The National Academies of

SCIENCES · ENGINEERING · MEDICINE

TRANSPORTATION RESEARCH BOARD

Sustainable highway construction

April 28, 2020
2:00-3:30 PM Eastern

@NASEMTRB
#TRBwebinar

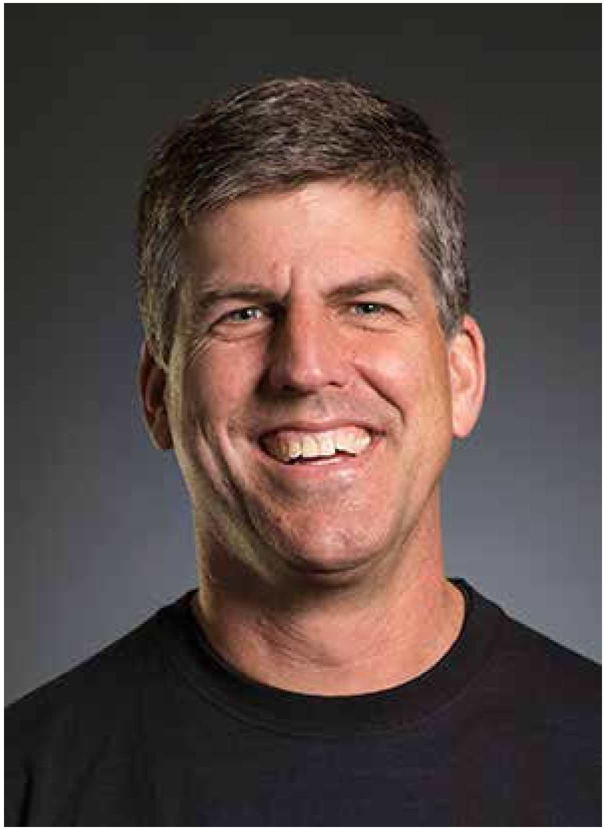
The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.

Learning Objectives

- Define sustainability as it relates to highway construction
- Use the guidebook to generate sustainable construction practice ideas
- Write a sustainability management plan

NCHRP Report 916:
Sustainable Highway Construction Guidebook

Authors:
Dr. Stephen T. Muench, University of Washington
Dr. Giovanni Migliaccio, University of Washington
Dr. Amlan Mukherjee, Michigan Technological University
Dr. Jeralee Anderson, Greenroads Foundation
Dr. Jessica Kaminsky, University of Washington
Chaitanya Bhat, Michigan Technological University
Milad Zokaei Ashtiani, University of Washington



Steve Muench, **Ph.D., P.E.**
Tom & Marilyn Draeger |
The Beavers Charitable Trust
Professor
University of Washington

Giovanni Migliaccio, **Ph.D.**
Associate Professor
Chair, CM Department
University of Washington

Amlan Mukherjee, **Ph.D., P.E.**
Associate Professor
Michigan Tech University

Presenters

Guidebook Outline

Part 1

- Section 1: Introduction
- Section 2: Background
- Section 3: Sustainable Highway Construction Practices
- Section 4: Evaluating Any Construction Practice for Sustainability
- Section 5: Procuring and Specifying Sustainability
- Section 6: Contracting Sustainability
- Section 7: References (not covered in this presentation)

Part 2: Sustainable Highway Construction Practices

(Part 2 is not covered in this presentation)

Section 1:
Introduction

Audience and Purpose

This Guidebook is intended for the highway construction industry: the practitioners who work for and with owner agencies, construction contractors, designers and related professions. It is intended to assist in:

- Communicating sustainability in highway construction
- Selecting appropriate sustainable construction practices
- Using sustainability as a criterion to evaluate highway construction practices.
- Specifying sustainability in procurement and contracts.

Introduction

Guiding Principles

- Provide concise, useful information to practitioners
  - Use by an industry short on time but wants information
  - Writing is concise and direct
  - Supporting information is left to other publications

- Provide ideas, but do not tell industry how to construct highways
  - An idea book, not a textbook
  - Guidance comes from industry

Scope

Addresses sustainable highway construction practices that can be implemented now. This means practices that:

- Influence how construction is delivered, procured, specified
- Are directly carried out during the construction process
- Can be implemented with today's knowledge/technology

Sustainable planning/design/operation practices are generally not addressed by this Guidebook unless they are directly influenced by construction practices. While such practices are important to sustainability on a large scale they are outside the scope of this Guidebook.

