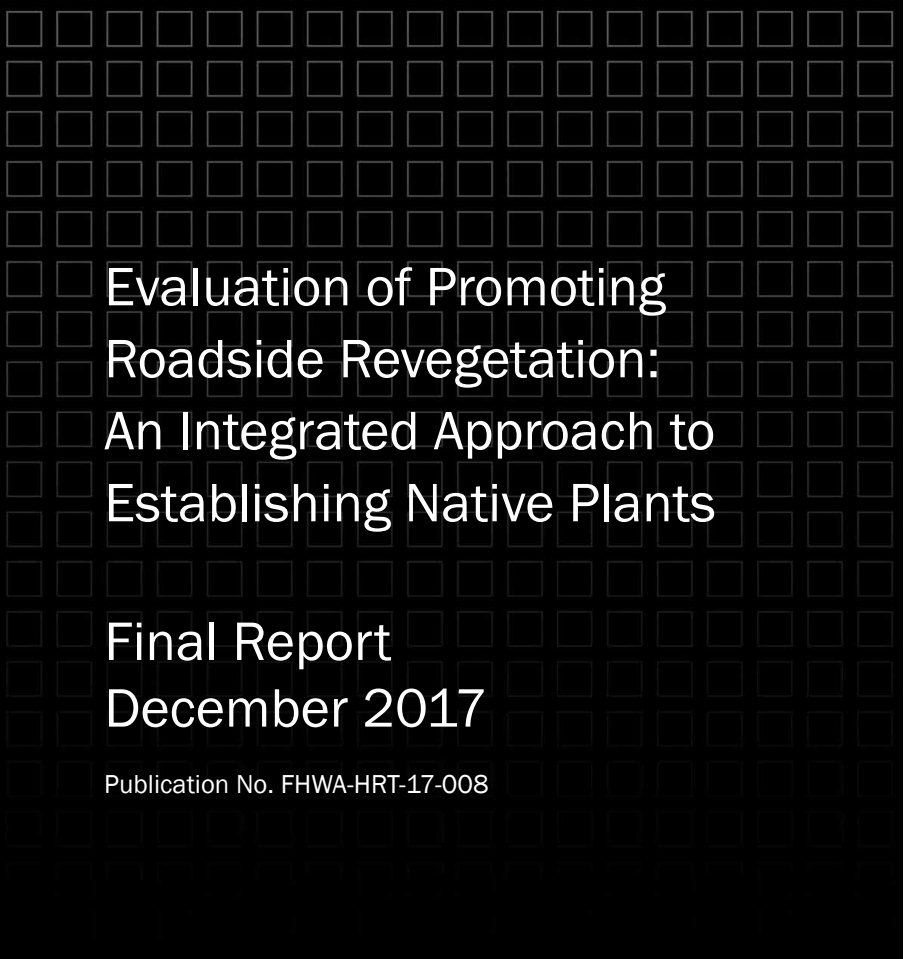
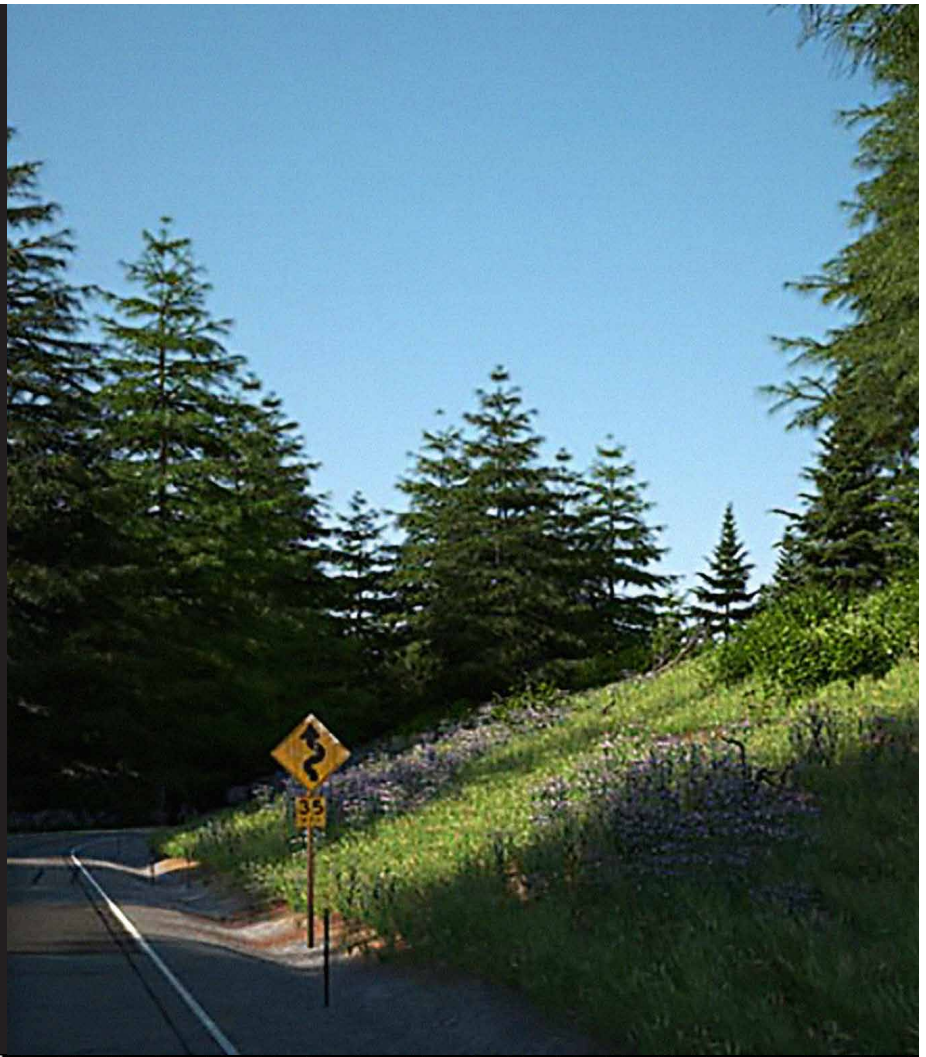


FHWA Research and Technology Evaluation



Evaluation of Promoting Roadside Revegetation: An Integrated Approach to Establishing Native Plants

Final Report
December 2017

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U.S. Department of Transportation
Federal Highway Administration

Foreword

The Federal Highway Administration (FHWA) Research and Technology Program strives to ensure transparency, accessibility, and responsiveness of Research, Development, and Technology (RD&T) for all stakeholders.

This report evaluates outcomes associated with *Roadside Revegetation: A Practical Guide to Working with Native Plants*, a 2007 guide encouraging agencies to adopt improved roadside revegetation practices.⁽¹⁾ Native roadside revegetation involves establishing or reestablishing appropriate plant material on areas that road construction projects disturb. This report should be of interest to natural resource practitioners responsible for the design and implementation of revegetation projects along roadways.

Monique Evans, Acting Associate Administrator
Research, Development, and Technology

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in ²	square inches	645.2	square millimeters	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yard	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	square kilometers	km ²
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic	m ³
meters NOTE: volumes greater than 1000 L shall be				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.47	acres	ac
km ²	square kilometers	0.386	square miles	mi ²
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inc h	lbf/in ²

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
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List of Abbreviations

Abbreviation	Term
AASHTO	American Association of Highway Transportation Officials
BLM	Bureau of Land Management
DVD	digital video disc
evaluation team	FHWA's R&T Evaluation Program Evaluation Team
FHWA	Federal Highway Administration
FLH	Office of Federal Lands Highway
FLMA	Federal Land Management Agency
NPS	National Park Service
R&T	Research and Technology
TIG	Technology Implementation Group
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WFL	Western Federal Lands Highway

Executive Summary

This report documents an evaluation of outcomes associated with *Roadside Revegetation: A Practical Guide to Working with Native Plants*, a 2007 guide encouraging agencies to adopt improved roadside revegetation practices.⁽¹⁾ The Research and Technology (R&T) Evaluation Program was created to help the Federal Highway Administration (FHWA) assess how effectively it is meeting its goals and objectives and to provide useful data to inform future project selections. For each evaluation, FHWA's R&T Evaluation Program Evaluation Team (evaluation team) is made up of non-FHWA third-party evaluators not involved in the research programs and projects being evaluated.

The evaluation describes how effective the guide and related materials such as a website and training course featuring the guide, have been in achieving their stated goals.^(2,3) Specifically, the project team sought to understand the following:

- Whether end users of the guide have changed their previous revegetation practices to adopt those put forth in the guide.⁽¹⁾
- How the establishment of native plants has been improved and resulted in other positive outcomes.

Native roadside revegetation involves establishing or reestablishing appropriate plant material on areas that road construction projects disturb. Its benefits include soil and slope stabilization, improved water quality, aesthetics, carbon sequestration, weed suppression, and enhanced wildlife habitat. Recognizing that sharing information about roadside revegetation processes and techniques is one way to advance the practice and achieve these benefits, FHWA's Office of Federal Lands Highway teamed with the U.S. Forest Service (USFS) to develop an assessment and monitoring protocol for roadside revegetation, which is described in the guide.⁽¹⁾

After conducting a literature review, the project team administered an online survey supplemented by subsequent telephone interviews to learn about end users' perspectives on *Roadside Revegetation*.⁽¹⁾ Informal feedback on the guide that FHWA and USFS have received as well as visitation statistics to *Roadside Revegetation*'s website were also analyzed.⁽³⁾

Findings and Recommendations

The project team found that end users have adopted the *Roadside Revegetation* practices by using the guide as a reference tool to reinforce existing measures mandated by agency policies.⁽⁴⁾ Generally, when end users are aware of *Roadside Revegetation* and its associated materials, they have found the guide to be very informative and useful. There was also evidence suggesting that overall outcomes on projects that apply *Roadside Revegetation*'s recommended practices guide have been improved. Specifically, survey respondents and interviewees believed *Roadside Revegetation* has generally improved erosion, sustainability and environmental stewardship, and visitor experience outcomes (see Establishment of Native Plants and Other Positive Outcomes). There are fewer indications that the technical guide has helped improve safety or reduce maintenance costs.

