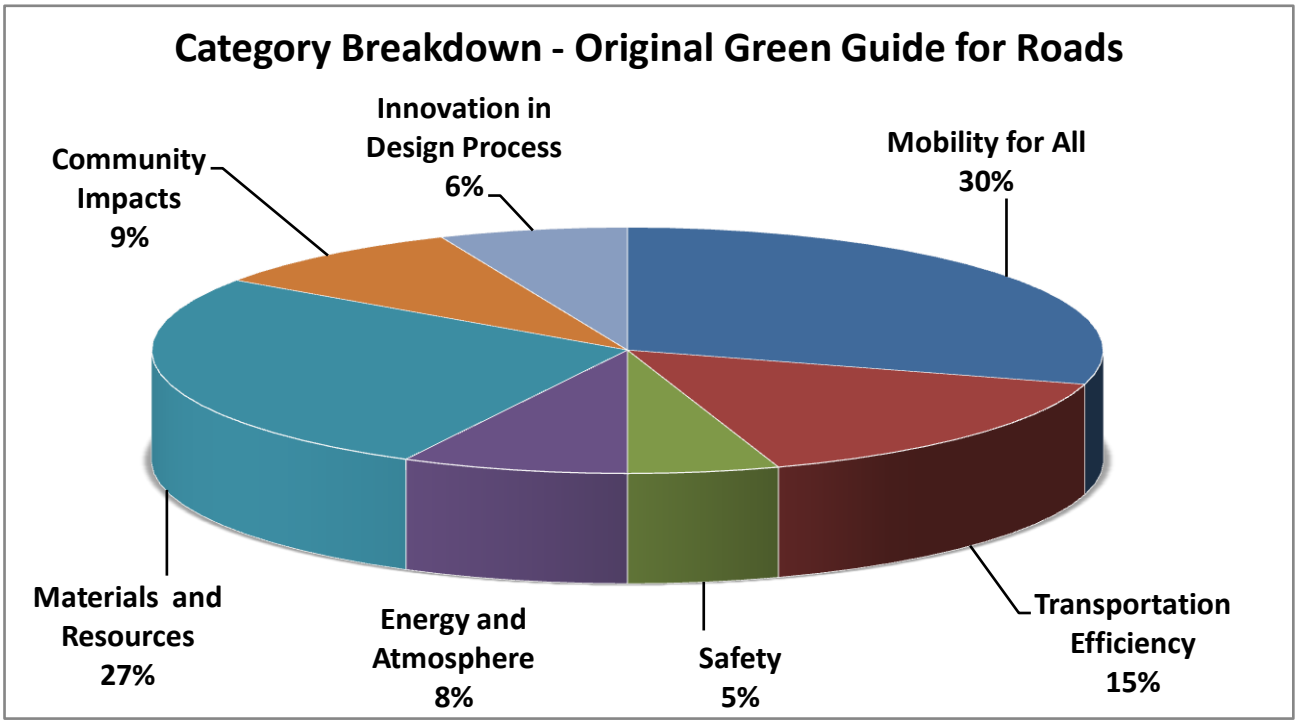


Figure 6: Category Breakdown - Original Green Guide for Roads

The chart clearly shows that two categories, *Mobility for All* and *Materials & Resources*, make up the majority of the guide. Together they comprise of nearly 60 percent of the possible points, while four of the other five categories are less than 10 percent each. Due to the major percentage differences, it became apparent that a more balanced guide better represents the goals of the Green Guide. By adjusting the categories more equally, it will require users of the guide to take a more holistic approach to roadway sustainability and eliminate the possibility of focusing on one or two categories to achieve certification. To see how the Green Guide's percentages rank, a comparison was completed against two other sustainable roadway rating systems that can be seen in Figure 7.

The first step in analyzing the Green Guide for Roads, Greenroads and GreenLITES was to develop a common set of criteria for comparison since each guide consists of its own, unique categories. Using this common set of criteria, the credits of each guide were redistributed to where they were most applicable based on their intent. This common set of categories was derived for all three guides and consists of:

- *Materials & Resources*: Preventing the use of virgin materials while promoting recycling and reuse, use of local materials and limiting the construction site footprint.
- *Transportation Efficiency*: Promoting effective and efficient transportation planning.
- *Community Impacts*: Increasing community involvement in the planning stages while minimizing impacts of the roadway such as light pollution and noise.
- *Energy & Atmosphere*: Encouraging energy reduction and conservation during construction and promoting alternative pavement designs that reduce emissions and increase worker safety.
- *Multimodal Transportation*: Promoting alternate modes of transportation by making roads more bicycle and pedestrian friendly and encouraging the use of public transit.
- *Environment & Water*: Limiting the impact of roadways on the environment for the entire lifetime of the road, primarily focusing on stormwater management.

- *Quality Management*: Producing and using quality products and services for construction of a better roadway.
- *Exemplary Performance*: Rewarding sustainable practices that exceed the requirements of the guides and promote innovation within the industry.

Based on the redistribution into the criteria listed above, Figure 7 shows the percentage of points each guide assigns to the various categories. Due to each guide having different point totals, percentages were used for comparison.

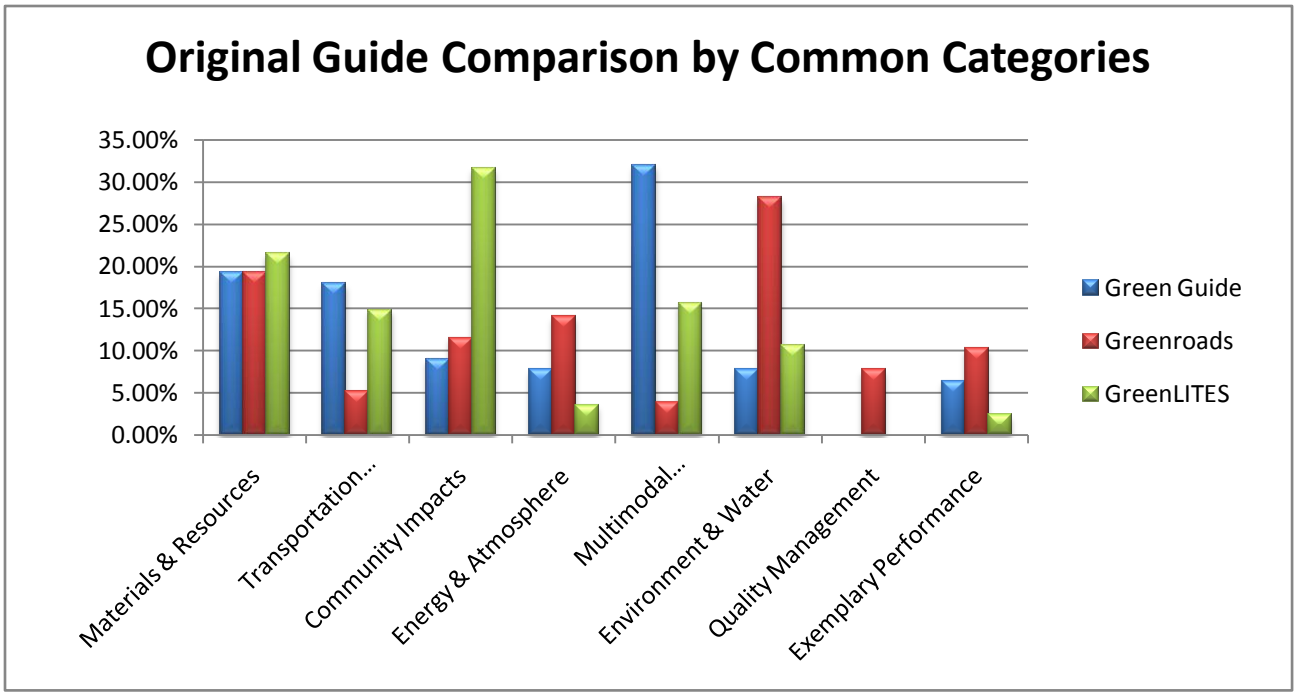


Figure 7: Original Guide Comparison by Common Categories

It is quite evident from Figure 7 that the three guides differ greatly from category to category. Only in *Materials & Resources* was there a similar percentage of points allotted, with each guide placing its largest emphasis on a different category. The highest point totals were Community Impacts in GreenLITES, *Multimodal Transportation* in the Green Guide and Environment & Water in Greenroads. One thing to note was the percentage differences in these three heavily emphasized categories, where the other two guides placed less than half the percentage. Quality Management was the only category not represented in all three rating systems. Figure 7 represents only the credits and point totals of each guide; it does not account

for the prerequisites, as they have no point value. When looking only at the credits, the graph clearly shows that while all the guides have the same goal, they each take a different approach towards evaluating sustainable roadways.

In addition to making a comparison based on their category weight, the team reviewed concepts from the other guides for possible incorporation and to fill any missing criteria in the Green Guide. This led to the addition of credits concerning low-impact development, paving energy reduction, paving emission reduction, reflective pavement and a construction noise mitigation plan. For like credits, the requirements were compared to look for similarities and differences. This led to the altering of some credit requirements, specifically a change towards performance based requirements rather than specifying methods or technologies for achievement. Finally, the team researched the sources used in the other guides to increase the content on the website and provide more credibility to the Green Guide.

4.3 Credit Assessment (Preliminary guide)

The results of the comparison and the review of the other guides led to the creation of a new draft of the Green Guide for Roads. This preliminary draft contained other major amendments aside from the addition of missing criteria and the altering of credits and requirements. The first of these changes was reworking the categories to mimic the common set developed for the original comparison. The team felt that these were a more accurate and precise representation of the rating system's goals. The changes made were the creation of an *Environmental Impacts* category, the integration of *Safety* into other areas, and the renaming of *Transportation Efficiency* to *Transportation Planning*. With the new categories in place, the credits were redistributed throughout the guide.

The second major modification was the shift to a 100 point system. When reviewing and comparing the other guides, the team found the points and scaling confusing. The change was made to alleviate this problem, making the guide more user-friendly and to better represent the value of a credit. The move to this new point system and the need to balance the categories led to a reevaluation of the point totals for each credit and category.

This balance naturally occurred when credits were reassigned to the amended set of categories and the incorporation of new credits. To adjust the credits to the 100 point system,

points were deducted from *Mobility for All* and *Materials & Resources* and redistributed among the other categories. The main beneficiaries were *Energy & Atmosphere* and *Environmental Impacts*, due to a heavier focus on emission reduction and stormwater management. With the incorporation of these changes, a new point breakdown chart was made, displayed in Figure 8 below.

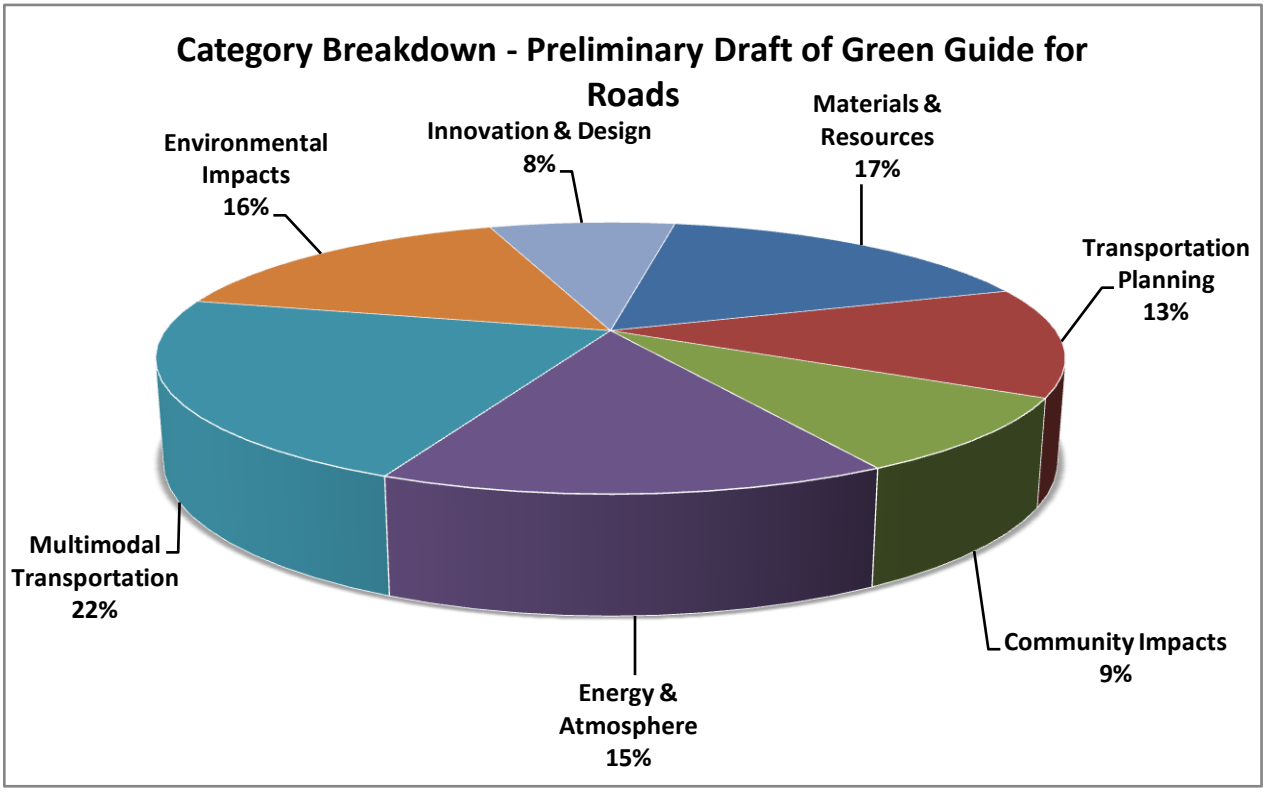


Figure 8: Category Breakdown - Preliminary Draft of Green Guide for Roads

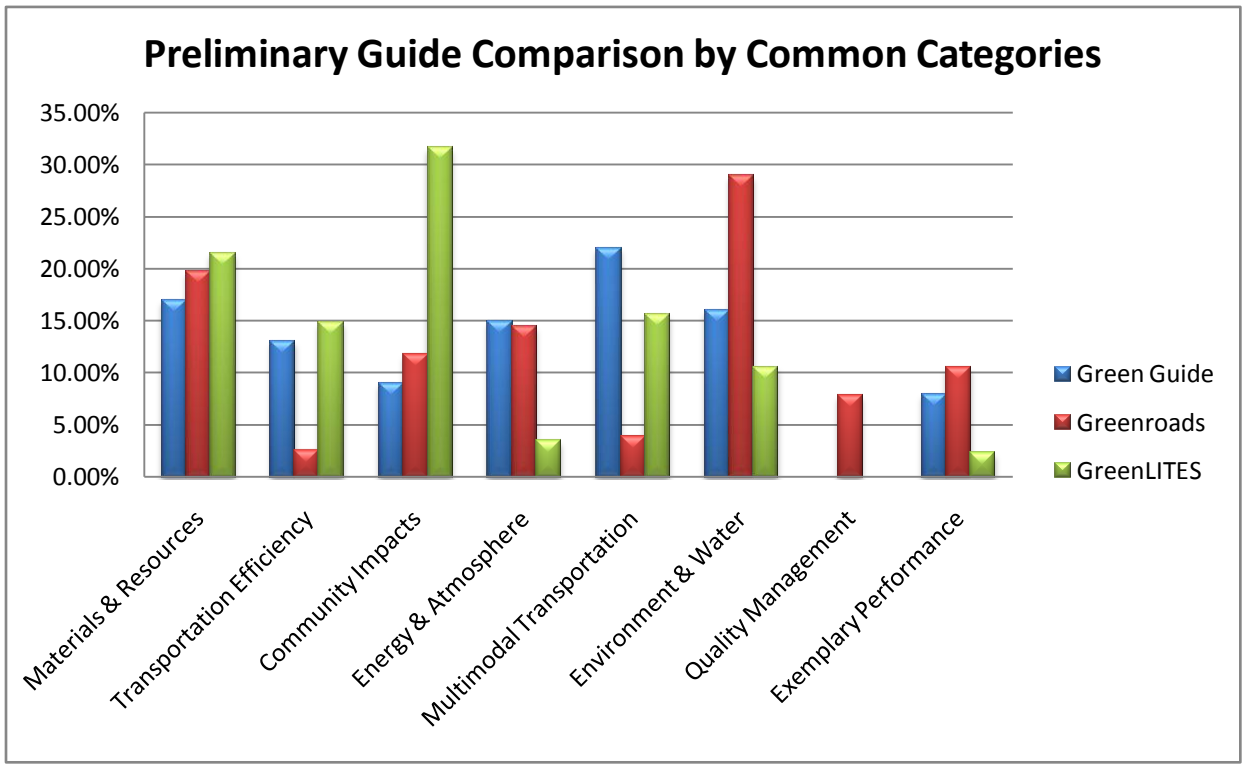


Figure 9: Preliminary Guide Comparison by Common Categories

Figure 9, shown above, displays the comparison of the preliminary guide against the Greenroads and GreenLITES rating systems. From the comparison chart, the preliminary guide is more balanced and evenly spread out amongst the categories. In every area of comparison, the Green Guide had allotted a similar percentage of points to one of the other rating systems. *Materials & Resources* remains the only category that all three guides have a similar percentage, while all continue to place an emphasis on different areas. From the reweighing of points, however, the Green Guide's main focus on *Multimodal Transportation* has been significantly lowered in comparison to the other guides' primary foci. In keeping with Stantec's vision, the preliminary guide still stressed the importance of *Multimodal Transportation.*

4.4 Meetings

Meetings were used to gain an understanding of current standards and practices of the industry. The meetings were used to review the guide's structure and credit system and provide

feedback from industry experts. Results from the meetings were used in the scoring of roadway projects, revision of the guide and recommendations for further development.

Stantec Advisors:

Carl Clayton – Senior VP, Transportation:

Canadian Representative, Sustainable Transportation Technical Committee, World Road Association, and a member of the Transportation Associate of Canada's Green Guide for Roads Task Force. He is the creator of the Green Guide for Roads, putting together the initial framework of the guide. His original vision for the guide was aimed toward *Mobility for All* and *Materials & Resources*. Through weekly meetings he provided ideas for further development and offered continual critiquing, input and analysis. His overall vision of the Green Guide is to make a marketable resource that drives the industry towards more sustainable practices.

Klaas Rodenburg – Sustainable Design Coordinator:

Chair of the Alberta Chapter of the Canadian Green Building Counsel and a member of the Transportation Association of Canada's Green Guide for Roads Task Force. He is the team's main advisor and provided advice geared toward Stantec's needs for the guide. Also, Klaas acted as a resource manager for the team, providing multiple connections to various parts of the industry, both within Stantec and outside resources. He also provided guidance towards the development and implementation of the GreenAlberta website as a databank and discussion forum.

Stantec Personnel

Victor Saly – Senior Associate, Urban Land:

Provided insight into the overall planning and design processes as well as the current practices associated with them. The meetings covered all aspects of the Green Guide, with a focus on *Mobility for All*, *Transportation Planning*, and *Community Impacts*. The feedback from the meetings helped to define the city's role in roadway planning and design.

Dean Cooper – Principal, Transportation Planning and Traffic Engineering

A multimodal expert who specializes in the planning associated with cycling and walking. He provided detailed analysis of *Mobility for All*, which led to the altering of credit requirements and readjustment of the category structure. He and his group of multimodal experts introduced the concept of context sensitivity to the team. They suggested a more unilateral and detailed approach to the *Mobility for All* category.

Tori Liu – Senior Drainage Engineer:

Offered input for the *Environmental Impacts* category, with a focus on stormwater management practices. Her feedback on the credit requirements led to changes incorporating more Best Management Practices (BMP) based analysis, as well as additional methods of evaluation. She provided a clearer understanding of Low Impact Development (LID) and alternative strategies for implementation.

Gerry Devine – Senior Principal, Strategic Management:

An expert in project economics and asset management, he provided an understanding of lifecycle costing and analysis. He stressed the importance of assessing a project over its entire lifetime and evaluating all areas associated with sustainability costs. The meeting shaped the current lifecycle costing and the recommendation of a lifecycle analysis credit.

Kelsey D'Agostini – Lighting Specialist, EIT:

She supplied the team with information about all facets of lighting design. The main topics of discussion were energy efficiency, pathway lighting and light pollution. The meeting also covered the current city and international standards, as well as new sustainable solutions that are emerging. Her feedback helped shift the guide to a more standard based analysis and the creation of a new pathway lighting credit.

Outside Resources

Works Alberta – Jake Vanderburg - Marketing Coordinator:

The initial meeting with Jake offered insights into many of the categories, primarily focusing on construction activities. During the meeting he offered the team a chance to present their work and receive comments from a group of contractors and construction experts. The

lengthy question and answer session led to many changes to multiple categories and overall guide structure. This meeting concentrated on the current construction practices and the feasibility of *Energy & Atmosphere* and *Materials & Resources*.

Green Alberta – Stephani Carter – Principal Sustainable Building Materials Specialist:

Founder of Green Alberta, a company that provides 'green' assessment of building materials and resources. The meeting focused on the approach and fundamentals of how to assess green products and services. This was used in the reweighing of categories and credits in the Green Guide. Stephani's company also hosts the Green Guide for Roads website.

4.5 Scored Projects

To ensure that the Green Guide promotes sustainable strategies above and beyond the current industry practices, the team scored six different roadway projects using the preliminary draft of the guide, which can be found in Appendix B. The projects consisted of urban arterial roads and residential collectors, all within the province of Alberta. The construction drawings showing site plans and cross-sections of the roads can be seen in Appendix D. Each project was evaluated for two scores, what the project actually achieved and what the project could potentially achieve had it strived for certification. During this process, the team found that all of the information needed to assess the projects was not available and assumptions had to be made for some credits. These assumptions were based off of meetings with planners, designers and contractors who are familiar with current industry standards.

In *Mobility for All*, the majority of credits were scored using the site plans and cross-sections. In this category, most credits define the layout and sizing of multimodal paths, facilities and design that can be seen from the drawings. Assumptions that were made dealt with parking management and pathway lighting. There was no parking management plan available for review; therefore the credit was evaluated based on location. Residential collectors received a point because on-street parking is seen as desirable and urban arterials, where it is undesirable, received a point based on the fact the roadways did not contribute to on-street parking. Lighting levels presented in the guide were assumed to be met based off of city standards.

Due to the limited amount of information available, many assumptions had to be made about the *Transportation Planning* category. Many of the credits are based on decisions that

were made early in the projects and not reflected in the construction drawings or specifications. For the prerequisites of this category, the team assumed the level of service was consistent with the transportation plan and that a traffic maintenance plan was in effect. Conversely, a safety audit and calculations for fuel-usage savings were not part of current practices due to information from meetings with designers. Credit requirements assumed to not be met were Optimum Level of Service and the use of Intelligent Transportation Systems. Responsive Traffic Signals received half the possible points because all phasing design is done by the city and the information is unavailable. All projects met the Design Speed and Consistency requirement, as they were lower speed roads and in compliance with city specifications.

For *Energy & Atmosphere*, most of the information about these credits came from the meetings with Works Alberta. This led the team to grant no points for the first six credits, as current practices do not meet the requirements. However, if contractors were aware of the Green Guide, it would be possible to achieve partial points. The use of local materials was assumed to occur and was awarded full points.

The discussions with the contractors about the current industry standards and practices also helped shape the assumptions made for the *Materials and Resources* category. The recycling and reuse of materials is done on all job sites, but not to the level required in the guide. This led to partial points in these credits with potential for more to be achieved. For Lifecycle Costing and Long Life Pavements, the requirements were not met as they are not current practices in the industry. Specifically, roads are designed for a 20 year horizon while Long Life Pavements require 30 years.

Environmental Impacts did not receive many points, due to current city stormwater management practices. The prerequisite was met, because it was assumed that most construction projects require a sediment and erosion control plan. Current stormwater techniques tie directly into the sewer systems and do not implement any of the strategies laid out in the Green Guide. The city specifications call for the use of native species in roadway landscaping, which receives full points for Water Efficient Landscaping. Lastly, the use of reflective pavements is not a current practice and was awarded no points.

From the meetings about the *Community Impacts* category, it has become apparent that little to no effort is put into involving the community. The only community outreach is an open house, where planners are not required to take into account any community input. There is no evidence of any attempts to reduce noise and light pollution. In order to get any response from a city, the community has to pursue legal action. Almost no points were awarded in this category to any project scored.

Based on the assumptions above and the drawings provided, the scores of each project are shown below in Table 1. Also shown in the table below, is the certification level for each of the scored projects. The project score cards, which contain a point breakdown of each credit, can be found in Appendix E.

Table 1: Scoring Project Overall Results

		Points Scored	Certification	Potential Score	Potential Certification
Projects	**S. Terwillegar**	27	None	61	Certified
	Ellerslie Rd.	34	None	64	Certified
	167 Ave	30	None	62	Certified
	Secord, Stage 2	29	None	69	Silver
	The Hamptons	29	None	68	Silver
	Fort Saskatchewan	26	None	60	Certified

The table shows that all the projects scored similar totals and none of the projects would achieve certification based on current industry practices and standards. However, all of the projects could achieve some level of certification by implementing reasonable changes. The team found these scores to be a good indicator that the guide would push the industry toward more sustainable solutions and sets the bar above current standards. In Tables 2 and 3, shown below, are the actual and potential scores for each project by category, Figures 10 and 11 show the comparison of each.

Table 2: Actual Project Score by Category

Points Scored							
		Projects					
		S. Terwillegar	Ellerslie Rd.	167 Ave	Secord, Stage 2	The Hamptons	Fort Saskatchewan
Categories	Mobility for All	15	19	16	17	17	12
	Transportation Planning	3	5	5	3	3	5
	Energy & Atmosphere	2	2	2	2	2	2
	Materials & Resources	5	5	5	5	5	5
	Environmental Impacts	2	2	2	2	2	2
	Community Impacts	0	0	0	0	0	0
	Innovation & Design Process	0	1	0	0	0	0
Totals		**27**	**34**	**30**	**29**	**29**	**26**

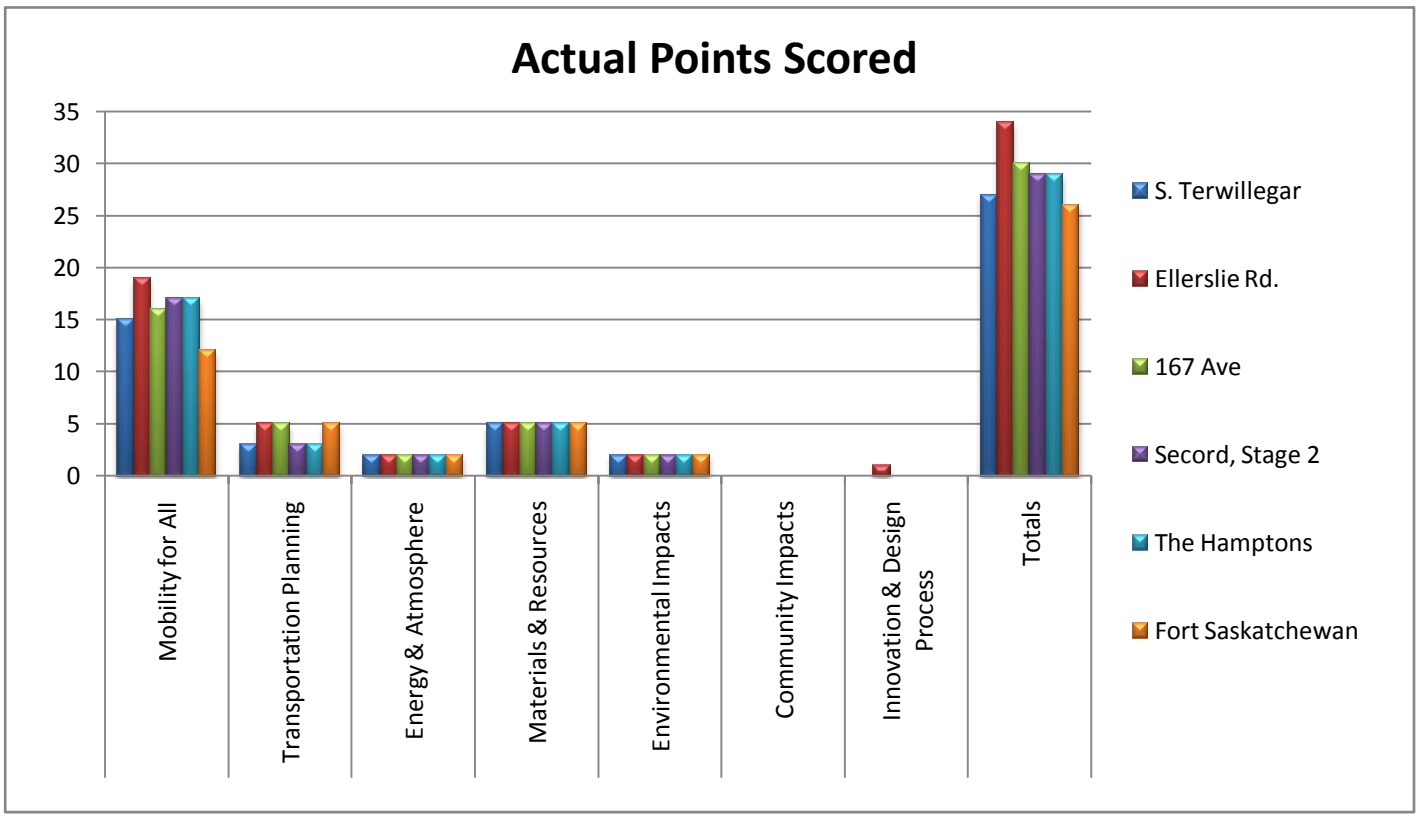


Figure 10: Actual Points Scored by Category

The majority of points were achieved in *Mobility for All*, where nearly every project earned over 50% of its total points. The remaining points were spread out amongst the other categories, with the exception of *Community Impacts*, which received no points for any project. The projects scored the same in many of the categories, due to the fact that the same assumptions were used for all projects. However, there was some variation in *Mobility for All*, because it was based on the site overview and cross-section, which varied from project to project.

Table 3: Potential Score by Category

Potential Score							
		Projects					
		S. Terwillegar	Ellerslie Rd.	167 Ave	Secord, Stage 2	The Hamptons	Fort Saskatchewan
Categories	Mobility for All	20	22	21	22	22	20
	Transportation Planning	7	11	11	10	9	11
	Energy & Atmosphere	10	8	8	10	10	8
	Materials & Resources	12	12	12	12	12	12
	Environmental Impacts	6	4	4	8	8	4
	Community Impacts	6	5	5	6	6	5
	Innovation & Design Process	0	2	1	1	1	0
Totals		**61**	**64**	**62**	**69**	**68**	**60**

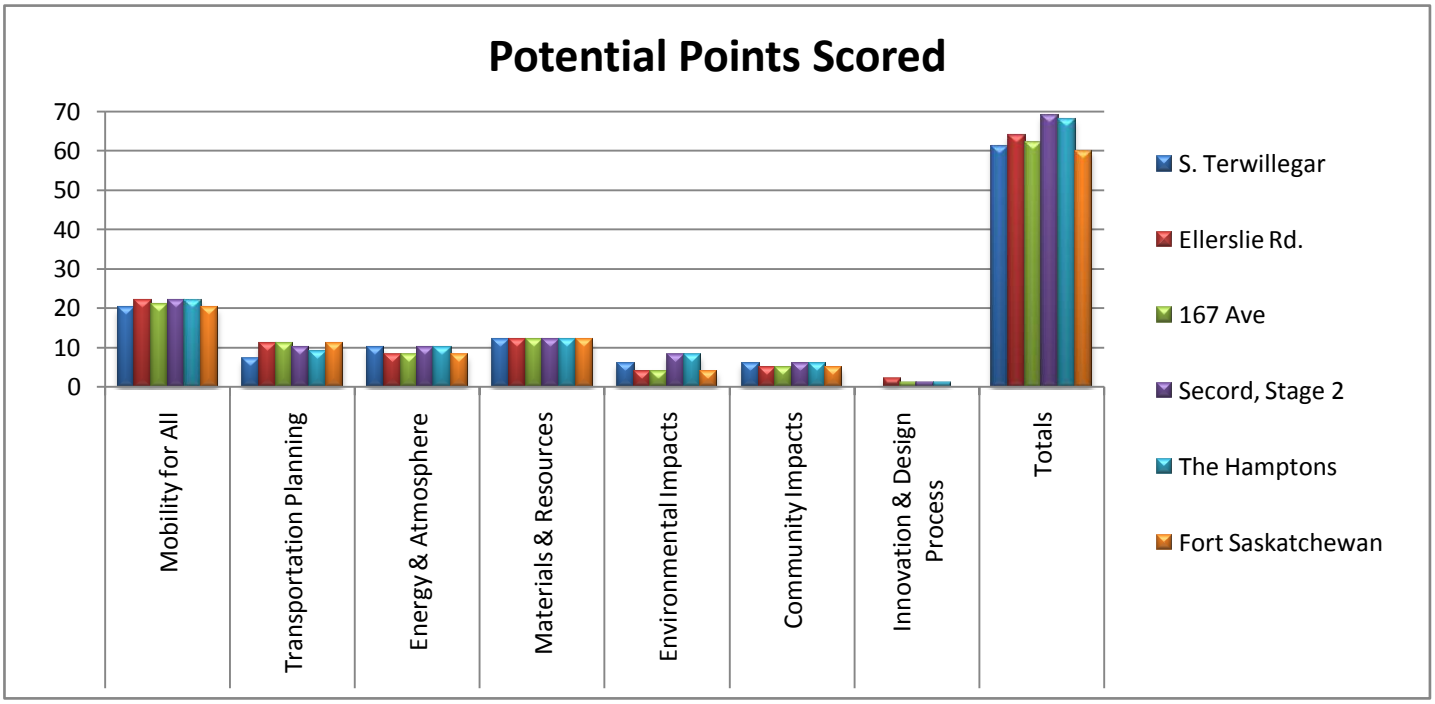


Figure 11: Potential Points Scored by Category

The potential scores were significantly higher and all projects would achieve a level of certification. *Mobility for All* remained the highest scoring category, but its percentage decreased to roughly one third of the total points achieved. *Transportation Planning*, *Energy & Atmosphere* and *Materials & Resources* all ranged from 7 to 12 points, while *Environmental Impacts* and *Community Impacts* scored from 4 to 8 points. A few of the projects gained a point in *Innovation and Design Process* due to exemplary performance. *Materials & Resources* was the only category where all projects scored the same, as the assumptions were based off of construction practices and were unaffected by project designs.

4.6 Credit Assessment (Revised Green Guide)

The results from scoring projects and the feedback from meetings shaped revisions made to the Green Guide for Roads. These changes sculpted the guide into a more complete, useable document. The removal and addition of credits, as well as the shifting of prerequisites and credits brought the guide from its preliminary stages to a comprehensive rating system for sustainable transportation, that can be found in Appendix C. Credits were refined further, adjusting their intent and requirements to shift towards plan based initiatives, rather than baseline percentages. The final amendment to the Green Guide was the reweighing of the credit point totals, keeping the 100 point scale, while maintain balancing between categories.

In *Mobility for All,* many of the credits were restructured to better convey their intent. An example of this is the re-tier of credit requirements allowing multiple parts of credits to be awarded points. The new credit Pathway Lighting & Design combined the lighting aspects from two credits, making the category breakdown more logical and easier to understand. Parking Management was moved to *Transportation Planning*, as it is more applicable to that category.

Aside from the addition of Parking Management, *Transportation Planning* shifted the Person-Time & Fuel Usage Savings prerequisite to a credit. The two amendments added a significant amount of points to the category, leading to a deduction of points from other credits. They were taken from Design Speed & Consistency, Intelligent Transportation Systems and Optimized Level of Service because the point values were too high compared to their importance and ease of attainability.

Energy & Atmosphere contained multiple changes that focused the credits on plan based requirements as opposed to baseline percentage reductions. Fossil Fuel Reduction & Equipment Emission Reduction were combined together and shifted from unrealistic baseline measurements to the formation of plans that monitor fuel use and emissions. In addition, Lighting Energy Efficiency was separated from Infrastructure Energy Efficiency to create a new credit. Paving Energy Reduction was modified from calculation of baseline percentages to the use of Best Management Practices, as they are a better measure of sustainable practices. Lastly, Local Materials was moved to *Materials & Resources,* which is a better fit.

Besides the integration of Local Materials, the only significant change to *Materials & Resources* was the switch between a prerequisite and a credit. Lifecycle Costing became a credit since there is a considerable amount of work required. On the other hand, Construction Waste Management is a current practice and was moved to a prerequisite.

In *Environmental Impacts*, Stormwater Lifecycle Costing was removed as it contained unrealistic criteria. With the help of Tori Liu, the team rewrote the Stormwater Management and LID Stormwater Management credits to better reflect an assessment of sustainable practices. Finally, a criterion was added to Construction Activity Pollution Prevention that gives an additional point for environmental stewardship awards and certifications.

For the *Community Impacts* category, Noise Mitigation Plan was turned into a credit and a point was deducted from Visual Elements. Each credit in *Innovation & Design* was reduced by one point to lower the weight of the category, as it was deemed to carry too high of an importance in the guide.

The new category breakdown of the guide is shown below, in Figure 12. The revised Green Guide for Roads is more balanced than the preliminary draft, but the emphasis remains on *Mobility for All* and *Materials & Resources* in keeping with the original vision. With the exception of *Innovation & Design*, all of the categories are worth over 10% of the total points with the majority of them around 15%.