How to Use this Guidebook

- Use the sustainability definition as the common meaning of sustainability when included in construction procurement and contracting.
- Use the sustainability framework to more precisely describe owner goals and objectives in project procurement and contracting.
- Identify what construction categories and practices best address what sustainability components
- A source of ideas for sustainable highway construction
- Evaluate any construction practice for sustainability
- Aid in procuring and contracting sustainability

Section 2:
Background

Background

Sustainability Defined

Construction practices able to assist in (1) building highways, (2) preserving and restoring surrounding ecosystems, (3) meeting basic human needs such as equity, employment, health, safety, and happiness, and (4) managing resources wisely (including, but not limited to, money)

Background
Practical Definition

Sustainable construction practices (SCPs) are those that (1) go above-and-beyond standard practice and/or required national regulatory minimums, or (2) show innovation in meeting these standards and minimums in support of people and the environment.

Sustainability = above-and-beyond for people & environment

About Sustainability

Sustainability:

- Has 3 dimensions: human, environment, economic
- Is context sensitive
- Elevates human, environment, long-term
- Implies improvement
- Goes beyond the bare minimum
- Constantly evolves

Background

Sustainability Trends

In Highway Construction

- Sustainability Values
  - Most organizations value sustainability
  - Generally not as important as cost or schedule
  - Durability and long-life are integral to sustainability
  - Sustainability efforts are driven largely by cost
  - There is no leading entity in highway sustainability

Background

Sustainability Trends (Continued)

- Use of sustainable highway construction practices
  - Little industry guidance of procuring sustainability
  - Materials recycling/reuse is most common SCP
  - Contractors will only do SCPs if there is a business advantage to them, or if they are paid for them
  - Competitive advantage from a new SCP is short-lived
  - SCPs tend to work when used
  - Alternate materials/methods must be as good as current standard practice

SCP = sustainable construction practice

Sustainability & SARS-CoV-2

Now

- Protecting people is consistent with sustainability
- It is common to set priorities within sustainability
- Prioritize people now

Near Future

- Likely economic recession
- Sustainable practices should have: benefits

Section 3:

Sustainable Highway Construction Practices

Highway Construction Framework

Level	Category
Project Delivery	Project Delivery Method
	Financing
	Procurement
	Contract
Project	Scheduling
	Estimating
	Project Controls & Administration
	Earthwork
	Drainage/Sewer/Water
	Aesthetics
	Walls
	Bridges
	Pavement

Level	Category
Project (continued)	Work Zone Traffic Control
	Materials
	Safety
	Employment
	Training
	Community Outreach
	Noise
	Light
	Constructability/ Deconstruction
	Quality
	Equipment
	Utilities
	Landscaping

2 levels, 26 categories

Sustainability Framework

Dimension	Category
Human Wellbeing	Workers
	Neighbors & Stakeholders
	Users
Environmental Wellbeing	Pollution
	Local Ecosystems and Habitat
	Consumption
	Climate
Economic Wellbeing	Project Budget
	Maintenance & Operations
	Econ. Development / Employment

3 dimensions, 10 categories

Highway Construction Framework		Sustainability Framework									
		Human Wellbeing			Environment Wellbeing				Economic Wellbeing		
Level	Category	Workers	Neighbors and Stakeholders	Users	Pollution	Local Ecosystem and Habitat	Consumption	Climate	Project Budget	Maintenance and Operations	Economic Development / Employment
Project Delivery	Project Delivery Method										
	Financing										
	Procurement										
	Contracting										
Project	Scheduling										
	Estimating										
	Project Controls & Administration										
	Earthwork										
	Drainage/Sewer/Water										
	Aesthetics										
	Walls										
	Bridges										
	Pavement										
	Work Zone Traffic Control										
	Materials										
	Safety										
	Employment										
	Training										
	Community Outreach										
	Noise										
	Light										
	Constructability/Deconstruction										
	Quality										
	Equipment										
	Utilities										
	Landscaping										

Key:

If a Highway Construction Category addresses a Sustainability Category, the corresponding cell is colored green

NCHRP

List of SCPs

- 26 construction categories
- 79 sustainable construction practices (SCPs)
- 3 categories with none identified
  - Drainage/water/sewer
  - Walls
  - Landscaping