Given these findings, the following recommendations (discussed in detail in chapter 4) are offered:

- Increase outreach to deliver roadside revegetation to a wider audience, especially within FHWA division offices. This includes identifying appropriate points of contact for revegetation at division offices and in FHWA headquarters.
- Provide additional training in *Roadside Revegetation* practices.⁽¹⁾
- Support the enhancement of the community of practice on the *Roadside Vegetation* website.⁽⁴⁾
- Consider making design standards available for native revegetation.
- Place future emphasis on site preparation and appropriate soil conditions.
- Tailor future roadside revegetation training courses for personnel who do not have natural resource backgrounds.
- Publish articles about this evaluation and any planned follow up activities as part of a renewed outreach effort on roadside revegetation. Potential publications for such an article include FHWA's *Public Roads* magazine or *Successes in Streamlining* newsletter.

1. Introduction



1.1 Evaluation Purpose

Leaders of governmental research and technology (R&T) programs, like that of the Federal Highway Administration (FHWA), have the obligation to communicate the impacts of their programs and to justify the expenditure of public funds. The R&T Evaluation Program was created to help FHWA assess how effectively it is meeting its goals and objectives and to provide useful data to inform future project selections. For each evaluation, FHWA's R&T Evaluation Program Evaluation Team (evaluation team) is made up of non-FHWA third-party evaluators not involved in the research programs and projects being evaluated.

This report documents an evaluation of outcomes associated with *Roadside Revegetation: A Practical Guide to Working with Native Plants*, a guide that FHWA's Office of Federal Lands Highway (FLH) developed in coordination with the U.S. Forest Service (USFS) within the R&T program.⁽¹⁾ The evaluation will help FHWA assess how effectively it is meeting its goals and objectives and provide useful data to inform future project selections.

The goal of *Roadside Revegetation* was to inform and encourage agencies to adopt roadside revegetation practices that improve safety, help avoid erosion, are sustainably designed, reduce maintenance costs, improve visitor experience, and enhance environmental stewardship.⁽¹⁾ Authors wanted to ensure that roadsides were being revegetated and that the resulting revegetation was not failing. FLH selected *Roadside Revegetation* for evaluation to determine how effective the guide was in achieving these goals, which support all of the following FLH R&T agenda objectives:⁽⁵⁾

1. Enhance Federal land management agency (FLMA), tribal, and public road systems to improve transportation access, movement, and traveler experience.
2. Improve FLMA, tribal, and public road systems to enhance safety.
3. Streamline FLMA and tribal processes to improve timeliness and effectiveness of program and project delivery.
4. Deploy new, emerging, underused, and innovative technologies to accelerate project delivery and improve sustainability of low-volume, low-speed roadways.

Because highways located on Federal lands also often serve as test beds for innovations that State and local transportation departments use on their rural roads, it was believed that a secondary benefit of *Roadside Revegetation* would be to influence roadside revegetation practices of agencies beyond FLMAs.⁽⁴⁾

1.2 Report Structure

This report was drafted for the FHWA R&T Program and was structured to coincide with parallel evaluations for other aspects of the program. Chapter 2 covers the evaluation design, which explains the logic model used to develop this evaluation. Chapter 3 describes the three hypotheses developed for this evaluation along with the outcomes and findings. Following the findings and outcomes sections, chapter 4 includes recommendations based on the results of the survey and findings from the interviews. Following the discussion of recommendations, the report concludes with chapter 5, which provides a summary of the overall evaluation.

1.3 Project/Program Background

A total of 28 percent of land in the United States is under Federal stewardship, including national parks, forests, wildlife refuges, and tribal and other Federal lands. Developing and maintaining the transportation networks within these areas poses unique challenges for transportation professionals. The primary purpose of FLH is to provide financial resources and technical assistance for a coordinated program of public roads that meets the transportation needs of Federal and tribal lands. FLH works in partnership with a diverse array of Federal agencies to identify new construction and maintenance techniques that are appropriate for environmentally sensitive and sparsely populated rural areas.

Native roadside revegetation involves establishing or reestablishing appropriate plant material on areas disturbed by road construction projects. Its benefits include soil and slope stabilization, improved water quality, aesthetics, carbon sequestration, weed suppression, and enhanced wildlife habitat. Recognizing that sharing information about roadside revegetation processes and techniques is one way to advance the practice and achieve these benefits, FHWA and USFS began working together in the 1990s to study successes and failures from projects that voluntarily tried roadside revegetation techniques. Together, the agencies identified a set of best practices and then created a process for revegetating roadsides using native plants, which they documented in *Roadside Revegetation*.⁽¹⁾ After publishing the manual, FHWA focused its efforts on sharing the information and training practitioners via an interactive website with an online training component and case studies.⁽⁴⁾ FHWA also offered an onsite, two-day training course for agencies participating in FHWA's Coordinated Technology Implementation Program.⁽⁶⁾

In 2011, FHWA conducted a national scan to better understand how end users were using recommended revegetation techniques. FHWA identified eight sites that were using *Roadside Revegetation*, and a panel of revegetation experts from FHWA, USFS, the National Park Service (NPS), the U.S. Fish and Wildlife Service (USFWS), and the Colorado Department of Transportation (CDOT) visited sites in New York, Oregon, Idaho, and Vermont. The field visits provided the panel with firsthand knowledge of native vegetation projects across the country that were then documented in a set of case studies in a domestic scan book and on video—both of which are available on the website.^(4,7,8) The results of the domestic scan found several key factors for revegetation project success that were consistently observed at all of the project sites, including early planning,

clear project objectives, collaboration among stakeholders, contractor commitment to revegetation, maintenance, and monitoring. The domestic scan also found that the planning phase of a native revegetation project is as vital to the success of a project as the installation phase. As discussed in subsequent sections of this report, several interviewees noted that performance standards along with the establishment of monitoring and maintenance protocols are key to long-term success—reiterating findings from the domestic scan.

2. Evaluation Design



A logic model is a series of statements that links program components in a chain of causality. Program components include inputs, activities, outputs, outcomes, and impacts. Logic models describe the relationships among program resources, planned activities, and expected results; ultimately, they make explicit how program stakeholders expect program activities to affect change. The project team evaluating *Roadside Revegetation* traced the desired effects of the guide using the logic model in table 1.⁽¹⁾

Table 1. *Roadside Revegetation* evaluation logic model.⁽¹⁾

Inputs	Activities	Outputs	Short-Term Outcomes	Medium- and Long-Term Outcomes
<ul style="list-style-type: none"> • FHWA R&T funding • Existing roadside revegetation research • FHWA/FLH staff • Partnerships with FLMAs • AASHTO partnership • Contractor support 	<ul style="list-style-type: none"> • Partnering with FLMAs to develop <i>Roadside Revegetation</i> technical guide⁽¹⁾ • Development of website⁽⁴⁾ • Information gathering • Domestic scan of eight sites • Creation of case studies • Presentation at workshops and conferences 	<ul style="list-style-type: none"> • <i>Roadside Revegetation</i> guide • Managers' guide⁽⁹⁾ • Illustrative guide⁽¹⁰⁾ • Interactive website • Video⁽⁸⁾ • Delivery of onsite training course⁽³⁾ • Domestic scan report⁽⁷⁾ • Poster⁽¹¹⁾ • Fact sheet⁽¹²⁾ • Timeline graphic⁽¹³⁾ 	<ul style="list-style-type: none"> • Awareness among stakeholders of new roadside revegetation practices/materials • Modified revegetation practice among stakeholders 	<ul style="list-style-type: none"> • Permanent adoption of more sustainable roadside revegetation practices • Improved safety • Avoided or reduced erosion • Reduced maintenance costs • Improved visitor experience • Enhanced environmental stewardship

AASHTO = American Association of State and Highway Transportation Officials.

The project team sought to answer the following two primary research questions regarding outcomes of the *Roadside Revegetation* and related material outputs:⁽¹⁾

- To what extent have stakeholders adopted the practices described in *Roadside Revegetation* and related materials?
- Have *Roadside Revegetation* and related materials improved the establishment of native plants and resulted in other positive outcomes?

The first research question was intended to find whether *Roadside Revegetation*'s recommended practices had been effective in meeting end users' needs.⁽⁴⁾ In other words, did *Roadside Revegetation* materials encourage and help stakeholders change or supplement previous practices and with *Roadside Revegetation* techniques? The second research question was intended to examine the relationship between activities; outputs; and short-, medium-, and long-term outcomes. In other words, has the development and promotion of *Roadside Revegetation*, awareness of the materials, and adoption of the promoted techniques resulted in positive outcomes for the environment, safety, visitor experience, and maintenance costs (see table 2)?

Table 2. Performance measures for short-, medium-, and long-term outcomes.

Outcome Type	Evaluation Component	Performance Measures
Short	Raised awareness among stakeholders of <i>Roadside Revegetation</i> ⁽¹⁾	<ul style="list-style-type: none"> • Number of stakeholders aware by region, agency type, etc. • Number of information requests received by FHWA
Short	Modified revegetation practice among stakeholders	Percentage of surveyed stakeholders who have adopted <i>Roadside Revegetation</i> 's recommended practice
Medium/long	Improved safety	Survey and interview input on any available correlative data on accidents with and without use of recommended practices; otherwise, qualitative views on the topic
Medium/long	Avoided or reduced erosion	Survey and interview input showing degree of reduced erosion, if available; otherwise, qualitative views on the topic
Medium/long	Reduced maintenance costs	<ul style="list-style-type: none"> • Survey and interview input describing cost comparison recommended versus alternate practices • Documented reduced herbicide or pesticide use
Medium/long	Improved visitor experience	Survey and interview input on whether visitors have noticed or commented on the qualities (e.g., beauty and driving experience) of a revegetated roadside with the recommended practices
Medium/long	Led to permanent adoption of more sustainable roadside revegetation practices	Survey and interview input on the benefits of using the recommended practices
Medium/long	Enhanced environmental stewardship	Survey and interview input on the benefits of using the recommended practices

2.1 Evaluation Methodology

The project team sought to answer the research questions by collecting both quantitative and qualitative information. The project team first conducted a review of relevant literature on roadside revegetation to begin the evaluation. Statistics from *Roadside Revegetation*'s website were then analyzed to gain insight on how interest in the guide may have changed over time.^(4,1) The project team also solicited information from FHWA and USFS regarding past requests for copies of *Roadside Revegetation* or training on the guide's principles. These background-gathering activities were followed by an online survey of revegetation practitioners and telephone interviews with select survey respondents to gain additional insights not possible in the survey.

