RECYCLING ROADWAYS FOR CARBON EMISSION REDUCTIONS - MIDSTATE RECLAMATION AND TRUCKING

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Project Title	Recycling Roadways for Carbon Emission Reductions - Midstate Reclamation and Trucking
Version	01
Date of Issue	28-July-2022
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1 PROJECT DETAILS

1.1 Summary Description of the Project

The Cold-in-Place Recycling (CIR) using Foam Stabilized Base (FSB) and asphalt emulsion mixture projects aim to enlist road construction contractors in the United States of America with the purpose of reducing Greenhouse gas (GHG) emissions during the asphalt installation process by using FSB and asphalt emulsions in place of Hot Mix Asphalt (HMA). Prior to project implementation, the road construction projects would have utilized typical HMA or Warm Mix Asphalt (WMA) installation which has a significant GHG emission footprint associated with the mining of virgin aggregates, trucking the virgin aggregate to the mix plant, heating the mix to 310°F, and then trucking the mixed product at high temperatures to the job site (further detailed in Sections 1.11 and 3.4).

FSB and asphalt emulsions, as compared to the baseline HMA or WMA scenario, greatly reduce GHG emissions by (further detailed in Section 1.11):

1) Recycling the existing roadway and eliminating the need for virgin aggregate mining.
2) Eliminating the need for long distance trucking of virgin aggregates.
3) FSB and asphalt emulsions do not need to be heated to high temperatures like HMA which reduces GHG emissions related to electricity, diesel, or natural gas consumption at the mix plant and to-site delivery.

The project activity quantifies the reductions in GHG emissions associated with the use of FSB and/or asphalt emulsions as substitutes to HMA for a group of highway asphalt construction projects. This grouped project was completed by Midstate Reclamation and Trucking, Inc. and subsidiary, Coughlin Company. The project instances consist of existing highway roads in need of repair to extend the useable lifespan for conveying vehicular traffic.

The initial instance of the project activity is a highway asphalt paving construction project located on North Dakota Highway 8 (ND 8) from ND 12 to ND 21 in Hettinger County, North Dakota. The project start date was July 19, 2021. Additional project instances include the following:

1. Chisago County, MN – US 61, from 0.2 miles north of US 8 to 0.1 mile west of US 35
2. Buena Vista County, IA – County Highway C63, from 50th Avenue to IA Hwy 110
3. Wright County, IA – IA 17, from 340th Street to S. Braden Avenue
4. Story County, IA – US 65, from 0.5 miles south of US 30 to IA 175 in Hubbard, IA
5. Boone County, IA – Lower Ledges Road and E52, from Lower Ledges Easterly 4.2 miles to Hwy. 17

6. Mower County, MN #1 – County State-Aid Highway System (CSAH) 2 (265th Street), from US 63 to the east county line; CSAH 3 (200th Street), from CSAH 7 (670th Avenue) to CSAH 8 (740th Avenue); CSAH 7 (140th Street), from CSAH 5 (640th Avenue) to CSAH 18 (140th Street)
7. Mower County, MN #2 – 555th Avenue, from 10th Place NE to 270th Street
8. Coffee County, TN – US-64, from west of Rutledge Road through Coffee County to west of I-24 in Grundy County
9. Porter County, IN – State Road (SR) 149, from US 12 to SR 130
10. Webster County, IA – IA 175, from Ash Street in Lohrville, IA to 4th Street in Gowrie, IA
11. Keokuk County, IA – IA 21, from IA 92 to 170th Street in What Cheer, IA
12. St. Louis County, MN – CSAH 5, between 1.2 miles north of MN 73 and CSAH 81
13. Sioux County, IA – Eagle Avenue (K30), from 390th Street to 450th Steet; K22, from 360th Street to 390th Street; 320th Street, from Elmwood Avenue to the East 0.5 miles
14. Sibley County, MN – CSAH 8, from 1,200-ft west of CSAH 17 to TH 169
15. Hennepin County, MN – CSAH 60, from 146-ft south of Fairway Drive to 200-ft south of I-494 bridge
16. Redwood County, MN – CSAH 101, from US 71/MN 19 to Minnesota River, North County Line
17. Madison County, TN – CSAH 8, from 1,200-ft west of CSAH 17 to US 169
18. Norman County, MN – CSAH 3, from US 75 in Shelly, MN to MN 9
19. Plymouth County, IA – Route C30, from Le Mars East to Route K 64; On Route K 64, from Route C38 north to Hwy 3
20. Ottertail County, MN – CSAH 67, from CSAH 58 to CSAH 8 West
21. Sanpete County, UT – US 89 from Fairview, UT to Utah County line
22. Elko County, NV – SR 232, from 5 miles south of Steeles Creek to US 93
23. Flathead County, MT – US 2, from Highline Boulevard to Pyramid Creek

This group of projects is submitted following VCS methodology VM0039, Methodology for Use of Foam Stabilized Base and Emulsion Asphalt Mixtures in Pavement Application V1.0. The methodology details the requirements for pavement projects within the United States that utilize FSB and asphalt emulsions in place of traditional HMA and determines the issuance of verified carbon unit credits (VCUs). Projects currently under design, construction, and future projects would be added under this project description. An estimated annual average of 37,923 tonnes of GHG emissions reductions is anticipated, with a total of 379,225 tonnes over a 10-year crediting period.

1.2 Sectoral Scope and Project Type

The project falls under Sectoral Scope 6: Construction and is a grouped project.

1.3 Project Eligibility

Eligible asphalt paving projects must occur in the United States of America and include the production and installation of FSB and/or asphalt emulsions using Cold Central Plant Recycling (CCPR), Cold In-place Recycling (CIR), and/or Full Depth Reclamation (FDR) processes. The grouped projects included under this project description include the production and installation of FSB or asphalt emulsions, use the CIR process, and are located in the United States of America.

1.4 Project Design

The project has been designed as a grouped project. New project instances will comply with the set of criteria listed below.

☐ The project includes a single location or installation only

☐ The project includes multiple locations or project activity instances, but is not being developed as a grouped project

☒ The project is a grouped project

Eligibility Criteria

- Project activities include the construction of any type of road and/or parking lot (including parking lot patching projects) in the United States.
- Project activities must apply one or more of the following processes for road construction:
  - a) FSB produced using the CCPR process
  - b) FSB produced using the CIR process
  - c) FSB produced using the FDR process
  - d) Asphalt emulsions produced using the CCPR process
  - e) Asphalt emulsions produced using the CIR process
  - f) Asphalt emulsions produced using the FDR process
- Production plants where the project activity occurs may serve multiple pavement types, including, but not limited to, roadways and parking lots.
- Project activities may have an HMA or WMA surface layer but must have at least one FSB or asphalt emulsions base layer

1.5 Project Proponent

Organization name	Global Emissionairy, LLC
Contact person	Harold Green
Title	CEO
Address	Corporate Office: 162 Lafayette Avenue, Laurel, MD 20707 Operations: 2600 Marble Court, Forestville, MD 20747
Telephone	202-288-4130
Email	hg@globalemissionairy.com

1.6 Other Entities Involved in the Project

Organization name	Midstate Reclamation and Trucking
Role in the project	Asphalt Contractor, performed the asphalt construction
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Title	Vice President of Business Development
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Organization name	University of Maryland, Smart Construction Center
Role in the project	Technical Consultant, Methodology development
Contact person	Dr. Qingbin Cui
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Organization name	Straughan Environmental, Inc
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Organization name	King Cow Interactive, LLC
Role in the project	Methodology and application development
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1.7 Ownership

The Project Proponent, Global Emissionairy, LLC, holds the rights of the GHG emissions savings achieved in the asphalt pavement construction projects performed by Midstate Reclamation and Trucking, Inc. using FSB and/or asphalt emulsion as conveyed via a sales and service agreement. This is consistent with VCS Standard Section 3.6.1 Ownership, Clause 3 which states:

3) Project ownership arising by virtue of a statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions and/or removals (where the project proponent has not been divested of such project ownership).

1.8 Project Start Date

The earliest construction start date for the 2021 grouped project instances included in this project description was April 27, 2021 and is considered the project start date for this grouped project.