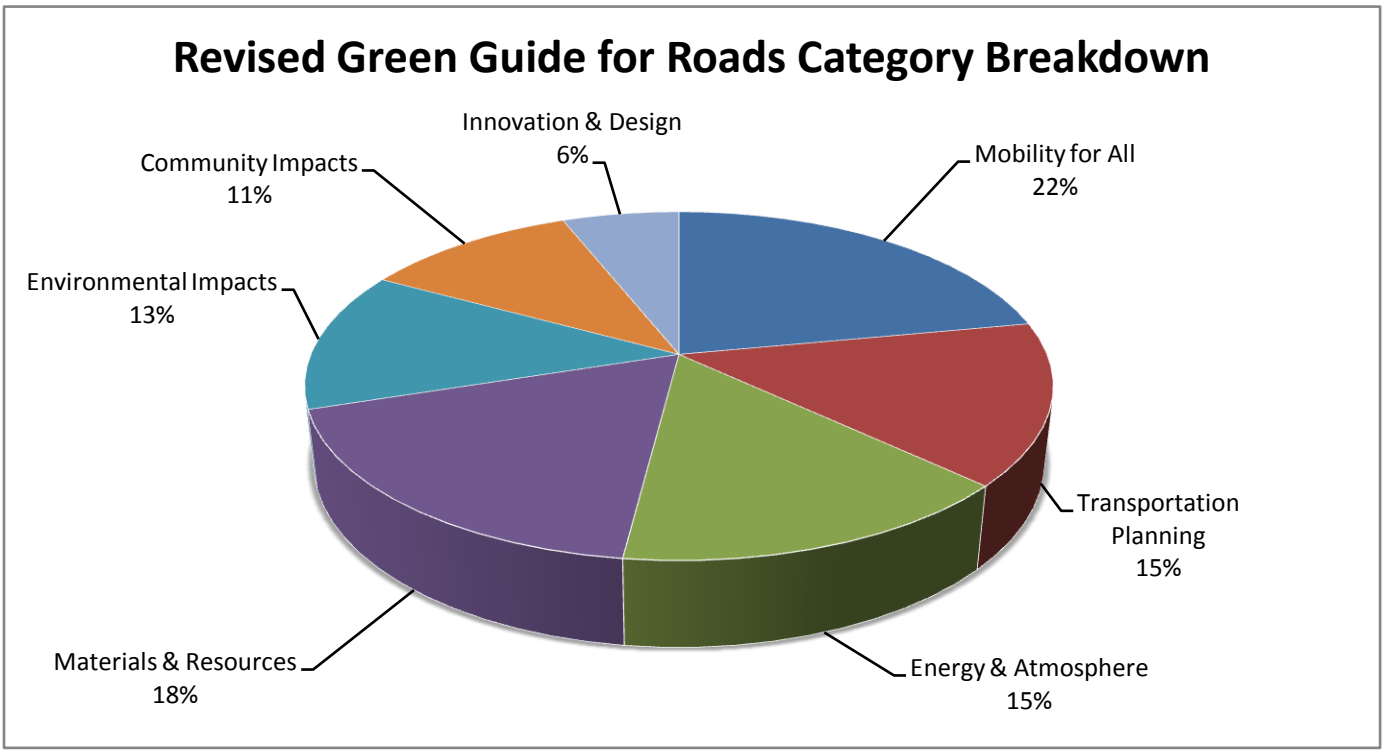


Figure 12: Revised Green Guide for Roads Category Breakdown

4.7 Populate Website & Discussion

In order to create a databank of sustainable transportation resources and to start discussion about the guide, the team developed a website originally created by Klaas Rodenburg and hosted by Green Alberta. From the initial shell of the website, the team created article posts and forums for all parts of the Green Guide for Roads, which can be seen in Appendix F. Users have full access to the Green Guide credits and structure, where they can comment and post sources online. Using the internet as a medium allows for continuous feedback and the most current version of the guide to be available.

The goal of posting articles is to provide the resources which support the credits and power the discussion. The website contains the breakdown of articles by credit and category, which allows the user easy navigation. Each article contains links to specific sources relevant to each topic. All of the articles came from the team's literature review and many were used in the development of the revised guide. In addition, users have the ability to create their own articles

and post supplementary sources. The purpose of these documents is to provide all users with further background knowledge about each credit and initiate discussion in the forums.

The function of the forums is to allow discussion of all aspects of the Green Guide and receive input from users of all backgrounds. The forums outline each credits intent, requirements and submittals, allowing users to make comments and create threads specific to the credit or category.

The website is an on-going process that will continue to grow with the development of the Green Guide and users' input. It is a powerful tool, containing the most current information in an easy to use format. Users have instant access and the ability to view, post and comment about all phases of the discussion.

Chapter 5: Conclusion

The intent of this project was to provide Stantec Consulting Ltd. with an enhanced version of the Green Guide for Roads that can be used as a marketing tool for potential clients. The team met the goals of Stantec, which were the further development of the Green Guide and the integration of the guide onto a website for future discussion. From the research conducted, a set of recommendations was created for continued development of the revised document. These recommendations consist of areas for future research, the possible incorporation of new credits, applicability of context sensitive solutions and defining credit relevancy and scoring of various roadway project types.

5.1 Recommendations

5.1.1 Future Research

One of the most important aspects of the Green Guide is the continuous push for more sustainable practices. It must remain ahead of current trends, incorporating emerging green technologies and standards. Future research will play a vital role in the integration of these practices, technologies and standards into the guide.

Mobility for All

- **Credit 1: Transit Facilities:**

  Currently the guide awards points based on the percentage of transit stops that are enclosed. A better solution may require shelters only at stops with a high frequency of use.

- **Credit 5: Pedestrian Facility Design:**

  The guide requires grades less than 3% to avoid water pooling. There has been no research found to confirm this grade, it may be possible that the requirement is not stringent enough.

- **Credit 6: Pathway Lighting & Design:**

  The current lighting chart referenced in the guide uses criteria not often used in lighting design. No benchmarks for pathway lighting have been found and they should be looked into further, with the incorporation of common design standards. A chart, however, may not be the best possible solution to address this credit.

Transportation Planning

- **Prerequisite 2: Safety Audit:**

  The safety audit does not stipulate which phase of the project it is conducted in. A project may require an audit at multiple stages. In addition, the audit for the construction duration should be defined further, with emphasis on a 3rd party review.

- **Prerequisite 3: Traffic Maintenance Plan:**

  The requirements of the credit need to be defined clearer and with more detail, specifically in regard to traffic accommodation and incident management. A set of required criteria needs to be created for the traffic maintenance plan. The baseline for vehicle delays and its calculations should be defined.

- **Credit 1: Parking Management:**

  Clarification is needed for the requirements, possibly more specific evaluation criteria. The removal of subjective wording in requirements should be reviewed and how to define whether parking is necessary.

  AND

  Provide a description of key locations within the project for bicycle stands and lockers. The parking management plan should be tied to its purpose, such as easily accessible parking.

- **Credit 2: Optimum Level of Service:**

  Possible merge with TP Prerequisite 1. Clarification is needed for requirements to define 'providing adequate, but not excessive, roadway capacity'. Currently there is no baseline for the planning horizon and should be reviewed.

- **Credit 3: Person-Time & Fuel Usage Savings:**

  Guidance is required on how to perform the required calculations.

- **Credit 6: Intelligent Transportation Systems:**

  No research has been found on current ITS technologies and its possible application to roadway design, other than highway networks. The credit may not be applicable.

Energy & Atmosphere

- **Credit 2: Infrastructure Energy Efficiceny:**

  Currently the guide requires a reduction of energy use from the baseline, but offers no guidance on how to perform the calculation. Research has provided no information on the feasibility of a 15% reduction from the baseline.

- **Credit 3: Fossil Fuel & Emission Monitoring:**

  The fuel usage and emission monitoring plans need more details in the requirements, specific criteria and frequency of measure need to be defined.

- **Credit 5: Paving Energy Reduction:**

  The credit requires a reduction of energy use from a baseline. There may be no baseline available for comparison and no research has been found to verify if requirements are possible.

- **Credit 6: Volatile Organic Compounds:**

  The maximum allowable limit needs to be stated and defined in the requirements. Research must be conducted to ensure products exist that meet these standards.

Materials & Resources

- **Credit 2: Construction Site Footprint:**

  Possible switch to project specific plan, research should be done to assess whether these plans would be a viable alternative.

- **Credit 3: Recycled Content:**

  Currently, the credit requirements address both concrete and asphalt mixes, which could potentially be split into two separate credits. The levels used need to be researched further to ensure they are feasible.

- **Credit 4: Long Life Pavements:**

  Define 'minimal restoration' and research the design and maintenance life of pavements that meet the current requirements.

Environmental Impacts

- **Credit 5: Reflective Pavement:**

  Research the effect of reflective pavement in cold climates and its impacts.

Community Impacts

- **Prerequisite 1: Community Outreach & Involvement:**

  Further clarification is needed for the outreach and involvement program and 'respects input' should be defined. More input should be provided regarding the inclusion of communities in the project design and construction phases.

- **Credit 2: Traffic Noise Reduction:**

  Research the feasibility of the credit and its requirements, specifically whether noise levels can be monitored before a road's construction.

- **Credit 3: Light Pollution Reduction:**

  The current guidelines are not stated and should be evaluated for their impact. Additional information should be provided about each guideline.

- **Credit 4: Visual Elements:**

  Research has not provided any evidence of these requirements being attainable. This credit appears to be very community based and out of the scope of the project.

5.1.2 Additional Credits

The feedback from meetings in conjunction with scoring projects brought the team to the conclusion that there may still be missing criteria for the Green Guide. These topics for possible assimilation into the guide are smooth pavement, lifecycle analysis, and utility impacts. Smooth pavement causes less friction between vehicle tires and the road that results in better gas mileage, decreasing energy use. Currently, the guide only examines lifecycle costing, which deals with the financial aspect of the project. Lifecycle analysis also scrutinizes the environmental and social impacts of a roadway, from its construction to end of service. Lastly, no credit in the guide addresses the impacts of utilities above or below ground. Research into sustainable practices for all utility activities could lead to the addition of a new credit.

5.1.3 Context Sensitive Solutions

One of the major obstacles in assessing *Mobility for All* was defining the most sustainable solutions for the category. The concept of context sensitive solutions was suggested in the meeting with Dean Cooper and his team of multimodal experts, where they pointed out that one design is not the best solution for every roadway. For example, three meter multiuse path on both sides of the road may be excessive if located in low use areas resulting in a waste of materials, energy and capital cost. Each roadway project has specific multimodal needs, and a generic solution may not be best.

From research and meetings, a need to address context sensitive solutions has arose. Further research into this topic is required to ensure the guide provides sensible sustainable solutions and promotes the best practices in multimodal transportation.

5.1.4 Project Scoring and Certification

The current scope of the Green Guide targets urban arterials and collectors. The guide focuses on these types and only similar roadway projects were scored. To meet the original vision, the guide must encompass all roadway types. Some credits will not be applicable to the various roadways and a range of projects must be scored to determine where credits are applicable and relevant. The scoring of more projects will provide more information about credit feasibility and ensure the guide is a practical measure of sustainable practices.

Bibliography

AASHTO. (2007). *Transportation: Invest in our future*. Washington, DC: AASHTO.

AASHTO. (2009). *Sustainability.* Retrieved 2/5, 2009, from http://environment.transportation.org/environmental_issues/sustainability/

Adams, W. M. (2006). *The future of sustainability: Re-thinking environment and development in the twenty-first century*

Bruntland, G. (. (1987). *Our common future: The world commission on environment and development*. Oxford: Oxford University Press.

Chartier, E. G., Cook, D. A., Gough, J. W., & Musters, Joanna M., Skene, Michael B., Woodhall, JoAnn. (2004). *Promoting sustainable transportation through site design: An ITE proposed recommended practice* No. RP-035)Institute of Transportation Engineers. Retrieved from www.ite.org

Green guide for health care. (2009). Retrieved 2/11, 2009, from http://gghc.org/

Green guide for roads. Unpublished manuscript.

Kats, G. H. (2003). *Green building costs and financial benefits.* Massachusetts, U.S.:

Katz, A. (2009,
National studies show green building as key part of America's economic future.

Keoleian, G. A., & Scheuer, C. W. (2002). *Evaluation of LEED using life cycle assessment methods* No. NIST GCR 02-836). Ann Arbor, MI: National Institute of Standards and Technology.

Muench, S. (2009). *Greenroads.* Retrieved 1/22, 2009, from http://greenroads.us/

Muench, S. (2009). *Greenroads* (.95th ed.) Retrieved from http://www.greenroads.us/files/42.pdf

Muench, S. (2009). Rating your project for sustainability. Presentation at TRB conference in Washington, DC.

New York State Department of Transportation. (2008). *GreenLITES*. New York State: New York State Department of Transportation.

Soderlund, M. (2007). Sustainable roadway design- A model for an environmental rating system. (Master of Science in Civil Engineering, University of Washington).

Stantec. (2008). Retrieved 1/28, 2009, from http://www.stantec.com/default.htm

The Centre for Sustainable Transportation. (2002). *Defininition and vision of sustainable transportation*. Mississauga, ON: The Centre for Sustainable Transportation.

The Centre for Sustainable Transportation. (2006). *The centre for sustainable transportation.* Retrieved 2/13, 2009, from http://cst.uwinnipeg.ca/

USGBC. (2006). *New construction & major renovation: Version 2.2 refrence guide* USGBC.

USGBC. (2009). *Green building facts.* Washington, D.C.: USGBC.

Appendix A: Original Green Guide for Roads

GREEN GUIDE FOR ROADS

Development of Concept
Sample for Internal Use Only

Stantec

CANADA GREEN BUILDING COUNCIL • CONSEIL DU BÂTIMENT DURABLE DU CANADA
CHAPTER
ALBERTA

January 2008

GREEN GUIDE FOR ROADS

Table of Contents

EA Credit 3: Local Materials

MR Prerequisite 1: Lifecycle Costing

MR Prerequisite 2: Construction Activity Pollution Prevention

MR Credit 1: Construction Site Footprint

MR Credit 2: Construction Waste Management

MR Credit 3: Recycled Content

MR Credit 4: Stormwater Management

MR Credit 5: Water Efficient Landscaping

CI Prerequisite 1: Community Outreach and Involvement

CI Credit 1: Noise

CI Credit 2: Light Pollution

CI Credit 3: Visual Elements

ID Credit 1: Innovation and Exemplary Performance

Introduction

The Canada Green Building Council (CaGBC) has been officially established as a national non-for-profit corporation and it has signed a Licensing Agreement with the U.S. Green Building Council (USGBC) for the exclusive implementation of the LEED (Leadership in Energy and Environmental Design) Green Building Rating System in Canada. Through its use as a design guideline and third-party certification tool, LEED has a proven track record of improving occupant well-being, environmental performance and economic returns of buildings using well established and innovative practices, standards and technologies. It provides one definition, widely accepted by the building industry, for what currently constitutes a "green building".

The USGBC in cooperation with the Congress of the New Urbanism and the Natural Resources Defense Council recently came together to develop a set of standards for neighbourhood location and design based on the combined principles of smart growth, new urbanism, and green building. LEED for Neighbourhood Development represents an effort to relate the neighbourhood of buildings and supporting infrastructure to its larger region and landscape. It is hoped that it will serve as an incentive for better location, design and construction of new developments.

Roadway infrastructure is an integral part of providing mobility for people and goods. Green Guide for Roads was originally conceived and developed by Stantec Consulting to promote consideration of sustainable design within its road based transportation practice. Subsequent discussions with the Alberta Chapter of the Canadian Green Building Council suggested that it could be a complementary effort to LEED for Neighbourhood Development. Stantec and the Alberta Chapter of the Canada Green Building Council are proposing to evolve the existing guideline in partnership with other stakeholders, such as the Transportation Association of Canada. The intent would be to promote smart growth and multi-modal transportation principles, safe roads and "green" construction techniques with a guideline that was applicable across Canada.

How LEED Rating Systems Work

LEED provides rating systems that are voluntary, consensus-based, market-driven, grounded in accepted and environmental principles, and that strike a balance between established practices and emerging concepts. LEED rating systems are developed by committees, in adherence with USGBC policies and procedures guiding the development and maintenance of rating systems.

LEED rating systems typically consist of a few prerequisites and many credits. In order to be certified, a project must meet each prerequisite. Each credit is optional, but achievement of each credit contributes to the project's point total. A minimum point total is required for certification, and higher point scores are required for silver, gold or platinum LEED certification. Certification Levels are based on the following criteria:

- LEED Certified – 40% or more of the Core Credits
- LEED Silver – 50% or more of the Core Credits

- LEED Gold – 60% or more of the Core Credits
- LEED Platinum – 80% or more of the Core Credits

Credit levels have been set such that Certification indicates that a project is in the top quartile in a particular market. (Note: one of the challenges is setting appropriate credit scores – the LEED Product Development Process through widespread input and use on a wide range of nominated trial projects is critical to setting “the bar” appropriately.)

Green Guide for Roads Rating System

Since the intent for this Green Guide for Roads is to mirror the LEEDS system, a similar rating system has been used as a starting point for its evolution. Where available, the criteria and point systems from comparable LEED products have also been used for further evaluation within the context of Green Guide for Roads.

Mobility for All

MFA Prerequisite 1: Comprehensive Transportation Plan

Required

Intent

Encourage development and use of comprehensive long-range transportation plans that minimize excessive bias to single occupant vehicles.

Requirements

Project is consistent with an overall long-range transportation plan for the community or region and is based on multi-modal transportation (e.g. walking, cycling private vehicle and public transit) principles.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the approved long-range transportation plan.

Mobility for All

MFA Prerequiste 2: Choice of Transportation Modes

Required

Intent

Promote social equity and choices by providing transportation options.

Requirements

Motorized and non-motorized modes of transportation are provided with continuous and clearly defined routes and handicapped accessibility is provided.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the overall plan showing pedestrian, cyclist and motorized transportation routes.
- A copy of the relevant design standards utilized to meet or exceed local requirements for handicapped accessibility.

Mobility for All

MFA Credit 1: Parking Management

2 Points

Intent

Avoidance of a surplus of nearby site and on-street parking

Requirements

Project is consistent with a parking management plan;

AND

Does not unnecessarily contribute to the parking supply in the area

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the parking management plan for the project area.
- A summary of how the project contributes to the principles of the parking management plan.

Mobility for All

MFA Credit 2: Transit Facilities

3 Points

Intent

Encourage transit use.

Requirements

- Transit stop signage and transit route information at each transit stop (1 point)

  AND

- Covered and at least partially enclosed transit shelters with a bench and lighting at each transit stop (2 points).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide an overall plan showing the location of transit stops and the transit shelter type installed.
- Provide a copy of the design details for the transit stop signage, transit route information and transit shelter types.

Mobility for All

MFA Credit 3: Bicycle Lanes/Paths

1 to 3 Points

Intent

Encourage cycling.

Requirements

An approved bicycle transportation plan

AND

- Provide roadway curb lanes and minimum of 0.5 metres wider than the vehicular lane width design criteria to accommodate cyclists (1 point).

  OR

- Provide a continuous designated and marked bicycle lane a minimum of 1.5 metres wide along both sides of the roadway (2 points).

  OR

- Provide a continuous, separate hard surfaced pathway a minimum of 3 metres wide along one side of the roadway (3 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the approved bicycle transportation plan
- Provide an overall plan showing the location and width of the cycling routes as well as route and regulatory signage and pavement markings as appropriate to the facility provided.

Mobility for All

MFA Credit 4: Bicycle Parking

1 Point

Intent

Encourage cycling.

Requirements

Easy to use and theft resistant (can lock frame and one wheel to stand) bicycle stands or lockers are provided at all key locations and are located in visible, well-trafficked areas, but do not obstruct other traffic flows.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A plan showing key destinations and linkages with provision of bicycle stand facilities at all locations.
- Individual site drawings showing layout of the bicycle stand or locker facilities.
- Standard design detail drawing of the bicycle stand or locker facilities.

Mobility for All

MFA Credit 5: Bicycle Facility Design

3 Points

Intent

Encourage cycling.

Requirements

Use design elements that improve the safety and ease of operation of a bicycle. These include:

- Ramps that do not unnecessarily orientate cyclists into traffic lanes.
- Ramps with curb lips no more than 10mm in height.
- Drainage grates with openings narrow and short enough so that bicycle tires do not drop into the grate
- Bridge railings a minimum of 1.4 metres high
- Lighting consistent with the following chart:

Area Class	E_H (lux)	E_{Vmin}	E_{av}/E_{min}
Urban	20.0	10.0	4.0
Suburban	5.0	2.0	4.0
Rural	2.0	0.6	4.0

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Standard design detail drawings for the relevant details used.

Mobility for All

MFA Credit 6: Pedestrian Paths/Sidewalks

1 to 5 Points

Intent

Encourage walking.

Requirements

- The area is part of a traffic management plan designed to reduce through traffic volumes and traffic speeds through roadway design features, which might include narrower travel lanes, tighter corner curb radii, raised medians, curb bulb outs and landscaping. (3 points)

  AND

- Provide continuous, hard surfaced sidewalks a minimum of 2.0 metres wide adjacent to both sides of the roadway. (1 point)

  OR

- Provide continuous, hard surfaced sidewalks a minimum of 1.5 metres wide along both sides of the roadway separated from the edge of roadway by a minimum of 3 metres (2 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a summary of the traffic management plan showing how through traffic volumes and traffic speeds are reduced.
- Provide an overall plan showing the location and width of the sidewalks, crossing locations and related pedestrian crosswalk signage and markings.

Mobility for All

MFA Credit 7: Pedestrian Facility Design

1 to 7 Points

Intent

Encourage walking.

Requirements

Use streetscape and design elements that improve the safety and quality of walking. These include:

- Grades less than 3%, but sufficient that they avoid water ponding

  AND

- Lighting levels along pedestrian paths consistent with the following chart:

Area Class	**E_H (lux)**	**E_{Vmin}**	**E_{av}/E_{min}**
Urban	20.0	10.0	4.0
Suburban	5.0	2.0	4.0
Rural	2.0	0.6	4.0

  AND

- Shortened crossings of vehicular traffic areas or median refuges that reduce exposure times to potential conflicts and better visibility of crossing locations (1 point)

  AND

- Priority crossing measures including pedestrian activated crossing or traffic signals at all major intersections that have reasonable maximum pedestrian waiting times and recognize the appropriate pedestrian walking speeds of the demographics of the area (1 point)

  AND

- Grade separation of crossing points that offer minimum resistance to pedestrian crossings and high levels of security (2 points)

AND

- Boulevard landscaping, including a mixture of grass, shrubs and trees that buffer pedestrians from the roadway, but do not create hazards for vehicles or restrict traffic flows (1 point).

AND

- An integrated streetscape that includes, but is not limited to sidewalks over 3 metres in width, special surfaces such as paving stones, seating areas, decorative pedestrian scale lighting, garbage receptacles, landscaping and guide signage consistent with a theme for the area (2 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A grading plan showing grades along pedestrian routes.
- A lighting plan with supporting calculations to demonstrate compliance with pedestrian lighting criteria.
- Pedestrian crosswalk protection warrant calculations and an overall plan showing locations where pedestrian activated crossing signals, traffic signals or grade separated crossings are warranted.
- A pedestrian crossing plan showing where shortened crossing locations, pedestrian activated crossing, traffic signals and grade separated crossings have been provided.
- Pedestrian signal timing plans along with a rationale for proposed pedestrian crossing times and walking speeds.
- An overall landscaping plan along with details of plantings and cross-sections illustrating the desired buffering effect.
- An overall streetscaping plan illustrating the theme and overall concept along with details of surfacing materials and street furniture.

Transportation Efficiency

TE Prerequisite 1: Level of Service

Required

Intent

Encourage provision of appropriate levels of mobility over the longer term.

Requirements

Provide an initial level of service for the project that is consistent with the goals of the overall long-range transportation plan and which can be maintained through staged implementation of capacity improvements during the course of the planning horizon period.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the section of the overall long range transportation plan outlining mobility objectives and target levels of service.
- A summary of the calculations for the initial design levels of service.
- An outline of the staging plan of future improvements to the project and a summary of the calculations to illustrate how they will maintain the target level of service.

Transportation Efficiency

TE Prerequisite 2: Person-Time and Fuel Usage Savings

Required

Intent

Encourage use of savings in terms of person-time and fuel usage rather than vehicle time savings in the evaluation of design element options.

Requirements

Design element options compared and selected based on optimization of person-time and fuel usage savings rather than use of volume to capacity calculations.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan illustrating the proposed roadway geometry, cross-section and intersection configurations.
- A summary of alternative roadway geometry, cross-section and intersection configurations considered.
- Calculations based on person-time and fuel usage savings illustrating that alternatives for the key design elements, such as lane configurations, intersection spacing and intersection geometry, were selected based on these criteria.

Transportation Efficiency

TE Credit 1: Optimum Level of Service

4 Points

Intent

Encourage provision of the required roadway capacity without providing excessive or unneeded capacity.

Requirements

Design elements selected based on providing adequate, but not excessive, roadway capacity, for a 10 to 15 year planning horizon.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the section of the overall long range transportation plan outlining mobility objectives and target levels of service.
- An overall plan illustrating the proposed roadway geometry, cross-section and intersection configurations.
- A summary of the calculations for the initial design levels of service and for the 10 to 15 year horizon.

Transportation Efficiency

TE Credit 2: Responsive Traffic Signals

1 to 4 Points

Intent

Encourage optimization of traffic signals to address different time of day events and provide priority of transit and non-motorized users where appropriate.

Requirements

- Use of fully actuated traffic signals (2 points)

  AND

- Traffic signal phasing and timing plans for all major different time of day events (1 point)

  AND

- Transit or non-motorized traffic signal priority measures (1 point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide an overall plan showing the location of all traffic signals and traffic priority measures.
- Provide a summary of the type of traffic control equipment installed at each location.
- Provide a summary of the traffic volume patterns by time of day and day of week at each signalized intersection.
- Provide a summary of the signal phasing and timing plans to address the traffic volume patterns for each traffic signal.

Transportation Efficiency

TE Credit 3: Traffic Maintenance Plan

1 to 4 Points

Intent

Encourage preparation of traffic management plans during construction and incidents.

Requirements

- A construction management plan that addresses traffic accommodation during the construction period (1 point)

  AND

- An incident management plan that addresses planned and unplanned constraints on capacity (1 point)

  AND

- Traffic accommodation strategy that reduces potential vehicle hour delays due to construction to less than 20% of the baseline estimate (2 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the construction management plan.
- Provide a copy of the incident management plan.
- Provide a copy of the detailed traffic accommodation plan along with documentation summarizing the baseline estimate of vehicle hour delays and the actual vehicle hour delays based on field verified delay studies (e.g. confirmation of modeled queue lengths through field data) after implementation of the plan.

Safety

SF Prerequisite 1: Safety Audit

Required

Intent

Encourage use of safety audits.

Requirements

Undertake a safety audit that addresses all modes of transportation.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the safety audit report.

Safety

SF Credit 1: Design Speed

1 Point

Intent

Encourage selection of design speeds that are context sensitive.

Requirements

Use context sensitive design principles to select appropriate design speeds.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the section of the overall long range transportation plan outlining the function of the roadway.
- An overall plan showing the adjacent land uses and selected design speeds for each distinct segment.

Safety

SF Credit 2: Design Speed Consistency

1 Point

Intent

Encourage consistency of design speeds within and adjacent to the project.

Requirements

- A maximum of 20km/h changes in design speed
  (NEED TO CONFIRM HOW WE WANT TO MEASURE DESIGN SPEED CONSISTENCY)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the selected design speeds within the project and immediately adjacent to the project.

Safety

SF Credit 3: Separation of Modes

1 Point

Intent

Improve safety of non-motorized modes of transportation

Requirements

- Pedestrians and cyclists are physically separated from motorized transportation by boulevards or non-mountable barriers.

  AND

- Guidance that defines which mode of transportation has the right-of-way is provided at the intersection of all public roads.

  OR

- Complete integration of motorized and non-motorized traffic in an area of low speeds.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the location of sidewalks and bike paths as well as barriers separating motorized and non-motorized traffic.
- An overall plan showing the pavement markings and signage that provide the regulatory control at the intersection of all public roads.

Safety

SF Credit 4: Conflict Points

1 Point

Intent

Encourage safety of non-motorized modes of transportation

Requirements

- An access control plan to minimize the number of accesses.

  AND

- Guidance either through design elements or traffic control that defines which mode of transportation has the right-of-way is provided at the intersection of all public roads.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the consolidation or elimination of existing access points.
- An overall plan showing the pavement markings and signage that provide the regulatory control at the intersection of all public roads.

Energy and Atmosphere

EA Credit 1: Infrastructure Energy Efficiency

2 Points

Intent

Reduce pollution from energy consumption

Requirements

Design and install any lighting, pump systems and treatment systems that are included as part of the project, to achieve a 15% reduction in energy use from the baseline energy use. Traffic signal lights are to use LED technology.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A site plan indicating the location of any relevant infrastructure.
- An estimate of the baseline energy use for any relevant infrastructure items.
- Documentation through a brief narrative and calculations to demonstrate that the 15% energy reduction was achieved.
- Confirmation that LED technology was used for any traffic signals.

Energy and Atmosphere

EA Credit 2: Volatile Organic Compounds

2 Points

Intent

Reduce pollution from release of volatile organic compounds to the atmosphere.

Requirements

Design and use those products that minimize the release of volatile organic compounds into the atmosphere.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A summary of the products being utilized (asphaltic cement, paint, etc) that release volatile organic compounds into the atmosphere.
- An estimate of the baseline energy use for any relevant infrastructure items.
- Documentation through a brief narrative and calculations to demonstrate that a 50% ?? (what are VOC requirements for paint) reduction in the release of volatile organic compounds was achieved.

Energy and Atmosphere

EA Credit 3: Local Materials

2 Points

Intent

Reduce energy use and vehicle emissions in the transport of materials by encouraging use of local materials.

Requirements

Use of materials and products created from a close local source.

Do we want to include use of "green aggregate" as a requirement here or elsewhere??

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A summary of all major elements and their quantities used in the project (e.g. aggregate, asphaltic cement, cement, street furniture and landscaping materials)
- A summary of available suppliers (not distributors), their location and distance to the project.
- A summary of suppliers utilized and confirmation that they are located within 120% of the distance of the closest available supplier.

Materials and Resources

MR Prerequisite 1: Lifecycle Costing

Required

Intent

Encourage use of life cycle costing to select products and methodologies.

Requirements

Undertake life cycle costing of all significant cost items using an appropriate discount rate including:

- Pipe materials
- Pavement structure
- Structures (bridges and walls)
- Lighting (fixtures and poles)
- Signage (sign and pole)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the life cycle cost assessments, along with the rationale for the selected Discount Rate, for each significant project element. Where a formal life cycle assessment has been used as part of approach to develop an agency policy on an element (e.g. pole types), submission of a signed letter documenting this approach will be considered as acceptable.

Materials and Resources

MR Prerequisite 2: Construction Activity Pollution Prevention

Required

Intent

Reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, airborne dust generation and limiting the potential for contamination of soils and waterways.

Requirements

Create and implement an erosion and sedimentation control plan for all construction activities associated with the project. The plan shall list the Best Management Practices (BMPs) employed and describe how the BMPs accomplish the following objectives:

- Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- Prevent sedimentation or contamination of any impacted stormwater conveyance systems or receiving streams.
- Prevent contamination of soils.
- Prevent polluting the air with dust and particulate matter.

The BMPs shall be selected from the most stringent guidelines that are applicable to the project.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the erosion and sedimentation control plan, which includes the source of the BMPs.
- An attestation that the erosion and sedimentation control plan was implemented in accordance with the plan.
- A summary of the monitoring reports for the implementation of the erosion and sedimentation control plan.

Materials and Resources

MR Credit 1: Construction Site Footprint

1 to 2 Points

Intent

Conserve existing natural areas and vegetation and minimize neighbourhood impacts.

Requirements

- Locate the project footprint on areas that are 100% previously developed as a transportation corridor.

  OR

- In areas, where there is no previous development, limit all site disturbances to no more than 5 metres beyond the limits of curbs, shoulders, sidewalks, pathways or utility cuts.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan indicating the location of any areas that are previously developed as part of a transportation corridor, the footprint of the project and the zone of construction impact.

Materials and Resources

MR Credit 2: Construction Waste Management

2 Points

Intent

Divert construction and demolition debris from disposal in landfills and incinerators by redirecting recyclable resources back to the manufacturing process and reusable materials to the appropriate sites.

Requirements

Develop and implement a construction waste management plan that recycles and/or salvages at least 50% of non-hazardous construction and demolition debris, excluding vegetation and soils.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the construction waste management plan.
- Provide a table of the demolition debris, including a general description of each category of waste generated, the quantity in tones or cubic metres and the location of the receiving agent (recycler/landfill) for the waste.

Materials and Resources

MR Credit 3: Recycled Content

2 to 10 Points

Intent

Use recycled materials to reduce the environmental impact of extraction and processing of virgin materials.

Requirements

- Any aggregate base and aggregate subbase shall be 90% by volume recycled aggregate materials, such as crushed asphaltic concrete and Portland cement concrete. (2 points)
- Any asphalt base shall be a minimum 15% by volume recycled asphaltic concrete pavement. (2 points)
- Any asphaltic concrete pavement shall:

  be a minimum 15% by volume recycled asphaltic concrete pavement

  OR

  be a minimum 75% by volume rubberized asphaltic concrete pavement from crumb rubber from scrap tires

  OR

  include a minimum of 5% by weight of pre-consumer or post-consumer asphalt roofing shingles (2 points)
- Any Portland cement concrete shall contain:

  recycled mineral admixtures, such as coal fly ash, ground granulated blast furnace slag, rice hull ash, silica fume or other pozzolanic industrial byproduct) to reduce by at least 25% of the concrete mix's typical Portland cement content

  AND

  a minimum of 10% by volume reclaimed concrete material aggregate (2 points)
- Piping made of Portland cement concrete shall contain recycled mineral admixtures, such as coal fly ash, ground granulated blast furnace slag, rice hull ash, silica fume or

other pozzolanic industrial byproduct) to reduce by at least 25% of the concrete mix's typical Portland cement content. (2 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A table of each material used on the project that is being tracked for recycled content including the type of material and recycled content.

Materials and Resources

MR Credit 4: Long Life Pavements

4 Points

Intent

Design of pavement structures intended to perform 35 years or more with minimal restoration of the surface and reduce future rehabilitation requirements.

Requirements

- Use of a pavement structure with a design life of at least 30 years.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the design report summarizing the pavement design principles and inputs, a comparison of pavement designs for traditional “20 year” pavements and a long life pavement design option with a life of at least 30 years and their expected rehabilitation requirements.
- Confirmation of the use of the long life pavement design option.

Materials and Resources

MR Credit 5: Stormwater Management

1 to 5 Points

Intent

Reduce pollution and hydrologic instability from stormwater, prevent flooding, and promote aquifer recharge.

Requirements

Implement a comprehensive stormwater management plan for the project that infiltrates, reuses, or evapotranspirates runoff from 90% of the average rainfall through use of practices such as permeable pavements and rainwater harvesting systems to the following criteria:

- Minimum 20% of the impermeable area (1 point)
- Minimum 40% of the impermeable area (2 points)
- Minimum 60% of the impermeable area (3 points)
- Minimum 80% of the impermeable area (4 points)
- Minimum 100% of the impermeable area (5 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan illustrating the project's potentially impermeable areas, the location of any stormwater management facilities and/or Best Management Practices.
- A calculation of the 90% of the average annual rainfall that occurs on the project's potentially impermeable areas.
- A calculation of the percentage of the potential impervious areas that will be infiltrated, reused or evapotranspirated.

Materials and Resources

MR Credit 6: Water Efficient Landscaping

1 Point

Intent

Minimize water use for landscape irrigation, where irrigation is warranted, to reduce the impact to natural water resources and burden on municipal water supply and wastewater supply.

Requirements

For irrigation, use only captured rainwater, recycled wastewater, recycled greywater, or water treated and conveyed by a public agency specifically for non-potable uses.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A brief narrative describing the landscaping and irrigation design strategies employed by the project.
- The project's baseline and actual water use, after implementation of reduction strategies.

Community Impacts

CI Prerequisite 1: Community Outreach and Involvement

Required

Intent

To encourage community participation in the project planning and design and involve people who will be impacted by the project in improving the project.

Requirements

A community outreach and involvement program that includes a range of consultation strategies and respects input from community stakeholders during the design and construction phases of the project.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the written community outreach and involvement program for both the design and construction components of the project.
- Provide a brief narrative describing the steps taken in implementing the community outreach and involvement program and how the program influenced the final design.

Community Impacts

CI Credit 1: Noise

3 Points

Intent

To encourage the reduction of noise levels associated with motorized traffic.

Requirements

A traffic noise study using an accepted methodology and software that calculates existing noise levels, projected noise levels at the completion of the project and projected noise levels at the projected traffic volumes at the 10 and 20 year horizons for all affected non-commercial areas.

AND

Implementation of a noise mitigation strategy that maintains traffic noise levels through all affected non-commercial areas through to the 20 year horizon at no more than existing levels (1 point)

AND

Implementation of a noise mitigation strategy that reduces traffic noise levels above 65 dBA through all non-commercial areas through to the 20 year horizon to less than 65 dBA (1 point)

AND

Implementation of a noise mitigation strategy that reduces traffic noise levels above 65 dBA through all non-commercial areas through to the 20 year horizon to less than 60 dBA (1 point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the noise study, which illustrates the non-commercial areas affected by the project, existing and projected noise levels and the impacts of the selected mitigation strategy.
- Provide detailed design drawings showing the how the noise mitigation strategy is implemented. Where the strategy involves construction methodologies, such as the use noise reducing pavements or sound absorbing walls, additional product technical data on the methodology to outline its effectiveness is also to be submitted.