Literature Review

Literature was collected primarily from screening relevant websites and through library scans on keywords such as “roadside revegetation” and “native revegetation.” The project team researched various public institutions, State transportation departments, the Bureau of Land Management (BLM), and NPS for relevant manuals and policy and guidance documents. Information, including manuals, policy, reports, and case studies from these and other agencies, was also collected. The project team also recorded other research reports that have cited *Roadside Revegetation* (see section entitled End Users’ Adoption of Roadside Revegetation Practices).⁽¹⁾

Website Visitation Analysis

The website for *Roadside Revegetation* is www.NativeRevegetation.org.⁽⁴⁾ FHWA’s Western Federal Lands (WFL) has been using Google® Analytics™ to track website visitation statistics since January 2010. WFL provided the project team with historical Web statistics for all dates between January 1, 2010, and February 17, 2015. The visitation statistics summary report for the *Roadside Revegetation* website includes the following five sections:⁽⁴⁾

- Audience Overview provides data on the numbers of sessions, users, and page views the website has had. It also reports the average number of pages viewed per website session, the average duration of a session, and the percentage of sessions that are started by new visitors. Visitation by country (as defined by “language”) is also noted.
- Content Drilldown sorts the website’s various pages by frequency of visitation, average page view time, and number of unique views.
- Landing Pages shows where visitors are entering the website.
- Exit Pages indicates from where visitors typically leave.
- Pages Report provides basic information for each page viewed on websites, including the number of times a page was viewed, the average time a user stayed on the page, the page’s bounce rate, and what percentage of visitors left through a specific page.¹

WFL/USFS Correspondence

The staff from WFL and USFS who drafted *Roadside Revegetation* and content for the associated website noted to the project team that much of the feedback regarding the guidance materials had come in the form of personal anecdotal interaction or correspondence from end users.^(1,4) Recent examples of emails from *Roadside Revegetation* end users were provided to the evaluation team. These emails offer insights about the perceived quality and effectiveness of the guide and Website.²

¹Bounce rate is defined as the percentage of single-page sessions. It represents the percentage of visitors who enter and leave a site after viewing one page versus continuing on to view additional pages within the same site.

²The project team received a series of internal emails from FHWA and USFS from *Roadside Revegetation* end users. The project team used these emails for the analysis.⁽¹⁾

Online Survey

From April 1, 2015, to approximately July 31, 2015, the project team administered an online survey of Federal agencies (appendix A) and offices or units that may have implemented *Roadside Revegetation* practices.⁽¹⁾ The project team re-opened the survey between March 1 and March 15, 2016, to encourage additional responses from FHWA. End users were expected to be staff from FLMAs, State and local transportation departments, tribal governments, FHWA division offices, and other Federal agencies and administrations that may have contracted out revegetation projects.

The survey asked questions regarding the level of awareness of *Roadside Revegetation* and its website, the extent to which stakeholders have adopted the practices described in the guide, and how effective the changed practices have been in achieving the establishment of native plants and other positive outcomes along roadsides (see appendix A).^(1,4)

Telephone Interviews

The project team selected respondents for interviews based on responses to the online survey. The project team contacted 10 respondents to invite them to participate in a follow-up telephone interview. Four individuals participated in follow-up calls. The interviews built on the online survey, asking in-depth questions related to the respondents' experiences using native plants and their end results. Calls were conducted using a standard interview guide that provided consistency across interviews (see appendix B), and interviewees shared a wide range of thoughts on the subject material and *Roadside Revegetation* itself.⁽⁴⁾ The project team documented the interviews in detailed notes.

2.2 Data Limitations

There are no data limitation concerns regarding the literature review and the website visitation statistics.⁽⁴⁾ Regarding email correspondence to FHWA and USFS, a minor limitation relates to feedback collected. FHWA and USFS may not have tracked all of the email, telephone, and in-person feedback on *Roadside Revegetation* that they have received.⁽⁴⁾ Of the feedback tracked, all example anecdotes provided to the evaluation team reflect positively on *Roadside Revegetation*. This does not mean that FHWA and USFS selectively tracked feedback, but there may have been end users who had unfavorable views of the guide but who did not provide their input to FHWA and USFS.

In terms of the survey, its results present the following three limitations:

- Given that the size of the target population is unknown, it was not possible to conclusively assess the quality of the response rate.
- Federal regulation limits the scope of information requests to Federal agencies only without Office of Management and Budget approval. FHWA and USFS speculated that a significant cohort of *Roadside Revegetation* end users included staff from State transportation departments.⁽¹⁾ It was not possible for the evaluation team to send the survey directly to State transportation departments. Instead, the team relied on FHWA division offices to respond as proxies for their counterpart State transportation departments and/or retrieve and report their respective States' views on behalf of the State transportation departments. Some FHWA division offices chose not to answer any survey questions, noting that the questions would be best directed toward State transportation departments. Other FHWA division offices forwarded the survey to their State transportation department counterparts on their own volition.
- The evaluation team intended to use survey results to screen candidates for more in-depth telephone interviews. The survey elicited 71 responses. However, 17 responses were incomplete in that the potential respondents only provided contact information or a response to the first question. Out of the other respondents, 27 were not aware of *Roadside Revegetation*.⁽¹⁾ Seven of the top interview candidates indicated that they did not want to participate in follow-up interviews. These factors reduced the potential pool of interviewees to 18. Of the remaining 18, 4 were staff members from the same organization who separately responded to the survey with similar input. (One was contacted and participated in an interview.) Of the remaining candidates, four participated in phone conversations, while others did not answer requests for interviews or declined interviews when the evaluation team tried to schedule convenient times.

3. Evaluation Findings



3.1 End Users' Adoption of Roadside Revegetation Practices

The first high-level question the project team addressed concerned whether *Roadside Revegetation* had encouraged and helped stakeholders change or supplement their native roadside revegetation practices.⁽¹⁾

The project team found that end users have adopted the *Roadside Revegetation* practices by using the guide as a reference tool to reinforce practices that agency policies already mandated.⁽¹⁾

Literature Review Results

In 2011, FHWA documented the results of a domestic scan aimed at developing a better understanding of processes and techniques used in successful and innovative projects using native plants for roadside revegetation.⁽¹⁴⁾ The scan was also intended to compare the FHWA revegetation effort with projects completed by other agencies to see whether the FHWA revegetation resources had influenced what others were doing. A key finding was that there were many interconnected elements involved in both the technical and non-technical aspects of the revegetation process, all of which should be addressed in a project revegetation plan. Notably, the non-technical aspects—planning, design, implementation, monitoring, and maintenance—were found to be just as critical to the success of revegetation projects as the technical aspects.

Apart from the scan report, the literature review revealed that many FLMAs already have policies, procedures, and guidelines in place for the use of native plants when revegetating roadsides after disturbances. For example, NPS has a conservation policy originating from the late 1980s and early 1990s that calls for the preservation of native plant communities and their genetic resources wherever possible in natural zones.⁽¹⁵⁾ The NPS requires that revegetation of park lands use germplasm taken from populations as closely related genetically and ecologically as possible to park populations. Accordingly, road slopes and other large areas intended to support self-sustaining native plant communities will usually be restored with local genetic stocks of native species. To support the implementation of this policy, NPS has created a Transportation Revegetation Program whereby a team at the NPS Denver Service Center can recommend revegetation strategies (salvage, propagate, or purchase), choose appropriate native species, and assist park personnel in seed and/or cuttings collection.⁽¹⁵⁾ Because many park units in the NPS system do not have the personnel, expertise, or equipment required to propagate quantities of the required native seeds and plants, and few regional offices have plant ecologists or landscape architects available, in 1989, NPS and the Natural Resources Conservation Service developed and signed a cooperative agreement to share technical expertise and develop indigenous native plant materials for use in park revegetation programs.⁽¹⁵⁾ Additionally, some park units, such as Denali National Park & Preserve, do have their own revegetation manuals.⁽¹⁶⁾

USFS has a similar native plant materials policy that predates *Roadside Revegetation*.^(17,1) According to the policy, native plant materials are to be given primary consideration when selecting plant materials for use in land management projects. Land management prescriptions must include the selection and use of native plant species that are genetically appropriate and adapted to on-the-ground ecological conditions. The policy also requires these prescriptions be written and/or approved by a plant materials specialist who is knowledgeable and trained in the plant community type where vegetation management will occur.

Documents collected also showed that BLM has guidance for the use of native plants for habitat restoration along with other uses such as roadside management.³ BLM, which maintains a large transportation network made up of approximately 76,088 road mi, 776 bridges, and 18,412 mi of multiple-use trails, has a number of programs related to native plant restoration. In 2001, Congress formed the Native Plant Materials Development Program, which BLM administers, to help ensure a stable and economical supply of genetically appropriate native plant materials for use in restoration and rehabilitation efforts on public lands.⁽¹⁸⁾ BLM's Seeds of Success program works to support this program and collects wildland native seed for research, development, germplasm conservation, and ecosystem restoration.⁴⁽¹⁸⁾

For State transportation departments, the project team collected 16 manuals that incorporate specifications for the use of native plants along roadsides. At least nine State transportation department websites were documented that provide information promoting the use of native plants along roadsides. Other collected literature included research and case study documentation conducted within the United States and Australia. Collected documents cover a range of topics related to the installation and maintenance of native plants along roadsides. See appendix C for an annotated bibliography of literature related to *Roadside Revegetation*.⁽¹⁾

Of particular interest is the body of literature that has specifically cited *Roadside Revegetation*.⁽¹⁾ The prevalence of citations of the technical guide across several years suggests that the guide has become integrated into the state of the practice.⁵

³See first four entries in appendix C.