1.9 Project Crediting Period

The Projects first crediting period is 10-years, beginning on the Project start date of April 27, 2021, and ending on April 27, 2030.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated annual GHG emission reductions/removals of the project are:

☐ <20,000 tCO_2e/year

☒ 20,000 – 100,000 tCO_2e/year

☐ 100,001 – 1,000,000 tCO_2e/year

☐ *>1,000,000 tCO_2e/year*

For the purposes of assessing materiality, VCS projects are disclosed across two project categories: Project category reductions may be up to 300,000 tonnes CO2e per year; Large Project category comprises more than 300k tonnes CO2e/year.

The Grouped Projects annual GHG reduction is anticipated to be between 20,000 – 100,000 tCO2e, under the threshold for large project scale and is therefore classified as project category. In addition, a 10-year fixed crediting period has been selected for the Grouped Projects.

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2021	29,225
2022	31,000
2023	32,500

2024	34,000
2025	35,750
2026	37,500
2027	39,500
2028	41,250
2029	43,500
2030	45,500
Total estimated ERs	369,725
Total number of crediting years	10
Average annual ERs	36,973

1.11 Description of the Project Activity

For over 40 years, FSB and asphalt emulsions have been used in road projects around the world when natural resources for virgin aggregate or funding to construct and maintain roads using HMA have been limited. In North America, where virgin aggregate has historically been easily accessible within proximity to project sites, FSB has not been as widely implemented as it has in other parts of the world. FSB has, therefore, been used on a very limited basis in the United States for the last 10 to 15 years. Most projects using FSB and asphalt emulsions in the United States are pilot projects funded by various state highway agencies. While these projects have proven successful, state highway administrations have been slow to accept and develop the protocol and practices for this approach in North America. Presently there are no national or regional standards for the production or application of FSB and asphalt emulsions, which serves as a major impediment to the acceptance and application of FSB and asphalt emulsions beyond the testing phase.

The project activity includes roadway paving projects that utilize FSB and/or asphalt emulsion instead of HMA in the production and installation of asphalt pavement construction. GHG emission reductions are generated from producing and installing FSB and asphalt emulsions instead of HMA as follows:

- FSB and asphalt emulsions consist of 50% less liquid asphalt/bitumen by weight and 2.5% less asphalt/bitumen by volume than required for HMA production, reducing the reliance on resources. No virgin aggregates are required, eliminating the energy and resources needed for excavating machines and trucking. In most applications, but especially in rural areas, the GHG emissions from trucking are significantly reduced. This is due to the fact that FSB and asphalt emulsions can be manufactured on or close to the project site.

- Aggregates in FSB and asphalt emulsions do not have to be heated, while HMA liquid, which is roughly 2.2% of the total weight of the mix, needs to be heated up to 310 °F and kept at high temperatures during storage and transport resulting in significant GHG emissions from the electricity, natural gas, or diesel fuel used to heat, mix, store, and transport the HMA.

1.12 Project Location

The grouped projects have been or will be constructed within the continental United States of America. The first project instance project activity is located on North Dakota Highway 8 (ND 8) from ND 12 to ND 21 in Hettinger County, North Dakota and covers approximately 24.6 miles. The Hettinger County, ND project instance will serve as the model project for the other project instances that are included in this Project Description. All 2021 grouped project instances are summarized in Table 1 below.

Table 1: 2021 CIR Project Instances

Project	State	Location Description	Length (Miles)
Hettinger County, ND	North Dakota	ND 8) *from ND 12 to ND 21 in Hettinger County, North Dakota* (Coordinates: 46°11'24.5"N, 102°28'36.6"W)	24.6
Chisago County, MN	Minnesota	US 61, from 0.2 miles north of US 8 to 0.1 mile west of US 35 (Coordinates: 45°18'51.1"N, 92°59'13.4"W)	2.03
Buena Vista County, IA	Iowa	County Highway C63, from 50th Avenue to IA Hwy 110 (Coordinates: 42°38'00.7"N, 95°16'35.9"W)	3.52
Wright County, IA	Iowa	IA 17, from 340th Street to S. Braden Avenue (Coordinates: 42°36'25.6"N, 93°54'08.7"W)	6.15
Story County, IA	Iowa	US 65, from 0.5 miles south of US 30 to IA 175 in Hubbard, IA (Coordinates: 42°06'17.7"N, 93°18'30.6"W)	16.48
Boone County, IA	Iowa	Lower Ledges Road and E52, from Lower Ledges Easterly 4.2 miles to Hwy. 17 (Coordinates: 41°58'46.7"N, 93°50'48.0"W)	4.21

Project	State	Location Description	Length (Miles)
Mower County (1), MN	Minnesota	• County State-Aid Highway System (CSAH) 2 (265th Street), from US 63 to the east county line (Coordinates: 43°44'22.7"N, 92°27'55.2"W) • CSAH 3 (200th Street), from CSAH 7 (670th Avenue) to CSAH 8 (740th Avenue) (Coordinates: 43°38'42.4"N, 92°38'43.3"W) • CSAH 7 (140th Street), from CSAH 5 (640th Avenue) to CSAH 18 (140th Street) (Coordinates: 43°33'32.5"N, 92°44'46.6"W)	11.10
Mower County (2), MN	Minnesota	555th Avenue, from 10th Place NE to 270th Street (Coordinates: 43°42'43.5"N, 92°56'21.4"W)	4.62
Coffee County, TN	Tennessee	US-64, from west of Rutledge Road through Coffee County to west of I-24 in Grundy County (Coordinates: 35°16'43.7"N, 85°55'24.9"W)	3.87
Porter County, IN	Indiana	State Road (SR) 149, from US 12 to SR 130 (Coordinates: 41°33'41.5"N, 87°07'30.9"W)	7.60
Webster County, IA	Iowa	IA 175, from Ash Street in Lohrville, IA to 4th Street in Gowrie, IA (Coordinates: 42°16'00.6"N, 94°25'07.6"W)	12.86
Keokuk County, IA	Iowa	IA 21, from IA 92 to 170th Street in What Cheer, IA (Coordinates: 41°22'13.9"N, 92°21'15.6"W)	3.83
St. Louis County, MN	Minnesota	CSAH 5, between 1.2 miles north of MN 73 and CSAH 81 (Coordinates: 47°31'49.6"N, 92°57'33.9"W)	8.80
Sioux County, IA	Iowa	• Eagle Avenue (K30), from 390th Street to 450th Steet; K22, from 360th Street to 390th Street (Coordinates: 43°01'10.6"N, 96°18'46.1"W) • 320th Street, from Elmwood Avenue to the East 0.5 miles (Coordinates: 43°03'15.6"N, 96°23'31.4"W)	9.45
Sibley County, MN	Minnesota	CSAH 8, from 1,200-ft west of CSAH 17 to TH 169 (Coordinates: 44°27'51.6"N, 93°59'10.8"W)	6.14
Hennepin County, MN	Minnesota	CSAH 60, from 146-ft south of Fairway Drive to 200-ft south of I-494 bridge (Coordinates: 44°53'15.6"N, 93°26'51.5"W)	2.77
Redwood County, MN	Minnesota	CSAH 101, from US 71/MN 19 to Minnesota River, North County Line (Coordinates: 44°33'31.4"N, 95°05'28.7"W)	1.61
Madison County, TN	Tennessee	CSAH 8, from 1,200-ft west of CSAH 17 to US 169 (Coordinates: 35°45'53.7"N, 88°40'40.9"W)	5.16
Norman County, MN	Minnesota	CSAH 3, from US 75 in Shelly, MN to MN 9 (Coordinates: 47°27'16.0"N, 96°39'56.1"W)	13.22

Project	State	Location Description	Length (Miles)
Plymouth County, IA	Iowa	• Route C30, from Le Mars East to Route K 64 (Coordinates: 42°46'45.5"N, 96°05'54.9"W) • On Route K 64, from Route C38 north to Hwy 3 (Coordinates: 42°46'54.3"N, 96°03'25.8"W)	8.20
Ottertail County, MN	Minnesota	CSAH 67, from CSAH 58 to CSAH 8 West (Coordinates: 46°36'12.6"N, 95°21'50.4"W)	6.42
Sanpete County, UT	Utah	US 89 from Fairview, UT to Utah County line (Coordinates: 39°43'45.9"N, 111°28'31.6"W)	7.76
Elko County, NV	Nevada	SR 232, from 5 miles south of Steeles Creek to US 93 (Coordinates: 40°55'52.1"N, 115°01'56.3"W)	6.88
Flathead County, MT	Montana	US 2, from Highline Boulevard to Pyramid Creek (Coordinates: 48°28'09.4"N, 113°50'12.3"W)	13.90

1.13 Conditions Prior to Project Initiation

The conditions prior to project initiation are consistent throughout all grouped project instances which are existing asphalt roadways in need of rehabilitation to extend their usable lifespan and continue supporting vehicular traffic.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The asphalt construction projects were or will be performed in compliance with local department of transportation and/or United States Federal Highway Administration construction specifications.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project instances under this grouped project are not registered for and have not pursued registration under any other GHG program.

