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California Green Leadership in Roadway Design and Environmental Sustainability (RODES)

Ramin Behani[1], M.Sc., P.E., Farzad Shahbodaghlou[2], Ph.D., Saeid Motavalli[2], Ph.D.
[1]*California Department of Transportation, Oakland California,*
[2]*Cal State University East Bay, Hayward, California*

Innovative environmental design has been truly revolutionizing the construction industry. Now building green has become an essential; it is among the fast growing markets in the U.S. In the meantime, Leadership in Energy and Environmental Design (LEED) has created a milestone in defining basics of green construction. It has encouraged public and private entities to adopt their own green policies. Other industries like transportation have also started their green movement. A few agencies have already initiated measuring their own transportation projects' environmental sustainability. Among the adopted programs is the New York Department of Transportation's (NYDOT) GreenLITES, i.e. the New York state green highway design certification system. University of Washington Greenroads is another example of such programs. California Department of Transportation (Caltrans) has a comprehensive procedure to satisfy environmental requirements for its proposed projects. However, Caltrans does not have a system to rate its proposed projects' environmental sustainability. This paper proposes a certification program for environmental sustainable highway design and construction in California.

1 INTRODUCTION

Environmental sustainability concerns have been gaining substantial attention in modern construction. A brief review of green movement in the U.S. shows that various sustainability certification programs have been developed in recent decades. These programs intended to encourage the use of more environmental friendly solutions in construction. Among them, U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) has created a benchmark. The 2010 California Green Building Standards (CALGreen) code has incorporated LEED into its building codes. CALGreen is the mandatory green provisions of California Building Standards that has gone into effect on January 1, 2011. What was considered a certificate is now a mandatory building code.

Environmental sustainability principles have also been spreading through other fields like transportation planning. Creating a framework, such as a certification program, for evaluating projects' alternative based on sustainability indicators is essential for future of transportation planning (ASCE, 2005). Such certification program will also enable us to compare the level of environmentally sustainable practices used in various transportation projects. States across the country are moving forward with their own approaches to make their highway design and construction green. For instance, State of New York has a green highway-design certification system in place named GreenLITES. University of Washington has also set a benchmark by creating GreenRoads, a sustainability-rating system. There is an opportunity for California Department of Transportation (Caltrans) to be a proactive leader in the green movement as well. This paper intends to create an initial framework for such system.

2 SCOPE OF THE WORK

The objective of this paper is to propose an environmental sustainability rating system in California. The proposed rating system would encourage and reward green transportation projects in the state. A review of literature, which includes study and research on existing rating systems and current California regulations for environmental design of roadway projects enabled us to develop the rating system.
GreenLITES and Greenroads are the two most prominent environmental rating systems on transportation infrastructure in the country. These two systems are chosen to be reviewed because they are the most active rating systems in the green U.S. transportation industry. Advantages and disadvantages of each system will be studied, strengths and weaknesses will be characterized, and general philosophy of sustainability rating system for roadway projects will be established. Finally, an environmental sustainability rating system for California roadway projects will be defined.

3 GreenLITES RATING SYSTEM

GreenLITES is the New York state Department of Transportation (DOT) environmental sustainability rating program. GreenLITES is created to integrate sustainability principles into transportation projects. It distinguishes transportation projects through rating their use of sustainable practices (GreenLITES, 2009). GreenLITES identifies a good number of sustainable practices in its five categories without introducing any prerequisite. GreenLITES categories are Sustainable Sites, Water Quality, Materials & Resources, Energy & Atmosphere, and Innovation/Unlisted. Participant projects may receive one of four GreenLITES certification levels, i.e. Certified, Silver, Gold, or Evergreen. Below is an overview of GreenLITES credits:

3.2 GreenLITES Sustainable Sites (S) Credits Review

S1: Alignment Selection, S2: Context Sensitive Solutions (CSS), S3: Land Use/Community Planning, S4: Protect, Enhance or Restore Wildlife Habitat, and S5: Protect Plant or Mitigate for Removal of Trees & Plant Communities

3.3 GreenLITES Water Quality (W) Credits Review

W1: Stormwater management and W2: Best Management Practices (BMPs): National Pollutant Discharge Elimination System (NPDES) has comprehensive regulations regarding both W1 and W2.

3.4 GreenLITES Materials & Resources (M), Energy & Atmosphere (E) Credits Review

Considering future worldwide shortage of material, energy and other resources, it becomes a high priority to define credit categories for earth recourses and energy conservation.