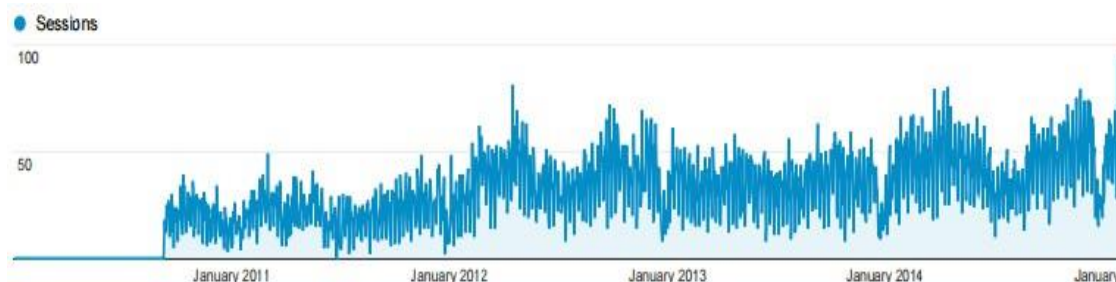
⁴BLM is the largest native seed buyer in the Western Hemisphere. In 1999, BLM's purchase of 6.5 million lb of seed was 70 percent non-native. Since the establishment of the Native Plant Materials Development Program, BLM now uses more native seed than not. From 2004 to 2013 BLM purchased more than 15 million lb of native seed and about 10.8 million lb of non-native seed. One of the issues affecting BLM's purchase of seed for fire rehabilitation, reclamation, and restoration projects is that seed for the desired native species is not always available in the quantity and quality needed. The Native Plant Materials Development Program's mission is to increase the quality and quantity of native plant materials available for restoring and supporting resilient ecosystems. BLM works with a variety of partners, including Federal, local government, non-profit, and private, to accomplish the steps of the native plant materials development process.

www.blm.gov/wo/st/en/prog/more/fish_wildlife_and/plants/1.html

⁵See references 19, 21–27, and 20.

Primary and Secondary Hypotheses and Key Measures of Effectiveness (MOEs)

The project team reviewed visitation statistics to the *Roadside Revegetation* website, which Google® Analytics™ provided.^(4,28) The team hoped to further understand the extent to which users have expressed interest and awareness in *Roadside Revegetation*.⁽⁴⁾ The overall trend shows an increase in website visitation over time (see figure 1).



Source: FHWA.

Figure 1. Screenshot. *Roadside Revegetation* website sessions (January 1, 2010, through February 17, 2015).

The website logged 44,621 total users from January 1, 2010, to February 17, 2015—approximately 24 per day.⁽⁴⁾ Over 7,000 of those users returned to the website more than once. The data show that the most visited pages included those pointing to chapters in the technical guide itself. Specifically, “Chapter 3: Road Plans and Terminology,” “Chapter 5: Assess Site,” and “Chapter 10.3: Implementation Guides, Installing Plant Materials” received the most visitation (see table 3).

Table 3. Website statistics from January 1, 2010, through February 17, 2015.

Statistic	New Users	Returning Users	Total Users
Sessions	—	—	53,183
Users	37,437	7,184	44,621
Page views	—	—	92,764
Pages per session	—	—	1.74
Average session duration	—	—	1 min 14 s
Average time on page—learning page	2 min 24 s	—	65,868
Average time on page—training page	31 s	—	8,653
Average time on page—home page	1 min 13 s	—	7,828
Most popular landing/exit pages—chapter 3	—	—	13,025
Most popular landing/exit pages—chapter 5	—	—	7,617
Most popular landing/exit pages—chapter 10	—	—	5,953

--No data available.

Feedback from the Field

Roadside Revegetation has experienced widespread distribution.⁽⁴⁾ Between 2009 and 2013, WFL received requests for the guide—either via hard copy or electronic download—from all continents except Antarctica. Countries requesting the guide included Australia, Brazil, Canada, China, Egypt, France, Germany, Italy, Peru, Spain, Slovenia, and Sweden. An equally global audience was reached via the following conferences and workshops at which *Roadside Revegetation* was presented:

- Oregon Association of County Engineers and Surveyors, 2008.
- North West Transportation Conference, 2008.
- American Indian Science and Engineering Society, 2009.
- International Conference on Ecology and Transportation, 2011.
- National Trust for Historic Preservation Annual Conference, 2012.
- Transportation Research Board Annual Symposium, 2012.
- National Association of Corrosion Engineers (NACE) Annual Conference, 2010.

Roadside Revegetation was also used as a training course guide and as a resource for university courses.⁽⁴⁾ Specifically, the guide was a centerpiece at the Western Forestry and Conservation Association’s January 2010 training, “Restoration of Disturbed Sites with Native Plants: An Integrated Approach,” in Vancouver, WA. The audience at the workshop included BLM, FHWA, USFS, and NPS staff, as well as personnel from non-governmental organizations and consulting firms.

Similarly, *Roadside Revegetation* has been used as course material at the University of Washington and University of Montana. In Montana, hard copies of *Roadside Revegetation* were also used as a textbook in a College of Forestry class.⁽⁴⁾

In light of the extensive interest in the materials, FHWA and USFS staff have received overwhelmingly positive feedback via face-to-face interactions, telephone calls, and emails, with much of this feedback coming from State transportation departments. Anecdotal praise from both domestic and international end users complements the notion that the guide is well received and that interest (as shown via Web statistics) is sustained.⁽⁴⁾ Some recent examples of this feedback include an email from a professor of ecology at the National University of Mongolia in May 2015 who noted that the website represented excellent work and thanked FHWA staff for their efforts.⁶ A researcher from the Korea National Arboretum added, “The *Roadside Revegetation* book is [a] very useful textbook for us to develop our research project. We are interested in revegetation using native plants in Korea. Recently, we used fast growing trees and shrubs imported from foreign country. These kind of plants are invasive in Korea’s natural habitat... I would like to keep in touch with you [regarding the topic].”⁷

⁶National University of Mongolia, email to FHWA, May 6, 2015.

⁷Korea National Arboretum, email to FHWA, January 8, 2009.

Comparable feedback has been received from domestic end users. An individual with the Oregon Department of Transportation said in June 2015, “Your *Roadside Revegetation* work with Western Federal Lands is THE seminal document on the subject and I have carried it with me for the last 5 years. Congratulations on such an important publication.”⁸ A Washington State Department of Transportation reader said, “As the Landscape Architecture office of the NW region in Washington State, we are constantly on the lookout for publications that will provide good, solid documentation for restoring roadsides. Our office consists of Landscape Architects, Landscape Designers, and CADD operators all with a strong desire to ensure that the roadsides that we design and build are sustainable. Would you please send us...copies of...*Roadside Revegetation* [?].”⁹

The interviewees in this evaluation also shared their praise for the technical guide and website, with one NPS staff member stating that *Roadside Revegetation* “pulls together a lot of useful information into one location.”^{10(1,4)} This person recommends the technical guide to other park units.

In addition to anecdotal praise, the revegetation material was selected as an AASHTO focus technology. AASHTO’s Innovation Initiative (formerly its Technology Implementation Group (TIG)) actively seeks out proven advancements in transportation technology and selects highly valuable innovations with a significant benefit to other agencies. The AASHTO TIG executive committee determined that *Roadside Revegetation* warranted creation of an information piece that was placed on the AASHTO Innovation Initiative website to help increase awareness of the materials.^(1,29) Likewise, FHWA’s *Public Roads* December 2007 issue includes an article that discusses the greening of public roadsides and describes the valuable information presented in *Roadside Revegetation*.⁽³⁰⁾

Survey Results

The survey elicited 71 total responses. Of the 54 responses that included more than a person’s contact information, 21 states and the District of Columbia were represented. Responding agencies included FHWA, USFS, NPS, USFWS, and two State transportation departments. (See references 39, 8, 6, and 3.) Of the 38 FHWA responses, 19 were from FLH, 18 were from State division offices, and 1 was from FHWA headquarters. The 19 FLH responses included 7 each from WFL and Eastern Federal Lands and 5 from Central Federal Lands.

Respondents became aware of *Roadside Revegetation* and its related materials primarily via training courses that FHWA and USFS conducted at various locations in the Pacific Northwest and from FHWA headquarters or a division office.⁽¹⁾ Others indicated that they learned about the technical guide during an annual botany meeting that the USFS hosts, from NPS’s Denver Service Center, from USFS headquarters and field offices, and through Internet searches on roadside revegetation practices.

⁸Oregon Department of Transportation, email to USFS, June 1, 2015.

⁹Washington State Department of Transportation, email to FHWA, November 25, 2009.

¹⁰For more information, see section 2, Telephone Interviews.

The ways that agencies have used the guide have varied. Multiple individuals noted that they primarily used *Roadside Revegetation* as a general reference guide, particularly while on project sites, in writing revegetation plans, while designing monitoring protocols, in developing scopes of work, and in analyzing data.⁽¹⁾ One interviewee commented that the guide is particularly helpful on maintenance topics, especially for those staff members who only have a general awareness of vegetation management. Other respondents noted that their agencies had incorporated *Roadside Revegetation*'s methods into existing restoration practices and construction and materials specifications, especially in coordination with USFS's Restoration Services Team, adding that the information in the guide is "invaluable to the profession."¹¹ An interviewee supplemented this thought, stating that the "authors have worked closely with engineers to be on the same page regarding site preparation. The guide is a good reference for helping to address the complexities that different sites present."¹²

There was also evidence that *Roadside Revegetation* has encouraged some agencies to change and improve specific roadside vegetation management practices.⁽⁴⁾ Responses highlighted how the technical guide has allowed practitioners to better define future conditions and end goals for project sites. With the guide, overall project planning now has an emphasis on coordination with engineers regarding specific planting design specifications. Similarly, prior to the publication of *Roadside Revegetation*, anecdotal evidence was often used for outcome measures. The technical guide provided a way to develop benchmarks against which outcomes might be better measured. One interviewee commented, "Previously, we did a great job of what we had to do, but the end result wasn't always what we wanted it to be. We needed to define the end result better. We were getting low germination; soil was compacted; we wanted more. We never said, if we don't achieve X we've not succeeded. The guide offers useful information on monitoring."¹³

Additionally, *Roadside Revegetation* has improved practices related to soil and site-specific seed mixes, most notably in promoting the use of native plants instead of ornamental species.⁽⁴⁾ According to one respondent, the guide has also increased the use of erosion control devices in lieu of simply using sediment control devices.