1.15.2 Projects Rejected by Other GHG Programs

The project instances under this grouped project have not been rejected by any other GHG Program.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project instances under this grouped project are not and will not be used in activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading.

Does the project reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading?

☐ Yes ☒ No

1.16.2 Other Forms of Environmental Credit

The project instances under this grouped project have not received and is not seeking any other form of GHG-related environmental credit.

Has the project sought or received another form of GHG-related credit, including renewable energy certificates?

☐ Yes ☒ No

1.17 Sustainable Development Contributions

1.17.1 Sustainable Development Contributions Activity Description

The United Nations (UN) Sustainable Development Goals (SDG) provide a global framework for all developed and developing countries to implement which contributes to an overall goal of a more sustainable future for all. Several of the SDGs align with the grouped project instances, including SDG 9 – Target 9.4, SGD 12 – Target 12.5, and SDG 13.

- SDG 9 – Target 9.4 aims to upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities, by 2030. The grouped project instances utilize CIR process technology to rehabilitate roadways through recycling of the existing roadway resulting in significant reduction of virgin aggregate mining and greater resource-use efficiency.
- SDG 12 – Target 12.5 aims to substantially reduce waste generation through prevention, reduction, recycling, and reuse, by 2030. The grouped project instances meet this design criteria through the CIR process by re-using asphalt millings onsite, greatly reducing wasted material.
- SDG 13 – aims to take urgent action to combat climate change and its impacts. While the grouped project instances do not directly correspond with an official SDG indicator, the very nature of the VCS Program applies aligns with this SDG through quantification of GHG emission

reductions. The grouped project instances use the CIR process to greatly reduce CO2 emissions as compared to the baseline HMA scenario as described in Section 4.

1.17.2 Sustainable Development Contributions Activity Monitoring

The grouped project instances implement CIR process technology to rehabilitate roadways by recycling the material of the existing roadway. This process results in significant reductions in waste material, reductions in virgin aggregate mining and trucking, and reductions in CO2 emission as compared to the baseline HMA scenario. The current set of 2021 grouped project instances rehabilitated 24 roadways, reused 430,500 tonnes of asphalt millings which prevented mining of virgin aggregates, and reduced CO_2 emissions by 29,255 tonnes as compared to the baseline HMA scenario. Table 2 below summarizes and quantifies the specific SDG targets met by the grouped project instances. Evidence of the project instances SDG contributions are included in Appendix A.

Table 2: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	9.4	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	Implemented activities to increase	By implementing Cold-in-Place Recycling technology, the current project has rehabilitated 24 roadways, reused 430,500 tonnes of asphalt millings which prevented mining of virgin aggregates, and reduced CO_2 emissions by 29,255 tonnes as compared to the baseline HMA scenario.	By implementing Cold-in-Place Recycling technology, the project is projected to rehabilitate 260 roadways, reuse 5,400,000 tonnes of asphalt millings preventing mining of virgin aggregates and reducing CO_2 emissions by 379,225 tonnes as compared to the baseline HMA scenarios.
2)	12.5	By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse	Implemented activities to increase		
3)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase		

1.18 Additional Information Relevant to the Project

Leakage Management

According to the applicable methodology, VM0039, it is reasonable to assume zero leakage because there is no difference in site preparation activities between baseline and project scenarios. Replacing HMA with FSB or asphalt emulsions for the pavement base layers does not entail a change in carbon efflux or carbon sink at the construction site.

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of this document.

Further Information

Not applicable.

2 SAFEGUARDS

2.1 No Net Harm

No potentially negative impacts to the natural or human environment have been identified for the project instances under this grouped project.

2.2 Local Stakeholder Consultation

Local Stakeholders consultation was achieved during the project's solicitation process and through direct correspondence. The Project Proponent has identified the following stakeholders:

- Asphalt Contractor and Construction personnel (Midstate Reclamation)
- North Dakota Department of Transportation
- General public/road users

The asphalt contractor worked with the North Dakota Department of Transportation to develop the asphalt emulsion mix and the use of CIR. Consultation to the public was typical for asphalt rehabilitation projects and included public notices for construction and road conditions. To date, Midstate Reclamation has not been notified of any comments or concerns from the public specific to the use of RAP, asphalt emulsions, or the CIR process.

On-going communication with stakeholders involved with projects and interested stakeholders can be achieved by accessing the Project Proponents website (https://globalemissionairy.com/). Any comments can be sent through the websites comment form or via email (contact@globalemissionairy.com).

2.3 Environmental Impact

The project activity includes applying an FSB and/or asphalt emulsion layer in place of HMA layers in asphalt paving applications. Environmental impacts would be the same as those for conventional HMA asphalt paving such as potential release of sediment and asphalt mixture into stormwater and impacts to traffic. The same state and federal avoidance, minimization, and mitigation techniques required for conventional HMA asphalt paving would apply to include FSB and/or asphalt emulsion.

2.4 Public Comments

This Project Description was listed on the Verra Registry and available for public comment from XXX – XXX and XXXX comments were received. (To be completed after posting)

2.5 AFOLU-Specific Safeguards

Not applicable.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The project is conducted under VCS methodology VM0039, "Methodology for Use of Foam Stabilized Base and Emulsion Asphalt Mixtures in Pavement Application," version 1.0 (VM0039). This methodology is located at https://verra.org/methodology/vm0039-methodology-for-us-of-fsb-in-pavement-application-v1-0/.

3.2 Applicability of Methodology

The methodology is applicable to the project(s) due to the following conditions:

1) Project activities include the construction of any type of road and/or parking lot (including parking lot patching projects) in the United States.

2) Project activities must apply one or more of the following processes for road construction:

a) FSB produced using the CCPR process

b) FSB produced using the CIR process

c) FSB produced using the FDR process

d) Asphalt emulsions produced using the CCPR process

e) Asphalt emulsions produced using the CIR process

f) Asphalt emulsions produced using the FDR process

3) Production plants where the project activity occurs may serve multiple pavement types, including, but not limited to, roadways and parking lots.

4) Project activities may have an HMA or WMA surface layer but must have at least one FSB or asphalt emulsions base layer.

Project instances will meet applicability conditions of VCS methodology VM0039. Project instances will include the construction, modification, and repair of road and/or parking lots in the United States. Project instances will use FSB and asphalt emulsions in CCPR, CIR, or FDR processes.

The first project instance includes the construction of a roadway, ND 8. The project instance replaces baseline scenario, base layers using HMA, with base layers produced and installed using asphalt emulsions using CIR.

3.3 Project Boundary

The extent of the project boundary encompasses the stages from raw material acquisition to product installation and complies with the cradle-to-gate assessment principle (Sinden, 2008). The GHG impact of producing an asphalt mixture is calculated by adding up the following emission sources: 1) GHG associated with manufacturing each of the constituent and ancillary materials; 2) GHG from transporting materials from factory to mix plant or project site; 3) GHG from all forms of energy involved in producing the asphalt at mixing plant; and 4) GHG from all forms of energy involved in milling the existing pavement and placing new pavement, including relevant transport activities.