Community Impacts

CI Credit 2: Light Pollution

1 Point

Intent

Minimize light trespass from the project, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction, and reduce development impact on nocturnal environments.

Requirements

NEED TO CHECK IESNA TM-10, IESNA TM-11 and IESNA RP-8 Annex C.

Submittals

- Provide the LEED submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the lighting sources.
- A statement as to the lighting zone(s) that the project is in.
- Design lighting drawings that show the design strategies and/or technologies used to reduce light pollution.

Community Impacts

CI Credit 3: Visual Elements

3 Points

Intent

Encourage transportation corridors that offer views and features that are architecturally compatible with their surroundings, provide aesthetic unity and coherence and improve the experience of passing through the corridor.

Requirements

Use geometries, streetscape and design elements that provide an improved experience at appropriate scales for motorized and on-motorized modes. These include:

- Landscaping, including a mixture of grass, shrubs and trees, at scales that are suitable for the different modes of transportation using the project.

  AND

- An integrated streetscape that includes, but is not limited to special surfaces such as paving stones, decorative poles, decorative lighting and banners. (1 point)

  AND

- Architecturally designed structures, such as bridges and walls, incorporating color and shapes within a consistent theme. (1 point)

  AND

- A geometric alignment that provides opportunities to provide varying and significant views for both motorized and non-motorized modes and blends into the surrounding landscape through a curvilinear alignment and appropriate sideslopes. (1 point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.

- An overall inventory of existing visual resources and plantings, improvement opportunities and the approach utilized to maximize these opportunities.

- An overall landscaping plan along with details of plantings.

- An overall streetscaping plan illustrating the theme and overall concept along with details of surfacing materials and street furniture.

- An overall plan showing all vertical structures and those structures with specific architectural treatment.
- Detail design drawings of the architectural treatments on vertical structures.
- An overall plan showing significant natural and man-made views of interest and illustrating how the geometric alignment and sideslopes have been optimized to provide opportunities for motorized and non-motorized modes to take advantages of those views in a manner that respects the existing landscape.

Innovation and Design Process

ID Credit 1: Innovation and Exemplary Performance

1 to 5 Points

Intent

To provide projects the opportunity to be awarded points for exceptional performance above the requirements set by the Green Guide for Roads Rating System and/or innovative performance in promoting mobility for all and green construction not specifically addressed by the rating system. (e.g. use of materials surfaced in titanium dioxide to reduce nitrogen dioxide emissions into the atmosphere)

Requirements

Identify the intent of the proposed innovation credit, the proposed requirement for compliance, proposed submittals to demonstrate compliance, and the design approach and strategies that might be used to meet the requirements. (1 point each, up to 5 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- The specific title for the ID credit, a statement of the credit intent, and a statement of the credit requirements.
- A narrative and overall plan describing the project's approach to achievement of the credit, including a description of the quantifiable environmental benefits of the credit proposal.
- Detailed plans and specifications, as necessary to illustrate the project's approach to this credit.

Appendix B: Preliminary Draft of Green Guide for Roads

GREEN GUIDE FOR ROADS

Development of Concept
Sample for Internal Use Only

February 2009

Table of Contents

Introduction

The Canada Green Building Council (CaGBC) has been officially established as a national non-for-profit corporation and it has signed a Licensing Agreement with the U.S. Green Building Council (USGBC) for the exclusive implementation of the LEED (Leadership in Energy and Environmental Design) Green Building Rating System in Canada. Through its use as a design guideline and third-party certification tool, LEED has a proven track record of improving occupant well-being, environmental performance and economic returns of buildings using well established and innovative practices, standards and technologies. It provides one definition, widely accepted by the building industry, for what currently constitutes a "green building".

The USGBC in cooperation with the Congress of the New Urbanism and the Natural Resources Defense Council recently came together to develop a set of standards for neighbourhood location and design based on the combined principles of smart growth, new urbanism, and green building. LEED for Neighbourhood Development represents an effort to relate the neighbourhood of buildings and supporting infrastructure to its larger region and landscape. It is hoped that it will serve as an incentive for better location, design and construction of new developments.

Roadway infrastructure is an integral part of providing mobility for people and goods. Green Guide for Roads was originally conceived and developed by Stantec Consulting to promote consideration of sustainable design within its road based transportation practice. Subsequent discussions with the Alberta Chapter of the Canadian Green Building Council suggested that it could be a complementary effort to LEED for Neighbourhood Development. Stantec and the Alberta Chapter of the Canada Green Building Council are proposing to evolve the existing guideline in partnership with other stakeholders, such as the Transportation Association of Canada. The intent would be to promote smart growth and multi-modal transportation principles, safe roads and "green" construction techniques with a guideline that was applicable across Canada.

How LEED Rating Systems Work

LEED provides rating systems that are voluntary, consensus-based, market-driven, grounded in accepted and environmental principles, and that strike a balance between established practices and emerging concepts. LEED rating systems are developed by committees, in adherence with USGBC policies and procedures guiding the development and maintenance of rating systems.

LEED rating systems typically consist of a few prerequisites and many credits. In order to be certified, a project must meet each prerequisite. Each credit is optional, but achievement of each credit contributes to the project's point total. A minimum point total is required for certification, and higher point scores are required for silver, gold or platinum LEED certification. Certification Levels are based on the following criteria:

- LEED Certified – 40% or more of the Core Credits

- LEED Silver – 50% or more of the Core Credits
- LEED Gold – 60% or more of the Core Credits
- LEED Platinum – 80% or more of the Core Credits

Credit levels have been set such that Certification indicates that a project is in the top quartile in a particular market. (Note: one of the challenges is setting appropriate credit scores – the LEED Product Development Process through widespread input and use on a wide range of nominated trial projects is critical to setting “the bar” appropriately.)

Green Guide for Roads Rating System

Since the intent for this Green Guide for Roads is to mirror the LEEDS system, a similar rating system has been used as a starting point for its evolution. Where available, the criteria and point systems from comparable LEED products have also been used for further evaluation within the context of Green Guide for Roads.

Prerequisites & Credits

Mobility for All

MFA Prerequisite 1: Comprehensive Transportation Plan

Required

Intent

To encourage development and use of comprehensive long-range transportation plans that minimize excessive bias to single occupant vehicles

Requirements

Project is consistent with an overall long-range transportation plan for the community or region and is based on multi-modal transportation (e.g. walking, cycling private vehicle and public transit) principles.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the approved long-range transportation plan.

MFA Prerequisite 2: Choice of Transportation Modes

Required

Intent

To promote social equity and choices by providing transportation options

Requirements

Motorized and non-motorized modes of transportation are provided with continuous and clearly defined routes and handicapped accessibility is provided.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the overall plan showing pedestrian, cyclist and motorized transportation routes.
- A copy of the relevant design standards utilized to meet or exceed local requirements for handicapped accessibility.

MFA Credit 1: Parking Management

2 Points

Intent

To avoid a surplus of nearby site and on-street parking

Requirements

Project remains consistent with a parking management plan (1 Point);

AND

Does not contribute to the parking supply in the area, unless deemed necessary (1 Point).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the parking management plan for the project area.
- A summary of how the project contributes to the principles of the parking management plan.

MFA Credit 2: Transit Facilities

3 Points

Intent

To encourage the use of transit systems

Requirements

- Transit stop signage and transit route information at each transit stop (1 Point)

  AND

- Covered and at least partially enclosed transit shelters with a bench and lighting at each transit stop (2 Points).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide an overall plan showing the location of transit stops and the transit shelter type installed.
- Provide a copy of the design details for the transit stop signage, transit route information and transit shelter types.

MFA Credit 3: Bicycle Lanes/Paths/Parking

1 to 4 Points

Intent

To encourage cycling as a mode of transportation

Requirements

An approved bicycle transportation plan

AND

- Provide roadway curb lanes and minimum of 0.5 metres wider than the vehicular lane width design criteria to accommodate cyclists (1 Point).

  OR

- Provide a continuous designated and marked bicycle lane a minimum of 1.5 metres wide along both sides of the roadway (2 Points).

  OR

- Provide a continuous, separate hard surfaced pathway a minimum of 3 metres wide along one side of the roadway (3 Points)

AND

- Proved easy to use and theft resistant (can lock frame and one wheel to stand) bicycle stands or lockers are provided at all key locations and are located in visible, well-trafficked areas, but do not obstruct traffic flows (1 Point).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the approved bicycle transportation plan
- Provide an overall plan showing the location and width of the cycling routes as well as route and regulatory signage and pavement markings as appropriate to the facility provided.

MFA Credit 4: Bicycle Facility Design

3 Points

Intent

To encourage cycling as a mode of transportation

Requirements

Use design elements that improve the safety and ease of operation of a bicycle. These include:

- Ramps that do not unnecessarily orientate cyclists into traffic lanes.
- Ramps with curb lips no more than 10mm in height.
- Drainage grates with openings narrow and short enough so that bicycle tires do not drop into the grate
- Bridge railings a minimum of 1.4 metres high
- Lighting consistent with the following chart:

Area Class	E_H (lux)	E_{Vmin}	E_{av}/E_{min}
Urban	20.0	10.0	4.0
Suburban	5.0	2.0	4.0
Rural	2.0	0.6	4.0

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Standard design detail drawings for the relevant details used.

MFA Credit 5: Pedestrian Paths/Sidewalks

1 to 4 Points

Intent

To encourage walking as a mode of transportation

Requirements

- The area is part of a traffic management plan designed to reduce through traffic volumes and traffic speeds through roadway design features, which might include narrower travel lanes, tighter corner curb radii, raised medians, curb bulb outs and landscaping. (2 Points)

  AND

- Provide continuous, hard surfaced sidewalks a minimum of 2.0 metres wide adjacent to both sides of the roadway. (1 Point)

  OR

- Provide continuous, hard surfaced sidewalks a minimum of 1.5 metres wide along both sides of the roadway separated from the edge of roadway by a minimum of 3 metres (2 Points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.

- Provide a summary of the traffic management plan showing how through traffic volumes and traffic speeds are reduced.

- Provide an overall plan showing the location and width of the sidewalks, crossing locations and related pedestrian crosswalk signage and markings.

MFA Credit 6: Pedestrian Facility Design

1 to 5 Points

Intent

To encourage walking as a mode of transportation

Requirements

Use streetscape and design elements that improve the safety and quality of walking. These include:

- Grades less than 3%, but sufficient that they avoid water ponding

  AND

- Lighting levels along pedestrian paths consistent with the following chart:

Area Class	**E_H (lux)**	**E_{Vmin}**	**E_{av}/E_{min}**
Urban	20.0	10.0	4.0
Suburban	5.0	2.0	4.0
Rural	2.0	0.6	4.0

  AND

- Shortened crossings of vehicular traffic areas or median refuges that reduce exposure times to potential conflicts and better visibility of crossing locations (1 Point)

  AND

- Priority crossing measures including pedestrian activated crossing or traffic signals at all major intersections that have reasonable maximum pedestrian waiting times and recognize the appropriate pedestrian walking speeds of the demographics of the area (1 Point)

  AND

- Grade separation of crossing points that offer minimum resistance to pedestrian crossings and high levels of security (1 Points)

  AND

- Boulevard landscaping, including a mixture of grass, shrubs and trees that buffer pedestrians from the roadway, but do not create hazards for vehicles or restrict traffic flows (1 Point).

  AND

- An integrated streetscape that includes, but is not limited to sidewalks over 3 metres in width, special surfaces such as paving stones, seating areas, decorative pedestrian scale lighting, garbage receptacles, landscaping and guide signage consistent with a theme for the area (1 Points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A grading plan showing grades along pedestrian routes.
- A lighting plan with supporting calculations to demonstrate compliance with pedestrian lighting criteria.
- Pedestrian crosswalk protection warrant calculations and an overall plan showing locations where pedestrian activated crossing signals, traffic signals or grade separated crossings are warranted.
- A pedestrian crossing plan showing where shortened crossing locations, pedestrian activated crossing, traffic signals and grade separated crossings have been provided.
- Pedestrian signal timing plans along with a rationale for proposed pedestrian crossing times and walking speeds.
- An overall landscaping plan along with details of plantings and cross-sections illustrating the desired buffering effect.
- An overall streetscaping plan illustrating the theme and overall concept along with details of surfacing materials and street furniture.

MFA Credit 7: Separation of Modes

1 Point

Intent

To improve safety of non-motorized modes of transportation

Requirements

- Pedestrians and cyclists are physically separated from motorized transportation by boulevards or non-mountable barriers.

  AND

- Guidance that defines which mode of transportation has the right-of-way is provided at the intersection of all public roads.

  OR

- Complete integration of motorized and non-motorized traffic in an area of low speeds.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the location of sidewalks and bike paths as well as barriers separating motorized and non-motorized traffic.
- An overall plan showing the pavement markings and signage that provide the regulatory control at the intersection of all public roads.

MFA Credit 8: Conflict Points

1 Point

Intent

To encourage safety of non-motorized modes of transportation

Requirements

- An access control plan to minimize the number of accesses.

  AND

- Guidance either through design elements or traffic control that defines which mode of transportation has the right-of-way is provided at the intersection of all public roads.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the consolidation or elimination of existing access points.
- An overall plan showing the pavement markings and signage that provide the regulatory control at the intersection of all public roads.

Transportation Planning

TP Prerequisite 1: Level of Service

Required

Intent

To encourage a provision of appropriate levels of mobility over the longer term

Requirements

Provide an initial level of service for the project that is consistent with the goals of the overall long-range transportation plan and which can be maintained through staged implementation of capacity improvements during the course of the planning horizon period.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the section of the overall long range transportation plan outlining mobility objectives and target levels of service.
- A summary of the calculations for the initial design levels of service.
- An outline of the staging plan of future improvements to the project and a summary of the calculations to illustrate how they will maintain the target level of service.

TP Prerequisite 2: Safety Audit

Required

Intent

To encourage the use of safety audits

Requirements

Undertake a safety audit that addresses all modes of transportation.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the safety audit report.

TP Prerequisite 3: Person-Time and Fuel Usage Savings

Required

Intent

To encourage the use of savings in terms of person-time and fuel usage rather than vehicle time savings in the evaluation of design element options

Requirements

Design element options compared and selected based on optimization of person-time and fuel usage savings rather than use of volume to capacity calculations.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan illustrating the proposed roadway geometry, cross-section and intersection configurations.
- A summary of alternative roadway geometry, cross-section and intersection configurations considered.
- Calculations based on person-time and fuel usage savings illustrating that alternatives for the key design elements, such as lane configurations, intersection spacing and intersection geometry, were selected based on these criteria.

TP Prerequisite 4: Traffic Maintenance Plan

Required

Intent

To prepare traffic management plans during construction and in the occurrence of traffic incidents

Requirements

- A construction management plan that addresses traffic accommodation during the construction period

  AND

- An incident management plan that addresses planned and unplanned constraints on capacity

  AND

- Traffic accommodation strategy that reduces potential vehicle hour delays due to construction to less than 20% of the baseline estimate

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the construction management plan.
- Provide a copy of the incident management plan.
- Provide a copy of the detailed traffic accommodation plan along with documentation summarizing the baseline estimate of vehicle hour delays and the actual vehicle hour delays based on field verified delay studies (e.g. confirmation of modeled queue lengths through field data) after implementation of the plan.

TP Credit 1: Optimum Level of Service

4 Points

Intent

To encourage a provision of the required roadway capacity without providing excessive or unnecessary capacity

Requirements

Design elements selected based on providing adequate, but not excessive, roadway capacity, for a 10 to 15 year planning horizon.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the section of the overall long range transportation plan outlining mobility objectives and target levels of service.
- An overall plan illustrating the proposed roadway geometry, cross-section and intersection configurations.
- A summary of the calculations for the initial design levels of service and for the 10 to 15 year horizon.

TP Credit 2: Responsive Traffic Signals

1 to 4 Points

Intent

To encourage the optimization of traffic signals to address different time of day events and provide priority of transit and non-motorized users where appropriate

Requirements

- Use of fully actuated traffic signals (2 Points)

  AND

- Traffic signal phasing and timing plans for all major different time of day events (1 Point)

  AND

- Transit or non-motorized traffic signal priority measures (1 Point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide an overall plan showing the location of all traffic signals and traffic priority measures.
- Provide a summary of the type of traffic control equipment installed at each location.
- Provide a summary of the traffic volume patterns by time of day and day of week at each signalized intersection.
- Provide a summary of the signal phasing and timing plans to address the traffic volume patterns for each traffic signal.

TP Credit 3: Design Speed & Consistency

3 Points

Intent

To encourage selection of design speeds and speed consistency within and adjacent to the roadway

Requirements

Use context sensitive design principles to select appropriate design speeds (2 Points).

AND

A maximum of 20km/h changes in design speed (1 Point).

(NEED TO CONFIRM HOW WE WANT TO MEASURE DESIGN SPEED CONSISTENCY)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the section of the overall long range transportation plan outlining the function of the roadway.
- An overall plan showing the adjacent land uses and selected design speeds for each distinct segment.

TP Credit 4: Intelligent Transportation Systems

2 Points

Intent

To encourage the use of ITS technologies (in addition to Responsive Traffic Signals) to improve mobility without adding capacity and/or improve the efficiency of transit systems

Requirements

- Use of proven ITS technologies (2 Points)

Submittals

- Provide a submittal template, signed by the responsible party, declaring that the requirements have been met

- Documentation of ITS technologies used and explanation of their benefits to a more sustainable transportation project

Energy and Atmosphere

EA Credit 1: Infrastructure Energy Efficiency

2 Points

Intent

To reduce pollution from energy consumption

Requirements

Design and install any lighting, pump systems and treatment systems that are included as part of the project, to achieve a 15% reduction in energy use from the baseline energy use.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A site plan indicating the location of any relevant infrastructure.
- An estimate of the baseline energy use for any relevant infrastructure items.
- Documentation through a brief narrative and calculations to demonstrate that the 15% energy reduction was achieved.

EA Credit 2: Fossil Fuel Reduction

1 to 2 Points

Intent

To reduce the reliance and use of fossil fuels in construction equipment and work vehicles on road construction projects. This credit rewards the use of hybrid and alternative fuels, i.e. bio-diesel and electric hybrids.

Requirements

The use of bio-fuels, or electric hybrids are required to achieve that 50% of the on-road and non-road construction fleet use either bio-fuels (B-20 grade or higher) or electric-diesel hybrids (1 Point). Another point will be awarded for a 75% move to bio-fuels and hybrids, where 100% compliance will result in an addition Exemplary Performance point.

Submittals

- A list of the construction equipment and work vehicles used on the project, which is to include the make and model of each vehicle.
- Provide the proper documentation for each vehicle which will demonstrate that these vehicles have used either bio-fuels (B-20 minimum) or documentation of hybrid engines.

EA Credit 3: Equipment Emission Reduction

1 to 2 Points

Intent

To reduce the emission from construction equipment and work vehicles on road construction projects; this credit rewards the use of hybrid engines, bio-fuels, as well as the retrofitting of construction equipment and vehicles on-site.

Requirements

The installation of emission reduction retrofits for exhaust, that meet the EPA Tier 4 standard, on 50% of the construction fleet will result in one point. Another point will be awarded for a construction fleet with 75% equipped with similar retrofits; where 100% compliance will result in an addition Exemplary Performance point.

Submittals

- A list of the construction equipment and work vehicles used on the project, which is to include the make and model of each vehicle.
- Provide the proper documentation for each vehicle which will demonstrate that these vehicles have had the proper and compliant exhaust retrofits, use bio-fuels (B-20 minimum), or have documentation of hybrid engines.

EA Credit 4: Paving Emission Reduction

1 to 2 Points

Intent

To improve the worker's health by reducing the amount of exposure to paving emissions

Requirements

- Reduce worker's exposure from current baseline by 25% (1 Point)
- Reduce worker's exposure from current baseline by 50% (1 Point)
- Over 75% exposure reduction (1 Exemplary Performance Point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide documentation that demonstrates a plan and execution for reducing workers emission exposure and effects.

EA Credit 5: Paving Energy Reduction

1 - 3 Points

Intent

To reduce energy consumption at the point of production and placement of product

Requirements

- Reduce energy use from production to placement of the product, by 30% from baseline (1 Point).
- Reduce energy use from production to placement of the product, by 40% from baseline (1 Point).
- Reduce energy use from production to placement of the product, by 50% from baseline (1 Point).
- Reduce energy use from production to placement of the product, by 70% from baseline (1 Exemplary Performance Point).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Submit documentation that shows the type of materials used and the type of pavement used on the project.
- Provide documentation demonstrating the current production and placement energy consumption and comparison to current project.

EA Credit 6: Volatile Organic Compounds

2 Points

Intent

To reduce pollution from release of volatile organic compounds to the atmosphere

Requirements

Design and use those products that minimize the release of volatile organic compounds into the atmosphere.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A summary of the products being utilized (asphaltic cement, paint, etc) that release volatile organic compounds into the atmosphere.
- An estimate of the baseline energy use for any relevant infrastructure items.
- Documentation through a brief narrative and calculations to demonstrate that a 50% ?? (what are VOC requirements for paint) reduction in the release of volatile organic compounds was achieved.

EA Credit 7: Local Materials

1 to 2 Points

Intent

To reduce energy use and vehicle emissions in the transport of materials by encouraging use of local materials

Requirements

Materials must come to the jobsite from less than 250 miles away. One point will be rewarded if at least 50% of the materials come from 250 miles away. A second point will be awarded for at least 75% of the materials to come from 250 miles away; and an Exemplary Performance point will be awarded for 100% compliance.

Do we want to include use of "green aggregate" as a requirement here or elsewhere??

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A summary of all major elements and their quantities used in the project (e.g. aggregate, asphaltic cement, cement, street furniture and landscaping materials)
- A summary of available suppliers (not distributors), their location and distance to the project.
- A summary of suppliers utilized and confirmation that they are located within 250 miles of the jobsite.

Materials and Resources

MR Prerequisite 1: Lifecycle Costing

Required

Intent

To encourage use of life cycle costing to select products and methodologies

Requirements

Undertake life cycle costing of all significant cost items using an appropriate discount rate including:

- Pipe materials
- Pavement structure
- Structures (bridges and walls)
- Lighting (fixtures and poles)
- Signage (sign and pole)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the life cycle cost assessments, along with the rationale for the selected Discount Rate, for each significant project element. Where a formal life cycle assessment has been used as part of approach to develop an agency policy on an element (e.g. pole types), submission of a signed letter documenting this approach will be considered as acceptable.

MR Credit 1: Construction Site Footprint

2 Points

Intent

To conserve existing natural areas and vegetation and minimize neighbourhood impacts

Requirements

- Locate the project footprint on areas that are 100% previously developed as a transportation corridor (2 Points).

  OR

- In areas, where there is no previous development, limit all site disturbances to no more than 5 metres beyond the limits of curbs, shoulders, sidewalks, pathways or utility cuts (2 Points).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.

- An overall plan indicating the location of any areas that are previously developed as part of a transportation corridor, the footprint of the project and the zone of construction impact.

MR Credit 2: Construction Waste Management

3 Points

Intent

To divert construction and demolition debris from disposal in landfills and incinerators by redirecting recyclable resources back to the manufacturing process and reusable materials to the appropriate sites

Requirements

- Develop and implement a construction waste management plan that recycles and/or salvages at least 50% of non-hazardous construction and demolition debris, excluding vegetation and soils (2 Points).
- A point can be award for projects where recycling/salvaging of 75% or more of the non-hazardous debris. (1 Point)
- An Exemplary Performance point can be award for projects where recycling/salvaging of 90% or more of the non-hazardous debris

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the construction waste management plan.
- Provide a table of the demolition debris, including a general description of each category of waste generated, the quantity in tones or cubic metres and the location of the receiving agent (recycler/landfill) for the waste.

MR Credit 3: Recycled Content

1 to 8 Points

Intent

To use recycled materials to reduce the environmental impact of extraction and processing of virgin materials

Requirements

- Any aggregate base and aggregate subbase shall be 90% by volume recycled aggregate materials, such as crushed asphaltic concrete and Portland cement concrete. (2 points)

- Any asphalt base shall be a minimum 15% by volume recycled asphaltic concrete pavement. (1 points)

- Any asphaltic concrete pavement shall:

  be a minimum 15% by volume recycled asphaltic concrete pavement

  OR

  be a minimum 75% by volume rubberized asphaltic concrete pavement from crumb rubber from scrap tires

  OR

  include a minimum of 5% by weight of pre-consumer or post-consumer asphalt roofing shingles (2 points)

- Any Portland cement concrete shall contain:

  recycled mineral admixtures, such as coal fly ash, ground granulated blast furnace slag, rice hull ash, silica fume or other pozzolanic industrial byproduct) to reduce by at least 25% of the concrete mix's typical Portland cement content

  AND

  a minimum of 10% by volume reclaimed concrete material aggregate (2 points)

- Piping made of Portland cement concrete shall contain recycled mineral admixtures, such as coal fly ash, ground granulated blast furnace slag, rice hull ash, silica fume or

other pozzolanic industrial byproduct) to reduce by at least 25% of the concrete mix's typical Portland cement content. (1 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A table of each material used on the project that is being tracked for recycled content including the type of material and recycled content.

MR Credit 4: Long Life Pavements

4 Points

Intent

To design of pavement structures intended to perform 35 years or more with minimal restoration of the surface and reduce future rehabilitation requirements.

Requirements

- Use of a pavement structure with a design life of at least 30 years (2 Points).
- Use of a pavement structure with a design life of at least 40 years (2 Points).
- Exemplary Performance point will be awarded a design life of 50 or more years.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the design report summarizing the pavement design principles and inputs, a comparison of pavement designs for traditional “20 year” pavements and a long life pavement design option with a life of at least 30 years and their expected rehabilitation requirements.
- Confirmation of the use of the long life pavement design option.

Environmental Impacts

EI Prerequisite 1: Construction Activity Pollution Prevention

Required

Intent

To reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, airborne dust generation and limiting the potential for contamination of soils and waterways

Requirements

Create and implement an erosion and sedimentation control plan for all construction activities associated with the project. The plan shall list the Best Management Practices (BMPs) employed and describe how the BMPs accomplish the following objectives:

- Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- Prevent sedimentation or contamination of any impacted stormwater conveyance systems or receiving streams.
- Prevent contamination of soils.
- Prevent polluting the air with dust and particulate matter.

The BMPs shall be selected from the most stringent guidelines that are applicable to the project.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the erosion and sedimentation control plan, which includes the source of the BMPs.
- An attestation that the erosion and sedimentation control plan was implemented in accordance with the plan.
- A summary of the monitoring reports for the implementation of the erosion and sedimentation control plan.

EI Credit 1: Stormwater Management Life-Cycle Costing

2 Points

Intent

To encourage use of low impact design (LID) stormwater management practices by performing life-cycle costing on potential stormwater management solutions

Requirements

Perform a life cycle costing on multiple stormwater management solutions for the project, evaluating all costs for the entire life cycle of the system.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide document showing the lifecycle costing of potential stormwater management solutions for the project.

EI Credit 2: Stormwater Management

1 to 4 Points

Intent

To reduce pollution and hydrologic instability from stormwater, prevent flooding, and promote aquifer recharge.

Requirements

Implement a comprehensive stormwater management plan for the project that infiltrates, reuses, or evapotranspirates runoff from 90% of the average rainfall through use of practices such as permeable pavements and rainwater harvesting systems to the following criteria:

- Minimum 20% of the impermeable area (1 point)
- Minimum 40% of the impermeable area (2 points)
- Minimum 60% of the impermeable area (3 points)
- Minimum 80% of the impermeable area (4 points)
- Minimum 100% of the impermeable area (Exemplary Performance Point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan illustrating the project's potentially impermeable areas, the location of any stormwater management facilities and/or Best Management Practices.
- A calculation of the 90% of the average annual rainfall that occurs on the project's potentially impermeable areas.
- A calculation of the percentage of the potential impervious areas that will be infiltrated, reused or evapotranspirated.

EI Credit 3: LID Stormwater Management

1 to 4 Points

Intent

To encourage use of low impact development (LID) stormwater management practices that promote reduced runoff volumes, higher pollutant removal rates and reduction of impervious surfaces

Requirements

Project incorporates LID stormwater management strategies that reduce the average annual post development runoff volume from the project right of way by at least 50%.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide list of LID strategies selected and the BMPs associated with each
- Provide calculations showing the reduction of average annual post-development runoff volume, from the project right-of-way

EI Credit 4: Water Efficient Landscaping

1 to 2 Points

Intent

To minimize water use for landscape irrigation, where irrigation is warranted, to reduce the impact to natural water resources and burden on municipal water supply and wastewater supply

Requirements

- For irrigation, use only captured rainwater, recycled wastewater, recycled greywater, or water treated and conveyed by a public agency specifically for non-potable uses (1 Point).

OR

- Select native species to use for roadway landscaping that do not require the need for irrigation after 6-months (2 Points).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A brief narrative describing the landscaping and irrigation design strategies employed by the project.
- The project's baseline and actual water use, after implementation of reduction strategies.

EI Credit 5: Reflective Pavement

3 Points

Intent

To reduce heat island effects and minimize temperature of stormwater runoff by using highly reflective pavements.

Requirements

Use a light colored/high albedo pavement of a minimum of .3 (according to ASTM E 903 test procedures) that will cover a minimum of 50% of the total project hardscape footprint

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide documentations that provide the albedo level of the surface layer, which meets the ASTM E 903 test standards and procedures.

Community Impacts

CI Prerequisite 1: Community Outreach and Involvement

Required

Intent

To encourage community participation in the project planning and design and involve people who will be impacted by the project in improving the project.

Requirements

A community outreach and involvement program that includes a range of consultation strategies and respects input from community stakeholders during the design and construction phases of the project.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the written community outreach and involvement program for both the design and construction components of the project.
- Provide a brief narrative describing the steps taken in implementing the community outreach and involvement program and how the program influenced the final design.

CI Prerequisite 2: Noise Mitigation Plan

Required

Intent

To encourage the reduction of noise levels associated with construction activities.

Requirements

- A noise mitigation plan that includes a description of construction activities, illustrates the expected noise levels at the affected areas with a noise map

AND

- Implementation of specific mitigation strategies

Submittals

- Provide a submittal template, signed by the responsible party, declaring that the requirements have been met

- Provide a copy of the noise mitigation plan and how it is to be implemented. It should include documentation showing the mitigation strategies that are being put to use and how they help lessen the impact that construction noise has on the surrounding areas.

CI Credit 1: Traffic Noise Reduction

3 Points

Intent

To encourage the reduction of noise levels associated with motorized traffic.

Requirements

A traffic noise study using an accepted methodology and software that calculates existing noise levels, projected noise levels at the completion of the project and projected noise levels at the projected traffic volumes at the 10 and 20 year horizons for all affected non-commercial areas.

AND

Implementation of a noise mitigation strategy that maintains traffic noise levels through all affected non-commercial areas through to the 20 year horizon at no more than existing levels (1 point)

AND

Implementation of a noise mitigation strategy that reduces traffic noise levels above 65 dBA through all non-commercial areas through to the 20 year horizon to less than 65 dBA (1 point)

AND

Implementation of a noise mitigation strategy that reduces traffic noise levels above 65 dBA through all non-commercial areas through to the 20 year horizon to less than 60 dBA (1 point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the noise study, which illustrates the non-commercial areas affected by the project, existing and projected noise levels and the impacts of the selected mitigation strategy.
- Provide detailed design drawings showing the how the noise mitigation strategy is implemented. Where the strategy involves construction methodologies, such as the use noise reducing pavements or sound absorbing walls, additional product technical data on the methodology to outline its effectiveness is also to be submitted.

CI Credit 2: Light Pollution Reduction

3 Point

Intent

To minimize light trespass from the project, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction, and reduce development impact on nocturnal environments

Requirements

NEED TO CHECK IESNA TM-10, IESNA TM-11 and IESNA RP-8 Annex C.

Submittals

- Provide the LEED submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the lighting sources.
- A statement as to the lighting zone(s) that the project is in.
- Design lighting drawings that show the design strategies and/or technologies used to reduce light pollution.

CI Credit 3: Visual Elements

3 Points

Intent

To encourage transportation corridors that offer views and features that are architecturally compatible with their surroundings, provide aesthetic unity and coherence and improve the experience of passing through the corridor

Requirements

Use geometries, streetscape and design elements that provide an improved experience at appropriate scales for motorized and on-motorized modes. These include:

- Landscaping, including a mixture of grass, shrubs and trees, at scales that are suitable for the different modes of transportation using the project.

  AND

- An integrated streetscape that includes, but is not limited to special surfaces such as paving stones, decorative poles, decorative lighting and banners. (1 point)

  AND

- Architecturally designed structures, such as bridges and walls, incorporating color and shapes within a consistent theme. (1 point)

  AND

- A geometric alignment that provides opportunities to provide varying and significant views for both motorized and non-motorized modes and blends into the surrounding landscape through a curvilinear alignment and appropriate sideslopes. (1 point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall inventory of existing visual resources and plantings, improvement opportunities and the approach utilized to maximize these opportunities.
- An overall landscaping plan along with details of plantings.
- An overall streetscaping plan illustrating the theme and overall concept along with details of surfacing materials and street furniture.

- An overall plan showing all vertical structures and those structures with specific architectural treatment.
- Detail design drawings of the architectural treatments on vertical structures.
- An overall plan showing significant natural and man-made views of interest and illustrating how the geometric alignment and sideslopes have been optimized to provide opportunities for motorized and non-motorized modes to take advantages of those views in a manner that respects the existing landscape.

Innovation and Design Process

ID Credit 1: Innovation & Design Process

1 to 3 Points

Intent

To reward innovative ideas, practices and technologies, not specified in the Green Guide. To continue the green movement, and applications of this Guide.

Requirements

Identify the intent of the proposed innovation credit, the proposed requirement for compliance, proposed submittals to demonstrate compliance, and the design approach and strategies that might be used to meet the requirements. (1 point each, up to 3 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- The specific title for the ID credit, a statement of the credit intent, and a statement of the credit requirements.
- A narrative and overall plan describing the project's approach to achievement of the credit, including a description of the quantifiable environmental benefits of the credit proposal.
- Detailed plans and specifications, as necessary to illustrate the project's approach to this credit.

ID Credit 2: Exemplary Performance

1 to 5 Points

Intent

To reward exemplary performance in the application of credits with-in the Green Guide. To give bonus credits to those who step beyond the minimum requirements for allotted credits.

Requirements

Identify where exemplary performance has been achieved, and demonstrate the strategies and approach used to exceed the minimum requirements. (1 to 5 Points awarded for each applicable credit)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the credit requirements have been met and exceeded.
- Detailed plans and specifications, as necessary to illustrate the project's approach to this credit.

Appendix C: Revised Draft of Green Guide for Roads

GREEN GUIDE FOR ROADS

Development of Concept
Sample for Internal Use Only

Stantec

CANADA GREEN BUILDING COUNCIL • CONSEIL DU BÂTIMENT DURABLE DU CANADA •
CHAPTER
ALBERTA

March 2009

Table of Contents

Introduction

The Canada Green Building Council (CaGBC) has been officially established as a national non-for-profit corporation and it has signed a Licensing Agreement with the U.S. Green Building Council (USGBC) for the exclusive implementation of the LEED (Leadership in Energy and Environmental Design) Green Building Rating System in Canada. Through its use as a design guideline and third-party certification tool, LEED has a proven track record of improving occupant well-being, environmental performance and economic returns of buildings using well established and innovative practices, standards and technologies. It provides one definition, widely accepted by the building industry, for what currently constitutes a "green building".

The USGBC in cooperation with the Congress of the New Urbanism and the Natural Resources Defense Council recently came together to develop a set of standards for neighbourhood location and design based on the combined principles of smart growth, new urbanism, and green building. LEED for Neighbourhood Development represents an effort to relate the neighbourhood of buildings and supporting infrastructure to its larger region and landscape. It is hoped that it will serve as an incentive for better location, design and construction of new developments.

Roadway infrastructure is an integral part of providing mobility for people and goods. Green Guide for Roads was originally conceived and developed by Stantec Consulting to promote consideration of sustainable design within its road based transportation practice. Subsequent discussions with the Alberta Chapter of the Canadian Green Building Council suggested that it could be a complementary effort to LEED for Neighbourhood Development. Stantec and the Alberta Chapter of the Canada Green Building Council are proposing to evolve the existing guideline in partnership with other stakeholders, such as the Transportation Association of Canada. The intent would be to promote smart growth and multi-modal transportation principles, safe roads and "green" construction techniques with a guideline that was applicable across Canada.

How LEED Rating Systems Work

LEED provides rating systems that are voluntary, consensus-based, market-driven, grounded in accepted and environmental principles, and that strike a balance between established practices and emerging concepts. LEED rating systems are developed by committees, in adherence with USGBC policies and procedures guiding the development and maintenance of rating systems.

LEED rating systems typically consist of a few prerequisites and many credits. In order to be certified, a project must meet each prerequisite. Each credit is optional, but achievement of each credit contributes to the project's point total. A minimum point total is required for certification, and higher point scores are required for silver, gold or platinum LEED certification. Certification Levels are based on the following criteria:

- LEED Certified – 40% or more of the Core Credits
- LEED Silver – 50% or more of the Core Credits

- LEED Gold – 60% or more of the Core Credits
- LEED Platinum – 80% or more of the Core Credits

Credit levels have been set such that Certification indicates that a project is in the top quartile in a particular market. (Note: one of the challenges is setting appropriate credit scores – the LEED Product Development Process through widespread input and use on a wide range of nominated trial projects is critical to setting "the bar" appropriately.)