A minority of survey respondents noted that *Roadside Revegetation* had not led to any particular change in revegetation practice.⁽⁴⁾ Some respondents pointed out the fact that their agencies had put native revegetation polices in place prior to development of the technical guide. Another respondent noted that its agency's revegetation projects are usually small in scale and therefore did not believe the technical guide to be applicable.

A total of 27 survey respondents indicated that they were not aware of *Roadside Revegetation*.⁽⁴⁾ While these respondents were generally spread across the country, there was a concentration of seven respondents from the southeast who did not know about the guide, suggesting there may be an opportunity for renewed outreach in that region.

¹¹For more information, see section 2, Telephone Interviews.

¹²For more information, see section 2, Telephone Interviews.

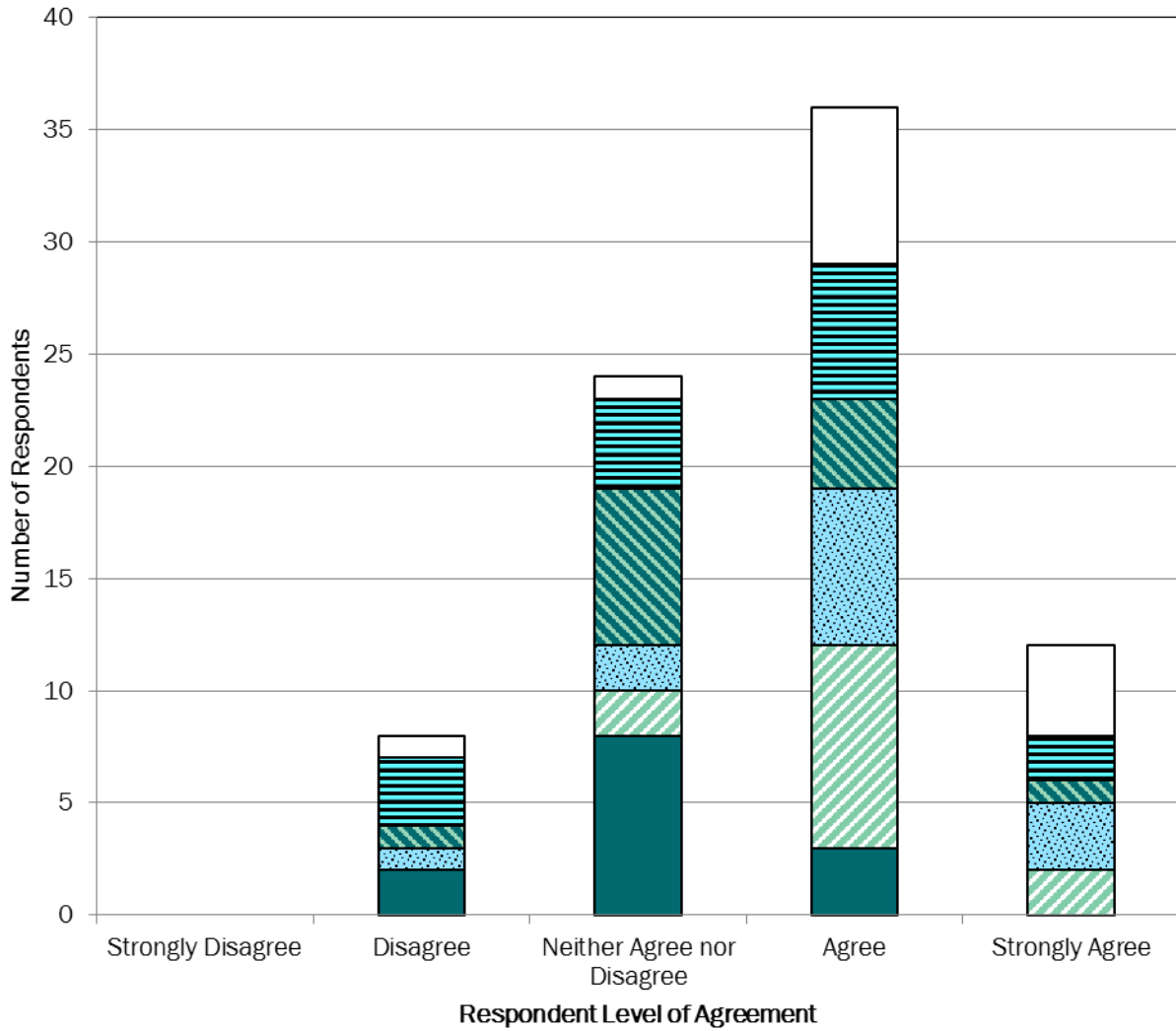
¹³For more information, see section 2, Telephone Interviews.

3.2 Establishment of Native Plants and Other Positive Outcomes

The second high-level question the project team addressed is whether the *Roadside Revegetation* guide and related materials improved the establishment of native plants and resulted in other positive outcomes.⁽⁴⁾ This question examined the relationship between activities, outputs, and short-term outcomes with medium- and long-term outcomes in the logic model. In other words, have the development and promotion of *Roadside Revegetation* and related materials, awareness of the materials, and adoption of the promoted techniques resulted in positive outcomes for the environment, safety, visitor experience, and maintenance costs?

Roadside Revegetation has generally improved erosion, sustainability, environmental stewardship, and visitor experience outcomes.⁽⁴⁾ There is less indication that the technical guide has helped to improve safety or reduce maintenance costs.

Survey results suggested that the majority of survey respondents agreed or strongly agreed that *Roadside Revegetation* has helped improve erosion outcomes, facilitate a more sustainable designed roadway, improve visitor experience, and enhance environmental stewardship.⁽⁴⁾ The findings also suggested that a majority of respondents had neutral views on whether the technical guide has helped improve safety or reduce maintenance costs (see figure 2).



- ENVIRONMENTAL STEWARDSHIP HAS BEEN ENHANCED
- VISITOR EXPERIENCE HAS BEEN IMPROVED
- MAINTENANCE COSTS HAVE BEEN REDUCED
- REVEGETATION NOW MORE SUSTAINABLY DESIGNED
- EROSION HAS BEEN AVOIDED OR REDUCED
- SAFETY HAS BEEN IMPROVED

Source: FHWA.

Figure 2. Graph. Degree to which survey respondents agreed with statements about *Roadside Revegetation*.

The project team used the interview process as a method to gather additional details regarding these six outcomes. In terms of sustainability and environmental stewardship and sustainability outcomes, one interviewee stated that over time, use of native plants increases habitat and promotes natural succession. Regarding maintenance costs, successful native plantings have reduced maintenance costs for many State transportation departments across the country by eliminating mowing and herbicide needs.⁽³¹⁾ Interviewees echoed what several survey respondents pointed out: the application of non-native plants is likely less expensive than using natives, but the maintenance of non-native plants is more costly in the long term. One interviewee added, “Upfront costs are more expensive. Nurseries put a lot of care into producing native plants. But they are hardier, and survivorship is much better than when using traditional methods. The short-term versus long-term benefits are compared, using native plants is more worthwhile.”¹⁴ However, one survey respondent noted that, given funding constraints, revegetation is only done where it is necessary or when funding is available.

Regarding visitor experience, one interviewee noted that sometimes visitor experience anecdotes are used to support funding requests for native revegetation projects. Improving the practice of native revegetation provides visitors with increased viewing and photography opportunities. Another interviewee noted that quick establishment of native revegetation improves public perception of a project, which provides increased community support for similar projects: “Seeing green grass is better than seeing construction. Because the public may not realize the plants are native species, our agency has made an effort to inform the public about natives, which encourages other agencies to also use them.”¹⁵

There was less agreement about whether *Roadside Revegetation* has helped improve safety outcomes. According to one interviewee, while it is important to put the right plants in the right place, there is no correlation between safety and the use of native plants. A majority of survey respondents who answered this question neither agreed nor disagreed with the statement, “Safety has been improved.”

¹⁴For more information, see section 2, Telephone Interviews.

¹⁵For more information, see section 2, Telephone Interviews.



4. Recommendations

Based on the survey evaluations and the interviews, the project team has the following recommendations:

Extend outreach to reach a wider audience, especially within the FHWA division offices:

According to survey and interview results, there are FHWA division office and State transportation department staff who are not aware of *Roadside Revegetation*, especially in regions other than the northwest, who may benefit from the technical guide.⁽¹⁾ Although agencies in these regions may be currently using native plants, the project team found that *Roadside Revegetation* is still a useful reference, even for knowledgeable practitioners. Therefore, expanding the extent to which end users adopt the recommended practices in the revegetation material through increased outreach would be beneficial. A revived outreach campaign reminding division offices about the guide and how it might be applied could broaden the extent of *Roadside Revegetation*'s influence. Such an effort would involve identifying points of contact at FHWA headquarters and FHWA division offices with whom revegetation information can be shared and discussed. Over 4,000 copies of *Roadside Revegetation* were initially printed, many of which went to FHWA division offices. Awareness of the guide within the divisions and beyond likely hinged on whether the appropriate staff member(s) received it.

Provide additional training on *Roadside Revegetation* practices:

Several survey respondents learned about the revegetation material through the training courses that FHWA offered in companion with the release of *Roadside Revegetation*.⁽¹⁾ Interviewees agreed that the course was a great resource and that they would take it again if given the opportunity. One interviewee stated that it would be beneficial if FHWA offered new training courses, noting that with several FLMAAs having experienced a high turnover rate, training is key to improving the practice of native revegetation along roadsides. Another respondent underscored the importance of trainees participating in any course that is offered at the "right time in their careers."¹⁶ This person believed that someone with greater experience in the field might benefit more from the original training course than someone with little or no experience.