Maintenance and excavation of the new pavement are not included due to the high variability of practices in each region. The boundary also excludes GHG emissions associated with the production of capital goods having lifetimes longer than one year and the transportation of employees to and from their normal place of work

There are three processes that the Grouped Projects can utilize: 1) Cold Central Plant Recycling (CCPR), 2) Cold in-place Recycling (CIR), 3) Full-Depth Reclamation (FDR). CIR and FDR have the same boundary.

Boundary for CIR or FDR system

CIR or FDR uses one or more mobile recycling machine for milling, production, and placement in a continuous operation at the pavement site. It reconstructs the roadways by using special equipment to mill up the existing pavement, mix it with hot bitumen oil (or asphalt emulsions) and additives, and then immediately place it back down on the road by permanent placement with a paver and rollers. CIR or FDR allows a paving contractor to re-use the aggregate from the existing road and, by adding liquid asphalt and cement on-site, it reduces the emissions of virgin aggregate materials, the transportation of materials to and from a central mix plant, and new liquid asphalt cement that must be shipped from the producer's plant site. The project boundary includes production of bitumen, water, and cement, operation of recycler and rollers, and transportation and storage of input materials.

Project instances must incorporate FSB and/or asphalt emulsions in place of traditional asphalt mixes while delivering or exceeding the baseline project structural strength design parameters. For example, the project boundary for the first project instance replaces the second layer in the pavement design with asphalt emulsions. Although other GHGs have been reduced in this first project instance, methodology VM0039 only calculates the reduction of CO2 emissions.

Table 3: GHG Sources Included in Baseline and Project Scenario

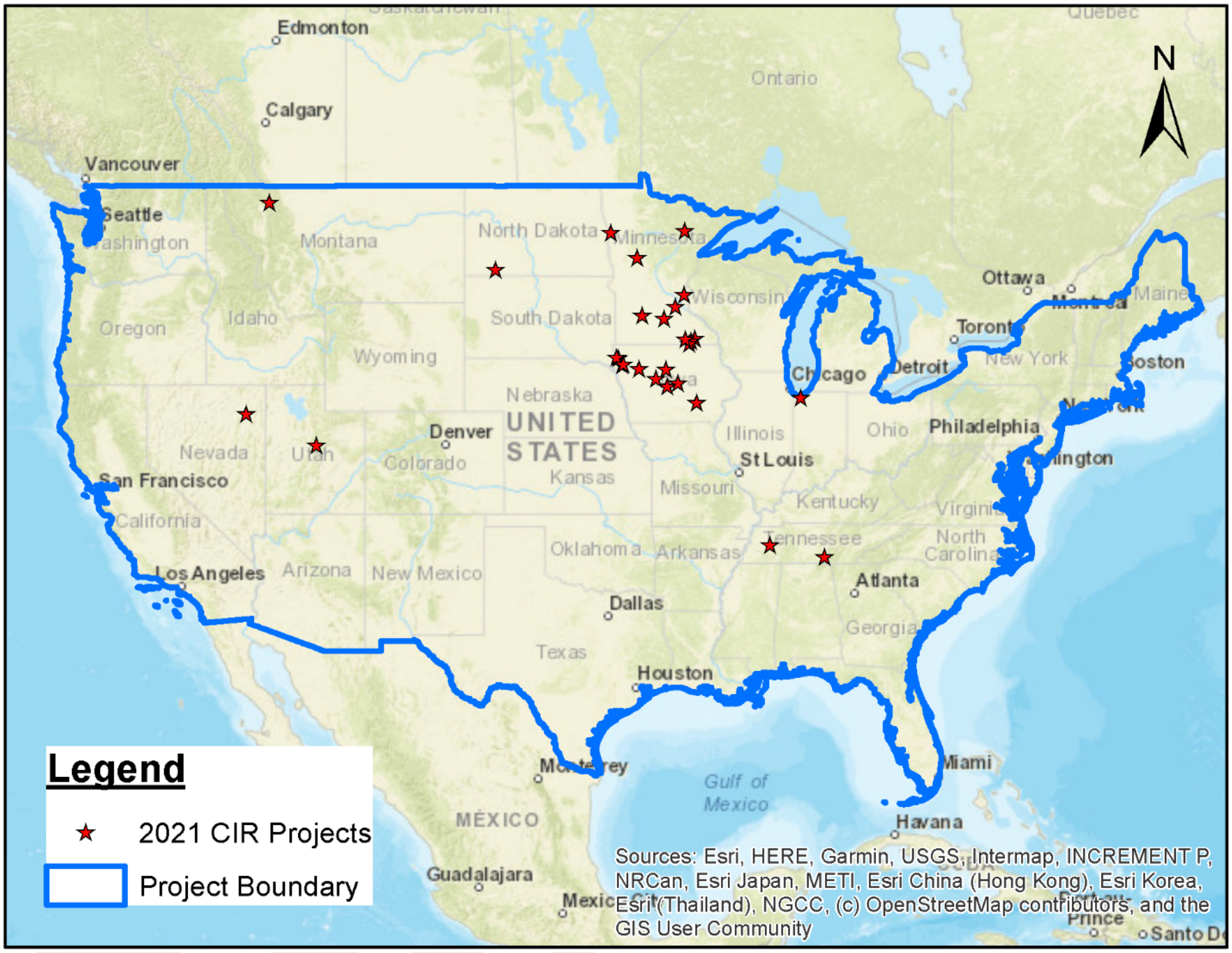
Source		Gas	Included?	Justification/Explanation
HMA (Baseline)	Raw material acquisition	CO_2	Yes	GHGs are released from energy consumption in material manufacture process.
HMA (Baseline)	Raw material acquisition	CH_4	No	Not Applicable
HMA (Baseline)	Raw material acquisition	N_2O	No	Not Applicable
HMA (Baseline)	Raw material transport	CO_2	Yes	GHGs are released from fuel consumption for transporting materials from producers to central plant.
HMA (Baseline)	Raw material transport	CH_4	No	Not Applicable
HMA (Baseline)	Raw material transport	N_2O	No	Not Applicable
HMA (Baseline)	In-plant production	CO_2	Yes	GHGs are generated from the usage of natural gas by the drum mixer, plant electricity (including electricity for plant office), and diesel equipment/vehicles operated for producing HMA at central plant.
HMA (Baseline)	In-plant production	CH_4	No	Not Applicable
HMA (Baseline)	In-plant production	N_2O	No	Not Applicable

Source		Gas	Included?	Justification/Explanation
	To site transport	CO_2	Yes	GHGs are released from fuel consumption for transporting materials from the central plant to construction site.
		CH_4	No	Not Applicable
		N_2O	No	
	Installation	CO_2	Yes	GHGs are released from diesel consumption by construction equipment/vehicles, including asphalt paving machine, backhoe, bobcat/loader, sweeper/broom, air compressor, roller, trucks, etc.
		CH_4	No	Not applicable
		N_2O	No	
	Maintenance	CO_2	No	GHGs from maintenance and rehabilitation are excluded due to uncertain traffic volume, failure type and repair options.
		CH_4	No	Not applicable
		N_2O	No	
	Excavation	CO_2	No	GHGs from excavation are excluded due to the uncertainty in determining pavement disposal options (e.g., landfill, recycling, remain in place).
		CH_4	No	Not applicable
		N_2O	No	
CIR (Project Instance)	Raw material acquisition	CO_2	Yes	GHGs are released from energy consumption in material manufacture process.
		CH_4	No	Not Applicable

Source		Gas	Included?	Justification/Explanation
		N_2O	No	
	Raw material transport	CO_2	Yes	GHGs are released from fuel consumption for transporting materials from producers to central plant.
		CH_4	No	Not Applicable
		N_2O	No	
	FSB/asphalt emulsions production & placement	CO_2	Yes	GHGs are released from fuel consumption by construction equipment/vehicles, including, but not limited to a cold recycler (e.g., Wirtgen 3800 CR), a cement spreader, a water truck, a bitumen truck, a vibratory roller and a pneumatic roller.
		CH_4	No	Not Applicable
		N_2O	No	
	Maintenance	CO2	No	GHGs from maintenance and rehabilitation are excluded due to uncertain traffic volume, failure type and repair options.
		CH4	No	Not applicable
		N2O	No	
	Excavation	CO_2	No	GHGs from excavation are excluded due to the uncertainty in determining pavement disposal options (e.g., landfill, recycling, remain in place).
		CH_4	No	Not applicable
		N_2O	No	

The geographic boundary for the grouped projects is the continental United States of America as shown in Figure 1. The first project instance, ND 8, took place in Hettinger, North Dakota.