Comparable Rating Systems for Roadways

Since the conception of this model, there have been other programs and guides that have been developed to push the transportation industry toward sustainable practices. The bases for these guides mirror the aspirations of the Green Guide for Roads. The two major documents currently being produced and implemented are Greenroads and GreenLITES. The first document is currently being produced and published by the University of Washington, with the goal of being implemented on a national level. The second rating system was produced by the New York State DOT, while being used in New York State.

This guide has been compared to both documents, and has adopted criteria and various ideas mentioned in both documents.

Green Guide for Roads Rating System

Since the intent for this Green Guide for Roads is to mirror the LEEDS system, a similar rating system has been used as a starting point for its evolution. Where available, the criteria and point systems from comparable LEED products have also been used for further evaluation within the context of Green Guide for Roads.

The Green Guide for Roads has incorporated seven different categories which are all geared towards shifting the current industry standards and practices toward sustainability. The seven categories approach the four different phases of a roadway; these being the planning, design, construction, and operation phases.

The current Green Guide for Roads is a living document that is undergoing modifications. This guide is a current rating system primarily for urban arterial roads, as well as urban collectors. There are many applications that this guide has to all types of roadways and situations; however, there have not been any steps taken towards readying the document for use on freeways, and rural roadways.

PREREQUISITES & CREDITS

Mobility for All

MFA Prerequisite 1: Comprehensive Transportation Plan

Required

Intent

To encourage development and use of comprehensive long-range transportation plans that minimizes excessive bias to single occupant vehicles

Requirements

- Project must remain consistent with an overall long-range transportation plan for the community or region and is based on multi-modal transportation (e.g. walking, cycling private vehicle and public transit) principles.

  OR

- Develop a transportation plan for a community or region, which is based on the use of multi-modal transportation (e.g. walking, cycling private vehicle and public transit) principles.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the approved long-range transportation plan.

MFA Prerequisite 2: Choice of Transportation Modes

Required

Intent

To promote social equity and choices by providing transportation options

Requirements

Motorized and non-motorized modes of transportation are provided with continuous and clearly defined routes and universal accessibility is provided.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the overall plan showing pedestrian, cyclist and motorized transportation routes.
- A copy of the relevant design standards utilized to meet or exceed local requirements for universal accessibility.

MFA Credit 1: Transit Facilities

1 to 3 Points

Intent

To promote the use of transit systems

Requirements

- Transit stop signage, seating and transit route information at each transit stop (1 Point)

  AND

- Covered and at least partially enclosed transit shelters with a bench and lighting at 50% transit stops on the project (1 Points).

  AND

- Covered and at least partially enclosed transit shelters with a bench and lighting at 75% transit stops on the project (1 Points).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide an overall plan showing the location of transit stops and the transit shelter type installed.
- Provide a copy of the design details for the transit stop signage, transit route information and transit shelter types.

MFA Credit 2: Bicycle Lanes & Pathways

1 to 3 Points

Intent

To encourage cycling as a mode of transportation

Requirements

An approved bicycle transportation plan

OR

Comply with city bicycle transportation plan

AND

- Provide roadway curb lanes and minimum of 0.5 metres wider than the vehicular lane width design criteria to accommodate cyclists (1 Point).

  OR

- Provide a continuous designated and marked bicycle lane a minimum of 1.5 metres wide along both sides of the roadway (3 Points).

  OR

- Provide a continuous, separate hard surfaced pathway a minimum of 3 metres wide along one side of the roadway (3 Points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the approved bicycle transportation plan
- Provide an overall plan showing the location and width of the cycling routes as well as route and regulatory signage and pavement markings as appropriate to the facility provided.

MFA Credit 3: Bicycle Facility Design

1 to 3 Points

Intent

To encourage cycling as a mode of transportation

Requirements

Use design elements that improve the safety and ease of operation of a bicycle. These include:

- Bridge railings a minimum of 1.4 meters high

  AND

- Ramps with curb lips no more than 10mm in height, which do not unnecessarily orientate cyclists into traffic lanes (1 Point).

  AND

- Drainage grates with openings narrow and perpendicular to the travel lane (1 Point).

  AND

- Provide bicycle accessible push buttons for cross-walks (1 Point).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Standard design detail drawings for the relevant details used.

MFA Credit 4: Pedestrian Paths & Sidewalks

1 to 4 Points

Intent

To encourage walking as a mode of transportation

Requirements

- The area is part of a traffic management plan designed to disperse through traffic volumes and reduce traffic speeds through roadway design features, which might include narrower travel lanes, tighter corner curb radii, raised medians, curb bulb outs and landscaping. (1 Points)

  AND

- Provide continuous, hard surfaced sidewalks a minimum of 1.5 meters wide adjacent to one side of the roadway (1 Point).

  AND

- Provide continuous, hard surfaced sidewalks a minimum of 1.5 meters wide adjacent to both sides of the roadway. (1 Point)

  OR

- Provide continuous, hard surfaced sidewalks a minimum of 1.5 meters wide along both sides of the roadway separated from the edge of roadway by a minimum of 3 meters (2 Points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a summary of the traffic management plan showing how through traffic volumes and traffic speeds are reduced.
- Provide an overall plan showing the location and width of the sidewalks, crossing locations and related pedestrian crosswalk signage and markings.

MFA Credit 5: Pedestrian Facility Design

1 to 5 Points

Intent

To encourage walking as a mode of transportation

Requirements

Use streetscape and design elements that improve the safety and quality of walking. These include:

- Grades less than 3%, but sufficient that they avoid pooling water

  AND/OR

- Shorten pedestrian crossing distances of roads that reduce exposure times to potential conflicts and better visibility of crossing locations (1 Point)

  AND/OR

- Priority crossing measures including pedestrian activated crossing or traffic signals at all major intersections that have reasonable maximum pedestrian waiting times and recognize the appropriate pedestrian walking speeds of the demographics of the area (1 Point)

  AND/OR

- Grade separation of crossing points that offer minimum resistance to pedestrian crossings and high levels of security (1 Points)

  AND/OR

- Boulevard landscaping, including a mixture of grass, shrubs and trees that buffer pedestrians from the roadway, but do not create hazards for vehicles or restrict traffic flows (1 Point).

  AND/OR

- An integrated streetscape that includes, but is not limited to sidewalks over 3 metres in width, special surfaces such as paving stones, seating areas, decorative pedestrian scale lighting, garbage receptacles, landscaping and guide signage consistent with a theme for the area (1 Points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A grading plan showing grades along pedestrian routes.

- Pedestrian crosswalk protection warrant calculations and an overall plan showing locations where pedestrian activated crossing signals, traffic signals or grade separated crossings are warranted.
- A pedestrian crossing plan showing where shortened crossing locations, pedestrian activated crossing, traffic signals and grade separated crossings have been provided.
- Pedestrian signal timing plans along with a rationale for proposed pedestrian crossing times and walking speeds.
- An overall landscaping plan along with details of plantings and cross-sections illustrating the desired buffering effect.
- An overall streetscaping plan illustrating the theme and overall concept along with details of surfacing materials and street furniture.

MFA Credit 6: Pathway Lighting & Design

2 Points

Intent

To promote the use of multi-use paths and sidewalks

Requirements

Lighting levels along multi-use paths and sidewalks should follow the current city or municipalities mandates on pathway lighting.

- Lighting consistent with the following chart:

Area Class	E_H (lux)	E_{Vmin}	E_{av}/E_{min}
Urban	20.0	10.0	4.0
Suburban	5.0	2.0	4.0
Rural	2.0	0.6	4.0

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A lighting plan with supporting calculations to demonstrate compliance with pathway lighting criteria.

MFA Credit 7: Separation of Modes

1 Point

Intent

To improve safety of non-motorized modes of transportation

Requirements

- Pedestrians and cyclists are physically separated from motorized transportation by boulevards or non-mountable barriers.

  AND

- Guidance that defines which mode of transportation has the right-of-way is provided at the intersection of all public roads.

  OR

- Complete integration of motorized and non-motorized traffic in an area of low speeds.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the location of sidewalks and bike paths as well as barriers separating motorized and non-motorized traffic.
- An overall plan showing the pavement markings and signage that provide the regulatory control at the intersection of all public roads.

MFA Credit 8: Conflict Points

1 Point

Intent

To encourage safety of non-motorized modes of transportation

Requirements

- An access control plan to minimize the number of accesses.

  AND

- Guidance either through design elements or traffic control that defines which mode of transportation has the right-of-way is provided at the intersection of all public roads.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the consolidation or elimination of existing access points.
- An overall plan showing the pavement markings and signage that provide the regulatory control at the intersection of all public roads.

Transportation Planning

TP Prerequisite 1: Level of Service

Required

Intent

To encourage a provision of appropriate levels of mobility over the longer term

Requirements

Provide an initial level of service for the project that is consistent with the goals of the overall long-range transportation plan and which can be maintained through staged implementation of capacity improvements during the course of the planning horizon period.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the section of the overall long range transportation plan outlining mobility objectives and target levels of service.
- A summary of the calculations for the initial design levels of service.
- An outline of the staging plan of future improvements to the project and a summary of the calculations to illustrate how they will maintain the target level of service.

TP Prerequisite 2: Safety Audit

Required

Intent

To encourage the use of third party safety audits

Requirements

- Undertake a safety audit of the roadway that addresses all modes of transportation.

AND

- Develop a safety audit for the construction duration.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the safety audit report.

TP Prerequisite 3: Traffic Maintenance Plan

Required

Intent

To prepare traffic management plans during construction and in the occurrence of traffic incidents

Requirements

- A construction management plan that addresses traffic accommodation during the construction period

  AND

- An incident management plan that addresses planned and unplanned constraints on capacity

  AND

- Traffic accommodation strategy that reduces potential vehicle hour delays due to construction to less than 20% of the baseline estimate

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the construction management plan.
- Provide a copy of the incident management plan.
- Provide a copy of the detailed traffic accommodation plan along with documentation summarizing the baseline estimate of vehicle hour delays and the actual vehicle hour delays based on field verified delay studies (e.g. confirmation of modeled queue lengths through field data) after implementation of the plan.

TP Credit 1: Parking Management

1 to 4 Points

Intent

To avoid a surplus of nearby site and on-street parking, and provides adequate parking for cyclists.

Requirements

- Project remains consistent with a parking management plan (1 Point);

AND/OR

- Does not contribute to the parking supply in the area, unless deemed necessary (1 Point).

AND/OR

- Proved easy to use and access, theft resistant (can lock frame and one wheel to stand) bicycle stands or lockers are provided at all key locations and are located in visible, well-trafficked areas, but do not obstruct traffic flows (2 Point).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the parking management plan for the project area.
- A summary of how the project contributes to the principles of the parking management plan.

TP Credit 2: Optimum Level of Service

2 Points

Intent

To encourage a provision of the required roadway capacity without providing excessive or unnecessary capacity

Requirements

Design elements selected based on providing adequate, but not excessive, roadway capacity, for a 15 to 20 year planning horizon.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the section of the overall long range transportation plan outlining mobility objectives and target levels of service.
- An overall plan illustrating the proposed roadway geometry, cross-section and intersection configurations.
- A summary of the calculations for the initial design levels of service and for the 10 to 15 year horizon.

TP Credit 3: Person-Time & Fuel Usage Savings

2 Points

Intent

To encourage the use of savings in terms of person-time and fuel usage rather than vehicle time savings in the evaluation of design element options

Requirements

Design element options compared and selected based on optimization of person-time and fuel usage savings rather than use of volume to capacity calculations.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan illustrating the proposed roadway geometry, cross-section and intersection configurations.
- A summary of alternative roadway geometry, cross-section and intersection configurations considered.
- Calculations based on person-time and fuel usage savings illustrating that alternatives for the key design elements, such as lane configurations, intersection spacing and intersection geometry, were selected based on these criteria.

TP Credit 4: Responsive Traffic Signals

1 to 4 Points

Intent

To encourage the optimization of traffic signals to address different time of day events and provide priority of transit and non-motorized users where appropriate

Requirements

- Use of fully actuated traffic signals (2 Points)

  AND

- Traffic signal phasing and timing plans for all major different time of day events (1 Point)

  AND/OR

- Transit or non-motorized traffic signal priority measures (1 Point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide an overall plan showing the location of all traffic signals and traffic priority measures.
- Provide a summary of the type of traffic control equipment installed at each location.
- Provide a summary of the traffic volume patterns by time of day and day of week at each signalized intersection.
- Provide a summary of the signal phasing and timing plans to address the traffic volume patterns for each traffic signal.

TP Credit 5: Design Speed & Consistency

1 to 2 Points

Intent

To encourage selection of design speeds and speed consistency within and adjacent to the roadway

Requirements

Use context sensitive design principles to select appropriate design speeds (1 Point).

AND

A maximum of 10km/h changes in design speed (1 Point).

(NEED TO CONFIRM HOW WE WANT TO MEASURE DESIGN SPEED CONSISTENCY)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the section of the overall long range transportation plan outlining the function of the roadway.
- An overall plan showing the adjacent land uses and selected design speeds for each distinct segment.

TP Credit 6: Intelligent Transportation Systems

1 Point

Intent

To encourage the use of ITS technologies (in addition to Responsive Traffic Signals) to improve mobility without adding capacity and/or improve the efficiency of transit systems

Requirements

- Use of proven ITS technologies (1 Points)

Submittals

- Provide a submittal template, signed by the responsible party, declaring that the requirements have been met

- Documentation of ITS technologies used and explanation of their benefits to a more sustainable transportation project

Energy & Atmosphere

EA Credit 1: Lighting Energy Efficiency

2 Points

Intent

To reduce energy consumption in street-lighting systems

Requirements

Meet but do not exceed IESNA street-lighting standards or local ordinances, whichever is more stringent.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A site plan indicating the location of any relevant lighting infrastructure.
- An estimate of the baseline energy use for any relevant lighting infrastructure items.
- Documentation through a brief narrative and calculations to demonstrate that the standards were met.

EA Credit 2: Infrastructure Energy Efficiency

2 Points

Intent

To reduce pollution from infrastructure energy consumption

Requirements

Design and install any pumping or treatment systems that are included as part of the project, to achieve a 15% reduction in energy use from the baseline energy use.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A site plan indicating the location of any relevant infrastructure.
- An estimate of the baseline energy use for any relevant infrastructure items.
- Documentation through a brief narrative and calculations to demonstrate that the 15% energy reduction was achieved.

EA Credit 3: Fossil Fuel & Emission Monitoring

2 to 4 Points

Intent

To reduce the reliance and use of fossil fuels in construction equipment and work vehicles on road construction projects, as well as address their emission output.

Requirements

Creation and implementation of a fuel-use monitoring plan for all construction equipment and work vehicles. This plan is to record the amount of fuel use for each vehicle type on the project. (2 Points)

AND/OR

Creation and implementation of a emission monitoring plan for all construction equipment and work vehicles. This plan is to record the amount of emission produced by each vehicle type on the project. (2 Points)

Submittals

- A list of the construction equipment and work vehicles used on the project, which is to include the make and model of each vehicle.
- Provide the proper documentation for each plan.
- Provide the proper documentation demonstrating the fuel use and emission outputs of each of the construction vehicles on the site.

EA Credit 4: Paving Emission Reduction

2 Points

Intent

To improve the worker's health by reducing the amount of exposure to paving emissions

Requirements

Employ the use of BMPs to reduce worker exposure to paving emissions. (2 Points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide documentation that demonstrates a plan and execution for reducing workers emission exposure and effects.

EA Credit 5: Paving Energy Reduction

1 - 3 Points

Intent

To reduce energy consumption at the point of production and placement of product

Requirements

- Reduce energy use from production to placement of the product, by 30% from baseline (1 Point).
- Reduce energy use from production to placement of the product, by 40% from baseline (1 Point).
- Reduce energy use from production to placement of the product, by 50% from baseline (1 Point).
- Reduce energy use from production to placement of the product, by 70% from baseline (1 Exemplary Performance Point).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Submit documentation that shows the type of materials used and the type of pavement used on the project.
- Provide documentation demonstrating the current production and placement energy consumption and comparison to current project.

EA Credit 6: Volatile Organic Compounds

2 Points

Intent

To reduce pollution from release of volatile organic compounds to the atmosphere

Requirements

Design and use those products that minimize the release of volatile organic compounds into the atmosphere.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A summary of the products being utilized (asphaltic cement, paint, etc) that release volatile organic compounds into the atmosphere.
- An estimate of the baseline energy use for any relevant infrastructure items.
- Documentation through a brief narrative and calculations to demonstrate that a 50% ?? (what are VOC requirements for paint) reduction in the release of volatile organic compounds was achieved.

Materials & Resources

MR Prerequisite 1: Construction Waste Management

Required

Intent

To divert construction and demolition debris from disposal in landfills and incinerators by redirecting recyclable resources back to the manufacturing process and reusable materials to the appropriate sites

Requirements

Develop and implement a construction waste management plan that recycles and/or salvages non-hazardous construction and demolition debris, excluding vegetation and soils.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the construction waste management plan.

MR Credit 1: Lifecycle Costing

3 Points

Intent

To encourage use of life cycle costing to select products and methodologies

Requirements

Undertake life cycle costing of all significant cost items using an appropriate discount rate including:

- Pipe materials
- Pavement structure
- Structures (bridges and walls)
- Lighting (fixtures and poles)
- Signage (sign and pole)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the life cycle cost assessments, along with the rationale for the selected Discount Rate, for each significant project element. Where a formal life cycle assessment has been used as part of approach to develop an agency policy on an element (e.g. pole types), submission of a signed letter documenting this approach will be considered as acceptable.

MR Credit 2: Construction Site Footprint

3 Points

Intent

To conserve existing natural areas and vegetation and minimize neighbourhood impacts

Requirements

- Locate the project footprint on areas that are 100% previously developed as a transportation corridor (3 Points).

  OR

- In areas, where there is no previous development, limit all site disturbances to no more than 5 metres beyond the limits of curbs, shoulders, sidewalks, pathways or utility cuts (3 Points).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan indicating the location of any areas that are previously developed as part of a transportation corridor, the footprint of the project and the zone of construction impact.

MR Credit 3: Recycled Content

1 to 6 Points

Intent

To use recycled materials to reduce the environmental impact of extraction and processing of virgin materials

Requirements

- Any aggregate base and aggregate subbase shall be 90% by volume recycled aggregate materials, such as crushed asphaltic concrete and Portland cement concrete. (2 points)
- Any asphalt base shall be a minimum 15% by volume recycled asphaltic concrete pavement. (1 points)
- Any asphaltic concrete pavement shall:

  be a minimum 15% by volume recycled asphaltic concrete pavement

  OR

  be a minimum 75% by volume rubberized asphaltic concrete pavement from crumb rubber from scrap tires

  OR

  include a minimum of 5% by weight of pre-consumer or post-consumer asphalt roofing shingles (2 points)
- Any Portland cement concrete shall contain:

  recycled mineral admixtures, such as coal fly ash, ground granulated blast furnace slag, rice hull ash, silica fume or other pozzolanic industrial byproduct) to reduce by at least 25% of the concrete mix's typical Portland cement content

  AND

  a minimum of 10% by volume reclaimed concrete material aggregate (2 points)

- Piping made of Portland cement concrete shall contain recycled mineral admixtures, such as coal fly ash, ground granulated blast furnace slag, rice hull ash, silica fume or other pozzolanic industrial byproduct) to reduce by at least 25% of the concrete mix's typical Portland cement content. (1 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A table of each material used on the project that is being tracked for recycled content including the type of material and recycled content.

MR Credit 4: Long Life Pavements

4 Points

Intent

To design of pavement structures intended to perform 30 years or more with minimal restoration of the surface and reduce future rehabilitation requirements.

Requirements

- Use of a pavement structure with a design life of at least 30 years (2 Points).

OR

- Use of a pavement structure with a design life of at least 40 years (4 Points).

AND

- Exemplary Performance point will be awarded a design life of 50 or more years.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the design report summarizing the pavement design principles and inputs, a comparison of pavement designs for traditional "20 year" pavements and a long life pavement design option with a life of at least 30 years and their expected rehabilitation requirements.
- Confirmation of the use of the long life pavement design option.

MR Credit 5: Local Materials

1 to 2 Points

Intent

To reduce energy use and vehicle emissions in the transport of materials by encouraging use of local materials

Requirements

Materials must come to the jobsite from less than 325 kilometers away. One point will be rewarded if at least 50% of the materials come from 325 kilometers away. A second point will be awarded for at least 75% of the materials to come from 325 kilometers away; and an Exemplary Performance point will be awarded for 100% compliance.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A summary of all major elements and their quantities used in the project (e.g. aggregate, asphaltic cement, cement, street furniture and landscaping materials)
- A summary of available suppliers (not distributors), their location and distance to the project.
- A summary of suppliers utilized and confirmation that they are located within 250 miles of the jobsite.

Environmental Impacts

EI Prerequisite 1: Construction Activity Pollution Prevention

Required

Intent

To reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, airborne dust generation and limiting the potential for contamination of soils and waterways

Requirements

Create and implement an erosion and sedimentation control plan for all construction activities associated with the project. The plan shall list the Best Management Practices (BMPs) employed and describe how the BMPs accomplish the following objectives:

- Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- Prevent sedimentation or contamination of any impacted stormwater conveyance systems or receiving streams.
- Prevent contamination of soils.
- Prevent polluting the air with dust and particulate matter.

The BMPs shall be selected from the most stringent guidelines that are applicable to the project.

AND

- Awards 1 Exemplary Point for obtaining an award/certification for environmental management. (1 Exemplary Point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A copy of the erosion and sedimentation control plan, which includes the source of the BMPs.
- An attestation that the erosion and sedimentation control plan was implemented in accordance with the plan.
- A summary of the monitoring reports for the implementation of the erosion and sedimentation control plan.
- Documentation proving that an award or certification has been award for environmental management.

EI Credit 2: Stormwater Management

4 Points

Intent

To protect and enhance the water quality of receiving watercourses, prevent flooding, and promote the public security and economic well being.

Requirements

Implement a comprehensive stormwater management plan for the project, with the use of possible Best Management Practices (BMPs) to achieve the water quality and quantity control objectives, such as

- Source control BMPs involving street sweeping, catch basin cleaning and creating site depression storage and increasing infiltration;
- Conveyance system BMPs using pervious pipe, catch basins plus grassed swales;
- End-of-Pipe BMPs using pond and wetland systems, infiltration and filtrations plus oil/grit separators.

Key criteria are to be evaluated on a site basis:

- Maximum allowable discharge rates to receiving watercourses are to be met;
- Maximum release rates to downstream storm sewer are to be satisfied;
- The removal of Total Suspended Solids (TSS) is to be in accordance with local guidelines with respect to stormwater quality treatment facilities;
- Overland flows are to be in accordance with local guidelines with respect to ponding depth and flow velocities in streets.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan illustrating the project's potentially impermeable areas, the location of any stormwater management facilities and/or Best Management Practices.
- A calculation illustrating the effectiveness of the project's selected BMPs, including runoff estimation, storage and water quality improvement.

EI Credit 3: LID Stormwater Management

4 Points

Intent

To encourage use of Low Impact Development (LID) stormwater management strategies that manage runoff at its sources, reduce stormwater conventional construction and maintenance cost, and reducer runoff volume and pollutant loadings.

Requirements

Evaluate project site for LID opportunities and suitability;

Incorporates LID stormwater management strategies that meet the stormwater regulations of permitting agencies, and reduce runoff volume and promote infiltration through possible practices and available techniques, such as,

- Maintain natural drainage through minimize the right-of-way to accommodate travel lanes, shoulder lanes, slopes, etc;
- Remove curb and gutters from roads wherever possible, by using vegetated swale conveyance systems instead of enclosed pipe systems, or utilizing an urban curb cut and swale systems;
- Build concave medians or possible depression storages to create bioretention area;
- Use permeable pavements (e.g. porous asphalt, porous pavers, porous concrete) instead of conventional impervious surfaces;
- Amended or engineered soils instead of conventional compacted soils.

The average annual reduce the average annual post development runoff volume from the project right of way by at least 50%.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met;
- Provide lists of LID strategies selected for the project;
- Provide calculations showing the percentage of pervious ratio within the project;
- Provide calculations illustrating the percentage of runoff volume reduction from the project right-of-way by using LID practices;
- Provide reduced capital costs due to the use of LID practices compared to conventional methods associated with construction and maintenance of the project.

EI Credit 4: Water Efficient Landscaping

1 to 2 Points

Intent

To minimize water use for landscape irrigation, where irrigation is warranted, to reduce the impact to natural water resources and burden on municipal water supply and wastewater supply

Requirements

- For irrigation, use only captured rainwater, recycled wastewater, recycled greywater, or water treated and conveyed by a public agency specifically for non-potable uses (1 Point).

OR

- Select native species to use for roadway landscaping that do not require the need for irrigation after 6-months (2 Points).

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- A brief narrative describing the landscaping and irrigation design strategies employed by the project.
- The project's baseline and actual water use, after implementation of reduction strategies.

EI Credit 5: Reflective Pavement

3 Points

Intent

To reduce heat island effects and minimize temperature of stormwater runoff by using highly reflective pavements.

Requirements

Use a light colored/high albedo pavement of a minimum of .3 (according to ASTM E 903 test procedures) that will cover a minimum of 50% of the total project hardscape footprint

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide documentations that provide the albedo level of the surface layer, which meets the ASTM E 903 test standards and procedures.

Community Impacts

CI Prerequisite 1: Community Outreach & Involvement

Required

Intent

To encourage community participation in the project planning and design and involve people who will be impacted by the project in improving the project.

Requirements

A community outreach and involvement program that includes a range of consultation strategies and respects input from community stakeholders during the design and construction phases of the project.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the written community outreach and involvement program for both the design and construction components of the project.
- Provide a brief narrative describing the steps taken in implementing the community outreach and involvement program and how the program influenced the final design.

CI Credit 1: Noise Mitigation Plan

3 Points

Intent

To encourage the reduction of noise levels associated with construction activities.

Requirements

- A noise mitigation plan that includes a description of construction activities, illustrates the expected noise levels at the affected areas with a noise map

AND

- Implementation of specific mitigation strategies

Submittals

- Provide a submittal template, signed by the responsible party, declaring that the requirements have been met

- Provide a copy of the noise mitigation plan and how it is to be implemented. It should include documentation showing the mitigation strategies that are being put to use and how they help lessen the impact that construction noise has on the surrounding areas.

CI Credit 2: Traffic Noise Reduction

1 to 3 Points

Intent

To encourage the reduction of noise levels associated with motorized traffic.

Requirements

- A traffic noise study using an accepted methodology and software that calculates existing noise levels, projected noise levels at the completion of the project and projected noise levels at the projected traffic volumes at the 10 and 20 year horizons for all affected non-commercial areas.

AND

- Implementation of a noise mitigation strategy that maintains traffic noise levels through all affected non-commercial areas through to the 20 year horizon at no more than existing levels (1 point)

AND

- Implementation of a noise mitigation strategy that reduces traffic noise levels above 65 dBA through all non-commercial areas through to the 20 year horizon to less than 65 dBA (1 point)

AND

- Implementation of a noise mitigation strategy that reduces traffic noise levels above 65 dBA through all non-commercial areas through to the 20 year horizon to less than 60 dBA (1 point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- Provide a copy of the noise study, which illustrates the non-commercial areas affected by the project, existing and projected noise levels and the impacts of the selected mitigation strategy.
- Provide detailed design drawings showing the how the noise mitigation strategy is implemented. Where the strategy involves construction methodologies, such as the use noise reducing pavements or sound absorbing walls, additional product technical data on the methodology to outline its effectiveness is also to be submitted.

CI Credit 3: Light Pollution Reduction

3 Point

Intent

To minimize light trespass from the project, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction, and reduce development impact on nocturnal environments

Requirements

To follow the guidelines for IESNA TM-10, IESNA TM-11 and IESNA RP-8 Annex C

Submittals

- Provide the LEED submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall plan showing the lighting sources.
- A statement as to the lighting zone(s) that the project is in.
- Design lighting drawings that show the design strategies and/or technologies used to reduce light pollution.

CI Credit 4: Visual Elements

2 Points

Intent

To encourage transportation corridors that offer views and features that are architecturally compatible with their surroundings, provide aesthetic unity and coherence and improve the experience of passing through the corridor

Requirements

Use geometries, streetscape and design elements that provide an improved experience at appropriate scales for motorized and on-motorized modes. These include:

- Landscaping, including a mixture of grass, shrubs and trees, at scales that are suitable for the different modes of transportation using the project.

  AND

- An integrated streetscape that includes, but is not limited to special surfaces such as paving stones, decorative poles, decorative lighting and banners. (1 point)

  AND

- A geometric alignment that provides opportunities to provide varying and significant views for both motorized and non-motorized modes and blends into the surrounding landscape through a curvilinear alignment and appropriate sideslopes. (1 point)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- An overall inventory of existing visual resources and plantings, improvement opportunities and the approach utilized to maximize these opportunities.
- An overall landscaping plan along with details of plantings.
- An overall streetscaping plan illustrating the theme and overall concept along with details of surfacing materials and street furniture.
- An overall plan showing all vertical structures and those structures with specific architectural treatment.
- Detail design drawings of the architectural treatments on vertical structures.
- An overall plan showing significant natural and man-made views of interest and illustrating how the geometric alignment and sideslopes have been optimized to provide opportunities for motorized and non-motorized modes to take advantages of those views in a manner that respects the existing landscape.

Innovation & Design

ID Credit 1: Innovation & Design Process

1 to 2 Points

Intent

To reward innovative ideas, practices and technologies, not specified in the Green Guide. To continue the green movement, and applications of this Guide.

Requirements

Identify the intent of the proposed innovation credit, the proposed requirement for compliance, proposed submittals to demonstrate compliance, and the design approach and strategies that might be used to meet the requirements. (1 point each, up to 2 points)

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the requirements have been met.
- The specific title for the ID credit, a statement of the credit intent, and a statement of the credit requirements.
- A narrative and overall plan describing the project's approach to achievement of the credit, including a description of the quantifiable environmental benefits of the credit proposal.
- Detailed plans and specifications, as necessary to illustrate the project's approach to this credit.

ID Credit 2: Exemplary Performance

1 to 4 Points

Intent

To reward exemplary performance in the application of credits with-in the Green Guide. To give bonus credits to those who step beyond the minimum requirements for allotted credits.

Requirements

- Identify where exemplary performance has been achieved, and demonstrate the strategies and approach used to exceed the minimum requirements. (1 to 4 Points awarded for each applicable credit)

AND/OR

- Identify what categories have achieved exemplary performance, a category receiving 90%, or higher, of its possible point totals can receive 1 exemplary performance point. (1 to 4 Points awarded for each applicable category)

Note that 4 Points are the maximum number of points allotted, exceeding requirements in more than four areas will not result in additional points.

Submittals

- Provide the submittal template, signed by the responsible party, declaring that the credit requirements have been met and exceeded.
- Detailed plans and specifications, as necessary to illustrate the project's approach to this credit.