Project Delivery SCPs

Category	Sustainable Construction Practice
Project Delivery Method	Contractor Input in Design Phase
	Integrated Approach for Sustainable Construction
	Early Inclusion of Sustainability
Financing	Public-Private Partnership (PPP)
Procurement	Include Sustainability in Best Value Procurement
	Life-Cycle Cost in Best-Value Procurement
	Value Engineering during Procurement: Alternative Technical Concept (ATC)
	Sustainable Procurement Rules
Contracting	Value Engineering during Construction: Value Engineering Change Proposals (VECP)
	Use of a Sustainability Rating System
	Indefinite Delivery / Indefinite Quantity (IDIQ) Contracts
	Sustainability Management Plan

Project SCPs (1 of 6)

Category	Sustainable Construction Practice
Scheduling	Accelerated Construction
	Flexible Start Times
	Flexible Work Window
	Full Road Closures
Estimating	Model-based estimating (BIM)
	Use life-cycle costs
Project Controls & Administration	Enhanced Information Technologies (IT)
	Geomatics
Drainage/Sewer/ Water	(no SCPs identified)
Earthwork	Balanced earthwork
	Trenchless drainage renewal
	Ground improvement instead of remove/replace

Project SCPs (2 of 6)

Category	Sustainable Construction Practice
Aesthetics	Economical aesthetic wall design
	Context-sensitive rock slopes
	Construction site aesthetics
Walls	(no SCPs identified)
Bridges	Accelerated bridge construction (ABC)
	Geo-synthetic reinforced soil-integrated bridge systems
	Segmental Concrete
Pavement	General: smoothness specification
	General: warranties
	General: on-site recycling/reuse
	Asphalt: density
	Asphalt: longitudinal joints
	Asphalt: eliminate segregation

Project SCPs (3 of 6)

Category	Sustainable Construction Practice
Pavement (continued)	Asphalt: eliminate density differentials
	Asphalt: tack coat application
	Concrete: dowel alignment
	Concrete: use HIPERPAV to predict early age behavior
	Concrete: non-potable water for mixtures and wash water
Work zone traffic control	Merge Control
	Speed management
	Driver information systems
	Oversized load detection
	Construction vehicle entering/exiting
Materials	Reduce materials use
	Reuse existing materials in place
	Recycle highway materials

Project SCPs (4 of 6)

Category	**Sustainable Construction Practice**
Materials (continued)	Use co-products and waste materials from other industries
	Alternate or improved materials
	Local Materials
	Environmental product declarations (EPDs)
Safety	Sustainable Construction Safety and Health Rating System
	Job hazard analysis
	Automated flagger assistance devices
	Work zone intrusion warning systems
	Unmanned aerial vehicle Inspection
Employment	Meet disadvantaged business enterprise goals
	Local employment
Training	Sustainability training
	Sustainability accreditation for individuals

Project SCPs (5 of 6)

Category	**Sustainable Construction Practice**
Community outreach	Project outreach
Construction Noise	Noise reduction based on ecological impact
	Backup alarm modifications and alternatives
	Use computer models to predict construction noise
Construction Lighting	Lighting plan
	Work zone glare reduction
	Semi-permanent high-mast lighting
Design for Constructability/ Deconstruction	Design for deconstruction
	Adaptive reuse
	Deconstruction
	Constructability reviews for projects
Quality	Quality management plans

Project SCPs (6 of 6)

Category	Sustainable Construction Practice
Equipment	Tier 4 engines
	Alternative fuels
	Automated grade control
	Vehicle Idling Policy
Utilities	Incorporating Utility Considerations in Highway Design
Landscaping	(no SCPs identified)

NCHRP

How to Read the SCPs

- Outline
  - How to read the construction category pages
  - How to read the SCP pages
  - More details of how to read the SCPs

Note:

- SCPs are just listed in Part 1, Section 3.
- Part 2 of the guidebook contains a detailed accounting of all SCPs
- Slides 29-34 describe how to read Part 2, the detailed accounting

How to Read a Category Summary

9.9 Earthwork

Overview

Most roadway construction involves some earthwork (moving of soil mass from one location to another). Earthwork can represent significant project expenses, leading most projects to minimize earthwork where practical. Sustainable earthwork practices generally involve minimizing equipment and haul vehicle operations, which minimizes fuel use, vehicle operating costs, and associated emissions.