4 Greenroads RATING SYSTEM

University of Washington (UW) and CH2M HILL created Greenroads rating system. It is a collection of sustainability practices applicable to roadway design and construction (Greenroads, 2010).

4.1 Greenroads Review

There are two credit categories in Greenroads, which are Project Requirements (PRs) and Voluntary Credits (VCs). PRs are prerequisite practices that must be satisfied in order to make a project eligible for Greenroads certificate. VCs, on the other hand, are optional measures selectively chosen to gain credit points toward achieving desired certificate level. There are four standard certification levels, which are Greenroads Certified, Silver, Gold, and Evergreen.
The following is a brief review of Greenroads Voluntary Credits.

4.2.1 Environment and Water Credits Review

This category is similar to GreenLITES water quality. Formatting of credit goal, requirements and documentation are taken from LEED.

4.2.2 Access and Equity Credits Review

This credit is based on factors such as Context Sensitive Solutions, Traffic Emission Reduction, Pedestrian Access, Bicycle Access, Transit and HOV Access, Scenic Views, and Cultural Outreach.

4.2.3 Construction Activities Credits Review

Credit concepts like Environmental Training, Site Recycling Plan, Equipment Emission Reduction, and Waste Use could be considered in California rating system.

4.2.4 Material & Resources Credits Review

Credits include Lifecycle Assessment, Pavement Reuse, Earthwork Balance, Recycled Materials, Regional Materials, and Energy Efficiency. All of these concepts are integrated components of a more sustainable design in roadway construction.

4.2.5 Pavement Technologies Credits Review

Caltrans is already a pro when it comes to using pavement technologies that helps California to be more environmentally friendly state.

5 COMPARISON BETWEEN GreenLITES AND Greenroads

Brief review of GreenLITES and Greenroads revealed that there are quite a few credits similar between the two. Water quality and material resources are examples of those similar credits. In fact, these credits are very similar to their LEED counterparts. However, detailed review of GreenLITES and Greenroads shows that GreenLITES simplicity makes it more user friendly, so users will have more inclination to use it voluntarily. Greenroads, on the other hand, has a complex weighing system. Some of the assumptions in Greenroads weighing system are disputable which complicate the rating. Besides, Greenroads has prerequisites that must be satisfied by any project that wants to be rated by it. This makes the execution of such rating system more difficult in public projects, especially in the state's bureaucratic environment.

In creation of California rating system, this proposal considers simplicity to be the most important factor. As such, it is not in California rating system's interest to be an absolute

measure of sustainability, Therefore Greenroads utilization of prerequisites are not adopted in this proposal.

6 PROPOSED CALIFORNIA ROADWAY DESIGN & ENVIRONMENTAL SUSTAINABILITY (RODES)

RODES is a proposed 132-point credit rating system applicable to any California roadway project. RODES evaluates California roadway projects for environmentally sustainable practices. It will stimulate state environmental practices to minimize, mitigate, or eliminate project impacts on environment. The following are basic principles utilized in developing RODES:

- Applying for RODES does not require any prerequisite.
- Credits are developed to be simple.
- Importance of RODES credit categories is subjective and based on an empirical experience. Statistical records of rated projects during RODES pilot program might change point allocations and thresholds for each certificate level down the road.
- All documents required for RODES come from Caltrans Project Development Process.
- Periodic revisions to incorporate new ideas, findings and lessons learned are a requirement.

6.1 RODES Certification Categories are; Sustainable Sites (SS), Water Quality Management (WQM), Materials & Resources (MR), Environmental Quality (EQ), Energy and Atmosphere (EA), Access (A) and Innovation (I)

6.2 RODES Instruction

RODES introduces three levels of certification. Certification levels are Green RODES (highest level), Gold RODES, and Certified RODES (lowest level). To gain a RODES certificate, the candidate roadway project may voluntarily apply for either 1st, 2nd, or 3rd tier of points available on each RODES credit category. Total Accumulated Point (TAP) is determined by adding all those points. TAP will determine certificate level for the candidate project.

The following schedule shows minimum TAP requirement for each certificate level:

Certificate Name	*Total Accumulated Point (TAP)*
Green RODES	> 86 points
Gold RODES	> 66 points
Certified RODES	> 40 points

As introduced earlier a candidate roadway project may voluntarily apply for either 1st, 2nd, or 3rd tier of points available on each credit. Conditions below will determine how either 1st, 2nd, or 3rd tier of points could be obtained on each RODES credit.