Appendix D: Project Drawings

South Terwillegar Site Plan and Cross-Sections

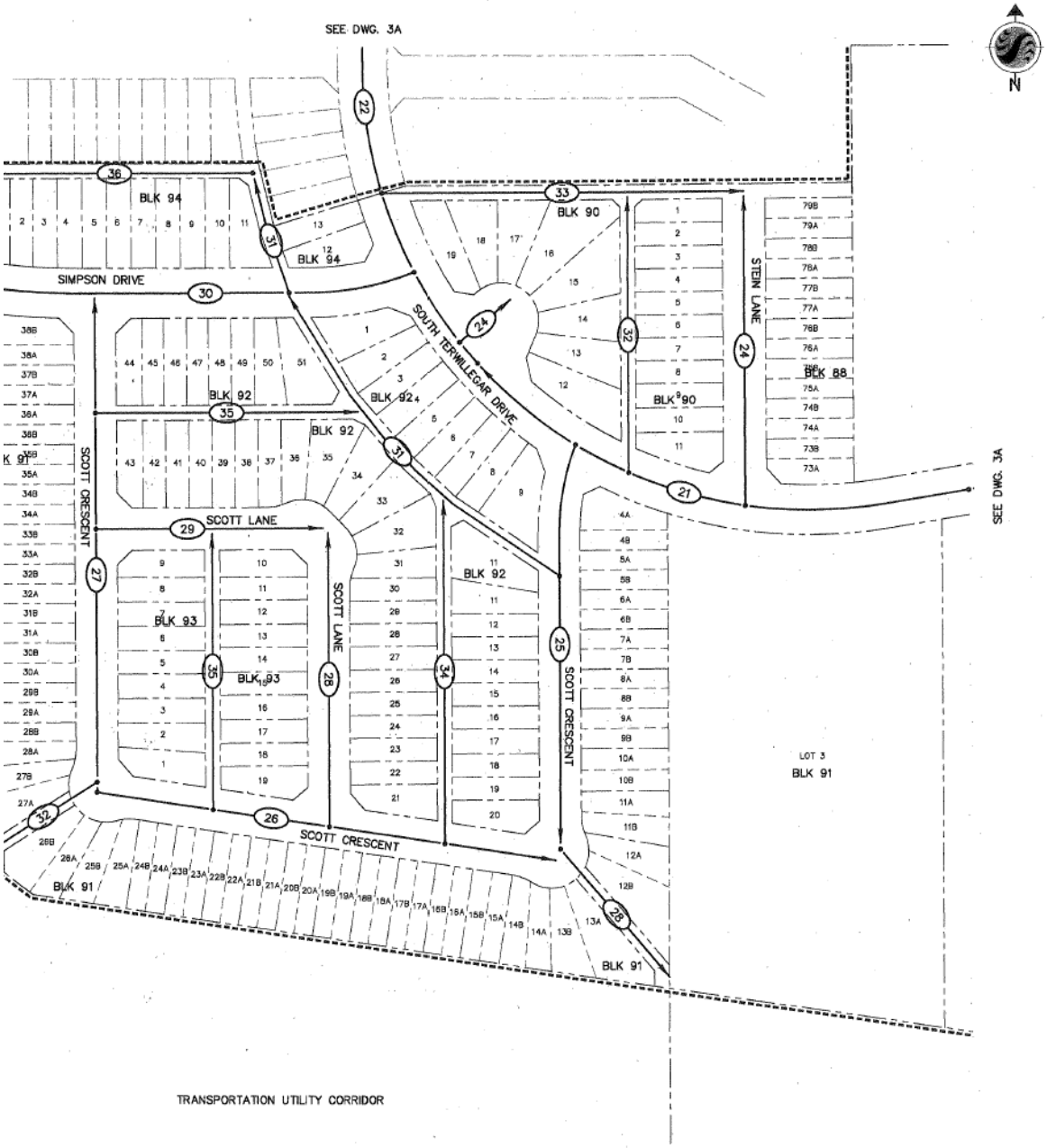


Figure 13: South Terwillegar Site Plan

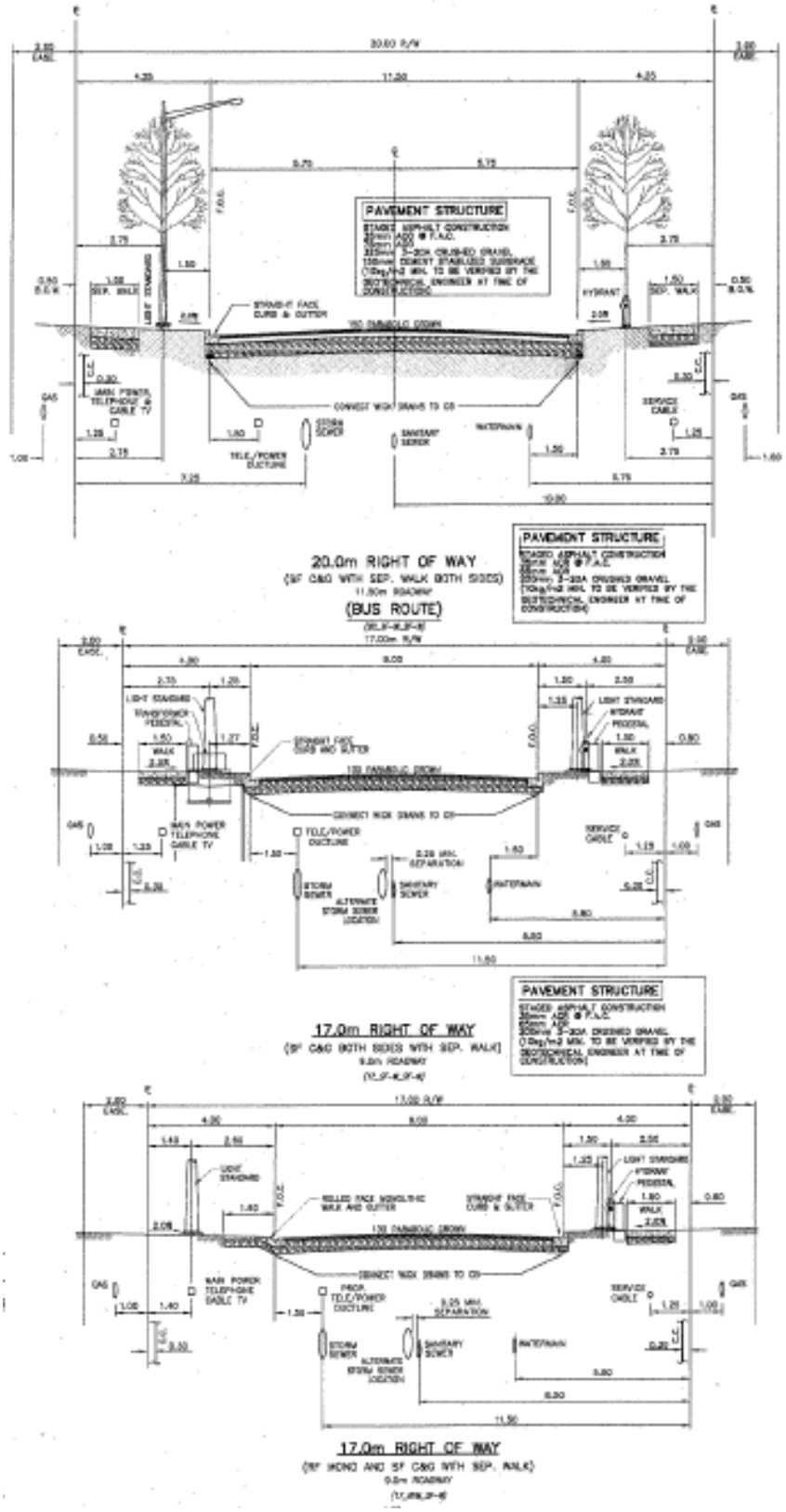


Figure 14: South Terwillegar Cross-Sections

Secord, Stage 2 Site Plan and Cross-Sections

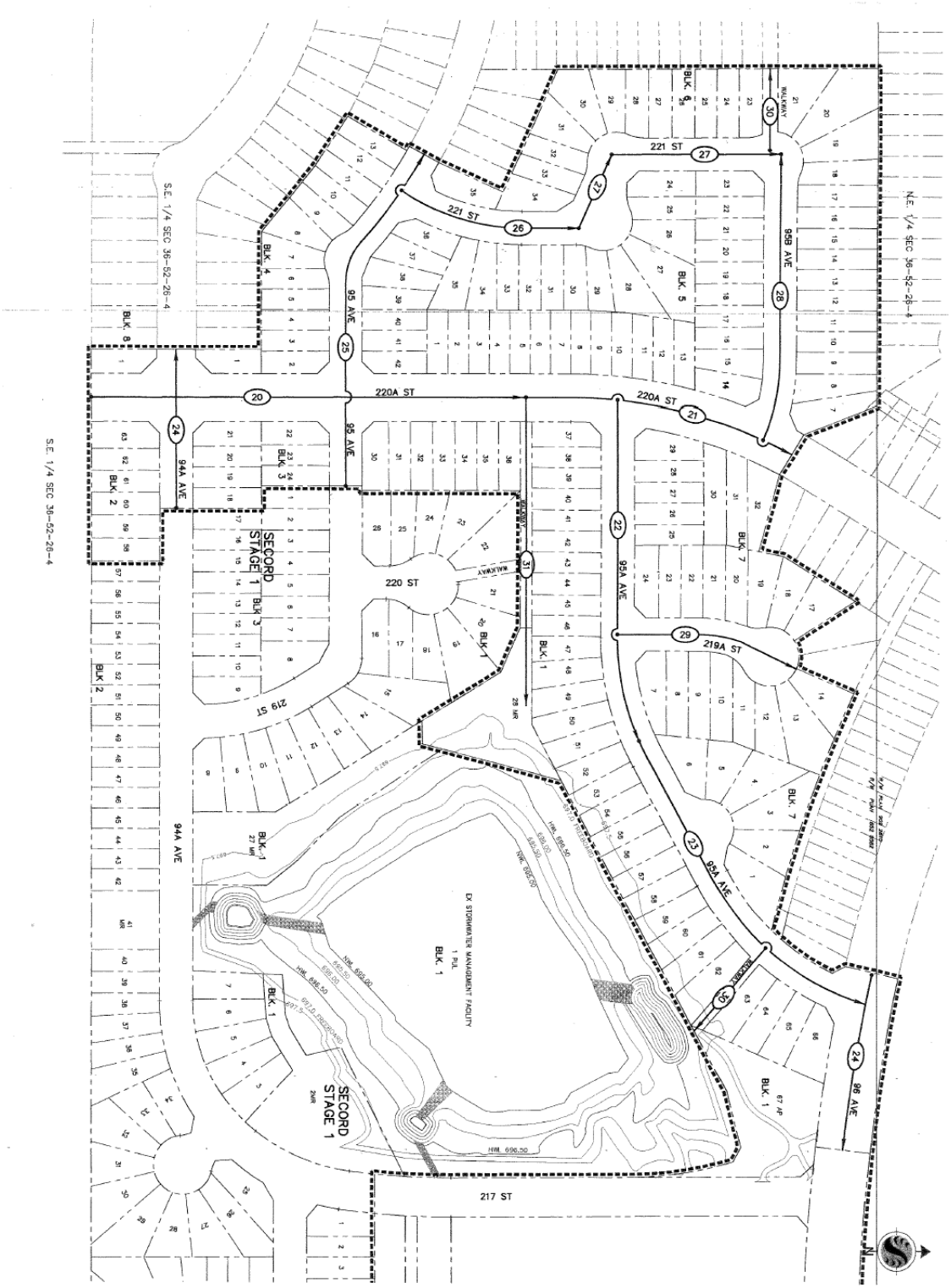


Figure 15: Secord, Stage 2 Site Plan

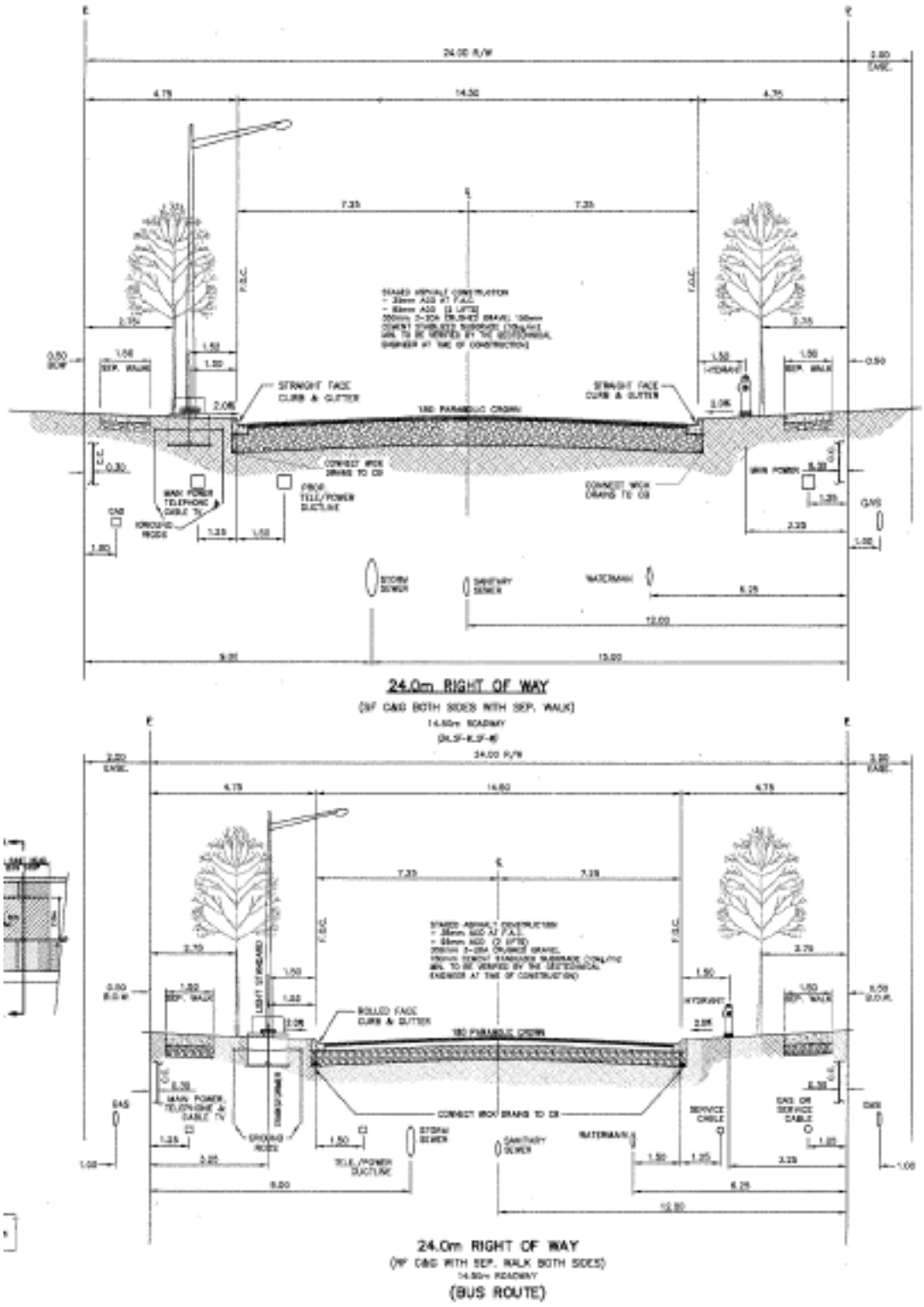


Figure 16: Secord, Stage 2 Cross-Sections

The Hamptons Stage 13 Site Plan and Cross Sections

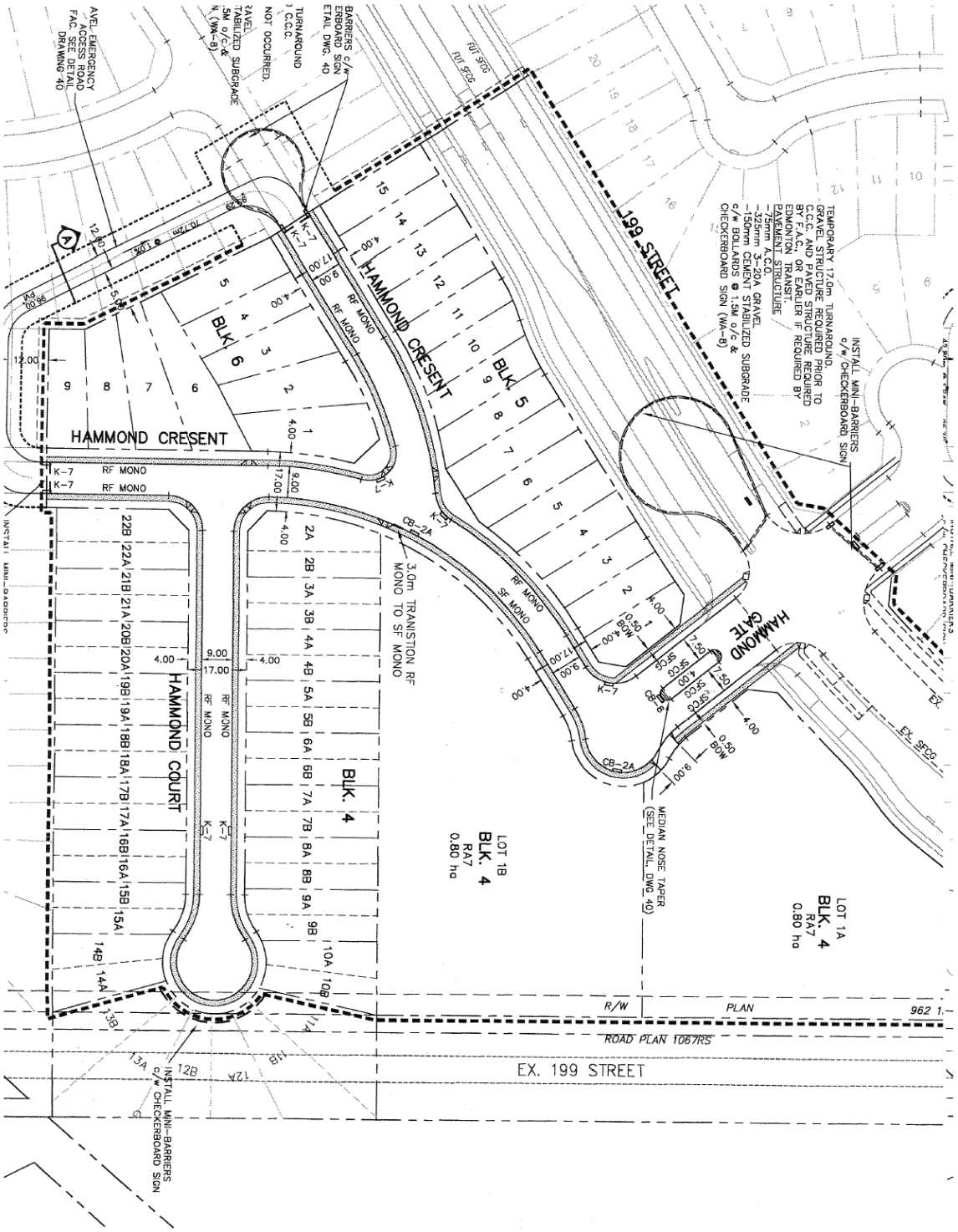


Figure 17: The Hamptons Stage 13 Site Plan

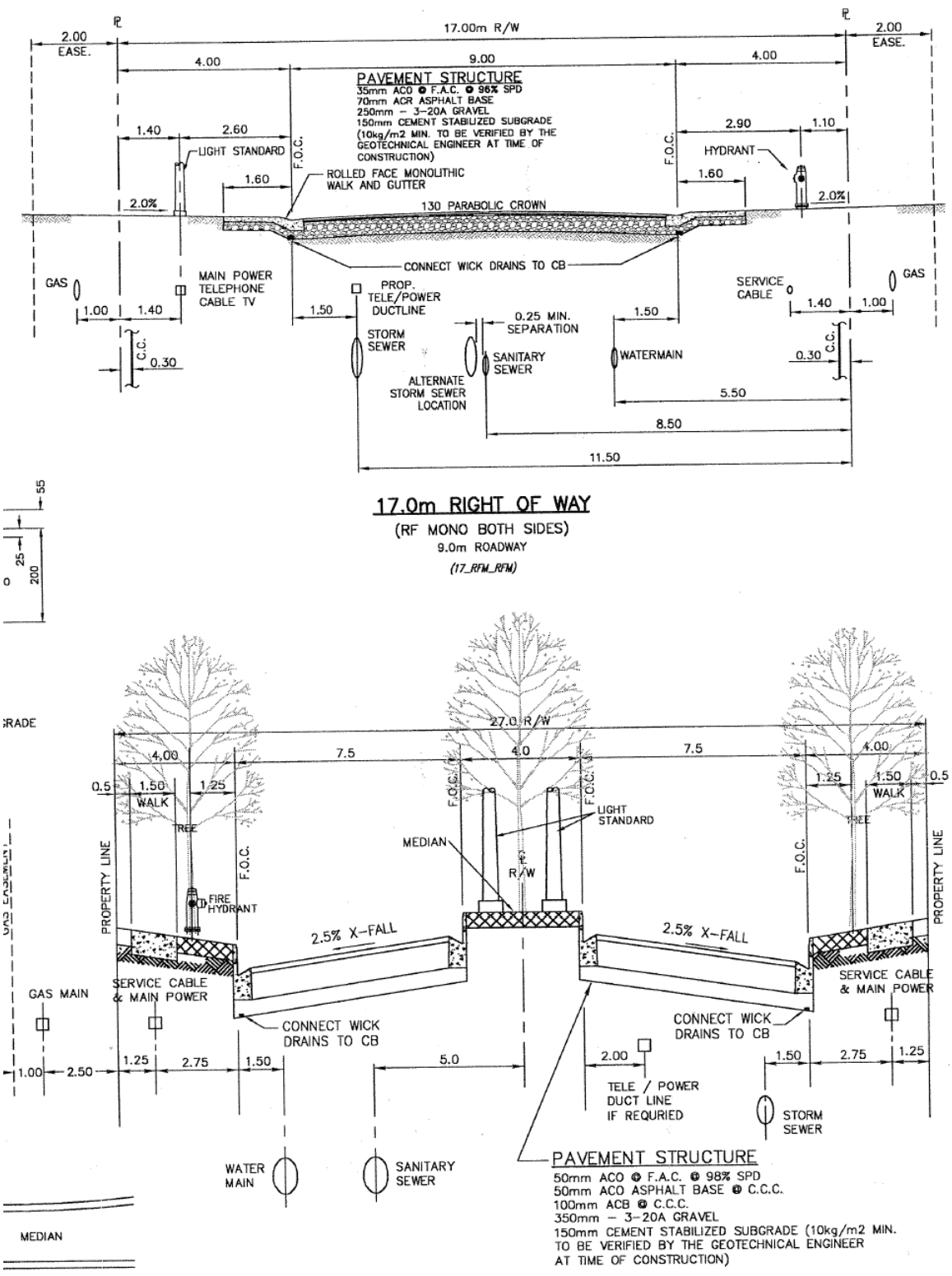


Figure 18: The Hamptons Stage 13 Cross-Sections

Ellerslie Road Gateway Blvd East of 91st St. Site Plan and Cross-Section

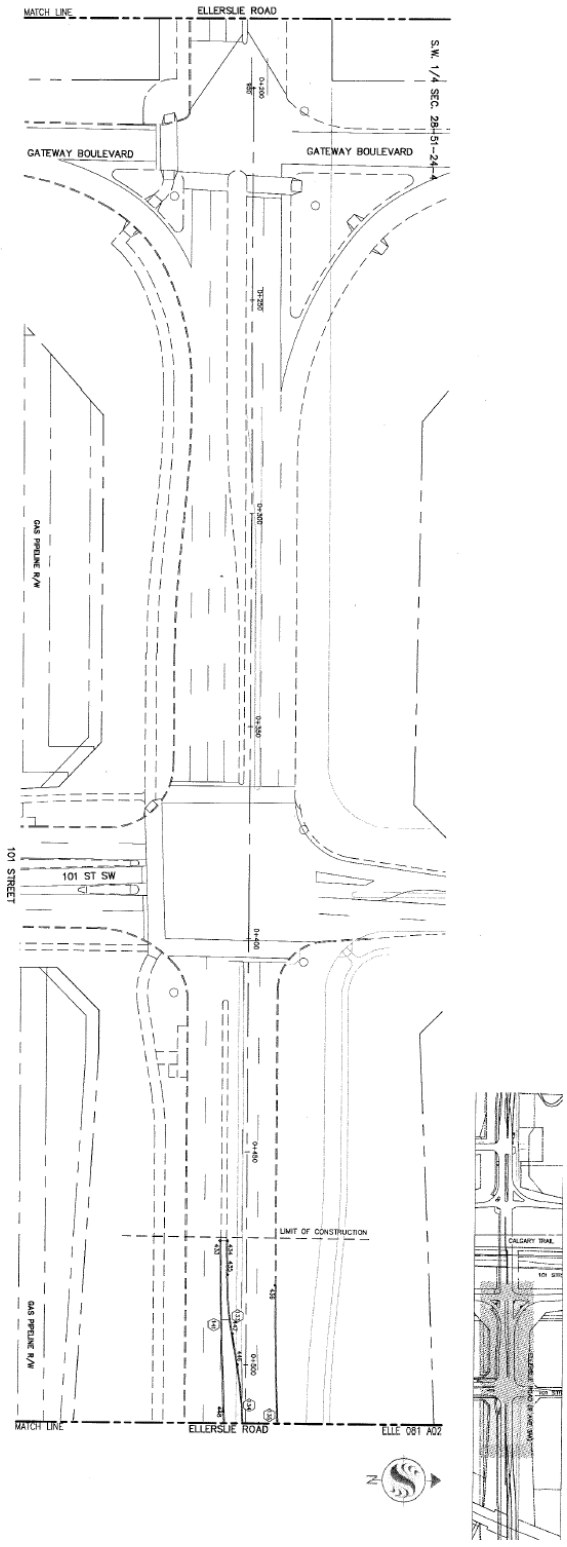


Figure 19: Ellerslie Road Gateway Blvd Site Plan

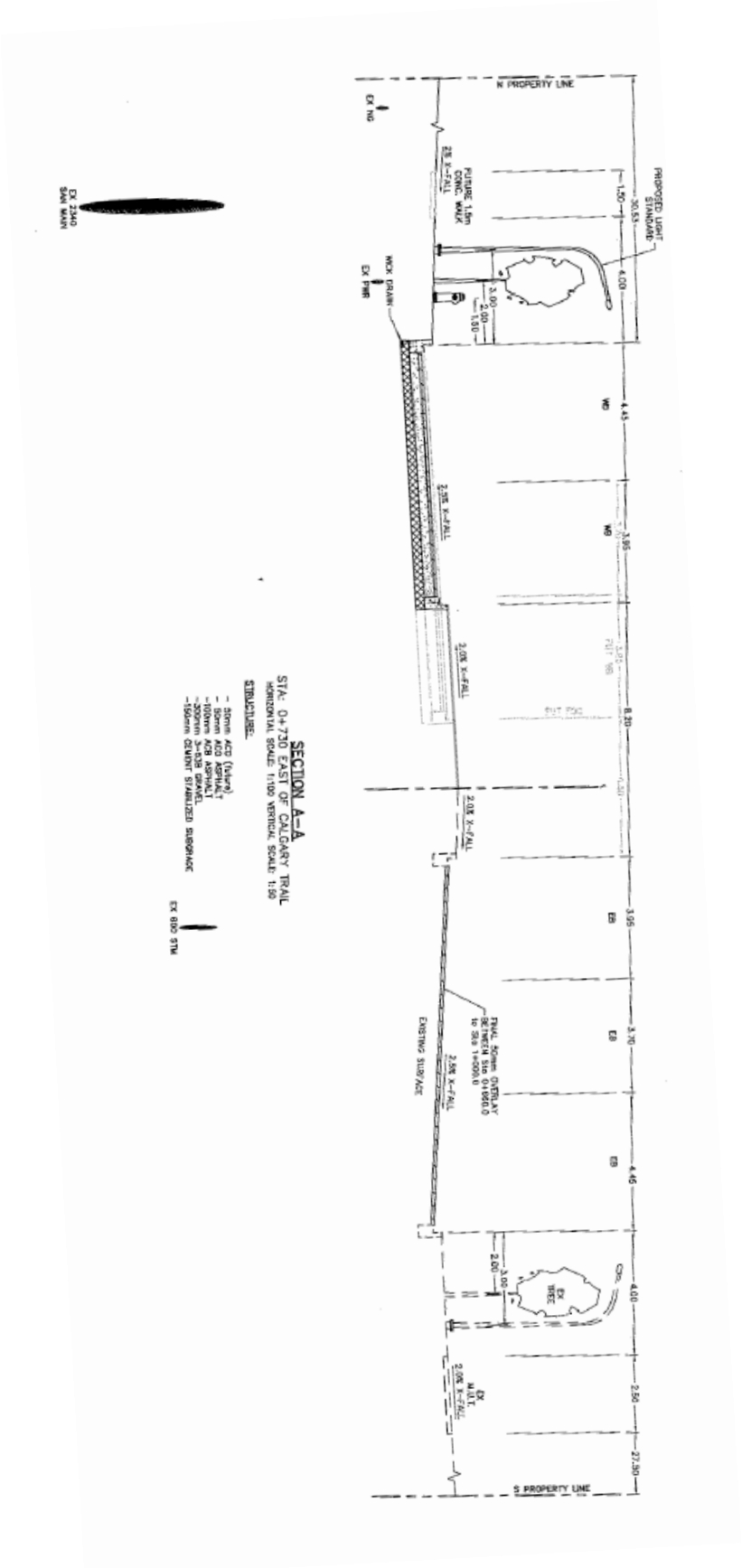


Figure 20: Ellerslie Road Gateway Blvd Cross-Section

167 Avenue 129st to 127st Site Plan and Cross-Section

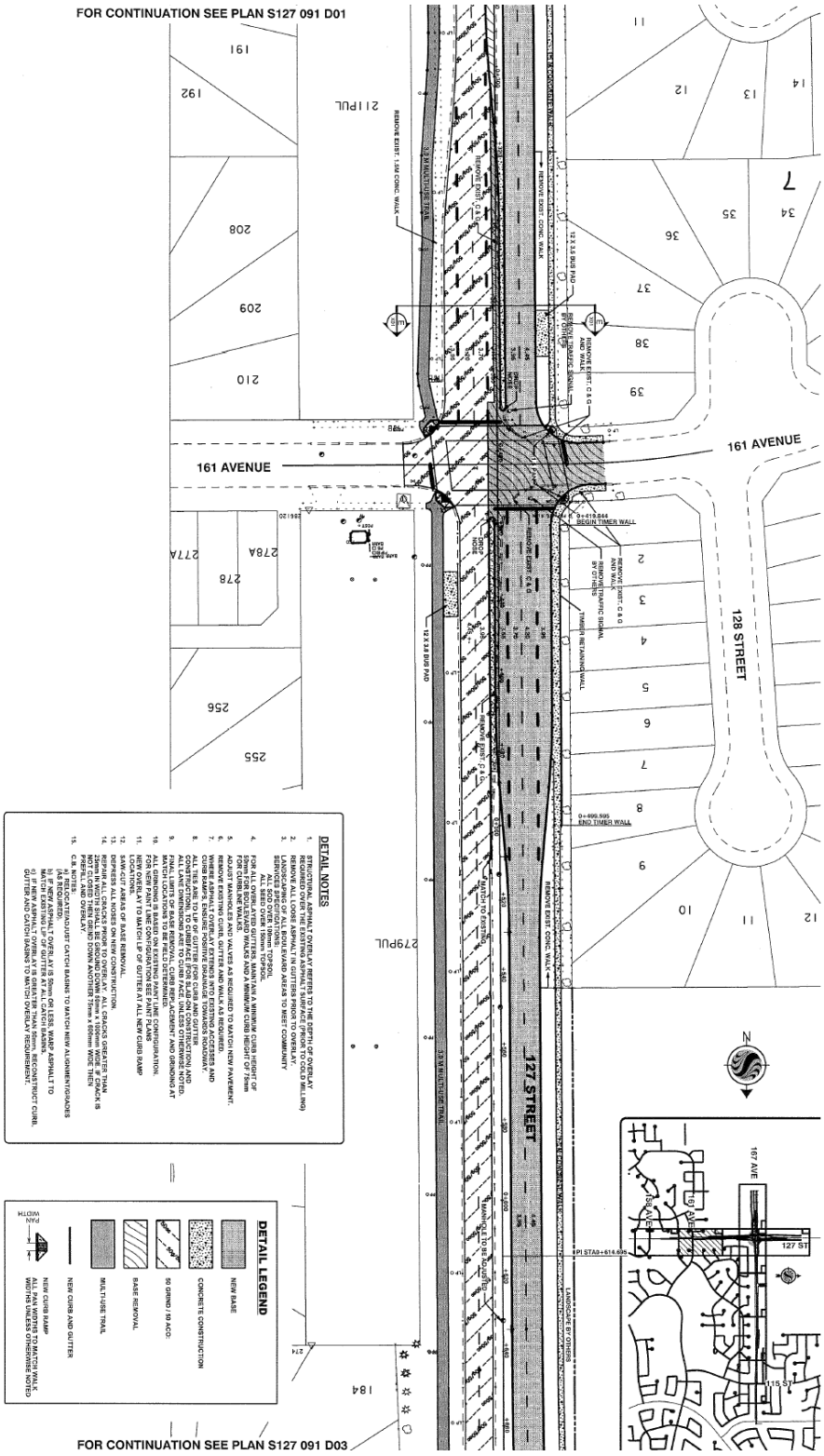


Figure 21: 167 Avenue 129 St to 127 St Site Plan

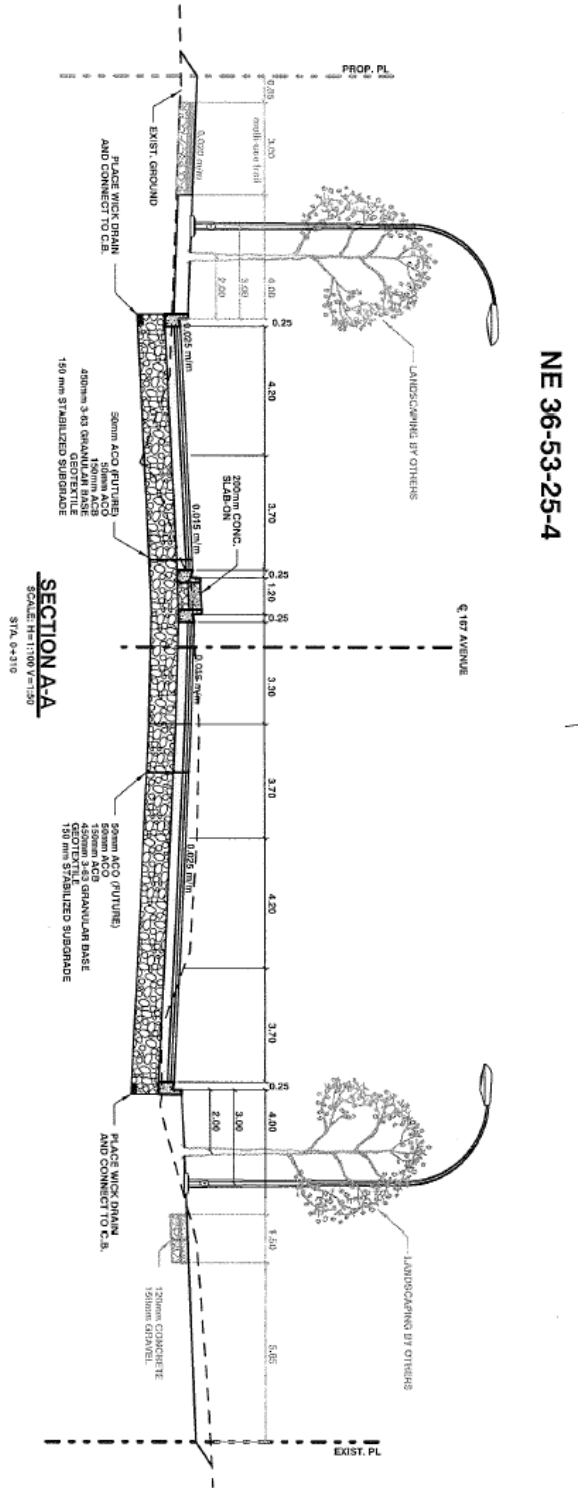


Figure 22: 167 Avenue 129 St to 127 St Cross-Section

Fort Saskatchewan – 86 Ave. Extension Site Plan and Cross-Section

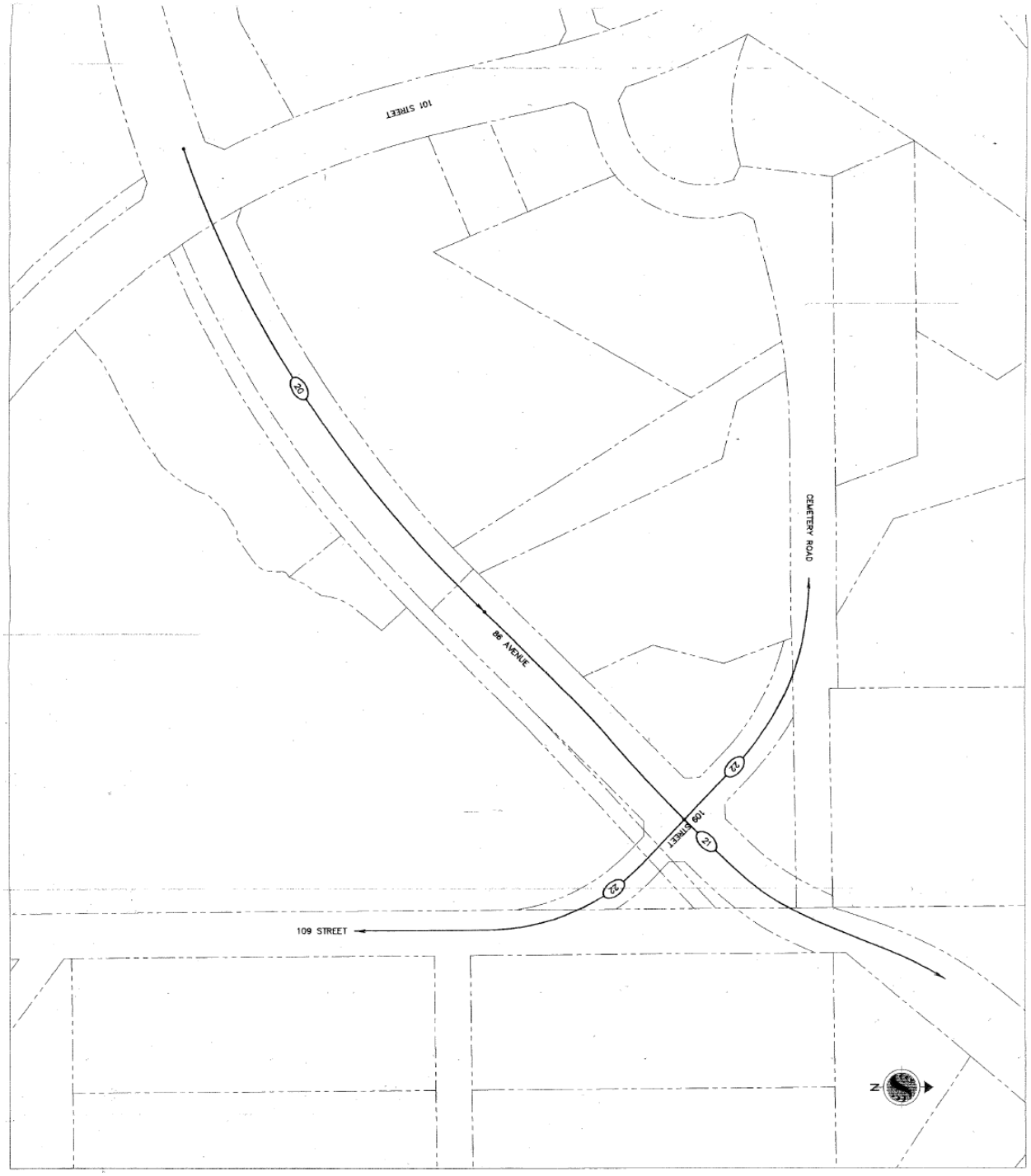


Figure 23: Fort Saskatchewan – 86 Ave. Extension Site Plan

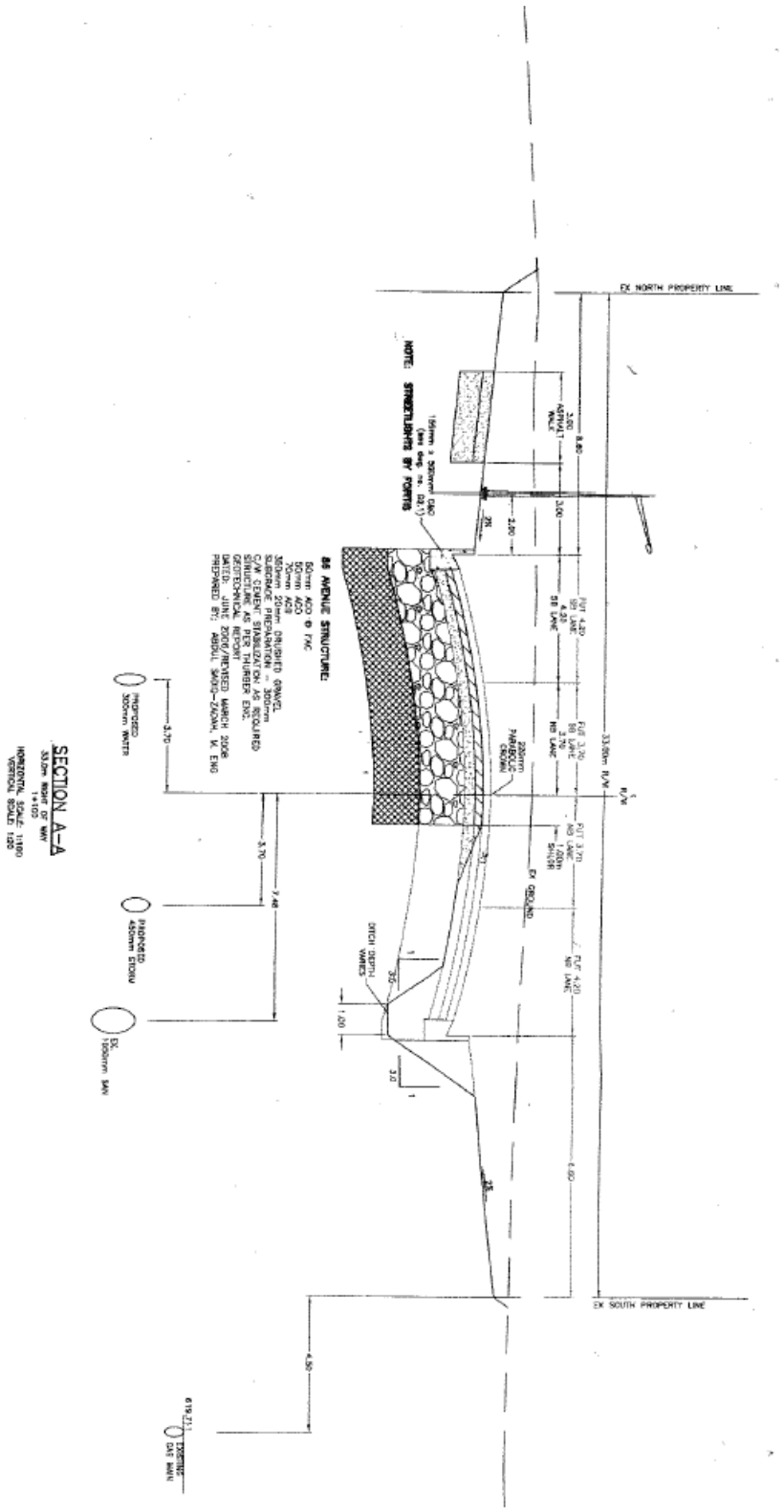


Figure 24: Fort Saskatchewan – 86 Ave. Extension Cross-Section

Appendix E: Score Cards

South Terwillegar Scores

Table 4: South Terwillegar Scores 1/2

Green Guide for Roads Checklist Project Name: South Terwillegar Edmonton, AL

Credits	Points Possible	Points Scored	Potential Score
Mobility for All			
MFA Prerequisite 1: Comprehensive Transportation Plan	Required	X	X
MFA Prerequisite 2: Choice of Transportation Modes	Required	X	X
MFA Credit 1: Parking Management	2	2	2
MFA Credit 2: Transit Facilities	3	1	2
MFA Credit 3: Bicycle Lanes/Paths/Parking	1 to 4	2	3
MFA Credit 4: Bicycle Facility Design	3	2	3
MFA Credit 5: Pedestrian Paths/Sidewalks	1 to 4	4	4
MFA Credit 6: Pedestrian Facility Design	1 to 5	2	4
MFA Credit 7: Separation of Modes	1	1	1
MFA Credit 8: Conflict Points	1	1	1
Totals	23	15	20
Transportation Planning			
TP Prerequisite 1: Level of Service	Required	X	X
TP Prerequisite 2: Safety Audit	Required	?	?
TP Prerequisite 3: Person-Time and Fuel Usage Savings	Required		
TP Prerequisite 4: Traffic Maintenance Plan	Required	X	X
TP Credit 1: Optimum Level of Service	4	0	4
TP Credit 2: Responsive Traffic Signals	1 to 4	0	0
TP Credit 3: Design Speed & Consistency	3	3	3
TP Credit 4: Intelligent Transportation Systems	2	0	0
Totals	13	3	7
Energy and Atmosphere			
EA Credit 1: Infrastructure Energy Efficiency	2	0	2
EA Credit 2: Fossil Fuel Reduction	1 to 2	0	1
EA Credit 3: Equipment Emission Reduction	1 to 2	0	1
EA Credit 4: Paving Emission Reduction	1 to 2	0	1
EA Credit 5: Paving Energy Reduction	1 to 3	0	1
EA Credit 6: Volatile Organic Compounds	2	0	2
EA Credit 7: Local Materials	1 to 2	2	2
Totals	15	2	10