Figure 1: Geographical Boundary and Project Instance Locations



3.4 Baseline Scenario

The baseline scenario for projects applying this methodology is the application of HMA, or the subcategory WMA, to surface and base layers of roads or parking lots during asphalt pavement construction. The emissions associated with the quarry, transportation, and production of HMA, or WMA serve as performance benchmarks.

CCPR, CIR, and FDR projects replace HMA or WMA base layers with FSB or asphalt emulsions. These processes typically outperform the performance benchmarks because they can reduce the emissions from producing bitumen and producing, transporting, and heating virgin aggregates.

3.5 Additionality

Project instance proponents follow two steps described in section 6 of VM0039 to determine additionality. First, proponents must demonstrate regulatory surplus in accordance with the rules and requirements described in the latest version of the VCS Standard. No rules or regulations mandating the use of FSB or asphalt emulsions to reduce CO2e emissions exist. Therefore, all CO_{2e} reductions are regulatory surplus.

Regulatory surplus is established in this project through the following aspects: No regulatory requirement in the United States exists that requires FSB or asphalt emulsion using CIR in highway construction. The design of the asphalt construction project using asphalt emulsion with the CIR process was based on a design-build selection process, where the contractor proposed innovative design and construction methods.

Second, a performance benchmark determines emissions for patching and roadway scenarios. This performance benchmark depends on whether a project is a parking lot or roadway, the distance materials need to be hauled, and the year a project has been completed. Project performance exceeds the benchmark metric for baseline HMA projects when FSB or asphalt emulsion pavement layers used in the project meet or exceed structural numbers of the baseline HMA design, and the harvesting, mixing, installation, and hauling of FSB materials emit less CO_2 than corresponding HMA layers.

3.6 Methodology Deviations

The Project Description does not include any deviations from methodology VM0039.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

As described in VM0039, baseline emissions have been predetermined by the performance benchmark for the crediting baseline, which have three strata of performance benchmarks based on project types and one-way distances between the HMA plant and job site. Stratum 1 is for patching projects with hauling distances less than 40 miles, while Stratum 2 is for patching projects with hauling distances greater than 40 miles. Stratum 3 is for roadway projects. The performance benchmark for the crediting baseline is adjusted annually based on the expected changes in the use of RAP for conventional HMA projects. Based on NAPA (2017), the use of RAP in HMA is expected to increase by 1.1% every year. This increase can reduce carbon emissions by 0.1kgCO2e/t (NAPA, 2012). Therefore, as shown in Table 4, the performance benchmark decreases by 0.1kgCO2e/t annually for all three strata of performance benchmarks.

Table 4: Crediting Baseline for Estimation of Emission Reductions from 2014 to 2025

Year	Patching Project (<40mile)	Patching Project (>40mile)	Roadway Project
2014	121.9	142.4	95.1
2015	121.8	142.3	95.0
2016	121.7	142.2	94.9
2017	121.5	142.1	94.8
2018	121.6	142.0	94.7
2019	121.4	141.9	94.6
2020	121.3	141.8	94.5
2021	121.2	141.7	94.4
2022	121.1	141.6	94.3
2023	121.0	141.5	94.2
2024	120.9	141.4	94.1
2025	120.8	141.3	94.0
Note: Unit: kgCO2e/t. 1kgCO2e per tonne of output = 0.001 tCO2e per tonne of output			

The Hettinger, ND project, as well as all the project instances in this grouped project, are roadway projects that were constructed in 2021. Therefore, 94.4 kgCO2e/t was used as the crediting baseline.

4.2 Project Emissions

Project emissions are calculated in one of two ways, depending on whether an FSB or asphalt emulsion mix was used in the CIR production process.

CIR emission intensity (CIR EI) represents the quantity of GHGs emitted from producing and installing one metric ton of FSB or asphalt emulsions using CIR. CIR EI is calculated using the following equation below:

$$CIR\ EI = EI_M + EI_{SD} + EI_I\ (Eq. 1)$$

Where:

CIR EI	=	Emission intensity of CIR ($kgCO_2e$/tonne)
EI_M	=	Emission intensity of raw material production (kgCO2e/tonne)
EI_{SD}	=	To-site delivery emission intensity (kgCO2e/tonne)
EI_I	=	On-site installation emission intensity (kgCO2e/tonne)

Four materials are used in the production and installation of FSB/asphalt emulsions using CIR: Recycled Asphalt Pavement (RAP), cement, bitumen, and water. To calculate the emission intensity of raw material production, each raw materials emission factor and weight are multiplied together and divided by the amount of FSB or asphalt emulsions manufactured (project amount).

Emission Intensity of raw material production (EI_M) is calculated using the following equation below:

$$EI_M = \frac{EF_M \times W_M}{Project\ Amount}\ (Eq.2)$$

Where:

EI_M	=	Emission intensity of raw material production (kgCO2e/tonne)
EF_M	=	Raw material emission factor (kgCO2e/tonne)
W_M	=	Raw material weight (kg)
Project amount	=	Amount of FSB/asphalt emulsions manufactured (tonnes)

For the initial project instance, Hettinger, ND project, EI_M is calculated for RAP, cement, bitumen, and water. During the CIR process, RAP is recycled on-site by milling the existing asphalt pavement which is reused it in the FSB/asphalt emulsion mixture. Therefore, the materials emission factor for RAP is zero. Similarly, water is not a manufactured material and therefore, has a materials emission factor of zero.

$$EI_M\ (RAP) = \frac{0.00\ \frac{kgCO2e}{kg} \times 50{,}027{,}972\ kg}{53{,}382.52\ tonnes} = 0.00\ k\,\frac{kg\ CO2e}{tonne}$$

$$EI_M\ (cement) = \frac{0.83\ \frac{kgCO2e}{kg} \times 273{,}253\ kg}{53{,}382.52\ tonnes} = 4.25\ \frac{kg\ CO2e}{tonne}$$

$$EI_M\ (bitumen) = \frac{0.48\ \frac{kgCO2e}{kg} \times 1{,}568{,}106\ kg}{53{,}382.52\ tonnes} = 14.10\ \frac{kg\ CO2e}{tonne}$$

$$EI_M\ (water) = \frac{0.00\ \frac{kgCO2e}{kg} \times 1{,}513{,}185\ kg}{53{,}382.52\ tonnes} = 0.00\ \frac{kg\ CO2e}{tonne}$$

$$\boldsymbol{Total\ EI_M = 0.00 + 4.25 + 14.10 + 0.00 = \ 18.35\ \frac{kg\ CO2e}{tonne}}$$

To calculate the emission intensity of raw material to-site delivery, the number of trips to the site, the number of trips from production plant to job site, discount factor, and truck emission factor are multiplied together and divided by the amount of the FSB or asphalt emulsions manufactured for the project. When hauling distance is not directly monitored, the distance is estimated using a map distance calculator. For conservativeness, a discount factor (DF) of 0.1 is applied when a map distance calculator is used to estimate hauling distance.