¹⁶For more information, see section 2, Telephone Interviews.

Support the enhancement of the *Roadside Revegetation* website community of practice:

Survey respondents and interviewees generally agreed that *Roadside Revegetation* is a comprehensive and useful guide.⁽¹⁾ However, some asserted that it would be beneficial to be able to discuss strategies and work through implementation issues with other professional practitioners. Because Federal and State agencies using native plants are working toward similar goals, interviewees believed that a community of practice where knowledge could be shared could be a cost-effective way to improve implementation outcomes, especially in a time of constrained budgets. Accordingly, the “SHARE” tab on the *Roadside Revegetation* website allows visitors to share their revegetation experiences, which FHWA and USFS can review before posting live for other website users.⁽⁴⁾ One issue is that maintaining the website’s community practice can be a time-intensive activity that is not included with regular job responsibilities. Additionally, few biologists or revegetation experts are available at FHWA to manage the community practice even if funding for their time was not a constraint. Renewed attention to the community of practice and the requirements for effectively managing it could broaden its use among interested stakeholders.

Consider making design standards available for native revegetation:

A survey respondent and interviewee requested design specifications for erosion control material such as erosion control blankets, wattle spacing, and soil lifts. State transportation departments typically have design specifications for these applications. Therefore, it may be straightforward to incorporate design standards that the greater technical guide readership could access to improve outcomes on non-State transportation department projects.

Place future emphasis on site preparation and appropriate soil conditions:

Several respondents and interviewees noted a limitation in the technical guide related to site preparation, specifically soil requirements.⁽¹⁾ Anecdotal evidence points to native plants’ ability to adapt to various conditions; however, during a construction project, soil can become heavily compacted, stripped of necessary nutrients, and replaced in various conditions that can limit the growth of plants. One interviewee stressed that ensuring installation of appropriate soil by contractors is a struggle, commenting that appropriate soil is needed to ensure successful native revegetation projects. Increased knowledge and guidelines would further support the need for appropriate soil conditions and give natural resource specialists the knowledge they need to make requirements in contracts and bid documents.

Tailor future roadside revegetation training courses for personnel who do not have natural resource backgrounds:

Several interviewees noted that they have experienced a knowledge gap between the natural resource practitioners responsible for the design and implementation of a revegetation project and the contractors or maintenance personnel responsible for the installation and long-term oversight of these sites. One interviewee recalled that agency staff have heard stories of contractors installing plants in unsuitable locations or installing plants upside down. One solution the agency had tried was to use an indefinite delivery/indefinite quantity contract that allows an indefinite quantity of services and supplies during a fixed period of time. The contract included a pool of contractors that specialize in native plant installation who can be called on for projects as needed. This approach ensured that qualified professionals were available to work on sites to prevent poor installation. Another interviewee noted that agency staff have started removing native revegetation components from road project contracts. This allows separate bids for native plantings, which then ensures that qualified contractors with native plant experience are used. For those agencies unable to implement these suggestions, training courses geared toward personnel who do not have natural resource backgrounds would be beneficial to highlight the nuances of native plants with specific training for the installation and maintenance of native plants.

Publish an article about this evaluation and any planned follow-up activities related to these recommendations:

Another way to reach a wider audience as part of a renewed outreach drive would be to draft and publish an article describing the outcomes of this evaluation. The article could briefly describe the *Roadside Revegetation* resources available, feedback collected over recent years regarding the materials, and any activities planned to implement this evaluation's recommendations.⁽¹⁾ Potential publications for such an article include FHWA's *Public Roads* magazine or *Successes in Streamlining* newsletter.

5. Conclusions



This evaluation focused on themes of implementation, outcomes, and communication. In implementation terms, the evaluation reported evidence suggesting that practitioners have at least used *Roadside Revegetation* practices to reinforce their own native revegetation specifications and policies, if not having adopted them where practicable.⁽¹⁾ The evaluation also identified outcomes that the use of *Roadside Revegetation* have had for each agency that implemented them. The survey and interview results were used to gain an understanding of outcomes. For the most part, *Roadside Revegetation* has led to improved environmental, cost, and visitor experience outcomes.

Nevertheless, despite having been well received internationally and domestically as evidenced by feedback and peer-reviewed citation, it became apparent that additional outreach and accompanying training could help further promote awareness and use of the revegetation resources. An effective revitalized outreach effort could be similar to what occurred when *Roadside Revegetation* was first published, given the positive feedback that the initial outreach and marketing garnered.⁽¹⁾

Appendix A. Roadside Revegetation Survey

This appendix presents the contents of the Roadside Revegetation survey administered to Federal agencies and offices or units that may have implemented *Roadside Revegetation* practices.

A.1 Introduction

The Federal Highway Administration (FHWA) is evaluating the effectiveness of a joint effort between FHWA and the United States Forest Service to improve the practice of re-vegetating roadsides using native plants. Please answer the survey questions to the best of your ability to help us evaluate how effective the roadside revegetation materials produced as part of this effort have been in meeting end users' roadside revegetation needs.

A.1.1 BACKGROUND

- Your name:
- Email address:
- Phone number:
- Agency name:
- Unit/Department name:
- Unit/Department location:

A.1.2 ROADSIDE REVEGETATION AWARENESS

- Q1. Does your agency/unit (or its contractors) revegetate roadsides after routine road maintenance or new construction projects?

YES / NO

- Q1a. If YES: How many projects are currently being planned that may incorporate native vegetation practices?

NUMBER

- Q1b. How many projects have you completed that incorporated native vegetation practices?

NUMBER

- Q2. Are you aware of the *Roadside Revegetation Technical Guide* and/or related materials available at *NativeRevegetation.org* that FHWA and the U.S. Forest Service developed starting in 2007?

YES / NO

- If NO: End survey.
- Q2a1. If YES: How you were you first made aware of these materials?

OPEN ENDED

- Q2a2. Please describe how your agency/unit has used the information from these materials.

OPEN ENDED

A.1.3 ROADSIDE REVEGETATION IMPLEMENTATION

- Q3. Has the information in the *Roadside Revegetation Technical Guide* and/or related materials on the website *NativeRevegetation.org* led your agency/unit to change its roadside revegetation practices in any way?

YES / NO

- Q4a. If NO: Please briefly describe why the practices described in the materials have not been implemented. If unknown, please note and provide the contact information of someone at your agency who might have this information.
- Unknown/OPEN ENDED, then Q5.
- Q4b. If YES: Please briefly describe what practices have been modified.
- OPEN ENDED, then Q4.

- Q4. Please indicate the degree to which you agree or disagree with the following six statements regarding the roadside revegetation practices your agency adopted as a result of the *Roadside Revegetation Technical Guide* and/or related materials on the website *NativeRevegetation.org*.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Safety has been improved.					
Erosion has been avoided or reduced.					
Roadside revegetation efforts are now more sustainably designed than before.					
Maintenance costs have been reduced.					
Visitor experience has been improved.					
Environmental stewardship has been enhanced.					

Evaluation of Promoting Roadside Revegetation: An Integrated Approach to Establishing Native Plants

- Q5. Are you aware of any Federal, State, or local transportation agencies that have implemented the practices recommended in the *Roadside Revegetation Technical Guide* and/or related materials on the website *NativeRevegetation.org*?
 - YES → Which agencies? /OPEN ENDED
- Q6. Would you be willing to have a brief telephone interview about your responses, if necessary?
 - YES / NO

SURVEY END: The survey is complete. Thank you for taking the time to share your experiences

Appendix B. Telephone Interview Guide

This appendix presents the interview guide used when contacting respondents to the online survey.

B.1 General Introduction

- What is your job and your level of involvement with roadside revegetation at your organization?
- How long have you been with your organization/doing roadside revegetation work?
- Can you describe what policies or guidelines, if any, your organization has on the use of native plants?
- Does your organization use the recommended practices from the *Roadside Revegetation Technical Guide* as part of your standard practice, or are the techniques selectively used? Why? What types of transportation projects? How often are these practices used?
- Generally, what are your organization's primary reasons for using natives (e.g., required as a permit condition; fix a trouble site (i.e., repeat erosion); reduce maintenance; erosion prone area; aesthetics)?

B.2 Revegetation Practice

- You mentioned in the survey that you modified [x, y, z] revegetation practices based on the *Roadside Revegetation* materials. Can you describe the type of materials used?
 - Follow-up: seed, live plants, bare root trees, container stock? Mulch: none, straw, blankets, hydro, other? Temporary cover crop used? (If applicable), what type of hard armor or erosion material was used (e.g., mechanically stabilized earth (mse) walls, soil encapsulated lifts, gabion baskets, coir logs, erosion blankets)?
- Does your organization have standard design specifications for the installation of native plants?
 - Follow-up: Did it change any specifications based on *Roadside Revegetation* (e.g., regarding minimum compaction, topsoil, timing, watering, and mulch)?
- In your experience, does the cost of native plant material prove to be comparable to traditional vegetation methods?
 - Follow-up: Can you provide any cost information?
- What maintenance or long-term monitoring will/did take place?
 - Follow-up: Did the contract specify maintenance or monitoring? If so, was this part of a permit condition?
- What hurdles or obstacles were there during implementation? Lessons learned?
 - Follow-up: E.g., timing (i.e., strict installation dates), costs, access to material, contractor experience/knowledge; agency information (e.g., did you need more/different information)?

B.3 Outcomes

- Did the *Roadside Revegetation* materials provide effective information related to maintenance of projects using native plants?
- Did the use of native plants meet the projects' goal(s)? If so, how do you know? If no, why not?
- Can you compare the overall effectiveness of native plants compared with traditional non-native grasses used in revegetation?
- In the survey, you agreed that the roadside revegetation practices your agency adopted as a result of the *Roadside Revegetation Technical Guide* were useful in achieving [x] outcome.
 - Follow-up: In what ways did your agency observe these benefits, or did your agency or another organization quantify these benefits?
- Will native plants be incorporated in future projects? Why or why not?
- If you wanted to further promote the use of native plants within your agency, is there any additional information or knowledge you would need?