Materials and Resources			
MR Prerequisite 1: Lifecycle Costing	Required		
MR Credit 1: Construction Site Footprint	2	2	2
MR Credit 2: Construction Waste Management	3	2	3
MR Credit 3: Recycled Content	1 to 8	1	5
MR Credit 4: Long Life Pavements	4	0	2
Totals	17	5	12
Environmental Impacts			
EI Prerequisite 1: Construction Activity Pollution Prevention	Required	X	X
EI Credit 1: Stormwater Management Life-Cycle Costing	2	0	2
EI Credit 2: Stormwater Management	1 to 4	0	0
EI Credit 3: LID Stormwater Management	1 to 4	0	2
EI Credit 4: Water Efficient Landscaping	1 to 2	2	2
EI Credit 5: Reflective Pavement	3	0	0
Totals	15	2	6
Community Impacts			
CI Prerequisite 1: Community Outreach and Involvement	Required	?	?
CI Prerequisite 2: Noise Mitigation Plan	Required	X	X
CI Credit 1: Traffic Noise Reduction	3	0	2
CI Credit 2: Light Pollution Reduction	3	0	3
CI Credit 3: Visual Elements	3	0	1
Totals	9	0	6
Innovation and Design Process			
ID Credit 1: Innovation & Design Process	1 to 3	0	0
ID Credit 2: Exemplary Performance	1 to 5	0	0
Totals	8	0	0
	100		
	Score	27	61

Table 5: South Terwillegar Scores 2/2

Secord, Stage 2 Scores

Table 6: Secord, Stage 2 Scores 1/2

Green Guide for Roads Checklist Project Name: Secord, Stage 2 Edmonton, AL

Credits	Points Possible	Points Scored	Potential Score
Mobility for All			
MFA Prerequisite 1: Comprehensive Transportation Plan	Required	X	X
MFA Prerequisite 2: Choice of Transportation Modes	Required	X	X
MFA Credit 1: Parking Management	2	2	2
MFA Credit 2: Transit Facilities	3	2	3
MFA Credit 3: Bicycle Lanes/Paths/Parking	1 to 4	2	3
MFA Credit 4: Bicycle Facility Design	3	2	3
MFA Credit 5: Pedestrian Paths/Sidewalks	1 to 4	4	4
MFA Credit 6: Pedestrian Facility Design	1 to 5	3	5
MFA Credit 7: Separation of Modes	1	1	1
MFA Credit 8: Conflict Points	1	1	1
Totals	23	17	22
Transportation Planning			
TP Prerequisite 1: Level of Service	Required	X	X
TP Prerequisite 2: Safety Audit	Required	?	X
TP Prerequisite 3: Person-Time and Fuel Usage Savings	Required		
TP Prerequisite 4: Traffic Maintenance Plan	Required	X	X
TP Credit 1: Optimum Level of Service	4	0	4
TP Credit 2: Responsive Traffic Signals	1 to 4	0	3
TP Credit 3: Design Speed & Consistency	3	3	3
TP Credit 4: Intelligent Transportation Systems	2	0	0
Totals	13	3	10
Energy and Atmosphere			
EA Credit 1: Infrastructure Energy Efficiency	2	0	2
EA Credit 2: Fossil Fuel Reduction	1 to 2	0	1
EA Credit 3: Equipment Emission Reduction	1 to 2	0	1
EA Credit 4: Paving Emission Reduction	1 to 2	0	1
EA Credit 5: Paving Energy Reduction	1 to 3	0	1
EA Credit 6: Volatile Organic Compounds	2	0	2
EA Credit 7: Local Materials	1 to 2	2	2
Totals	15	2	10

Table 7: Secord, Stage 2 Scores 2/2

Materials and Resources			
MR Prerequisite 1: Lifecycle Costing	Required		
MR Credit 1: Construction Site Footprint	2	2	2
MR Credit 2: Construction Waste Management	3	2	3
MR Credit 3: Recycled Content	1 to 8	1	5
MR Credit 4: Long Life Pavements	4	0	2
Totals	17	5	12
Environmental Impacts			
EI Prerequisite 1: Construction Activity Pollution Prevention	Required	X	X
EI Credit 1: Stormwater Management Life-Cycle Costing	2	0	2
EI Credit 2: Stormwater Management	1 to 4	0	2
EI Credit 3: LID Stormwater Management	1 to 4	0	2
EI Credit 4: Water Efficient Landscaping	1 to 2	2	2
EI Credit 5: Reflective Pavement	3	0	0
Totals	15	2	8
Community Impacts			
CI Prerequisite 1: Community Outreach and Involvement	Required	?	X
CI Prerequisite 2: Noise Mitigation Plan	Required	X	X
CI Credit 1: Traffic Noise Reduction	3	0	2
CI Credit 2: Light Pollution Reduction	3	0	3
CI Credit 3: Visual Elements	3	0	1
Totals	9	0	6
Innovation and Design Process			
ID Credit 1: Innovation & Design Process	1 to 3	0	0
ID Credit 2: Exemplary Performance	1 to 5	0	1
Totals	8	0	1
	100		
	Score	29	69

Green Guide for Roads Checklist Project Name: The Hamptons Stage 13 Edmonton, AL

Table 8: The Hamptons Stage 13 Scores 1/2

Credits	Points Possible	Points Scored	Potential Score
Mobility for All			
MFA Prerequisite 1: Comprehensive Transportation Plan	Required	X	X
MFA Prerequisite 2: Choice of Transportation Modes	Required	X	X
MFA Credit 1: Parking Management	2	2	2
MFA Credit 2: Transit Facilities	3	1	2
MFA Credit 3: Bicycle Lanes/Paths/Parking	1 to 4	3	4
MFA Credit 4: Bicycle Facility Design	3	2	3
MFA Credit 5: Pedestrian Paths/Sidewalks	1 to 4	4	4
MFA Credit 6: Pedestrian Facility Design	1 to 5	3	5
MFA Credit 7: Separation of Modes	1	1	1
MFA Credit 8: Conflict Points	1	1	1
Totals	23	17	22
Transportation Planning			
TP Prerequisite 1: Level of Service	Required	X	X
TP Prerequisite 2: Safety Audit	Required	?	X
TP Prerequisite 3: Person-Time and Fuel Usage Savings	Required		
TP Prerequisite 4: Traffic Maintenance Plan	Required	X	X
TP Credit 1: Optimum Level of Service	4	0	4
TP Credit 2: Responsive Traffic Signals	1 to 4		2
TP Credit 3: Design Speed & Consistency	3	0	3
TP Credit 4: Intelligent Transportation Systems	2	3	0
Totals	13	3	9
Energy and Atmosphere			
EA Credit 1: Infrastructure Energy Efficiency	2	0	2
EA Credit 2: Fossil Fuel Reduction	1 to 2	0	1
EA Credit 3: Equipment Emission Reduction	1 to 2	0	1
EA Credit 4: Paving Emission Reduction	1 to 2	0	1
EA Credit 5: Paving Energy Reduction	1 to 3	0	1
EA Credit 6: Volatile Organic Compounds	2	0	2
EA Credit 7: Local Materials	1 to 2	2	2
Totals	15	2	10

Table 9: The Hamptons Stage 13 Scores 2/2

Materials and Resources			
MR Prerequisite 1: Lifecycle Costing	Required		
MR Credit 1: Construction Site Footprint	2	2	2
MR Credit 2: Construction Waste Management	3	2	3
MR Credit 3: Recycled Content	1 to 8	1	5
MR Credit 4: Long Life Pavements	4	0	2
Totals	17	5	12
Environmental Impacts			
EI Prerequisite 1: Construction Activity Pollution Prevention	Required	X	X
EI Credit 1: Stormwater Management Life-Cycle Costing	2	0	2
EI Credit 2: Stormwater Management	1 to 4	0	2
EI Credit 3: LID Stormwater Management	1 to 4	0	2
EI Credit 4: Water Efficient Landscaping	1 to 2	2	2
EI Credit 5: Reflective Pavement	3	0	0
Totals	15	2	8
Community Impacts			
CI Prerequisite 1: Community Outreach and Involvement	Required	?	X
CI Prerequisite 2: Noise Mitigation Plan	Required	X	X
CI Credit 1: Traffic Noise Reduction	3	0	2
CI Credit 2: Light Pollution Reduction	3	0	3
CI Credit 3: Visual Elements	3	0	1
Totals	9	0	6
Innovation and Design Process			
ID Credit 1: Innovation & Design Process	1 to 3	0	0
ID Credit 2: Exemplary Performance	1 to 5	0	1
Totals	8	0	1
	100		
	Score	29	68

Ellerslie Road Gateway Blvd East of 91st St. Scores

Table 10: Ellerslie Road Gateway Blvd East of 91st St. Scores 1/2

Green Guide for Roads Checklist Project Name: Ellerslie Rd.-Gateway Blvd. E of 91st St. Edmonton, AL

Credits	Points Possible	Points Scored	Potential Score
Mobility for All			
MFA Prerequisite 1: Comprehensive Transportation Plan	Required	X	X
MFA Prerequisite 2: Choice of Transportation Modes	Required	X	X
MFA Credit 1: Parking Management	2	1	2
MFA Credit 2: Transit Facilities	3	3	3
MFA Credit 3: Bicycle Lanes/Paths/Parking	1 to 4	3	4
MFA Credit 4: Bicycle Facility Design	3	2	3
MFA Credit 5: Pedestrian Paths/Sidewalks	1 to 4	4	4
MFA Credit 6: Pedestrian Facility Design	1 to 5	4	4
MFA Credit 7: Separation of Modes	1	1	1
MFA Credit 8: Conflict Points	1	1	1
Totals	23	19	22
Transportation Planning			
TP Prerequisite 1: Level of Service	Required	X	X
TP Prerequisite 2: Safety Audit	Required	?	?
TP Prerequisite 3: Person-Time and Fuel Usage Savings	Required		
TP Prerequisite 4: Traffic Maintenance Plan	Required	X	X
TP Credit 1: Optimum Level of Service	4	0	4
TP Credit 2: Responsive Traffic Signals	1 to 4	2	4
TP Credit 3: Design Speed & Consistency	3	3	3
TP Credit 4: Intelligent Transportation Systems	2	0	0
Totals	13	5	11
Energy and Atmosphere			
EA Credit 1: Infrastructure Energy Efficiency	2	0	0
EA Credit 2: Fossil Fuel Reduction	1 to 2	0	1
EA Credit 3: Equipment Emission Reduction	1 to 2	0	1
EA Credit 4: Paving Emission Reduction	1 to 2	0	1
EA Credit 5: Paving Energy Reduction	1 to 3	0	1
EA Credit 6: Volatile Organic Compounds	2	0	2
EA Credit 7: Local Materials	1 to 2	2	2
Totals	15	2	8

Table 11: Ellerslie Road Gateway Blvd East of 91st St. Scores 2/2

Materials and Resources			
MR Prerequisite 1: Lifecycle Costing	Required		
MR Credit 1: Construction Site Footprint	2	2	2
MR Credit 2: Construction Waste Management	3	2	3
MR Credit 3: Recycled Content	1 to 8	1	5
MR Credit 4: Long Life Pavements	4	0	2
Totals	17	5	12
Environmental Impacts			
EI Prerequisite 1: Construction Activity Pollution Prevention	Required	X	X
EI Credit 1: Stormwater Management Life-Cycle Costing	2	0	2
EI Credit 2: Stormwater Management	1 to 4	0	0
EI Credit 3: LID Stormwater Management	1 to 4	0	0
EI Credit 4: Water Efficient Landscaping	1 to 2	2	2
EI Credit 5: Reflective Pavement	3	0	0
Totals	15	2	4
Community Impacts			
CI Prerequisite 1: Community Outreach and Involvement	Required	?	?
CI Prerequisite 2: Noise Mitigation Plan	Required	X	X
CI Credit 1: Traffic Noise Reduction	3	0	2
CI Credit 2: Light Pollution Reduction	3	0	3
CI Credit 3: Visual Elements	3	0	0
Totals	9	0	5
Innovation and Design Process			
ID Credit 1: Innovation & Design Process	1 to 3	0	0
ID Credit 2: Exemplary Performance	1 to 5	1	2
Totals	8	1	2
	100		
	Score	34	64

167 Avenue 129st to 127st Scores

Table 12: 167 Avenue 129st to 127st Scores 1/2

Green Guide for Roads Checklist

Project Name: 167 Ave- 129 St. to 127 St. Edmonton, AL

Credits	Points Possible	Points Scored	Potential Score
Mobility for All			
MFA Prerequisite 1: Comprehensive Transportation Plan	Required	X	X
MFA Prerequisite 2: Choice of Transportation Modes	Required	X	X
MFA Credit 1: Parking Management	2	1	2
MFA Credit 2: Transit Facilities	3	1	2
MFA Credit 3: Bicycle Lanes/Paths/Parking	1 to 4	3	4
MFA Credit 4: Bicycle Facility Design	3	2	3
MFA Credit 5: Pedestrian Paths/Sidewalks	1 to 4	4	4
MFA Credit 6: Pedestrian Facility Design	1 to 5	3	4
MFA Credit 7: Separation of Modes	1	1	1
MFA Credit 8: Conflict Points	1	1	1
Totals	23	16	21
Transportation Planning			
TP Prerequisite 1: Level of Service	Required	X	X
TP Prerequisite 2: Safety Audit	Required	?	X
TP Prerequisite 3: Person-Time and Fuel Usage Savings	Required		
TP Prerequisite 4: Traffic Maintenance Plan	Required	X	X
TP Credit 1: Optimum Level of Service	4	0	4
TP Credit 2: Responsive Traffic Signals	1 to 4	2	4
TP Credit 3: Design Speed & Consistency	3	3	3
TP Credit 4: Intelligent Transportation Systems	2	0	0
Totals	13	5	11
Energy and Atmosphere			
EA Credit 1: Infrastructure Energy Efficiency	2	0	0
EA Credit 2: Fossil Fuel Reduction	1 to 2	0	1
EA Credit 3: Equipment Emission Reduction	1 to 2	0	1
EA Credit 4: Paving Emission Reduction	1 to 2	0	1
EA Credit 5: Paving Energy Reduction	1 to 3	0	1
EA Credit 6: Volatile Organic Compounds	2	0	2
EA Credit 7: Local Materials	1 to 2	2	2
Totals	15	2	8

Table 13: 167 Avenue 129st to 127st Scores 2/2

Materials and Resources			
MR Prerequisite 1: Lifecycle Costing	Required		
MR Credit 1: Construction Site Footprint	2	2	2
MR Credit 2: Construction Waste Management	3	2	3
MR Credit 3: Recycled Content	1 to 8	1	5
MR Credit 4: Long Life Pavements	4	0	2
Totals	17	5	12
Environmental Impacts			
EI Prerequisite 1: Construction Activity Pollution Prevention	Required	X	X
EI Credit 1: Stormwater Management Life-Cycle Costing	2	0	2
EI Credit 2: Stormwater Management	1 to 4	0	0
EI Credit 3: LID Stormwater Management	1 to 4	0	0
EI Credit 4: Water Efficient Landscaping	1 to 2	2	2
EI Credit 5: Reflective Pavement	3	0	0
Totals	15	2	4
Community Impacts			
CI Prerequisite 1: Community Outreach and Involvement	Required	?	X
CI Prerequisite 2: Noise Mitigation Plan	Required	X	X
CI Credit 1: Traffic Noise Reduction	3	0	2
CI Credit 2: Light Pollution Reduction	3	0	3
CI Credit 3: Visual Elements	3	0	0
Totals	9	0	5
Innovation and Design Process			
ID Credit 1: Innovation & Design Process	1 to 3	0	0
ID Credit 2: Exemplary Performance	1 to 5	0	1
Totals	8	0	1
	100		
	Score	30	62

Green Guide for Roads Checklist

Project Name: Fort Saskatchewan-86 Ave. Extension

Credits	Points Possible	Points Scored	Potential Score
Mobility for All			
MFA Prerequisite 1: Comprehensive Transportation Plan	Required	X	X
MFA Prerequisite 2: Choice of Transportation Modes	Required	X	X
MFA Credit 1: Parking Management	2	1	2
MFA Credit 2: Transit Facilities	3	0	1
MFA Credit 3: Bicycle Lanes/Paths/Parking	1 to 4	3	4
MFA Credit 4: Bicycle Facility Design	3	2	3
MFA Credit 5: Pedestrian Paths/Sidewalks	1 to 4	2	4
MFA Credit 6: Pedestrian Facility Design	1 to 5	2	4
MFA Credit 7: Separation of Modes	1	1	1
MFA Credit 8: Conflict Points	1	1	1
Totals	23	12	20
Transportation Planning			
TP Prerequisite 1: Level of Service	Required	X	X
TP Prerequisite 2: Safety Audit	Required	?	?
TP Prerequisite 3: Person-Time and Fuel Usage Savings	Required		
TP Prerequisite 4: Traffic Maintenance Plan	Required	X	X
TP Credit 1: Optimum Level of Service	4	0	4
TP Credit 2: Responsive Traffic Signals	1 to 4	2	4
TP Credit 3: Design Speed & Consistency	3	3	3
TP Credit 4: Intelligent Transportation Systems	2	0	0
Totals	13	5	11
Energy and Atmosphere			
EA Credit 1: Infrastructure Energy Efficiency	2	0	0
EA Credit 2: Fossil Fuel Reduction	1 to 2	0	1
EA Credit 3: Equipment Emission Reduction	1 to 2	0	1
EA Credit 4: Paving Emission Reduction	1 to 2	0	1
EA Credit 5: Paving Energy Reduction	1 to 3	0	1
EA Credit 6: Volatile Organic Compounds	2	0	2
EA Credit 7: Local Materials	1 to 2	2	2
Totals	15	2	8

Table 14: Fort Saskatchewan - 86 Ave Extension Scores 1/2

Materials and Resources			
MR Prerequisite 1: Lifecycle Costing	Required		
MR Credit 1: Construction Site Footprint	2	2	2
MR Credit 2: Construction Waste Management	3	2	3
MR Credit 3: Recycled Content	1 to 8	1	5
MR Credit 4: Long Life Pavements	4	0	2
Totals	17	5	12
Environmental Impacts			
EI Prerequisite 1: Construction Activity Pollution Prevention	Required	X	X
EI Credit 1: Stormwater Management Life-Cycle Costing	2	0	2
EI Credit 2: Stormwater Management	1 to 4	0	0
EI Credit 3: LID Stormwater Management	1 to 4	0	0
EI Credit 4: Water Efficient Landscaping	1 to 2	2	2
EI Credit 5: Reflective Pavement	3	0	0
Totals	15	2	4
Community Impacts			
CI Prerequisite 1: Community Outreach and Involvement	Required	?	?
CI Prerequisite 2: Noise Mitigation Plan	Required	X	X
CI Credit 1: Traffic Noise Reduction	3	0	2
CI Credit 2: Light Pollution Reduction	3	0	3
CI Credit 3: Visual Elements	3	0	0
Totals	9	0	5
Innovation and Design Process			
ID Credit 1: Innovation & Design Process	1 to 3	0	0
ID Credit 2: Exemplary Performance	1 to 5	0	0
Totals	8	0	0
	100		
	Score	26	60