Fulfilling minimum environmental criteria (Federal and California state criteria) on any of RODES credits will earn the 1st tier of points. Environmental criteria is satisfied through either avoiding or minimizing adverse environmental effects, or via using compensatory measures. Use of preventative, mitigative or compensatory measures beyond minimum regulations' requirement (Federal and California state level) on any of the available RODES credits will earn the 2nd tier of points on the corresponding credit.

3rd tier of points are for use of extraordinary innovative measure(s). Figure 1 shows details of the RODES rating system.

A RODES Review Committee (RRC) assesses the strength of each measure used in the candidate project. RRC approves the tier used on each credit, and subsequently approves the candidate project's TAP. RODES credit details include available points for tier 1, tier 2, and tier 3. Points for each tier are written in front of each credit category in parenthesis. Existing credits and corresponding tier 1, 2, and 3 points are presented in Appendix A. As an example credit, "Sustainable Sites-1 (SS-1), Option a" has (5-10-15 points) written in front of its description. This means fulfilling minimum environmental criteria for SS-1 will earn 5 points for the project. Use of preventative, mitigative, and/or compensatory measures beyond minimum regulations' requirement will earn 10 points for the project. Finally, any extraordinary innovative measure(s) taken relative to SS-1 will earn 15 points for the project.

RODES Credit Schedule and Scorecard						
California Green Leadership in Roadway Design & Environmental Sustainability (RODES)						
Project:						
Project Manager:						
Date:		Maximum Available Points				
Cedit						
Category	Description	Tier 1	Tier 2	Tier 3	Proposed	Approved
		Maximum	Maximum	Maximum		
Sustainable Sites 1 (SS-1)	Imapct Analysis	5	10	15		
Sustainable Sites 2 (SS-2)	Landscape Protection	2	4	6		
Sustainable Sites 3 (SS-3)	Impervious Surface Mgmt.	1	2	3		
Sustainable Sites 4 (SS-4)	Context Sensitive Solution	8	16	24		
Sustainable Sites 5 (SS-5)	Conservation Buffer	1	2	3		
Water Quality Management 1 (WQM-1)	Temporary Storm Water Pollution Control	3	6	9		
Water Quality Management 2 (WQM-2)	Permanent Storm Water Pollution Control	6	12	18		
Water Quality Management 3 (WQM-3)	Watershed Planning	2	4	6		
Water Quality Management 4 (WQM-4)	Water Quality Monitoring	2	2	2		
Water Quality Management 5 (WQM-5)	Public Outreach	2	2	2		
Materials and Resources 1 (MR-1)	LCCA & Other Factors	1	2	3		
Materials and Resources 2 (MR-2)	Construction Waste Diversion	1	2	3		
Materials and Resources 3 (MR-3)	Environmnetal Material Assessment	10	10	10		
Environmental Quality 1 (EQ-1)	Environmnetal Mgmt. System	5	5	5		
Environmental Quality 2 (EQ-2)	Wildlife Access	1	1	1		
Environmental Quality 3 (EQ-3)	Air Quality Improvement	1	1	1		
Environmental Quality 4 (EQ-4)	Public Awareness	1	1	1		
Environmental Quality 5 (EQ-5)	Noise Pollution Mgmt.	1	2	2		
Energy and Atmosphere 1 (EA-1)	Solar Energy (1)	2	2	2		
Energy and Atmosphere 2 (EA-2)	Solar Energy (2)	2	2	2		
Energy and Atmosphere 3 (EA-3)	Wind Energy (1)	2	2	2		
Energy and Atmosphere 4 (EA-4)	Wind Energy (2)	2	2	2		
Energy and Atmosphere 5 (EA-5)	Construction Equipment Clean Exhaust	2	2	2		
Access 1 (A-1)	Transportation Facility Incorporation	5	5	5		
Access 2 (A-2)	Scenic Facility	1	1	1		
Innovation 1 (I-1)	Green Innovation	2	2	2		
Total Accumulated Point (TAP)						
Notes:						
1) Minimum Total Accumulated Point (TAP) to get Certified RODES is 40 points.						
2) Minimum Total Accumulated Point (TAP) to get Certified RODES is 66 points.						
3) Minimum Total Accumulated Point (TAP) to get Certified RODES is 86 points.						