Emission Intensity of to-site delivery (EI_{SD}) is calculated using the following equation below:

$$EI_{SD} = \frac{Trips_S \times Distance_S\ \times\ (1 + DF)\ \times\ EF_T}{Project\ Amount}\quad (Eq. 3)$$

Where:

$Trips_S$	=	Number of trips from production plant to job site
$Distances_S$	=	Distance to site (miles)
DF	=	Discount factor
EF_T	=	Truck emission factor (kgCO2e/mile)
Project amount	=	Amount of FSB/asphalt emulsions manufactured (tonnes)

For the first project instance, the Hettinger, ND project, there were three materials delivered to the site: cement, bitumen, and water. RAP, also used in the CIR process however it is recycled on-site through milling of existing pavement, resulting in to-site delivery emission intensity of zero.

$$EI_{SD}(RAP) = \frac{0\ trips\ \times\ 0\frac{miles}{trip}\ \times\ (1 + 0.1)\ \times\ 10.2\frac{kgCO2e}{mile}}{53{,}382.52\ tonnes} = 0.00\ \frac{kgCO2e}{tonne}$$

$$EI_{SD}(cement) = \frac{12\ trips\ \times\ 126\frac{miles}{trip}\ \times\ (1 + 0.1)\ \times\ 10.2\frac{kgCO2e}{mile}}{53{,}382.52\ tonnes} = 0.32\ \frac{kgCO2e}{tonne}$$

$$EI_{SD}(bitumen) = \frac{55\ trips\ \times\ 316\frac{miles}{trip}\ \times\ (1 + 0.1)\ \times\ 10.2\frac{kgCO2e}{mile}}{53{,}382.52\ tonnes} = 3.65\ \frac{kgCO2e}{tonne}$$

$$EI_{SD}(water) = \frac{80\ trips\ \times\ 7.5\frac{miles}{trip}\ \times\ (1 + 0.1)\ \times\ 10.2\frac{kgCO2e}{mile}}{53{,}382.52\ tonnes} = 0.13\ \frac{kgCO2e}{tonne}$$

$$\boldsymbol{Total\ EI_{SD} = 0.00 + 0.32 + 3.65 + 0.13 \ = 4.10\ \frac{kgCO2e}{tonne}}$$

On-site installation emissions intensity (EI_I) is derived from diesel consumption from the equipment used for the installation project. For CIR installation, this equipment typically includes a cold recycler (e.g., Wirtgen 3800 CR), cement spreader, water truck, bitumen truck, vibratory roller, pneumatic roller, skid steer, etc. A list of common emission factors used for FSB and asphalt emulsion CIR projects are provided in Appendix B of VM0039 as well as those used in this project as presented in Section 5.1.

Emission Intensity of on-site installation equipment (EI_I) is calculated using the following equation below:

$$EI_I = \frac{EF_{EQ} * HR_{EQ}}{Project\ Amount}\ (Eq.4)$$

Where:

EI_I	=	Emission intensity of pavement installation (kgCO2e/tonne)
EF_{EQ}	=	Equipment emission factor (kgCO2e/tonne)
HR_{EQ}	=	Equipment operation hours (hour)
Project amount	=	Amount of asphalt emulsions manufactured (tonne)

Where equipment operation hours are not available, labor hours (HR_{LA}) can be used to approximate equipment operation hours according to the below equation. Labor hours must be documented in the project daily log for verification. Conversion factors (CF) for commonly used equipment are listed in Section 5.1.

$$HR_{EQ} = HR_{LA} \times CF\ (Eq.5)$$

Where:

HR_{EQ}	=	Equipment operation hours (hour)
HR_{LA}	=	Labor hours (hour)
CF	=	Conversion factor

For the first project instance, the Hettinger, ND project, there were a total of nine pieces of construction equipment used during the CIR installation process. First, the labor hours reported in the daily timesheet logs were summed together for each piece of construction equipment over the entire project duration. Then, using Eq. 5, the labor hours were multiplied by the conversion factor to calculate the equipment operation hours. Finally, to calculate the emission intensity of pavement installation, the equipment emission factor and the corresponding equipment operating hours were multiplied by together and divided by the amount of the FSB or asphalt emulsions manufactured for the project. The total amount of asphalt emulsions manufactured for the Hettinger, ND project was 53,383.52 tonnes and serves as the project amount data input. Table 4 summarizes the equipment used during the on-site installation and their data inputs for HR_{LA}, CF, HR_{EQ}, EF_{EQ}, and EI_I for the Hettinger, ND project. Each of the individual installation equipment emission intensities were then summed together to obtain the total installation equipment emission intensity for the Hettinger, ND project instance of 4.35 kgCO2e/tonne.

$$\boldsymbol{Total\ EI_I = 1.76 + 0.26 + 0.20 + 0.08 + 0.12 + 0.12 + 0.12 + 0.84 + 0.84 = 4.35\ \frac{kgCO2e}{tonne}}$$

Table 5: Emission Intensity of Installation Equipment Summary

Equipment	Labor Hours, HR_{LA}	Conversion Factor, CF (Hours)	Equipment Operating Hours, HR_{EQ} (Eq. 5)	Equipment Emission Factor, EF_{EQ}	On-site installation Emission Intensity, EI_I (Eq. 4)
	(Hours)	(Hours)	(Hours)	(Kg CO_2e/Hr)	(Kg CO_2e/Hr)
Cold recycler, Wirtgen 12'	158	0.66	104	901.4	1.76
Milling machine, Others	158	0.66	104	132.3	0.26
Paver, Wheeler Machinery	158	0.50	79	134.7	0.20
Skid Steer Loaders, John Deere	158	0.33	52.1	77.6	0.08
Rollers, Dynapac	158	0.59	93.2	70.1	0.12
Rollers, Dynapac	158	0.59	93.2	70.1	0.12
Rollers, Dynapac	158	0.59	93.2	70.1	0.12
Water Trucks, Freightliner	158	1.00	158	284.6	0.84
Water Trucks, Freightliner	158	1.00	158	284.6	0.84

Using Eq. 1, the overall CIR emission intensity for the first project instance, Hettinger, ND, is the sum of the raw material emission intensity, the to-site delivery emission intensity, and the installation equipment emission intensity, which comes out to 26.79 kgCO2e/tonne.

$$\boldsymbol{CIR\ EI = 18.35 + 4.10 + 4.35 = 26.79\frac{kgCO2e}{tonne}}$$

All other 2021 project instance variables are summarized in Table A.1 of Appendix A. As future project instances are incorporated into this group project description, additional appendices will be added to defined and document all required variables.

4.3 Leakage

Leakage is not considered an issue under VM0039 methodology and is therefore set at zero. It is reasonable to assume zero leakage because there is no difference in site preparation activities between baseline and project scenarios. Replacing HMA with FSB or asphalt emulsions for the pavement base layer does not entail a change in carbon efflux or carbon sink at the construction site.

4.4 Estimated Net GHG Emission Reductions and Removals

Net GHG emission reductions for FSB and asphalt emulsions are the emission intensity differences adjusted by the weight differences. A correction factor (θ) of 1.02 for FSB and 1.17 for asphalt emulsions is applied for all project instances.

Net GHG emission reductions for a single FSB project using CIR must be calculated as follows:

$$ER_{FSB-CIR} = \left(\frac{CB}{\Theta_{FSB}} - CIR\ EI\right) * \frac{Project\ Amount}{1{,}000}\ Eq.6$$

Where:

$ER_{FSB-CIR}$	=	Net emission reductions of FSB using CIR (tCO2e)
CB	=	Crediting baseline (kgCO2e/t)
Θ_{FSB}	=	Correction factor for FSB (default value is 1.02)
CIR EI	=	Emission intensity of CIR project (kgCO2e/t)
Project amount	=	Amount of FSB manufactured (t)

Net GHG emission reductions for a single asphalt emulsion project must be calculated as follows:

$$ER_{AE-CIR} = \left(\frac{CB}{\Theta_{AE}} - CIR\ EI\right) * \frac{Project\ Amount}{1{,}000}\ Eq.7$$

Where:

$ER_{AE\text{-}CIR}$ (tCO2e)	=	Net emission reductions of asphalt emulsions using CIR
CB	=	Crediting baseline (kgCO2e/tonne)
θ_{AE}	=	Correction factor for asphalt emulsion (default value is 1.17)
CIR EI	=	Emission intensity of CIR project (kgCO2e/tonne)
Project amount	=	Amount of asphalt emulsions manufactured (tonne)

The first project instance, Hettinger, ND, utilized asphalt emulsions installed through CIR which uses a default Correction Factor, θ_{AE}=1.17. This project, as well as all 2021 project instances, were completed in the year 2021 which corresponds to a Crediting Baseline value of 94.4 per Section 5.1. Applying these values and those summarized in the preceding sections to Eq. 7, results in a net emission reduction of 2,876.89 tonnes of CO2 for the first project instance.

$$ER_{AE-CIR} = \left(\frac{94.4}{1.17} - 26.79\right) * \frac{53,382.52}{1,000} = 2,876.89 \ tonnes\ of\ CO2\ (net\ reduction)$$

The same procedure outlined in Section 5.1 and 5.2 were applied to all 2021 project instances which resulted in an overall 29,225.10 tonnes of CO2 net reduction for the first monitoring year. Table 5 below provides ex-ante estimate of net GHG emission reductions from the potential expansion of the project activity including the first project instance.