Table 15: Fort Saskatchewan - 86 Ave Extension Scores 2/2

Appendix F: GreenAlberta Website Flow Charts & Screen Shots

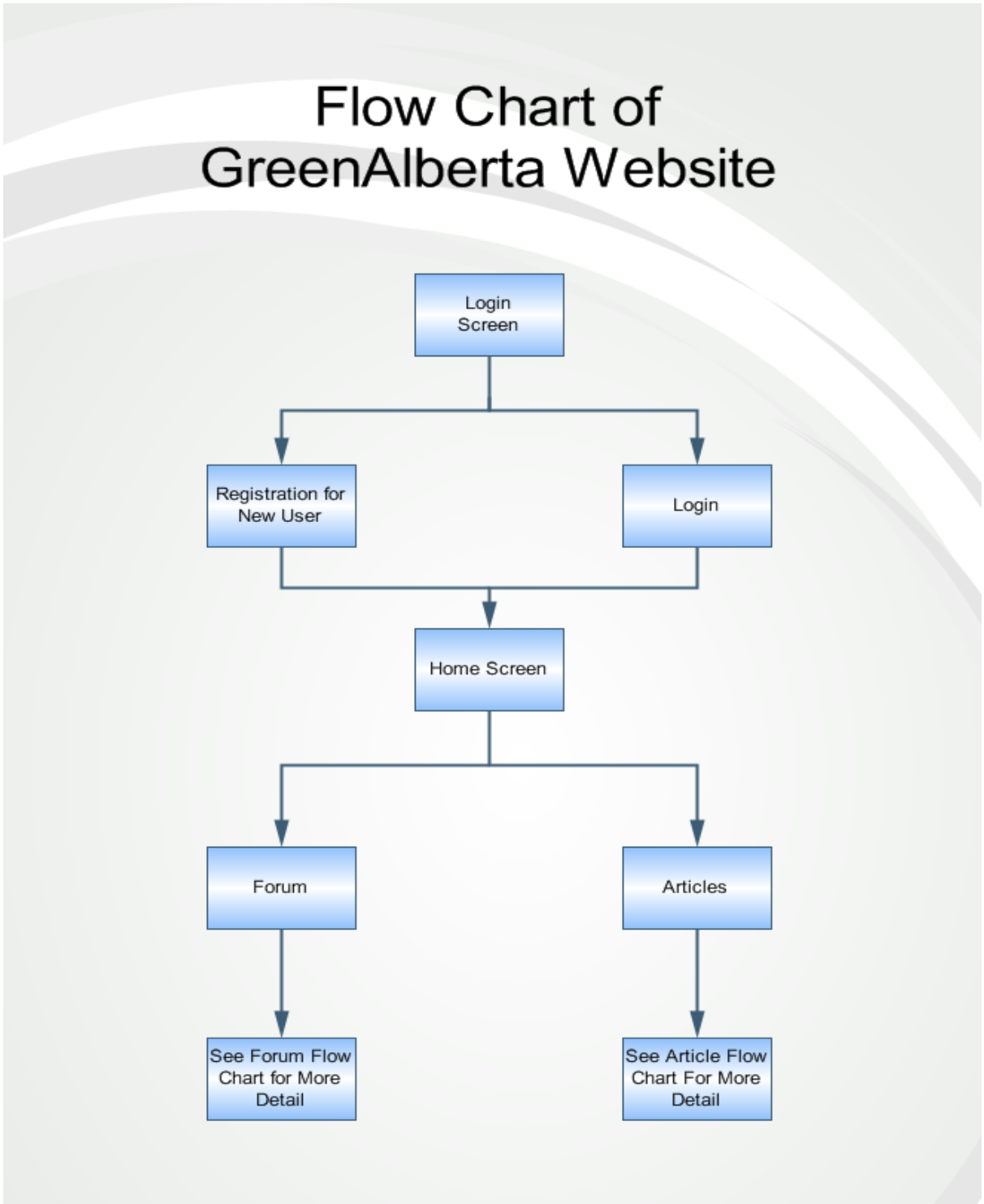


Figure 25: GreenAlberta Website Overview Flow chart

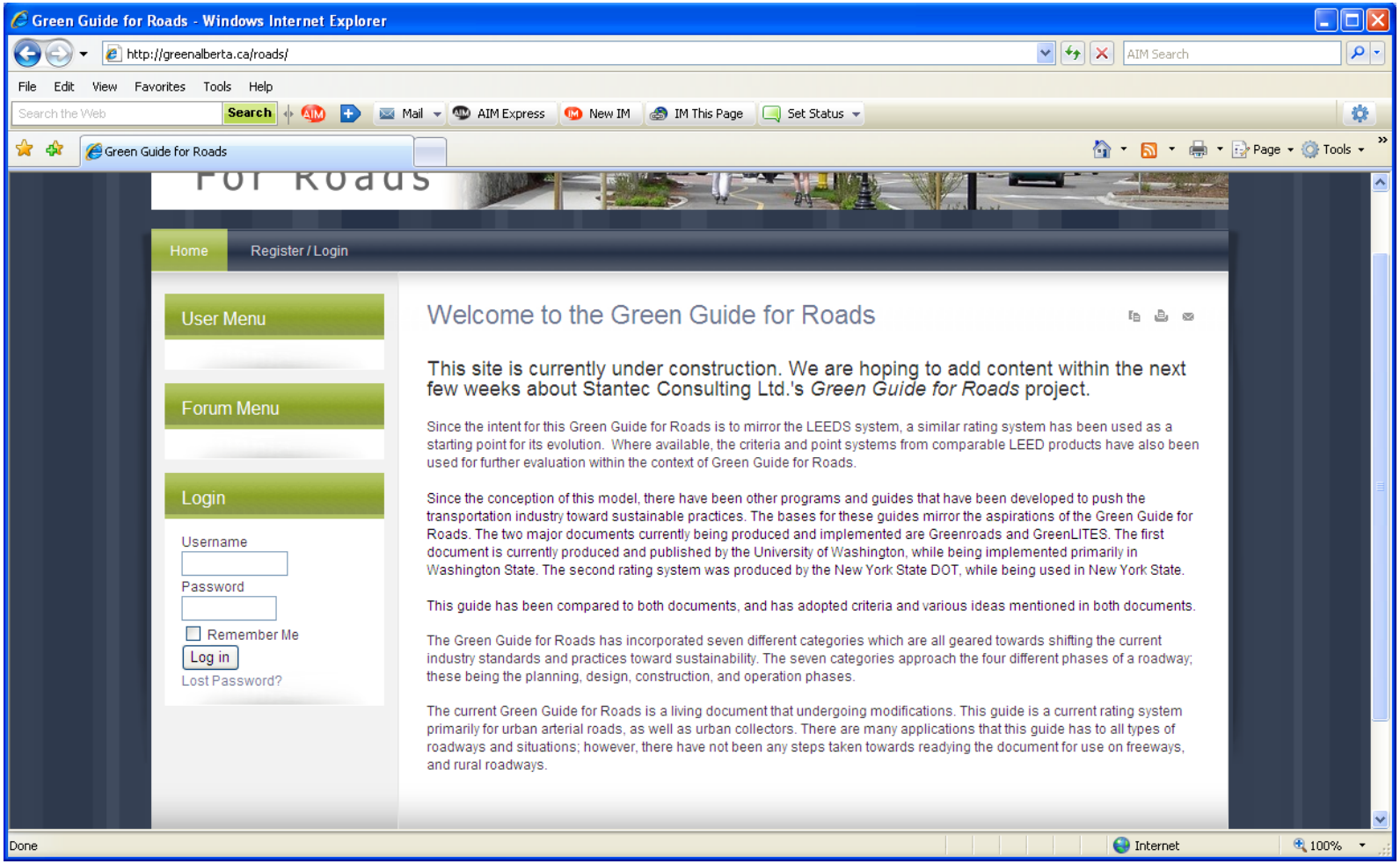


Figure 26: Login Screen Shot

Figure 27: Registration Screen Shot

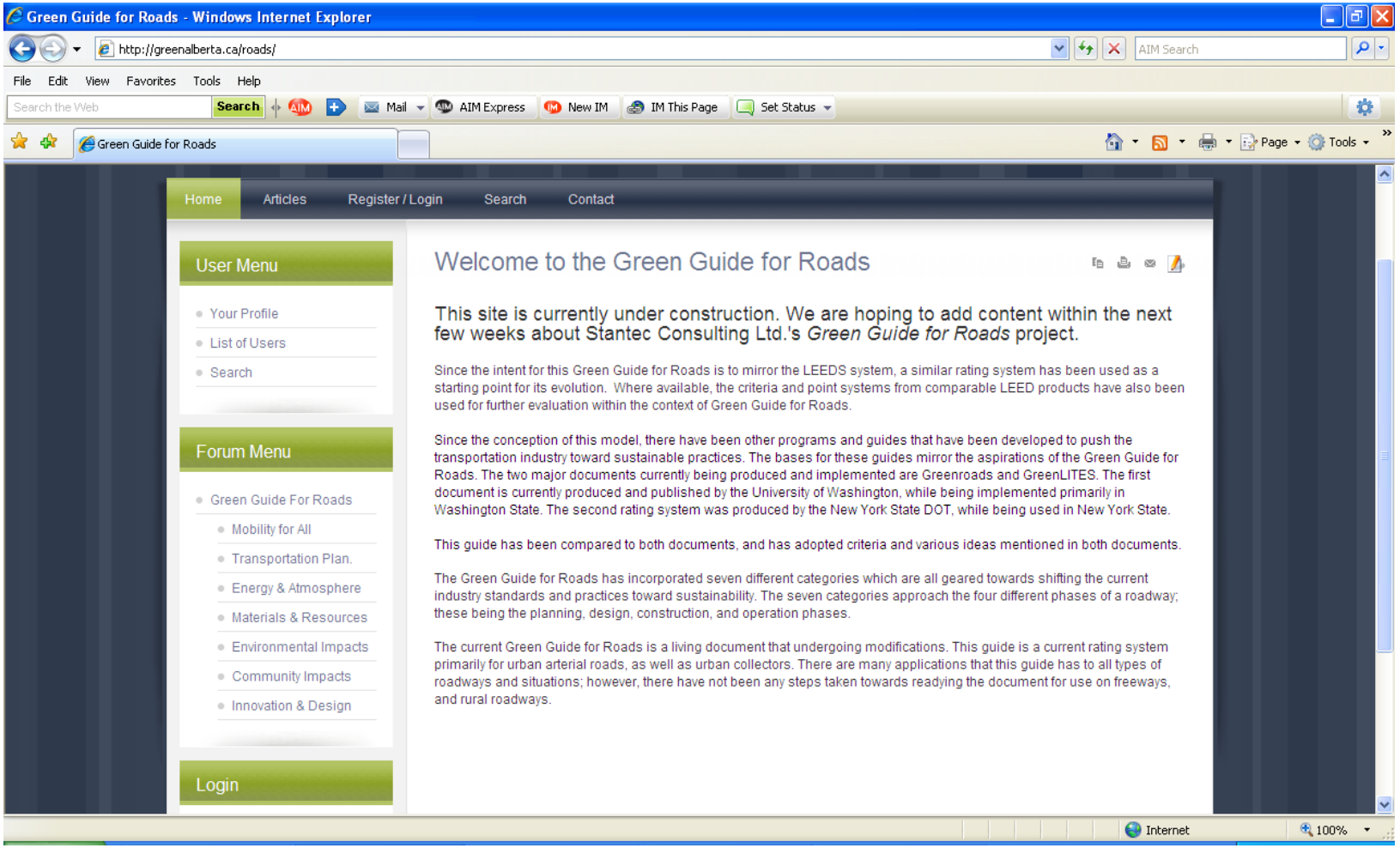


Figure 28: Home Page Screen Shot

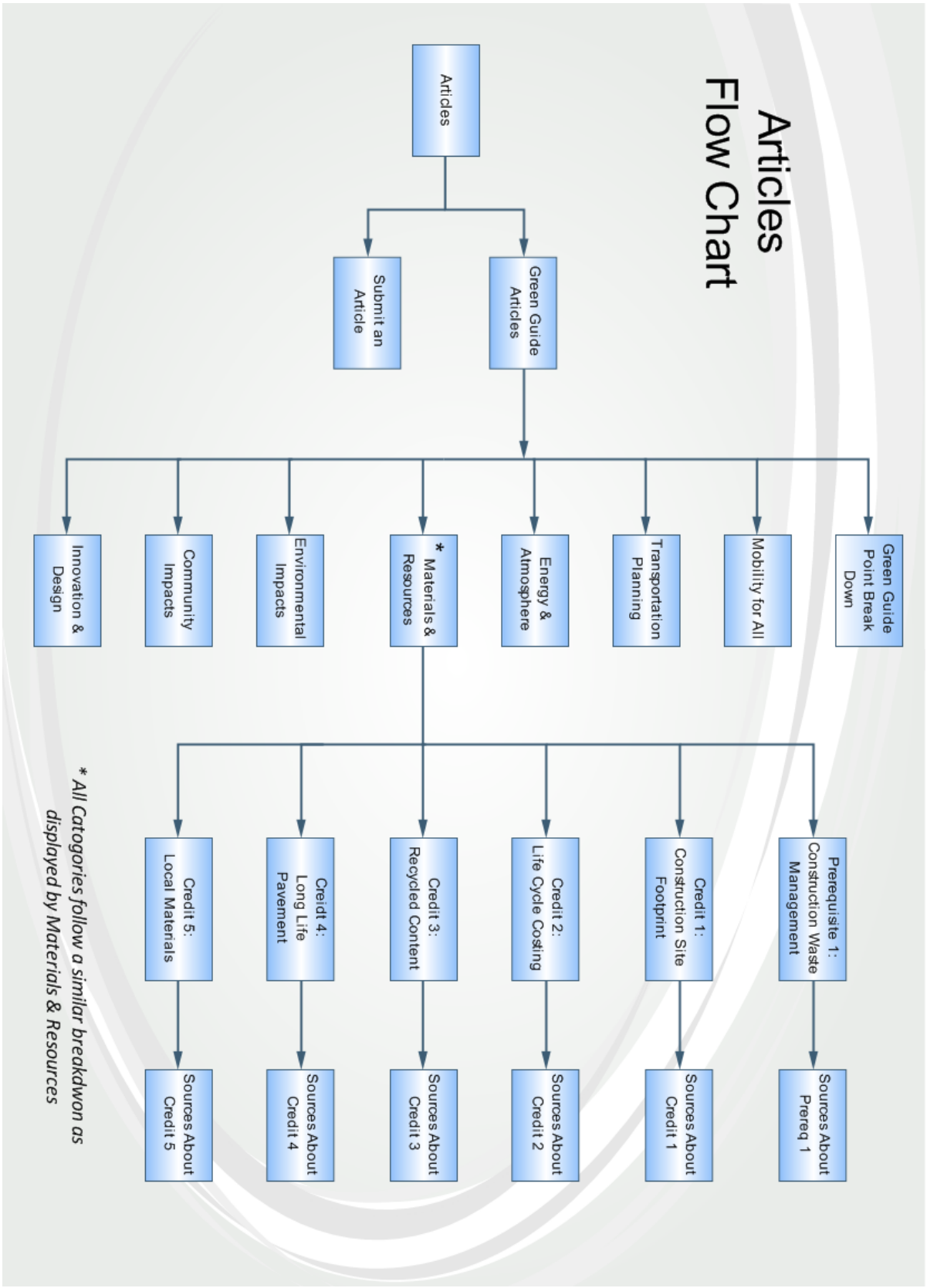


Figure 29: GreenAlberta Articles Flow Chart

Figure 30: Articles Drop Down Menu Screen Shot

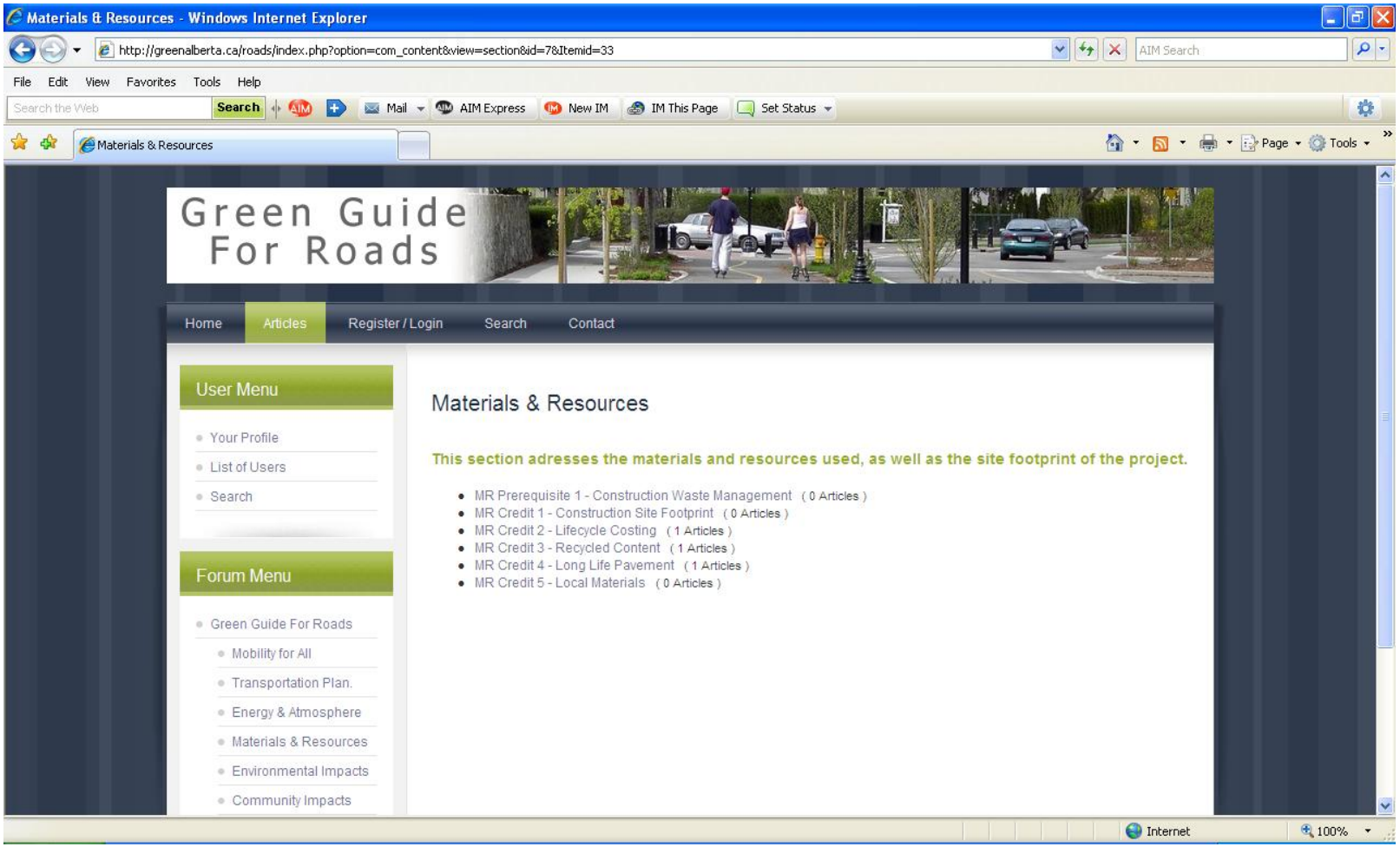


Figure 31: Materials & Resources Screen Shot

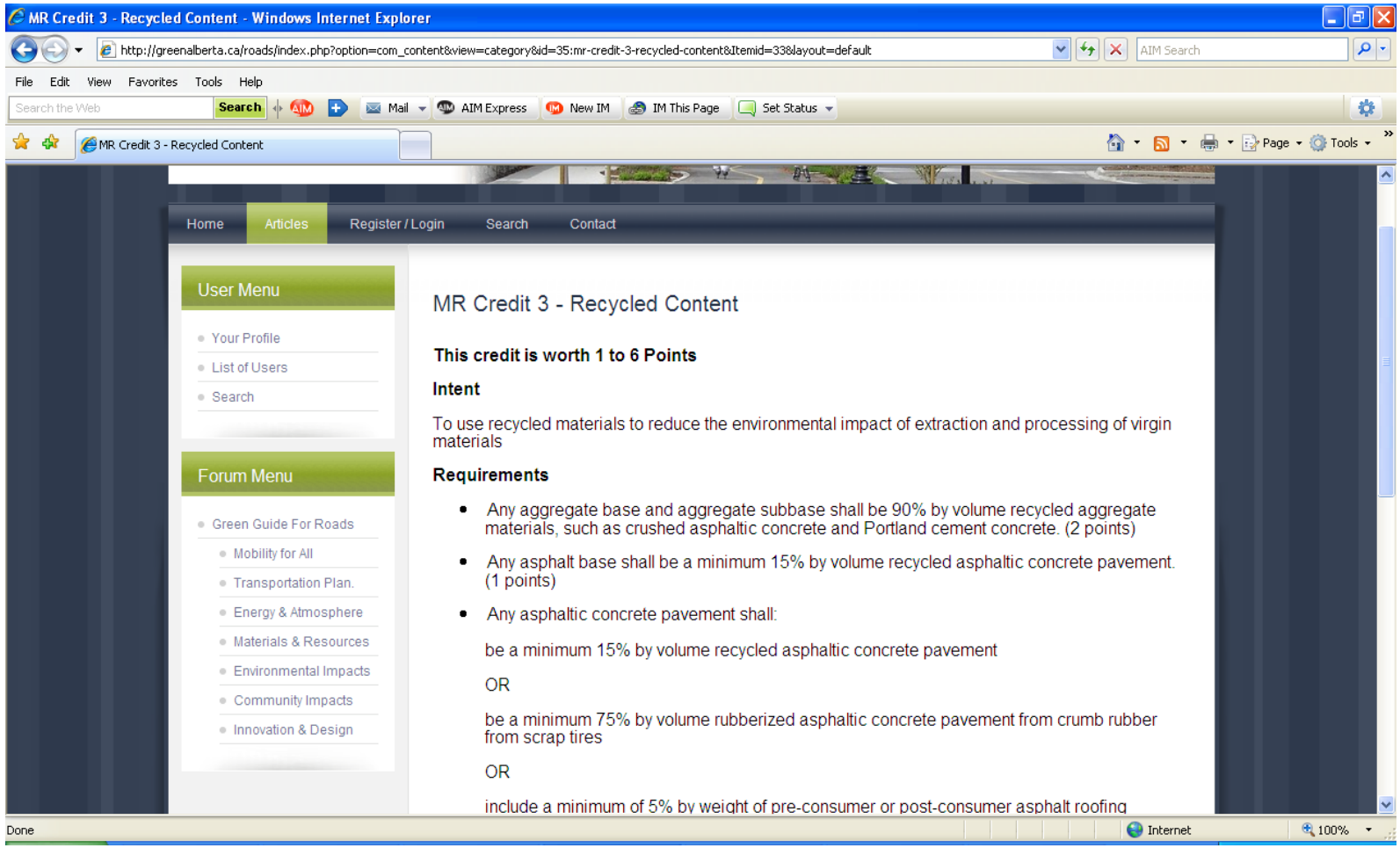


Figure 32: Materials & Resources Credit 3 Screen Shot

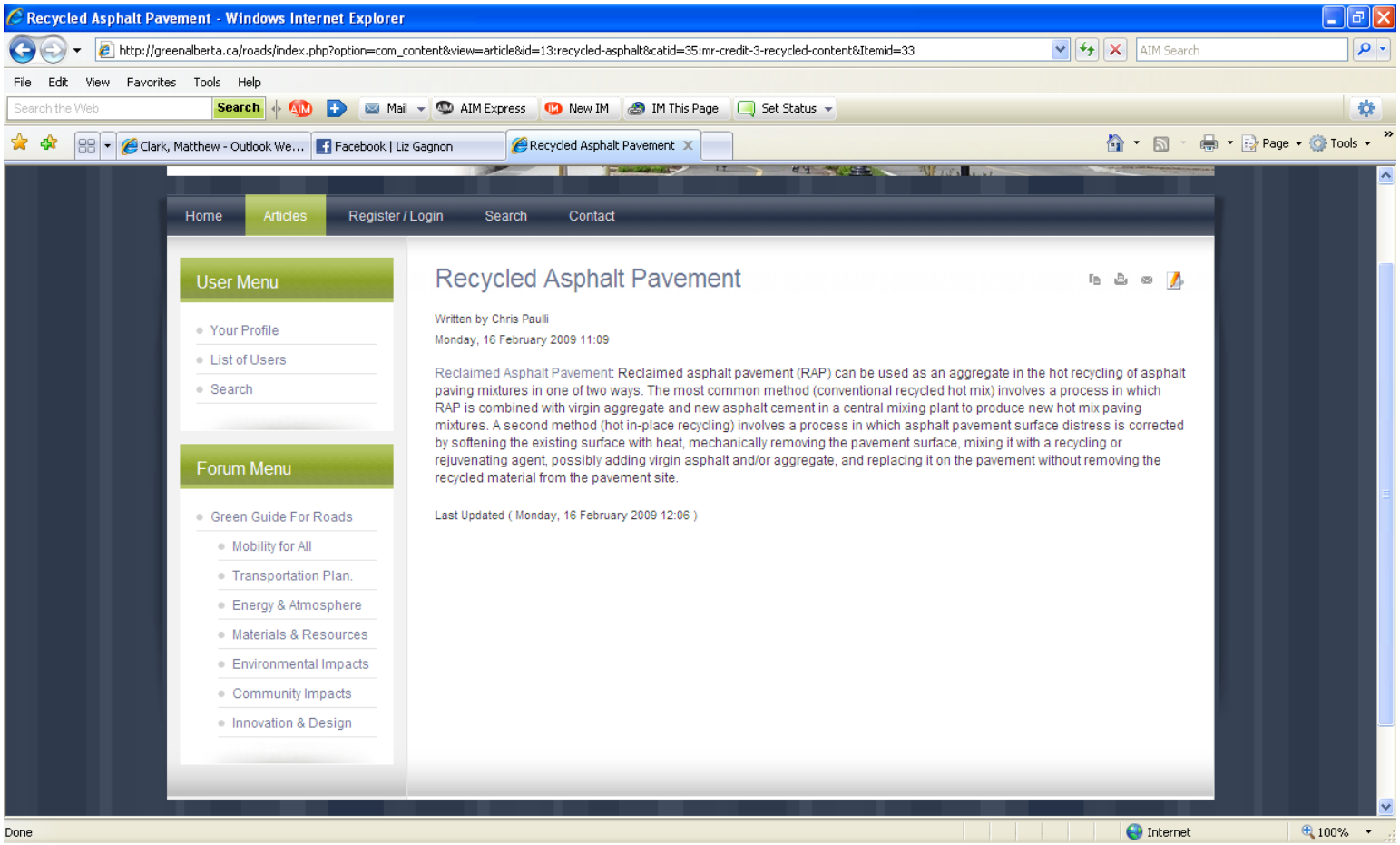


Figure 33: Materials & Resources Credit 3 Sources Screen Shot

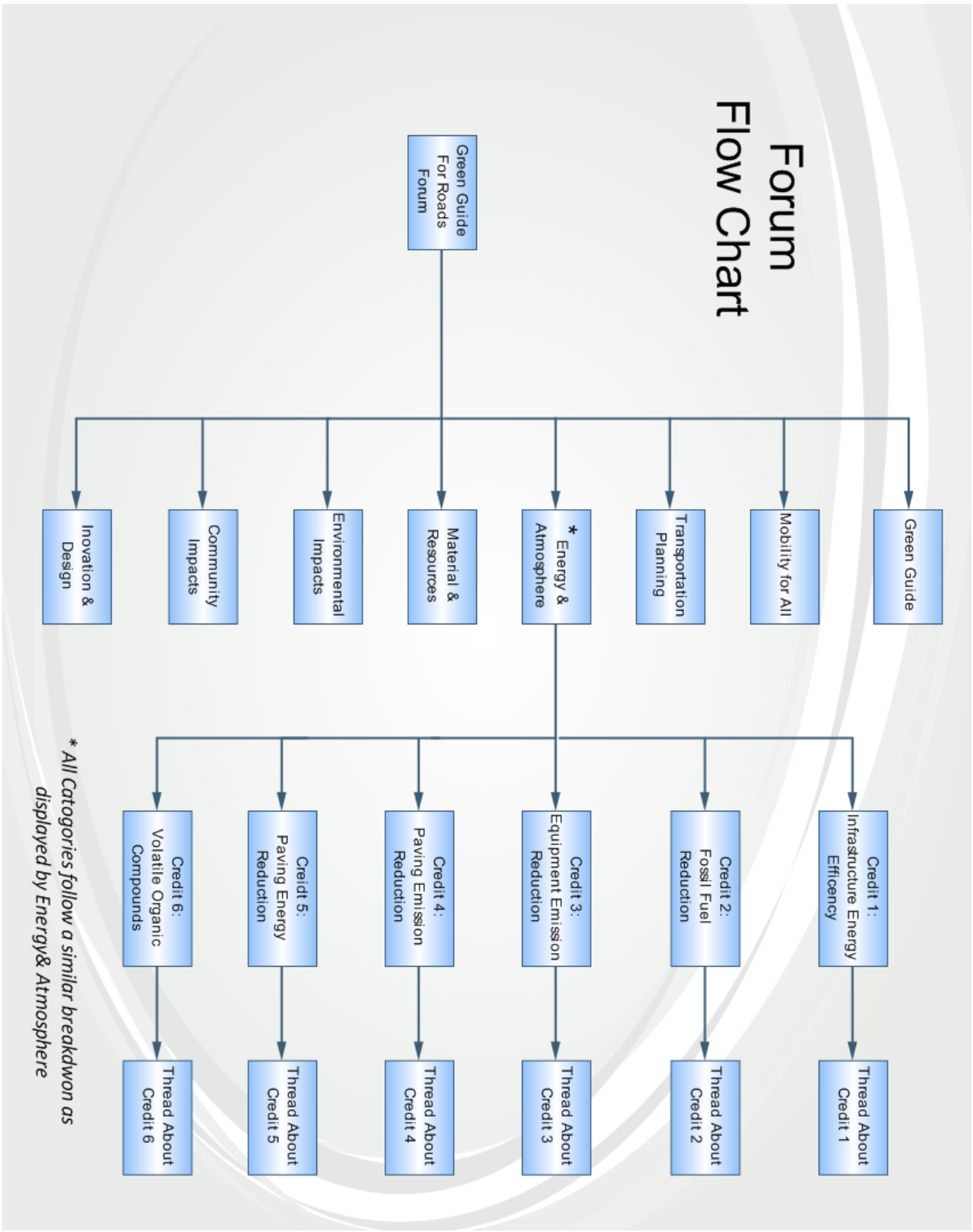


Figure 34: GreenAlberta Forum Flow Chart

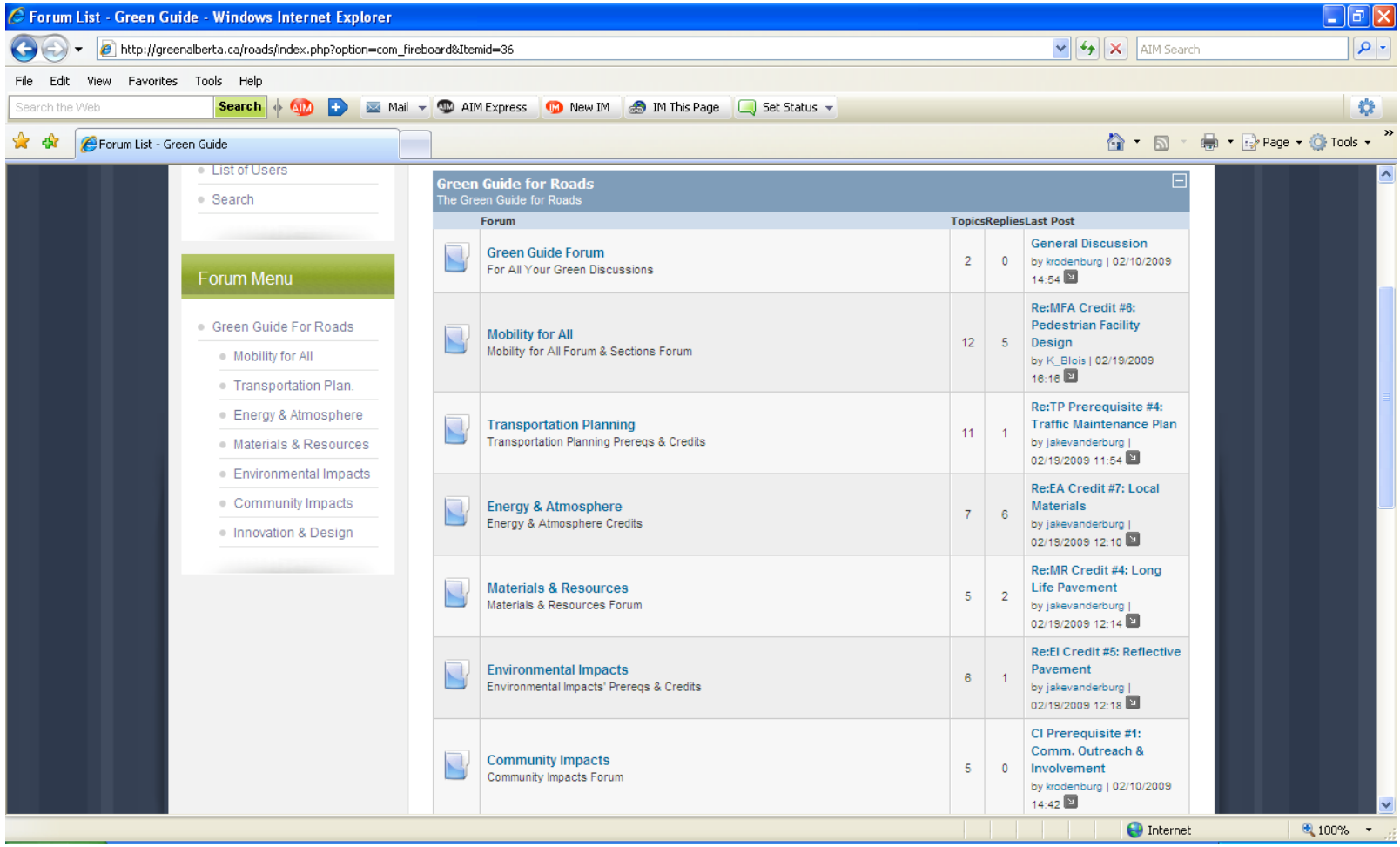


Figure 35: Forum Menu Screen Shot

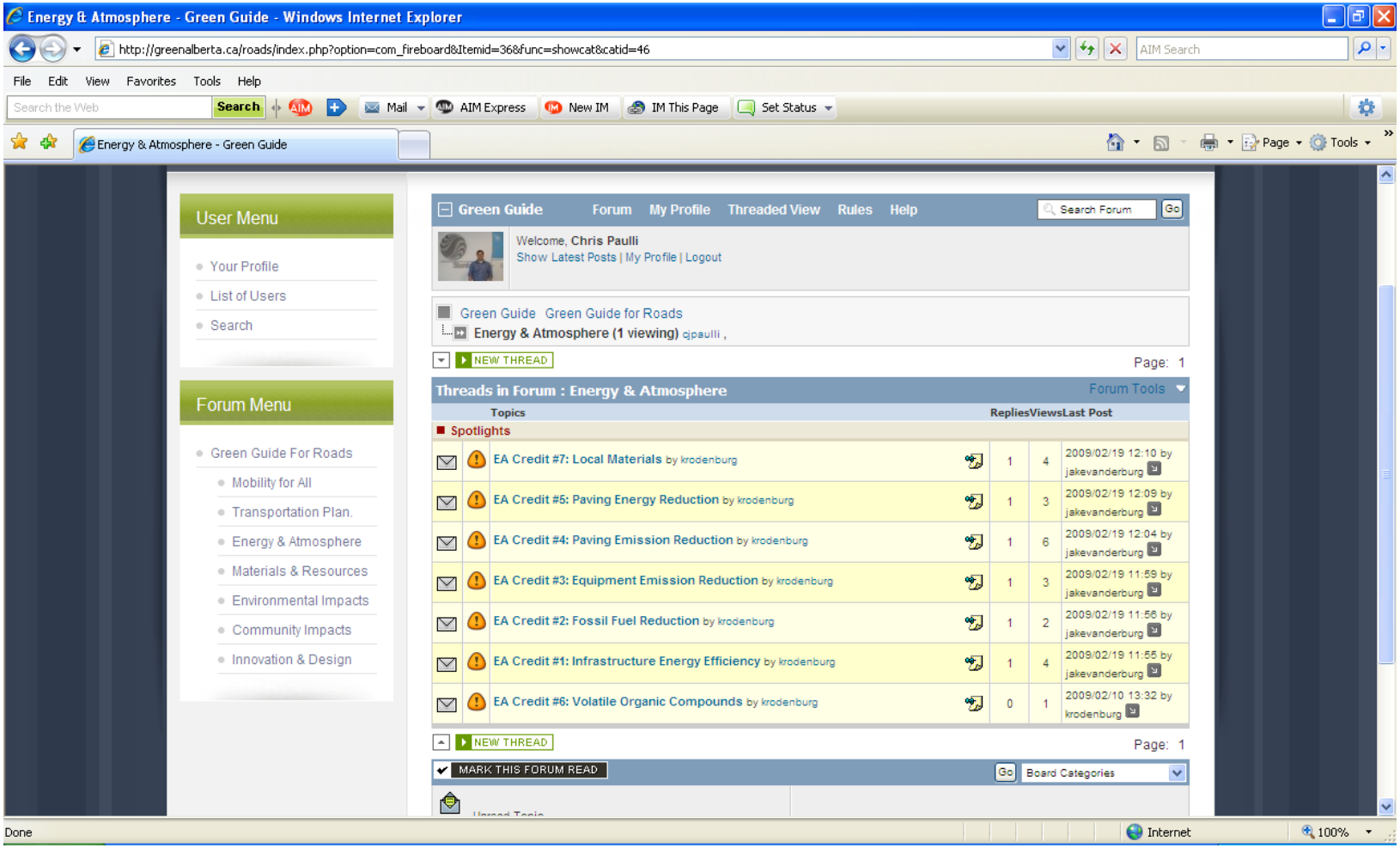


Figure 36: Energy & Atmosphere Screen Shot

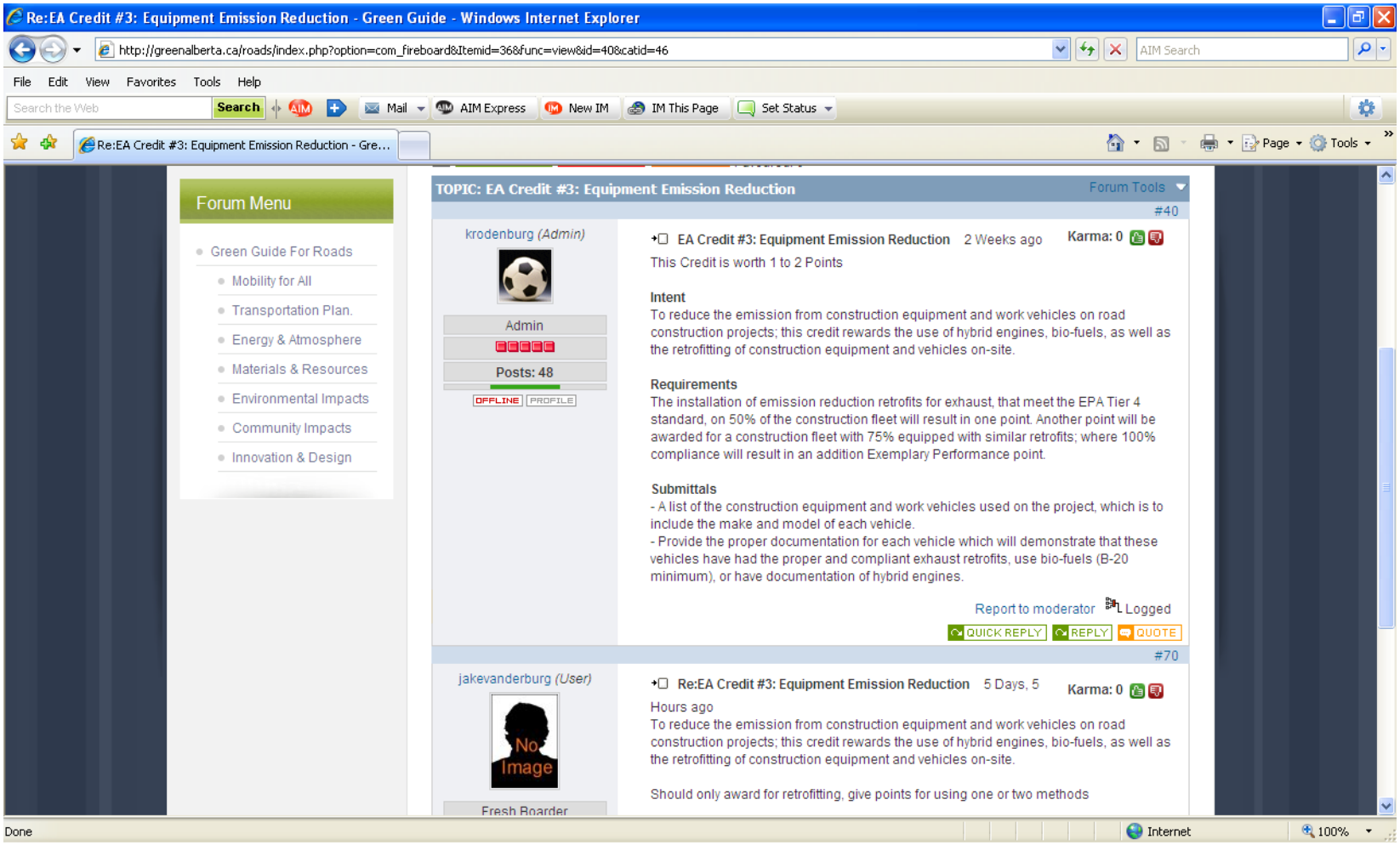


Figure 37: Energy & Atmosphere Credit 3 Thread Screen Shot

Appendix G: Timeline

The timeline displayed below represents the distribution of work over the course of the project. The time line is divided up into the seven weeks that were spent at the Stantec Sustainable Design site. The methods that were used to complete the project are listed in a row and shaded yellow to represent the time spent on it for completion.

Table 16: Timeline of Work

Timeline of Work

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Literature Review							
Comparison to Other Rating Systems							
Preliminary Draft Green Guide							
Credit Assessment							
Score Projects							
Meetings							
Revised Draft Green Guide							
Populate Website							
WPI MQP Report							
Presentations							

Appendix H: Capstone Design

15% Recycled Asphalt Mix (using the Asphalt Institute method)

The project is for designing a HMA base course for an industrial roadway (ACB type mix) in Edmonton. The reclaimed asphalt pavement has a binder content of 5.75% by weight of the total mix. The viscosity of the asphalt binder recovered from the reclaimed asphalt pavement (RAP) is 10,000 poises at 60^{o}C. The grade of asphalt binder normally used is AC 5, and the target viscosity at a temperature of 60^{o}C is 500 poise. Gradation of RAP and the new aggregate is:

Sieve Size, mm	Percent Passing	
	RAP Aggregate	New Aggregate
25	100	100
20	98	93
12.5	85	53
5.0	65	30
0.16	22	5
0.08	9	2

In the new design, 15 % RAP was selected, considering a batch plant, the moisture content of the RAP (close to 4%) and a practical range of RAP content.

Step 1: Combined aggregates in recycling mixture

Sieve Size, mm	Percent Passing			
	15% RAP Agg	85% New Agg	Combination Agg	Specification for aggregate gradation (for ACB type mix)
25	[100 × 0.15 = 15.0]	[100 X 0.85 = 85.0]	100.0	100
20	[98 × 0.15 =14.7]	[93 X 0.85 = 79.05]	93.75	80-95
12.5	[85 × 0.15 = 12.75]	[53 X 0.85 = 45.05]	57.8	
5.0	[65 × 0.15 = 9.75]	[30 X 0.85 = 25.5]	35.25	40-60
0.16	[22 × 0.15 = 3.3]	[5 X 0.85 = 4.25]	7.55	9-14
0.08	[9 × 0.15 = 1.35]	[2 X 0.85 = 1.7]	3.05	4-8

Note: The combination aggregate gradation does not fall within the specified gradation for an ACB type mix. This could be solved by using virgin aggregate with a different gradation but the difference is not big enough to rule out the use of RAP at this percentage.

Step 2 – Determine approximate asphalt demand of combined aggregates

P = 0.035a + 0.045b + Kc + F
where:
P = approximate total asphalt demand of recycled mix, percent by weight of mix
a = percent of mineral aggregate retained on 2.36 mm sieve, expressed as a whole number
b = percent of mineral aggregate passing the 2.36 mm sieve and retained on the 75 µm sieve, expressed as a whole number
c = percent of mineral aggregate passing the 75µm sieve
K = 0.15 for 11-15 percent passing 75 µm sieve, 0.18 for 6-10 percent passing 75µm sieve, and 0.20 for 5 percent or less passing 75 µm sieve
F = 0 to 2.0 percent. Based on absorption of light or heavy aggregate. In the absence of other data, a value of 0.7 is suggested

In this case:
a = 79 (determined from sieve analysis)
b = 17.95 (21-3.05; 21 is the percent passing the 2.36 mm sieve)
c = 3.05
K = 0.20
F = 0.7

P = 0.035*79+0.045*17.95+0.20*3.05+0.7
= 4.89%

Step 3 - Estimated percent of new asphalt binder in mix

$$P_{nb} = \frac{(100^2 - rP_{sb})P_b}{100(100 - P_{sb})} - \frac{(100 - r)P_{sb}}{100 - P_{sb}}$$

where:
P_{nb} = Percent of new asphalt binder in recycled mix (plus recycling agent, if used), expressed as whole number
r = new aggregate expressed as a percent of the total aggregate in the recycled mix expressed as a whole number
Pb = percent, estimated asphalt content of recycled mix (assumed to be the same as that of 100 percent virgin HMA mix or determined as an approximate asphalt demand of combined aggregates in the preceding step)
Psb = percent, asphalt content of reclaimed asphalt pavement (RAP) (plus recycling agent, if used)

$$P_{nb} = \frac{(100^2 - (85 * 5.75))P_b}{100(100 - 5.75)} - \frac{(100 - 85)5.75}{100 - 5.75}$$
$$P_{nb} = 1.01P_b - .92$$

For an approximate asphalt binder demand of 5.8 :

$$P_{nb} = 1.01 * 5.8 - .92 = 4.94\%$$

The percent of new asphalt binder, P_{nb}, to total asphalt, P_b, will then be:

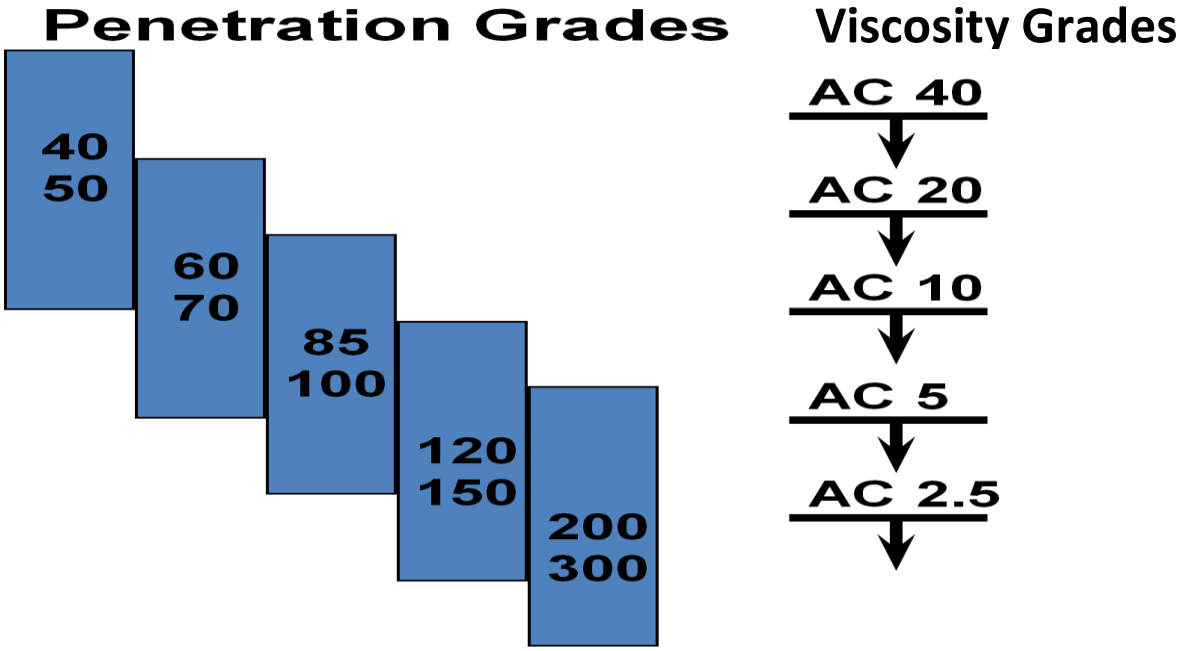
$$R = \frac{100 * 4.94}{5.8} = 85.2\%$$

Step 4 - Select grade of new asphalt binder

On Figure 38, Point A is the viscosity of the aged asphalt binder at 10,000 poises (1×10^4). Point B is located from a target viscosity of 500 poises (5.0×10^2) and R = 85.2. The projected line from Point A through Point B to Point C indicated that the viscosity of the new asphalt binder is 3.0×10^2 (300).

Since AC-5 is the normal grade of asphalt cement used in the area of construction, climate and traffic, an AC-2.5 will be chosen for this project. The AC-2.5 when blended with the aged asphalt binder in the RAP should result in an AC-2.5 within acceptable tolerances.

Note: The City of Edmonton uses penetration grade asphalt binders. The blending charts are available for viscosity grades. To account for the difference, the following equivalency has been used. This shows that the normally designated Penetration 150 asphalt is equivalent to an AC 5.



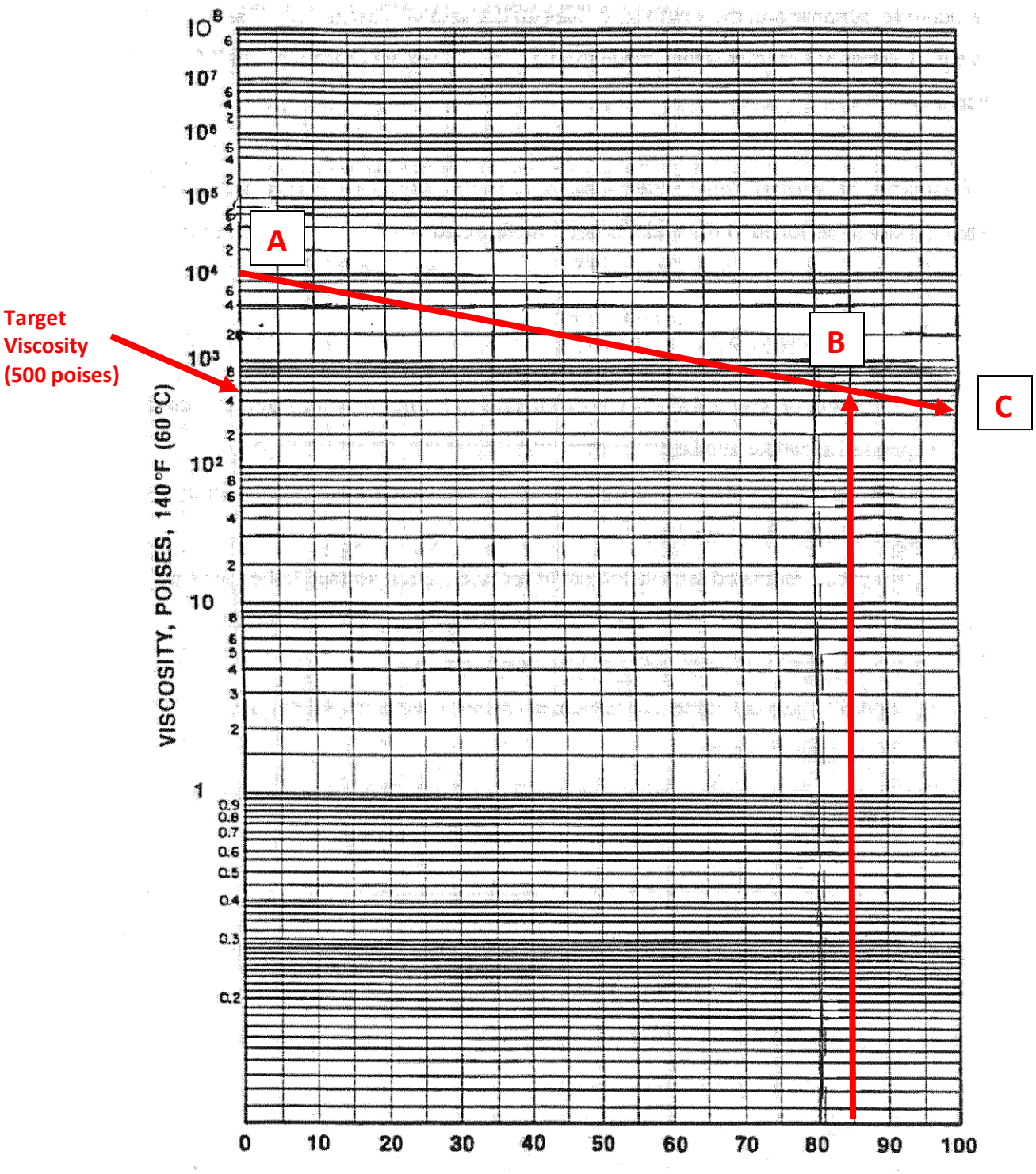


Figure 38: 15% Recycled Asphalt Blending Chart

Step 5 - Trial mix design (laboratory testing)

Using an aggregate blend of 85 percent new aggregate and 15 percent RAP aggregate, trial mixes of different asphalt contents (varying in 0.5 percent increments on either side of the estimated asphalt demand) are to be prepared according to standard Marshall mix design procedures.

Step 6 - Select job mix formula

The optimum new asphalt content and the mix design are determined according to established standard Marshall mix design criteria (as is used for virgin materials), as outlined in the Table in section 6.3 of the specification.