Related Categories

Sustainability	Construction	
Workers	Project Delivery Method	Work Zone Traffic Control
Neighbors and Stakeholders	Financing	Materials
Users	Procurement	Safety
Pollution	Contracting	Employment
Local Ecosystem and Habitat	Scheduling	Training
Consumption	Estimating	Community Outreach
Climate	Project Controls/Administration	Noise
Project Budget	*Earthwork*	Lighting
Maintenance and Operations	Drainage/Sewer/Water	Constructability/Deconstruction
Economic Development/Employment	Aesthetics	Quality
	Walls	Equipment
	Bridges	Utilities
	Pavement	Landscaping

Motivations

Business Opportunity	X
Project Requirement	X
Goodwill	

Sustainable Construction Practices

- **Balanced earthwork.** Balancing cut and fill to reduce earthwork hauling and associated fuel use and emissions.
- **Ground improvement for construction.** Techniques used to improve geotechnical characteristics of ground that would otherwise be unsuitable for construction.
- **Trenchless drainage renewal.** Drainage renewal methods that avoid open-cut trenches and thus eliminate trenches in the traveled lanes and reduce equipment use and associated fuel use and emissions.

Principal Guidance, Assistance, and Tools

Nazarian, S., M. Mazari, I. N. Abdallah, et al. 2015. *Modulus-Based Construction Specification for Compaction of Earthwork and Unbound Aggregate.* Transportation Research Board of the National Academies, Washington, D.C.

TRB. n.d. Transportation Earthworks: Information Resource Center. http://www.trb.org/AFS10/AFS10.aspx.

Sustainable Highway Construction Practices

Details (how to read *related categories*)

Sustainability	**Construction**	
Workers	Project Delivery Method	Work Zone Traffic Control
Neighbors and Stakeholders	Financing	Materials
Users	Procurement	Safety
Pollution	Contracting	Employment
Local Ecosystem and Habitat		Training
Consumption	Estimating	Community Outreach
Climate	Project Controls & Admin.	Noise
Project Budget	Earthwork	Light
Maintenance and Operations	Drainage/Sewer/Water	Constructability/Deconstruction
Economic Dev. /Employment	Aesthetics	Quality
	Walls	Equipment
	Bridges	Utilities
	Pavement	Landscaping

Left side: Relates given construction category to sustainability
Right side: Relates given category to other construction categories

Sustainable Highway Construction Practices

Details (how to read *motivations*)

Business Opportunity	X
Project Requirement	X
Goodwill	

Business opportunity. The SCP offer the contractor the opportunity to increase revenue and/or market share, reduce expenses, increase employee productivity, and/or reduce risks.

Project requirement. The SCP likely costs the contractor more to accomplish than it receives in benefit, therefore contractors could be expected to accomplish these SCPs only if required to by contract and properly compensated. This happens most often when the expense of accomplishing an SCP is assigned to the contractor, but the benefits of the SCP accrue to the owner or general public.

Goodwill. The SCP might be accomplished by the contractor for the greater good of society regardless of contractor expense.

How to Read a Sustainable Construction Practice

9.22.1 Constructability Reviews for Projects

Effort (time and cost):	2.4	Impact/Effort Ratio
Human Welfare:	1.8	2.9
Environmental Benefit:	2.1	
Cost Savings:	3.1	

Summary

The review process usually occurs during the design phase and is intended to ensure that (1) the design can be constructed using standard materials and techniques, (2) the plans and specifications provide clear, non-conflicting information, and (3) the project will result in something that can reasonably be maintained over time. Post-construction reviews can help correct problems encountered on future projects and are done by most state DOTs (AASHTO, 2000). Constructability reviews work for all project delivery methods, and many state DOTs have written constructability review processes. Benefits are typically lower construction cost because of fewer disputes, and more efficient construction techniques.

Key References

AASHTO and NSBA. 2016. *G12.1-2016: Guidelines to Design for Constructability*. Collaboration of AASHTO and National Steel Bridge Association.

AASHTO. 2000. Constructability Review Best Practices Guide. AASHTO Subcommittee on Construction.

NCHRP Project 10-99, Framework for Implementing Constructability across the Entire Project Development Process: NEPA to Final Design, is ongoing at the time of this publication.

Details (SCP ratings described)

Effort (time and cost):	2.3	Impact/Effort Ratio
Human Welfare:	2.9	2.4
Environmental Benefit:	1.1	
Cost Savings:	1.5	

Average expert rating on a scale of
0 (no effect/impact) to 5 (large impact/effect)

Effort. Combined rating that represents the cost and time you it takes to do or implement the sustainable practice.

Human welfare. The impact the sustainable practice has on human health and well-being.

Environmental benefit. The positive impact the sustainable practice has on the environment.

Cost savings. Immediate and long-term cost savings from the sustainable practice. The cost of a SCP is captured in the "effort" topic, the savings is captured here.