Table 6: Ex-ante Estimate of Overall Project Activity Emissions

Year	Estimated baseline emissions (tCO_2e)	Estimated project emissions (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2021	38,844	9,618	0	**29,225**
2022	40,750	9,750	0	**31,000**
2023	42,750	10,250	0	**32,500**
2024	44,750	10,750	0	**34,000**
2025	47,000	11,250	0	**35,750**
2026	49,250	11,750	0	**37,500**

2027	51,750	12,250	0	39,500
2028	54,250	13,000	0	41,250
2029	57,000	13,500	0	43,500
2030	59,750	14,250	0	45,500
Total	486,094	116,368	0	369,725

5 MONITORING

5.1 Data and Parameters Available at Validation for CIR

Data / Parameter	CB
Data unit	kgCO2e/tonne of CIR installed
Description	Crediting Baseline
Source of data	Table 4 of VM0039 Methodology for Use of Foam Stabilized Base and Emulsion Asphalt Mixtures in Pavement Application
Value applied:	Year 2021: 94.4 Year 2022: 94.3 Year 2023: 94.2 Year 2024: 94.1 Year 2025: 94.0
Justification of choice of data or description of measurement methods and procedures applied	Baseline emissions have been predetermined by the performance benchmark for the crediting baseline as detailed in the VM0039 Methodology for Use of Foam Stabilized Base and Emulsion Asphalt Mixtures in Pavement Application.
Purpose of Data	Calculation of net GHG emission reductions
Comments	Data to be updated when the diesel emissions factor is updated

Data / Parameter	EF_T
Data unit	kgCO2e/mile
Description	Truck's emission per mile travelled
Source of data	The Climate Registry (TCR 2015)
Value applied:	10.2
Justification of choice of data or description of measurement methods and procedures applied	Emission factors from The Climate Registry are compiled from publicly available data sources and updated each year to ensure that project proponents have the most accurate and up-to-date greenhouse gas data.
Purpose of Data	Calculation of CIR to-site delivery emissions
Comments	Data to be updated when the diesel emissions factor is updated

Data / Parameter	EF_M
Data unit	kgCO2e/kg
Description	Material emission factor
Source of data	Carnegie Mellon University Green Design Institute (CMUGDI 2008)
Value applied:	RAP: 0 Cement: 0.83 Bitumen: 0.48 Water: 0
Justification of choice of data or description of measurement methods and procedures applied	CMUGDI (2008) is comprised of national economic input-output models and publicly available resources use and emission data, which has been accessed over 1 million times by researchers or business users.

Purpose of Data	Calculation of raw material production emissions
Comments	Data to be updated when the material emissions factor is updated

Data / Parameter	EF_{EQ}
Data unit	kgCO2e/hr
Description	Equipment emission per hour
Source of data	EPA (2012). "Engine Certification Data for Heavy Truck, Buses, and Engines."<http://www.epa.gov/oms/certdata.htm#largeng>.
Value applied:	Cold Recycler, Wirtgen 12': 901.4 Milling machine, Others: 132.3 Paver, Wheeler Machinery: 134.7 Skid Steer Loaders, John Deere: 77.6 Rollers, Dynapac: 70.1 Water Truck, Freightliner: 284.6
Justification of choice of data or description of measurement methods and procedures applied	The engine emission information is from the EPA off-road engine certification database and stratified by equipment type, engine make, and horsepower rating. The database created for equipment emission estimation is presented in Appendix B of VM0039 Methodology.
Purpose of Data	Calculation of installation equipment emissions
Comments	Data was collected one time and must be updated when more strict emissions standards are implemented nationwide

Data / Parameter	CF
Data unit	Between 0 and 1
Description	Conversion factor: the percentage of equipment operating time in the total labor time

Source of data	Liu et al. (2016)
Value applied:	Milling machine: 0.66 Backhoe: 0.33 Loader: 0.33 Sweeper: 0.55 Paver: 0.50 Roller: 0.59 Truck: 1
Justification of choice of data or description of measurement methods and procedures applied	Three projects were observed on-site to count the effective operation time of each piece of equipment. The percentage utilization (PU) was calculated using the effective operation time divided by the total labor hours. The average PU values are 0.55 for the asphalt-milling machine; 0.10 for the backhoe; 0.10 for the bobcat/loader; 0.4 for the sweeper/broom; 0.10 for the excavator; 0.33 for the paver and 0.45 for the roller. Different PUs will produce different amounts of GHG emissions. According to a study by Lewis et al. (2009), the emission rate of idling equipment is about one quarter of the emission rate of the operating equipment. This difference is simplified and incorporated into the emission calculation as an average conversion factor (CF), which equals PU+0.25(1-PU).
Purpose of Data	Calculation of installation equipment emissions
Comments	N/A

Data / Parameter	DF
Data unit	Between 0 and 1
Description	For conservativeness, a discount factor (DF) must be applied when a map distance calculator is used to estimate hauling distance. DF is equal to 0 if using actual logged miles.
Source of data	On-site observations
Value applied:	0.1

Justification of choice of data or description of measurement methods and procedures applied	Ten projects were observed on site to count the distance between map and equipment odometer. Hauling distance = Map distance × (1+DF)
Purpose of Data	Calculation of to-site delivery emissions
Comments	N/A

5.2 Data and Parameters Monitored for CIR

Data / Parameter	W_M
Data unit	Kg
Description	The weight of each raw material used to produce FSB or asphalt emulsions.
Source of data	Bill of lading receipts from material suppliers
Description of measurement methods and procedures applied	The bill of lading receipts were supplied by the shipment carriers to the on-site project staff accepting the raw materials. The bill of lading reports the net tonnage of raw material delivered by each shipping truck. All net tonnage is then summed together to provide the total amount of raw material used for each project instance.
Frequency of monitoring/recording	Once per project instance
Value applied:	RAP: 50,027,973 Kg Cement: 273,253 Kg Bitumen: 1,568,106 Kg Water: 1,513,185 Kg See Table A.1 in Appendix A for all other 2021 project instance variables
Monitoring equipment	Truck scales
QA/QC procedures applied	Ensuring that the project instance raw material tonnage reported by Midstate is cross-checked with the supporting documentation of bill of lading receipts.

Purpose of data	Calculation of CIR material emissions
Calculation method	Performing a summation of all individual raw material weights reported in the bill of lading for each project instance
Comments	N/A

Data / Parameter	Project amount
Data unit	tonnes
Description	Output quantity of FSB and asphalt emulsions
Source of data	Individual project instance engineering plans for project installation areas and mix design or installation density testing reports for CIR mix densities
Description of measurement methods and procedures to be applied	State Departments of Transportation (DOTs) require all project instances to include detailed engineering plans to define the project limits and the scope of work performed for each project instance. In addition, density testing is a standard requirement to ensure that project specifications are being met and that the roads are safe to handle vehicular traffic without posing a risk to public safety and meet the intended design life.
Frequency of monitoring/recording	Once per project instance
Value applied	53,383.52 tonnes See Table A.1 in Appendix A for all other 2021 project instance variables
Monitoring equipment	N/A
QA/QC procedures to be applied	Reviewing material weight calculations for arithmetic or unit conversion errors
Purpose of data	Calculation of CIR emissions
Calculation method	The project instance engineering plans and density testing reports were provided by Midstate. Those engineering plans were used to calculate total volume of CIR mix installed (Project Amount) based on project area and CIR layer thickness. The total volume of CIR mix installed was then multiplied by the density of the CIR mix, per density testing reports, resulting in the total weight of CIR mix installed.