Step 7- Cost analysis

Prices are based off a local manufacturer in Edmonton, Alberta Canada for 2008.

Virgin HMA/ton = $95.00
RAP/ton = $26.00

15% * $26 = $3.90
85% * $95 = $80.75

HMA Mix/ton = $84.65/ton

Save $9.45/ton in comparison of a 100% virgin mix

$9.45/$95.00 = .0995 *100 =9.95%

Savings of 9.95% per ton compared to a 100% virgin mix

20% Recycled Asphalt Mix (using the Asphalt Institute method)

The project is for designing a HMA base course for an industrial roadway (ACB type mix) in Edmonton. The reclaimed asphalt pavement has a binder content of 5.75% by weight of the total mix. The viscosity of the asphalt binder recovered from the reclaimed asphalt pavement (RAP) is 10,000 poises at 60^{o}C. The grade of asphalt binder normally used is AC 5, and the target viscosity at a temperature of 60^{o}C is 500 poise. Gradation of RAP and the new aggregate is:

Sieve Size, mm	Percent Passing	
	RAP Aggregate	New Aggregate
25	100	100
20	98	93
12.5	85	53
5.0	65	30
0.16	22	5
0.08	9	2

In the new design, 20 % RAP was selected, considering a batch plant, the moisture content of the RAP (close to 4%) and a practical range of RAP content.

Step 1: Combined aggregates in recycling mixture

Sieve Size, mm	Percent Passing			
	20% RAP Agg	80% New Agg	Combination Agg	Specification for aggregate gradation (for ACB type mix)
25	[100 × 0.2 = 20.0]	[100 X 0.8 = 80.0]	100.0	100
20	[98 × 0.2 = 19.6]	[93 X 0.8 = 74.4]	94.0	80-95
12.5	[85 × 0.2 = 17.0]	[53 X 0.8 = 42.4]	59.4	
5.0	[65 × 0.2 = 13.0]	[30 X 0.8 = 24.0]	37	40-60
0.16	[22 × 0.2 = 4.4]	[5 X 0.8 = 4.0]	8.4	9-14
0.08	[9 × 0.2 = 1.8]	[2 X 0.8 = 1.6]	3.4	4-8

Note: The combination aggregate gradation does not fall within the specified gradation for an ACB type mix. This could be solved by using virgin aggregate with a different gradation but the difference is not big enough to rule out the use of RAP at this percentage.

Step 2 – Determine approximate asphalt demand of combined aggregates

P = 0.035a + 0.045b + Kc + F
where:
P = approximate total asphalt demand of recycled mix, percent by weight of mix
a = percent of mineral aggregate retained on 2.36 mm sieve, expressed as a whole number
b = percent of mineral aggregate passing the 2.36 mm sieve and retained on the 75 µm sieve, expressed as a whole number
c = percent of mineral aggregate passing the 75µm sieve
K = 0.15 for 11-15 percent passing 75 µm sieve, 0.18 for 6-10 percent passing 75µm sieve, and 0.20 for 5 percent or less passing 75 µm sieve
F = 0 to 2.0 percent. Based on absorption of light or heavy aggregate. In the absence of other data, a value of 0.7 is suggested

In this case:
a = 77 (determined from sieve analysis)
b = 19.6 (23-3.4; 23 is the percent passing the 2.36 mm sieve)
c = 3.4
K = 0.20
F = 0.7

P = 0.035*77+0.045*19.6+0.20*3.4+0.7
= 4.96 %

Step 3 - Estimated percent of new asphalt binder in mix

$$P_{nb} = \frac{(100^2 - rP_{sb})P_b}{100(100 - P_{sb})} - \frac{(100 - r)P_{sb}}{100 - P_{sb}}$$

where:
P_{nb} = Percent of new asphalt binder in recycled mix (plus recycling agent, if used), expressed as whole number
r = new aggregate expressed as a percent of the total aggregate in the recycled mix expressed as a whole number
Pb = percent, estimated asphalt content of recycled mix (assumed to be the same as that of 100 percent virgin HMA mix or determined as an approximate asphalt demand of combined aggregates in the preceding step)
Psb = percent, asphalt content of reclaimed asphalt pavement (RAP) (plus recycling agent, if used)

$$P_{nb} = \frac{(100^2 - (80 * 5.75))P_b}{100(100 - 5.75)} - \frac{(100 - 80)5.75}{100 - 5.75}$$
$$P_{nb} = 1.01P_b - 1.22$$

For an approximate asphalt binder demand of 5.8 :

$$P_{nb} = 1.01 * 5.8 - 1.22 = 4.64\%$$

The percent of new asphalt binder, P_{nb}, to total asphalt, P_b, will then be:

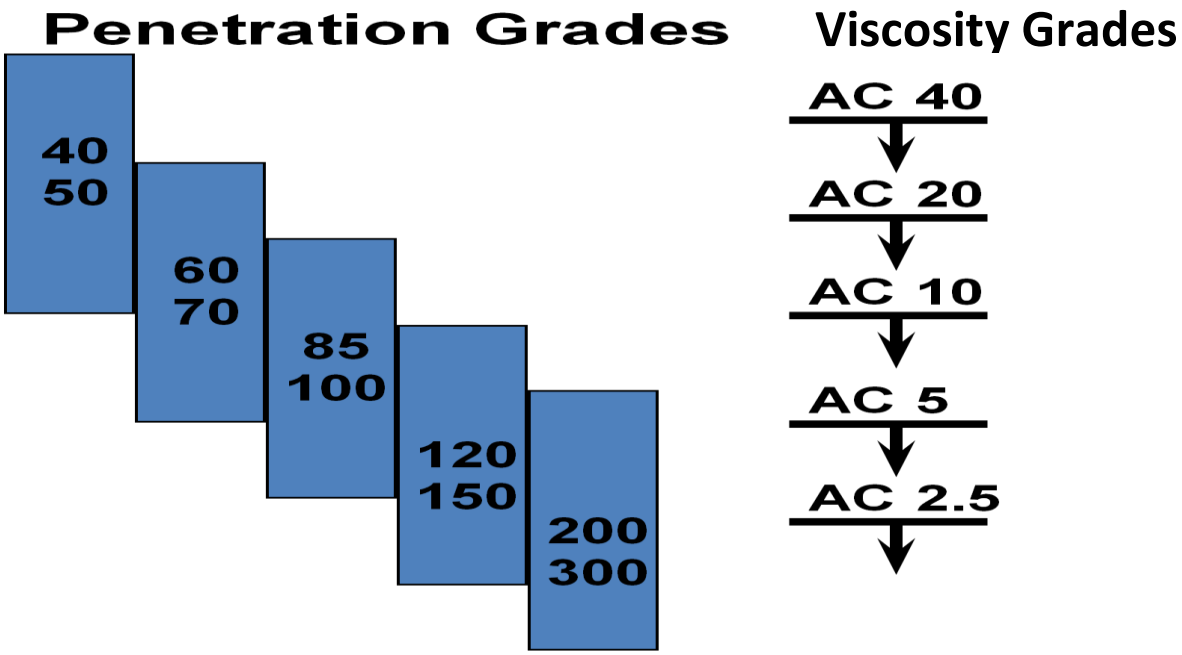
$$R = \frac{100 * 4.64}{5.8} = 80.0\%$$

Step 4 - Select grade of new asphalt binder

On Figure 39, Point A is the viscosity of the aged asphalt binder at 10,000 poises (1×10^4). Point B is located from a target viscosity of 500 poises (5.0×10^2) and R = 80.0. The projected line from Point A through Point B to Point C indicated that the viscosity of the new asphalt binder is 2.7×10^2 (270).

Since AC-5 is the normal grade of asphalt cement used in the area of construction, climate and traffic, an AC-2.5 will be chosen for this project. The AC-2.5 when blended with the aged asphalt binder in the RAP should result in an AC-2.5 within acceptable tolerances.

Note: The City of Edmonton uses penetration grade asphalt binders. The blending charts are available for viscosity grades. To account for the difference, the following equivalency has been used. This shows that the normally designated Penetration 150 asphalt is equivalent to an AC 5.



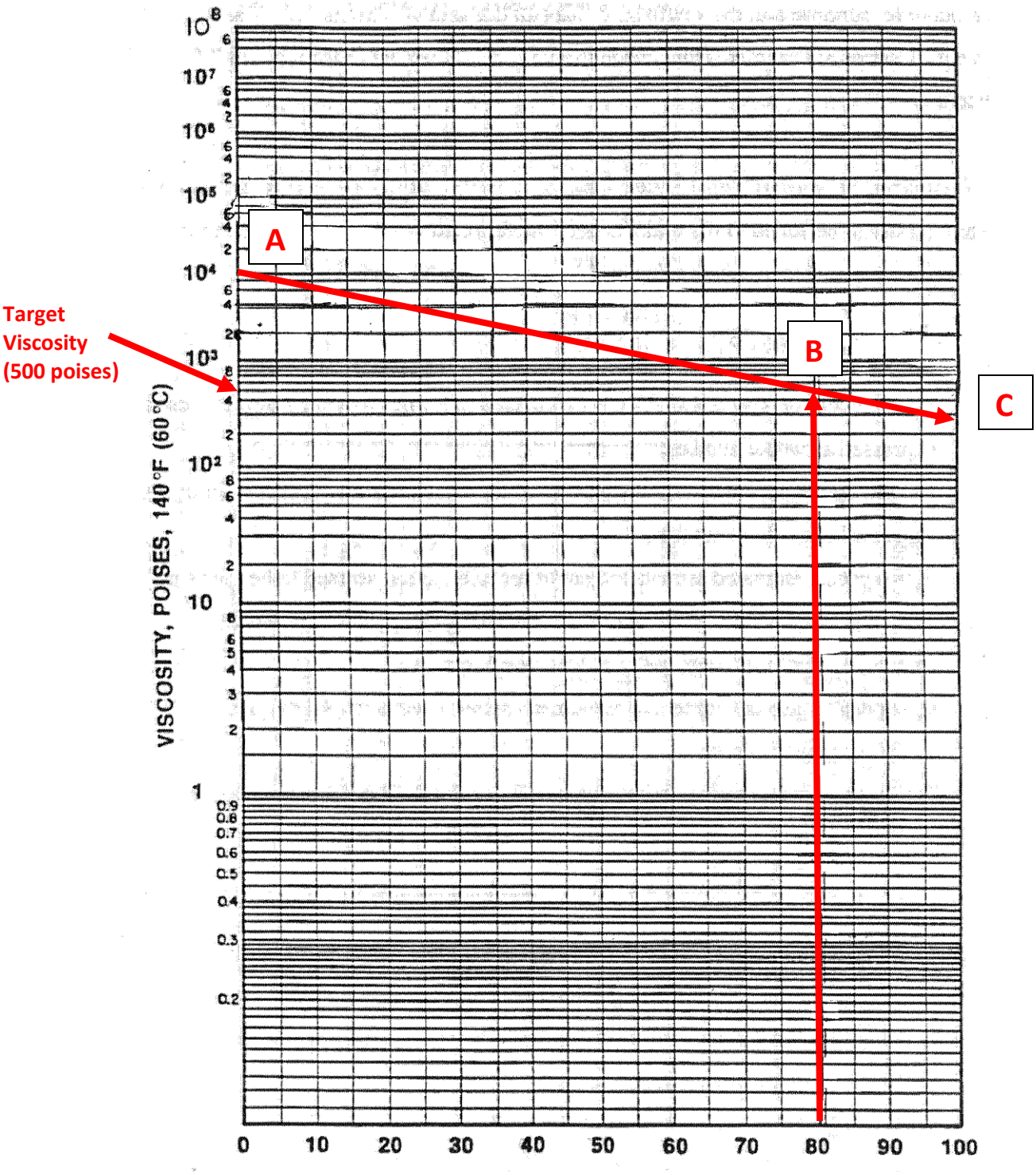


Figure 39: 20% Recycled Asphalt Blending Chart

Step 5 - Trial mix design (laboratory testing)

Using an aggregate blend of 80 percent new aggregate and 20 percent RAP aggregate, trial mixes of different asphalt contents (varying in 0.5 percent increments on either side of the estimated asphalt demand) are to be prepared according to standard Marshall mix design procedures.

Step 6 - Select job mix formula

The optimum new asphalt content and the mix design are determined according to established standard Marshall mix design criteria (as is used for virgin materials), as outlined in the Table in section 6.3 of the specification.

Step 7- Cost analysis

Prices are based off a local manufacturer in Edmonton, Alberta Canada for 2008.

Virgin HMA/ton = $95.00
RAP/ton = $26.00

20% * $26 = $5.20
80% * $95 = $76.00

HMA Mix/ton = $81.20/ton

Save $13.80/ton in comparison of a 100% virgin mix

$13.80/$95.00 = .1453*100 =14.53%

Savings of 14.53% per ton compared to a 100% virgin mix

30% Recycled Asphalt Mix (using the Asphalt Institute method)

The project is for designing a HMA base course for an industrial roadway (ACB type mix) in Edmonton. The reclaimed asphalt pavement has a binder content of 5.75% by weight of the total mix. The viscosity of the asphalt binder recovered from the reclaimed asphalt pavement (RAP) is 10,000 poises at 60^{o}C. The grade of asphalt binder normally used is AC 5, and the target viscosity at a temperature of 60^{o}C is 500 poise. Gradation of RAP and the new aggregate is:

Sieve Size, mm	Percent Passing	
	RAP Aggregate	New Aggregate
25	100	100
20	98	93
12.5	85	53
5.0	65	30
0.16	22	5
0.08	9	2

In the new design, 30 % RAP was selected, considering a batch plant, the moisture content of the RAP (close to 4%) and a practical range of RAP content.

Step 1: Combined aggregates in recycling mixture

Sieve Size, mm	Percent Passing			
	30% RAP Agg	70% New Agg	Combination Agg	Specification for aggregate gradation (for ACB type mix)
25	[100 × 0.3 = 30.0]	[100 X 0.7 = 70.0]	100.0	100
20	[98 × 0.3 = 29.4]	[93 X 0.7 = 65.1]	94.5	80-95
12.5	[85 × 0.3 = 25.5]	[53 X 0.7 = 37.1]	62.6	
5.0	[65 × 0.3 = 19.5]	[30 X 0.7 = 21.0]	40.5	40-60
0.16	[22 × 0.3 = 6.6]	[5 X 0.7 = 3.5]	10.1	9-14
0.08	[9 × 0.3 = 2.7]	[2 X 0.7 = 1.4]	4.1	4-8

Note that the combination aggregate gradation falls within the specified gradation for a ACB type mix.

Step 2 – Determine approximate asphalt demand of combined aggregates

P = 0.035a + 0.045b + Kc + F
where:
P = approximate total asphalt demand of recycled mix, percent by weight of mix
a = percent of mineral aggregate retained on 2.36 mm sieve, expressed as a whole number
b = percent of mineral aggregate passing the 2.36 mm sieve and retained on the 75 µm sieve, expressed as a whole number
c = percent of mineral aggregate passing the 75µm sieve
K = 0.15 for 11-15 percent passing 75 µm sieve, 0.18 for 6-10 percent passing 75µm sieve, and 0.20 for 5 percent or less passing 75 µm sieve
F = 0 to 2.0 percent. Based on absorption of light or heavy aggregate. In the absence of other data, a value of 0.7 is suggested

In this case:
a = 75 (determined from sieve analysis)
b = 20.9 (25-4.1; 25 is the percent passing the 2.36 mm sieve)
c = 4.1
K = 0.20
F = 0.7

P = 0.035*75+0.045*20.9+0.20*4.1+0.7
= 5.1 %

Step 3 - Estimated percent of new asphalt binder in mix

$$P_{nb} = \frac{(100^2 - rP_{sb})P_b}{100(100 - P_{sb})} - \frac{(100 - r)P_{sb}}{100 - P_{sb}}$$

where:
P_{nb} = Percent of new asphalt binder in recycled mix (plus recycling agent, if used), expressed as whole number
r = new aggregate expressed as a percent of the total aggregate in the recycled mix expressed as a whole number
Pb = percent, estimated asphalt content of recycled mix (assumed to be the same as that of 100 percent virgin HMA mix or determined as an approximate asphalt demand of combined aggregates in the preceding step)
Psb = percent, asphalt content of reclaimed asphalt pavement (RAP) (plus recycling agent, if used)

$$P_{nb} = \frac{(100^2 - 70 * 5.75\ \ )P_b}{100(100 - 5.75)} - \frac{(100 - 70)5.75}{100 - 5.75}$$
$$P_{nb} = 1.02P_b - 1.83$$

For an approximate asphalt binder demand of 5.8 :

$$P_{nb} = 1.02 * 5.8 - 1.83 = 4.1\ percent$$

The percent of new asphalt binder, P_{nb}, to total asphalt, P_b, will then be:

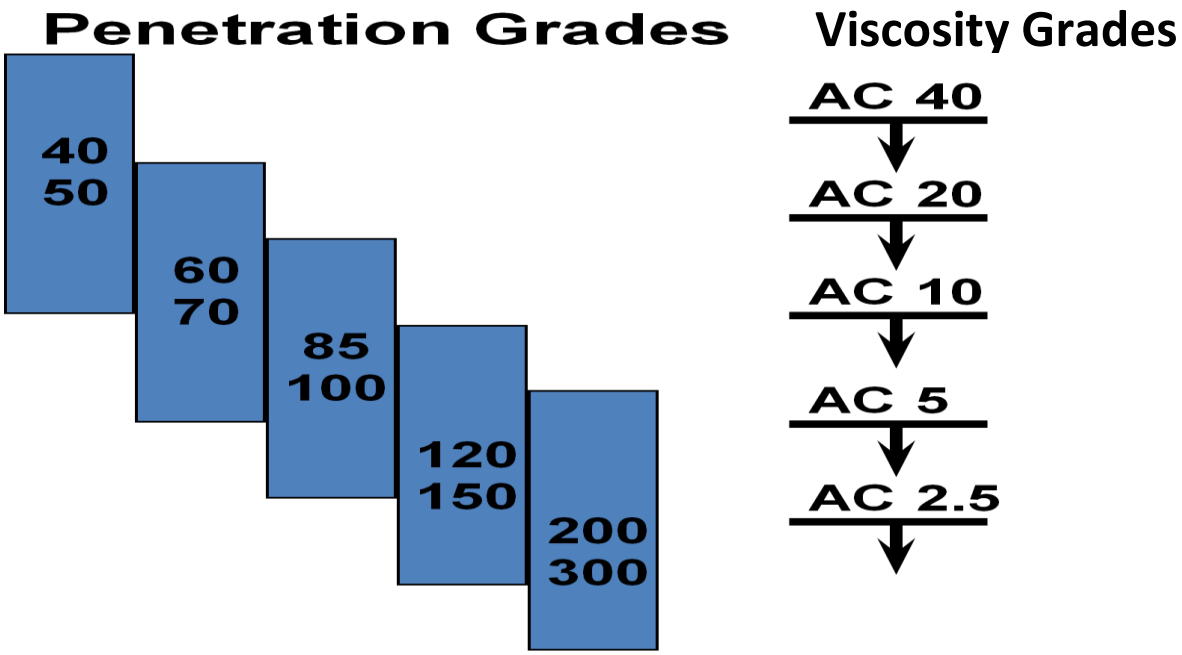
$$R = \frac{100 * 4.1}{5.8} = 70.7\%$$

Step 4 - Select grade of new asphalt binder

On Figure 40, Point A is the viscosity of the aged asphalt binder at 10,000 poises (1×10^4). Point B is located from a target viscosity of 500 poises (5.0×10^2) and R = 70.7. The projected line from Point A through Point B to Point C indicated that the viscosity of the new asphalt binder is 2.0×10^2 (200).

Since AC-5 is the normal grade of asphalt cement used in the area of construction, climate and traffic, an AC-2.5 will be chosen for this project. The AC-2.5 when blended with the aged asphalt binder in the RAP should result in an AC-5 within acceptable tolerances.

Note: The City of Edmonton uses penetration grade asphalt binders. The blending charts are available for viscosity grades. To account for the difference, the following equivalency has been used. This shows that the normally designated Penetration 150 asphalt is equivalent to an AC 5.



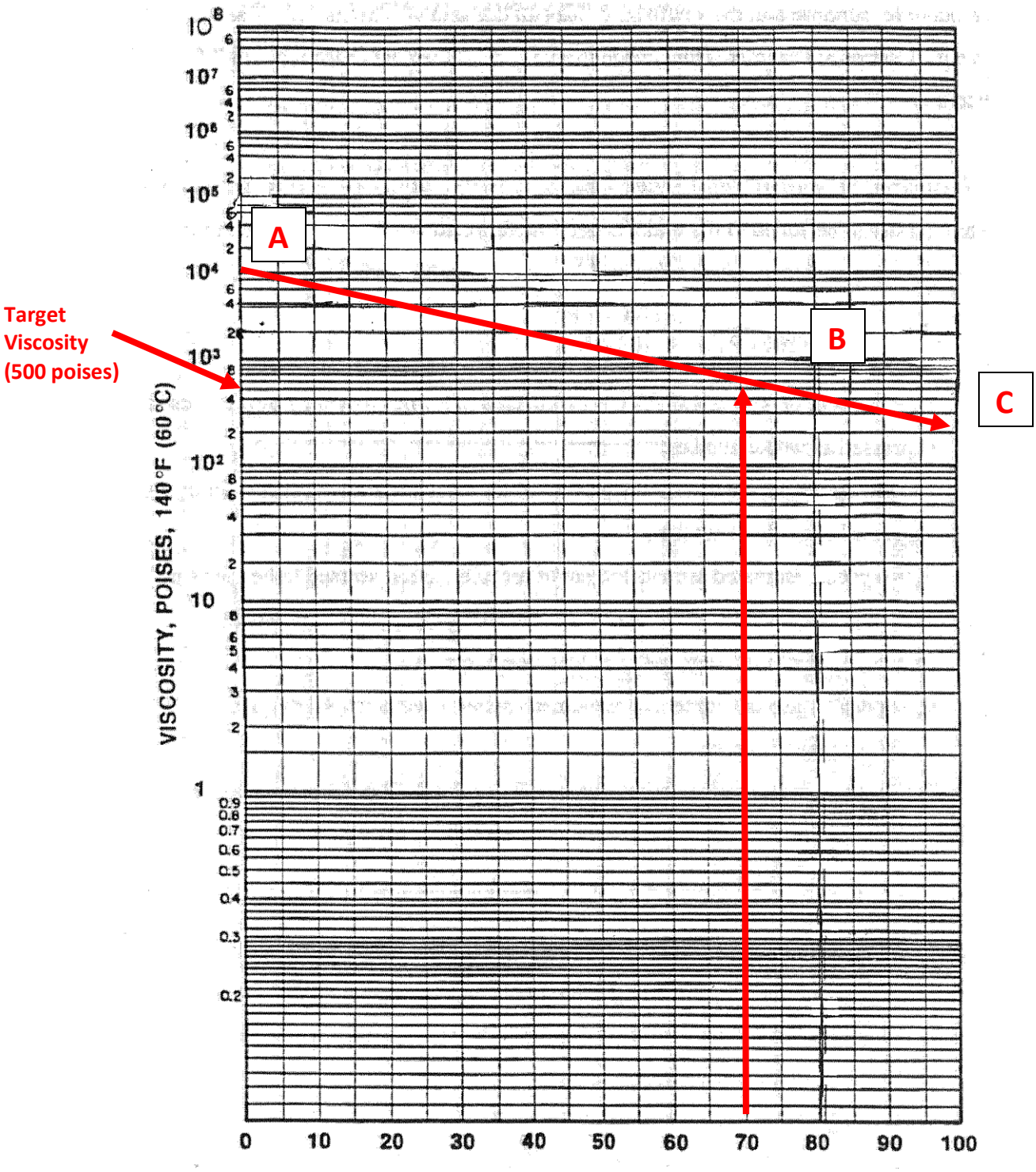


Figure 40: 30% Recycled Asphalt Blending Chart

Step 5 - Trial mix design (laboratory testing)

Using an aggregate blend of 70 percent new aggregate and 30 percent RAP aggregate, trial mixes of different asphalt contents (varying in 0.5 percent increments on either side of the estimated asphalt demand) are to be prepared according to standard Marshall mix design procedures.

Step 6 - Select job mix formula

The optimum new asphalt content and the mix design are determined according to established standard Marshall mix design criteria (as is used for virgin materials), as outlined in the Table in section 6.3 of the specification.

Step 7- Cost analysis

Prices are based off a local manufacturer in Edmonton, Alberta Canada for 2008.

Virgin HMA/ton = $95.00
RAP/ton = $26.00

30% * 26 = $7.80
70% * 95 = $66.50

HMA Mix/ton = $74.30/ton

Save $20.70/ton in comparison of a 100% virgin mix

$20.70/$95.00 =.2179 * 100 = 21.79%

Saving of 21.79% per ton compared to a 100% virgin mix

40% Recycled Asphalt Mix (using the Asphalt Institute method)

The project is for designing a HMA base course for an industrial roadway (ACB type mix) in Edmonton. The reclaimed asphalt pavement has a binder content of 5.75% by weight of the total mix. The viscosity of the asphalt binder recovered from the reclaimed asphalt pavement (RAP) is 10,000 poises at 60^{o}C. The grade of asphalt binder normally used is AC 5, and the target viscosity at a temperature of 60^{o}C is 500 poise. Gradation of RAP and the new aggregate is:

Sieve Size, mm	Percent Passing	
	RAP Aggregate	New Aggregate
25	100	100
20	98	93
12.5	85	53
5.0	65	30
0.16	22	5
0.08	9	2

In the new design, 40 % RAP was selected, considering a batch plant, the moisture content of the RAP (close to 4%) and a practical range of RAP content.

Step 1: Combined aggregates in recycling mixture

Sieve Size, mm	Percent Passing			
	40% RAP Agg	60% New Agg	Combination Agg	Specification for aggregate gradation (for ACB type mix)
25	[100 × 0.4 = 40.0]	[100 X 0.6 = 60.0]	100.0	100
20	[98 × 0.4 = 39.2]	[93 X 0.6 = 55.8]	95	80-95
12.5	[85 × 0.4 = 34.0]	[53 X 0.6 = 31.8]	65.8	
5.0	[65 × 0.4 = 26.0]	[30 X 0.6 = 18]	44.0	40-60
0.16	[22 × 0.4 = 8.8]	[5 X 0.6 = 3.0]	11.8	9-14
0.08	[9 × 0.4 = 3.6]	[2 X 0.6 = 1.2]	4.8	4-8

Note that the combination aggregate gradation falls within the specified gradation for a ACB type mix.

Step 2 – Determine approximate asphalt demand of combined aggregates

P = 0.035a + 0.045b + Kc + F
where:
P = approximate total asphalt demand of recycled mix, percent by weight of mix
a = percent of mineral aggregate retained on 2.36 mm sieve, expressed as a whole number
b = percent of mineral aggregate passing the 2.36 mm sieve and retained on the 75 µm sieve, expressed as a whole number
c = percent of mineral aggregate passing the 75µm sieve
K = 0.15 for 11-15 percent passing 75 µm sieve, 0.18 for 6-10 percent passing 75µm sieve, and 0.20 for 5 percent or less passing 75 µm sieve
F = 0 to 2.0 percent. Based on absorption of light or heavy aggregate. In the absence of other data, a value of 0.7 is suggested

In this case:
a = 72 (determined from sieve analysis)
b = 23.2 (28-4.8; 28 is the percent passing the 2.36 mm sieve)
c = 4.8
K = 0.20
F = 0.7

P = 0.035*72+0.045*23.2+0.20*4.8+0.7
= 5.22 %

Step 3 - Estimated percent of new asphalt binder in mix

$$P_{nb} = \frac{(100^2 - rP_{sb})P_b}{100(100 - P_{sb})} - \frac{(100 - r)P_{sb}}{100 - P_{sb}}$$

where:
P_{nb} = Percent of new asphalt binder in recycled mix (plus recycling agent, if used), expressed as whole number
r = new aggregate expressed as a percent of the total aggregate in the recycled mix expressed as a whole number
Pb = percent, estimated asphalt content of recycled mix (assumed to be the same as that of 100 percent virgin HMA mix or determined as an approximate asphalt demand of combined aggregates in the preceding step)
Psb = percent, asphalt content of reclaimed asphalt pavement (RAP) (plus recycling agent, if used)

$$P_{nb} = \frac{(100^2 - (60 * 5.75))P_b}{100(100 - 5.75)} - \frac{(100 - 60)5.75}{100 - 5.75}$$
$$P_{nb} = 1.02P_b - 2.44$$

For an approximate asphalt binder demand of 5.8 :

$$P_{nb} = 1.02 * 5.8 - 2.44 = 3.48\%$$

The percent of new asphalt binder, P_{nb}, to total asphalt, P_b, will then be:

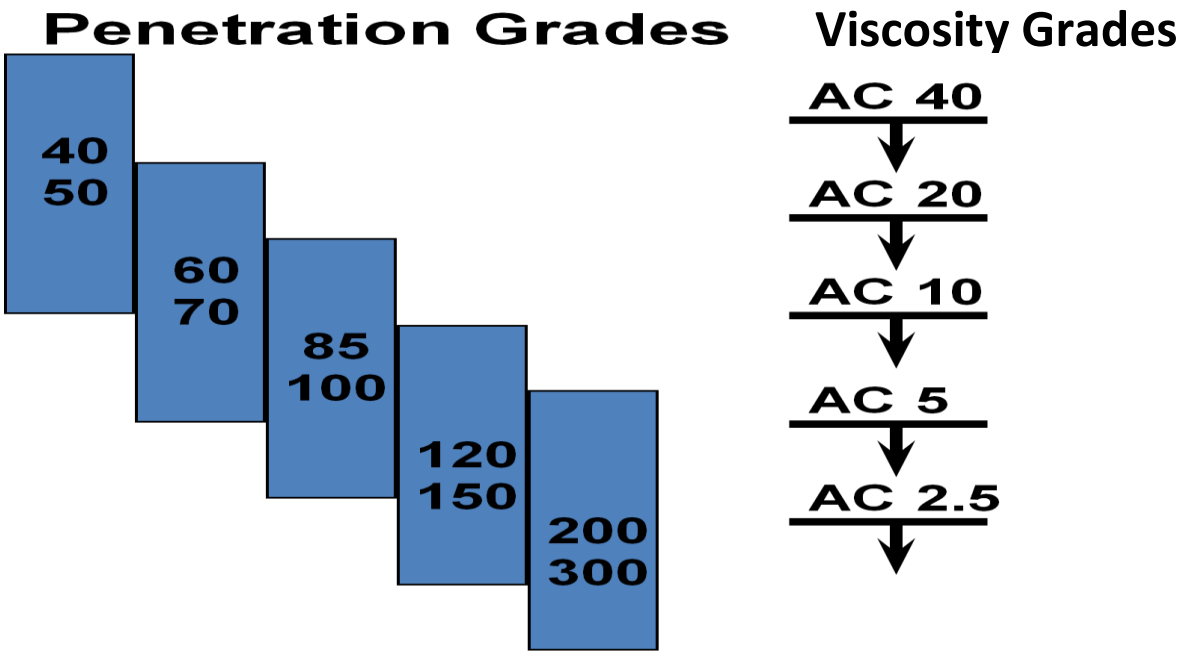
$$R = \frac{100 * 3.48}{5.8} = 60.0\%$$

Step 4 - Select grade of new asphalt binder

On Figure 41, Point A is the viscosity of the aged asphalt binder at 10,000 poises (1×10^4). Point B is located from a target viscosity of 500 poises (5.0×10^2) and R = 60.0. The projected line from Point A through Point B to Point C indicated that the viscosity of the new asphalt binder is 1.0×10^2 (100).

Since AC-5 is the normal grade of asphalt cement used in the area of construction, climate and traffic, an AC-2.5 will be chosen for this project. The AC-2.5 when blended with the aged asphalt binder in the RAP and recycling agent should result in an AC-5 within acceptable tolerances.

Note: The City of Edmonton uses penetration grade asphalt binders. The blending charts are available for viscosity grades. To account for the difference, the following equivalency has been used. This shows that the normally designated Penetration 150 asphalt is equivalent to an AC 5.



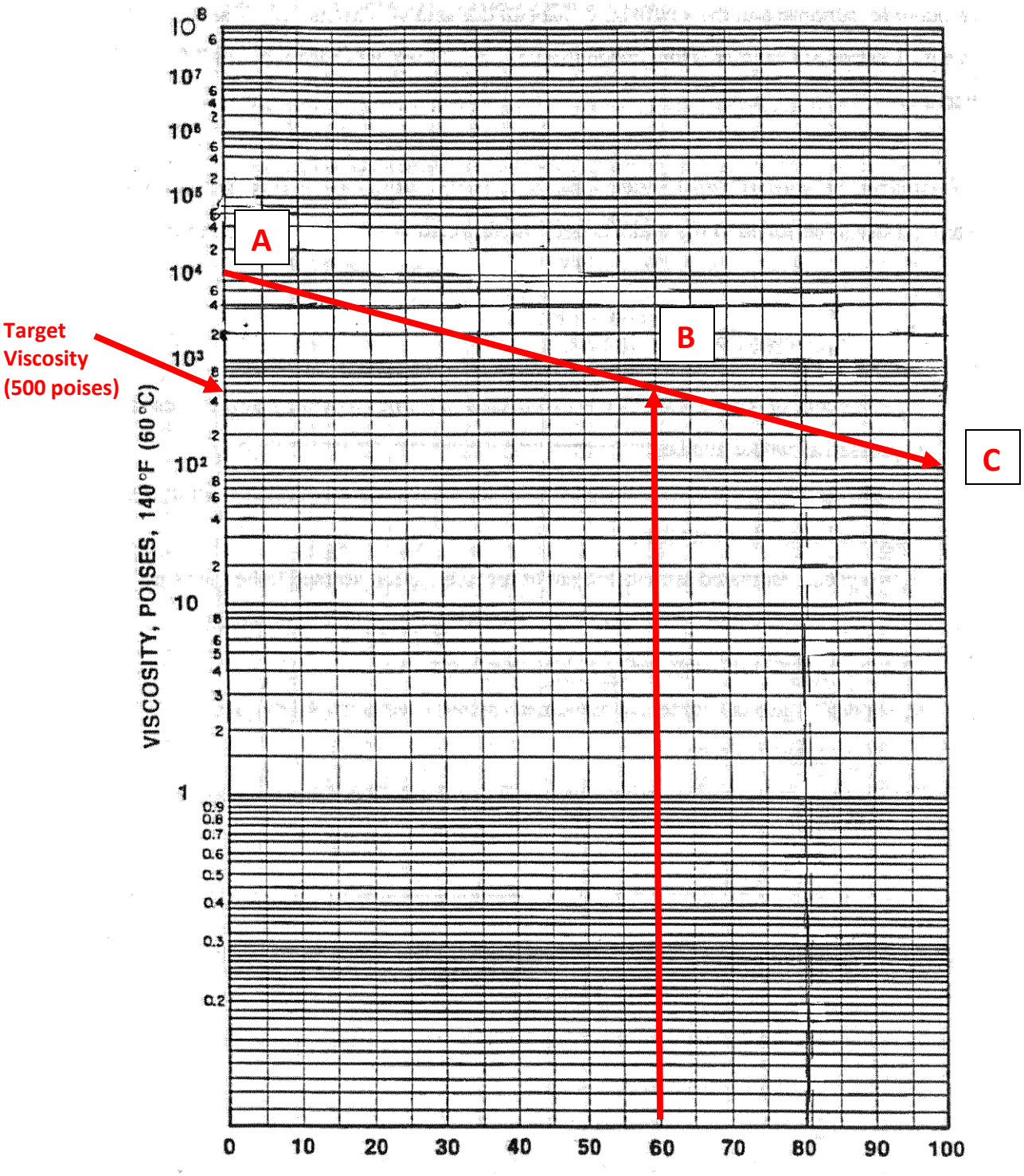


Figure 41: 40% Recycled Asphalt Blending Chart

Step 5 - Trial mix design (laboratory testing)

Using an aggregate blend of 60 percent new aggregate and 40 percent RAP aggregate, trial mixes of different asphalt contents (varying in 0.5 percent increments on either side of the estimated asphalt demand) are to be prepared according to standard Marshall mix design procedures.

Step 6 - Select job mix formula

The optimum new asphalt content and the mix design are determined according to established standard Marshall mix design criteria (as is used for virgin materials), as outlined in the Table in section 6.3 of the specification.

Step 7- Cost analysis

Prices are based off a local manufacturer in Edmonton, Alberta Canada for 2008.

Virgin HMA/ton = $95.00
RAP/ton = $26.00

40% * $26 = $10.40
60% * $95 = $57.00

HMA Mix/ton = $67.40/ton

Save $27.60/ton in comparison of a 100% virgin mix

$27.60/$95.00 = .2905*100 =29.05%

Savings of 29.05% per ton compared to a 100% virgin mix

Cost Comparison of the Four Recycled Mixes

After doing the cost analysis of the four recycled hot mix base course designs, the team created a chart to better compare them. The cost of virgin Hot Mix Asphalt in 2008 for Edmonton, Alberta Canada was $95/ton and Recycled Asphalt Pavement was $26/ton. The results show that the cost savings increases as the amount of recycled asphalt increases in the mix compared to virgin hot mix asphalt. Table 17, below represents the cost analysis of the four mixes.

Table 17: Cost Comparison of the Four Recycled Asphalt Mixes

% of Virgin Material	% of RAP	Cost per Ton of HMA Mix	Savings per Ton	% Saved per Ton
100%	0%	$95	$0	0%
85%	15%	$84.65	$10.35	9.95%
80%	20%	$81.20	$13.80	14.53%
70%	30%	$74.30	$20.70	21.79%
60%	40%	$67.40	$27.60	29.05%