Appendix C. Annotated Bibliography

BLM, California State Office. (2001). 1745—Native Plant Materials Manual.

www.blm.gov/style/medialib/blm/ca/pdf/pa/botany.Par.87693.File.dat/1745-Manual.pdf

This manual gives practitioners policy guidance on the use of native plants and plant seed in restoration and other revegetation projects on BLM lands under the jurisdiction of the California State Office.⁽³²⁾

BLM Ecoregional Plant Programs—Native Plant Materials Development Program.

www.blm.gov/programs/natural-resources/native-plant-communities/native-seed-and-plant-material-development

This website provides tools to assist in the collection and dissemination of information on native plant materials and design and implementation of effective revegetation projects. The major goals of this effort are to increase the availability of native plant materials and to provide the knowledge and technology required for their use in restoring diverse native plant communities across different ecoregions in the United States.⁽³³⁾

BLM. (2008). *H1740—2 Integrated Vegetation Management*.

https://www.blm.gov/sites/blm.gov/files/uploads/Media_Library_BLM_Policy_Handbook_H-1740-2.pdf

Chapter 8—Using Native Plants details guidance on using native plants for revegetation projects on BLM lands. It describes recommended native plant priorities, treatment design considerations, and plant material sources.⁽³⁴⁾

Colorado DOT. (2014). *Innovative Vegetation Practices for Construction Site Plant Establishment*.

<https://trid.trb.org/View/1235104>

This study reviews Colorado state transportation department’s specifications, guidelines, processes, and compliance for construction site revegetation. It identifies ways in which site stabilization can be accelerated, improved, or optimized using innovative techniques that take into account specific habitat conditions and the difficulties present in transportation construction and planning.⁽³⁵⁾

Colorado Natural Areas Program, Colorado State Parks, and Colorado Department of Natural Resources. (October 1998). *Native Plant Revegetation Guide for Colorado*.

<https://cpw.state.co.us/Documents/CNAP/RevegetationGuide.pdf>

The Native Plant Revegetation Guide for Colorado provides readers with recommendations on selecting, planting, and maintaining native plant species in Colorado for a variety of revegetation needs. It emphasizes a basic understanding of Colorado’s natural communities and the processes involved in establishing native species in those communities.⁽³⁶⁾

Department of the Interior. (2000). *Native Plant Revegetation Manual for Denali National Park and Preserve*.

http://alaska.usgs.gov/products/pubs/2000/2000_Densmore_VanderMeer_Dunkle_USGS_ITR_20_00-0006.pdf

This manual, which is based on a long history of research at Denali National Park and Preserve, describes methods that practitioners should use to revegetate subarctic sites with native plants. Authors also present data collected over several years for two revegetation projects, which entailed the testing of 46 native plant species.⁽³⁷⁾

Department of the Interior. *Native Species Revegetation Plan for Pelekane Bay Watershed Management Project*. <https://data.doi.gov/dataset/native-species-revegetation-plan-for-pelekane-bay-watershed-management-project>

This plan describes biological and physical management practices that can reduce land-based sediments inputs into Hawai'i's Pelekane Bay. It discusses recommendations for protecting native species in the Pelekane Bay watershed, as well as accomplishments in doing so.⁽³⁸⁾

Dorner, Jeanette. (November 2002). *An introduction to using native plants in restoration projects*. www.fs.fed.us/wildflowers/Native_Plant_Materials/documents/intronatplant.pdf

This document provides guidance related to the use of native plants in restoration projects covering planning, site preparation, planting, and maintenance.⁽³⁹⁾

DNR, Alaska (2008). *A Revegetation Manual for Alaska*. www.dnr.alaska.gov/ag/RevegManual.pdf

The purpose of this manual is to provide revegetation guidance using native plants and seed. Created by the Alaska Department of Natural Resources and used by the Alaska Department of Transportation, the manual focuses on the revegetation of sites for the purpose of erosion control and the techniques employed for successful revegetation of disturbed sites. Non-native species are discussed; however, the manual does place emphasis on the benefits of native species stating that native plants are more adaptable to the environmental conditions and provide a more attractive appearance compared with introduced species.⁽⁴⁰⁾

DOT, Arizona. FHWA. (2012). *Evaluation of Salvage and Replanted Native Plants on ADOT Projects*.

This report documents the outcomes of Arizona Department of Transportation research into the factors contributing to the long-term high survival and good health of saguaro cacti transplanted as part of roadside revegetation projects. A height of less than 12 ft., few arms, and shallow planting are factors cited as contributing to higher survival and good health.⁽⁴¹⁾

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DOT, California. Roadside Management Toolbox Native and Non-Irrigated Vegetation. www.dot.ca.gov/hq/LandArch/16_la_design/guidance/roadside_safety_tb/detail-niv.htm

The California Transportation Roadside Management Toolbox, among other maintenance related items, offers details on how practitioners can successfully incorporate native vegetation into roadside revegetation projects in California.⁽⁴²⁾

DOT, California. University of California, Davis. (2008). Vegetation Conversion to Desirable Species along Caltrans Rights-of-Ways.

This study evaluates ways to convert existing, annual non-native species to native, perennial species along roads in California. The motivation for doing so according to the authors is that native, perennial grass stands can be relatively weed-resistant over long time periods.⁽⁴³⁾

DOT, Colorado (2014) – Landscape Architecture Manual. www.codot.gov/programs/environmental/landscape-architecture/cdot-landscape-architecture-manual-8-18-14/at_download/file

This manual focuses on natural resources and provides guidelines for mitigation measures, assessment procedures, design details, environmental resources and engineering principles that can be used on transportation projects in Colorado.⁽⁴⁴⁾

DOT, Florida. (2009). A Guide for Roadside Vegetation Management. www.dot.state.fl.us/research-center/Completed_Proj/Summary_MNT/FDOT_BDK75_977-11_rpt.pdf

This document offers guidelines for roadside vegetation establishment and management in Florida. It encourages the use of native plants, mentioning the reduced maintenance, lower costs, and beneficial ecological outcomes associated in doing so.⁽⁴⁵⁾

DOT, Florida. Native Wildflowers on Roadside of Central and South Florida. <http://edis.ifas.ufl.edu/ep138>

This two-page guide developed by the Florida DOT provides for easy identification of native wildflowers commonly found along roadsides. It includes photos of flowers, information about their lifecycles, and the types of habitats in which Florida wildflowers can be found.⁽⁴⁶⁾

DOT, Idaho. (2014). Native Plants for Roadside Revegetation: Field Evaluations and Best Practices Identification.

<http://itd.idaho.gov/wp-content/uploads/2016/06/RP217Final02102014.pdf>

The Idaho DOT prefers to utilize native species for roadside revegetation given the desirable environmental, economic, and safety outcomes that can be achieved. This guide provides practical information for improving roadway revegetation in Idaho.⁽⁴⁷⁾

DOT, Illinois. Roadside Maintenance. www.idot.illinois.gov/transportation-system/environment/roadside-maintenance

The Illinois DOT considers native vegetation and prairie habitat for maintenance activities, maintaining a prairie inventory with information related to protecting prairie habitat. This website is a portal where users can find technical reports and information approaches to avoid invasive species.⁽⁴⁸⁾

DOT, Indiana. Hoosier Roadside Heritage Program. <https://secure.in.gov/indot/2583.htm>

The Indiana DOT's (INDOT) Hoosier Roadside Heritage Program website describes the agency's activities and programs to promote and incorporate native plants and wildflowers into Indiana's roadside landscapes. Users can find information on INDOT's seed list and mowing and vegetation management policies.⁽⁴⁹⁾

DOT, Iowa. Iowa Living Roadway Trust Fund. www.iowadot.gov/Irtf/

The Iowa State legislature established the Living Roadway Trust Fund, administered by the Iowa DOT. This grant program provides funding for roadside vegetation management. This fund ensures that roadside vegetation is preserved, planted, and maintained; visually interesting; ecologically integrated; and useful for many purposes.⁽⁵⁰⁾

DOT, Minnesota. (2008). Best Practices Handbook for Roadside Vegetation Management. www.lrrb.org/pdf/200820.pdf

This handbook from the Minnesota DOT focuses on the installation and maintenance of native vegetation for roadside revegetation in Minnesota.⁽⁵¹⁾

DOT, Minnesota. University of Minnesota, St Paul. (2008). Improved Methodologies for the Inoculation of Prairie Legumes in Roadside/Revegetation Settings.

This technical report describes the results from a field study on five different seed inoculation treatments in Minnesota. Major findings pointed to the need for higher than normal inoculation rates in the state.⁽⁵²⁾

DOT, Minnesota. (2010). Native Seed Mix Design for Roadsides. www.dot.state.mn.us/environment/erosion/pdf/native-seed-mix-dm.pdf

Minnesota DOT's Native Seed Mix Design and Roadsides describes the processes and strategies that practitioners should use to revegetate roadsides in Minnesota.⁽⁵³⁾

DOT, Missouri. (2003). Roadside Vegetation Management. www.modot.org/services/documents/roadsidevegmgmt5-03.pdf

Missouri DOT's Roadside Vegetation Management is a guide describing the processes and strategies that practitioners should use to revegetate roadsides in Missouri. The benefits of using native vegetation are discussed.⁽⁵⁴⁾

DOT, Nebraska. (2014). NDOR Roadside Vegetation Establishment and Management. www.roads.nebraska.gov/media/4016/veg-manual.pdf

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Nebraska DOR's Roadside Vegetation Establishment and Management describes the processes and strategies that practitioners should use to revegetate roadsides in Nebraska. The guide notes a preference for using native species given improved environmental outcomes.⁽⁵⁵⁾

DOT, North Carolina. Guidelines for Planting within Highway Right-of-Way.
www.ncdot.gov/doh/operations/dp_chief_eng/roadside/design/graphics/PlantingGuidelines.pdf

North Carolina DOT's Guidelines for Planting within Highway Right-of-Way describes the processes and strategies that practitioners should use to revegetate roadsides in North Carolina.⁽⁵⁶⁾