Comments	N/A

Data / Parameter	HR_{EQ}
Data unit	Hours
Description	The total operating hours of on-site installation equipment
Source of data	Equipment operating hours are approximated by labor hours reported on equipment operator timesheets and conversion factors defined in the VM0039 Methodology
Description of measurement methods and procedures to be applied	Where equipment operation hours are not available, labor hours can be used to approximate equipment operation hours. Labor hours are documented in the project daily log for verification.
Frequency of monitoring/recording	Once per project instance
Value applied	Cold recycler, Wirtgen 12': 104 hours Milling machine, Others: 132.3 hours Paver, Wheeler Machinery: 134.7 hours Skid Steer Loaders, John Deere: 77.6 hours Rollers, Dynapac: 70.1 hours Rollers, Dynapac: 70.1 hours Rollers, Dynapac: 70.1 hours Water Trucks, Freightliner: 284.6 hours Water Trucks, Freightliner: 284.6 hours See Table A.1 in Appendix A for all other 2021 project instance variables
Monitoring equipment	N/A
QA/QC procedures to be applied	Cross-checking reported values versus operator timesheet documents
Purpose of data	Calculation of CIR installation equipment emissions
Calculation method	Summing the labor hours reported for each piece of installation equipment and multiplying by the conversion factors (CF) defined in Section 5.1.1
Comments	N/A

Data / Parameter	Distance

Data unit	Miles
Description	The total miles that trucks travelled to supply raw materials to the job site
Source of data	To-site delivery mileage is obtained by mapping out the driving distance between each raw material supplier and the project instance site
Description of measurement methods and procedures to be applied	To-site delivery mileage is obtained from online mapping software by determining the driving distance between each of the raw material suppliers and the project instance location
Frequency of monitoring/recording	Once per project instance
Value applied	RAP: 0 miles (recycled on-site) Cement: 126 miles Bitumen: 316 miles Water: 7.5 miles See Table A.1 in Appendix A for all other 2021 project instance variables
Monitoring equipment	Distance that trucks travelled to supply raw materials to the job site measured using online mapping software
QA/QC procedures to be applied	Confirming the reported distance matches actual mapping distance between each raw material supplier's address and the project instance site
Purpose of data	Calculation of CIR to-site delivery emission
Calculation method	Using online mapping service to determine driving distance between each raw material supplier's address and the project instance site
Comments	N/A

Data / Parameter	DE
Data unit	lb./cu. ft
Description	Density of FSB or asphalt emulsion CIR mix
Source of data	Density testing reports generated by independent third-party laboratories

Description of measurement methods and procedures to be applied	State Departments of Transportation (DOTs) require all project instances to include density testing to ensure that project specifications are being met and that the roads are safe to handle vehicular traffic without posing a risk to public safety.
Frequency of monitoring/recording	Once per project instance
Value applied	129.3 lb./cu. ft See Table A.1 in Appendix A for all other 2021 project instance variables
Monitoring equipment	N/A
QA/QC procedures to be applied	Cross-checking of reported data versus theoretical density to confirm quality measurement.
Purpose of data	Calculation of CIR emission reduction
Calculation method	N/A
Comments	N/A

Data / Parameter	LC
Data unit	Unitless
Description	Layer coefficient of FSB or asphalt emulsions
Source of data	The standard layer coefficients for FSB and asphalt emulsions were used per Footnote 6 of the VM0039 Methodology
Description of measurement methods and procedures to be applied	The composition and structural properties of central plant recycled cold mix and cold in-place recycled paving materials are virtually the same; the range of structural layer coefficients recommended for recycled cold mixes (0.25 to 0.35) is also applicable for cold in-place recycled mixes. On average, various Departments of Transportation are considering a structural layer coefficient of 0.32 for FSB and of 0.30 for asphalt emulsion mixes (Schwartz and Khosravifar, 2013).
Frequency of monitoring/recording	Once per project instance
Value applied	FSB: 0.32 Asphalt Emulsion: 0.30

Monitoring equipment	N/A
QA/QC procedures to be applied	Cross-checking of reported data versus DOT commonly used coefficients to confirm quality measurement.
Purpose of data	Calculation of CIR emissions and emissions reduction
Calculation method	N/A
Comments	N/A

5.3 Monitoring Plan

The monitoring plan involves detailing the procedures for collecting and reporting all data and parameters listed in Section 5.2. Monitored data and parameters will depend on the baseline, the materials used (FSB or asphalt emulsions), and the process used (CCPR, CIR, or FDR) for the calculations. The project proponents monitoring plan consists of the collection of project data relating to travel distances, energy and equipment usage, quantity of asphalt materials produced; asphalt material composition; and equipment type and usage. The project proponent provides a spreadsheet that is filled out by the asphalt contractors and access to a web based protected folder for uploading all project documentation. The project proponent reviews data for typical errors, including inconsistent physical units, unit conversion errors, transcription errors, and missing data for specific time periods or physical units.

All data collected as a part of monitoring process must be archived electronically and be kept at least for two years after the end of the last project crediting period. All direct measurements must be conducted with calibrated measurement equipment according to relevant industry standards. Where direct measurements are not applied, project proponents must demonstrate that the values used for the project are reasonably conservative, considering the uncertainty associated with these values. Project data requested for quantifying and reporting GHG emissions are typical of the data that asphalt contractors are required to monitor, collect, and have on hand as part of any asphalt installation project. Therefore, specialized measurements or data procedures are not anticipated.

For the first project instance, project data collection was achieved by obtaining project documents from the asphalt contractor in electronic format. The data required for the calculation of net carbon emissions reductions were collected by the asphalt contractor in electronic form through the asphalt contractor's internal software system or as electronic copies of design documentation (engineering plans, asphalt mix design tickets, material bill of lading receipts, and equipment operator timesheets). The asphalt contractor personnel are responsible for collecting data monitored at the asphalt production facility and at the construction site.

The asphalt mix composition undergoes testing before and during its production and before, during, and after it is installed.

All project data inputs were reviewed by the project proponent, and as stated previously, in cases where data was unknown, conservative estimates were applied. Project data values were input into the project proponent's proprietary excel spreadsheets which performs the GHG quantification equations presented in the methodology. The project proponent is currently developing a proprietary PaveNext application that will automate the emission reduction calculations and provide summarized outputs similar to the spreadsheets presented in Appendix A for future project instances.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Complete the table below for all data and parameters monitored during the monitoring period (copy the table as necessary for each data/parameter). The values provided are used to quantify actual GHG emissions and removals achieved for the monitoring period. Data and parameters determined or available at validation which remain fixed throughout the project crediting period are included in Section 5.1 (Data and Parameters Available at Validation) above.

Data / Parameter	
Data unit	*Indicate the unit of measure*
Description	*Provide a brief description of the data/parameter*
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

6.2 Baseline Emissions

Quantify the baseline emissions and/or removals for this monitoring period, providing sufficient information to allow the reader to reproduce the calculation. Attach electronic spreadsheets as an appendix or separate file to facilitate the verification of the results.

6.3 Project Emissions

Quantify project emissions and/or removals for this monitoring period, providing sufficient information to allow the reader to reproduce the calculation. Attach electronic spreadsheets as an appendix or separate file to facilitate the verification of the results.

6.4 Leakage

Quantify leakage emissions for this monitoring period, providing sufficient information to allow the reader to reproduce the calculation. Attach electronic spreadsheets as an appendix or separate file to facilitate the verification of the results.

6.5 Net GHG Emission Reductions and Removals

Quantify the net GHG emission reductions and removals achieved for this monitoring period, summarizing the key results using the table below. Specify breakdown of GHG emission reductions and removals by vintages where the intent is to issue each vintage separately in the VCS registry system.

For non-AFOLU projects, use the following table:

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
Year A				
Year…				
Total				

For AFOLU projects, include quantification of the net change in carbon stocks. Also, state the non-permanence risk rating (as determined in the AFOLU non-permanence risk report) and calculate the total number of buffer credits that need to be deposited into the AFOLU pooled buffer account. Attach the non-permanence risk report as either an appendix or a separate document.

For AFOLU projects, use the following table:

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)	Buffer pool allocation	VCUs eligible for Issuance

Year A						
Year…						
Total						

APPENDIX A: 2021 PROJECT INSTANCE SUPPORTING DOCUMENTATION