Sustainable Highway Construction Practices

Details (SCP ratings explained)

What the ratings represent

Each SCP has been rated by a panel of experts for the necessary effort to do it, and the sustainability impacts it can have. Ratings represent an average of the expert panel's of each SCP within the context of their own professional experience.

Why do the ratings

These ratings provide value by (1) quantifying expert industry perception of each SCP, and (2) stimulating debate and thought about each SCPs contribution to sustainability within the context of a particular project.

Who did the ratings

Ratings were done by 22 individuals where were either (1) panel members for this NCHRP project, (2) industry experts invited to a workshop conducted for this NCHRP project, or (3) the project team that did the work for this NCHRP project.

Sustainable Highway Construction Practices

Details (SCP ratings explained)

All ratings are relative

Effort and impacts for most SCPs vary based on project context. For instance, balanced earthwork may have a large impact on an earthwork-intensive project but may have little impact on a pavement overlay. It is nearly impossible to rate a SCP for all possible contexts Therefore, experts rated SCPs based on their own personal experience and knowledge, which varies between experts.

How to use the ratings

Ratings represent a general perception of the SCP, which may or may not coincide with reality for a given context. Use these ratings as a quick guide to their effort and impacts but be comfortable with overriding them for a given project's context. For example, is listed at a 2.5 for effort, but a particular project may have geometric constraints and neighborhood concerns that might make it more appropriate to consider effort a 4 or 5.

Details (SCP ratings explained)

Rating perceptions may not be generalizable

Ratings by a select group of industry professionals may not be representative of the industry as a whole. This is true of any non-randomly selected sample population. However, raters were not selected based on their ability to replicate industry perception, but rather they were selected based on their expertise in highway construction and their knowledge of sustainability as it is defined in this Guidebook; both essential to produce ratings consistent with the ideas presented in this Guidebook.

There is no absolute truth in sustainability ratings

Sustainability is context sensitive and multi-faceted; traits which effectively prohibit a universal metric based on physically measurable parameters. Therefore, sustainability ratings and accounting standards necessarily involve subjectivity.

9.2.1 Public-Private Partnership (PPP)

		Impact/Effort Ratio
Effort (time and cost):	3.6	1.8
Human Welfare:	2.1	
Environmental Benefit:	1.6	
Cost Savings:	2.8	

Summary

The U.S. DOT's report to congress on PPPs in 2004 defines PPP as ". . . a contractual agreement formed between public and private sector partners, which allow more private sector participation than is traditional. The agreements usually involve a government agency contracting with a private company to renovate, construct, operate, maintain, and/or manage a facility or system.

While the public sector usually retains ownership in the facility or system, the private party will be given additional decision rights in determining how the project or task will be completed."

A PPP represents a different way of financing than the traditional 100% government-financed project. Because private sector financing partners are included, PPPs can alter traditional highway construction goals to ones that may be more sustainable. For instance, PPPs can finance projects beyond available public funds, shift cost thinking to a life-cycle approach, introduce nontraditional private entity values into a project, and perhaps deliver projects sooner and for less money. For instance, some private entities have stockholder or other mandates for sustainable investment, which may motivate them to push for sustainability features and/or sustainability rating system certification. More directly, the Sustainability Accounting Standards Board standards for construction services companies contains a metric that requires reporting the "number of (1) commissioned projects certified to a multi-attribute sustainability standard and (2) active projects seeking such certification."

Key References

FHWA. 2018. *Center for Innovative Finance Support. Public Private Partnerships (P3).* https://www.fhwa.dot.gov/ipd/p3. Accessed September 2018.

Jenkins, B., L. Amini, K. deMello, et al. 2019. *NCHRP Synthesis 540: Leveraging Private Capital for Infrastructure Renewal*. Transportation Research Board of the National Academies, Washington, D.C.

Parsons Brinkerhoff, Nossaman LLP, and HS Public Affairs. 2015. *Effect of Public-Private Partnerships and Nontraditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making.* SHRP 2 Report S2-C12-RW-1.

9.15.7 Environmental Product Declarations (EPDs)

		Impact/Effort Ratio
Effort (time and cost):	2.8	2.0
Human Welfare:	1.9	
Environmental Benefit:	2.8	
Cost Savings:	0.7	

Summary

EPDs are third-party verified documents that communicate the environmental impacts of a material using a cradle-to-gate life-cycle assessment (LCA). ISO 14025 (2006) and ISO 21930 (2017) provide a compliance regime for developing EPDs. EPDs can be used to benchmark impacts of a pavement or construction process, and in the long-run to consider improvements in design and construction to reduce impacts. The pavement construction materials industry has embraced LCA, and both the concrete and asphalt industries have developed ISO 14025 and EN 15804 compliant EPD programs. Additionally, the Buy Clean California Act (2017) requires successful bids to produce EPDs for a list of eligible materials before installing them. The use of EPDs in the highway industry is in its infancy but may become much more commonplace in the coming years.