DOT, Texas. (2013). Roadside Vegetation Management Manual.
<http://onlinemanuals.txdot.gov/txdotmanuals/veg/veg.pdf>

Texas DOT's Roadside Vegetation Management Manual describes the processes and strategies that practitioners should use to revegetate disturbed roadsides in Texas.⁽⁵⁷⁾

DOT, Texas. FHWA. (2014). Turf-Type and Early Maturing Annual Ryegrass to Establish Perennial Vegetation: Technical Report. <http://tti.tamu.edu/documents/O-6620-S.pdf>

Annual ryegrass (*Lolium multiflorum*) is not currently recommended by Texas Department of Transportation (TxDOT) as a roadside revegetation nurse crop because its late maturity and height are too competitive for establishing perennial or spring plant mixtures. Two available genotypes used for turf that could be seeded with perennial grasses/legumes and annual wildflowers are Panterra V and Hanamiwase. Panterra V is turf-type annual ryegrass developed for home lawns while Hanamiwase is an early maturity annual ryegrass that produces seed in February and March. Both the turf-type and early-maturing annual ryegrasses could be less competitive for nutrients, moisture, and sunlight while providing adequate cover. Appropriate warm-season perennial grasses/legumes and wildflower mixes specified by TxDOT were planted as treatments in each of four regions to evaluate these annual ryegrass genotypes, seeding rates, and mowing influences. Additionally, similar treatments were installed at five locations in a roadway implementation trial. The turf-type and early-maturing ryegrasses proved to be both competitive and persistent when used as nurse crops for warm-season perennials with mature heights similar to the annual ryegrass varieties used in the past.⁽⁵⁸⁾

DOT, Washington State. (2014). Roadside Manual, Chapter 800 Vegetation.
www.wsdot.wa.gov/publications/manuals/fulltext/M25-30/Roadside.pdf

Washington State DOT (WSDOT) has found that use of native plants planted in the right locations is integral to an ecologically sound vegetation design and management program. The agency's *Roadside Classification Plan*, which is described in this chapter of the *Roadside Manual*, provides guidance for the installation of native plants, including the State-required creation of revegetation plans, which a WSDOT landscape architect reviews during a project's design phase.⁽⁵⁹⁾

FHWA. (January 2011). Current and Innovative Solutions to Roadside Revegetation Using Native Plants: A Domestic Scan Report.
www.nativerrevegetation.org/pdf/B1422_Roadside_revegetation_Report_complete.pdf

This report provides a summary of the 2009 scan tour of roadside revegetation practices. The national revegetation experts participating in the scan found that the revegetation process is a multifaceted, interdisciplinary process with interconnected technical and non-technical aspects. The scan team recommended that a project revegetation plan be developed for roadside revegetation projects so that all aspects, which are of similar importance, are adequately addressed.⁽⁷⁾

FHWA. (2007). The Greening of Public Roadsides.
www.fhwa.dot.gov/publications/publicroads/07nov/01.cfm

This article describes FHWA's approach to establishing native plants along roadsides. It also promotes the availability of the Roadside Revegetation materials that FHWA and the Forest Service developed in partnership.⁽⁶⁰⁾

FHWA. (2007). A Manager's Guide to Roadside Revegetation Using Native Plants.
www.nativerevegetation.org/pdf/resource_materials/02_managers_guide.pdf

This FHWA publication summarizes the concepts described in *Roadside Revegetation: An Integrated Approach to Establishing Native Plants* in a manner intended to be accessible to managers versus field-level practitioners. The document is a reference that managers can consult as their engineers plan, design, and implement roadside revegetation projects.⁽⁹⁾

Herold, J., Lowe, Z., and Dukes, J. (2014). Integrated Vegetation Management for INDOT Roadsides.
<http://docs.lib.purdue.edu/jtrp/1550/>

This report presents results from a study to assess outcomes after applying different herbicide mixtures to roadside revegetation projects. Researchers found evidence suggesting that ecological and economic outcomes are improved when native vegetation is used for highway revegetation projects.⁽⁶¹⁾

Jinxing, Zhou, Jun, Yang, Gong, and Peng. (2008). Constructing a green railway on the Tibet Plateau: Evaluating the effectiveness of mitigation measures.
www.sciencedirect.com/science/journal/13619209

This study describes results from an analysis of different revegetation approaches used following the construction of the Qinghai-Tibet Railway. Researchers found that railway construction resulted in minimal vegetation and soil disturbances. They also found evidence suggesting that mitigation measures involving the translocation of original vegetation mats after disturbance on a large scale at high altitude were not successful.⁽⁶²⁾

Kingery, Robson. (2006). Native Plants for Idaho Roadside Restoration and Revegetation Programs.
http://itd.idaho.gov/wp-content/uploads/2016/06/RP171Roadside_Revegetation.pdf

This document, funded in part by the Idaho Department of Transportation, focuses on native plants. Written for transportation maintenance officials and others interested in native plant restoration along transportation corridors, the guide provides detailed information for a selection of native plants.⁽⁶³⁾

Kuennen, Tom. (2013). Integrating Roadside Vegetation and Erosion Control. <https://trid.trb.org/Results?txtKeywords=Integrating+Roadside+Vegetation+and+Erosion+Control#/View/1258212>

This article details how several State transportation departments have introduced vegetation management into their integrated roadside management programs.⁽⁶⁴⁾

Mack Blackwell National Rural Transportation Center, Research and Innovative Technology Administration. (2012). The Development of Novel and Non-Invasive Germplasm Selections Native to Arkansas for Highway Re-Vegetation Projects.

This research project aimed to develop best management practices for using plant species native to Arkansas for roadside revegetation efforts in the State. Twenty-seven native, perennial species were evaluated, all of which were found to have high transplant survival rates and to be tolerant of extreme seasonal conditions.⁽⁶⁵⁾

Native Plant Network. <https://nnp.rngr.net/>

This website is a resource for practitioners who grow forest and conservation seedlings to access for state-of-the-practice information, as well as information on points of contact at other organizations with similar native revegetation interests.⁽⁶⁶⁾

Nebraska Department of Roads. (2014). Fertilizer Effects on Attaining Vegetation Requirements.

This report presents results from a Nebraska Department of Roads research project to assess different substrate and fertilization approaches on road construction revegetation sites. Using topsoil purchased locally and Department of Roads planting protocols, practitioners applied fertilizer immediately after seeding to a site and then monitored results compared to a control site. Results suggest that there was no benefit to applying a nitrogen or phosphorus fertilizer; grass cover was lower where fertilizer was applied.⁽⁶⁷⁾

North Carolina State University, Raleigh. (2007). The Establishment Success of Native Versus Non-Native Herbaceous Seed Mixes on a Revegetated Roadside in Central Texas.

This report presents the results of a study to compare the establishment characteristics of three seed mixes along Texas roadsides. Researchers found highly significant evidence suggesting that native-only grass and forb species seed mixes performed better after spring and summer sowing than standard, non-native species seed mixes. The authors recommended that using native-only seed mixes can reduce the potential for negative ecological outcomes related to revegetation projects.⁽⁶⁸⁾

NPS. (2004). Acadia National Park Revegetation Program.

<http://irmafiles.nps.gov/reference/holding/486242?accessType=DOWNLOAD>

This document inventories the revegetation methods and progress for nine revegetation sites planted or maintained in Acadia National Park in 2004. That summer, volunteer groups and the Acadia Youth Conservation Corps worked alongside park staff to restore native vegetation after construction and trail maintenance projects. The effort included mapping revegetation sites and establishing a monitoring plan.⁽⁶⁹⁾

NPS. CD Workbook for Planning, and Specifications for Ecological Restoration.

www.georgewright.org/0735hassell.pdf

This document describes successful approaches to writing ecological specifications for ecology restoration on NPS lands. It is intended to help NPS staff plan, design, and write specifications for ecological restoration projects given the unique governance structures of parklands. Its recommendations are based on case histories of past NPS ecological restoration projects.⁽⁷⁰⁾

NPS. Pipe Spring National Monument Revegetation Panel.

www.nps.gov/pisp/learn/photosmultimedia/revegetation-panel.htm

This summary describes an effort at Pipe Spring National Monument to establish a native vegetation plot similar to how the grasslands in the area may have looked prior to the 1850s. Practitioners expect reintroducing native species will promote plant diversity in the region.⁽⁷¹⁾

NPS. (2008). Rocky Mountain National Park Revegetation Evaluation.

www.nps.gov/romo/learn/management/upload/revegetation.pdf

This document is a one-page summary of results from an NPS research project to compare three different revegetation methods. Results suggested that in instances where funds are not constrained, a combined approach of seeding and transplanting is most effective. Seeding was found to be the most cost-effective approach when financial resources are limited.⁽⁷²⁾

Richardson, Robert. (forthcoming). Improving Vegetation Management Practices and Cost Effectiveness on North Carolina Roadsides.

<https://trid.trb.org/Results?txtKeywords=Improving+Vegetation+Management+Practices+and+Cost+Effectiveness+on+North+Carolina+Roadsides#/View/1235320>

This research aimed to identify target management species on NCDOT roadsides; develop current and comprehensive guidelines for woody vegetation management; revise and update NCDOT vegetation management guidelines; and develop maintenance procedures for the long-term management of native warm season grasses.⁽⁷³⁾

Roadside Environment Committee, Australia Resources and Case Studies.

www.lgns.wa.gov.au/policy/roadside-environmental-management/resources-and-case-studies

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The NSW Environmental Trust has funded an update of the Managing Roadsides guidelines documents, which cover assessment, planning, implementation, monitoring, and evaluation. Specific case studies show how councils in Australia have used their funding to undertake priority roadside vegetation management.⁽⁷⁴⁾

USFS. (2012). Native Plant Materials Policy.

www.fs.fed.us/wildflowers/Native_Plant_Materials/documents/NativePlantMaterialsPolicy_Sept2012.pdf

This document presents the Forest Service's policy for promoting the use of native plants in revegetation projects, specifically on USFS lands. The policy instructs practitioners to give native plant materials "primary consideration" when they are deciding which plant material to use for USFS land management projects.⁽⁷⁵⁾

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