Figure 1 RODES Credit Schedule

6.3.1 Sustainable Sites (SS)

SS-1: Consider either one of the following choices when project is in environmental study phase (Choose a or b option; not both):
a) Perform any kind of cumulative impact analysis to determine potential cumulative effects of a proposed project on environment. (5-10-15 points) and
b) Identify any potential individual impact of the proposed project from the following list; analyze it, and specify mitigation measures intended to reduce adverse project effects.
SS-2: Consider landscape protection/restoration in site developments. (2-4-6 points)
SS-3: Impervious surface management (1-2-3 points)
SS-4: Context Sensitive Solution (CSS) (8-16-24 points), and
SS-5: Conservation buffer (1-2-3 points)

6.3.2 Water Quality Management (WQM)

The concentration of water quality management credits are mostly around the National Pollution Discharge Elimination System (NPDES) permitting program. NPDES general permit's two important elements are Best Management Practices, BMPs, and the monitoring requirements during construction.
WQM-1: Plan temporary storm water runoff pollution control, and itemize use of various temporary BMPs for construction period in project estimate. Estimate should also include BMPs' proper maintenance during rainy season/s. (3-6-9 points)
WQM-2: Plan permanent storm water runoff pollution control for post construction. Consider designing pollution prevention BMPs, treatment and maintenance BMPs. (6-12-18 points)
WQM-3: Adopt holistic problem-solving approaches on regional and watershed planning and management while planning for new facilities or rehabilitation projects. (2-4-6 points)
WQM-4: Consider special water quality monitoring inspection and SWPPP/WPCP enforcement to oversee construction SWPPP/WPCP by water quality design crew. Inspection program should be incorporated in the contract special provisions. (2 points), and
WQM-5: Consider budget for various public outreach and education programs on stormwater pollution prevention approaches. (2 points)

6.3.3 Materials and Resources (MR)

Caltrans considers Life-Cycle Cost Analyses (LCCA) in early phase of project development when defining project alternatives. Although LCCA tries to ensure effective investments in California's transportation system, it should not be used as a single tool.
MR-1: Utilize LCCA in decision-making process through PDP along other factors. (1-2-3 points)
MR-2: Construction waste diversion, and
MR-3: Use the following steps in project's material selection:

a. Create environmental material assessment matrix as suggested in Table 1.
b. Find three products which satisfy material specifications (in the same category of materials) needed for a project.
c. Rank each product (out of 100) on their recycled content, sustainable sources or material sustainability, durable materials, and local product.
d. Score each product by adding its rank on items mentioned in step c.
e. Spot products with highest environmental score in the material selection matrix.

Environmental Criteria	Product A	Product B	Product C
Recycled Content			
Sustainable Sources/Sustainability			
Durable Materials			
Local Product			
Environmental Score			

Table 1: Environmental Material Assessment Matrix

6.3.4 Environmental Quality (EQ)

EQ-1: Choose contractors that have any form of Environmental Management System (EMS) defined in their company structure. (prime contractor with EMS: 2 points; sub contractor with EMS: 1 point per sub; up to 3 subs)
EQ-2: Plan appropriate wildlife access across roadway facility right of way. (1 point)
EQ-3: Innovative air quality improvement (1 point)
EQ-4: Public Awareness (1 point)
EQ-5: Management of noise pollution (1-2 points)

6.3.5 Energy and Atmosphere (EA)

EA-1: Design systems to produce and use energy from sunlight. Incorporate such system/s into highway projects,
EA-2: Use of solar energy source in various project phases,
EA-3: Design systems to produce and use energy from wind,
EA-4: Use of wind energy source in various project phases.
EA-5: Incorporate the following specifications in project special provisions.

6.3.6 Access (A)

A-1: Incorporate plans for transportation facilities that increase interaction of various transportation modes (auto, transit, bicycle, and pedestrians) into project plan.
A-2: Provide scenic view facility and access to it. (1 point per facility)

6.3.7 Innovation (I)

Any innovation in highway design, PDP, and etc. that helps environmental sustainability will be considered for bonus points.

7 CONCLUSIONS AND RECOMMENDATIONS

This paper details proposed rating system (RODES) that would promote and stimulate sustainable practices in transportation projects. Further development of RODES would ensure

adequacy of its measurement metrics. Below are some of the recommended areas for future developments of RODES:

- RODES expansion to construction, operation and maintenance.
- Further developments of RODES components through revising RODES credits and requirements by utilizing RODES Review Committee or interested intellectuals.

Moreover, use of a proposed pilot program in Caltrans is strongly recommended. The RODES pilot program is a beta version of the final process. This will expose RODES to various unforeseen challenges while using it as a certification system at the state level. Final adjustments of RODES could be made during the pilot program, making it an ideal certification process.

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