Key References

ISO 14025. 2006. *Environmental Labels and Declarations—Type III Environmental Declarations—Principles and Procedures*. https://www.iso.org/standard/38131.html.

ISO 21930. 2018. *Sustainability in Buildings and Civil Engineering Works*. http://www.iso.org/standard/61694.html.

Assembly Bill No. 262. 2017. Public Contracts: Bid Specifications: Buy Clean California Act. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB262.

Kanaras, K. 2018. *NAPA EPD Program*. National Asphalt Pavement Association. http://www.asphaltpavement.org/EPD.

University of Washington. 2017. *Concrete Product Category Rule: Establishing the Standard to Calculate EPDs*. Carbon Leadership Forum. http://www.carbonleadershipforum.org/2017/01/03/concrete-pcr.

9.13.1 Smoothness Specification

		Impact/Effort Ratio
Effort (time and cost):	2.1	2.9
Human Welfare:	2.4	
Environmental Benefit:	2.1	
Cost Savings:	1.4	

Summary

Smoothness is a defining quality characteristic for pavement. Smoother pavements are generally thought to be an indicator of higher construction quality. They reduce vehicle operating costs and emissions, and there is evidence that they are more durable. Tactics for achieving smoothness vary with pavement type, but include underlying surface preparation, uniform delivery of material through the paver, grade control, compaction/consolidation efforts, and joint construction.

About ¾ of state DOT asphalt pavement specifications have International Roughness Index–based smoothness requirements and about 90% of those involve incentive/disincentive pay adjustments based on statistical analysis (Merritt et al., 2015). About half of smoothness is related to the roughness of the underlying layer and improvements in smoothness per lift are on the order of 40% to 65% at most. For those states that base pay on smoothness, the lower limit for full pay (lower values would result in a penalty) ranges from 43 to 100 inches/mile (Merritt et al., 2015). Incentive/disincentive specifications for smoothness should also allow for construction methods to improve smoothness such as leveling course and milling of the existing surface.

Key References

Merritt, D. K., G. K. Chang, and J. L. Rutledge. 2015. *Best Practices for Achieving and Measuring Pavement Smoothness, A Synthesis of State-of-Practice*. Southeast Transportation Consortium, Final Report 550. Louisiana Transportation Research Center, Baton Rouge, Louisiana.

Brock, J. D., and J. Hedderich. 2007. *Pavement Smoothness*. Technical Paper T-123. Astec Industries, Chattanooga, Tennessee.

SCP Rating Top/Bottom 10 Lists

Top/Bottom 10 SCPs for Human Welfare

	Top 10 SCPs	**Score**
1.	Contractor communications	3.8
2.	Public outreach	3.7
3.	Suicide prevention programs	3.6
4.	Accelerated bridge construction (ABC)	3.6
5.	Use a sustainability rating system	3.5
6.	Driver information systems	3.4
7.	Backup alarm modifications and alternatives	3.4
8.	Work zone intrusion alerting systems (WZIA) technology	3.3
9.	Work zone glare reduction	3.3
10.	Semi-permanent high-mast lighting	3.2

	Bottom 10 SCPs	Score
67.	Asphalt: density	1.1
68.	Ground improvement instead of remove/replace	1.0
69.	Asphalt: eliminate density differentials	1.0
70.	Asphalt: tack coat application	0.9
71.	Concrete: HIPERPAV to predict early age behavior	0.9
72.	Paver automated grade control	0.9
73.	Geomatics	0.9
74.	Concrete: dowel bar alignment	0.8
75.	IDIQ contract	0.5
76.	Model-based estimation	0.5

SCP Rating Top/Bottom 10 Lists

Top/Bottom 10 SCPs for Environmental Benefit

Top 10 SCPs		Score
1.	Use of recycled and supplementary materials	4.2
2.	Paving: on-site recycling/reuse	3.9
3.	Use a sustainability rating system	3.6
4.	Adaptive reuse	3.5
5.	Include sustainability in best value procurement	3.5
6.	Limit site disturbance	3.4
7.	Innovative use of materials in construction	3.4
8.	Early inclusion of sustainability objectives	3.3
9.	Trenchless technologies	3.3
10.	Concrete: non-potable water for concrete & wash water	3.2

Bottom 10 SCPs		Score
67.	Contractor communications	0.8
68.	Merge control	0.7
69.	Construction vehicle entering/exiting	0.6
70.	Construction site aesthetics	0.6
71.	IDIQ contract	0.5
72.	Oversized load detection technology	0.5
73.	Automated flagger assistance devices (AFAD)	0.2
74.	Work zone intrusion alerting systems (WZIA)	0.2
75.	Suicide prevention programs	0.1
76.	Increasing employment opportunities	0.0

SCP Rating Top/Bottom 10 Lists

Top/Bottom 10 SCPs for Cost Savings

	Top 10 SCPs	Score
1.	Life cycle cost analysis (LCCA)	3.5
2.	Delivery methods that allow contractor input in design	3.4
3.	Balanced cut/fill	3.4
4.	Constructability reviews for projects	3.3
5.	Value engineering during construction	3.1
6.	Pavement on-site recycling/reuse	3.1
7.	Model-based estimation	3.0
8.	Geo-synthetic reinforced soil-integrated bridge systems	3.0
9.	Public-private partnership	2.8
10.	Use of recycled and supplementary materials	2.8

	Bottom 10 SCPs	Score
67.	Work zone glare reduction	1.0
68.	Tier 4 engines	1.0
69.	Suicide prevention programs	1.0
70.	Alternative fuels	0.9
71.	EPDS included in contracts	0.7
72.	Noise reduction based on ecological impact	0.7
73.	Use computer models to predict construction noise	0.6
74.	Reduce noise	0.6
75.	EPDs used for materials	0.4
76.	Increasing employment opportunities	0.2

SCP Rating Top/Bottom 10 Lists

Top/Bottom 10 SCPs for Impact/Effort Ratio

	Top 10 SCPs	Score
1.	Vehicle idling policy	5.8
2.	Early inclusion of sustainability objectives	4.5
3.	Non-potable water for concrete mixture & wash wtr	4.5
4.	Use of recycled and supplementary materials	4.3
5.	Include sustainability in best value procurement	4.1
6.	On-site recycling/reuse	3.8
7.	Sustainable procurement rules	3.8
8.	Balance cut/fill	3.7
9.	Schedule flexibility for contractor	3.6
10.	Reduce noise	3.5

	Bottom 10 SCPs	Score
67.	Sust. const. safety and health rating system (SCSH)	1.8
68.	Enhanced information technologies	1.8
69.	Public-private partnerships	1.8
70.	Context sensitive rock slopes	1.7
71.	Pavement warranties	1.7
72.	Use computer models to predict construction noise	1.6
73.	Model-based estimation	1.4
74.	Geomatics	1.4
75.	Increasing employment opportunities	1.1
76.	IDIQ contract	0.9

Section 4:

Using Sustainability as a Criterion to Evaluate Any Highway Construction Practice

Process Description

- Determine the impacts of a construction practice on each of the 10 sustainability categories
  - Impacts can be rated as follows:

Value	Criteria
+1	Positive impact that is unquantified or quantified and small (< 1% of contract value)
+2	
–1	Negative impact that is unquantified or quantified and small (< 1% of contract value)
– 2	

  - Consider both impacts during construction and impacts over the life of the facility
  - Life-of-facility impacts weighted 2x
  - Total up impacts (including multipliers)
  - If total is POSITIVE, consider it a SCP (sustainable construction practice)

Using Sustainability as a Criterion to Evaluate Highway Const. Prac.

Process Description (continued)

Dimension	Indicator	Construction Impacts Only	Life of the Facility Impacts
Human Wellbeing	Workers		
	Neighbors & Stakeholders		
	Users		
Environmental Wellbeing	Pollution		
	Local Ecosystems and Habitat		
	Consumption		
	Climate		
Economic Wellbeing	Project Budget		
	Maintenance & Operations		
	Economic Development / Employment		
	SUM		
	MULTIPLIER	x 1	x 2
	SUBTOTAL		
	TOTAL		

Worksheet table

Using Sustainability as a Criterion to Evaluate Highway Const. Prac.

Process Description (customization)

Dimension	Indicator	Weight Factor	Construction Impacts Only	Life of the Facility Impacts
Human Wellbeing	Workers	?		
	Neighbors & Stakeholders	?		
	Users	?		
Environmental Wellbeing	Pollution	?		
	Local Ecosystems and Habitat	?		
	Consumption	?		
	Climate	?		
Economic Wellbeing	Project Budget	?		
	Maintenance & Operations	?		
	Economic Development / Employment	?		
		SUM		
		MULTIPLIER	x ?	x ?
		SUBTOTAL		
		TOTAL		

The process can be customized by

(1) Weighting each sustainability category

(2) Changing the multipliers for construction only and life of the facility

(3) Using actual quantifications instead of +2, +1, -1, -2 values

NCHRP

Section 5:

Procuring Sustainability

Procuring Sustainability

Best-Value Procurement

- Include an environmental considerations evaluation criterion
  - Go beyond requesting proposers' plans to meet regulatory requirements by asking for proposed SCPs that address the environment
- Include a life-cycle cost evaluation criterion
- Include a sustainable construction evaluation criterion
- Set a project goal of achieving a sustainable rating system score, rating, or achievement level
- Use lane rental and traffic control evaluation criteria
- Reward contractors who have experience with sustainability efforts or have credentialed personnel on the project
- Require a sustainability management plan

Terminology and logic based on

Alternative Technical Concepts

- Include sustainability as criterion in ATC evaluation
  - Use sustainability definition from this Guidebook
  - Allow SCPs from Appendix A of this Guidebook
  - Evaluate proposed practices using evaluation method from this Guidebook
  - Use a sustainability rating system

Sustainable Procurement

Definition

A purchasing process that accounts for not only economic but also environmental and social considerations.

Sustainable procurement guidance/examples:

- FHWA Green Procurement Guide (2010)
- California public procurement using EPDs (recent legislation)
- Best-value procurement + context sensitive design may lead to aesthetic and socio-economic procurement criteria

Section 6:
Contracting Sustainability

Ways to Contract Sustainability

- Allowing sustainability
  - Passive method: no guarantee you get anything
  - Contractors do what is allowed AND has business value
  - Example: RAP in asphalt pavement
- Requiring sustainability
  - Aggressive method: get what you specify
  - Call out SCPs in contract and specifications
  - Example: specification to use a particular ABC method
- Incentivizing sustainability
  - Positive method: provide incentive to do SCPs
  - Still does not guarantee accomplishment, but allows contractor to come up with ideas
  - Example: payment to contractor for a staff personnel credentialed in a sustainability rating system being used

Other Contractual Elements

- Pricing sustainability
  - Can price SCPs separately on a unit bid schedule
  - Best to use alternate bid
    - Base bid: project bid as usual
    - Alternative bid: project bid including all SCPs
- Sustainability risk
  - There are risks involved with SCPs
    - SCP may not function as planned
    - SCP may cost more than anticipated
    - SCP may be removed by change order but still required for other reasons (like getting a rating system certification)
  - Project delivery methods that make communication amongst parties easier are better suited to sustainability

Sustainability Management Plans

Definition

A documented plan that describe how sustainability will be incorporated, measured, managed and reported within an organization or project.

Purpose

Ensure high-level project sustainability goals are translated to construction practices in the field, and ultimately, the infrastructure put in place.

Use

Required by specification and part of contract documentation for the project to ensure they are given proper importance.

Procuring Sustainability

Sustainability Management Plans

Key Elements

- Sustainability objectives
- Sustainability roles and responsibilities
- Key deliverables
- Sustainability commitments
- Sustainability measurement
- Plan for reporting issues
- Adjust the plan as necessary to keep it functional

The guidebook also contains a Sustainability Management Plan Template

Today's Panelists

- Steve Muench, stmuench@uw.edu
- Giovanni Migliaccio, gianciro@uw.edu
- Amlan Mukherjee, amlan@mtu.edu

#TRBwebinar

Get Involved with TRB

- Getting involved is free!
- Join a Standing Committee (http://bit.ly/TRBstandingcommittee)
- Become a Friend of a Committee (http://bit.ly/TRBcommittees)
  - Networking opportunities
  - May provide a path to become a Standing Committee member
- For more information: www.mytrb.org
  - Create your account
  - Update your profile

@NASEMTRB

@NASEMTRB

Transportation Research Board

#TRBwebinar

TRB turns 100 on November 11, 2020

Help TRB:

- Promote the value of transportation research;
- Recognize, honor, and celebrate the TRB community; and
- Highlight 100 years of accomplishments.

Learn more at

www.TRB.org/Centennial

#TRB100

MOVING IDEAS: ADVANCING SOCIETY—100 YEARS OF TRANSPORTATION RESEARCH